SAARC ENERGY OUTLOOK 2030

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Foreword

Energy security is an important consideration for peace and prosperity of the region. The economic and population growth along with urbanization and industrialization in all the SAARC Member States has led to continued expansion in demand for energy. As a result, the energy sector in the SAARC countries has grown rapidly in recent years. Realizing the need for energy, policy makers are putting lots of efforts to remove obstacles to investment in energy supply. The demand forecast and identification of potential energy sources in long time horizon are very important for securing and maintaining the energy security in the region. Therefore, the development of Energy Outlook of individual member countries and consolidation at the whole South Asia level will help in combating the energy security challenges prevailing in the region.

Mohammad Naeem Malik
Director
SAARC Energy Centre

The SAARC Energy Outlook 2030 not only presents energy demand forecasts for all the eight SAARC Member States till the year 2030, but it also aims to provide policy makers with an understanding of the energy trends and challenges being faced by the region up to the year 2030. It aims to give deep and cohesive insight into the trends in energy supply and consumption both at regional and national level, while also providing recommendations to improve regional energy cooperation. This report reflects the relevance of SAARC Energy Centre's effort to fulfil its function as a regional centre of excellence that builds a coherent, coordinated, focused and robust energy policy agenda and strategy for the SAARC region.

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Executive Summary

The SAARC member states (SMSs), comprising India, Pakistan, Bangladesh, Sri Lanka, Afghanistan, Nepal, Bhutan and Maldives, have contrasting economic profiles, energy consumption patterns and energy portfolios. While India is one of the fastest growing nations in the world (~7% GDP growth during fiscals 2013-2018), Afghanistan continues to be among the poorest nations.

In 2017, with a cumulative nominal GDP of ~$3.31 trillion, the eight nations that form the South Asian Association of Regional Cooperation (SAARC) accounted for only 4% of the world's aggregate GDP of $79.86 trillion (IMF estimates). Ironically, more than 1.5 billion people – i.e. ~24% of the world's population – reside in these countries. Although most of the SMSs have been growing faster than the world average, their per capita income has not been significant. Widespread poverty and lack of access to affordable energy continue to restrict their growth.

The medium-term forecasts point towards the SMSs' growth firming up, putting an upward pressure on budgets of the countries and widening account deficits, since all of them are import-dependent for their energy requirements.

The energy outlook for the region has been prepared by deeply diving into each nation's energy profile, determining the underlying demand drivers and corresponding supplies (domestic production as well as imports).

I. Regional Energy Profile

The SMSs' primary energy consumption varies significantly, both in terms of volume and mix. Each country has varied usage, depending on energy availability, access, underlying geopolitical scenario, commercial and economic viability, technologies available for energy exploration and degree of energy sector trade.

i. Afghanistan

Afghanistan is one of the least developed nations in the world, hindered by years of armed conflict and war. With a per capita income of $1,824, the country is one of the poorest with a vast majority of the population living in dire poverty. However, with increasing political stability and a plethora of international aid flowing in to revive the war-ravaged nation, economic growth is expected to rebound.

With only 35% of the country electrified and 90% of the rural households un-electrified, the energy sector is yet to evolve in the country. This also leads to widespread use of biomass in the rural areas. Fuel wood, charcoal and agricultural and animal waste still dominate energy sources and are used for cooking and heating. A large percentage of the population still use kerosene, candles and biogas for lighting. Biomass forms ~10% of the total primary energy consumption in the country (as of fiscal 2018).

Going forward, increased electrification, rise in per capita income and growth in vehicular population will improve primary energy consumption. Biomass will continue to be a strong component in the energy mix. Overall, primary energy consumption is seen at 9.3 million ton of oil equivalent (MTOE) in fiscal 2030, growing at a strong CAGR of 7% from 4.3 MTOE in fiscal 2018.

Figure 1: Afghanistan's Primary Energy Consumption and Energy Mix: Review and Outlook

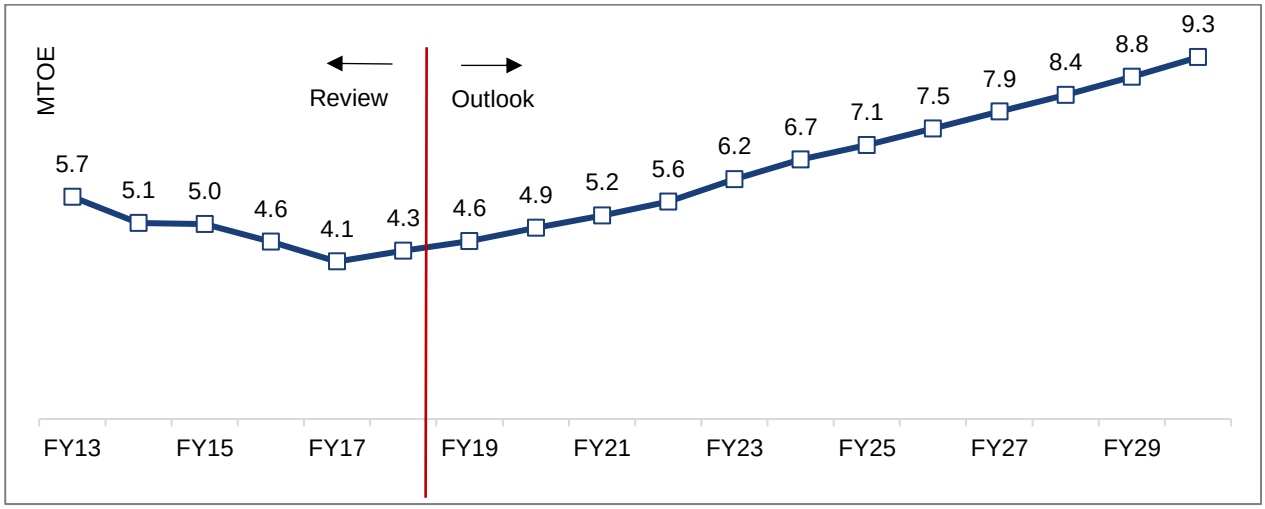
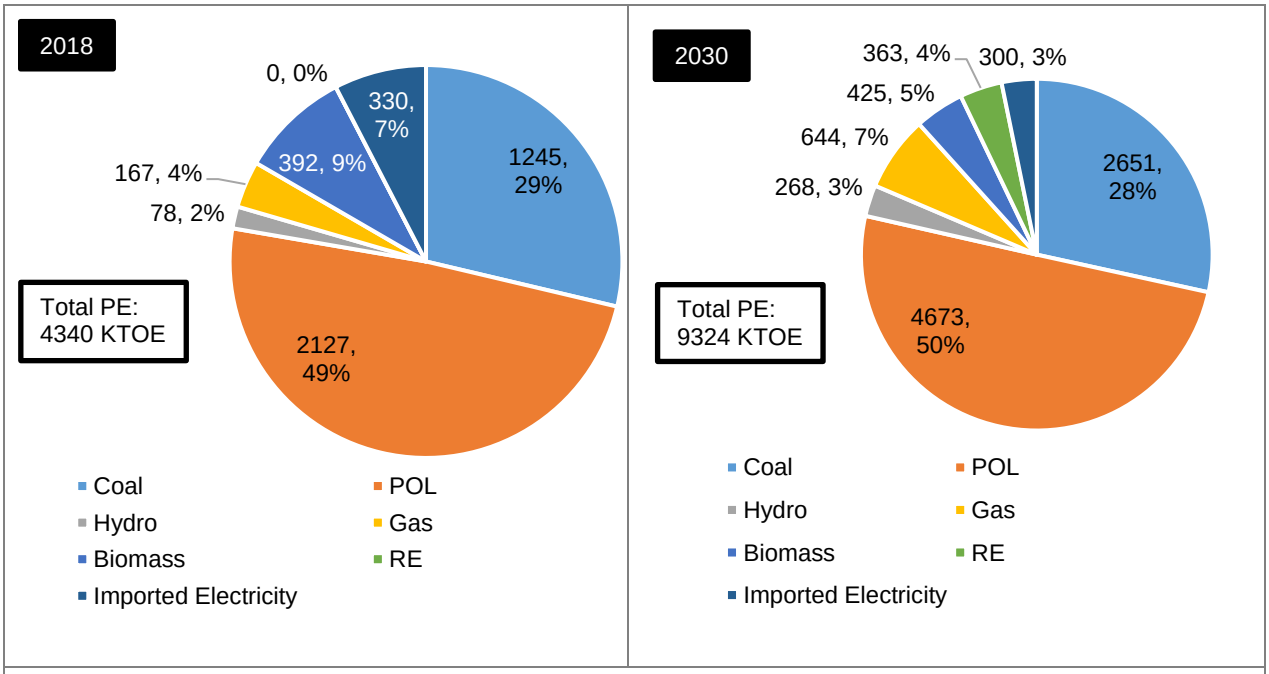


Figure 2: Afghanistan's Energy Mix: Review and Outlook



- **Hydro** to remain the major contributor in power generation; its contribution expected to rise 3.4 times by fiscal 2030
- Electrification expected to reach ~52% by fiscal 2030 from 35% now, thereby improving primary energy usage
- **Gas** usage to rise as ~650 MW gas-based power plants are expected to be set up
- **Coal** usage to increase as additional 2,000-3,000 tonne per day (TPD) of cement capacities come on stream
- End-use LPG demand and transport sector growth to result in strong **POL** growth of ~7.2% CAGR
- Consumption of **biomass,** which is used extensively by households, for heating and cooking will continue to rise due to strong rural usage as power supply is intermittent

ii. Bangladesh

The country has been growing strongly with GDP rising 6.0-7.2% from fiscal 2013 onwards, led by rapid urbanisation and improvement in energy access. Gas accounts for about two-thirds of its primary energy consumption at present. However, with domestic production of gas depleting, consumption of coal and imported LNG is expected to increase. Accelerated electrification and steady growth in end-use industrial and transport segments are further expected to push up the country's primary energy usage. This would, however, increase the imports manifold, especially of power, petroleum, oil and lubricants (POL) and gas. Overall, primary energy consumption is expected to rise to 85.3 MTOE in fiscal 2030 from 37.6 MTOE in fiscal 2018 at a strong CAGR of 7%.

Figure 3: Bangladesh's Primary Energy Consumption: Review and Outlook

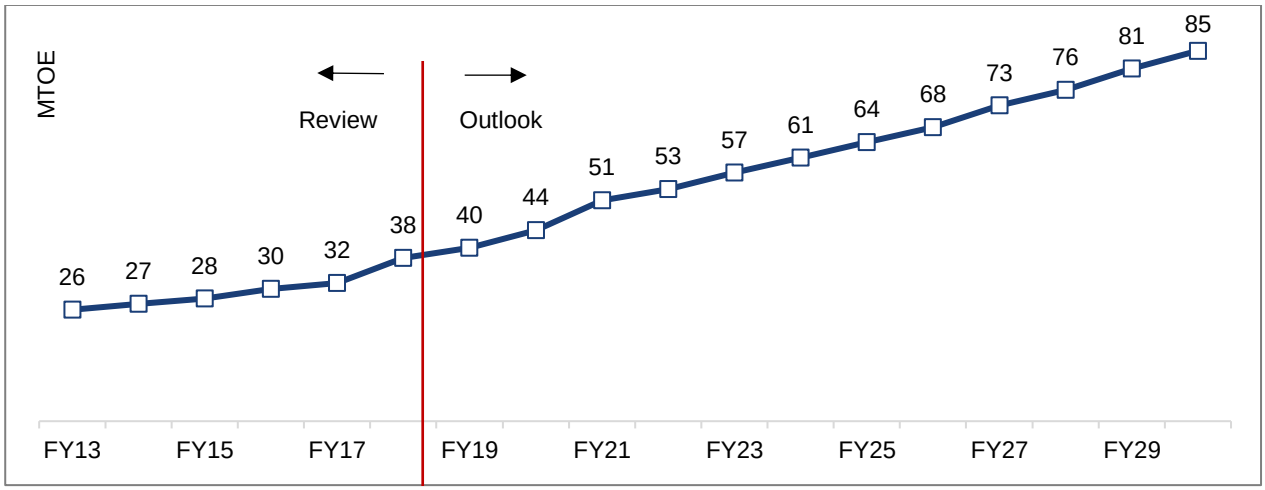
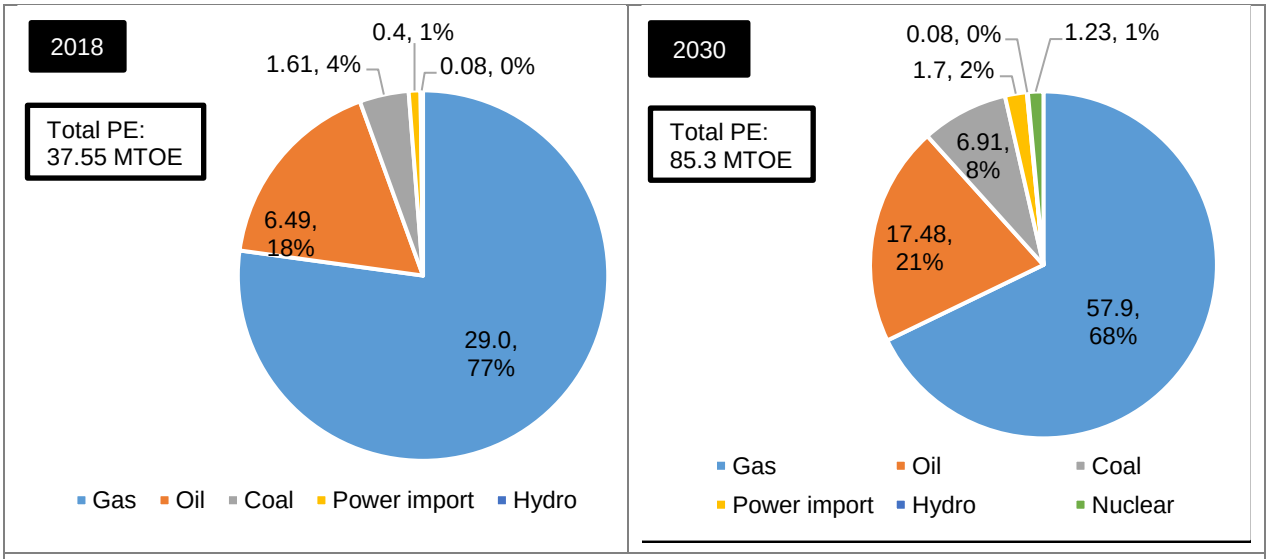


Figure 4: Bangladesh's Energy Mix: Review and Outlook



- **Gas**, which accounts for about two-thirds of the primary energy consumption in fiscal 2018, to remain the mainstay going forward; depleting domestic production to be substituted through LNG imports
- **Coal** usage will grow manifold to ~12 million tonnes by fiscal 2030 owing to massive build-up of coal-fired thermal plants in the country (~6,000 MW)
- Increased transportation activity to boost **POL** demand by a healthy 6.4%
- **Renewable energy (RE)** usage to remain small; no new large-scale hydro projects planned; distributed solar and wind power projects negligible

iii. Bhutan

Bhutan, a landlocked nation between China and India, spreads over 38,394 sq. km, of which approximately 70% is covered with forests and 7% with year-round snow and glaciers. Bhutan is one of the fastest growing economies in the world with GDP growth of around 7.5% in 2017.

Biomass and electricity generated from hydel projects meet around 60% of the total primary energy requirement of the country. POL and coal meet the balance demand. However, Bhutan does not have any proven oil reserves and has only very low coal reserves. So, for POL and coal, the country is dependent on imports from India. With hydro power generation rising strongly, energy access is improving and the country is expected to maintain strong GDP growth rate. This will boost the usage of primary energy.

Overall, primary energy consumption is expected to reach 1,550 kilo ton of oil equivalent (KTOE) by 2030 from 725 KTOE in 2017, mainly led by the energy demand from industrial, transport and building sectors.

Figure 5: Bhutan's Primary Energy Consumption: Review and Outlook

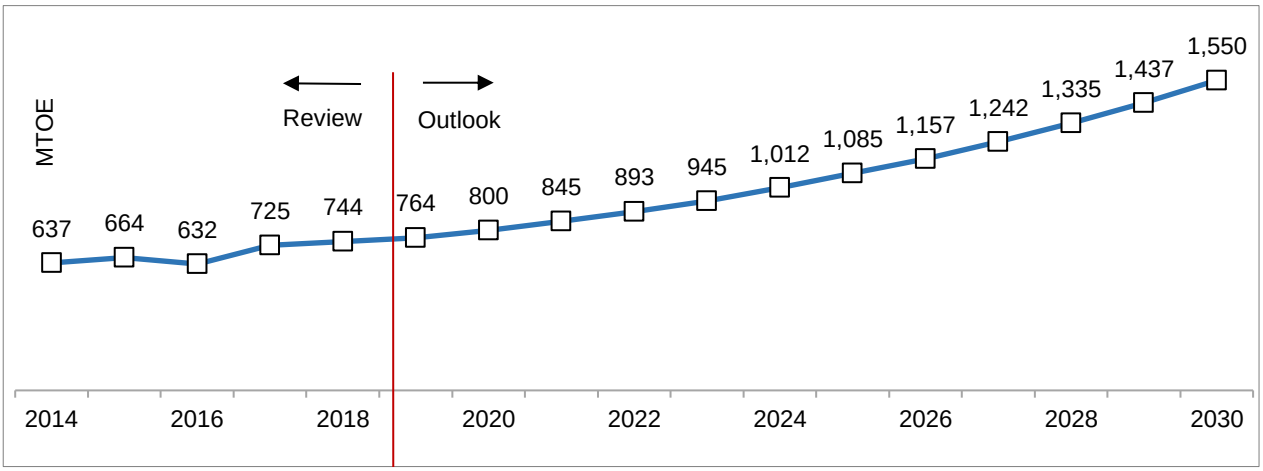
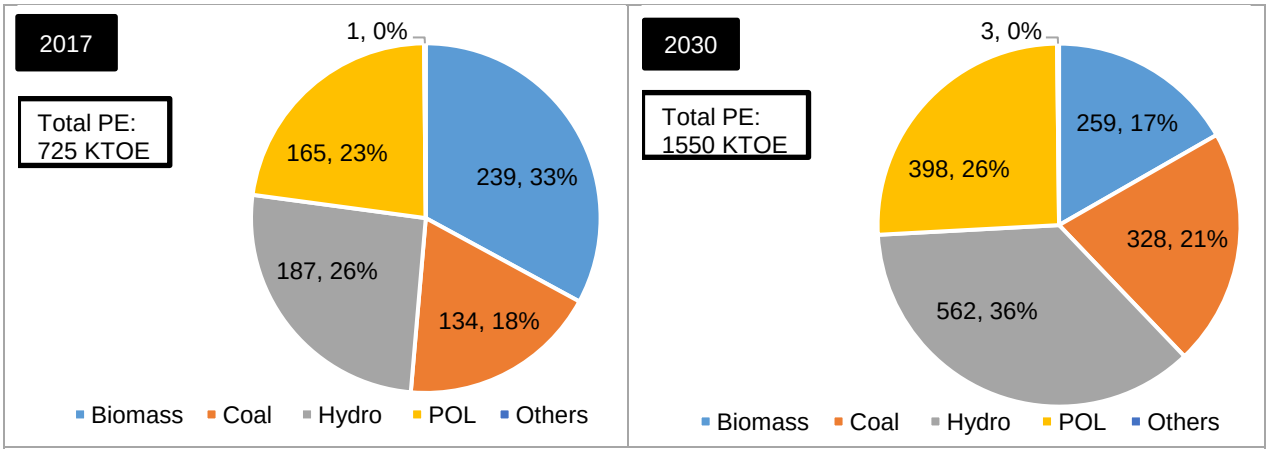


Figure 6: Bhutan's Energy Mix: Review and Outlook



- Biomass and hydroelectricity have around 60% share in the total primary energy consumption of Bhutan
- Power generated from **hydro** projects, which comprised more than 99% of the total installed capacity (1,614 MW) of the country in 2017, is expected to increase to 5,272 MW by 2030
- **Biomass** demand is expected to grow at a rate of less than 1% to reach around 259 KTOE by 2030
- Overall demand for **POL products**, which are mainly consumed by the transport sector, is expected to increase 2.4 times at a CAGR of around 7% from 2017 until 2030 with growing population of conventional vehicles
- **Coal**, mainly consumed by sectors such as heavy cement and ferro-alloy-based industries, is expected to see an increase in demand from 284 kilo tonne in 2017 to around 744 kilo tonnes in 2030, growing at 7.7% CAGR

iv. India

India, the largest country among the SAARC nations by economy and size, has grown steadily at a CAGR of ~7% over the last five fiscals. A rise in consumer demand and surge in domestic and foreign investment have contributed to the country's growth momentum. Better income levels and a steady rise in the industrial activity have boosted the country's energy demand. Coal is the major primary energy source of the country. Going forward, usage of renewable energy (RE) is expected to improve strongly on the back of conducive government policies and higher private sector participation. However, the country's reliance on fossil fuels is expected to continue. Primary energy consumption will rise to 1,392 MTOE in fiscal 2030 from 817 MTOE in fiscal 2018, growing at a CAGR of 4.5%.

Figure 7: India's Primary Energy Consumption: Review and Outlook

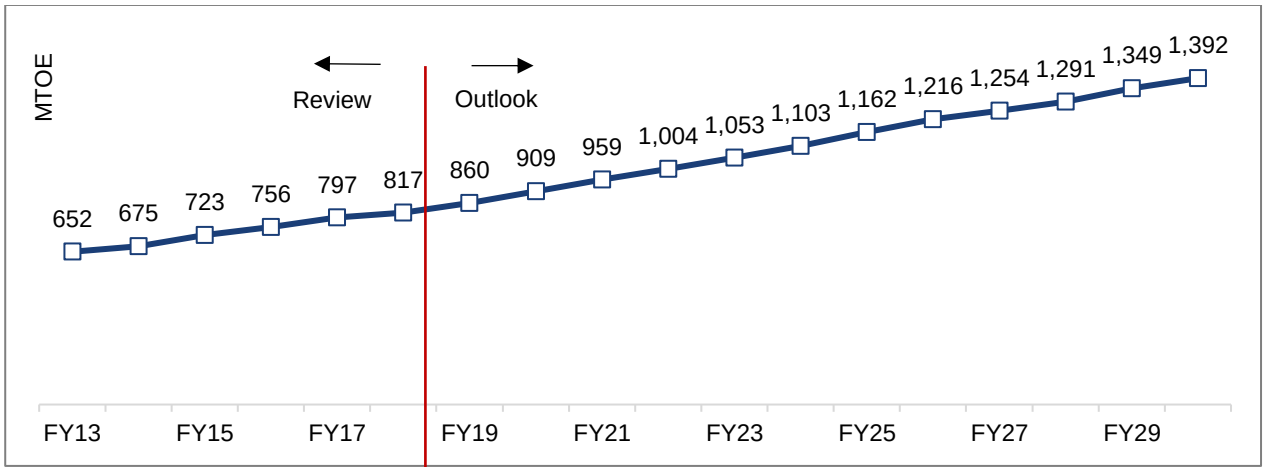
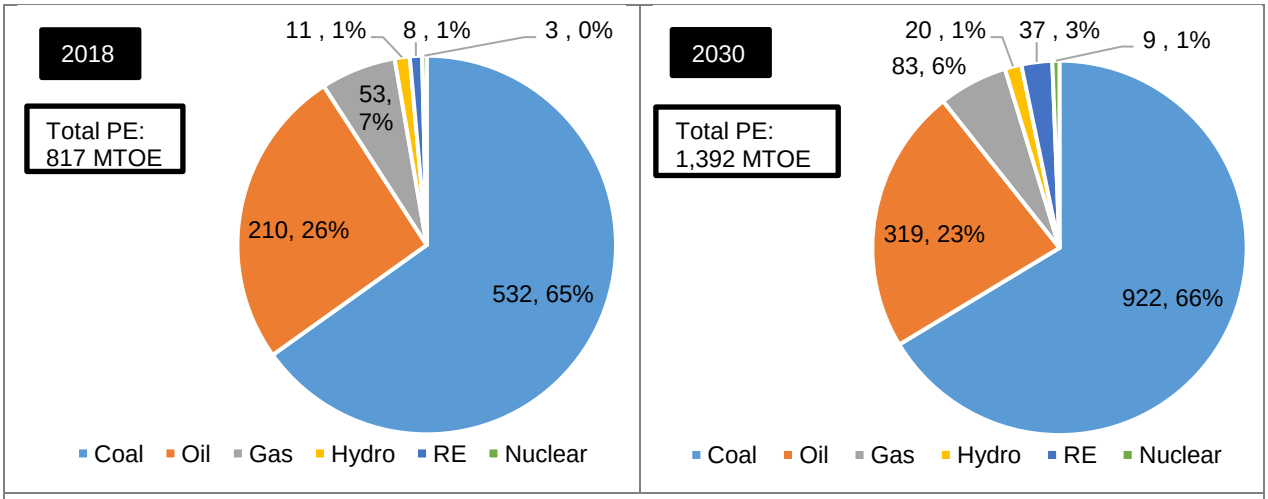


Figure 8: India's Energy Mix: Review and Outlook



- Demand for **coal,** which at present accounts for about 65% of the country's total primary energy needs, will continue to rise manifold; its usage in power is set to rise to ~1,220 million tonnes by fiscal 2030
- **Gas** demand in the country is expected to reach ~217 million metric standard cubic meter per day (mmscmd) by fiscal 2024 at a CAGR of 5% and ~252 mmscmd by fiscal 2030 at a CAGR of 2.5%, driven primarily by fertilizer and city gas distribution (CGD) sectors
- Robust capacity additions of ~150 GW of **solar** energy and ~70 GW of **wind** energy expected between fiscals 2018 and 2030
- Additional ~12 GW of **nuclear** plants expected to come up by fiscal 2030, increasing its contribution in the generation mix to 4.5-5.0% from the present 4.3%
- **Petroleum product** consumption expected to log a subdued CAGR of 4.1% as demand gets crimped on account of rising substitution by CNG, ethanol blending, and greater focus on electric vehicles

v. Maldives

Maldives is a nation comprising 1,192 dispersed tropical islands grouped into 26 geographical atolls spread over an area of 115,300 sq. km. The real GDP of Maldives witnessed a 6% CAGR over 2012-2017, primarily led by the construction sector, large public infrastructure projects and a rise in tourism. The country, owing to lack of indigenous fossil fuel resources, is completely dependent on imports of POL to meet its energy needs.

Strong demand from transportation and infrastructure sectors, growth in per capita income, and booming tourism are seen boosting the country's primary energy consumption. However, it will continue to be import-dependent. Overall, its primary energy consumption is expected to rise to 1,116 KTOE in 2030 from 543 KTOE in 2017, growing at a CAGR of 5.7%.

Figure 9: Maldives' Primary Energy Consumption: Review and Outlook

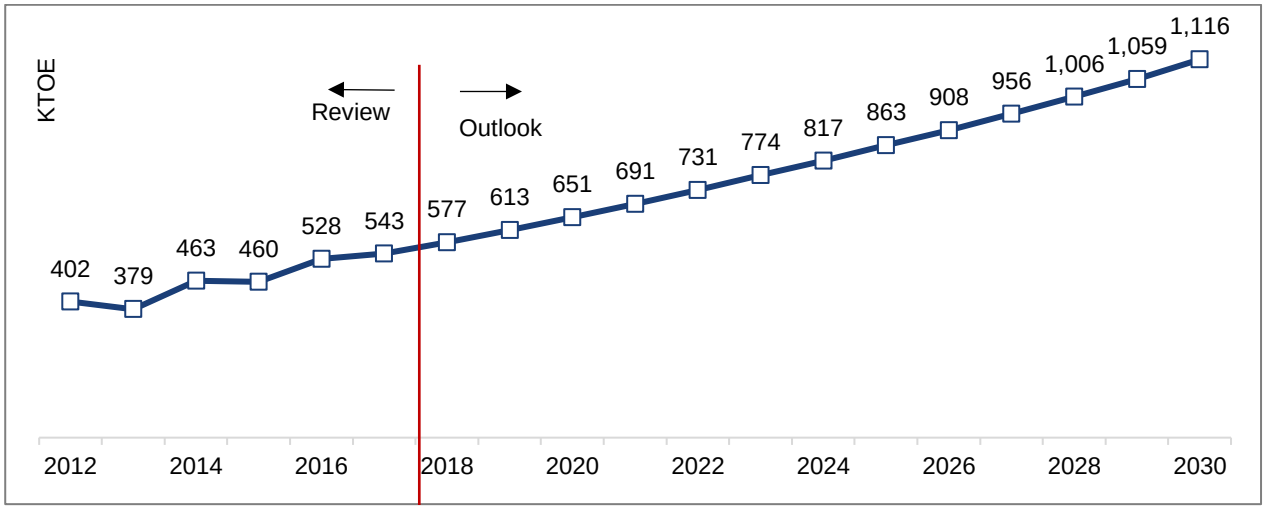
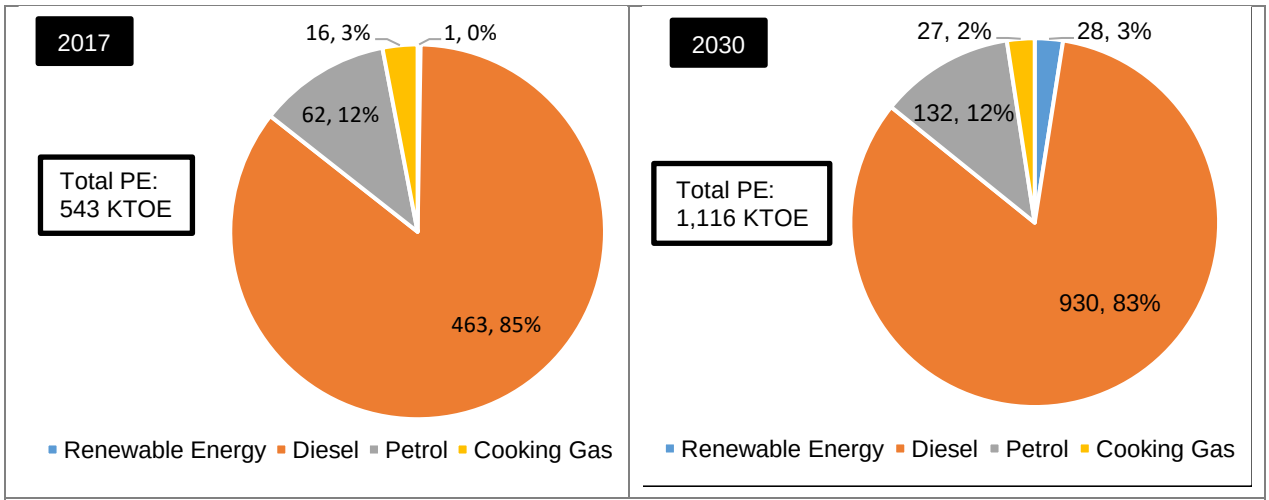


Figure 10: Maldives' Energy Mix: Review and Outlook



- **Diesel** is expected to remain the primary fuel for meeting the country's power demand. It is estimated that in addition to 214 MW of centralized installed diesel-based power capacity in inhabited islands, tourist resorts cumulatively have 260 MW of diesel-based captive power capacity
- Demand for **cooking gas** is expected to rise, with the fuel effectively replacing kerosene as the primary energy source for cooking
- Only 10% of total electricity demand is estimated to be met from **RE** sources by 2030.

vi. Nepal

Nepal is a landlocked nation spread over 147,181 sq. km and shares border with China and India. Nepal's economy witnessed a softer 4.3% CAGR during fiscals 2013-2017 due to its prolonged political transition, inadequate infrastructure and natural calamities such as earthquake. Nepal is rich in fuel wood and hydro reserves but has very limited coal resources and no proven petroleum reserves. As of 2018, traditional fuel – mainly fuel wood – met around 71% of the country's overall demand for primary energy. To fulfil its rising POL products and coal demand, Nepal is mainly dependent on imports from India.

A rise in per capita electricity consumption, improved demand from the residential sector and growth in industries such as cement, pulp and paper, food products, metals, brick, etc. are expected to drive the country's energy usage. It is estimated that Nepal's overall primary energy consumption will reach 21.2 MTOE by fiscal 2030, growing at a CAGR of 3.8% from fiscal 2018.

Figure 11: Nepal's Primary Energy Consumption: Review and Outlook

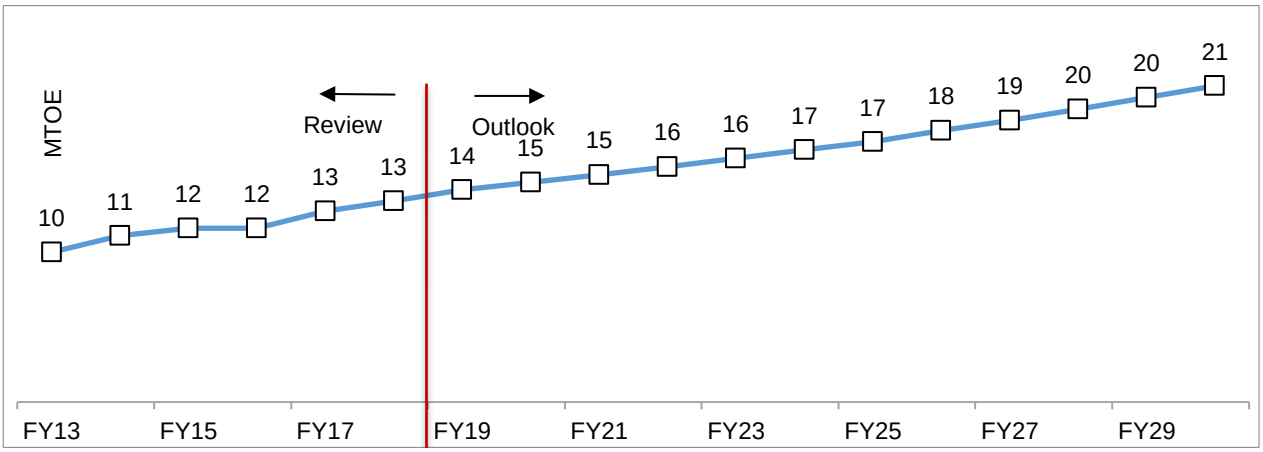
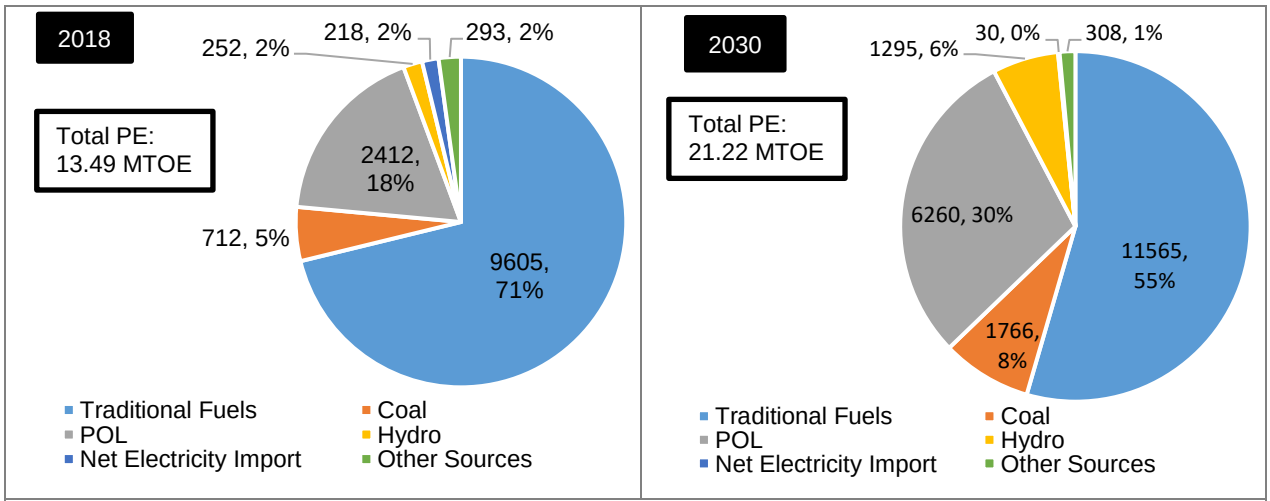


Figure 12: Nepal's Energy Mix: Review and Outlook



- **Traditional fuels,** which met around 71% of total primary energy requirement of Nepal in fiscal 2018, are expected to see their share decline to 54% by fiscal 2030 with the share of cleaner fuels rising
- Power supply, which is dominated by **hydro** power plants, is expected to grow by around 4.1 times to 4,457 MW during the period, mainly driven by the addition of new hydel plants
- Growth in industrial activities is expected to increase the total **coal** demand by around 2.5 times to 2,993 kilo tonnes by fiscal 2030 compared with 1206 kilo tonne in fiscal 2018
- Consumption of **POL** products is expected to grow at a CAGR of 8.3% between 2018-2030 to reach ~6 million tonnes, mainly driven by strong growth in the transport and industrial sectors led by a GDP growth of 4.5-5.0%

vii. Pakistan

Although Pakistan's nominal GDP grew a strong 8.5% during fiscals 2013-2018, the country is stuck with circular debt in the power sector, poor financial position of energy companies, high fossil fuel imports (~85% of crude oil and POL demand) and decline in domestic gas production. Oil and gas constitute the majority of primary energy usage in Pakistan (~40% each as of fiscal 2018). Increased commercial and industrial growth owing to setting up of China-Pakistan Economic Corridor (CPEC), improvement in power supplies, growth in the transport sector, and increasing energy access will be the major drivers for primary energy usage in the country. Falling domestic gas production will be substituted by imported LNG and coal. The country's overall primary energy consumption will rise to 147 MTOE by fiscal 2030, growing at a CAGR of 5.8% from 75 MTOE in fiscal 2018.

Figure 13: Pakistan's Primary Energy Consumption: Review and Outlook

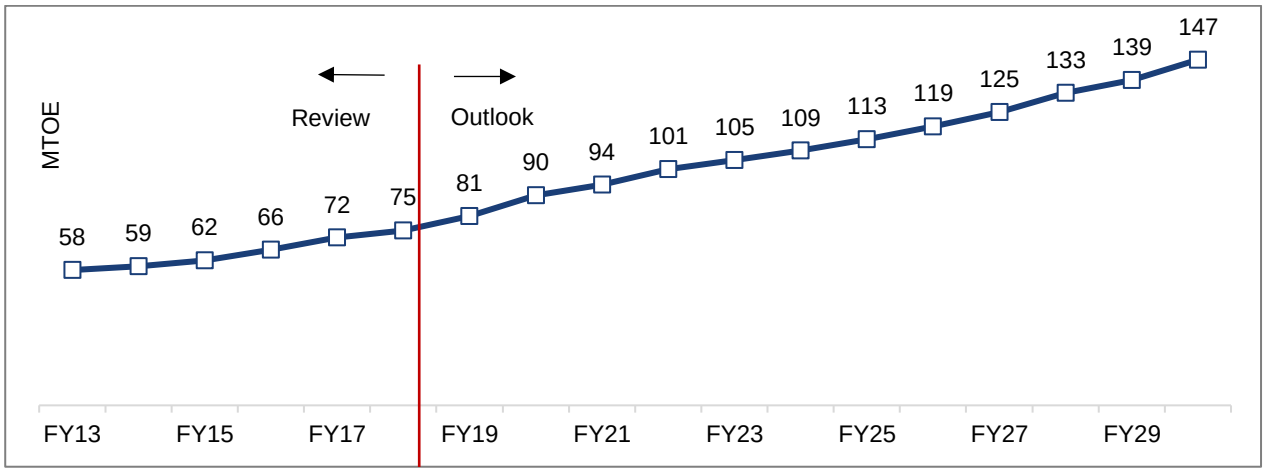
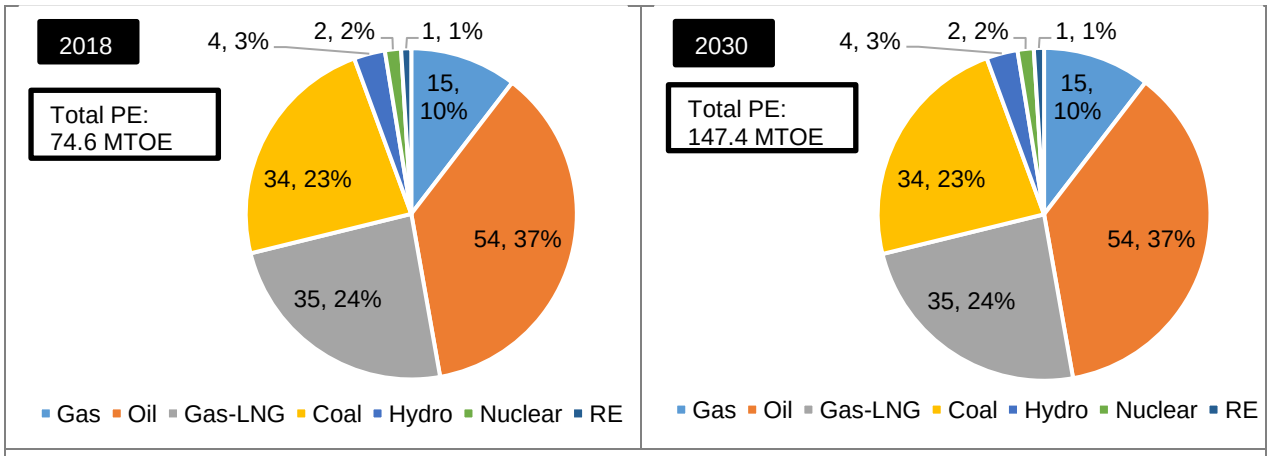


Figure 14: Pakistan's Energy Mix: Review and Outlook



- Demand for **coal** has been growing steadily to 11.58 million tonnes in fiscal 2018. With more than 10 new coal-fired power plants coming up, which would utilise produce from the Thar block, the usage of the fuel is expected to grow by 4.5 times to 60 million tonnes in fiscal 2030
- **Gas** requirement (constrained) will increase marginally from 5,174 million cubic feet per day (mmcfd) in fiscal 2019 to ~5,900 mmcfd in fiscal 2030 on the back of power production, domestic and industrial use
- Three new **nuclear** plants are expected to come up in the next decade, increasing power generation from 7,897 million units (MUs) in fiscal 2019 to ~27,850 MUs in fiscal 2030
- **POL** demand will grow at a healthy 5.2% CAGR driven mainly by the transportation segment and improved economic activity
- An additional ~8,000 MW of **solar, wind and biomass**-based power projects are expected to come up, improving RE's share in power generation to ~9% in fiscal 2030 from 2% in fiscal 2018

viii. Sri Lanka

The small island nation, off the southern tip of India, relies mostly on imports to meet its fuel requirements. This has widened its current account deficit to 5.5% (as of 2017). Sri Lanka is a large consumer of bioenergy with ~12 million tonnes of biomass used in 2017, accounting for ~40% of its energy mix. The major consumers of biomass are household and commercial segments followed by industries. Strong growth in the transportation sector will keep POL demand buoyant going forward. Although power demand is not expected to rise significantly as the country is already 100% electrified, improved usage of coal is expected as more coal-based power plants are to be set up. Overall, its primary energy consumption is seen rising to 16 MTOE by fiscal 2030 from 11 MTOE in fiscal 2018, growing at a CAGR of 3%.

Figure 15: Sri Lanka's Primary Energy Consumption: Review and Outlook

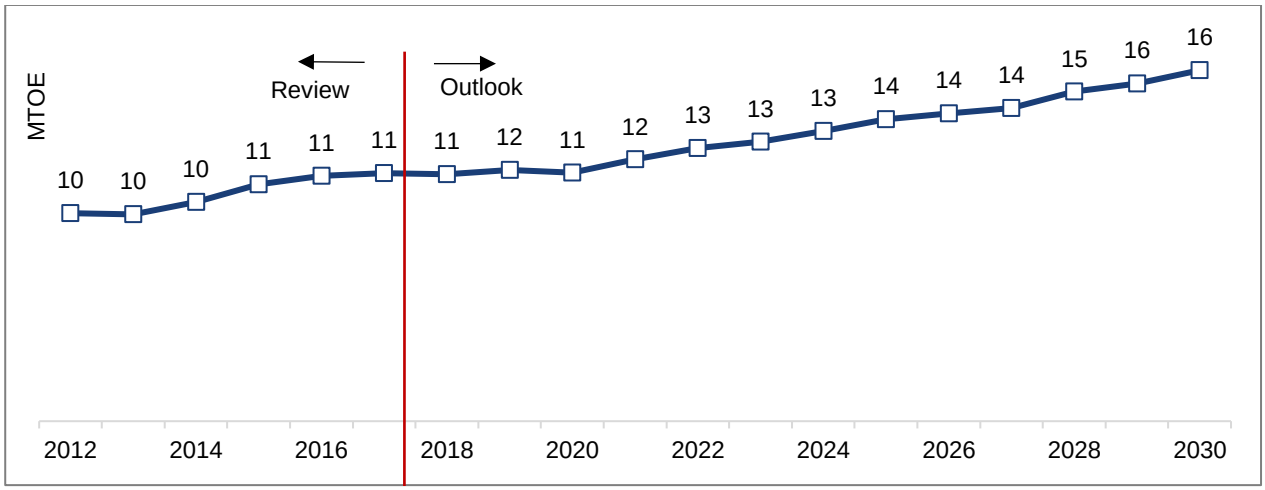
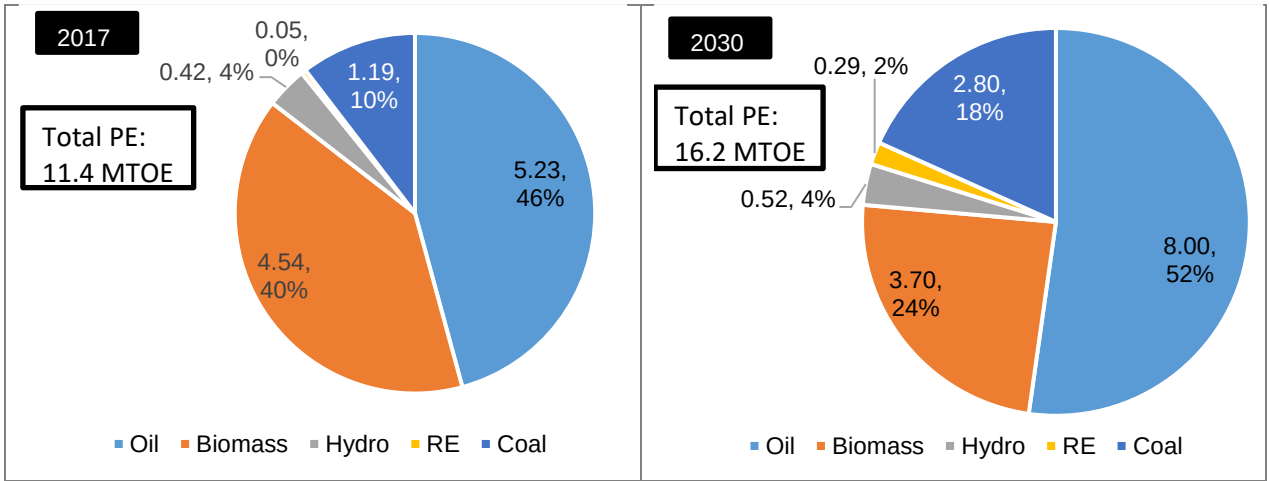


Figure 16: Sri Lanka's Energy Mix: Review and Outlook



- With the entire country being electrified and no significant outages, power supply is not expected to grow significantly. Most of the electricity is sourced through hydro and gas
- Owing to more than 1000 MW of coal fired power plants expected to come up, **coal** usage is expected to rise to ~4.91 million tonnes in FY30 from 2.08 million tonnes in 2017
- **Natural gas** usage is expected to reach ~37.5 bcf by FY30 on the back of ~1000 MW of new gas power plants
- **Hydro power**, the main stay for Sri Lanka, accounted for ~33% of total generated power in 2017, however significant future growth is unlikely
- Sri Lanka is a big consumer of **bioenergy** with ~12 million tons of bio fuel used in 2017. However, due to expected drawdowns in household and commercial use, cumulative biofuel usage will drag to ~9.7 million tonnes by FY30

II. Problems with Energy Sector of SAARC Nations

Underutilisation of resources: Although the SAARC region is well endowed with natural resources, most energy sources (natural gas, coal, hydropower, RE) continue to be underutilised. India, Pakistan and Bangladesh have significant coal reserves. They are, however, not exploited to their potential. Moreover, with gas supplies depleting in Pakistan and Bangladesh, federal push has been towards increasing import dependence, rather than securing domestic supplies to cater to burgeoning demand.

Lack of diversification of fuel basket: Primary energy consumption pattern (by fuel mix) varies widely from one country to the other. India, the largest consumer of primary energy, is heavily dependent on coal (~65% of primary energy as of fiscal 2018). Bangladesh, on the other hand, meets more than 70% of its primary energy demand through gas. Large domestic gas reserves, lower cost and well-spread pipeline infrastructure have led to high usage of gas across all segments (industry, domestic, commercial, power plants). Pakistan also relies heavily on gas (~48% of primary energy as of fiscal 2018), although growth in usage has tempered due to domestic supply constraints and rising reliance on imported LNG. Bhutan and Nepal are predominantly hydro-based energy generators. Overall, there is overarching dominance of a single fuel in the energy mix across all SAARC nations.

Limited focus on RE: Despite abundant RE sources available across the region, they have not been efficiently tapped. Increasing federal push and private participation have given an impetus to RE adoption in India. However, the share of RE in the final primary energy mix is still a meagre 1%. Usage of solar and wind resources in Bangladesh, Pakistan and Sri Lanka continues to be very poor (<0.01%). Afghanistan also has abundant RE resources, which if exploited fully could help reduce supply gaps. The country is currently meeting its power requirements mostly through import, leading to supply constraints. This also impacts the domestic currency's exchange rate.

Strong focus on imports**:** Despite utilising domestic energy resources, all the SAARC nations continue to be strongly dependant on imports. Afghanistan has enough crude oil to sustain its domestic demand; however, 100% of its POL demand is met through imports. Lack of refinery infrastructure in the SMSs (except India) has prompted heavy imports. Apart from Bhutan, Nepal and Maldives, which are isolated due to land mass pattern and geographical location, doe all other SAARC members it is economically viable to augment their refining capacities. Also, dwindling gas production in countries such as Pakistan and Bangladesh has raised concerns of fuel security.

Lack of intra-regional energy trade: Energy trade is limited to only POL and electricity. At present, trade in electricity happens between Bhutan (sells 1,450 MW) and India; India (600 MW) and Bangladesh; and India (300 MW) and Nepal. There is no existing intra-regional gas pipelines. India exports refined petroleum products to Nepal, Bhutan, Sri Lanka and Bangladesh (only diesel). However, in terms of volume of total power and POL traded among SAARC nations, it is grossly insignificant. The region is heavily dependent on crude and POL imports from the Middle Eastern nations and Iran. There is immense scope for expansion of intra-regional energy trade through India's open-access power transmission system, power interconnection between adjacent countries, and gas and oil transmission through pipelines connecting two or more SMSs.

III. Improved Regional Cooperation and Intra-Regional Trade

There are significant avenues to improve trade among SMSs through concerted federal efforts, facilitation of overseas investments and establishment of a holistic energy market. To analyse prospects of imports from neighbouring countries, it is imperative to understand projected quantum of energy to be traded and the import costs to be incurred. A business case exists if the prospective exporting nation has surplus energy and an economic case exists if the total import costs (generation costs + transmission costs/supply costs) are less than the generating costs in the prospective importing nation.

Cross-border power trade may be improved through establishment of interconnections. Bhutan, which is expected to see high power surplus of ~ 600% by 2024, will need to transmit it to adjacent countries such as India, Nepal and Bangladesh, which would be in deficit. Through increased inter-connectivity of power systems by setting up inter-country transmission lines, continuity in supply can be ensured, thereby reducing deficits and ensuring supply in case of contingencies. In cases where power loads of one country are in close proximity with generation facilities of a neighbouring country compared with its own generation facilities, power evacuation will be easier and more economical for inter-country trade. Such arrangements may be further expedited in case of India-Bangladesh, India-Nepal, India-Nepal, India-Pakistan, and Nepal-Bhutan. The interconnected nations within the region may set up a cross-border power exchange, whereby generators/ consumers of one country may seamlessly sell/ buy power on short- or long-term basis. The open access mechanism may be explored by establishing an interconnected, seamless power market.

The SAARC region shall become self-sufficient in petrol and diesel by 2030. However, the dependence on inter-regional trade for LPG and crude oil shall continue. By setting up product pipelines, POL can be seamlessly supplied between any two countries. The proposed west coast refinery in India can serve as one of the possible options to supply POL products to other SAARC nations and promote intra-regional trade by 2030. The plan is to set up an integrated refinery of 60 million tonne capacity with an associated petrochemical complex of an overall investment of $3 trillion. This refinery is expected to come up in the Ratnagiri district of Maharashtra and will be a joint venture India's state-run Indian Oil Corporation (IOCL), Hindustan Petroleum Corporation Ltd (HPCL) and Bharat Petroleum Corporation Ltd (BPCL) and Saudi Aramco. In addition to earnings from refining margins, the member states can make significant savings on freight cost while importing from other SAARC nations, provided the country-level taxation regime for imports and pricing of POL products remains the same.

Overall, through sustained cooperation, conducive trade norms, and harmonised legal and regulatory frameworks, cross-country energy transactions within the SAARC nations may rise manifold.

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Abbreviations

Abbreviation	Meaning
AEDB	Alternate Energy Development Board (Pakistan)
AEIC	Afghan Energy Information Center
AIT	Advance income tax
APPC	Automatic petroleum pricing mechanism
APSCL	Ashuganj Power Station Company
ARL	Attock Refinery Ltd
ASKM	Available seat kilometers
ATF	Aviation turbine fuel
ATV	Advance trade VAT
BAPEX	Bangladesh Petroleum Exploration and Production Company Ltd
BAU	Business as usual
BCF	Billion cubic feet
BCFD	Billion cubic feet per day
BEA	Bhutan Electricity Authority
BECS	Biomass Energy Conversion Systems
BERC	Bangladesh Energy Regulatory Commission
BOC	Bhutan Oil Corporation
BOGMC	Bangladesh Oil, Gas and Mineral Corporation
BPC	Bangladesh Petroleum Corporation
BPC	Bhutan Power Corporation
BPCL	Bharat Petroleum Corporation Ltd
BPDB	Bangladesh Power Development Board
CAD	Current account deficit
CAGR	Compounded annual growth rate
CASA	Central Asia South Asia
CBM	Coal-bed methane
CD	Customs duty
CEA	Central Electricity Authority of India
CEB	Ceylon Electricity Board
CENVAT	Central value added tax
CERC	Central Electricity Regulatory Commission (India)
CIL	Coal India Ltd

Abbreviation	Meaning
CNG	Compressed natural gas
COD	Commercial operational date
CPC	Ceylon petroleum corporation
CPEC	China Pakistan Economic Corridor
CTU	Central transmission utility
DABM	Da Afghanistan Breshna Moassassa
DABS	Da Afghanistan Breshna Sherkat
DESCO	Dhaka Electric Supply Company
DGH	Directorate General of Hydrocarbon
DoED	Department of Electricity Development
DoFPS	Department of Forests and Park Services
DPDC	Dhaka Power Distribution Company
DPRD	Downstream Petroleum Regulation Department
DSF	Discovered small field
DSM	Demand side management
EA & CEI	Electrical Advisor and Chief Electrical Inspector
EGCB	Electricity Generation Company of Bangladesh
EMRD	Energy and Mineral Resource Division
EPP	Export parity price
FENEKA	FENEKA Corporation Ltd
FiT	Feed in tariff
FLGE	Fuel liquid gas enterprises
FO	Fuel oil
GBI	Generation-based incentive
GDP	Gross domestic product
GDS	Gas development surcharge
GRM	Gross refining margin
GST	Good and services tax
GVA	Gross value added
HELP	Hydrocarbon Exploration and Licensing Policy
HMEL	HPCL Mittal Energy Ltd
HOBC	High octane blending component
HOEC	Hindustan Oil Exploration Co. Ltd
HPCL	Hindustan Petroleum Corporation Ltd

Abbreviation	Meaning
HSD	High-speed diesel
HT	High tension
HVDC	High voltage direct current
ICE	Inter-ministerial commission for energy
IMF	International Monetary Fund
IOCs	International oil companies
IOC/IOCL	Indian Oil Corporation Ltd
IPPs	Independent power producers
IPP	Import parity price
JICA	Japan International Cooperation Agency
KESC	Karachi Electric Supply Company
KTOE	Kilo tonne of oil equivalent
LCC	Lanka coal company
LCV	Light commercial vehicle
LECO	Lanka electricity company
LNG	Liquefied natural gas
LT	Low tension
MCF	Million cubic feet
MEA	Maldives Energy Authority
MEE	Ministry of Energy and Environment
MHCV	Medium & heavy commercial vehicle
MmBtu	Million British thermal units
Mmcfd	Million cubic feet per day
Mmscmd	Million metric standard cubic meter per day
MoAF	Ministry of Agriculture and Forests
MOE	Ministry of Energy
MoEA	Ministry of Economic Affairs
MOMP	Ministry of Mines and Petroleum
MOP, GOI	Ministry of Power, Government of India
MOPE	Ministry of Power and Energy (Sri Lanka)
MoPEMR	Ministry of Power, Energy and Mineral Resources (Bangladesh)
MoPNR	Ministry of Petroleum and Natural Resources (Pakistan)
MP	Madhya Pradesh
MPRD	Ministry of Petroleum Resources Development (Sri Lanka)

Abbreviation	Meaning
MRRD	Ministry of Rural Reconstruction and Development
MS	Motor spirit
MT	Medium tension
MT	Metric tonne
MTOE	Million tonne of oil equivalent
MU	Million units
MVA	Mega volt amp
MVR	Maldivian rufiyaa
MWSC	Male Water and Sewerage Company
NBT	Nation building tax
NEA	Nepal Electricity Authority
NEEPCO	North Eastern Electric Power Corporation Ltd
NELP	New Exploration and Licensing Policy
NEPRA	National Electric Power Regulatory Authority (Pakistan)
NESCO	Northern Electricity Supply company Ltd (Bangladesh)
NHPC	National Hydro Power Corporation (India)
NLDC	National Load Despatch Center (India)
NOC	Nepal Oil Corporation
NPCIL	Nuclear Power Corporation of India
NPTI	National Power Training Institute (India)
NRDCL	Natural Resources Development Corporation Limited (Bhutan)
NRL	National Refinery Ltd
NTDC	National Transmission and Dispatch Company Limited (Pakistan)
NTPC	National Thermal Power Corporation (India)
Nu	Bhutanese ngultrum
NVVNL	NTPC Vidyut Vyapar Nigam Ltd (India)
NWPGCL	North West Power Generation Company Ltd (Bangladesh)
OGDCL	Oil & Gas Development Corporation Ltd (Pakistan)
OGRA	Oil and Gas Regulatory Authority (Pakistan)
OIL	Oil India Ltd
OMC	Oil marketing companies
ONGC	Oil and Natural Gas Corporation (India)
OPAL	ONGC Petro Additions Ltd
OVL	ONGC Videsh Ltd

Abbreviation	Meaning
PAEC	Pakistan Atomic Energy Commission
PAL	Ports and Airports Development Levy
PARCO	PARCO – Pak Arab Refinery Ltd
PBS	Palli Bidyut Samiti
PCI	Pulverised coal injection
PEC	Provincial energy committees
PEDO	Pakhtunkhwa Energy Development Organisation
PEPCO	Pakistan Electric Power Company
PFC	Power Finance Corporation (India)
PGCB	Power Grid Company of Bangladesh Ltd
PLF	Plant load factor
PNGRB	Petroleum and Natural Gas Regulatory Board (India)
PNRA	Pakistan Nuclear Regulatory Authority
POL	Petroleum products
POSOCO	Power System Operation Corporation Ltd
POWERGRID	Powergrid Corporation of India Ltd
PPAC	Petroleum Planning & Analysis Cell (India)
PPDB	Punjab Power Development Board (Pakistan)
PPIB	Private Power and Infrastructure Board (Pakistan)
PPL	Pakistan Petroleum Ltd
PRL	Pakistan Refinery Ltd
PSC	Production sharing contracts
PSDP	Public Sector Development Program
PSMP	Power system master plan
PSO	Pakistan State Oil
PSTI	Power Systems Training Institute
PTC	Power Trading Corporation (India)
PUCSL	Public Utilities Commission of Sri Lanka
RD	Regulatory duty
REB	Rural Electrification Board (Bangladesh)
REC	Rural Electrification Commission (India)
RECC	Rural Energy Coordination Committee
RGoB	Royal Government of Bhutan
RIL	Reliance Industries Ltd (India)

Abbreviation	Meaning
RLDC	Regional Load Dispatch Center
RPCL	Rural Power Company Ltd (Bangladesh)
SCCL	Singareni Collieries Company Ltd (India)
SD	Supplementary duty
SECI	Solar Energy Corporation of India
SERC	State Electricity Regulatory Commission (India)
SEZ	Special economic zone
SKO	Superior kerosene oil
SLSEA	Sri Lanka Sustainable Energy Authority
SMS	SAARC member states
SNGPL	Sui Northern Gas Pipelines Ltd (Pakistan)
SPA	Sale purchase agreement
SPP	Small power producer
SSGPL	Sui Southern Gas Pipelines Ltd
STELCO	State Electric Company Ltd (Maldives)
STO	State Trading Organisation
STU	State transmission utility (India)
SZPDCL	South Zone Power Distribution Company Ltd
T&D	Transmission and distribution
TAP	Turkmenistan Afghanistan Pakistan
TCF	Trillion cubic feet
TPP	Trade parity price
VAT	Value added tax
WAPDA	Water and Power Development Authority (Pakistan)
WECS	Water and Energy Commission Secretariat (Nepal)
WZPDCL	West Zone Power Distribution Co. Ltd (Bangladesh)

Technical Glossary

1. KWh/ GWh – Measure of energy usage. 1 KWh is equivalent to one kilowatt (1 kW) of power expended for one hour (1 h) of time. 1 GWh is equivalent to one gigawatt (1 kW) of power expended for one hour (1 h) of time
2. KTOE/ MTOE - tonne of oil equivalent (toe) is a unit of energy defined as the amount of energy released by burning one tonne of crude oil. Multiples of the toe used are KTOE (Kilo-toe), MTOE (million – toe)
3. Primary Energy - It is the energy that is harvested directly from natural resources. Primary energy accounting is a way of looking at energy use at the natural resource end. Primary energy differs from secondary energy which is derived from some primary fuel or fuels through chemical or physical processes
4. MU / BU – Measure of power generation and consumption. 1 MU is one million units of electricity where one unit is equal to one Kilowatt hour. 1 BU is one million units of electricity where one unit is equal to one Kilowatt hour
5. Transmission and Distribution (T&D) losses - T&D losses represent electricity that is generated but does not reach intended customers. By formula, T& D Losses = { 1- (Total energy Billed/ Total energy Input in the system)} x 100

   T&D loss is an often-quoted metric to assess the health of the electricity distribution sector. High losses could be due to low investment in the network, poor maintenance or theft
6. Billion cubic meters (bcm): Stands for billion cubic meters and is commonly used as a measure of natural gas and other gases that are extracted, processed or transported in high quantities
7. Crude oil condensates - Condensate is a very light hydrocarbon with a specific gravity of greater than 50 degrees and less than 80 degrees. In underground formations condensate can exist separately from the crude oil or dissolved in the crude oil
8. High Tension (HT) / Low Tension (MT): Classifications of overhead power transmission lines based on voltage of transmitted power. If transmitted voltage is greater than 440 V, it is generally considered to be high tension
9. British Thermal Units (BTU): It is a measure of the quantity of heat, defined as approximately equal to 1,055 joules, or 252 gram calories. Gas utilities use the unit as a measure of gas consumption.
10. Asia Pacific Petroleum Price Index (APPI): An independent price source for crude oils, and is acknowledged to be the standard price setting mechanism in the Far East. The prices are compiled from the assessments provided by a panel of the most active participants in the Asia-Pacific market
11. Low Voltage (LV)/ Medium Voltage (MV)/ High Voltage (HV): Segregations based on system voltage levels. The International Electrotechnical Commission has classified the voltages into following levels: LV – Up to 1000V, MV – 1000V to 35 kV, HV – 35 kV to 230 kV, EHV (Extra High Voltage) – Above 230 kV
12. Clean coal technology: It is a collection of technologies being developed in attempts to lessen the negative environmental impact of coal energy generation and to mitigate worldwide climate change by reducing emission of pollutants associated with burning coal
13. Gross Calorific Value: The total amount of heat released when a fuel is burned. Higher GCV denotes higher heating power

14. Import Parity Pricing (POL product pricing): The monetary value of a unit of product bought from a foreign country, valued at a geographic location of interest in the importing country. IPP includes international transport costs and tariffs
15. Export Parity Pricing: Represents the price which oil companies would realise on export of petroleum products
16. Trade Parity Price (POL product pricing): The TPP is determined based on prices for these products prevailing in the international market assuming that 80 per cent of the petrol and diesel is imported and 20 per cent is exported
17. Super critical technology – New age technology deployed in power plants which help in improvement in efficiency measures and reduction in greenhouse gas emissions
18. Direct Reduced Iron (DRI) (Coal): Also called sponge iron, is produced from the direct reduction of iron ore (in the form of lumps, pellets, or fines) to iron by carbon monoxide and hydrogen derived from natural gas or coal
19. BF route: Stands for Blast Furnace route. It is a process of producing steel using raw materials such as iron ore, coal, limestone and steel scrap
20. Euro V/VI grade: European emission standards which define the acceptable limits for exhaust emissions of new vehicles sold in the European Union
21. Available Seat Kilometres (ASKM): It is a measure of passenger carrying capacity in an aircraft and is equal to the number of seats available multiplied by the number of miles or kilometres flown
22. MMBTU: stands for one million British Thermal Units (BTU). A BTU is a measure of the energy content in fuel, and is is used in the power, steam generation, heating and air conditioning industries. One BTU is equivalent to1.06 Joules.
23. Mmscmd: Million Metric Standard Cubic Meter per Day is commonly used as a measure of natural gas and other gases that are extracted, processed or transported in high quantities
24. Renewable purchase obligation: Refers to the obligation imposed by law on some entities to either buy electricity generated by specified 'green' sources or renewable sources.
25. Cross Subsidy (Power prices): practice of charging higher prices to one type of consumers to artificially lower prices for another group
26. Run-of-river (Hydro): Is a type of hydroelectric generation plant whereby little or no water storage is provided and harvest power from flowing water. Run-of-river systems require reasonably substantial flow rate, either from rainfall or a melting snowpack
27. Mmcfd: Stands for Million Cubic Feet per Day (energy industry) and is commonly used as a measure of natural gas and other gases that are extracted, processed or transported in high quantities
28. Demand Side Management (DSM): the modification of consumer demand for energy through various methods such as financial incentives. Usually, the goal of demand-side management is to encourage the consumer to use less energy during peak hours, or to move the time of energy use to off-peak times such as night time and weekends

1 Introduction

1.1 Rationale and Scope of Report

The SMSs are among the fastest-growing developing nations in the world, with a growing middle-class population, which, with improving economic conditions, has witnessed higher growth in primary energy consumption. However, SMSs are net deficit in major conventional fossil fuel-based energy sources. While India, with its coal reserves, Pakistan, with its coal and natural gas reserves, and Bangladesh, with its natural gas reserves, are able to meet some of their energy demand, these sources are polluting and fast depleting. This warrants a shift to cleaner and abundantly available sources. Crude oil, which is the key energy source for driving transportation and power generation, is conspicuous by its absence in all these nations. They are dependent on the Middle East for meeting their demand for oil and oil products. At present, countries such as Maldives and Afghanistan largely depend on import of POL products to meet their energy needs.

Since the present energy mix of all these nations is heavily tipped towards fossil fuels such as coal, gas and crude oil, a logical way forward in the business-as-usual scenario would be to make large-scale investments in import of these fuels, in terms of long-term agreements and port and shipping infrastructure. However, recent technological developments threaten to disrupt the existing energy mix in these nations and tip the scale towards non-conventional and clean energy sources.

Sizeable hydro potential in Nepal, Bhutan and Sri Lanka, and high solar and wind potential in India and Pakistan could help these countries displace fossil fuels as primary sources of energy and meet COP21 targets on reduction of carbon emissions. Further, disruption in energy mix is expected with commercial availability of alternative fuels and rising fleet of electric vehicles. Inter-regional energy trade (electricity and POL) would allow the SMS to cut down cost and save sizeable foreign exchange.

It is, therefore, imperative not only to forecast rising energy requirements and plan for investments, but also to understand future energy options and share of fuels in the energy mix. This would help the SMSs achieve national energy security and meet the targets to mitigate climatic change.

The objective of this report is to assess nation-wise energy outlook till 2030, which shall facilitate policy/ decision-makers, planners and other stakeholders of the energy sector to interpret investment requirements for meeting the demand of the rising population.

1.1.1 Scope of Study

Terms of reference of the study include:

- Country-wise profiling, detailing factors affecting the energy sector, including:
  - Population, GDP, industrial activity, and availability of energy sources
  - Overview of the existing regulatory and policy framework in the energy sector
  - Overview of the existing energy mix and assessment of end-use sectors driving demand
- Existing cross-border energy trade (global and intra-SMSs, including SAARC framework agreement for energy co-operation)
- Development of energy outlook until 2030
  - Country-wise assessment of key factors expected to drive energy demand, including:
    - Macro-economic indicators (GDP, population growth, per capita income, etc)
    - Growth of end-use industry (transportation, power generation)
  - Country-wise assessment of demand, supply growth and deficit/surplus scenario
    - Assess the requirement for future cross-border energy trade

1.1.2 Structure of Report

Coverage and scope of this report demands assessment of all the SAARC nations in a detailed manner. Therefore, each of them has been dealt with in separate sections. The final section discusses the review of and outlook for SAARC cross-border energy trade, giving this report its justified conclusion.

1.2 Approach and Methodology

5-Step Framework Towards Energy Outlook 2030

Data-driven bottom-up and top-down approach, to derive demand and supply outlook of SAARC member-states until 2030

Data collection

Annual government data, energy reports for multilateral funding agencies, press releases

Long-term demographic and economic trends

Economic and demographic forecasts and impact on energy requirement due to impending changes

Sector deep dives: Power, residential, industrial, transport

Demand outlooks and forecasts, underlying factors leading to change

Fuel supply outlook

Domestic production and import of fuels, changing fuel mix owing to supply constraints, price rises, government policies

Recalibrating unconstrained demand in line with fuel supplies

Changing fuel mix, matching demand with constrained supply

1.2.1 Long-Term Demographic and Economic Trends

Change in income (measured by per capita GDP), population growth and improving economic output shall impact future energy needs of a nation. What shall be the correlation factor between GDP and energy demand?

Growth in middle-income class in the country boosts domestic prosperity. How much of augmented purchasing power will translate into energy sales? To what extent will propensity to buy energy rise with increasing income and purchasing power?

How would increasing technological breakthroughs and new innovation impact energy intensity?

SAARC nations are developing or under-developed where energy security is critical. The world is moving towards energy efficiency and energy savings. What would be the SAARC nations' stance on the same?

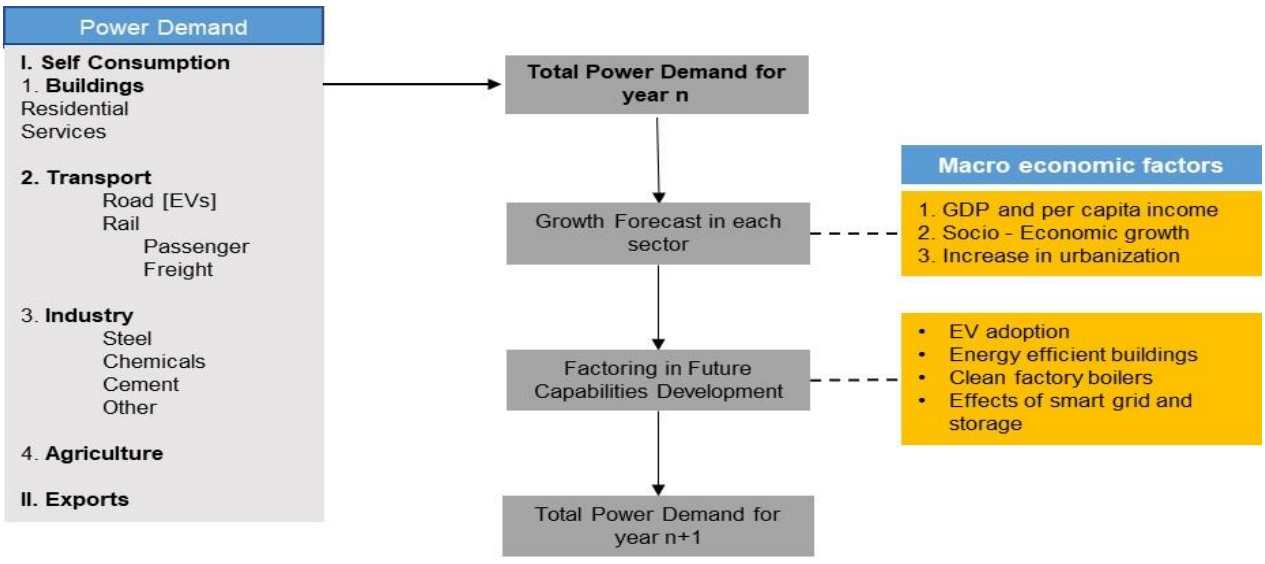
1.2.2 Sector Deep Dives

Electricity and Power Generation

Power is the backbone of economic development and prosperity of a nation. It is imperative to accurately measure and forecast a country's power demand, to take an informed call on generation planning and outlook on fuel mix shift.

A combination of top-down approach, including regression analysis, and bottom-up approach has been adopted, whereby, taking into account historical load data, underlying factors that drive power demand have been objectively deduced. Since each SAARC nations has unique demand drivers or constraints which may not apply for the rest, separate models have been developed to suitably accommodate all the deviations.

Figure 17: Power Demand Forecasting Model (illustrative)



The following underlying factors driving load growth have been assessed for each of the power consumer categories:

Domestic Category: The major underlying factors driving domestic demand are rate of access to electricity in the country (measured by electrification rate), demographic change (growth in population, household size), and per capita consumption of electricity. Future economic development and rise in income levels will lead to a seismic shift towards urbanisation, more purchasing power, and propensity for improved well-being. This will, in turn, lead to higher power demand in the nation. However, establishing a relationship between the independent variable and dependent ones are more of judgmental in nature rather than inferential. Nations such as India and Pakistan, which are undergoing accelerated electrification, tend to widen customer base by leaps and bounds and is the single largest determining factor towards improving domestic sales. For such nations, on-year improvement in electrification rates has been assessed and deviations from government targets have been studied. Future electrification rates will be a function of government eagerness, policy intervention and sector preparedness. Power policy outlooks prepared by federal governments have been studied for relevant cues. Future capital expenditure outlays made by government and private players for grid expansion, augmentation, and interconnections have also been factored in. Quantitative analysis, backed by sound judgment, shows consumer rise. In countries such as Sri Lanka and Bhutan, with >97% electrification levels, future sales growth is predominantly imputed to rise in consumption. Reduction in urban-rural divide, development of new urban centres, and increase in energy intensity will lead to increased power consumption per consumer.

Alternatively, domestic power sales have been forecasted through regression modelling. Seven variables have been considered for the modelling. These are GDP, per capita GDP, population, average electricity price, previous year demand (t-1), number of domestic consumers and number of domestic consumers for previous year (t-1). For each nation, significant variables within the basket of variables have been ascertained which could predict domestic power sales to the highest degree of precision.

Industrial and Commercial: These sectors generally rank second- and third-highest in consuming energy (by sales). Although the number of industrial and commercial (I&C) consumers is not as high as residential ones, realised sales from these consumers are generally high owing to higher tariff imposed through cross-subsidisation. With tariffs being regulated and controlled in all SAARC nations, higher burden is placed on I&C consumers due to their greater buying power and sales inelasticity. Although I&C consumption is a direct proxy for economic activity prevailing in a nation, unreliable power supply and stiff tariffs may lead to consumer leakage and a radical shift towards decentralised, off-grid solutions. Countries such as India and Sri Lanka have been focusing on tariff rationalisation, to arrest reducing growth trends from I&C sales.

To objectively forecast I&C power sales, it is imperative to understand the industrial maturity of a nation and likely trends in future industrial growth. Degree of dependence on imports, growth in domestic consumption, and outlook on exports have been studied to arrive at present and future industrial outlook of the nation. With the industry embracing technological innovation (use of super-critical boilers, energy-efficient machinery, etc.), expected reduction in power demand has been ascertained and relevant assumptions have been duly incorporated in the model. I&C power consumption has also been derived through regression modelling.

Table 1: Regression Modelling Variables for I&C Power Consumption

Consumer category	Variables used for regression modelling
Industrial	GDP, previous GDP, population, average electric price for industrial category, previous year demand (t-1), industrial sector GDP
Commercial	GDP, previous GDP, population, average electric price for commercial category, previous year demand (t-1), services sector GDP

In countries such as Sri Lanka and Maldives, having booming tourism industries, a big chunk of commercial demand emanates from hotel demand and other leisure activities catering to tourists. A nation's attractiveness as a travel destination can wax and wane depending on its political and economic climate, spending on tourism infrastructure, and perceived attractiveness by potential visitors. For such countries, relevant factors like capital investment, contribution of travel and tourism to the nation's GDP, spending pattern of tourists, and ancillary industries catering to tourism have provided insights on future growth potential. Thus, power requirement owing to incremental growth in travel and tourism has been assessed.

Agriculture: Almost all the SAARC member states are agrarian economies with federal governments focusing on providing subsidised electricity to agricultural consumers. However, depleting ground water levels has resulted in shift of focus towards enabling sustainable agriculture through improved energy efficiency. Statistical analysis has not been able to justify agricultural power sales with a high degree of precision. Variables such as agricultural GDP growth, share of agriculture as percentage of GDP, and GVA by the agricultural sector were used to explain power sales in the category. However, a large proportion of randomness remained. Therefore, growth outlook has been ascertained using qualitative analysis and sound judgment. Agricultural pump-sets are the highest contributors to power sales for this category. Demand drivers for pump-set penetration like subsidies doled out by federal government, buying power of end-users, and availability of electricity to agricultural consumers have been understood. Several forward-looking initiatives proposed by the government and power distribution companies, including setting up of separate feeders and metering of consumers, to improve power availability have also been duly noted.

Power demand estimated from the aforementioned approach has been suitably modified to include non-historical factors that are expected to result in additional demand growth such as metro corridors, railway electrification, and electric vehicle charging. Similarly, role of demand-side management (DSM) measures and promotion of energy efficiency measures by subsidising smart appliances, imposing time-of-day (ToD) tariffs and other load management tactics, have been suitably considered.

Residential and Commercial

Apart from electricity, residential and commercial consumers use coal, natural gas, liquefied petroleum gas (LPG), and biomass to meet the energy requirements. With modernisation of energy supply to the residential sector, it has been consuming natural gas and LPG at increased rates. However, in un-electrified rural households, coal and biofuel usage is widespread for heating and cooking purposes. With improved urbanisation and rise in government support for gas and LPG adoption among poor households, a shift is expected in energy mix. Although household electrification is being undertaken, vast areas of some of SMSs continue to be under-served. For commercial establishments operating out of areas with unreliable power, genset usage is pertinent. Such factors affect future prospects of energy demand and, therefore, have been objectively assessed.

Transport Sector

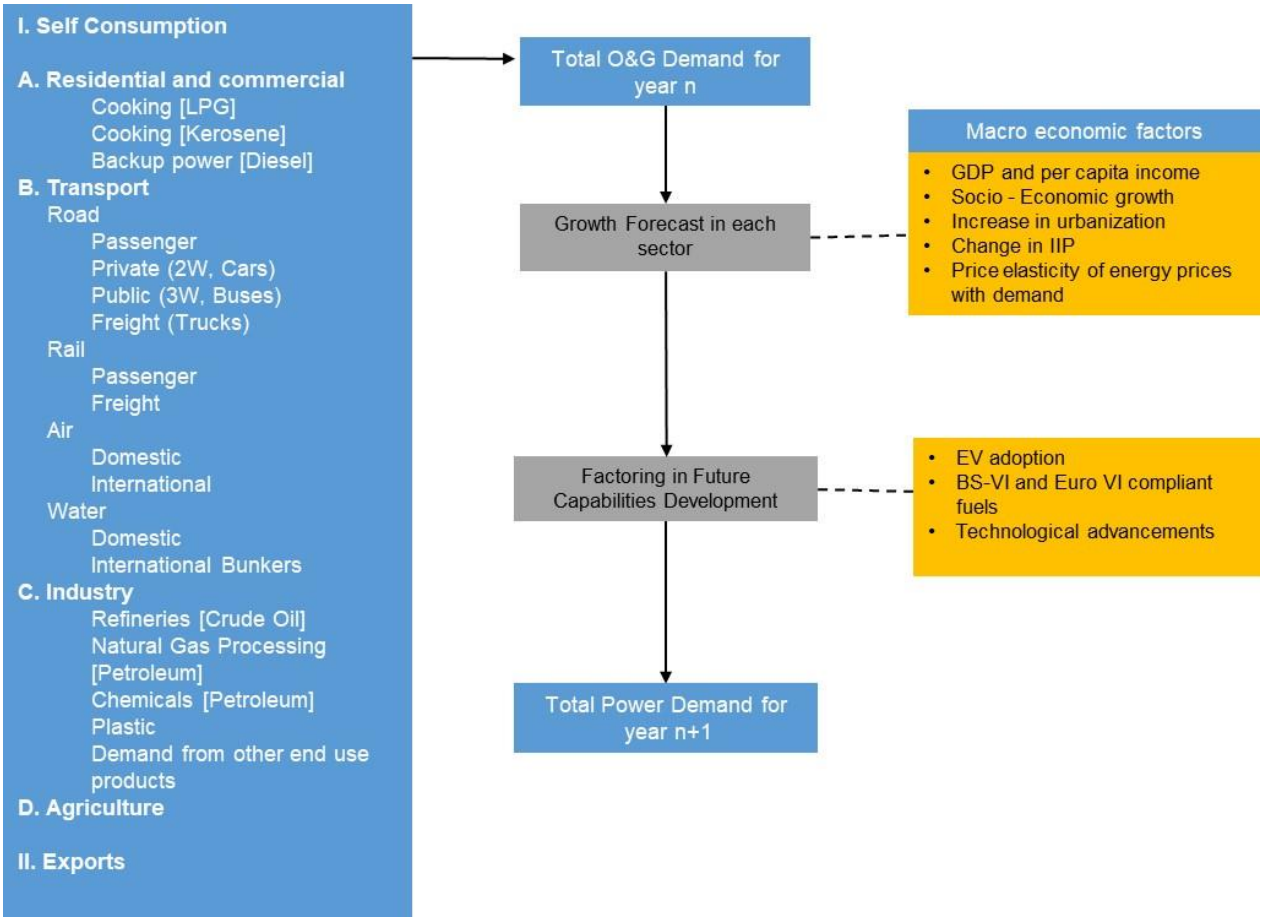
Petroleum and other fuels (natural gas, bio fuels) are dominant sources of energy for the transportation sector in these nations. Increased economic activity has boosted per capita income, standard of living, and demand for personal transportation. Commercialisation and industrialisation have increased usage of commercial vehicles. To estimate growth in vehicles, several quantitative factors have been considered. The pace of urbanisation and on-year growth in vehicle registrations across different categories in previous years have provided a baseline for future growth forecasts. Rise in vehicles owing to improvement of road infrastructure has been assessed. With new focus areas such as creation of waterways and building of new airports in tier-II and -III cities, growth forecasts have been considered. Improved domestic and international trade and commerce will lead to additional cargo movement via rail, road, sea and air. Future growth in tonne-km has been estimated taking into consideration growth in the industrial sector, import/export outlook and improvement in transportation infrastructure. Growth in air traffic, and rising middle class aspirations and disposable income will raise jet fuel demand.

Countries such as India have been formulating policies to promote electric vehicles and use of alternative fuels (hydrogen, ethanol, and biomass) in vehicles and railway engines. The degree to which these measures will bear result and any negative impact they will have on petroleum usage have been evaluated. Cumulatively, energy consumption and growth projections in the sector have been computed.

Industrial Sector

The industrial sector is a large consumer of primary energy (coal, oil, gas). Over-dependence on traditional industries, as in the case of Bangladesh, leads to creation of a labour-intensive nation rather than an energy-intensive one. Industrial policies of each nation have been studied to understand the extent of industrialisation. Gross value added (GVA) by power-intensive industries such as manufacturing has been used to understand diversification of industries in the country. Nations at the lower end of the industrial maturity spectrum have enough scope for development in the sector. Current and future industrial policies such as incentives in foreign direct investment (FDI), infrastructure development and industrial resource development can help understand future industrial outlook of the nation. For countries like India, striving for import substitution through home-bred industrialisation, federal support policies such as promotion of deregulation and infant industry protection through high tariffs on imports have been studied closely to understand future industrial roadmap. Export-oriented growth in the technological and capital-intensive industries can spur energy demand. Accelerated construction of industrial parks such as special economic zones (SEZs), roads, ports and railways can be considered as signs of development. However, empirical factors such as sovereign downgrades, flight of foreign institutional investors (FIIs), reduction in index of industrial production (IIP), slack in gross fixed capital formation (GFCF), downtick in investment owing to deceleration in consumption, and political and economic uncertainties can result in de-growth. These factors have also been studied closely.

Figure 18: Oil and Gas Demand Forecasting Model (illustrative)



1.2.3 Fuel Supply and Recalibrating Unconstrained Demand

Although unconstrained demand for primary energy will continue to rise, it is imperative that a country secures energy supplies commensurate with underlying demand. Each country's fuel reserves and prospects for fuel supply augmentation have been assessed. Government policy documents on the power and hydrocarbon sectors have been studied to understand proposed system capacity additions and supply forecasts. Policy intervention to encourage penetration and usage of a specific primary energy (like renewables) is understood. In case of domestic demand-supply gap, opportunities for imports to bridge it are studied. In conclusion, quantum of cross-border energy trading in addition to domestic fuel supplies (taking capacity-building into consideration) have been deduced. In case fuel demand outlook outstripped supply outlook, primary energy demand mix was changed by substituting the fuel that is likely to be in short supply with the fuel which is expected to be abundant.

Intended Nationally Determined Contribution (INDC) commitments by a country for abatement of greenhouse gas emissions have been studied and change in fuel mix is assessed taking into consideration federal targets as well as practicality.

Figure 19: Power Supply Forecasting Model (illustrative)

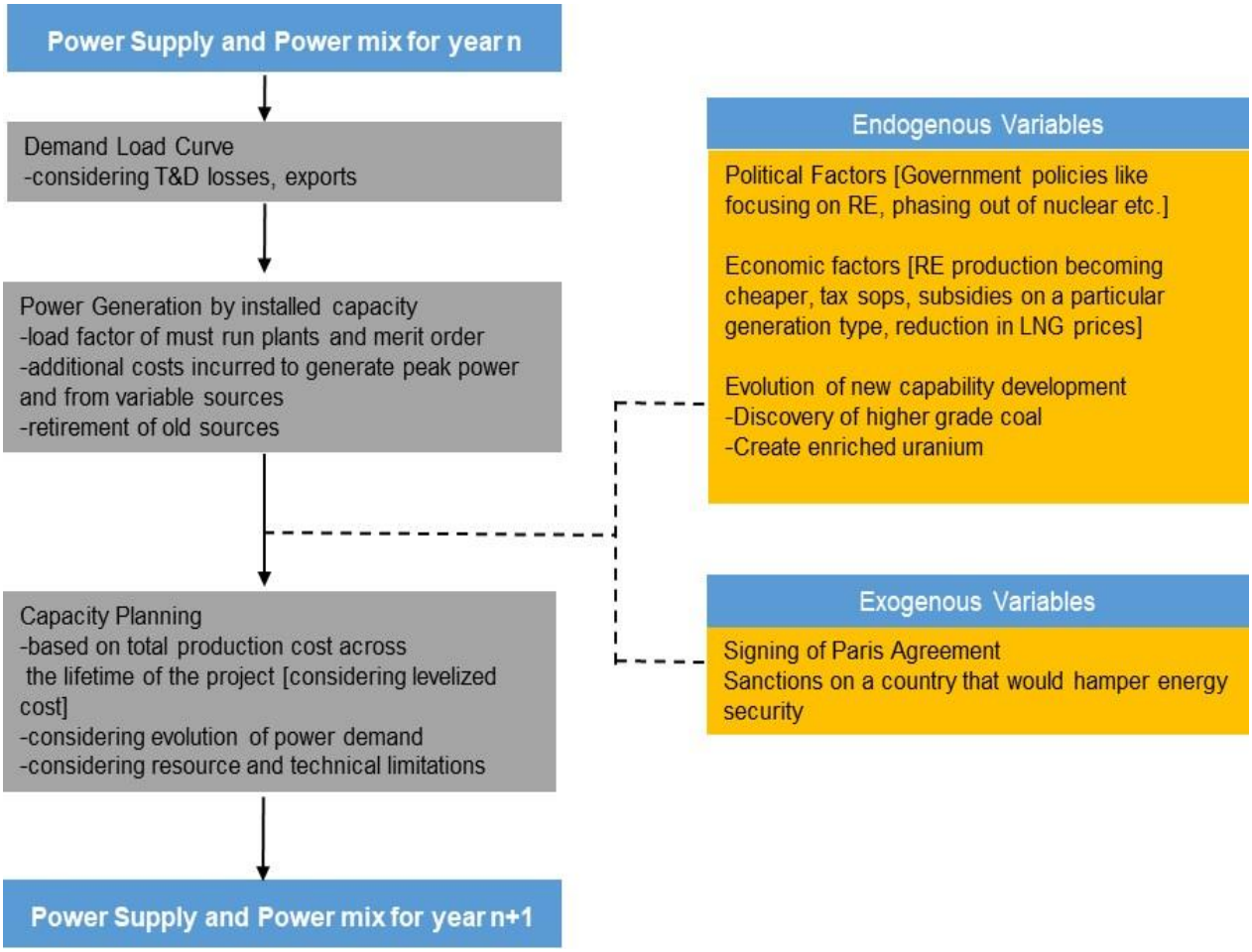
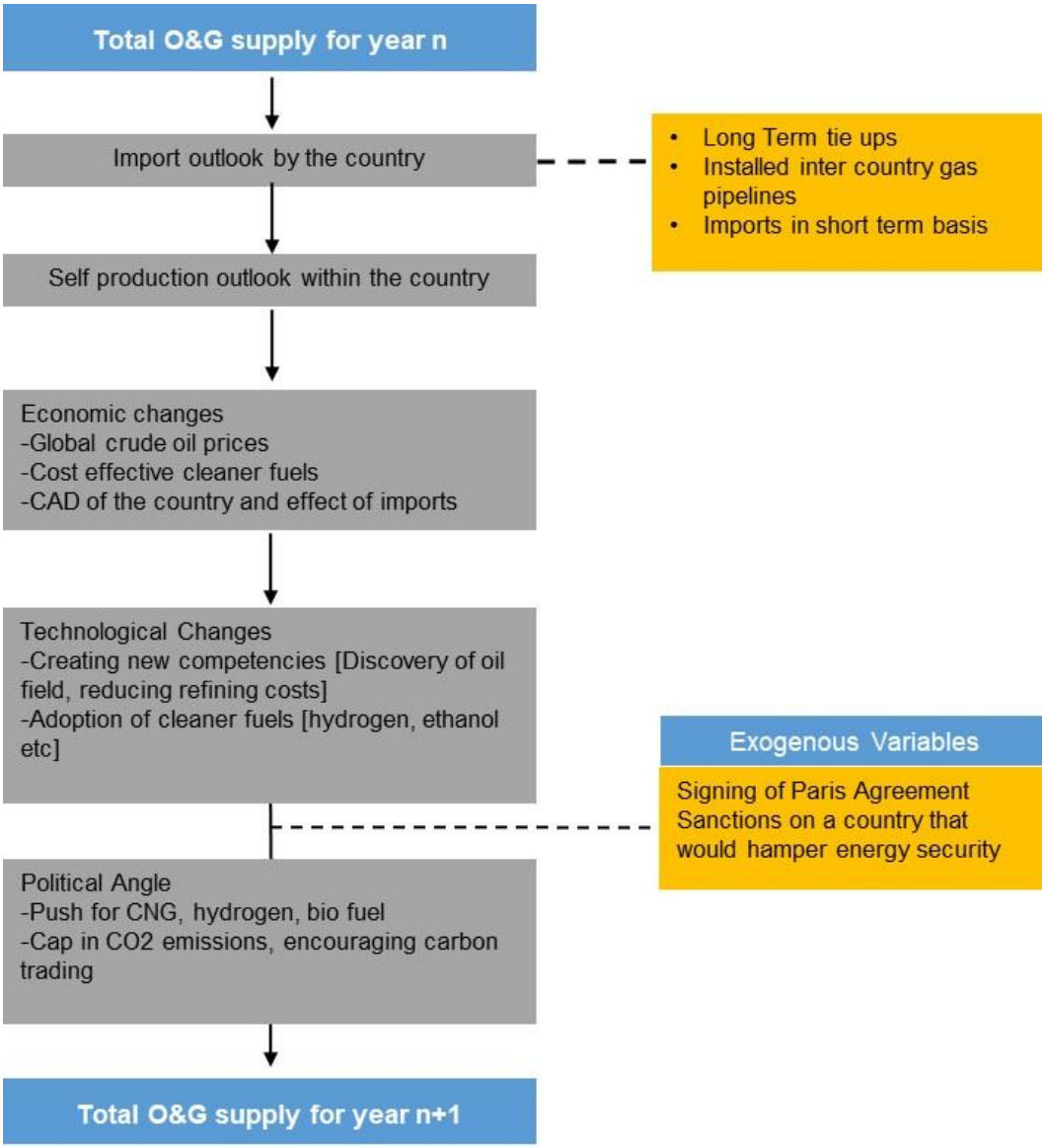


Figure 20: Oil and Gas Forecasting Model (illustrative)



1.2.4 Adding Everything Up

After incorporating future demand and supply scenarios and taking into consideration all endogenous and exogenous factors, primary energy outlook up to 2030 has been derived using the bottom-up methodology.

Energy outlook has also been computed using two top-down methodologies:

- Regressing past primary energy consumption with a country's GDP and calculating future primary energy on the basis of forecasted GDP and derived regression equation
- Future primary energy demand until 2024 is estimated using forecasted GDP and changing energy intensity (as per expectations), 2025 onwards, primary energy is calculated by regressing past primary energy (up to 2024) with corresponding GDP.

Primary energy outlook, estimated using bottom-up approach, is re-validated by top-down approach, to address any significant deviation.

1.3 Assessment of Factors Affecting SAARC Energy Sector

1.3.1 Internal factors

Economy	Growth in trade and commerce
	Investments in energy sector
	Rise in per capita income
	Rise in industrialisation/ shift from labour-intensive to energy-intensive industry profile
	Change in energy intensity
	Change in energy supply reliability
	Energy trade with other nations
Technology	Usage of electric vehicles and bioenergy
	Adoption of clean technologies for energy generation (coal gasification, coal-based methane, efficient boilers in industries, etc.)
	Energy efficiency and demand-side management
	Reduction in costs for fuel extraction
	Change in energy supplies owing to new technology adoption, leading to change in energy mix on a least-cost basis
Regulations	Compliance with GHG emissions
	Adoption of Sustainable Development Goals (SDG)
	Change in fuel standards (adoption of bio-fuels, conversion to BS VI, etc.)
	Push for RE penetration
	Short-term and long-term energy policies for promoting affordable and accessible energy in the nation
	Policies on energy pricing (subsidies, taxes, etc.)
Social	Rise in population and mortality levels
	Change in demographics leading to change in per capita energy demand
	Rise in income levels and urbanisation rates
	Poverty alleviation leading to rise up the energy ladder (rural population moving from kerosene to LPG)
	Change in latent demand
	Rise in disposable income
Energy infrastructure	Existing energy balance
	Present energy supply channels and change in future supply infrastructure
	Change in supply costs, leading to rebalancing of energy mix
	Expected imbalance between unconstrained demand and domestic supply and steps towards bridging the gap
	Government and private participation in augmentation of energy infrastructure
	Outlook on energy imports, including strategic tie-ups, government-to-government contracts, etc.
	Outlook on energy exports

1.3.2 External Factors

Change in world energy supply
Degree of dependence on imports
Sensitivity of change in trade deficit to change in global fuel prices
Geo-political stability/tensions in the country/region
International agreements ratifying change in energy mix
Imposed sanctions and unforeseen trade wars

1.4 Limitations of the Study

This study has been undertaken through a detailed secondary research exercise. As such the detailing, assumptions and the outlook are entirely dependent on the information available in the public domain. While undertaking this study special care has been taken to cover all aspects of the terms of references. This study however has certain limitations including:

- The data utilised in this study has been sourced majorly from government documents of the respective countries. However, in case of data constraints, especially in countries like Afghanistan, reasonable assumptions have been taken based on further secondary reading and information available from reports of other multilateral funding agencies.
- The economic outlook for the country has been developed in line with IMF projections till 2023 beyond which they have been assumed on similar lines.
- While developing the outlook, all the possible developments in terms of infrastructure, policy change, investment and technology have been incorporated based on the information present in the public domain. These developments have been considered as the business as usual scenario. No specific disruptive scenarios or changes have been considered while developing this report which does not find mention in any policy or strategy documents.
- This report primarily focuses on developing SAARC energy outlook till 2030 and showcases the energy mix based on the existing plans of the SAARC Member states. While care has been taken to assess the applicability of these plans in line with COP21 climatic convention to promote renewable energy, no recommendations have been made in this regard.
- While the outlook has been developed for demand, supply and trade, the pricing outlook is limited to directional calls while comparing alternative fuel sources to meet the demand-supply gap
- The report details the existing pricing structure for power and other fuel sources, wherever available. The taxes and duties are on as is basis and have been detailed as per inputs from ministries and customs departments of respective countries

2 Afghanistan

2.1 Country Overview

Afghanistan is one of the least developed nations in the world, hindered by years of armed conflict and war. The UN Human Development Index 2018 ranked the country at 168 out of 188 countries, with poor performance in life expectancy, gender equality, education, and gross national income. With per capita income of $1,824, the country is among the poorest in world with a vast majority of the population living in dire poverty. However, with growing political stability and substantial amount of international aid flowing in to revive the war-ravaged nation, economic growth is expected to pick up.

