স্মার্ট বাংলাদেশের প্রত্যয়
জ্বালানির সাশ্রয়

Energy Scenario of Bangladesh

2022-23

February 2024

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 2022 to June 2023. 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: 27 February, 2024

Md. Shameem Khan
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Table of Contents

List of Tables

List of Figures

Chapter 1

Background and Energy Sectoral Mechanism of Bangladesh

1.1 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 54 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.

1.2 Background of Energy Sector of Bangladesh

Development of energy sector is the key factor for continued development of a country. The father of our nation Bangabandhu Sheikh Mujibur Rahman is the founder of the Energy sector of Bangladesh.

Figure 1: Bangabandhu Sheikh Mujibur Rahman

Since the independence in 1971, Bangabandhu showed his great visionary leadership in in the energy sector as it is the backbone of a nation. He envisaged Shonar Bangla with ensuring self-reliant of each citizen. To ensure national energy security of Bangladesh, some of the great strategic initiatives of Bangabandhu is listed below-

1.2.1 Establishment of state ownership over energy and mineral resources (Article 143 (1) (b) of the Constitution)

1.2.2 Formation of Bangladesh Minerals, Oil and Gas Corporation (BMOGC)

1.2.3 Formulation of Petroleum Act and Petroleum Policy

1.2.4 Introduction of 'Production Sharing Contract' system in Bangladesh

1.2.5 Purchase of the country's five largest gas fields at nominal prices

1.2.6 Formulation of 'The Territorial Waters and Maritime Zones Act' to protect the sea and maritime boundaries of Bangladesh etc.

1.3 Bangladesh Energy Resources:

With a population of 165.16 million[1], Bangladesh is one of the world's most populated countries. Agriculture used to be the main source of income for the people of this country. However, the Gross Domestic Product (GDP) in Bangladesh is 5.78% in the FY 2022-23 and 7.1 in the FY 2021-22.[2] Rapid urbanization and industrialization is fueled by stable economic growth has created a huge demand of energy.

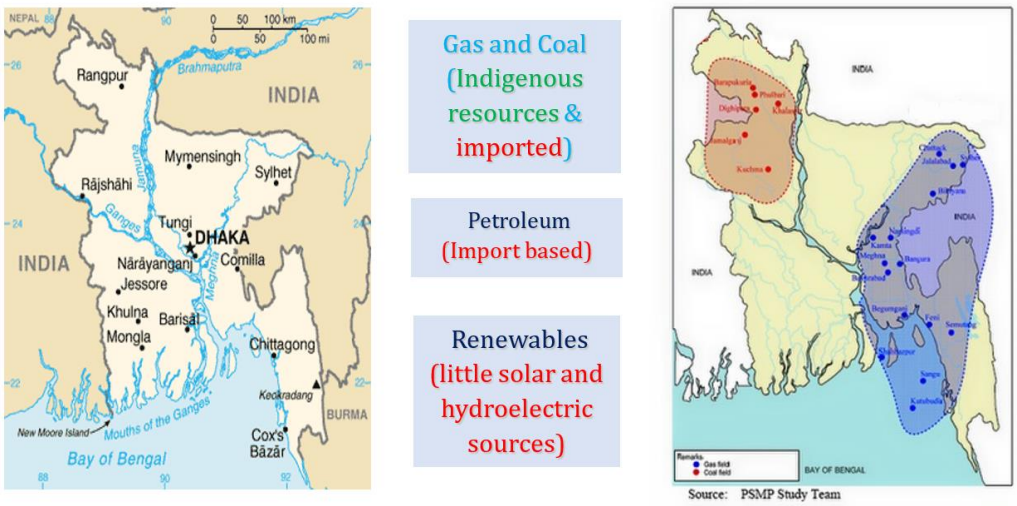


Figure 2: Bangladesh Energy Resources

[1] Population and Housing Census 2022, BBS
[2] Gross Domestic Product (GDP) of Bangladesh 2022-23(Final), BBS

It is well known that energy plays a vital role in poverty eradication, economic growth, sustainable infrastructure development and security of any country. To maintain continuous economic growth, it is substantial to harness indigenous natural resources of the country.

North eastern folded basin are enriched for the indigenous natural gas of Bangladesh. North western basin are enriched for coal and hard rock of Bangladesh.

1.4 Energy Sectoral Mechanisms

The main indigenous energy resources of Bangladesh are Natural Gas and Coal. To elaborate Energy sectoral mechanism, we can delineate it among-

- Upstream
- Midstream
- Downstream

In the following figure, the energy (fuel) value chain is represented briefly-

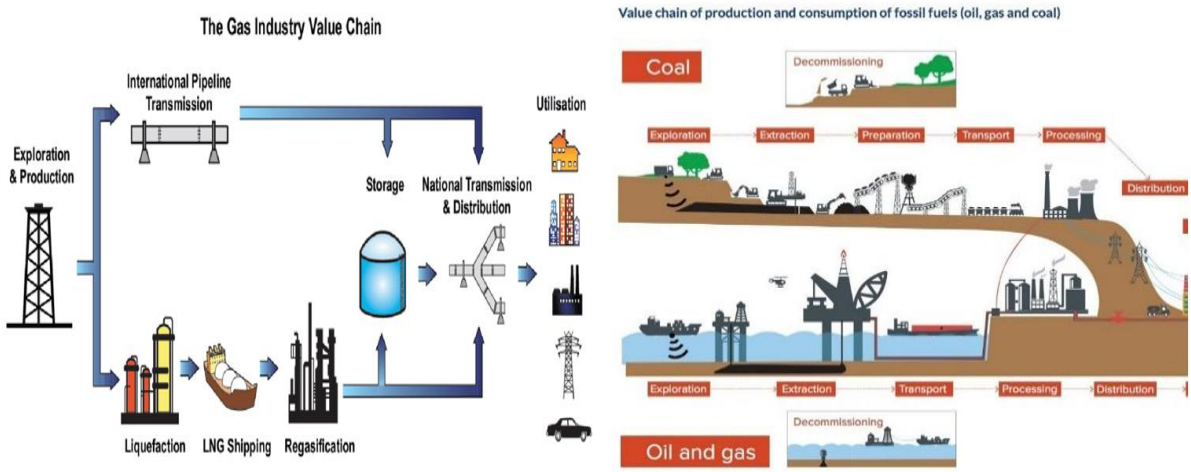


Figure 3: Energy Sectoral Value Chain[3]

[3] https://cpd.org.bd/wp-content/uploads/2019/03/The-Power-and-Energy-Sector-of-Bangladesh.pdf

Chapter 2

Energy Sectoral Achievement of Current Government

2.1 Major Initiatives in the Energy Sector:

To accelerate economic and social development, the Government of Bangladesh (GoB) has emphasized on the energy and power sector of Bangladesh. International experience has demonstrated that government policies have a significant impact on attracting private sector participation in the power and energy sector, and Bangladesh is no different in this regard.

The GoB has a crucial role to play in creating a climate which makes investment in energy and power infrastructure development attractive, thus supporting the strategic goal of "affordable, reliable, sustainable and modern energy for all" in Bangladesh through the development of conventional and non-conventional energy infrastructure, with both public and private sector participation.

Formation of 'Gas Development Fund' to increase national capacity for exploration & production activities

Formation of another fund called 'Energy Security Fund' for overall support to gas sector

Installation of single point mooring with double pipeline (SPM)

Planning to set up a new unit of Eastern Refinery (ERL-Unit 2) in Chittagong

Successful completion and operation of India Bangladesh Friendship Pipeline (IBFPL)

Construction of pipeline for fuel oil transportation from Chittagong to Dhaka (Dhaka Chittagong Pipeline)

Construction of Jet-A1 fuel pipeline from Pitalganj to Kurmitola Aviation Depot

Figure 4: Major Initiatives by current Government

2.2 Achievement of Current Government in Energy Sector:

Table 1: Energy Sectoral Achievement in the current Govt.

Activities	*Till Dec 2008*	*June, 2023*	*Increased*
Gas fields	*23*	*29*	6 (Sundalpur, Srikail, Rupganj, Bhola North, Jokiganj and Elisha)
Well drilling rig	02 (Ineffective)	4 new rigs purchased & 1 rehabilitation of existing rig	*5*
Oil-Gas Exploration 2D Seismic Survey	20,017 line kilometers	32,351 line kilometers	12,334 line kilometers
Oil-Gas Exploration 3D Seismic Survey	1301 sq. km.	5,971 sq. km.	4,670 sq. km
Gas supply (including LNG)	1744 million cubic feet	3000+ million cubic feet	1256 million cubic feet
Geological survey	557 line kilometers	19,868 line kilometers	19,311 line kilometers
Gas transmission pipelines	2102 km	3625 km	1523 km
LNG import capacity	-	1000 MMCFD	1000 MMCFD
Installation of residential prepaid meters	-	4,34,000	4,34,000
Installation of the compressor	-	16 wellheads and 3 pipelines	*19*
Multi-client 2D seismic survey for oil, gas exploration in Bay of Bengal	-	12,932 line km.	12,932 line km
Petroleum Product Supply (Thru Govt. Channel)	33.26 Lakh M.T.	73.46 Lakh M.T.	Increased 40.20 Lakh M.T.

Activities	*Till Dec 2008*	*June, 2023*	*Increased*
Oil Storage Capacity (45 Days)	9 Lakh M.T.	13.70 Lakh M.T	Increased 4.70 Lakh M.T
Oil Pipeline	0 k.m	624 k.m.	624 k.m.
LPG Supply	45,000	12.94 Lakh M.T	Increased 28 times
Exploration Well	76	97	21
Development Well	94	148	54
Workover Well	22	93	71

Chapter 3

Energy Sector: Current Status of Bangladesh

3.1 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 25% of the primary energy and the rest 75% is being met by commercial energy. Natural gas accounts for about 54% of the commercial energy[4] (with 13% imported LNG). Imported oil accounts for the lion's share of the rest. In this year, Bangladesh imports about 10.49 million metric ton of crude and refined Petroleum Products.

Moreover, power is also generated by capitalizing Solar Home System (SHS) in on-grid and off grid areas. The amount of Renewable Energy (Solar+ wind) is currently about 964.17 MW. 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.[5]

Per capita consumption of energy in Bangladesh is on an average 335 kgoe (Kilogram Oil Equivalent) and per capita generation of electricity is 602 kWh with an access to electricity 100%, which is lower than those of South Asian neighboring countries.

3.2 Primary Energy:

Estimated total primary energy of Bangladesh is approx. 57.27 MTOE.

Here, natural gas & LNG plays combined 41% share, biomass 25%, petroleum oil 18% and rest is others (coal, LPG, RE, electricity import) of the total primary energy.

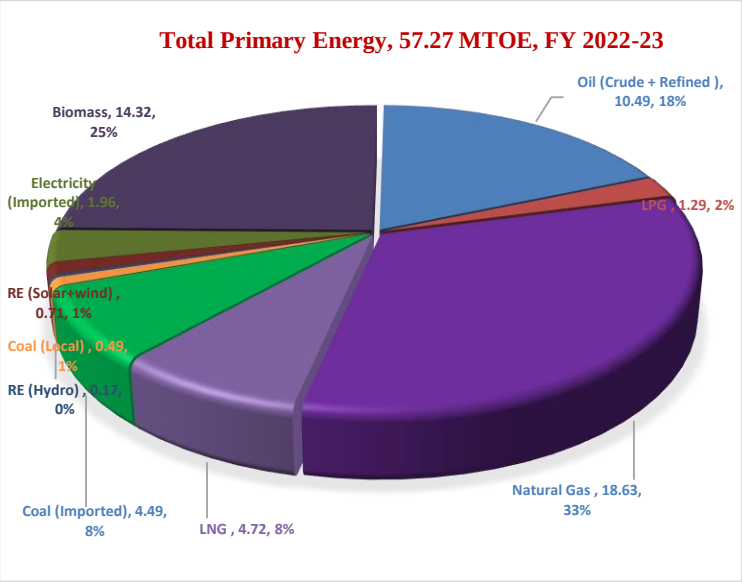


Figure 5: Share of Total Primary Energy of Bangladesh (FY 2022-23)[6]

[4] Energy Data Center, Hydrocarbon Unit
[5] http://www.renewableenergy.gov.bd/
[6] Energy Data Center, Hydrocarbon Unit

Table 2: Total Primary Energy FY 2022-23 in MTOE (Million Ton Oil Equivalent)[7]

Name	*Unit*	*Amount*	*MTOE*
Oil (Crude + Refined)	K ton	10491.56167	10.49
LPG	K ton	1294	1.29
Natural Gas	Bcf	803.63	18.63
LNG	Bcf	203.41	4.72
Coal (Imported)	K ton	7102.54424	4.49
Coal (Local)	K ton	767.3078	0.49
RE (Hydro)	MW	230	0.17
RE (Solar+ wind)	MW	964.17	0.71
Electricity (Imported)	MW	2656	1.96
Total Commercial			**42.95**
Biomass			14.32
Total primary			**57.27**

3.3 Total Commercial Energy:

Estimated total commercial energy of Bangladesh is approx. 42.95 MTOE.

Here, natural gas & LNG plays combined 54% share, petroleum oil 24% and rest is others (coal, LPG, RE, electricity import) of the total commercial energy.

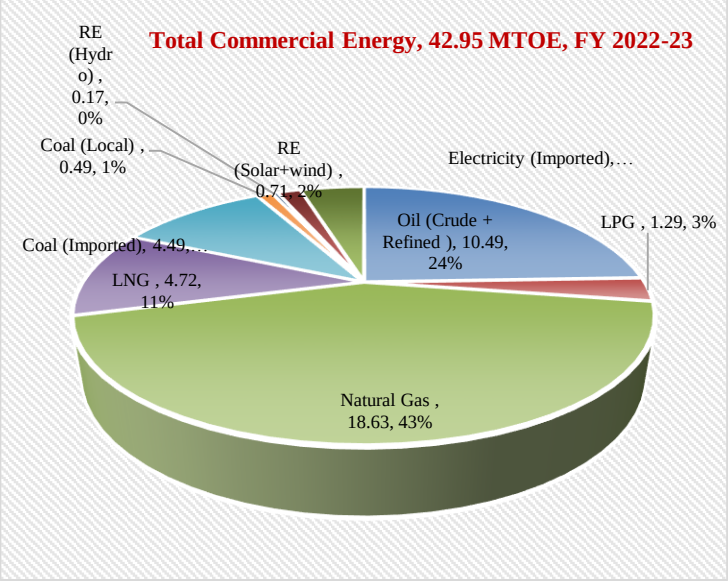


Figure 6: Share of Total Primary and Commercial Energy (2022-23)[8]

[7] Energy Data Center, Hydrocarbon Unit
[8] Energy Data Center, Hydrocarbon Unit

3.4 Historical Commercial Energy:

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.

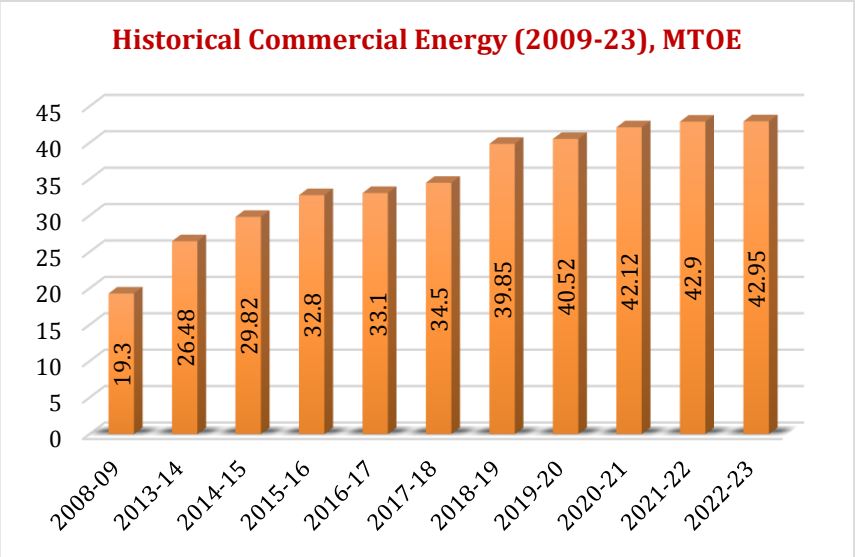


Figure 7: Year-wise (2009-23) Commercial Energy in MTOE[9]

[9] Energy Data Center, Hydrocarbon Unit

Chapter 4

Energy Sector: Detailed Primary Energy

4.1 Natural Gas

4.1.1 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.

