Energy Scenario of Bangladesh

2020- 21

Hydrocarbon Unit

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

December 2021

HYDROCARBON UNIT
Energy and Mineral Resources Division

Preface

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 2020 to June 2021. In this report, Energy Scenario of Bangladesh has been reflected. Daily average gas production rate has 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 have been depicted.

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.

Date: 5 December , 2021

Dr. Md. Rafiqul Islam
Director General (Additional Charge), Hydrocarbon Unit

Nasrul Hamid MP
Honorable State Minister
Ministry of Power, Energy and Mineral Resource
Government of the People's Republic of Bangladesh

Message from Honorable State Minister

I express my heartiest congratulation to the initiative of publishing **"Energy Scenario of Bangladesh 2020-21"** by Hydrocarbon Unit.
Energy is undoubtedly a substantial factor in socio-economic development, industrialization and poverty alleviation of a country that needs to be addressed with immense care. The present government of Bangladesh has been conducting energy security and diversification of energy sources with top most priority since taking power. For this reason, Hydrocarbon Unit (HCU) the think tank of EMRD, publishes Energy Scenario of Bangladesh every year. This publication is very inclusive and informative for all stakeholders reflecting current, historical & upcoming energy trends in Bangladesh.

I wish every success of this initiative.

Joy Bangla, Joy Bangabandhu.
Long live Bangladesh

(Nasrul Hamid MP)

Md. Anisur Rahman
Senior Secretary
Energy & Mineral Resources Division
Government of the People's Republic of Bangladesh

A Welcome Message from the Senior Secretary

I take the opportunity in appreciating Hydrocarbon Unit for the publication of **"Energy Scenario of Bangladesh 2020-21"**. Hydrocarbon Unit (HCU) being the technical arm as well as the think tank of Energy and Mineral Resources Division (EMRD) tends to assist it in achieving energy security by providing updated data and analysis of primary, commercial and alternative energy and mineral resources. That is the reason HCU publishes Energy Scenario of Bangladesh every year. This publication is very inclusive and informative for the policymaker reflecting present, historical & future energy trends in Bangladesh.

I appreciate Hydrocarbon Unit for this publication.

(Md. Anisur Rahman)

Dr. Md. Rafiqul Islam
Director General (Additional Charge)
Hydrocarbon Unit
Energy & Mineral Resources Division
Government of the People's Republic of Bangladesh

Message from the Director General

It is an honor to announce that Hydrocarbon Unit (The Think Tank of EMRD) has published **"Energy Scenario of Bangladesh 2020-21"** aimed at assisting technical expertise to the policymaker and sharing current technical ideas and views with the respective stakeholders.

We have strived to make this Energy Scenario a high-quality publication. This publication is very inclusive containing overall gas sector scenario, share of Primary and Commercial energy, overall liquid fuel scenario, status of coal sector, LPG, LNG, power sector at a glance, Net Energy Generation, renewable energy etc. along with the graphical presentation have been depicted.

Hydrocarbon Unit is looking forward to preparing more dynamic and infographic this type of publication in the following year.

(Dr. Md. Rafiqul Islam)

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1.0 Introduction

Bangladesh is a mid-income country. Her GDP growth rate is one of the world's largest. For any country, development is the precondition for continued growth of GDP. And the main driving force of the country's development is energy. Proper use of energy is essential to meet the country's growing energy demands as well as to lift up from a mid-income country to a developed country. Energy is playing a vital role in implementing Vision-2121, Vision-2041 and achieving Sustainable Development Goals.

In Bangladesh, about 61 percent of energy demand is met from natural gas. Among other fuels- oil, coal, biomass etc. are vital. There is a huge reserve of coal in our country, but coal is less produced as well as less used here. On the other hand, natural gas reserve is not that substantial, but its production and consumption are the highest among the available resources. Besides those, energy demand is being met through imported oil and LPG. Moreover, the government has already started importing LNG to meet increasing gas demand. Biomass is being used as a lion's share of energy. The energy demand is also being met by importing electricity from India.

The use of renewable energy instead of gas, coal and oil has been started in the whole world and is essential for sustainable development and keeping up with the environment by preventing carbon emissions. Many countries in the world like Sweden, Germany, China and USA are currently using renewable energy as a significant part of their energy demand. Bangladesh is also using renewable energy, but it's very less than necessity. The government has taken various steps to increase the use of renewable energy in the future, including solar home system, solar irrigation system, Rooppur nuclear project, etc.

Development of energy sector is the key factor for continued development of the country. Bangladesh needs to emphasize on the new exploration activities using latest techniques to explore new mines. Apart from reducing dependence on natural gas, it needs to be coordinated with the imported LNG and enhance the percentage of usage oil and LPG; thereby Bangladesh will succeed in reaching its desired goal of development.

2.0 Current Position of Energy Resources

Known commercial energy resources in Bangladesh include indigenous natural gas, coal, imported oil, LPG, imported LNG, imported electricity and hydro-electricity. Biomass accounts for about 26% of the primary energy and the rest 74% is being met by commercial energy. Natural gas accounts for about 61% of the commercial energy (with 12% imported LNG). Imported oil accounts for the lion's share of the rest. In this year, Bangladesh imports about 8.5million 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 generated by capitalizing Solar Home System (SHS) in on-grid and off grid areas. The amount of power generation using solar system is currently about 542.44 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 0.69 MW. Generation of electricity by Bio-Mass Gasification Method is 0.4 MW in the country.

[Source: http://www.renewableenergy.gov.bd/]

Estimated final consumption of total energy is around 56.92 MTOE. Average increase of energy consumption is about 6% per annum. Per capita consumption of energy in Bangladesh is on an average 335 kgoe (Kilogram Oil Equivalent) and per capita generation of electricity is 560 kWh with an access to electricity 99.5%, which is lower than those of South Asian neighboring countries.

Table 1: Energy calculation for 2020-21. (MTOE) [Source: HCU Data Bank]

Name	Unit	Unit		Mtoe
Oil (Crude + Refined)	K ton	8805	375.9735	8.81
LPG	K ton	1441	61.5307	1.44
Natural Gas	Bcf	892.76	883.8324	20.70
LNG	Bcf	216.1	213.939	5.01
Coal (Imported)	K ton	6751	182.277	4.27
Coal (Local)	K ton	754	20.358	0.48
RE (Hydro)	MW	230	7.25328	0.17
RE (Solar+ wind)	MW	535.4	16.88437	0.40
Electricity (Imported)	MW	1160	36.58176	0.86
Total Commercial			1779.073	42.12
Biomass				14.80
Total Primary				56.92

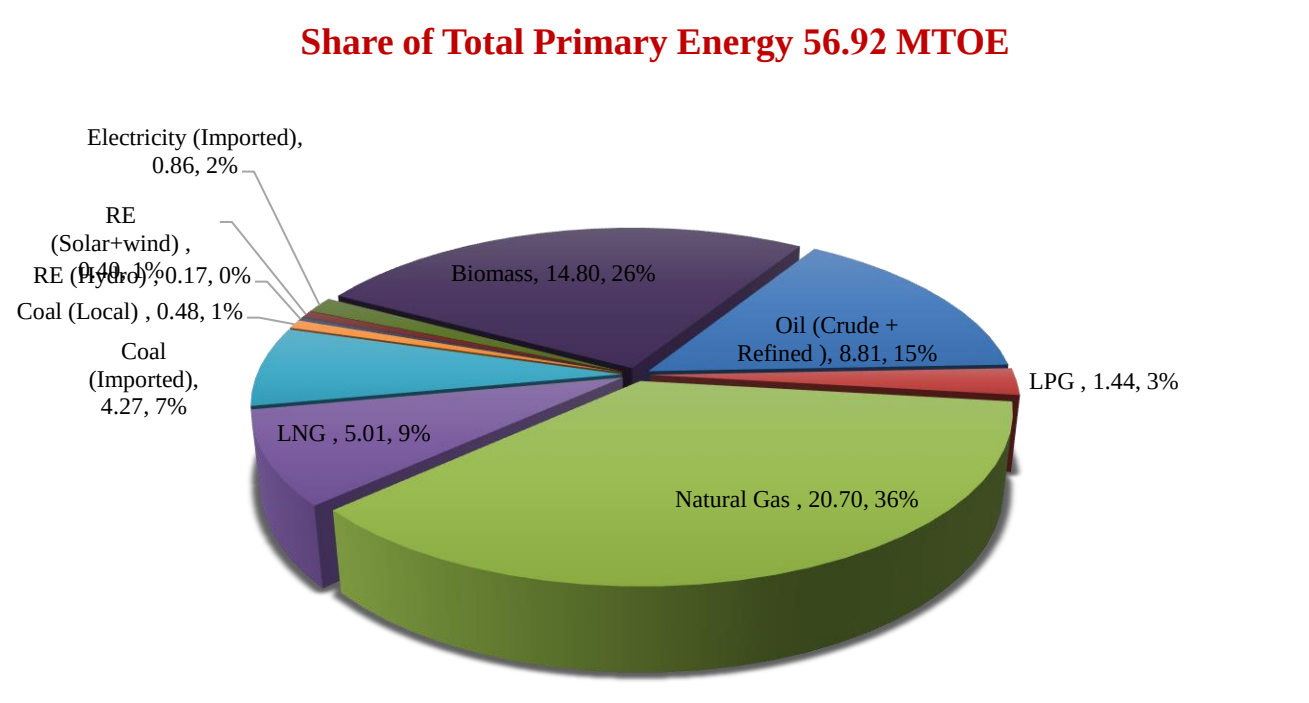


Figure 1: Share of Total Primary Energy (2020-21) [Source: HCU Data Bank]

