HYDROCARBON UNIT

Energy and Mineral Resources Division

ENERGY SCENARIO OF BANGLADESH 2023-24

DECEMBER 2024

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 2023 to June 2024. 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: 29 December, 2024

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Chapter 1

Background and Energy Sectoral Mechanism of Bangladesh

1.1 Introduction

Bangladesh is categorized as a mid-income nation, exhibiting one of the highest GDP growth rates globally. For any nation, development serves as a fundamental prerequisite for sustained GDP growth. The primary catalyst for the country's development is energy. Effective energy management is crucial to satisfy the increasing energy requirements and to transition from a mid-income status to that of a developed nation.

Approximately 40 percent of energy needs are fulfilled by natural gas, including biomass in Bangladesh. Other energy sources such as oil, coal, and biomass also play significant roles. Although the country possesses substantial coal reserves, its production and utilization remain limited. Conversely, while the natural gas reserves are not extensive, its production and consumption are the highest among the available resources. Additionally, energy demands are supplemented through the importation of oil and liquefied petroleum gas (LPG). The government has also commenced the importation of liquefied natural gas (LNG) to address the rising gas demand. Biomass constitutes a significant portion of the energy mix, and electricity is also imported from India to meet energy demand.

The global transition from fossil fuels such as gas, coal, and oil to renewable energy sources is underway and is crucial for achieving sustainable development while mitigating environmental impact through the reduction of carbon emissions. Numerous countries, including Sweden, Germany, China, and the United States, are currently integrating renewable energy into a substantial portion of their energy consumption. Although Bangladesh is also adopting renewable energy, its current utilization falls short of what is necessary. The government has implemented several initiatives aimed at enhancing the adoption of renewable energy in the future, including the solar home system, solar irrigation system, and the Ruppur nuclear project.

1.2 Bangladesh Energy Resources:

Bangladesh, with a population of 172.92 million, ranks among the most densely populated nations globally. Historically, agriculture served as the primary income source for its citizens. Nevertheless, the Gross Domestic Product (GDP) for Bangladesh is projected at 5.82% for the fiscal year 2023-24, compared to 5.78% for the fiscal year 2022-23. [Source: BBS] The combination of rapid urbanization and industrialization, driven by consistent economic growth, has resulted in a significant increase in energy demand.

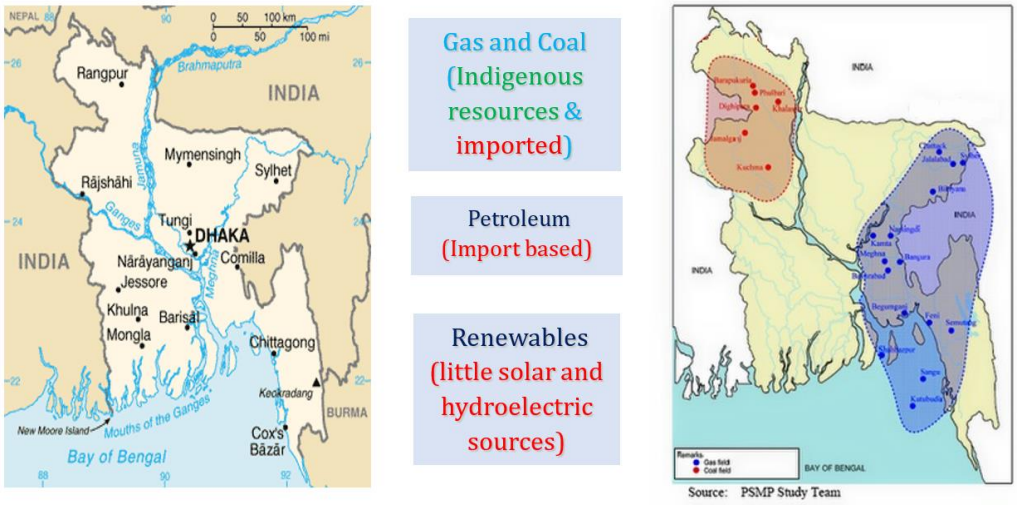


Figure 1: Bangladesh Energy Resources

Energy is widely recognized as a crucial factor in alleviating poverty, fostering economic growth, developing sustainable infrastructure, and ensuring the security of any nation. To sustain ongoing economic development, it is essential to utilize the country's indigenous natural resources.

The northeastern folded basin is particularly rich in the indigenous natural gas of Bangladesh, while the northwestern basin is enriched in coal and hard rock resources.

1.3 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-

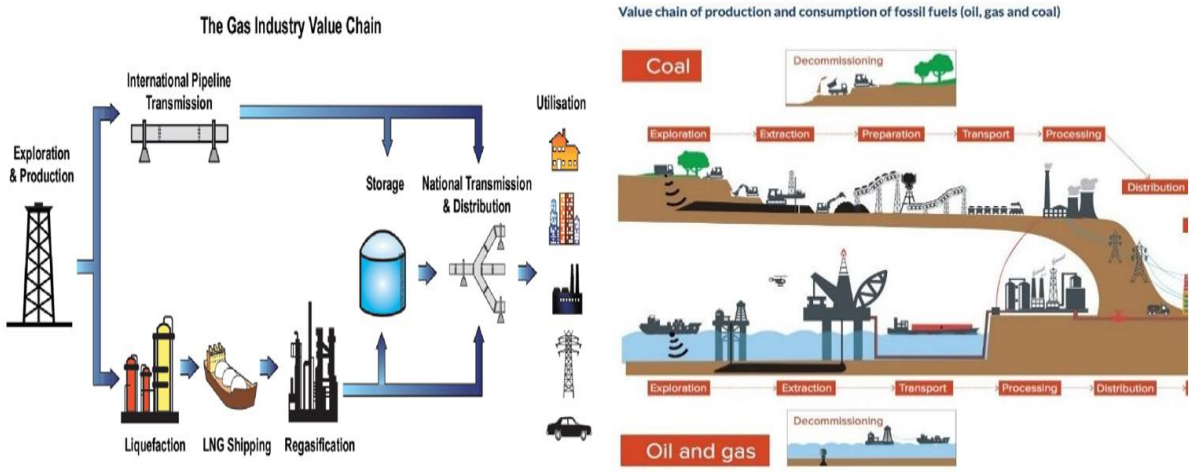


Figure 2: Bangladesh Energy Resources

Chapter 2

Energy Sector: Current Status of Bangladesh

2.1 Current Position of Energy Resources

Primary energy resources in Bangladesh include indigenous natural gas, coal, imported oil, LPG, imported LNG, imported electricity, solar, wind and hydro-electricity. Biomass accounts for about 23% of the primary energy and the rest 77% is being met by the rest of the components of primary energy. Natural gas accounts for about 40% of the primary energy (with imported LNG). *[Source: Energy Data Center, Hydrocarbon Unit]* Imported oil accounts for the lion's share of the rest. In this tenure, Bangladesh imports about 8.44 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 1,143 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.

[Source: http://www.renewableenergy.gov.bd/ (Dated 16th July, 2024)]

Per capita consumption of energy in Bangladesh is on an average 338 kgoe (Kilogram Oil Equivalent) and per capita generation of electricity is 640 kWh (Source: Annual Report of BPDB 2023-24) including captive and off-grid renewable energy in the FY 2023-24.