4.1.2 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 20.35 Tcf gas has already been produced leaving only 9.57 TCF recoverable reserve in proven plus probable category. Some key information about the natural gas sector is presented in the Table 3.

Table 3: Natural Gas Sector at a Glance, FY 2022-23[10]

Description	***Amount***
Total number of gas fields	*29*
Number of gas fields in production	*20*
Number of producing wells	*145*
Number of producing wells	*105*
Present gas production capacity	*2750 MMcfd*
Highest Production (6th May, 2015)	*2785.80 MMcfd*
Total recoverable (Proven + Probable) reserve	*40.09 Tcf*
Recoverable reserve (2P)	*29.93*
Cumulative Production (June,2023)	*20.35 Tcf*
Annual Production by NOC	*300.70 (37%)*
Annual Production by IOC	*502.91 Bcf (63%)*
Remaining Reserve (Proven + Probable)	*9.57 Tcf*
Present Demand	*3508 MMcfd*
Present Deficit	*530 MMcfd (along with LNG)*
Number of Customer	*43 Lakh (Appx.)*

[10] Petrobangla MIS Report June, 2023; Gas and Coal Reserve & Production-June 2023, Hydrocarbon Unit

4.1.3 Historical Gas Production:

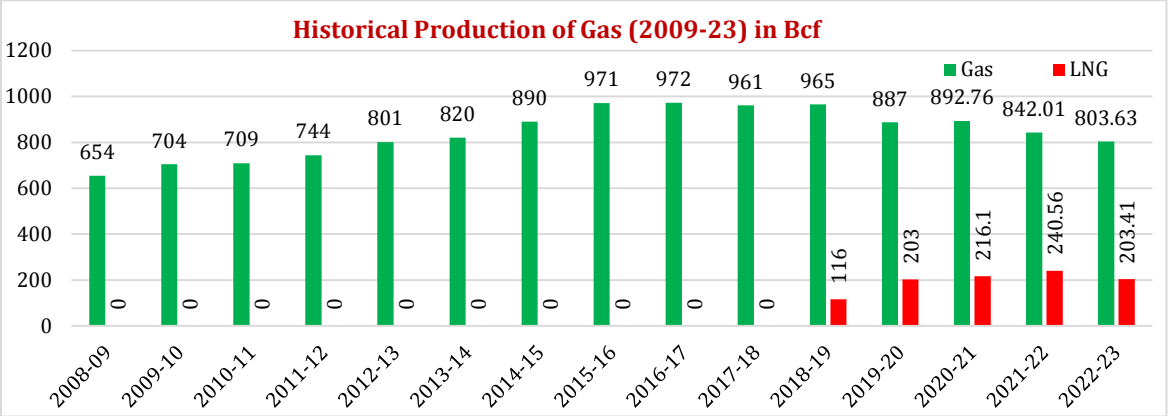


Figure 8: Historical Gas Production in Bangladesh (2009 – 2023)[11]

From the above Figure 8, it is very clear that natural gas production is declining after the FY 2016-17. Simultaneously, LNG import introduced from 2018. Due to the rapid industrial growth, to meet energy demand, LNG import is increasing. Hence, GoB has taken immediate initiatives to expedite national gas exploration activities and gas augmentation activities.

4.1.4 Gas Production by Companies:

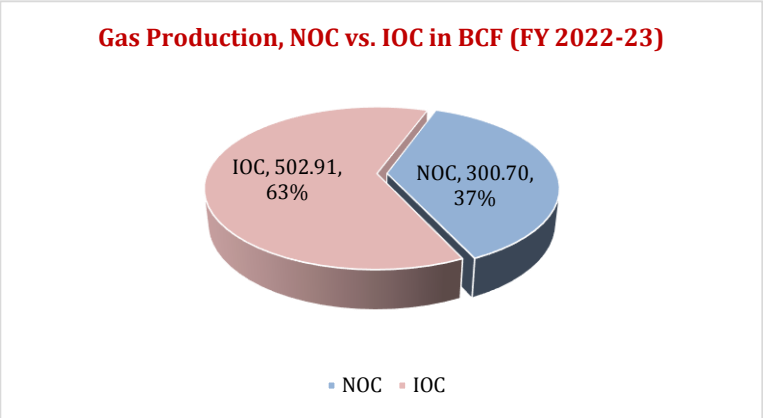


Figure 9: Gas Production in Bangladesh NOC vs. IOC[12]

[11] Petrobangla and Energy Data Center, Hydrocarbon Unit
[12] Petrobangla and Energy Data Center, Hydrocarbon Unit

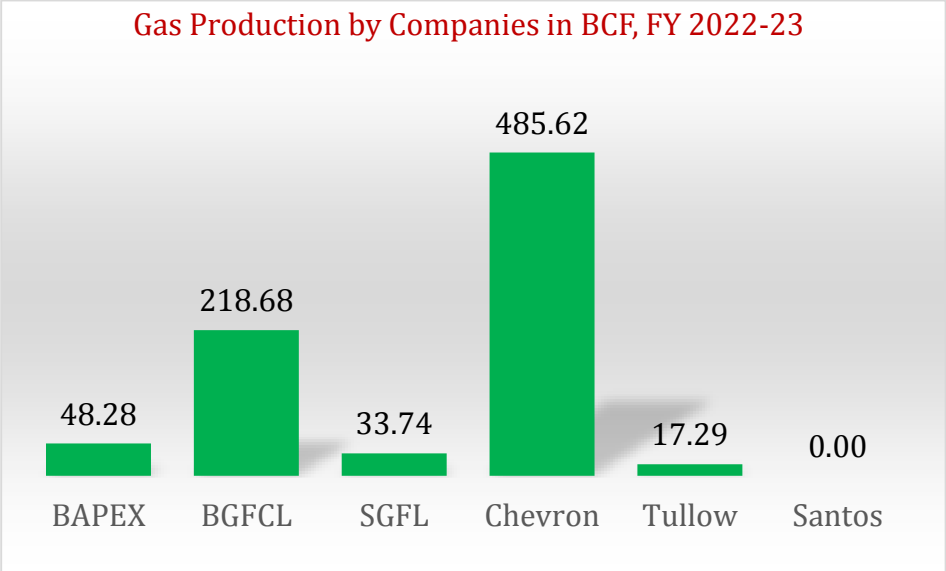


Figure 10: Gas Production by companies, FY 2022-23[13]

In the FY 2022-23, gas production by National Oil companies (NOC) i.e. Bapex, BGFCL, SGFL is 300 BCF. In the same time, International Oil Companies (IOC) i.e. Chevron, Tullow produce 502.9 BCF which is approx. 63% of the total national gas production.

4.1.5 Natural Gas Consumption

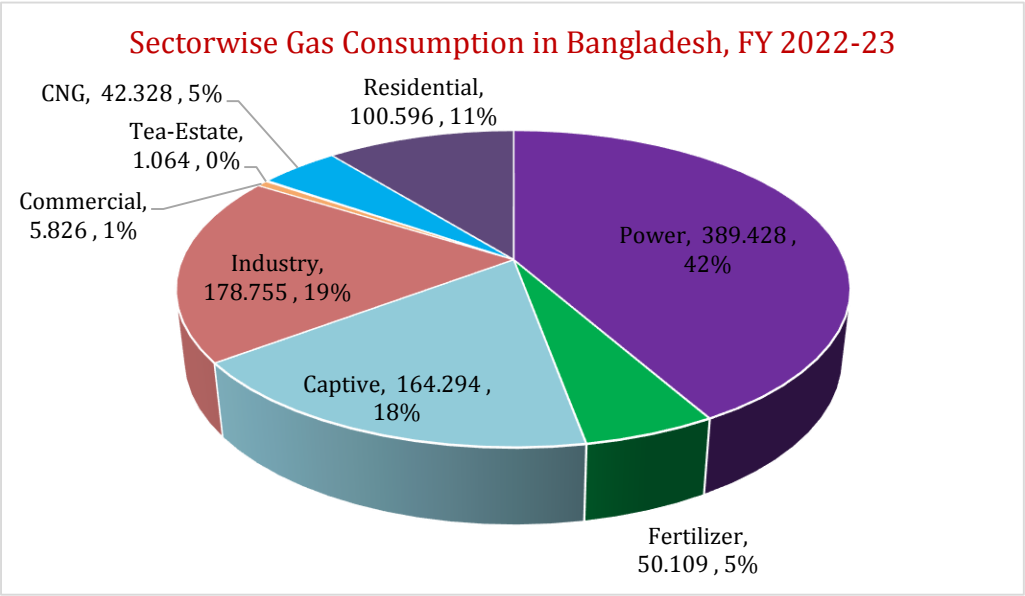


Figure 11: Sector wise Gas Consumption in Bangladesh (2022-23)[14]

[13] Petrobangla and Energy Data Center, Hydrocarbon Unit
[14] Petrobangla MIS Report June, 2023

The current average production of natural gas is about 2978 MMcfd. A total 803.63 billion Cubic Feet (BCF) of natural gas was produced and 203.41 BCF LNG is imported in 2022-23 which was used by power 42%, fertilizer 5%, captive power 18%, industry 19%, domestic 11%, CNG 5% and others is 1% (commercial and tea estate). Natural gas accounts for the 52% 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.

4.1.6 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 4: Natural Gas Demand Forecast (Unit: MMcfd)[15]

Year	Power	Fertilizer	Captive Power	Industry	Domestic	CNG	Commercial	Tea	Total
FY2020-21	1,412.00	188.00	614.00	615.00	369.00	124.00	22.00	3.00	**3,346.00**
FY2022-23	1,433.00	263.00	663.00	771.00	361.00	124.00	22.00	3.00	**3,650.00**
FY2024-22	1,454.00	269.00	685.00	873.00	347.00	124.00	22.00	3.00	**3,777.00**
FY2026-27	1,601.00	337.00	735.00	1,132.00	335.00	124.00	22.00	3.00	**4,288.00**
FY2028-29	1,738.00	337.00	772.00	1,319.00	328.00	124.00	22.00	3.00	**4,643.00**
FY2030-31	1,827.00	337.00	782.00	1,467.00	323.00	124.00	22.00	3.00	**4,885.00**
FY2032-33	2,009.00	337.00	802.00	1,627.00	315.00	124.00	22.00	3.00	**5,238.00**
FY2034-35	2,249.00	337.00	813.00	1,759.00	307.00	124.00	22.00	3.00	**5,612.00**
FY2036-37	2,391.00	337.00	816.00	1,889.00	299.00	124.00	22.00	3.00	**5,880.00**
FY2038-39	2,438.00	337.00	810.00	2,010.00	291.00	124.00	22.00	3.00	**6,035.00**
FY2040-41	2,682.00	337.00	809.00	2,089.00	291.00	124.00	22.00	3.00	**6,356.00**

[15] Source: Petrobangla

4.2 LNG

In order to ensure energy security of the country Bangladesh Government planned to import LNG in line with the existing and increasing gas demand in the country. Under the supervision of Petrobangla, RPGCL is accomplishing all necessary functions regarding LNG infrastructure development, LNG import and RLNG supply to national gas grid. LNG operation started from 2018 which is a great strategic move to ensure the national energy security of Bangladesh.

4.2.1 LNG import to Supplement Indigenous Supply

Two terminal use agreements (TUAs) were signed with Excelerate Energy Bangladesh Limited (EEBL) and Summit LNG Terminal Co. (Pvt.) Ltd. to install 2 FSRUs at Moheshkhali approximately 90 kilometers south of Chattogram for supplying 500 MMscfd of LNG each. After installation of the FSRU by EEBL, commissioning started on 12 August, 2018 and RLNG supply to the national gas grid commenced commercially on 19 August, 2018. Total LNG imports from this terminal were 10.01 million tons and the total RLNG supply to the national gas grid was 482,446 million cubic feet from inception to 31 December, 2022. After the set-up of the 2nd FSRU by Summit, commissioning took place on 29 April, 2019 and RLNG supply to the national grid commenced commercially on 30 April, 2019. Total LNG import from this terminal was 7.87 million tons and the total RLNG supply to the national grid was 378,20 million cubic feet from inception to 31 December, 2022.

In addition, the selection of a Terminal Developer to install a Land-Based LNG Terminal with a capacity of 1,000 MMscfd at Matarbari, Cox's Bazar has been undertaken. A request for proposal (RFP) has been issued to 8 shortlisted bidders. The last date for submission of RFP was extended to 10/08/2023. A committee consisting of 8 members has been constituted for the purpose of selecting a suitable place from Coal Power Generation Company Bangladesh Limited for the establishment of Land based LNG Terminal. Beside this, a gas supply agreement (GSA) between H-Energy and Petrobangla is in process to import RLNG through a cross-border pipeline.

The proposal from Summit Oil and Shipping Co. Ltd. (SOSCL) to set up an FSRU at Moheshkhali has been approved in principle by the Government. Negotiations with SOSCL

are in progress to finalize the draft agreements (TUA and IA). The proposal from Excelerate Energy to set up an FSRU at the Payra deep sea area has been approved in principle by the Government. Again, a proposal from Excelerate Energy to expand the existing FSRU (MLNG) to increase its regasification capacity has also been approved in principle by the Government. Negotiations with Excelerate Energy are in progress.

To import LNG from Qatargas, a sale and purchase agreement (SPA) was signed on 25 September, 2017 with Ras Laffan Liquefied Natural Gas Company Limited (3), a Qatar-based Government agency, to ensure the supply of 1.8 - 2.5 MTPA LNG for 15 years. A total volume of 10.64 million tons of LNG was imported from Qatar through 176 cargoes from inception to 31 December, 2022. Another SPA was signed with Oman Trading International Ltd. (present name: OQT), an Oman-based Government agency, on 6 May, 2018 for supplying 1.0-1.5 MTPA LNG for 10 years. A total volume of 5.42 million tons of LNG was imported from OQT through 86 cargoes from inception to 31 December, 2022. [16]

In addition, a master sale and purchase agreement (MSPA) was signed with 21 organizations (suppliers/ traders) to purchase LNG from the spot market. The first cargo from the spot market was imported on 25 September, 2020. A total volume of 1.83 million tons of LNG was imported from the spot market through 29 cargoes from inception to 31 December, 2022.

Figure 12: LNG Operation

In order to reduce the gap between demand and supply of gas, the Government has planned to increase LNG import. Accordingly, a proposal from SOSCL to supply LNG as long term basis has been approved in principle by the Government. Negotiations are in progress. On the other hand, negotiations with the Emirates National Oil Company Limited (ENOC), Qatar Energy and OQT on a G to G basis for long term contracts are in progress.

[16] Source: Petrobangla Annual Report 2022

In addition, an LNG supply contract on a long-term basis with EEBL along with the expansion of MLNG is also in progress.

4.2.2 LNG Scenario:

Table 5: LNG Scenario, FY 2022-23[17]

Total LNG Import in June 2023	***25.70***	***Bcf***
LNG Import from July 2022 to June 2023	***203.42***	***Bcf***
Cumulative LNG import from August 2018 to June 2023	***978.84***	***Bcf***

4.3 Natural Gas Exploration

4.3.1 Geological Activities

During 2022, a 95 line-km geological survey has been completed in Jatinga and Jaldi-Matamohri, Cox's Bazar-Bandarban structure of Sylhet, Chattogram & Bandarban districts. A complete geological map of the structure is being prepared after analyzing the collected data and information. Well proposals for Srikail-5 well, Sundalpur-3 appraisal-cum development well, Begumganj-4 (west) appraisal-cum development well and 1 exploratory well Jamalpur-1 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 areas. In line with the study, well locations for and Kailastila-8 exploratory and Kailashtila-9 appraisal-cum development wells under SGFL have been confirmed through field surveys. In order to meet the growing demand for gas in the country, explore the presence of gas in the deeper zone of the existing gas field, well proposals have been prepared for Srikail Deep-1 exploratory well and Mubarakpur Deep-1 exploratory well.

Two consultants have been appointed to ensure smooth implementation of the geological and geophysical survey. In order to explore gases from dry, abandoned and suspended

[17] RPGCL

wells, 2 EOI have been called from the eligible companies experienced in this regard. A Memorandum of Understanding (MoU) was signed between BAPEX and Gazprom EP International to evaluate Bhola Island fields.