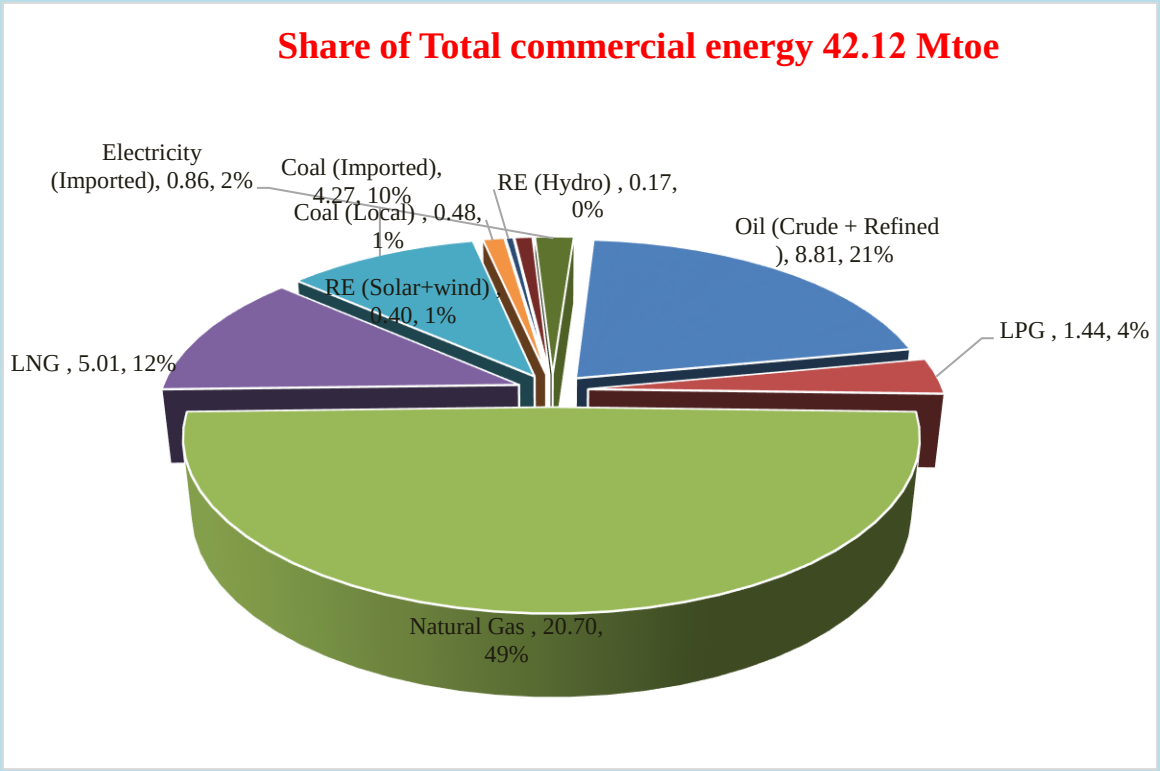


Figure 2: Share of Total Commercial Energy (2020-21) [Source: HCU Data Bank]

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.

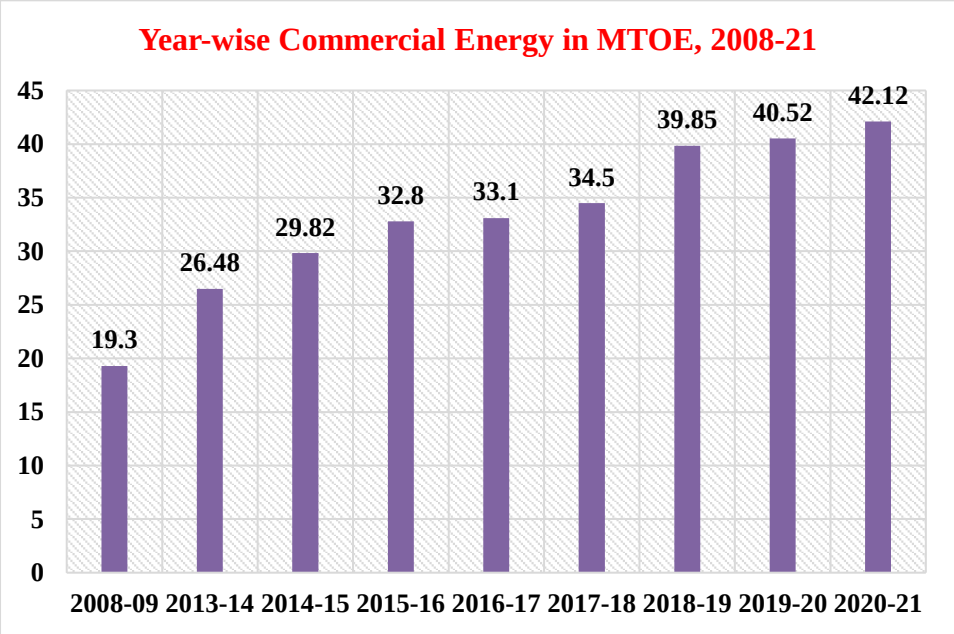


Figure 3: Year-wise (2008-20) Commercial Energy in MTOE [Source: HCU Data Bank]

3.0 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, 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.

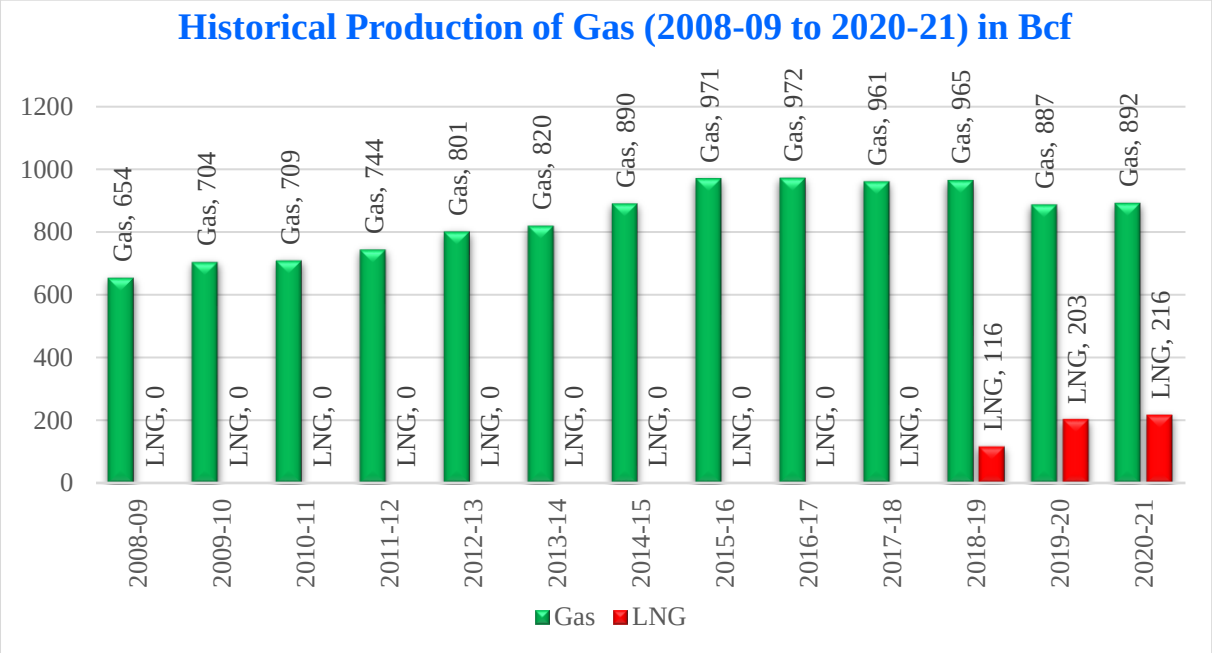
3.2 Natural Gas Reserve

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 20 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 40.09 Tcf. As of June 2020, a total of 18.68 Tcf gas has already been produced leaving only 11.37 TCF recoverable reserve in proven plus probable category. Some key information about the natural gas sector is presented in the Table 2.

