

Energy Scenario

Bangladesh

2016-17



Hydrocarbon Unit
Energy and Mineral Resources Division
Ministry of Power, Energy and Mineral Resources

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P r e f a c e

Report on Energy Scenario, Bangladesh was prepared and published by Hydrocarbon Unit for the first time in October 2009. The present one is the issue of Energy Scenario, Bangladesh for the period of July 2016 to June 2017. In this report, Energy Scenario of Bangladesh has been reflected. Daily average gas production rate have been included in the report as well. Moreover, Share of Primary and Commercial energy, Sector-wise Liquid fuel consumption, Historical Gas production and Net Energy Generation along with the graphical presentation.

This report has been prepared based on the data available from the Monthly Reserve and Gas Production Report of HCU and Monthly Information System (MIS) of Petrobangla. Bangladesh Petroleum Corporation (BPC), Bangladesh Power Development Board (BPDB)

It is expected that the report will be helpful as reference book and elements of interest for the concerned.

The report will also be available at HCU's website: www.hcu.org.bd

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1.0 Introduction

Energy is the prime mover for a socio-economic development of a country. Economic Development depends on reliable energy supply. To achieve Vision 2021, SDGs and Vision 2041, Bangladesh has to meet increasing energy demand. In order to ensure energy security as well as to meet the increasing energy demand, the primary energy source of the country especially gas, coal and other energy resources have been taken into consideration.

The role of energy sector is unlimited in reducing poverty i.e., the overall socio economic development of the country. At present energy crisis has become an acute shape due to the lack of proper initiatives in the energy sector during the regime of past government. As a result, acquiring overall growth of the industry and other production sectors including power generation has been hampered. To overcome the stagnant situation of the country the present government is working to ensure energy supply to expedite the motion of economic development and to achieve this goal mid-term and long-term plan has been undertaken for exploration, development and production of domestic primary fuel such as gas and coal.

The main purpose of oil, gas and natural resource sector is to meet growing energy demand of the country by undertaking enhanced exploration activities based on modern seismic survey like 3D survey and development and appraisal of oil and gas fields. Besides strengthening exploration and development of gas fields, the sector strategy also aims to reduce extreme dependence on Natural Gas through diversification of energy mix, balanced and synchronized development of gas production, transmission and distribution activities, encourage participation of private entrepreneurs in oil and gas exploration, production, and distribution.

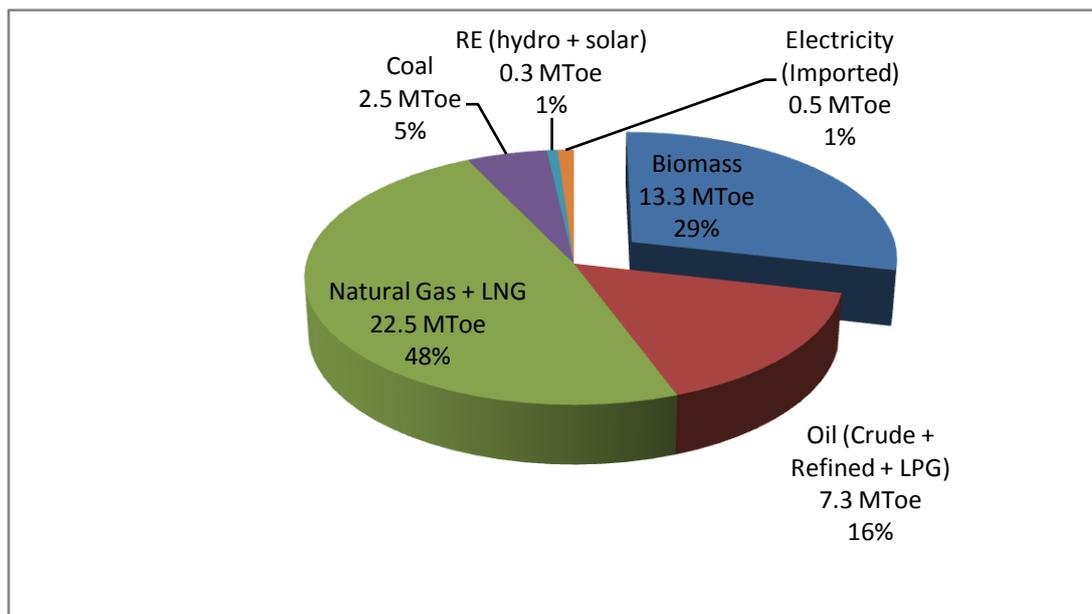
To meet energy demand at desired level, initiative has been taken to increase gas production and its optimum utilization. Steps have been taken to import LNG to meet up the increasing energy demand. Realistic policies for development of coal fields in northern part of the country are under process for national interest. Initiative has also been taken to build up regional energy security based on mutual co-operation with the neighboring countries under SAARC umbrella.

2.0 Current Position of Energy Sector

Known commercial energy resources in Bangladesh include indigenous natural gas, coal, imported oil and hydro-electricity. Biomass accounts for about 29% of the primary energy and the rest 71% is being met by commercial energy. Natural gas accounts for about 68% of the commercial energy. Imported oil accounts for the lion's share of the rest. Every year Bangladesh imports about 5.4 million metric ton of crude and refined Petroleum Products. Apart from natural gas and crude oil, coal is mainly used as fuel in the brick-fields and Thermal Power Plant.

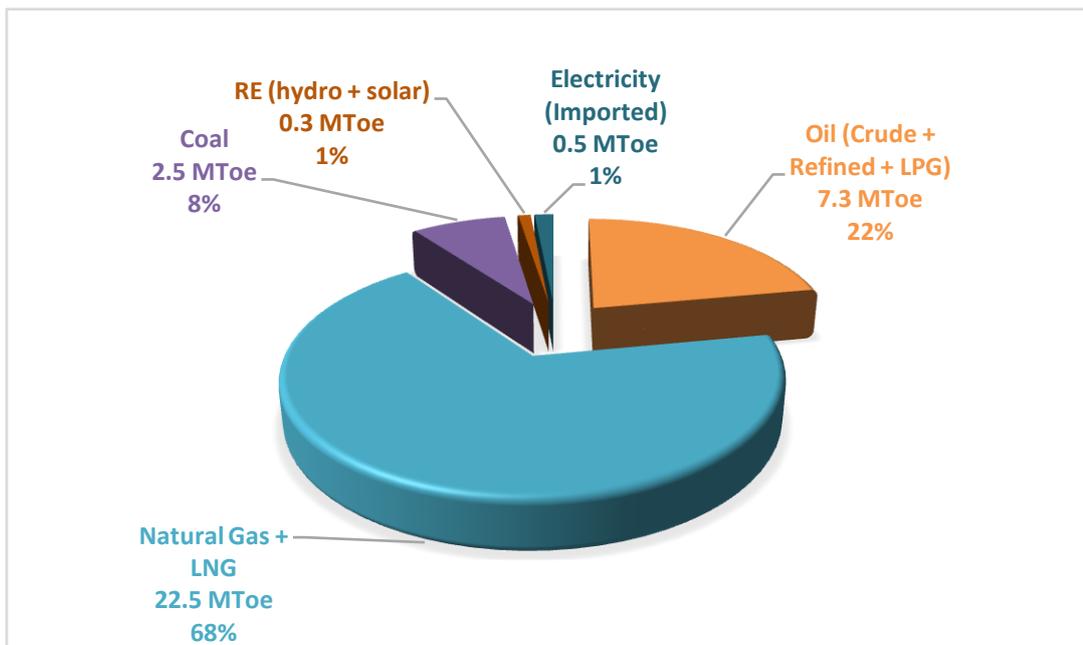
Moreover, power is also being generated by using Solar Home System (SHS) in off grid areas. The amount of power generation using solar system is currently about 213 MW. In addition there are some poultry and dairy farms in which bio-gas plants are being set up and this bio-gas is used for cooking and power generation. The amount of power generation from such plants is currently about 1 MW. Steps have been taken to generate electricity by Bio-Mass Gasification Method in the country.