2.2 Primary Energy:

Estimated total primary energy in the FY 2023-24 of Bangladesh is approx. 58.38 MTOE. Here, natural gas & LNG plays combined 40% share, biomass 23%, petroleum oil 15% and rest is others (coal, LPG, RE, electricity import) of the total primary energy.

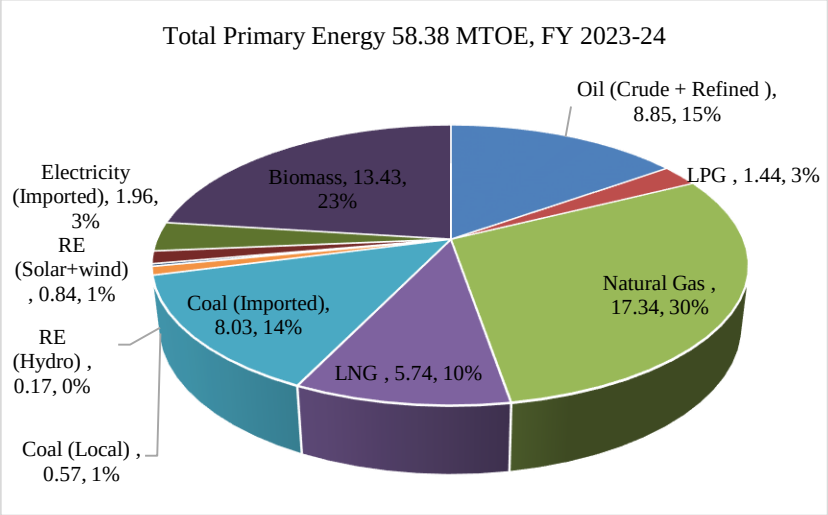


Figure 3: Share of Total Primary Energy of Bangladesh (FY 2023-24)

[Source: Energy Data Center, Hydrocarbon Unit]

Table 1: Total Primary Energy FY 2023-24 in MTOE (Million Ton Oil Equivalent)

Name	***Unit***	***Amount***	***MTOE***
Oil (Crude + Refined)	K ton	8,850.78	8.85
LPG	K ton	1,439.00	1.44
Natural Gas	Bcf	747.76	17.34
LNG	Bcf	247.58	5.74
Coal (Imported)	K ton	12,704.32	8.03
Coal (Local)	K ton	907.12	0.57
RE (Hydro)	MW	230.00	0.17
RE (Solar+ wind)	MW	1,144.00	0.84
Electricity (Imported)	MW	2,656.00	1.96
Biomass			13.43
Total Primary Energy			58.38

[Source: Energy Data Center, Hydrocarbon Unit]

Chapter 3

Energy Sector: Detailed Primary Energy

3.1 Natural Gas

3.1.1 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.

3.1.2 Natural Gas Reserve

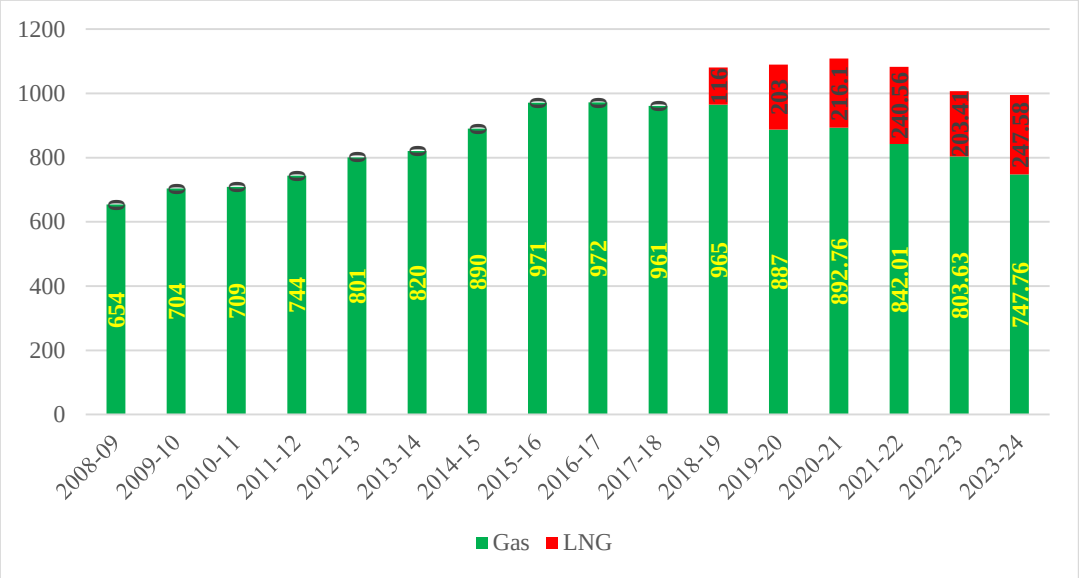
Since first discovery in 1955 as of today 29 gas fields have been discovered in the country. Of them 20 gas fields are in production, one offshore gas field have depleted after 14 years of production while other offshore field has not been viable for production due to small reserve. The estimated proven plus probable recoverable reserve was 40.09 Tcf and 2P reserve was 29.93. As of June 2024, a total of 21.10 Tcf gas has already been produced leaving only 8.83 TCF recoverable reserve in proven plus probable category. Some key information about the natural gas sector is presented in the Table 2.

Table 2: Natural Gas Sector at a Glance, FY 2023-24

Description	***Amount***
Total number of gas fields	*29*
Number of gas fields in production	*20*
Number of producing wells	*107*
Present gas production capacity	*2000+ MMcfd*
Re-gasified LNG supply capacity	*1100 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,2024)	*21.10 Tcf*
Annual Production by NOC	*290.92 Bcf (39%)*
Annual Production by IOC	*456.82 Bcf (61%)*
Remaining Reserve (Proven + Probable)	*8.83 Tcf*
Present Demand	*3500+ MMcfd*
Number of Customer	*43 Lakh (Appx.)*

[Source: MIS Report June 2024, Petrobangla and HCU]

3.1.3 Historical Gas Production:

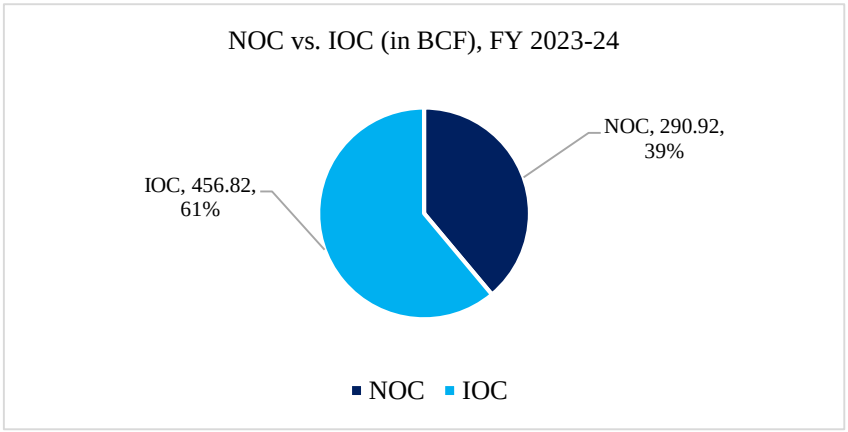


[Source: Petrobangla and Energy Data Center, Hydrocarbon Unit]