Table 2: Natural Gas Sector at a Glance

Description	Amount
Total number of gas fields	26
Number of gas fields in production	20
Number of producing wells	112
Present gas production capacity	2750 MMcfd
Avg. gas production rate	1744-2750 MMcfd
Avg. Gas Production/day	2978 MMcfd
Highest Production (6th May, 2015)	2785.80 MMcfd
Total recoverable (Proven + Probable) reserve	40.09 Tcf
Cumulative Production (June,2021)	18.68 Tcf
Annual Production by NOC	307.27 Bcf (34%)
Annual Production by IOC	554.43 Bcf (66%)
Remaining Reserve (Proven + Probable)	11.37 Tcf
Present Demand	3508 MMcfd
Present Deficit	530 MMcfd (along with LNG)
Number of Customer	43 Lakh (Appx.)

[Source: Petrobangla MIS Report and HCU Data Bank]



[Source: Petrobangla, HCU Data Bank]

Figure 4: Historical Gas Production in Bangladesh (2008 – 2020)

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.

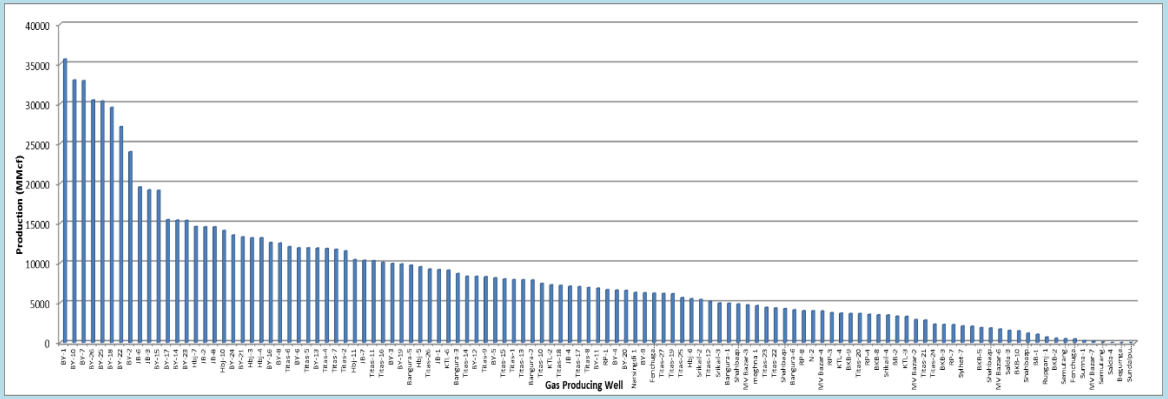
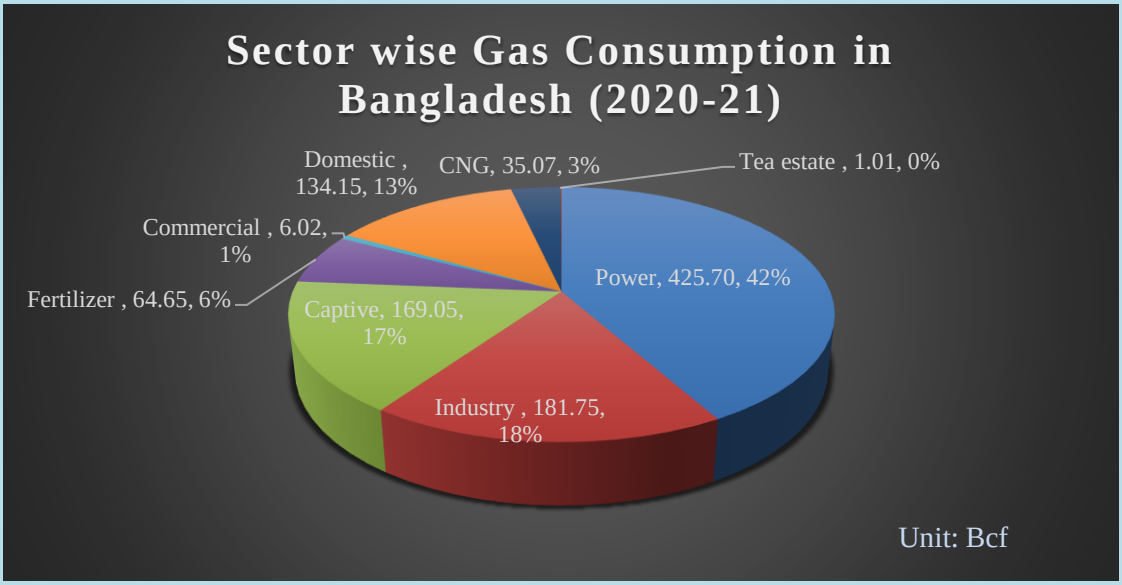


Figure 5: Well-wise gas production in 2020-21

3.3 Natural Gas Consumption

The current average production of natural gas is about 2978 MMcfd. A total 892.76 Billion Cubic Feet (BCF) of natural gas was produced in 2020-21 which was used by power 42%, fertilizer 6%, captive power 17%, industry 18%, domestic 13%, CNG 3% and others very small amount. Natural gas accounts for the 60.3 % grid electricity generation while all the 7urea 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 13% of the populations have directly been benefitted by using piped natural gas for household purposes. Compressed Natural Gas is being used as automobile fuel by about 504,293 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.



[Source: Petrobangla, HCU Data Bank]

Figure 6: Sector wise Gas Consumption in Bangladesh (2020-21)

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 3508 MMscfd whereas supply is 2978 MMscfd (Gas + imported LNG) indicating a shortage of about 530 MMscfd. It is estimated that demand for natural gas will rise to about 4622 MMscfd by the 2030. Natural gas demand projection in the country is shown in the figure below:

Table 3: Natural Gas Supply & Demand

Unit: MMcfd

Year	* Power	Fertilizer	Cap. Power	Industry	Domestic	CNG	Commercial & Tea	Total Demand	Total Supply
2019	1284	316	480	710	425	139	38	3392	3331
2020	1334	316	480	776	425	139	38	3508	3477
2021	1384	316	480	842	425	139	38	3624	3500
2022	1662	316	432	908	425	130	38	3911	3769
2023	1786	316	389	974	420	125	38	4048	3915
2024	1780	316	350	1040	431	120	38	4075	4061
2025	1803	316	315	1106	442	110	38	4130	4300
2026	1844	317	283	1172	453	100	38	4207	4350
2027	1958	319	255	1238	465	100	38	4373	4400
2028	2087	321	230	1304	476	75	38	4531	4450
2029	2060	323	207	1370	488	75	38	4561	4500
2030	2058	325	186	1440	500	75	38	4622	4600

[Source: HCU Data Bank]

3.5 LNG import to Supplement Indigenous Supply

To meet the growing energy demand of the country, the government initiated the import of LNG from abroad. At present, a total of 1000 mmcfd LNG is added to the national grid.

❖ **Floating LNG Terminal:**

- Agreement with Excelerate Energy, Singapore has been signed for setting up FSRU. Already, floating LNG terminal has been installed in Maheshkhali in Cox's Bazar district. Currently, daily 500 MMcfd re-gasified LNG is added to the national grid by Excelerate Energy.
- SUMMIT LNG Terminal Co. (Pvt.) Ltd. has signed the Agreement (BOOT) to set up FSRU at Maheshkhali in Cox's Bazar district with a capacity of supplying daily 500 mmcf re-gasified LNG. 500 MMcfd re-gasified LNG is added to the national grid since April 2019.
- Negotiation is underway on the proposal of Reliance Power Limited, India on BOOT basis, to install 500 MMcfd capacity floating LNG terminal in Kutubdia.
- Study activities are in progress to set up 500 MMcfd capacity FSRU and Fixed Jetty Based LNG Receiving Terminal in Kutubdia Honkong Shanghai Manjala Power Ltd. Co. (HSMPL) with Global LNG & Petronas on BOOT basis.

Figure 7: Maheshkhali LNG Terminal

❖ **Land Based LNG Terminal:**

(i) Consortium of China Huanqui Contracting & Engineering Corp. (HQC) and China CAMC Engineering Co. Ltd. has performed the Feasibility study on the proposal of 1000 MMcfd capacity land based LNG Terminal in Maheshkhali. If the project is marked feasible then the next negotiation will be done.

(ii) Feasibility study has been completed to establish 1000 MMcfd land based LNG terminal at Kutubdia by Petronet India Limited. Since the project is feasible, a term-sheet has been signed with them. Negotiation has begun to sign an agreement.

(iii) Tokyo Gas, Japan has been appointed as consultant for the feasibility study financed by Petrobangla for setting up land based LNG terminals in Payra port, rest of Kutubdia and Maheshkhali area. Feasibility study is in the final stage. Land based LNG Terminal will be installed in one or two places of these places if the study becomes feasible.