Estimated final consumption of total energy is around 46.43 MTOE. Average increase of energy consumption is about 6% per annum. Per capita consumption of energy in Bangladesh is on an average 285 kgoe (Kilogram Oil Equivalent) and per capita generation of electricity is 371 kWh with a access to electricity 76%, which is lower than those of South Asian neighboring countries.



Total Primary Energy 46.43 Mtoe

Figure 1: Share of Primary Energy (2016 – 17)



Total Commercial Energy 33.1 Mtoe

Figure 2: Share of Commercial Energy (2016-17)

Bangladesh also has a bright potential to produce electricity from wind and mini-hydro. Recently, solar power based irrigation pump has been used in a number of areas of the country. Its wide use will lessen the pressure on diesel and electricity.

3. Natural Gas

3.1 Organizational Structure

Bangladesh Oil, Gas, and Mineral Corporation, short named Petrobangla, under the Energy and Mineral Resources Division of the Ministry of Power the Energy and Mineral Resources is entrusted with the responsibility of exploration of oil and gas, and production, transmission and marketing of natural gas in the country.

3.2 Natural Gas Reserve

Since first discovery in 1955 as of today 26 gas fields, 24 in the onshore and 2 in the offshore have been discovered in the country. Of them 19 gas fields are in production, one offshore gas field have depilated after 14 years of production while other offshore field has not been viable for production due to small reserve. The estimated proven plus probable recoverable reserve was 28.52 Tcf. As of June 2017, a total of 15.00 Tcf gas has already been produced leaving only 13.52 TCF recoverable reserve in proven plus probable category. Some key information about the natural gas sector is presented in the Table – 1.

Table 1: Gas Sector at a Glance

Total number of gas fields	26
Number of gas fields in production	21
Number of producing wells	112
Present gas production rate	2663.2 MMcfd
Highest Production (February 2017)	2738.2 MMcfd
Total recoverable (Proven + Probabale) reserve	28.52 Tcf
Cumulative Production (June,2017)	15.00 Tcf
Remaining Resurve (Proven + Probabale)	13.52 Tcf
Present Demand	3400 MMcfd
Present Deficit	737 MMcfd
Number of Customer	36 Lakh (Appx.)

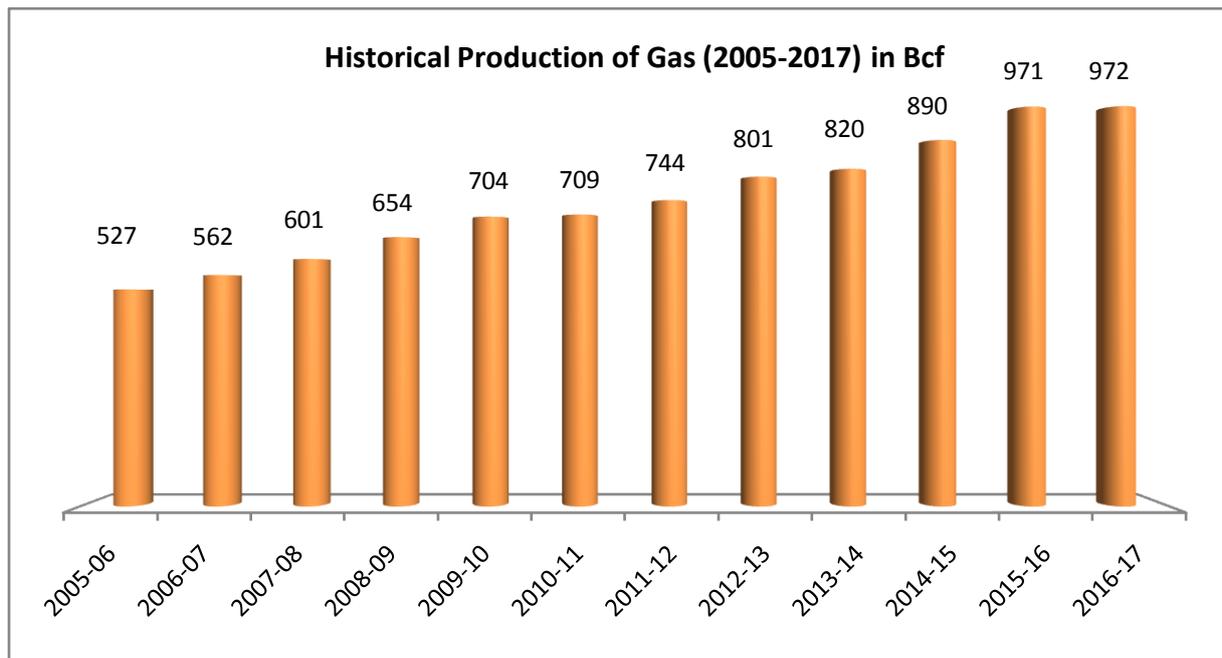
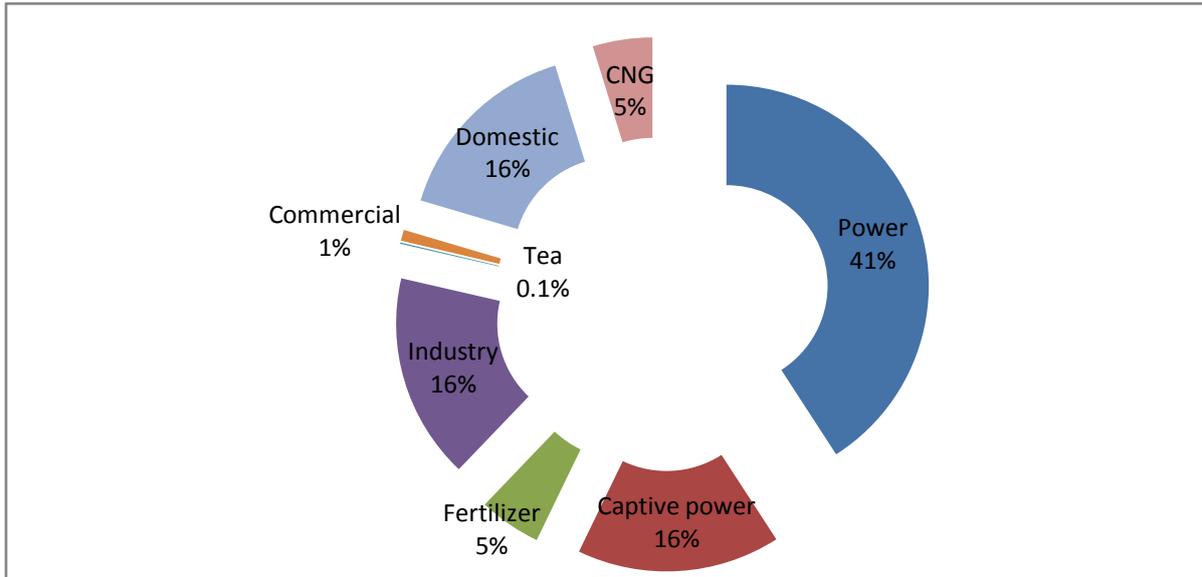


Figure 3: Historical Gas Production in Bangladesh (2005 – 2017)

Although natural gas was introduced as commercial fuel in early 1960s, its consumption got real momentum in eighties marking the beginning of the industrialization in the country.