Figure 4: Historical Gas Production in Bangladesh (2009 – 2024)

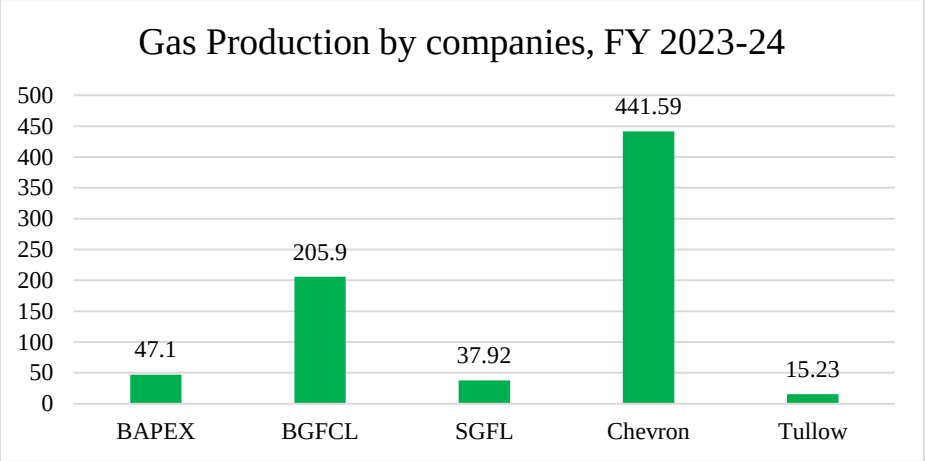
From the above Figure 4, it is very clear that natural gas production is declining after the FY 2016-17. Simultaneously, LNG import introduced from 2018. Due to the rapid industrial growth, to meet energy demand, LNG import is increasing. Hence, GoB has taken immediate initiatives to expedite national gas exploration activities and gas augmentation activities.

3.1.4 Gas Production by Companies:



[Source: Petrobangla and Energy Data Center, Hydrocarbon Unit]

Figure 5: Gas Production in Bangladesh NOC vs. IOC (FY 2023-24)

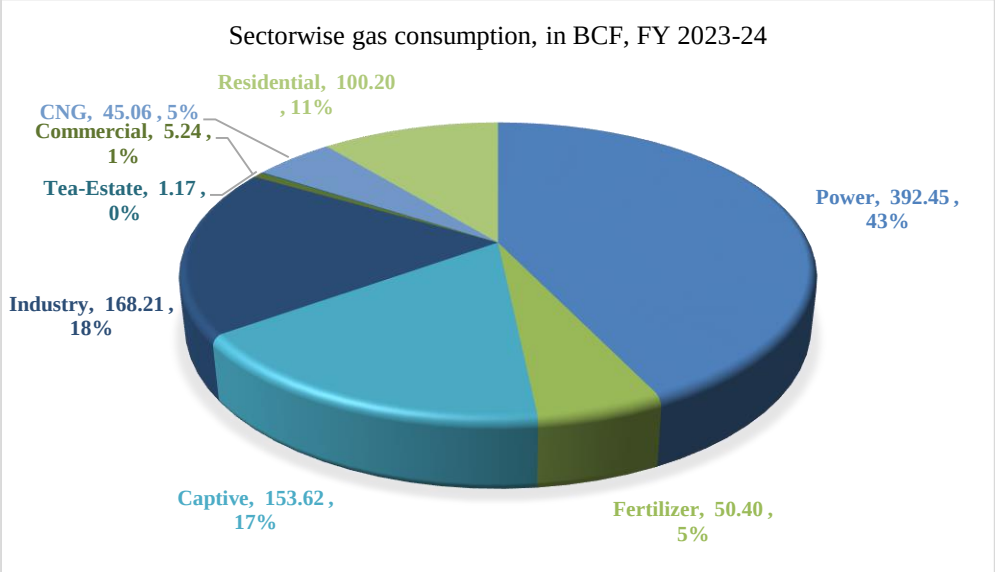


[Source: Petrobangla and Energy Data Center, Hydrocarbon Unit]

Figure 6: Gas Production by companies, FY 2023-24

In the FY 2023-24, gas production by National Oil companies (NOC) i.e. Bapex, BGFCL, SGFL is 290.92 BCF. In the same time, International Oil Companies (IOC) i.e. Chevron, Tullow produce 456.82 BCF which is approx. 61% of the total national gas production.

3.1.5 Natural Gas Consumption



[Source: Petrobangla MIS Report June, 2024]

Figure 7: Sector wise Gas Consumption in Bangladesh (2023-24)

In the FY 2023-24, a total of 747.76 billion cubic feet (BCF) of natural gas was produced, alongside the importation of LNG was 247.58 BCF. Sector wise gas consumption was as follows: power generation accounted for 43%, fertilizer production 5%, captive

power 17%, industrial use 18%, domestic consumption 11%, compressed natural gas (CNG) 5%, and other uses, including commercial and tea estates, represented 1%. Natural gas contributed to 44% of grid electricity generation, and all seven urea fertilizer plants rely on natural gas as their feedstock. This resource has significantly supported industrial growth in the country, serving as a cost-effective fuel for heating and captive power generation. While the entire nation has reaped the benefits of this resource, approximately 13% of the population has directly benefited from the use of natural gas pipeline for household applications.

3.2 LNG

To ensure the national energy security, GoB has devised a plan to import LNG, addressing the current and growing demand for gas within the country. Under the supervision of Petrobangla, RPGCL is executing all essential tasks related to the development of LNG infrastructure, the importation of LNG, and the supply of RLNG to the national gas grid. The commencement of LNG operations in 2018 marks a significant strategic initiative aimed at bolstering the energy security of Bangladesh.

3.2.1 LNG Scenario:

Table 3: LNG Scenario, FY 2023-24

Total LNG Import in June 2024	***18.67***	***Bcf***
LNG Import from July 2023 to June 2024	***247.58***	***Bcf***
Cumulative LNG import from August 2018 to June 2024	***1,226.42***	***Bcf***

[Source: RPGCL and HCU]

In the FY 2023-24, 247.58 BCF LNG has been imported in Bangladesh. Cumulative LNG import from August 2018 to June 2024 becomes 1226.42 BCF.

3.3 Oil (Petroleum) Sector

3.3.1 Organizational Structure

Bangladesh Petroleum Corporation (BPC), operating under the Energy & Mineral Resources Division of the government, serves as the primary organization in the petroleum sector. Its responsibilities encompass the importation of crude oil and petroleum products, as well as the refining and marketing of finished petroleum goods. The sole crude oil refinery, located in Chittagong, is operated by a single refining company, while four oil marketing firms are tasked with distributing the finished products throughout the nation. Until 1997, the oil industry was a government monopoly, but that year marked the entry of a private company into the fractionation of gas condensate sourced from gas fields. Currently, gas condensates are fractionated by small-scale plants operated by Petrobangla, BPC, and private entrepreneurs. Additionally, there are two private sector petrochemical plants that import condensate for use as feedstock.