Table 2: Country Profile: Afghanistan

	Factors	FY13	FY17[#]
Demographics	Population [in millions]	26.88	29.22
Macro-economic scenario	GDP growth rate	10.9%	3.6%
	Sectoral growth rate		
	a. Industry	7.8%	-1.9%
	b. Services	16.0%	2.4%
	c. Agriculture	3.2%	12.4%
	Inflation	6.4%	5.65%
Fiscal position	Exports [$ million]*	414.5	596.5
	Imports [$ million]**	8,932.4	6,534.1
	Trade balance [$ million]	-8,517.9	-5,938

Source: Statistical yearbook

**Exports do not include smuggled and re-exported goods*
***Imports do not include smuggled and duty-free goods*
[#]*Actual data for fiscal 2018 was not available*

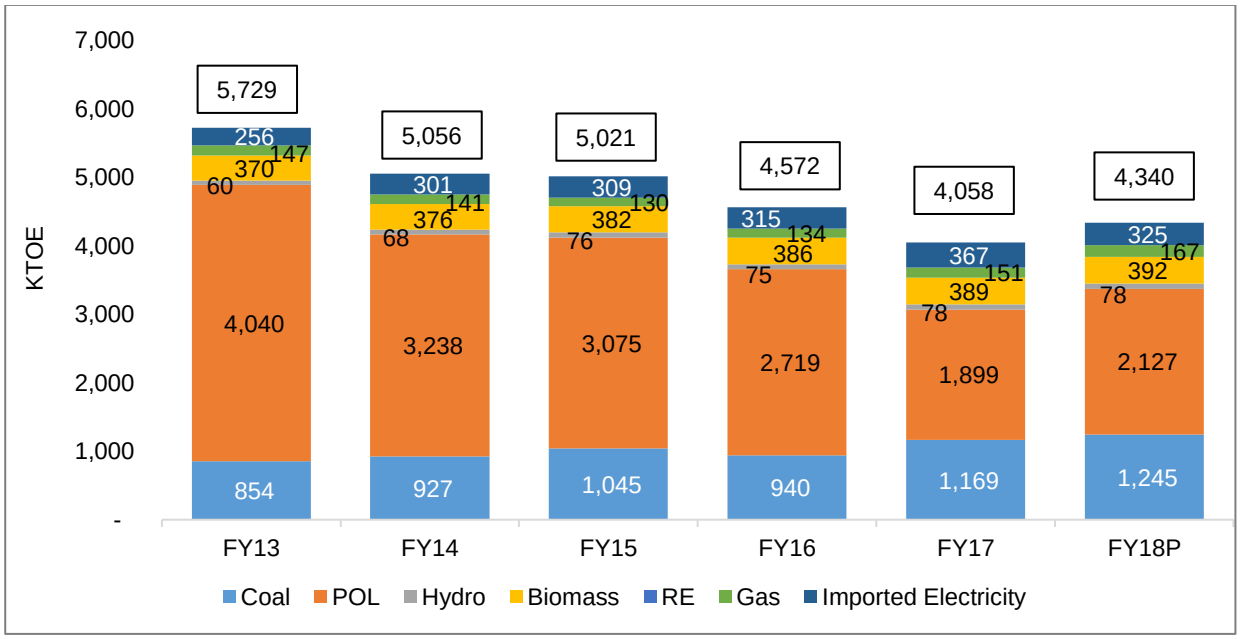
2.1.1 Overview of Energy Structure

Energy Mix

With only 9% of the rural population and 30% of the urban population enjoying access to electricity, primary energy consumption in Afghanistan is low. More than 75% of power and 100% of POL requirements are imported. Cost of imported energy has increased 14 times, from $16 million to nearly $224 million from 2007 to 2015 (ADB, 2015). With heavy reliance on imports, energy procurement is susceptible to future price rise, political instability of neighbours, and limited enforceability of commercial contracts. Lack of access to affordable energy has resulted in high usage of biomass as primary energy (~9% as of fiscal 2018) and limited economic and social opportunities for people in the country. More than 80% of rural population is estimated to have been using solid fuels for cooking. Despite high gas and coal deposits and large RE potential, the country's electrification rate is low and a majority of population lack access to energy. This offers huge opportunity for the country to increase its primary energy consumption manifold. Such an

increase would hinge on policy, sector and institutional reforms; flow of international aid; and growth in private participation. Primary energy consumption in the country has reduced from 5.73 MTOE in fiscal 2013 to 4.34 MTOE in fiscal 2018 at CAGR of 5%, owing to sizeable fluctuation in POL demand, led by changing demand from the government and coalition forces.

Figure 21: Primary Energy Supplies by Source: Afghanistan



Source: Central Statistics Organisation, SAARC Energy Databook

Domestic Availability and Imports of Fuels

Afghanistan is highly dependent on imports for meeting its energy demand. Significant imports of POL products and electricity are undertaken. Here is a snippet showing domestic production and import of the major fuels over fiscals 2013-2017.

Table 3: Domestic Production and Import of Major Fuels: Afghanistan

Fuel	Supply type	FY13	FY17
Coal [in '000 tonne]	Domestic production	1,479.6	1,364.8
	Imports	-	-
Crude oil [in '000 tonne]	Domestic production	1.1	1.1
	Imports	-	-
Petroleum products [in '000 tonne]	Domestic production	-	-
	Imports	2,082	1,757
Gas [in million cubic metres]	Domestic production	160.3	165.3
	Imports	-	-
Electricity [in GWH]	Domestic production	883	1,076
	Imports	3,071	4,400

Source: Central Statistics Organisation, Economic Survey

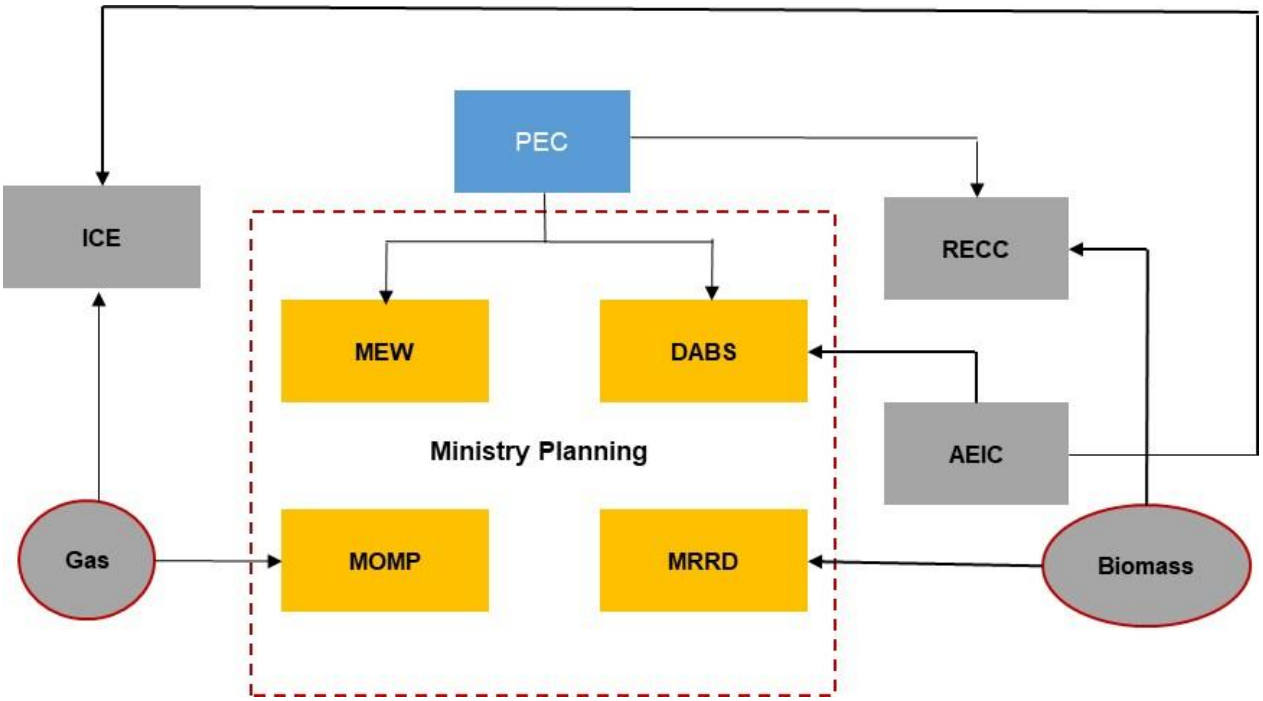
2.2 Institutional and Regulatory Framework of Energy Sector

2.2.1 Planning and Regulatory Bodies

Afghanistan's energy sector is managed principally by Ministry of Energy and Water (MEW), Government of Afghanistan, which is responsible for policy formulation in power, coal and gas and other primary fuels with the exception of POL products, which fall under the purview of Ministry of Mines and Petroleum. The detailed sector-level organograms, segregated across power and POL products are discussed below.

Power Sector

Figure 22: Organogram of Power Sector: Afghanistan



DABS: Da Afghanistan Breshna Sherkat; MEW: Ministry of Energy and Water; MRRD: Ministry of Rural Reconstruction and Development; MOMP: Ministry of Mines and Petroleum; AEIC: Afghan Energy Information Center; RECC: Rural Energy Coordination Committee; ICE: Inter-Ministerial Commission for Energy; PEC: Provincial energy committees

Below is the brief overview of the power sector public stakeholders in Afghanistan:

- *The Ministry of Energy and Water,* or MEW, aims to improve energy access in the country through policy formulation, strategy and investment planning, project feasibility studies, and sector development programmes. In collaboration with the MOMP, the MEW provides estimates on overall natural resources available for energy production, e.g., coal, gas, oil, hydro, solar, wind, biomass, geothermal, etc.

- *Da Afghanistan Breshna Sherkat,* or DABS, is a 100% state-owned company, established under 'Corporations and Limited Liabilities Law' of Afghanistan. DABS is a limited liability company with all its equity shares owned by ministries of finance (45%), energy and water (35%), economy (10%) and urban development (10%) (DABS AoA, 2008). The company was corporatised on May 4, 2008, and replaced Da Afghanistan Breshna Moassassa (DABM) – a government enterprise -- as the national power utility. It was the sole power for transmission and distribution in generator, transmitter and distributor in the country. However, with the enactment of the electricity law, independent power

producers (IPPs) can invest in generation and distribution companies. DABS' main responsibilities and duties are to:

- Provide customers with cost-effective, reliable, and safe electricity supply;
- Purchase and procure cost-effective electricity from sources within and outside Afghanistan;
- Sell electricity to foreign countries when necessary; and,
- Design, establish, manage, maintain and oversee power generation facilities, transmission and distribution systems, including substations, transformers, cable networks, and dispatch and control systems

- *Ministry of Rural Reconstruction and Development,* or MRRD, was established to develop and implement programmes promoting responsible social and financial growth in rural areas, primarily in the non-farm sector. The MRRD chalks out electrification and energy security programmes and enables small, independent power projects which can improve lives of rural households and communities, cut off from grid supply. Under the National Rural Access Program (NRAP), the MRRD strives to develop rural renewable energy through community participation and partnerships with the rural sector. The ministry is in charge of off-grid projects and all other initiatives in the renewable energy sector up to the threshold of 200 kW, located within its jurisdiction.

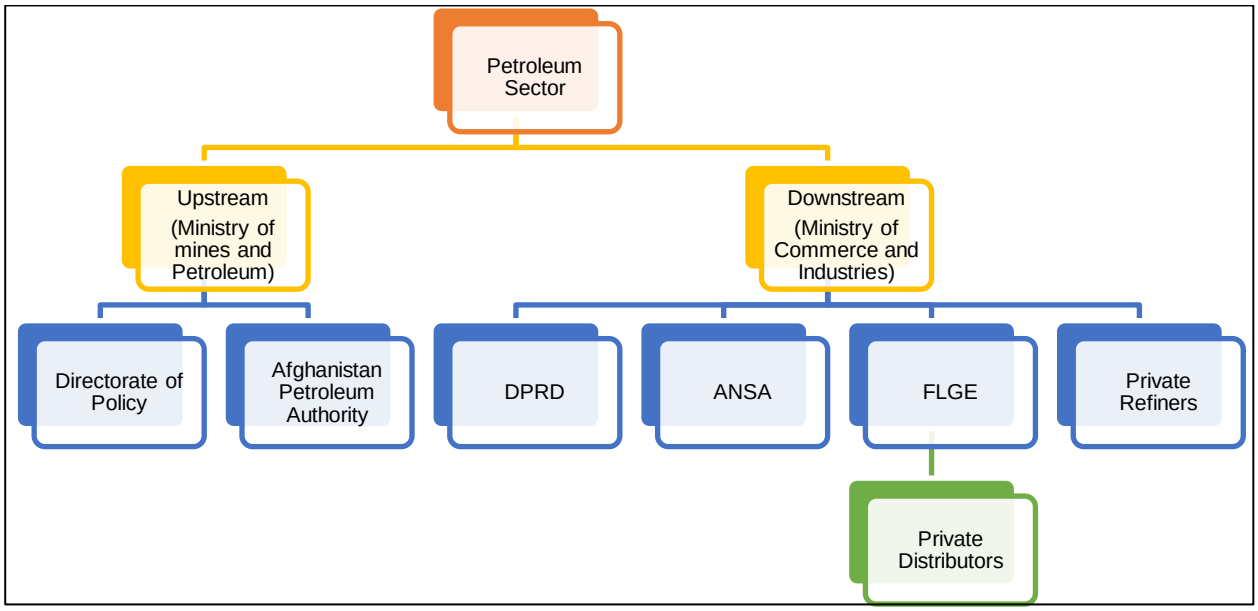
- *Provincial energy committees*: These work with the national ministries and authorities to implement strategies and sectoral plans.

- *Rural Energy Coordination Committee,* or RECC, aims to promote and facilitate access to rural energy in rural areas of Afghanistan through appropriate technologies. The body identifies policy and strategy needs for rural energy development, develops standard guidelines for various renewable energy technologies, prepares rural and renewable energy development master plans for next 20 years, and develops and encourages use of provincial electrification plan with baseline and potential assessment.

- *Inter-ministerial Commission for Energy,* or ICE, was established through a presidential decree in 2006 to provide a platform for coordination of energy sector activities in Afghanistan. ICE brings together 40–50 representatives from various government agencies, embassies, multilateral development banks (MDB), private sector, environmental organisations, and NGOs to talk about pressing issues of the energy sector in Afghanistan. This setting is perceived to be vital for coordination and harmonisation of agendas and plans of stakeholders. However, from a practical point of view, no executive decisions are made during the ICE meetings. The meetings are meant for sharing information with a wide array of participants, updating all on progress reports and exchanging news of portfolio performances.

Hydrocarbon Sector

Figure 23: Organogram of Hydrocarbon Sector: Afghanistan



- *The Ministry of Mines and Petroleum,* or MOMP, is the overarching body responsible for developing policies, attracting investment and regulating the upstream oil and gas sector in Afghanistan. The Directorate of Policy under the MOMP develops policies to govern and regulate the oil and gas and mining sectors. It also oversees implementation of these policies and is responsible for maintaining data relating to crude oil and petroleum products. The Afghanistan Petroleum Authority (APA) was established under the ministry in 2013 to undertake project management, governance, regulation and supervision of the country's oil and gas sector. It primarily serves as the technical arm of the MOMP.
- *Ministry of Commerce and Industries,* with its Downstream Petroleum Regulation Department (DPRD) and Fuel Liquid Gas Enterprises (FLGE), undertakes downstream activities in the oil and gas sector, including demand assessment, imports and pricing. It also represents the government in entering into oil and gas-related agreements.
- *FLGE* is the key body for the downstream segment of oil and gas sector in Afghanistan, responsible for importing oil and gas, issuing import and distribution licensing, managing storage, and controlling prices.
- *Afghanistan National Standard Authority,* or ANSA, is an independent body, responsible for quality control of petroleum products and drafting of environmental safety laws. It charges a service fee for undertaking petroleum quality check-up.

2.2.2 Regulatory and Policy Framework

The Hydrocarbons Law, 2014, developed by the MOMP, governs hydrocarbon exploration in Afghanistan. Hydrocarbon regulations were enacted under the provisions of this law to regulate:

- Hydrocarbon operations' contract bids;
- Execution of hydrocarbons operation contracts and issuance of licenses and authorisations;
- Identification of hydrocarbon blocks and contract areas; and
- Regulation of supervision of hydrocarbons' operations

The Afghanistan National Renewable Energy Policy aims to mainstream renewable energy in the national energy sector planning through different projects in the country. The policy is aligned to the Power Sector Master Plan and the Afghanistan National Development Strategy to set a framework for deployment and growth of renewable energy. The salient features are:

- Target for deploying 350-450 MW of renewable capacity by 2032
- Support the involvement of the private sector, government and non-government organisations, donors and the people of Afghanistan
- Optimally deploy and utilise renewable energy resources in all possible manner

2.2.3 Government Support: Pricing, Existing Subsidies on Fuel and Controlling Regime

Our secondary reading shows that prices of key energy sources are ascertained by federal agencies in line with directions of the government. However, no specific governmental policy could be ascertained for the same. Since Afghanistan is largely dependent on imports, multiple duties detailed below serve as a strong revenue source for the government.

Table 4: Import and Export Duties: Afghanistan

	Description	ID	ED	SAFTA ID
COAL	Anthracite, bituminous, other	2.5%	2.5%	2.5%
	Lignite	2.5%	2.5%	2.5%
	Coke and semi-coke of coal	5%	5%	5%
PETROLEUM OILS	Gasoline for aviation and vehicle	12%	12%	12%
	Light distillate	12%	12%	12%
	Naphtha (Primagon)	12%	12%	12%
	Gasoil (Diesel)	12%	12%	12%
	Gasoil (Diesel) 'L05 – 62'	14%	14%	14%
	Jet fuel (aviation jet oil)	12%	12%	12%
	Kerosene, lubricant oil, grease, middle distillate, heavy distillate	8%	8%	8%
GAS	Natural gas	2.5%	2.5%	2.5%
	Propane, butane, ethylene, butylene	2.5%	2.5%	2.5%
ELECTRICITY		2.5%	2.5%	2.5%

ID: Import duty, ED: Export duty: SAFTA ID: Import duties applied on imported goods produced in SAFTA countries, based on certificate of origin

Source: Afghanistan Tariff Structure

2.3 Overall Energy Outlook 2030

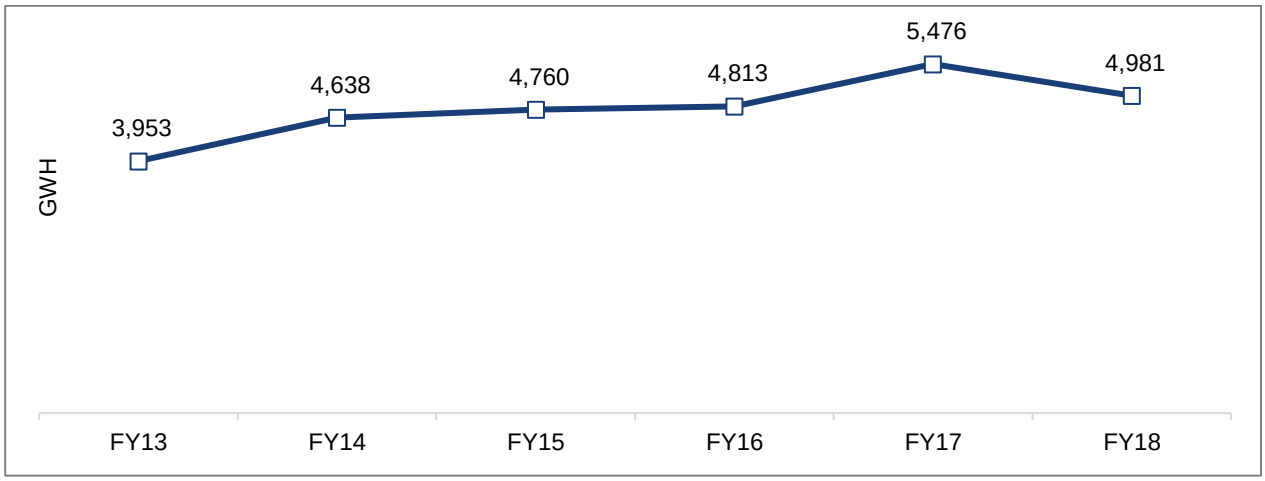
Overall energy outlook of Afghanistan has been assessed by undertaking a detailed review of all the primary sources of energy, including coal, gas, hydro, POL products and renewable. Since power sector serves as a major consumer of these sources and is the single largest supplier of secondary energy, its analysis precedes the fuel-wise discussion.

2.3.1 Power Demand, Supply Review

Power Demand Position

With power accessibility at a low 35% in the country and 90% of un-electrified households living in rural areas, the sector is yet to evolve in Afghanistan. Only ~9% of the rural population and 30% of the urban population have access to electricity. Average per capita electricity consumption is between 100 KWH and 150 KWH per person per year which is among the lowest in the world. Three decades of armed conflict ravaged the nation, stalling development of an efficient power system and damaging and demolishing existing systems. Constrained demand has grown from 3,953 MUs in fiscal 2013 to 4,981 MUs in fiscal 2018, at CAGR of 8.9%.

Figure 24: Power Demand in Afghanistan: Review



Source: Economic Survey, CSO, Energy Databook

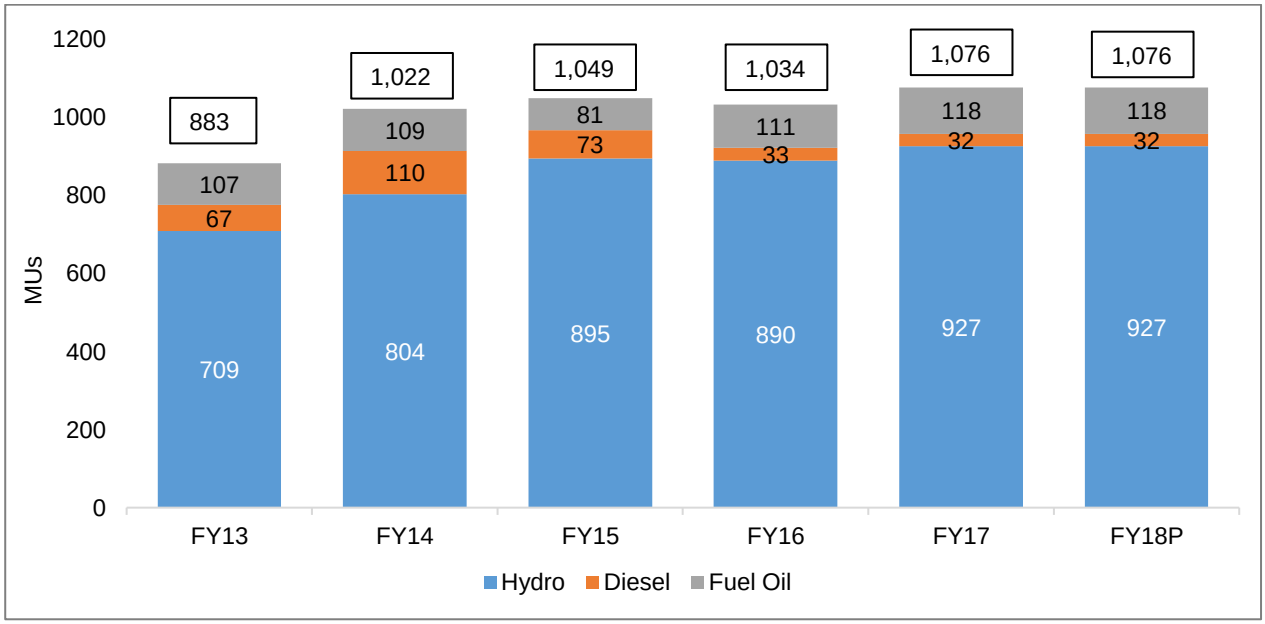
Power Supply Position

More than $4 billion has been spent for upgradation of power infrastructure and electrification in Afghanistan since 2002. In spite of that, the sector continues to languish. As much as ~80% of total power requirement is imported from Central Asian republics (CARs), such as Tajikistan, Uzbekistan and Turkmenistan, and Iran. As of fiscal 2018, imports from Tajikistan and Uzbekistan comprised 27% and 23% of total power requirement. Domestic power plants, with a cumulative capacity of ~623 MW installed in the country, generated 1,076 MUs in fiscal 2018. In fiscal 2017, system losses and rampant power thefts amounted to ~47%.

Existing plants also continue to be underutilised. Diesel-fired plants, North West Kabul PP and Tarakhil PP generate intermittent power (only during peak demand) due to high operation and maintenance (O&M) costs, and expensive fuel and supply issues of diesel (chances of theft). Most of the diesel units, supplying to rural communities through the National Solidarity Program, to provide limited service to rural areas, require overhaul or replacement. Hydro plants, which comprise ~46% of total installed capacity, are mostly run-of-the-river.

Currently there are 14 Hydro Power Plants, 14 diesel power plants, and two oil-based plants operating in the country. Hydropower accounted for ~86% of total power produced in the country in fiscal 2018.

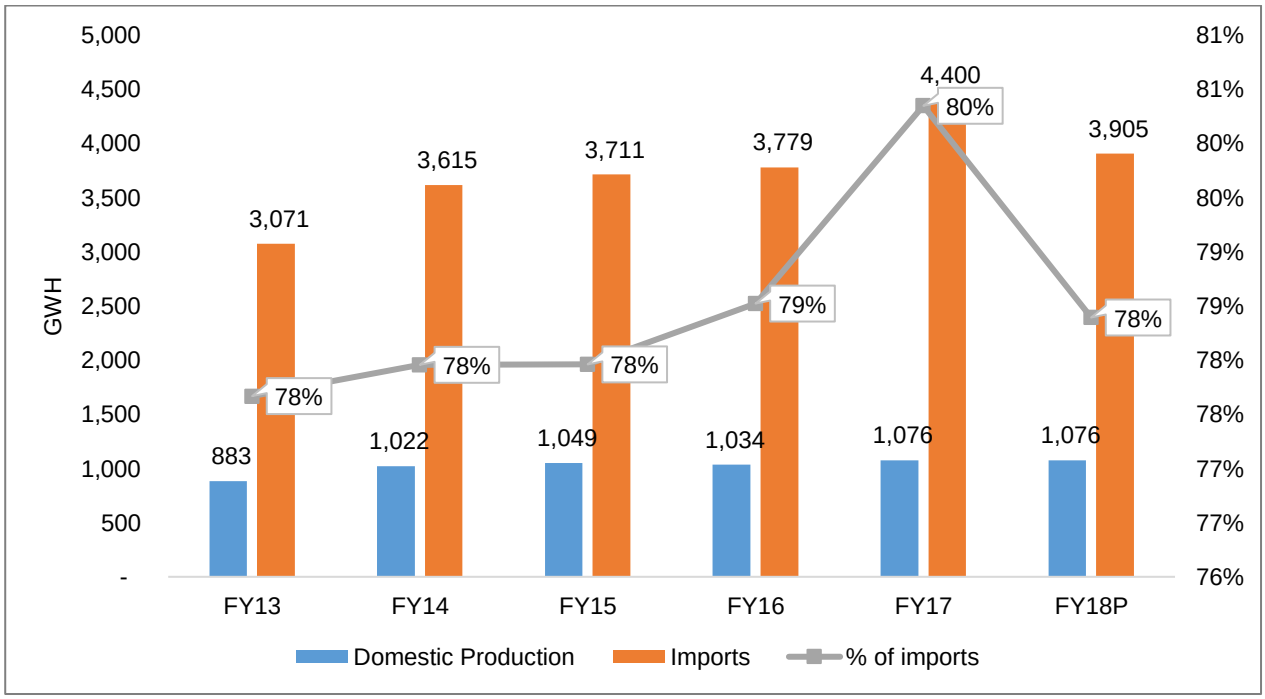
Figure 25: Domestic Power Production: Afghanistan



Source: Economic Survey, CSO, Energy Databook

Imports from the neighbouring countries continue to dominate majority of power requirement needs of Afghanistan. Lack of a unified national electricity grid in the country impedes seamless transfer of power from generation to source. The country at present has several isolated grids or islands which are fed by power from Iran, Turkmenistan, Tajikistan and Uzbekistan. The National Infrastructure Plan (NIP) 2016 highlights plans to synchronise the separate power supplies and interlinking the isolated grids. As on date, several such interlinking projects are underway. As of fiscal 2018, the country continues to rely heavily on power imports (~78% of total power requirement).

Figure 26: Power Supply Review -- Domestic Production and Imports: Afghanistan



Source: Economic Survey, CSO, Energy Databook

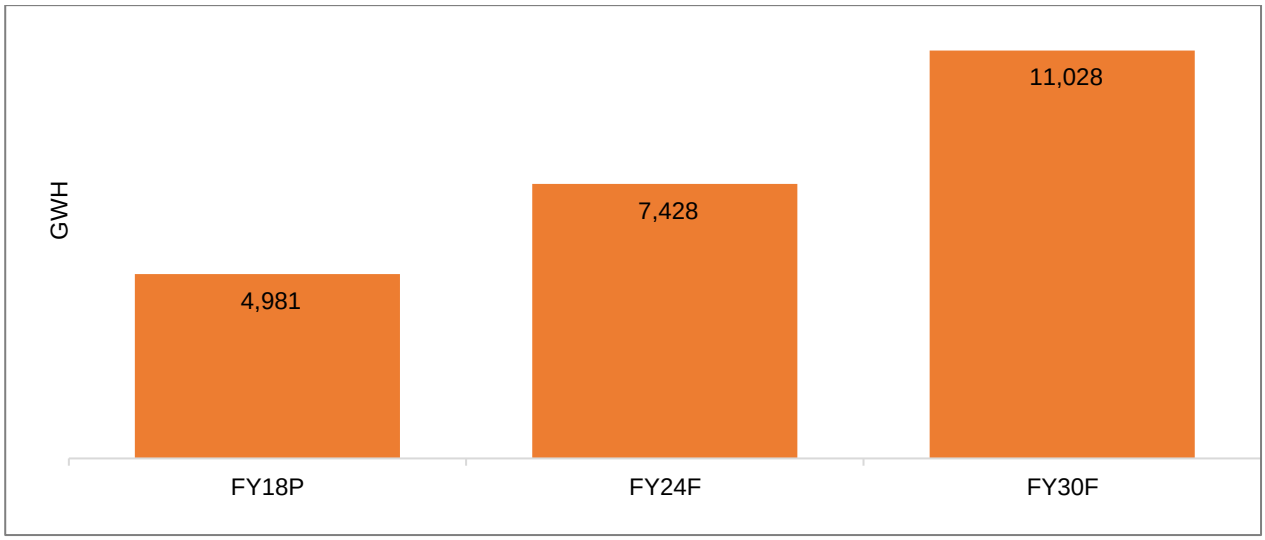
2.3.2 Power Demand, Supply Outlook

Power Demand Outlook

As per the Afghanistan Power System Master Plan 2013, gross demand in the country will grow approximately seven times to reach 15,909 MU in 2032 in base case. This may be slightly over-optimistic and electrification levels to that extent may not be achievable. Gross demand is expected to reach 10,985 MU by fiscal 2030, growing at a modest CAGR of 6.2% from fiscal 2018.

Grid electrification levels are expected to reach ~52% by fiscal 2030, from current levels of 35%, thereby bringing an additional 1.15 million households onto the power grid. System losses are also expected to dip marginally to ~30% from existing 38%. The Kabul city and province and the provinces of Laghman, Logar, Nangahar and Paktiya are expected to account for ~45% of the demand in the country with connection rates and high average consumption levels. The other consumer areas (North East Power System and South East Power System) will show relatively low power requirement due to lesser consumer addition and power usage.

Figure 27: Power Demand Outlook: Afghanistan

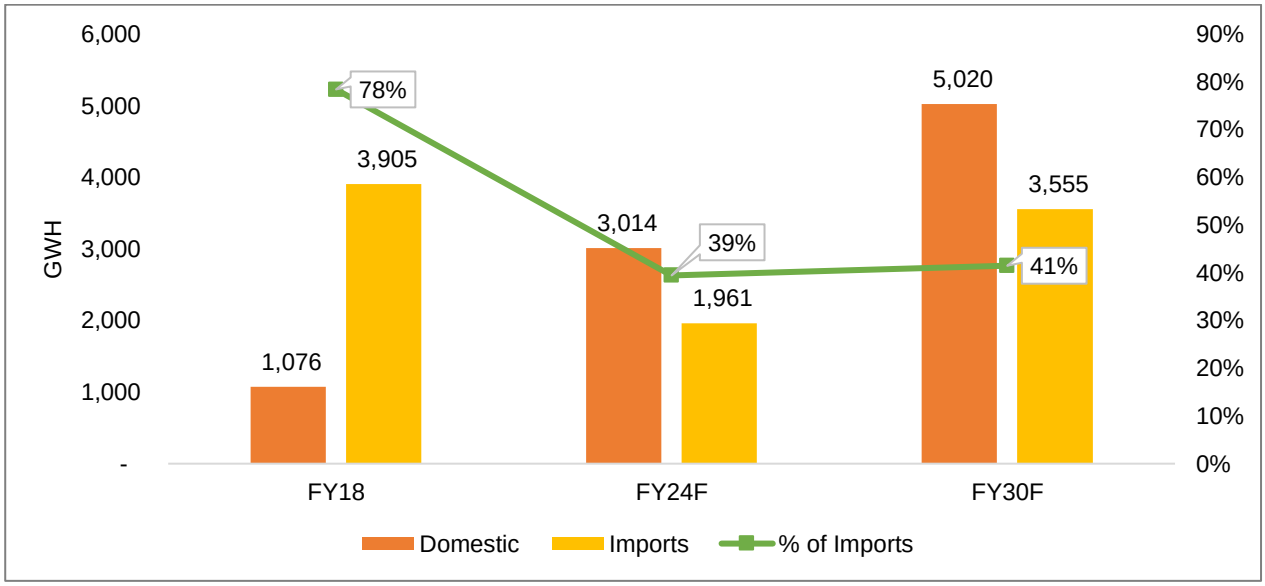


Power Supply Outlook

Installed capacity in the country is expected to reach 2,377 MW by fiscal 2030, thereby increasing domestic power generation to 5,020 MU from current levels of 1,076 MU. However, the reliance on imports will continue throughout the period, albeit to a lower extent. The transmission line network is expected to expand with additional interconnections and cross-border infrastructure augmentation. Uzbekistan has signed a new power purchase agreement (PPA) for construction of a new 500 kV transmission line, and Turkmenistan is in the process of augmenting the existing transmission line from Tourgundi to Herat to account for an additional 300 MW of power transfer.

An accelerated distribution programme and a shift from island grid to integrated grid is expected in the future. Additionally, 15 HPP, eight solar power plants, and three wind power projects are expected to come up by fiscal 2030. Also, new gas-based plants at Mazar-i-Sharif and Sheberghan are expected to be set up in fiscals 2020 and 2022, respectively, which will utilise domestic gas. The country is not expected to set up any large-scale, coal-based power plants and will source power from gas-based plants, RE-based plants and through imports. This is in line with the nation's INDC commitments to reduce 13.6% of greenhouse gas (GHG) emissions from its business-as-usual (BAU) scenario by 2030. With emissions from gas and RE-based power plants significantly lower than those from coal fired plants, Afghanistan will reduce its CO_2 emissions emanating from the power sector going forward.

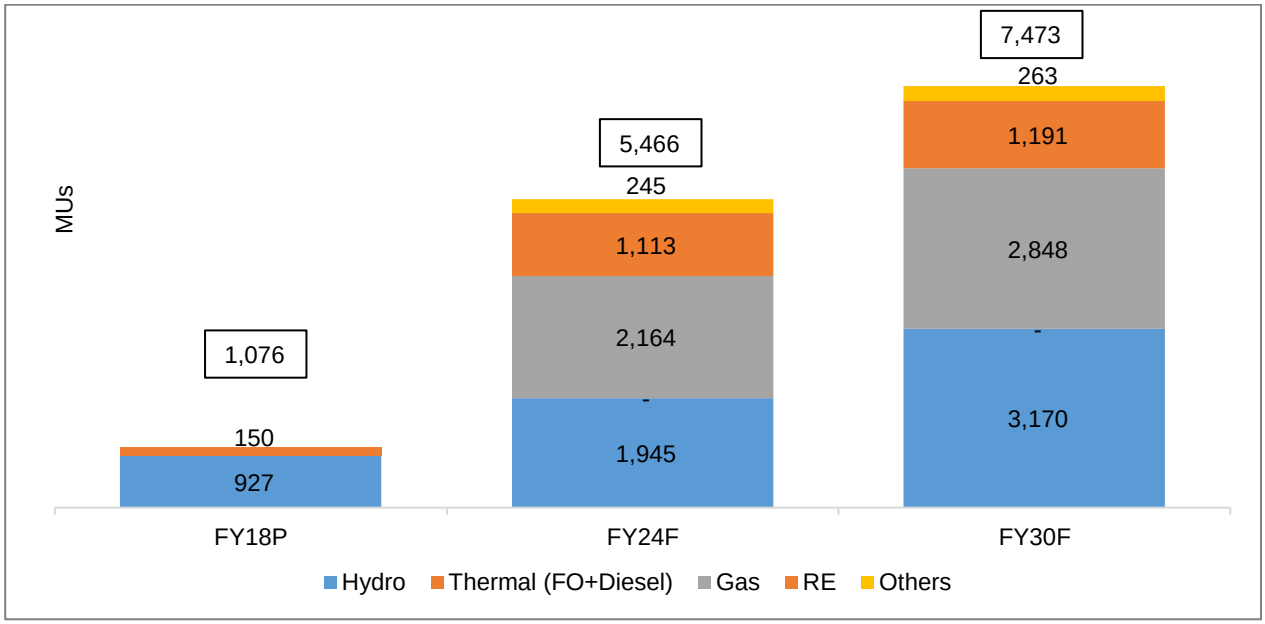
Figure 28: Power Supply Outlook - Domestic Production and Imports: Afghanistan



In terms of generation, the country's reliance on hydro power will continue. Hydro power generation will grow approximately 3.5 times to reach ~3,170 GWH by fiscal 2030 on the back of several new hydro-based plants, expected to come into production. Major HPPs includes Sagi HPP (300 MW), Kata Sang HPP (140 MW), Kajaki (100 MW), and Salma HPP (42 MW). At 66%, gas-based power plants will become the largest contributor to power generation by fiscal 2030 as several such units are expected to commence production. Increased domestic production and sustained imports from neighbouring countries will help the country meet the power demand.

With the decade-long war now over, the country is poised to grow at a higher rate. Distributed generation and micro grids will be pivotal in providing power access to remote areas which are away from centralised power plants. With weak and unreliable transmission and distribution (T&D) infrastructure, small solar, wind and biomass-based plants will provide power to local communities. Apart from expanding energy security in the nation, decentralised systems will offset polluting kerosene and bio gas with cleaner energy.

Figure 29: Outlook for Domestic Power Production (by Source): Afghanistan



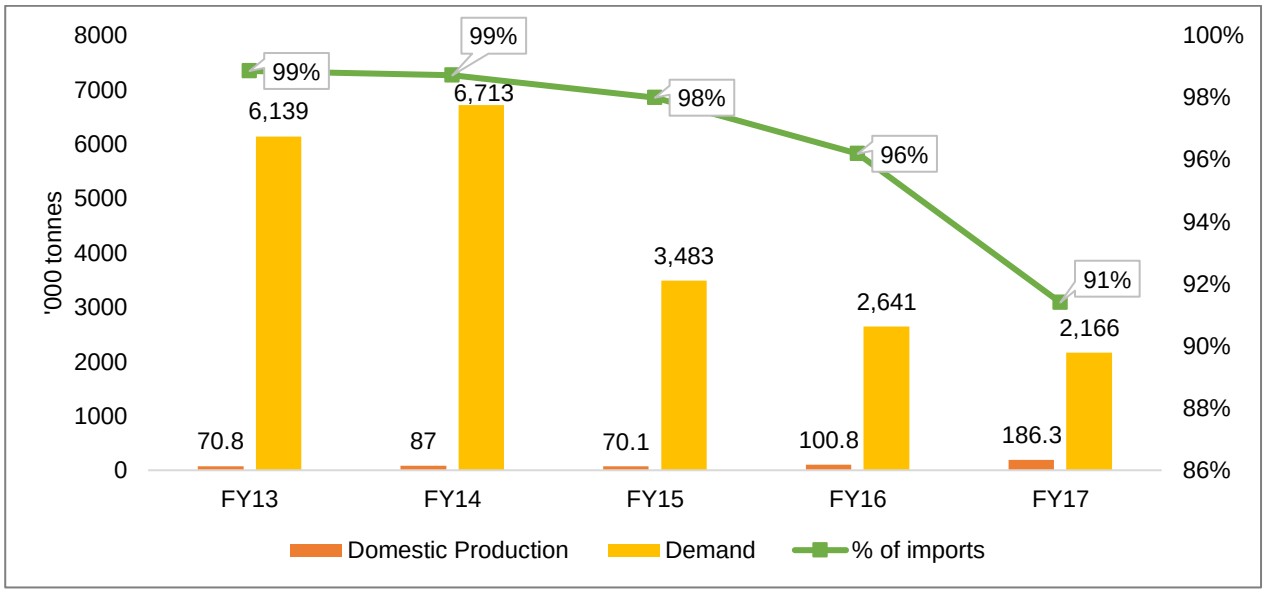
2.3.3 Fuel-Wise Energy Review and Outlook

Coal

Demand, Supply Review

Coal is mainly used by the cement and construction industries. There are three major cement plants (Ghori-I and -II, Jabal-e-Seraj, Herat) in the country with a cumulative production capacity of 2,200 TPD. Although domestic cement production has clocked a strong CAGR of ~23% from fiscal 2013 to 2018, it serves only a minuscule 9% of the country's annual cement demand. Afghanistan meets most of its cement requirement through imports from neighbouring Pakistan and Iran.

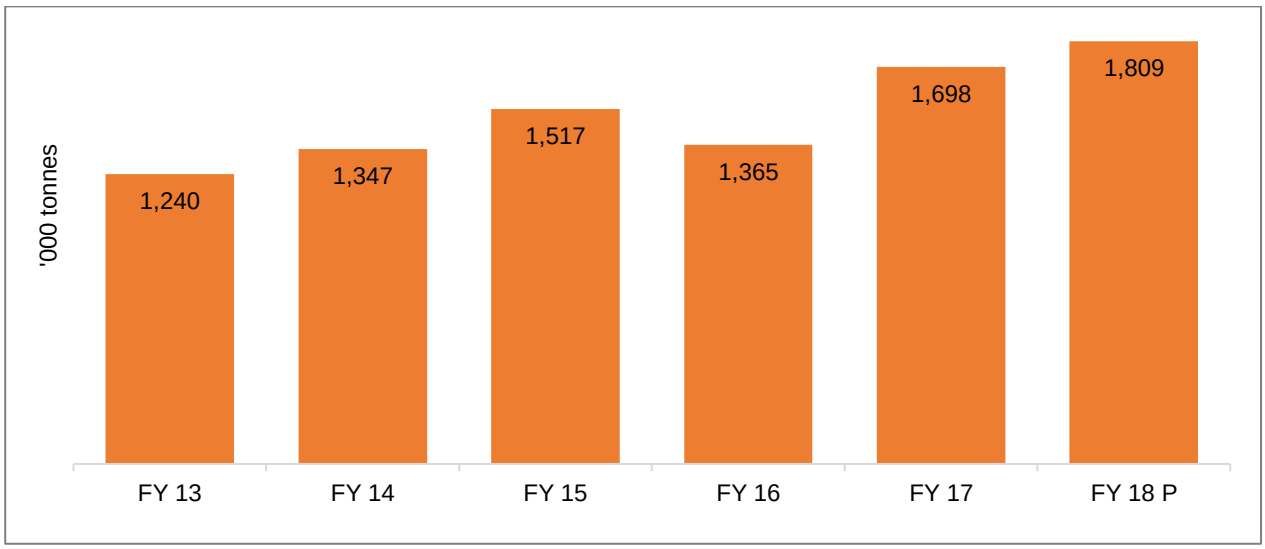
Figure 30: Review of Domestic Production and Imports of Cement: Afghanistan



Source: Economic Survey, CSO, Energy Databook

The growth of the construction sector in the country has been tepid, clocking a CAGR of 4% over fiscals 2013-2017. At present, the country does not have any coal-fired power plants in operation. Overall, coal demand in Afghanistan has risen from 1.2 million tonne in fiscal 2013 to 1.8 million tonne in fiscal 2018.

Figure 31: Review of Coal Demand: Afghanistan

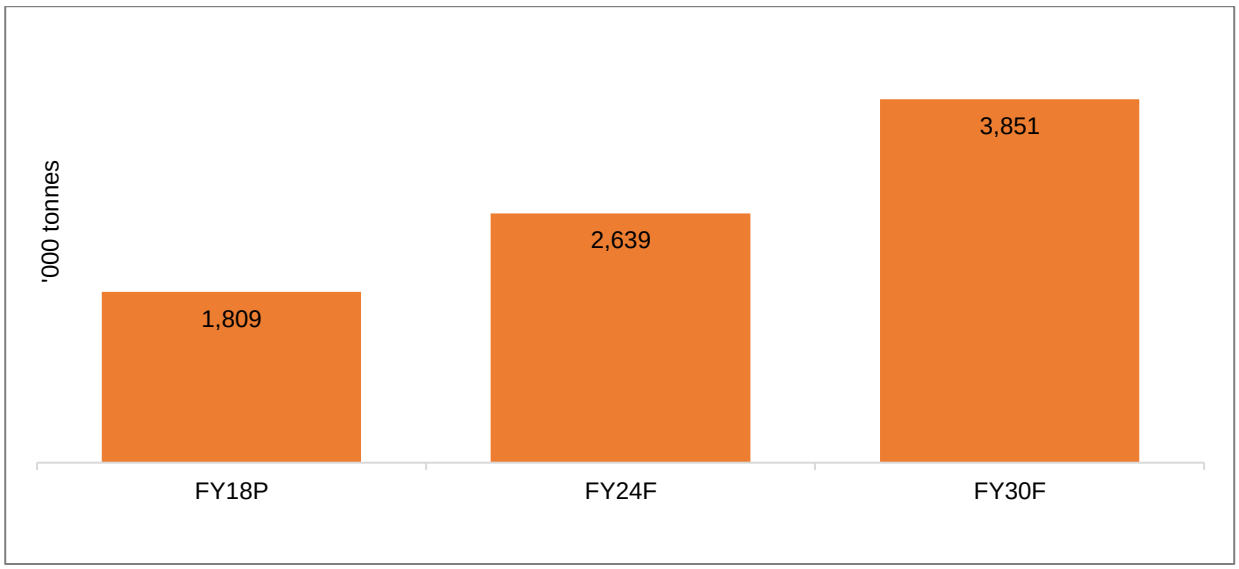


Source: Economic Survey, CSO, Energy Databook

Demand, Supply Outlook

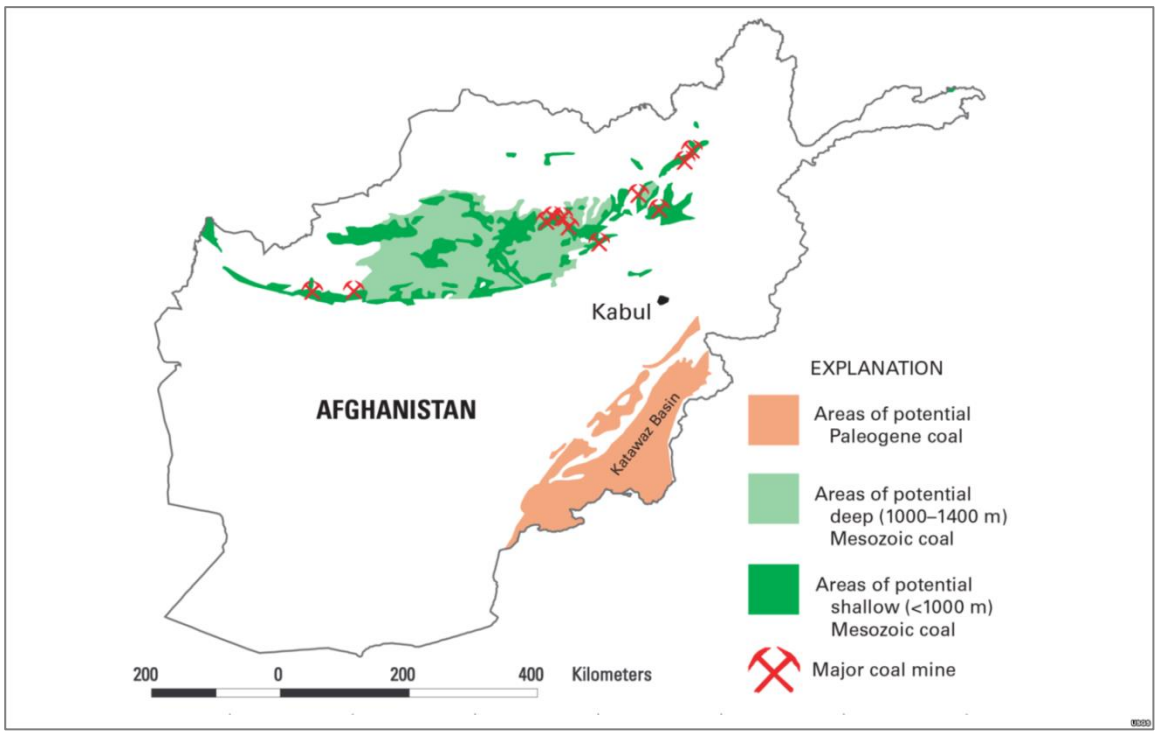
Demand for coal is expected to rise in line with the growth of cement production in the country. Any additional utility for coal (power production, domestic use) is unlikely. Coal requirement will rise to ~2.6 million tonnes by fiscal 2024 and ~3.85 million tonnes by fiscal 2030 at a healthy CAGR of 7% because of additional 2,000-3,000 TPD of cement plants coming online by fiscal 2030. Cement plants' energy efficiency will improve going forward, reducing emissions and in line with the INDC commitments.

Figure 32: Outlook for Coal Demand: Afghanistan



Afghanistan has a large reserve of coal resources. Major coal deposits are located in the northern, central and western regions of the country.

Figure 33: Major Coal Deposits and Coal Mines in Afghanistan



Source: United States Geological Survey

However, a large chunk of coal mined is illegal and overseen by warlords and politicians. Digging pits and taking out coal without regulatory approvals is rampant. As per a 2016 report by Special Inspector General for Afghanistan Reconstruction (SIGAR), the US has pumped in more than $500 million since 2009 to clean up the regulatory structure for Afghanistan's extractive industries. The National Coal Policy, formulated in 2011, stressed on the development of integrated coal mines in Afghanistan. However, it failed to make significant headway. Also, mining is a big revenue for the Taliban and several deposits lie in Taliban-led areas. Many companies have been paying insurgents to ensure protection and safety. In early 2018, there were three reported incidents of insurgents torching coal trucks and attacking coal mines. However, amid grave security concerns, the Afghanistan government is in advanced stages of negotiation with several US companies to mine coal in the country.

Going forward, domestic coal production is expected to grow in line with recurrent demand (at a CAGR of ~7%) and reach annual production of 3.85 million tonnes by fiscal 2030, thereby curbing import requirement.

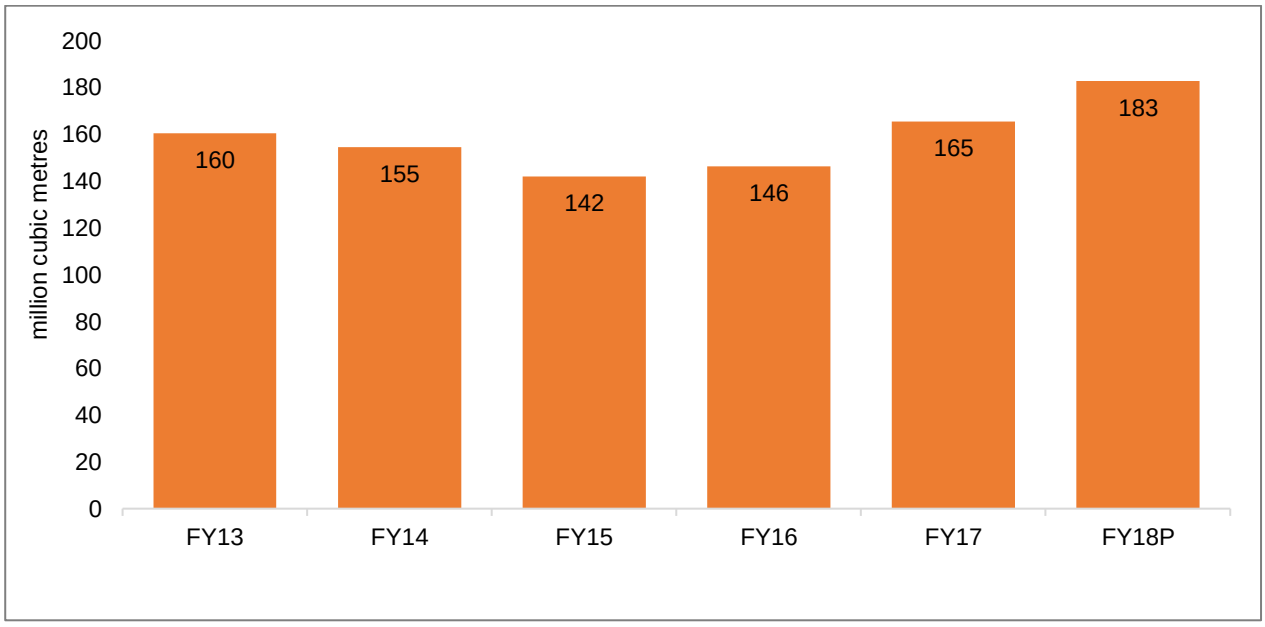
Gas

Demand, Supply Review

Gas is solely being used to make fertilisers. No gas-based power plants are in operation currently. The country's sole fertiliser plant, the Kud Bergh facility, is capable of producing 105,000 tonnes annually. However, due to shortage of gas, lack of spare parts and infrastructural upgrades, the plant is being highly underutilised. As of fiscal 2017, the plant produced only 41,000 tonnes of fertiliser at a capacity utilisation of 39% and amounting to only 11% of the domestic fertiliser demand. The remaining demand is met through imports. Most of the urea is being imported (or smuggled) from Pakistan whereas di-ammonium phosphate (DAP), another commonly used fertiliser, is being imported from the US, China, Australia and Pakistan. Gas is not used for other commercial purposes and power production.

A small amount of natural gas is being distributed through a network of pipelines to domestic consumers in Sheberghan, Khoja Dokho, Aqcha and other villages in the Jowzjan province. However, in volume terms, it is insignificant. Overall, the country's gas demand has grown from 160.3 million cubic metres in fiscal 2013 to 183 million cubic metres in fiscal 2018 (provisional) at a CAGR of 2.8%.

Figure 34: Gas Demand in Afghanistan - Review



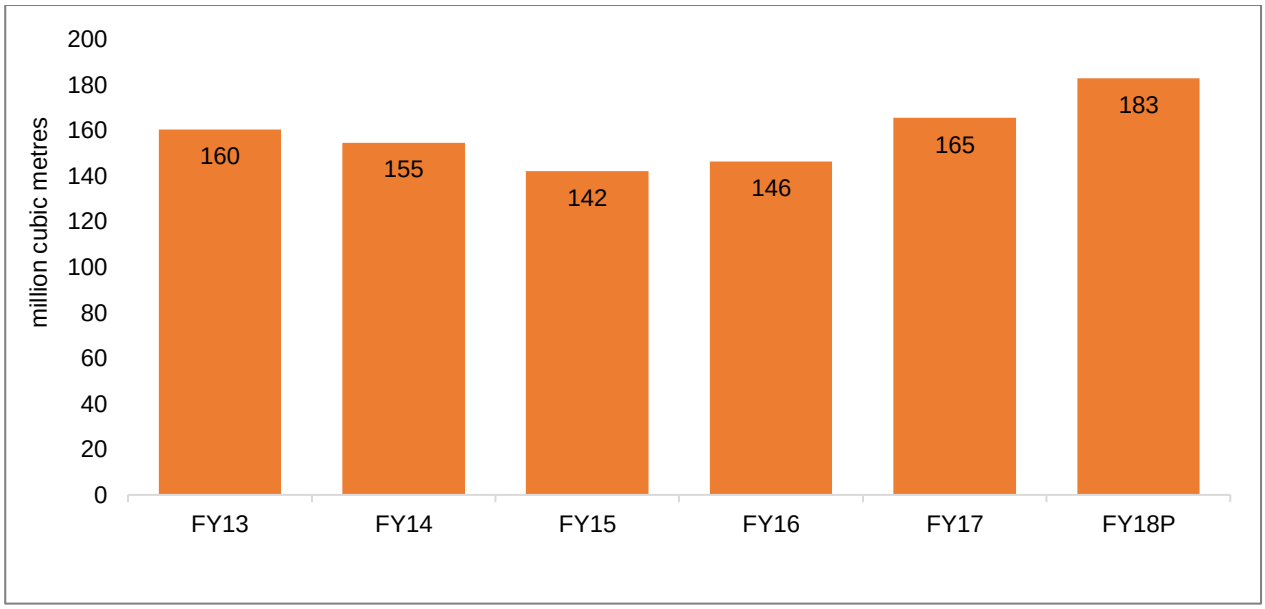
Source: Afghanistan Oil and Gas Industry Report

In the 1960s, during the Soviet era, 144 natural gas wells (exploration, observation and exploitation) were drilled in the three major producing gas fields - Gerquduq, Yatimtaq and Khoja Gogerdak. Several other exploration activities were also carried out in the Bashikurd, Juma, Checkchi, Khoja Bolan, Jangle-e-Kolan, and Shakarak gas fields. About half of the wells were completed as exploitation wells and produced gas at varying levels over the past 60 years. Until the Soviet withdrawal in 1989, natural gas produced from the Sheberghan gas fields was exported to the Soviet Union.

Following the Soviet military's withdrawal, natural gas production and operations in Afghanistan dropped drastically. No additional exploration and development were done during the Afghan civil war and by the Taliban government. Following the American invasion and removal of the Taliban government, operations resumed slowly. As of 2011, 34 natural gas wells in the three producing gas fields were in limited production. Afghan Gas Enterprise successfully rehabilitated a well in the Shakarak gas field in early 2011, which represented the first major addition to Afghanistan's natural gas supplies in decades.

As of fiscal 2018, ~180 million cubic metres of gas was produced in the country. Gas is not being imported at present.

Figure 35: Gas Production in Afghanistan - Review

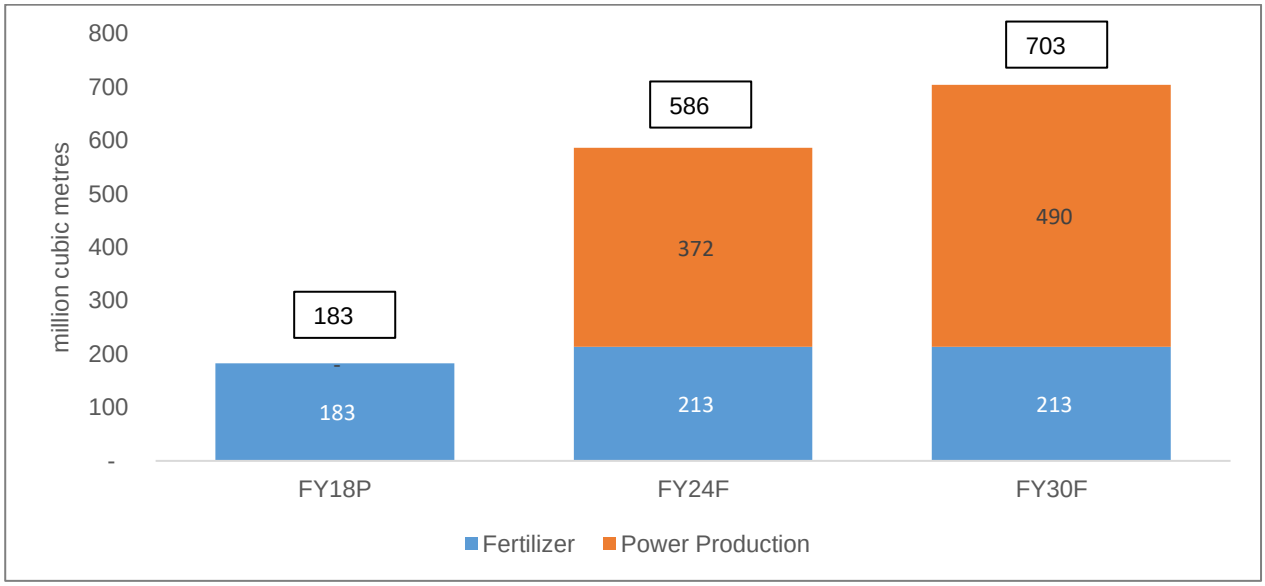


Source: Afghanistan Oil and Gas Industry Report

Demand, Supply Outlook

Going forward, production from the Kud Bergh fertiliser plant may rise slightly from 45,000 tonne in fiscal 2018 to ~52,500 tonne in fiscal 2022. No incremental growth is expected after that. No new fertiliser units have been planned yet in the country and domestic demand will continue to be met through imports. Two new gas-based power plants, Mazar (50 MW) and Sherberghan (600 MW) are expected to commence production in fiscals 2020 and 2022, respectively. On account of that, demand for gas for power generation will rise to 372 million cubic metres by fiscal 2024 and 490 million cubic metres by fiscal 2030.

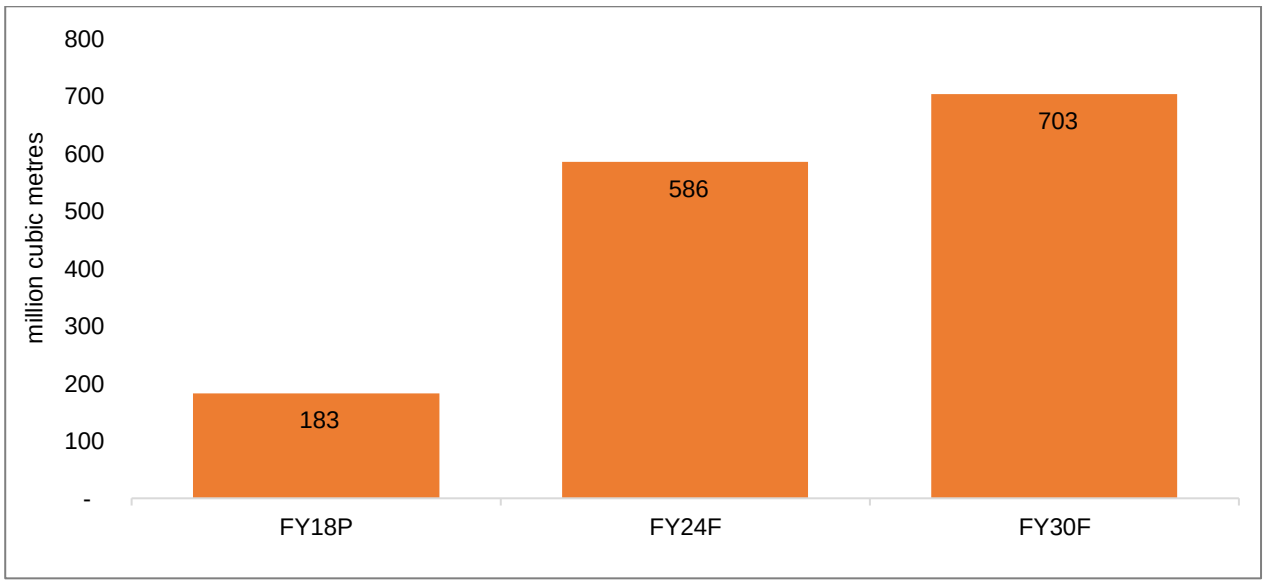
Figure 36: Gas Demand in Afghanistan - Outlook



As per a recent re-assessment by USGS Petroleum Resource Assessment, the country has an undiscovered 16 trillion cubic feet of natural gas and 0.5 billion barrels (0.8 billion tonne) of natural gas liquids in the country. Most of the technically recoverable natural gas reserves are located in the Amu Darya basin. The Ministry of Mines and Petroleum has been striving with international donor organisations such as the United States Agency for International Development (USAID), Asian Development Bank (ADB), and the World Bank for development of new gas wells. However, prospects of such deals are sketchy and fraught with uncertainties. As per a conservative estimate, domestic production of gas will grow in line with the underlying demand, from 183 million cubic meters in fiscal 2018 to 703 million cubic meters in fiscal 2030 at a healthy CAGR of 11%. No future import or export prospects are expected going forward.

Additionally the Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline, which is expected to be completed by fiscal 2022, will bring 33 billion cubic metres (bcm) of natural gas from Turkmenistan's Galkynysh gas fields and Afghanistan is supposed to buy ~5.11 bcm, or 16% of the gas, as per the sales purchase agreement (SPA) signed in 2012. However, based on the projected scenario, demand for gas in Afghanistan is not expected to reach those levels.

Figure 37: Gas Production in Afghanistan - Outlook



Petroleum Products

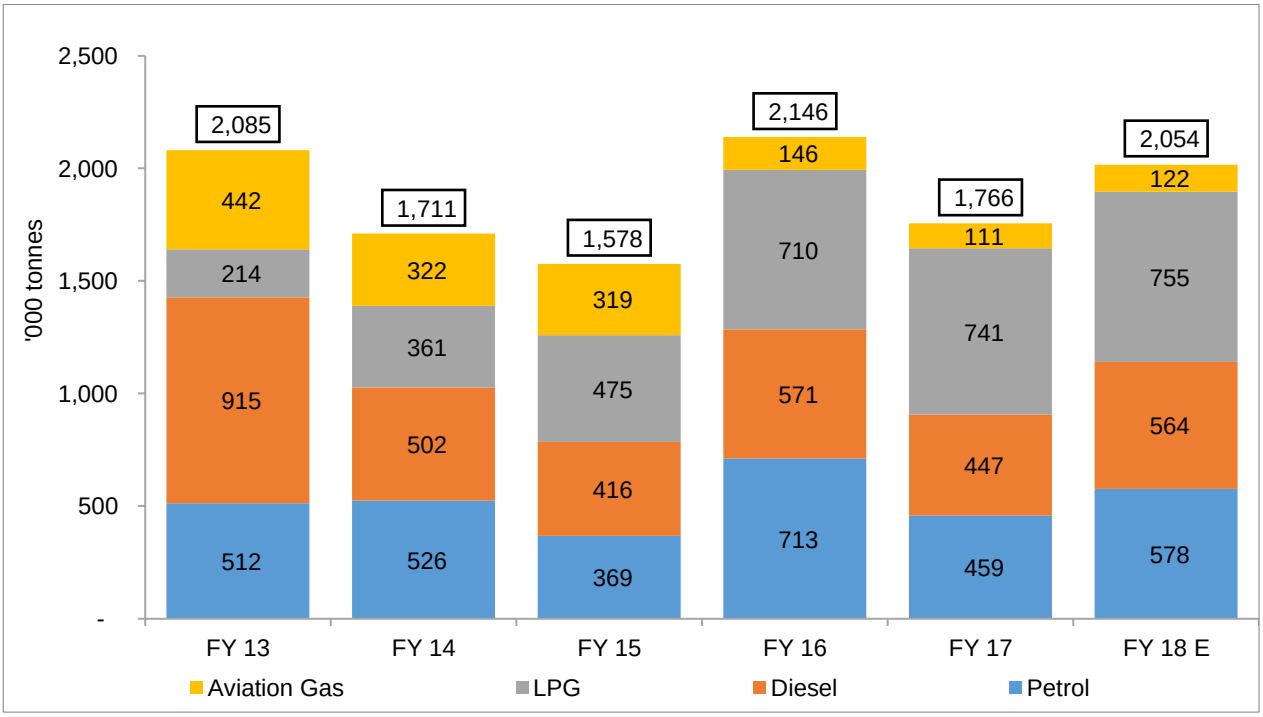
Demand, Supply Review

Afghanistan's overall demand for POL products is estimated to have remained stable between fiscals 2013 and 2018. While demand for petrol and LPG saw a growth of 2.4% and 28% CAGR, respectively, during the period, this was offset by a decline in diesel demand (de-growth of 9.2% CAGR) and aviation turbine fuel (ATF), which saw a sharp decline of 22% CAGR during the period.

The only available authentic data to rely upon to review the POL product demand is the import data from the Central Statistic Organisation (CSO), which is only private import data. Additionally, POL products have been imported and consumed by foreign vehicles of coalition forces, the data for which is not available. However, the report suggests that there has been a significant decline in demand subsequent to settlement of political turmoil in the country. There is also a strong possibility of consumption of unreported POL products that have been imported illegally in the country.

Diesel and petrol in overall terms comprise 51% of the total POL demand in the country. More than 95% of their demand comes from the transportation segment that has seen a decent growth over the past five years. Both diesel- and petrol-based vehicles have clocked a CAGR of 3% over fiscals 2013-2018. LPG is the second largest POL component accounting for almost 40% of the total demand share. Its demand seems to have risen with replacement of biomass as domestic cooking fuel in both rural and urban households.

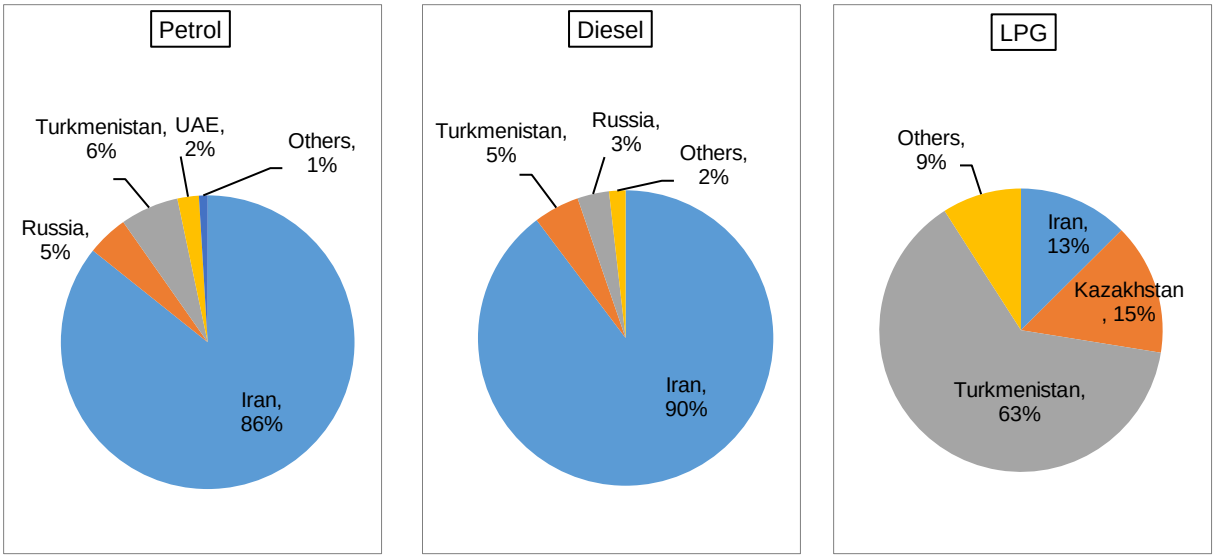
Figure 38: Consumption of Major POL Products: Afghanistan



Source: Afghanistan Oil and Gas Industry Report

Afghanistan imports 100% of its total POL products requirement, mainly from Iran, Turkmenistan and Uzbekistan, as shown below:

Figure 39: Country-wise POL Product Imports in FY17: Afghanistan



Source: Afghanistan Oil and Gas Industry Report

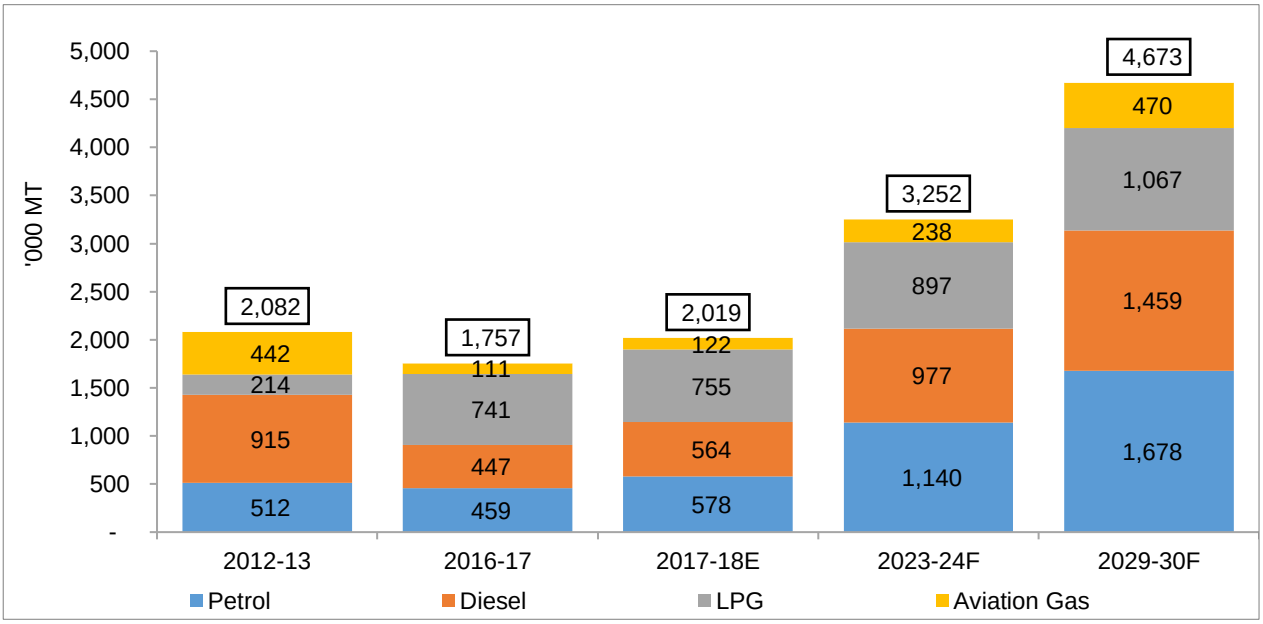
Demand, Supply Outlook

Petroleum product consumption in Afghanistan is expected to log a CAGR of 7.2% between fiscals 2018 and 2030 as against no growth seen over the past five years. The overall economic activity is expected to continue to be strong with GDP growth between 4% and 5%, which would result in strong demand from the transportation segment.

POL product-wise factors resulting in demand growth are detailed as follows:

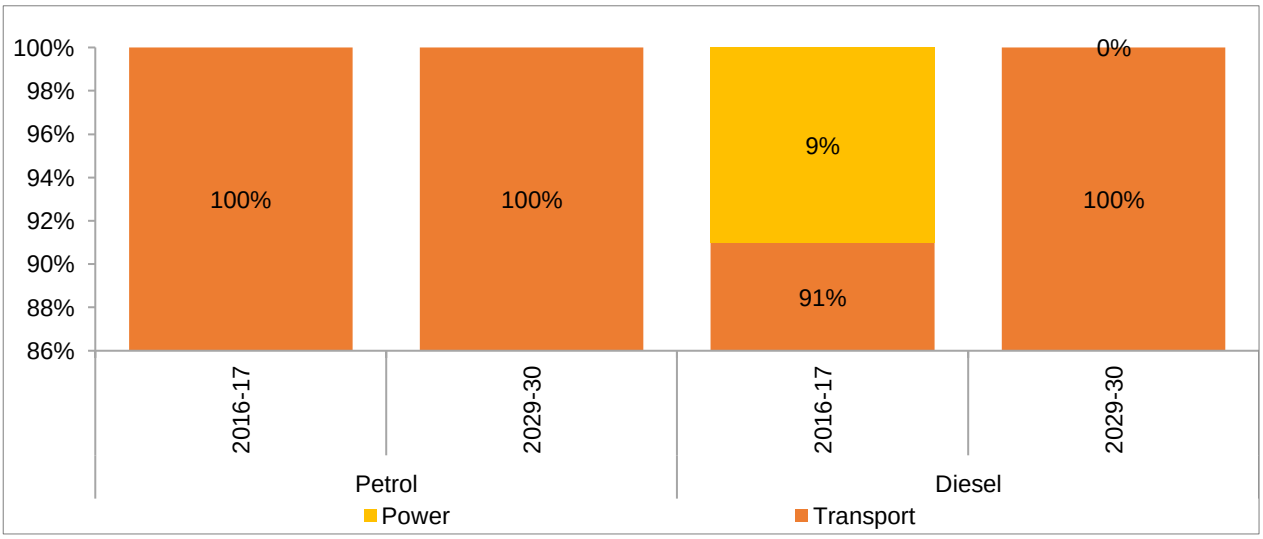
- *Petrol:* Strong GDP growth and resultant increase in per capita income are expected to boost overall vehicle sales (particularly cars and two-wheelers) in the coming years. Cars and two-wheelers are expected to grow rapidly during the period, boosting overall demand for petrol, which is expected to grow at a 9.3% CAGR.
- *Diesel:* Diesel demand is expected to grow at 8.2% CAGR between fiscals 2018 and 2030, driven by higher demand from the transport segment. Demand from the power sector is expected to effectively decline to zero with availability of cheaper power from imports and increase in renewable energy supply.
- *LPG:* This gas is primarily used for cooking in both rural and urban households. Afghanistan is expected to see a growth of 3% CAGR, pushing demand for liquid gas. Demand growth will remain tepid compared with the growth seen in the past five years, as per capita consumption of LPG is already significant at 27 kg per capita and is not expected to grow much further.

Figure 40: Overall POL Demand Outlook 2030: Afghanistan



Pertaining to segment-wise consumption, while no major change is expected for petrol, the share of diesel in the transport segment is expected to increase due to retirement of diesel-based power plants.

Figure 41: Segment-Wise Break-Up of Consumption of Major Petroleum Products: Afghanistan



Afghanistan's current refining capacity is 32,500 barrels per day (1,643 thousand tonnes per annum). However, these refineries are at present non-operational because of the ban on crude oil imports. For the sake of this assessment, it has been assumed that since the economy has started to grow and political turmoil is over, these refineries shall become operational by fiscal 2020. Additionally, there is a plan to add 50,000 barrels per day (2,489 thousand tonnes per annum) of refining capacities over the next 10 years, entailing a total investment of $700 million. This refinery is expected to be fully operational by fiscal 2027. Because of this expansion, Afghanistan is expected to produce petroleum products of 4.1 million tonne against a demand of 4.6 million tonne, leaving an import requirement of only 0.5 million tonnes.

In addition, the country has a strategic goal to increase its crude oil production to 100,000 barrels per day (4.9 million tonne per annum or MTPA) over the long term. We expect this production to completely come on-stream by fiscal 2030. Thus, the country would not require any import of crude oil by fiscal 2030 if the production target is achieved.

Table 5: POL Trade Balance: Afghanistan

('000 MT)	FY13	FY17	FY18E	FY24F	FY30F
Refining capacity	1,643	1,643	1,643	1,643	4,132
Crude oil condensates production	1.1	1.1	1.1	498	4,979
Crude oil imports	0	0	0	0	-847
Petroleum products demand	2,082	1,757	2,019	3,252	4,673
Petroleum product production	0	0	0	400	4,132
Petroleum product net import	2,082	1,757	2,019	2,852	541

Hydro

Afghanistan has significant potential to generate hydropower. It has river catchment area of 677,900 sq km and recoverable hydro potential of more than 23,000 MW. The vast majority of this potential (~20,000 MW) is located in the northeast on the Amu Darya, Panj and Kokcha rivers. However, exploitation has been minimal with installed capacity at ~280 MW.

Afghanistan has developed more than 5,000 mini- and micro-hydro plants that feed power to mini-grids located in areas that are not yet connected to the national grid, thereby creating an islanding system. Most of the micro- and mini-hydro projects are installed on irrigation canals, where the villagers divert water to the plant for generating electricity at night. This power has been very important to local people and communities who had to rely on kerosene lamps for lighting. The National Solidarity Programme (NSP), created in 2003 by the Ministry of Rural Rehabilitation and Development, with support from the World Bank and the Afghanistan Reconstruction Trust Fund, has been implementing small-scale hydropower projects (5-25KW) and empowering local communities.

Major large hydro projects in the country include Naghlu HPP (100 MW), Mahipar HPP (66 MW), Salma HPP (42 MW), Sarobi HPP (22 MW) and Darunta HPP (11.2 MW).

Table 6: Major Hydro Power Plants in Afghanistan

Station	Capacity [MW]	Commissioned
Naghlu	100	1967
Sarobi	22	1957
Mahipar	66	1967
Darunta	11.5	1964
Salma	42	2016
Assassab	0.7	1983
Charikar	2.4	1973
Kajaki (I & III)	33	1975
Grishk	2.4	1957
Pul-i-Chomri	4.12	1950
Pul-i-Chomri II	8.79	1962

Source: Economic Survey, CSO, Energy Databook

However, hydropower is seasonal and capacity factors of HPPs are below 40%. Factoring in operation and maintenance costs, power generation from hydro projects is costlier than imported power. Moreover, as these projects typically do not have extensive storage, they deliver most of their output during April-October, leaving the country with a capacity shortfall during the winter months, which are also the months for peak power demand. Therefore, development of HPP would need to be backed up by adequate thermal power development for base load power generation and/or commitments from neighbouring countries for sufficient imported power during times of intermittency emanating from hydro generation.

Also, all of the country's river basins are transnational and usage of water and building of dams may give rise to inter-regional water sharing disputes. Barring Iran, Afghanistan has no water-sharing agreement with any country. This has hindered development of large-scale hydropower in the country.

Other Renewable Energy Sources

Solar

The country has abundant solar energy. Blessed with arid terrain and with more than 300 days per year counted as sunny, there is potential to generate ~222 GW of solar power. However, large-scale solar power development is unlikely. Around 580 MW of solar projects are expected to come up over fiscals 2018 to 2030.

Table 7: Upcoming Solar Power Plants in Afghanistan

Name of Power Plant	Capacity [MW]	Expected Year of Commissioning
Kabul	10	FY19
Nagarhar	100	FY20
Kandahar Phase 1	10	FY20
Daikundi	10	FY21
Baghdara	240	FY22
Sarubi – II	180	FY23
Paktika	10	FY24
Kandahar Phase 2	20	FY25

Source: Economic Survey, CSO, Energy Databook

Several off-grid solar projects providing power to schools, shops, communities that are currently not grid connected are expected to come up. The Afghan government's rural development ministry in collaboration with the United Nations Development Programme (UNDP) and USAID has been working towards development of such micro solar power plants.

Wind

More than 67,000 MW can be produced through wind power in the country (estimated by MEW study), with at least 12,000 MW exploitable in the Herat province, 10,000 MW in Nimruz and 1,800 MW in Farah.

With significant exploitable capacity located in the three provinces, all of which are in the west-central part of the country, the challenge lies in evacuation of power through a strong transmission network. Herat has transmission links from the capital Kabul to both Iran and Turkmenistan, but is isolated from the rest of the country's transmission network. Nimruz, like Herat, is connected to Iran, and receives power at the 20 kV level. However, it has no transmission connections to other provinces. Farah does not have any connections

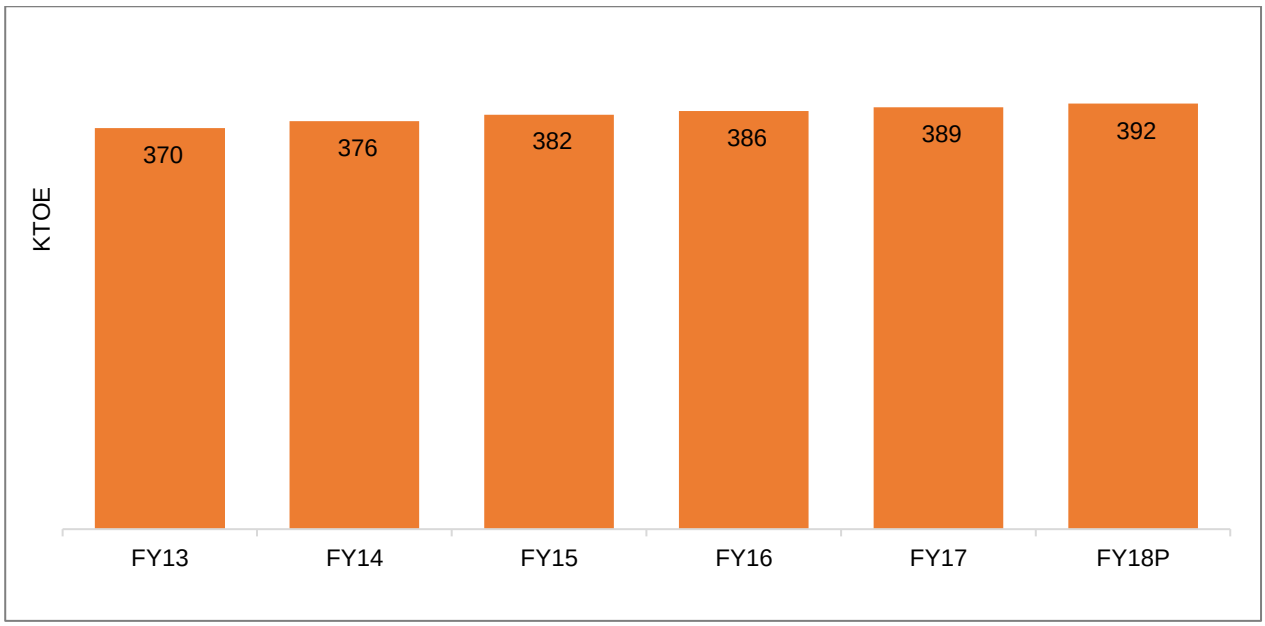
either with the Afghanistan network or with Iran. Its power supply is limited to only a few isolated mini-grids. Given the isolation of the wind resources, substantial capital investments in transmission lines and substations is required to connect new wind farms even to local load centres. In order to supply wind power to the rest of the country, the currently isolated Herat network would need to be connected to the other parts of the existing transmission network, either by constructing a link to the northeast system in Farah Province and/or by building a link to the southeast system at Kandahar.

Private participation and lack of government oversight have hindered development of wind power. At present, no wind projects are operational in the country. However, 100 MW of wind-based plants are expected to come up by fiscal 2030.

Biomass

Biomass is being used extensively in Afghanistan for heating homes and cooking purposes. With electricity eluding the majority of the country's population, biomass usage in the rural areas is widespread. The primary resources available are crop residue, animal manure, firewood, and municipal waste. According to the Afghanistan Living Conditions Survey (ALCS), 74% of all households and 90% of rural households relied on biomass as their primary fuel for cooking, while 82% of households and 90% of rural households used it as their primary source of heat. Per capita biomass consumption has reduced marginally from 14.51 KTOE in fiscal 2013 to 13.9 KTOE in fiscal 2018 (provisional). However, dependence on biomass continues to be strong and comprises ~10% of the total primary energy consumption in the country (as of fiscal 2018).

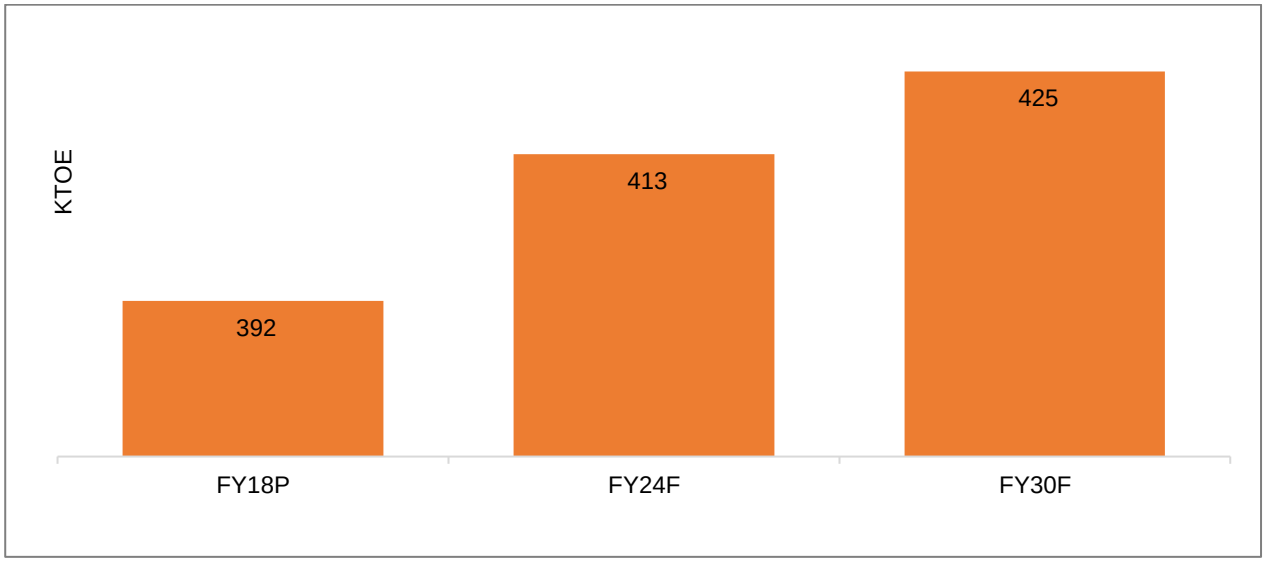
Figure 42: Biomass Usage in Afghanistan - Review



Source: Economic Survey, CSO

No biomass-based power plants are operational in the country now. As per the Afghanistan five-year energy plan, ~20 MW of biomass-based power plants is proposed to be set up. However, domestic usage will be the largest contributor of biomass going forward. Waste-to-energy plants may be set up in urban areas from dumped discards where electricity is still intermittent. With availability of additional gas supply once the TAPI gas pipeline gets commissioned, some of the domestic supply may be substituted by gas. On a conservative basis, biomass usage may clock a tepid 1% CAGR from 392 KTOE in fiscal 2018 to 425 KTOE in fiscal 2030.

Figure 43: Biomass Usage in Afghanistan - Outlook

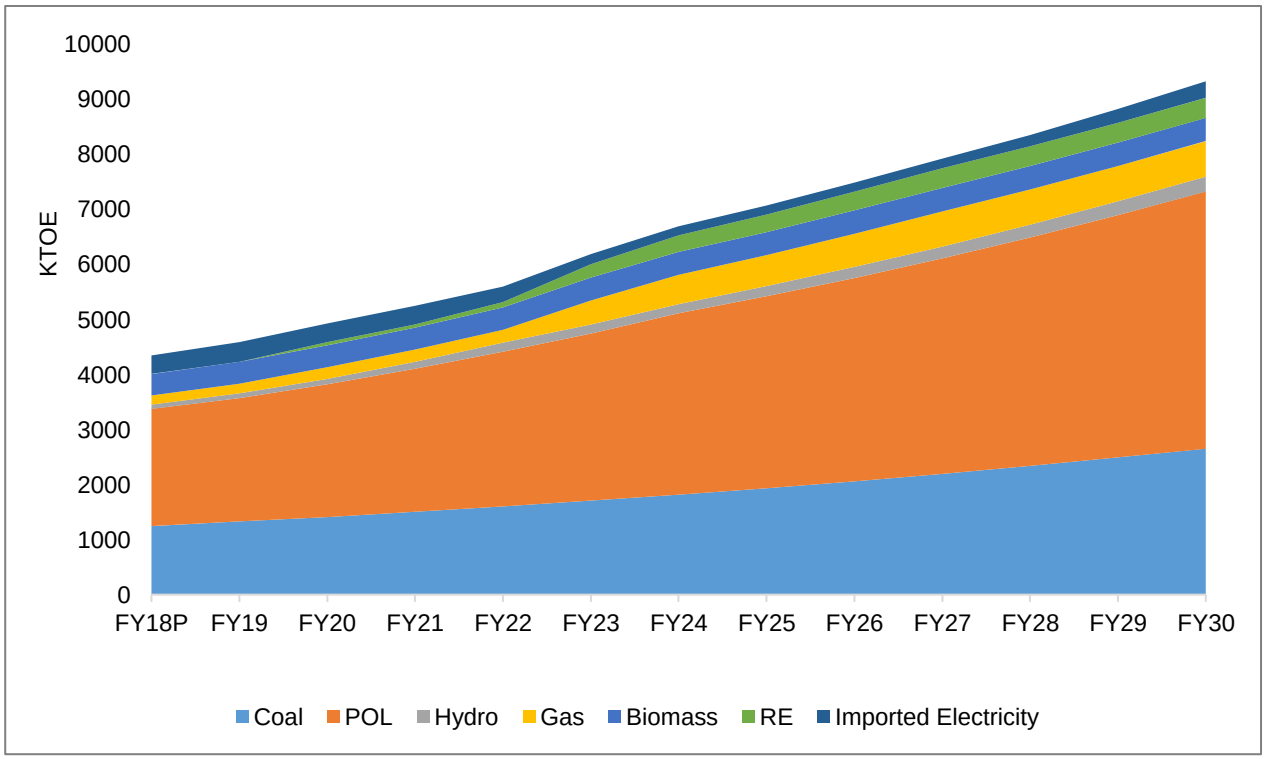


Energy Outlook 2030

Combining the usage outlook for all the aforementioned fuels, it is estimated that the overall energy requirement in Afghanistan shall rise from 4,340 KTOE in fiscal 2018 to 9,324 KTOE in fiscal 2030. POL shall continue to contribute almost 50% of the total energy requirement.

All figures in KTOE	**FY18P**	**FY19F**	**FY24F**	**FY30F**
Primary energy	4,340	4,590	6,687	9,324

Figure 44: Primary Energy Outlook 2030: Afghanistan



Outlook on Imports

Considering the requirement for coal and gas will come only from industries, the increased domestic production is expected to be sufficient to meet the rising demand. Even though at present POL demand is met completely by imports, going forward, with additional upcoming refining capacities, Afghanistan shall become almost self-sufficient. However, as far as demand for electricity is concerned, the reliance on cheaper imports from Iran, Turkmenistan, Uzbekistan and Tajikistan will continue.

Table 8: Outlook for Import of Fuels: Afghanistan

Fuel	FY19	FY24	FY30
Crude oil [in '000 tonne]	-	-	-
Petroleum products [in '000 tonne]	2,177	2,852	541
Electricity [in GWH]	4,257	1,961	3,555
Coal [in '000 tonne]	-	-	-
Gas [in million cubic meters]	192	586	703

3 Bangladesh

3.1 Country Overview

Bangladesh is one of the fastest-growing economies in South Asia, clocking a CAGR of 6.6% fiscal 2013 onwards. The government aims to achieve the status of a middle-income country by 2021 and a high-income country by 2041, which means the country would need to achieve consistent economic growth, poverty eradication, infrastructure development and energy security. This can only happen if there is sound policy-making, government intervention, private sector participation and technological advances. Transition milestones need to be achieved by taking into account economic and industrial growth, resource scarcity and GHG emission reduction targets as part of its INDC.

Table 9: Country Profile: Bangladesh

	Factors	**FY13**	**FY17[#]**
Demographics	Population [in million]	153.7	161.7
Macroeconomic scenario	GDP growth rate	6.0 %	7.3%
	Sectoral growth rate		
	a. Industry	4.1%	3.9%
	b. Services	3.8%	3.2%
	c. Agriculture	3.2%	-0.8%
	Inflation	6.8%	5.4%
Fiscal position	Exports [$ million]	2123.5	34019.0
	Imports [$ million]	2683.8	43491.0
	CAD [as a percentage of GDP]	0.8 %	7.5%

[#]*Actual data for FY18 was not available*

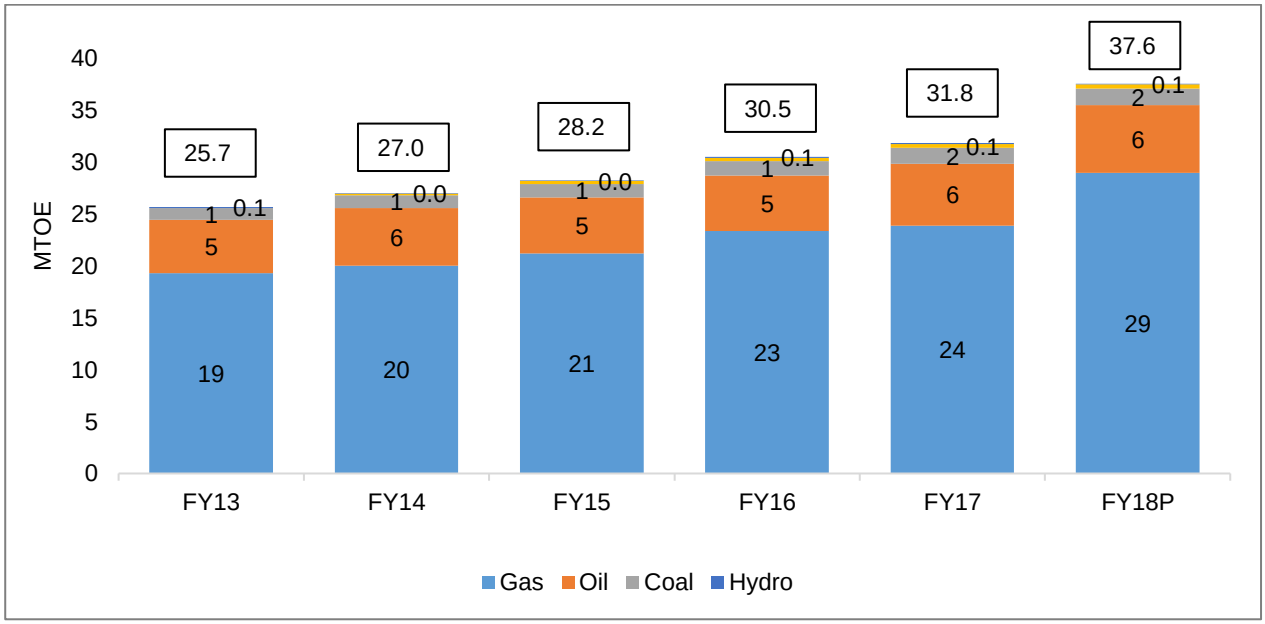
Source: Country reports, Economic Survey

3.1.1 Overview of Energy Structure

Energy Mix

Rapid urbanisation and social development have steadily increased energy demand in Bangladesh. On the supply side, concerted efforts have been put in place to reduce the demand-supply gap. Through long-term power generation plans and power system master plan 2016, the country is planning capacity additions and fuel diversification based on viability and sound economic analysis. Gas, which constitutes around two-third of the nation's primary energy, is facing depletion. Efforts have been put in place to enhance domestic gas production in addition to installing LNG terminals for augmenting gas imports. The country is looking to improve coal production by striking a balance between higher dependence on fossil fuels and managing environmental degradation. The country is implementing a massive electrification programme to bring every household into the grid. Energy saving and environment-friendly energy generation systems are being given precedence. Overall, the nation's primary energy demand has grown from 25.7 MTOE in fiscal 2013 to 37.6 MTOE (provisional) in fiscal 2018 at a CAGR of 7.4%.

Figure 45: Primary Energy Supplies by Source: Bangladesh



Source: Country Reports, Bangladesh Economic Survey

Domestic Availability and Imports of Fuels

Bangladesh is predominantly dependent on imports of all major fuels.