3.3 Natural Gas Consumption

The current average production of natural gas is about 2663.2 MMcfd. A total 972 billion cubic feet (BCF) of natural gas was produced in 2016-17 which was used by power- 41%, fertilizer-5%, captive power-16%, industry-16%, domestic-16%, CNG - 5% and others very small amount. Natural gas accounts for the 66% grid electricity generation while all the 7 urea fertilizer factories are dependent on natural gas for feedstock. Natural gas has made tremendous contribution towards industrial growth in the country as fuel for heating and captive power generation at very favorable price. While the whole nation has been benefitted by this resource, about 7% of the populations have directly been benefitted by using piped natural gas for household purposes. Compressed National Gas is being used as automobile fuel by about 250,000 motor vehicles in the country. Expansion of CNG facilities early last decade dramatically improved air quality in large cities especially in the capital Dhaka as well as lot amount of foreign exchange has been saved due to less amount of oil import.



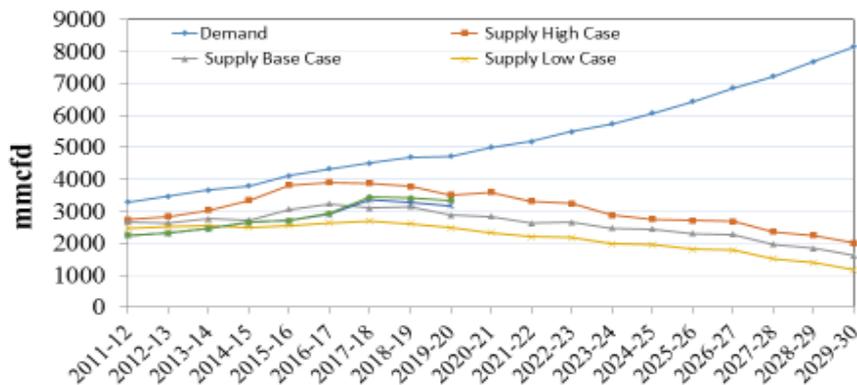
A Total of 972 Bcf gas was produced in 2016-17

Figure 4: Sector wise Gas Consumption in Bangladesh (2016-17)

3.4 Natural Gas Demand

Being almost single indigenous sources of commercial energy demand for natural gas experienced vary fast growth over the last three decades often outstripping the supply. Present demand for gas in the country is about 3400 MMscfd whereas supply is 2650-2750 MMscfd indicating a shortage of about 700 MMscfd. It is estimated that demand for natural gas will rise to about 8000 MMscfd by the 2030. Natural gas demand projection in the country is shown in the figure below:

Demand and Supply of Gas



Demand Supply gap is increasing, production is likely to decline from 2016-17

Figure 5: Demand and Supply of Gas in Bangladesh (2011 – 2030)

3.5 LNG import to Supplement Indigenous Supply

As seen from the figure above, existing demand supply gap will widen with time, if large reserves cannot be discovered shortly. Foreseeing the uncertainty in new discovery, government has undertaken a project to import LNG equivalent to 500MMscfd in the first phase to offset demand supply gap. It is expected that re-gasified LNG will be fed to the network in April 2018 after installation of a floating storage re-gasification unit (FSRU) at Maheshkhali in Cox's Bazar district by a private entrepreneur on build, own, operate and transfer (BOOT) basis, and construction of a 30 inches dia 91 km transmission pipeline from re-gasification facilities to Chittagong ring-main by the national gas transmission company, GTCL. Two land based LNG terminal of 1000 MMcfd each at Maheshkhali and Payra are to be set up. Besides that different initiative has been taken for power generation more FSRU and land base LNG terminal are to be set up under Power Division.

3.6 Exploration Activities

Exploration for oil and gas in this country in the early last century while first success came in with discovery of gas field in Sylhet. So far 97 exploration wells have been drilled in the country with 26 discoveries of gas fields. Government has attached utmost importance to the exploration for oil gas in the country both in the onshore and in the offshore. It is the government priority sector. National exploration company BAPEX is engaged in the exploration in the onshore while international oil companies (IOC) are carrying out in onshore and offshore.

A total no. of 119 well will be drilled by BAPEX & IOCs under a crash program of gas exploration/production up to 2021. Additional 1220 – 1278 MMcfd gas is expected to be added to the national grid.

Two PSCs, signed in February 2014, are currently active in the shallow offshore, one with ONGC Videsh Limited and Oil India Limited while another with the consortium of Santo and Kriss Energy (Asia) limited.

It has been decided in the backdrop of maritime boundary settlement with Myanmar and India to conduct “ Non-Exclusive Multi-Client Seismic Survey” on the offshore to get seismic data of deep sea which is an internationally recognized practice followed by many countries.

The blocks of the country are rearranged; the Model PSC for Onshore 2015 and Model PSC for Offshore 2015 are in the final stage of approval.

3.7 Exploration of Unconventional form of energy

Exploration of different form of Unconventional energy like Coal Bed Methane (CBM), Shale gas, Underground Coal Gasification (UCG) is going on in search of alternate energy.

Petrobangla has undertaken a project to assess the potentiality of coal bed methane in Jamalganj coal deposit, the largest and deepest coal deposit in the country.

A Preliminary Study on Shale Gas Potentiality in Bangladesh has been prepared by the Hydrocarbon Unit. Hydrocarbon Unit has prepared another report titled “Action Plan and Guide lines for CBM, UCG and Hard Rock Development in Bangladesh”.

4.0 Oil (Petroleum) Sector

4.1 Organizational Structure

Bangladesh Petroleum Corporation under the Mineral Resources Division of the government is the nodal organization in the petroleum sectors which deals with import of crude oil and products, oil refining and marketing finished petroleum products. One refining company with lone crude oil refinery in Chittagong is engaged in refining of crude oil while four oil marketing companies are responsible for marketing of finished products across the country. Oil business used to be government monopoly until 1997 when one private company entered in fractionation of gas condensate extracted from gas fields. Presently, gas condensates, are fractionated by small scale fractionation plants of Petrobangla, BPC and private entrepreneurs. Besides, there two petrochemical plants in the private sector that imported condensate as feed.