3.3.2 Supply and Consumption of Oil

The liquid fuel consumed in Bangladesh is predominantly sourced from imports. In the fiscal year 2023-24, Bangladesh imported approximately 1.92 million metric tons of crude oil and around 4.42 million metric tons of refined petroleum products. The sole domestic source of liquid fuel consists of approximately 406,622.45 metric tons of locally produced gas condensate, which is primarily processed into petrol, diesel, and kerosene. During this period, the production of naphtha reached about 124,037 metric tons, while local LPG production amounted to 12,640 metric tons. Additionally, around 1,426,860 metric tons of LPG were imported in the same fiscal year.

Table 4: Petroleum Sector at a Glance (2023-24)

Product	2023-24 (in Metric Ton)
Import of refined oil	4,415,907.36
Import of furnace oil	2,107,675.13
Import of crude oil	1,920,570.94
Production of Condensate	406,622.45
Total Import & Production	8,850,775.87
Production of Naptha	124,037.00
Storage Capacity of BPC	1,358,000.00

Refining Capacity of ERL	1,570,000.00
LPG Production (Local)	12,542.00
LPG import (private)	1,426,860.29

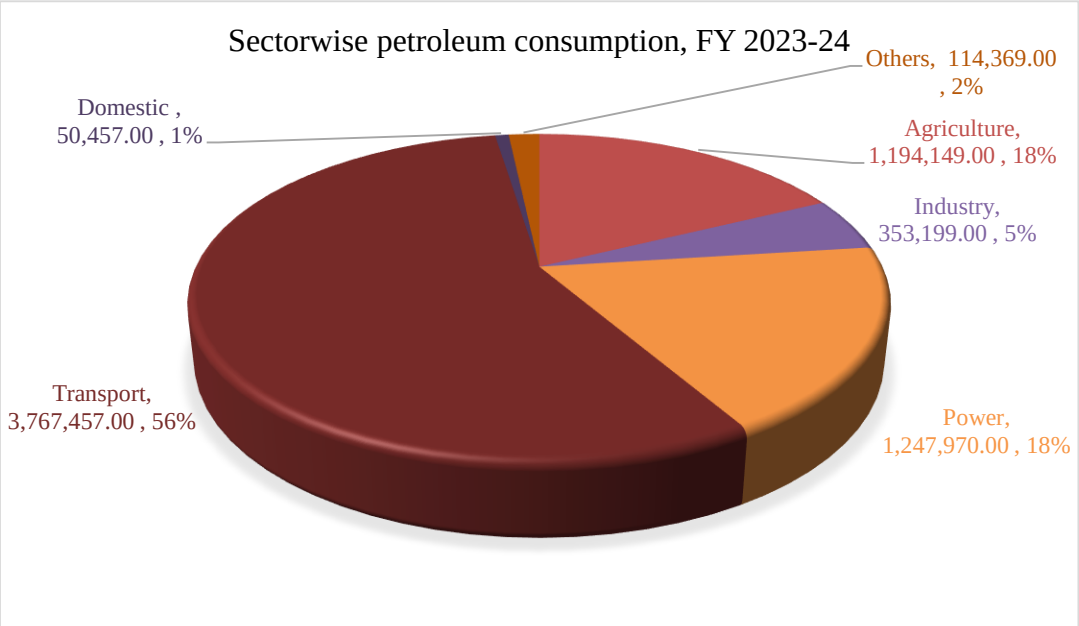
[Source: NBR, BPC and HCU Data Bank]

Diesel shares the major portion in the consumption of primary liquid fuel in Bangladesh. During the FY 2023-24, the consumption of diesel reached 4.2 million metric tons. Additionally, the usage of furnace oil and Jet A-1 oil amounted to 955,308 metric tons and 545,697 metric tons, respectively. The sales of petroleum products over the past five years are detailed in the accompanying table.

Table 5: Sale of Petroleum Products by BPC during last 5 Years in MT, FY 2023-24

Products	2019-20	2020-21	2021-22	2022-23	2023-24
Octane	262,943	303,917	395,602	393,557	385,435
Petrol	321,940	378,846	446,647	454,556	430,836
Diesel	4,015,633	4,597,585	4,850,700	4,935,483	4,244,527
Kerosene	106,195	101,783	86,117	77,487	70,001
Furnace Oil	362,713	559,032	571,586	880,702	955,308
Jet A-1	350,605	237,894	428,024	471,535	545,697
Others	68,639	120,673	136,334	132,775	95,797
Total	**5,488,668**	**6,299,730**	**6,915,010**	**7,346,095**	**6,727,601**

[Source: BPC Website and Annual Report 2023-24]



[Source: BPC and HCU Energy Data Center]

Figure 8: Sector wise Liquid Fuel Consumption in Bangladesh (2023-24)

The transport sector is the largest consumer of liquid fuel, followed by the power, agriculture, industry, and commercial sectors. In the FY 2023-24, the sector-wise distribution of petroleum product consumption was as follows: transport at 56%, power at 18%, agriculture at 18%, industry at 5%, domestic use at 1%, and other sectors at 2%.

3.3.3 Petroleum Refinery:

Capacity of Refinery

Eastern Refinery Limited (ERL), established in 1968 in Chittagong, has an annual processing capacity of 1.57 million tons.

Crude oil Processing units

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

Table 6: ERL Process plant scenario

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)	--

[Source: ERL]

A project has been initiated for the installation of a second unit at the existing refinery, which will have an annual refining capacity of three million tons. In addition to this state-led initiative, the government has permitted private entrepreneurs to establish Condensate Fractionation Plants. These facilities will process Natural Gas Condensate (NGC) sourced from various gas fields within Bangladesh, as well as imported NGC. The total storage capacity for different grades of petroleum throughout the country is approximately 1.35 million metric tons.

It is important to note that, in accordance with the national energy policy, a stock of petroleum products equivalent to 60 days' supply must be maintained to ensure the country's energy security.

Table 7: Historical Processing (Last Five years) by ERL in MT, FY 2023-24

Product	2019-20	2020-21	2021-22	2022-23	2023-24
LPG	8,902.00	11,583.00	12,516.00	13,879.00	12,520.00
Naphtha	77,015.00	143,561.00	101,602.00	118,327.00	124,410.00
Octane	1,732.00	-	-	247.00	2,270.00
Petrol	92,491.00	94,199.00	85,624.00	79,704.00	42,227.00
Diesel	451,789.00	731,088.00	638,129.00	672,746.00	578,601.00
Kerosene	83,157.00	72,956.00	56,018.00	53,682.00	59,026.00
MTT	360.00	-	-	-	-
Jet A-1	895.00	-	2,437.00	72.00	-
JBO	13,112.00	8,587.00	10,172.00	7,681.00	12,074.00
Furnace Oil	275,023.00	447,518.00	357,418.00	389,714.00	350,945.00
Bitumen	30,500.00	52,786.00	54,999.00	63,026.00	49,505.00
Gas+ Loss	18,307.00	38,654.00	23,216.00	35,224.00	30,977.00
Total Processed	1,053,283.00	1,600,932.00	1,342,131.00	1,434,302.00	1,279,080.00

[Source: Bangladesh Petroleum Corporation (BPC)]

However, at present BPC is able to maintain 35 to 40 days' stock of petroleum products due to lack of storage capacity as well as involvement of huge amount money for procuring petroleum. BPC has completed a project for construction of **Mongla Oil Installation** as 2nd main installation to enhance 0.10 million metric tons with 14 oil storage tanks.