4.3.2 2D Seismic Survey

With a view to identifying locations of exploratory wells under the scope of a project titled '2D Seismic Survey over Exploration Block 15 & 22' financed by the gas development fund (GDF) and its own fund, a total of 3,000 line kilometer of 2D seismic data acquisition (1,000 line kilometer by BAPEX and 2,000 line kilometer by SINOPEC), processing, interpretation, and resource estimation have been underway in 8 districts namely Chattogram, Cumilla, Noakhali, Feni, Khagrachari, Rangamati, Bandarban and Cox's Bazar. The project duration is from July 2021 to June 30, 2024. In the 2022-23 fiscal year, 1106-line kilometer data has been acquired with the expenditure of Tk. 70.75 crore taka. A total of 3000-line kilometer data has already been acquired under the project. Data processing and preliminary data interpretation have been completed.

With a view of identifying locations of exploratory wells under the scope of a project titled '2D Seismic Survey over Exploration Block 6B South & 10' financed by the gas development fund (GDF) and its own fund to conduct a total of 3220 LKM 2D Seismic Survey over several districts of Dhaka, Barishal and Chittagong Division. The estimated cost of the project is 15,195.00 lac taka including 8,496.00 lac foreign currency. Implementing period of the project is 01 July, 2022 to 30 June, 2025. 2D Seismic Survey Data Acquisition, Processing and Interpretation of 2352 LKM will be done by own crew of BAPEX and 868 LKM in Transition zone will be done be hiring foreign Seismic service crew. In the 2022-2023 fiscal year, a total of 282.775 LKM 2D Seismic Data has been acquired at a cost of 700.00 lac taka. The Project has achieved its 100% RADP target with 20% physical progress of the whole project.

4.3.3 3D Seismic Survey

To ensure long-term energy security of the country, maximum gas production from existing wells and to strengthen gas exploration and production activities from potential undiscovered gas fields a project titled '3D Seismic Survey Over Zakiganj and Patharia

West Structure' financed by the gas development fund (GDF) and its own fund, to acquire a total of 580.00 Sq.Km. of 3D seismic data in Zakiganj gas field at Zakiganj Upazila of Sylhet district and in Patharia west structure at Barlekha & Kulaura Upazila of Moulvibazar district.

Figure 13: Mud Logging Unit of BAPEX[18]

The project duration is from 1st March, 2022 to June 30, 2024. The project has just been approved on 25th April, 2022.

[Source: Petrobangla Annual Report, 2022]

4.3.4 Drilling

Drilling of the Tabgi-1 well: Drilling of the Tabgi-1 well under the project "Drilling of 2Nos. Exploratory Wells (Tabgi-1 & Illisha-1) and 1No. Appraisal cum Development Well (Bhola North-2)" started on June, 2022 and completed on November, 2022 by GAZPROM. The well was drilled up to 3,524 meters. Perform DST & testing activities from this well there is a possible to 19.5-20.0 MMscfd of gas are supply to the national grid.

Drilling of the Bhola North-2 well: Drilling of the Bhola North-2 well under the project "Drilling of 2Nos. Exploratory Wells (Tabgi-1 & Illisha-1) and 1No. Appraisal cum Development Well (Bhola North-2)" started on December, 2022 and completed up to 3,006 meters within December by GAZPROM.

Shariatpur-1 Exploratory Well Drilling Project: The project has been undertaken with a view to drilling 1 exploratory well in Naria Upazila of Shariatpur. The project has already

[18] Source: Petrobangla Annual Report, 2022

been approved by the Energy and Mineral Resources Division. Drilling started on November 2022 and will be completed on March, 2023 with Bijoy-10 rig. The estimated cost of the project is Tk. 959.00 million and the tenure is from 1 July, 2021 to June, 2023.

Srikail North-1A Exploratory Well Drilling Project: The project has been undertaken with a view one exploratory (Srikail North-1A) and two appraisals cum development (sundulpur-3 & begumgonj-4, west) drilling well. Drilling started June, 2022 & completed on January, 2023 at Muradnagar Upazila of Cumilla district with Bijoy-12 rig. The project has already been approved by the Energy and Mineral Resources Division. The estimated cost of the project is Tk. 2,841.90 million and the tenure is from 1 March, 2022 to June, 2024.

[Source: Petrobangla Annual Report, 2022]

4.3.5 Workover

Kailastila-7: The workover activities started on February, 2022 with BAPEX's (Bijoy-11) rig and manpower without foreign consultants and the workover was successfully completed on May, 2022. About 10 MMscfd of gas is being supplied to the national grid from this well at initial stage.

Bianibazar-1: The workover activities started on September, 2022 with BAPEX's (Bijoy-11) rig and manpower without foreign consultants and the workover was successfully completed on November, 2022. At present, about 10 MMscfd of gas is being supplied to the national grid from this well.

Semutang-5: The workover activities started on March, 2022 with BAPEX's (XJ650T) rig and manpower without foreign consultants and the workover was successfully completed on July, 2022.

Saldanodi-2: The workover activities started on January, 2022 with BAPEX's (ZJ50DBS) rig and manpower which ended successfully on March, 2022. At present, about 03 MMscfd of gas is being supplied to the national grid from this well.

Fenchuganj-3: After successfully completed the workover activities with BAPEX's (Bijoy-10) rig on March, 2022 rig down & rig dismantling job done. At present, about 9 MMscfd gas is being supplied to the national grid from this well.

Sylhet-8: The workover activities started on 31 October, 2021 with BAPEX's (XJ650T) rig and manpower under Sylhet Gas Fields Limited (SGFL) was completed on 5 January, 2022. At initial stage about 5 MMscfd of gas is being supplied to the national grid from this well.[19]

4.3.6 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".

4.4 Oil (Petroleum) Sector

4.4.1 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.

4.4.2 Supply and Consumption of Oil

Petroleum products viz. diesel, petrol, octane, furnace oil etc. account for about 24% commercial energy supply in the country. Liquid fuel used in Bangladesh is mostly

[19] Petrobangla Annual Report, 2022

imported. Bangladesh imports about 1.45 million metric tons of crude oil along with 5.3 million metric tons (approx.) of refined petroleum products in the last financial year. About 0.38 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- 58%, power 18%, agriculture 15%, industry 6%, domestic 1% and others 2% in the FY 2022-23.

Table 6: Petroleum Sector at a Glance (2022-23)[20]

Product	2022-23 (in Metric Ton)
Import of refined oil	5,308,534.35
Import of furnace oil	3,346,587.56
Import of crude oil	1,453,337.33
Production of Condensate	383,102.43
Total Import & Production	10,491,561.67
Production of Naptha	101,861.14
Storage Capacity of BPC	1,358,000.00
Refining Capacity of ERL	1,570,000.00
LPG Production from ERL	14,246.00
LPG Production from Kailashtila Frac. Plant	748.00
LPG import (private)	1,278,859.50

Table 7: Sale of Petroleum Products by BPC during last 10 Year in MT, FY 2022-23[21]

Products	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Octane	117452	126114	147557	186911	230280	266988	262943	303917	395,602	393,557.00
Petrol	178674	166823	137360	232359	284668	318593	321940	378846	446,647	454,556.00
Diesel	3242554	3396061	3606404	4000044	4835712	4593486	4015633	4597585	4,850,700	4,935,483.00
Kerosene	289871	263029	213685	170993	138403	121497	106195	101783	86,117	77,487.00
Furnace Oil	1202505	906771	711889	806440	925150	683725	362713	559032	571,586	880,702.00
Jet A-1	323327	338829	347323	376700	408272	429951	350605	237894	428,024	471,535.00
Others	130583	123796	91802	115283	125851	129982	68639	120673	136,334	132,775.00
Total	**5484966**	**5321423**	**5256020**	**5888730**	**6948336**	**6544222**	**5488668**	**6299730**	**6,915,010**	**7,346,095.00**

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

[20] NBR, BPC, Petrobangla and HCU Data Bank
[21] BPC Website and Annual Report 2022-23

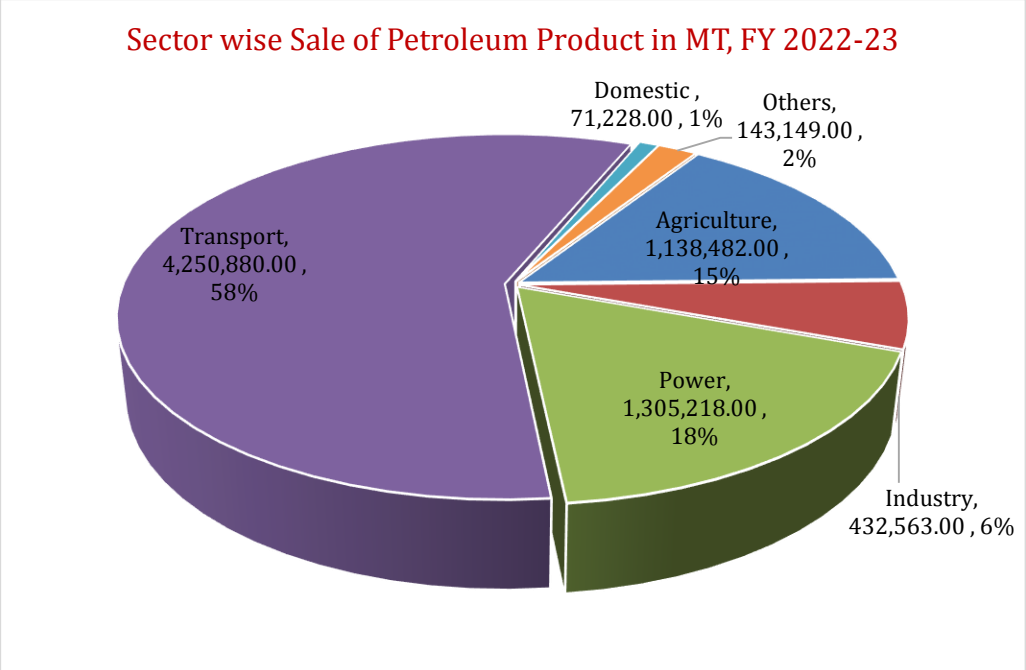


Figure 14: Sector wise Liquid Fuel Consumption in Bangladesh (2022-23)[22]

4.4.3 Petroleum Refinery:

Capacity of Refinery

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

Crude oil 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[23]

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

[22] BPC and HCU Energy Data Center
[23] ERL Website

A Project has taken for installation of 2nd unit of the existing refinery with annual refining capacity of three (03) 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.

Table 9: Historical Processing by ERL in MT, FY 2022-23[24]

Item	2018-19	2019-20	2020-21	2021-22	2022-23
LPG	12,831.00	8,902.00	11,583.00	12,516.00	13,879.00
Naphtha	100,679.00	77,015.00	143,561.00	101,602.00	118,327.00
Octane	3,963.00	1,732.00	-	-	247.00
Petrol	105,520.00	92,491.00	94,199.00	85,624.00	79,704.00
Diesel	640,940.00	451,789.00	731,088.00	638,129.00	672,746.00
Kerosene	95,196.00	83,157.00	72,956.00	56,018.00	53,682.00
MTT	3,150.00	360.00	-	-	-
Jet A-1	1,403.00	895.00	-	2,437.00	72.00
JBO	11,052.00	13,112.00	8,587.00	10,172.00	7,681.00
Furnace Oil	337,338.00	275,023.00	447,518.00	357,418.00	389,714.00
Bitumen	69,877.00	30,500.00	52,786.00	54,999.00	63,026.00
Gas+ Loss	23,973.00	18,307.00	38,654.00	23,216.00	35,224.00

Petroleum Productions from Public Refineries:

In the FY 2022-23, a total of 165.55 KT is refined from the public sector refineries.

[24] Bangladesh Petroleum Corporation (BPC)

Table 10: Petroleum Productions from Refineries (Public Sector) in MT, FY 2022-23[25]

Product	Haripur Gas Field, SGFL	Kailashtila Gas Field, SGFL	Rashidpur Gas Field, SGFL	Kailashtila, RPGCL	Bakharabad Gas Field, BGFCL	Titas Gas Field, BGFCL	4000 BPD Condensate Fractiona-tion Plant, SGFL	Total
Octane	-	-	226.00	-	-	-	64,700.00	**64,926.00**
Petrol	-	-	-	-	-	-	68,666.00	**68,666.00**
Diesel	-	-	606.00	-	-	-	13,767.00	**14,373.00**
Kerosene	-	-	1,042.00	-	-	-	16,547.00	**17,589.00**
Condensate	-	-	-	-	-	-	-	**-**
Total	**-**	**-**	**1,874.00**	**-**	**-**	**-**	**163,680.00**	**165,554.00**

In the FY 2022-23, a total of 411.12 KT is refined from the private sector refineries.

Table 11: Petroleum Productions from Refineries (Private Sector) in MT, FY 2022-23[26]

Product	Petromax Refinery	Super Petrochemi-cal	Aqua Refinery	Bashundhara Refinery	Partex Refinery	CVO Petrochemi-cal	Total
Octane	52,452	77,929	34,735	-	29,278	-	**194,394**
Petrol	10,638	54,014	23,646	-	36,128	-	**124,426**
Diesel	9,030	28,431	6,525	9,840	20,838	-	**74,664**
Kero-sene	3,388	-	-	-	-	-	**3,388**
MTT	-	5,246	-	-	-	-	**5,246**
Light MS	-	234	-	-	-	-	**234**
SBPS	-	3,861	-	-	-	2,653	**6,514**
Jet A-1	-	-	-	-	2,260	-	**2,260**
Total	**75,508**	**169,715**	**64,906**	**9,840**	**88,504**	**2,653**	**411,126**

Table 12: Naptha Production Scenario[27]

FY	Crude Pro-cessing, MT	Naptha Production, MT	Naptha Sales in MT		Total
			Local	International	
2018-19	1,358,159.00	100,679.00	71,888.00	36,513.00	**108,401.00**
2019-20	1,151,814.00	77,015.00	82,386.00	-	**82,386.00**
2020-21	1,506,099.00	143,561.00	129,842.46	18,795.27	**148,637.73**
2021-22	1,466,177.00	101,602.00	101,194.59	-	**101,194.59**
2022-23	1,550,897.00	118,327.00	108,839.00	-	**108,839.00**

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

[25] Bangladesh Petroleum Corporation (BPC)
[26] Bangladesh Petroleum Corporation (BPC)
[27] Bangladesh Petroleum Corporation (BPC)

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 commissioning stage 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 15: Single Point Mooring (SPM) with Double Pipeline

Construction of Storage facility 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 is going to be a new dimension to ensure energy security in the petroleum sector of Bangladesh. Operational flexibility will improve amazingly after completion of the SPM project.

Upcoming major projects of BPC:

- 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.

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.

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

countries. 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.

4.5 Liquefied Petroleum Gas (LPG)

Demand of Liquefied Petroleum Gas (LPG) in Bangladesh is very high. In the public sector 15,215 MT is produced during 2022-23 FY whereas 1,278,859 MT is imported thru private entity. Therefore, public and private sector combining do the marketing of 1.29 million MT of LPG in 2022-23, which is meeting a certain portion of LPG demand of the country.

Table 13: LPG scenario of last 5 year[28]

Year	**Public Sector Production, MT**	**Import (Private), MT**	**Total, MT**
2016-17	16,382.00	307,000.00	323,382.00
2017-18	15,936.00	537,686.00	553,622.00
2018-19	19,228.00	681,036.00	700,264.00
2019-20	13,414.00	835,027.00	848,441.00
2020-21	13,461.00	1,427,826.00	1,441,287.00
2021-22	12,361.00	1,531,230.80	1,543,591.80
2022-23	15,215.00	1,278,859.50	1,294,074.50

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.