4.2 Supply and Consumption of Oil

Petroleum products viz. diesel, petrol, octane furnace oil etc, account for about 20% primary the commercial energy supply in the country. Liquid fuel used in Bangladesh is mostly imported. Locally produced gas condensate shares only 6% of total liquid fuel consumption. Only. Bangladesh imports about 1.2 million metric tons of crude oil along with 4.3 million metric tons (approx) of refined petroleum products per annum. About 350 thousand tons per year locally produced gas condensate, which is fractionated mainly into petrol, diesel and kerosene, is the only domestic source of liquid fuel. Major consumer of liquid fuel is transport followed by power, agriculture, industry and commercial sectors. Sector-wise consumption of petroleum products are: transport-51.6%, power-23.3%, agriculture 15.38%, industry6.3%, domestic-3.1% and others 0.32%

Table 2: BPC at a Glance (2016 – 17)

Total Consumption of POL	58.89 Lac MT.
Import of Refined Oil	44.53 Lac MT.
Import of Crude Oil	13.79 Lac MT.
Export of Naphtha	1.09 Lac MT.
Total Storage Capacity	12.13 Lac MT
Supply of POL in Power Plant	13.72 Lac MT.
Domestic Production of LPG	16382 MT
Production of LPG Under Private	307000 MT
Import of Furnace Oil	5.21 Lac MT
Demand of POL in FY 2017-18	59.50 Lac MT

Table 3: Petroleum Sector at a Glance
SALE OF PETROLEUM PRODUCTS DURING LAST 7 YEAR

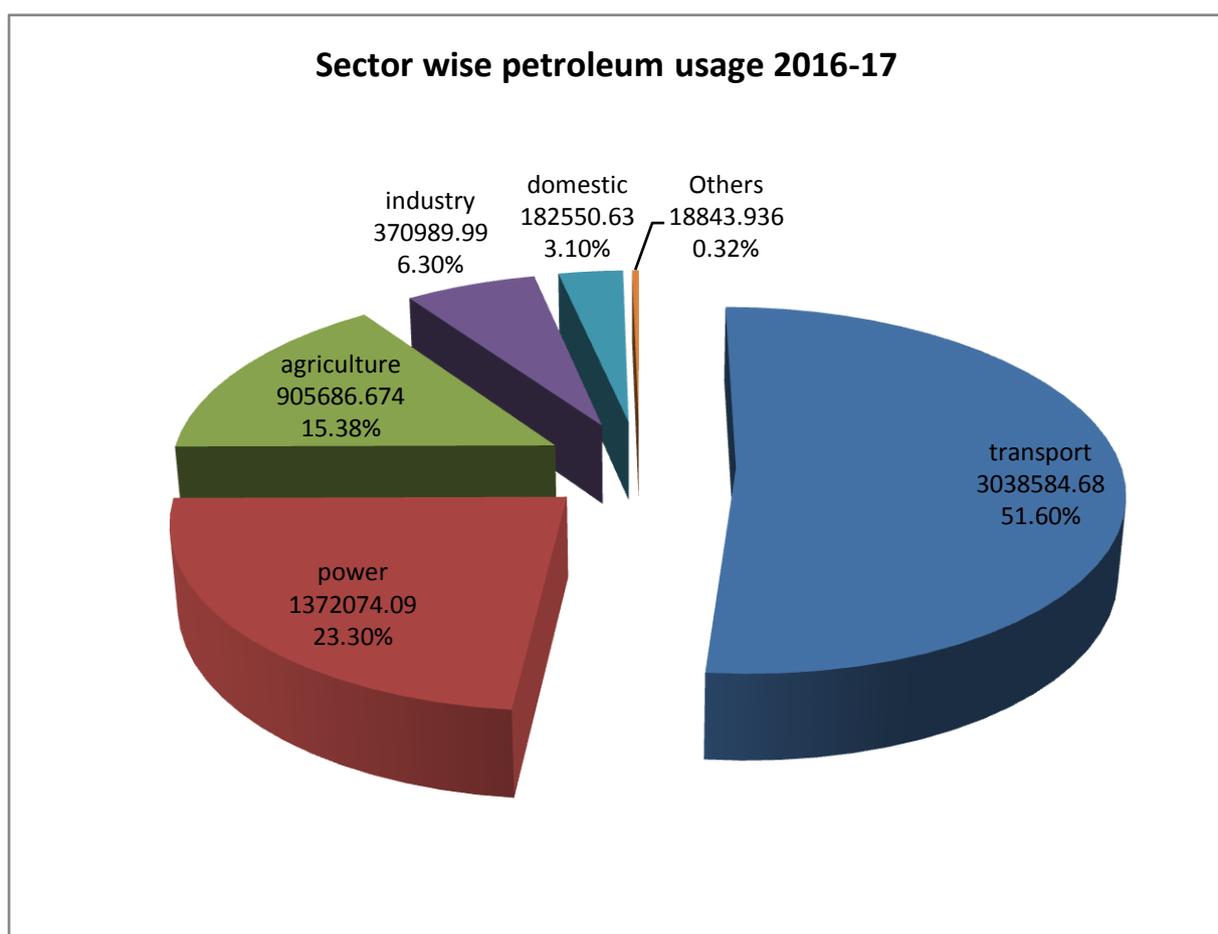
Quantity in MT

Products	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Octane	97264	107150	110850	117452	126114	147557	186911
Petrol	141491	158707	169710	178674	166823	137360	232359
Diesel	3239279	3240349	2962872	3242554	3396061	3606404	4000044
Kerosine	397209	358436	314450	289871	263029	213685	170993
Furnace Oil	544617	883735	1070096	1202505	906771	711889	806440
Jet A-1	335732	311890	318423	323327	338829	347323	376700
Others	112432	153379	131591	130583	123796	91802	115283
Total	48868024	5213646	5077992	5484966	5321423	5256020	5888730

Diesel is the dominant liquid fuel used in the country. Petroleum products used during last seven years are shown in the above table.

Sector wise petroleum consumption:

Sector	Uses amount in M.T.	%
Transport	3038585	51.6
Power	1372074	23.3
Agriculture	905686.7	15.38
Industry	370990	6.3
Domestic	182550.6	3.1
Others	18843.94	0.32
Total	5888730	100



Total Consumption 5888730 MT

Figure 6: Sector wise Liquid Fuel Consumption in Bangladesh (2016-17)

Table 4: Financial Performance of BPC from 2002-2013 to 2014-2015

(Taka in Crore)

Financial Year	Profit/(Loss)	Contribution to Exchequer
2001-2002	(780.16)	3,033.00
2002-2003	(7.61)	2,766.00
2003-2004	(958.93)	3,087.27
2004-2005	(2,317.88)	2458.95
2005-2006	(3,337.78)	2,620.26
2006-2007	(2,914.63)	2,756.55
2007-2008	(7,750.30)	3,003.61
2008-2009	(1,022.63)	1,908.99
2009-2010	(2,571.22)	2,324.25
2010-2011	(9,799.91)	3,508.50
2011-12	(10,548.09)	4,548.06
2012-13 (Provisional)	(5,368.70)	5,022.31
2013-14 (Provisional)	(2,477.69)	4,854.06
2014-15 (Provisional)	4212.67	-
2015-2016	6753.30	1000.00
2016-2017	3351.02	1200.00
Total	(35,538.5)	44,091.81

Source: BPC

4.3 Capacity Enactment Projects

Eastern Refinery Limited (ERL) installed in 1968 at Chittagong with the processing capacity of 1.5 million tons annually, now dated to around 1.3 million tons per year. A Project has taken for installation of 2nd unit of the existing refinery with annual refining capacity of 3 (three) million tons. Besides the state initiative, government allowed private entrepreneurs to establish Condensate Fractionation Plants to split Natural Gas Condensate (NGC) received from various gas fields in Bangladesh as well as imported NGC.