Single Point Mooring (SPM) project 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 9: 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

The demand for petroleum products is rising at an annual rate of 2 to 4%. Should this trend persist, the demand for oil is projected to reach approximately 15 million tons by the year 2030. The Government of Bangladesh has resolved to enhance road connectivity with neighboring countries such as India, Nepal, and Bhutan. This initiative is expected to significantly boost transport activity within Bangladesh as neighboring countries seek to utilize the port facilities at Chittagong and Mongla. Nevertheless, the future demand will be contingent upon the evolving energy mix within the country and the availability of alternative fuels.

Source Countries for Imported Oils

Bangladesh primarily sources its oil imports from Saudi Arabia and the United Arab Emirates. These imports occur annually through agreements with the respective companies from these nations. The payment for the oil is determined by the prevailing world market price on the day of shipment. The Bangladesh Petroleum Corporation (BPC) receives crude oil from ADNOC of the UAE and Saudi Aramco of Saudi Arabia, while finished petroleum products are procured from 13 National Oil Companies (NOCs) across various countries.

3.4 Liquefied Petroleum Gas (LPG)

The demand for Liquefied Petroleum Gas (LPG) in Bangladesh is significantly high. In the public sector, a total of 12,542 MT was produced during the fiscal year 2023-24, while private entities imported 1,426,860.29 MT. Consequently, the combined efforts of both the public and private sectors resulted in the marketing of 1.44 million MT of LPG in 2023-24, fulfilling a portion of the country's LPG demand.

Table 8: LPG scenario of last 5 year

Year	**Public Sector Production, MT**	**Import (Private), MT**	**Total, MT**
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
2023-24	12,542.00	1,426,860.29	1,439,402.29

[Source: Bangladesh Petroleum Corporation (BPC), NBR and HCU Data Bank]

Considering the rising demand for LPG, government has decided to enhance LPG bottling facilities for marketing more imported LPG. For this purpose, two LPG bottling plants, each having capacity of 100 thousand MT per annum, will be set up in the coastal area.

Table 9: LPG Summary, FY 2023-24 (MT)

LPG Production in Patenga (ERL/LPGL)	12,298.00
LPG Production from Kailashtila Fractionation Plant	244
LPG import (private)	1,426,860.29
Total	1,439,402.29

[Source: Bangladesh Petroleum Corporation (BPC), NBR and HCU Data Bank]

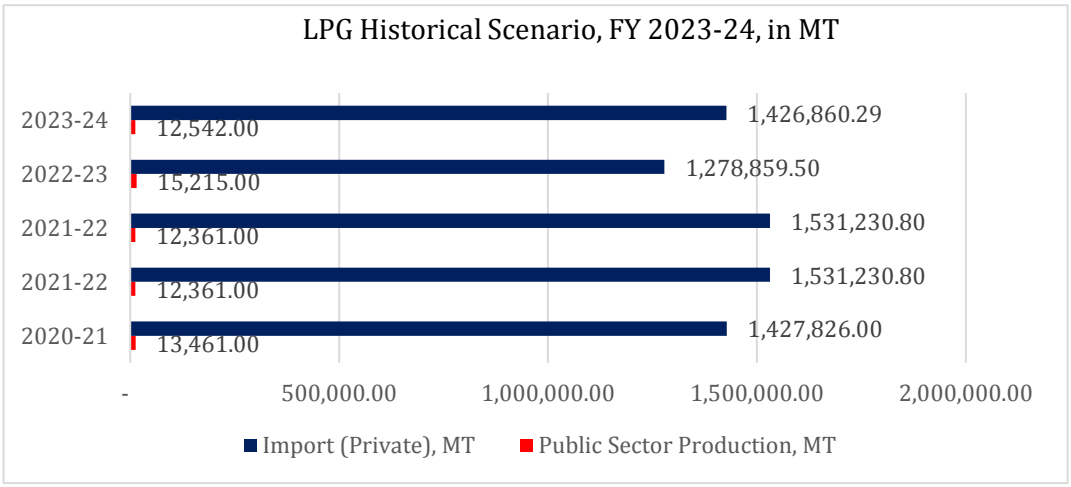


Figure 10: LPG Scenario in Last 5 years in Bangladesh

The historical scenario of LPG over the past five years is illustrated in Figure 10. It is evident that local LPG production has been minimal, while imports of LPG have been substantial during this period.

3.5 Coal

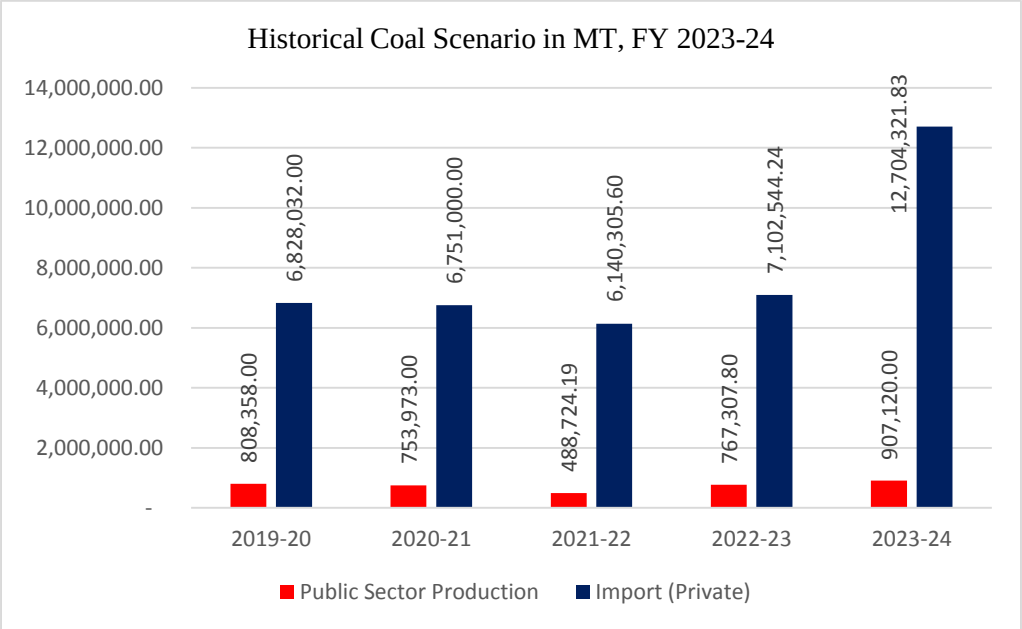
Energy serves as a crucial indicator of a nation's economic growth and is a fundamental component of the infrastructure necessary for socio-economic development. Currently, natural gas stands as the primary indigenous energy source in Bangladesh. Research indicates that the domestic production of natural gas is expected to decline significantly in the near future. Given the uncertainties surrounding the sustainable supply of primary energy, it is essential to diversify the country's energy sources. In this context, domestic coal presents a viable alternative to enhance the nation's energy security. At present, 6.24% of electricity is generated from both domestic and imported coal.