Table 14: LPG Summary, FY 2022-23 (MT)

LPG Production in Patenga (ERL/LPGL)	**14,246.00**
LPG Production from Kailashtila Frac. Plant	748.00
Previous Stock	221.00
LPG import (private)	1,278,859.50
Total	1,294,074.50

[28] HCU Data Bank

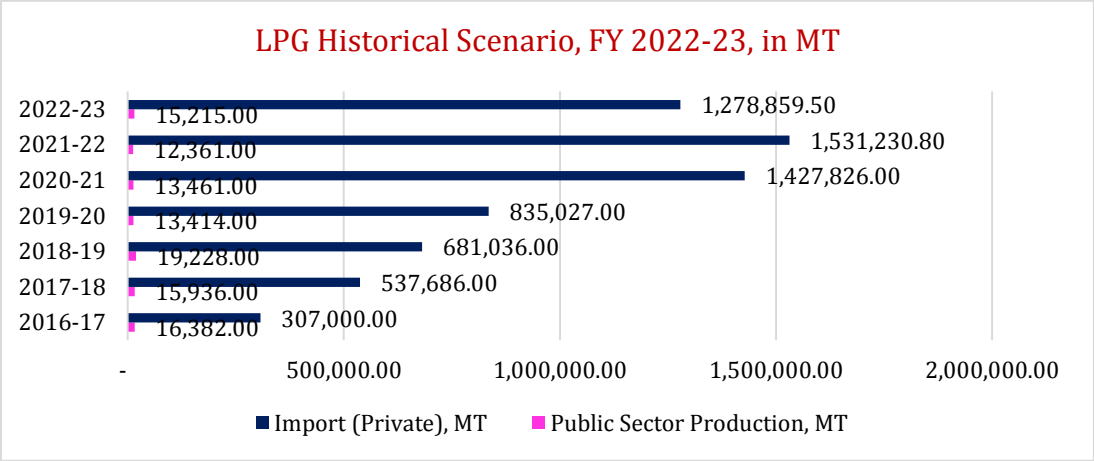


Figure 16: LPG Scenario in Last 5 years in Bangladesh

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

4.6 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 6.24% of electricity has been produced from domestic and imported 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 15: Coal Fields of Bangladesh

Place/Field (Discovery Year)	Depth (Meter)	Reserve (Million Ton)	Calorific Value (BTU/lb.)
Barapukuria, Dinajpur (1985)	119-506	410	11,040
Khalaspir, Rangpur (1995)	257-483	685	12,700
Phulbari, Dinajpur (1997)	150-240	572	11,900
Jamalganj, Jaipurhat (1965)	900-1000	5,450	11,000
Dighipara, Dinajpur (1995)	327	706	13,090
		Total = 7,823	

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.

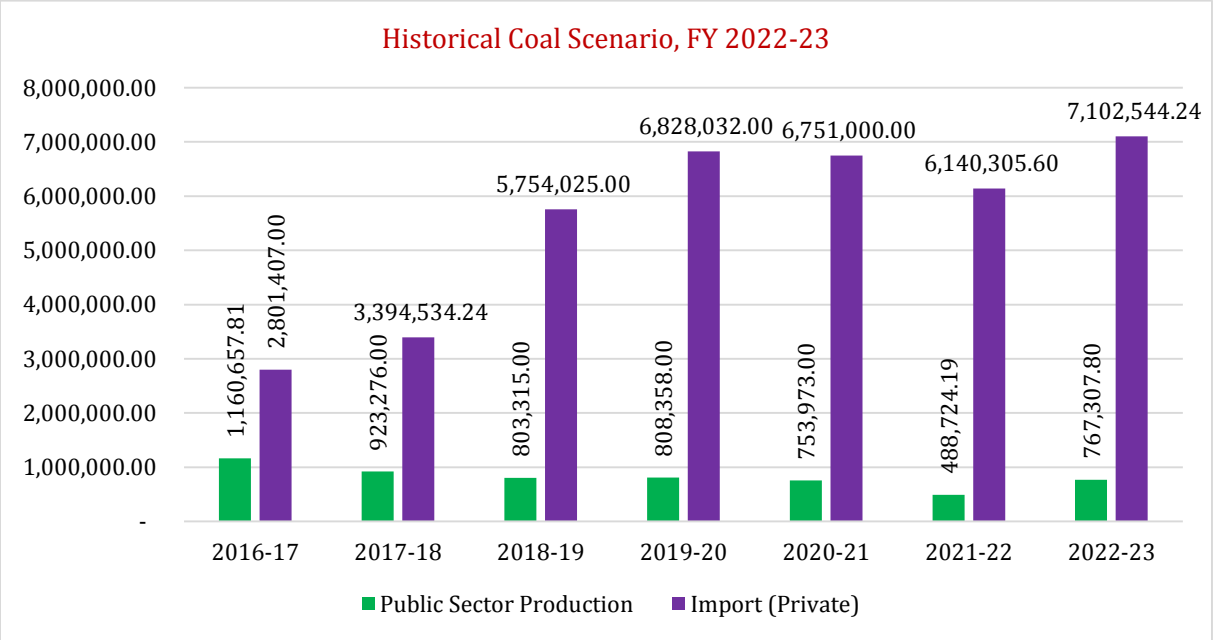


Figure 17: Coal scenario of last 5 year[29]

Commercial coal production started from September 2005 with a capacity of 1 million metric tons per annum and currently the production rate is 2500-3000 metric tons per day. Till December 2022, total 13.47 million metric tons of Coal has been produced

[29] HCU Data Bank

from the commencement of commercial production. About 0.77 million metric tons of coal has been produced in the year 2022 from Barapukuria mine. Presently entire amount of produced coal is being supplied to Barapukuria 525 MW coal fired thermal power plant. A contract has been signed between BCMCL and XMC-CMC consortium in 30 December 2021 to extract 4.5 million metric tons of coal within a period of next 6 years.

A total of 767,307.80 MT of coal has been extracted in the FY 2022-23 and 7,102,544.24 MT has been imported. As a result, about 7.87 million MT coal has been consumed in this FY.

4.7 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.

4.8 Condensate and Natural Gas Liquids (NGL)

Some of the gas fields located in the north-eastern part of Bangladesh contain high concentrations of liquid hydrocarbons or condensate. This condensate has been processed in refineries and turned into petrol, diesel and kerosene since the beginning. In FY 2022-23, a total of 2,738,229.25 barrels of condensate has been produced as gas byproducts from the gas fields operating under national gas production companies and production sharing contracts (PSCs).

In FY 2021-22, a total of 25,62,721 barrels of condensate has been produced and 3,057 barrels of condensate have been sold directly to Bangladesh Petroleum Corporation and private companies. The rest of the condensate and the whole amount of NGL produced are processed in plants owned by companies operating under Petrobangla and in this way 13,71,167 barrels of petrol, 1,26,022 barrels of diesel, 1,30,548 barrels of kerosene and 774.1 metric tons of liquefied petroleum gas (LPG) have been produced in FY 2021-22. These products are sold to various companies operating under the Bangladesh Petroleum Corporation.

In 2018, a fractionation plant of 4,000-barrel capacity was established in Rashidpur by SGFL to process the condensate produced. Moreover, in 2021 a catalytic reforming unit (CRU) with 3,000 barrels of capacity has been established by SGFL.[30]

[30] Annual Report Petrobangla, 2022

Chapter 5

Power Generation

5.1 Primary Energy Mix for Power Generation

Maximum generation actually obtained till 30 June 2023 was 15,648 MW. It might have occurred due to fuel supply constraint. Of the total generation capacity among public sector, private sector, joint venture and import are 42%, 40%, 7% and 11% respectively.

Bangladesh has started importing 500MW electricity from India (started in October 2013) additional 100 MW from March'16, 560 MW from December 2018, and rest is imported from Adani Power cumulatively 2656 MW which is contributing 11% of total power generation.

5.2 Power Sector at a Glance

Table 16: Bangladesh's Power Sector: At a Glance (2022-23)[31]

Types	Amount
Number of Power Plants	152
Installed Capacity (MW)	28,134
Maximum Generation (MW)	15,648
Total Consumers (in Millions)	45.30
Transmission Lines (km)	13,889
Distribution Lines (km)	643,000
Grid Substation Capacity (MVA)	61,525
Per Capita Generation (including Captive)	602 Kwh
Access to Electricity (Including Off-Grid Renewable)	100%
Overall System Loss (%)	10.33

As of June 2023, the total installed power generation capacity on-grid and off-grid is 28,134 MW. On-grid installed power generation capacity is 24,911 MW.

[31] Power Division Annual Report 2022-23

5.3 Power Generation Capacity

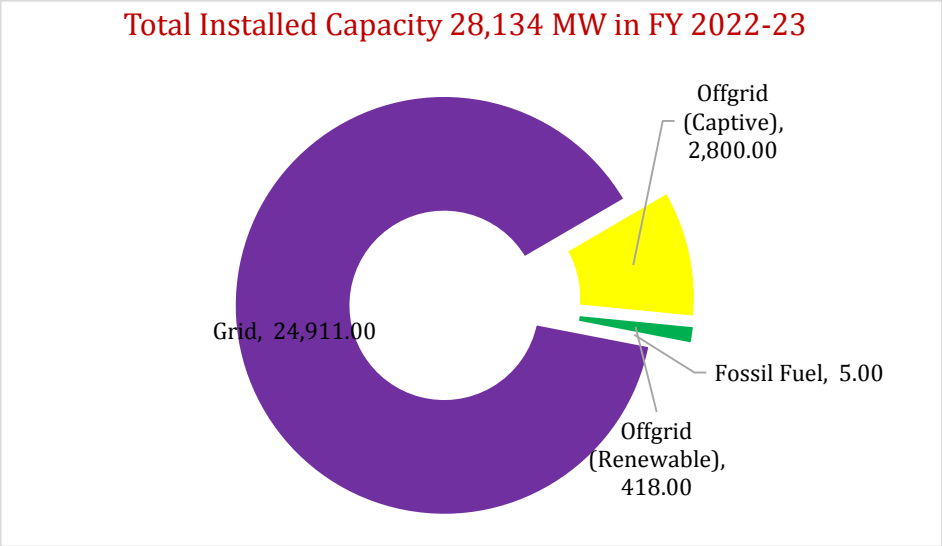


Figure 18: Total Installed Capacity 28,134 MW (2022-23)[32]

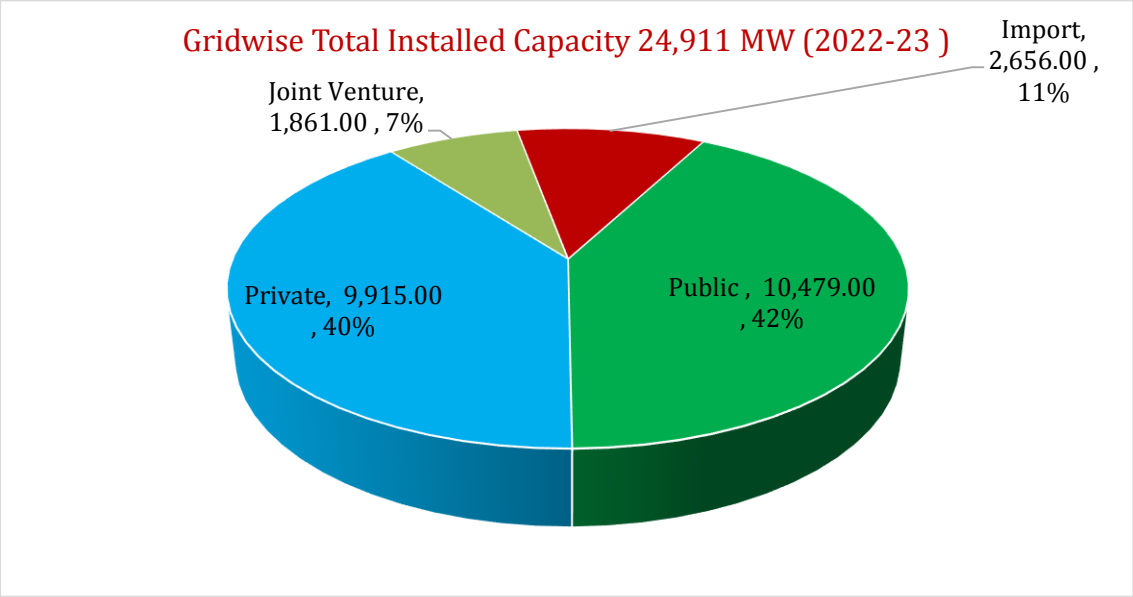


Figure 19: Grid wise Total Installed Capacity 24,911 MW (FY 2022-23)

As of June 2023, grid wise total installed capacity is 24,911 MW which is presented in the above figure.

[32] Power Division Annual Report 2022-23

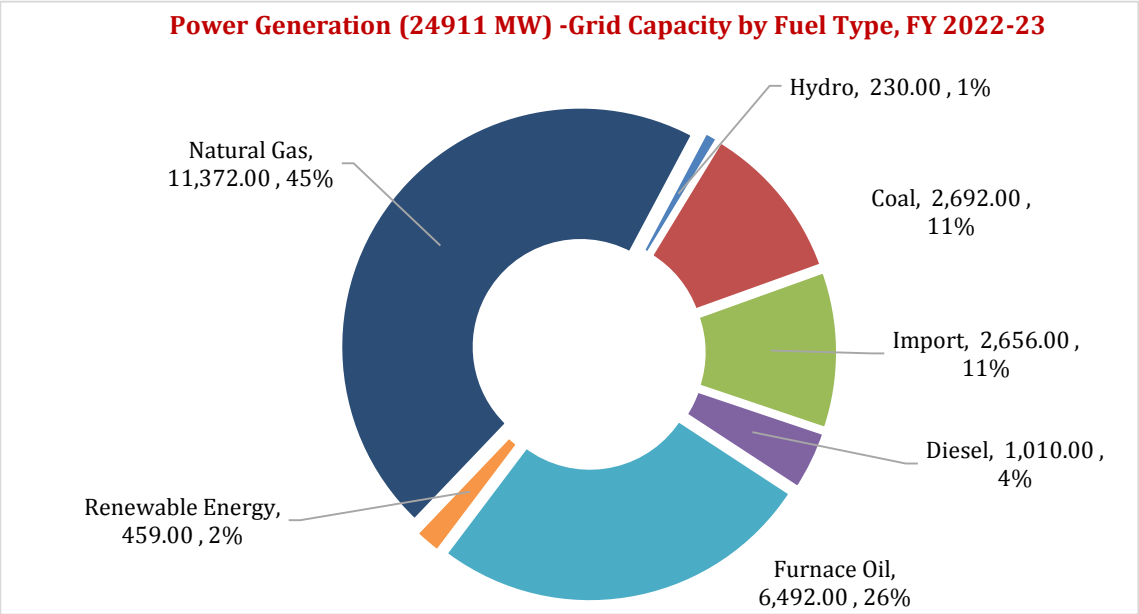


Figure 20: Power Generation by Fuel Type[33]

As of June 2023, grid wise (on grid 24,911 MW) total power generation by fuel type is highlighted in the above figure. In this figure, it is obvious that power generation by indigenous natural gas plays the major share (45%).

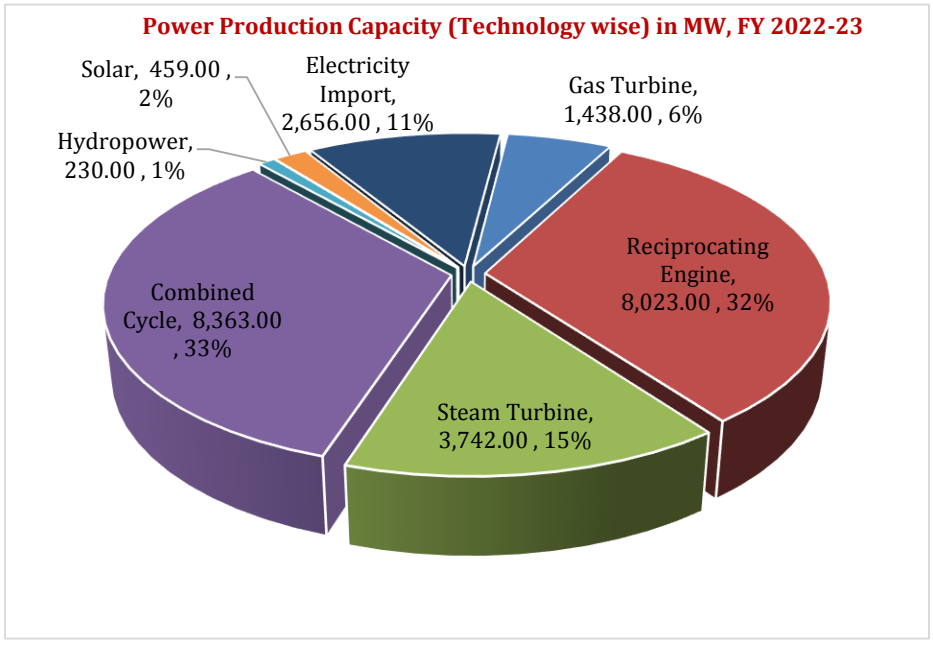


Figure 21: Power Production Capacity (Technology wise) in MW 2022-23

As of June 2023, grid wise (on grid 24,911 MW) total power generation by technology wise

[33] Power Division Annual Report 2022-23

is highlighted in the above figure. In this figure, it is clear that combined cycle power plant holds the major share in generation by indigenous natural gas plays the major share (33%). The rest is reciprocating engine, steam turbine, gas turbine etc. respectively.