Total storage capacity of different grades of petroleum is around 1.08 million metric tons across the country. It may be mentioned that, according to the national energy policy, 60 days stock of petroleum products to be maintained for energy security of the country. But at present BPC is able to maintain 35 to 40 days stock of petroleum products due to lack of storage capacity as well as involvement of huge amount money for procuring petroleum. BPC has taken a project for construction of **Mongla Oil Installation** as 2nd main installation to enhance 0.10 million metric tons with 14 oil storage tanks.

Single Point Mooring (SPM) project is now in progress which will enable BPC to receive Crude Oil and Diesel from large size vessels of 120,000 metric tons carrying capacity through subsea pipeline, from near Kutubdia of the Bay of Bengal, within 48 hours instead of present required time of 9/10 days. Storage facility will be constructed of 0.24 million metric tons, for crude oil 0.15 million metric tons and for diesel 0.09 million tons, at Maheshkhali under SPM Project for smoothing receiving of petroleum. Operational flexibility will improve amazingly after completion of the SPM project.

4.4 Demand for Petroleum Products

Demand for petroleum products is growing at the rate of 2 to 4% per year. If this trend continues demand for oil will increase to about 8 million tons by the year 2030. Government of Bangladesh has decided to make road connectivity with the neighboring countries like India, Nepal, Bhutan etc. Transport movement will increase remarkably in Bangladesh territory to avail port facilities Chittagong and Mongla ports by our neighbors. However, future demand will depend upon the future energy mix in the country and availability of other fuels.

4.5 Source Countries for Imported Oils

ADNOC Of UAE and Saudi Aramco of Saudi Arabia are suppliers for crude that BPC imports while finished products are imported from 13 National Oil Companies (NOC) of different countries. A project is in active consideration by the government to import diesel, produced in Numaligarh Refinery Limited (NRL) in Assam, from its marketing terminal at Shiliguri through pipeline to Parbatipur depot at Dinajpur district of Bangladesh.

5.0 Liquefied Petroleum Gas (LPG)

Demand of Liquefied Petroleum Gas (LPG) in Bangladesh is very high. In the public sector 16,382 MT of LPG are bottling every year, out of which 10000 MT is obtained as byproduct from processing of crude oil in Eastern Refinery and 6000 MT from is extracted from natural gas in Kailashtila gas field. LPG is imported by only private sector. Around 3,07,000 MT of LPG is imported and marketed by private sector entrepreneurs every year. So public and private sector combining do the marketing of 3,23,382 MT of LPG every year, which is meeting a certain portion of LPG demand of the country. Considering the rising demand for LPG, government has decided to enhance LPG bottling facilities for marketing more imported LPG. For this purpose, two LPG bottling plants, each having capacity of 100 thousands MT per annum, will be set up in the coastal area. Of them, one plant will be installed by Bangladesh Petroleum Corporation (BPC) and the in public private partnership with BPC.

6.0 Coal

In Bangladesh, the reserve of coal (Bituminous Coal) is about 31,000 million tones which is equivalent to 85Tcf gas in 5 coal fields so far discovered, namely Barapukuria, Khalaspir, Phulbari, Jamalganj and Dighipara. If initiatives are taken for exploration all over the country, there are enough possibilities to discover more coal mines. Out of the discovered mines, coal from 4 deposits (118-509 meters) is extractable at present. Production from Jamalganj may not be viable with present day's technology due to the depth of the deposits.

Table - 5 : Coal Fields of Bangladesh

Place/Field (Discovery Year)	Depth (Meter)	Area (Sq.Km)	Reserve (Million Ton)	Depth (Meter)	Calorific Value (BTU/lb)
Barapukuria, Dinajpur (1985)	119-506	6.68	390	119-506	11,040
Khalaspir, Rangpur (1995)	257-483	12.00	523	257-483	12,700
Phulbari, Dinajpur (1997)	150-240	30.00	572	150-240	11,900
Jamalganj, Jaipurhat (1965)	900-1000	16.00	1,054	900-1000	11,000
Dighipara, Dinajpur (1995)	327	15.00	600	327	13,090
			Total = 3139		

Coal resources can be alternative source of fuel to natural gas. These coals can conveniently serve the energy needs of Bangladesh for 50 years. It is notable that the coal of Bangladesh is considered to be high quality in terms of its high level of heat generation capacity as well as low sulphur content.

Commercial production of Barapukuria Coal Mine commenced from 10 September 2005 using underground mining method with the targeted capacity of one million metric ton per year. Almost 65% of the production is being used by 250 MW (2x 125 MW) Coal fired power station operated by Power Development Board of Bangladesh near Barapukuria coal mine. Remaining 35% coal is being used in brick fields and other domestic purposes which have an impact of reducing deforestation. A total of 67.50 lakh metric ton of coal has been extracted from its inception up to June 2016. At present Barapukuria Coal Mine is producing at an average 4,000 - 5000 MT coal per day.

7.0 Peat

The peat deposits of Bangladesh are located in the low lying areas of the alluvial plain which are generally submerged under water for a large period each year. Peat occurs in Baghia-Chanda beel under Madaripur and Gopalganj district, Kola Mouza of Khulna district, Chatal beel area of Moulavibazar district, Pagla, Dirai and Shalla area of Sunamganj district, Chorkai area of Sylhet district, Brahmanbaria Sadar upazila of Brahmanbaria district and Mukundapur area of Habiganj district. It has a carbon content of 50-60% and has a calorific value between 5500 Btu/lb and 7000 Btu/lb. The peat occurs at the surface or at shallow depths below the surface. The total peat reserve (dry peat) discovered in Bangladesh is 146.36 million ton. There is no commercial utilization of peat in Bangladesh at present. Peat can be conveniently used in the form of briquette, ovoid and compressed tablets as an alternative fuel to household work, in brick and lime industries and in small capacity thermal power plant (10 MW) in rural areas. Three exploration licenses of peat is granted in Rajoir Upazila of Madaripur and Kotalipara Upazila of Gopalganj district.

8.0 Compressed Natural Gas (CNG)

To reduce the dependency on imported fuel significantly, to reduce environment pollution and to save foreign currency, the use of CNG vehicles was introduced in 1997. About 5% of total natural gas (974 Bcf) was used as Compressed Natural Gas (CNG) in FY 2015-2016. For advantage of CNG usage in vehicle, 548 CNG filling stations and 180 CNG conversion workshops till June 2016 are in operations by the public and private entrepreneurs. These CNG Stations are consuming approximately 112 MMCM gas monthly which is equivalent to more than 12.1 crore litres of oil . Thereby, Government is saving a lot of foreign exchange.

9.0 Condensate and Natural Gas Liquids (NGL)

Some of the gas fields located in north - eastern part of Bangladesh contains high percentage of liquid hydrocarbon. Extraction of this liquid, especially value added by-products, is becoming a growing activity. Apart from the condensate fractionation plant installed in different gas fields, Rashidpur Condensate Fractionation Plant with a capacity of 3750 bbl/day is producing petrol, diesel and kerosene by fractioning the condensate received from Bibiyana Gas Field. During 2015-16, a total of 530,000 barrels of condensate was produced by SGFL, BGFCL and BAPEX and 3,609,924 barrels by IOCs as a by-product of gas. During the same period, SGFL extracted 1, 62,057 barrels of NGL from the gas processed at its Mole-Sieve Turbo Expander plant at Kailashtila. On the other hand, a total of 707,688 barrels of petrol, 381,188 barrels of diesel and 102,318 barrels of kerosene was produced by fractionating the condensate at the fractionation plants located at different fields of SGFL, BGFCL and RPGCL.