Five coal fields have been identified to date: Barapukuria, Khalaspir, Phulbari, Jamalganj, and Dighipara. Should exploration efforts be expanded nationwide, there is significant potential for the discovery of additional coal mines. Currently, coal can be extracted from four of the identified deposits, which range in depth from 118 to 509 meters. However, the extraction of coal from the Jamalganj deposit may not be feasible with contemporary technology due to its considerable depth.

Table 10: Coal Fields of Bangladesh

Place/Field (Discovery Year)	Depth (Meter)	Reserve (Million Ton)	Calorific Value (BTU/lb.)
Barapukuria, Dinajpur (1985)	118-509	410	11,040
Khalaspir, Rangpur (1989)	239-485	685	12,700
Phulbari, Dinajpur (1997)	150-270	572	11,900
Jamalganj, Jaipurhat (1962)	640-1158	1,053.9	11,000
Dighipara, Dinajpur (1995)	320-506	706	13,090
		Total = 3,426.9	

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.



[Source: HCU Data Bank]

Figure 11: Historical (last 5 year) Coal scenario

Commercial coal production began in September 2005, starting with an annual capacity of approximately 1 million metric tons. Presently, the daily production rate fluctuates between 2,500 and 3,000 metric tons. In the FY 2023-24, a total of 907,120.00 metric tons of coal has been extracted, alongside 12,704,321.83 metric tons imported. Consequently, the total coal supply for this financial year amounts to around 13.6 million metric tons.

3.6 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.

3.7 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 the FY 2023-24, the gas fields managed by national gas production companies and production sharing contracts (PSCs) have produced a total of 2,900,385.80 barrels of condensate as byproducts of gas production. During this period, the production of natural gas liquids (NGL) has been approximately 8,616.35 barrels. (Source: MIS Report June 2024, Petrobangla).

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.

Chapter 4

Power Generation

4.1 Primary Energy Mix for Power Generation

Maximum generation actually obtained till 30 June 2024, was 16,477 MW (30 April 2024). It might have occurred due to fuel supply constraint. Of the total installed capacity (sector wise) among public sector, private sector, joint venture, REB and import are 40%, 41%, 9%, 1%and 9% 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 9% of total power generation.

4.2 Power Sector at a Glance

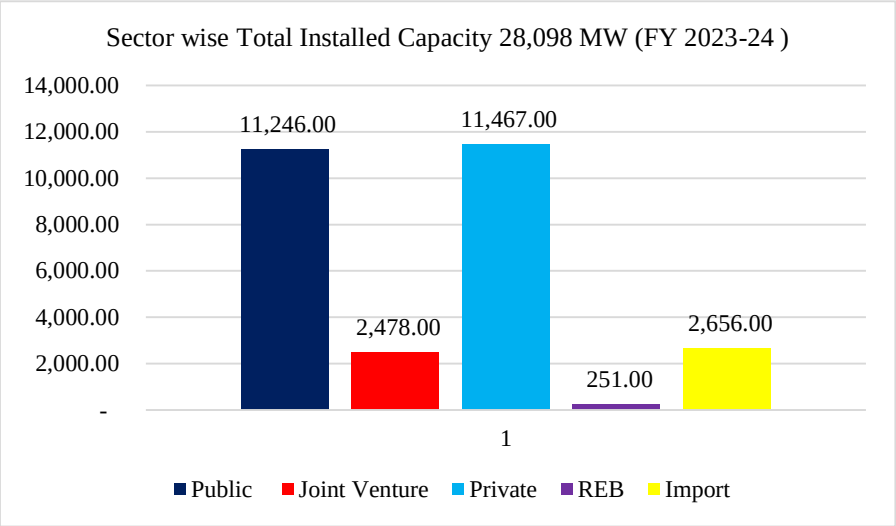
Table 11: Bangladesh's Power Sector: At a Glance (2023-24)

Types	Amount
Number of Power Plants	151
Installed Capacity (MW)	28,098
Maximum Generation (MW)	16,477
Total Consumers (in Millions)	47.1
Transmission Lines (km)	15,624
Distribution Lines (km)	648,724.72
Grid Substation Capacity (MVA)	68,369
Per Capita Generation (including Captive)	640 Kwh
Access to Electricity (Including Off-Grid Renewable)	100%
Overall System Loss (%)	10.06

[Source: Power Division and BPDB Annual Report 2023-24]

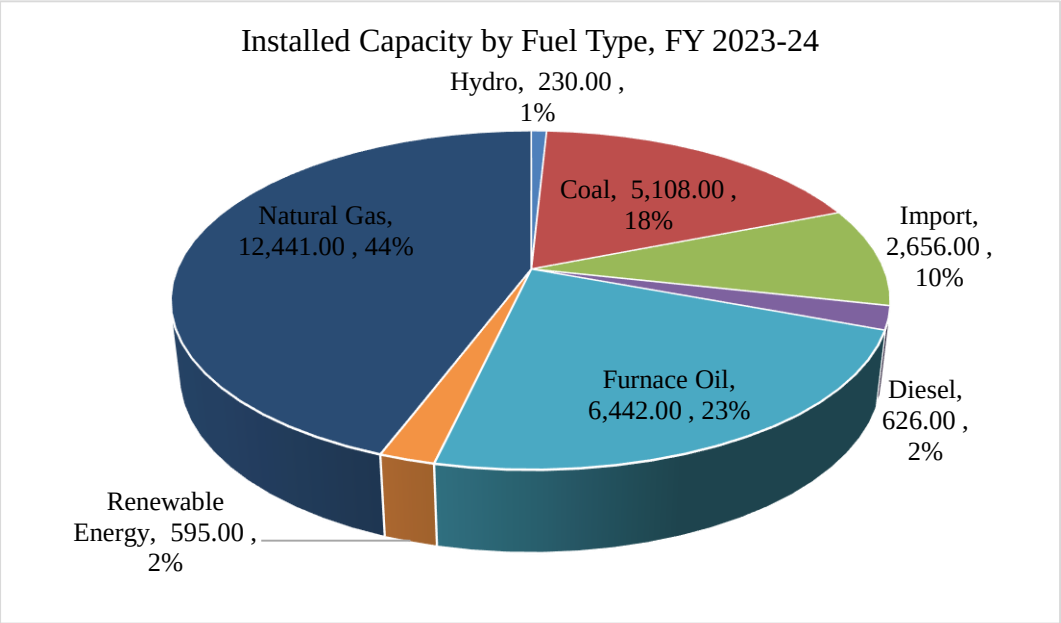
4.3 Power Generation Capacity

As of June 2024, the overall installed power generation capacity, categorized by sector, stands at 28,098 MW. The contributions from various sectors include 11,246 MW from the public sector, 2,478 MW from joint ventures, 11,467 MW from private entities, 251 MW from rural electrification boards, and 2,656 MW from imports.