Table 10: Domestic Production and Import of Major Fuels: Bangladesh

Fuel	Supply type	FY13	FY17
Coal [in '000 tonne]	Domestic production	855	1,161
	Imports	1,172	1,485
Crude oil [in '000 tonne]	Domestic production	59.6	26.3
	Imports	1,301	1,365
Petroleum products [in '000 tonne]	Domestic production	1,360.9	1,392
	Imports	3,705.8	4,481
Gas [in billion cubic feet or BCF]	Domestic production	800.6	971.6
	Imports	-	-
Electricity [in GWH]	Domestic production	36,482	57,276
	Imports	-	4,656

Source: Country reports, Bangladesh Economic Survey, Energy Book

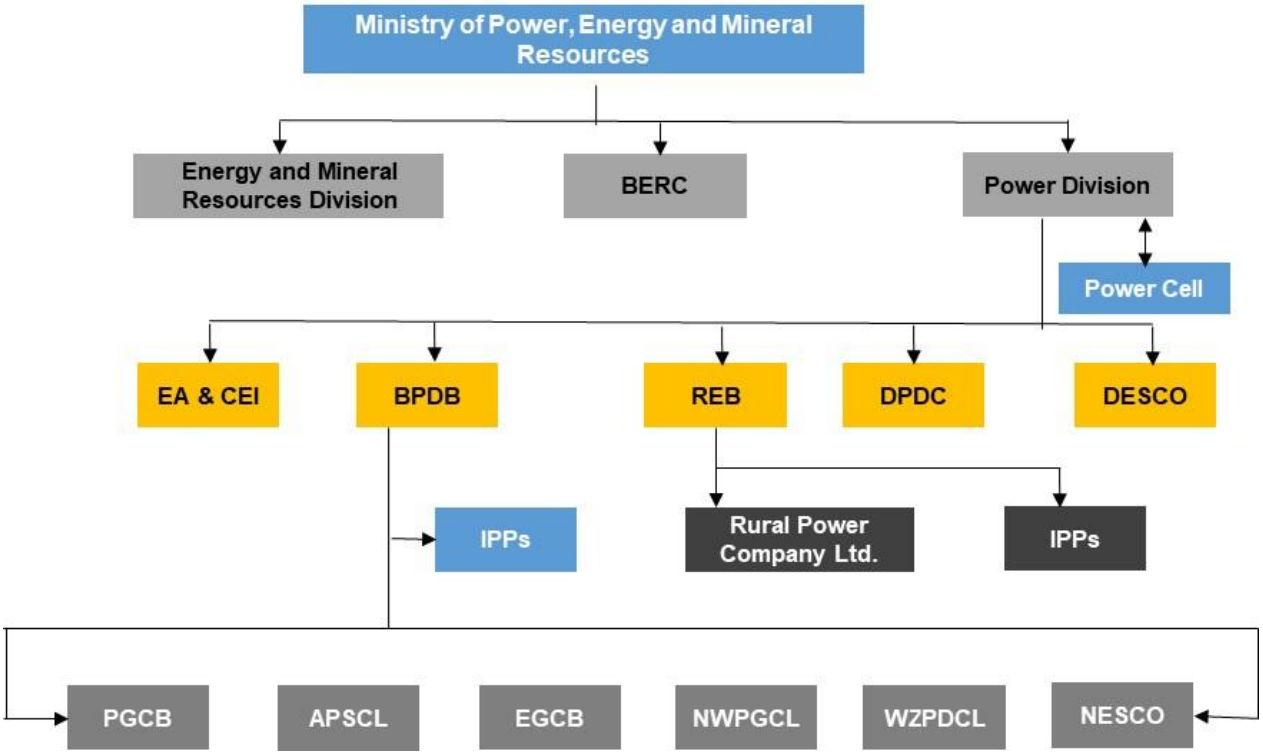
3.2 Institutional and Regulatory Framework of Energy Sector

3.2.1 Planning and Regulatory Bodies

Bangladesh's energy sector is principally managed by the Ministry of Power, Energy and Mineral Resources. The Bangladeshi government is responsible for policy formulation in the areas of power, coal, gas and other primary fuels, including POL products.

Power Sector

Figure 46: Organogram of Power Sector: Bangladesh



BERC = Bangladesh Energy Regulatory Commission, EA & CEI = Electrical Advisor and Chief Electrical Inspector, BPDB = Bangladesh Power Development Board, REB = Rural Electrification Board, DPDC = Dhaka Power Distribution Company, DESCO = Dhaka Electric Supply Company, PBS = Palli Bidyut Samiti PGCB = Power Grid Company of Bangladesh Ltd, APSCL = Ashuganj Power Station Company, EGCB = Electricity Generation Company of Bangladesh, NWPGCL = North West Power Generation Company Ltd , WZPDCL = West Zone Power Distribution Co Ltd, NESCO = Northern Electricity Supply Company Ltd

- *BPDB* was created as a public sector organisation in 1972 in order to boost the power sector in the country. It has the authority to plan, construct and operate power generation units throughout the country as well as distribute power in urban areas. It purchases power from generating companies as a single consumer and then sells it to customers and distribution companies.
- *EA & CEI* ensures safety and proper control of assets in the generation, transmission and distribution of power in the country. The office is entrusted with inspecting installations, substations, high-tension (HT) and low-tension lines and granting licenses to HT and medium tension (MT) consumers. The energy monitoring unit, as a sub-unit under this office, ensures efficient use of energy and induces energy conservation.
- *Power cell* was established in 1995 to assist the power division for designing, facilitating and monitoring reform measures in the power sector. It plays a vital role in reforming and unbundling the power sector, facilitating private sector participation, evaluating power tariffs and establishing

regulatory commissions. The power cell is headed by a director general appointed by the government and is assisted by four deputy generals who oversee four different divisions - commercial, management, sustainable energy and private power.

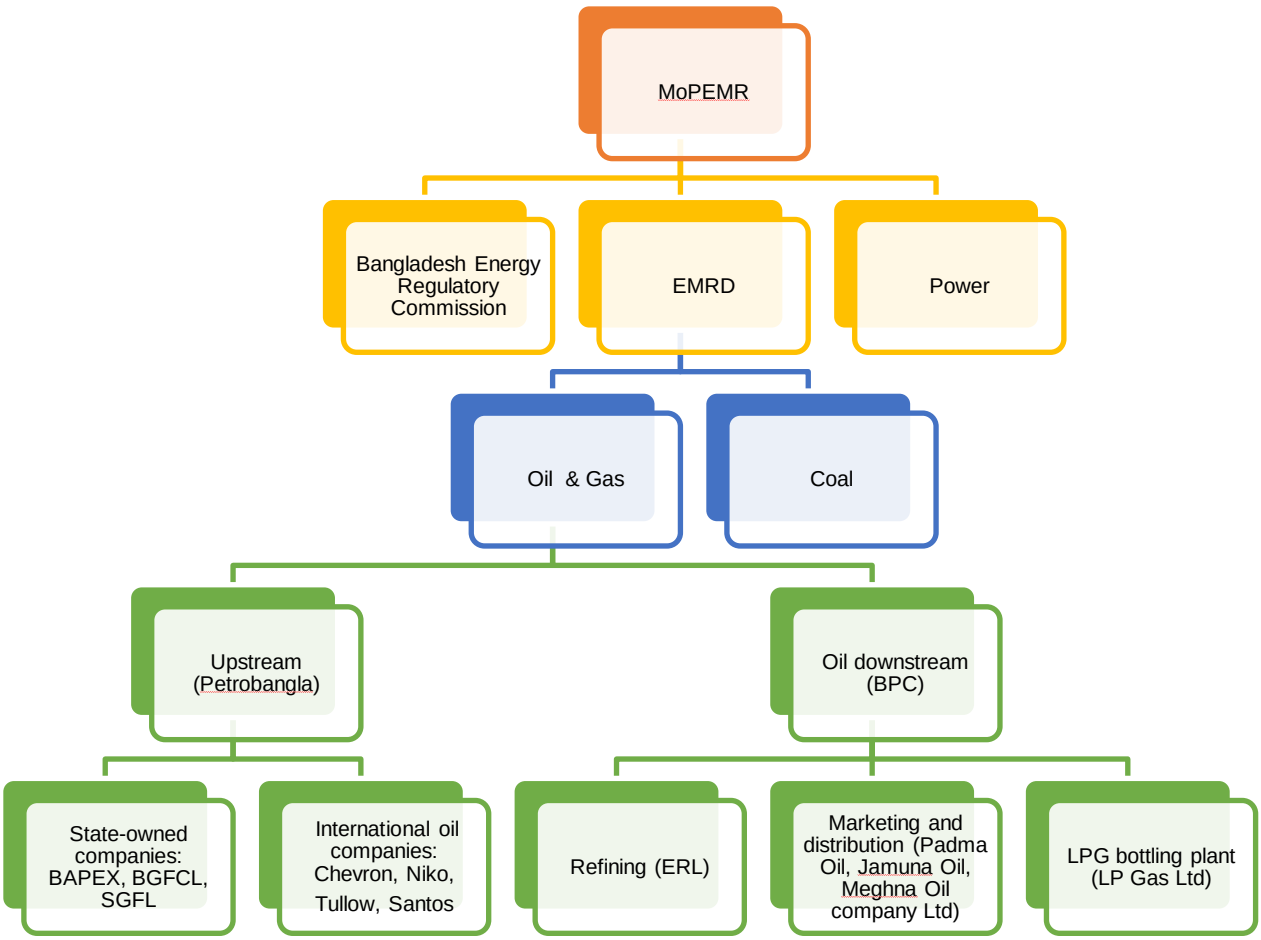
- *BERC* was established in 2004. It frames codes and standards to maintain efficiency, transparency and compliance pertaining to management and operations in electricity, gas and petroleum sectors. It is an independent and autonomous body.

The key operating entities across the power sector in Bangladesh include:

- Power producers - BPDB, APSCL, EGCB, RPCL NWPGCL, BPDB-RPCL JV
- Power transmission company - PGCB is the sole power transmission company in the country
- Power distribution company - BPDB distributes power in six zones across the country – Chittagong, Comilla, Mymensing, Sylhet, Rajshahi and Rangpur. Apart from BPDB, there are six other distribution companies, WZPDC, NESCO, SZPDC, DPDC, DESCO and NESCO

Hydrocarbon Sector

Figure 47: Organogram of Petroleum Sector: Bangladesh



- *The Ministry of Power, Energy and Mineral Resources (MoPEMR)* is the overarching body with the responsibility of overall planning, development and management of different types of commercial energy resources, including power. There are two divisions under the ministry – the Energy and Mineral Resource Division (EMRD) and Power Division.

- *The EMRD* is the administrative authority of all energy and mineral resources including oil, gas, coal and other minerals, of Bangladesh.
- *Bangladesh Oil, Gas and Mineral Corporation (BOGMC)*, commonly known as Petrobangla, holds the shares of companies dealing in exploration and development of oil and gas on behalf of the EMRD. PetroBangla is the upstream regulator and thus, administers production-sharing contracts (PSCs) with international oil companies on behalf of the government.
- *Bangladesh Petroleum Corporation (BPC)* is responsible for import, refining and processing of crude oil, blending of lubricants, export and marketing of petroleum products including by-products and lubricants. BPC has eight subsidiaries – one oil refinery, three distribution and marketing companies, two lubricant blending plants, an LPG bottling and distribution plant and a bitumen production company.

3.2.2 Regulatory and Policy Framework

The Electricity Act, 1910 (Act No. IX of 1910) was the overarching act for the power sector in the country. However, it is now subsumed by the Electricity Act, 2018.

The basic legal framework for exploration, development, exploitation, production, processing, refining and marketing of petroleum is provided by Bangladesh Petroleum Act, 1974.

The government of Bangladesh has announced the National Energy Policy (NEP), which intends to provide energy for sustainable economic growth so that the economic development activities of different sectors are not constrained due to shortage of energy. The policy also focuses on the growth of the renewable energy sector in the country.

3.2.3 Government support: Pricing, Existing Subsidies on Fuel and Controlling Regime

Pricing of a specific energy source for retail consumption varies based on domestic availability, dependence on imports and pricing policies specifically adopted by the government for individual end-uses.

Gas

Gas distribution companies compute gas tariffs across various consumer categories based on future sales forecast and average revenue requirements. Petrobangla and BERC take into account inputs from all stakeholders, including market participants, sector experts, independent research bodies and finally take a stance on price revisions. As such, gas prices are regulated. In most of the cases, consumers are cross-subsidised to account for imparity in income levels within different categories. With the country expected to import LNG by fiscal 2018, prices may see upward pressure.

Table 11: Gas Prices with Effect from June 1, 2017: Bangladesh

Sector	Prices (per cubic meter) [$]
Power	¢3.99
Captive power	¢12.15
Fertilisers	¢3.42
Industrial	¢9.8
Commercial	¢21.53

Source: BPC

Coal

Imported coal attracts total taxes in the range of 24-29% depending on the grades.

Table 12: Taxes and Duties on Coal Imports: Bangladesh

Items	CD (%)	SD (%)	VAT (%)	AIT (%)	RD (%)	ATV (%)	Total Tax incidence (%)
Anthracite coal, not agglomerated	0	0	15	5	0	4	24
Bituminous coal, not agglomerated	0	0	15	5	0	4	24
Other coal, not agglomerated	0	0	15	5	0	4	24
Coke and semi-coke of coal, of lignite or of peat; retort carbon	5	0	15	5	0	4	29

All values in percentage; CD: Customs duty, SD: Supplementary duty, VAT: Value added tax, AIT: Advance income tax, RD: Regulatory duty, ATV: Advance trade VAT
Source: Bangladesh Tariff Duties

Petroleum Products

The National Energy Policy (2004) determines the pricing rules that are applicable for crude oil and LPG.

- The price of locally produced LPG is linked to international kerosene price on British thermal units (BTU) basis with appropriate discount to encourage consumption and local production; and
- The value of oil from each production area is determined based on market value comparable to Asia Pacific Petroleum Price Index (APPI).

The government controls other POL product prices in Bangladesh with revision being undertaken irregularly. Pricing for petroleum products, except jet fuel and furnace oil, have not been revised since April 2016. The price of LPG (12.5 kg cylinder) has stood at Tk700 ($8.75[1]) since June 2009.

Table 13: POL Product Prices: Bangladesh

Product name	Local selling price (Tk/litre)	Prices ($/litre)	Effective date
HSD (Diesel)	65.00	0.82	24/04/2016
SKO (Kerosene)	65.00	0.82	24/04/2016
HOBC (Octane)	89.00	1.11	24/04/2016
MS (Petrol)	86.00	1.08	24/04/2016
FO (Furnace Oil)	42.00	0.53	1/4/2016
	For domestic flight	For international flight	
Jet A-1	86.00 (Tk/litre)	0.75 (USD/litre)	3/7/2018

Source: BPC

[1] $1 = 80 Tk

In April 2016, the government slashed the prices of octane, petrol, diesel, kerosene and furnace oil by Tk 3 to Tk 10 per litre expecting lower crude oil prices and high profits by BPC. At that time, the World Bank and the International Monetary Fund suggested the government should deregulate domestic oil prices and introduce a system that automatically adjusts the prices in line with global market rates. BPC rejected the proposal saying it needed to adjust its huge previous losses. However, it has still been incurring huge losses as petroleum prices have increased in the international market with the recent spike in crude oil prices. As a result, it put forth a proposal to the energy ministry in February 2018 to introduce an automated pricing formula to adjust petroleum prices against international prices on a monthly basis. If the formula is introduced, the prices of diesel, kerosene, and furnace oil will go up significantly.

3.3 Overall Energy Outlook 2030

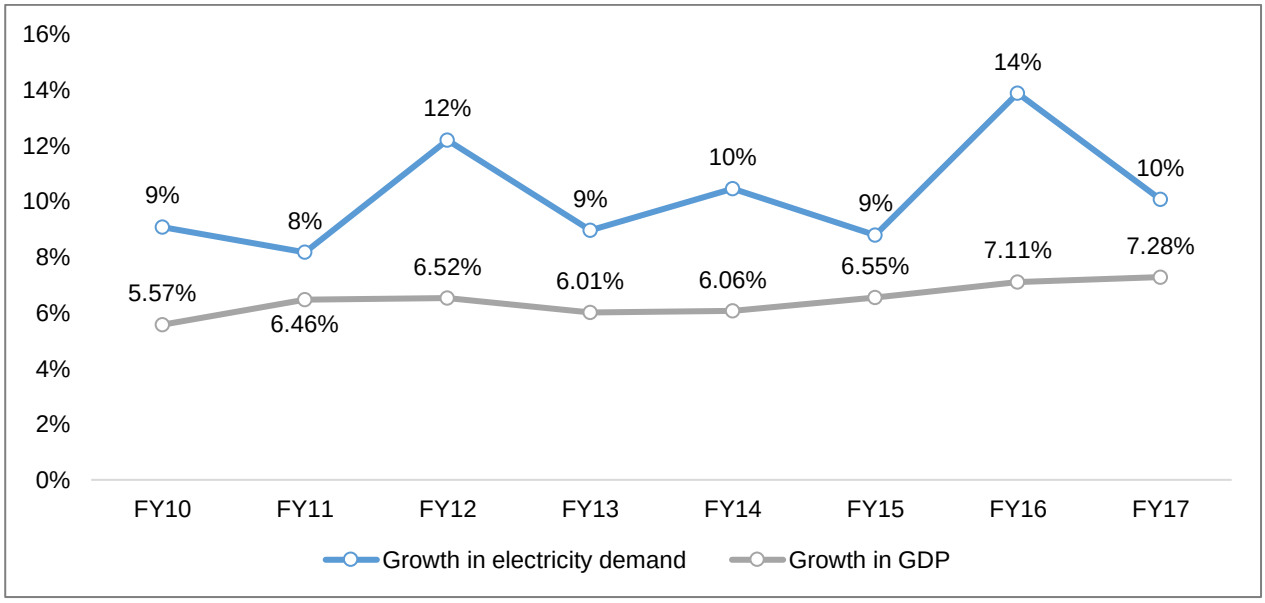
The overall energy outlook of Bangladesh has been assessed by undertaking a detailed review of all the primary sources of energy including coal, gas, water, POL products and renewable sources. As the power sector serves as a major consumer of these sources and is the single largest supplier of secondary energy, its analysis precedes the fuel-wise discussion.

3.3.1 Power Demand, Supply Review

Power Demand Position

Growth in Bangladesh's power demand exceeded its GDP growth during fiscals 2009-2017 owing to high electrification rates, improvement in consumption in urban areas and better power availability. A GDP elasticity of 1.58 shows strong underlying power demand in the country.

Figure 48: Power Demand Growth with Respect to GDP Growth: Bangladesh



Source: BPDB Annual Report, Economic Survey

Gross power demand has grown from 37,441 MU in fiscal 2013 to 64,990 MU in fiscal 2018 at a CAGR of 11.7%. Owing to gas shortage and inadequate capacity additions, the unconstrained demand surpassed generation capability a few years ago, prompting the government to put in place aggressive generation augmentation plans.

The country had a very low rural electrification rate of 15% when it was liberalised in 1975. However, with the government's thrust and sound monitoring, more than 72% of rural areas have already been added to the electricity grid. Under the 'upazila-wise 100% electrification' programme, the REB aims to provide 100%

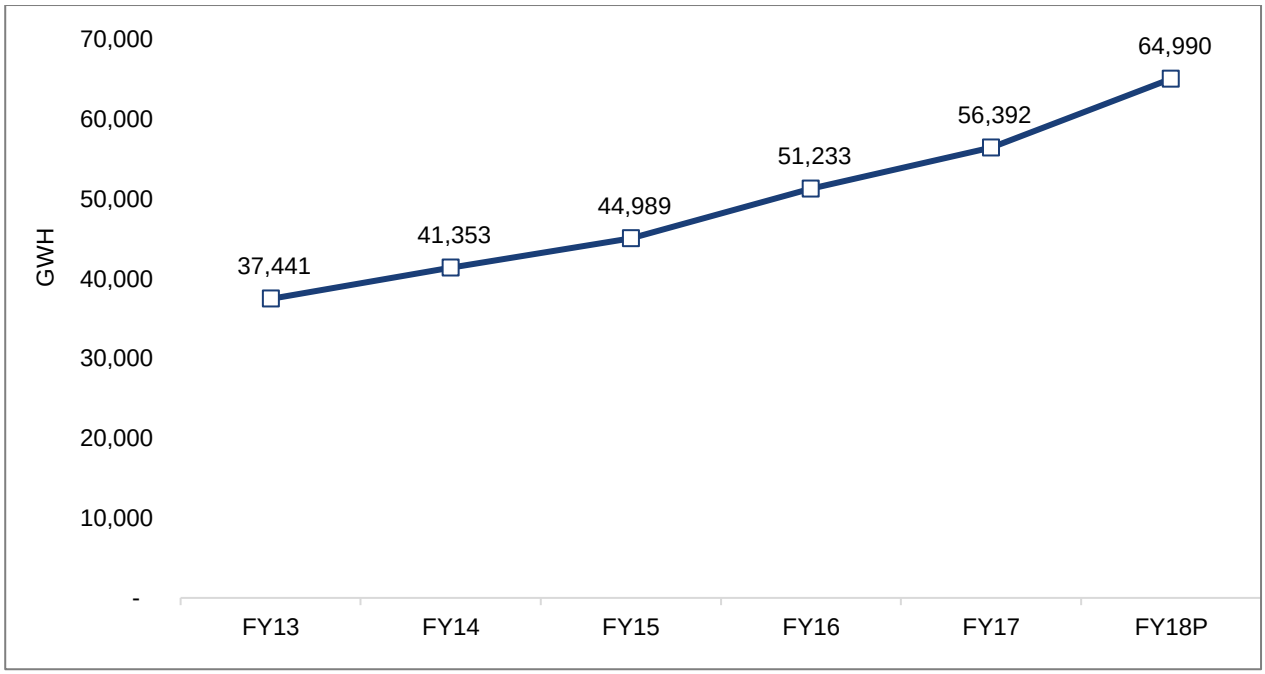
electricity to 460 upazilas under its jurisdiction by 2021. The country has been moving aggressively towards the target with more than 150 upazilas having already been electrified. Eighty PBS were created to fast-track area-based electrification in the country. To make the PBSs financially viable, cross subsidy has been provided from the solvent ones to the financially weaker ones.

Cost-based tariff and reduction of overhead costs have been prioritised to compensate for losses owing to poor consumer mix and low power sales prices. As a result, the number of consumers under the REB has more than doubled from 83.6 million in fiscal 2011 to 190.98 million in fiscal 2017. The other electricity distributors (WZPDCL, DPDC, DESCO, BPDB) have improved sales by 7-9% on year from fiscal 2011 to fiscal 2017.

The industrial sector is mostly labour-intensive, with the garment industry accounting for a majority share. Other traditional industries include jute and leather. Heavy manufacturing industries are not prevalent in the country. Construction of industrial parks and facilitation of infrastructure development have also been slow.

The overall transmission and distribution losses have reduced to 11.9% in fiscal 2018 (provisional) from 14.4% in fiscal 2013, thereby reducing supply constraints.

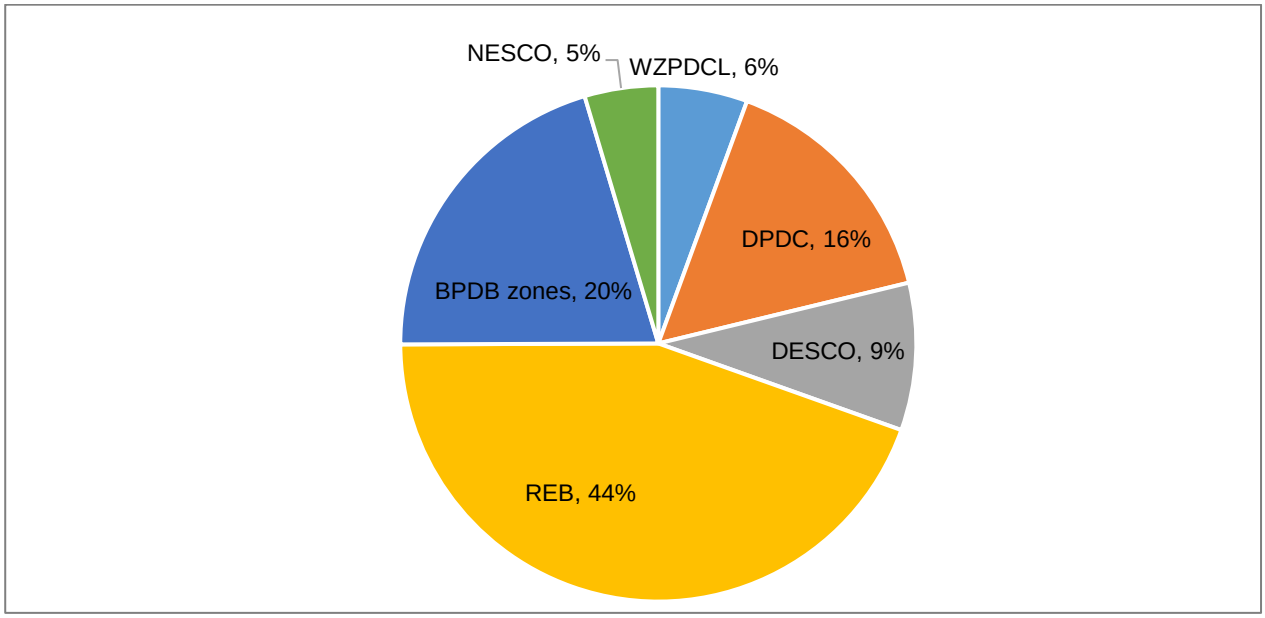
Figure 49: Demand Load Curve: Bangladesh



Source: BPDB Annual Report, Economic Survey

The REB is the largest bulk sale consumer in Bangladesh accounting for 44% of total sales in fiscal 2017. BPDB and DPDC contributed to 20% and 16% of power sales, respectively. NESCO, which was carved out of BPDB in 2016 to look after distribution systems in Rajshahi and Rangpur zones, accounted for 5% of sales.

Figure 50: Utility-Wise Bulk Sales (FY17): Bangladesh



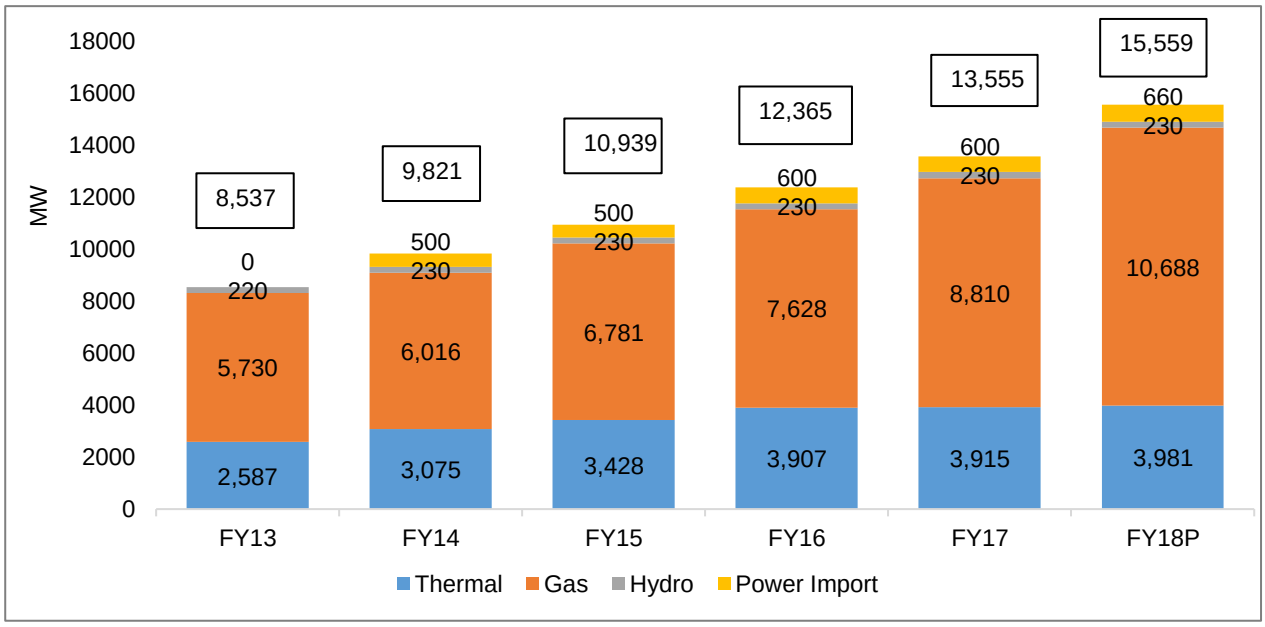
Source: BPDB Annual Reports

Power Supply Position

The total installed capacity in the country as of fiscal 2018 stands at 15,559 MW, of which BPDB holds the highest ownership (~5300 MW). More than 70% of the gross power generation is from gas-based plants with thermal (coal + oil)-based power accounting for only 20% of the total. The total gross energy generation in fiscal 2018 was 62,925 GWH (provisional), ~9.8% higher than the previous year. Around 4,656 GWH of power was imported from India by connecting Bheramara and Tripura. The per capita energy generation (including captive) had increased to 433 KWH in fiscal 2017.

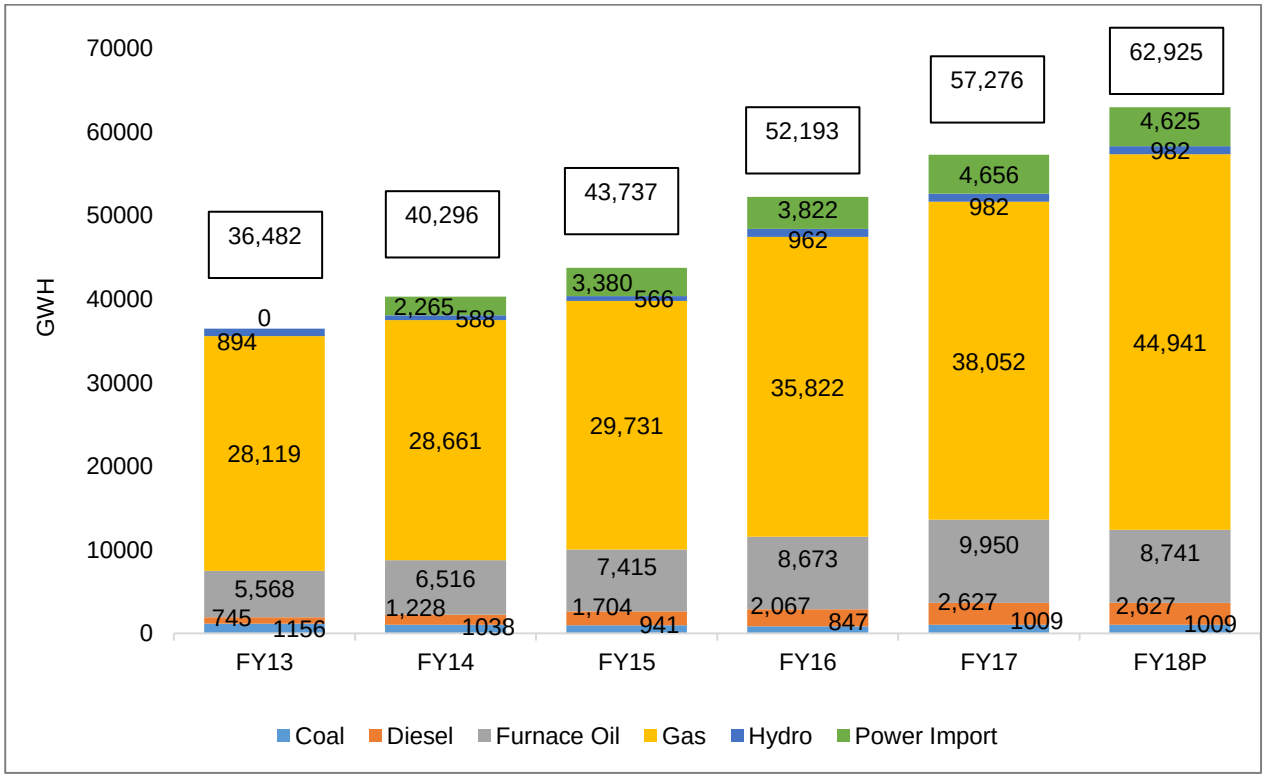
There is negligible renewable power generation in the country. Only one hydroelectric station of 230 MW rated capacity is currently present in the country.

Figure 51: Installed Capacity: Bangladesh



Source: BPDB annual reports
Note: Thermal includes coal and oil

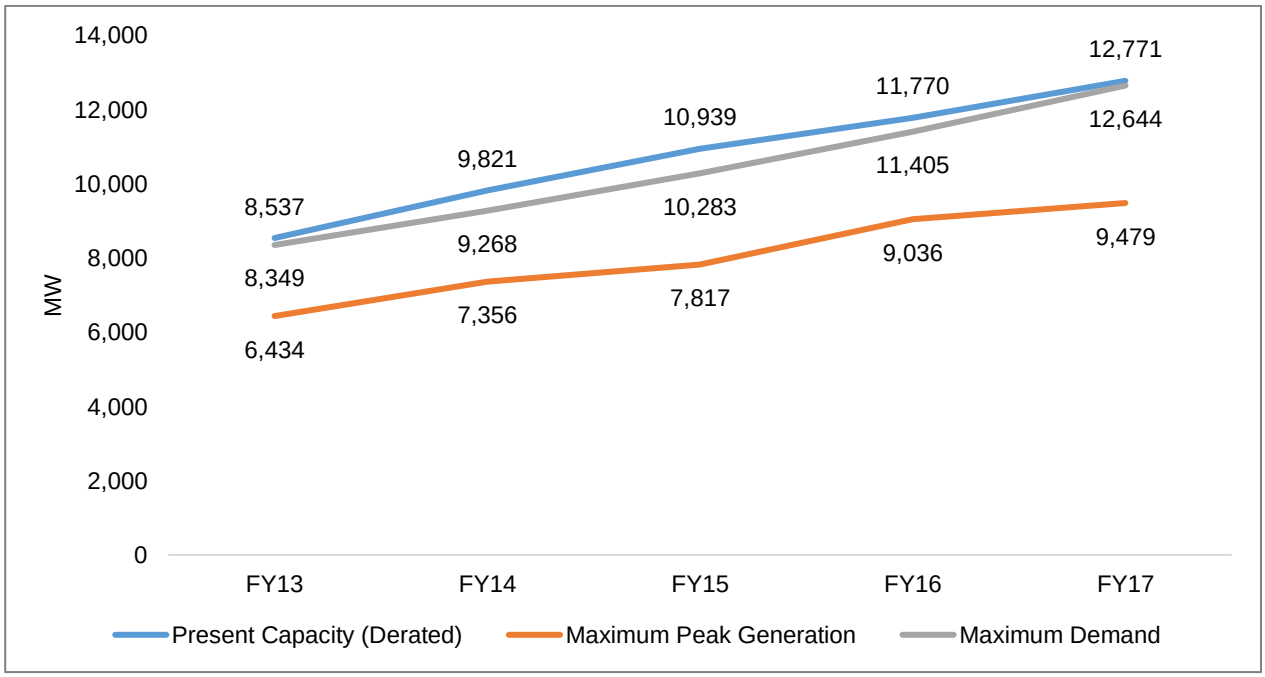
Figure 52: Annual Electricity Generation by Source: Bangladesh



Source: BPDB annual reports, Bangladesh Economic Survey

Capacity additions have grown in line with load demand from fiscal 2014, and power deficits have reduced significantly. Maximum load shedding has reduced to 250 MW in fiscal 2017 from a high of 1,345 MW in fiscal 2007 due to rapid expansion in power generation, improvement in transmission infrastructure and reduction in system losses.

Figure 53: Installed Capacity (De-Rated), Maximum Peak Generation and Load Demand: Bangladesh



Source: BPDB annual reports

3.3.2 Power Demand, Supply Outlook

Power Demand Outlook

Bangladesh has been growing steadily with GDP registering 6.6% CAGR over the last five fiscal years. Power demand has exceeded the GDP growth by a factor of 1.58 (demand growth of ~10.7% during fiscals 2013-2017). By fiscal 2020, the GDP growth is expected to reach 7.4% as the per seventh five-year plan formulated by the government. After mid-2020s, the growth rate is expected to moderate as the country's economic development reaches a certain level of maturity.

The power demand will continue to show strong growth until 2022 as the country is expected to be 100% electrified by then, in line with the government's 'Electricity for all by 2021' vision. The consumer base of the REB, the country's largest distribution company (discom) by bulk sales, is seen growing from 191 million in fiscal 2017 to ~262 million in fiscal 2022. Large investments are being made by discoms in smart grid infrastructure, sub-station upgradation and SCADA (Supervisory control and data acquisition system) automation to improve power reliability, remote monitoring and revenue collections.

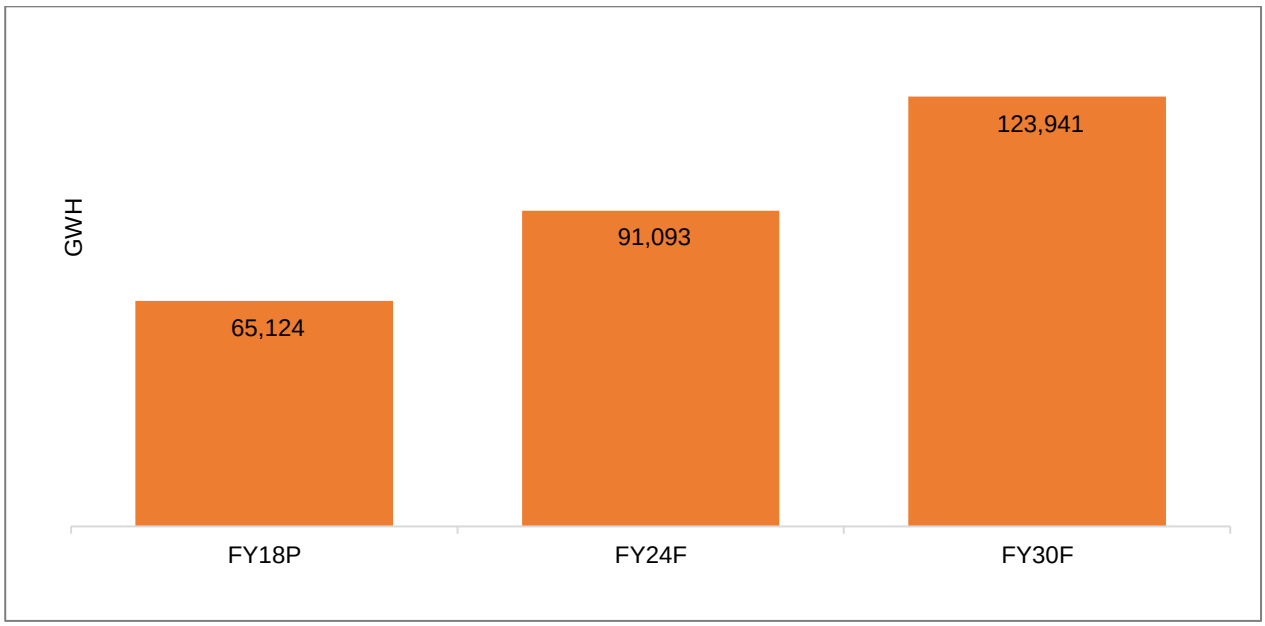
The industrial sector is expected to diversify from traditional textile-based manufacturing sector. Apart from traditional industries such as jute and leather, new high-value-added industries and products such as electronics, information technology, automobile parts and ship-building are expected to grow. Therefore, the industrial sector is expected to shift from labour-intensive industries to energy-intensive ones. This would lead to increased industrial power consumption. With not much focus being placed on demand side management, there is no significant demand constraint. The five urban distribution companies (DPDC and DESCO in Dhaka region, WZPDCL for Khulna and Barisal and BPDB for the rest) will see a sluggish demand after fiscal 2022 owing to a slowdown in new customer addition.

System losses will reduce to ~10% with transmission infrastructure in the country expected to improve as all the discoms are making heavy capex in building and renovating transmission lines and interconnection facilities for better power evacuation from source to destination.

Increased focus on energy efficiency will reduce CO_2 emissions going forward. Bangladesh intends to reduce energy efficiency (per GDP) up to 20% by 2030 compared with 2013 levels as per its INDC.

Gross power demand is expected to reach 95.88 billion units (BU) in fiscal 2024 and 123.9 BU in fiscal 2030 growing at a CAGR of 5.5%.

Figure 54: Demand Load Curve Outlook: Bangladesh



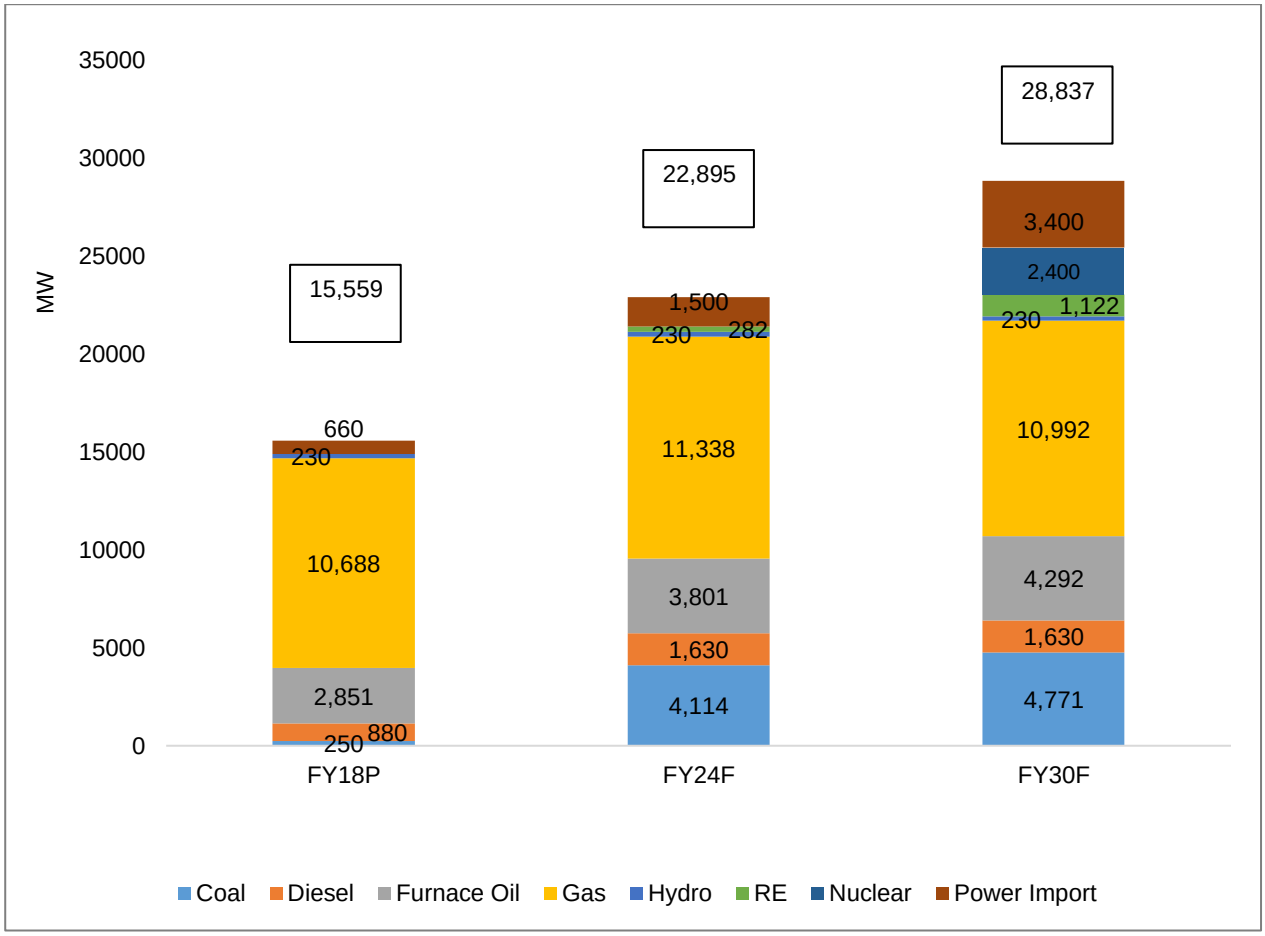
Power Supply Outlook

According to the Bangladesh Power Sector Master Plan, the country's power generation capacity will be enhanced to 24,000 MW by 2021 and 40,000 MW by 2030. Considering the retirement plans of the existing generation stations, de-rating of the current plants, adoption of a strategy for early retirement of inefficient power plants and building of new and efficient facilities, power plants with an additional 14,500 MW capacity are expected to come up by 2030.

Majority of the additions will be coal-fired plants (~6,000 MW) with at least eight new projects in the pipeline. Major coal-based plants include Potuakhali plant (1,320 MW), Chittagong plant (1,324 MW), BIFPCL Rampal plant (1,320 MW) and Gazaria plant (350 MW). Although the cost of power generation is high in heavy fuel-oil-based plants (0.21¢/kWh in fiscal 2017 in BPDB plants), the government has planned more than 20 new such projects.

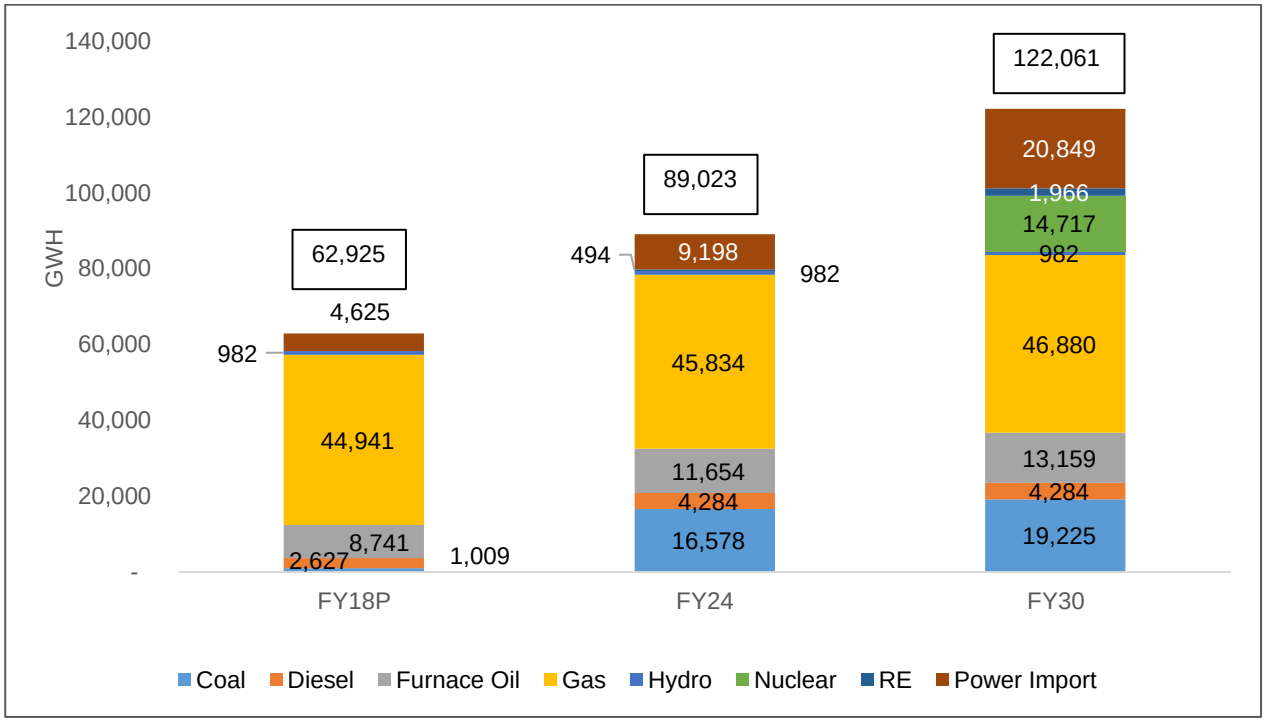
With domestic gas production expected to deplete, new LNG-based plants will come up, taking power generation from LNG to ~11% of the total power mix. Renewable energy (RE)-based power will continue to be underutilised due to lack of government support and implementation bottlenecks. The country's first nuclear reactor (Rooppur-1) is expected to go live by fiscal 2025 and the second reactor is expected to be connected to the grid subsequently. Gross electricity generation from domestic sources is expected to reach 79.8 BU in fiscal 2024 and 101.2 BU in fiscal 2030 with the remainder expected to be imported from neighbouring countries such as India, Bhutan and Myanmar.

Figure 55: Installed Capacity Outlook: Bangladesh



The following chart depicts the annual electricity generation outlook by source:

Figure 56: Outlook for Annual Electricity Generation by Volume: Bangladesh



3.3.3 Fuel-Wise Energy Review and Outlook

Coal

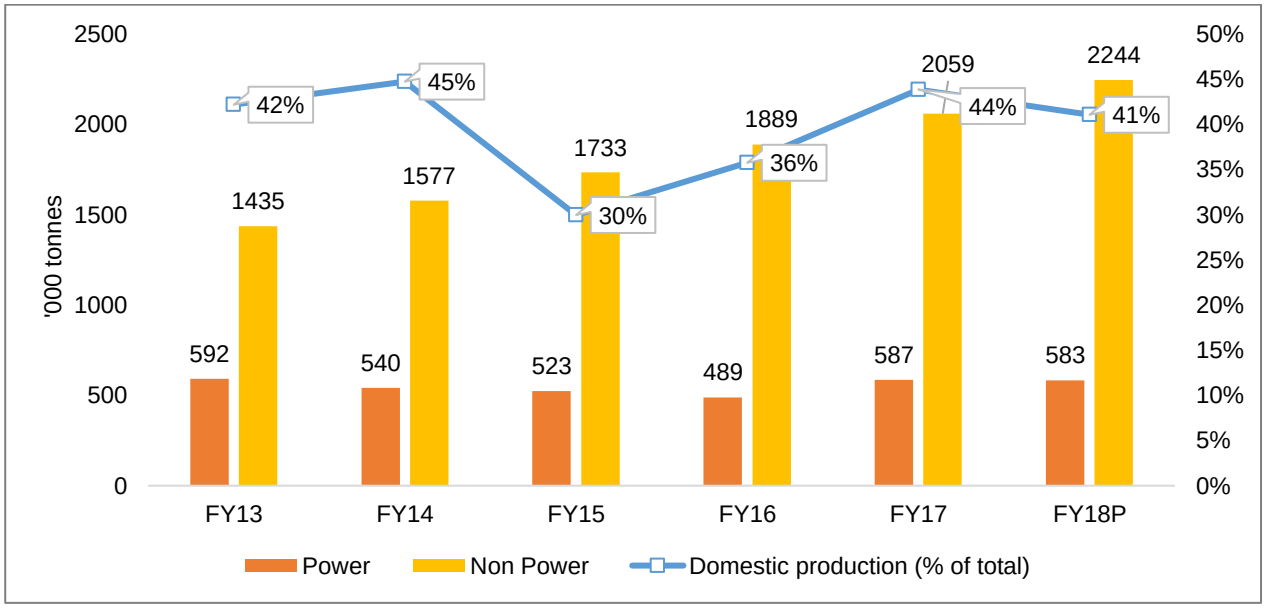
Domestic coal is of high quality and in abundance. However, technology constraints, social and environmental impacts and cheaper gas production have hindered coal mining in the country. Currently, there is one active coal mine (Barakpukuria) with a production capacity of ~5,000 tonne/day. The Barakpukuria Coal Mining Company Ltd (BCMCL) produced 1,161 million tonnes of coal in fiscal 2017 and supplied to the sole 250 MW coal-fired plant in the country. However, as demand for coal is expected to rise steadily, the government intends to mine untapped coal fields in the country. The country is relying increasingly on imports (56% of the demand in fiscal 2017), mainly from Indonesia and China, for meeting higher coal demand due to strong growth in non-power segments.

Table 14: Coal Reserves in Bangladesh

Coal fields	Reserve (million tonne)
Barapukuria, Dinajpur	390
Khalaspir, Rangpur	523
Phulbari, Dinajpur	572
Jamalganj, Jaipurhat	1,054
Dighirpar, Dinajpur	600

Coal India Ltd is keen to develop three new coal fields in Barakpukuria, Khalaspur and Jamalganj. However, commercial development of additional mines is not expected to begin before fiscal 2024. The demand is expected to reach 15 MTPA by fiscal 2030 as coal-based power generation increases. Coal demand from the industrial sector has grown steadily and is expected to show sustained growth in the short to medium term. Brick kilns, the major end-user of coal and briquette, will continue to see strong usage. The demand for coking and semi-coking coal will also continue to rise due to higher iron and steel output and increased capacity utilisation of plants.

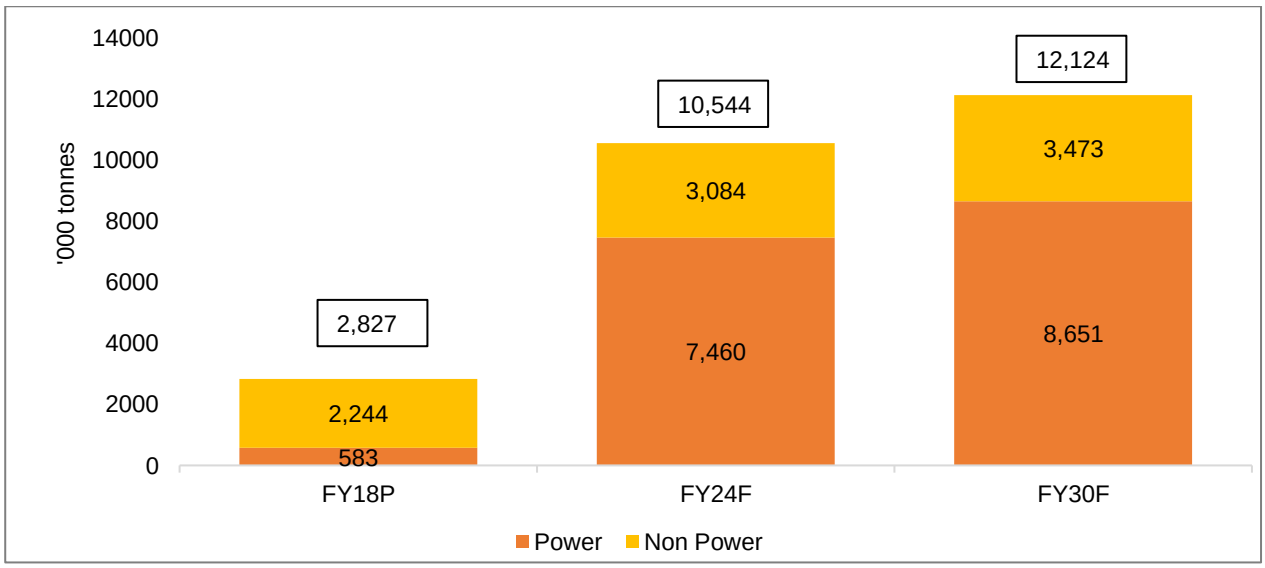
Figure 57: Coal Demand, Supply Review: Bangladesh



Source: Company reports

At present, coal is the cheapest primary form of energy and going forward with depleting domestic gas reserves and a spike in international crude oil prices, the usage of coal will increase rapidly. Majority of the plants will rely on imported coal as domestic production will not rise in line with the underlying demand.

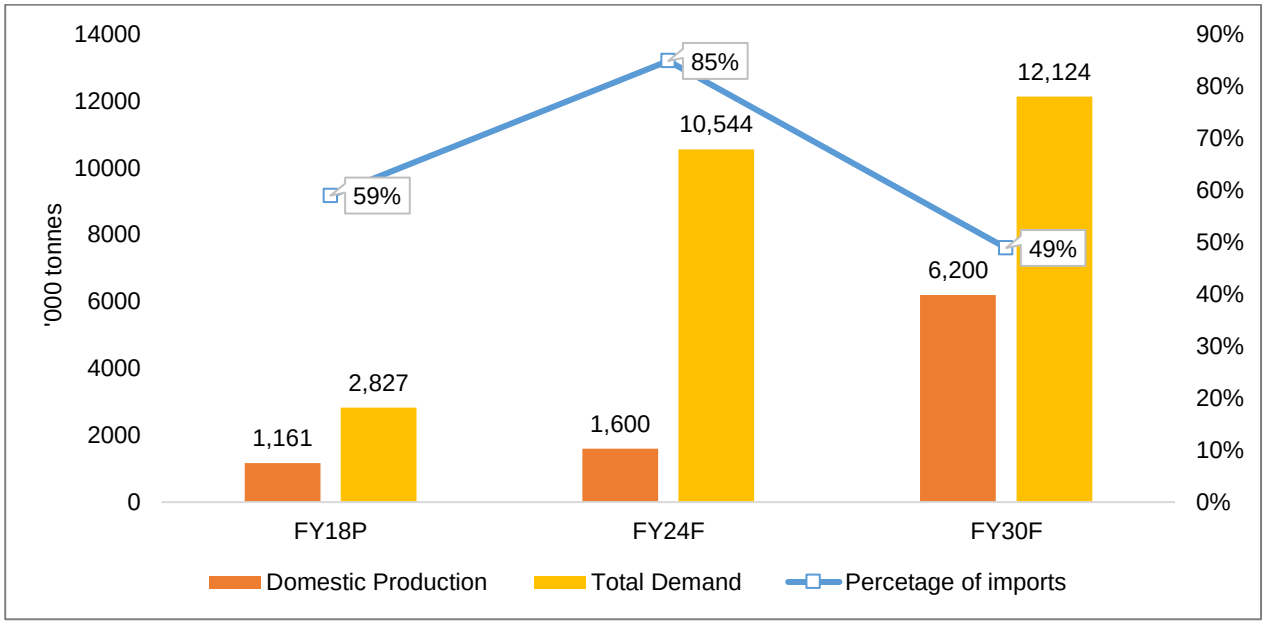
Figure 58: Coal Usage Outlook: Bangladesh



Coal-based power generation will rise from 1.6% in fiscal 2018 to ~20% in fiscal 2030. But domestic supply of coal will remain constrained with environmentalists and climate activists raising issues at open pit mine in Phulbari. The existing Barakpukuria coal mine is expected to increase coal output by an additional 1 MTPA on account of open cast mining. New coal mines, namely Khalaspir, Dighipara and Phulbari, are expected to start commercial coal production from fiscal 2027, fiscal 2029 and fiscal 2030, respectively. However, the domestic production will be able to meet only ~ 40% of the country's annual coal requirement.

The country is boosting imports infrastructure to handle additional coal cargos. The Matabari Coal Transhipment Terminal is being built with a planned handling capacity of 25.6 MTPA. The imports are expected to reach 5,924 MTPA by fiscal 2030.

Figure 59: Coal Supply Outlook: Bangladesh

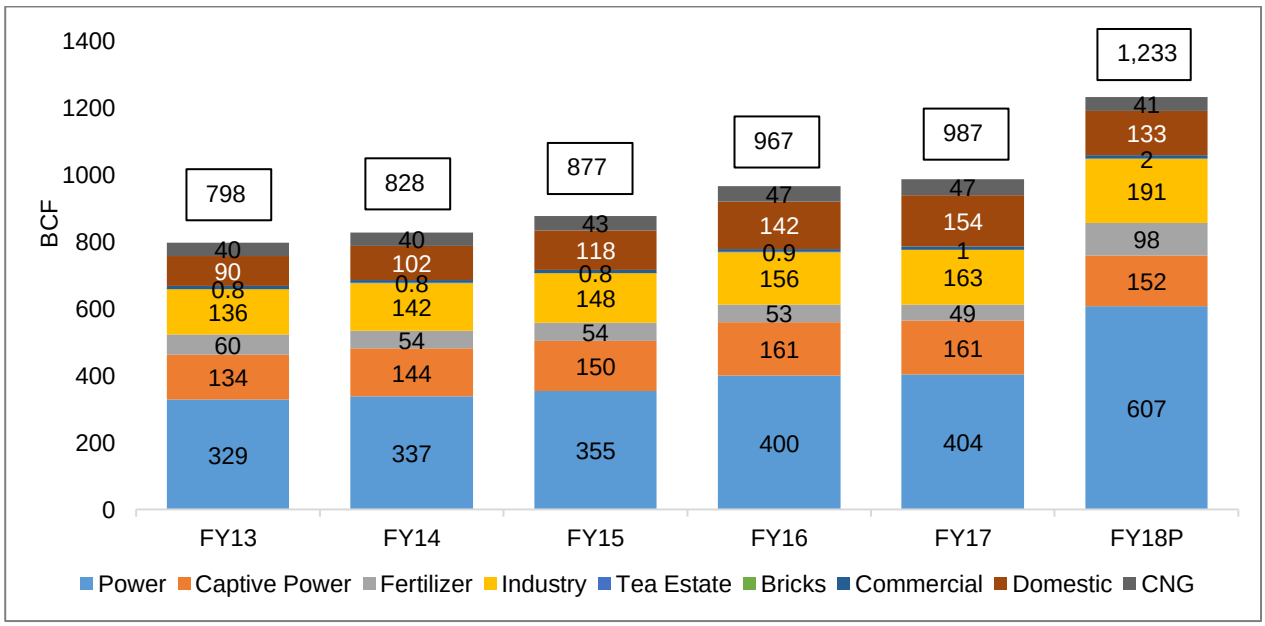


Gas

Demand, Supply Review

Bangladesh is highly dependent on gas which meets ~70% of the primary energy requirement of the country. Power plants are its biggest users followed by captive power, industrial usage and domestic usage. Six marketing and distribution companies, entrusted by PetroBangla for marketing and selling gas to consumers, have extensive distribution networks and cater to ~3.52 million consumers, majority of whom are domestic household consumers.

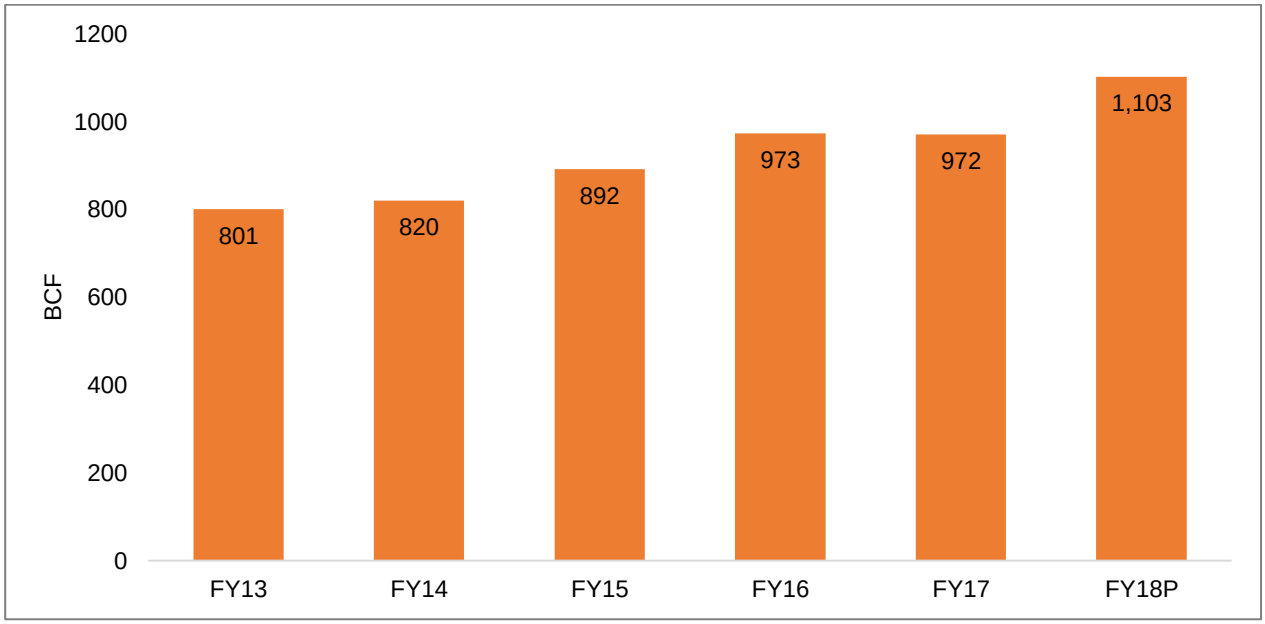
Figure 60: Gas Usage Review: Bangladesh



Source: PetroBangla Annual Report

There are 26 gas fields in the country and 20 of them are operational. Bangladesh Gas Fields Company Ltd (BGFCL), Sylhet Gas Fields Ltd (SGFL), Bangladesh Petroleum Exploration and Production Company Ltd (BAPEX) and international oil companies Chevron and Tullow are entrusted with operation of these fields.

Figure 61: Gas Production Review: Bangladesh

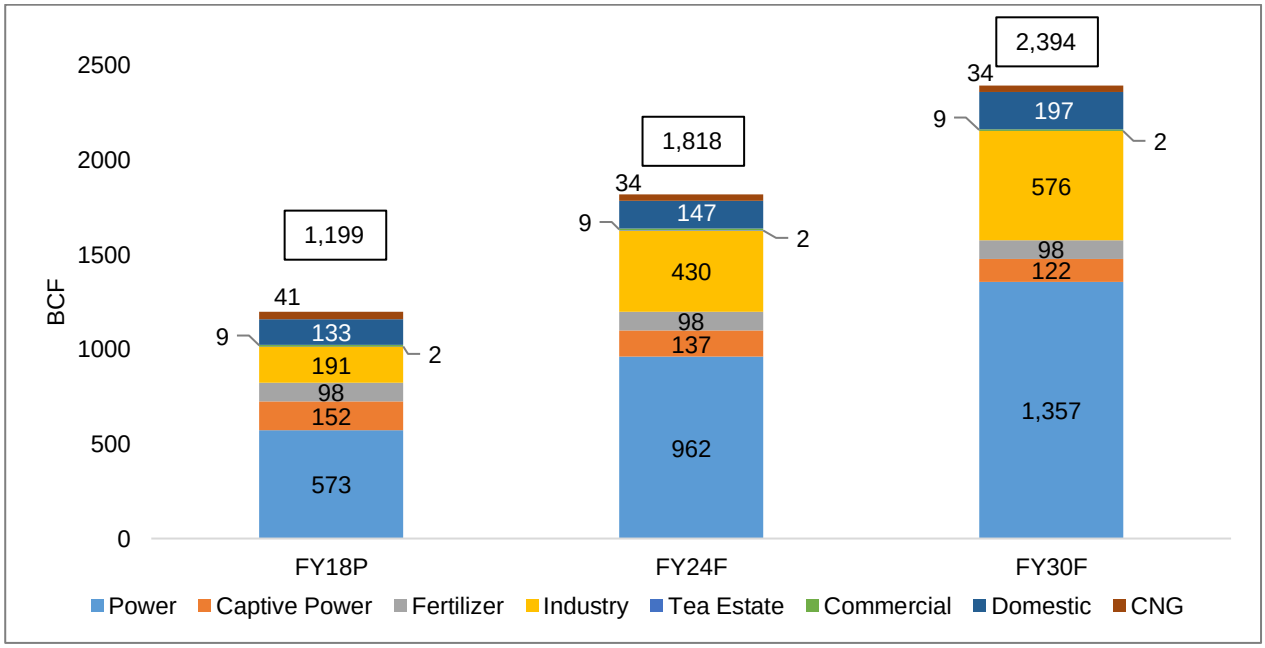


Source: PetroBangla Annual Report

Demand, Supply Outlook

Gas-based power plants will continue to be added to the grid, albeit at a slower pace. Share of power generation from gas will marginally go down from 68% in fiscal 2018 to ~65% in fiscal 2030. However, majority of gas-based additions (~2,700 MW between fiscals 2018 and 2030) will be LNG-fuelled. CNG-fired units and captive power plants will take a hit and are expected to move to other fossil fuels due to supply constraints and availability of cheaper alternatives.

Figure 62: Gas Usage Outlook: Bangladesh



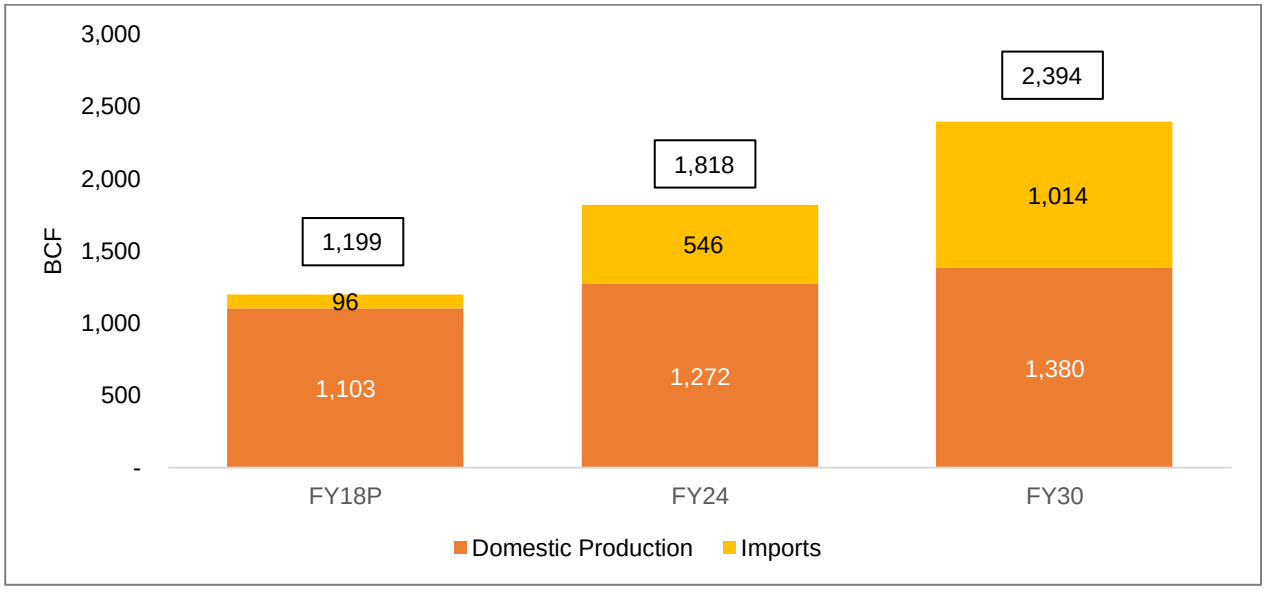
Gas production in the country is expected to slow down and domestic recoverable reserves will not be enough to meet the increasing end-use demand. As of fiscal 2017, cumulative production from gas fields reached 14.24 trillion cubic feet (tcf) with the remaining reserves (proved + probable) at 12.88 tcf. Assuming that the country carries on with gas production of 1,000 billion cubic feet, or bcf (in line with the current

levels), Bangladesh will exhaust its domestic gas supplies in the next 12 years. Taking cognisance of the impending gas shortages, the government has devised a two-pronged strategy to secure steady supplies. Apart from allocating capex for increasing domestic supplies, the country is developing LNG terminals (transport, storage and regasification units) to handle gas imports. Under the Rupkalpa Vision 2021, national exploration company BAPEX has launched 108 wells for exploration, production and augmentation of on-shore gas production. This is expected to yield an additional 1,000 million cubic feet per day (mmcfd). Terminal use agreements have been signed for setting up two floating storage and regasification units (FSRU) at Moheshkhali for supplying 500 mmcfd of LNG each. The units are in process of getting commissioned. Two land-based LNG terminals at Moheshkhali and at Paira port with handling capacity of 2000 mmcfd cumulatively are also expected to come up.

Bangladesh has signed SPAs with RasGas of Qatar, Pertamina and Oman Trading International for purchasing LNG under long-term contracts. A pipeline from Moheshkhali to Anowara has been built for transmission of LNG from the upcoming FSRU to the national grid.

The new wells are expected to improve the domestic supplies to ~1,380 bcf/annum by fiscal 2030. Gas deficit currently stands at ~25% (demand at 3.96 bcf/day vis-à-vis supply of 3.02 bcf/day). However, with LNG shipments expected to reach 18-20 million tonnes by fiscal 2030, the deficit will be bridged significantly.

Figure 63: Gas Supply Outlook: Bangladesh



Petroleum Products

Demand, Supply Review

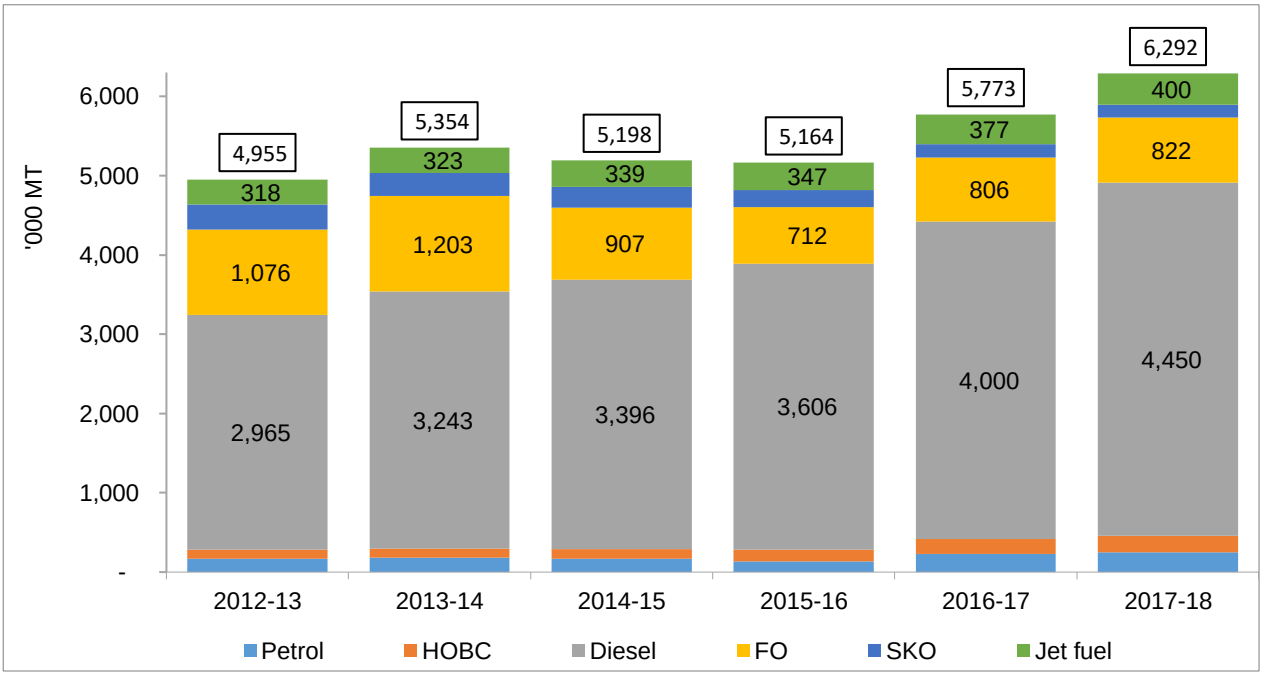
Bangladesh's overall demand for POL products (excluding LPG) is estimated to have risen at 4.7% CAGR during fiscals 2013-2018. The growth in fiscal 2018 alone was 8.7% due to the rising demand for petrol and diesel from the booming transportation industry.

Lower fuel prices combined with increased vehicular growth, mainly motorcycles and cars (25% CAGR over the last five fiscal years), increased the consumption of petrol and high-octane blending component (HOBC) 7.6% and 12.4%, respectively, in fiscal 2018. Diesel consumption grew 11.2% on year in fiscal 2018 due to increased activity in the transportation sector led by a strong 7.1% GDP growth. Commercial vehicles, which drive the diesel consumption, saw a 15% growth in fiscal 2018 and 12.3% CAGR over the last five fiscals. Furnace oil consumption saw a relatively slower 2% growth as power plants' plant load factors (PLFs) fell with rising cheap electricity imports from India.

Overall, petrol and HOBC consumption in Bangladesh rose steeply between fiscals 2013 and 2018 at a CAGR of 8% and 14%, respectively. Diesel consumption, meanwhile, grew at 8.5% CAGR driven by a rise in demand from industrial and agricultural segments and increased offtake from the transport segment. Consumption of furnace oil, with the power sector accounting for a major share, has been decreasing over the years. Between 2012 and 2013, its consumption actually declined 5.3% as electricity imports from India increased.

The Japan International Cooperation Agency (JICA) estimates the LPG demand in Bangladesh, as of today, is less than 2% of the overall oil demand. Publicly available information suggests the LPG consumption over the last few years stood at approximately 110,000 tonne per annum. More than 80% of the gas distribution was done by the private sector.

Figure 64: Consumption Trend of Main POL Products: Bangladesh



Source: BPC

Bangladesh, with a domestic production of 1.2 million tonnes, imported more than 80% of its total POL products requirement in fiscals 2017 and 2018. The overall trends in POL products imports are given below:

Table 15: Trend in Petroleum Product Imports: Bangladesh

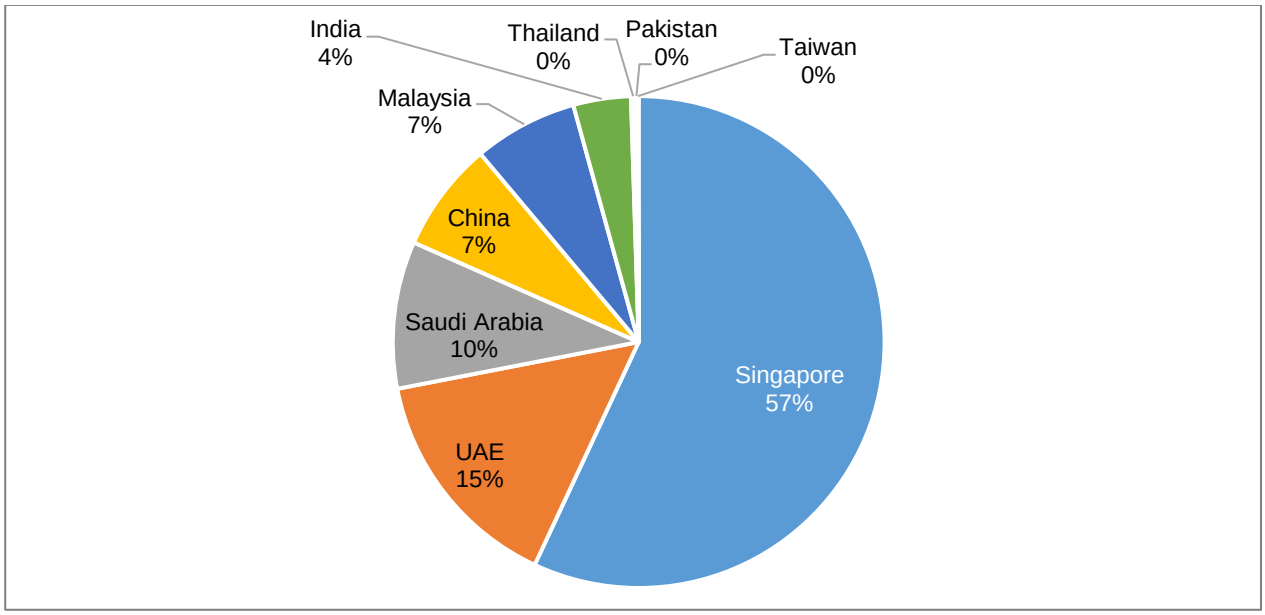
in '000 tonne	2012	2013	2014	2015	2016	2017
Petrol	96	98	36	34	151	33
HSD	2,619	2,609	2,904	2,975	3,130	3,716
Jet fuel	340	311	334	338	354	394
SKO	20	28	0	0	0	0
FO	671	1,005	869	414	482	564

Source: BPC

Diesel, with high demand from the transportation and industrial sectors, is evidently the most imported POL commodity. Fuel oil imports saw a decline with the shift in supply of electricity to cheaper Indian imports.

The Bangladesh Bank, the country's apex bank, details country-wise and commodity-wise imports in value terms. POL products are estimated to have been categorised under "*Mineral fuels, mineral oils and products of their distillation bituminous substances; mineral".* Overall, country-wise POL product imports in value terms is illustrated below:

Figure 65 : Import Payment for Oil Products 2016-17: Bangladesh



Source: Bangladesh Bank

Demand, Supply Outlook

Petroleum product consumption in Bangladesh is expected to grow at a CAGR of 6.4% (excluding LPG) between fiscals 2018 and 2030 as against 4.7% growth seen over the past five fiscals. The overall economic activity is expected to remain strong with the GDP likely to grow between 6.5% and 7%, resulting in strong demand for diesel from the transportation and industrial sectors. The demand for fuel oil is expected to pick up again with the rising power demand and limited power supply from gas-based capacities and through the imports.

POL product-wise factors resulting in demand growth are detailed as follows:

Petrol

Strong GDP growth and the resultant increase in per capita income is expected to boost overall vehicle sales in the coming years. Especially, sales of cars and two-wheelers are expected to grow rapidly, boosting the overall demand for petrol and HOBC at 10% CAGR. Lack of domestic gas availability will limit the use of CNG in the transport segment, which in turn will also help the demand for petrol and HOBC.

Diesel

Diesel demand is expected to grow at 7% CAGR between fiscals 2018 and 2030, driven by higher demand arising out of the growth in the transport and industrial sectors.

- Transport accounted for 55% of the diesel demand as of fiscal 2017. Strong economic activity is expected to keep the demand for commercial vehicles high supporting the diesel demand.
- The demand from the power sector, which accounts for 15% of the overall diesel demand, is also expected to see a marginal growth for the next two-three years, and stagnate thereafter. As a result, overall share of the power sector in the diesel demand is expected to decline to 10% in 2030.

However, growth in diesel as well as petrol will be capped owing to focus on fuel efficiency under INDC commitments. In the transport sector, a modal shift from road to rail is expected, led by metro systems and bus rapid transit systems in urban areas. The country also intends to achieve a 15% improvement in the efficiency of vehicles.

Furnace oil (FO)

FO is consumed primarily in the power sector. At present, FO-based capacities in Bangladesh stand at 2,851 MW. The Bangladeshi government, as per the Bangladesh Power Development Board's annual report for fiscal 2017, is planning to add 1,450 MW more to this. This is expected to grow the FO demand at 3.2% CAGR between fiscal 2018 and fiscal 2030. Additionally, the demand from industries is expected to grow marginally due to the improved economic activity.

LPG

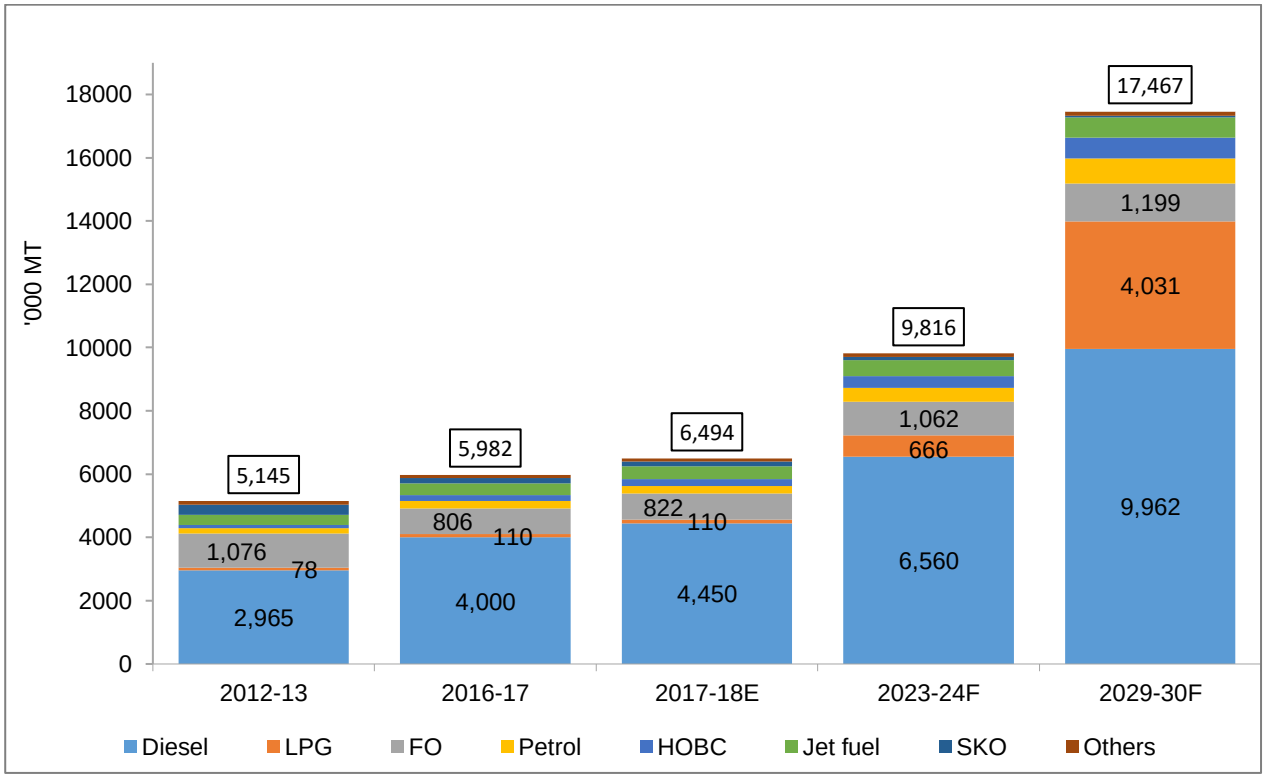
LPG is a relatively new entrant in Bangladesh's POL value chain. It is increasingly substituting piped natural gas (PNG) as household cooking fuel owing to the shortage of the domestic natural gas. The government's piped gas access limit policy is encouraging consumers to use LPG. The government has restricted piped gas connections for new households and commercial buildings and also reduced the hours of distribution. The energy division of the government has come out with the following proposals in its "LPG Strategy Paper", which has obtained the approval of the prime minister as an authorised policy:

- Natural gas prices should be raised to an appropriate level
- No further new connection for domestic customers
- LPG price should be aligned with the international market
- Natural gas risers at buildings should be utilised for LPG
- Import duty on LPG cylinder material should be lowered
- Land acquisition for LPG business should be promoted
- The government's LPG storage capacity should be secured and expanded
- Tax incentive for LPG import facilities (e.g. LPG road tanker) should be introduced
- Conversion of compressed natural gas (CNG) vehicles to LPG should be encouraged (should started with government vehicles)
- Lower the fee for LPG business license for private enterprises
- LPG statistics and database, and preceding survey should be implemented
- Should conduct programmes to create awareness about LPG use

Assuming that the above policy is applied, the demand for LPG is expected to grow rapidly in the future. With domestic gas only being supplied to existing consumers and a rise in demand from the transportation segment as CNG vehicles get converted to either gasoline or LPG, the demand for LPG is expected to surge at a CAGR of 35% between fiscals 2018 and 2030.

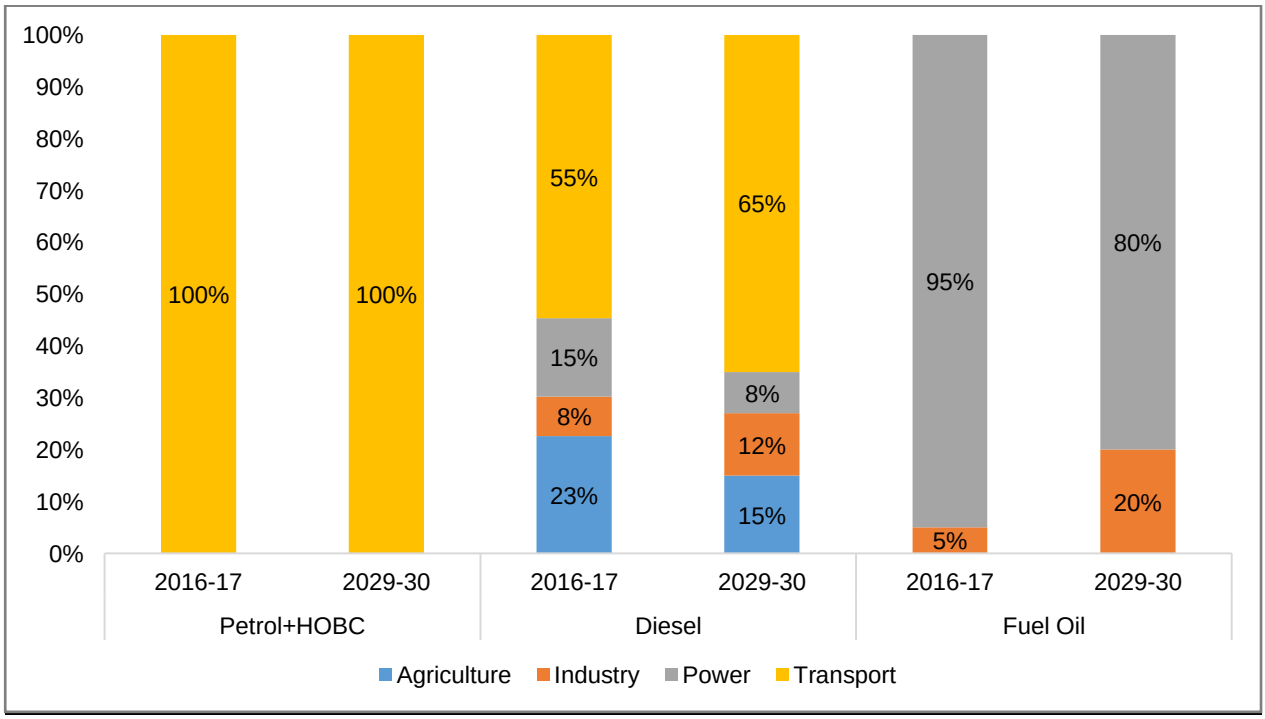
Overall the demand for POL products (excluding LPG) is expected to rise from 6.4 million tonne in fiscal 2018 to 13.4 million tonne in fiscal 2030. Meanwhile, the demand for LPG is expected to rise from 0.1 million tonne to 4 million tonnes.

Figure 66: Overall POL Demand Outlook: Bangladesh



Source: BPC, JICA

Figure 67: Segment-Wise Break-Up of Major Petroleum Products Consumption: Bangladesh



Source: BPC, JICA

ERL, the only refinery in Bangladesh, plans to expand its existing capacity from 1.5 million tonne to 4.5 million tonnes by fiscal 2020. This is expected to help cut down POL product imports of the country. There is plan to increase the capacity of another refinery after fiscal 2020. However, the location and the size of the capacity expansion have not yet been determined. In addition to this brownfield expansion, Kuwait

Petroleum Corporation (KPC), is also considering setting up a greenfield refinery and petrochemical complex at the Moheshkhali Island in southern Chittagong. The project was envisaged in 2000, but it did not see much progress until May 2015, when a delegation of KPC visited Dhaka and requested for 1,000 acres of land for the project. It is expected that the refinery shall have a crude oil distillation capacity of 8.0 million tonne and shall come online by fiscal 2027. Overall investment planned is of $6.0 billion.

The total refining capacity in Bangladesh is expected to increase at 19% CAGR to reach 12.5 million tonnes by fiscal 2030. Still the capacity will fall short of demand. While the total domestic production of petroleum products is expected to increase to 11.2 million tonnes by fiscal 2030, the overall demand will be far higher at 17.5 million tonnes. This would mean an import requirement of 6 million tonne. The country will also have to import crude oil to feed the incremental refining capacities.

The following table showcases the balance of POL trade for Bangladesh until fiscal 2030 highlighting it shall have an overall deficit of 6.2 million tonne by 2030.

Table 16: POL Trade Balance: Bangladesh

in '000 tonne	FY13	FY17	FY18E	FY24F	FY30F
Refining capacity	1,500	1,500	1,500	4,500	12,500
Crude oil condensates production	60	26	27	30	40
Crude oil Imports	1,301	1,365	1,139	4,023	11,210
Petroleum product production	5,145	5,982	6,494	9,816	17,467
Petroleum product net import	1,361	1,392	1,166	4,050	11,250

Source: BPC

Large Hydro

There is just one hydro power plant in the country, Karnafuli Hydro, with an installed capacity of 230 MW (2x40 MW+3x50 MW). Hydropower generated in fiscal 2018 was 982 MU, a meagre 1.6% of total power production. The governments of Bangladesh, Bhutan and India have signed an MoU for constructing 1,125 MW Dorjilung hydro project with prospects of future exports of power from Bhutan to India and Bangladesh. However, the project has not received much traction and there is uncertainty over commencement of commercial production. Bangladesh has no plans to set up hydropower projects owing to high capital expenditure. With the country already reeling under incessant floods and change in rainfall patterns, it does not intend to build new dams for power projects.

Other RE Sources

Under the Power Sector Development Plan, the government and the BPDB has laid special emphasis on Renewable Energy Development Program. For sustainable power generation, the board intends to move away from fossil fuels and look towards RE as the future. However, with electrification lagging behind, the country had to rely on cheaper conventional sources, over which they had technical expertise, in order to augment supply. Now, as Bangladesh looks at adding all households to the grid by 2022, rebalancing the fuel mix is a focus area. The BPDB has installed solar systems of 270 kWh in its offices with another 500 kWh in the pipeline. Small wind projects have been set in the Kutubdia Island and Cox's Bazaar. Eight cities are installing solar street lights and solar charging stations are being set up in Sylhet and Chittagong.

Table 17: Upcoming Major Projects in RE: Bangladesh

Type	Name of plant	Capacity (MW)	Developer
Solar	Solar Park on BOO basis at Teknaf, Cox's Bazar	200	Sun Edsion Energy Holding (Singapore) Pte Ltd
	Solar Park at Dharmapasha, Sunamganj"	32	EDISUN-Power Point & Haor Bangla-Korea Green Energy Ltd.
	Solar Park at Sutiakhali	50	HETAT-DITROLI-IFDC SOLAR
	Solar PV Power Project at Shekhgach	30	Consortium of Beximco Power Co. Ltd, Bangladesh & Jiangsu Zhongtian Technology Co. Ltd., China.
	Solar PV Power Project at Sundarganj	200	Beximco Power Company Ltd, Dhaka
	Grid Tied Solar PV Power Project at Bora Durgapur, Mongla	100	Consortium of Energon Technologies FZE and China Sunergy Co. Ltd. (ESUN)
Wind	Wind Power Project at Anwara, Chittagong	100	Consortium of PIA Group LLC, Spain and Bangladesh Alternative Energy Systems Ltd.
	Wind Power Project at Cox's Bazar	60	US-DK Green Energy (BD) Ltd.
	Wind Power Project at Anwara, Chittagong	100	Consortium of PIA Group LLC, Spain and Bangladesh Alternative Energy Systems Ltd.

Source: BPDB Reports

An additional 800-1,000 MW of RE plants are expected to be set up taking power generation to ~2000 GWH. However, the share of RE in the total power production will continue to linger at 1.6%. The major constraints for the RE additions are lack of land availability and low RE potential in the country (up to 3,700 MW as per the SREDA-World Bank report). Biogas can be used for home cooking fuel, especially in rural areas where increasing LPG prices may see some shift from gas to this affordable and clean energy. However, consumers are unlikely to shift in large numbers as gas prices are expected to be subsidised for low income households.

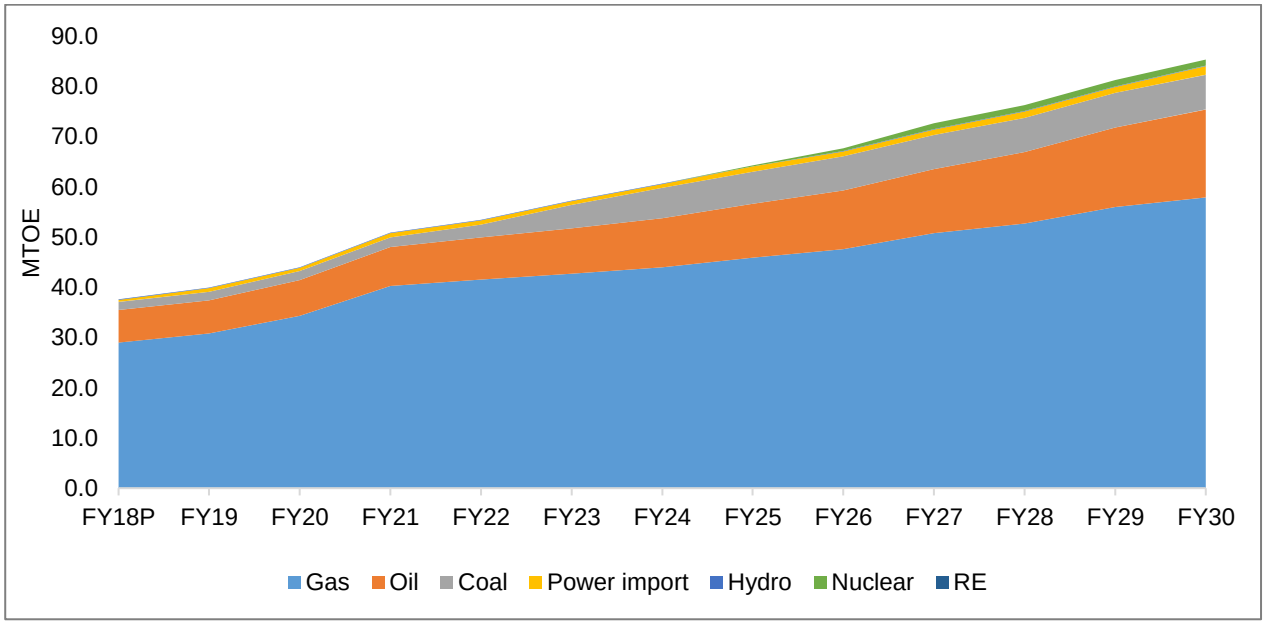
The country has been executing projects like Rural Electrification and Renewable Energy Development (RERED) with assistance from the World Bank to increase access to clean energy in rural areas through renewable energy. Under its conditional scenario of INDC commitments, Bangladesh intends to set up 400 MW of wind generating capacity and 1000 MW of utility-scale solar power plants by 2030. Taking into consideration federal targets, power generation expansion plan and practical feasibility, around 1000 MW of solar- and wind-based plants are expected to come up in the country (in line with INDC targets).

Energy Outlook 2030

Combining the usage outlook for all the fuels mentioned above, it is estimated that the overall energy requirement in the country shall rise from 37.6 MTOE in fiscal 2018 to 85.3 MTOE in fiscal 2030.

All figures in MTOE	**FY18P**	**FY19F**	**FY24F**	**FY30F**
Primary Energy	37.6	39.9	60.7	85.3

Figure 68: Primary Energy Outlook Until 2030: Bangladesh

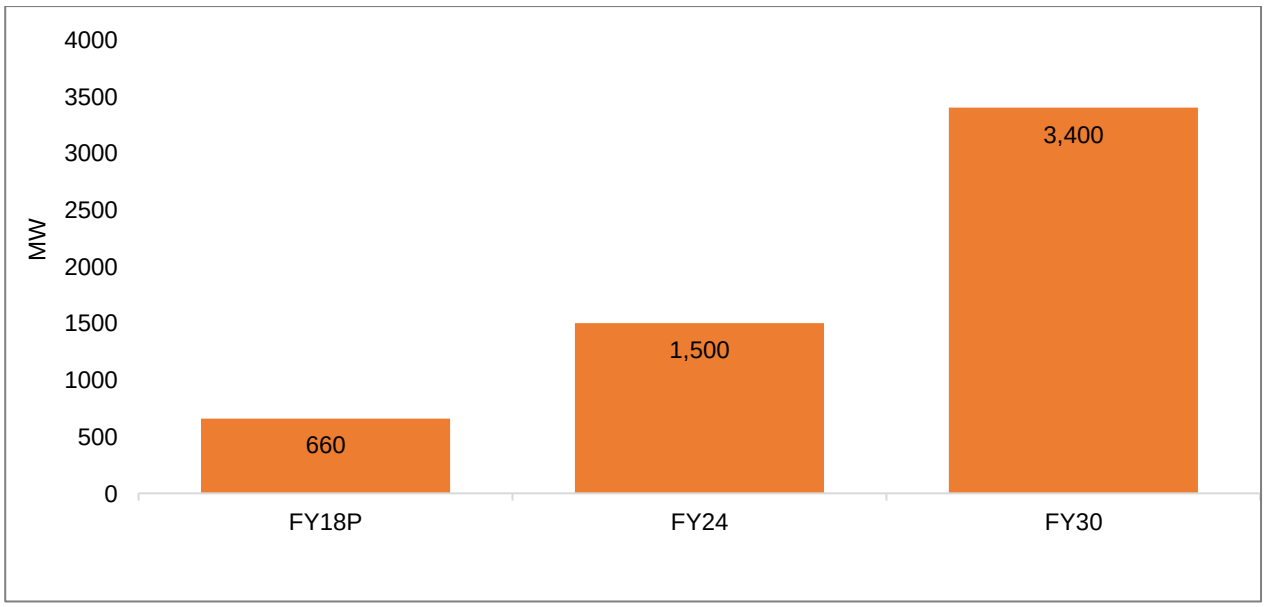


**RE not shown in the bar chart as contribution to primary energy mix <0.01 MTOE*

Outlook on Imports

To meet the rising demand, the country is looking at power imports from the neighbouring countries. Currently, around 600 MW is being imported from India via the Bangladesh-India regional grid interconnection project. Another 500 MW is expected to be imported by fiscal 2019 when the second interconnection line is built. Beyond fiscal 2025, another 2,000 MW will be imported from India (Tripura) and Bhutan. With neighbouring countries such as Nepal, Bhutan and Myanmar and India's north-eastern states and West Bengal having abundant hydro power potential, Bangladesh may look towards more power imports for fuel diversification and base load supply. As per conservative estimates, ~3,400 MW of electricity will be imported by fiscal 2030.