5.4 Net Power Generation

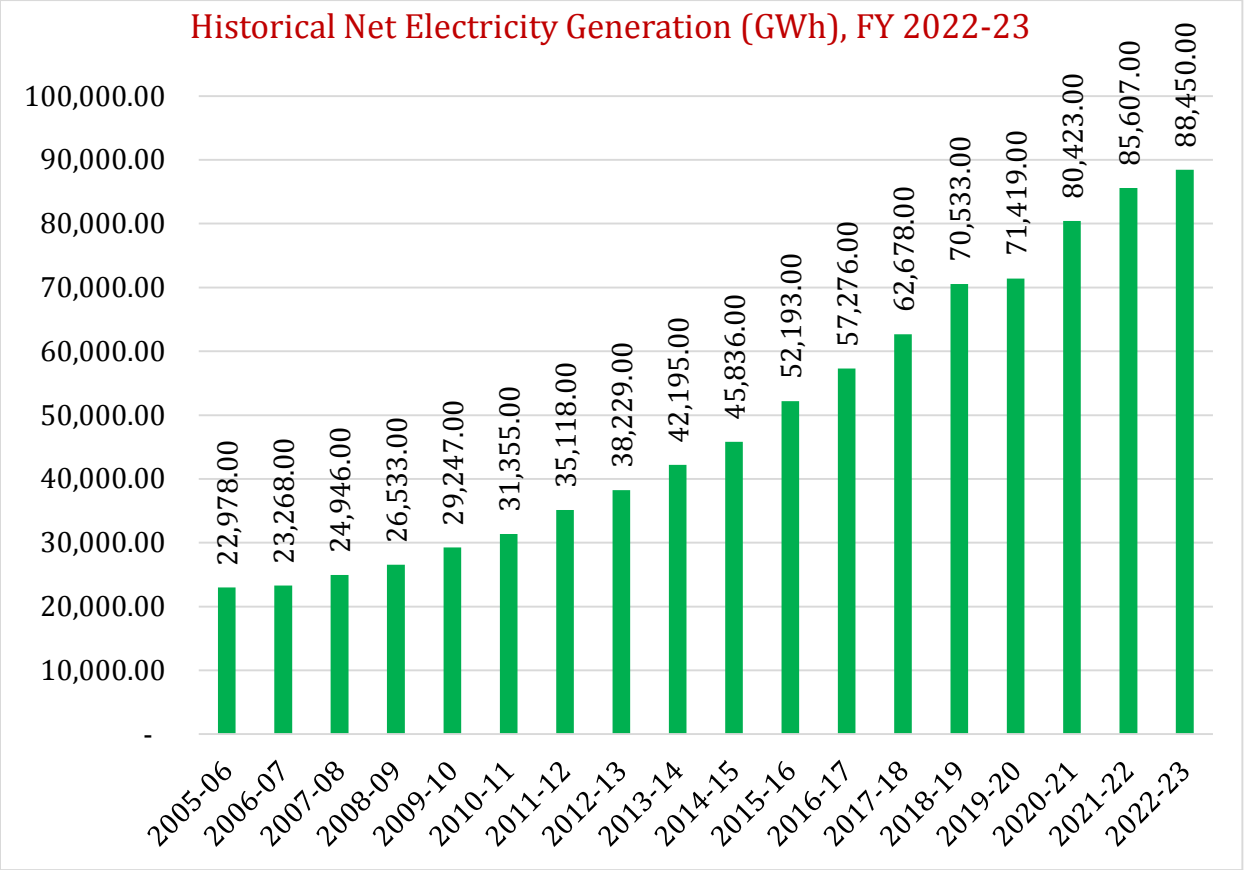


Figure 22: Historical Net Electricity Generation (GWh) in Bangladesh[34]

5.5 Power Generation by Fuel Type

In the FY 2022-23, Net Electricity Generation (GWh) in Bangladesh is 88,450 GWh represented in the above figure.

[34] Power Division Annual Report 2022-23

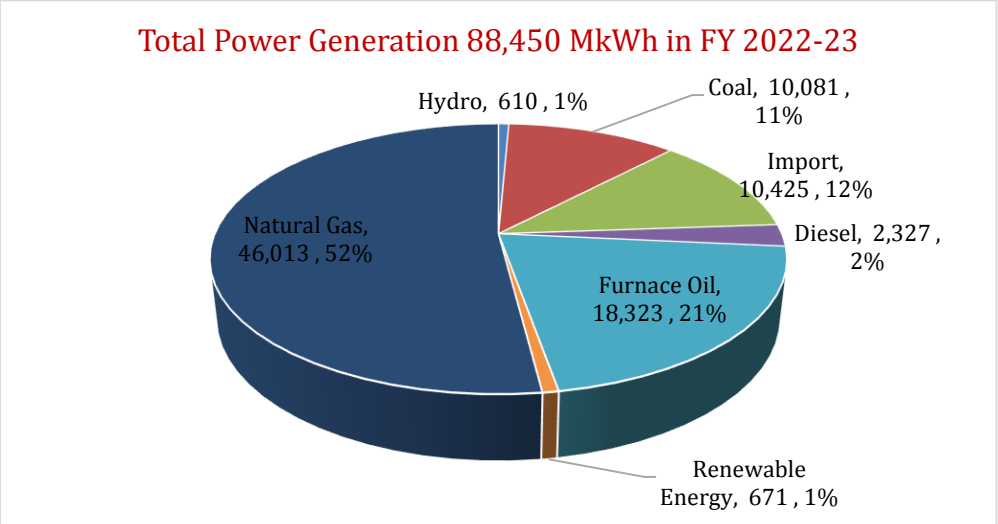


Figure 23: Power Generation by Fuel Type (2022-23)[35]

Of the total electricity generated in 2022-23, 52% is generated from indigenous natural gas, 21% from furnace oil, 11% from coal, 12% from import and rest is from Diesel, hydro and renewable energy.

5.6 Power Consumption

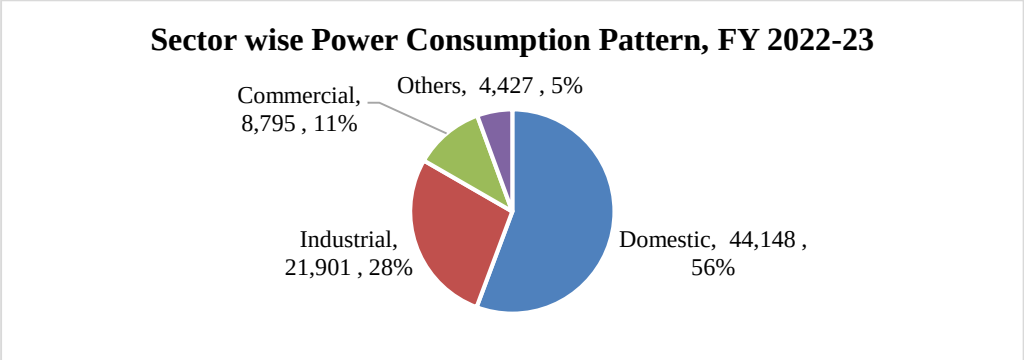


Figure 24: Sector wise Power consumption Pattern (2022-23)[36]

From the above figure, it is clear that major power consumer is the domestic sector (56%). Industrial sector, commercial sector and others are consuming 28%, 11% and 5% respectively.

[35] Power Division Annual Report 2022-23
[36] Power Division Annual Report 2022-23

5.7 Power Import

Bangladesh has entered into the era of cross border energy trade in October 2013 by importing electricity from India. Additional 160 MW from March 2016 from Tripura. From 2023, 1496 MW (Capacity 1600 MW) is imported from Adani power (Jharkhand, India).

Figure 25: Bangladesh India Power Transmission Plant, Bheramara (Kustia)

Table 17: Electricity Import Scenario[37]

Import Location	**Imported Electricity Amount (MW)**
Bheramara, Kustia (from Baharampur, India)	1000
Cumilla (From Tripura)	160
Adani Power (Capacity 1600 MW)	1,496
Total Power Import from India	**2,656**

[37] Source: Power Division

Chapter 6

Renewable Energy Resources

6.1 Renewable Energy

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.

6.1.1 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 26: 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.

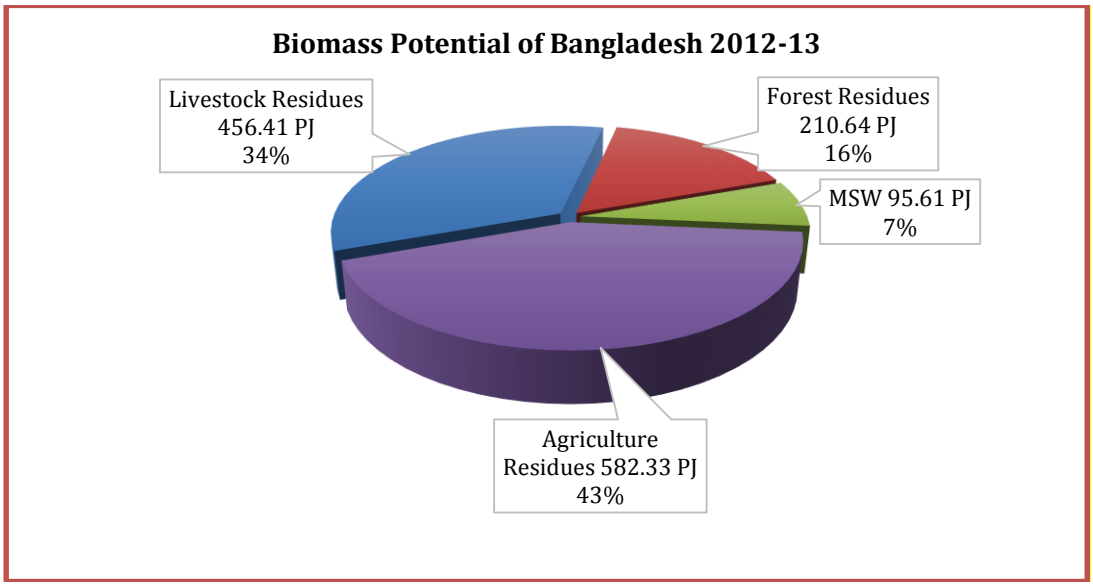


Figure 27: Biomass Potential of Bangladesh (2012 –13)

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.

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

6.1.3 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 re-

newable energy technology. The authority (SREDA) is in the process of institutionalization. Total generation of electricity from renewable energy sources (e.g., solar, wind, hydro, biomass, biogas etc.) up to 2022 was 957.674 MW.

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.

- **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 28: 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 schemes 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 29: 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.

- **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 2020.

- **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 30: 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).

- **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.

- **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.

- **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.

- **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.

- **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 18: Planned Nuclear Power Reactors

Unit	Type	Capacity	Construction starts	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.

Chapter 7

Energy targets and projections towards Energy transition

Bangladesh has formulated long-term energy plans such as Power System Master Plan 2016 (PSMP2016), Revisiting Power System Master Plan 2016 (Revisiting PSMP2016), Energy Efficiency and Conservation Master Plan 2016 (EECMP2016). These plans mainly focus on power sector. But there is no substantial actionable roadmap/plan/ integrated policy on energy sector. It is very obvious to prepare an integrated master plan on energy sector to address energy transition considering declining growth of indigenous resources, international fuel market's price volatility, sudden global energy crisis due to post COVID pandemic, war between Russia vs. Ukraine and low carbon pathway etc.

7.1 Energy transitions and projections: Rationale of IEPMP

To focus on energy sector, an integrated plan was necessary and in this context, Integrated Energy & Power Master Plan (IEPMP) has been formulated in 2023. To implement the roadmap of IEPMP, EMRD is working to formulate the operational roadmap with all the stakeholders. The main step of this operational roadmap is to understand the demand/supply forecast.

So, the forecasts and projections of different types of energies together are going to be discussed in the following.

7.2 Main Features of IEPMP

7.2.1 Case Setting on Technical Progress

An econometric model is developed for projection of energy demand outlook. Energy demand functions are estimated by sector applying regression analysis in relation to GDP, energy prices and other relevant factors based on the historical data; the IEA statistics is mainly used on energy.

Three cases are examined for the GDP projection, which are:

a. PP2041 Case; based on the projections of the Perspective Plan 2041, which seeks for an optimistic economic growth to achieve a high-income country status by 2041 accelerating development.
b. IMF Extension Case; based on the projections of the IMF World Economic Outlook, which envisages a relatively moderate growth.
c. In-between Case: a projection in-between the above two cases, which may represent a view to achieve a steady development.

This Master plan adopts the PP 2041 GDP case, the basis for the present national development plan, as the main scenario and an exercise case is run on the In-Between GDP case.

7.2.2 Scenario Setting on Technical Progress

On evolution of energy related technologies and policies that will guide the direction and indicate the goal to be pursued in this Master Plan, three scenarios are considered as below:

a. Reference Scenario (REF): a so-called business as usual case where energy consumption will follow the past trends. Technology development and improvement in quality of life will progress likewise as observed in the past.
b. Advanced Technology Scenario (ATS): on top of REF, utmost efforts will be made to keep energy-based emissions of GHGs as low as possible, while assuring adequate and stable supply, introducing energy conservation measures and adopting cleaner energy options that are affordable and practicable.
c. Net-zero Scenario (NZS): Under the NZS, Bangladesh is assumed to achieve net-zero emissions of energy-based GHGs by 2050 applying every possible option and, if insufficient, harnessing energy consumption.

The energy demand/supply forecast is run on the Advanced Technology Scenario (ATS) with two GDP projections of PP2041 case and In-Between Case.

7.2.3 Comparison of Three Scenario

Preliminary evaluation was made on the three scenarios in terms of their appropriateness and practicability applying two indices, namely, energy efficiency index and decarbonization index.

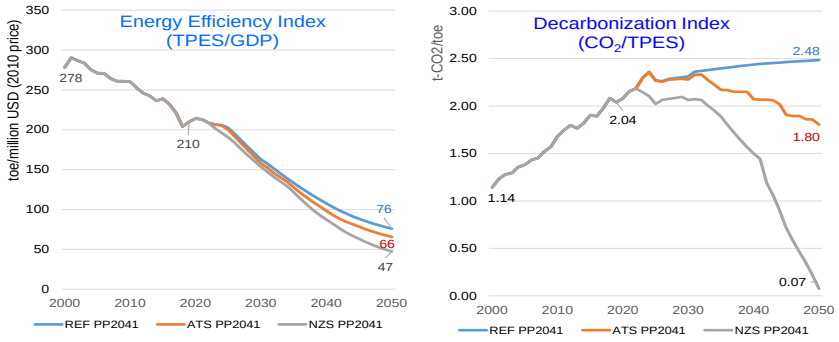


Figure 31: Comparison of Three Scenario of IEPMP

The energy demand/supply forecast is run on the Advanced Technology Scenario (ATS) with two GDP projections of PP2041 case and In-Between Case.

7.3 Primary Energy Supply Forecasting

Total primary energy supply (TPES) is a sum of the final energy consumption excluding electricity, a secondary energy, and the fuel input in power sector. In the PP2041 case, TPES will expand by about four-fold to 169 million tons' oil equivalent (Mtoe) in 2050 from 44 Mtoe in 2019. The size of TPES in 2050 is close to that of the United Kingdom in 2019. In the ATS In-between, TPES will expand by about three-fold to 138 Mtoe in 2050, which is close to that of Thailand in 2019.