Table 4: LNG Scenario

Total LNG Import in June 2021	24.03	Bcf	0.02	Tcf
LNG Import from July 2020 to June 2021	**216.10**	**Bcf**	**0.22**	**Tcf**
Cumulative LNG import from August 2018 to June 2021	**534.86**	**Bcf**	**0.53**	**Tcf**

[Source: RPGCL]

3.6 Exploration Activities

During fiscal year 2019-2020, geological survey of 93 line-km has been completed in Sitapahar structure of Rangamati district with own finance of BAPEX. A complete geological map of the structure is being prepared after analyzing the collected data and information. Moreover, well proposals for Shariatpur-1 exploratory well, Sundalpur-3 Appraisal-cum Development well and Begumganj-4 (west) Appraisal-cum Development well have been prepared after analyzing relevant 2D and 3D seismic data and information as well as the information collected from the previously drilled wells in the surrounding area. Well location of Sylhet-9 and Kailashtila-9 Appraisal cum Development Wells under SGFL has been confirmed through field survey. Two consultants have been appointed for smooth implementation of Geological and Geophysical survey. In order to product gases from dry, abandoned and suspended wells, an EOI has been called from the eligible Companies experienced in this regards. On November 8, 2020 a Memorandum of Understanding (MoU) has been signed between BAPEX and Mitsui Oil Exploration Co. Ltd. (MOECO), Japan on "Joint exploration proposal for Bangladesh Onshore Blocks 8 & 11"

Being directed by Energy and Mineral Resources Division, “Operating Procedure (OP) for

Exploration to Production of Hydrocarbon” for BAPEX has been published by incorporating opinions/suggestions and evaluations received from Experts in the Oil/Gas Sector, University Faculty and Oil Field Service providers. Hon'ble Minister of State for Power, Energy and Mineral Resources of the Government of the People's Republic of Bangladesh officially unveiled Operating Procedure (OP) Manual at BAPEX Bhaban on 15-12-2019.**2D seismic Survey Activities:**

With a view to identifying locations of exploratory wells under the scope of a project entitled `Rupkalpa-9 2D Seismic Project’ financed by the Gas Development Fund, a total of 3000 line-km 2D seismic data has been acquired over Kishoreganj, Narsingdi, Tangail, Gazipur, Netrokona, Sherpur, Jamalpur and Sunamganj districts. Till 30 June 2020, total of Tk. 77.92 crore has been spent out of total allocated Tk.105.80 crore marking 34% financial progress. Revised DPP of Rupkalpa-9 2D Seismic Project has already been approved to acquire 500 line-km more seismic data from Noakhali and Laxmipur district and adjacent areas.

Figure 8: Seismic Survey by BAPEX

3D Seismic Survey:

200-line kilometer 3D seismic survey have been completed over Semutang Gas Field. So far 2700 sq.-km 3D seismic data has been collected from Sunetra, Srikail, Sundalpur, Begumganj, Shahbajpur, Narsingdi, Mobarakpur, Rupganj and Semutang Gas Fields under `3D Seismic Project’ of BAPEX. Total of Tk. 233.82 crore has been spent out of allocated Tk. 247.69 crore marking a financial progress of 94.40% and physical progress of 100%.

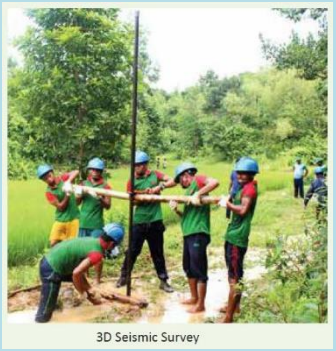


Figure 9: 3-D Seismic Survey by BAPEX

Drilling Activities

Rupkalpa-1 Drilling Project:

Under this project, Srikail East-1 Exploratory Well Drilling Program has successfully been completed on 31st January 2020. A reserve of 50 BCF gas has been estimated in this well after DST operation. 10-12 MMSCFD gas supply to the National Grid will be possible after construction of required gas gathering line. Ended on 30-06-2020, the project spent a total of 144.25 crore from allocated 162.2 8 crore marking a financial progress of 89% and physical progress of 100%.

Rupkalpa-2 Drilling Project:

With the view to implementing Vision-2021 of the Government, drilling preparation of Zakiganj-1 well with Bijoy-12 (ZJ50DBS) Rig is completed under GDF finance. A total of Tk. 148.92 crore has been spent out of allocated to 220.20 crore marking a financial progress of 68%.

Rupkalpa-3 Drilling Project:

The project for drilling Kasba-1 well and Madarganj-1 well was approved under GDF finance. Drilling of Kasba-1 well has already been successfully completed. The existence of gas was detected in this well but it was not commercially viable for production. Madarganj-1 well was scheduled to be drilled by SOCAR-AQS. However, this program was suspended due to to the cancellation of contract. As a result, Tk. 73.88 crore was spent out of allocated Tk. 216.22 under this project. The project ended on 31-12-2019 marking financial progress of 34.17%.

Development:

Rupkalpa-5 Drilling Project:

With the view to implementing Vision-2021 of the Government, the project for Appraisal and Drilling of Begumganj-3 and Begumganj-4 well was approved under GDF finance. A contract was signed with SOCAR-AQS within the scope of the project for drilling of Begumganj-4 well. However, in March 2019 SOCAR-AQS served BAPEX a notice for terminating the contract and consequently the drilling could not be completed. At present in the issue is waiting to be resolved.

Workover Activities

Narsingdi-1:

Under the scope of a contract between BAPEX and BGFCL, workover operation of Narsingdi-1 well was started on 27-06-2019 with Rig Bijoy-11 (ZJ40DBT) and manpower. The workover operation ended on 30-07-2019 successfully and now a total of 20 MMSCFD gas is being supplied to the National Grid.

Titas-9:

Workover operation of Titas-9 well was started on 10-12-2019 with BAPEX's own rig and manpower. The workover operation ended on 02-02-2020 successfully and now a total of 20-25 MMSCFD gas is being supplied to the National Grid.

Titas-7:

Contract between BAPEX and BGFCL work over operation of Titas-7 well was started after killing the well. Due to the prolonged production, the tubing got damaged which created a bit complications in the operation.

Titas-13:

The operation was started on 05-09-2019 a□□er killing the well, but there aroused some technical complications. For this reason, in the light of the instructions of the foreign consultant of BGFCL, measures were taken to shut the well ensuring well protection. Preparations are underway to resume the workover.

Shahbazpur-3:

The IPS Cardwell Rig and other equipment where shifted to Shahbazpur-3 well location in Bhola in order to complete the Shahbazpur-3 Well workover with the own rig and manpower of BAPEX. However, the operation was discontinued for the time being due to the Covid-19 pandemic situation. Finally, the work over operation of this highly sensitive well was resumed on 09-08- 2020 and ended on 18-09-2020. The well is ready to produce about 20 MMSCFD.

3.7 *Future Planning:*

Sl	Type of Proposed Project	2019-2021		2022-2030		2031-2041		Total (2019-2041)	
		No. of Project	Job	No. of Project	Job	No. of Project	Job	No. of Project	Job
1)	Gas-Oil Exploration								
	a) Geological Survey	01	200 Line-KM	01	1500 Line-KM	--	---	01	1700 Line-KM
	b) 2D Seismic Survey	01	2100 Line-KM	01	5000 Line-KM	01	10000 Line-KM	03	5000 Line-KM
	c) 3D Seismic Survey	01	600 Square-KM	01	2000 Square-KM	01	1500 Square-KM	03	4100 Square-KM
2)	Exploratory Well Drilling	01	02 Wells	03	13 Wells	05	20 Wells	09	35 Wells
3)	Appraisal/ Development Well Drilling	01	01 Wells	01	06 Wells	02	10 Wells	04	17 Wells
4)	Workover	01	03 Wells	--	Not Finalized	---	Not Finalized	01	03 Wells
5)	Installation of Process Plant	01	01 Process Plant	01	01Process Plant	---	Not Finalized	02	01Process Plant
6)	Installation of Wellhead Compressor	01	03 Compressor	--	Not Finalized	---	Not Finalized	01	03 Compressor
7)	Procurement of Rig/ Rehabilitation/ Upgradation	01	Rig Upgradation	03	Rig Rehabilitation	01	Procurement of Rig	05	Procurement of Rig/ Rehabilitation/ Upgradation

Figure 10: Future Planning by BAPEX

3.8 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 (BPC) under the Energy & 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 % commercial energy supply in the country. Liquid fuel used in Bangladesh is mostly imported. Bangladesh imports about 1.31 million metric tons of crude oil along with 4.3 million metric tons (approx.) of refined petroleum products per annum. About 0.52 million metric 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 is transport- 63%, power 10 %, agriculture 15 %, industry 7 %, domestic 2 % and others 3 %.