Figure 69: Power Imports Outlook: Bangladesh



Source: BPDB reports, Power System Master Plan

Domestic production of gas is expected to rise at a CAGR of 2% until fiscal 2030 but will not be enough to sustain the increasing demand. Imports for coal are also expected to grow steadily owing to high coal-fired thermal power plant addition as well as strong end-use demand from brick kilns.

Depending on the as-is scenario and taking into consideration the expected change in fuel availability, Bangladesh would need imports as shown below:

Table 18: Fuel Import Outlook: Bangladesh

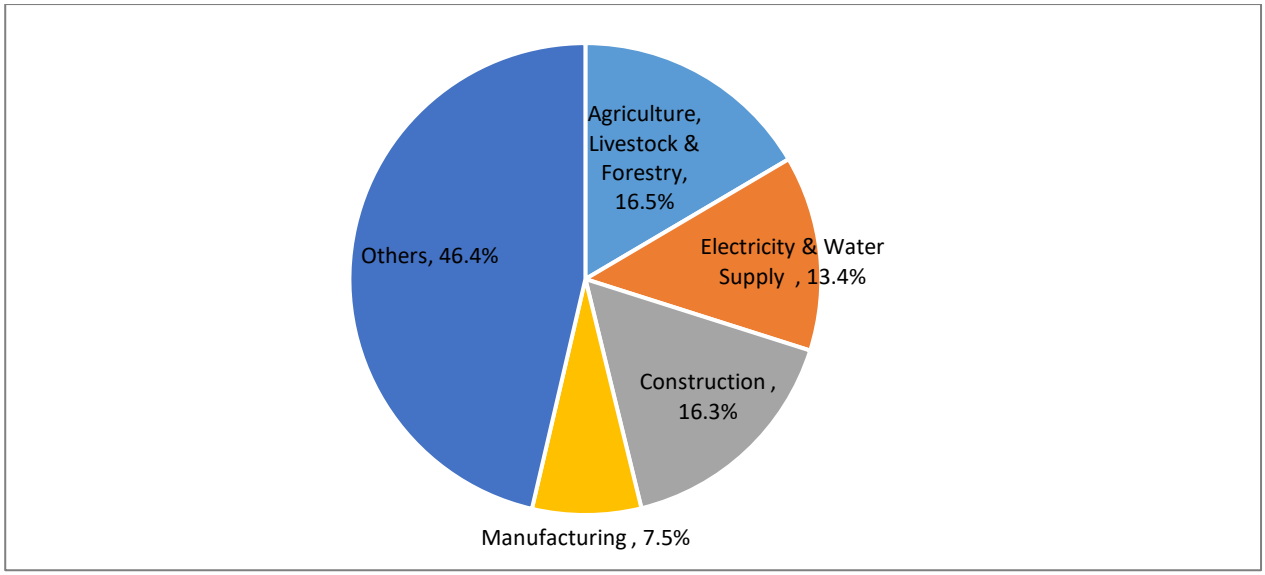
Fuel	FY19	FY24	FY30
Crude Oil [in '000 tonne]	1,173	4,015	11,210
Petroleum Products [in '000 tonne]	5,284	5,100	2,186
Electricity [in GWH]	8,129	9,198	20,849
Coal [in '000 tonne]	1,828	8,944	5,924
Gas [in bcf]	96	546	1,013

4 Bhutan

4.1 Country Overview

The Kingdom of Bhutan, a small landlocked country between China and India, spreads over 38,394 sq km, of which approximately 70% is covered with forests and 7% with year-round snow and glaciers. It has a population of 0.74 million which is expected to reach 0.84 million by 2030. Bhutan's GDP over the past has grown at ~6% CAGR from 2012 to 2017 led primarily by investments in construction, mining and quarrying. In 2016, agriculture, construction, electricity and water supply and manufacturing accounted for more than 50% in the GDP of the country.

Figure 70: Sectoral Share in GDP: Bhutan (2016)



Source: National Accounts Statistics 2017

A brief snapshot of Bhutan's Macroeconomic profile is as below:

Table 19: Country Profile: Bhutan

	Factors	2012	2017
Demographics	Population [in millions]	0.72	0.74[2]
Macro-economic scenario	GDP growth rate	5.07%	4.63%
	Sectoral growth rate		
	a. Primary	0.31	3.39
	b. Secondary	2.89	2.41
	c. Tertiary	1.88	7.15
	Inflation % change (CPI)	10.92%	4.96%
Fiscal position	Exports [million USD]	541	577
	Imports [million USD]	1011	1037
	Fiscal deficit [as % of GDP]	1.1%	3.3%

Exchange rates Considered: One US Dollar (US $) = Nu; for 2012-> 52.5, for 2017 -> 64.6
Source: National Accounts Statistics; Statistical Yearbook 2018

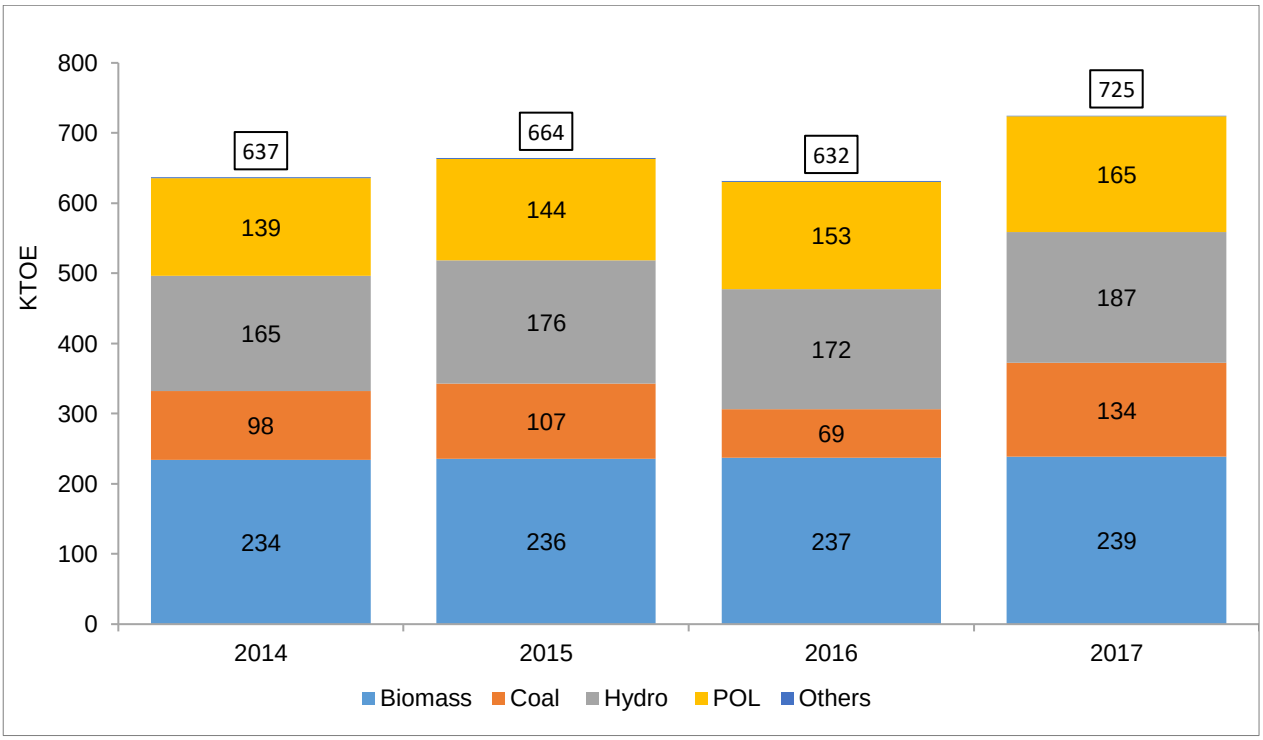
[2] As of May 30th May 2017 (Population and Housing Census of Bhutan)

4.1.1 Overview of Energy Structure

Energy Mix

Bhutan's overall energy consumption grew steadily at ~4.6% CAGR from 2005 to 2014 after which the growth slowed down marginally to ~4.4% CAGR from 2014 until 2017 owing to a decline in consumption by the industrial sector. Industrial energy consumption declined due to various issues ranging from raw material availability issues, power shortage and tax regime change in India, a country with which Bhutan is engaged in trade for sourcing raw materials and selling end products.

Figure 71: Energy Mix Review: Bhutan[3]



Source: Bhutan Energy Directory 2015, Statistical Yearbook

Overall primary energy consumption of Bhutan was ~725 KTOE in 2017 with building (including residential consumption) and industrial sectors cumulatively accounting for ~79% of it. The balance 21% was consumed mainly by the transport sector.

Biomass, primarily fuel wood, forms the major source of primary energy in Bhutan. It is used for cooking and space heating in the building sector (residential, institutional and commercial sector). The country's fossil fuel needs are met mostly thorough imports. Hydropower is the main resource of electricity, which is mostly consumed by the industrial and building sectors. The country also imports petroleum oil products, mostly from India, which is used by all the sectors of the economy.

[3] Energy mix has been shown from 2014 as biomass data is not available for the year 2012 and 2013. Biomass consumption data for the year 2014 has been considered from Bhutan Energy Directory 2015. In addition, biomass consumption data for 2015, 2016 and 2017 data has been estimated to calculate total primary energy consumption of the country.

Domestic Availability and Imports of Fuels

The following table details the domestic production and import of the major fuels in 2012 and 2017

Table 20: Domestic production and import for major fuels

Fuel	Supply type	2012	2017
Coal [in '000 MT]	Domestic production	98.73	161.53
	Net imports	93.7	122.75
Key Petroleum Oil Products (Petrol, Diesel, Kerosene, LPG, Fuel Oil, ATF, LDO) [in '000 MT]	Domestic production	0	0
	Net imports	134.2	157.9
Electricity [in GWH]	Domestic production	6824	7730
	Net imports	0	0

Source: Statistical Yearbook

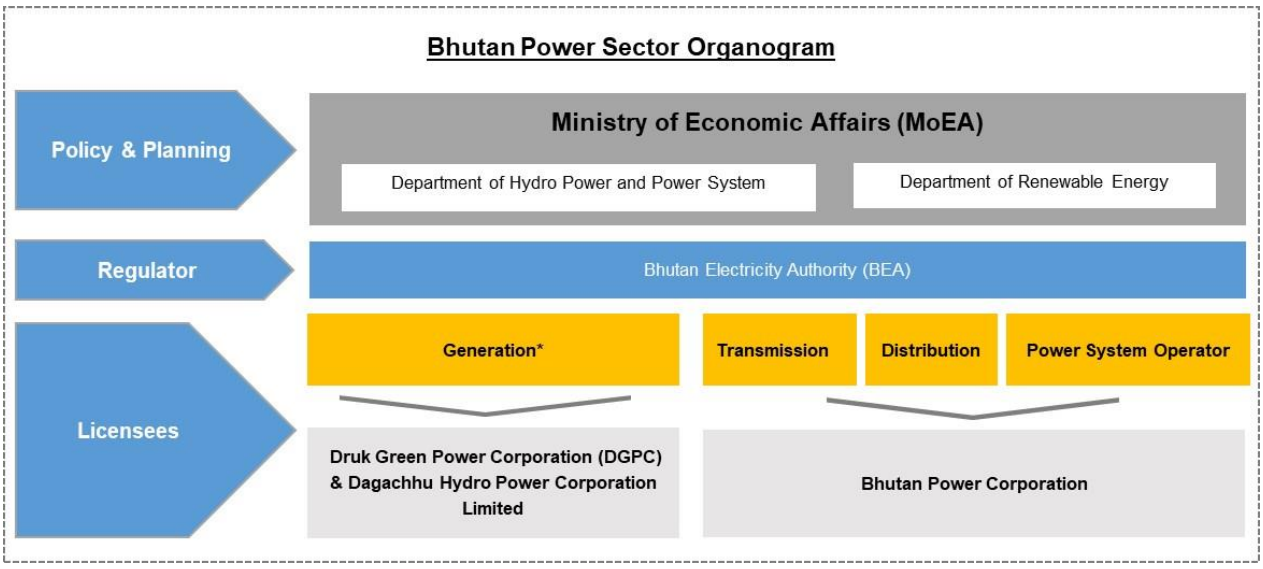
4.2 Institutional and Regulatory Framework of Energy Sector

4.2.1 Planning and Regulatory Bodies

The Bhutanese government has 10 ministries that work to achieve the goal of gross national happiness. The energy sector falls mainly under the scope of the Ministry of Economic Affairs and Ministry of Agriculture and Forests. *The Ministry of Economic Affairs (MoEA)* performs key functions related to planning, monitoring and evaluation for the overall energy sector Following section describes the key bodies and their functions in power and petroleum sectors in Bhutan:

Power Sector

Figure 72: Organogram of Power Sector: Bhutan



**For generation, only entities that have present operational hydro power plants are shown*
Source: Bhutan Electricity Authority, DHI

Key departments and organisations along with their roles and functions are as follows:

- *The Department of Hydropower and Power Systems (DHPS)* is a planning and coordination body of Bhutan and is mainly responsible for granting approval to the utility companies for development of hydropower, upgradation and expansion of transmission systems. DHPS is responsible for hydro projects with capacity greater than 25 MW.

- *The Department of Renewable Energy (DRE)* was established in December 2011 with the mandate to serve as the central coordination agency and the focal point of the government on all matters related to RE development. The department's main aim is to broaden the energy supply mix by exploring other forms of clean and renewable energy sources that will supplement the hydropower generation shortage the country faces during the lean season. The department is responsible for development of rural electrification, small/mini/micro hydro (below 25 MW) projects. There are three specific divisions under it:

    - Allternate Energy Division
    - Planning & Coordination Division
    - Research and Development Division

- *The Bhutan Electricity Authority (BEA)* was established as a functional autonomous agency as per Section 7 of the Electricity Act of Bhutan, 2001, to restructure and regulate the electricity supply industry, to allow private sector participation and to empower the government to create companies for carrying out all or any of the purpose of the Act. The authority was granted full autonomy in January 2010.

- *Druk Green Power Corporation Ltd (DGPC)* is a wholly owned subsidiary of Druk Holding and Investments Ltd established in 2008 through a merger of the erstwhile Chhukha, Kurichhu, Basochhu and Tala Hydro power plants with the vision of harnessing and sustaining Bhutan's RE resources. Druk Holding and Investments (DHI) is the commercial arm of the government of Bhutan and was established in 2007 by issuing a charter "to hold and manage the existing and future investments of the Royal Government for the long-term benefit of the people of Bhutan". DHI is the largest and only government-owned holding company in Bhutan. DGPC also holds 59% share in the 126 MW Dagachhu Hydro Power Corporation Ltd.

- *Bhutan Power Corporation Ltd (BPC)* distributes electricity throughout the country and provides transmission access for domestic supply as well as export. Its basic mandate is to ensure supply of reliable, adequate and cheap electricity to all citizens. The corporation is owned by Druk Holding and Investments (DHI).

The Ministry of Agriculture and Forests (MoAF) ensures sustainable social and economic well-being of the Bhutanese people through adequate access to food and natural resources. The Department of Forests and Park Services (DoFPS) under the ministry has the mandate to maintain a minimum of 60% of the country's geographical area under forest cover, which is in line with Bhutan's first INDC commitments. As per Bhutan's first INDC, the country has intended to remain carbon neutral where emissions of GHG should not increase carbon sequestration by forests, which has been estimated at 6.3 million tonnes of CO_2[4].

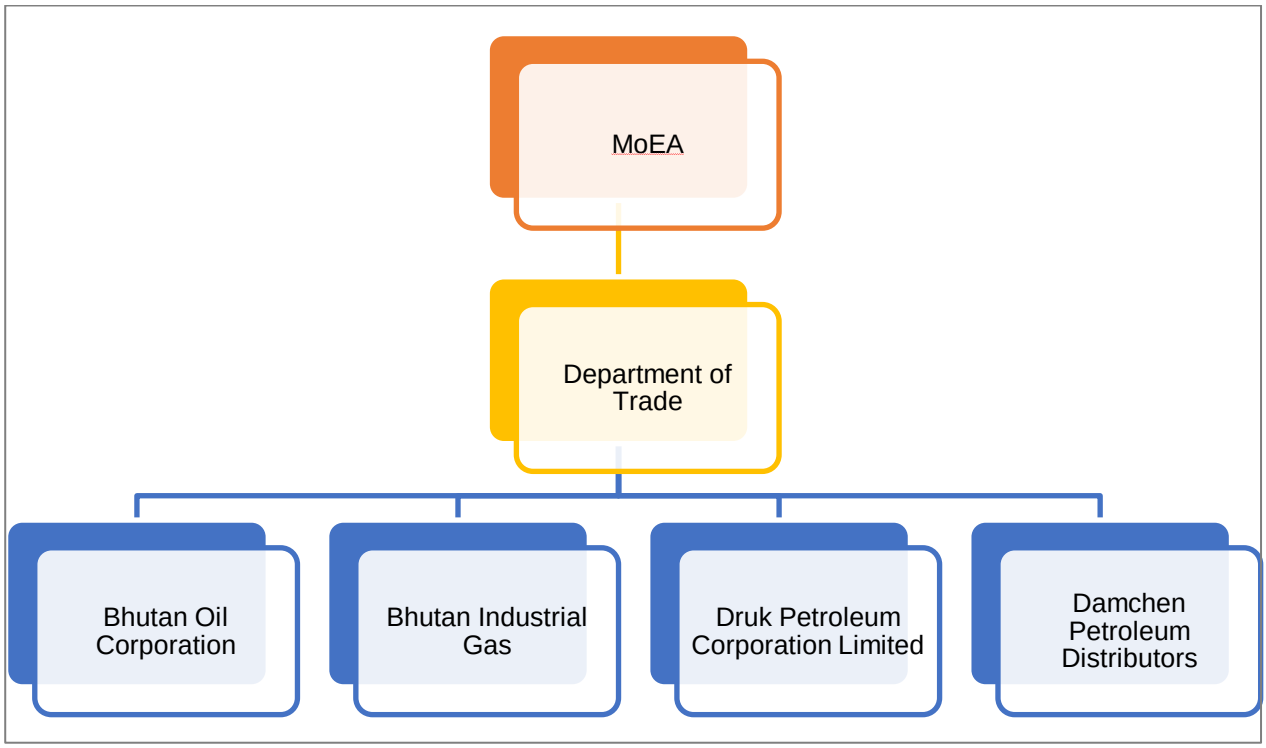
Another body of Bhutan, Natural Resources Development Corporation Ltd (NRDCL), which is 100% government-owned investment company, manages and provides services related to timber, sand, stone and other natural resources.

[4] Bhutan's first INDC

Hydrocarbon Sector

The Department of Trade under the MoEA is the overarching body in Bhutan which manages the imports and regulates pricing of POL products. The Bhutanese government has a long-term agreement with India for the supply of petroleum products through IOCL and BPCL. The products are then distributed through Bhutan Oil Corporation (BOC), Druk Petroleum Corporation Ltd (DPCL), Damchen Petroleum Distributors (DPD) and Bhutan Industrial Gas.

Figure 73: Hydrocarbon Sector Organogram



4.2.2 Regulatory and Policy Framework

Key regulations governing energy sector of Bhutan are:

- Electricity Act of Bhutan
- Bhutan Sustainable Hydropower Development Policy
- Alternative Renewable Energy Policy
- Grid Code Regulations
- Tariff Determination Regulation
- Domestic Electricity Tariff Policy

Since Bhutan is completely dependent on imports with negligible domestic reserves, no policy pertaining to exploration for crude oil could be ascertained. The pricing policies for POL products are detailed subsequently.

4.2.3 Government Support: Pricing, Existing Subsidies on Fuel and Controlling Regime

Since majority of the primary sources of energy, including coal and POL products, are imported, the pricing is dependent upon the import prices which are effectively subsidised by the government.

Electricity

The BEA regulates the electricity price for the consumers in the country. The following table showcases the comparison between applicable tariffs for various categories of consumers for Bhutan Power Corporation:

Table 21: Power Tariffs in Bhutan

Tariff (1st July 2018 to 30th July 2019)		
Wheeling (Nu/ KWH)		0.195
Low Voltage*		
Block	KWH/ Month	Energy Charges
I (Rural)	0-100	0
I (Others)	0-100	1.28
II(All)	101-300	2.68
III (All)	Above 300	3.53
Low bulk Voltage		4.02
Medium Voltage		
Energy Charges (Nu/ KWH)		2.16
Demand Charges (Nu/kva/ month)		300
High Voltage		
Energy Charges (Nu/ KWH)		1.59
Demand Charges (Nu/kva/ month)		262

** Demand charges not applicable for Low Voltage category*
Source: Bhutan Electricity Authority

The LV Block-I (Rural) category is entitled for 100 free units. The category includes the rural domestic households, rural cooperatives, communities and micro-trade activities. However, for consumption beyond 100 units per month, the tariffs paid by the LV Blocks II & III (All) are applicable. Subsidy on electricity to LV and MV consumers is also provided by the government.

Compared with the neighbouring nations, Bhutan supplies cheap electricity to energy-intensive industries such as ferro alloys and cement, thus providing cost competitive edge to these industries.

Petroleum Products

The DOT regulates and determines the prices of POL products across various regions of Bhutan. The variation in prices across different districts depends upon the transportation cost. Since India is the only supplier for key POL products the prices are directly influenced by the market price in India. At present, the prices of petrol and diesel in Bhutan are, however, much cheaper than in India, owing to exemption of excise duty on fuel imports at source in India.

LPG and kerosene are sold at subsidised rates in Bhutan. Subsidy for LPG is in the 55-60% range, depending on distance of the location of the outlets from the bordering towns. The Indian government provides the subsidy on both LPG and superior kerosene oil (SKO) as both these products are part of the grant assistance from India. Retail price of LPG is fixed by the Department of Trade and is inclusive of the dealer's commission, transportation cost and sales tax built over Indian invoice price.

Table 22: Price of Key Petroleum Products in Bhutan

Petroleum oil products	Price
Subsidised LPG refilling cost (January 2018)	~537 Nu.
Non-subsidised LPG (Thimphu price) refilling cost (Feb 2018)	~815 Nu.
Petrol (Thimphu Price for June 2018)	63.29 Nu/ Ltr.
Diesel (Thimphu Price for June 2018)	65.39 Nu/Ltr.

The following tables details the customs duty and taxes applicable on import of coal and POL products:

Table 23: Duty Structure Applicable on Coal and Petroleum Oil Products Imported by Bhutan

Type of Fuel	Duty	Sales tax	Green tax
Motor spirit (gasolene) including aviation spirit (petrol)	20%	5%	5%
Spirit type (gasolene type) jet fuel (ATF)	20%	5%	-
S.K. Oil (Subsidy)	20%	-	-
S.K. Oil	20%	-	-
Kerosene type jet fuel (ATF)	20%	-	-
Other light oils and preparations (HSD)	20%	5%	5%
Coal	10%	-	-

Source: Bhutan Trade Classification & Tariff Schedule (2017)

4.3 Overall Energy Outlook 2030

Bhutan's energy outlook has been assessed by undertaking a detailed review of all primary sources of energy, including coal, hydro, POL products, biomass and renewable. As the power sector serves as a major consumer of these sources and the single largest secondary energy in the country, its analysis precedes other fuels:

4.3.1 Power Demand, Supply Review

Power Demand Position

Overall power demand from the industrial, building and other sectors rose at a slower ~2.9% CAGR from 2014 to 2017. The industrial sector is the single-largest consumer of electricity, accounting for ~78% of total power demand, followed by the building sector at ~20% share, and remaining being consumed by the agriculture sector and other areas. The building sector includes consumption from the residential, commercial and institutions categories, residential accounting for ~55% of total building sector's electricity demand in 2017.

On an overall level, power demand in Bhutan was ~2,186 MU in 2017.

Power Supply Position

Bhutan had total installed capacity of ~1,623 MW in 2017, with hydro capacity constituting ~99% share. High share of hydro assets in the total power supply of Bhutan helps to keep emission low from the overall power supply to the grid. In addition to hydro, diesel generators (for emergency purpose), wind power stations and

solar home lighting system (off-grid) comprise the electricity generation ecosystem. In 2017, Bhutan net exports were ~70% of the total electricity produced.

Table 24: Major Hydro Power Plants Operational in Bhutan

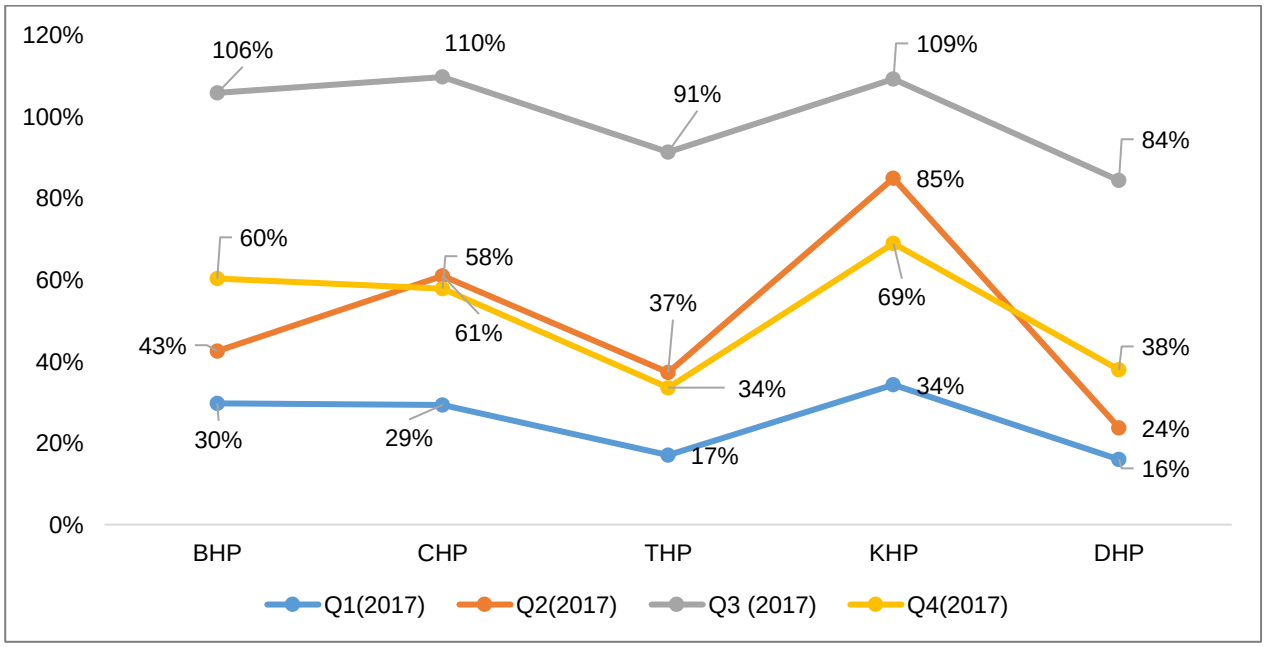
Hydro power plants	Installed capacity (MW)
Chhukha Hydro power Plant	336
Kurichuu Hydro power Plant	60
Basochhu Hydropower Plant– I & II	64
Dagachhu	126
Tala Hydro power Plant	1,020
Total	**1,606**

Source: Quarterly report of Bhutan Power Corporation Ltd

Overall, the country's power capacity has increased only ~124.8 MW from 2014 to 2017, with the commissioning of 126 MW Dagachhu (DHP) hydro power plant and slight reduction in diesel generator capacity.

Hydro power meets most of the domestic demand for electricity in Bhutan; however, the generated electricity depends mostly on run-of-the-river-based hydro power plants. Therefore, power generated fluctuates seasonally. The availability of water in the river is high during the summer months and low during the winter months.

Figure 74: Average Capacity Factors of Major Hydro Power Plants

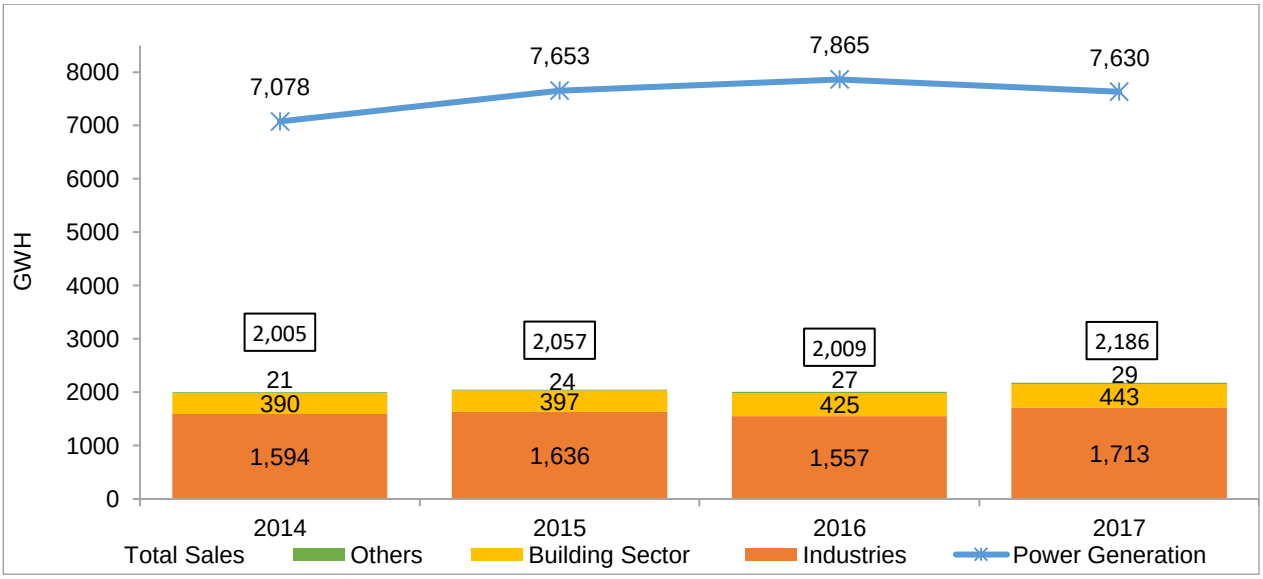


Source: Quarterly report of Bhutan Power Corporation Ltd

Power generation is typically high during June to October because of snow melting and the monsoon while November to April is the lean season. Although the trend of electrical energy demand throughout the day is similar in winter and summer, peak demand is significantly higher during winters at all hours. This situation poses challenges as generation from hydro power plant is low in the winters when peak demand is high.

Lack of availability of round-the-clock power supply across all season has impacted industrial growth as the government previously managed power supply by withholding licenses. However, this situation is expected to improve with the commissioning of new hydro power plants.

Figure 75: Review on Power Sales vs Power Generation



Source: Statistical Yearbooks, Bhutan Electricity Authority

4.3.2 Power Demand, Supply Outlook

Power Demand Outlook

Overall power demand is expected to increase at ~8.8% CAGR, from 2,186 MU in 2017 to 6,572 MU in 2030, led by power demand from the industrial and building sectors.

Industrial Sector: Electricity demand in the industrial sector is expected to grow at ~9.3% CAGR from 2017 until 2030 owing to demand from existing energy-intensive industries such as ferro alloys and cement, in addition to upcoming demand from new industrial estates. Four industrial estates are identified for development at Jigmeling in Sarpang, Dhamdum in Samtse, Motanga in Sandra Jongkhar, and Bondeyma in Mongar. These estates are expected to get completed within the Twelfth Five Year Plan (2018-2023). It is estimated that electricity demand from these upcoming industrial estates should add an industrial load of ~900 MW in phase-wise manner by 2030.

Going forward, energy demand from industries will also be a function of the energy efficiency measures taken by the industries. The Consolidated Energy Audit Report for Industries by the Department of Renewable Energy stated that there are significant opportunities to reduce energy demand in large and medium scale industries through process optimisation. The report mentioned that energy efficiency measures across different types of industries can help to save more than 260 KTOE by 2030. It is expected that coal substitution with electricity as a fuel in the coming years will also increase electricity demand in existing and new industries; but as coal is a cheap and reliable option for industries, a significant reduction is not expected in the near future.

Building Sector: Overall electricity demand in the building sector is expected to grow at ~7.2% CAGR from 2017 till 2030 to ~1,100 GWH. The reasons are:

- Increased demand from households already connected to the grid owing to addition of appliances such as washing machine and refrigerators, bulbs, etc.
- Connections to new households

Power supply Outlook

Bhutan is expected to add 3,658 MW of hydro power generating stations by 2027. Besides new hydro capacities, solar and wind power installed capacities are expected to reach 5 MW each by 2025, as per the target of the Alternative Renewable Policy 2013.

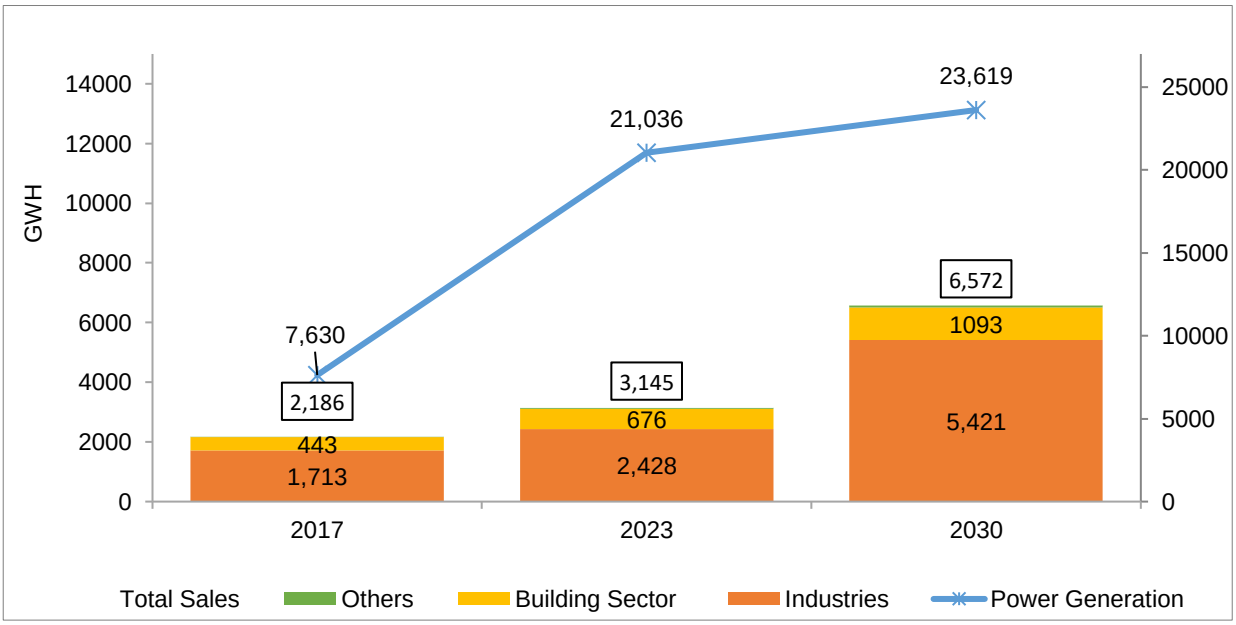
Table 25: List of Upcoming Key Hydro Projects

Hydro plants	Plant capacity (MW)	Year of commissioning
Mangdechhu Hydro Project	720	Feb 2019
Nikachhu Hyropower Project	118	July 2020
Punatsangchhu-II Hydropower Project	1,020	Jun 2021
Punatsangchhu-I Hydropower Project	1,200	Jun 2022
Kholongchhu Hydropower Project	600	Jan 2027

Bhutan's total installed capacity is expected to reach 5,291 MW by 2030 resulting in an increase of net power exports by 213% over 2017. This will also increase CO_2e offsets by 2030.

Besides earning healthy revenue from the exported power, timely commissioning of the hydro plants will be very critical to meet power demand from the Bhutan's industrial and building sectors. Bhutan's electricity peak load has been estimated to reach 772 MW by 2030 from 362 MW in 2017, assuming peak load will grow at a historical growth rate (2012 to 2017) of 5-6% CAGR from 2017 till 2030. Considering the peak load of ~772 MW and total available power capacity of ~5,291 MW in 2030, it is expected that Bhutan will be able to meet its peak load demand during the dry season. However, peak load demand can grow faster than the assumed 5-6% CAGR depending upon the nature of new industries and pace of new industry addition. Faster than 5-6% CAGR of peak load could lead to import of electricity from neighbouring countries.

Figure 76: Power Sales vs Power Generation



4.3.3 Fuel-Wise Energy Review and Outlook

Hydro

Hydro power projects constituted ~99% share of Bhutan's total installed power capacity in 2017. Going forward, with the commissioning of hydro power plants, the share of hydro power in the overall primary energy consumption in Bhutan is expected to reach 36% by 2030 from 26% in 2017.

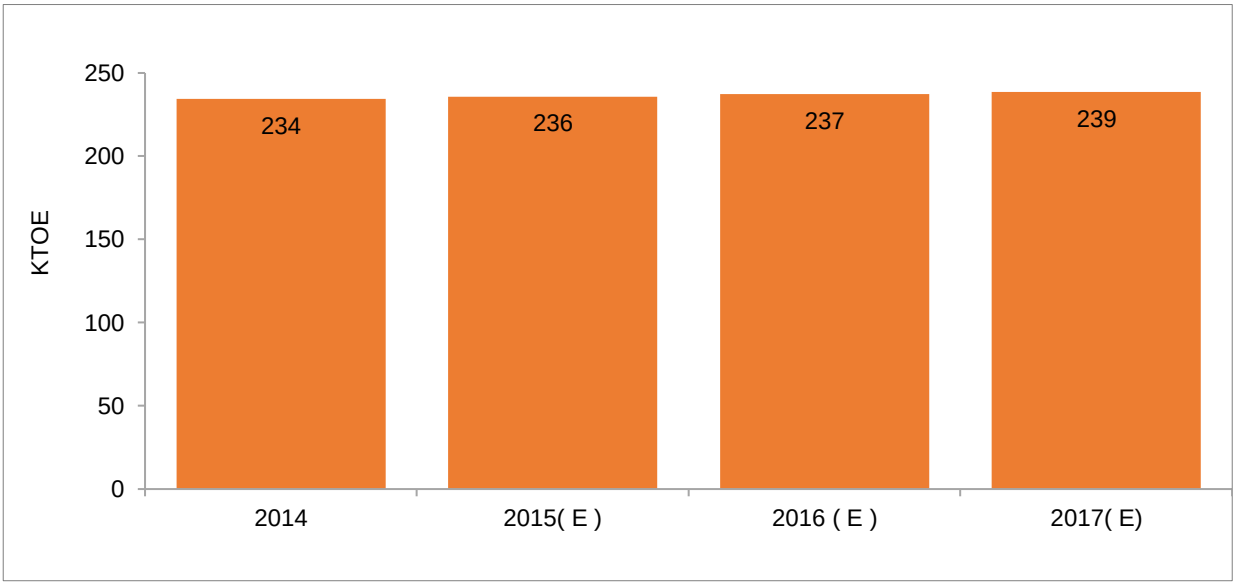
Biomass

Biomass, mostly in the form of fuel wood, is mainly consumed for heating and cooking purpose by the building sector, which comprises residential, commercial and institutional segments. The industrial sector also consumes a small amount of biomass (1-2%) for heating applications.

The building sector derived ~82% of its energy demand in 2017 from biomass. Overall consumption of biomass rose at ~0.6% CAGR from 2014 till 2017(E). Per capita consumption of biomass (mostly fuel wood) in Bhutan was ~0.8 tonne in 2017(E) and contributed ~33% of the total energy consumption of Bhutan in 2017(E).

Overall, the share of biomass has not changed much as the rise in energy demand from the building sector during this period has been met by increased energy consumption from cleaner fuels such as electricity and LPG.

Figure 77: Biomass Energy Demand Review

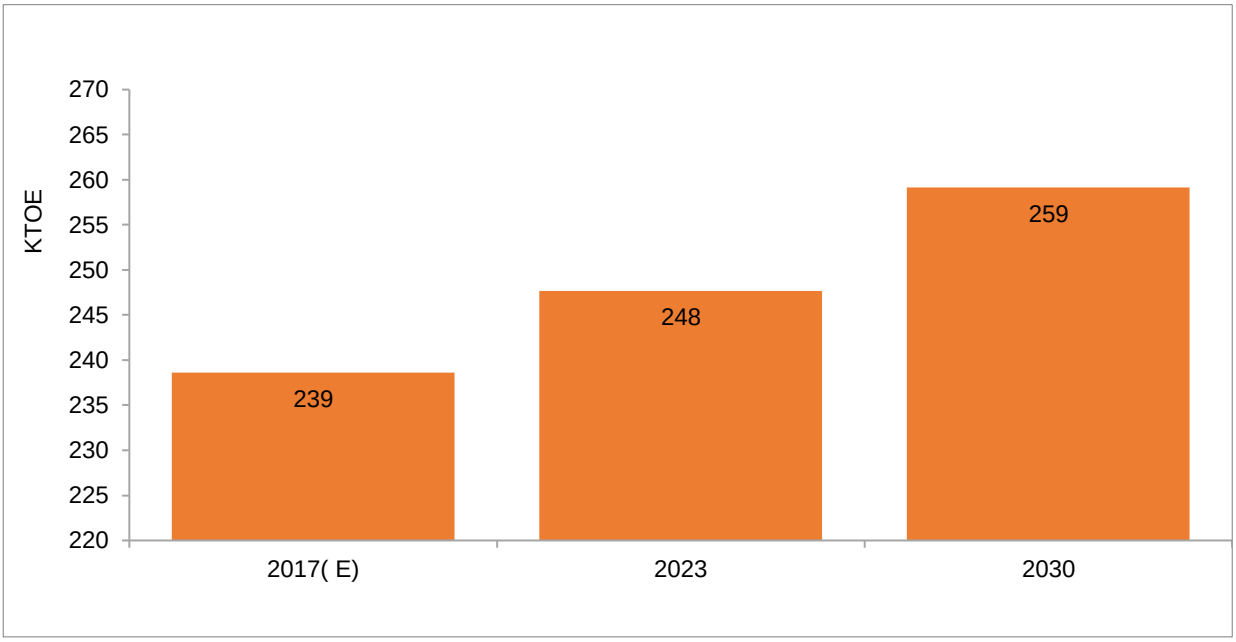


E: Estimated
Source: Bhutan Energy Directory

It is estimated that biomass consumption per household is not expected to increase significantly going forward owing to the availability of cleaner and more efficient fuel sources. As fuel wood is a cheap and easily accessible source of energy in rural areas of Bhutan, huge reduction in biomass consumption at household level is not expected in the near future.

Overall consumption of biomass is expected to increase at a marginal ~0.64% CAGR over 2017(E) -2030 to reach 259 KTOE. With the shift towards cleaner fuel, biomass share in overall fuel-wise primary energy consumption of Bhutan is also expected to decline from ~33% in 2017(E) to ~17% by 2030. Decline in biomass share is also critical from the perspective of maintaining a minimum of 60% of total land cover under forest. However, the low biomass consumption trend is subject to increase in electricity supply from new hydro power projects.

Figure 78: Biomass Energy Demand Outlook



Petroleum Products

Demand, Supply Review

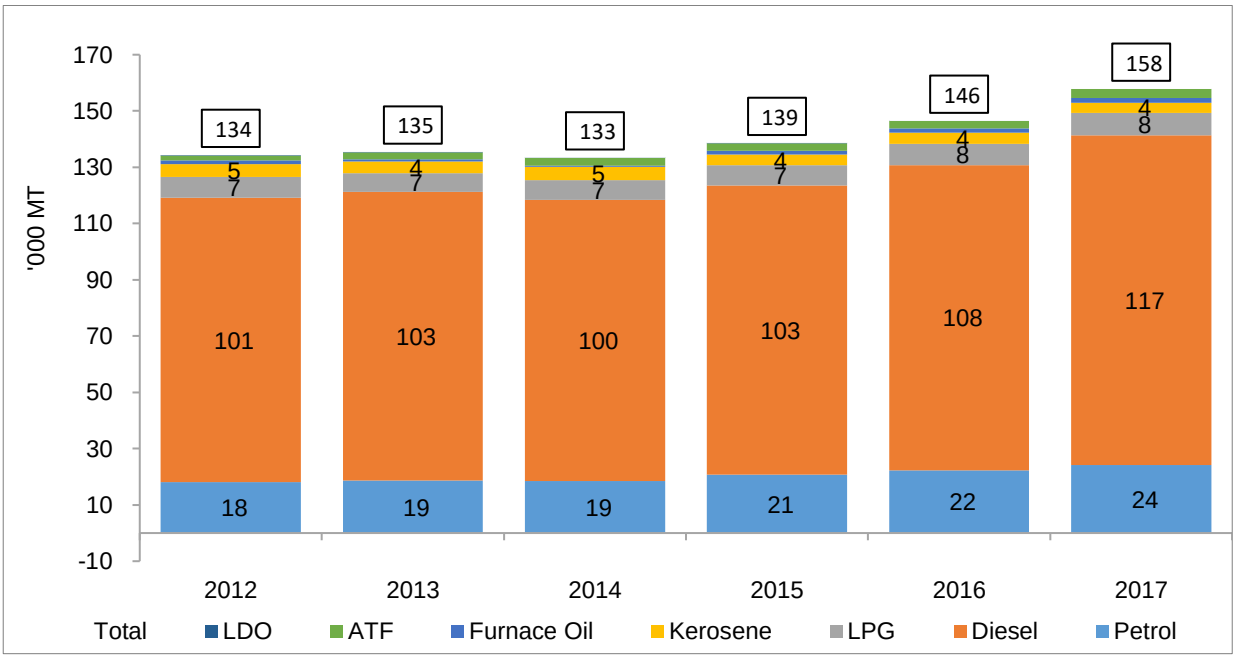
Bhutan saw demand for POL products from the transportation sector stagnate between 2012 and 2014 owing to the ban on import of private and commercial vehicles (except for tourism purposes) by the government. Following the lifting of the ban in 2014, despite the imposition of a revised stringent tax structure (100%) on import of vehicles, vehicular demand grew at 9% CAGR from 2014 to 2017, resulting in strong growth in POL products demand at 6% CAGR over the period.

Strong vehicular growth at 6.1% CAGR from 2012 to 2017, even after the ban on imports, particularly in passenger cars and utility vehicles, increased petrol consumption at 6% CAGR. Diesel consumption grew at 3% CAGR during the period, with a pick-up in demand of commercial vehicles subsequent to removal of the vehicle import ban. In fact, the transport sector accounted for over 95% share of the country's total diesel demand in 2017. The other areas where diesel is consumed include agricultural pump sets and industrial furnaces.

Petrol and diesel cumulatively accounted for over 90% of total POL products demand in 2017. Another key petroleum product was kerosene, which saw demand decline at 5% CAGR from 2012 to 2017 owing to replacement with subsidised LPG as cooking fuel. LPG demand rose at 5% CAGR from 2014 to 2017 to 8,100 MT.

Some portion of the total imports of petrol and diesel in Bhutan is consumed by Indian vehicles plying on Bhutanese roads. Refueling by Indian vehicles is undertaken in the border towns of Samdrup Jongkhar, Gelephu, Phuntsholing and Samtse. Also, as per data reported in Bhutan Energy Directory, ~20% of petrol and 6.5% of diesel were re-exported from 2010 to 2014.

Figure 79: Consumption of Major POL Products: Bhutan



Source: Statistical Year Book

Demand, Supply Outlook

Consumption of key petroleum products in Bhutan is expected to grow at 7% CAGR from 2017 to 2030 as against 6.8% CAGR between 2015 and 2017, with the lifting of the vehicular import ban. Also, economic activity is expected to continue to grow at a strong pace, led by growth in the power and industrial sectors, thereby translating into robust growth of the transportation segment.

POL product-wise factors resulting in demand growth are:

- *Petrol:* Strong GDP growth (more than 8-9%) and resultant increase in per capita income is expected to boost overall vehicular sales (particularly cars) going forward. Lack of availability of alternative fuels (CNG) and minuscule penetration of electric vehicles in overall vehicle stock (1%) is expected to boost demand for petrol, which is expected to grow at 8.9% CAGR from 2017 to 2030.

- *Diesel:* Diesel demand is expected to grow at 6.7% CAGR between 2017 and 2030 on higher demand from the transport segment and industrial growth. The transport sector constituted ~95% share of diesel demand in 2017. Strong economic activity is expected to be driven by increasing investment in infrastructure and construction, which will keep demand for commercial vehicles high, thereby supporting diesel demand

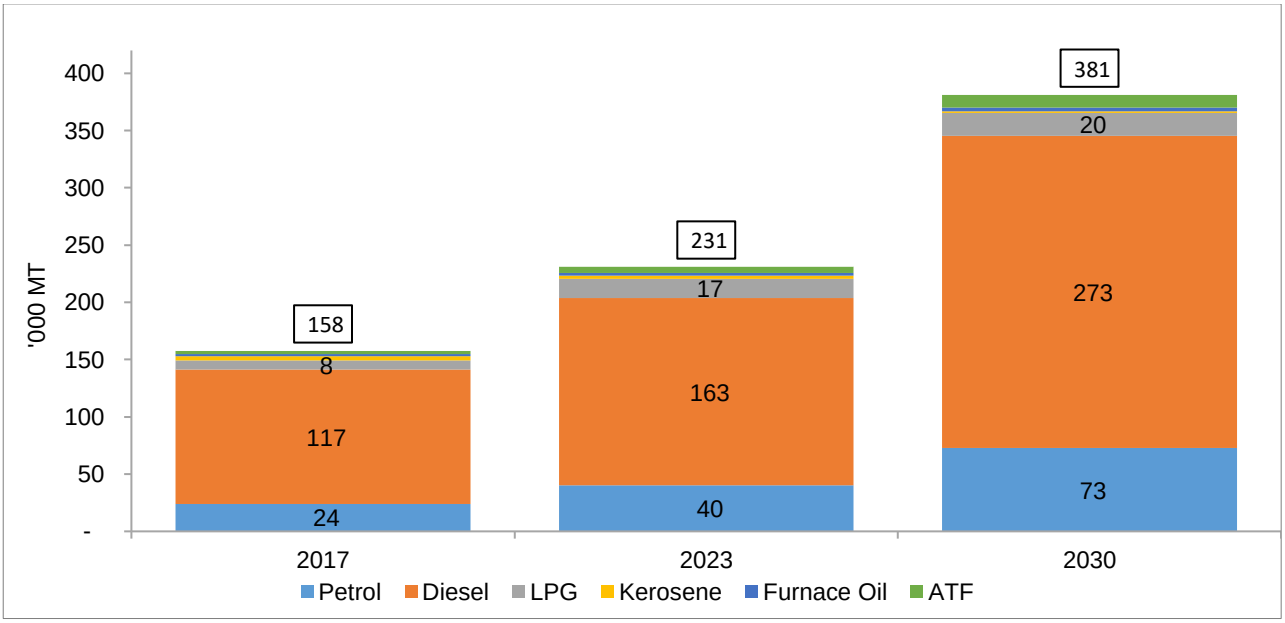
- *LPG:* LPG consumption is expected to grow at 7.3% CAGR from 2017 to 2030 as compared with 4.6% CAGR between 2014 and 2017. Increase in LPG availability subsequent to the launch of non-subsidised cylinder scheme in February 2018 and focus on shifting towards cleaner cooking fuels are expected to be the key demand driving factors. Previously, the total monthly quota was of 1,200 MT for domestic subsidised LPG (700 MT) and commercial LPG (500 MT); however, Bhutan has now authorised procuring an additional 1,000 MT per month of non-subsidised LPG (14.2 kg cylinder) per month from Indian Oil Corporation.

- *Other petroleum products (furnace oil, ATF and kerosene, LDO):* Demand for these products is expected to rise 5% CAGR over 2017-2030, driven by the ATF demand, which is expected to grow at ~10% CAGR. In contrast, kerosene demand is expected to decline at 5.8% CAGR, as its use in

domestic cooking is expected to be substituted by LPG. Light diesel oil (LDO), demand for which has already reduced considerably, is not expected to increase in the future.

Overall, demand for POL products is expected to rise from 0.158 million tonne in 2017 to 0.381 million tonnes in 2030. This will lead to POL product imports rising to ~2.4 times in 2030 from 2017 levels.

Figure 80: Overall POL Demand Outlook 2030: Bhutan



Coal

Demand, Supply Review

Thermal energy consumption in the industrial sector is dominated by coal. Bhutan's industrial sector mainly consists of ferro-alloys, cement, mineral and mining along with several smaller firms related to handicraft, food processing, construction, wood, saw-mills, poly-products and paper processing.

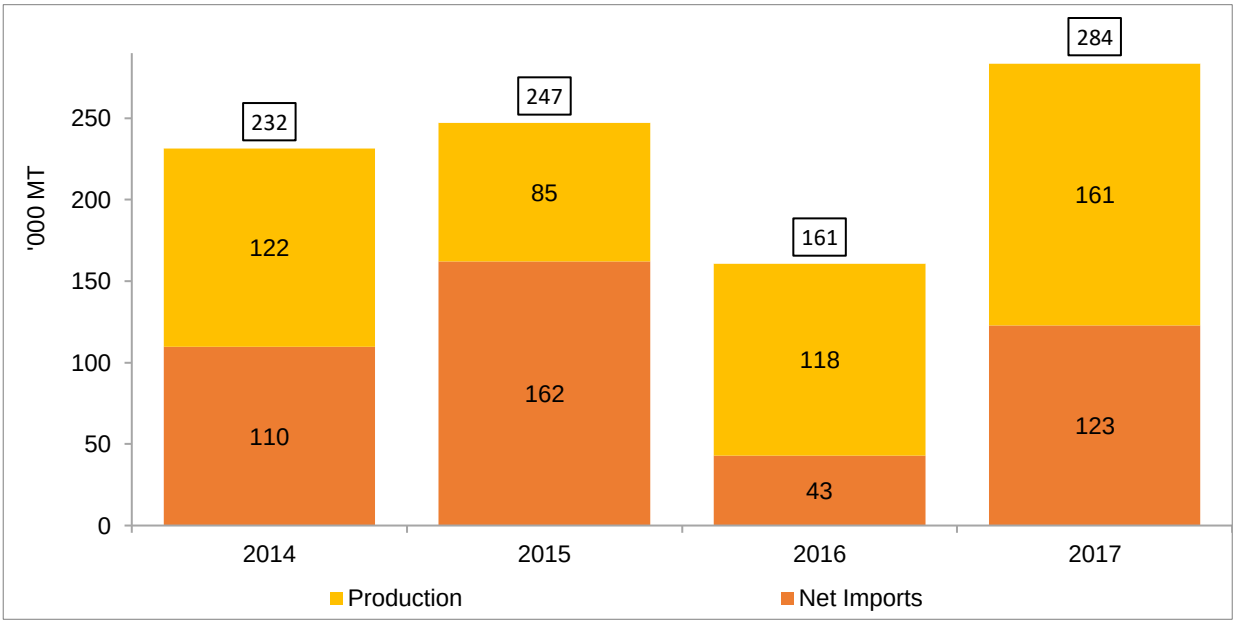
Coal is mainly sourced by the ferro alloy and cement industries. Considering the coal import-export data analysis from "Bhutan Trade Statistics" reports along with the country's domestic coal production, it is estimated that total coal demand declined in 2016, with demand, thereafter, rising ~284 kilo tonne in 2017. The decline in coal demand in 2016 was due to issues related to raw material supplies to ferro-alloys industries in Bhutan.

Bhutan's coal demand is fulfilled through imports in addition to domestic production. Coal, which is extracted in the country, is mainly of sub-bituminous type and some other coal of inferior quality compared with imported coal, which is mainly bituminous and anthracite. Derivatives of coal like coke and semi-coke are also imported, and mainly used as reducing agents in industrial processes.

Bhutan's average coal production from 2014 till 2017 was ~121 kilo tonne compared with domestic coal demand average of ~230 kilo tonnes. The gap in domestic coal production and demand has been bridged though imports. Bhutan coal import averaged 109 kilo tonnes from 2014 till 2017.

As per the Annual Environmental Statistics report of 2017, Bhutan coal stock at the end of 2016 was ~340 kilo tonne. Therefore, at the current rate of production, domestic production of coal is expected to reduce to zero by 2020, assuming no new commercially feasible mines are developed from 2018 till 2030.

Figure 81: Coal Demand, Supply Review



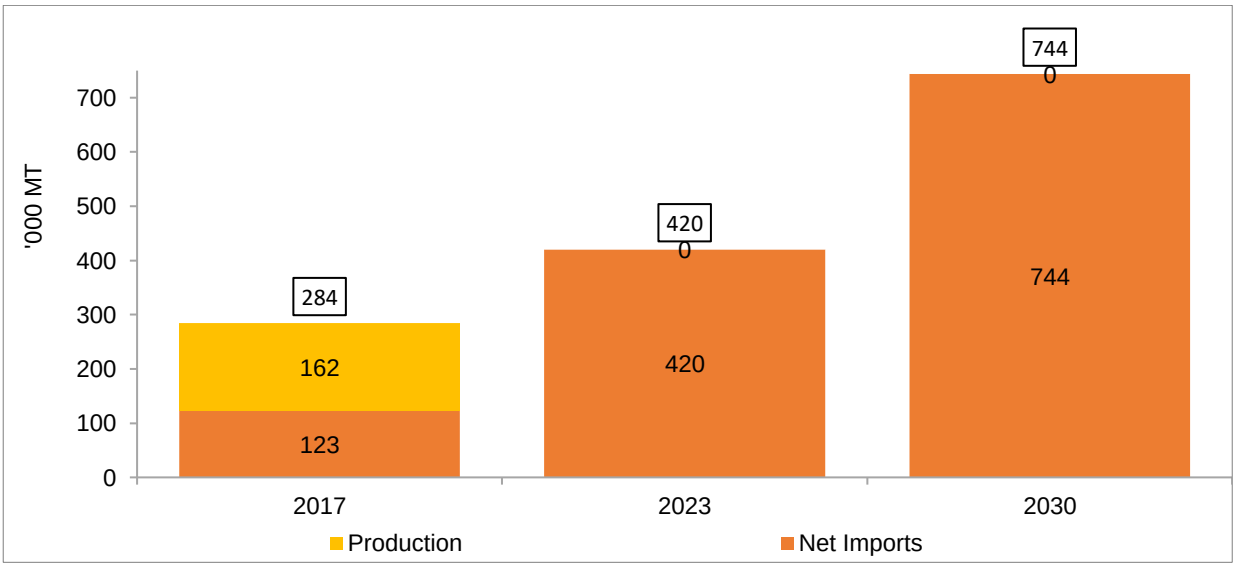
Source: Statistical Year Book

Demand, Supply Outlook

Bhutan's ferro-alloys industries supply large quantities of alloys to India. The country's ferro-alloys industries' coal demand is expected to pick up owing to expected rise in demand of stainless steel in India.

It is estimated that demand for chrome alloys as well as manganese alloys in India will grow at ~6% CAGR over the next few years. In addition, coal demand is expected to increase on account of demand from new industrial estates. Overall, demand for coal is expected to grow from 284 kilo tonne in 2017 to 744 kilo tonnes by 2030, which is a ~7.6% CAGR. As domestic coal production will reduce to zero by 2020, the entire coal demand is expected to be met by coal imports post 2019.

Figure 82: Coal Demand, Supply Outlook



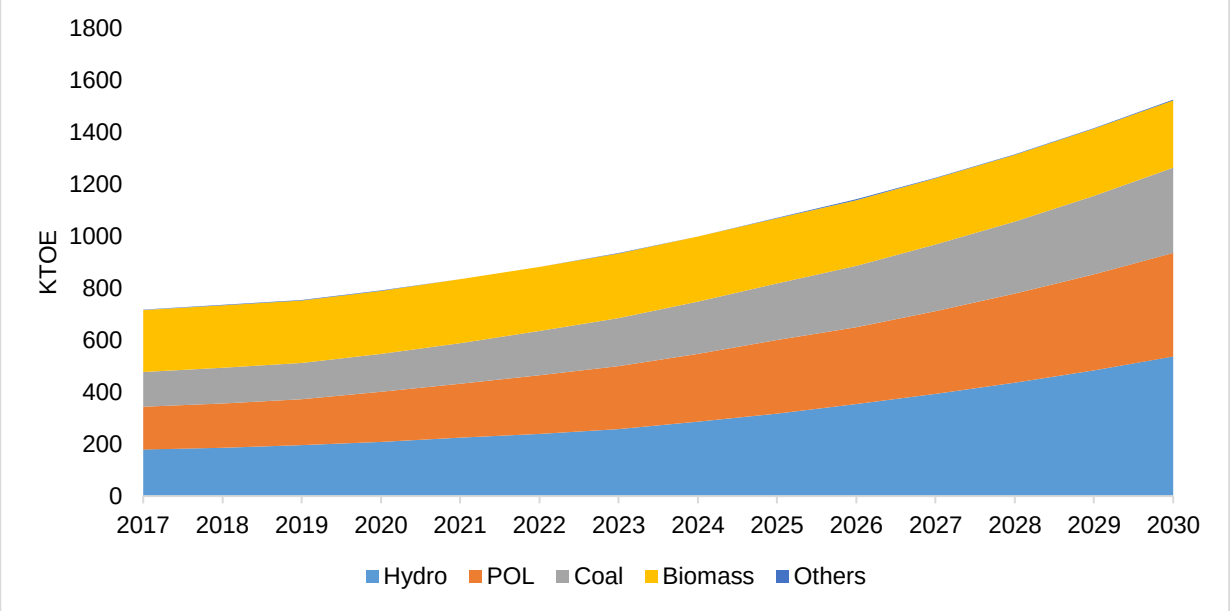
Energy Outlook 2030

The total primary energy consumption of Bhutan is expected to grow at ~6.3% CAGR over 2018-2030 to 1,550 KTOE, led by energy consumption demand in the industrial and transport sectors. Upcoming demand

growth for primary energy is expected to be met from new hydro plants and increased import of petroleum products and coal.

All figures in KTOE	2017	2018	2023	2030
Primary energy	725	744	945	1,550

Figure 83: Primary Energy Outlook - 2030: Bhutan



Outlook on Imports

Bhutan's cross-border trade is expected to increase significantly by 2030, with the rise in export of electricity, and import of POL products and coal.

As an import partner, India accounted for ~80% of the total monetary value of imports by Bhutan in 2017. The bilateral trade relations between India and Bhutan are governed by the Agreement on Trade, Commerce and Transit. This agreement provides for a free-trade regime between India and Bhutan.

With the new hydro capacity additions, Bhutan's export to neighbouring countries will reach ~16,632 MU by 2030 from ~5,300 MU in 2017, and import of POL products and coal imports is expected to rise to 381 kilo tonne and 744 kilo tonnes, respectively.

Table 26: Import of Fuels - Outlook: Bhutan

Fuel	2017	2023	2030
Petroleum products ['000 tonne]	158	231	381
Electricity [GWH]	0	0	0
Coal ['000 tonne]	123	356	744

5 India

5.1 Country Overview

India, the largest economy among SAARC nations, has seen its economy grow at steady ~7% CAGR over the last five years. Rise in domestic consumer demand and surge in domestic and foreign investments have contributed to the country's growth momentum.

Improvement in income and steady rise in industrial activity have increased the country's energy demand. However, upside risk of inflation continues to be a major challenge for the economy, with rising crude oil prices and widening fiscal deficit.

Table 27: Country Profile: India

	Factors	FY13	FY18
Demographics	Population [million]	1,294	1,342
Macroeconomic scenario	GDP growth rate	5.5%	6.7%
	Sectoral growth rate		
	a. Industry	1.2%	4.4%
	b. Services	5.3%	8.3%
	c. Agriculture	1%	2.1%
	Inflation	9%	3.6%
Fiscal position	Exports [$ billion]	300.40	478.15
	Imports [$ million]	490.74	565.32
	CAD [% of GDP]	4.8%	1.9%
	Fiscal deficit [% of GDP]	4.8%	3.5%

Source: Country reports, Economic survey

With Indian companies remaining over-leveraged and banks reeling under high non-performing assets, it is imperative that the government continue investments in the energy sector to keep pace with rising demand.

5.1.1 Overview of Energy Structure

Energy Mix

The Indian energy sector has been evolving rapidly. More than 120 GW of power generation capacities have been added over the past five years, with thermal power contributing a majority share at ~73 GW. RE, though, is the government's focus area, with successively lowering tariff (Rs 2.5 per unit in July 2018).

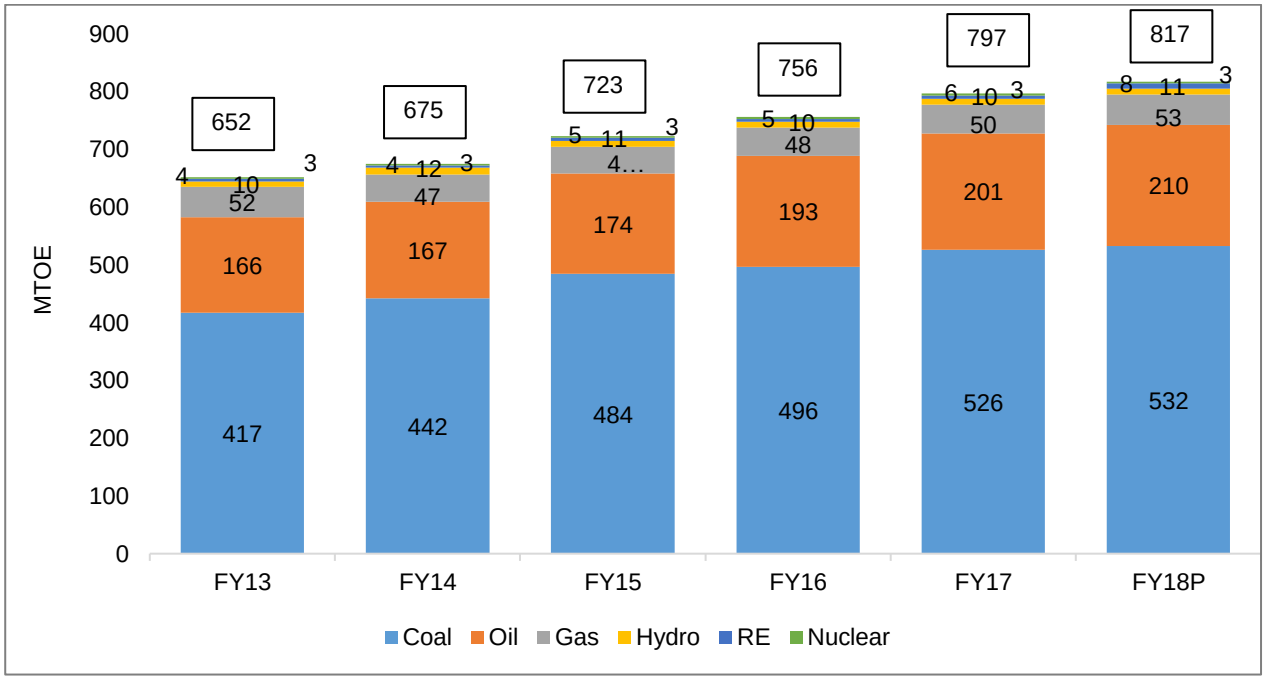
The government has set the renewable energy target at 175 GW by 2022. However, overcapacity in the power sector and weak power demand growth have led to idle capacities and falling plant load factors (PLFs), mostly in thermal plants (demand growth of 5.2% CAGR from fiscal 2013 to 2018 vis-à-vis power generation growth of 9.6% CAGR).

India has pledged to reduce emissions by 33-35% by 2030 from 2005 levels under COP-21 commitments. The government has also envisioned a 10% reduction in energy imports by 2022 and move towards self-sufficiency. Increasing push for electric vehicles, bio-fuels and clean coal technologies are steps in the right direction.

However, overarching dominance of fossil fuels is here to stay. Coal, oil and gas will continue to be major contributors of primary energy. Policies like Discovered Small Field policy and Hydrocarbon Exploration and Licensing Policy are aimed at boosting oil and gas production in the country.

India's primary energy has grown steadily, from 652 MTOE in fiscal 2013 to 817 MTOE in fiscal 2018 (provisional), which is a CAGR of 4.6%.

Figure 84: Primary Energy Supplies by Source: India



P: Projected
Source: Economic survey, sector reports

Domestic Availability and Imports of Fuels

Table 28: Domestic Production and Import for Major Fuels: India

Fuel	Supply type	FY13	FY18
Coal [million tonnes]	Domestic production	556	679
	Imports	146	209
Gas [mmscmd]	Domestic production	111	90
	Imports	48	70
Crude oil ['000 barrels]	Domestic production	38	36
	Imports	185	220
Petroleum products ['000 tonne]	Domestic production	218	254
	Imports	16	36
	Exports	63	67
Electricity [TWH]	Domestic production	963	1,308
	Imports*	4	-

**Net imports considered after netting off power imports from Bhutan and exports to Bangladesh and Nepal. In fiscal 2018, India was a net exporter of power*
Source: Country reports, Sector reports, Economic survey

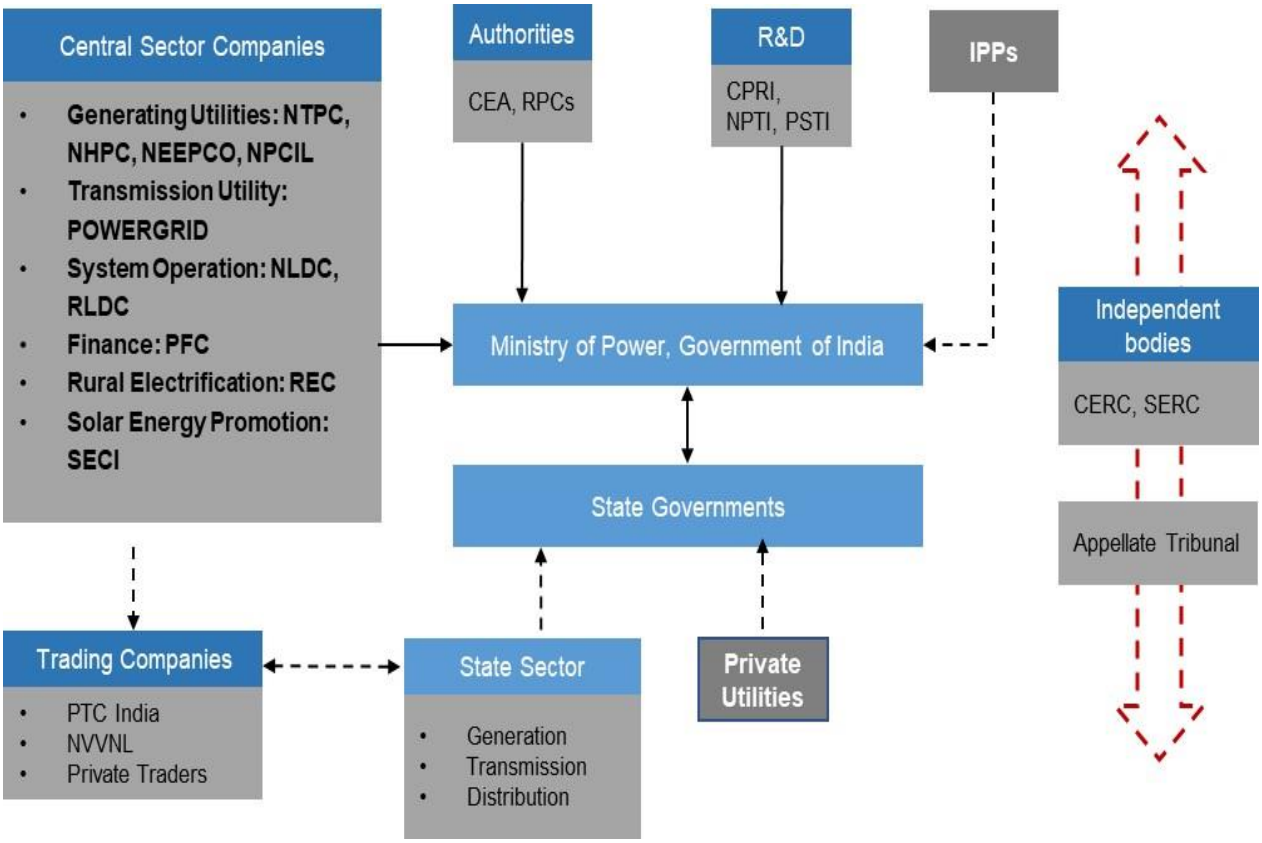
5.2 Institutional and Regulatory Framework of Energy Sector

5.2.1 Planning and Regulatory Bodies

India has separate ministries for policy formulation in power, coal and gas and other primary fuels, including POL products. These comprise the Ministry of Power (MoP), Ministry of Coal, Ministry of New and Renewable Energy, and Ministry of Petroleum and Natural Gas.

Power Sector

Figure 85: Organogram of Power Sector: India



NTPC: National Thermal Power Corporation, NHPC: National Hydro Power Corporation, NEEPCO: North Eastern Electric Power Corporation Ltd, NPCIL: Nuclear Power Corporation of India, NLDC: National Load Despatch Center, RLDC: Regional Load Despatch Center, PFC: Power Finance Corporation, REC: Rural Electrification Commission, PTC: Power Trading Corporation, NVVNL: NTPC Vidyut Vyapar Nigam, CEA: Central Electricity Authority of India, RPC: Regional Power Committee, CPRI: Central Power Research Institute, NPTI: National Power Training Institute, PSTI: Power Systems Training Institute, IPP: Independent power producer, CERC: Central Electricity Regulatory Commission, SERC: State Electricity Regulatory Commission, Powergrid: Powergrid Corporation of India Ltd

Federal Agencies

- *CEA* is a statutory technical wing of the MoP to assist in planning, coordination and regulation of power development programmes of the country. It advises the ministry on technical, financial and economic matters pertaining to the power sector's development.
- *CERC* was set up under the Electricity Regulatory Commissions Act, 1998, as an independent statutory body with quasi-judicial powers. CERC regulates tariff-related matters and inter-state bulk

sale of power, aids and advises the central government on the formulation of a tariff policy, frames the guidelines pertaining to tariff, and promotes competition and efficiency in the electricity sector.

- *NHPC* plans, promotes and integrates development of hydroelectric, tidal and wind power in India.
- *NTPC*'s main activities are setting up of power plants and generating electricity through its coal- and gas-based power plants. The company has also diversified into the construction of hydro power plants and generation of hydro power besides power trading and distribution of electricity. It is also involved in coal mining, coal washery and oil exploration.
- *SECI* is a central public sector undertaking under the administrative control of MNRE, created to facilitate implementation of renewable energy targets. Major functions of SECI include bid coordination, setting up solar park infrastructure and power trading.
- *REC* provides loan assistance to state electricity boards (SEBs)/state power utilities for investments in rural electrification schemes.
- *PFC* mobilises capital from non-budgetary sources to provide term finance for power generation projects.
- *MNRE* facilitates research, design, development, manufacture and deployment of new and renewable energy systems/devices for transportation, portable and stationary applications in rural, urban, industrial and commercial sectors. The body also lays down standards, specifications and performance parameters at par with international levels, and facilitates industry in attaining the targets.
- *The Ministry of Coal* is responsible for development and exploitation of coal and lignite reserves in India. All matters relating to production, supply, distribution and prices of coal are overseen by the ministry.

Sector Structure

Power Generation: The central, state and private sectors have their own generation capacities, representing 30%, 25% and 45% of the total installed power base.

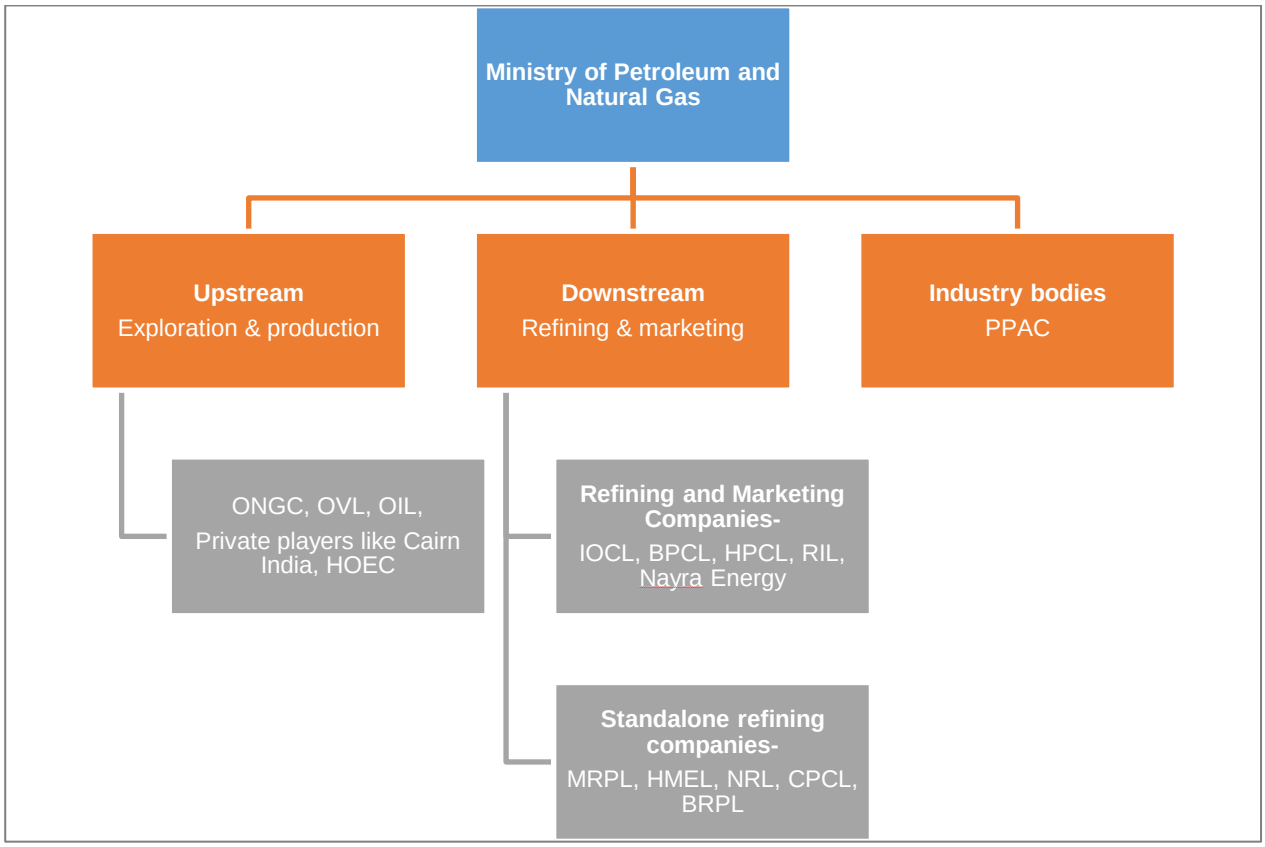
Power Transmission: Power Grid Corporation of India Ltd, a central transmission utility (CTU), is responsible for planning inter-state transmission systems (ISTS) and state transmission utilities (STU) (namely state transco/ SEBs) responsible for the development of intra-state transmission system. Power System Operation Corporation Ltd (POSOCO) manages the national and regional grid from National Load Despatch Centre (NLDC) and five regional load despatch centers (RLDC) through unified load dispatch and communication facilities. In addition, private sector players also operate as transmission licensees.

Power Distribution: The responsibility for distribution and supply of power to rural and urban consumers rests with the states. Several discoms, both public and private, manage power distribution in the country.

De-licensing in generation of electricity and open access in distribution of electricity brought through the Electricity Act, 2003, have led to unbundling, corporatisation and privatisation of the sector.

Hydrocarbon Sector

Figure 86: Organogram of Hydrocarbon Sector: India



The Ministry of Petroleum and Natural Gas (MoPNG) is responsible for exploration and production of oil and gas. The transportation, refining of petroleum, distribution, marketing, import, export and conservation of petroleum products is also overseen by the MoPNG.

The Directorate General of Hydrocarbons (DGH) manages India's hydrocarbon resources. It also maintains a repository of data pertaining to oilfields and promotes participation of oil companies in bidding rounds and supervises the award of concessions after evaluating the bids.

With the enactment of the Petroleum and Natural Gas Regulatory Board Act in 2006, the regulator for the oil and gas downstream sector was established. The objective of the Act is to regulate the refining, processing, storage, transport, distribution, marketing, and sale of petroleum, petroleum products, and natural gas to protect the interests of the consumers and entities engaged in specified activities, to ensure uninterrupted and adequate supply of petroleum products and natural gas across the country, and to promote competitive markets. It supervises the work of the operator and approves the budgets and the establishment of reserves of hydrocarbons.

India's oil and gas market is primarily dominated by public sector enterprises. In the upstream sector, Oil and Natural Gas Corporation Ltd (ONGC) is the largest player, accounting for ~80% of India's crude oil production. Oil India Ltd, Cairn India Ltd and Hindustan Oil Exploration Co Ltd are some of the other players involved in exploration and production activities.

In the downstream segment, there are consolidated refining and marketing players as well as standalone refiners. Despite significant efforts by the government to encourage private participation, public sector enterprises continue to dominate the space.

5.2.2 Regulatory and Policy Framework

The power sector in India is governed by the Electricity Act, 2003. The core objectives of this Act include consolidation of laws relating to generation, transmission, distribution, trading and use of electricity, and taking measures conducive to the development of the electricity industry, promoting competition, protecting the interest of consumers, and ensure supply of electricity to all areas, rationalisation of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and environmentally benign policies, constitution of Central Electricity Authority, regulatory commissions and establishment of appellate tribunal for regulating the sector

Unlike power, the oil and gas sector is governed and regulated by separate policies for exploration and production, and pricing and distribution of POL products. The Hydrocarbon and Exploration Licensing Policy takes care of exploration and production. Parity pricing policy (trade and import) is followed for pricing of POL products.

5.2.3 Government Support: Pricing, Existing Subsidies on Fuel and Controlling Regime

Pricing of a specific energy source for retail consumption varies, based on domestic availability, dependence on imports, and pricing policies specifically adopted by the government for individual end-uses

Gas

Gas prices in India are determined by the pricing formula laid down in the new Domestic Natural Gas Pricing Guidelines 2014. Domestic gas price is the weighted average price of four global benchmarks – US-based Henry Hub, Canada-based Alberta gas, UK-based NBP and Russian gas. The domestic price is based on benchmark prices in the prior year and kicks in with a quarter's lag. It applies for six months. The gas price determined under these guidelines are applicable to all gas produced from nomination fields given to ONGC and Oil India, and under New Exploration and Licensing Policy and coal-bed methane blocks, unless prices have been fixed contractually for a certain period of time for a particular block. The latest price for domestic natural gas is $3.36 per MMBTU determined by the Petroleum Planning & Analysis Cell (India)

Pertaining to gas imports, pricing is essentially determined by contracted long- / short-term international prices.

Table 29: Customs Duty on Gas Imports: India

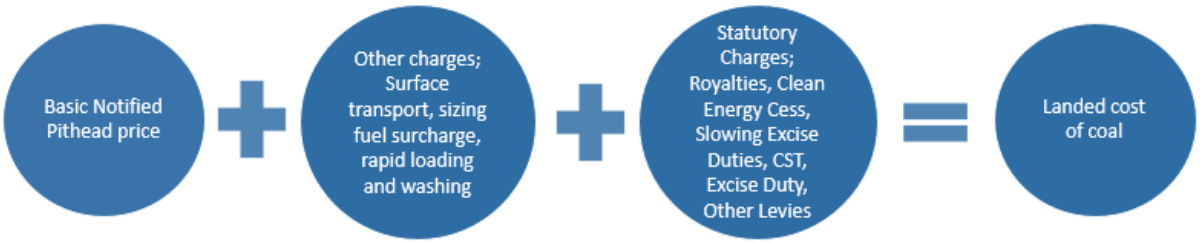
Particulars	Customs		Central excise
	Basic Customs Duty	Additional Customs Duty (CVD)	Basic excise Duty
Liquefied natural gas	2.50%	Nil	Nil
Natural gas [gaseous state]	5.00%	Nil	Nil
Natural gas [compressed]	5.00%	14.00%	14.0%

Source: Tariff structure of the country

Coal

The coal industry is closely regulated by Coal India Ltd (CIL), which sets the price of coal centrally. Singareni Collieries Company Ltd (SCCL), accounting for ~10% of the production share, also notifies its respective coal prices. The final price of coal paid at the purchase is a build-up of several company-imposed (other) charges and government set (statutory) charges.

Figure 87: Pricing Equation of Coal in India



Prices are finally determined depending on gross calorific value (GCV) of coal and end-use segments.

Table 30: Prices of Coal as of Fiscal 2018

Grade	GCV bands	For power utility, fertiliser and defence sectors	Other sectors
A	6,700-7,000	3,450	3,288
	6,400-6,700	3,210	3,144
B	6,100-6,400	3,000	3,000
	5,800-6,100	2,750	2,737
C	5,500-5,800	1,900	2,524
D	5,200-5,500	1,600	2,311
	4,900-5,200	1,420	1,757
E	4,600-4,900	1,100	1,368
	4,300-4,600	980	1,228
F	4,000-4,300	810	1,145
	3,700-4,000	760	1,063
G	3,400-3,700	720	980
	3,100-3,400	650	897

Note: All prices in Rs per tonne
Source: Coal India Ltd

Regarding coal imports, the pricing is essentially determined by contracted long or short-term international prices.

Table 31: Customs Duty on Coal Imports: India

Type of coal	Customs basic duty	Social welfare surcharge	IGST
Anthracite	2.5	10	5
Bituminous	2.5	10	5
Other coal: Coking and steam	2.5	10	5

Source: Tariff structure of the country

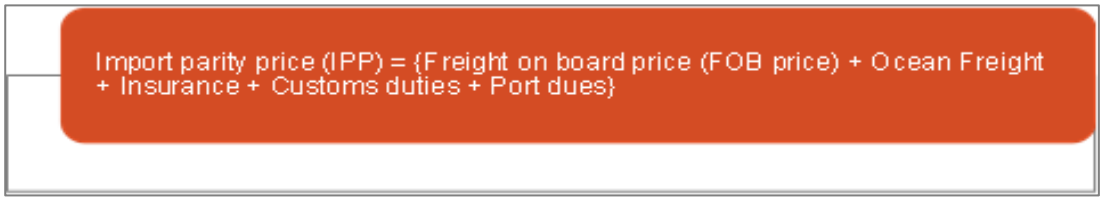
Petroleum Products

Currently, all product prices are based on import parity price (IPP), except petrol and diesel, which are based on trade parity price (TPP). The price that domestic refiners receive for petroleum products (sold in the domestic market) is higher than international prices because custom duties, freight, insurance, etc. are included in the refinery gate price, even though the refinery is not actually incurring these costs. This keeps petroleum product prices higher than international prices and also improves GRMs.

- IPP

IPP represents the price that importers would pay in case of actual import of product at the respective Indian ports.

Elements of IPP



- EPP

EPP represents the price that exporters would realise in case of actual export of product at Indian ports.

Elements of EPP

- TPP

TPP is calculated as weighted average of IPP and EPP. Currently, for computing TPP, the weight assigned to IPP is 80% and EPP is 20% as India exports about 20% of its petroleum products while the rest is used for domestic consumption.

Earlier, the government introduced the IPP mechanism to promote the refining sector in India as the country was a net importer of petroleum products. This, along with other reforms, aided growth in refining capacity. Consequently, India became a net exporter of petroleum products. The recommendation thus provided the need for changing the mechanism from IPP to TPP, considering crude oil imports.

Also, based on the same recommendations, the customs duty on petrol and diesel was reduced to 7.5% in June 2006, from 10%. As IPP includes international petroleum product price *plus* insurance and freight cost *plus* customs duty, a higher customs duty would translate into higher GRMs. The basic customs duty on petrol and diesel is 2.5%, effective from June 2008.

In India, petroleum products such as LPG and kerosene are sold by downstream public oil marketing companies (OMCs) to households at regulated prices, which are well below their market-determined prices (petrol prices were de-regulated in June 2010 and diesel in October 2014). The resultant loss is termed as under-recovery. Under-recoveries are generally shared between three parties - the government, upstream oil companies (ONGC, Oil India and GAIL) and oil marketing companies (IOCL, BPCL and HPCL) - in a proportion determined by the government at the end of every year.

Note that prices of petrol and diesel are revised on a daily basis based upon movement in global crude oil prices, while that of other products is revised on a fortnightly basis.

Table 32: Trend in Retail Selling Price of Petrol and Diesel in Delhi ($ per litre)

Price as on	Price of Petrol	Price of Diesel
1.4.2010	1.1	0.9
1.4.2011	1.3	0.9
1.4.2012	1.3	0.8
1.4.2013	1.3	0.9
1.4.2014	1.2	0.9
1.4.2015	1.0	0.8
1.4.2016	0.9	0.7
1.4.2017	1.0	0.9
1.4.2018	1.1	1.2

Source: MoPNG

Electricity

The electricity price in India for retail supply is determined by regulatory commissions at the state level, based on costs incurred by distribution utilities for supply. The cost of electricity is mainly segregated across domestic, commercial, industrial and agricultural activities. The regulation of electricity prices is governed under the provisions of Electricity Act, 2003.

5.3 Overall Energy Outlook 2030

The overall energy outlook of India has been assessed by undertaking a detailed review of all primary sources of energy, including coal, gas, hydro, nuclear, POL products, and renewable. The INDC targets and commitments have also been studied to derive fuel-wise demand review and outlook. As of 2012, the country emitted 1.92 billion tonnes of CO_2, contributing to 5.7% of the global annual emissions for the year. As per voluntary pledge, it intends to reduce emission intensity by 33-35% in 2030 from 2005 levels resulting 3.59 billion tonnes of avoided emissions of CO_2 equivalent.

As the power sector serves as a major consumer of these sources, and is the single largest supplier of secondary energy, its analysis precedes the fuel-wise discussion.

5.3.1 Power Demand, Supply Review

The power sector has significant impact on economic development and social welfare of the country. Therefore, it is imperative to understand the dynamics of the sector and its likely impact on primary energy consumption.

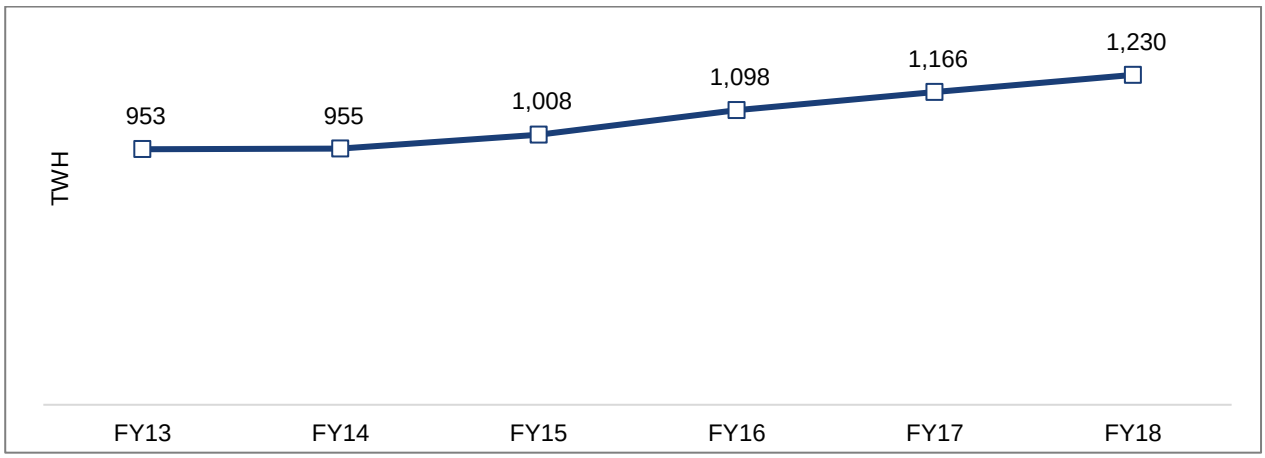
The power sector has been studied from the perspective of demand-supply positioning, generation mix forecasting, policy and regulatory interventions, and long-term implication on the sector.

Power Demand Position

Base demand (sum of actual consumption and T&D losses) for power rose at 5.2% CAGR to 1,230 BU in fiscal 2018, from 953 BU in fiscal 2013. The primary reason for the growth of demand can be attributed to increased income levels, accelerated rural electrification and intensive electrification programmes.

T&D losses have come down marginally, from 23% in fiscal 2013 to 21% in fiscal 2018, thereby leading to a saving of 140 BUs cumulatively. The Saubhagya scheme has added ~6 BU to base load demand, with a connection target achievement of 16% by the end of fiscal 2018. With an estimated 1,300 MW of installed off-grid, rooftop solar capacity in the country, base load demand has been reduced by ~1.8 BU in fiscal 2018. The northern region accounted for 30.7% of the total demand in fiscal 2018, closely followed by the western region at 30.3% and the southern region at 26.4%.

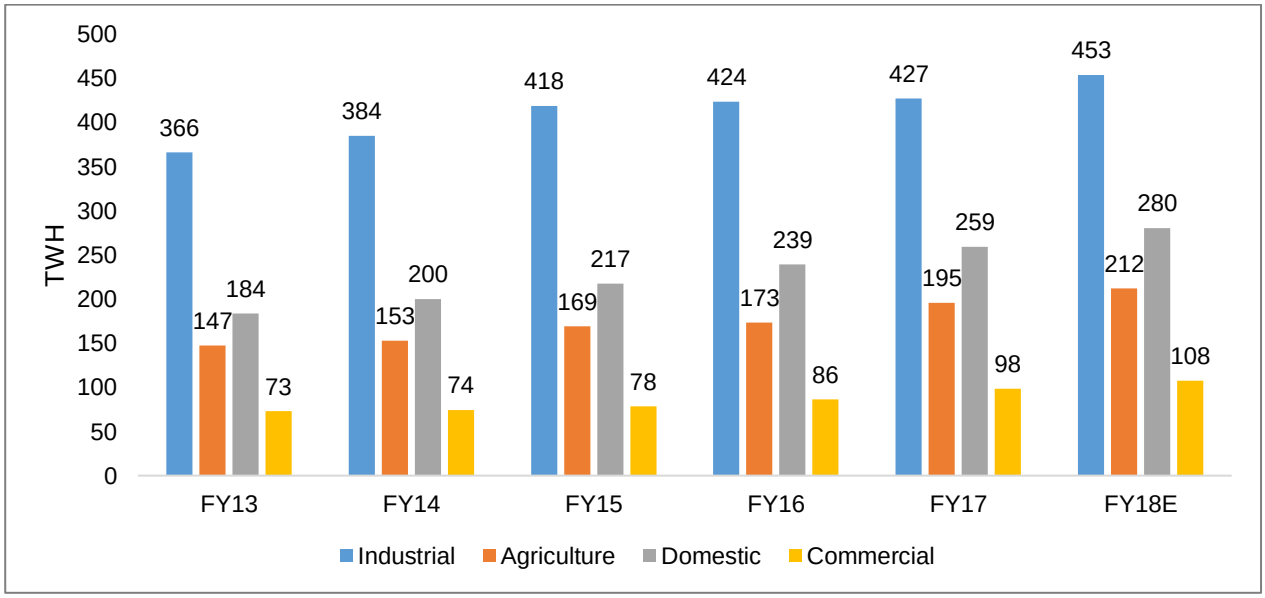
Figure 88: Demand Load Curve: India



Source: CEA

Growth has been the fastest in the domestic (household) segment, at a CAGR of 8% over fiscal 2013 to 2018 owing to strong electrification rates, rise in consumption and urbanisation. Industrial and agricultural consumption have grown at CAGRs of 4% and 6%, respectively. The industrial sector has accounted for the largest share of total consumption followed by domestic and agriculture sectors.

Figure 89: Power Sales by Consumer Category: India



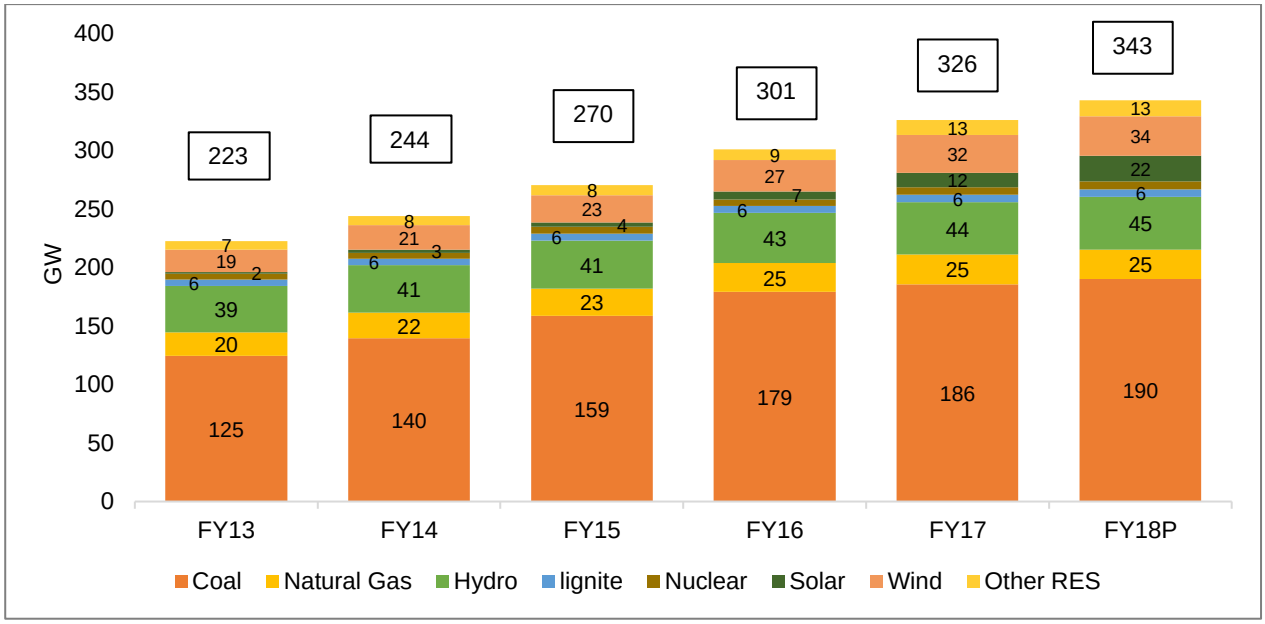
E: Estimated
Source: CEA

Power Supply Position

Power supply has increased to 1308 BU from 963 BU over a period of fiscal 2013 to fiscal 2018 at 5.6% CAGR. This has led to a reduction in base energy deficit to about 7.8 BU in fiscal 2018 from 87 BU in fiscal 2013 owing to higher capacity additions that helped supply growth to outpace demand growth. The total

installed capacity in the country stood at ~342.7 GW as of fiscal 2018 with 56% of the plants being coal fired. RE penetration in the country improved from 13% in fiscal 2013 to ~20% in fiscal 2018 due to conducive policies, the government's push and increased private sector participation.