10.0 Power Sub-Sector

10.1 Primary Energy Mix for Power Generation

As of June 2017 the total power generation capacity combining public and private sector was 15755 MW, leaving 20% capacity for maintenance and forced outage, available generation capacity should be about 12604 MW without fuel constraint. Maximum generation actually obtained till 30 June 2017 was 9479 MW, which was less than 12604 MW. It might have occurred due to fuel supply constraint. Of the total generation capacity, distribution between public sector and private sector entities are 52% and 43% respectively and from import 5%. Bangladesh has started importing 500MW electricity from India (started in October 2013) additional 100 MW from March'16 which contributed 7% of total power generation.

Table – 6: Bangladesh’s Power Sector: At a Glance (2016-17)

Electricity Growth	8.17%
Installed Capacity (MW)	15755
Maximum Generation (MW)	9479 (30 June 2017)
Total Consumers (in Millions)	25.90
Transmission Lines (km)	10436
Distribution Lines (km)	401000
Per Capita Generation (including Captive)	433 Kwh
Access to Electricity (including Off-Grid Renewable)	80%

The composition of primary energy mix for power generation in FY 2016 - 17 is shown in Figure 8. Of the total electricity generated in 2016 -17, 70% was generated from domestic fuels (natural gas, coal & hydro) and 22% from imported petroleum fuels (diesel and furnace oil) and 8% was electricity Import from India as cross border energy trade.

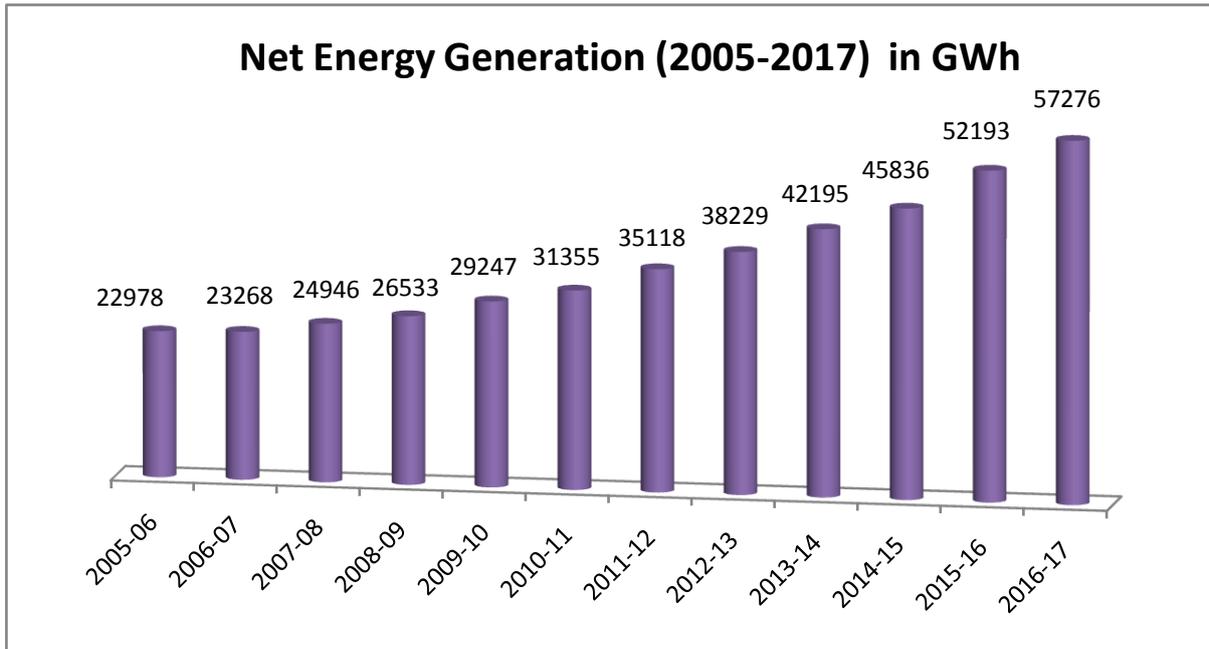
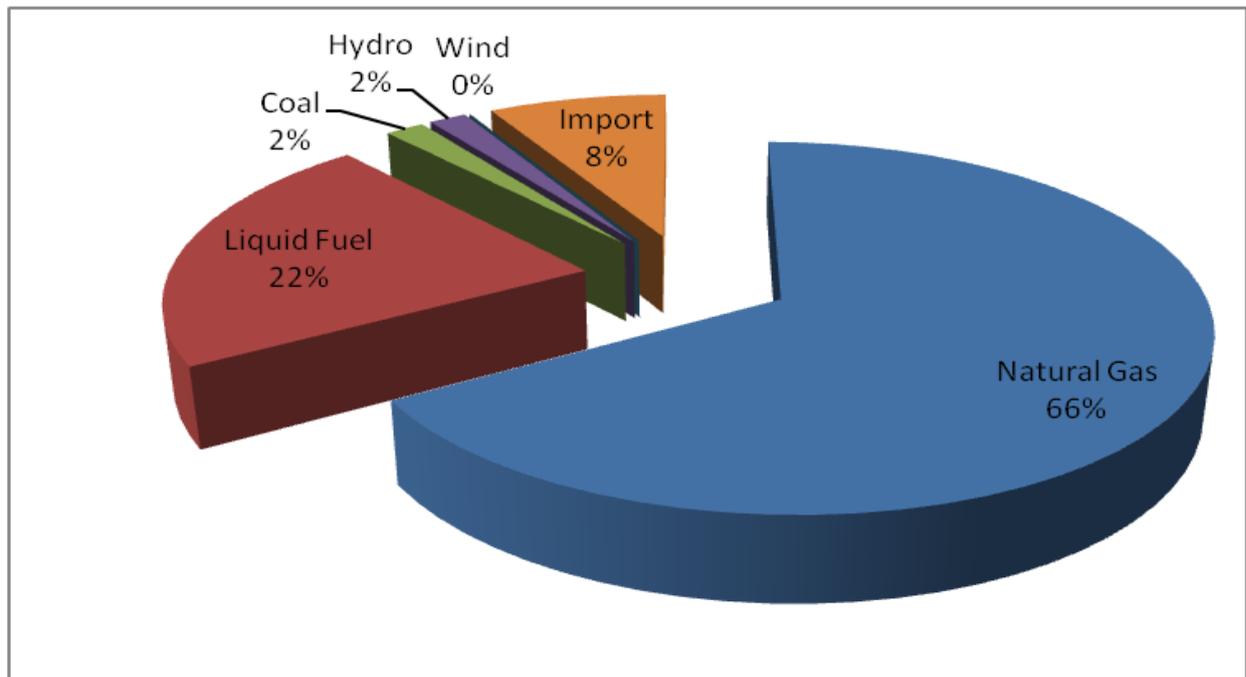


Figure 7: Historical Net Energy Generation (Gwh) in Bangladesh



Total Net Energy Generation (2016-17): 57276 Gwh

Figure – 8: Energy Generation by Fuel Type (2016-17)

10.2 Electricity Import

Bangladesh has entered into the era of cross border energy trade in October 2013 by importing electricity from India. Additional 100 MW from March 2016 from Tripura At present 600 MW electricity is being importing from India and in near future it will increase considerably.