Table 5: Petroleum Sector at a Glance (2020-21)

Product	2020-21 (in Metric Ton)
Import of refined oil	4,344,958.84
Import of furnace oil	2,694,668.53
Import of crude oil	1,307,261.92
Production of Condensate (1 Bbl.=0.1364 MT)	457,980.46
Total Import & Production	**8,804,869.75**
Export of Naptha	0
Storage Capacity of BPC	1,358,000.00
Refining Capacity of ERL	1,250,000.00
LPG Production from ERL	12,406.00
LPG Production from Kailashtila Frac. Plant	1,055.00
LPG import (private)	1,427,826.00

[Source: NBR, BPC, Petrobangla and HCU Data Bank]

Table 6: Sale of Petroleum Products by BPC during last 10 Year

Quantity in MT

Products	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Octane	107150	110850	117452	126114	147557	186911	230280	266988	262943	303917
Petrol	158707	169710	178674	166823	137360	232359	284668	318593	321940	378846
Diesel	3240349	2962872	3242554	3396061	3606404	4000044	4835712	4593486	4015633	4597585
Kerosene	358436	314450	289871	263029	213685	170993	138403	121497	106195	101783
Furnace Oil	883735	1070096	1202505	906771	711889	806440	925150	683725	362713	559032
Jet A-1	311890	318423	323327	338829	347323	376700	408272	429951	350605	237894
Others	153379	131591	130583	123796	91802	115283	125851	129982	68639	120673
Total	**5213646**	**5077992**	**5484966**	**5321423**	**5256020**	**5888730**	**6948336**	**6544222**	**5488668**	**6299730**

[Source: BPC Website and Annual Report 2020-21]

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

Table 7: Sector wise petroleum consumption 2020-21

Sector	2020-21	%
Agriculture	975,604.00	15%
Industry	450,437.00	7%
Power	652,066.00	10%
Transport	3,963,725.00	63%
Domestic & Others	97,600.00	2%
Others	160,298.00	3%
Total	6,299,730.00	100%

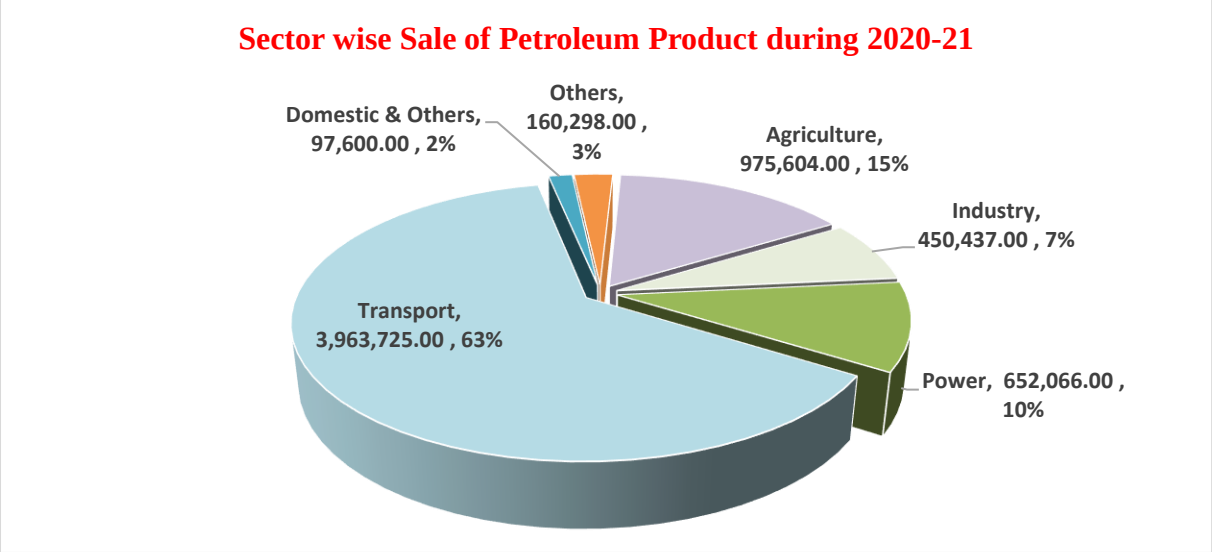


Figure 11: Sector wise Liquid Fuel Consumption in Bangladesh (2019-20)

4.3 Capacity Enactment Projects

Eastern Refinery Limited (ERL) installed in 1968 at Chittagong with the processing capacity of 1.5 million tons annually.

Crude Oil Refining Process: Crude oil is processed through a single-stage atmospheric pipe-still producing an overhead naphtha cut, kerosene and gas oil sidestream cuts and bottoms at 350°C.

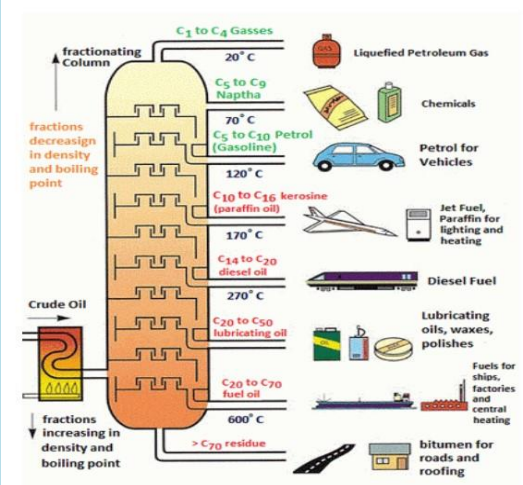


Figure 12: Crude Oil Refining Process

Variation of sidestream cut points produces kerosene or aviation fuel and auto diesel or marine diesel in blocked operations. The Naptha cut is de-ethanised, de-butanised and split with light and heavy virgin naphtha's to blend motor gasoline, while heavy virgin naphtha is also blended to middle distillates and heavy fuel oil (HFO). Light end fractionalization splits into propane and butane, liquefied petroleum gases, (LPG) and butane for gasoline blending. The kerosene sidestream is hydrofined and run down to tankage as dual purpose kero/turbo fuel. Auto diesel oil is produced by blending a part, or all of the kerosene sidestream. However, as a heavier cut it may also be run down directly to tankage as marine diesel oil. Atmospheric Pipe still bottom is blended with gas oil, kero and/or heavy virgin Naptha to produce Bunker C fuel oil. The vacuum Pipe still produces two grades of penetration asphalt.

Processing units:

The refinery was the first to start production with three main processing units. These three processing units are-

Table 8: ERL Process plant scenario

No.	Description	Annual Production Capacity (Metric Ton)
1	Crude Distillation Unit	1.5 Millions
2	Catalytic Reforming Unit	70,0000
3	Hydrodesulphurization unit (this is later converted to a mild hydrocracking unit)	--

[Source: ERL Website]

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 1.3 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. However, 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 completed 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.

Figure 13: Single Point Mooring (SPM) with Double Pipeline

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.

Upcoming major projects of BPC:

- India-Bangladesh Friendship pipeline (IBFPL).
- Installation of Custody Transfer Flow Meter at ERL Tank firm.
- Terminal Automation of marketing companies of BPC.
- Establishment of LPG terminal by BPC in Maheshkhali-Matarbari area of Cox's Bazar district.

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 15 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

Bangladesh mainly imports oil from Saudi Arabia and the United Arab Emirates. These are imported on a year-to-year basis with the respective companies of relevant coun-

tries. Basically, the price has to be paid based on the price of the day of the world market on which the oil will be shipped. 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 13,461 MT is produced during 2020-21 FY whereas 1,427,826 MT is imported thru private entity. Therefore, public and private sector combining do the marketing of 1.44 Million MT of LPG in 2020-21, which is meeting a certain portion of LPG demand of the country.

Table 9: LPG scenario of last 5 year

Year	Public Sector Production MT	Import (Private) MT	Total MT
2016-17	16,382	307,000	323,382
2017-18	15,936	537,686	553,622
2018-19	19,228	681,036	700,264
2019-20	13,414	835,027	848,441
2020-21	13,461	1,427,826	1,441,287

[Source: HCU Data Bank]

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 thousand MT per annum, will be set up in the coastal area.