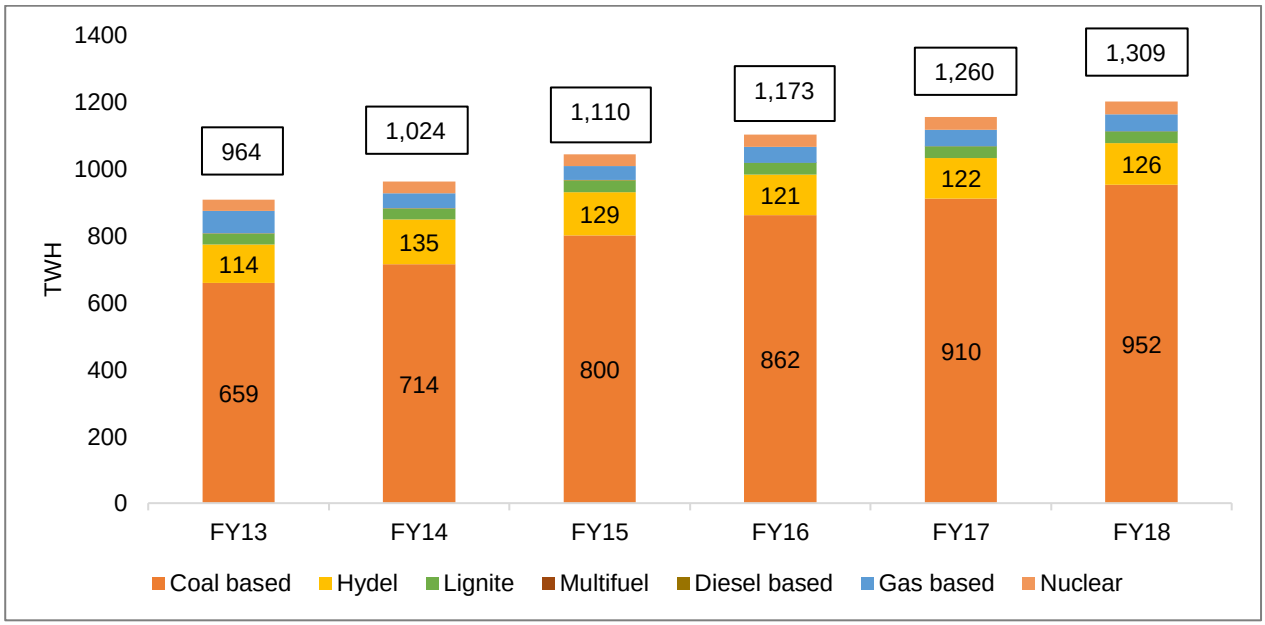
Figure 90: Installed Capacity: India



P: Provisional
Source: CEA

Annual electricity generation subsequently increased to 1308 BU in fiscal 2018 with coal-based plants contributing to two-thirds of the total (73%). Hydropower produced 10% of the annual power generation, whereas RE production still lingered at ~6%.

Figure 91: Annual Electricity Generation: India



Source: CEA

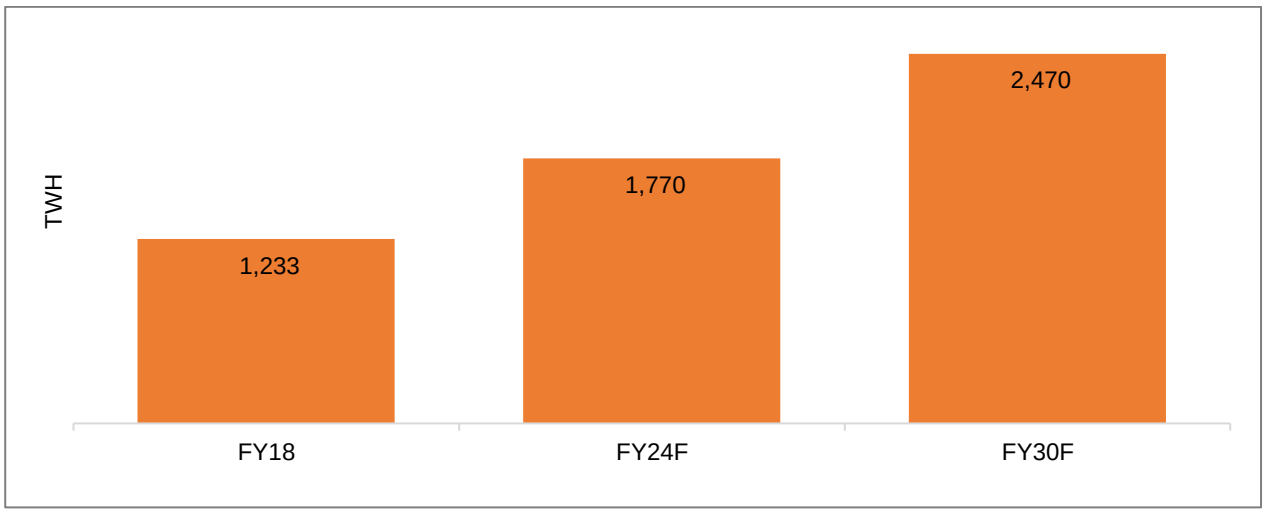
5.3.2 Power Demand, Supply Outlook

Power Demand Outlook

Power demand is expected to rise at ~6% CAGR between fiscals 2018 and 2030 led by the pick-up in industrial activity, rising disposable income and infrastructure growth (push for smart cities, dedicated freight corridors). The industrial segment will continue to account for bulk of the total power consumption. However, share of the domestic segment is expected to rise to ~28% owing to the increase in per capita consumption and intensive electrification under government-led schemes. Demand restraints emanating from energy efficiency measures across industries (PAT scheme), self-consumption through rooftop solar and T&D loss reduction will result in reduction in power generation of 150 BUs by fiscal 2030. On the contrary, demand drivers like electric vehicle penetration, expansion/new construction of metro rail projects and intensive electrification under Saubhagya scheme will improve electricity demand going forward. With electric vehicle population expected to reach ~53 million by fiscal 2030, power demand will grow by an additional 170 BU/annum owing to vehicle charging. With expected strengthening and augmentation of the transmission network, power supply is likely to be more reliable, thereby resulting in latent power demand coming into the fold of overall demand.

With the goal of reducing energy intensity of the Indian economy, the Ministry of Power through the Bureau of Energy Efficiency (BEE) has initiated a number of energy efficiency initiatives. The National Mission for Enhanced Energy Efficiency (NMEEE) aims to strengthen the market for energy efficiency by creating a conducive regulatory and policy regime. It seeks to upscale the efforts to unlock the market for energy efficiency and help achieve total avoided capacity additions and fuel savings.

Figure 92: Demand Load Curve in India - Outlook



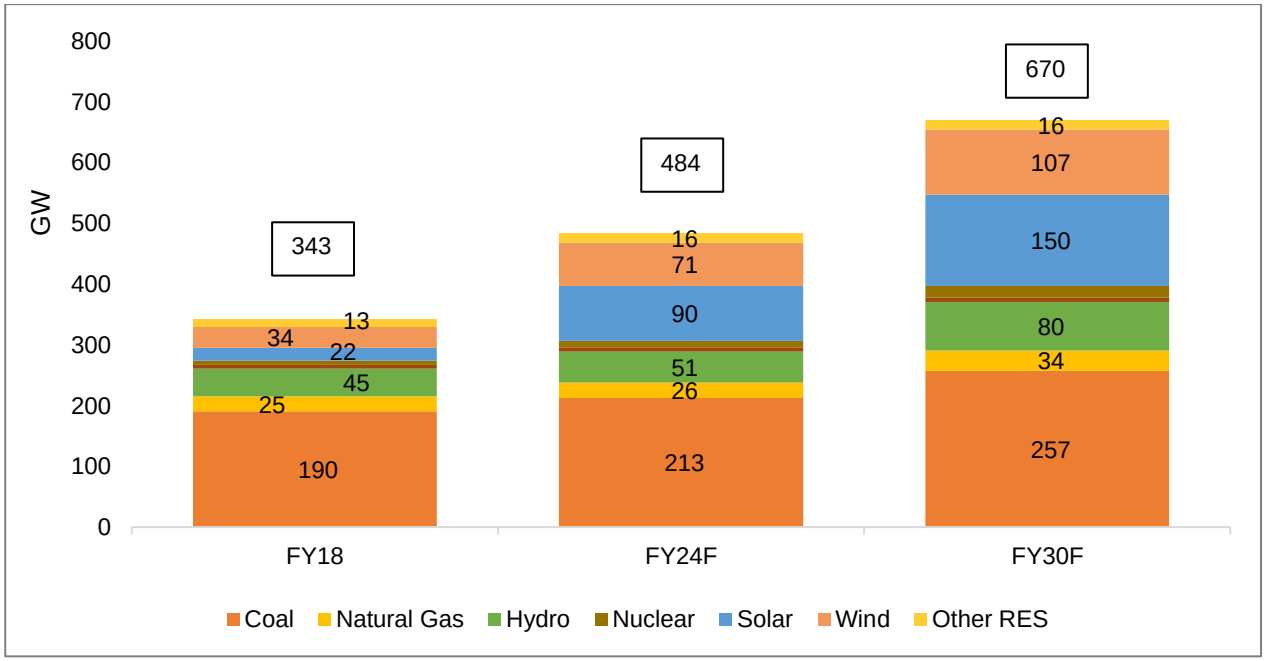
F- Forecasted

Power Supply Outlook

India is expected to see ~327 GW of net capacity additions (new capacities minus retirement) from fiscals 2019 to 2030 with the majority coming from solar plant installations (~128 GW). Wind and hydro will also show strong additions with 73 GW and 34 GW, respectively. Coal-based plants are also expected to grow, albeit at a slower pace, owing to lack of assured offtake and fuel supply linkages. Availability of low-priced power in the short-term market, likely migration of high tariff paying industrial and commercial consumers to open access and adequate existing PPAs with discoms contribute to bleak revival prospects. Recently, 34 coal-run power projects have been identified as stressed assets and are awaiting insolvency proceedings. The major reasons for stress for most of the thermal projects have been non-availability of fuel, cancellation of coal blocks, lack of PPAs, delays in project implementations leading to cost overrun and aggressive bidding by developers during PPAs. However, turnaround for most of the projects is expected as underlying

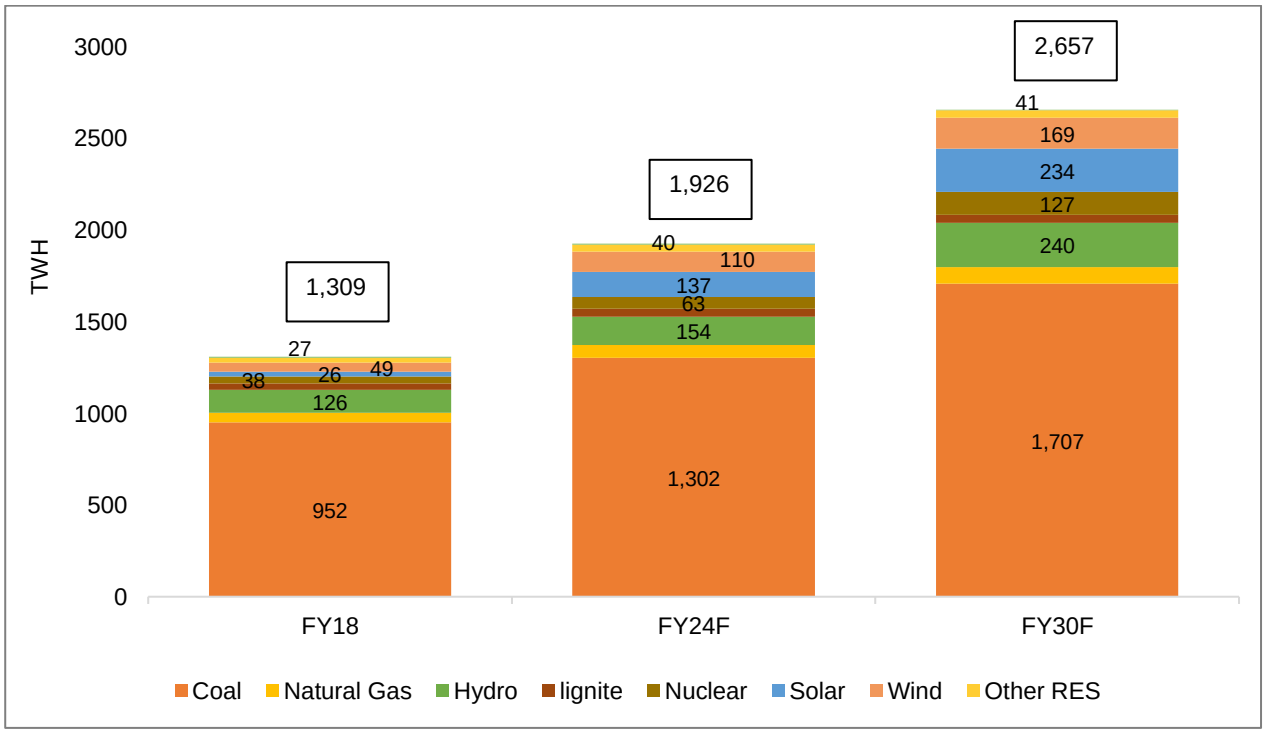
power demand in the nation will remain strong. PLFs are expected to improve and thermal-based projects will see strong capacity additions (~81 GW up to fiscal 2030). Gas-based plants will show bleak growth (~7.7 GW) due to costly and inadequate fuel.

Figure 93: Installed Capacity in India - Outlook



Power generation will increase from 1,308 Bs in fiscal 2018 to ~2,657 BU in fiscal 2030 at 6% CAGR. Coal-based generation will contribute to ~64% of total power supply in fiscal 2030. RE generation will grow from 8% of total supply to ~17%. Power supply deficit is expected to narrow down to zero. PLFs of coal-based plants are also expected to steadily rise to ~72% in fiscal 2023 and ~82% in fiscal 2030.

Figure 94: Annual Electricity Generation in India - Outlook



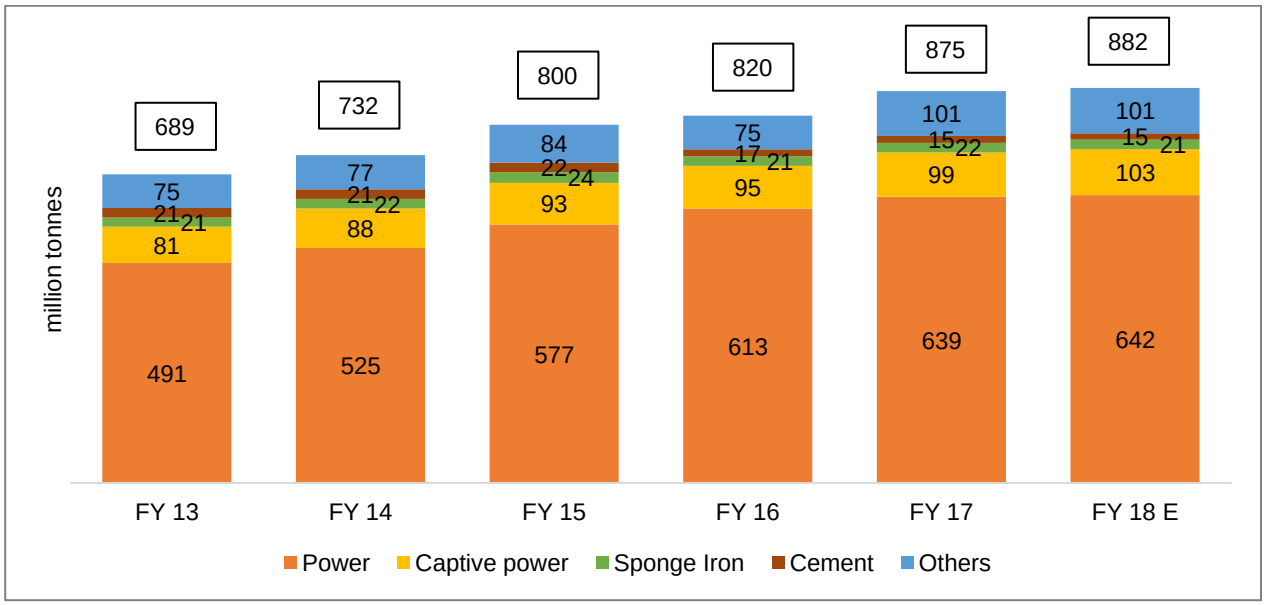
5.3.3 Fuel-Wise Energy Review and Outlook

Coal

Demand, Supply Review

Coal accounts for about 45% of the country's total energy needs. It is used as a source of heat for power generation and clinker production and is mixed (as a reducing agent) with the raw material (iron ore) to produce finished products (steel, foundries). Primary energy consumption in India increased at 5.2% CAGR over fiscals 2013 to 2018, while coal consumption posted a CAGR of 6%. The power sector (including captive plants) accounted for major proportion of the total coal consumption (78% in fiscal 2018) due to it is easy availability and cheap costs. Other major end-use sectors of coal include cement, sponge iron, textiles, chemicals and paper.

Figure 95: Sectoral Non-Coking Coal Demand in India - Review

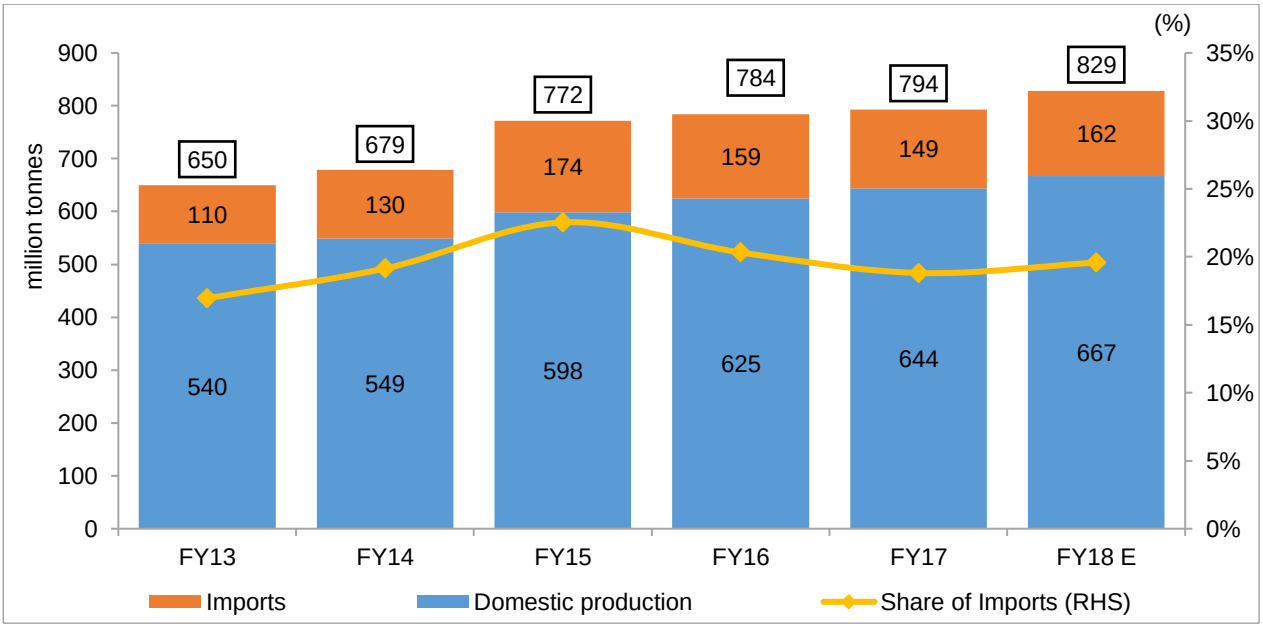


India is the third-largest coal producer in the world. During fiscal 2018, India's total coal production rose to ~678 million tonnes from ~662 million tonnes in fiscal 2017, with Coal India Ltd (CIL) accounting for bulk of the increase. In fiscal 2018, CIL produced 567 million tonnes of coal, accounting for 84% of the total coal production, while SCCL produced ~62 million tonnes, accounting for 9%. Captive production during the period was around 47 million tonnes, which constituted the remaining share in overall production.

Despite having abundant reserves of coal, domestic coal production in India has consistently lagged due to various issues such as delays in getting environment and forest approvals, and hurdles in land acquisition. Consequently, India had to increasingly rely on coal imports to meet domestic coal demand. However, post fiscal 2014, India's domestic coal production increased consistently up to fiscal 2018, clicking 4.6% CAGR, following the government's initiative to increase production and reduce dependence on imported coal. The ramp-up in production was majorly on account of rise in coal production by CIL, which rose at 5.3% CAGR from ~462 million tonnes in fiscal 2014 to ~567 million tonnes in fiscal 2018. Consequently, India's overall imports too have witnessed moderation over the years. However, power plants designed on imported coal continue to import coal for their production, and hence, the gap between demand and supply of non-coking coal cannot be bridged completely. This has resulted in non-coking coal imports rising to 161 million tonnes in fiscal 2018 from 149 million tonnes reported a year earlier.

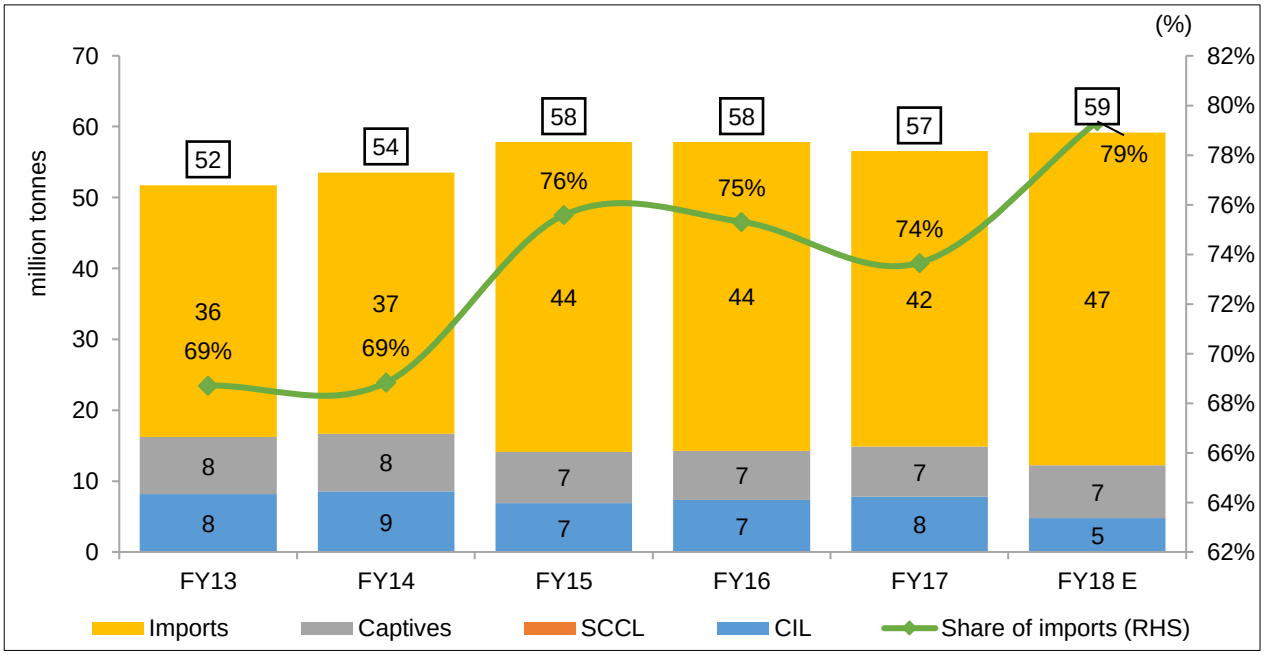
During fiscal 2018, ~12 million tonnes of coking coal was produced in India. However, being lower grade, it has to be washed, which reduces the quantity of coal. Meanwhile, ~47 million tonnes of coking coal was imported.

Figure 96: Non-Coking Coal Supply in India - Review



Source: CIL

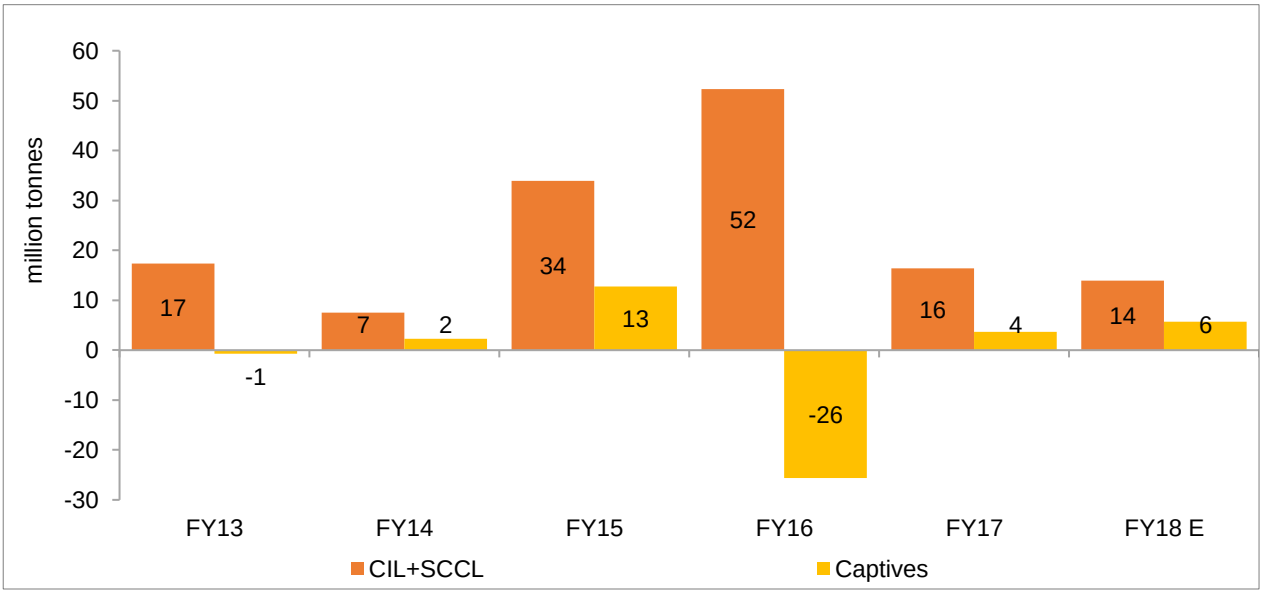
Figure 97: Coking Coal Supply in India - Review



Source: CIL

Captive production fell by 26 million tonnes in fiscal 2016 compared with fiscal 2015, on account of coal block de-allocation. However, production slowly recovered post auctioning of coal mines as per the new Coal Mines (Special Provisions) Act, 2015.

Figure 98: Source-Wise Incremental Production in India - Review



Source: CIL

Demand, Supply Outlook

Coal-based power is expected to meet ~68% of India's total power demand by fiscal 2024 and ~64% by fiscal 2030 from current levels (73%) amid accelerated wind and solar capacity additions as well as decline in conventional capacities. However, in volume terms, coal-based generation is expected to record ~2.5% CAGR over the next 12 years. Therefore, coal demand emanating from power is also expected to rise to ~900 million tonnes by fiscal 2024 and ~1,220 million tonnes by fiscal 2030. Rising power demand, decline in capacity additions and retirement of old, inefficient units owing to strict environmental norms are expected to improve plant load factors of coal-fired power plants from 61% in fiscal 2018 to ~82% by fiscal 2030. Additionally, super critical technology installed in upcoming coal-based plants along with retirement of old plants will see emissions from plants come down going forward. This will go a long way towards abatement of carbon dioxide and GHG emissions.

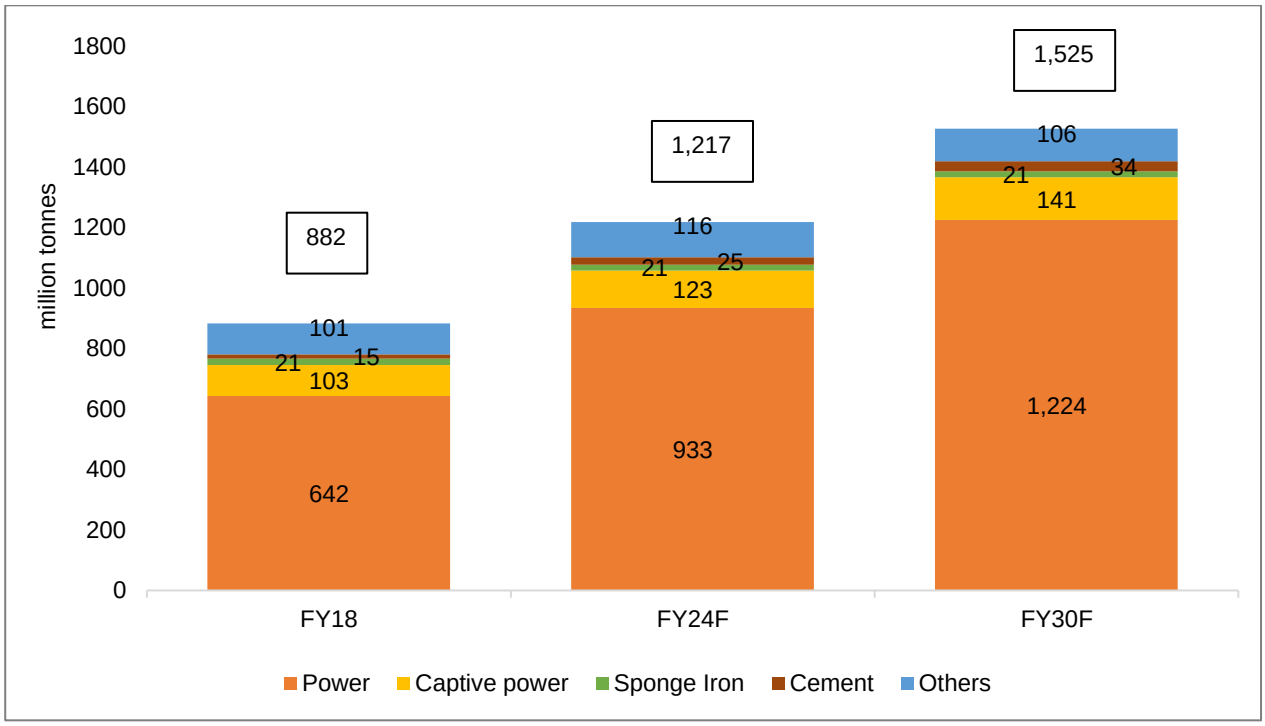
Robust growth in demand from infrastructure, led by the government-driven investments in sectors like road, railways, irrigation projects, rural and urban housing, is expected to boost cement production. Coal consumption by the cement sector is expected to clock ~7% CAGR on the back of operationalisation of captive mines allocated to cement players as well as rising concerns over usage of alternate fuels such as pet coke owing to rising pollution levels. India is the largest producer of sponge iron with an installed capacity of more than 46 million tonne spread over 320 units across the country, out of which ~34 million tonnes is of coal-based capacity and the rest, gas-based units. Going forward, coal-based sponge iron production is expected to marginally decline or remain constant on account of stricter emission norms, switch-over to gas-based DRI (Direct Reduced Iron) and competition from integrated steel plants having large BF capacities as well as big expansion projects in pipeline.

Coking coal demand grew at a slower pace with respect to hot metal (4% versus 8%, respectively), due to substitution by pulverised coal injection coal and coke imports. Going forward, rise in pulverised coal injection usage and reduction in coke rate will reduce dependence on coke and coking coal.

It is expected that hot metal/pig iron production through the BF route will increase at ~6% CAGR over fiscals 2018-2030 to meet steel demand. Coking coal demand from the Integrated Steel Producers (ISPs) as well as merchant coke players is expected to grow at ~5% CAGR over fiscals 2018-2030 to reach ~90 million tonnes from current levels (largely led by ISPs producing ~90% of their coke requirement themselves in their own coke oven batteries).

Cumulatively, all India coal demand (coking + non-coking) will rise from ~933 million tonnes in fiscal 2018 to ~1600 million tonnes in fiscal 2030.

Figure 99: Non-Coking Coal Usage in India - Outlook



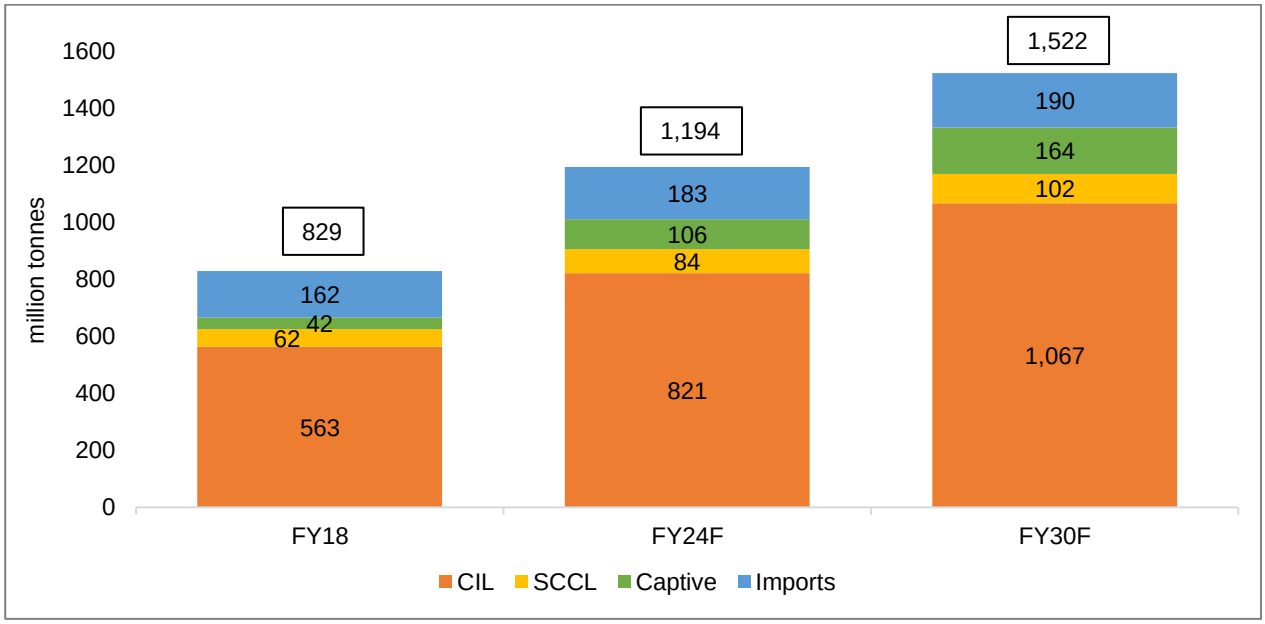
Coal production from CIL is expected to reach ~800 million tonnes by fiscal 2024 and ~1,050 million tonnes by fiscal 2030. With at least eight new mining projects under various stages of completion, supply augmentation will follow.

Commissioning of key rail projects in Odisha, Jharkhand and Chhattisgarh as well as de-congestion of existing lines is expected to help domestic coal miners to evacuate more coal from key mining areas in these states. Captive coal mine production declined by ~26 million tonnes in fiscal 2016 following de-allocation of 204 coal blocks by the Supreme Court. Since March 2015, under the new Coal Mines (Special Provisions) Act, 2015, the government has allocated 89 coal mines to various end users in power as well as non-power sectors. These blocks are expected to produce ~106 million tonne of non-coking coal by fiscal 2024 and ~165 million tonnes by fiscal 2030, contributed by blocks like Talaipali of NTPC and Naini of SCCL.

In fiscal 2018, non-coking coal imports shot up by ~8% on year after falling for two consecutive years due to sharp growth in coal consumption by power sector as well as non-power sector amid slower-than-expected domestic production.

Going forward, non-coking coal imports are expected to fall up to fiscal 2023 on account of domestic supply growth, shift in energy mix, efficiency measures implemented across industries as well as nation's commitment of reduce the GHG emissions by reducing dependence on fossil fuels. Beyond fiscal 2023, PLFs of coal-based plants are expected to rise from 72% to 82% by fiscal 2030 owing to the slowdown in capacity additions. As a result, coal demand from power will increase and imports will rise subsequently.

Figure 100: Non-Coking Coal Supply in India - Review



Petroleum Products

Demand, Supply Review

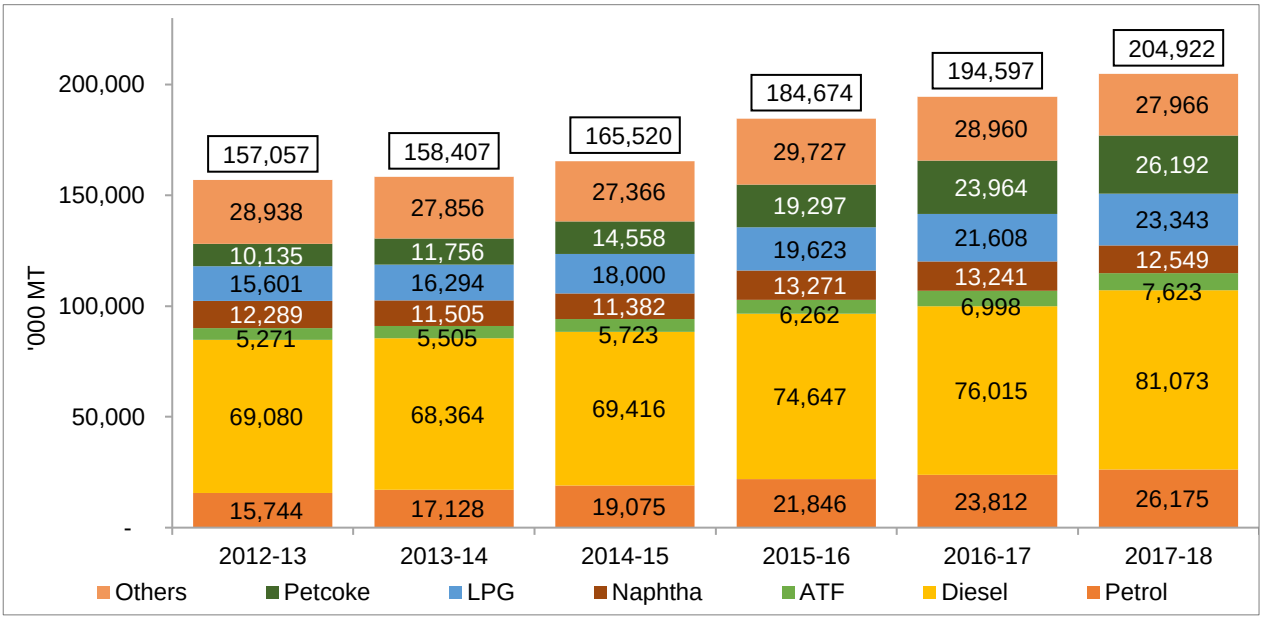
India's overall demand for POL products is estimated to have risen at 5.5% CAGR from fiscal 2013 to fiscal 2018 led by rising demand for petrol and LPG, driven by increased transportation activity and promotion of clean fuel for cooking in below poverty line (BPL) households.

Petrol consumption showcased a strong growth at 11% CAGR from fiscals 2013 to 2018, primarily led by healthy growth in passenger vehicles. Passenger car sales grew 10%, driven by stable cost of ownership and interest rate cuts. Fuel prices before March 2018 were on the lower side, which further contributed to demand growth. New model launches in the small-car segment also boosted demand. Diesel consumption grew 6.7% in fiscal 2018 post recovery in economic activity, after demonetisation in the second half of fiscal 2017 led to slowdown in GDP, affecting industrial and transportation sectors. Diesel demand growth dipped to 2% on year in fiscal 2017. Overall, the diesel demand grew at 3.3% CAGR over fiscals 2013-2018 led by commercial vehicles sales growth while LCVs (light commercial vehicle) grew by 28-30%, MHCV (medium & heavy commercial vehicles) grew by 19-20% in fiscal 2018.

LPG demand rose at a healthy 8.4% CAGR from 15.6 million tonne in fiscal 2013 to 23.3 million tonne in fiscal 2018 driven by a concerted push from the government through the Pradhan Mantri Ujjwala Yojana to disburse free LPG connections to BPL families. The scheme aimed to provide 50 million LPG connections to BPL families. More than 35 million LPG connections have already been released in the last two years under this scheme. The demand for aviation turbine fuel (ATF) grew at 7.7 % CAGR between fiscals 2013 and 2018 with an increase in passenger carrying capacity, determined in available seat kilometres, to 122 billion-km in fiscal 2018 from 58 billion-km in fiscal 2013.

While the key POL products include petrol, diesel, LPG, fuel oil and aviation fuel, 13% of the total POL demand in fiscal 2018 came from pet coke owing to a strong cement industrial base. Its demand saw a robust growth of 21% from fiscals 2013 to 2018 owing to rise in coal prices, which made pet coke more competitive for use in cement plants.

Figure 101: Consumption of POL Products: India



Source: PPAC

India is a net exporter of petroleum products, with a net exportable surplus of 43 million tonne in fiscal 2018. Presently, petrol and diesel form over 75% of the net surplus. However, it is private players such as Reliance and Essar (Nyara Energy) that export majority of petrol and diesel (more than 95%), as they produce Euro V/VI grade fuel, which is more suited for the global markets. These players mainly export refined products to the European Union, Singapore and Japan, where they have established markets. The quantum of exports by public sector units accounts for a miniscule proportion, and they are majorly undertaken to other SAARC nations including Bhutan, Nepal and Sri Lanka. India is, however, deficit in LPG and is dependent on the Middle Eastern nations, mainly Qatar, for meeting its domestic demand.

Table 33: Product-Wise Imports and Exports of Major Petroleum Products: India

'000 MT	FY13	FY14	FY15	FY16	FY17	FY18
Imports						
Crude oil	184,795	189,238	189,435	202,850	213,932	220,434
LPG	6,301	6,567	8,313	8,959	11,097	11,382
Naphtha	1,762	1,020	1,034	2,931	2,777	2,150
Others	193,087	198,348	201,388	220,416	236,345	242,793
Total product imports	**385,945**	**395,173**	**400,170**	**435,156**	**464,151**	**476,759**
Exports						
Petrol	16,657	15,247	16,048	16,817	15,417	14,035
Naphtha	8,647	8,322	7,008	7,116	8,727	8,951
Diesel	22,464	26,469	25,559	24,037	27,302	29,676
Fuel oil	5,922	6,159	4,762	2,806	2,248	2,492
Others	9,718	11,667	10,554	9,763	11,821	11,603
Total product exports	**63,408**	**67,864**	**63,932**	**60,539**	**65,513**	**66,757**

Source: PPAC

Demand, Supply Outlook

Petroleum product consumption in India is expected to clock 4.1% CAGR between fiscals 2018 and 2030 as against 5.5% growth seen over the past five years. The slowdown in growth shall be primarily on account of reduction in growth of petrol demand with rising substitution by CNG, ethanol blending and increased focus on electric vehicles.

Diesel

Diesel demand is expected to grow at 4.2% CAGR from fiscals 2018 to 2030, led by the improvement in commercial vehicle transportation activity constituting two-thirds of the overall demand. Transportation activity is expected to increase due improved industrial activity and strong focus on infrastructure project execution. Commercial vehicle (CV) sales are expected to grow at 4-6%, which will support diesel demand growth. However, slower growth in the sales of diesel cars (cars and utility vehicles) will restrict demand for diesel.

Diesel demand from the non-transport sectors is expected to increase only marginally during the period, primarily driven by a rising demand from the agriculture segment, where it is used to run agri pump sets and tractors. Growth in demand from transport and agriculture sectors will be partially offset by lower off-take of diesel in the railways with the government having a target to electrify all diesel-based rail locomotives by 2021. India has adopted Corporate Average Fuel Efficiency (CAFÉ) norms which require cars to be 30% or more fuel efficient from 2022 and 10% or more between 2017 and 2021. This will reduce fuel requirements owing to better vehicle efficiency. India is well poised towards achieving its target well before deadlines with the country already reaching fuel efficiency of ~22%.

Petrol

The demand for petrol is expected to record 5.7% CAGR from fiscals 2018 to 2030 as against 11% growth seen over the last five years. The growth shall be driven by rising sales of passenger vehicles and two-wheelers. However, improving efficiencies (implementation of CAFÉ norms) and substitution with CNG in the medium term and ethanol blending and electric vehicles over the long term are expected to restrict demand growth in petrol. With improvements in vehicle technology, electric vehicle charging infrastructure and declining battery costs, electric vehicle sales are expected to pick up post 2023, when battery costs in the global market fall to ~$100/kWh. Electric vehicles are estimated to form 10% of the total car stock and 12% of the total two-wheeler stock by 2030. The Indian government targets to increase the blending rate to 20% by 2030 from 2% currently. However, due to lack of domestic production, blending rate is not expected to exceed 10% by fiscal 2030.

LPG

LPG demand is expected to grow at 4.6% CAGR between fiscals 2018 and 2030, on account continuing policy push by the government to promote the use of LPG and target of rolling out 100 million connections in the next three-four years. LPG penetration is expected to reach 97% by fiscal 2022 and 100% by fiscal 2030 from 75% in fiscal 2017. While growth in demand will be higher in the medium term, clocking 6-7% over the next four-five years, once the penetration reaches 100%, demand growth in LPG will slow down. Moreover, with the spread of city gas distribution (CGD) network in the remaining parts of the country, some LPG demand is expected to be substituted by piped natural gas.

Pet coke

Pet coke demand saw a sharp growth of 21% over the last five years due to its increasing competitiveness with coal in cement plants amid a low crude oil price environment. However, demand growth is expected to slow down significantly between fiscals 2018 and 2030, growing at 1.2% CAGR on account of:

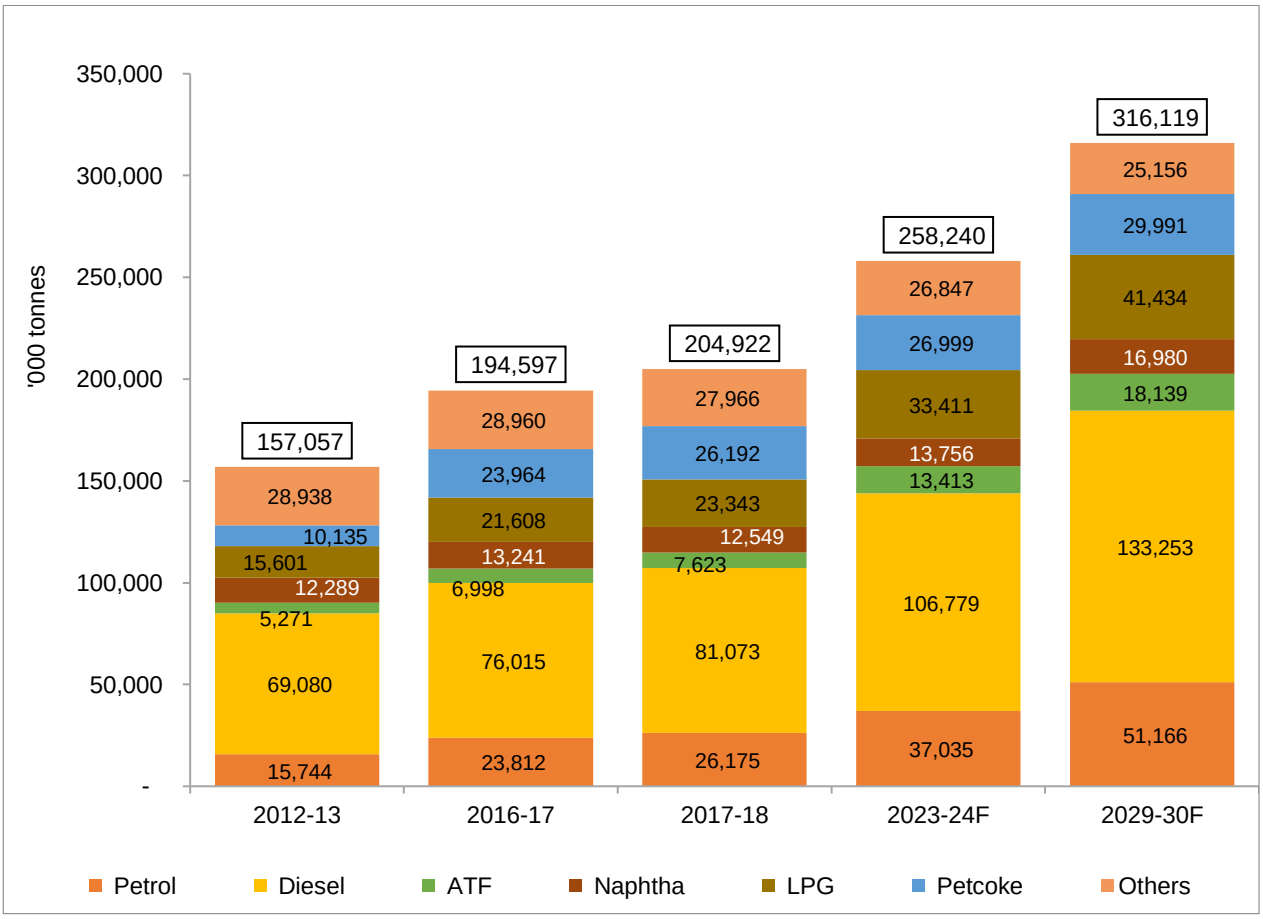
- Coal prices becoming more competitive than crude oil prices in the long term, resulting in increased substitution; and
- Extended ban on the use of pet coke owing to pollution-related concerns

Other Petroleum Products

Naphtha demand is expected to increase at 2.5% CAGR from fiscals 2018 to 2030, as against a muted growth of 0.4% seen over the last five years, driven by increased utilisation of recently commissioned petrochemical capacities, as well as newer capacities expected to be added going forward.

ATF demand is expected to see 4.2% growth between fiscals 2018 and 2030, due to a rise in Available Seat Kilometres (ASKM), which is expected to record 9% CAGR during the period, due to addition of fleet by airlines such as IndiGo, GoAir and Jet Airways.

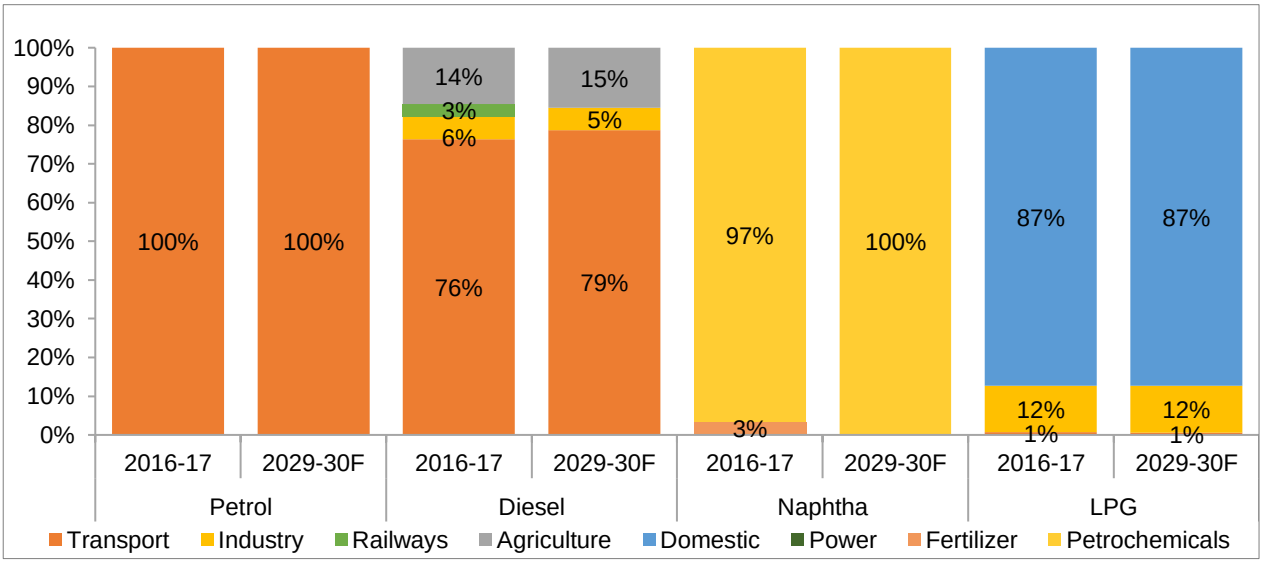
Figure 102: Outlook on Petroleum Product Consumption: India



Source: PPAC

The sector-wise consumption of petroleum products is not expected to change significantly over fiscals 2018-2030. In case of naphtha, as all naphtha-based fertiliser plants are shutting down, entire naphtha demand is expected to be taken up by the petrochemicals sector as against 3% of naphtha being consumed by the fertiliser sector today.

Figure 103:End-Use-Wise Consumption of Major Petroleum Products: India



Source: PPAC

India's current oil production is at around 36 million tonnes, while annual consumption of crude oil by refineries stood at 251 million tonnes as of fiscal 2018. India is, therefore, dependent on imports from the Middle Eastern nations for the supply of balance 220 million tonne. Most of India's currently producing nomination fields are ageing and witnessing a decline in production of 0.5-1% every year. The government recently bid out 55 exploration blocks under the Open Acreage Licensing Policy. The 55 blocks have a total area of 59,282 sq. km compared with about 102,000 sq km being under exploration currently. With these blocks coming into commercial production, oil production is expected to increase only marginally in the long term with natural decline in India's mature fields to offset this rise.

In contrast, oil players in the refining segment have significant capacity addition plans going forward, taking India's total crude oil demand to 350 million tonnes by fiscal 2030 from current 251 million tonne (CAGR of 2.7%).

Table 34: Upcoming Refineries in India

Refinery	Capacity ('000 tonne)	Expected commissioning
BPC, BORL-Bina, MP (Expansion)	1,800	FY20
IOC, Barauni, Bihar	3,000	FY23
IOC, Panipat, UP	5,000	FY24
IOC, Panipat, UP - 2	5,000	FY28
BPC, BORL-Bina, MP (Expansion)	7,200	FY26
HPC, Mumbai	2,000	FY21
HPC, Visakhapatnam	6,700	FY22
NRL, Nurmaligarh (Expansion)	6,000	FY23
HPCL, Rajasthan	9,000	FY24
Mega Project, Ratnagiri - Phase 1	20,000	FY26
Mega Project, Ratnagiri - Phase 2	20,000	FY29
CPCL, Narimanam (expansion)	9,000	FY26

Source: Company reports

Considering the rise in domestic production, crude oil imports are expected to increase to 310 million tonnes from current 220 million tonnes. As against the above, petroleum product demand is expected to reach only 316 million tonnes by fiscal 2030.

The following table showcases the balance of POL trade for India till fiscal 2030, highlighting that it shall have an overall surplus of 32 million tonne by fiscal 2030.

Table 35: POL Trade Balance: India

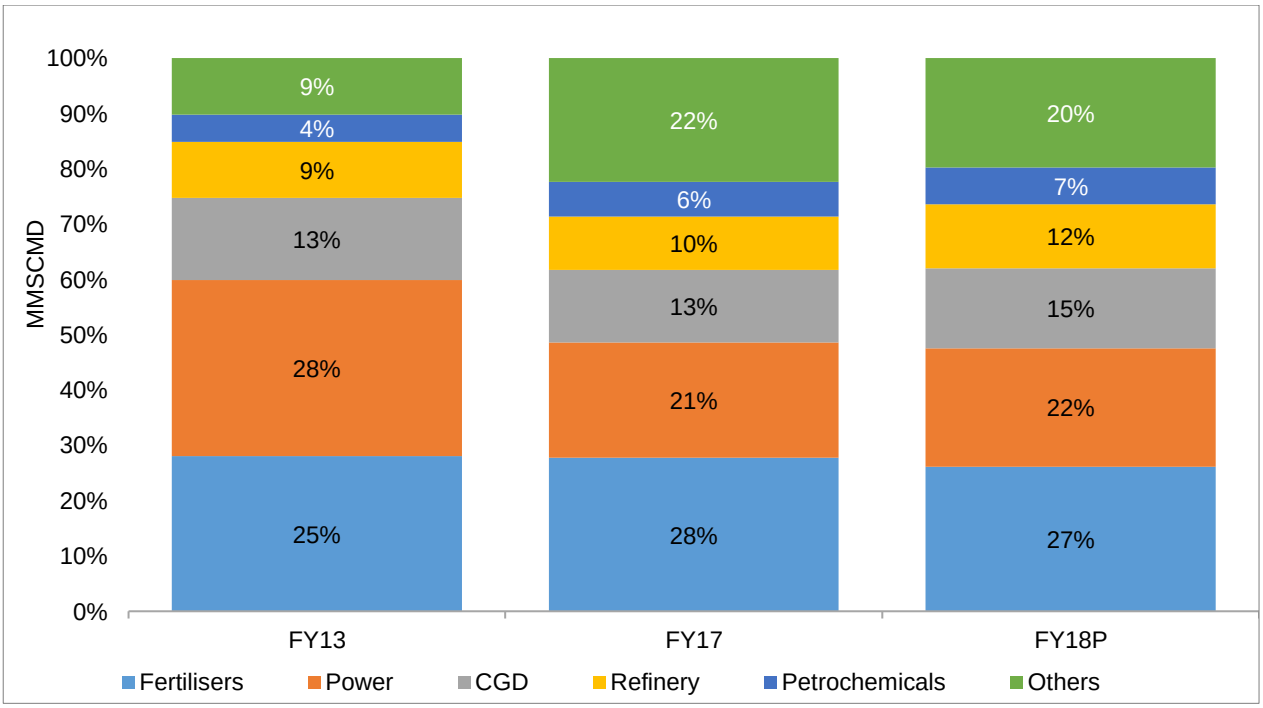
('000 MT)	FY13	FY17	FY18E	FY24F	FY30F
Refining capacity	215,066	233,966	247,516	281,016	342,216
Crude oil production	37,919	36,008	35,700	36,000	36,000
Crude oil imports	184,795	213,932	220,434	245,016	306,216
Petroleum product demand	157,057	194,597	204,922	258,240	316,119
Petroleum product production	219,212	245,360	252,839	281,233	348,475
Petroleum product net surplus	62,155	50,763	47,918	22,993	32,356

Gas

Demand, Supply Review

Gas is a major contributor in the country's energy mix. It serves several purposes from generating power, industrial use, to domestic and commercial consumption. Demand for natural gas remained stagnant during fiscals 2013-2018 owing to falling gas production in the country. Consumption is majorly driven by the demand from fertilisers and power sectors, which together accounted for 49% of domestic gas consumption in fiscal 2017. Other major end-use sectors include CGD (23%) and refineries (11%).

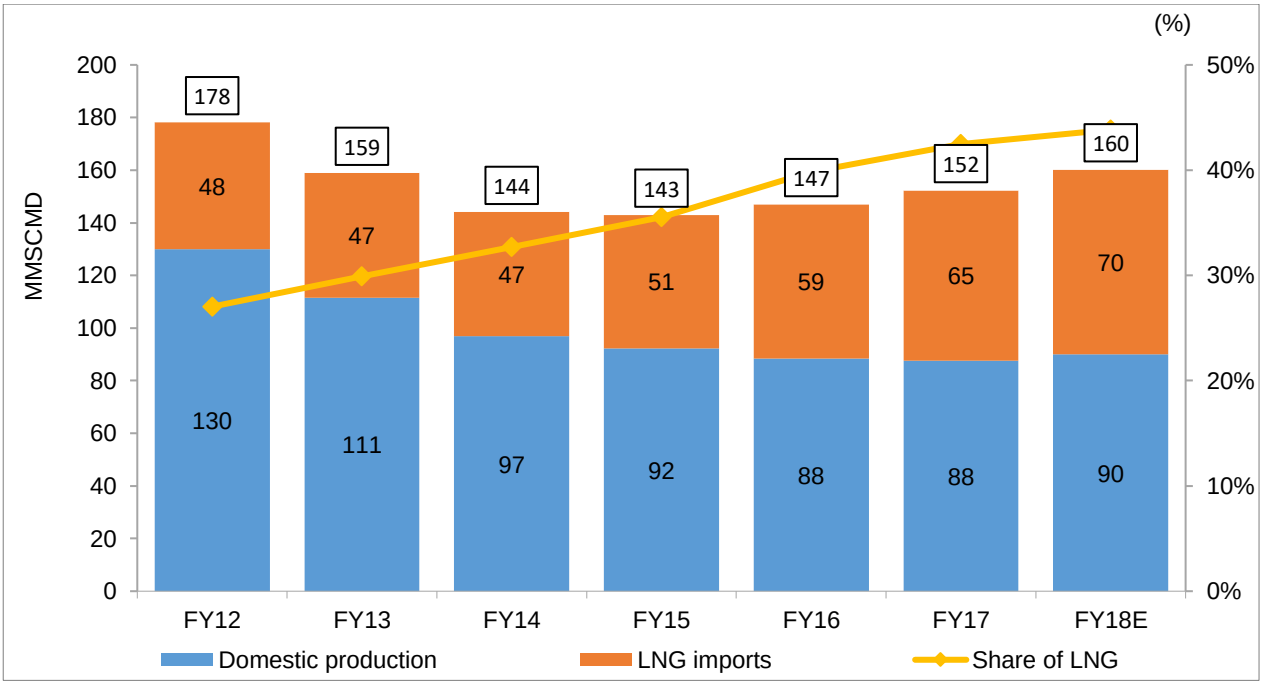
Figure 104: Usage of Gas in India - Review



Source: Economic Survey, Ministry of Petroleum and Natural Gas

With domestic gas available at a discount unlike imported gas ($3.06/mmBtu versus $7-8/mmBtu in fiscal 2018), the former commands a huge share of the demand. However, domestic production being lower, the government has prioritised end-use sectors for supply. Sectors with regulated prices (fertilisers, CGD) and limited affordability (power) get higher priority as opposed to sectors with market-determined products (industries, steel plants, refineries). Thus, demand for natural gas also depends on the cost competitiveness of LNG vis-à-vis alternate fuels such as furnace oil and naphtha, as it competes with these fuels in the industrial sector. With fall in domestic gas output, the share of LNG imports further rose from 30% in fiscal 2013 to 44% in fiscal 2018.

Figure 105: Gas Supply in India - Review



Source: Economic Survey, Ministry of Petroleum and Natural Gas

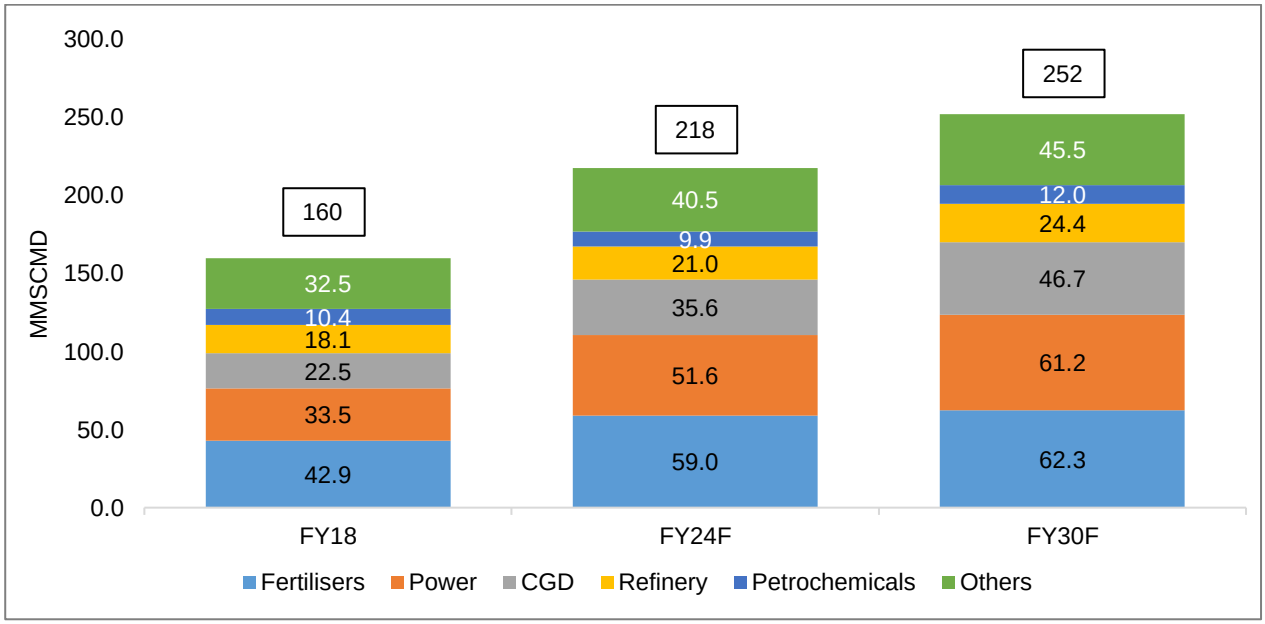
Demand, Supply Outlook

Gas demand is expected increase to ~217 mmscmd by fiscal 2024 at 5% CAGR and ~252 mmscmd by fiscal 2030 at 2.5% CAGR. Gas demand rise will be driven primarily by fertilisers and CGD sectors. Conversion of naphtha-based units, revival of existing units and capacity additions under the New Urea Investment Policy shall drive demand from the fertiliser segment.

Subdued demand growth is anticipated from the power sector, owing to weak cost competitiveness of LNG and withdrawal of LNG subsidy scheme. However, demand is expected to improve slightly from fiscal 2020 due to new domestic supply. Although additional 7.6 GW of gas-based capacity additions are expected between fiscals 2018 and 2030, the plants will continue to face curtailments due to fuel supply intermittencies and high costs (cost of power from gas-based power plant ranges at Rs 4.75.7/unit, which is high compared with coal and renewable).

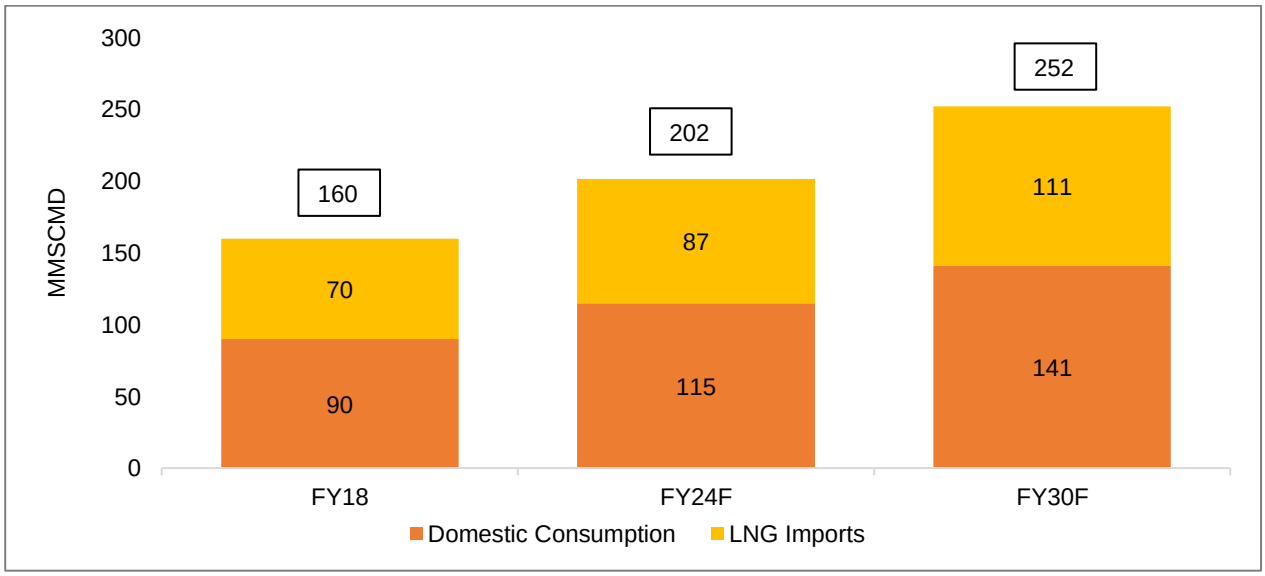
Expansion in CNG and domestic PNG sectors is expected to drive gas demand growth from the CGD sector. Expanding geographical coverage and improving cost competitiveness of gas shall drive growth in CGD demand. Assured domestic gas supply will also aid competitiveness and drive gas demand (~7% CAGR) for CNG and domestic PNG. Additionally, ban on polluting fuels in northern states and expected expansion to other states shall push the demand upward. However, demand from the petrochemicals segment will witness a drop fiscal 2020 onwards after a sharp increase in fiscals 2017-2019 due to feedstock substitution.

Figure 106: Usage of Gas in India - Outlook



On the supply side, domestic gas production is expected to pick up, but remain significantly below demand. Domestic production is expected to reach ~141 mmscmd by fiscal 2030, at 3.8% CAGR, between fiscals 2018 and 2030. ONGC's eastern offshore fields (KG-DWN-98/2) are expected to add ~16 mmscmd with a targeted start date of June 2021. Further, RIL's satellite fields and D34 fields are also expected to reach peak gas production of ~23 mmscmd during the period. LNG imports are expected to reach ~110 mmscmd, keeping the share of LNG in total consumption (44%) in line with current levels.

Figure 107: Gas Supply in India – Outlook



Hydro

As per the Central Electricity Authority's assessment, the economically exploitable hydropower potential in terms of installed capacity is 148 GW, out of which large hydro capacity (above 25 MW) is around 145 GW. However, as of fiscal 2018, only 45 GW of hydro projects have been set up in the country, contributing ~13% of the power generation mix. Several problems like replacement and rehabilitation (R&R) issues, land acquisition problems, clearance and approval procedures, and capability of developers have been hindering

development. Hydropower projects are capital intensive with long payback periods. This makes developers wary of investing.

Additional ~34 GW of additional hydro projects are expected to come up by fiscal 2030. The government is striving to stem investor confidence by creating a conducive environment and removing impediments through sound policy formulation.

Renewable Energy

Solar

India had an installed solar capacity of ~22 GW as of fiscal 2018. Annual capacity additions rose to 9,363 MW in fiscal 2018 compared with 5,526 MW in fiscal 2017 with Karnataka and Telangana leading the pack. Large capacities of solar power plants have been allocated fiscal 2016 onwards owing to conducive state policies, central schemes of NVVN Tranche I and JNNSM Phase II Batch III. With tariffs falling to Rs 2.7/unit owing to steep decline in module prices, economies of scale benefits and aggressive bidding by developers, the country has been seeing a boom in solar power development. With more than 30 GW solar tendering completed in 2018, aggressive tendering roadmap is expected in the short to medium term. States have also been rallying to tender solar capacities, driven by the higher renewable purchase obligation (RPO) and low tariffs. It is expected that India will see robust solar capacity additions of ~60 GW over fiscals 2019-2023 and ~70 GW over fiscal 2024-2030.

Table 36: Solar Capacity in India - Review and Outlook

	FY13	***FY18***	***FY24F***	***FY30F***
Installed capacity (GW)	1.7	21.7	90.1	150.1
Solar as % of power generation	0.50%	2%	8%	9%

Source: CERC, Ministry of Renewable Energy

Wind

As of fiscal 2018, wind power constituted ~10% of the total installed power generation capacity in India and 49% share in renewable energy capacities (69 GW). Wind power is estimated to have accounted for about 4.3% of the country's total power generated in fiscal 2018. Capacity additions plummeted by 67% in fiscal 2018 from fiscal 2017 levels on account of multiple factors including unplanned phasing out of feed-in tariff regime by state governments, delay in the issuance of bidding guidelines and tenders by states and cancellations of allotted capacities (LOAs) to developers for setting up project capacities under the feed-in-tariff mode. Moreover, halving of accelerated depreciation benefit (from 80% in fiscal 2017 to 40% in fiscal 2018) and elimination of generation-based incentives of Rs 0.5/unit also reduced investments in the sector from non-IPP players. In addition, delays in signing of PPAs by states led by cancellation of bid capacities and significant payment delays in the wind energy sector over the last 12 months, led to fewer capacity additions to the tune of 1.8 GW fiscal 2018. Capacity additions were led mainly by states such as Karnataka, Andhra Pradesh and Tamil Nadu, which together added 1,452 MW (~82% of total additions in the year) of wind capacities owing to attractive tariffs of Rs 4.83/unit, Rs 4.19/unit and Rs 4.5/unit, respectively, compared with Rs 2.65/unit weighted average competitively bid tariffs for fiscal 2018.

In fiscal 2018, ~4.5 GW of wind capacities were auctioned, which are likely to be commissioned in fiscals 2019 and 2020. Post the auctioning of 1 GW of SECI projects in February 2017, the pace of auctioning increased with larger demand from states not having wind energy potential but look forward towards using wind energy for meeting their RPO targets. The RPO compliance of 70-75% in fiscal 2018 was completely driven by a few states including Tamil Nadu, Rajasthan, Gujarat and Maharashtra, given the large installed capacity set up on account of attractive wind FiTs, high industrial tariffs and favourable state policies for

renewable energy. On the other hand, despite high RE potential, large states like Uttar Pradesh, Punjab and Madhya Pradesh are significantly lagging in terms of RPO achievement owing to low installed base and poor financial health of the discoms (except Madhya Pradesh).

Table 37: Wind Capacity in India - Review and Outlook

	FY13	***FY18***	***FY24F***	***FY30F***
Installed Capacity (GW)	19	34	71	107

F- Forecasted
Source: CERC, Ministry of Renewable Energy

Wind-based power generation is expected to rise to ~6% of total power by fiscal 2030, with capacity additions of ~70 GW over the next 12 years (fiscals 2018-2030s) driven by rising participation of the central government and other strong off-takers like PTC, which significantly reduces risk compared with direct exposure to state discoms. Moreover, capacity additions will be driven by the decline in tariffs and higher procurement from non-windy states.

Biomass

As of fiscal 2018, the total installed capacity for biomass ((bagasse cogeneration power) based power was ~8 GW. The potential for power generation from biomass is nearly ~19 GW (agro residue and plantations), while an additional ~ 7 GW potential exists in bagasse-based co-generation.

Table 38: State-Wise Installed Biomass Capacity in Major States (as of December 2017)

State	Total capacity (MW)
Maharashtra	2,065
Uttar Pradesh	1,958
Karnataka	1,605
Tamil Nadu	893
Andhra Pradesh	378
Chhattisgarh	228

Source: CERC, Ministry of Renewable Energy

The government has been promoting the Biomass Power and Bagasse Co-generation Programme with the aim of recovering recover energy from biomass including bagasse, agricultural residues such as shells, husks, de-oiled cakes and wood from dedicated energy plantations for power generation. The potential for power generation from 40 agricultural and agro-industrial residues is estimated at about 18 GW. With efficient project configuration in new sugar mills, and modernisation of existing ones, the potential of surplus power generation through bagasse cogeneration in sugar mills is estimated at around 7 GW. Thus, the total estimated potential for biomass power is about 25 GW. Punjab has the maximum potential of power generation through biomass, while leading sugarcane producing states like Uttar Pradesh and Maharashtra have the maximum potential for bagasse-based power generation.

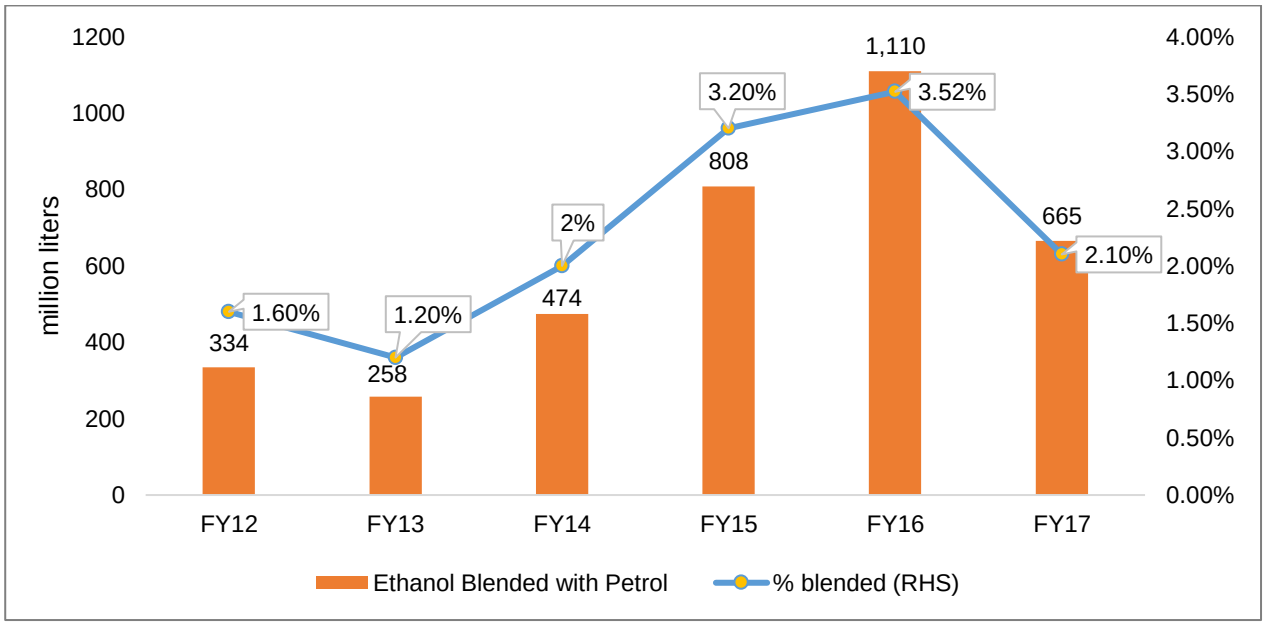
The country intends to achieve 40% of power installed capacity from non-fossil fuel (wind power, solar, hydropower, biomass, waste to energy and nuclear power) by 2030 as per its INDC commitments. Going by current capacity addition trends, India is expected to reach its goal by as early as 2020. It may result in achievement of a key Paris Climate Goal by the country ten years before deadline.

Biofuels

Ethanol

Demand for ethanol has been strong primarily due to the mandatory blending petrol with it. The government made 5% blending of ethanol mandatory in the country from November 2006. However, constrained by volatility in alcohol production and fixed pricing for fuel alcohol, the all-India blending rate has not crossed 2%, over the last five years. During fiscal 2015, the government took several steps to boost ethanol production. It has fixed remunerative price for ethanol supplied for blending with petrol, at Rs 42/litre. Further, blending targets under the ethanol blending programme have been increased from 5% to 10%.

Figure 108: Trend in Ethanol Blend Rate



Biodiesel

In order to reduce dependence on imports of fossil fuels and promote domestic biofuel production, the government approved the National Biofuel Policy in September 2008 and revised it in May 2018. A target of achieving 20% for biofuel blending was set till 2017, which has not been achieved so far.

The government had identified 40 million hectares of wasteland that can be used for jatropha cultivation. Of this, nearly 17% of land lies in the states of Madhya Pradesh and Chhattisgarh. The cost of biodiesel is directly linked to the cost of jatropha seeds. Further, cost of production varies significantly depending on the economies of scale of the project. Production of biodiesel has been negligible due to lack of availability of jatropha and other oil seeds. Distribution channels for biodiesel are almost absent in India, which constraints assured off-take of jatropha, thereby impacting its production. In addition, smaller land holdings, ownership issues with government and community-owned wastelands have also been an impediment to jatropha production. Lack of sufficient feedstock and insufficient research and development to evolve drought-resistant jatropha seeds have also been major barriers towards production of biodiesel. Currently, jatropha occupies only about 0.5 hectares of low-quality wastelands across the country. Despite all the incentives provided by the government, only a few states have been able to establish the plantations.

Nuclear

At present, ~7 GW, more than 22 nuclear units in operation, of nuclear power facilities exist in the country, contributing to 3% of the power generation mix (as of fiscal 2018). Additional ~12 GW of nuclear plants are expected to come up by fiscal 2030, taking contribution to 4.5-5% of the generation mix. Although, the

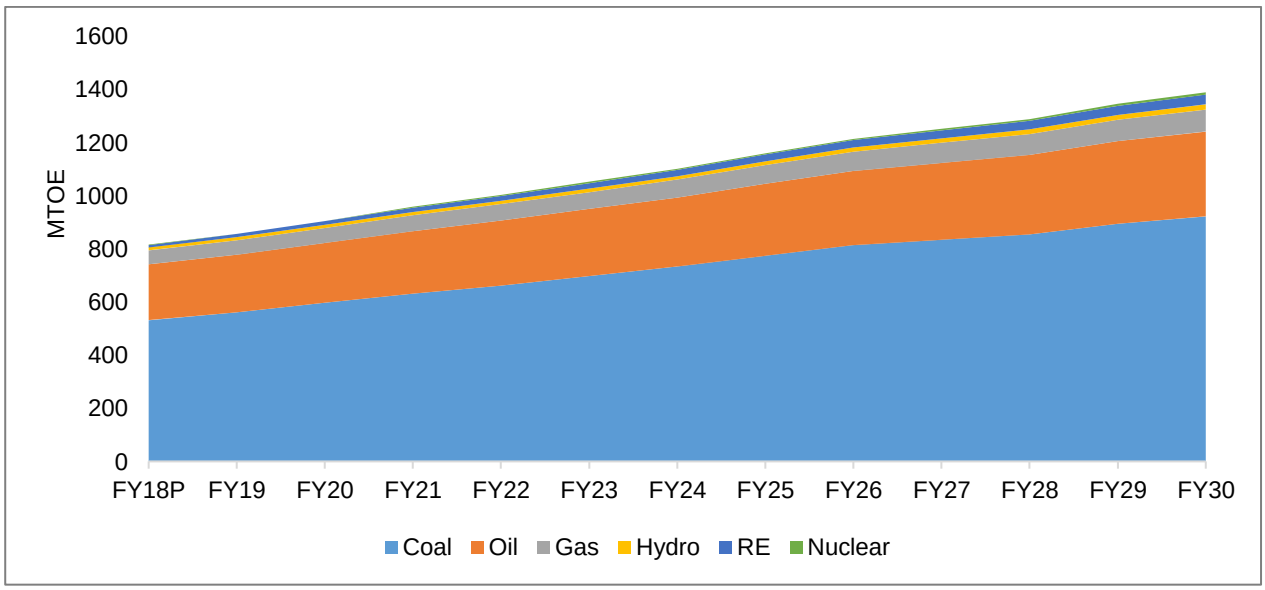
government had set ambitious targets for 63 GW of nuclear power capacity addition, it has been cut to 22.48 GW by fiscal 2032 due to curtailment in the construction of new reactors. This shift in balance of new power requirement will likely be met by coal-fired plants.

Energy Outlook 2030

Based on the usage outlook for all the aforementioned fuels, it is estimated that the overall energy requirement in India shall rise from 817 MTOE in fiscal 2018 to 1,392 MTOE in fiscal 2030.

All figures in MTOE	FY18P	FY19F	FY24F	FY30F
Primary energy	817	860	1,103	1,392

Figure 109: Primary Energy Outlook for India – 2030



Outlook on Imports

India, with its burgeoning population and rising income levels, will witness manifold increase in energy requirement. India has been heavily dependent on crude oil, petroleum products and gas imports due to lack of proven, exploitable reserves. The country intends to change the primary energy mix through focus on renewables in the power sector and biofuels and electric vehicles in the transport sector. Depending on the as-is scenario and taking into consideration the expected change in fuel availability, India would need imports as shown below.

Table 39: Import of Fuels - Outlook

Fuel	FY18	FY24	FY30
Crude oil ('000 tonne)	220	244	312
Electricity (TWH)*	-	-	-
Coal (million tonne)	209	185	161
Gas (mmscmd)	70	87	111

**Imports from Bhutan are considered to be same as fiscal 18 levels, India will be a net exporter of electricity*

6 Maldives

6.1 Country Overview

Maldives is an island nation comprising 1,192 dispersed tropical islands grouped into 26 geographical atolls, spread over an area of 115,300 sq. km and occupying 224 km with an estimated population of 352,795 in 2016. The real GDP of Maldives witnessed clocked 6% CAGR from 2012 to 2017 to reach MVR 66,000 million ($4,281 million), primarily led by the construction sector growth. Large public infrastructure projects such as roads, bridges and ports, along with residential housing and resort development, significantly contributed to GDP growth.

Table 40: Maldives' Macroeconomic Profile

	Factors	2012	2017
Demographics	Population ('000)	330.6	358.4
Macroeconomic scenario	GDP growth rate (y-o-y)	2.5%	6.9%
	Sectoral contribution to GDP		
	a. Construction	5.0%	6.7%
	b. Tourism	25.7%	22.7%
	c. Transportation	6.3%	6.5%
	d. Real estate	7.3%	7.2%
	Inflation	N.A.	~3%
Fiscal position	Exports ($ million)	314	318
	Imports ($ million)	1,576	2,222
	CAD (% of GDP)	6.4%	18.9%
	Fiscal deficit (% of GDP)	6.7%	2.0%

Source: Country Reports

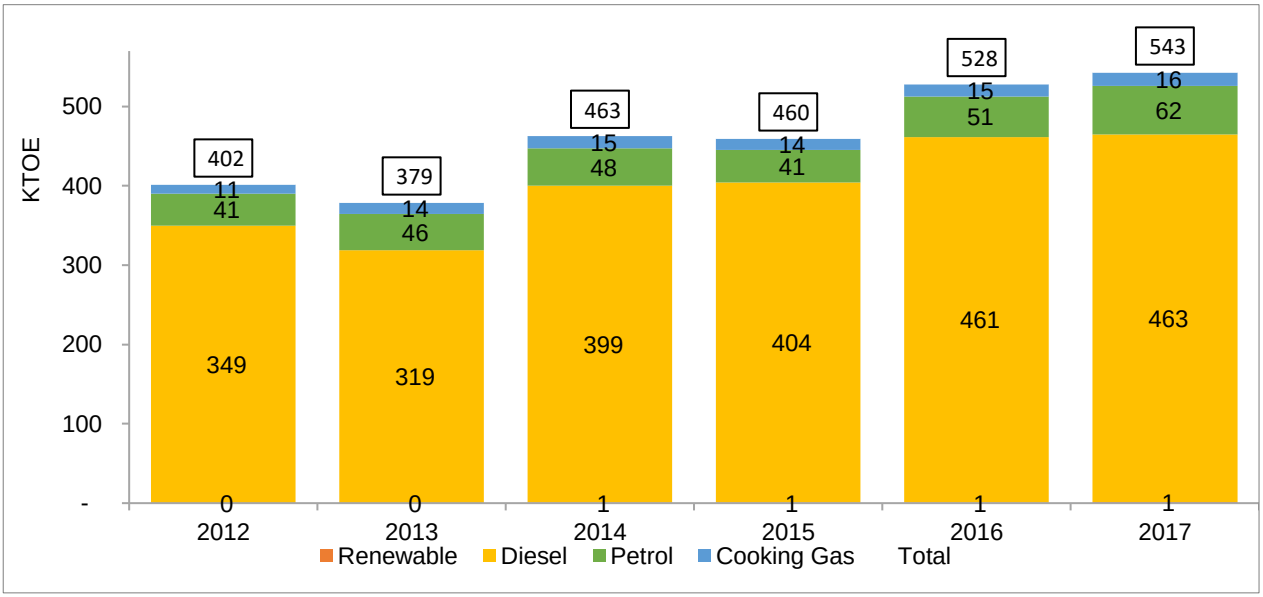
Maldives, owing to lack of indigenous fossil fuels resources, is completely dependent on imports for meeting its energy needs. It sources its entire energy requirement from imported POL. Maldives, with its focus for provision of reliable and sustainable energy services to all the people at the lowest possible cost, is trying to rejig its existing energy mix by introducing RE (primarily solar energy). The target is to reduce the dependence on imported fuels and bring down the current account deficit (CAD).

6.1.1 Overview of Energy Structure

Energy Mix

Maldives' energy requirement, driven by a strong GDP growth of 6% CAGR, has risen from 401 KTOE in 2012 to 542 KTOE in 2017 (excluding aviation gas), or at 6.2% CAGR. At present, the energy mix of Maldives comprises oil as the single largest source of energy, which includes consumption of POL products (diesel, petrol and cooking gas), with insignificant contribution from RE. Among POL products, diesel forms the single largest energy source, accounting for ~85% of energy supply in 2017. The power sector is the largest consumer of diesel, with no other power generating sources in the country.

Figure 110: Primary Energy Mix Review – Maldives



Source: SAARC Energy Databook, Maldives Custom Services

Domestic Availability and Imports of Fuels

The State Trading Organisation Plc (STO) is responsible for undertaking trading and commercial activity on behalf of the Maldivian government. It undertakes the trade and import of POL products. Petrol and diesel (or, marine diesel oil in official terminology) cumulatively accounted for 90% of the total POL products imported in 2017. The United Arab Emirates (UAE) forms the single largest supplier of petrol and diesel, followed by refining and trading hubs of Singapore and Maldives. Additionally, cooking gas (for household, commercial heating, and cooking needs) and aviation gas are also imported from these countries. The UAE singularly accounted for ~80% of total POL imports in 2017. Cumulatively, ~561,000 tonnes of POL products were imported for MVR 4,675 million (or $303 million) in 2017, which accounted for 7% of GDP at constant prices and 21% of total governmental expenditure for that year.

6.2 Institutional and Regulatory Framework of Energy Sector

The Ministry of Environment and Energy is the body responsible for the government's environmental, energy, and climate policy. The ministry works on issues concerning the climate, energy, biological diversity, chemicals, nature, marine and water environment, and international environmental cooperation.

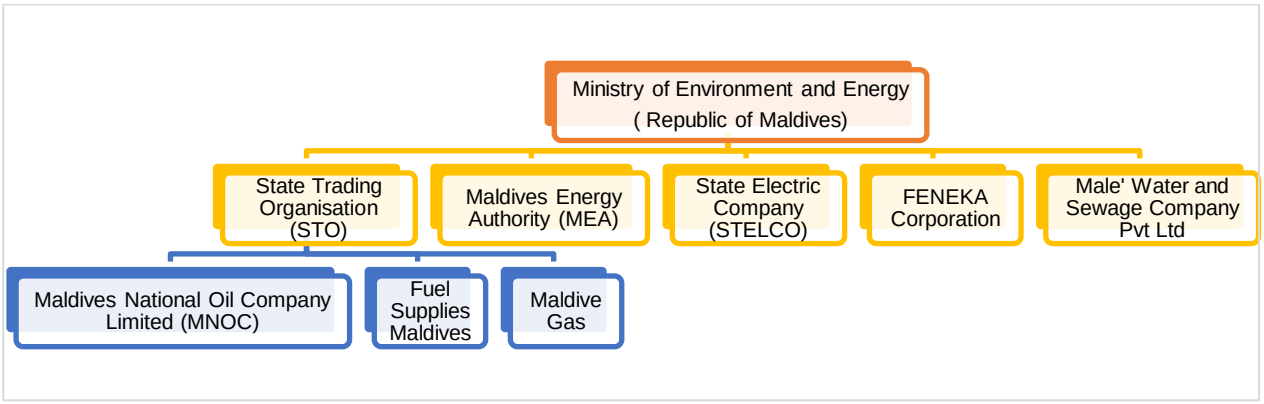
6.2.1 Planning and Regulatory Bodies

The energy department is in charge of formulating policies related to the energy sector in line with the legislative framework of the Republic of Maldives. It strengthens international cooperation to boost both investment and know-how in the sector and is committed to raise awareness on energy resources and consumption. The department is divided into two sections:

- *Policy and sector development:* This section is responsible for implementation of laws and regulations alongside formulation of strategies in the energy sector. It undertakes identification and ensures supply of the most convenient energy sources to meet the domestic demand as well as managing carbon-neutral policies.
- *Energy technology development:* This oversees limiting of energy misuse and waste. It advises the government and legal sectors on efficient energy use, on low-carbon development strategies, and renewable energy technologies.

The institutional framework for the energy sector is shown below:

Figure 111: Energy Institution Framework for Maldives



STO Plc is the main importer and supplier of petroleum products in Maldives. It is responsible for ensuring availability of POL products through international trade and coordination.

- Established in 2003, Maldives National Oil Company (MNOC) is a 100% owned subsidiary of STO and was incorporated to explore potential and oversee production, refining, and transport of hydrocarbons, gas, and POL products.
- Established in 2001, Fuel Supplies Maldives Ltd's (FSM) objective is to provide fuel-related services, including sales, distribution, and maintenance of storage facilities across the country.
- Established in 1999, Maldives Gas is the distributor of cooking gas in the nation and supplies LPG to more than 40,000 customers

Owing to the dispersed nature of the islands, each have a separate power generation and distribution system operated mainly by three utility companies:

- *State Electric Company Ltd (STELCO)* operates 35 powerplants and generates and supplies electricity to 37,660 consumers in Male and 14,462 consumers in different islands (as of June 2016).
- *FENEKA Corporation Ltd (FENEKA)* was established in 2012 by a presidential decree under the Companies Act of 10/96, as a limited liability company. It is a 100% government owned utility company with a mandate to provide island communities with electricity, water, sewerage, and waste management services. It operates 148 power houses.
- *Male Water and Sewerage Company (MWSC)*, established in 1995 is the pioneer organisation in Maldives to institute a water production and wastewater management system. It currently serves ~50% of the Maldivian population. It operates its own single powerhouse to meet its demand.

6.2.2 Regulatory and Policy Framework

The Maldivian government's vision for the energy sector is provision of reliable and sustainable energy services for social and economic development for all the people of Maldives at the lowest possible cost. The following policy documents guide the activities in this domain:

- The Energy Action Plan (2009-2013), focused on achieving energy efficiency and conservation awareness and reduction in CO_2 emissions;
- Energy Policy and Strategy 2010, detailing policy statements and strategies for developing greater sustainability conservation and efficiency in energy while promoting low carbon technologies and the quality of energy supply; and

- Maldives Scaling up Renewable Energy Investment Plan, to identify opportunities and plan for scaling up renewable energy in the country.

The government revised the energy policy and strategy document in 2016 to focus on the following policy statements:

- Strengthen the institutional and regulatory framework of the energy sector
- Promote energy conservation and efficiency
- Increase the share of RE in the national energy mix
- Improve the reliability and sustainability of electricity service and maintain universal access to electricity
- Increase national energy security

Maldives Energy Authority (MEA) is a semi-autonomous regulatory body working under the guidance of a Governing Board appointed by the President. The regulator is mandated with establishing tariffs, issuing guidelines and regulations to ensure the reliability and security of the grids, and safeguarding the rights and obligations of consumers and service providers.

Maldives is dependent on a combination of centralised and distributed diesel power generating sets for meeting its power demand. Under the policy objective of increasing national energy security, the government seeks to produce 70% of energy from clean energy sources. However, no specific renewable energy targets have been fixed. While the Greater Male Region Renewable Energy Integration Plan assesses a renewable energy potential of 43.5 MW, Maldives Scaling up Renewable Energy Program in Low Income Countries Investment Plan envisages an investment of $139 million with cumulative target of 26 MW tentatively till 2020. However, the targets are expected to spill over further, with existing installed RE capacity estimated at 11 MW in 2018.

6.2.3 Government Support: Pricing, Existing Subsidies on Fuel and Controlling Regime

Petroleum Products

Since all the petroleum products are imported, the retail prices are determined and revised based on international prices by STO. However, this revision is undertaken in consultation with the Maldivian government. Petrol and diesel prices were last revised in May-June 2018 subsequent to a rise in global crude oil prices to MVR 10.24/litre ($0.66/litre) and MVR 11.23/litre ($0.72/litre), respectively. LPG prices ranged from MVR 112.50/cylinder ($7.27/cylinder) for 5 kg to MVR1260/cylinder ($81/cylinder) for 45kg cylinders, with no sales tax and customs duty applicable for cooking gas. All the other POL products attract a customs duty of 5% on cost, insurance and freight (CIF) price.

Electricity

The MEA undertakes the determination of electricity tariff as per the tariff methodology released by it in 2009. It is a single part tariff determined by using an ad-hoc method (trying to produce small adjustments to previously existing tariffs) and a reconciliation test (assuring that with the approved tariffs each region is capable to collect allowed revenues). In addition to the base tariff, there is a fuel surcharge which serves as an adjustment for variation in fuel prices, and is calculated by assuming average efficiency of generating set at $0.351/kWh.

As a part of social welfare protection, the government of Maldives subsidises electricity tariff to domestic consumers, which includes:

- Cross subsidy, whereby higher tariffs are fixed for businesses
- Direct subsidies
- Fuel surcharge subsidy, where the domestic consumers were paid by government in full. This, however, has been discontinued
- Usage subsidy, where subsidy is given to consumers for up to 400 units

However, these subsidies were exerting a huge pressure on the exchequer, and therefore, were limited only to the needy through the National Social Protection Agency from October 1, 2016. The overall electricity subsidy has come down from MVR 458 million ($29.6 million) in 2012 to MVR 100 million ($6.46 million) in 2018 (as budgeted).

Electricity tariffs in Maldives were last revised in January, 2016. However, the fuel surcharge is determined regularly based on diesel prices. Fuel surcharge is charged to customers if the price of diesel goes beyond the base rate. For every MVR 0.10 increase per diesel litre, MVR 0.03 has been approved as fuel surcharge by the MEA. STELCO is charging MVR 0.38 per unit as surcharge from January 2018 in addition to the following electricity tariffs.

Table 41: Electricity Tariffs in Maldives

		Greater Male Region	Other island powerhouses	Other island powerhouses	Greater Male Region	
		Domestic	Domestic	Commercial	Commercial	
1	Units 0 – 100	1.50	1.50	4.50	3.30	
2	Units 101 – 200	1.70	1.70	5.75	100-300	3.35
3	Units 201 – 300	2.15	2.15	6.50	301-500	3.65
4	Units 301 – 400	2.50	2.50	7.50	501 – 600	4.00
5	Units 401 – 500	2.95	4.00	7.50	601-3,000	4.35
6	Units 501 – 600	3.55	4.50	7.50	3001-10,000	5.75
7	Units >600	4.25	5.50	7.50	>10,001	6.65

Source: STELCO website - September 2018

6.3 Overall Energy Outlook 2030

The overall energy outlook of Maldives has been assessed by undertaking a detailed review of all the primary sources of energy including POL products and renewables. Since the power sector serves as a major consumer of these sources and the single largest supplier of secondary energy, its analysis precedes the fuel wise discussion.

6.3.1 Power Demand, Supply Review

Maldives, unlike other SAARC nations, has the distinction of having achieved provision of 24 hours electricity supply throughout the country by 2008. However, till date, diesel continues to serve as the singular source of power generation. Over-reliance on diesel imports to meet power demand makes Maldives highly vulnerable to global fuel price fluctuations, which affects the government’s control over fiscal and current account deficits.

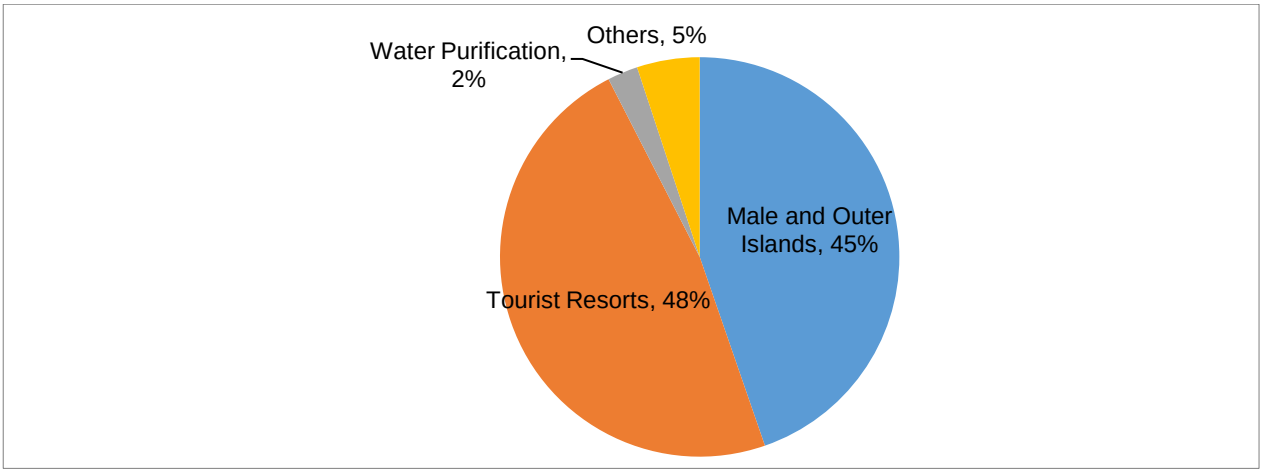
Electricity generation and consumption, like the nature of the islands, happens in a dispersed manner. The country capital Male (Male, Villingili, and Hulhumale) is the single largest electricity producing and consuming region. It accounted for ~60% of total electricity generation of all inhabited islands (excluding tourist resorts) in 2017 with an installed capacity of 87.7 MW. Its electricity consumption in 2017 was ~375 MU, compared with 285 MU of the outer islands.