11.0 Renewable Energy Resources

Renewable energy resources could assist in the energy security of Bangladesh and could help reduce the natural gas demand. Regions of the country without supply or access to natural gas or the electric grid use biomass for cooking and solar power and wind for drying different grains and clothes. Biomass is currently the largest renewable energy resource in use due to its extensive noncommercial use, mainly for cooking and heating. Biomass comprises 29 percent of the total primary energy use in Bangladesh. The country has a huge potential for generating solar power. Moreover the use of renewable energy has become popular worldwide in view of the depleting reserves of non-renewable fossil fuels. Renewable energy is environmentally friendly.

Renewable energy resources used in Bangladesh may be classified into three major types- (i) traditional biomass fuels, (ii) conventional hydropower, (iii) new-renewable resources (e.g. solar PV, wind, biogas etc.) of energy.

11.1 Traditional Biomass fuels

In Bangladesh, three major types of biomass fuel resources are in use: wood fuels, agricultural residues and animal dung. Wood fuels are obtained from different types of forests and tree resources grown in rural areas. Agricultural residues and animal dung contribute a substantial portion of biomass fuel in Bangladesh. A part of the total agricultural residues available during harvesting of crops and a part of total animal dung produced by animal resources are used as fuel. Availability of these resources (agricultural residues, animal dung) as fuel depends on local situation and socio-economic condition of the owners.

Converting biomass into more energy efficient fuel is a means of upgrading the rural energy consumption pattern. Biogas is very suitable for cooking and lighting (Mantel/Hazak) and for running a small generator to produce electricity. Throughout Bangladesh, there are currently about 80,000 households and village-level biogas plants in place. Around 50,000 domestic biogas plants already installed by IDCOL. There is a real potential for harnessing basic biogas technology through rural electrification, village-level biogas production, and internal combustion (or even micro turbine) power generation.

Biomass Potential of Bangladesh (2012-13)

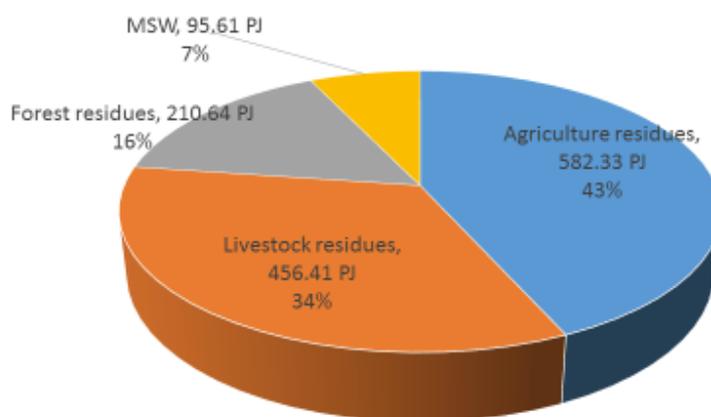


Figure 9: Biomass Potential of Bangladesh (2012 – 13)

The power generation of the country largely depends on the non-renewable (fossil fuel) energy sources, mainly on the natural gas. This trend causes rapid depletion of non-renewable energy sources. Thus, it is necessary to trim down the dependency on non-renewable energy sources and utilize the available renewable resources to meet the huge energy demand facing the country. Most of the people living in rural, remote, coastal and isolated areas in Bangladesh have no electricity access yet. However, renewable energy resources, especially biomass can play a pivotal role to electrify those rural, remote, coastal and isolated areas in the country. Humankind has been using biomass as an energy source for thousands of years. In a study (Paul & Others) assesses the bio-energy potential, utilization and related Renewable Energy Technologies (RETs) practice in Bangladesh. Improved cooking stove, biogas plant and biomass briquetting are the major RETs commonly practiced in Bangladesh. The assessment includes the potential of agricultural residue, forest residue, animal manure and municipal solid waste. The estimated total amount of biomass resource available for energy in Bangladesh in 2012–2013 is 90.21 million tons with the annual energy potential of 45.91 million tons of coal equivalent. The recoverable amount of biomass (90.21 million tons) in 2012–2013 has an energy potential of 1344.99 PJ which is equivalent to 373.71 TWh of electricity.

11.2 Conventional Hydropower

Total hydropower potential of the country was reported as 1500 MkWh/year at Kaptai (1000MkWh/year). Matamuhury (300MkWh/year) and Sangu (200MkWh/year) (GOB 1996). In 2013, total generation capacity of 5 hydropower units installed at Kaptai was 230MW and electricity generated was 8934 MkWh. Depending upon rainfall, yearly electricity generation capacity of hydro plants varies between 700 MkWh to 1000 MkWh. Total electricity generated in 2013 was 36,482MkWh, of which the share of hydro power (primary electricity) was only 2.5 percent.

It was reported that a feasibility study was undertaken in 1998 to establish additional hydropower units (Nos. 6 & 7) at Kaptai with generation capacity of 100MW. There is potential to install hydropower plant at the Sangu and the Matamuhury rivers in the Chittagong Hill Tracts and possibility of constructing a second dam, six kilometers downstream of existing Kaptai dam to generate hydropower. Though in Chittagong Hill Tracts local population are already conscious about the negative impacts of existing hydropower plants at Kaptai proper rehabilitation program should be undertaken. Considering the energy scarcity of the country, the feasibility of harnessing additional electricity through conventional hydropower technologies and mini & micro hydropower technologies should be explored to meet a part of future energy needs.

11.3 New-Renewable Energy Resources

It was mentioned in the Renewable Energy Policy 2008 that 5% and 10% of total electricity would be generated using renewable energy by 2015 and 2020 respectively (GOB 2008). SREDA Act 2012 was enacted for the establishment of Sustainable & Renewable Energy Development Authority (SREDA) for promotion of efficient energy and renewable energy technology. The authority (SREDA) is in the process of institutionalization. Total generation of electricity from new-renewable energy sources (e.g. solar PV, biomass, biogas etc.) up to June 2016 was 200 MW. Total generation from RE including hydropower (230MW) was 430MW, which was 3% of total electricity generation capacity (14,539 MW) of the country including off grid, RE and Captive.

In line with the policy, government has already taken different initiatives in renewable energy development, in which some projects/programmes have been completed and some are under implementation.

i. Solar Energy

Bangladesh is geographically located in a favorable position (within 20^o34' to 26^o38' north latitude) for harnessing sunlight, available abundantly for most of the year except for the three months June-August when it rains excessively. The amount of Solar Energy available in Bangladesh is high about 4 to 7 kWh/m²/day, enough to meet the demand of the country. There is a fast-growing acceptance of rural people to solar photovoltaic (PV) systems to provide electricity to households and small businesses in

rural off grid areas. The Rural Electrification Board (REB), a government agency has been engaged in commercializing solar power electrification of domestic, commercial, irrigation in rural area. IDCOL, a government-owned entity has disseminated some SHS through its partners NGOs. Due to higher cost of its production it has to go a long way to become commercially competitive. However, in remote areas of Bangladesh it is gradually becoming popular and government has undertaken a lot of scheme to subsidize on it. Government has planned to setup solar panel with capacity of 5~10 MW.