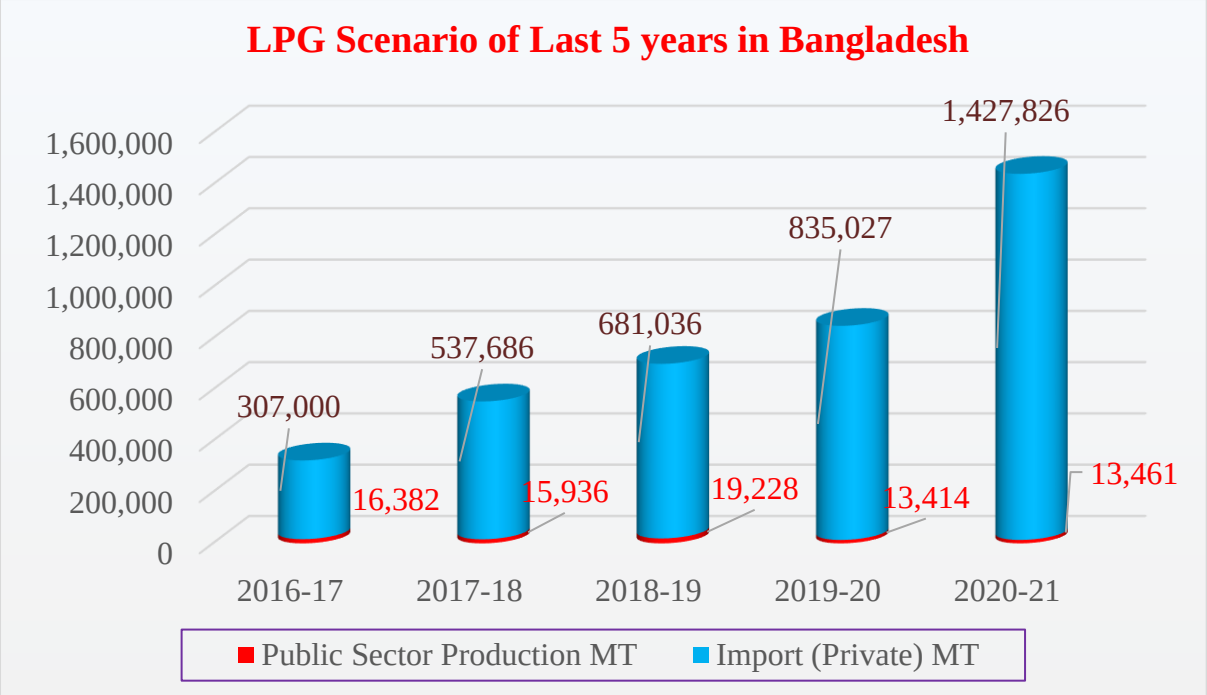


Figure 14: LPG Scenario in Last 5 years in Bangladesh

Of them, one plant will be installed by Bangladesh Petroleum Corporation (BPC) and the other in public private partnership with BPC.

6.0 Coal

Energy is the main indicator of economic growth for a country and constitutes one of the vital infrastructural inputs in socio-economic development. At present, natural gas is the main indigenous primary energy source of Bangladesh. Several studies reveal that domestic production of natural gas will be depleting soon in the near future. Considering the uncertainty of sustainable supply of primary energy, it is imperative to diversify the primary energy sources in the country. In that case, domestic coal can be a major alternative energy source for the energy security of the country. At present 2.55 % of electricity has been produced from domestic coal.

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 10: 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 might be the alternative fuel to natural gas. These coals can conveniently meet 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.

Table 11: Coal scenario of last 5 year

Year	Public Sector Production	Import (Private)	Total (Metric Ton)
2016-17	1,160,657.81	2,801,407.00	3,962,065.00
2017-18	923,276.00	3,394,534.24.00	4,317,810.00
2018-19	803,315.00	5,754,025.00	65,57,339.00
2019-20	808,358.00	6,828,032.00	7,636,390.00
2020-21	753,973.00	6,751,000.00	7,504,973.00

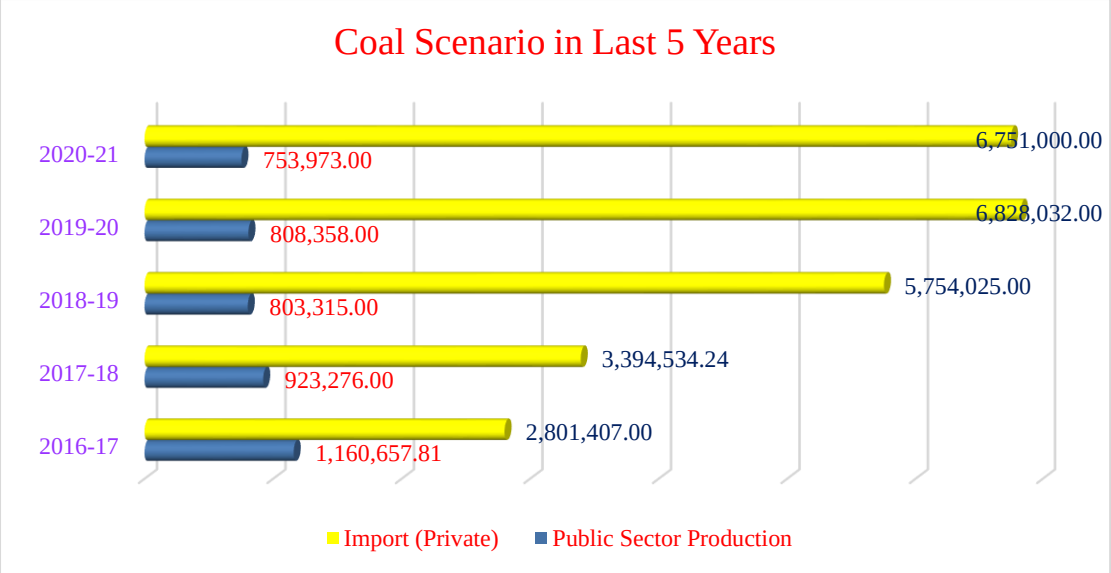


Figure 15: Coal scenario of last 5 year

Commercial production of Barapukuria Coal Mine commenced from 10 September 2005 using underground mining method with the targeted capacity of one million metric tons 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 753,973 MT of coal has been extracted in the FY 2020-21 and 6,751,000 MT has been imported. As a result, 7,504,973 MT coal has been consumed in this FY.

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 tons. 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 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 3,700 bbl./day is producing petrol, diesel and kerosene by fractioning the condensate received from Bibiyana Gas Field. During 2020-21, a total of 411,615 barrels of condensate was produced by SGFL, BGFCL and BAPEX and 2,946,013 barrels by IOCs as a by-product of gas. During the same period, SGFL, BGFCL and BAPEX extracted 3,212,000 litre or of NGL from the gas processed at its Mole-Sieve Turbo Expander plant at Kailashtila. On the other hand, a total of 68,256,253 litre of petrol, 9,783,723 litre of diesel and 7,166,151 litre of kerosene was produced by fractionating the condensate at the fractionation plants located at different fields of SGFL, BGFCL and BAPEX.

9.0 Power Sub-Sector

9.1 Primary Energy Mix for Power Generation

As of June 2021, the total power generation capacity combining public and private sector was 25,235 MW, leaving 20% capacity for maintenance and forced outage, available generation capacity should be about 20,188 MW without fuel constraint.

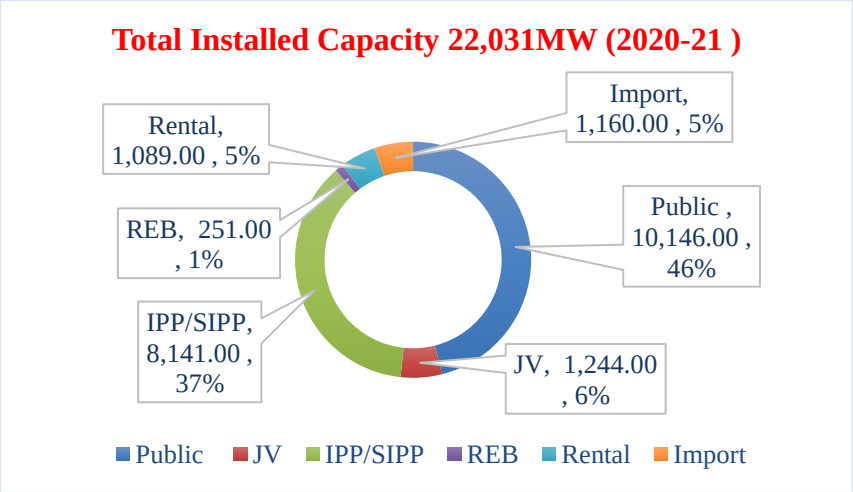
Maximum generation actually obtained till 30 June 2021 was 13,792 MW, which was less than 20,188 MW. It might have occurred due to fuel supply constraint. Of the total generation capacity, distribution between public sector and private sector entities are 46% and 49% respectively and from import 5%. Bangladesh has started importing 500MW electricity from India (started in October 2013) additional 100 MW from March'16 and 560 MW from December 2018 which contributed 10% of total power generation.