Since the overall power demand for Maldives is not reported, the same can be estimated based on the methodology suggested by Maldives Energy Supply and Demand Survey 2010-2012

- Electricity demand for Male and Outer Islands, as estimated and reported in the Electricity Databook and Statistical Pocket Book of Maldives
- Electricity demand from standalone tourist resorts, based on consumption per tourist nights
- Electricity demand for water purification from Male Water and Sewage Company Pvt Ltd

It is estimated that the power demand for Maldives has grown at 6.8% CAGR, from 1,010 MU in 2012 to 1,400 MU in 2017.

Figure 112: Power Demand 2017 – Maldives



The total installed capacity of the inhabited islands of Maldives stood at 223 MW in 2016, including 214 MW of diesel-based capacity and 6.7 MW of renewable energy capacity. Considering diesel-based system runs at 35% PLF, it can be estimated that the indigenous diesel-based installed capacity for tourist resorts stood at ~270 MW in 2016. Overall estimates, therefore, suggest that the power demand in Maldives was met from ~480 MW of installed diesel-based capacity in 2016.

6.3.2 Power Demand, Supply Outlook

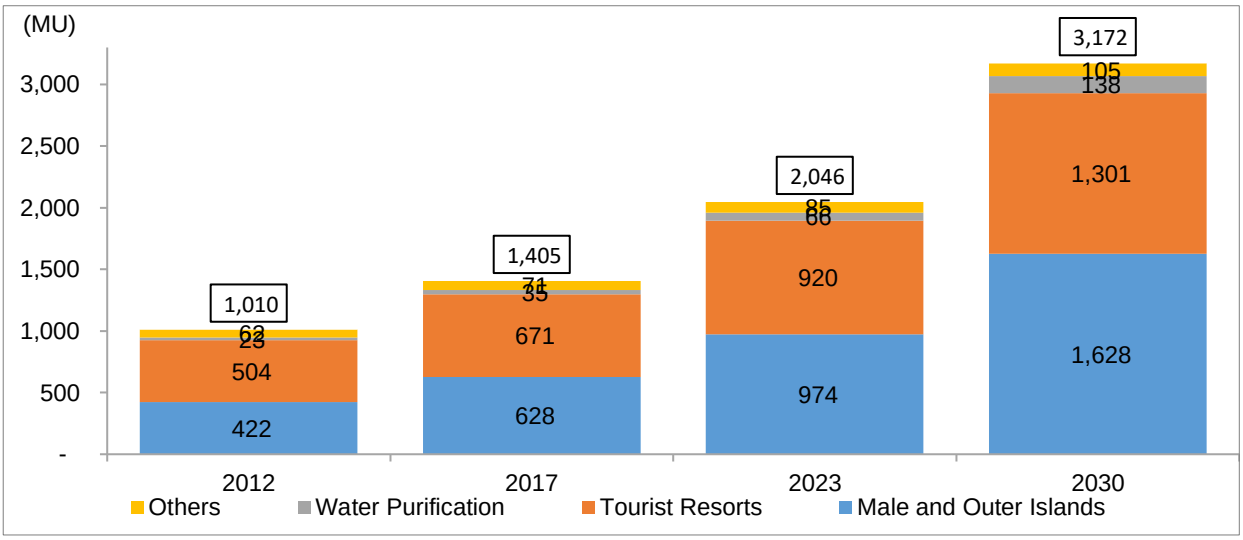
The power demand outlook estimation has been undertaken in a similar manner as that of the review. The broad assumptions for each category are:

- Electricity consumption for Male and Outer Islands has been estimated based on correlation with GDP and per capita consumption. The IMF's GDP forecasts have been utilised for this. Maldives' energy strategy document forecast for power demand has also been considered and given an overall weightage of 60% while estimating the weighted average power requirement.
- Electricity consumption for tourist resorts has been estimated based on outlook in number of tourist bed-nights, which are expected to grow at 5-5.5% CAGR and electricity demand per tourist bed-night ranging from 77-78 kWh.

- Electricity demand for water purification has been estimated considering 4.76 kWh/m^3 of requirement and estimates of overall water distribution growth.

Overall, it is estimated that power demand will grow at 6.5-7% CAGR to reach 3,171 MU in 2030 from 1,400 MU in 2017.

Figure 113: Power Demand Outlook: Maldives



Considering the estimates for renewable energy given by Greater Male Region Renewable Energy Integration Plan, Maldives Scaling up Renewable Energy Program in Low Income Countries Investment Plan and based on the existing progress, it is estimated that the target of 26 MW of RE will spill over from 2020 to 2023. Subsequently, capacity addition rate is expected to be faster, and capacity is expected to reach 140-150 MW by 2030. The remaining power demand is expected to be met from diesel-based power generation which is expected to reach 930 MW.

The country intends to take actions and undertakings to reduce 10% of its GHG emissions unconditionally by 2030. This would require financial resources, technology transfer and capacity building in terms of accelerated renewable energy development. However, owing to land constraints and buildings ownership concerns, solar and wind development potential is constrained in the country. For large-scale renewable energy deployment in Greater Male, it would require the islands of Male, Villingili, Thilafushi, Gulhifalhu and HulhuMale/ Hulhulé to be interconnected using undersea electrical cables and deploy renewable assets in nearby uninhabited islands. This may be cost prohibitive for the small island nation.

Overall primary energy outlook for Maldives has been estimated fuel-wise, based on the requirements from multiple end-use sectors. Since Maldives does not have any indigenous energy sources, its entire energy needs are met through fuel imports. Unlike other SAARC nations, Maldives is completely dependent on POL products for its energy requirements.

Since the primary energy POL products include petrol, diesel, and cooking gas, these have been considered to develop an energy forecast in line with Maldives Energy Outlook developed by the Ministry of Energy and Environment. Aviation gas, utilised to fuel international flights, has not been considered in this outlook.

6.3.3 Fuel-Wise Energy Review and Outlook

Overall primary energy outlook for Maldives has been estimated fuel-wise, based on the requirements from multiple end-use sectors. Since the nation does not have any indigenous energy sources, its entire energy needs are met through fuel imports. Unlike other SAARC nations, the country is completely dependent on POL products for its energy requirements. Since the primary energy POL products include petrol, diesel, and

cooking gas, these have been considered to develop an energy forecast in line with Maldives Energy Outlook developed by the Ministry of Energy and Environment. Aviation gas, utilised to fuel international flights, has not been considered in this outlook.

Petroleum Products

Demand, Supply Review

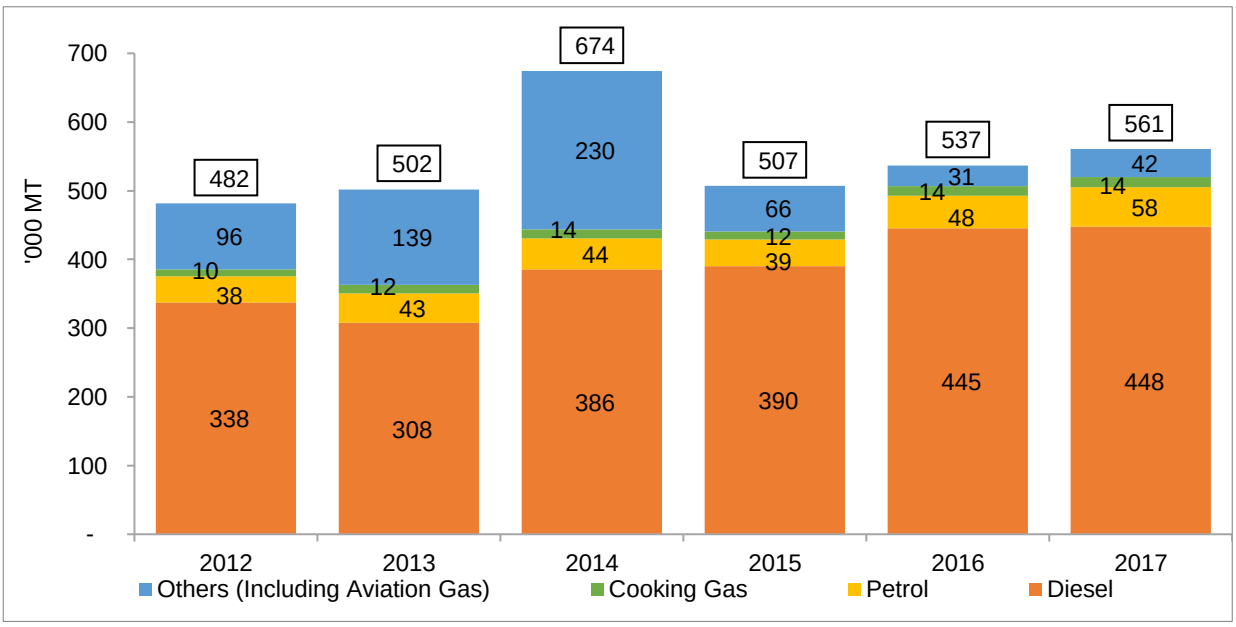
Demand for POL products in Maldives rose at 3% CAGR, to 561,433 MT in 2017 from 481,577 MT in 2012, led by strong growth in demand for petrol and cooking gas, which grew at 9% and 8% CAGR, respectively.

Diesel serves as the primary energy fuel source, accounting for ~80% of total POL imports in the country in 2017. Power sector accounted for ~80% of diesel consumption with power generation growing 6.2% CAGR to reach 1,370 MU from 1000 MU in 2012. The overall installed diesel-based power capacity in inhabited islands for meeting residential demand is estimated to have risen from 141 MW in 2012 to 214 MW in 2017. Passenger and cargo movement, undertaken using boats and barges, accounted for 8-9% of diesel demand in 2017, vis-à-vis land transport, which made up only 1% of the overall demand. Demand for diesel also comes from resorts for undertaking tourist ship excursions and fishing.

Demand for petrol rose significantly over the past five years to account for 10% of total POL imports in the country in 2017, led by rising number of motorcycles and passenger cars, whose population doubled during this period. Petrol demand for the speed boats segment utilised for tourist transit also rose at 9% CAGR, led by 8% CAGR growth in tourist arrivals from 2012 to 2017.

Import data suggests that cooking gas demand in Maldives rose from 10,000 MT in 2012 to 14,500 MT in 2017, with residential consumption accounting for more than 60% of the total demand. The remaining demand came from resorts and fishing segments. The focus on clean energy has led to a complete conversion from kerosene to LPG as the cooking fuel over the past 5 years. The demand for aviation gas has been quiet erratic, since it is dependent on refuelling of international aircraft, and is not utilised for domestic consumption.

Figure 114: Imports of POL Products (Demand): Maldives

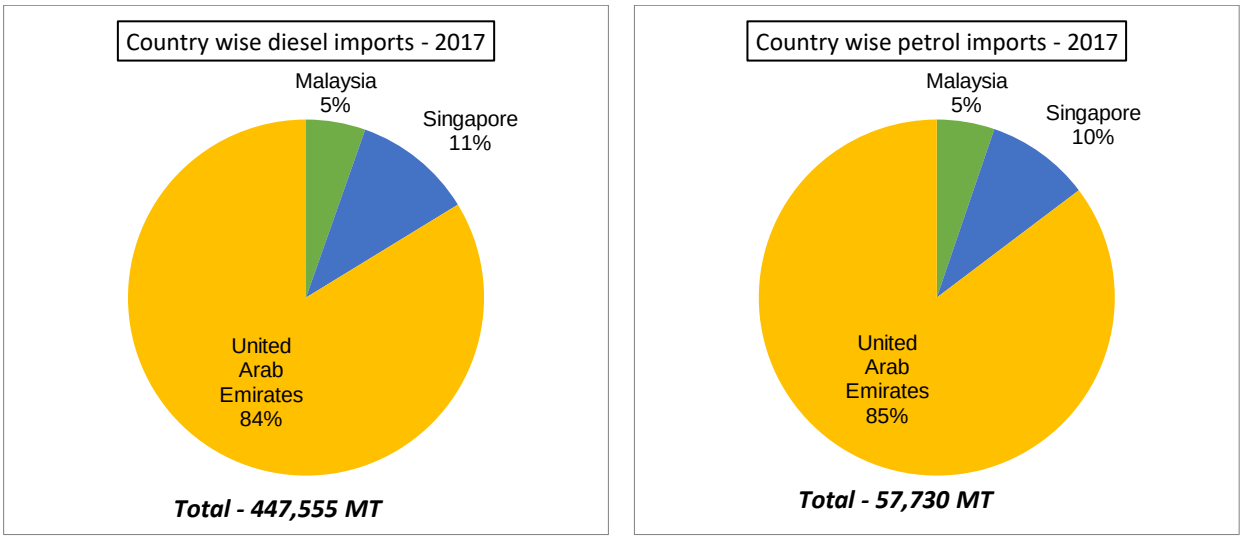


Source: Maldives Customs Services

Maldives imports most of its POL products from the Middle East, primarily UAE, which accounted for ~80% of total POL imports in 2017. Maldives entered into a free trade agreement (FTA) with China in 2017, under which import tariffs were proposed to be waived off on Chinese products. Subsequently, Maldives started

importing petrol from China in 2018. Diesel imports from India stopped in 2016, though the import of bituminous mixtures and fuel oil still continue.

Figure 115: Country-Wise Diesel and Petrol Imports: Maldives



Source: Maldives Custom Services

Demand, supply Outlook

Maldives National Oil Company plans to source crude oil for the purpose of refining and processing in refineries of neighbouring countries such as India, Sri Lanka, and Singapore. However, these plans are at a nascent stage, and therefore, no crude oil imports/re-exports are estimated to be undertaken till 2030. It is estimated that Maldives will continue to depend on imports for meeting its primary POL demand. The outlook on demand for POL products in Maldives has been estimated by utilising industry level benchmarks established in Maldives Energy Supply and Demand Survey.

Diesel

The Maldivian government, in its effort to reduce dependence on imported fuel, is pushing for power generation through RE. However, diesel is still expected to remain the primary fuel for meeting power demand, with only 10% of total electricity demand estimated to be met from renewable energy sources by 2030. It is estimated that, in addition to 214 MW of centralised installed diesel-based power capacity in inhabited islands, there is cumulatively 260 MW of distributed diesel-based power capacity with tourist resorts utilised by them to meet their captive power requirements.

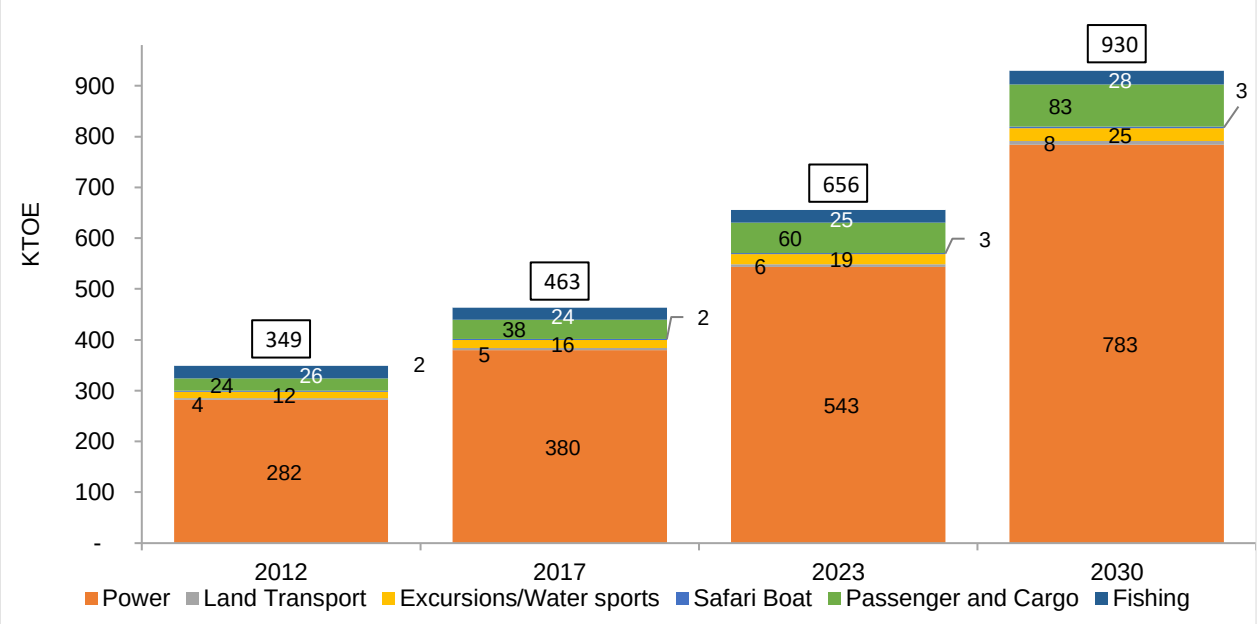
Maldives achieved universal access of electricity in 2008. Electricity demand arises from residential consumers, tourist resorts, and other industries, including water purification. Total electricity demand in the nation was estimated at 1,378 MUs in 2017 and is expected to rise in line with the past trends at 6.5% CAGR to reach 3,171 MUs in 2030. About 90% of the total power demand is expected to be met from diesel-based capacities, expected to reach 930 MW by 2030.

In addition to the power sector, which is expected to continue to account for more than 80% of diesel demand in the country, pick up in passenger movement across islands through boats, yachts, and launches and cargo movement using barges and *bahthelis* is also expected to contribute towards additional diesel requirements. Tourist resorts, which are expected to rise from 135 at present to 200 by 2030, will push demand for diesel on account of rising excursions and water sports.

Demand for diesel from the fishing industry for running fishing boats is expected to remain static with a fall in fish catch per year and rising dependence on imports for food. Demand from land transport is expected to rise at 4% CAGR, with a rise in population of trucks to 2,500 in 2030 from 1,600 in 2017.

Overall, diesel demand is expected to rise 5.5% CAGR to 898,791 MT in 2030.

Figure 116: Energy Supply Outlook from Diesel – Maldives



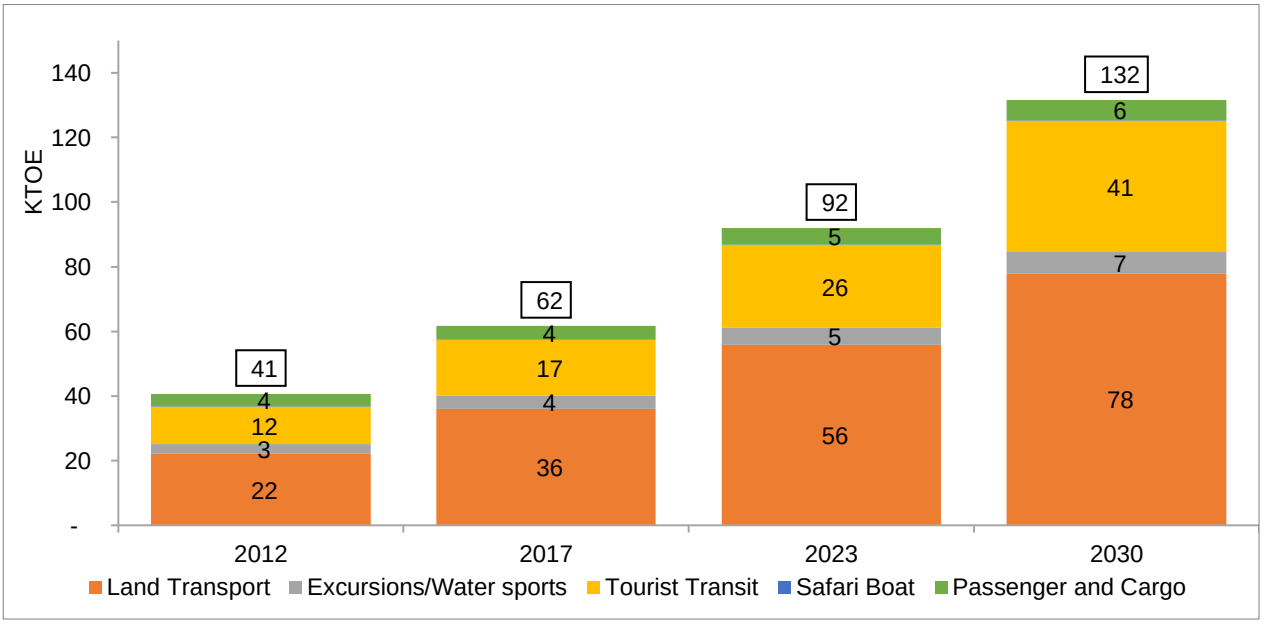
Petrol

Even with limited land mass, the number of cars and motorcycles have grown significantly over the past five years at 11-12% CAGR, led by rising per capita income on account of 6% GDP growth. Going forward, we expect the number of cars and motorcycles to grow at a strong pace of 9% and 11% CAGR, respectively, up to 2022, and slow down to 5% thereafter. Hence, demand for petrol from the transport segment is expected to rise at 6% CAGR, accounting for 60% of total consumption in 2030.

Additionally, growth in the tourism segment with an expected rise in tourist arrivals at 7-8% CAGR, is likely to push up demand for petrol from speed boats utilised for tourist transits. The demand from this segment is expected to grow at 7% CAGR, accounting for 30% of total consumption in 2030.

Overall, petrol demand is expected to rise 6.0% CAGR to 122,955 MT in 2030.

Figure 117: Energy Supply Outlook from Petrol – Maldives

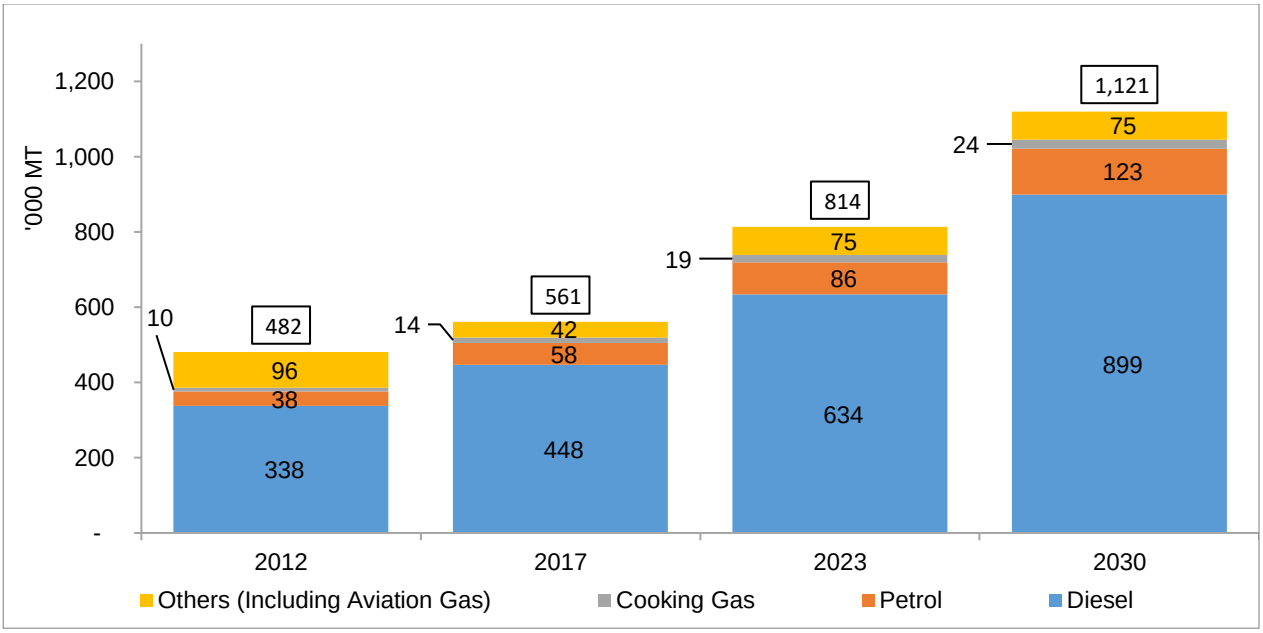


Other Petroleum Products

Cooking gas forms another critical POL product for import. The decline in kerosene demand suggests that cooking gas has effectively replaced kerosene as the primary cooking fuel. While cooking gas demand has grown significantly over the past 5 years on account of low base effect, growth rate is expected to be moderate at 4% CAGR going forward. Growth will be led by rising per capita cooking gas consumption, expected to reach 32 kg in 2030 from 26 kg in 2017. Overall cooking gas demand is expected to reach 24,000 MT in 2030 from 14,500 MT in 2017.

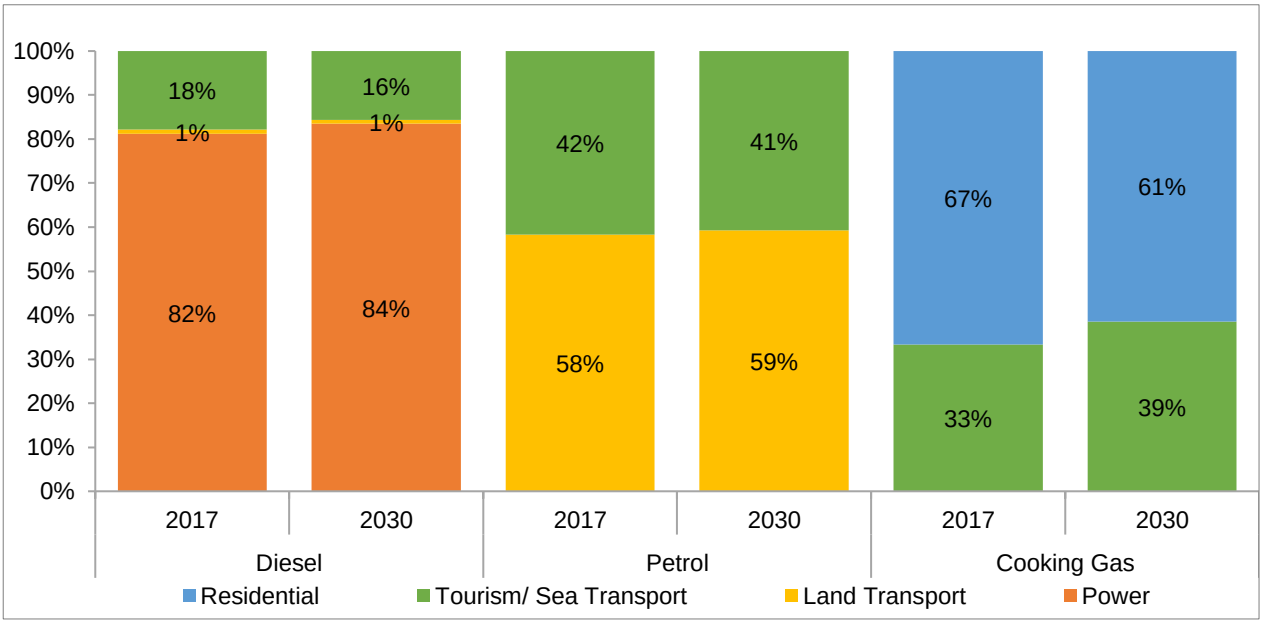
Demand for POL products in Maldives is expected to rise at 5.4% CAGR to 1,114,203 MT in 2030 from 561,433 MT in 2017, led by strong growth in demand for petrol and cooking gas.

Figure 118: Overall POL Demand Outlook 2030: Maldives



No major change in the sector-wise share in consumption of POL products is expected, as is evident below.

Figure 119: Segment-Wise Break-Up of Major Petroleum Products Consumption: Maldives

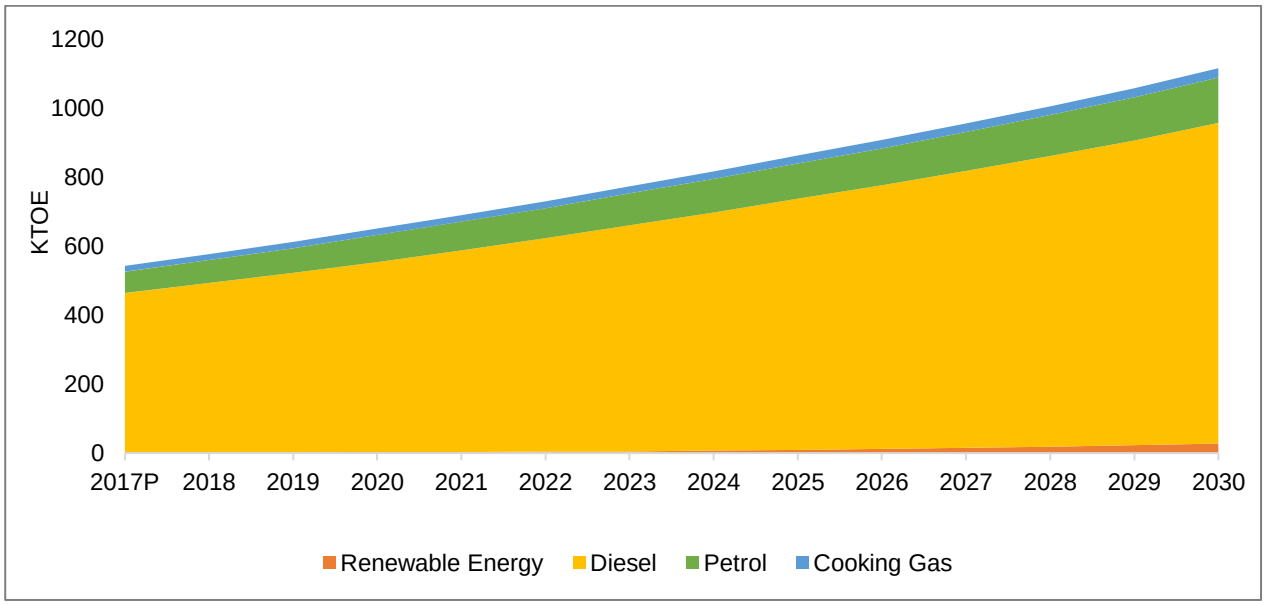


Energy Outlook 2030

The overall energy demand in Maldives is expected to rise at 6% CAGR, from 543 KTOE in 2017 to 1,116 KTOE in 2030. Overall energy mix is expected to shift slightly, with diesel losing share to renewable energy, petrol, and cooking gas.

Demand (in KTOE)	2017P	2018F	2023F	2030F
Primary energy	543	577	774	1,116

Figure 120: Energy Outlook 2030 for Maldives



Outlook on Imports

All fuel requirements in the country will continue to be sourced through imports. Though Maldives will be entirely dependent on imports for meeting its energy requirement, the present import trends, including its long-standing import tie-ups with the UAE, Malaysia, and Singapore, suggest that a minimal amount of primary POL products is expected to be imported from other SAARC nations. In addition to its existing free trade agreement (FTA) with China, the Maldivian government has extended FTA invitations to countries such as Japan, the US, and the UK, which is expected to change the import dynamics in future.

7 Nepal

7.1 Country Overview

Landlocked between India and China, Nepal's area measures ~147,181 sq. km. Its population has grown at ~1.7% CAGR between fiscals 2013 and 2017. In this period, GDP has grown ~ 4.3% CAGR. Nepal's economy saw significant rebound from a growth rate of 0.4% in fiscal 2016 to ~6.9% in fiscal 2017 (provisional), led by factors such as favourable monsoon leading to better harvest, normalisation of trade since February 2016, acceleration of post-earthquake reconstruction work, better supply management of electricity, and low base effect. Strong economic growth has been the key factor behind the growing energy demand in the country.

A snapshot of Nepal's macroeconomic profile is given below:

Table 42: Country Profile: Nepal

Factors		FY13	FY17P
Demographics	Population (million)	27.21	28.71
Macro-economic scenario	GDP growth rate	3.76%	6.94%
	Sectoral growth rate		
	a. Primary	1.11	5.32
	b. Secondary	2.69	10.97
	c. Tertiary	5.73	6.90
	Inflation % change (CPI)	9.9%	4.5%
Fiscal position	Exports (million US $)	915	685
	Imports (million US $)	6620	9288
	Public debt share to GDP (as % of GDP)	32.2	24.1

Note: Exchange rate: One US dollar (US $) = 84.1 NPR for FY13; 106.6 for FY17
Source: Statistical Yearbook, ADB

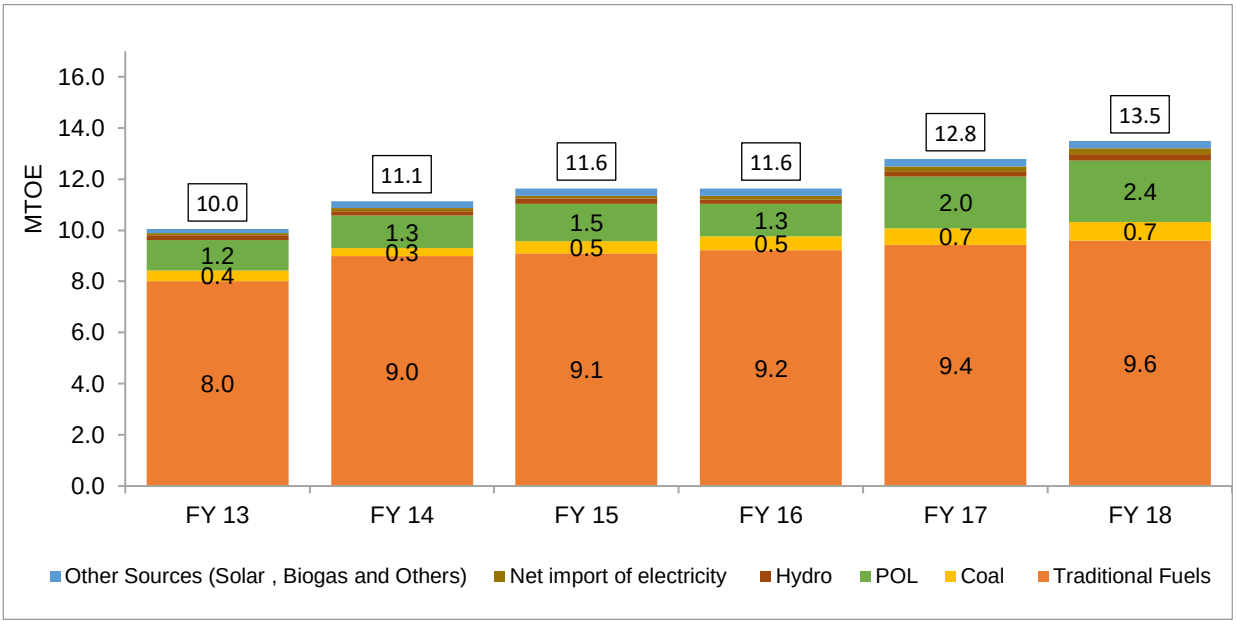
Nepal is engaged in the trade of various commodities. Top import commodities by value are diesel, LPG, petrol, semi-finished products of iron or non-alloy steel, cement clinkers, gold, etc. Top export commodities by value are carpets, cardamom, mixture of juices, etc. With the value of imports being higher, country's current account deficit has widened by ~70% in fiscal 2017 over fiscal 2013.

7.1.1 Overview of Energy Structure

Energy Mix

Nepal's per capita energy consumption grew at ~4.5% CAGR between fiscals 2013 and 2017, to ~0.44 TOE. The energy supply is dominated by traditional fuels such as fuelwood, animal dung, and agricultural residue. Overall primary energy consumption demand grew ~7.7% CAGR between fiscals 2013 and 2015, to ~11.6 MTOE. Consumption stagnated in fiscal 2016. This was mainly owing to a decline in POL product imports and consumption, owing to road blockage issues. Subsequently, consumption picked up to grow at ~5.5% in fiscal 2018 on-year

Figure 121: Primary Energy Consumption Mix Review: Nepal



Source: Statistical Yearbook, Nepal Oil Corporation

In addition to traditional fuels, Nepal also consumes coal and POL products to meet domestic energy demand. For this, it relies on imports, owing to the absence of any indigenous refining capacities. Key POL products imported include: diesel, petrol, ATF, LPG, light diesel oil, etc. In addition to POL, Nepal is engaged in cross-border trade of coal and electricity to fulfil its domestic energy demand.

Electricity demand is met mostly through the generation from hydro power assets, which constituted ~95% of total installed capacity of 1,074 MW in fiscal 2018. However, present installed hydro capacity is only ~2% of the country's total potential of 43,000 MW. Development of more hydro plants will not only help Nepal meet the increasing power demand from existing consumers, but also help supply to consumers who do not have any access to electricity (which was ~40% of the population in 2017). Apart from hydro power stations, Nepal has a small installed capacity of oil based thermal power plants (53.41 MW) and grid-connected solar (100 KW).

Domestic Availability and Imports of Fuels

Nepal imports coal, POL products, and electricity, as domestic production is insufficient to meet demand. The following table details the domestic production and imports of major fuels in fiscal 2013 and fiscal 2017 (E).

Table 43: Domestic Production and Import of Major Fuels: Nepal

Fuel	Supply type	FY13	FY17 (E)
Coal (in '000 MT)	Domestic production	14.08	8.2
	Net imports	771.7	1,127.4
Key petroleum oil products - petrol, diesel, kerosene, LPG, furnace oil, ATF (in '000 MT)	Domestic production	0	0
	Net imports	1,122.5	1,924
Electricity (in GWH)	Domestic production	3,468	4,082
	Net imports	787	2,172

Source: Statistical Yearbook, Department of Customs, Nepal Electricity Authority

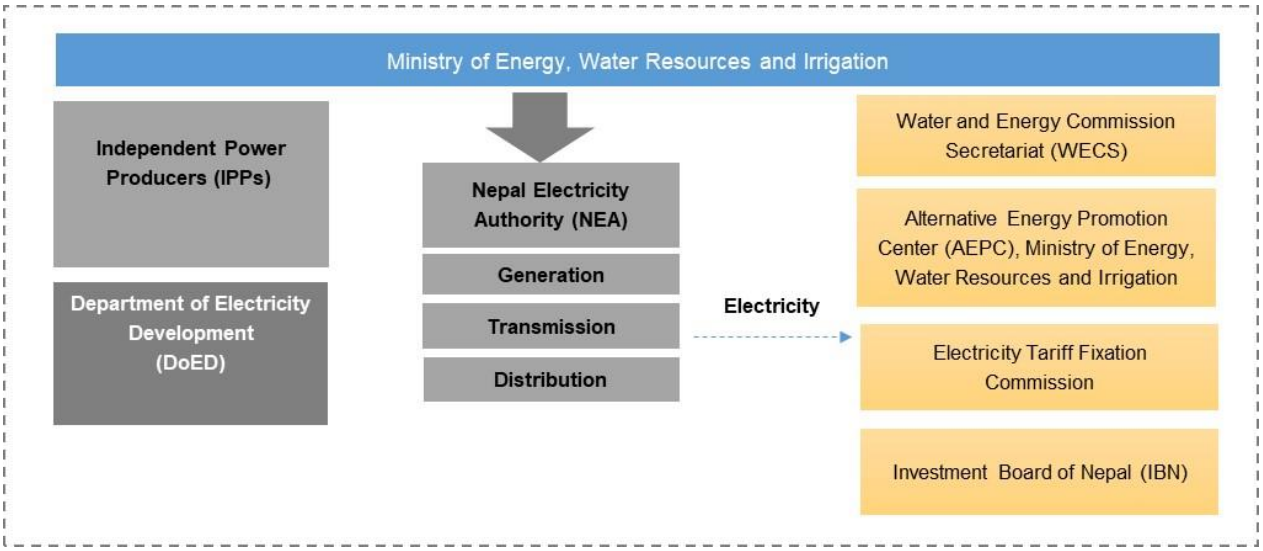
7.2 Institutional and Regulatory Framework of Energy Sector

7.2.1 Planning and Regulatory Bodies

Nepal's energy sector is managed by the Ministry of Energy, Water Resource and Irrigation (or MoE), Government of Nepal which is responsible for policy formulation in the areas of power alongside with Ministry of Industries, which takes care of policies and regulations for coal and POL products. The detailed sector level organograms segregated across power and POL products are discussed below:

Power Sector

Figure 122: Power Sector Organogram



The Ministry of Energy (MoE) oversees electricity development in Nepal. The Water and Energy Commission Secretariat (WECS) is a key administrative body that supports the MoE in the formulation of policies and planning of projects in the water and energy resources sectors. The Energy Commission is headed by the Minister of Energy.

The Department of Electricity Development (DoED) assists in implementation of overall government policies related to power/electricity sector. The major functions of the DoED are to ensure transparency of regulatory framework, accommodate, promote, and facilitate private sector participation in power sector by providing one-window service and licences to power projects.

The Nepal Electricity Authority (NEA) was created in August 1985 under the Nepal Electricity Authority Act, 1984. It is responsible for the generation, transmission, and distribution of power. It is also responsible for purchase of power from independent power producers (IPPs).

The Alternative Energy Promotion Centre (AEPC) is a public institution established in 1996 and operates under the MoE. AEPC is responsible for promotion of renewable and alternative energy technologies.

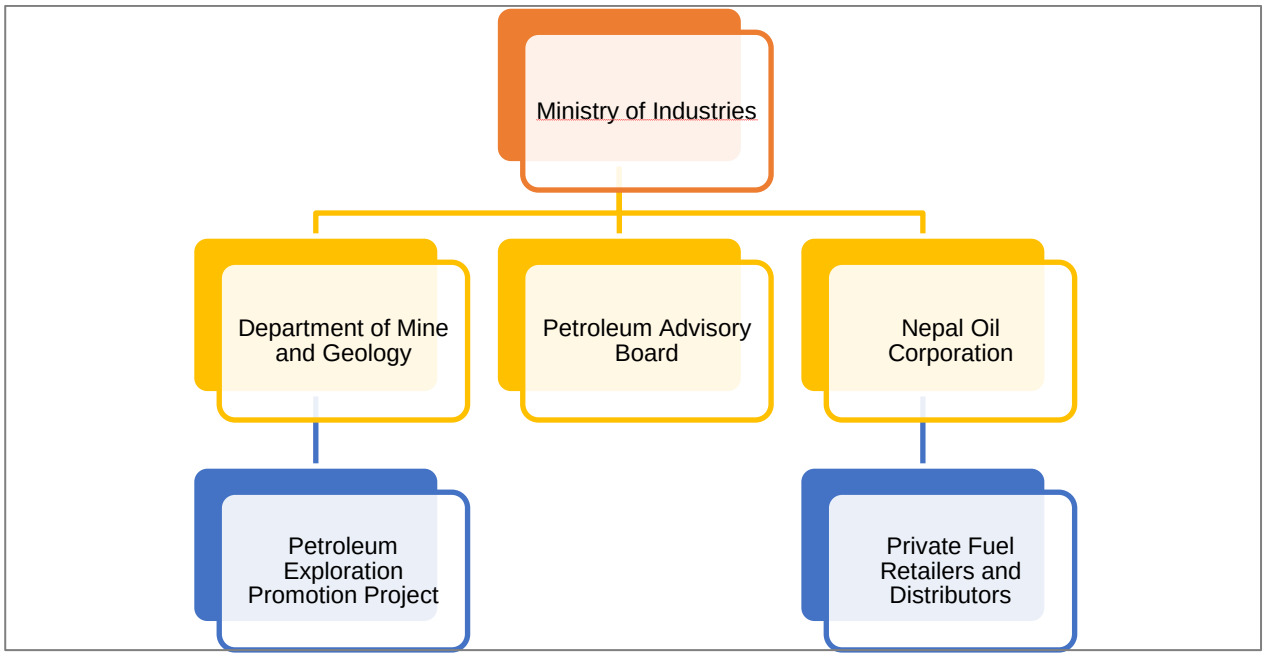
The Investment Board of Nepal's (IBN) objective is to improve the country's investment climate by creating a framework for the selection and evaluation of projects, providing incentives to encourage investments, negotiating concession/project development agreements, and carrying out investment promotion activities. IBN is responsible for the implementation of Nepal's large infrastructure projects, including hydropower projects above 500 MW.

The Electricity Tariff Fixation Commission reviews and approves retail electricity tariff rates for electricity service at the consumer level.

Hydrocarbon Sector

The Department of Mines & Geology, under the Ministry of Industry, set up an independent unit called Petroleum Exploration Promotion Project (PEPP) in 1982 to promote petroleum exploration activities. It serves as the responsible authority for undertaking necessary arrangements for negotiation with petroleum companies regarding petroleum agreements, along with monitoring ongoing exploration and production activities. The Petroleum Advisory Board, comprising senior officials of most ministries, has broad powers and responsibilities for all petroleum related activities. Nepal Oil Corporation (NOC), a public enterprise under the Ministry of Industry, is responsible for handling imports, storage, and distribution of petroleum products throughout the country.

Figure 123: Organogram of Petroleum Sector



7.2.2 Regulatory and Policy Framework

Key regulations governing the energy sector of the country are:

- Electricity Act
- Electricity Regulations
- Hydropower Development Policy
- Renewable Energy Subsidy Policy

7.2.3 Government Support: Pricing, Existing Subsidies on Fuel and Controlling Regime

The Electricity Tariff Fixation Commission and NOC regulate the prices of power and petroleum oil products, respectively, in Nepal.

Electricity

Nepal has differential pricing for different categories of domestic consumers on the basis of type of connection (single or three phase), voltage level, and amount of electricity consumption.

Power tariffs for industrial, commercial, non-commercial, irrigation, water supply, temple, and street light categories of consumers are based on:

- Voltage (low, medium, high)
- Time of day (peak, off-peak, normal)
- Season (dry, wet)

There is a considerable difference in tariff rates between wet and dry season. Off-peak period tariff in wet season is not applicable during the dry season.

Petroleum Products

The following table provides a snapshot on retail selling price of POL products in Kathmandu:

Table 44: Retail Selling Price (Including VAT) of POL Products in Kathmandu

Petroleum products	Retail selling price (as on October 5, 2018)
High speed diesel (HSD)	NR 101/ litre
Motor spirit	NR 114/ litre
Kerosene (superior kerosene oil, or SKO)	NR 101/ litre
Aviation turbine fuel (ATF) (Jet A-1)	USD 1,125/ kilolitre
LPG	NR 1,400/ cylinder

**Price applicable within 15 km of depot only*
Source: Nepal Oil Corporation

Considering that majority of the POL products are imported, a snapshot on duties applicable on various POL products is shown below:

Table 45: Import Duties Applicable on Various Types of Fuels Imported by Nepal

POL product	Applicable duty
Petrol	NR 15,200/kilolitre ($ 142/kl)[5]
Kerosene (SKO)	NR 2,000/ kilolitre ($ 19/kl)
ATF	NR 2,100/kilolitre ($ 20/kl)
HSD	NR 2,000/ kilolitre ($19/kl)
Light diesel oil	NR 440/kilolitre ($4/kl)
Fuel/ furnace oil	5%
Coal	5%

Source: Department of Customs, Ministry of Finance

Other Subsidies:

Nepal has emphasised on the subsidy delivery mechanism as one of the ways to address the climate change under Mitigation Actions reported in Nationally Determined Contributions. The government provides subsidies for the promotion of various renewable energy technologies (RETs) such as mini/ micro hydropower, improved water mill, solar energy, biogas, biomass energy, wind energy etc. under “Renewable Energy Subsidy Policy of Nepal”. The policy primarily focusses on off-grid applications and the subsidy amount differs according to technology and the region - with higher subsidy being offered for remote areas.

[5] US $1 = NR 107

7.3 Overall Energy Outlook 2030

7.3.1 Power Demand, Supply Review

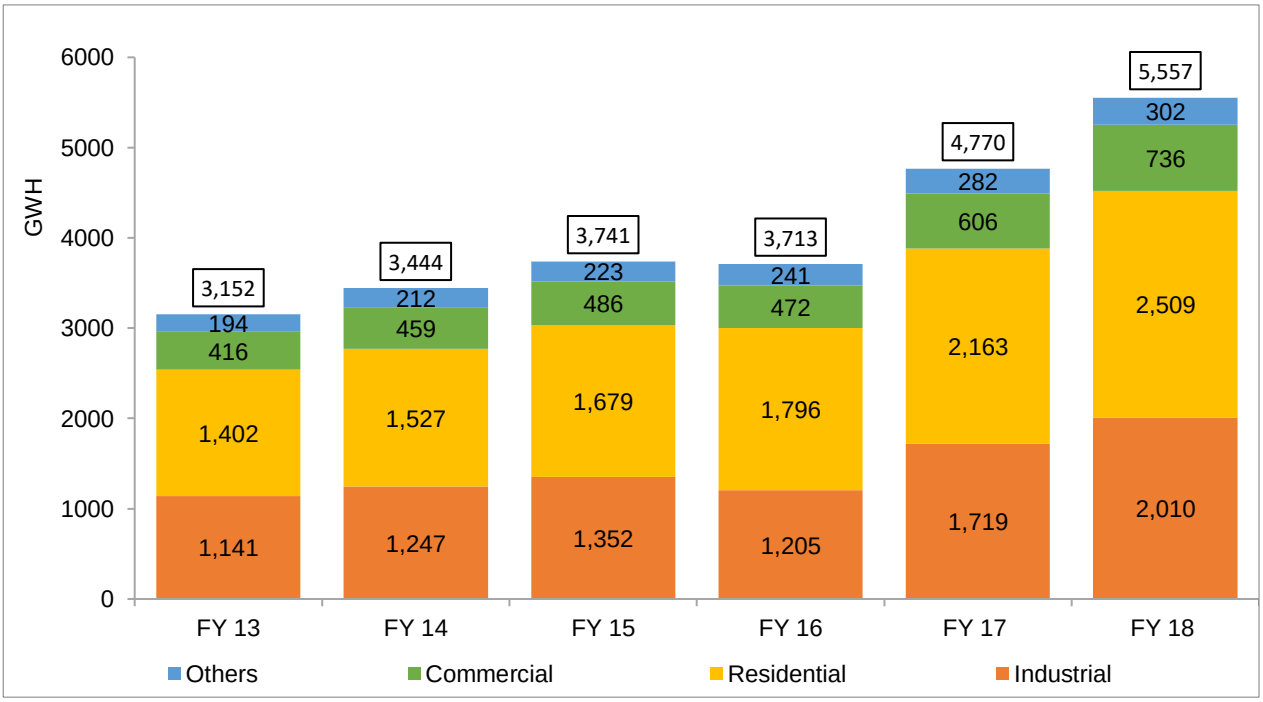
Power Demand Position

Electricity sales in Nepal have grown ~12% CAGR between fiscals 2013 and 2018 (estimates). About 5,557 MU were sold in fiscal 2018, with residential and industrial categories accounting for ~45% and ~36% share, respectively, in the total power sales. The commercial sector accounted for ~13%, with remaining electricity being consumed by agriculture and other areas.

Electricity in the residential sector is mainly used for lighting. As per the annual household survey (fiscal 2016), ~76% of the total households were utilising electricity as the main source of lighting. In addition, homes also use electricity for heating. Key industries which consume electricity in Nepal are cement, brick, paper, food and beverage, and metal industries.

The commercial sector comprises various sub-sectors such as academic (school, college, university), health (health posts, hospitals), institutions (private and public), retail shops (essential, non-essential), hotels, (star/non-star hotels, restaurants, cinema/hi-vision halls), water supply, military and police barracks, and others (public lighting, religious places).

Figure 124: Power Demand Review: Nepal



Source: Nepal Electricity Authority

Power Supply Position

In Nepal, hydro stations are the key source for electricity supply, accounting for ~95% of the total power installed capacity of the country. In addition to hydro, solar (0.1 MW) and oil-based thermal power plants (53.4 MW) also contribute to total electricity production in Nepal. At present, Nepal has an installed capacity of 1,020.6 MW of hydro power stations. Below is the list of major operational NEA hydro power plants, with a cumulative installed capacity of 489.15 MW.

Table 46: Major Operational Hydro Power Plants in Nepal

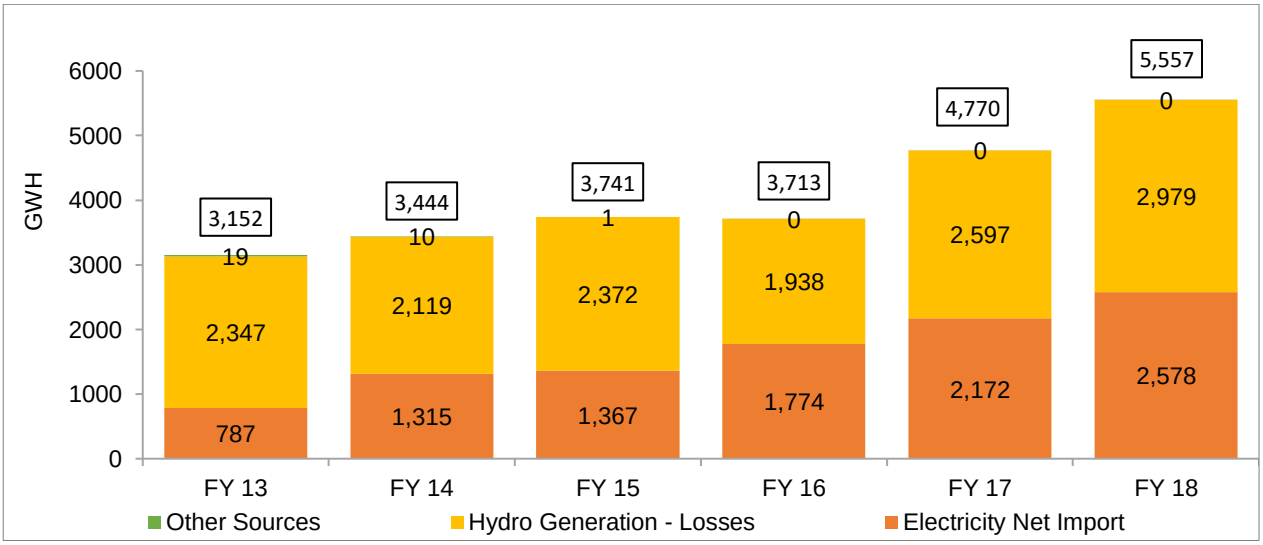
Hydro Power Plant	Installed Capacity (MW)
Kaligandaki A	144
Middle Marsyangdi	70
Marsyangdi	69
Trishuli	24
Sunkoshi	10.05
Gandak	15
Kulekhani I	60
Devighat	14.1
Kulekhani II	32
Puwa Khola	6.2
Modi Khola	14.8
Chameliya	30

Source: Nepal Electricity Authority

In addition, IPP hydro power plants contribute to 512.6 MW of hydro capacity. As per NEA's annual report for fiscal 2018, Nepal's total power installed capacity stood at 1074.14 MW.

Power supply from hydro power plants met ~63% of the total power requirement of Nepal (including system losses) that year. the country's power system losses reduced to 20.5% in fiscal 2018 from 22.9% in fiscal 2017. As power supply from the present installed capacity is not adequate to meet the total electricity load, the country relies on power imports from India, which grew 19% on year in fiscal 2018. Power imports from India contributed to ~37% of the total power requirement of the country. The chart below shows the total power supply from hydro power plants, imports, and other sources such as oil based-thermal plants and solar plants. For ease of comparison between power demand and supply, system losses have been subtracted from the hydro power generation mentioned below:

Figure 125: Power Supply Review: Nepal



Source: Nepal Electricity Authority

At present, most of the hydro stations are run-of-river type and generation drops in the dry season. Due to inadequate installed capacity and unavailability of the existing capacity on account of low river discharge in the dry season, regulators relied on load shedding to manage demand. The country has suffered greatly on the economic front due to load shedding over the past decade. It faced up to 14 hours of load shedding in the dry season in 2016.

As per the study, "How much has Nepal lost in the last decade due to load-shedding", Nepal's total GDP loss because of load-shedding between 2008 and 2016 amounted to a staggering $14.5 billion. In other words, the report states, the country lost, on average, more than 6% of its GDP annually in this period.

However, load shedding has considerably reduced in the past one year. As per NEA's latest annual report, there has been no load shedding for both industrial and residential consumers since March 2018. In addition to load shedding, the country has also relied on electricity imports from India to manage the power demand, especially in the dry season. Net import of electricity had reached 2581.8 MU in fiscal 2018, an increase of ~3.2 times over that in fiscal 2013. Inadequate supply led to an increase in production cost of industrial firms, as they had to rely on expensive diesel-based captive generation for their electricity supply. For small and medium enterprises, lack of quality electricity supply is a much bigger problem, as they cannot afford captive power generation.

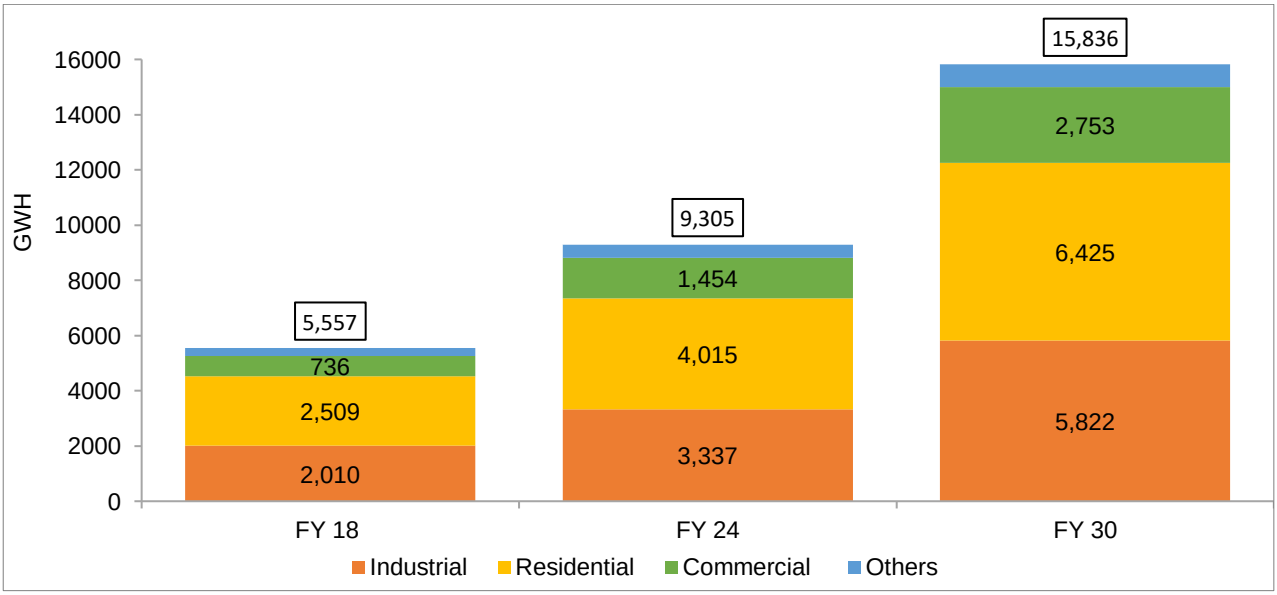
7.3.2 Power Demand, Supply Outlook

Power Demand Outlook

Power demand is expected to increase from ~5,557 MU in fiscal 2018 to ~15,836 MU in fiscal 2030, driven by rising demand from residential and industrial sectors. In terms of growth rate, it is estimated to grow at ~9.1% CAGR, which is close to the electricity demand forecast projected by the Water and Energy Commission Secretariat under BAU scenario.

The residential sector electricity demand is expected to increase from ~2,509 MU in fiscal 2018 (estimates) to ~6,425 MU by fiscal 2030, or at 8.2% CAGR, owing to additions of new households to the grid and increase in electricity demand from the existing electrified households. Household electrification is expected to reach 80-85% by fiscal 2030 from 50-55% in fiscal 2018. Industrial electricity consumption is projected at ~5,822 MU by fiscal 2030, growing at 9.3% CAGR from fiscal 2018. The commercial sector electricity consumption is expected to grow at ~11.6% CAGR to reach ~2,753 MU by fiscal 2030.

Figure 126: Power Demand Outlook: Nepal

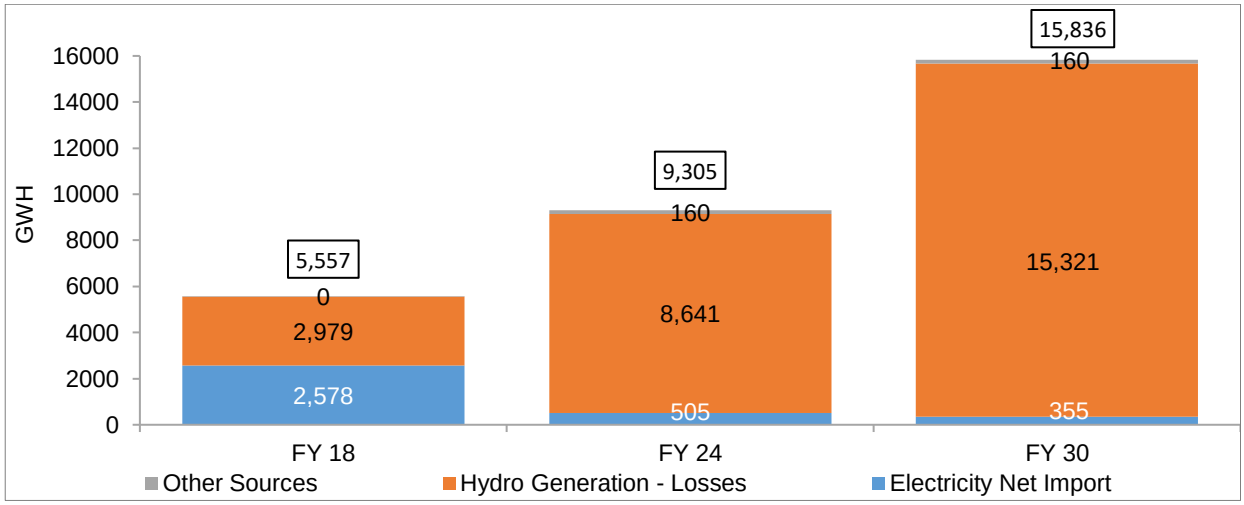


Source: Nepal Electricity Authority

Power Supply Outlook

As against the total demand of ~15,836 MU in fiscal 2030, total domestic power supply (minus system losses) is estimated at ~15,646 MU, with total installed power capacity of ~4,457 MW. About 3,256 MW of new hydro capacity is expected to be commissioned by Nepal by fiscal 2030. Hydro power plants are expected to remain a significant contributor to power generation, with ~96% share in the total installed capacity. Net electricity import is estimated to reduce considerably, but Nepal might still need to import power to meet the load requirement in the dry season.

Figure 127: Power Supply Outlook: Nepal



Source: NEA, IBN

Key hydro projects (with capacity of more than 50 MW) to be commissioned in the near future, along with the year from which they are expected to come on stream, are as follows:

Hydro Power Plant	Installed Capacity (MW)	Power Generation From
Likhu-1, Likhu -2, Likhu A	109	FY22
Lower Solu	82	FY21
Upper tamakoshi	456	FY21
Middle Bhotekoshi	102	FY21
Likhu-IV	52	FY22
Rasuwagadhi	111	FY21
Solu Khola (Dudhkoshi)	86	FY22
Trishuli 3A	60	FY21
Upper Lapche	52	FY23
Middle Tamor	52	FY22
Trishuli Galchi	75	FY23
Sanjen Khola	78	FY24
Arun -3	900	FY26
Upper Karnali	900	FY27
Tanahu Hydro Ltd	140	FY23
Total	3,256	

Source: Nepal Electricity Authority, IBN

7.3.3 Fuel-Wise Energy Review and Outlook

Hydro

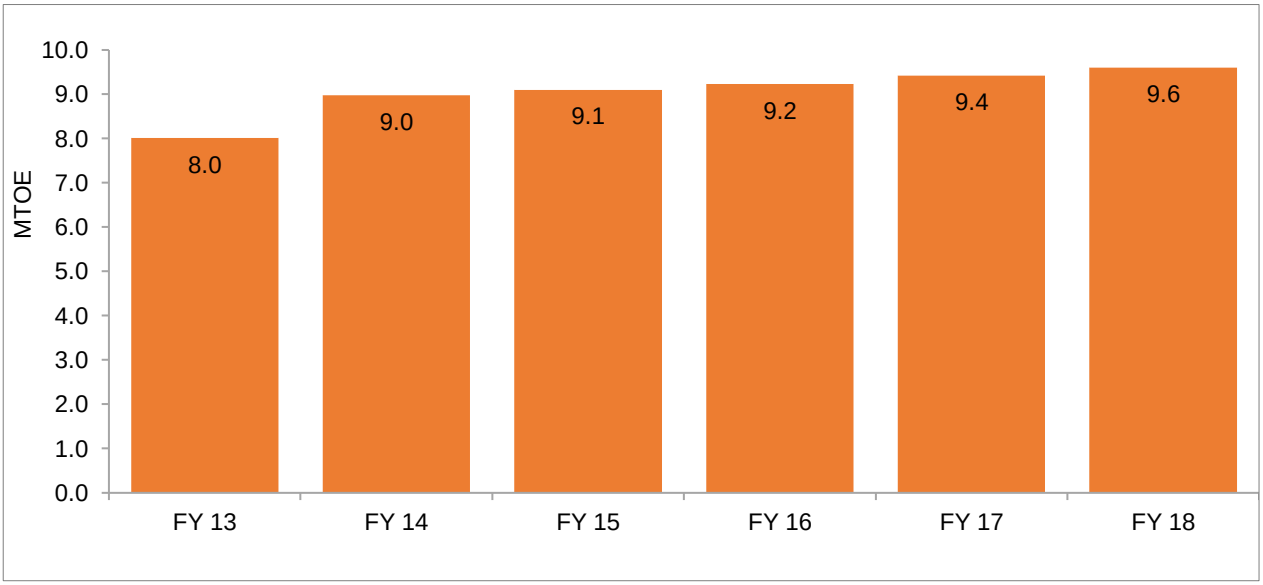
Power generation from hydropower plants accounted for ~99.9% of total power generation in fiscal 2018. Going forward, with the commissioning of the new hydropower capacity, the share of hydro energy in the overall primary energy consumption of the country is expected to grow from ~2% in fiscal 2018 to ~6% by fiscal 2030.

Traditional Fuels

Demand, Supply Review

Traditional fuels, in the form of fuel wood, animal dung and agricultural residue, contributed ~71% of the total primary energy consumption of Nepal in fiscal 2018 (E). Overall, traditional fuel consumption clocked ~3.7% CAGR over fiscals 2013-2018. Traditional fuels are mostly consumed by the residential sector for heating and cooking purposes. In fiscal 2018 (E), the residential sector accounted for more than 85% of total traditional fuel consumption, the rest being consumed by the commercial and industrial sector. Fuel wood is the largest contributor to the primary energy demand of the commercial sector. At present, fuel wood accounts for ~55% of the overall energy consumption of the commercial sector. In addition, fuel wood contributed to ~20% of the total energy consumption demand of the industrial sector in fiscal 2018 (E).

Figure 128: Traditional Fuel Energy Consumption Review: Nepal



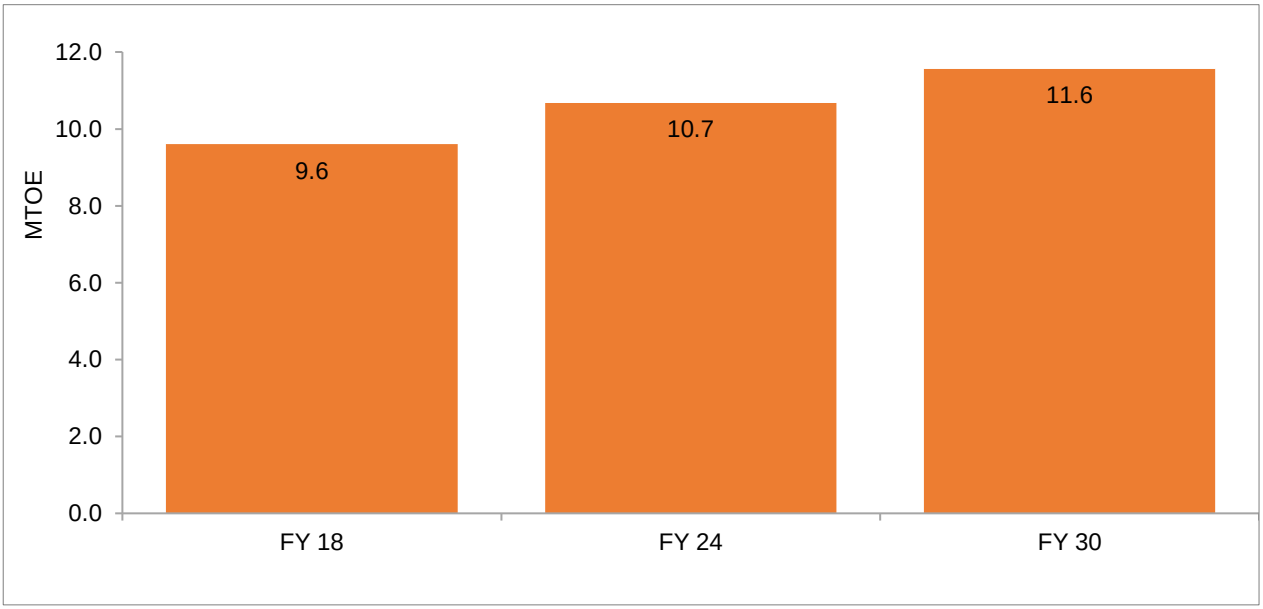
Source: Statistical Yearbook

Demand, Supply Outlook

With increased availability of clean energy in the form of electricity, traditional fuel consumption is expected to witness slow growth of ~1.6% CAGR from fiscal 2018 to 2030. The overall share of traditional fuels in the total primary energy consumption of Nepal is expected to decline, but not significantly so, as this fuel is cheap and easily available, especially in rural Nepal.

This is in line with the "National Energy Strategy of Nepal" document by WECS, 2013, which mentions a gradual decrease in the share of traditional energy in the country's overall energy mix, and its replacement by other renewable and alternative sources of energy. Slow growth of traditional fuels consumption will help in improved carbon storage by lowering the impact on forest coverage. It is estimated that traditional fuel energy consumption will grow slowly to reach ~11.6 MTOE by fiscal 2030, with its contribution decreasing to ~55% in the overall energy consumption of Nepal, down from ~71% in fiscal 2018.

Figure 129: Traditional Fuel Energy Consumption Outlook: Nepal



Coal

Demand, Supply Review

Overall coal consumption in Nepal clocked ~9% CAGR from fiscal 2013 to 2018 (E), driven by demand from the country's industries. The industries mainly consume coal for thermal applications related to process heat, boiler etc. Key energy-intensive industries in Nepal include the cement, brick, and metal (iron and steel) industries. In addition, coal is also consumed by the commercial sector in Nepal. In fiscal 2018 (E), coal accounted for 52-54% of the industrial sector's total energy demand and 6-8% of the commercial sector's energy demand. Overall, coal accounted for ~5% of Nepal's total primary energy consumption in fiscal 2018 (E).

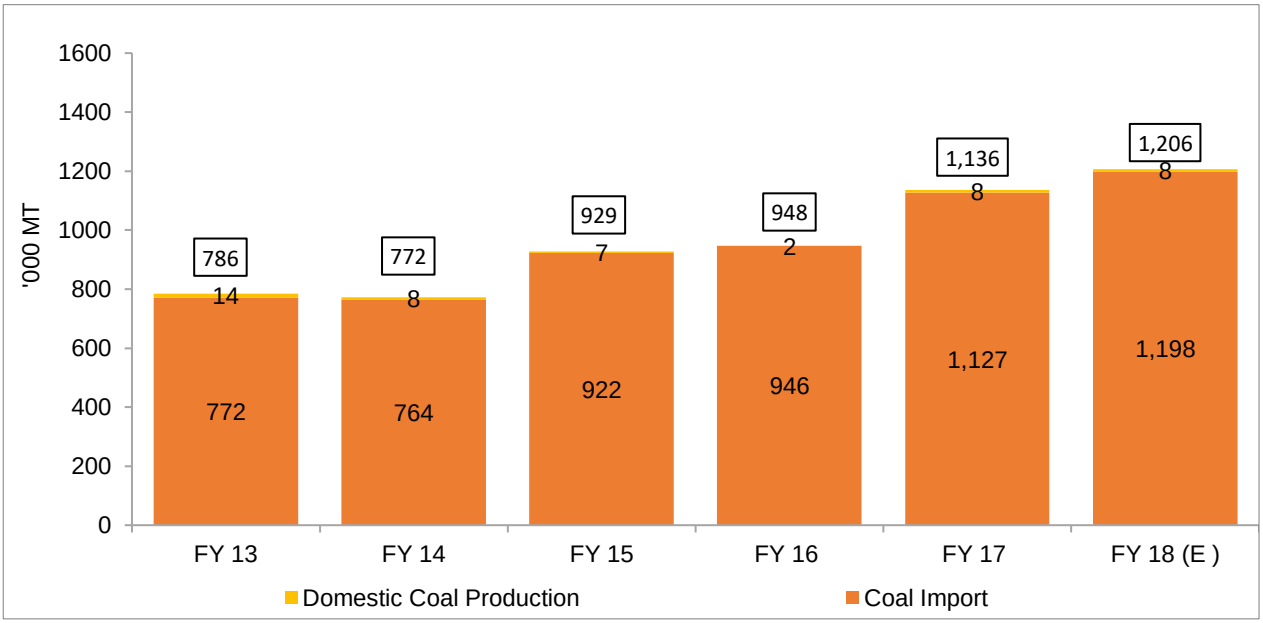
Nepal has sporadic deposits of low-grade coal (lignite), which are not commercially attractive. A tiny amount of the required total coal supply is extracted in the Dang district for consumption in brick industries. Occurrences of coal in Nepal can be classified into four major categories:

- Quaternary lignite from the Kathmandu valley
- Coal from Dang
- Siwalik coal
- Gondwana coal

Of the above, only quaternary lignite and coal from Dang are of any economic significance.

Nepal is dependent upon imports from India to fulfil its coal requirements as domestic coal production constitutes a meagre 1% of the country's total coal requirement. For instance, in fiscal 2017, against the total demand of ~1136 kilo tonne, domestic production of coal was only 8.2 kilo tonne.

Figure 130: Review of Coal Demand



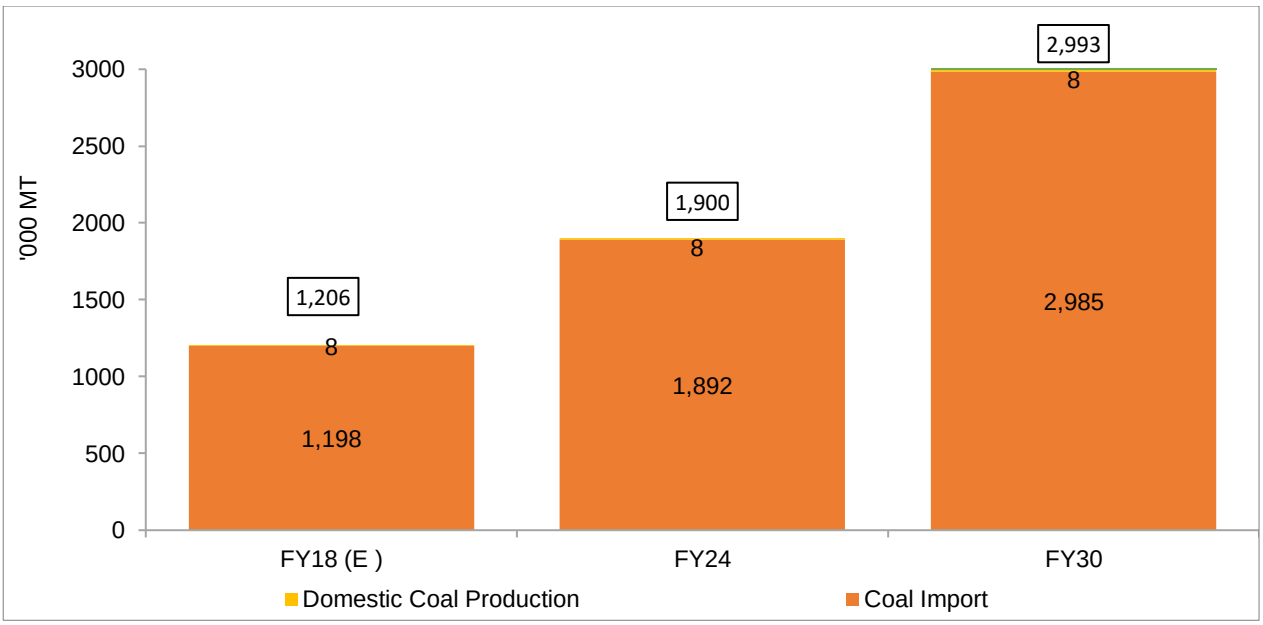
Source: Statistical Yearbook

Demand, Supply Outlook

With an expected rise in industrial production and increased share of industry in the country's overall GDP, coal consumption is expected to increase from 1206 kilo tonne in fiscal 2018 to 2993 kilo tonne in fiscal 2030. With the rising energy demand from coal, the share of coal in the total primary energy consumption of Nepal is expected to increase from 5% in fiscal 2018 to 8.4% by fiscal 2030. It is estimated that overall energy consumption from coal will clock 8% CAGR from fiscal 2018 to 2030 to reach 1,766 KTOE.

With domestic coal production not expected to increase significantly, Nepal will mainly have to rely on coal imports from India in the future.

Figure 131: Outlook on Coal Demand



Petroleum Products

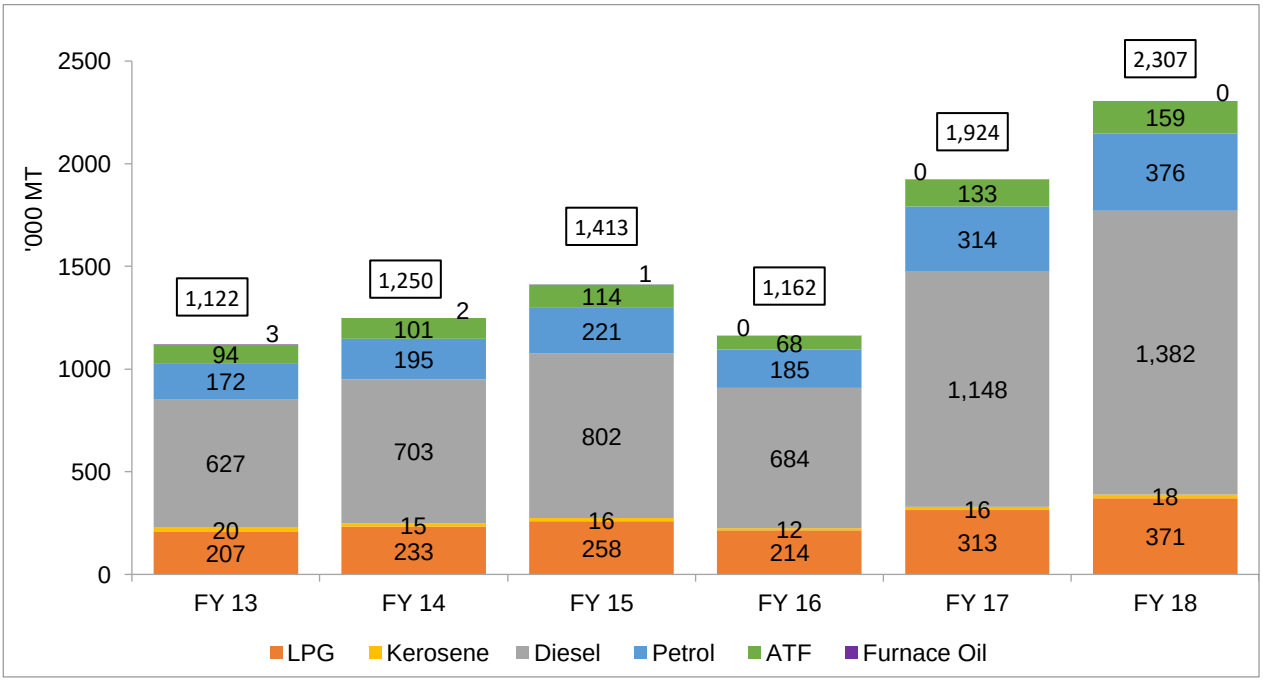
Demand, Supply Review

While demand for POL products in Nepal clocked strong 8% CAGR from fiscal 2013 to 2015, it declined by ~18% from fiscal 2015 to 2016. The decline could be attributed to the political unrest in the country following the introduction of the new constitution in September 2015. This resulted in a trade blockade in the Terai region due to which all imports, including POL products, were impacted. Additionally, Nepal was already recovering from the impact of an earthquake in April 2015. The cumulative effect of the earthquake and the blockade resulted in a fall in overall POL product demand in fiscal 2016. During fiscal 2016, the country's GDP growth slowed to 0.4%, as against growth of ~3.3% in fiscal 2015. Post the normalisation of the situation, consumption of POL products witnessed a significant growth, owing to the low base effect in fiscal 2017. Overall POL product demand clocked 15% CAGR from fiscal 2013 to 2018.

Petrol, diesel and LPG cumulatively accounted for 92% of total POL product imports in fiscal 2017. Petrol and diesel are mainly consumed by the transport sector, which accounted for 82% of total key POL products consumption for the fiscal. In addition, the industrial sector accounted for 11% of diesel consumption in fiscal 2017, primarily as a fuel for backup power, with the rest being consumed by agriculture and other sectors.

The shift towards cleaner fuels for residential cooking resulted in LPG demand clocking 12% CAGR from fiscal 2013 to 2018. This strong shift towards LPG resulted in substitution of kerosene which, in turn, saw a dip in demand. Demand for aviation fuel remained strong at 11% CAGR from fiscal 2013 to 2018, backed by strong tourism potential and foreign aid to support relief efforts in the aftermath of the earthquake.

Figure 132: Import Trend of Key Petroleum Oil Products



Source: Nepal Oil Corporation

Demand, Supply Outlook

Consumption of POL products in Nepal is expected to clock 8.3% CAGR from fiscal 2018 to 2030, mainly driven by strong growth in the transport and industrial sectors, led by a GDP growth of 4.5%-5%.

POL product-wise factors resulting in demand growth are detailed as follows:

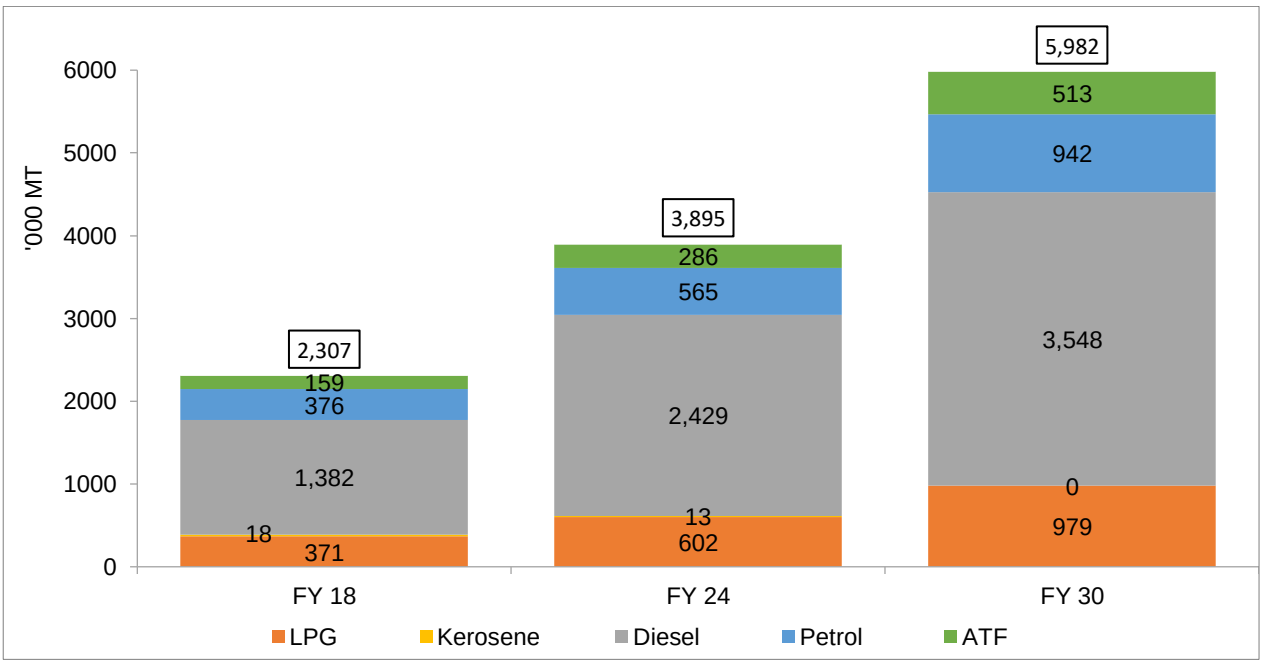
- *Petrol:* Petrol vehicles are expected to grow at 7.8% CAGR from fiscal 2018 to 2030, led by rising per capita incomes. Even though Nepal has a taxation policy to promote electric vehicles, their

demand has not picked up much. Going forward, even with an increase in number of such vehicles, the impact on petrol demand is expected to remain small. Overall petrol demand is expected to clock a strong 8% CAGR from fiscal 2018 to 2030.

- *Diesel:* Consumption of diesel is expected to clock 8.2% CAGR from fiscal 2018 to 2030, driven by demand from the transport and industrial sectors.
    - Diesel consumption by the transport sector, which constitutes around 80% of the country's total diesel demand, is expected to clock 9% CAGR, led by the growth in commercial vehicles.
    - The industrial sector, which accounts for ~11% of the country's total diesel consumption, is expected to clock ~5.2% CAGR, lower than the historical growth, with the improvement in Nepal's power supply situation.
    - Demand from other sectors is expected to clock 4% CAGR, in line with historical trends.
- *LPG:* Mostly consumed by the residential, commercial and institutional segments for cooking purposes, LPG has been estimated to clock ~8.4% CAGR, driven by rising per capita consumption in Nepal as people replace biomass with cleaner fuels. Rising per capita LPG consumption due to substitution of biomass will also lead to low carbon emissions.
- *Other petroleum products (ATF, kerosene, and furnace oil):* Other POL products are expected to clock 9.3% CAGR, driven by the demand for ATF. The aviation fuel demand is expected to clock ~10% CAGR from fiscal 2018 to 2030. Kerosene demand has already reduced considerably over the last few years and is expected to reduce to zero by fiscal 2030, considering that clean energy fuels such as electricity and LPG will substitute its consumption in the residential segment. In addition, furnace oil demand, which had already reduced to zero in fiscal 2018, is not expected to increase in the future

The overall import of POL products is expected to rise from ~2.3 million tonnes in fiscal 2018 to ~6 million tonnes in fiscal 2030.

Figure 133: Import Outlook of Key Petroleum Oil Products

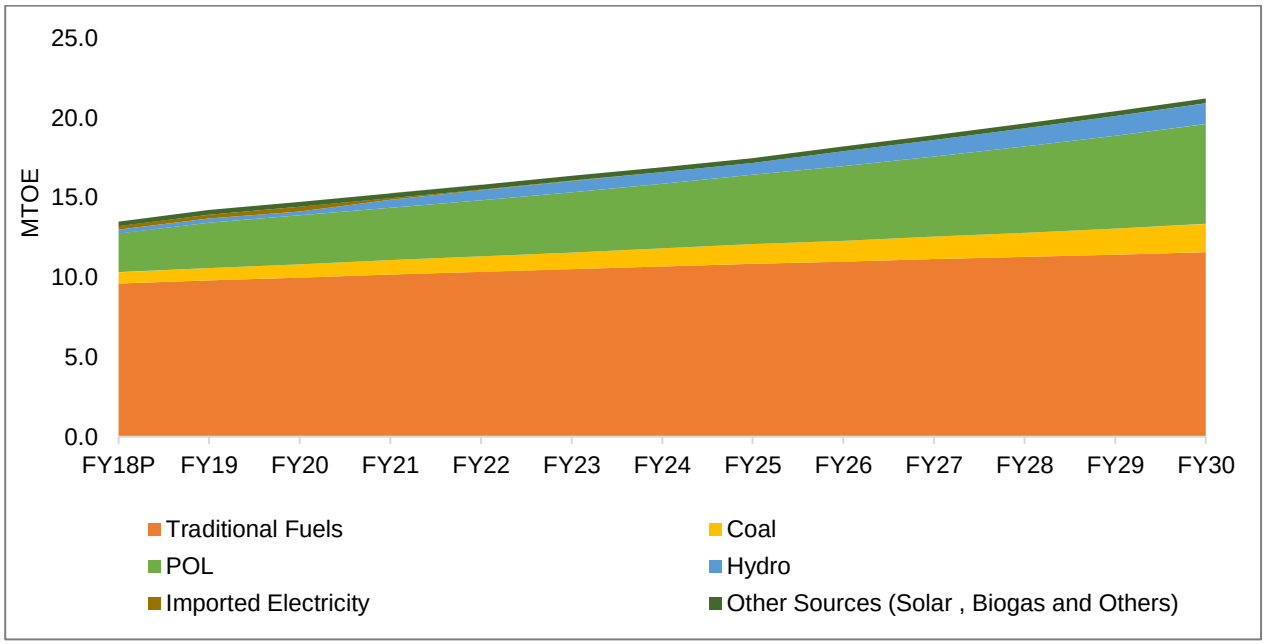


Energy Outlook 2030

Nepal's total primary energy consumption of Nepal is expected to clock ~3.8% CAGR from fiscal 2018 to 2030. The country's overall primary energy consumption is expected to reach ~21.2 MTOE by fiscal 2030, an increase of 1.6 times as compared with fiscal 2018. The increased energy consumption is expected to be met by new hydropower plants and increased imports of coal and POL products.

All figures in MTOE	**FY18P**	**FY19F**	**FY24F**	**FY30F**
Primary energy	13.5	14.2	16.9	21.2

Figure 134: Primary Energy Outlook – 2030: Nepal



With increased consumption from clean energy, the share of traditional fuels is expected to decline from ~71% in fiscal 2018 to ~54% by fiscal 2030.

Outlook on Imports

It is expected that cross-border trade will rise due to rising demand for coal and POL products. However, with the improvement in availability of electricity from new hydro plants, net import of electricity by the country is expected to reach zero by fiscal 2030. It is estimated that the overall contribution of imported fuels (coal, POL and electricity) to the total energy consumption of Nepal is expected to increase from ~22% in fiscal 2017 to ~38% by fiscal 2030.

Table 47: Import of Fuels – Outlook: Nepal

Fuel	**FY17**	**FY24**	**FY30**
Key petroleum oil products (petrol, diesel, kerosene, LPG, furnace oil, ATF) [in kilo tonne]	1,924	3,895	5,982
Electricity [in GWH]	2,172	505	355
Coal [in '000 tonne]	1,127	1,892	2,985

Source: Statistical Yearbook, Department of Customs, Nepal Electricity Authority

8 Pakistan

8.1 Country Overview

Pakistan, in spite of showing strong growth among South Asian economies, most of its growth is fuelled by foreign debt. Driven by rising industrialisation and economic revival, the country's energy demand has grown at an average of 5% on year since fiscal 2014. However, overdependence on fossil fuel imports has led to a weakening of its domestic currency, thereby increasing its current account deficit from 1.1% of GDP in fiscal 2013 to 2.4% of GDP in fiscal 2017.

A brief snapshot of Pakistan's macroeconomic profile is as below:

Table 48: Country Profile: Pakistan

	Factors	FY13	FY17[#]
Demographics	Population [in millions]	184.3	199.1
	Urban/ Rural Divide	38.01%	39.88%
Macro-Economic Scenario	GDP Growth rate	3.68%	5.37%
	Sectoral Growth Rate		
	a. Industry	0.8%	5.4%
	b. Services	5.1%	6.5%
	c. Agriculture	2.7%	2.1%
	Unemployment rate	6.24%	5.90%
	Inflation	7.40%	4.20%
Fiscal Position	Exports [US $million]	24,802	21,938
	Imports [US $million]	40,157	48,506
	CAD [as % of GDP]	1.10%	2.40%
	Fiscal Deficit [as % of GDP]	8.20%	5.80%

[#]*Actual data for FY18 was not available*
Source: Country Reports, Economic Survey

Pakistan's focus on economic growth also envisages attainment of energy security by reducing oil imports and improving renewable energy generation. Under Intended Nationally Determined Contribution, Pakistan intends to reduce up to 20% of its 2030 projected GHG emissions. By institutionalising policies like National Power Policy 2013, Hydropower Development Plan - Vision 2025 and Policy for Development of Renewable Energy for Power Generation (Small Hydro, Wind and Solar Technologies), the country strives to meet its future energy needs.

8.1.1 Overview of Energy Structure

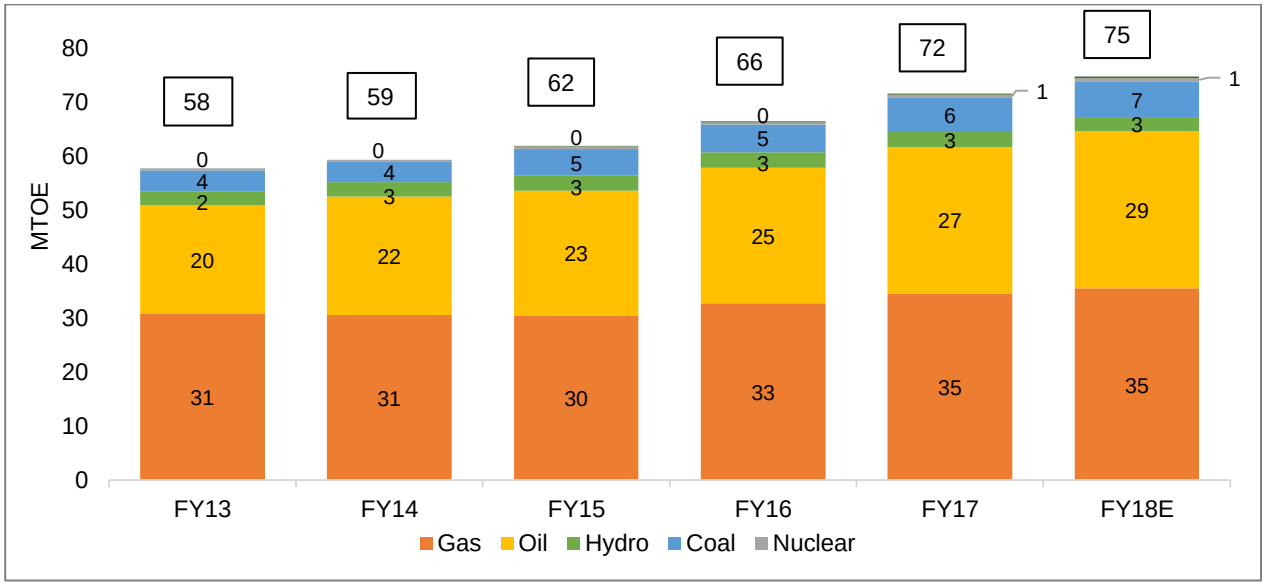
Energy Mix

Pakistan's primary energy requirement has steadily grown from 58 MTOE in fiscal 2013 to 73 MTOE in fiscal 2018 at 5.2% CAGR. Multiple issues plaguing Pakistan's energy sector, including circular debt and poor financial positions of energy companies, falling gas production and low utilisation of domestic coalfields, are being addressed through sound policy and government initiatives. However, high electricity generation costs from thermal power units (especially oil-based ones) and inconsistent fuel mixes still need to be addressed to overcome acute power shortages.

Domestic gas, the most significant energy source, is on the decline, making the country increasingly dependent on LNG imports to curb deficits. Pakistan has signed a 15-year agreement with Qatar to import up to 3.75 million tonnes of LNG annually.

The country is also heavily dependent on fossil fuel imports (85% of the nation's crude oil and petroleum products are imported), thereby exposing itself to global price and supply shocks. The country's abundant renewable energy sources continue to be unexploited with installed capacity of only ~1400 MW against a potential of >120 GW.

Figure 135: Primary Energy Supplies by Source: Pakistan



Source: Country Reports, Economic Survey
**RE in volume terms is very low (~0.26 MTOE as of FY18), hence now shown in above chart*

Domestic Availability and Imports of Fuels

The following table details the domestic production and import of major fuels, as of fiscals 2013 and 2017.

Table 49: Domestic Production and Import of Major Fuels: Pakistan

Fuel	Supply type	FY13	FY17
Coal [in '000 tonne]	Domestic production	3,179	4,165
	Imports	3,710	7,021
Gas [in billion cubic feet]	Domestic production	1,505	1,472
	Imports	0*	190
Crude oil [in '000 tonne]	Domestic production	3,797	4,391
	Imports	7,402	8,834
Petroleum products [in '000 tonne]	Domestic production	8,857	10,474
	Imports	10,489	15,145
Electricity [in GWH]	Domestic production	96,121	116,829
	Imports	375	497

**Imports for gas began FY15 onwards*
Source: Energy Sector Reports, Economic Survey

Imports of all major fuels have increased in the last five years, leading to an appreciation in final energy costs. A majority of imports are sourced from China, Saudi Arabia, the UAE and Indonesia. Imports from SAARC nations have declined marginally (in percentage terms) from 3.8% of total imports in fiscal 2009 to 3.5% in fiscal 2017.

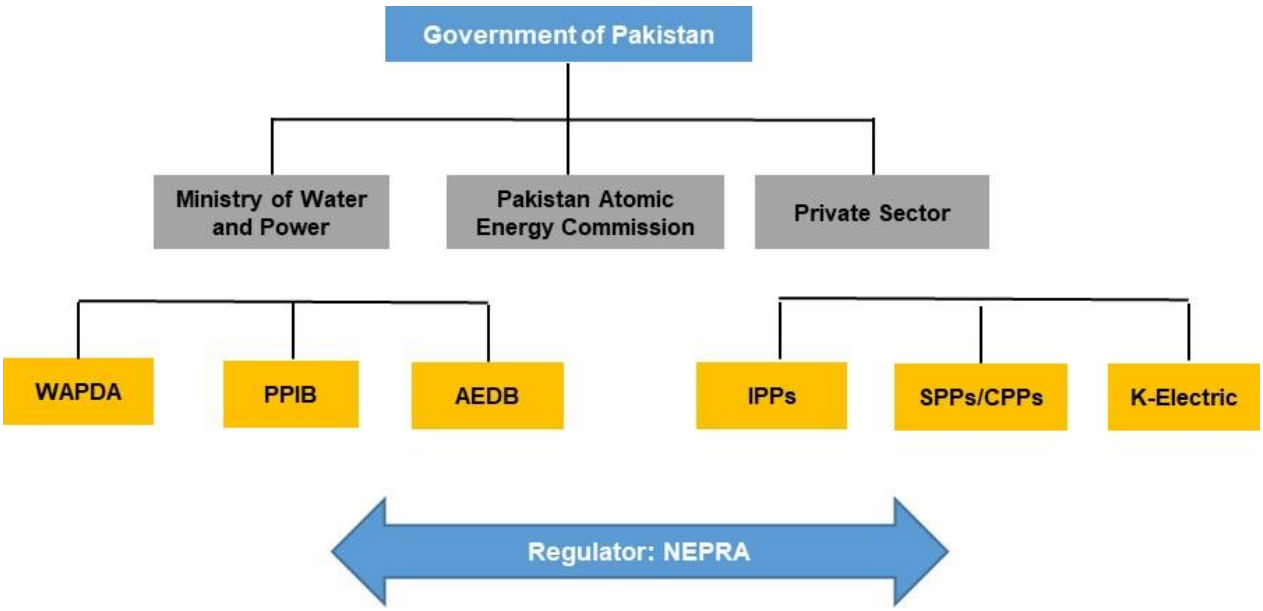
8.2 Institutional and Regulatory Framework of Energy Sector

Pakistan's energy sector is managed principally by the Ministry of Water and Power. State and regional governments are involved in managing small-scale power generation projects (< 50 MW capacity), exploration and mining leases for natural resources, except oil and gas, and granting permissions for renewable energy projects.