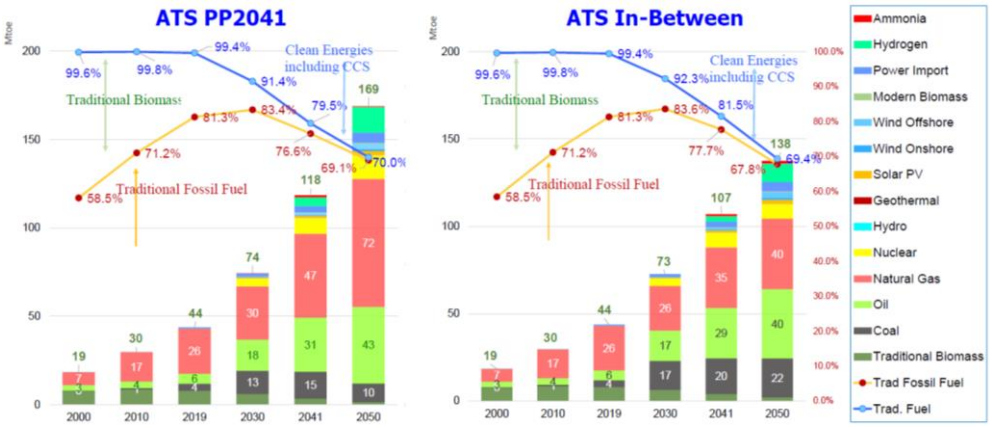
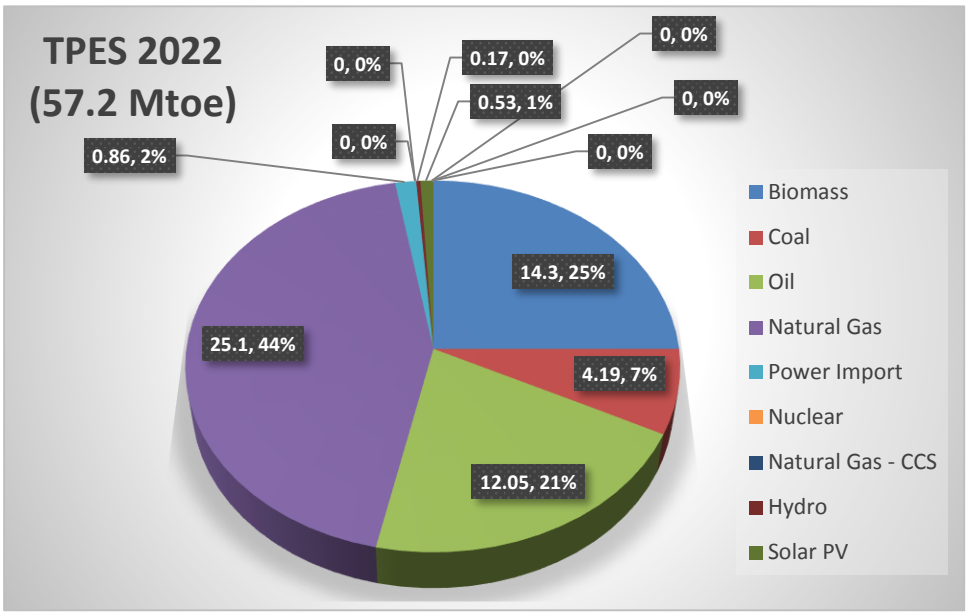


Figure 32: Primary Energy Supply[38]

[38] Primary Energy Supply, Executive Summary 14, Integrated Energy & Power Master Plan (IEPMP), 2023.

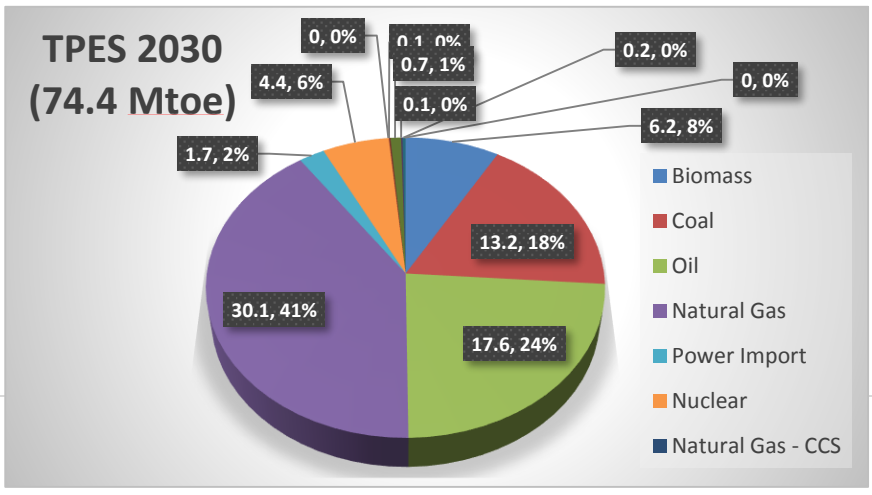
Traditional biomass consumption, mainly firewood, is being replaced with modern fossil fuels such as coal, oil or natural gas. This trend continues and traditional biomass consumption will almost disappear by 2050. On the other hand, clean energies such as solar PV, wind, CCS, nuclear, ammonia and hydrogen will be introduced. These clean energies will exceed 20% of the TPES by 2041 and reach almost 30% in 2050.

7.4 Primary Energy Supply Forecasting- HCU Version

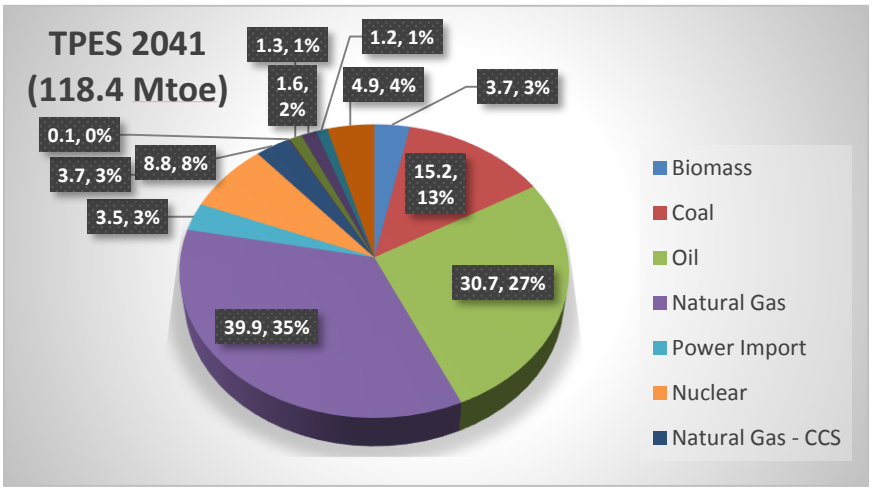


Total Primary Energy Supply of Bangladesh (TPES) in 2022 is 57.2 Mtoe.

For Reference case- PP2041 and Advanced Technology Scenario, TPES of Bangladesh in 2030, 2041 and 2050 is 74.4 Mtoe, 118.4 Mtoe and 168.9 Mtoe respectively.



Reference case: PP2041
Scenario: ATS (Advanced Technology Scenario)



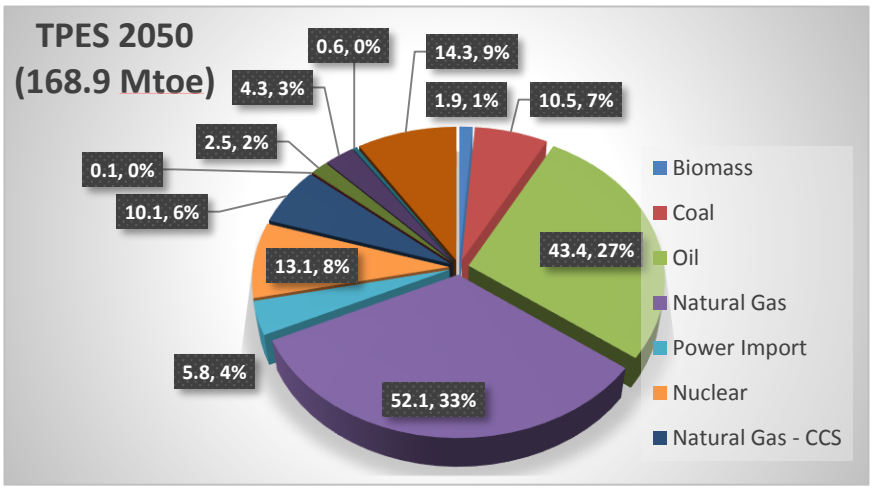


Figure 33: Primary Energy Supply forecasting by HCU[39]

7.5 Energy Transition: Future Projection

As Bangladesh is signatory/ allied partner of the numerous global goal/pact/ agreement e.g. Millennium Development Goals (MDGs), Sustainable Development Goals (SDGs), Kyoto protocol, Paris Agreement, Nationally Determined Contributions (NDC), Perspective plan, 8th Five Year Plan, Mujib Climate Prosperity Plan etc**.** The following table represents addressing the urgency of low carbon pathway of Bangladesh.

[39] Energy Data Center, Hydrocarbon Unit and IEPMP 2023

Table 19: Projected Total Primary Energy of Bangladesh (in terms of percentage)[40]

	2022	2030	2041	2050
Natural Gas	43.88	40.51	34.82	32.83
Oil	21.07	23.69	26.79	27.35
Coal	7.33	17.77	13.26	6.62
Electricity Import	1.50	2.29	3.05	3.65
Nuclear	0.00	5.92	7.68	8.25
Natural Gas-CCS	0.00	0.00	3.23	6.36
Hydroelectric	0.30	0.13	0.09	0.06
Solar-PV	0.93	0.94	1.13	1.58
Wind	0.00	0.13	1.40	2.71
Hydrogen	0.00	0.00	4.28	9.01
Ammonia	0.00	0.27	1.05	0.38
Biomass	25.00	8.34	3.23	1.20
Total	100	100	100	100

[40] Total Primary Energy Supply, Page-59, Integrated Energy & Power Master Plan (IEPMP), 2023.

7.5.1 Natural Gas Demand & Production

Natural gas consumption will expand 2.8-folds between 2019 and 2050 for PP 2041 GDP case and 1.7-folds for In-Between case. Main driver is the power sector.

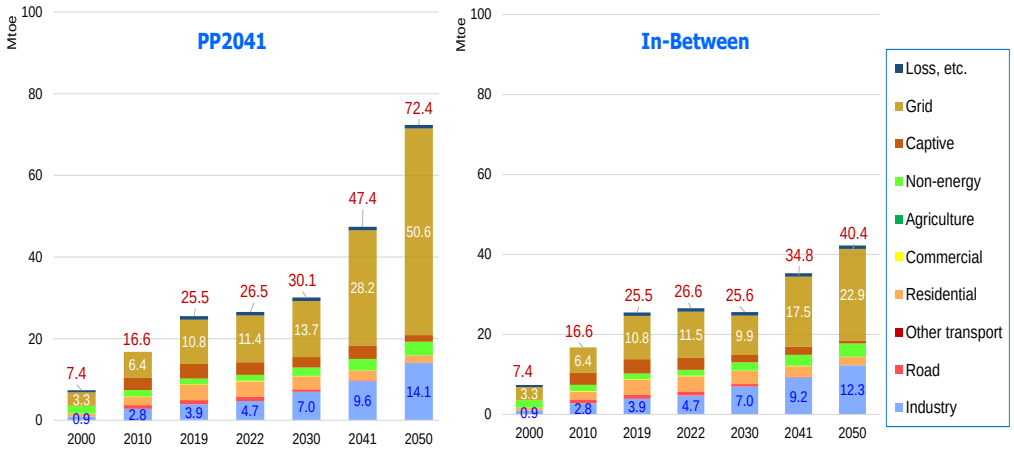


Figure 34: Natural Gas Demand Outlook[41]

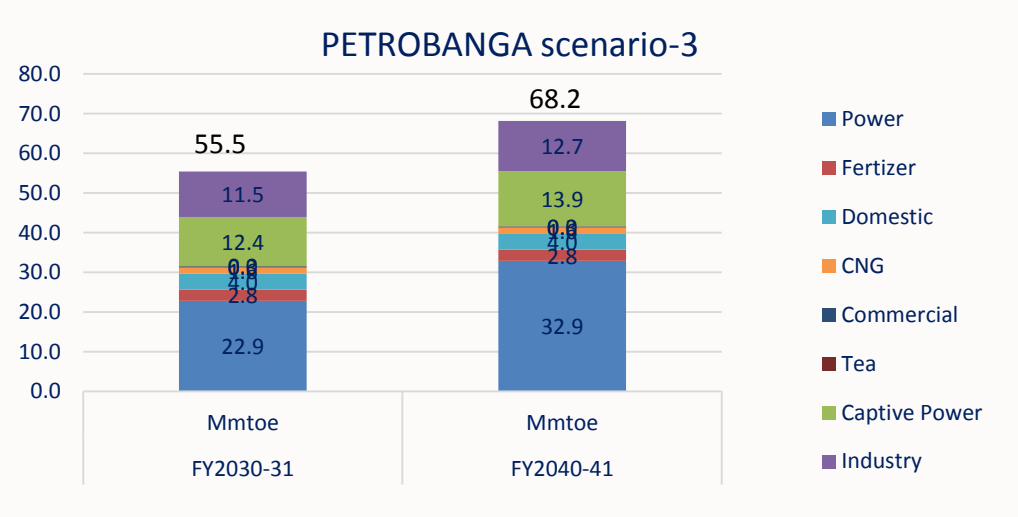


Figure 35: Natural Gas Demand Outlook[42]

Because of its lower carbon footprint among fossil fuels, natural gas consumption by power sector will expand 3.6-folds in PP2041 and 1.6-folds in In-Between during the same period.

[41] Natural Gas Demand Outlook, page- 115, Integrated Energy & Power Master Plan (IEPMP), 2023.
[42] Natural Gas Demand Outlook, page- 115, Integrated Energy & Power Master Plan (IEPMP), 2023.

It is very clear that indigenous gas production from onshore is decline stage in the

	2020-21	2030-31	2040-41	2050-51
	MMcfd	MMcfd	MMcfd	MMcfd
Existing Well	2,415	701	188	40
Well Workover	25	301	136	140
Appraisal and Development Wells (Existing)	0	311	258	160
Onshore Exploration	0	377	156	100
Onshore Unconventional Potential	0	90	30	30
Onshore Total	2,440	1,779	768	470
Offshore: Shallow Water	0	200	250	250
Offshore: Deepwater	0	0	680	980
Offshore Total	0	200	930	1,230
Total	2,440	1,979	1,698	1,700

Figure 36: Forecast of Domestic Natural Gas Production[43]

Outlook of Natural Gas Supply Balance

	2030	2035	2040	2045	2050
Gas Demand	mmcfd	mmcfd	mmcfd	mmcfd	mmcfd
Petrobangla (Scenario-3)	6,240	6,941	7,675	-	-
PP2041	3,384	4,008	4,985	5,823	8,142
In-Between	2,879	3,213	3,717	3,982	4,545
Production					
Low Risk Potential	1,779	1,221	768	580	470
High Risk Potential	200	900	930	1,080	1,230
Total	1,979	2,121	1,698	1,660	1,700
LNG Demand (mmscfd)	mmscfd	mmscfd	mmscfd	mmscfd	mmscfd
Petrobangla: Base	4,261	4,820	5,977		
Without High Risk Potential	4,461	5,720	6,907		
PP2041: Base	1,405	1,887	3,287	4,163	6,442
Without High Risk Potential	1,605	2,787	4,217	5,243	7,672
In-Between: Base	900	1,092	2,019	2,322	2,845
Without High Risk Potential	1,100	1,992	2,949	3,402	4,075
LNG Demand (million tonnes)	Mt	Mt	Mt	Mt	Mt
Petrobangla: Base	32.7	36.9	45.8		
Without High Risk Potential	34.2	43.8	52.9		
PP2041: Base	10.8	14.5	25.2	31.9	49.4
Without High Risk Potential	12.3	21.4	32.3	40.2	58.8
In-Between: Base	6.9	8.4	15.5	17.8	21.8
Without High Risk Potential	8.4	15.3	22.6	26.1	31.2

Location	Terminal	Capacity/Expansion	Start-up
		MMcfd	
Moheskhali	#1 FSRU (Operating)	500 → 630	Expnasion to be discussed
	#2 FSRU (Operating)	500 → 630	Expnasion to be discussed
	#3 FSRU	500-750	2026
Payra	#4 FSRU	630-1,000	2028
Matarbari	Land-based	1,000	2030
Total	3,430~4,010 MMcfd (24.0~30.7 million tonnes)		

Figure 37: Outlook of Natural Gas Supply Balance[44]

[43] Forecast of Domestic Natural Gas Production, page- 117, Integrated Energy & Power Master Plan (IEPMP), 2023.
[44] Outlook of Natural Gas Supply Balance, page- 119, Integrated Energy & Power Master Plan (IEPMP), 2023.