Table 12: Bangladesh's Power Sector: At a Glance (2020-21)

Types	Amount
Electricity Growth	8.27%
Number of Power Plants	146
Installed Capacity (MW)	25,235
Maximum Generation (MW)	13,792
Total Consumers (in Millions)	40.70
Transmission Lines (km)	12,836
Distribution Lines (km)	612,000
Grid Substation Capacity (MVA)	50,359
Per Capita Generation (including Captive)	560 Kwh
Access to Electricity (including Off-Grid Renewable)	99.5%
Overall System Loss (%)	11.11

[Source: Power Division Annual Report 2020-21, BPDB Annual Report 2020-21]

The composition of primary energy mix for power generation in FY 2019-20 is shown in Figure 8. Of the total electricity generated in 2019-20, 77 % was generated from domestic fuels (natural gas, coal & hydro) and 13.44 % from imported petroleum fuels (diesel and furnace oil) and 9.34 % was electricity Import from India as cross border energy trade.



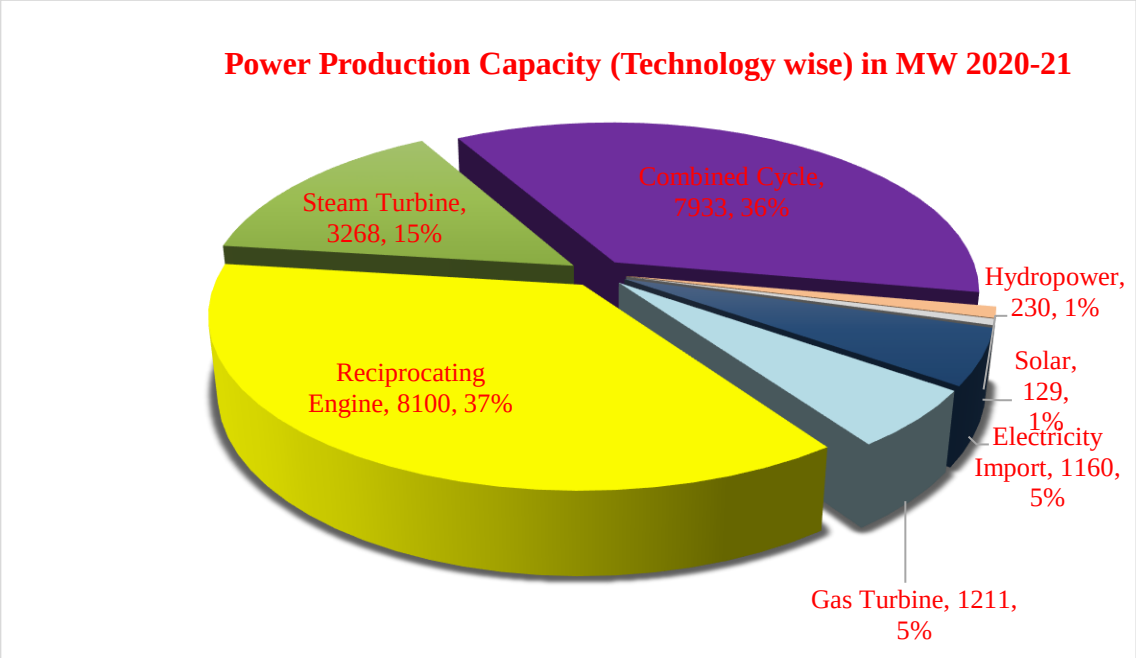
[Source: Power Division Annual Report 2020-21]

Figure 16: Total Installed Capacity 22,031MW (2020-21)

Table 13: Power Production Capacity (Technology wise) in MW 2020-21

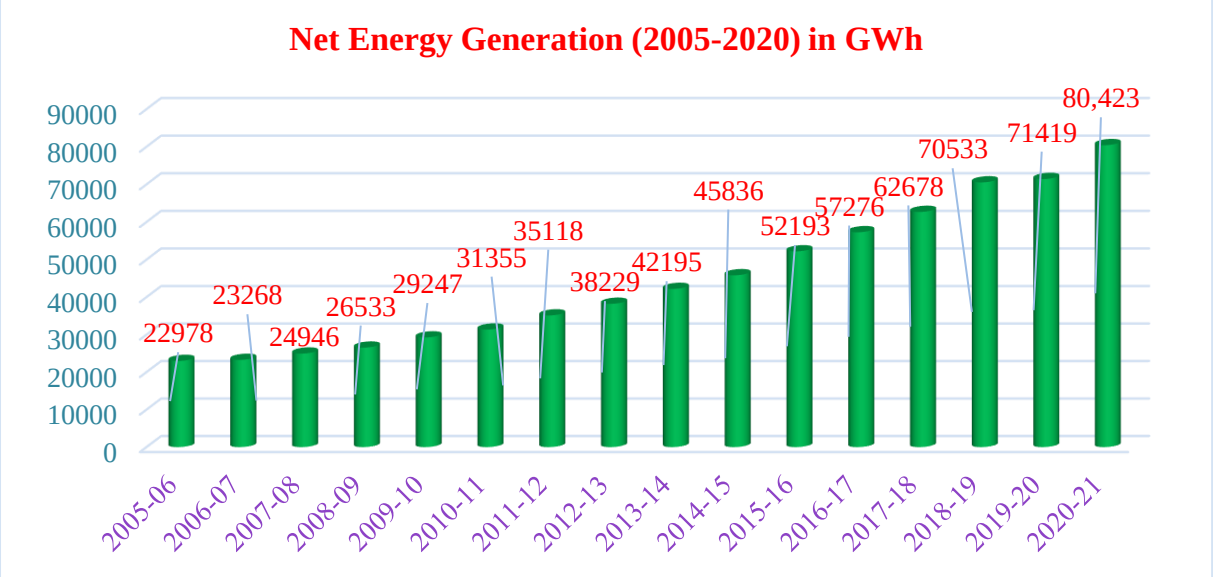
Power Production Capacity (Technology wise)	Installed Capacity (MW)	%
Gas Turbine	1211	5%
Reciprocating Engine	8100	37%
Steam Turbine	3268	15%
Combined Cycle	7933	36%
Hydropower	230	1%
Solar	129	1%
Electricity Import	1160	5%
Total	22031	100%

[Source: Power Division Annual Report 2020-21]



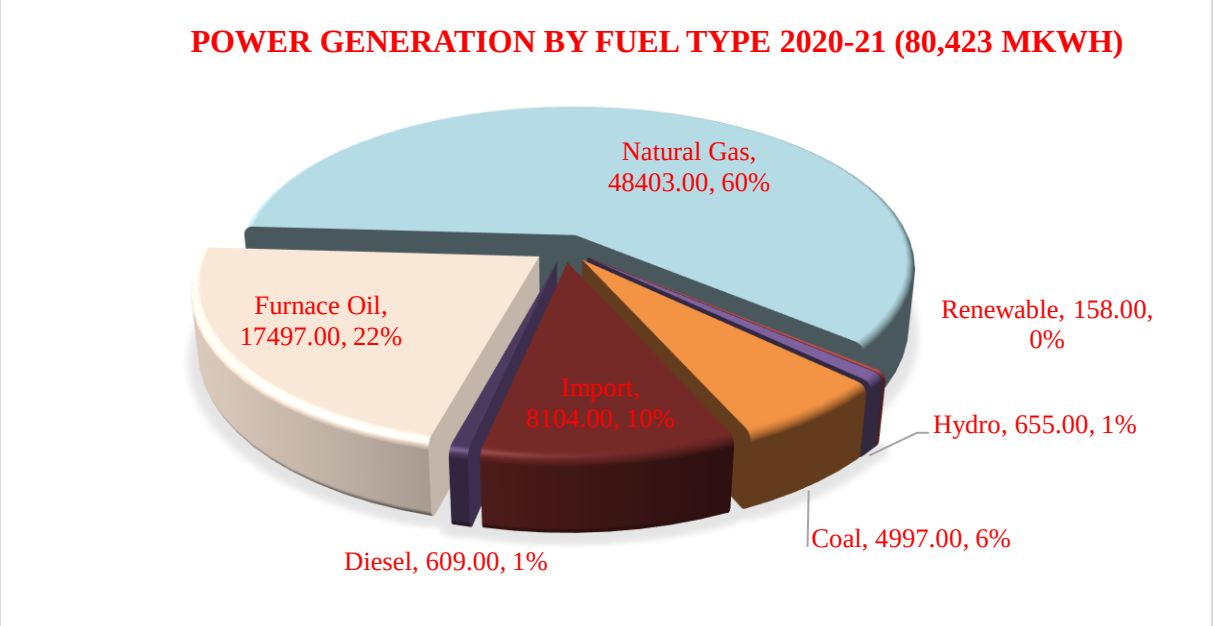
[Source: Power Division Annual Report 2020-21]