8.2.1 Planning and Regulatory Bodies

Power Sector

Figure 136: Organogram of Power Sector: Pakistan



Source: Pakistan Electricity Sector Report

WAPDA: Water and Power Development Authority, PPIB: Private Power and Infrastructure Board, AEDB: Alternate Energy Development Board, NEPRA: National Electric Power Regulatory Authority

The power division is overseen by the power wing of the Ministry of Water and Power. It undertakes the following functions:

- Strategic inputs in master plan, five-year plan and Annual Development Plan (ADP), financial planning of projects included in five-year plan and ADP
- Co-ordination among federal agencies and electricity departments for development and operation of power projects
- Supervision of performances of several power organisations like NEPRA, WAPDA, PPIB
- General monitoring of power generation, transmission and distribution of power projects

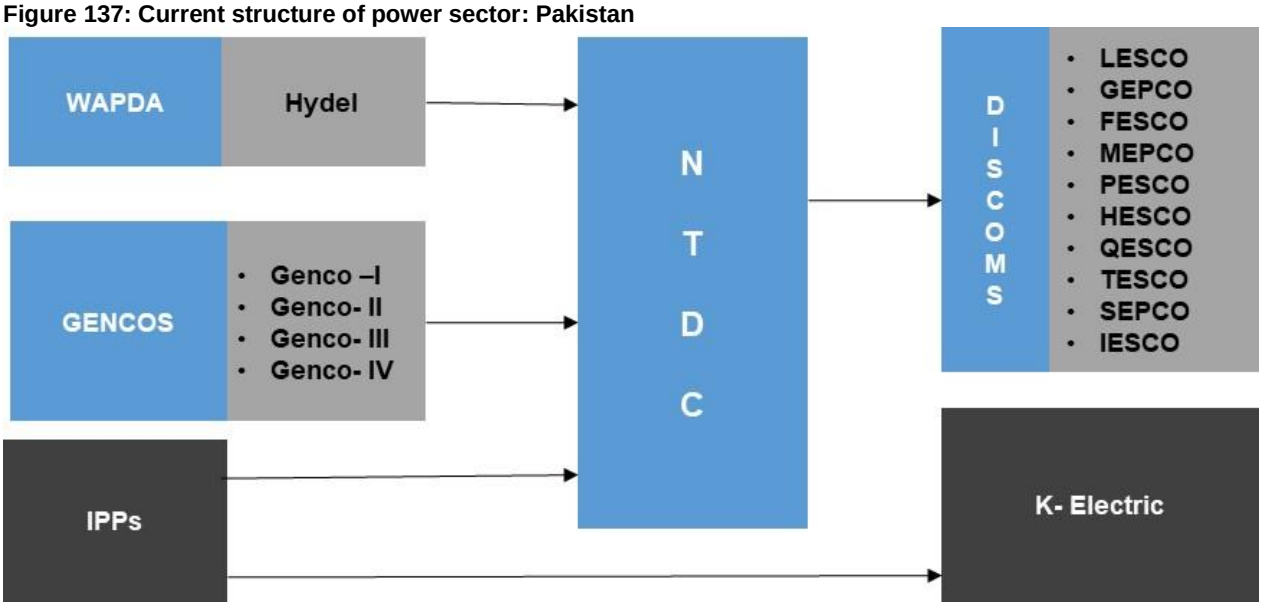
Federal Agencies

- *NEPRA* was established under the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997. The major functions of NEPRA, as defined in the Act, include granting licenses for generation, transmission and distribution of electric power, and prescribing and enforcing performance standards for generation, transmission and distribution companies
- *WAPDA* operates to address acute water challenges and produce clean hydroelectricity. It is responsible for development of water and hydropower resources in the country
- *PPIB* looks after promotion and facilitation of private sector participation in power sector. It is guided by private power policies of the Government of Pakistan
- *AEDB* is the representative agency of the Federal Government, entrusted with the mission of developing alternative and renewable energy in the country. It promotes, facilitates and encourages development of RE through policy and project implementation

Current Structure

The power sector was restructured in 1998 with the creation of PEPCO (Pakistan Electric Power Company). Prior to that, there were two vertically integrated utilities; K- Electric, which served the Karachi area, and WAPDA, which served the rest of the country. Post 1998, WAPDA's power wing has been restructured into distinct corporate entities comprising four generation companies, ten distribution companies and one transmission company. However, in 2008, PEPCO was merged into its parent organisation, WAPDA. K-Electric meets its overall demand with its own generation as well as purchase from National Transmission and Dispatch Company Ltd (NTDC), IPPs and from Karachi Nuclear Power Plant.

Figure 137: Current structure of power sector: Pakistan



Source: Pakistan Electricity Sector Report

There are four major power producers in Pakistan- WAPDA, KESC, IPPs and PAEC.

Hydrocarbon Sector

Institutional Framework

Pakistan's energy sector is managed principally by the central government agencies. State and regional governments are involved only in managing small scale power generation projects (< 50 MW capacity),

awarding exploration and mining leases for natural resources except oil and gas and granting permissions for renewable energy projects.

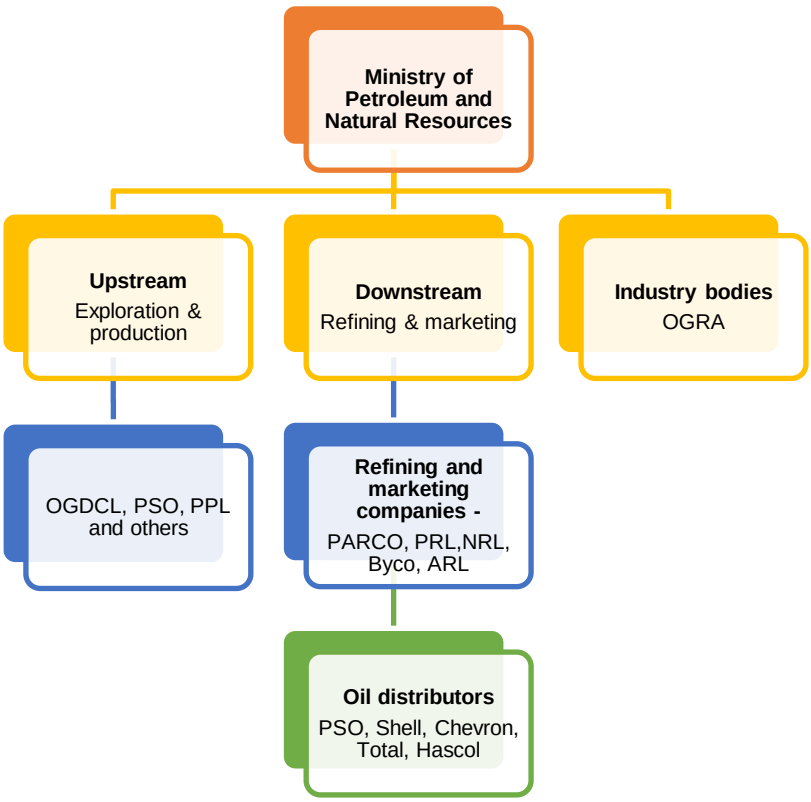
The oil and gas industry in Pakistan has both public and privately owned companies, which are controlled by the Ministry of Petroleum and Natural Resources (MoPNR) and regulated by the Oil and Gas Regulatory Authority (OGRA).

The MoPNR is responsible for policies pertaining to oil and gas production. Hydrocarbon development institute of Pakistan (HDIP) is principal body responsible for R&D in fossil fuel applications and compiling Pakistan's energy statistics. Within the MoPNR, the Director General of Petroleum Concessions (DGPC) takes care of awarding and managing of oil and gas Exploration & Production licenses as per the petroleum policy, which is revised by the government from time to time (Petroleum Exploration & Production Policy 2012 is currently in effect). The major companies responsible for oil and gas production include Oil and Gas Development Corporation (OGDCL) and Pakistan Petroleum Limited (PPL). In addition, there are several private companies involved in Exploration & Production activities.

The OGRA has objective of increasing private sector investment and increasing competition within the midstream and downstream activities and regulate these segments. The Directorate General of Oil takes care of administering activities like refining, import, distribution and retail of oil and petroleum products in Pakistan. The Pakistan State Oil Company (PSO) accounts for about majority (55% as of fiscal 2017) of the retail oil market with the balance shared by private sector companies. Since 2016, OGRA has issued 11 new marketing licenses taking the total number of Oil Marketing Companies (OMCs) to 22 as of fiscal 2017. The OGRA also granted 12 storage capacity construction licenses to new firms. Subject to compliance with regulatory requirement for storage capacity, these licenses may be converted to marketing licenses in coming years. Despite new entrants, industry structure has remained at a semi-oligopolistic level, with few players dominating the market.

Sector Structure

Figure 138: Current Structure of Pakistan Hydrocarbon Sector



8.2.2 Regulatory and Policy Framework

The Power Policy of 2002 entitled “Policy for Power Generation Projects – Year 2002”, makes it possible for investors to participate in public tendering and propose power plant projects on their own.

Pakistan Onshore Petroleum (Exploration and Production) Rules 2013 apply to all onshore areas in Pakistan and regulates all petroleum rights except those relating to coal bed methane.

To accelerate renewable energy development in the country, the country has formulated “Policy for development of Renewable Energy for Power Generation” in 2006.

8.2.3 Government Support: Pricing, Existing Subsidies on Fuel and Controlling Regime

Gas

The OGRA determines the retail gas prices in the country for each consumer category, taking into account the revenue requirements of gas companies. Prices are kept constant across the country and do not take into consideration price differential of supplying gas to different regions. Retail gas is priced on a two-part tariff:

- Prescribed price for gas companies
- Gas prices for producer (linked to international crude oil prices)
- Transmission and distribution costs
- Depreciation
- Assured returns to Sui Northern Gas Pipelines Limited (SNGPL) and Sui Southern Gas Pipelines Limited (SSGPL) at 17.5% and 17%, respectively, of net depreciated value of assets
- Gas development surcharge (GDS)

Subsequently, the OGRA advises the revenue requirement of the utilities and the prescribed gas prices to the GOP. The GOP notifies the gas prices for different consumer categories after adding or subtracting GDS with the prescribed prices. Minimum monthly charges are applicable for each of the consumer category as shown below.

Table 50: Consumer Gas Tariff Schedule in Fiscal 2017

Consumer category	Gas prices [USD/mmBtu]	Minimum monthly charges (USD)
Domestic	1.04-5.71	1.42
Commercial	6.67	40.03
Industrial	5.71	192.86
CNG station	6.67	225.01
Captive power	5.71	192.86
Cement factories	7.14	241.08
Fertiliser factories	1.17-5.71	-
Power stations	1.17-4.22	128.57-9,294.56

Source: OGRA

RLNG prices are subject to international LNG prices and domestic currency fluctuations. Many LNG suppliers of Pakistan have government-to-government (G2G) 15-year agreements with Qatar for import price set at 13.37% of the preceding three-month average Brent crude oil price.

Coal

Pakistan meets the majority of its coal requirements via imports from South Africa. South African coal is preferred to Australian coal due to its higher quality and significantly lower freight. Indonesian coal, which comprises mainly low-grade coal, is also imported for blending with high-grade coal. With high dependence (66%) on imports, prices of coal follow international coal price trends. Customs duty of 3% is applicable on thermal coal imports, while 5% is applicable for other grades.

Petroleum Products

The price for domestically produced crude oil delivered at the nearest refinery gate is equal to cost and freight (C&F) price (freight on board (FOB) price of imported crude oils into Pakistan *plus* freight on Average Freight Rate Assessment (AFRA): deemed chartered rate) of a comparable crude oil, or a basket of Arabian/Persian Gulf crude oils, *plus* or *minus* a quality differential between the reference basket and the local crude oil. In addition, a Windfall Levy Oil (WLO) is applied. No other levy or discount is applicable other than the WLO. Imported crude is subject to ad valorem customs duty of Rs 9,050 ($81.97) per tonne, as of fiscal 2018.

Pricing of petroleum products at an ex-refinery level is based on import parity pricing, i.e., the price that would be applicable to the refiner if the fuel was imported, including FOB price, customs duty and freight. To this, the refiner adds excise duty, petroleum levy, and inland freight charges, after which the product is made available at the depot level to the OMC. The OMC then adds a profit margin, margin paid to the dealer of the product, and sales tax to arrive at the ex-depot selling price of the petroleum product. The government may choose not to pass on the rise or decline in global fuel prices to the end consumer.

- Ex-refinery prices cannot exceed the average of PSO's import prices of POL products in the preceding two weeks, excluding PSO's import incidentals. If PSO's prices are not available, ex-refinery prices are based on an import-parity formula.
- For LPG, the government sets ceilings for ex-refinery or ex-processing plant prices of domestically-produced LPG, but not imported LPG. In 2012, the MoPNR reported on its website that fuel prices were being subsidised through adjustments in the petroleum levy.

Table 51: Customs Duty for Imported Petroleum Products, as of Fiscal 2018

Product	Customs duty
Motor spirit	3%
Aviation fuel	3%
Light diesel oil	3%
Kerosene	3%
High speed diesel	11%
Furnace oil	11%
Naphtha	20%

Source: Federal Board of Revenue, Pakistan

Prior to import parity pricing, the government of Pakistan was setting ceiling for ex-depot prices of petroleum products based on an import-parity formula until June 2011, when these prices were also deregulated, except kerosene.

Product	Customs duty (%)
Motor spirit	3
Aviation fuel	3
Light diesel oil	3
Kerosene	3
High speed diesel	11
Furnace oil	11
Naphtha	20

Source: Customs Duty Website, Pakistan

8.2.4 Government Subsidy

The government of Pakistan has been reducing its overall subsidy share over the years. The consolidated subsidy doled out in fiscal 2013 was $3.58 billion, which reduced to $1.33 billion in fiscal 2018. While subsidies on petroleum products are given through change in petroleum levy (PL), gas infrastructure development cess (GIDC) and natural gas development surcharge (NGDS) are altered from time to time to meet gas revenue requirements and subsidy targets. WAPDA, PEPCO and K-Electric were given $1.04 billion on account of tariff differential, amounting to ~0.7% of GDP.

8.3 Overall Energy Outlook 2030

The overall energy outlook of Pakistan has been assessed by undertaking a detailed review of all the primary sources of energy, including coal, gas, hydro, POL products and renewables. The country, in its INDC submission, has articulated a framework for abatement of carbon dioxide emissions in line with its obligations under UNFCCC process. Besides eliminating current demand supply gaps, Pakistan has stressed on optimizing energy mix and low carbon development. National policies on energy efficiency and alternative energy have been formulated as part of Pakistan's Vision 2025. Although, the country has stated that it intends to mitigate up to 20% of CO_2 emissions by 2030, there is no target given for conditional and unconditional abatement. Energy insecurity continues to be a major stumbling block.

Since the power sector serves as a major consumer of energy sources and the single largest supplier of secondary energy, its analysis precedes the fuel wise discussion.

8.3.1 Power Demand, Supply Review

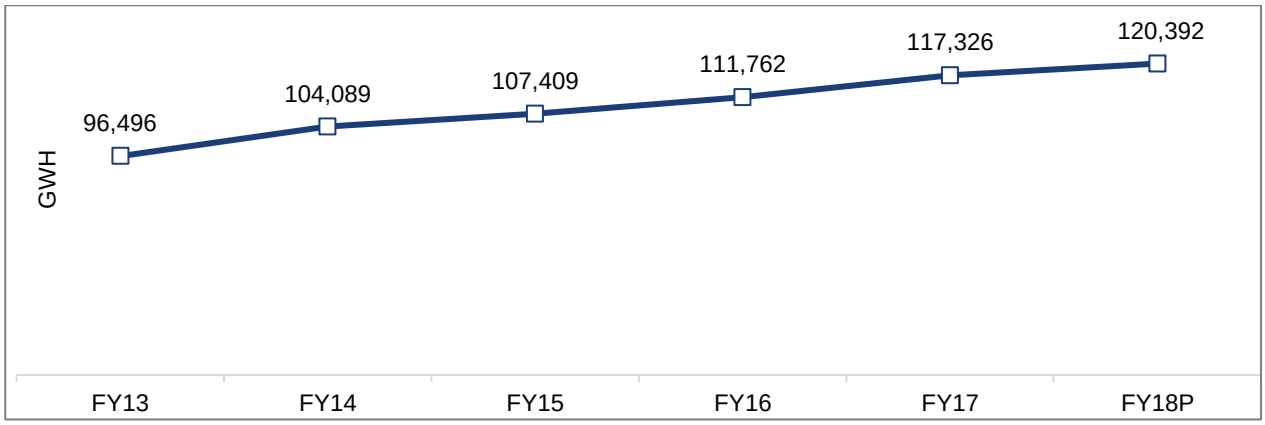
With power being a major contributor of secondary energy in the country, the sector has been studied in detail. Demand and supply scenarios have been assessed and subsequently forecasted, taking into consideration load growth and capacity planning, keeping in mind government outlook and policy reviews.

Power Demand Position

Electrification levels in Pakistan are at present at a decent 70%; however, vast parts of the country that have been electrified are still subject to long power cuts resulting in significant latent demand. Power demand has grown from 96,496 MU in fiscal 2013 to 120,392 MU in fiscal 2018 at a CAGR of 4.52%. Transformation

[MVA] capacity ratio at 0.76 with respect to installed capacity was poor vis-à-vis global standards of >1.5, while T&D losses stood at ~17.5%, as of fiscal 2018.

Figure 139: Demand Load Curve: Pakistan



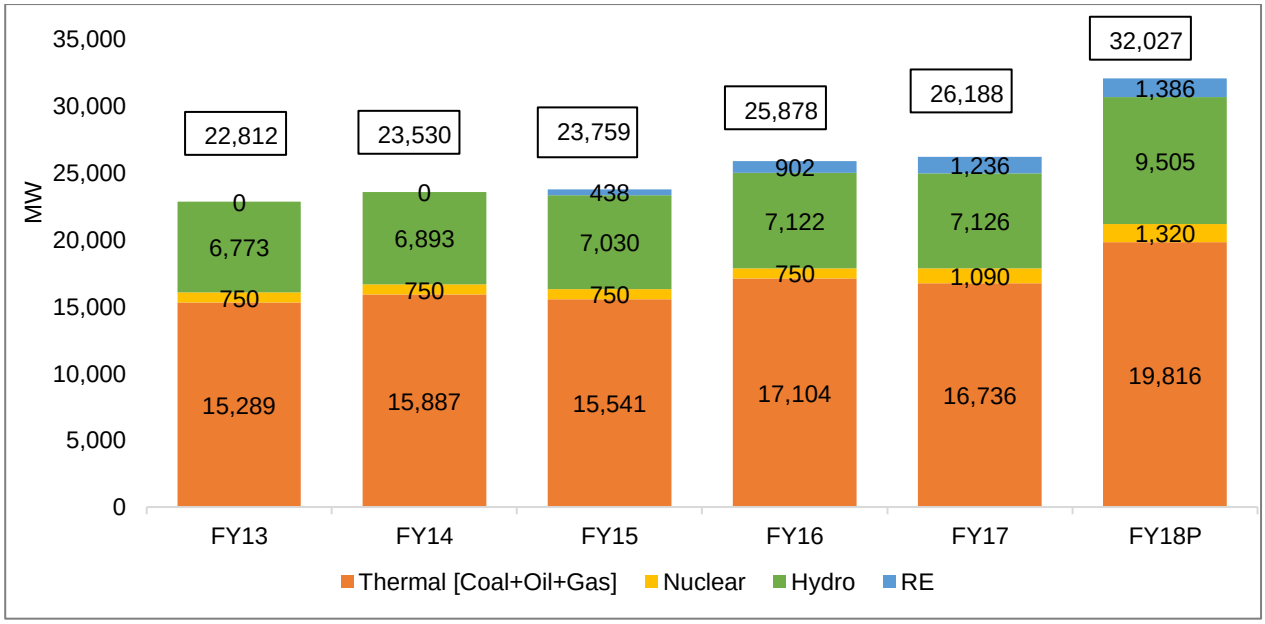
Source: Nepra Annual Report 2017

A majority of power consumers (85%) belonged to the domestic category, and 12.2% to the commercial category as of fiscal 2018. Agricultural power consumers comprised only 1.21%, owing to lack of buying power by agricultural end-users and poor ground water availability. Although industrial consumers comprised only ~1.2% of the consumer mix, they accounted for ~26% of total power sales in fiscal 2018 (provisional). The industrial sector primarily comprises textile industries (20% of large-scale manufacturing), food and beverage industries (12% of large-scale manufacturing) and coke and petroleum product industries (5.5% of large-scale manufacturing).

Power Supply Position

The total installed capacity of Pakistan stood at 29,573 MW as of February, 2018 and is expected to reach 32,027 MW by the end of fiscal 2018. The country has significantly added fuel oil (FO) and nuclear-based power plants whereas gas-based capacity additions have remained slow. Natural gas and FO are the major fuels presently contributing ~29% each to the total mix.

Figure 140: Installed Capacity - Review: Pakistan



Source: Nepra Annual Report 2017

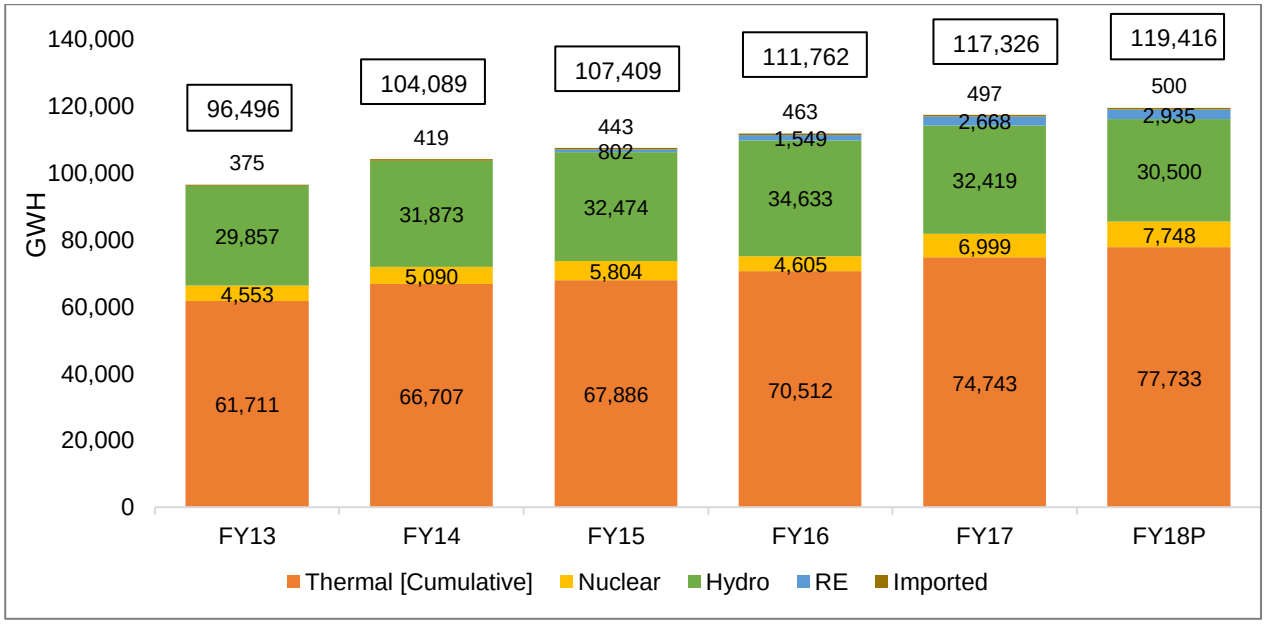
The performance of four public sector GENCOs (Jamshoro Power Company Limited, Central Power Generation Company Limited, Northern Power Generation Company Limited, Lakhra Power Generation Company Limited) have been unsatisfactory, owing to low annual capacity utilisation (<50% for most power plants), forced outages and unscheduled maintenance issues.

Hydropower generation has been lagging owing to falling PLF (~50% in fiscal 2013 vis-à-vis ~38% in fiscal 2018) from lack of water availability and unreliable rainfall patterns. Competitive bidding planned for seven hydropower projects and successful completion of bidding for Taunsa Hydropower Project under Competitive Bidding Tariff Regulations (CBTR), 2014, may provide a much-needed impetus to this sector.

Five nuclear power plants with a combined installed capacity of 1320 MW are operational in the country at a healthy PLF of 73%.

Overall annual generated electricity reached ~119,416 MU in fiscal 2018. Renewable energy generation has not improved significantly over the years and is still at a nascent stage. Wind power of ~750 MU and solar power of ~700 MU was generated in fiscal 2018.

Figure 141: Annual Electricity Generation: Pakistan



Source: Nepra Annual Report 2017

8.3.2 Power Demand, Supply Outlook

Power Demand Outlook

Domestic power consumption per consumer is expected to grow at 1.5% on-year going forward, with rising urbanisation and augmentation in distribution infrastructure (as per capex plans outlined by distribution companies). Consumer growth at a steady pace of ~3.9% is expected to result in residential consumption growth of 6% per annum.

Commercial power consumption, the second highest contributor to demand, will grow between 4%-6% on-year from fiscal 2018 onwards, led by growth in the services sector and rising demand from the hospitality industry. Industrial demand is expected to remain muted at an annual growth rate of 3%-3.7%, assuming GDP growth rate remains in the range of 5-7%. No significant traction in railway electrification and electric vehicle charging is expected till fiscal 2030. Around 120 km of new metro corridors are expected to come up in the country, thereby leading to additional demand.

The China Pakistan Economic Corridor (CPEC), envisaged to be completed by 2030, proposes the building of nine special economic zones (SEZs), heralding huge industrial and commercial development potential. All the SEZs await pre-feasibility studies to date from the Chinese side.

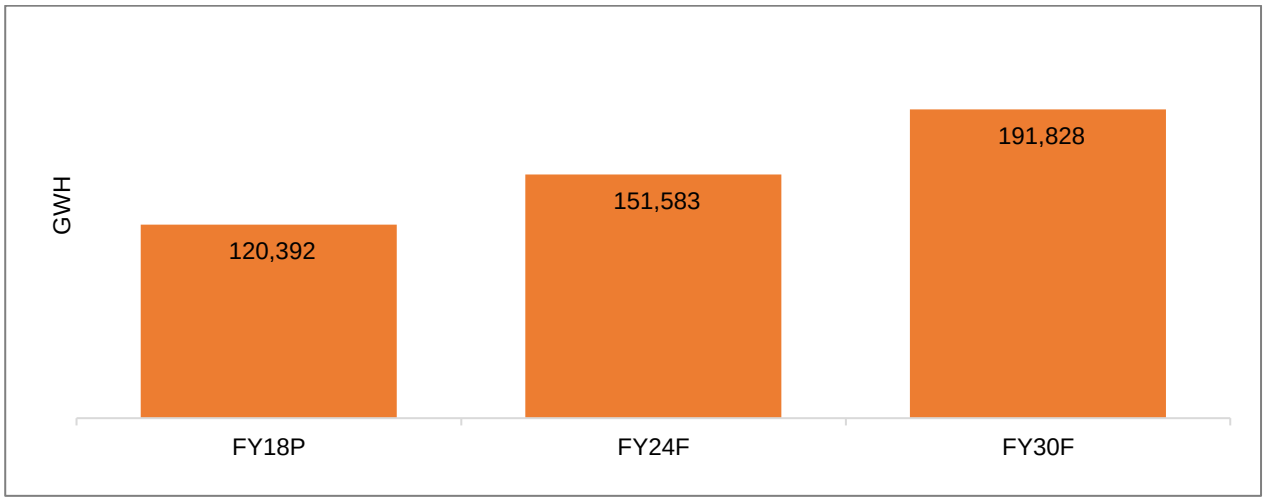
Although the textile industry will continue to be Pakistan's mainstay, the automobile, cement and electronics industry will show traction, leading to improved power sales. Socio-political uncertainties may hinder foreign investments; however, growth will continue to remain moderate, buoyed by China taking a long-term interest in Pakistan.

Latent demand is significantly high in the country. The transformation capacity of grid stations has been increasing at ~4% every year and stood at ~26000 MVA for 220 kV level, as of fiscal 2018. As per reported data by NTDC, there was planned outage of 4,777 hours/annum in fiscal 2017, accounting for a massive 28% of total power sales. NEPRA and NTDC have taken cognisance of this problem and have allocated huge sums of money towards upgradation and augmentation of transmission and distribution infrastructure. Allowable investment by NEPRA and actual expenditure by NTDC have grown significantly over the years. Chinese investment in transmission projects, grids and transmission line infrastructure are expected to improve the situation. These measures will translate latent demand into actual sales in the coming years.

On the demand side, efficient irrigation motors, stoves, water heaters and LED adoption measures are highlighted as part of the country's INDC commitments. These measures are expected to curtail base load demand going forward.

T&D losses stood at ~18% in fiscal 2018 vis-à-vis targeted T&D of 15.27%. However, losses reduced from 20.4% in fiscal 2013. T&D losses are further expected to reduce to 12%-14% by fiscal 2030. Overall gross power demand is expected to grow to 191,546 MUs in fiscal 2030 at a CAGR of 4%.

Figure 142: Demand Load Curve – Outlook: Pakistan



Power Supply Outlook

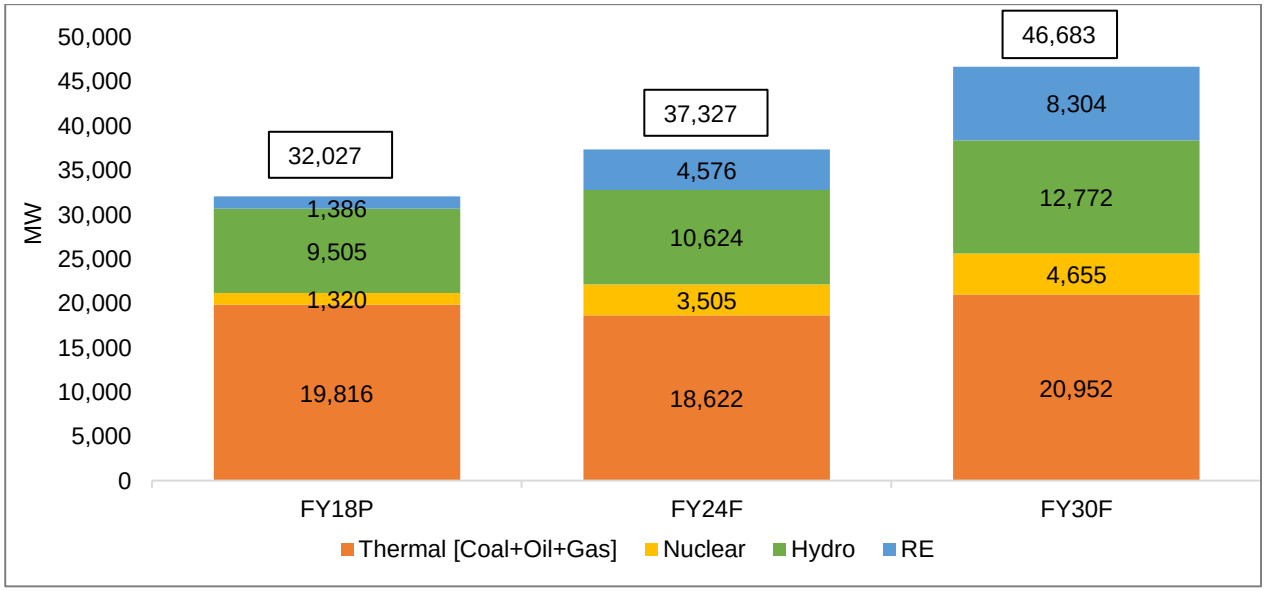
With demand reaching 191.5 BU by fiscal 2030, it is imperative that the country keep adding new plants to its portfolio to cater to the rising demand. Coal-based power plants are expected to contribute the maximum to new capacity additions with as many as 10 plants with a combined capacity of ~8000 MW to come up by fiscal 2030. Lignite coal extracted from the Thar desert region of Sindh will be the major fuel with the remainder to be met by imported coal. The CPEC has taken earnest interest in setting up coal-fired power plants with more than 5 GW achieving financial closure and many more expected to come up in the near future. Major projects include Engro Thar Block, Thar Mine Mouth Oracle Power Plant, and HUBCO imported coal-based project. China is investing billions of dollars into setting up new hydropower plants (2714 MW),

coal-based power projects (8220 MW) and in setting up the first privately operated transmission line between Matiari and Lahore. Additional load demand from industrial SEZ is expected to come post-fiscal 2024.

Around 4,700 MW of gas-based plants are expected to come up in the next decade. With an additional RLNG terminal being built by Mitsubishi, in addition to the existing two LNG terminals, re-gasification capacity will reach close to 2 billion cubic feet per day. The new gas-based plants are expected to mostly run on RLNG.

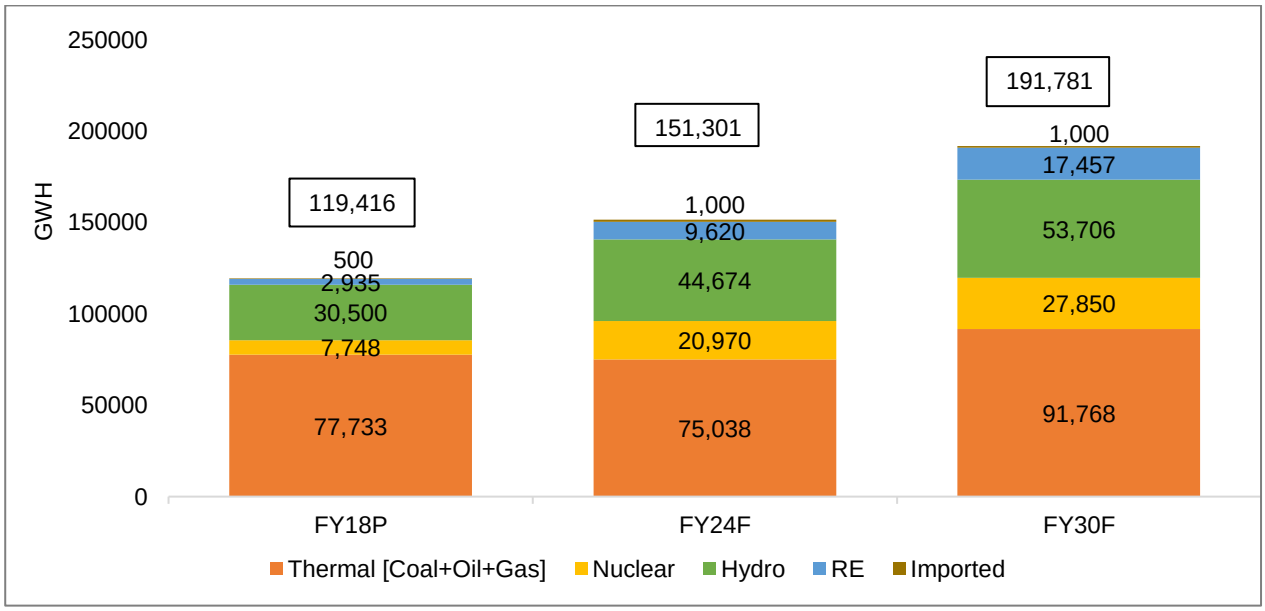
RE-based power is expected to increase six times from fiscal 2018 levels owing to governmental push, net metering regulations and private sector participation. No new oil-based plants are expected to be built, owing to high fuel costs and unreliable power generation (due to high costs and supply constraints).

Figure 143: Installed Capacity – Outlook: Pakistan



Electricity imports are expected to rise to ~1000 MU annually. The planned capacity additions, coupled with power imports, will help address demand-side growth in the country and deep deficits are unlikely to crop up in the future.

Figure 144: Annual Electricity Generation – Outlook: Pakistan

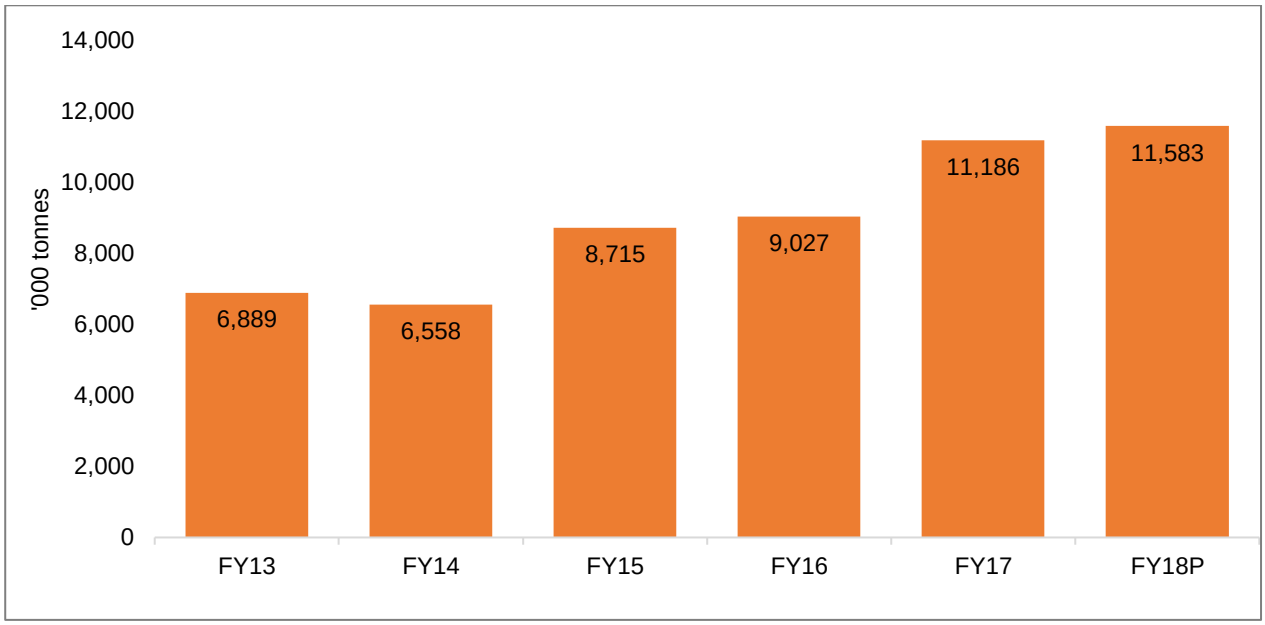


8.3.3 Fuel-Wise Energy Review and Outlook

Coal

The estimated coal reserves in Pakistan are ~186 billion tonnes, of which 175 billion tonnes is expected to be extracted from the Thar coalfield. Demand for coal has been growing steadily, from 6.8 million tonne in fiscal 2013 to 11.58 million tonne in fiscal 2018. As of fiscal 2017, over 66% of coal was used in cement production, while brick kilns and power generation contributed 25.5% and 7.7%, respectively, towards coal usage.

Figure 145: Coal Demand – Review: Pakistan



Source: Economic Survey

With indigenous gas drying up and its power deficit ballooning, the government has given special impetus to the exploitation of domestically available coal in the country. The world's seventh largest coal mine, Thar Block, was discovered in 1992. However, companies were reluctant to mine owing to poor quality coal and high costs. Later, Sindh Engro Coal Mining Company (SECMC), a joint venture between the Sindh government and Engro Powergen, took up development of Thar coalfield in three phases. With more than 10 new coal fired power plants coming up that would utilise coal from the Thar Block, work is underway to expand production from the mine to 7.6 MTPA in phase 2 from 2 MTPA at present, and to 33 MTPA in phase-III.

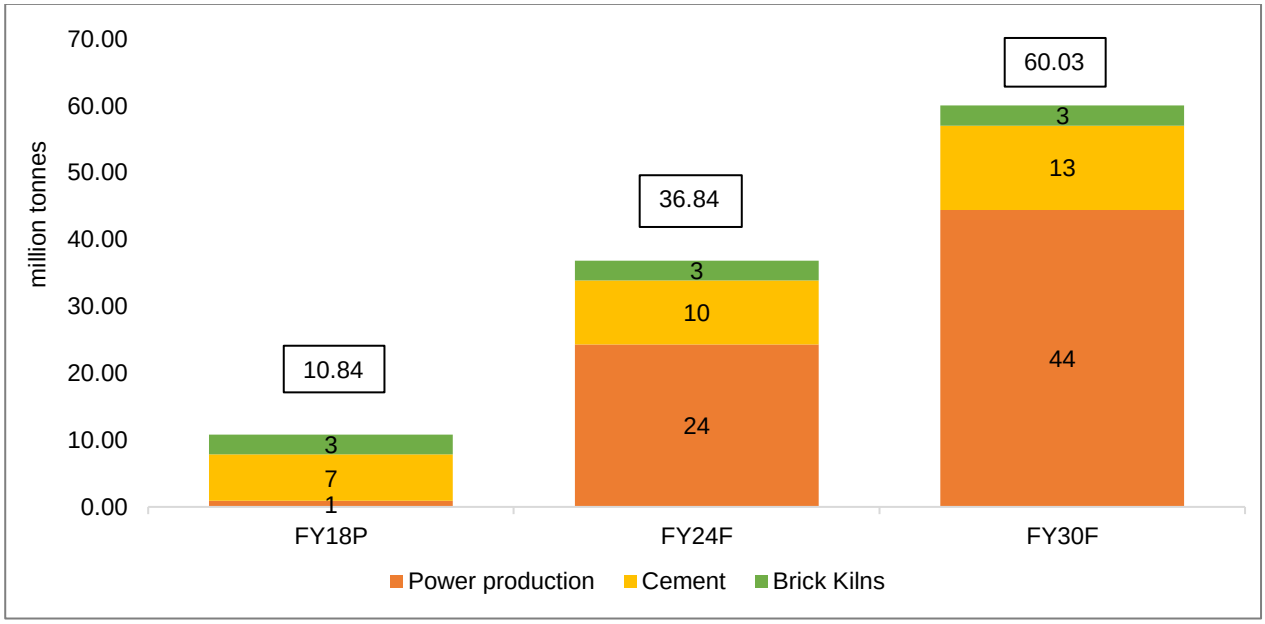
More than 300 MW of coal-fired power plants have been committed towards Thar, Block-II. Additional blocks are expected to be auctioned for development and extraction in the future. The GOP is banking on coal-based power to put an end to the country's crippling power outages. Approximately 9000 MW of coal-based plants are expected to come up, taking coal-based power generation's share of total power generation from 0.55% in fiscal 2018 to 19.4% in fiscal 2030.

Cement production in Pakistan has grown from 31.21 million tonne to 41.6 million tonnes in fiscal 2018, buoyed by strong domestic consumption growth. Going forward, cement manufacturers are aggressively looking to expand production capacities to 72.8 million tonnes in the next few years, as per a Bank of Pakistan quarterly report. Several projects under Public Sector Development Program (PSDP), CPEC, private housing schemes would lead to a construction boom, thereby bolstering end-use sales. However, export prospects will continue to remain bleak, owing to the influx of cheap Iranian cement to Afghanistan and imposition of anti-dumping duties by South Africa on Pakistani cement. Incidentally, Afghanistan and South Africa are the largest buyers of Pakistani cement. Some coal usage may emanate from industrial

usage as the country begin importing increasing amounts of costly RLNG and gas-based industries find it economical to move to coal.

Coal demand from brick kilns is expected to remain steady going forward. Total coal consumption is expected to increase 4.5 times from 12.15 million tonne in fiscal 2019 to 60 million tonne in fiscal 2030.

Figure 146: Coal Usage – Outlook: Pakistan



Petroleum Products

Demand, Supply Review

Petroleum products consumption grew 7.9% from 23.9 million tonne in fiscal 2016 to 25.8 million tonne in fiscal 2017. Transport and power were the main driving segments, registering a high consumption growth of 12% and 10% in fiscals 2017 and 2016, respectively. Consumption of POL products in the agriculture and government sectors contracted by 13% and 8%, respectively, during the same period. Consumption across the industrial sector remained stagnant during the year without any growth.

The consumption of petrol increased by more than 16% on-year in fiscal 2017. This increase may be attributed to the rising demand from the transport sector (largest consumers of motor spirit in volume terms), particularly due to the growing number of motorcycles and cars and partially due to the lower prices of petrol over the years. Petrol consumption has been rising steeply over the years, due to rising demand from the transport sector, primarily due to rising sales of cars, two-wheelers and three-wheelers, which grew at an annual rate of 7%, 17%, and 16%, respectively, between fiscals 2017 and 2018. Further, low crude oil prices, coupled with reduced availability of CNG due to lack of domestic gas availability, boosted petrol consumption in recent years. In 2011, the government had banned the import of CNG kits and cylinders to reduce CNG usage.

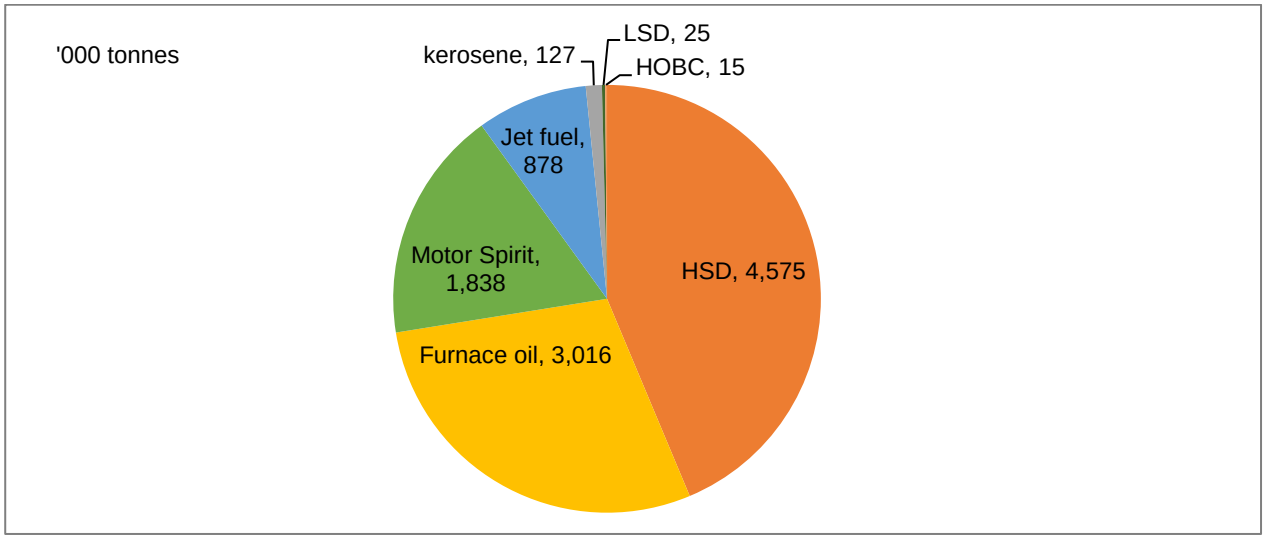
The consumption of diesel grew ~9.5% on-year in fiscal 2017, mainly on account of higher utilisation by the transport sector, led by increased economic activity in the country. The consumption growth remained muted until fiscal 2014, seeing de-growth annually from fiscal 2008. However, with pick-up in economic activity and a subdued oil price environment, coupled with a ban on CNG usage in public transportation, diesel consumption grew rapidly post fiscal 2015 at 6.9% annually till fiscal 2017.

The consumption of FO, with the power sector accounting for a major share, has shown mixed trend over the years. Despite low prices in recent years, consumption did not rise as OMCs were reluctant to supply

the fuel on credit to the power sector due to their continued liquidity constraints and delayed cash flows. Further, as the government plans to move away from FO in the power sector, its consumption in the country is expected to remain subdued in the coming years.

Overall POL consumption in Pakistan is estimated to have grown at 7.9% on year from fiscal 2016 to 2017 and at 7.6% CAGR (including LPG) from fiscal 2013 to 2018.

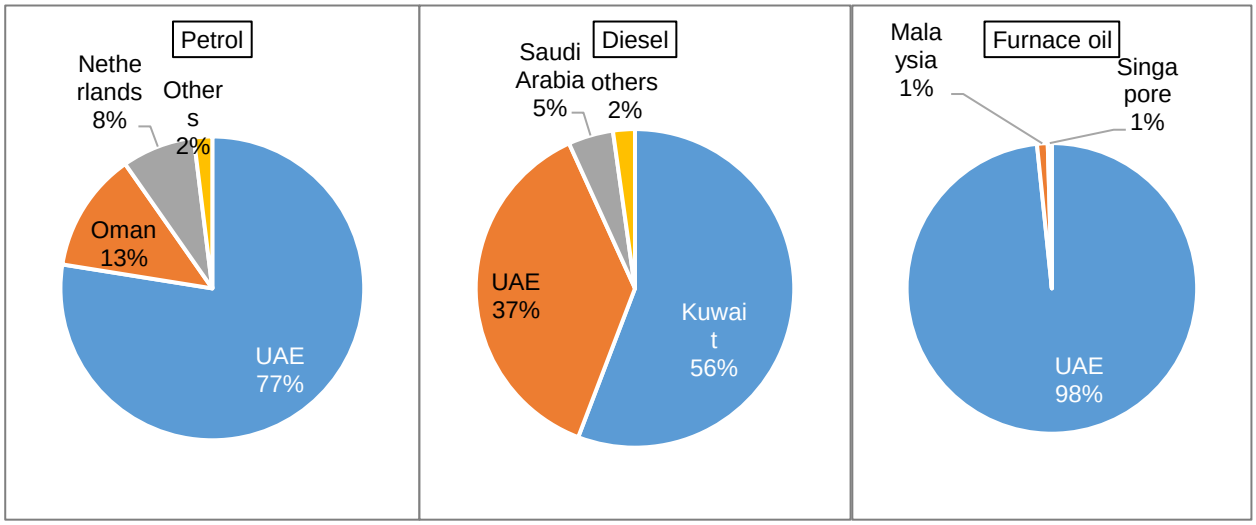
Figure 147: POL Production at Refineries in FY17: Pakistan



Source: OCAC

Imports of POL products are primarily sourced from the Middle East (the UAE, Oman, Saudi Arabia, and Kuwait) and European countries like the Netherlands.

Figure 148: Country-wise POL Products Imports in FY17: Pakistan



Source: Pakistan Bureau of Statistics

Demand, Supply Outlook

Petroleum product consumption in Pakistan is expected to grow at an annual rate of 5.2% between fiscals 2018 and 2030, driven by rising demand for petrol in the transportation segment. In addition, diesel demand is also expected to rise due to improving economic activity. However, the rising demand for petrol and diesel will be partially offset by a decline in FO consumption, slowing down overall oil demand growth. POL's product-wise factors resulting in demand growth are detailed as follows:

Petrol

Pakistan's vehicle market is currently under-penetrated with only 20 vehicles per 1,000 people. Rising per-capita income is expected to boost overall vehicle sales (particularly cars and two-wheelers) in the upcoming years. Cars and two-wheelers are expected to grow rapidly at an 11% CAGR during the period, boosting overall demand for petrol, which is expected to grow ~12%.

As of today, Pakistan is not focusing on shifting towards CNG as a transport fuel, due to limited domestic gas availability. Hence, CNG consumption is expected to grow at a muted pace of 2% per annum until fiscal 2030. Some of this growth can be attributed to increased availability of LNG, which could divert some of the existing domestic gas to the CNG segment. The emergence of electric vehicles is not expected to significantly impact Pakistan's car market, as there is no policy by the government on electric vehicles. The lack of adequate infrastructure, coupled with higher cost of electric vehicles is expected to keep penetration low over the next 13 years.

Diesel

Diesel demand is expected to grow at a 4.5-%% CAGR between fiscals 2018 and 2030, driven by higher demand from the transport segment and industries. Transport constitutes 90% of diesel demand as of fiscal 2017. Pakistan's GDP is expected to grow at ~5% CAGR over the next 13 years. As a result, the commercial vehicle market is expected to grow at ~7-8% CAGR during the period, supporting diesel demand. In particular, diesel demand is expected to see a robust growth over the next 2-3 years, growing at 7% per annum, and later moderating over the longer term.

Diesel demand is also expected to see a marginal growth, coming from the improvement in industrial activity. Further, in 2014, the Ministry of Railways launched Pakistan Railways Vision 2026, which also includes the China–Pakistan Economic Corridor rail upgrade. The plan includes new locomotives, development and improvement of current rail infrastructure. The first phase of the project was completed in 2017, and the second phase is scheduled for completion by 2021. This is expected to improve diesel demand from railways. However, diesel demand from power is expected to decline due to narrower power deficit and the shift to alternative fuels.

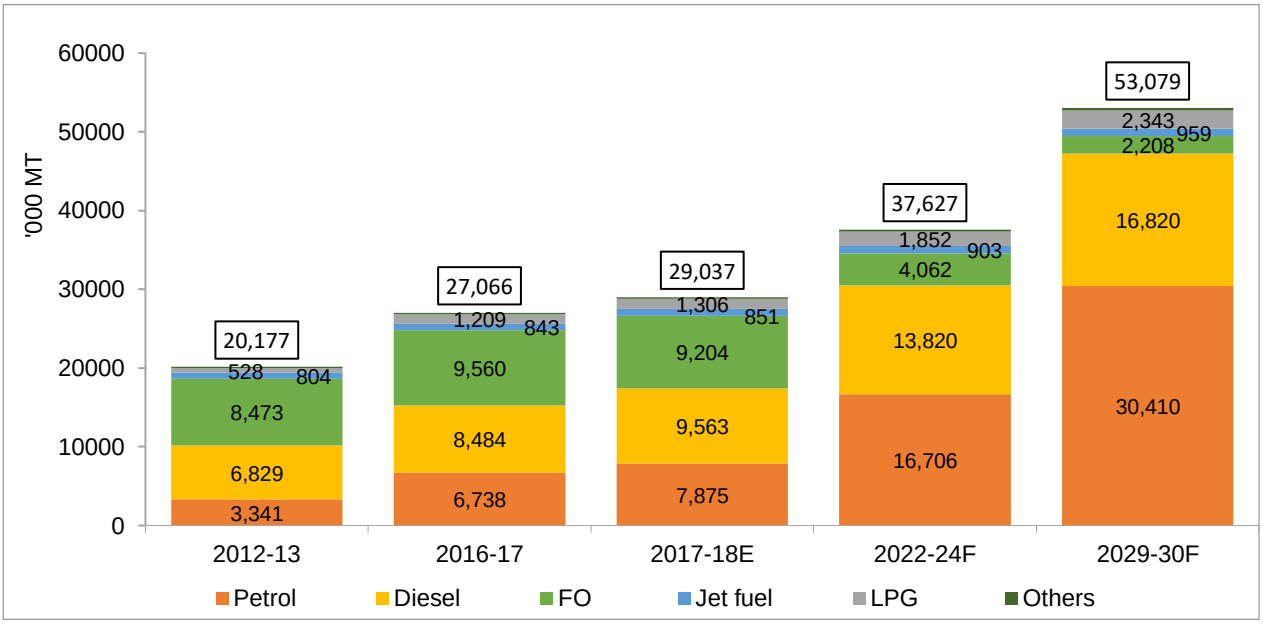
Furnace oil

FO is consumed primarily in the power sector and in industries. As of today, FO-based capacity in Pakistan stands at 9,500 MW. As the government is planning a shift from FO-based capacity to coal- and gas-based capacities in the power sector, we expect FO-based capacities to go down to 2,500 MW from current levels by 2030. Therefore, its consumption is expected to decline at an 11% CAGR to 2.2 million tonnes by fiscal 2030.

Other petroleum products

The jet fuel segment is estimated to have a 2% annual growth, with inputs from Oil Companies Advisory Committee (OCAC). Since the majority of LPG supply in Pakistan comes through its gas fields and imports, the fuel is not considered as part of petroleum products in Pakistan. LPG consumption in the country is expected to grow at a CAGR of 5% between fiscals 2018 and 2030, driven by increasing penetration of LPG in the household cooking segment.

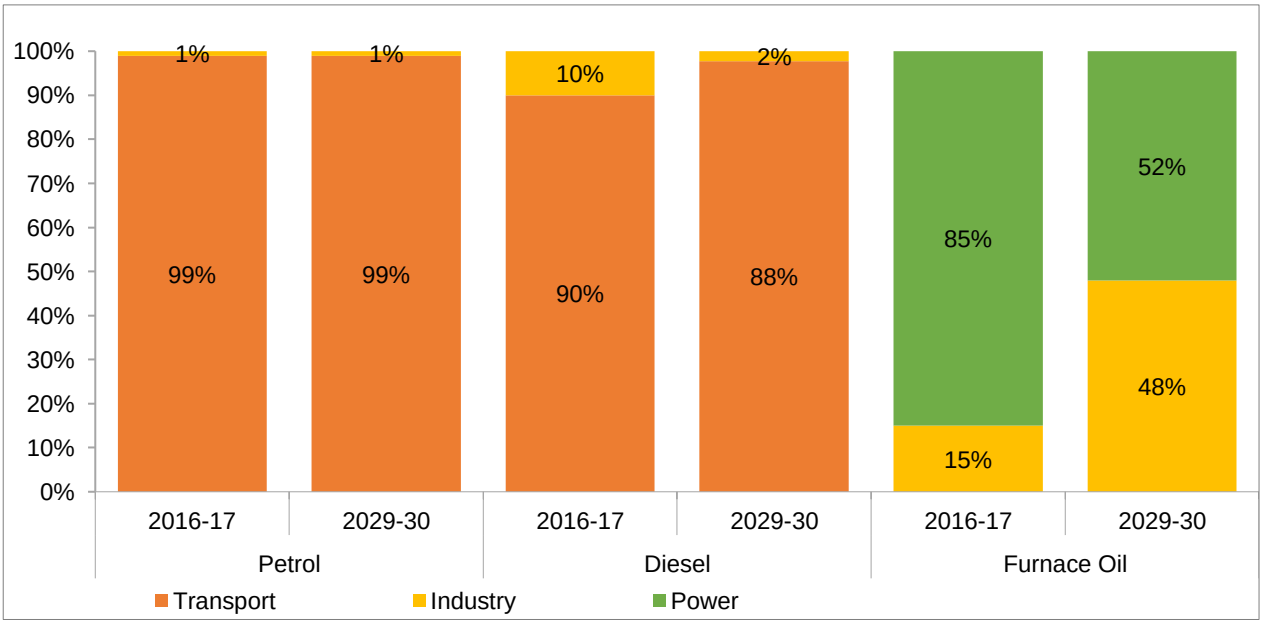
Figure 149: Outlook on Demand for Petroleum Products: Pakistan



Source: OGRA

The transport sector will continue to dominate petrol and diesel consumption in Pakistan. However, in case of FO, its usage is expected to change significantly, as a large dip is expected in demand for FO from the power sector, with the government moving to alternative sources of power supply. As a result, the share of power in FO consumption is expected to decline to 52% by fiscal 2030 from 85% currently, with its share being substituted by demand from industries.

Figure 150: Sector-wise Usage of Petroleum Products: Pakistan



Pakistan's sedimentary basin still remains majorly unexplored, leaving significant potential for exploration activities. With increased investment in upstream activities, oil production is expected to increase to ~96 thousand barrels per day from 87,000 barrels per day currently. Significant new discoveries are being made in the region, with oil production from newer discoveries to more than offset the decline in production from mature fields, leading to higher oil production. However, due to increasing demand for petroleum products,

dependence on imports will remain, as the pace of rising oil production is not expected to match the growing oil demand in Pakistan.

OGDCL has made a discovery in the Dhok Hussain field, where it expects an oil production of ~400 bpd by September 2018. The Pakistan Oil Limited (POL) has discovered its largest oil and natural gas reservoir in the Jhandial well, located in the Ikhalas block. About 23 million barrels of oil are expected to be recovered from this block. The provincial government of Khyber-Pakhtunkhwa (KP) aims at increasing the production from its field to four times of the current level by 2025. KP currently produces about 50,000 bpd of crude, more than a half of the country's total production of about 91,000 bpd.

Currently, more than 50% of the POL requirement in Pakistan is met through imports with the remaining being supplied through refineries. Attock Refinery Ltd (ARL), which completed an expansion of its refining capacity by 10.4 thousand bpd in December 2016, is expected to improve its throughput. In addition, Pak Arab Refinery Limited (PARCO) is planning to set up a new refinery with a capacity of 250,000 barrels per day in a joint venture with Abu Dhabi through Mubadala Investment Company, entailing an investment of ~$6 billion. The project is expected to come on-stream by 2023. ARL also has plans to install a state-of-the-art new deep conversion greenfield refinery of 50,000 barrels per day capacity, if sustainable enhanced supplies of local crude from the north become available and the government comes up with investment friendly refining policy.

Overall, it is expected that the total refining capacity shall increase at a 4% CAGR until 2030, provided both of the above-mentioned refineries come online. Total domestic production of POL products is expected to increase to 24.6 million tonnes in fiscal 2030, from the current 10.4 million tonne in fiscal 2017 (excluding LPG). However, overall demand for POL products will still remain higher, reaching 53 million tonnes by fiscal 2030. As a result, Pakistan will remain a net importer of petroleum products.

The following table showcases the balance of POL trade for Pakistan until fiscal 2030, highlighting that it shall have an overall deficit of 26 million tonne by fiscal 2030.

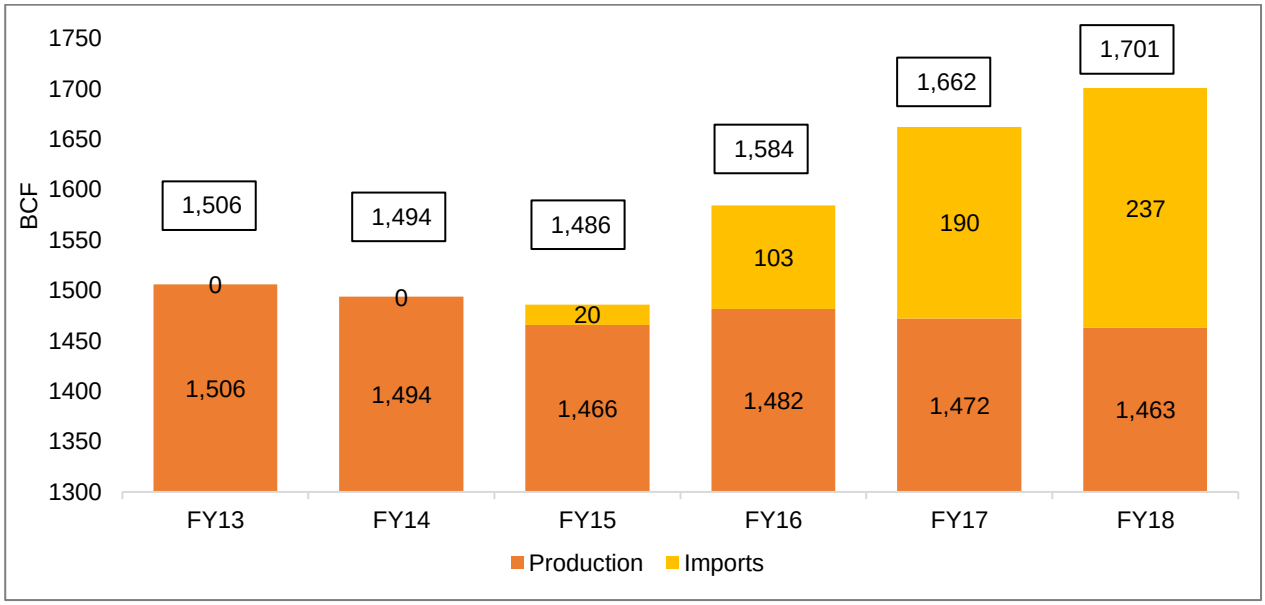
Table 52: POL Trade Balance: Pakistan

('000 MT)	FY17	FY18E	FY24F	FY30F
Refining capacity	19,600	19,600	32,400	35,200
Crude oil condensates production	4,390	4,460	4,627	4,755
Crude oil Imports	6,084	6,281	18,073	19,862
Petroleum product production	10,475	10,741	22,700	24,618
Petroleum product net import (Excluding LPG)	15,381	16,012	13,074	26,118

Gas

Gas is a major contributor in the country's energy mix. It serves several purposes, including power generation, industrial feedstock, domestic and commercial consumption. Demand for natural gas has risen at 2.1% CAGR over fiscals 2013 to 2018. As of fiscal 2017, power generation stood the single largest consuming industry at 32%, followed by domestic use (21%) and industrial use (19%). Punjab and Sindh provinces are the highest consumption centres at 47% and 43%, respectively. On the supply front, Sindh, Balochistan and Khyber Pakhtunkhwa have contributed 56%, 13% and 12%, respectively.

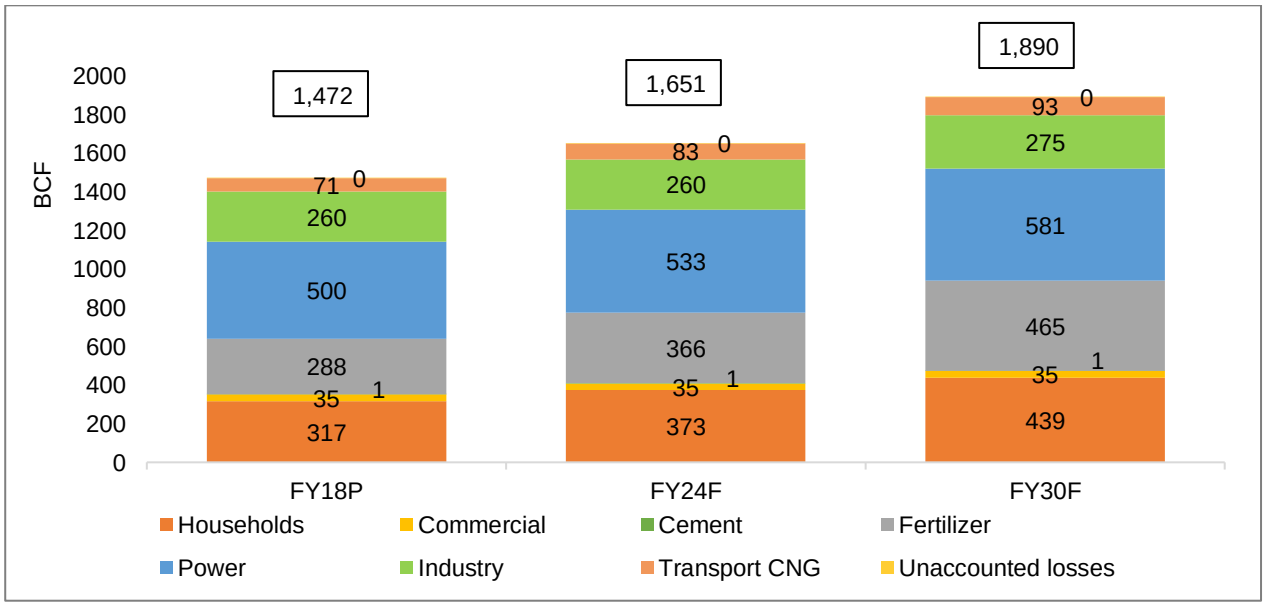
Figure 151: Natural Gas Usage Pattern – Review: Pakistan



Source: OGRA, Economic Survey

The total discovered gas reserves in the country stood at 57 tcf and extracted reserves as of end fiscal 2018 stand at ~39 tcf. Assuming that NG domestic production stays the same as in fiscal 2017, the country has enough gas resources only for the next 12 years. On the demand front, gas utilities will keep adding new consumers and existing gas-based power plants will continue to need additional gas, because of ageing. As per the merit order of power generation plants, 13 of top 15 power plants are gas-based, due to cheaper fuel costs, thereby alluding to the fact that gas requirement from power will stay intact in the short-to-medium term, unless cheaper forms of energy (such as coal and RE) come up. Gas requirement from fertiliser plants have also seen steady growth of 4% on-year and expected to continue on the same lines.

Figure 152: Natural Gas Usage Pattern – Outlook: Pakistan

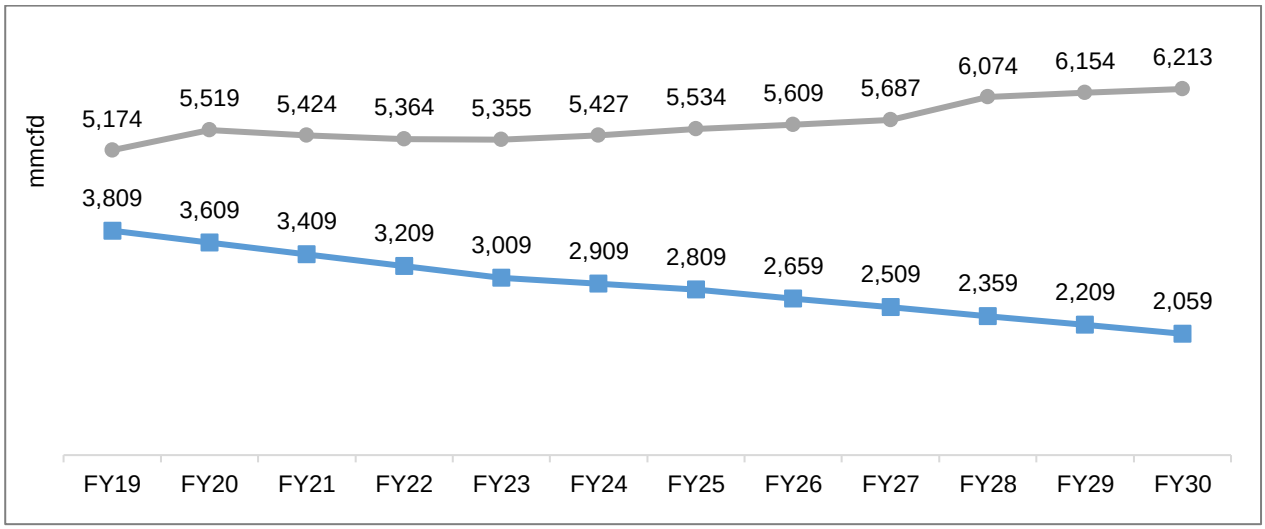


Gas requirement (constrained) will increase marginally from 5174 mmcfd in fiscal 2019 to ~5900 mmcfd in fiscal 2030. LNG imports are expected to grow to ~2160 mmcfd by fiscal 2030, with additional 1670 mmcfd to be procured from upcoming Iran-Pakistan pipeline and TAPI. OGRA has estimated that unconstrained demand will soar to ~8120 mmcfd by fiscal 2030, thereby leading to a demand-supply gap of ~3020 mmcfd.

Gas will no longer remain the cheapest fuel for power production and will be substituted by domestically produced coal, solar and wind. Competitive bidding in RE projects and net-metering regulations are already in place and will pave the way for accelerated development of RE plants. Gas-based plants will face curtailment and early retirement, thereby reducing proportion of gas-based generation from 32.7% to ~24% of total power produced.

Fiscal initiatives offered by the government and rising prices of gasoline had prompted proliferation of CNG vehicles in the country. However, it was soon envisaged that domestic natural gas cannot sustain the rising CNG demand. After fiscal 2012, CNG demand has been on the decline and no new CNG pumping stations have been granted licenses in the country after 2008. The highest curtailment has been in the case of transport CNG. With increase in LNG imports, CNG will see slight improvement in usage and sales but will not reach highs of fiscal 2012.

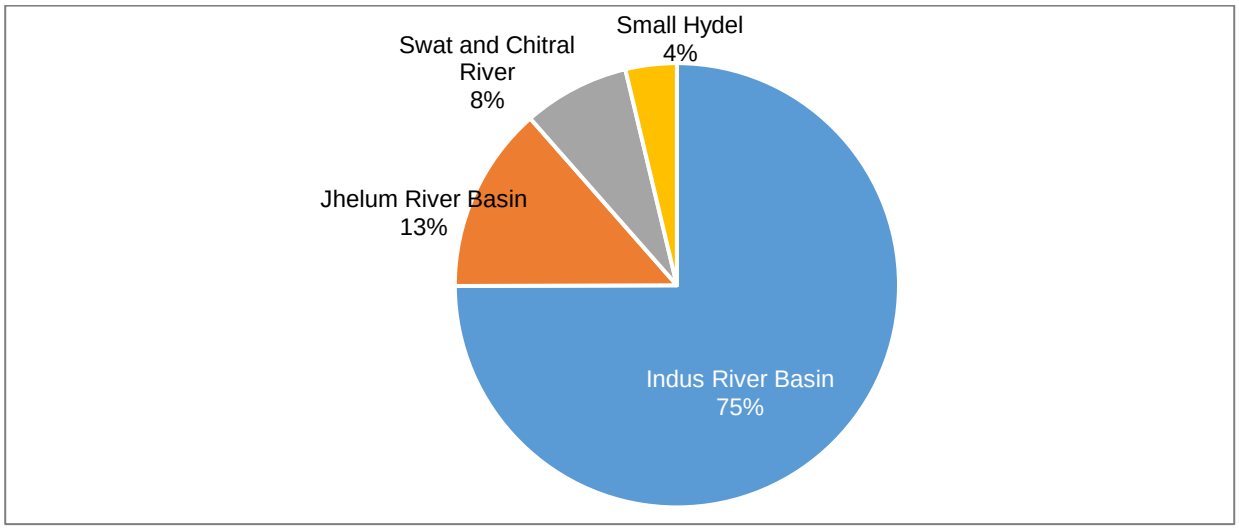
Figure 153: Gas Supply – Outlook: Pakistan



Hydro

Hydropower is one of the cheapest and cleanest forms of energy. As per WAPDA, Pakistan is estimated to have a cumulative hydropower potential of 60,000 MW. The Indus River Basin contains ~75% of the entire hydropower potential of the country.

Figure 154: Distribution of Hydropower Potential (MW): Pakistan



Source: WAPDA

Large-scale hydro

As of fiscal 2018, Pakistan has an estimated installed capacity of 9,500 MW of large hydro projects, of which over 95% is owned by WAPDA, while the remainder is owned and operated by IPPs. However, on the generation front, power production has been reducing from 2016, due to the lack of water availability and diversion of water from large reservoir-based power plants towards irrigation.

Table 53: Major Hydropower Projects in Pakistan: Pakistan

Sr. No	Name of Project	Installed Capacity (MW)
1	Tarbela	3,478
2	Ghazi Barotha	1,450
3	Mangla	1,000
4	Warsak	243
5	Chashma	184
6	Khan Khwar	72
7	Allai Khwar	121
8	Jinnah	96
9	Duber Khwar	130

Source: WAPDA, NEPRA

WAPDA and private concessionaires have a healthy lineup of hydel projects, which are under construction or awaiting clearance. However, as hydro power is subject to seasonal variation, depending on reservoir level, inflow and discharge of water from reservoirs, power from hydro can be unreliable and inconsistent. Therefore, despite making capacity additions towards hydro projects, the country will add thermal power plants in the earnest. More than 12,500 MW of hydro projects are expected to be set up by fiscal 2030. However, the share of large hydro projects in the power generation mix in fiscal 2030 is seen at 28%, in line with fiscal 2018 levels of 26%.

Table 54: Upcoming major hydro power projects: Pakistan

Sr. No	Name of project	Installed capacity (MW)	Status
1	Hamza Sugar Mill	15	Commercial Operation
2	Layyah Sugar Mills	41	Commercial Operation
3	Almoiz Industries	36	Financial Closure
4	Safina Sugar Mills	20	LOI Stage
5	Alliance Sugar Mills	30	LOS Stage
6	Etihad Power Generation	74.4	LOS Stage
7	Shahtaj Sugar Mills	32	LOS Stage
8	Chanar Energy	22	Financial Closure
9	RYK Energy	25	LOS Stage
10	Sheikhoo Power	30	LOS Stage
11	Indus Energy.	31	LOS Stage
12	Hamza Sugar Mill (Unit-II)	30	LOS Stage
13	Hunza Power Pvt.	49.8	LOS Stage

Sr. No	Name of project	Installed capacity (MW)	Status
14	Bahawalpur Energy	31.2	LOS Stage
15	Mirpurkhas Energy	26	LOS Stage
16	Faran Power	26.5	LOS Stage
17	Ittefaq Power Pvt.	31.2	LOS Stage
18	Mehran Energy	26.5	LOS Stage

Source: WAPDA, NEPRA

Renewable

It is expected that an additional 2,500 – 3,000 MW of bioenergy/biomass projects will be implemented by fiscal 2030. Cumulatively, ~8000 MW of other RE power projects are expected to come up, improving its share in power generation from 2% in fiscal 2018 to ~9% in fiscal 2030.

Although the country has been taking steps in the right direction, several problems persist, which have been hindering the country from taking the full advantage of its full RE potential.

1. Currently, there is no set target for RE development. Therefore, private investors are wary about future political will and government support towards the sector. As there is no act or law enforcing renewable obligation, the investment climate in the RE space is dictated by the whims and fancies of the political climate.

2. Inadequate capacity of system grid to integrate variable RE. The national grid of Pakistan is highly unreliable and insecure and large fluctuations because of RE tend to make the grid more vulnerable to tripping and unscheduled outages. Steps are being taken to set up interconnection arrangements for existing and upcoming RE projects.

Nuclear

Currently, five nuclear facilities are under commercial operation with a cumulative installed capacity of 1,355 MW. Karachi-1, Chashma 1, Chashma 2, Chashma 3 and Chashma 4 have generated ~7,750 GWH in fiscal 2018. Karachi-1 was the first nuclear reactor to be set up in 1972 and is expected to retire in fiscal 2019.

Three more nuclear plants – namely Karachi 2, Karachi 3 and Chashma 5 – are expected to come up in the next decade. Karachi 2 is planned to go live by fiscal 2022, whereas Karachi 3 by fiscals 2023 to 2024. Chashma 5 unit is subject to Non-Proliferation Treaty (NPT) and guidelines of Nuclear Suppliers Group (NSG).

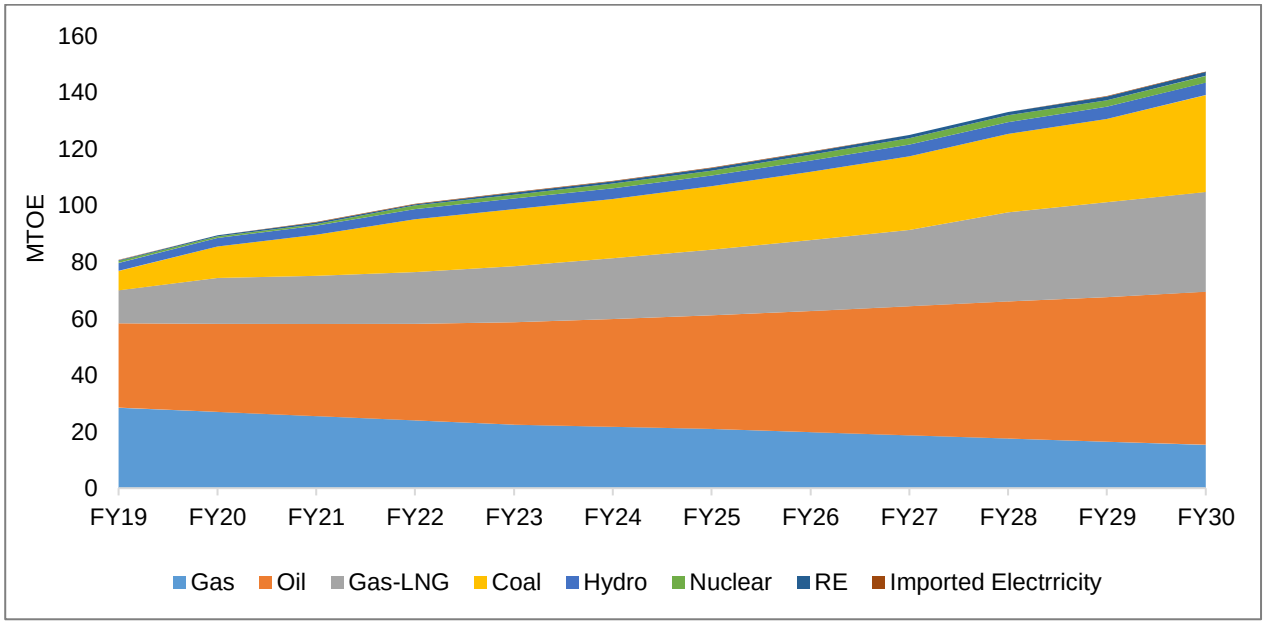
Pakistan Nuclear Regulatory Authority (PNRA) regulates the safety of nuclear facilities and material and is also responsible for licensing and supervision. If all 3 nuclear units are set up as planned, power generation will move from 7897 GWH in fiscal 2019 to ~27850 GWH in fiscal 2030.

Energy Outlook 2030

Combining the usage outlook for all the aforementioned fuels, it is estimated that the overall energy requirement in Pakistan shall rise from 73 MTOE in fiscal 2018 to 147 MTOE in fiscal 2030.

All figures in MTOE	**FY18P**	**FY19F**	**FY24F**	**FY30F**
Primary energy	75	81	109	147

Figure 155: Primary Energy Outlook 2030: Pakistan



Outlook on Imports

Pakistan is expected to face fuel shortage with the reduction in growth for domestic production of all major fuels (except coal). The country will be leaning more towards imports to bridge the demand-supply gap.

Depending on the as-is scenario and taking into consideration expected change in fuel availability, Pakistan would need imports as shown below:

Table 55: Import of Fuels – Outlook: Pakistan

Fuel	FY17	FY24	FY30
Crude Oil [in '000 tonne]	8,834	18,073	19,862
Petroleum Products [in '000 tonne]	15,145	13,074	26,118
Electricity [in GWH]	497	1,000	1,000
Coal [in '000 tonne]	7,021	24,456	31,903
Gas [in bcf]	190	919	1,516

9 Sri Lanka

9.1 Country Overview

Sri Lanka is a small island nation, off the southern tip of India. The country's GDP has been growing steadily at a CAGR of 4.1% from 2013 to 2017. Like any other developing nation, the country's energy requirement has been rising steadily. However, it relies on importing the majority of its gross fuel requirement. The country's profile is as follows:

Table 56: Country Profile: Sri Lanka

	Factors	2013	2017
Demographics	Population (million)	20.6	21.4
	Urban/rural divide	18.3%	18.4%
Macro-Economic Scenario	GDP growth rate	3.4 %	3.13%
	Per-capital GDP (at current prices)	9%	10.4%
	Sectoral growth rate		
	a. Industry	4.1%	3.9%
	b. Services	3.8%	3.2%
	c. Agriculture	3.2%	-0.8%
Fiscal Position	Exports ($ million)	15,098	19,173
	Imports ($ million)	21,500	25,477
	CAD (% of GDP)	5.4 %	5.5%

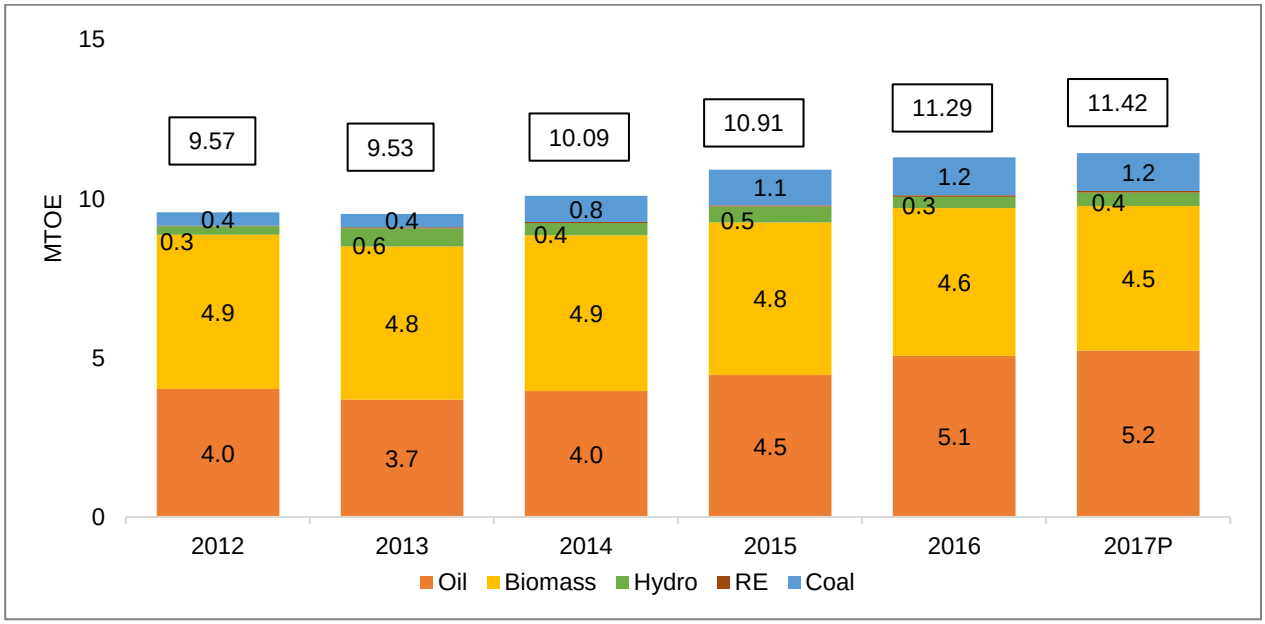
Exchange rates: One US Dollar (US $) = Rupees; for 2013-> 129.1, for 2017 -> 152
Source: Economic Survey, Country Reports, Central Bank Sri Lanka

9.1.1 Overview of Energy Structure

Energy Mix

The country is majorly dependent on imports to meet the primary energy requirement. On the demand side, per-capita energy use has grown from 434 TOE in 2013 to 510 TOE in 2017, a CAGR of 4.12%, which is in line with the real GDP growth of 4.15% during the same period. The government intends to narrow the widening CAD to 3.5% by 2020. The country has put energy efficiency as a key focus area and has set short- and long-term goals for achieving energy savings. It is also working towards commercially exploiting discovered oil and gas reserves in Mannar and Cauvery basins.

Figure 156: Primary Energy Supplies, by Source: Sri Lanka



**RE usage was <0.05 MTOE/year for the period 2009-2017P, hence insignificant in volume terms and not shown in above chart.*

Source: Economic Survey, Energy Balance

Domestic Availability and Imports of Fuels

Below is the snippet for domestic production and import for the major fuels as of 2013 and 2016.

Table 57: Domestic Production and Import for Major Fuels: Sri Lanka

Fuel	Supply Type	2013	2016
Coal [in '000 tonne]	Domestic Production	0	0
	Imports	761	2,082
Crude Oil [in '000 tonne]	Domestic Production	0	0
	Imports	1,743	1,685
Petroleum Products [in '000 tonne]	Processed in Refinery	1,555	1,633
	Imports	2,463	3,630
	Exports	806	1,218
Electricity [in GWH]	Domestic Production	12,024	14,361
	Imports	-	-

Source: Economic Survey, Energy Balance

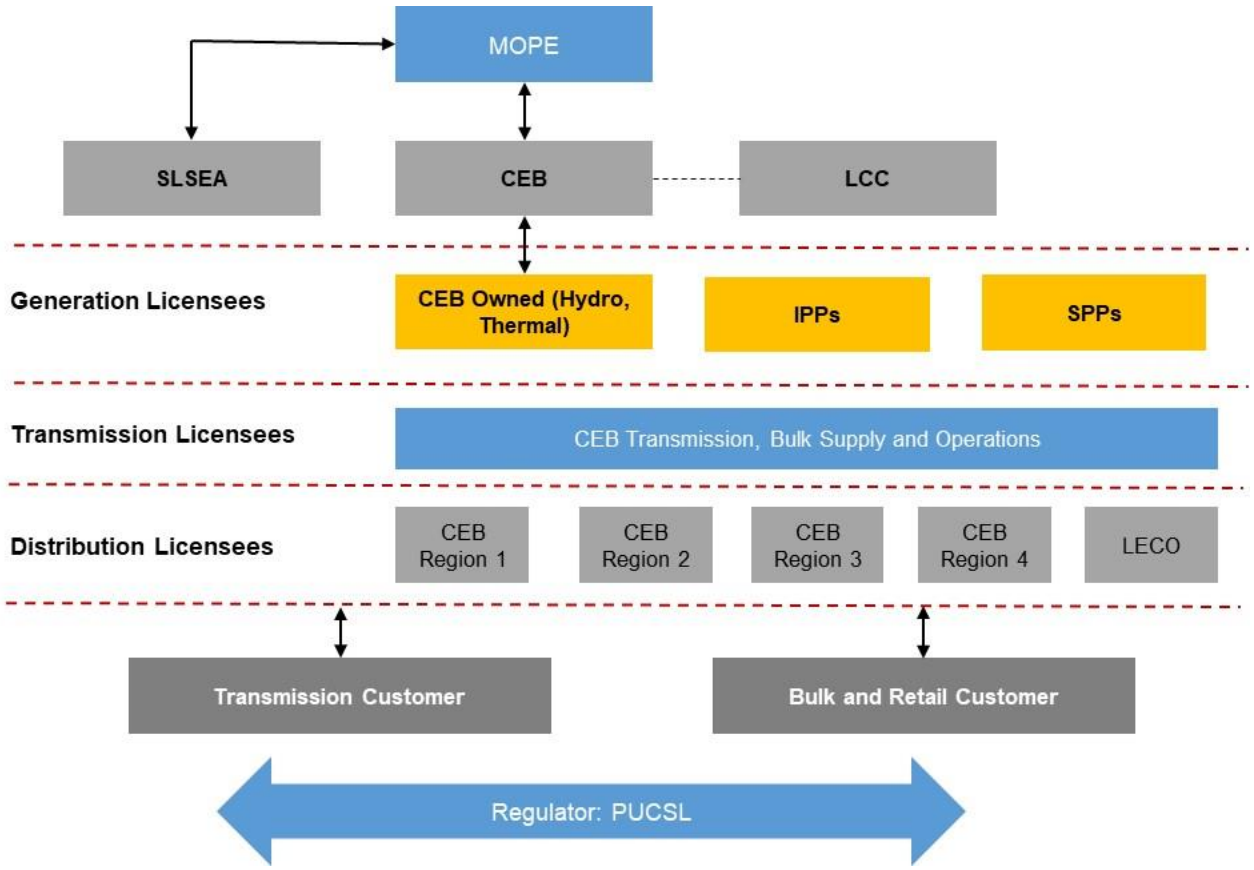
9.2 Institutional and Regulatory Framework of Energy Sector

9.2.1 Planning and Regulatory Bodies

Sri Lanka's energy sector is managed principally by the Ministry of Power and Energy, along with the Ministry of Petroleum Resources Development, specifically for POL products

Power Sector

Figure 157: Organogram of The Power Sector: Sri Lanka



CEB = Ceylon Electricity Board, IPP = independent power producer, LECO = Lanka Electricity Company, MOPE = Ministry of Power and Energy, PUCSL = Public Utilities Commission of Sri Lanka, SLSEA = Sri Lanka Sustainable Energy Authority, SPP = Small power producer, LCC= Lanka Coal Company
**CEB owns majority stake in LCC, therefore dashed relationship shown between the two*

Federal Agencies

MOPE is responsible for formulating and implementing national policy for power and energy of the country. It facilitates the development of projects in generation, distribution and transmission by ensuring efficient conduct of business and sound monitoring, investigating and planning of electricity facilities. It develops electricity policy for the country by taking into account future energy needs, specific targets and milestones to be achieved.

PUCSL was established under Act No. 35 of 2002 and is empowered to regulate the electricity industry as well as the petroleum industry. It acts as an economic, technical and safety regulator by advising the government on all matters related to the industries under its purview, exercising licensing and standardising of industries, regulating tariffs for consumers. Under Sri Lanka Electricity Act No. 20 of 2009, PUCSL is the economic, safety and technical regulator of the electricity sector.

SLSEA was established in 2007 under the Sri Lanka Sustainable Energy Authority Act No. 35 of 2007. It is the apex institution for policy formulation, promotion and conducting research for development of renewable energy and indigenous energy sources. It also strives to improve energy efficiency through research and development and knowledge management.

Power generating entities in Pakistan can be broadly classified as follows:

- *CEB:* State-owned corporation; engaged in power generation, transmission and distribution (four licenses, catering across four distribution regions) of power. More than 66% of total installed capacity is licensed to CEB.
- *IPPs*: Private power plants engaged in thermal power production. Seven IPPs are operating in the country as of 2013.
- *SPPs*: Independent private power plants producing non-conventional renewable energy (hydro, solar, wind, biomass). Currently, ~130 SPPs are operating in the country.

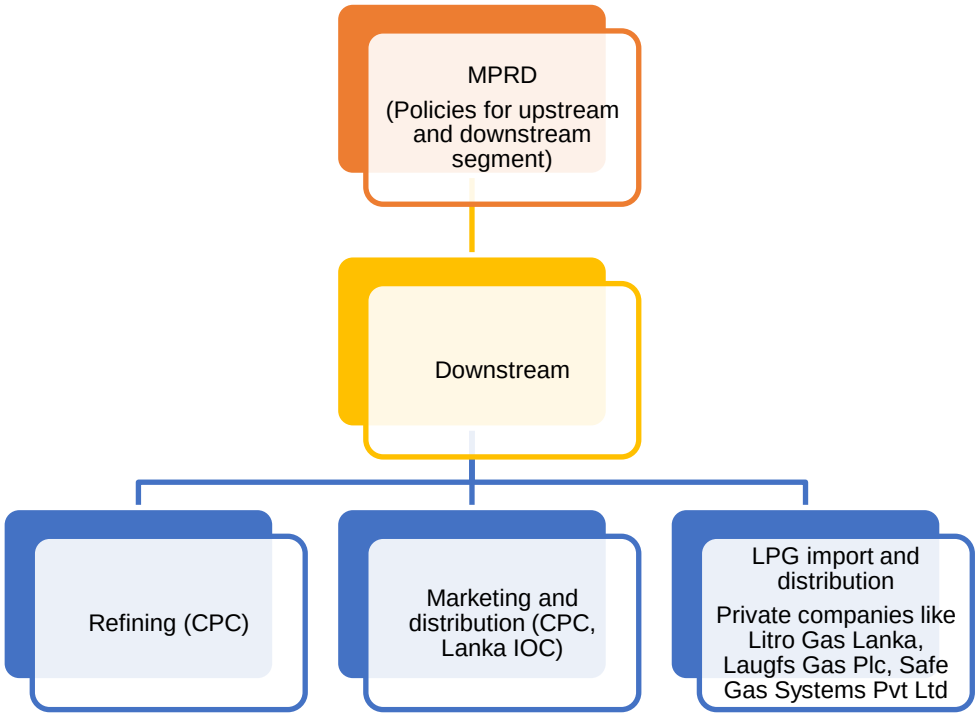
CEB solely owns and operates the electricity transmission network of the country. There are five distribution licensees, whereby four are controlled by CEB and one is privately managed, named LECO.

Hydrocarbon Sector

Institutional Framework

The Ministry of Petroleum Resources Development (MPRD) is responsible for making policies pertaining to upstream and downstream activities in Sri Lanka. Since the nationalisation in 1961, management of the country's petroleum industry was largely managed by Ceylon Petroleum Corporation (CPC) until 2003. In 2003, a large part of marketing and distribution business was taken over by the Lanka Indian Oil Company (a subsidiary of Indian Oil Corporation). The import and distribution of LPG is largely handled by the private sector, with CPC contributing to 15% of the country's LPG supply through its refinery.

Figure 158: Current Structure of Sri Lanka Hydrocarbon Sector



9.2.2 Regulatory and Policy Framework

The Sri Lanka Electricity (Amended) Act, No. 31 of 2013 is the overarching regulatory framework of the Sri Lanka power sector.

The petroleum industry is at present governed by the Petroleum Products (Special Provisions) Act No.33 of 2002 and Ceylon Petroleum Corporation Act No. 28 of 1961.

9.2.3 Government Support: Pricing, Existing Subsidies on Fuel and Controlling Regime

Coal

There are no general and preferential duties on coal imports. However, it attracts VAT (value-added tax), PAL (ports and airports development levy) and NBT (nation building tax) as shown below.

Table 58: Taxes and duties on coal imports: Sri Lanka

Type of Coal	Preferential Duty	General Duty	VAT	PAL	NBT
Anthracite and bituminous	Free	Free	15%	Exempted	Exempted
Lignite	Free	Free	15%	7.50%	2%
Other	Free	Free	15%	Exempted	Exempted
Peat	Free	Free	Exempted	7.50%	2%
Coke and semi-coke	Free	Free	15%	7.50%	2%

**As on September 2018*
Source: Sri Lanka customs

Petroleum Products

In Sri Lanka, the government determines prices for motor spirit (petrol), diesel, and kerosene sold by the Ceylon Petroleum Corporation (CPC). It can revise the pricing formula every two months. LPG price increases require prior authorisation by the Consumer Affairs Authority. Lanka Indian Oil Corporation (IOC) is free to set its prices, but given that CPC controls two-thirds of the market and is the price setter, CPC's prices effectively limit Lanka IOC's price movement.

The Sri Lankan government had cut fuel prices in January 2015. The prices have not been increased since then due to political pressure and fear of unpopularity among voters. However, under pressure from the IMF to increase revenue, the government increased excise duty on diesel by rupees 10 to rupees 13 per litre in August 2017, but asked retailers to not pass on this cost to the consumers. In May 2018, however, the government hiked fuel prices by ~130%, when the IMF pressurised the government, saying it would halt the scheduled fourth instalment of a $1.5 billion loan to Sri Lanka, unless the government introduces an "automatic fuel pricing mechanism."

In addition, the government also announced that fuel subsidy would only be provided on kerosene for low-income families and fishermen, and there would be no subsidy on petrol and diesel. The government has also introduced a formula for fuel pricing, which will vary based on Singapore prices and is reviewed on the 10th of every month.

The tables below include details on taxes and duties on petroleum products and price revisions of the past five years.

Table 59: Duties on Petroleum Products in Sri Lanka as in 2018

	General Duty ($ per litre)	Excise ($ per litre)
Petrol having Octane number of 92	0.16	0.17
Petrol having Octane number of 95	0.16	0.17
Super diesel	0.07	0.08
Other diesel	0.04	0.08

Source: Sri Lanka customs

Note: Super diesel is diesel with Sulphur content up to 10 mg per kg; 1USD= 161. 26 Sri Lankan Rupees (Rs) as of August 2018

Table 60: Fuel Price Revisions in Sri Lanka

(Rs per litre)	Petrol 92 Octane	Auto Diesel	Kerosene	Furnace oil 1500
December-12	1.25	0.90	0.83	0.71
February-13	1.24	0.93	0.81	0.69
September-14	1.20	0.90	0.66	0.69
December-14	1.14	0.85	0.62	0.69
January-15	1.04	0.77	0.56	0.56
January-15	0.81	0.66	0.45	0.56
January-15	0.81	0.66	0.41	0.56
November-15	0.81	0.66	0.34	0.56
May-18	0.87	0.69	0.64	0.51
June-18	0.87	0.69	0.44	0.51
July-18	0.92	0.75	0.44	0.51
August-18	0.92	0.75	0.44	0.51

Source: CPC

9.3 Overall Energy Outlook 2030

This report assesses the overall energy outlook of Sri Lanka by undertaking a detailed review of all primary sources of energy, including coal, gas, hydro, POL products, and renewables. The island nation intends to achieve its development objectives while moving towards a low carbon pathway. It wants to reduce GHG emissions against BAU scenario by 20% in energy sector (4% unconditionally and 16% conditionally) and by 10% in other sectors (transport, industry, forests and waste) by 3% unconditionally and 7% conditionally by 2030. To achieve its INDC target in the energy sector, the country has highlighted certain goals: *a)* Establishment of large scale wind power farms of 514 MW; *b)* solar power plants with capacity of 115 MW to be established; *c)* promote use of biomass (fuel wood) and waste (municipal waste, industrial and agricultural waste) by elevating its use in the power generation, adding 104.62 MW in 2025; *d)* mini-hydro power plants with the capacity of 176 MW to be established; *e)* introduction of demand side management (DSM) activities in order to improve the load factor of the system. The SAARC energy outlook 2030 for Sri Lanka incorporates all the above action points.