Under the most-likely case of the indigenous gas production plan, LNG import will increase to 11 million tons (Mt) in 2030, 25 Mt in 2040 and 49 Mt in 2050 for the PP2041 GDP case and 7 Mt in 2030, 16 Mt in 2040 and 22 Mt in 2050 for the In-Between case, respectively. However, if exploration on the high-risk potential resources were not successful, additional import of LNG will become necessary on top of these projections by 7.1 Mt in 2040 and 9.4 Mt in 2050.

7.5.2 Oil Demand & Supply

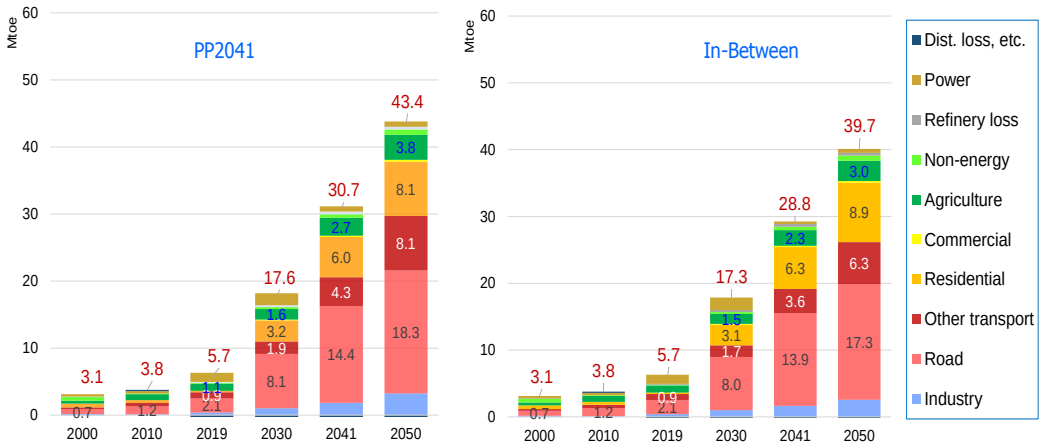


Figure 38: Oil Demand Outlook[45]

Unit: million tons per year	2021FY	2030FY	2041FY	2050FY
Total liquid fuel demand	**12.3**	**17.5**	**30.4**	**43.1**
Refinery production	**2.0**	**5.0**	**5.0**	**8.5**
ERL-1	1.5	1.5	1.5	
ERL-2		3.0	3.0	3.0
ERL-3 (replace ERL-1)				5.0
Other small refineries	0.5	0.5	0.5	0.5
Product import (excl LPG)	**8.9**	**10.0**	**20.4**	**24.6**
BPC@Chittagong	4.5	5.0	5.0	5.0
IBFPL		1.0	1.3	1.3
SPM-1@Chittagong		3.0	9.0	9.0
New SPM@TBD (excl crude oil)			5.1	9.3
HSD/FO for IPP	4.4	1.0	0.0	0.0
LPG	**1.4**	**2.5**	**5.0**	**10.0**
Existing LPG terminal	1.4	1.5	2.0	2.0
ERL	0.0	0.1	0.1	0.2
New LPG Terminals@TBD		0.9	2.9	7.8

[45] Oil demand Outlook, page- 125, Integrated Energy & Power Master Plan (IEPMP), 2023.

Consumption of petroleum products is forecast to expand 7.6-folds between 2019 and 2050 for the PP 2041 GDP case and 7.0-folds for the In-Between Case. The increase will be mainly led by motor fuel such as gasoline and diesel oil in response to increasing demand for mobility. Diesel and fuel oil are also used for sea and river water transport.

7.5.3 Coal demand and indigenous production outlook

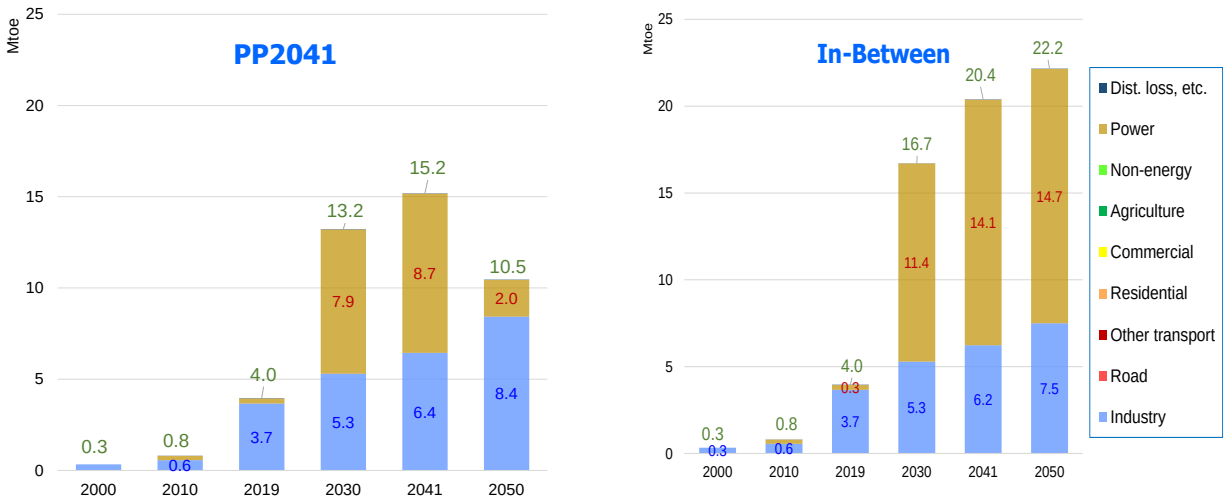


Figure 39: Coal Demand Outlook[46]

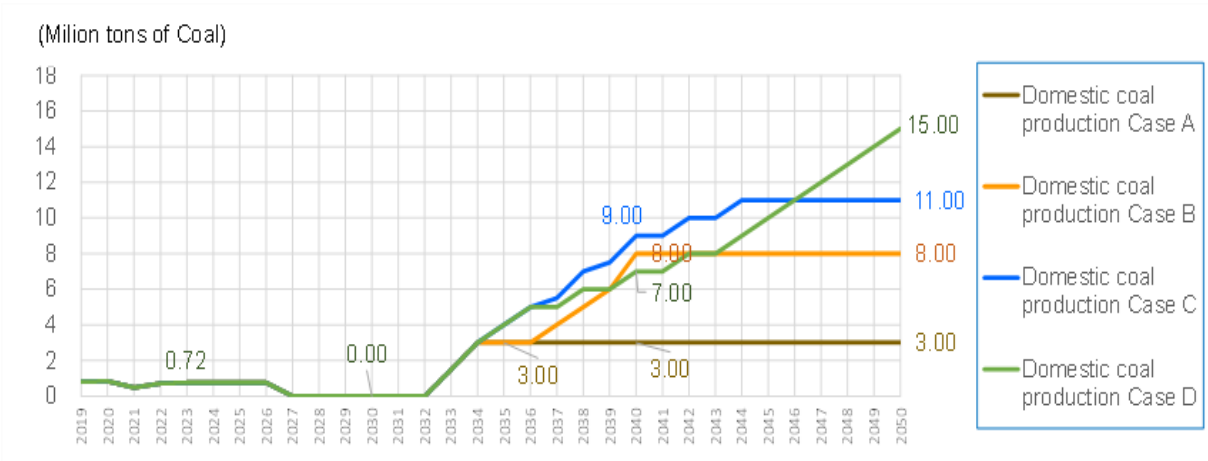


Figure 40: Coal Production Outlook by scenarios[47]

[46] Coal Demand Outlook, page- 129, Integrated Energy & Power Master Plan (IEPMP), 2023.
[47] Coal Production Outlook by scenarios,

Under the PP2041 demand projection under vigorous economic growth, introduction of new energies will progress fast in the power generation sector, and coal consumption may start decreasing in the 2040s. If domestic coal utilization would be stagnant like in Case-A, coal import needs to be continued. On the other hand, with coal mine development like in Case-C, coal import may almost cease by 2050.

7.5.4 Outlook of Clean Energy Supply

To build a low carbon economy, clean energy supply must expand rapidly, which include hydro, nuclear, solar PV, wind, modern biomass as well as CCS, ammonia and hydrogen.

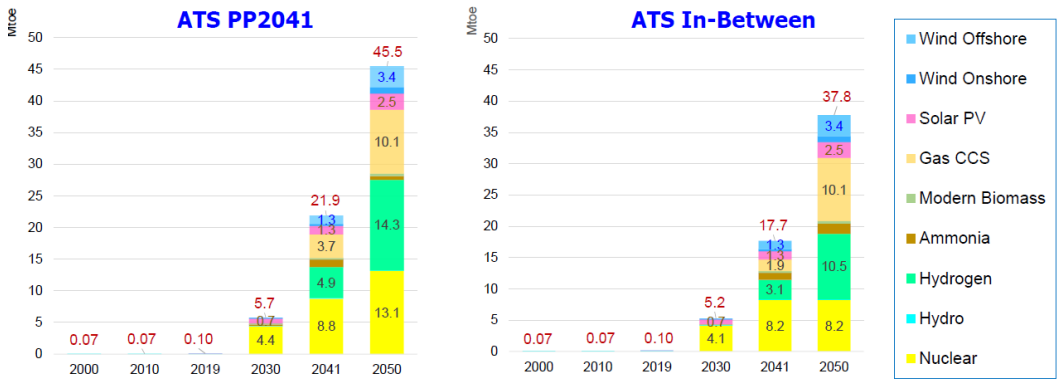


Figure 41: Coal Production Outlook by scenarios[48]

The total supply of clean energy will amount to 45.5 MTOE in 2050 for the PP2041 GDP case and 37.3 MTOE for the in between case.

[48] Coal Production Outlook by scenarios, , Integrated Energy & Power Master Plan (IEPMP), 2023.

7.5.5 CO_2 emission

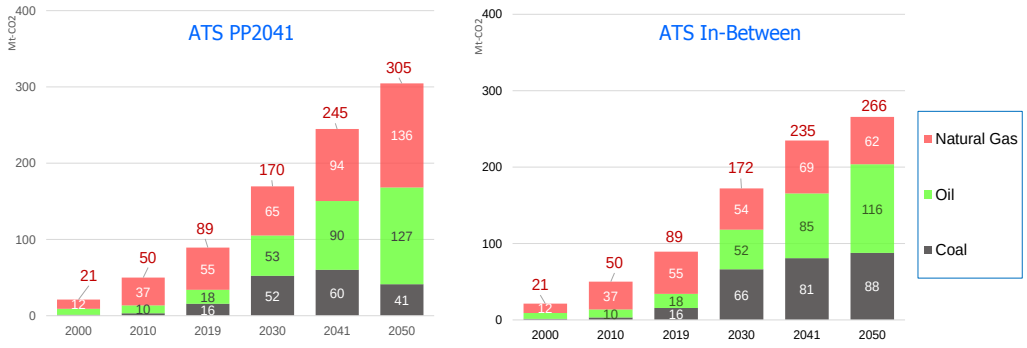


Figure 42: Energy-Related CO2 Emissions by Source[49]

The emissions of ATS PP2041 will be relatively moderate at 305 million tons-CO_2 in 2050. That of ATS In-between will be even slower at 266 million tons-CO_2 in 2050.

7.5.6 Energy Intensity

Energy Intensity is measured by the quantity of energy required per unit output or activity, so that using less energy to produce a product reduces the intensity. The numerical value is traditionally calculated by taking the ratio of energy use (or energy supply) to gross domestic product (GDP), indicating how well the economy converts energy into monetary output. Typical units for energy intensity are joules (or Btu) per US dollar; however, there are other equivalent metrics used. For Bangladesh, Ktoe per billion BDT is used. The smaller the energy intensity ratio is, the lower the energy intensity of a particular nation.

Concepts:

Total energy supply is made up of production plus net imports minus international marine and aviation bunkers plus-stock changes. Gross Domestic Product (GDP) is the

[49] Energy-Related CO2 Emissions by Source, Executive Summary 20, Integrated Energy & Power Master Plan (IEPMP), 2023.

measure of economic output. For national comparison purposes, GDP is measured in current terms at purchasing power parity.

Table 20: Energy intensity measured in terms of primary energy and GDP[50]

Energy Intensity of Bangladesh			
Year	**Energy Mix (Primary) MTOE**	**GDP (Current) (billion BDT)**	**Intensity ktoe/billion BDT**
2015-16	**46.10**	**20758.21**	**2.22**
2016-17	**46.43**	**23243.07**	**2.00**
2017-18	**47.01**	**26392.48**	**1.78**
2018-19	**54.60**	**29514.29**	**1.85**
2019-20	**55.50**	**31704.69**	**1.75**
2020-21	**56.92**	**35301.85**	**1.61**
2021-22	**57.20**	**39717.16**	**1.44**

In FY 2021-22 it was 1.44 while in FY 2015-16 it was 2.22; therefore, energy intensity is reduced by 35% over this period.

[50] BBS and HCU

Chapter 8

Alternate Fuels

Bangladesh has its own indigenous resources e.g., Natural gas, coal and small amount of petroleum. Natural gas being the primary energy source of Bangladesh, comprises 41% share in the primary energy mix (FY 2022-23) though around 25% of gas demand is being fulfilled through LNG import. 90% of coal and almost all the petroleum demand is met by importation. Therefore, to reduce the future import dependency as well as to comply with the decarbonization mission of the world, Bangladesh is looking forward to adopting emerging energy options diligently such as, alternate sources of energy e.g., Hydrogen, Ammonia, etc. and Critical/ Emerging Technologies e.g., CCUS, etc.

Brief GoB targets

The 2015 Paris Agreement signatories pledged to NZE 2050. In August 2021, Bangladesh submitted its updated Intended National Determined Contributions (NDC). We have a mandate to reduce carbon emission. Moreover, from the provision of Perspective Plan (Vision- 2041), 8th Five Year Plan, Mujib Climate Prosperity Plan 2022-2041, SDG 2030 and respective other plans and mandate, it is obvious to emphasize on the Development of renewable energy and its generation and the use of alternative sources of energy. At COP26, Prime Minister Sheikh Hasina envisaged more sustainable energy mix with up to 40% renewable & alternate energy share in the primary energy mix by 2041".[51] With all of those visions, GoB has initiated Integrated Energy and Power Master Plan (IEPMP) to materialize sustainable renewable and alternate energy in the national primary energy mix to ensure energy security of Bangladesh.

Integrated Energy and Power Master Plan (IEPMP) 2023- In the PP2041 case, Total Primary Energy Supply (TPES) will expand by about four times to 169 million tons oil equivalent (Mtoe) in 2050 from 2019.[52]

Traditional biomass consumption will almost disappear by 2050 and will be replaced by modern fossil fuels such as coal, oil or natural gas etc. On the other hand, clean energies such as solar PV, wind, CCS, nuclear, ammonia and hydrogen will be introduced. These clean energies will exceed almost 20% (27.2 Mtoe) of the TPES by 2041 and reach almost

51 Page no-12, Integrated Energy and Power Master Plan (IEPMP) 2023
52 Page no-14, Integrated Energy and Power Master Plan (IEPMP) 2023

30% in 2050 (50.8 Mtoe). Among the clean technologies,

- Expected demand of natural gas with CCS is 3.7 Mtoe (by 2041), 10.1 Mtoe (by 2050);
- Expected demand of Hydrogen is 4.9 Mtoe (by 2041), 14.3 Mtoe (by 2050);
- Expected demand of Ammonia is 1.2 Mtoe (by 2041), 0.6 Mtoe (by 2050).[53]

8.1 Hydrogen as energy source

Since the beginning of the 1990s, hydrogen generation has been studied as a method for decarbonizing the mix of energy sources. Hydrogen is demanded by energy-consuming sectors like industry, transport, commercial, residential, etc. Besides, hydrogen is greatly demanded as a feedstock for many industrial processes such as the production of ammonia and methanol, glass making, food processing, petroleum refining, and metal treatment. According to the International Energy Agency (IEA)[54], hydrogen demand reached 94 million tons (Mt) in 2021 (40 Mt in the refineries and rest in other H2 consuming industries) and containing energy equal to about 2.5% of global final energy consumption. Most of the increase came from traditional uses in refining and industry, though demand for new applications grew to about 40 thousand tons (up 60% from 2020, albeit from a low base). Considering policies and measures that governments around the world have already put in place, Hydrogen demand could reach 115 Mt by 2030. This is the high time to explore the Hydrogen potential in Bangladesh.