Figure 17: Power Production Capacity (Technology wise) in MW 2020-21



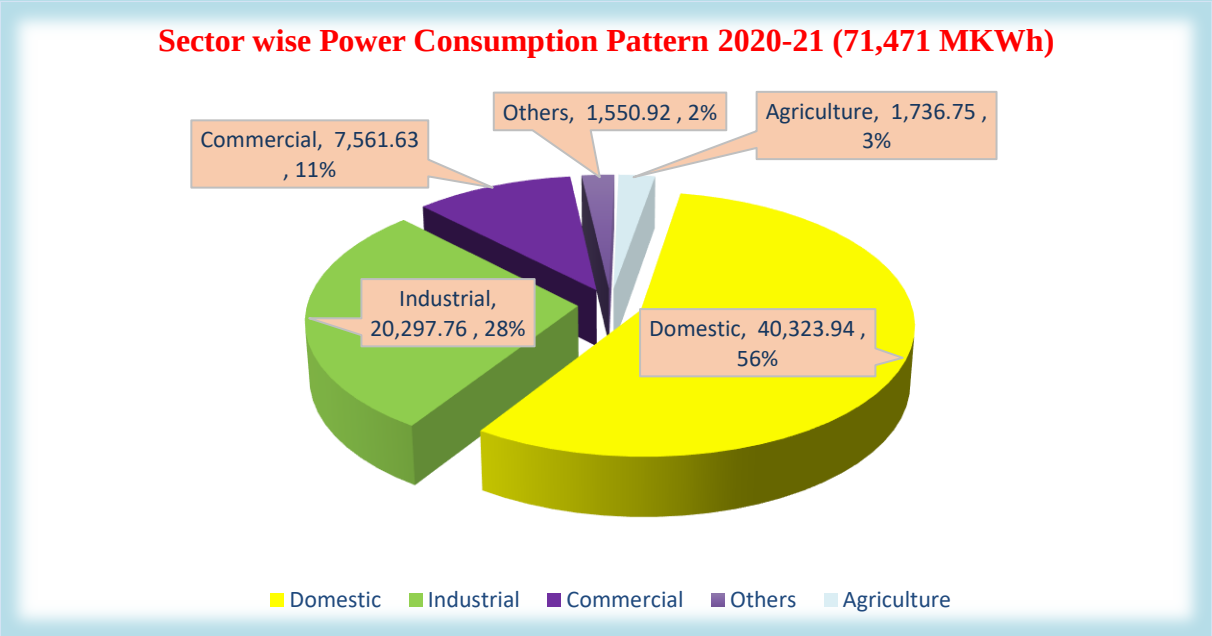
[Source: Power Division Annual Report 2020-21]

Figure 18: Historical Net Electricity Generation (GWh) in Bangladesh



[Source: Power Division Annual Report 2020-21]

Figure 19: Power Generation by Fuel Type (2020-21)



[Source: Power Division Annual Report 2020-21]

Figure 20: Sector wise Power consumption Pattern (2020-21)

9.2 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 1160 MW electricity is being importing from India and in near future it will increase considerably.

Figure 21: Bangladesh India Power Transmission Plant, Bheramara (Kustia)

Table 14: Electricity Import Scenario 2019-20

Import Location	Power Transmission Capacity	Imported Electricity Amount (MW)
Bheramara, Kustia (from Baharampur, India)	400 KVA	1000
Cumilla (From Tripura)		160
Total Import from India		1160

[Source: Power Division]

10.0 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 27 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.

10.1 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.

Figure 22: Conventional Biomass plant and ILRRC (Jashore) Operation

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.

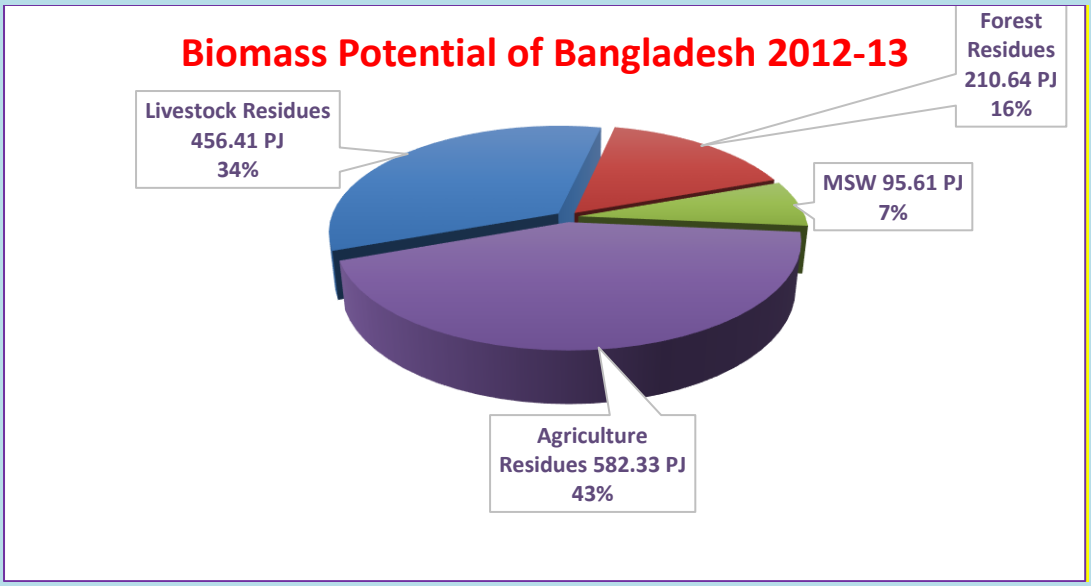


Figure 23: Biomass Potential of Bangladesh (2012 –13)

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.

10.2 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 2018-19, 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.

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 programed should be under taken. Considering the energy scarcity of the country, the feasibility of harnessing additional electricity through conventional hydro-

power technologies and mini & micro hydropower technologies should be explored to meet a part of future energy needs.

10.3 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 renewable energy sources (e.g. solar PV, biomass, biogas etc.) up to June 2019 was 368 MW. Total generation from RE including hydropower (230MW) is 765.62 MW, which was 3.035% of total electricity generation capacity (25,235 MW) of the country including off grid, RE and Captive in the FY 2020-21.

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

i. Solar Energy

Bangladesh is geographically located in a favorable position (within $20^0 34'$ to $26^0 38'$ 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 country's largest solar power plant at Mymensingh has been connected to the national grid. The plant has the capacity to generate 73 MW of electricity, which will help meet the government’s target of generating 10% of the country’s total electricity through using renewable energy by 2021.

Figure 24: Bangladesh's Largest (73 MW) Solar Power Plant, Mymensingh

With a 173K solar panel and 332 inverters, the solar power plant was fully installed with Huawei Smart photovoltaic (PV) solution to connect to the national grid.

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 equipment 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 60 lakhs (installed capacity 250 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.

Figure 25: Solar Pump System in Rangpur District

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'21, a 2,125 nos. solar irrigation pump has been installed resulting 44 MW capacity.

ii. Bio fuel

Bio fuels can be produced from a variety of plants like rapeseed, mustard, corn, sun-flower, 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 2020.

iii. Wind Energy

Bangladesh is exploring the potential of wind power. In the coastal area of Bangladesh, windmills with a capacity of 2.9 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.

Figure 26: Windmill in Kutubdia, Cox's bazar

Based on the results of the pilot project, another 200 MW of power could be harnessed from wind power. Rising fossil fuel and CO_2 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 boasts 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 program is being taken by the Government.

11.0 Nuclear Power

Nuclear power 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 CO_2 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.

Table 15: Planned Nuclear Power Reactors

Unit	Type	Capacity	Construction start	Commercial Operation
Rooppur 1	VVER-1200/V-523	1200 MW	Oct 2017	*2023 or 2024*
Rooppur 2	VVER-1200/V-523	1200 MW	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, and power infrastructure and communication system.

12.0 Conclusion

The government has taken several steps to deal with the reduction in the production of gas. Exploitation and exploration of domestic resources have been emphasized. Power Sector Master Plan has already been formulated and initiative has been taken to produce a large portion of the electricity using coal. Gas exploration activities by BAPEX have been strengthened and some prospective wells have already been identified. Discoveries of more new wells are much expected in the future. Besides onshore, exploration activities are being undertaken in the offshore and fields with large amount of gas are expected. In some old gas fields, the 3D Seismic survey has revealed more reserves of gas than before. For example, using new technology Bibiyana gas field found an increase of its reserve and a further production for some additional periods will continue. The government has taken initiative to meet the demand of energy through import of LNG, already LNG supplies have started and more LNG will be added to the national grid in the next few years. GSMP has been formulated and new entrepreneur-friendly PSC has been revised. Moreover, government has taken several steps to boost up the coal sector. ERL expansion is underway and SPM project has been initiated and the progress of the project work is ongoing. When the ongoing & future planning of development work of BPC will be implemented then the energy security will be enriched for the mass people of Bangladesh. New horizon has been exposed in sea after settlement of maritime boundary with Myanmar and India. Cross border energy trade will get momentum. Considering all the perspectives, we hope that in the near future, Bangladesh is well prepared to meet the Energy demand and ensure the supply of uninterrupted energy for achieving the 8th FYP, Vision-2021, SDG-2030 and Vision-2041.