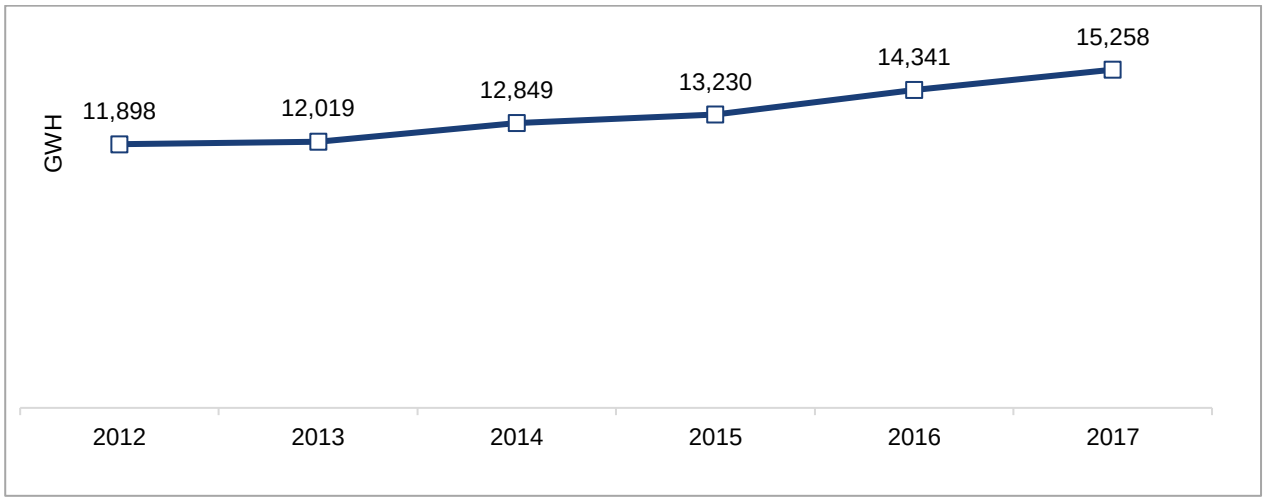
Since the power sector serves as a major consumer of energy sources and the single largest supplier of secondary energy, its analysis precedes the fuel wise discussion.

9.3.1 Power Demand, Supply Review

Power Demand Position

The demand load curve grew from 11,898 MU in 2012 to 15,258 MU in 2017 at 5.1% CAGR. Some 99.7% of the country is electrified and electricity intensity has increased significantly, from 510 MU/million population in 2012 to 637 MU/ million population in 2017.

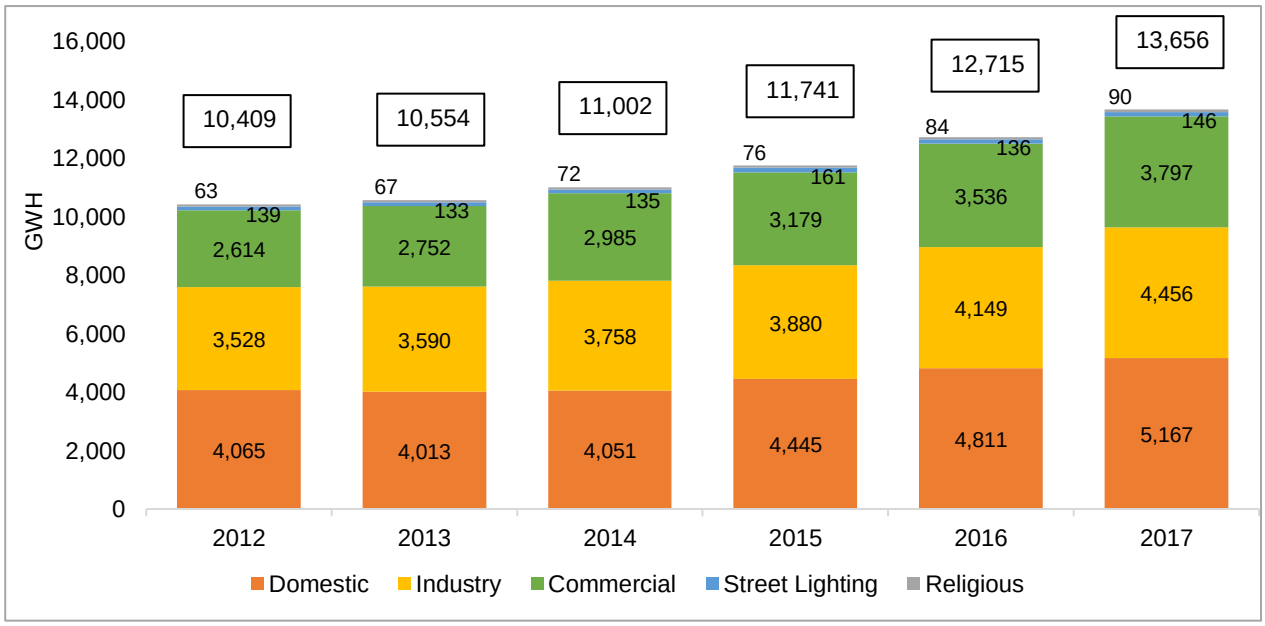
Figure 159: Demand Load Curve - Review: Sri Lanka



Source: Energy Balance, LTGEP

Some 87% of the country's consumers fall under the domestic category, and 11% under the commercial category. Industrial consumers comprise only 1% of the total consumer base. As per electricity sales, domestic consumption contributed to 38% of total sales, closely followed by industrial (33%) and commercial (29%) consumption.

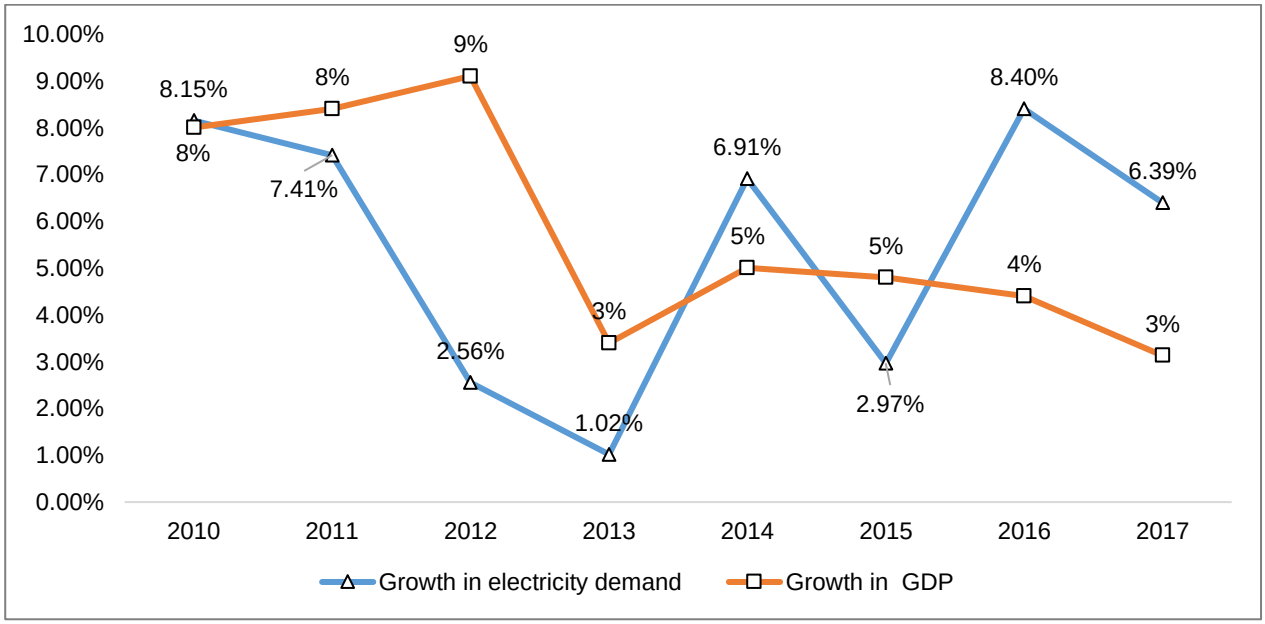
Figure 160: Consumer-wise Electricity Sales – Review: Sri Lanka



Source: Energy Balance, LTGEP

Although GDP growth for a country is subject to short-term cyclicality, increase in electricity demand typically correlates with long-term (eight-year) GDP. The demand load curve has grown at 5.47% CAGR 2009 and 2017 vis-à-vis 5.78% GDP growth rate for the period.

Figure 161: Power Demand Growth with Respect to GDP Growth: Sri Lanka

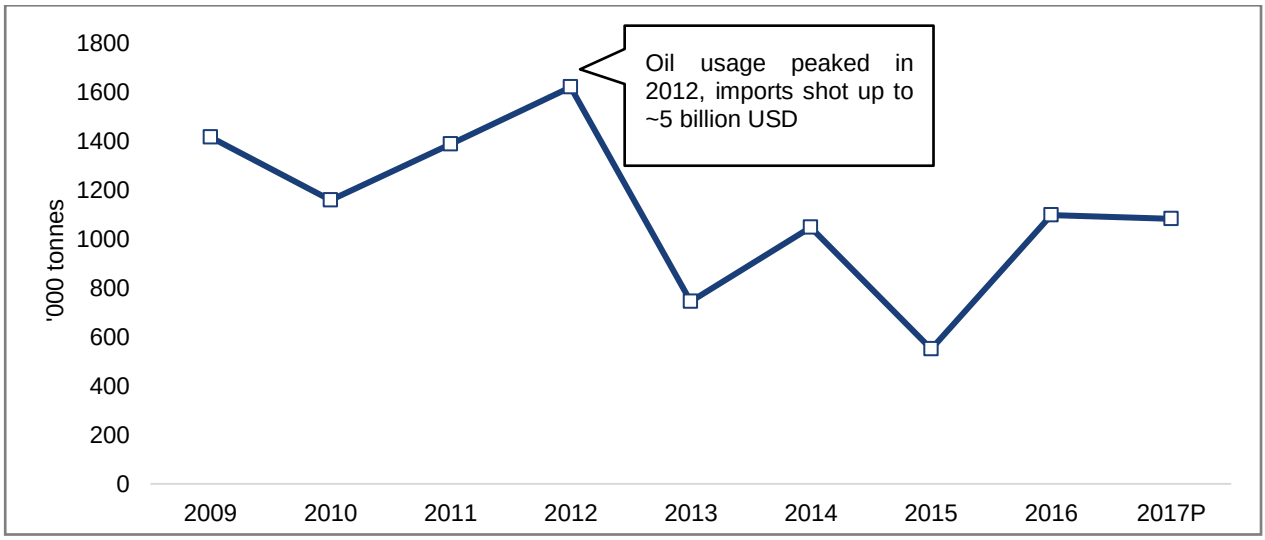


Source: Energy Balance, LTGEP, Economic Survey

Power Supply Position

Sri Lanka's total installed capacity was 4,109 MW (including 50 MW of net-metered power projects) as in 2017. The country had been highly dependent on hydro power in the early 1990s, with ~100% of power produced by hydro plants in 1990. This resulted in heavy power shortages, especially in the dry seasons and the peak of summer when water level subsided and generation fell sharply. Over the next two decades, Sri Lanka transitioned from being a hydropower nation to a hydrothermal nation. However, this led to its oil import bill ballooning. At its peak in 2012, 1.6 million tonnes of oil (diesel + residual fuel + naphtha + fuel oil) was used for power generation.

Figure 162: Oil Usage in Thermal Plants: Sri Lanka

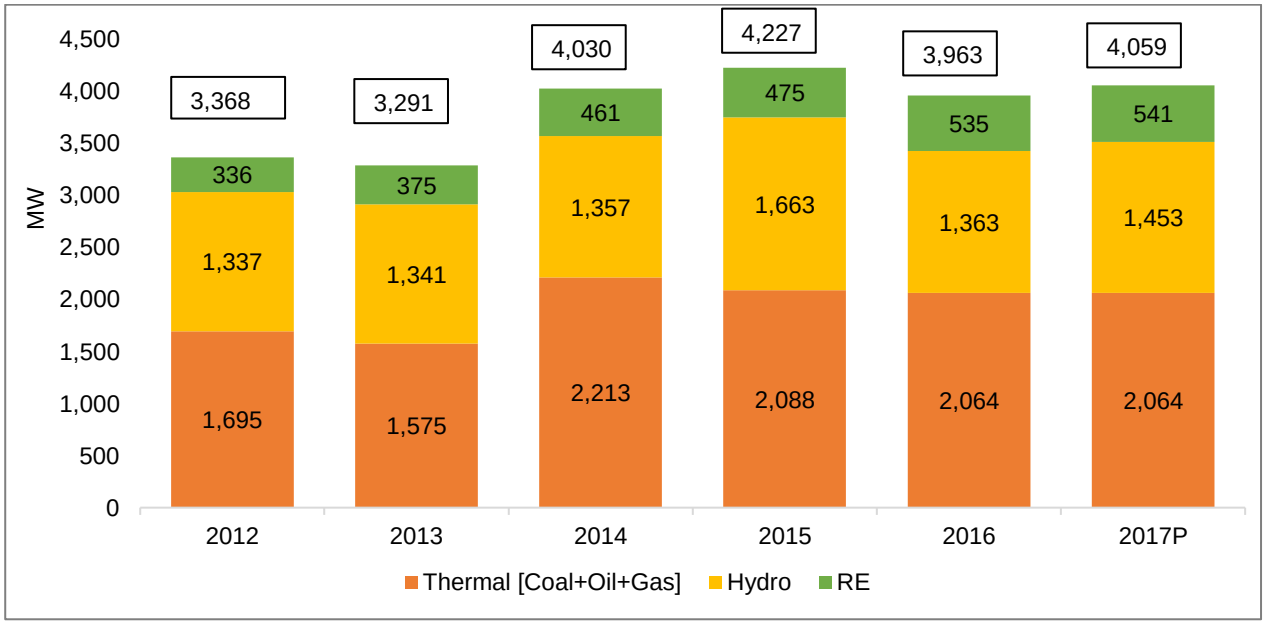


Source: Energy Balance, LTGEP

The country has been lowering its oil-fired thermal generation from 2013 given rising global oil prices and lack of domestic oil production. RE generation is small in the country, with ~500 MU produced in 2017.

With a provisional system peak demand of ~2600 MW in 2017, the system reserve margin was maintained at a healthy 54.6%.

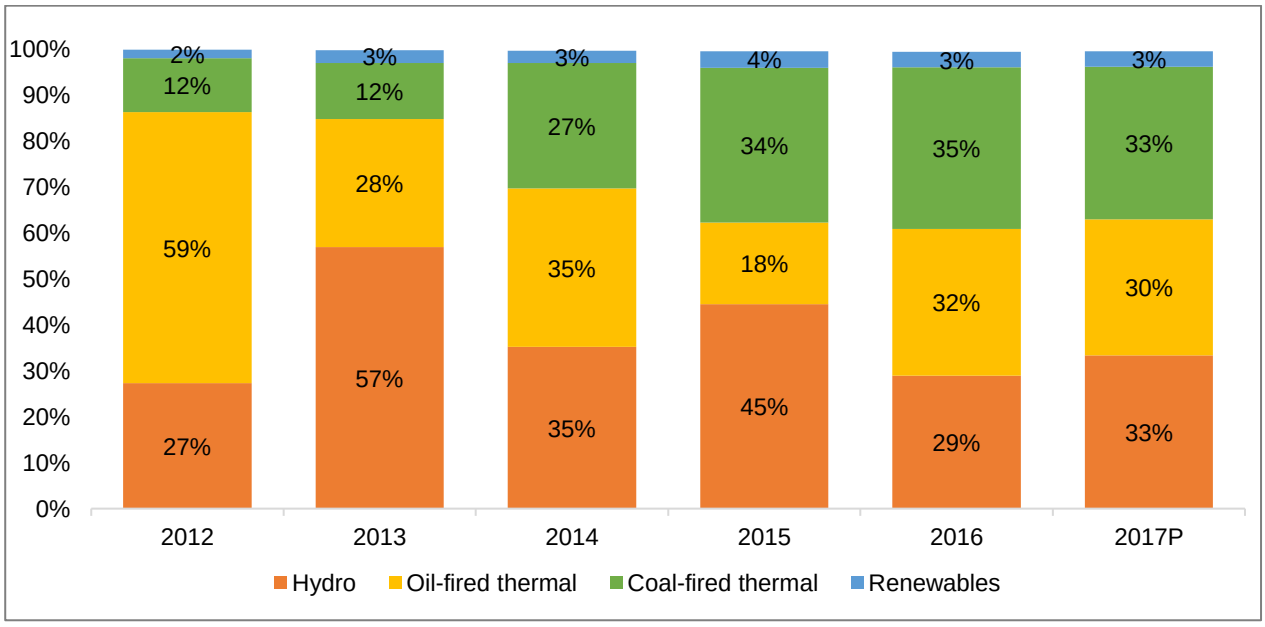
Figure 163: Installed Capacity – Review: Sri Lanka



Source: Energy Balance, LTGEP

Overall, power generation rose at 5.1% CAGR from 11898 BUs in 2012 to 15239 BUs in 2017.

Figure 164: Annual Electricity Generation – by Source: Sri Lanka



Source: Energy Balance, LTGEP

9.3.2 Power Demand, Supply Outlook

Power Demand Outlook

Domestic category sales are a function of four major factors: *a)* Number of consumers; *b)* consumption per consumer; *c)* population growth rate; and *d)* electrification rate. With the country achieving 100% electrification, additional consumption will be driven by a rise in population. Consumption per consumer is expected to grow steadily over the years. We have taken a staggered growth of 20 basis points every five years up to 2030. The electrification rate will continue to be in line with current levels with no significant domestic off-grid systems expected to come up.

Commercial power sales have been growing rapidly at a healthy 7.8% CAGR during 2012-2017. Buoyed by strong tourism growth and upcoming commercial clusters such as the Colombo Central Business District, Horana and Mirigama Industrial Township, this category will likely show strong sales going forward. With the Colombo Port City taking shape, an additional 0.03 million consumers are expected to be added per year.

Street lighting and religious category sales, which comprise a cumulative 2% of total sales, are expected to grow in line with past sales growth.

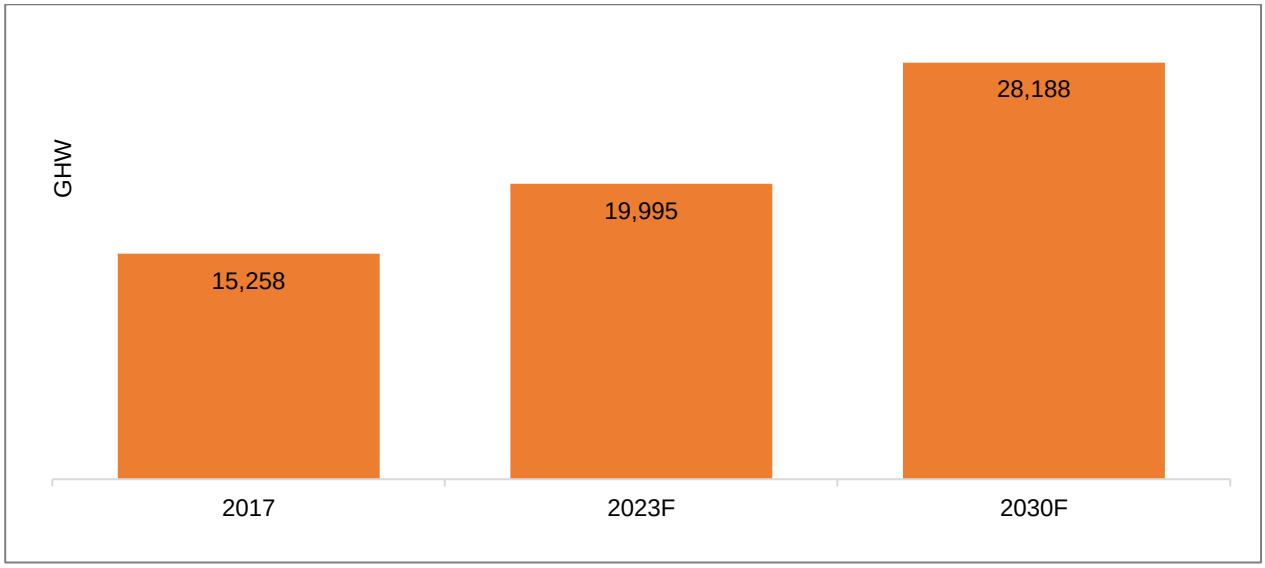
We do not see much traction in railway electrification and electric vehicle charging up to 2030. There is no significant latent demand in the country. With 100% electricity accessibility and 24 hours uninterrupted electricity supply, Sri Lanka does not face any unscheduled outages. Also, no supply constraints are expected in the future. Additional power demand is expected to come from the proposed light rail transit (LRT) system in Colombo. With ~75 km of track length to come up in three stages by 2030, an additional load demand of ~100 MUs is likely in 2030.

The country is striving to improve energy efficiency. It has set up a Presidential Task Force on DSM and formulated policies such as the 'National Program on Energy Demand Side Management'. Several steps in the right direction are being taken, such as replacing inefficient street lights with efficient LED bulbs, energy labelling for electric appliances, and development of smart grids.

According to the Long Term Generation Expansion Plan (LTGEP) 2018-2037, the country intends to save 1,000 MUs in the next five years. A conservative estimate of 80 MUs / year savings owing to DSM have been considered, beyond which 100 MUs/year is taken for load growth calculations. T&D losses stood at ~10.5% in 2017, a significant improvement over the 16% in 2009. We have assumed a conservative loss reduction of 4 basis points every year going forward.

Taking into consideration all category-wise sales, demand drivers, and demand constraints towards sales, demand load has been estimated at 28,188 MU by 2030, growing at a healthy 4.9% on-year.

Figure 165: Demand Load Curve – Outlook: Sri Lanka



Power Supply Outlook

The country has put in place five-year and 20-year forward-looking installation capacity targets in line with estimated demand. More than 3,500 MW of net installations are expected by 2030. Coal-fired thermal power will likely grow significantly, with an additional 1,000 MW of committed plants. Additionally, implementation of super-critical coal technology is undergoing a feasibility study.

Moreover, renewable generation will increase to ~12% of the generation mix by 2030 from the current 3%. Base load power will be served majorly by coal- and gas-based plants. Furthermore, gas-based plants of ~1,000 MW will come up, with the country planning to set up import facilities, domestic storage, and regasification unit of 1.4 MTPA LNG. Oil-based production will fall to 10% of total power owing to increasing power generation costs. Hydro generation will improve significantly up to 2024, beyond which growth would be slow. The system reserve margin will be range-bound at 55%-80% for the period under consideration.

Figure 166: Installed Capacity – Outlook

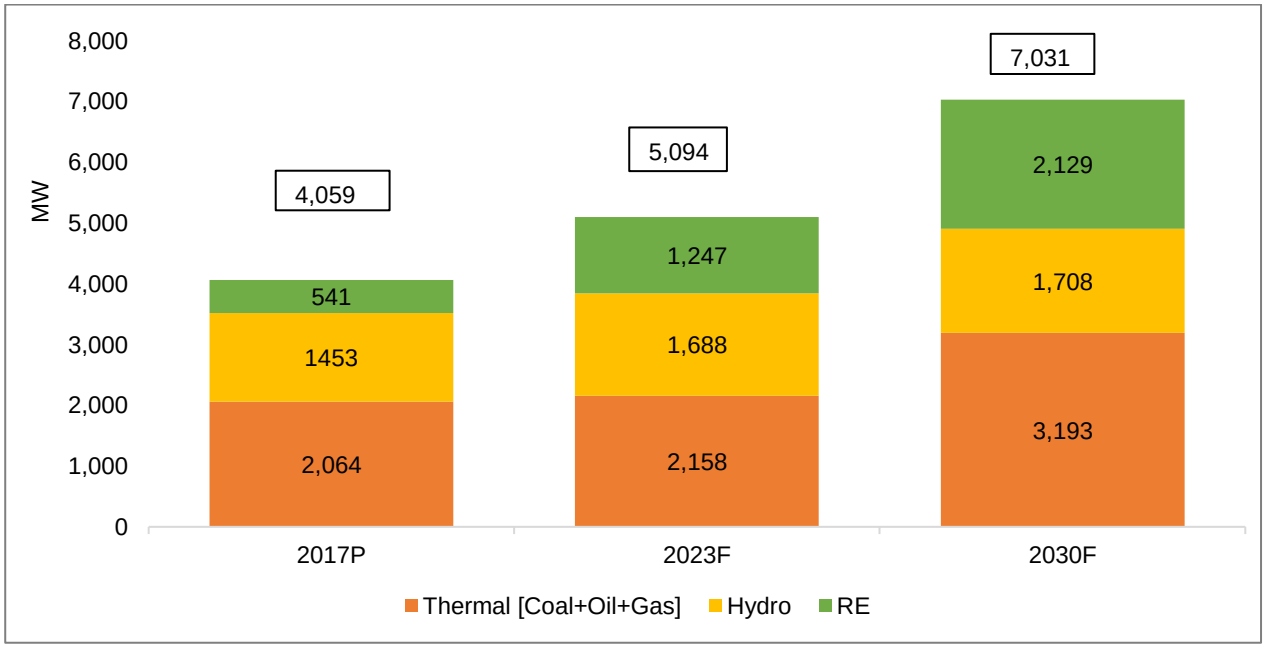


Figure 167: Annual Electricity Generation by Volume - Outlook: Sri Lanka

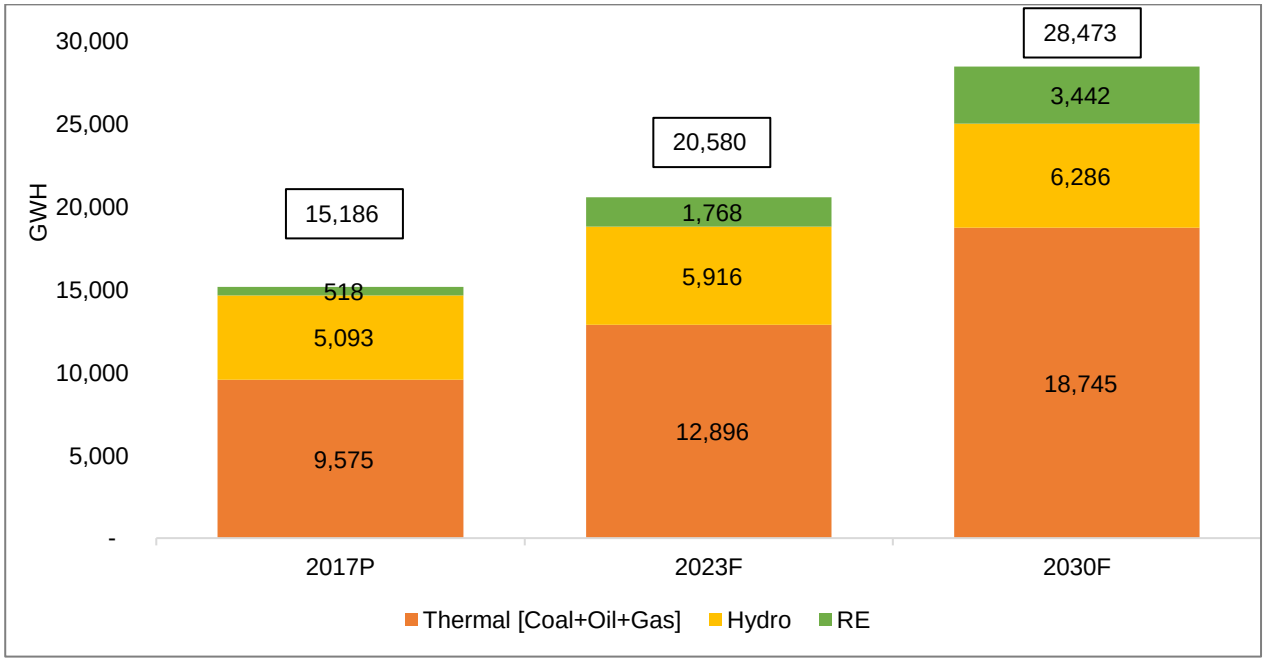
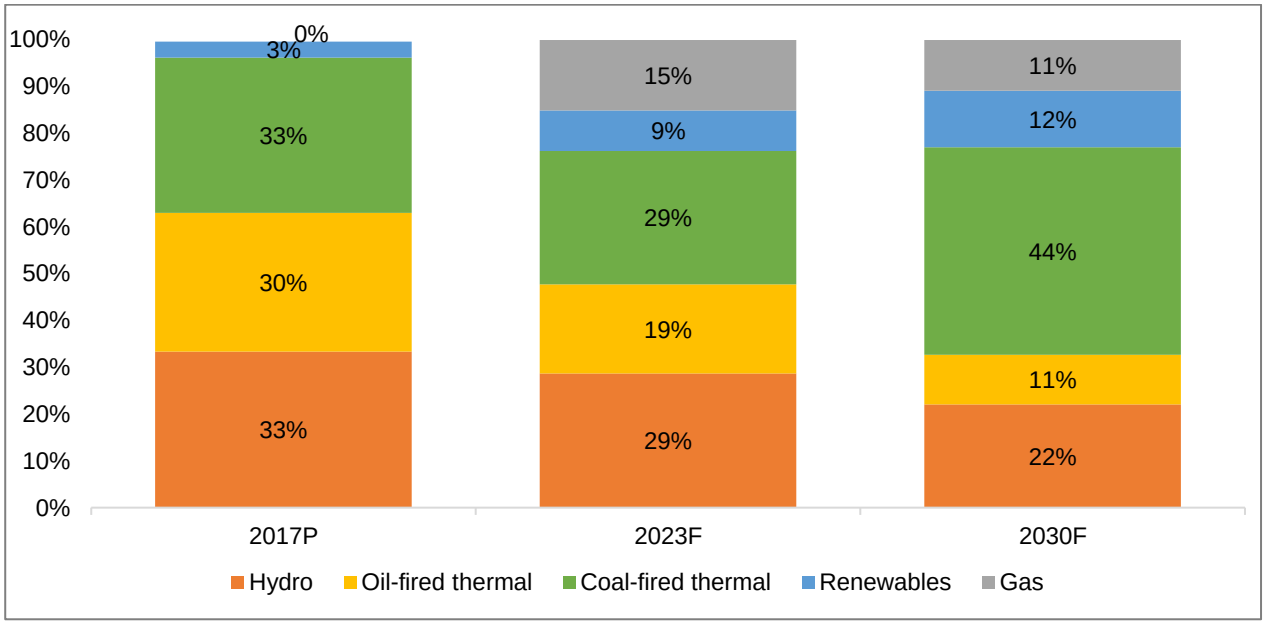


Figure 168: Annual Electricity Generation by Fuel Source - Outlook: Sri Lanka



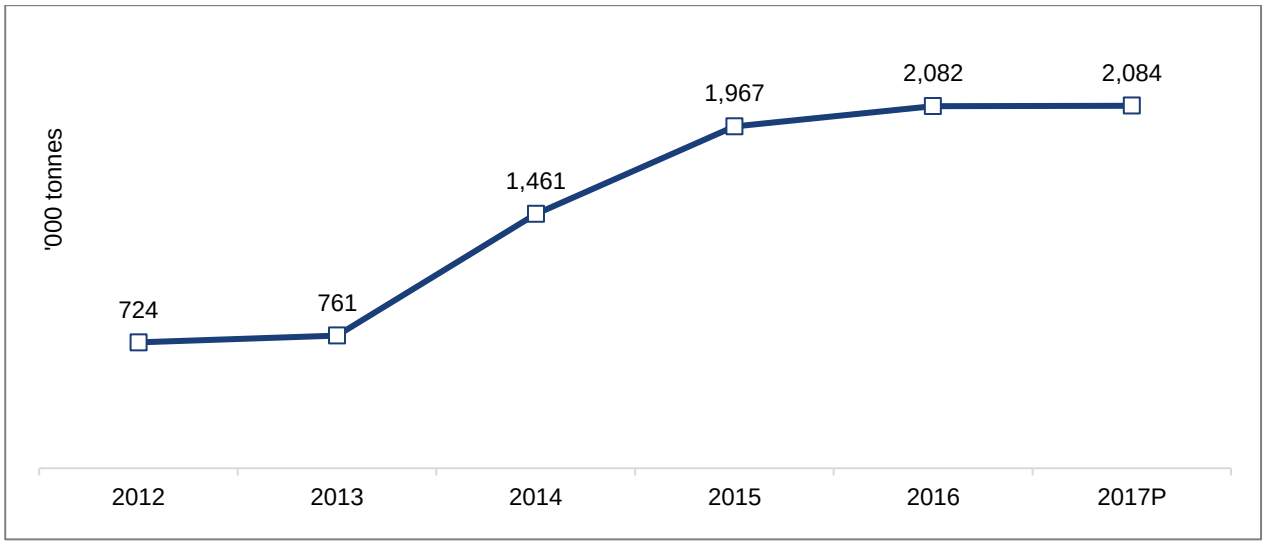
9.3.3 Fuel-Wise Energy Review and Outlook

Coal

Sri Lanka does not have any exploitable coal reserves. Major import shipments of coal come from South Africa and China. More than 96% of the total coal is used to fire thermal power plants. The country has one coal-based power plant (Lakvijaya Power Plant) in the Puttalam district, with a combined capacity of 900 MW (3 X 300 MW). The first unit of the plant, with a rated capacity of 300 MW, was set up in 2011. The other two units came up in 2014, taking coal-based power production to ~4,450 MUs. Usage in cement and iron and steel production remained sluggish with demand showing de-growth of 19% from 2012 levels.

The country imports most of the coal required for the sole coal-based plant through Lanka Coal Company, which is government-controlled. After receiving the annual coal requirement from CEB, the company makes import arrangements through forward-booking. Cement and steel plants import their own coal requirements from their respective suppliers.

Figure 169: Coal Demand – Review: Sri Lanka

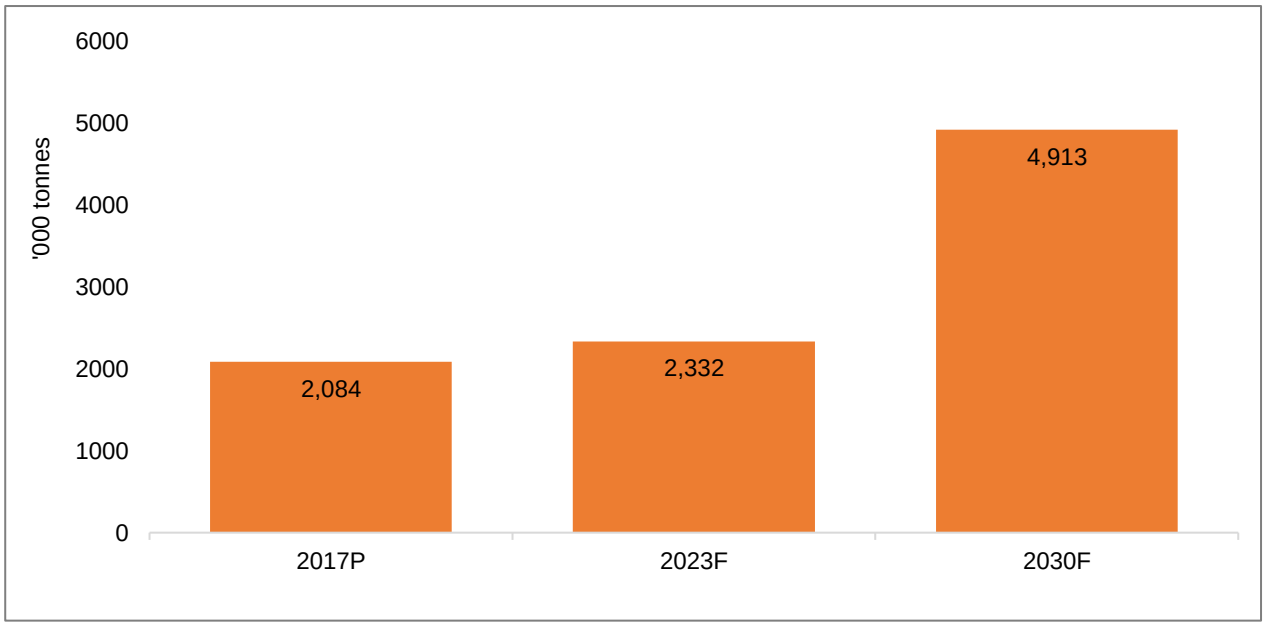


Source: Economic Survey, Energy Balance, LECO

Early in 2015, the CEB, in its LTGEP had pitched for the construction of 11 new coal plants with a cumulative capacity of 3,200 MW. However, environmental concerns, negative public sentiment over increasing pollution, and fall in the costs of RE generation led to the CEB discarding any further plans to construct new coal plants.

The country intends to use super-critical coal technology to contain environmental concerns and meeting emission standards as per the Paris Agreement. As per estimates, Sri Lanka will add an additional 1,500 MW of coal-based power plants, taking generation to ~44% of the power mix.

Figure 170: Coal Usage – Outlook: Sri Lanka



Source: Economic Survey, Energy Balance, LECO

Petroleum Products

Demand, Supply Review

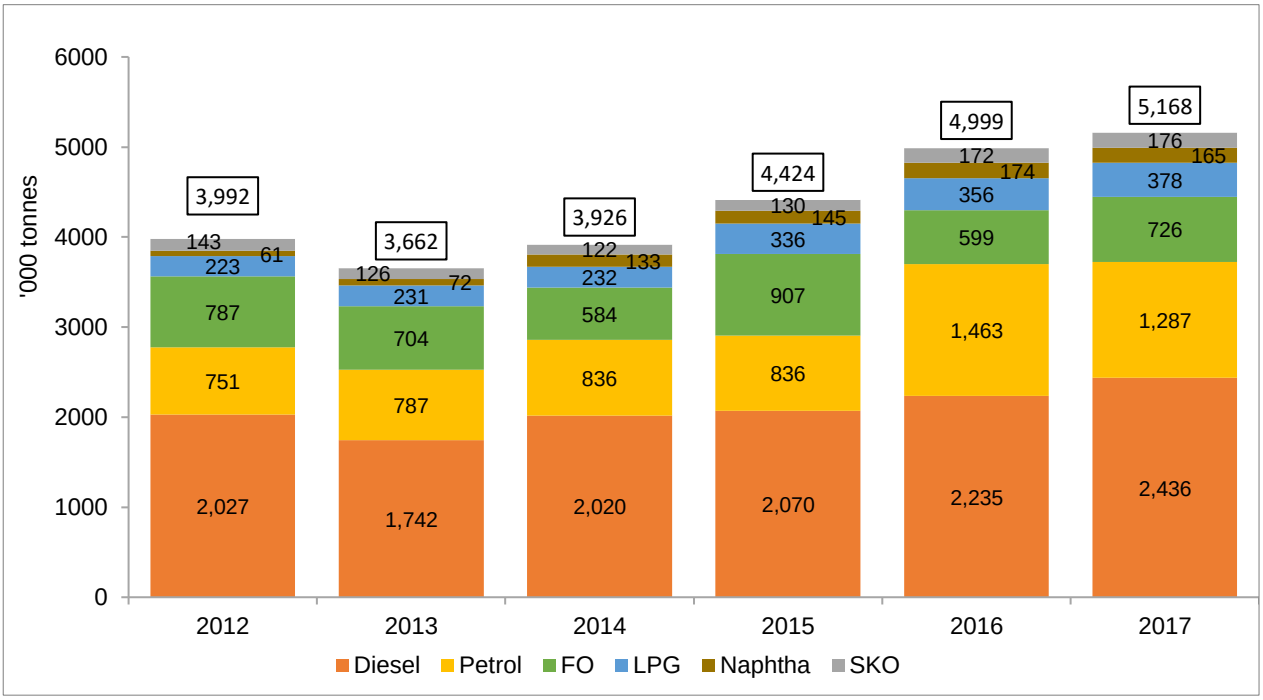
The demand for POL products in Sri Lanka is estimated to have risen at 3% CAGR over the past five years, till 2017, driven by a rise in demand for petrol which increased by 11.5%. In particular, demand for POL products was up 15% in 2016 on-year. This was primarily on account of rising demand for petrol and diesel, which was the result of increased transportation activity.

Petrol demand surged by ~75% on-year in 2016, aided by significantly low prices, revised downwards in 2015, alongside the increasing vehicle population. However, such demand growth is expected to be an anomaly, which is to likely to have corrected in 2017 with the rise in fuel prices. Rising demand from the transport sector was the result of the increasing number of cars, two-wheelers and three-wheelers, which grew at an annual rate of 9%, 11%, and 9.5%, respectively, from 2011 to 2016.

Diesel consumption grew 16% on-year in 2016 due to increased transportation activity as a result of GDP growth, coupled with a significant rise in demand from the power sector. The country experienced severe drought leading to reduced generation from its hydropower units. FO consumption, on the other hand, declined 22% on-year, despite a rise in power demand, due to lower offtake from industries.

Overall, the demand for POL products in Sri Lanka is estimated to have risen from 4.5 million tonne in 2012 to 5.2 million tonnes in 2017.

Figure 171: Consumption Trend of Main POL Products: Sri Lanka

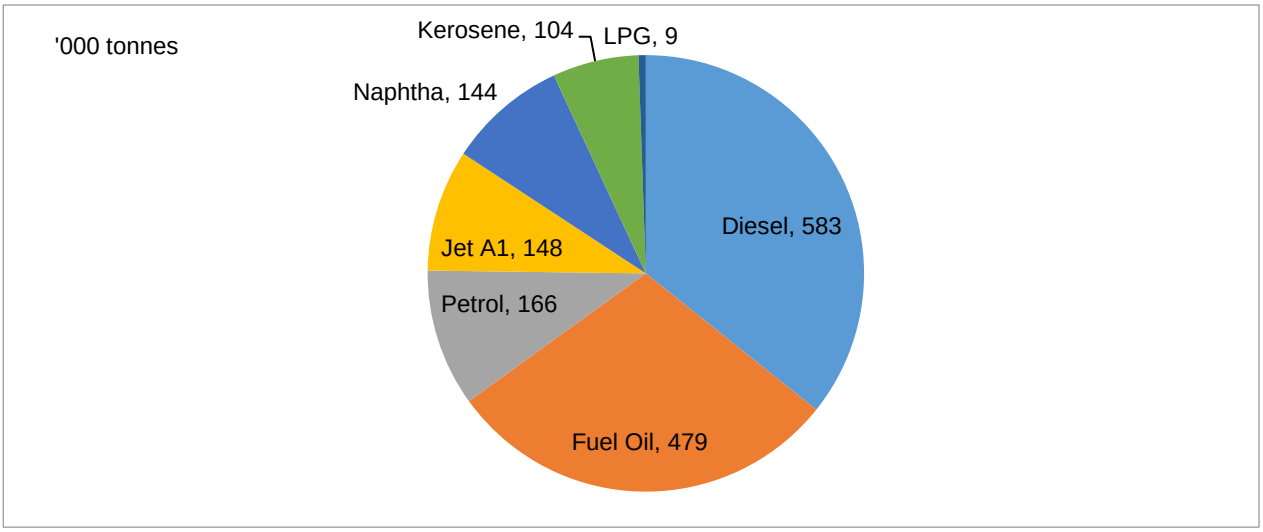


Source: Sri Lanka Energy Authority

Petrol consumption has risen steeply between 2011 and 20 due to increase in demand from the transport sector. Further, low petrol prices have boosted consumption in recent years. Diesel consumption also saw a rapid growth, climbing growing at ~4% annually between 2011 and 2016. It was driven by increased offtake from the transport segment, where pick-up in economic activity boosted the sale of commercial vehicles. Sri Lanka's GDP rose at 5.3% CAGR during the period, leading to 5% growth in the number of commercial vehicles. Consumption of furnace oil, with the power sector accounting for the major share, has shown mixed trends. Even though FO consumption from power grew in 2016 over 2015, the trend has been downwards in five years due to the retirement of FO-based capacities from 342 MW in 2011 to 160 MW in 2016.

Sri Lanka imports more than 60% of its POL products demand. It's estimated the production of petroleum products through refineries was ~1.8 million tonnes in 2017 against a total demand of 5.2 million tonnes.

Figure 172: POL Production at Refineries, Sri Lanka 2016



Source: Sri Lanka Energy Authority

The remainder of the demand was met from imports from Singapore, Malaysia, China, and India. Data analysis from the Ministry of Commerce, India, suggests 45-50% of diesel import in Sri Lanka is done from India for distribution by Lanka IOC, suggesting a strong trade relationship between the two SAARC nations.

Demand, Supply Outlook

POL product consumption in Sri Lanka is expected to grow at 3.3% CAGR of between 2017 and 2030 as against 3% growth over the past five years. This will primarily be driven by rising demand for petrol in the transportation segment. In addition, diesel demand will also likely rise due to improving economic activity. However, the rising demand from petrol and diesel will be partially offset by a decline in demand for naphtha, thus slowing down overall oil demand growth.

As part of transport INDC, the country intends to launch electric buses as a pilot project, introduce bus rapid transit systems, reduce unproductive vehicles by 25% in 2025 unconditionally and enhancing efficiency of public transport by promoting environment friendly transport modes. These measures will taper demand of petrol and diesel going forward.

POL product-wise factors resulting in demand growth are detailed as follows:

Petrol

Sri Lanka's vehicle market is currently under-penetrated, with only 24 cars per 1,000 people. Rising per capita income is expected to boost overall vehicle sales (particularly cars and two-wheelers) in the coming years. The number of cars and two-wheelers is expected to grow rapidly at 5% CAGR from 2017 to 2030, boosting overall demand for petrol, which is expected to grow at 5.4% CAGR. While the demand is expected to remain strong at more than 6% growth till 2025, rising electric vehicle penetration with development of infrastructure and government support towards purchase of electric vehicles would moderate demand growth to 5.5% by 2030.

Diesel

Diesel demand will likely expand at 3.2% CAGR between 2017 and 2030, driven by demand from the transport segment and industries. Transport constituted 83% of diesel demand as of 2016. Sri Lanka's GDP is expected to grow at ~4.7% CAGR over the next 13 years. As a result, with the pickup in economic activity, the commercial vehicle market is expected to grow at ~4-5% CAGR during the period, supporting diesel demand. In particular, diesel demand is expected to see a slowdown over the next two years, growing at 1-2% per annum due to increased fuel prices, and rising subsequently over the longer term. Diesel demand is also expected to see marginal growth owing to improved industrial activity. However, diesel demand from power is expected to decline due to the contraction in the power deficit and a shift to alternate fuels.

Furnace oil

FO demand is expected to rise in 2018 subsequent to the commissioning of 320 MW of additional FO-based capacity. This would take overall capacity to 430 MW. However, over the longer term, we expect 100 MW of old capacities to be retired, resulting in a decline in demand from the power sector.

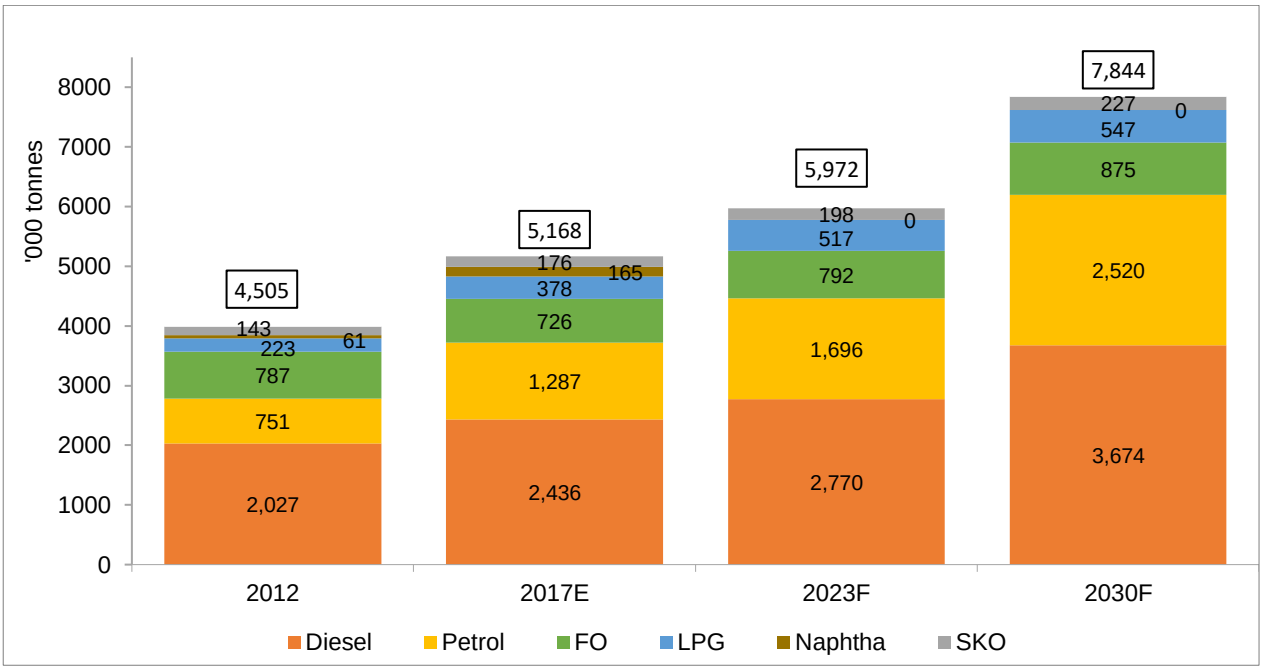
This fall in demand would be compensated by demand from the industry which sector will likely grow by a marginal 2%. At an overall level, furnace oil demand is expected to grow at 1.4% CAGR between 2017 and 2030.

Other petroleum products

We expect LPG demand in Sri Lanka to grow at 3% CAGR from 2017 to 2030, driven by population growth and increased per capita consumption of LPG from the household cooking segment. Naphtha demand would decline, with its consumption falling to zero by 2030. No new naphtha-based thermal power capacities are expected going forward and all existing capacities will be retired.

Overall, the demand for POL products is expected to rise from 5.2 million tonne in 2017 to 7.8 million tonnes in 2030.

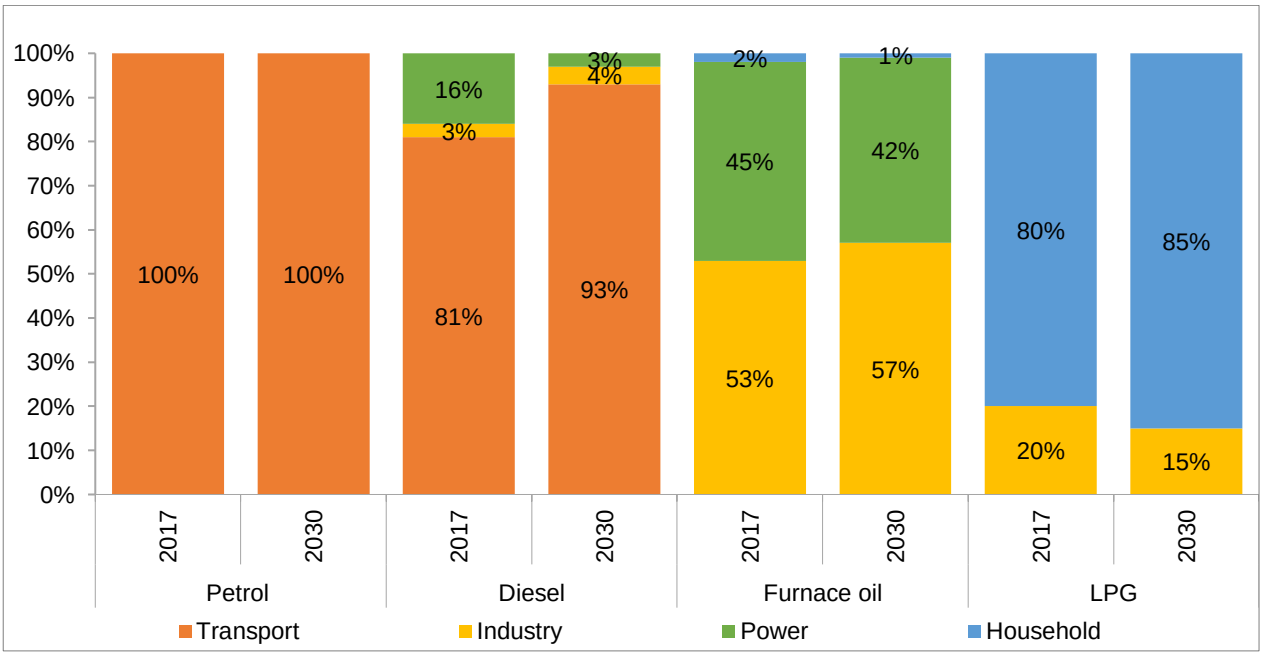
Figure 173: Overall POL Demand Outlook 2030: Sri Lanka



Source: Sri Lanka Energy Authority

The composition of fuel demand is not expected to change significantly for most fuels in Sri Lanka by 2030. The transportation segment will continue to dominate demand for petrol and diesel. Growth in activities in the commercial vehicle segment, coupled with reduced demand from the power sector, is expected to further increase the share of the transport sector in diesel demand from the current 81% to 93% in 2030. On the other hand, there will be strong demand growth from LPG from the household cooking segment, increasing its share from the 80% currently, to 85% by 2030.

Figure 174: Segment-wise Break-Up of Major Petroleum Products Consumption: Sri Lanka



Source: Sri Lanka Energy Authority

Domestic production was able to meet only 32%-35% of Sri Lanka's total POL requirement in 2017, with the remaining being met through imports. Sri Lanka is planning to set up a new refinery, with a tie-up with Iran, of a total capacity of 100,000 bpd. This project is not expected come on-stream before 2024 owing to recent political developments. Sri Lanka is also discussing a 100,000 bpd refinery in partnership with Indian Oil Corporation, but it is not expected to materialise before 2030. As a result, total refining capacity is expected to increase at 9% CAGR till 2030.

Considering the aforementioned capacity additions, the total domestic production of petroleum products is expected to increase to 5.9 million tonnes from the current 1.7-1.8 million tonne. However, overall demand for POL products will remain higher, reaching 7.8 million tonnes by 2030. As a result, Sri Lanka will remain a net importer of petroleum products. However, with the addition of this new refinery, imports will reduce from the current 3.4 million tonne to 1.9 million tonnes. This, however, will be substituted with increased imports of crude oil to feed the refineries to the tune 6.3 million tonne as against an import of 1.9 million tonne of crude as of now.

The following table showcases the balance of POL trade for Sri Lanka till 2030, highlighting it will have an overall deficit of 6.3 million tonne by 2030.

Table 61: POL Trade Balance: Sri Lanka

('000 MT)	2013	2016	2017E	2023F	2029F
Refining capacity	2490	2490	2490	2490	7470
Crude oil imports	1743	1685	1980	1980	6314
Petroleum product production	1556	1633	1867	1867	5976
Petroleum product net import	2160	3462	3500	4104	1868

Source: Sri Lanka Energy Authority

Gas

At present, there is no gas production or usage in the country. The Mannar basin, with an area of approximately 42,000 square kilometers, has a potential of 9 TCF of natural gas. The test wells drilled by Cairn, namely Dorado and Barracuda, have discovered ~2 tcf of exploitable gas reserves. The Petroleum Resource Development Secretariat (PRDS) will be tendering out 14 offshore blocks for possible testing and exploration. However, commercial production will not start before 2022 as bids have not yet been invited and the winning bidder would need to set up transport and storage infrastructure which has huge cost and time implications. The government and the PUCSL have prepared four development scenarios (BAU, NG1, NG2, NG3) with differing rates of gas penetration in the country.

a. BAU: Business as usual; present consumption is used to forecast future needs by assuming the same fossil fuel mix.
b. NG1: Gas introduced in power and other sectors (domestic, industrial, transport) at a low penetration. For power sector, gas usage to substitute coal.
c. NG2: High penetration in all sectors, coal-based power plants to be converted to gas-powered.
d. NG3: Optimum use of gas across all segments; the country will export production surplus.

Taking a realistic and conservative view, realising NG2 and NG3 potential by 2030 is highly unlikely. Rather, the country is expected to achieve mid-way transition from BAU to NG1.

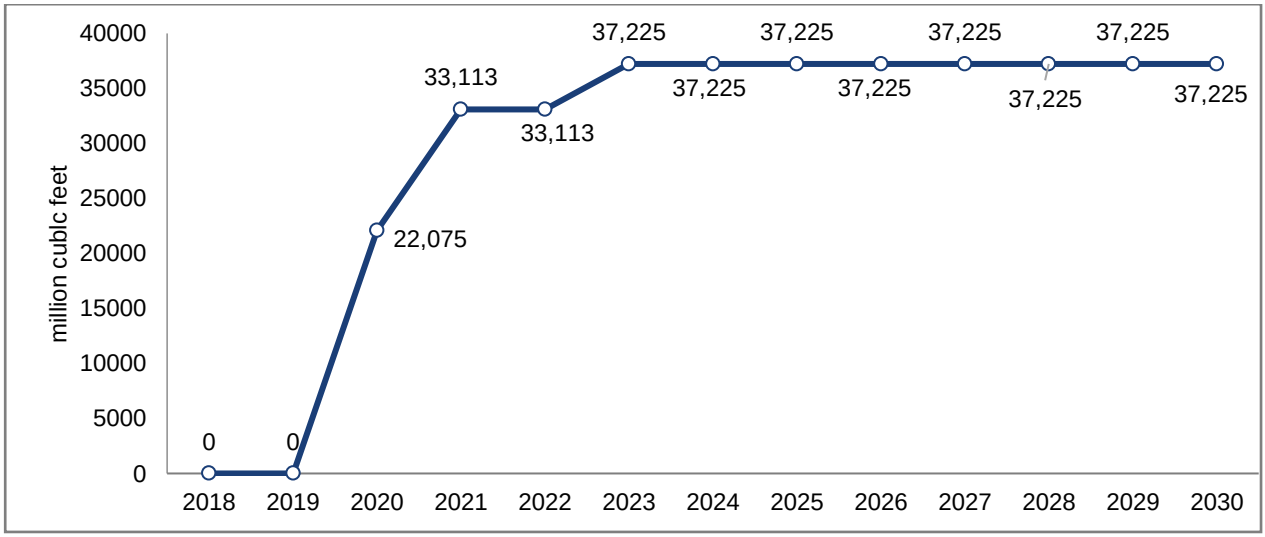
Gas will be used primarily for power consumption with ~1,000 MW of capacity additions expected by 2030. As per the base case plan outlined by the LTGEP, the first natural gas-fired combined cycle power plant will be commissioned by 2019. Usage of gas in the domestic and industrial segment is unlikely as the country

needs to set up grid pipeline infrastructure, which requires time and capital. The country is drafting its first national gas policy with to set up a regulatory framework for gas exploration and commercialisation.

The combined cycle Sojitz Kelanitissa plant is planned to be converted to a natural gas-fired power plant 2023 onwards.

Petronet, in collaboration with Mitsubishi and Sojitz, is in advanced talks to set up the country's first LNG terminal to fire power plants and small industries. The government is contemplating government-to-government deals to procure long-term LNG. This is expected to range between 0.3-0.8 MTPA depending on wet or dry conditions in the country.

Figure 175: Natural Gas Usage – Outlook: Sri Lanka



Large Hydro

Hydropower was the major source of power for Sri Lanka in the past owing to the abundance of water resources in the country. Presently, it produces one-third of the total power demand. The Mahaweli River Complex, with a cascade of six hydropower plants totalling 660 MW, is the largest hydroelectric scheme. The Kelani complex, with a cascade of five power plants, has a cumulative capacity of 335 MW. On a standalone basis, Victoria and Kotmale hydro plants are the largest in the country, at 210 MW and 201 MW of rated capacity, respectively.

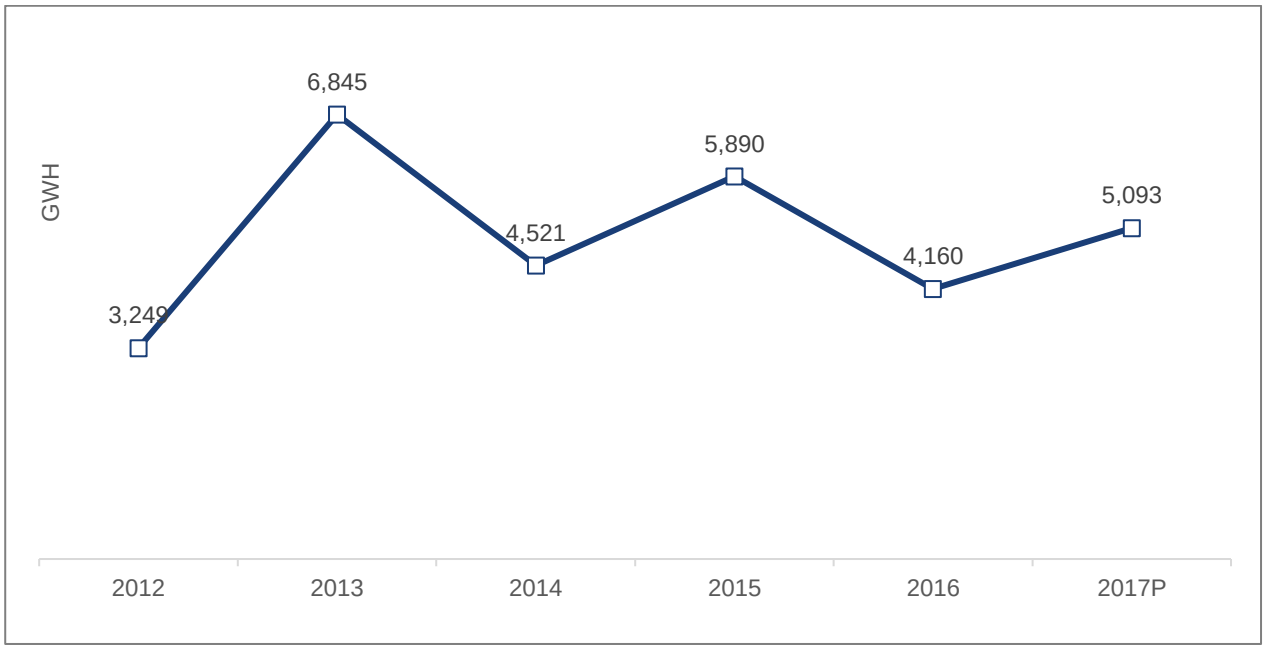
Table 62: Major Hydropower Plants in Sri Lanka

Sr. No	Name of plant	Capacity [MW]
1	Wimalasurendra	50
2	Old Laxapana	53.5
3	Canyon	60
4	New Laxapana	116
5	Polpitiya	75
6	Kotmale	201
7	Victoria	210

Sr. No	Name of plant	Capacity [MW]
8	Randenigala	122
9	Rantambe	49
10	Ukuwela	40
11	Bowatenna	40
12	Upper Kotmale	150
13	Samanalawewa	120
14	Kukule	70
15	Inginiyagala	11.25
	Total	**1368**

Source: Power Sector Report, LTGEP

Figure 176: Hydropower Generation in Sri Lanka - Review



Source: Power Sector Report, LTGEP

With increasing power demand, the government and the PUCSL has been focusing majorly on augmentation of coal, gas, and RE-based capacities. Exploitable large hydro projects have been stagnating. Variability in the south-west and north-east monsoon rains and climactic changes have had a direct impact on water availability. Deforestation and soil erosion have caused siltation in various major reservoirs, thereby significantly reducing their water-holding capacities. New innovations such as pumped water storage plants (PWSP) are likely to be implemented post 2025 as feasibility studies are underway. Potential capacity improvements are being assessed for sites such as Kotmale and Upper Kotmale.

Table 63: Upcoming Hydropower Projects in Sri Lanka

No	Name of plant	Capacity [MW]	Expected year of commissioning
1	Uma Oya	122	2019-2021
2	Broadlands	35	2020-2022
3	Thalpitigala	15	2020-2022
4	Moragolla	30	2022-2024
5	Seethawaka	20	2023-2025
6	Pumped Storage Power Plant	200	2027-2030
7	Pumped Storage Power Plant	200	2027-2030
8	Victoria Upgradation (Proposed)	100	Not finalised
9	Samanala Upgradation (Proposed)	120	Not finalised
	Total	**842**	

Source: Power Sector Report, LTGEP

As per estimates, an additional 300-500 MW of major hydro plants are expected to come up by 2030. However, hydro power generation would reduce from 33% of the power mix in 2017 to 21% in 2030.

Other Renewable Energy Sources

The government established the Sustainable Energy Authority (SEA) in 2007 to develop indigenous RE resources and attain sustainability in energy generation. The private sector is being encouraged to set up other renewable energy (ORE) plants. Through a competitive bidding process, purchasing tariffs have fallen by up to 50% for solar and wind projects. In two 10 MW of wind projects, tariffs have gone down from Rs 22/kWh to Rs 12.29/kWh. In one 10 MW solar project, tariff has fallen from Rs 23.1/kWh to Rs 11.86/kWh (*Ministry of Power and Renewable Energy, Performance 2017*). It is estimated ORE in the power sector will rise from ~550 MW in 2017 to ~2,150 MW in 2030, with share in total generation rising significantly to 12%.

Table 64: Use of Other Renewable Energy in Power Sector – Outlook and Review: Sri Lanka

Year	Small hydro (MW)	Solar power (MW)	Biomass (MW)	Wind (MW)	Cumulative ORE capacity (MW)	Annual ORE generation (GWH)	Share of ORE in total generation (%)
2017	360	21	29	131	541	518	3%
2023	435	297	305	456	1247	1768	9%
2030	505	779	787	751	2129	3442	12%

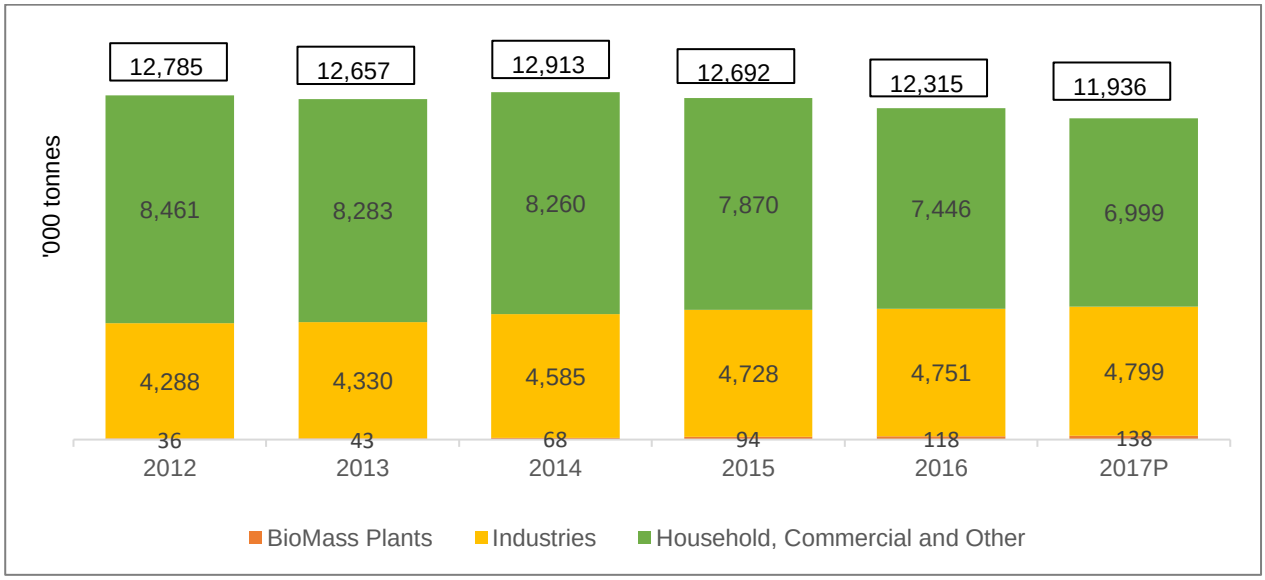
Source: LTGEP

The major focus areas will be the implementation of the solar rooftop scheme under the Suryabala Sangramaya program and setting up a wind farm on Mannar Island. The Sooryabala Sangramaya is expected to be implemented in four phases and has a target of ~1,500 MW rooftop and ground-mounted solar power plants. The Mannar region in the northern province of Sri Lanka has been shortlisted for future wind power development. The first 100 MW wind farm has already been set up with the assistance of the Asian Development Bank. Several wind projects are in the pipeline for development.

Bioenergy

Sri Lanka consumed ~12 million tonnes of biofuel in 2017. The biggest consumers of biofuel are the household and commercial segment followed by the industrial segment. Biomass-based energy production is being promoted in the country in association with the UNDP. Agriculture and industrial waste power plants are being set up in line with LTGEP targets to increase RE generation.

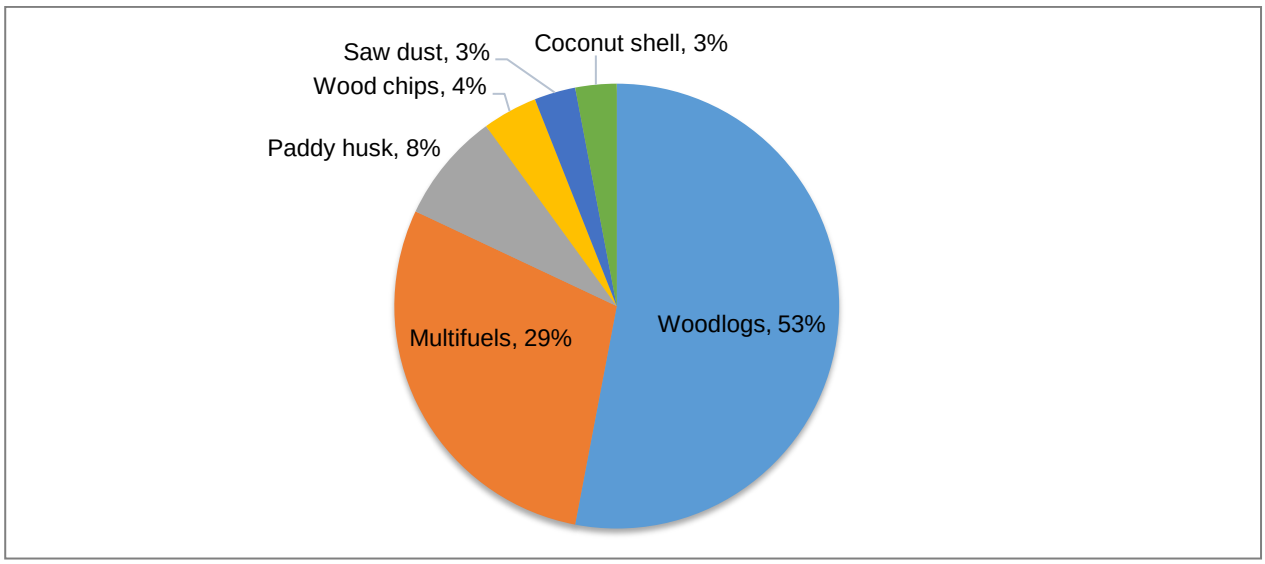
Figure 177: Usage of Biofuel – Review: Sri Lanka



Source: Energy Balance

Going forward, industrial biomass usage is expected to rise. The industrialised districts of Colombo, Gampaha and Kalutara are the major consumers of biomass and fuel wood for thermal energy. With increasing fossil fuel prices, more than 350 industrial biomass energy conversion systems (BECS) have been operationalised. BECS are primarily used to provide industrial services such as steam, hot water, hot thermic oil, and electric power. Most BECS have been using wood logs and multi-fuels as feedstock.

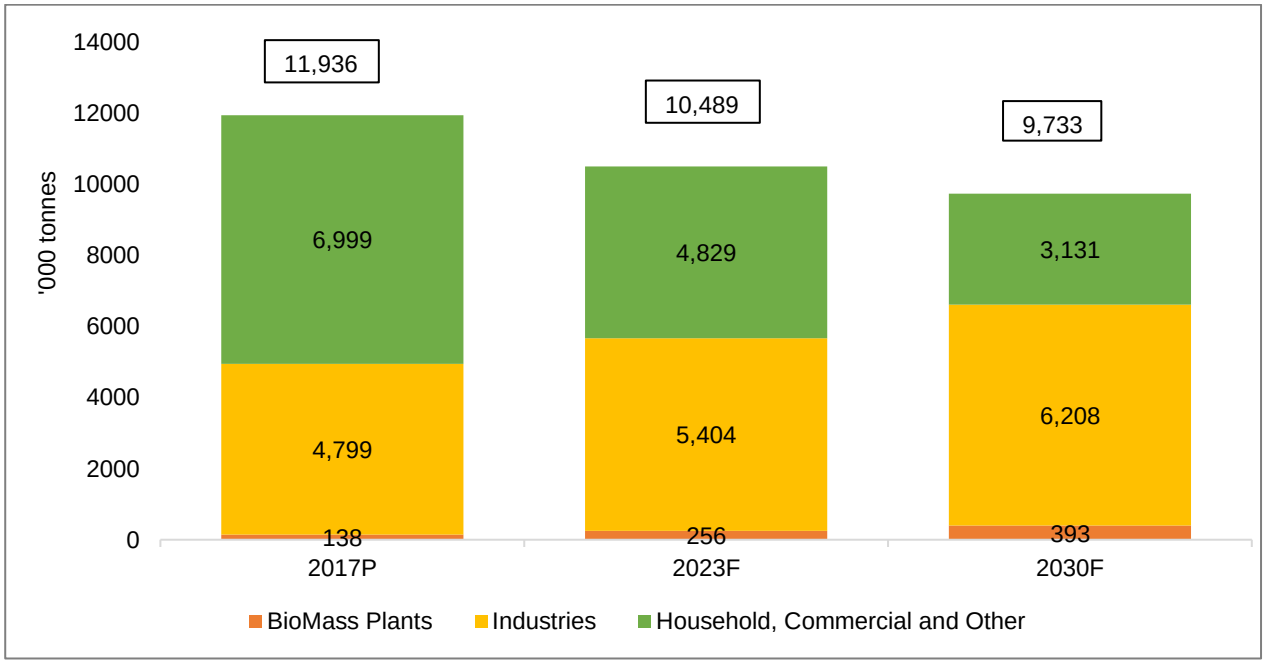
Figure 178: Share of Biofuel Feedstock in Industrial Usage (2017): Sri Lanka



Source: Ministry of Renewable Energy, Sri Lanka

With an expected on-year biomass-based power plant additions of 5 MW, fuel usage will rise 5% every year. Feasibility studies are underway to set up municipal waste-to-energy plants and wood gasification technology is also being developed for thermal energy applications.

Figure 179: Biomass Usage - Outlook

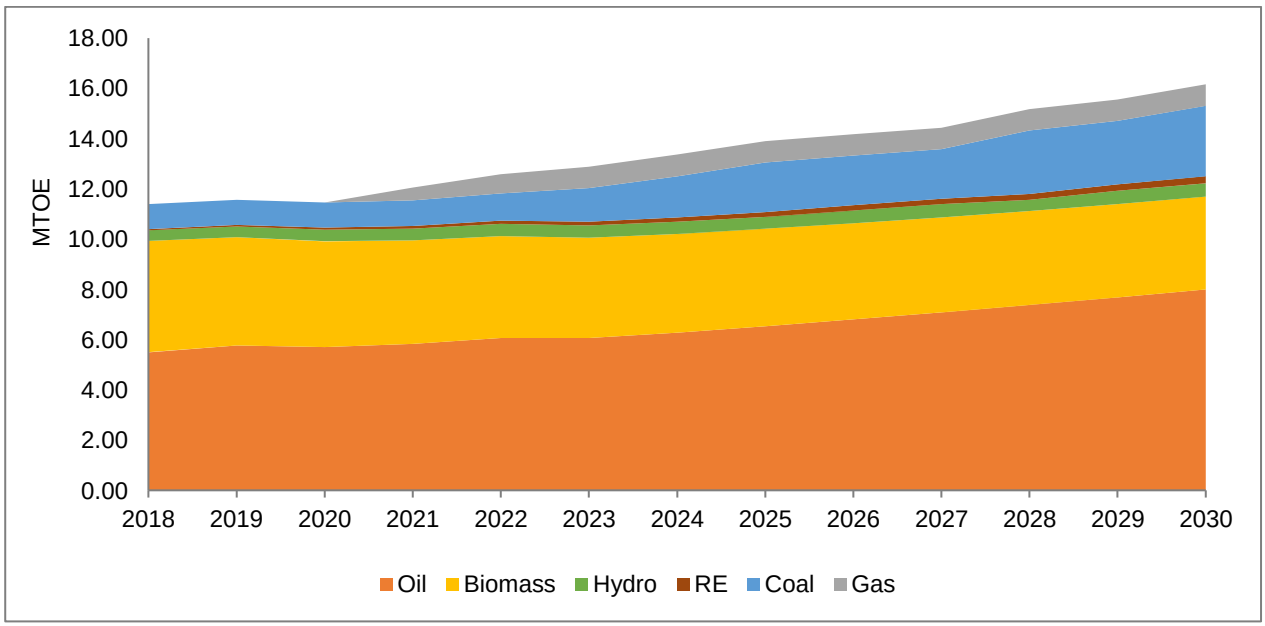


Energy Outlook 2030

Combining the usage outlook for all the aforementioned fuels it is estimated the overall energy requirement in Sri Lanka would rise from 11.4 MTOE in 2017 to 16.2 MTOE in 2030.

All figures in MTOE	**2017P**	**2018F**	**2023F**	**2030F**
Primary energy	11.4	11.4	12.9	16.2

Figure 180: Primary Energy Outlook – 2030: Sri Lanka



Outlook on Imports

With coal usage expected to rise manifold, the entire feedstock will have to be imported as the country does not have any exploitable coal reserves. Even after taking into consideration that Mannar gas field will start production, the country would need to import LNG to sustain the expected rise in gas-based power plants. Depending on an as-is scenario and taking into consideration the expected change in fuel availability, Sri Lanka would need imports as shown below:

Table 65: Import of Fuels – Outlook: Sri Lanka

Fuel	2017	2023	2030
Crude oil [in '000 tonne]	1,980	1,980	6,314
Petroleum products [in '000 tonne]	4,481	4,104	1,868
Electricity [in GWH]	0	0	0
Coal [in '000 tonne]	2,084	2,237	4,913
Gas [in bcf]	0	33.1	33.1

10 Cross-Border Energy Trade

10.1 Current Energy Scenario in SAARC Region

SAARC countries are witnessing the deficit scenario across energy segments and it is not likely to improve in the near future. Therefore, it is imperative for them to utilise available energy resources effectively and optimally. Cross-border trade can help in effective utilisation of energy resources while ensuring availability and reliability.

10.1.1 Prevailing Energy Trade

Each SAARC member nation has varied primary energy consumption pattern. India, the largest consumer of primary energy, is heavily dependent on coal (~65% of primary energy as of fiscal 2018). Increasing federal push and private participation towards RE adoption has benefits, however, its share is still a meagre 1%. Bangladesh, is highly reliant on gas with more than 70% of primary energy consumption being met through it. High domestic gas reserves coupled with cheap fuel costs and widespread pipeline infrastructure has led to high usage of gas across all segments (industry, domestic, commercial, power plants). Pakistan is also highly reliant on gas (~48% of PE as on FY18), although growth in usage has tempered due to domestic supply constraints and rising reliance on imported LNG. Bhutan and Nepal are predominantly hydro-based energy generators. Overall, across SAARC nations, there is overarching dominance of a single fuel in the energy mix. Limited exploitation of RE resources, increasing energy deficits and rising imports dependence have paved the way for higher cross-border energy trade with SAARC and non-SAARC nations.

Keeping in view the deficit scenario, SAARC nations have realised the importance of energy cooperation and have taken certain steps in that direction. In 2004 at the 12th SAARC summit a concept of “Energy Ring” was included in declaration aimed at promoting regional cooperation. The SAARC Framework Agreement for Energy Cooperation was also signed in 2014 at the 18th summit in Kathmandu.

At present, there is inter-regional and intra-regional trade for coal, gas, POL and electricity in the energy segment.

Table 66: Domestic Supply and Imports of Power in SAARC Nations (FY18/CY17)

Countries	Electricity [GWH]		Surplus/Deficit Position	Deficit/ Surplus %	Major Importing/ Exporting Nations
	Gross Demand	Domestic Supply			
Afghanistan	4,981	1,076	Deficit	-78%	Iran, Tajikistan, Uzbekistan, Turkmenistan
Bangladesh	65,124	58,300	Deficit	-10%	India
Bhutan	2,186	7,630	Surplus	249%	India
India	1,205,266	1,202,099	Deficit	0%	Bangladesh, Bhutan, Nepal
Maldives	1,405	1,405	Self-Sufficient	0%	-
Nepal	5,557	4,476	Deficit	-19%	India
Pakistan	120,392	118,916	Deficit	-1%	Iran
Sri Lanka	15,763	15,763	Self-Sufficient	0%	-

Source: Country Power Reports

Table 67: Domestic Supply and Imports of POL in SAARC Nations (FY18/CY17)

Countries	POL ('000 tonne)		Surplus/Deficit Position	Deficit/Surplus %	Major Importing/ Exporting Nations
	Gross Demand	Domestic Supply			
Afghanistan	2,019	0	Deficit	-100%	Iran, Russia, Turkmenistan, UAE
Bangladesh	6,384	1,166	Deficit	-82%	Singapore, UAE, Saudi Arabia
Bhutan	158	0	Deficit	-100%	India
India	204,922	252,839	Surplus	23%	EU, Singapore, Japan
Maldives	561	0	Deficit	-100%	UAE, Singapore, Malaysia
Nepal	2,307	0	Deficit	-100%	India
Pakistan	29,037	10,741	Deficit	-63%	UAE, Oman, Kuwait, Saudi Arabia
Sri Lanka	5,168	1,867	Deficit	-64%	Singapore, China, Malaysia, India

Source: Country Oil and Gas Reports

Intra-regional trade of energy is limited to POL and electricity. Although, India exports small quantities of coal to Bhutan, it is insignificant by volume terms. There are no existing intra-regional gas pipelines. Electricity trade at present happens between Bhutan-India (1450 MW), India-Bangladesh (600 MW) and India-Nepal (300 MW) and POL trading happens between India-Bhutan, India-Nepal, India-Sri Lanka and India-Bangladesh.

POL Trade within the SMSs is limited to India exporting to adjacent countries of Bhutan, Sri Lanka, Bangladesh and Nepal. Around 4 million tonnes of POL was traded between the SMS in fiscal 2018/CY17.

Table 68: Estimated POL Trade Volumes within SMSs in FY18/CY17

Country Pair	POL Traded (in '000 tonne)
India-Bhutan	160
India-Nepal	2,307
India-Bangladesh*	453
India-Sri Lanka*	1,056

**Only Diesel*
Source: Country Wise Oil and Gas Authority Reports

10.1.2 Current Cross-Border Infrastructure

Development of commensurate infrastructure is of utmost importance for successful cross-border trade. Some of the SAARC nations like India, Bhutan and Nepal have taken initiatives to establish requisite infrastructure for this.

Electricity

Cross-border electricity trade (CBET) has increased between India and Bangladesh with the commissioning of 500 MW of capacity through 400 KV back-to-back HVDC link with West Bengal. Subsequently, 100 MW

of power transfer from Tripura in India to Comilla in Bangladesh was commissioned in February 2016. An additional 500 MW capacity on the existing interconnection is slated to be completed in fiscal 2019.

Under inter-governmental agreement, India has developed hydropower plants with a cumulative capacity 1,416 MW in Bhutan. India is developing another 2,220 MW capacity in the sector. The excess power generated will be exported to India.

India started power trade with Nepal in 1971 by exporting 5 MW. The country's electricity exports to Nepal has gone up from 790 GWH in fiscal 2013 to 2,175 GWH in fiscal 2017 led by the commissioning of a 400 kV transmission line in 2016 from Dhalkebar in Nepal to Muzzafarnagar in India.

POL

Bhutan and Nepal at present import 100% of their POL requirement from India. Bhutan doesn't have any POL-based midstream infrastructure in terms of refineries and pipelines. In case of Nepal as well, POL products are directly imported from India and are distributed through road tankers. India currently exports diesel to Bangladesh via rail route covering a distance of 510 km.

10.1.3 Energy Trade and Investment Outlook

The SAARC region is bestowed with high RE potential and increased exploitation in the future will drive growth in energy generation. Gas supplies in Pakistan and Bangladesh will face curtailments owing to limited remaining exploitable resources. Coal supplies will rise in India and Pakistan, with growth in imports expected to be moderate. In electricity generation, depending on as-is scenario, Sri Lanka, India and Maldives will continue to be self-reliant whereas, Bhutan and Sri Lanka are expected to reach surplus position.

Table 69: Power Demand, Supply Scenario in 2024 and 2030

Countries	FY24/ CY23		Deficit/Surplus	FY30/ CY30		Deficit/ Surplus
	Demand (GWH)	Domestic Supply (GWH)		Demand (GWH)	Domestic Supply (GWH)	
Afghanistan	7,428	5,466	**-26%**	11,028	7,473	**-32%**
Bangladesh	91,093	79,825	**-12%**	123,941	101,212	**-18%**
Bhutan	3,145	21,035	**568%**	6,572	23,691	**259%**
India*	1,769,609	1,776,224	**0.4%**	2,470,238	2,452,106	**-0.7%**
Maldives	2,046	2,046	**0%**	3,172	3,172	**0%**
Nepal	9,305	11,094	**19%**	15,836	18,978	**20%**
Pakistan	151,583	150,301	**-1%**	191,828	190,781	**-1%**
Sri Lanka	19,985	20,610	**6%**	28,188	28,503	**1%**

**Imports and exports are omitted*

Bhutan and Sri Lanka are expected to surplus position, India and Maldives will become self-sufficient while Afghanistan and Bangladesh will languish with deficits >10% of annual power demand. This highlights the avenues of intra-SAARC power trade within two nations where supply to a deficit nation may be seamlessly transferred from a surplus one through interconnections.

Infrastructure for Electricity Trade

Inter connectivity of power systems by setting up inter-country transmission lines can help addressing deficit scenarios. In cases where loads of one country are in close proximity with generation facilities of a neighbouring country as compared to its own generation facilities, power evacuation will be easier and more economical for inter-country trade. Such infrastructure can be expedited in case of India-Bangladesh, India-Nepal, India-Nepal, India-Pakistan, Nepal-Bhutan. In 2013, a World Bank-financed pre-feasibility study was carried out for interconnection from Amritsar in India to Lahore in Pakistan and the project has not been executed yet. This interconnection could help transfer power from the surplus state of Punjab to deficit Pakistan. This will help Pakistan forego high costs of oil and gas imports. India could also buy additional power from Bhutan if it is cheaper than domestic power generation.

India is the only country in the SAARC region with fully functioning power exchanges where producers and buyers can participate. The interconnected nations within the region may set up a cross-border power exchange, whereby generators/ consumers of one country may seamlessly sell/ buy power in short-term or long-term basis.

Infrastructure for POL Trade

Some of the countries in the SAARC region have planned infrastructure to augment the energy trade in the region. In case of POL trade, product transport between Nepal and India is expected to get cheaper and convenient subsequent to commissioning of Motihari-Amlekhgunj Pipeline. Nepal Oil Corporation and Indian Oil Corporation are jointly laying a 69 km long, 2 million tonne, cross country POL product pipeline from Motihari in Bihar to Amlekhgunj in Nepal at an estimated cost of $48 million. Of the total length, 32.7 km of pipeline is proposed to be laid in the Indian territory and remaining in Nepal. Once commissioned by 2020, this is expected to provide more security on fuel transfer compared with road movement.

Sri Lanka is discussing a 100,000 barrels per day refinery in partnership with Indian Oil which is not expected to materialise before 2030. India is also planning to build a product pipeline of 136 km from India's Numaligarh refinery (NRL) to Bangladesh. Once the pipeline comes into operation, NRL can supply diesel to Bangladesh in a swap arrangement with the West Coast Refinery.

Table 70: Diesel Demand, Supply Scenario in 2030

'000 tonne	**Diesel Demand**	**Production**	**Deficit/ Surplus**
Afghanistan	1,459	1,859	400
Bangladesh	9,961	5,063	-4,898
Bhutan	273	0	-273
India	133,253	154,035	20,782
Maldives	899	0	-899
Nepal	3,547	0	-3,547
Pakistan	16,034	10,984	-5,050
Sri Lanka	3,674	2,135	-1,539
		Net surplus in the region	**4,976**

Among the other POL products, LPG is the one which will be significantly in deficit in the region primarily on account of low production capacity in Indian refineries. Therefore, while the SAARC region shall become

self-sufficient in petrol and diesel by 2030, the dependence on inter-regional trade for LPG and crude oil shall continue. India is expected to drive this inter-regional trade, considering strong demand growth for LPG and significant refinery capacity additions.

Table 71: LPG Demand, Supply Scenario in 2030

'000 Tonne	LPG Demand	Production	Deficit/ Surplus
Afghanistan	1,067	165	-902
Bangladesh	4,030	450	-3,580
Bhutan	20	0	-20
India	41,434	12,682	-28,752
Maldives	24	0	-24
Nepal	0	0	0
Pakistan	2,343	1,500	-843
Sri Lanka	547	239	-308
		Net deficit in the region	**-34,429**

The SAARC Secretariat in its report on SAARC Regional Energy Trade Study (SRETS) published in 2010 discussed a petroleum product deficit scenario within the region and recommended construction of a regional refinery of 23 million tonne per annum. However, since then, most of the SAARC member states, including India, Pakistan, Bangladesh and Sri Lanka, have chalked out plans for significant additions in refining capacities through greenfield and brownfield expansions. Considering the outlook for demand and supply scenario in 2030, these additions will be sufficient to cater to the demand for POL products within the region. One of the most important developments which is expected to result in this scenario is India's plan to add a 60 million tonne refinery at its western coast. While estimating exportable surplus for 32 million tonnes for India, only 40 million tonnes of this capacity is considered. This is because India's demand for petroleum products is not expected to rise sharply given the government's focus on alternative fuels.

India's west coast refinery can serve as one of the possible options to supply POL products to other SAARC nations and promote intra-regional products trade by 2030. It is planned as an integrated refinery, with an associated petrochemical complex, to be set up at an overall investment of $3 trillion for the 60 million tonne capacity. The refinery is proposed to produce 16-17 million tonnes of diesel (40-45% of the total capacity). Other products proposed include petrol, Naphtha, ATF, LPG, and by-products for industrial use. This refinery can serve as a plausible option for balancing the demand in the region with other SAARC members increasing their stake in terms of investment, crude sourcing or purchase requisition.

Pakistan, which currently buys majority of its diesel from Kuwait, could instead purchase fuel from India's HMEL (Bhatinda) refinery, which is approximately 150 km away from Lahore by road. Bhatinda refinery could again enter into a swap arrangement with the west coast refinery and meet its fuel requirement. This would lead to a savings of $3.0 per tonne in freight cost for Pakistan. Bangladesh, may also consider buying diesel from India instead of importing from Singapore (as it does at present).

10.2 Energy Trade with Regions beyond SAARC

10.2.1 Prevailing Energy Trade

Afghanistan imports electricity from Central Asian Republics of Tajikistan, Uzbekistan and Turkmenistan. Pakistan also imports ~0.4% of its power requirement from Iran.

All gas imports are sourced from nations beyond SAARC as none of the nations are surplus in gas production. Currently, there is no inter-regional gas pipelines.

Coal demand in all countries far surpasses domestic production in all SAARC countries. India is the second largest importer of coal in the world (after China). Pakistan, Bangladesh and Sri Lanka source coal from several countries like Indonesia, China, Australia and South Africa.

Most of the POL imports for SAARC nations (except Bhutan and Nepal) is sourced from regions beyond SAARC. The UAE, Iran, Kuwait and Singapore are the major exporters of crude and POL to the SAARC region.

10.2.2 Current Cross-Border Infrastructure

Electricity

Afghanistan has set up transmission lines of more than 3,600 km from Kabul to neighbouring Uzbekistan with funding from the ADB and India. Power component of the Emergency Infrastructure Rehabilitation and Reconstruction Project has been completed at an investment cost of ~$40 million. This included setting up of switching stations and double circuit 220 kV transmission lines from the Uzbekistan border and hinterlands of Afghanistan. Completion of this project in 2007 enabled power to be imported from Uzbekistan and supplied to major load centres, including Kabul. The Regional Power Transmission Interconnection Project, set up at an investment cost of $109.5 million, allowed power to be transmitted from Tajikistan to Afghanistan by construction of a 220 kV interconnection between the Afghan and Tajik power grids. Under a 20-year PPA, 500 GWH is being imported annually from Tajikistan through this line.

POL

All countries have set up ports to manage imports of crude oil and POL from other countries. Afghanistan, being a landlocked country, imports POL products through road from its neighbouring nations, mainly Turkmenistan, Uzbekistan and Russia. It has seven land ports that facilitate import and storage of petroleum products of which Herat, Nimroz and Andkhoi form the major ones.

Bangladesh has two major seaports connecting the country to the rest of the world, namely the ports of Chittagong and of Mongla. The Chittagong port is considered the heart of the economy of Bangladesh. Its geographic location makes the country’s trade with Asian countries easy and cost-effective. POL product import is majorly carried out through the port. For LPG, there are four import storage units. Several private operators in Bangladesh are engaged in LPG import, shipping and distribution. In addition to the above two ports, the Payra port, with a draft of 16 metres, is situated in Meghna Estuary at Rabnabad channel in Patuakhali district and is partially constructed. It is partially operational since August 2016 and once completed in 2023, it will have rail, road, and waterway links with the capital of Dhaka. India is also planning to invest ~$750 billion to construct a multipurpose container terminal. India has 12 major and 200 minor and intermediate notified ports to handle imports.

10.2.3 Energy Trade and Investment Outlook

In order to analyse the prospects of imports from the neighbouring countries, it is important to understand the projected quantum of energy to be traded and the costs likely to be incurred. The Central Asian

Republics, i.e. Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, are energy rich with vast hydropower and hydrocarbon resources. According to a World Bank report titled Central Asian Regional Electricity Export Potential, these nations will cumulatively have a power surplus of 23,178 GWH by 2025. Afghanistan already imports ~78% of its power requirements from these countries and Iran. The CASA 1000 project, supported by the World Bank, intends to set up an electricity transmission system between Kyrgyz Republic, Tajikistan, Afghanistan and Pakistan, spanning 477 km. The project is expected to come up in 2019 at an investment of $1.16 billion. Power would be supplied through hydropower plants in Kyrgyzstan and Tajikistan with a 1,300 MW AC-DC convertor station in Tajikistan and another 1300 MW DC-AC convertor station in Pakistan.

In addition to CASA 1000 project, Turkmenistan, Afghanistan and Pakistan have entered into a tripartite agreement to set up TAP- 500 line (500 denoting 500 kV) with Turkmenistan expected to make available 3,500 MW of excess power by 2020 to be transmitted through this line.

The construction of the TAPI gas pipeline has begun and is expected to pump 33 billion cubic meters of natural gas from Turkmenistan's Galkynysh gas fields by 2022. Although the construction of the line is fraught with political uncertainties (rivalry between India and Pakistan) and security concerns (the line traverses war-torn Afghanistan), the 1,840 km pipeline will bring easy access of gas to deprived nations (especially India) from gas rich Turkmenistan. Additionally, the Iran-Pakistan gas pipeline is expected to come up in the next two-three years with Iran completing laying of the pipeline in its territory.

Bangladesh has begun importing LNG in fiscal 2019 and has signed SPAs with Qatar, Indonesia, and Oman. LNG imports are expected to go up for India, Pakistan and Bangladesh, whereas Sri Lanka will begin LNG imports to reduce dependence on oil.

Coal will continue to be used in SAARC countries owing to low prices and easy availability. India, Bangladesh and Pakistan have significant coal deposits and domestic production will ramp up in the future. Coal-based power plants will continue to grow in Bangladesh, Pakistan, India and Sri Lanka whereas rise in industrial usage will improve coal requirement in Afghanistan, Nepal and Bhutan. Imports will grow for all countries (except Maldives) and several power plants are expected to come up with overseas coal linkages.

To facilitate additional POL imports, all SAARC nations have been investing heavily in building and augmenting terminals to unload imported crude and finished petroleum products. Bangladesh is building three tanks for crude oil and another three for diesel on the Moheshkhali Island in the Bay of Bengal near Chittagong port. The project is expected to start operations in December 2018. In India, under the National Perspective Plan for Sagarmala, six new mega ports are proposed to be developed in the country. The government of Maldives plans to further develop Thilafushi Port to facilitate additional POL products import in future.

11 Conclusion

Energy mix in the SAARC region is predominantly inclined towards fossil fuels. Even though there is significant focus on promotion of clean energy fuel sources, it is expected that the fossil fuels will account for a major share till 2030. While coal will dominate energy production in India and Pakistan, Bangladesh will continue to rely on natural gas. Maldives will continue to rely on fossil fuel imports to meet its energy needs. While there exists significant renewable energy potential in Afghanistan, the need to improve energy access is expected to keep the share of fossil fuels high in the overall energy mix.

Bhutan, Nepal and Sri Lanka are expected to continue their reliance on hydro power and biomass to meet their energy requirements.

The demand is expected to move upwards for all SMSs with rise in population, economic growth and social well-being. However, energy bottlenecks are expected to continue due to unavailability of large indigenous oil and gas reserves. Although, discoveries of gas have been made in India, Sri Lanka and Bangladesh, more cross-country engagement is required to assess commercial viability and resource exploration. Much of the crude oil imports for the region are sourced from the UAE and Iran. However, sanctions imposed on Iran by the US and declining oil reserves in Saudi Arabia pose threats towards securing energy supplies. This provides an opportunity for enhancing sub regional energy ties through technology development, resource sharing, building energy infrastructure and enhancing energy trade.

Efforts are being made by all SMSs to shift the energy mix towards cleaner fuels. Countries like Bangladesh, Sri Lanka and India have been implementing sectoral programmes (power and industry) to increase energy efficiency. All countries have stated the need to focus on energy security as well as climate change mitigation. External aid from World Bank and UNDP are being mobilized to improve usage of renewable energy. While SMSs are trying to articulate an energy vision with environment as key focus, it is difficult for countries which are well behind meeting their energy security needs to realize the same. International funding would be required to harness untapped, large scale, renewable energy, especially in Afghanistan and Pakistan, where potential for development is large and financial prowess for the nations is poor.

With the SAARC region being rich in hydropower and renewable energy, there is ample scope for extraction of this untapped potential. Improved cooperation among the SMSs through conducive policies, increased cross-border energy infrastructure and greater private sector participation by setting up collaborative projects can improve energy trade manifold. Legal, policy and regulatory risks emanating from cross-border trade may be dealt with by setting up a common framework among the nations. A regional trade treaty will help promote long-term energy cooperation. A sub regional policy agenda may be developed keeping in view future energy needs and sustainable development goals. In addition to drafting new, collaborative development frameworks, the countries need to push for implementation of the proposed projects by ensuring that they do not get embroiled in political uncertainties, inordinate delays. The energy development-sustainability nexus may be underlined in policy formulations by all established institutions in the country. Also, energy poverty can be thwarted by promoting distributed generation and off grid systems in the nation.

Moreover, on the policy level, awareness, capacity building and training regarding the energy outlook should be taken at all levels, from policy makers to the persons who are implementing the policy. Legislation will be the main driving force in order to implement the government policies and to achieve sustainable energy targets. Therefore, SAARC Member states should be encouraged through the SEC platform to undertake relevant legislation.

These measures will go a long way towards expediting regional energy trade and improving the overall energy security of the SAARC region.

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