[Solar Home System (SHS)]

Solar Home System (SHS) provides reliable power for lighting and operating low powered appliances such as radio, television, small electric fans. The electricity provided by a SHS can also be used to run Direct Current (DC) driven equipments such as DC shouldering irons, drilling machines etc and to charge the battery of mobile phones. Larger systems can run computers, refrigerators, pumps etc. IDCOL and BREB are distributing Solar Home System (SHS) to the people living in the off-grid areas. IDCOL through different partner organization has already distributed about 49.7 lakh (installed capacity 190 MW) SHS and BREB distributed about 30 thousand SHS throughout the country.

[Solar Irrigation System]

Solar powered irrigation is the breakthrough technology for energy stricken agro-based economy. Solar powered irrigation is the innovative and environment friendly solution for the irrigation system, which currently depends on hugely inefficient electric and diesel pumps. Gradually replacing the electric and diesel pumps for irrigation with solar water pumps could save significant capacity of electricity and huge investment cost. Up to June'16, a 366 nos (installed capacity 2.5 MW) solar irrigation pump has been installed by IDCOL.

ii. Bio fuel

Bio fuels can be produced from a variety of plants like rapeseed, mustard, corn, sunflower, canola algae, soybean, pulses, sugarcane, wheat, maize, and palm. The most popular option for producing bio-fuels is from non-edible oilseed bearing trees. The two most suitable species are:

Jamal gota (*Jatropha curcas*) and Verenda (*Ricinus Communis*). Both of these trees can grow virtually anywhere in any soil and geo- climatic condition.

Bio-fuel use is not new in Bangladesh. In the early 20th century, bio-fuel was used for lighting lamps or lanterns. In an agriculturally based country like Bangladesh, bio-fuel can be a better alternative because a 30 percent blend of bio-fuel can be used along with our diesel or petrol. This can also be an excellent fuel to kindle lamps in rural Bangladesh.

The use of bio-fuel is increasing in most European countries. Germany has thousands of filling stations supplying bio-fuel and it is cheaper than petrol or diesel. The German government declared that 5 percent of every liter of fuel must be bio-fuel by 2010 and 10 percent of every liter of fuel must be bio-fuel by 2015.

iii. Wind Energy

Bangladesh is exploring the potential of wind power. In the coastal area of Bangladesh, windmills with a capacity of 2 MW are in operation. Bangladesh has had to wait for a breakthrough in wind power technology to be competitive against other conventional commercial energy sources. A pilot project to install windmills along the seashore with a capacity of 20 MW has been planned by the government. Based on the results of the pilot project, another 200 MW of power could be harnessed from wind power.

Rising fossil fuel and CO₂ prices, technological advances and economies of scale with wider deployment are expected to make renewable-based systems increasingly cost-competitive in coming decades (IEA 2011).

iv. Tidal Energy

The tides at Chittagong, south east of Bangladesh are predominantly semidiurnal with a large variation in range corresponding to the seasons, the maximum occurring during the south-west monsoon. A strong diurnal influence on the tides results in the day time tides being smaller than the night time.

In the year 1984, an attempt was made from the EEE department of BUET, Dhaka to access the possibility of tidal energy in the coastal region of Bangladesh, especially at Cox's Bazar and at the islands of Maheshkhali and Kutubdia. The average tidal range was found to be within 4-5 meter and the amplitude of the spring tide exceeds even 6 meter. From different calculation it is anticipated that there are a number of suitable sites at Cox's Bazar, Maheshkhali, Kutubdia and other places, where a permanent basin with pumping arrangements might be constructed which would be a double operation scheme. Tidal energy might be a good alternative source for Kutubdia Island where about 500 kw power could be obtained. At present there are only 2x73kVA diesel generator sets to supply electricity for 5-6 hours/day for 72,000 people and there is practically no possibility of main grid supply in the future.

v. **Wave Energy**

Until to now no attempt has been made by Government of Bangladesh to assess the prospects for harnessing energy from sea waves in the Bay of Bengal. Wave power could be a significant alternative source of energy in Bangladesh with favorable wave conditions especially during the period beginning from late March to early October. Waves are generally prominent and show a distinct relation with the wind. Waves generated in the Bay of Bengal and a result of the south-western wind is significant. Wave heights have been recorded by a wave rider buoy and correlated with wind data. Maximum wave heights of over 2 m, with an absolute maximum of 2.4 m, on the 29 July were recorded. The wave period varies between 3 to 4 sec for waves of about 0.5 m, and about 6 sec for waves of 2 m.

In Bangladesh wind speeds of up to 650 kmph (400mph), 221 kmph (138 mph) and 416 kmph (260 mph) have been recorded in the years 1969, 1970 and 1989 respectively. Severe cyclonic storms and storm surge of up to 15 m have been reported. Plant must also be able to survive the exceptional occurrence of very high waves in storm conditions.

vi. **River Current**

A network of rivers, canals, streams etc. numbering about 230 with a total length of 24140 km covers the whole of Bangladesh flowing down to the Bay of Bengal. Different sizes of boats are the main carriers of people and goods for one place to another. Boatmen usually use the water-sails to run their boats against the wind direction. But until now no research has been reported to utilize the energy of river current properly.

vii. **Waste to Electrical Energy**

Dhaka City has been suffering for a long time from a tremendous environmental pollution caused by municipal solid waste, medical waste and various industrial wastes. In order to save the city from environmental pollution the waste management as well as electricity generation from the solid wastes programme is being taken by the Government.

12.0 Nuclear Power

Nuclear powers is characterized by very large up-front investments, technical complexity, and significant technical, market and regulatory risks, but have very low operating costs and can deliver large amount of based load electricity while producing almost no CO₂ emissions. Typical construction times are between five and eight years from first concrete poured. Government of Bangladesh has signed a general contract with Russia on December 25, 2015 for the construction and commissioning of the country's first nuclear power plant (2*1200 MW) at Rooppur in Pabna at the cost of \$12.65 billion.

Planned Nuclear Power Reactors:

Unit	Type	Capacity	Construction start	Commercial Operation
Rooppur 1	VVER-1200/V-523	1200 MWe	Oct 2017	2023 or 2024
Rooppur 2	VVER-1200/V-523	1200 MWe	2018	2024 or 2025

All fuel for Rooppur is being provided by Rosatom, and all used fuel is to be repatriated to Russia, in line with standard Russian practice for such countries. A draft agreement on used fuel was signed in March 2017, totaling about 22.5 ton/yr from each reactor (42 fuel assemblies, each with 534 kg of fuel). A further agreement for repatriation of used fuel for reprocessing was signed in August 2017.

The Bangladesh Atomic Energy Commission (BAEC) has taken an initiative to conduct a survey in eight char areas of southern region to select one or two suitable sites to set up the country's second nuclear power plant, aiming to meet the future demand of huge electricity. The study will cover a demographic survey over a 5-km diameter, seismic stability, geological location, power infrastructure and communication system.

13.0 Conclusion

Bangladesh is facing scarcity of energy. There is gap between demand and supply of energy. The gap is increasing day by day. A different initiative has been taken to increase supply of energy. Contract has been signed to install a FSRU of 500 MMscfd capacity for LNG import, ERL expansion and SPM project have been thrown, Cross boarder energy trade will get momentum, Setting up of land based LNG terminals to import LNG has been initiated. New horizon has exposed in sea after settlement of maritime boundary with Myanmar and India. Discovered Coal Fields will be developed. Coal based power production will get momentum. Successful implementation of all these activities will meet up the energy demand of the country that will help to achieve the Vision 2021, SDG's and Vision 2041 of the government.