[Source: BPDB Annual Report 2023-24]

Figure 12: Grid wise Total Installed Capacity 28,098 MW (FY 2023-24)



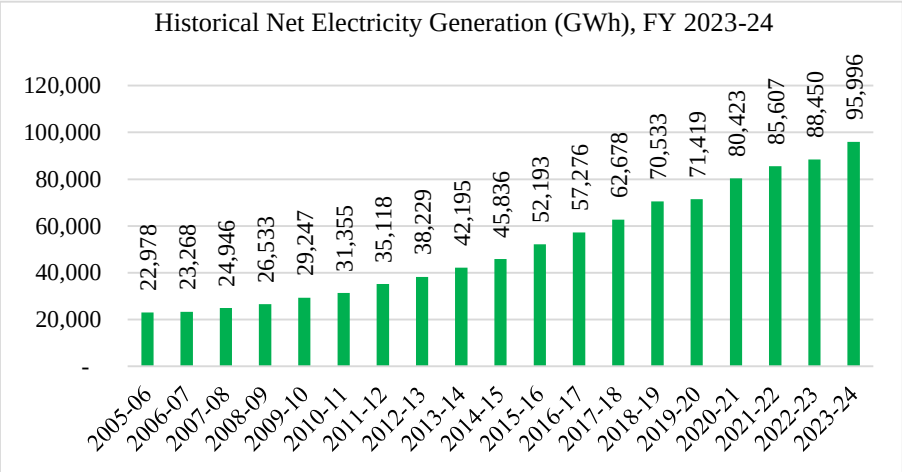
[Source: BPDB Annual Report 2023-24]

Figure 13: Installed Capacity (in MW) by Fuel Type, FY 2023-24

The above illustration depicts the total installed power generation capacity categorized by fuel type. The contributions from different fuel sources are as follows: 12,441 MW from gas, 6,442 MW from furnace oil, 5,108 MW from coal, 626 MW from diesel, 595 MW from renewable energy, 230 MW from hydroelectric sources, and 2,656 MW from imports.

4.4 Net Power Generation

In the FY 2023-24, Net Electricity Generation (GWh) in Bangladesh is 95,996 GWh represented in the following figure.

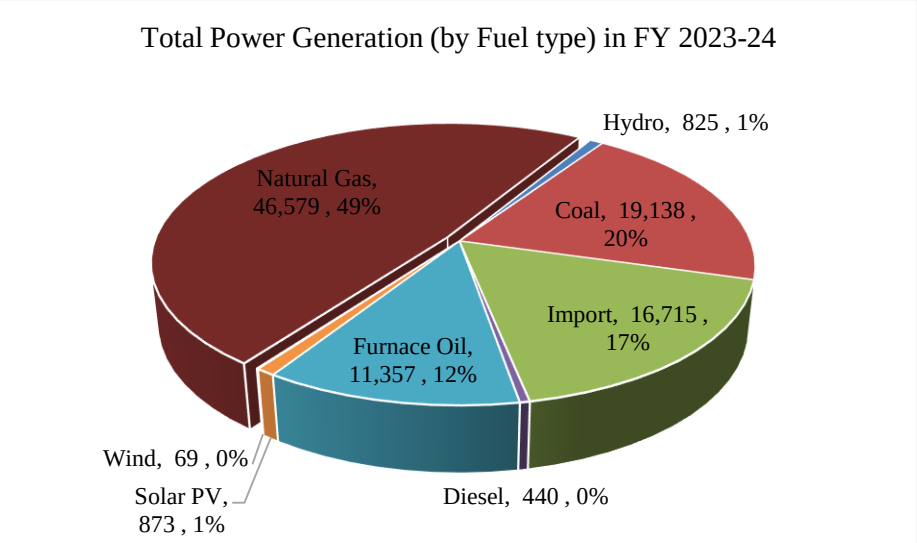


[Source: BPDB Annual Report 2023-24]

Figure 14: Historical Net Electricity Generation (GWh) in Bangladesh

4.5 Power Generation by Fuel Type

In the FY 2023-24, Net Electricity Generation in Bangladesh is 95,996 GWh represented in the following figure.

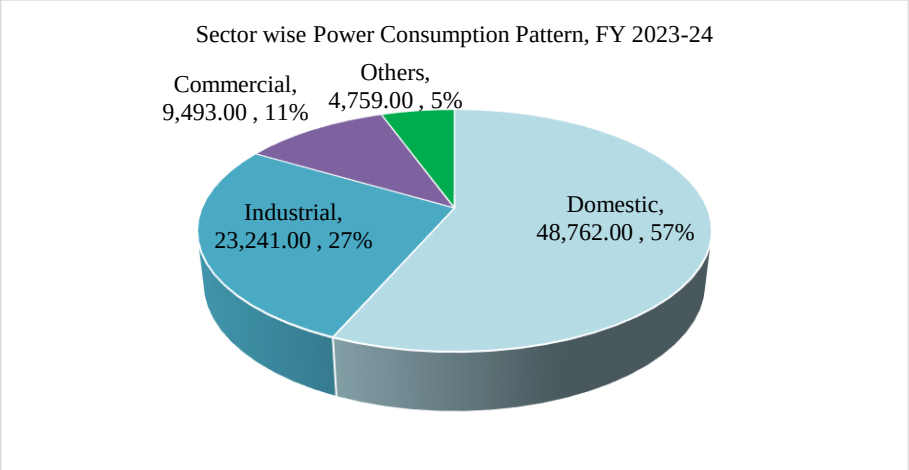


[Source: BPDB Annual Report 2023-24]

Figure 15: Power Generation 95,996 GWh (by Fuel Type), FY 2023-24

In the FY 2023-24, the power composition reveals that 49% is derived from domestic natural gas, 20% from coal, 17% from imports, and 12% from furnace oil. The remaining portion is sourced from diesel, hydroelectric power, and renewable energy.

4.6 Power Consumption



[Source: Power Division]

Figure 16: Sector wise Power consumption Pattern (in GWh), FY 2023-24

From the above figure, it is clear that major power consumer is the domestic sector (57%). Industrial sector, commercial sector and others are consuming 27%, 11% and 5% respectively.

4.7 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 17: Bangladesh India Power Transmission Plant, Bheramara (Kustia)

Table 12: Electricity Import Scenario

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**

Chapter 5

Renewable Energy Resources

5.1 Renewable Energy

Renewable energy resources have the potential to enhance energy security in Bangladesh while simultaneously decreasing the demand for natural gas. In rural areas, lack of access to natural gas or the electrical grid, residents rely on biomass for cooking. Currently, biomass stands as the predominant renewable energy source, accounting for 23 percent of the national primary energy mix. Bangladesh possesses significant potential for solar power generation. Additionally, the global trend towards renewable energy adoption is driven by the diminishing reserves of non-renewable fossil fuels. Renewable energy sources are also recognized for their environmental benefits.

In Bangladesh, renewable energy resources can be categorized into three primary types: (i) traditional biomass fuels, (ii) conventional hydropower, and (iii) new renewable resources, such as solar photovoltaic, wind, and biogas.

5.1.1 Renewable Energy (Installed Capacity) in Bangladesh

Renewable energy as per installed capacity in the FY 2023-24 is listed in the following table.

Table 13: Renewable Energy (Installed Capacity) in Bangladesh, FY 2023-24

Technology	Off-grid (MW)	On-grid (MW)	Total (MW)
Solar	373.84	706.52	1080.36
Wind	2	60.9	62.9
Hydro	0	230	230
Biogas to Electricity	0.69	0	0.69
Biomass to Electricity	0.4	0	0.4
Total	**376.93**	**997.42**	**1374.35**

[Source: National Database of Renewable Energy, SREDA (dated June 2024)]

In Bangladesh, a total renewable energy capacity of 1,374.35 MW has been installed during the FY 2023-24, with solar energy representing the largest portion of this capacity.