Among the different colors of hydrogen, we envisage that the production of Blue Hydrogen would be at the forefront of the decarbonizing scheme entrusted by the world communities. Blue Hydrogen is derived from fossil fuels, with integrated carbon capture and storage (CCS). Globally, approximately 95% of all hydrogen is produced by the Steam Methane Reforming (SMR) process.
Hydrogen energy can be produced from methane (CH4) through SMR reaction.

$$CH4 + H2O \rightarrow CO + 3H2$$

[53] Page no-113, Integrated Energy and Power Master Plan (IEPMP) 2023
[54] Global Hydrogen Review 2022, IEA

Also, there is promising prospect of Green hydrogen production using bio-gasification (other than electrolysis powered by RE sources), e.g., Biomass gasification with CO2 capture will give an energy conversion system with negative CO2 emissions.

Probable way forward on Hydrogen Energy: Being a new technology, following task should be carried out to analyze the viability and readiness of Hydrogen Energy in Bangladesh.

- Task 1: Feasibility assessment of domestic hydrogen market (industry/off takers), supply and demand analysis
- Task 2: Feasibility of piloting hydrogen energy in Bangladesh, mainly blue hydrogen and green hydrogen (bio-gasification, not electrolysis through RE sources)
- Task 3: Hydrogen policy formulation mechanism.
- Task 4: Capacity building through knowledge and technology transfer.

8.2 Ammonia

Ammonia is considered to be a potential medium for hydrogen storage, facilitating CO2-free energy systems in the future. Its high volumetric hydrogen density, low storage pressure and stability for long-term storage are among the beneficial characteristics of ammonia for hydrogen storage.

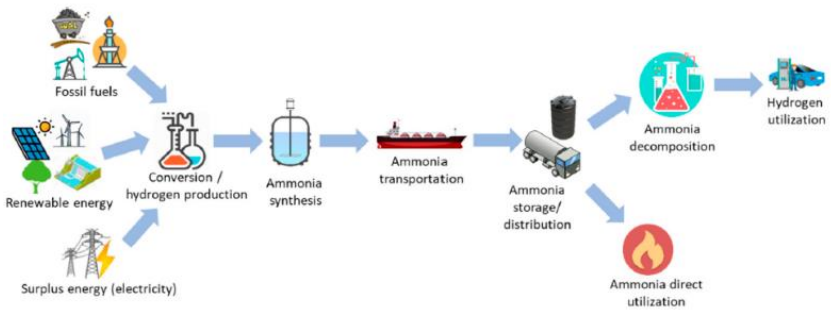


Figure 43: Production and utilization routes of ammonia in the energy sector[55]

Ammonia production includes the currently adopted Haber–Bosch, electrochemical and

[55] Aziz, Muhammad et. al., Ammonia as Effective Hydrogen Storage: A Review on Production, Storage and Utilization, Energies 2020, 13, 3062; doi:10.3390/en13123062.

thermochemical cycle processes. Furthermore, in this study, the utilization of ammonia is focused mainly on the possible direct utilization of ammonia due to its higher total energy efficiency, covering the internal combustion engine, combustion for gas turbines and the direct ammonia fuel cell.

Ammonia is produced from hydrogen and is currently used directly as a fertilizer and chemical feedstock, although it can also serve as an energy carrier. It is considered as a "low-carbon fuel" because it does not result in direct carbon emissions when combusted.

- Grey ammonia is derived from hydrogen produced by fossil gas or coal. More than 99% of ammonia produced today falls within this category.
- Blue ammonia is also derived from fossil fuels, with integrated carbon capture and storage (CCS). Less than 1% of ammonia is produced in this way.
- Green ammonia is produced through water electrolysis powered by renewable electricity. Only 0.01% of ammonia was produced with renewable power in 2021.[56]

Bangladesh is able to produce only 30% of the demand whereas the rest 70% is imported from countries such as Russia, China, Saudi Arabia, Qatar, United Arab Emirates (UAE).[57] To address low carbon pathway, it is the high time to explore Ammonia market's feasibility and piloting Ammonia co-firing in Bangladesh.

- Task 1: Feasibility of production potential of Ammonia and its preferred production method along with available feedstock in Bangladesh
- Task 2: Feasibility of potential Ammonia market (end-users/ industries)
- Task 3: Feasibility of Piloting Ammonia co-firing in coal based power plants in Bangladesh
- Task 4: Formulation of Ammonia Policy
- Task 5: Knowledge Transfer and Technology Transfer through capacity Building.

[56] https://www.e3g.org/news/explained-why-ammonia-co-firing-with-coal-in-southeast-asia-is-a-risky-approach/#:~:text=The%20%E2%80%9Cco%2Dfiring%20ratio%E2%80%9D,serve%20as%20an%20energy%20carrier.

[57] https://theconfluence.blog/bangladesh-opens-southeast-asias-largest-fertilizer-factory/

8.3 Municipal waste to clean energy/fuel

Being a founding member of the Global Biofuel Alliance (GBA), Bangladesh bears the responsibility to achieve various UN Sustainable Development Goals (SDG), in particular, SDG-7 (provide access to affordable, reliable, sustainable, and modern energy for everyone).

- With growing GDP of Bangladesh, resource consumption is increasing. As a result, everywhere from villages to cities, waste generation has increased manifold. If this increased waste cannot be disposed of, the country's overall environment will be destroyed.
- The country has already taken steps to promote waste to electricity. Waste-to-energy plant being built in Aminbazar at a cost of $300 million. The biopower project is planned to commence commercial operation by 2026. Municipal solid waste will be used as a feedstock to power the project. In December 2021, BPDB, Dhaka North City Corporation (DNCC) and Chinese firm CMEC (China Machinery Engineering Corporation) signed an agreement for the country's first ever waste-based power plant in Dhaka with electricity generation capacity 42.5MW from the garbage in the capital. In September 2022, another contract was signed among BPDB, Narayanganj City Corporation (NCC) and Chinese firm U&D to develop the country's second waste-based power plant (at Jalkuri) which will generate 6MW of electricity from garbage of Narayanganj city and adjoining areas.

8.4 Biomass gasification to Biomethane and biofuel

In 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. Biofuels can help reduce these emissions by substituting fossil fuels in various applications in Bangladesh. For example, bioethanol can be blended with gasoline to power vehicles, biodiesel can be used in diesel engines or generators, biogas can be used for cooking or electricity generation, and solid biomass can be used for heating or industrial processes. Biofuels can also reduce the need for importing fossil fuels, which can save foreign exchange and increase energy security in Bangladesh.

Global Biofuel Alliance (GBA) was announced during 2023 G20 New Delhi summit on 9 September 2023[58] to promote the development and adoption of sustainable biofuels and set relevant standards and certification. Bangladesh joins the Global Biofuels Alliance because it recognizes the potential of biofuels to reduce its dependence on fossil fuels, enhance its energy security, and mitigate its greenhouse gas emissions. Bangladesh is one of the most vulnerable countries to the impacts of climate change, and it has committed to reducing its emissions by 5% by 2030 under the Paris Agreement. Biofuels can help Bangladesh achieve this target by replacing conventional fuels in the transport sector, which accounts for about 18% of its total energy consumption[59]. The World Bank estimates that Bangladesh could raise $12.5 billion in additional financing in the medium term for climate action, including biofuel development. With strong implementation, technology development and uptake, and regional collaboration, Bangladesh can achieve its climate goals and benefit from biofuels.

Potential way forward on Biomass gasification to Biomethane and biofuel: Being a new technology, following task should be carried out to analyze the viability and readiness of Biomass gasification to Biomethane and biofuel in Bangladesh.

- Task 1: Feasibility of potential of "Biomass gasification to Biomethane and biofuel" in Bangladesh
- Task 2: Study to develop policy framework for promoting biofuel production and utilization in Bangladesh
- Task 3: Knowledge Transfer and Technology Transfer through capacity Building.

[58] https://indianexpress.com/article/india/india-clean-energy-g20-global-biofuel-alliance-8932129/
[59] https://www.eurasiareview.com/11092023-bangladesh-joins-global-biofuels-alliance-opportunities-and-challenges-for-biofuel-development-analysis/

Chapter 9

Critical/ Emerging Technologies

9.1 UCG to produce hydrogen and biofuel

While surface gasifiers (e.g., fixed-bed gasifier, fluidized bed gasifier, etc.) for coal utilization is very popular in the world for exploiting the resource to produce hydrogen and biofuel, subsurface gasification is further capable of being the instrument which does not involve surface coal extraction, handling, transportation, etc. Therefore, Underground Coal Gasification (UCG) has been popularized as an environmentally beneficiary technique and economical way of producing pure energy, by extracting and making use of the vast unmineable coal resources around the world and considered as a clean coal technology (CCT). UCG is advancing to achieve the status of other universally-accepted industrial methods, such as open-cast and underground coal mining, coking, oil refining. UCG can be tested to produce hydrogen and biofuel. Bangladesh can also be benefitted by extracting the resource through this unconventional method as the deepest and largest coalfield of Bangladesh has long been untapped due to the problems of adopting any conventional coal mining method.

Potential way forward UCG to produce hydrogen and biofuel: Being a new technology, following task tasks could be broadly identified-

- Task 1: Feasibility of UCG Technology adoption at Jamalganj coalfield
- Task 2: Feasibility of piloting UCG at Jamalganj coalfield
- Task 3: Feasibility of production efficiency of hydrogen and biofuel through UCG at Jamalganj coalfield
- Task 4: Knowledge Transfer and Technology Transfer through capacity Building

9.2 CCUS (Carbon Capture, Utilization and Storage)

The role of CCUS is pivotal in clean energy transitions for the world. CCUS can be retrofitted to existing power and industrial plants, allowing for their continued operation. It can tackle emissions in hard-to-abate sectors, particularly heavy industries like cement, steel or chemicals. CCUS is an enabler of least-cost low-carbon hydrogen production, which can support the decarbonization of other parts of the energy system, such as industry, trucks and ships. Finally, CCUS can remove CO2 from the air to balance emissions that

are unavoidable or technically difficult to abate.

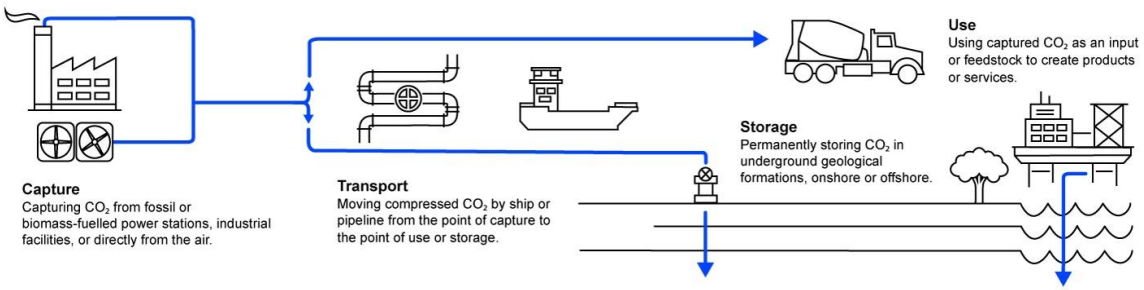


Figure 44: CCUS (source: IEA) [60]

According to the IEA published report entitled "Tracking Clean Energy Progress 2023", around 40 commercial facilities are already in operation applying carbon capture, utilization and storage (CCUS) to industrial processes, fuel transformation and power generation. CCUS deployment has trailed behind expectations in the past, but momentum has grown substantially in recent years, with over 500 projects in various stages of development across the CCUS value chain. Since January 2022, project developers have announced ambitions for around 50 new capture facilities to be operating by 2030, capturing around 125 Mt CO2 per year. Nevertheless, even at such a level, CCUS deployment would remain substantially below (around a third) the around 1.2 Gt CO2 per year that is required in the Net Zero Emissions by 2050 (NZE) Scenario.[61]

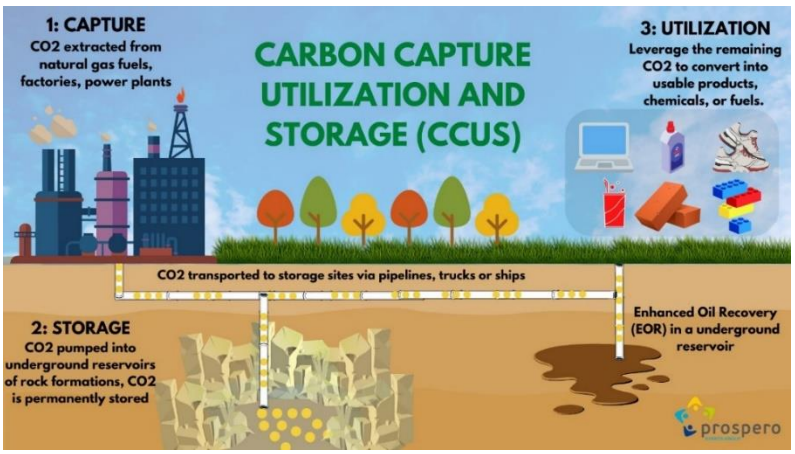


Figure 45: General schematic of Carbon Capture, Utilization and Storage [62]

[60] https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage
[61] https://www.iea.org/reports/tracking-clean-energy-progress-2023
[62] https://twitter.com/ProsperoEvents/status/1493555694771085317/photo/1

Bangladesh would like to test the CCUS feasibility and want to contribute the world to some extent by joining the cohorts. At the same time, this could be an immensely beneficial project if the CO2 storage is set in the depleted gas fields; this could result in enhanced recovery of our main indigenous resource.

CCUS being an emerging technology, following task tasks could be broadly identified-

- Task 1: Assessment of CCUS potential in Bangladesh (potential CO2 emitting industries, Industrial use potential of CO2, Underground Geological storage potential of CO2 in Bangladesh, etc.)
- Task 2: Feasibility of piloting CCUS in Bangladesh
- Task 3: Knowledge Transfer and Technology Transfer through capacity Building.

9.3 EGR (Enhanced Gas Recovery)

The main indigenous energy resource Natural gas is depleting at a fast rate. But among the depleted gas fields, some fields have lost the optimum pressure to produce the remaining substantial amount of gas. This remaining gas can be boosted through injecting CO2 into those depleted fields (e.g., Bakhrabad gas field).

When CO_2 is injected into a gas reservoir, it can act as a displacement agent, pushing the remaining gas towards the production wells. CO_2 also has a lower viscosity than natural gas, which can reduce the pressure drop in the reservoir and improve the efficiency of gas production. Moreover, CO_2 can also interact with the natural gas in the reservoir, leading to a process called miscible flooding. Miscible flooding occurs when CO_2 mixes with the natural gas in the reservoir and creates a single-phase fluid, which can more easily flow through the reservoir and be extracted. This process can result in a significant increase in gas recovery rates.

Worldwide initiatives: There are information of new initiatives around the world such as, BP plc: in Oman 2021, Total SE: in Argentina 2020, Eni S.p.A.: in Indonesia 2020,

Petrobras: in Brazil 2019, Gazprom in Russia 2019.

The K12-B CO2 injection project in the Netherlands - A pilot-scale EGR project was started in the K12-B gas field in the Dutch sector of the North Sea in 2004.

Strategic Development:

- In 2021, Chevron Corporation announced its plans to increase its investment in the Permian Basin, one of the largest oil and natural gas producing regions in the United States. The company plans to use advanced drilling techniques and enhanced oil recovery methods, including EGR, to improve the efficiency and productivity of its operations in the region.
- In 2020, Royal Dutch Shell plc announced its plans to invest $10 Billion in its EGR program over the next decade. The company aims to increase the recovery of natural gas from its existing reserves using advanced technologies, including carbon capture and storage.
- In 2019, Exxon Mobil Corporation announced its plans to invest $10 Billion in EGR and carbon capture and storage technologies over the next decade. The company aims to reduce greenhouse gas emissions and improve the efficiency of its operations by using these advanced technologies.

To identify EGR opportunity and detailed geological characterization and model building studies as part of the feasibility and pilot planning phase, as such the following tasks could be broadly identified-

- Task 1: Assessment of EGR potential in the depleted gas fields of Bangladesh
- Task 2: Feasibility of piloting EGR in Bangladesh
- Task 3: Knowledge Transfer and Technology Transfer through capacity Building

Chapter 10

Discussion and Conclusion

10.1 Discussion and 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. 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.