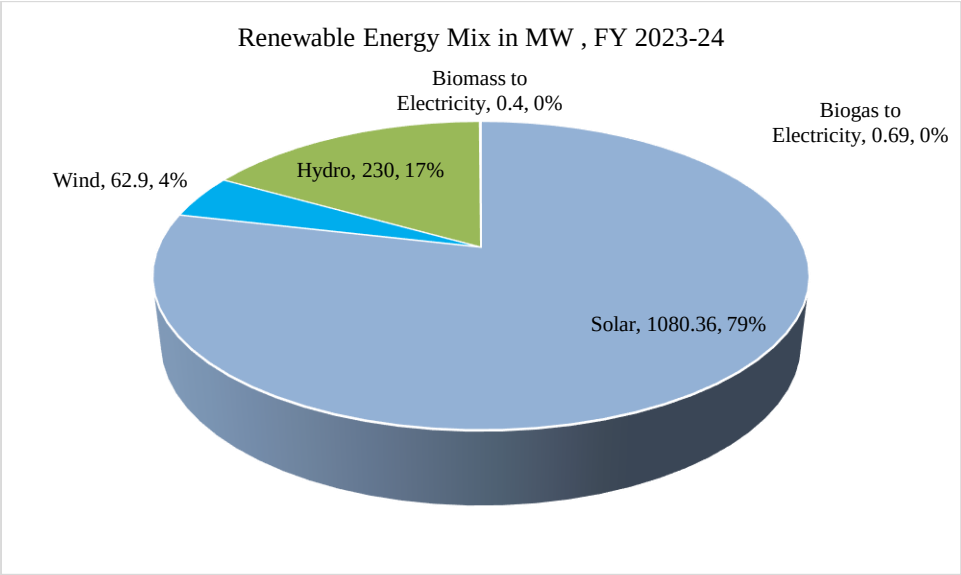


Figure 18: Renewable energy mix of Bangladesh (in MW), FY 2023-24

Solar energy accounts for nearly 79% of the overall renewable energy composition, while hydroelectric power contributes 17%. Wind energy represents 4%, and the remaining portion is derived from waste-to-energy sources.

Chapter 6

Energy targets and projections towards Energy transition

Bangladesh 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.

6.1 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.

6.2 Main Features of IEPMP

6.2.1 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.

6.2.2 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.

6.2.3 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.

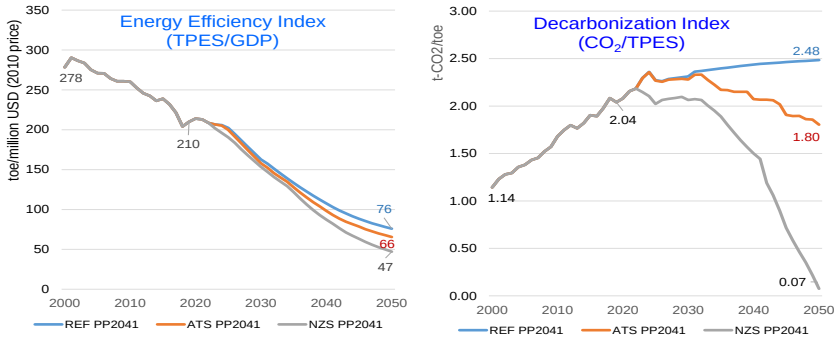
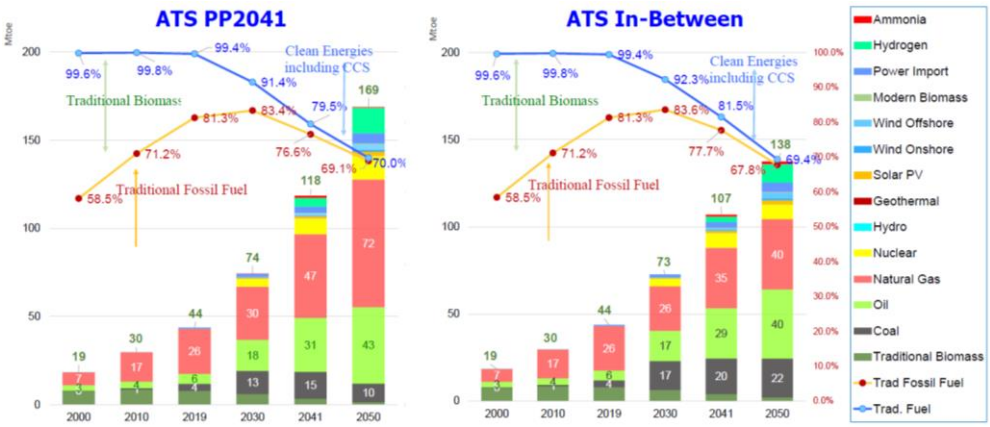


Figure 19: Comparison of Three Scenario of IEPMP

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

6.3 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.

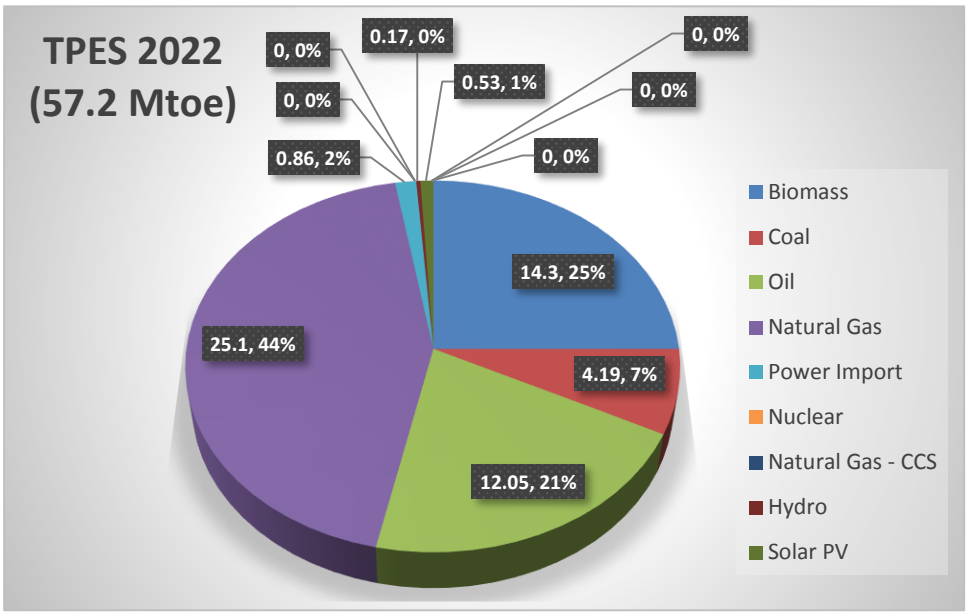


[Source: Primary Energy Supply, Executive Summary 14, Integrated Energy & Power Master Plan (IEPMP), 2023]

Figure 20: Primary Energy Supply

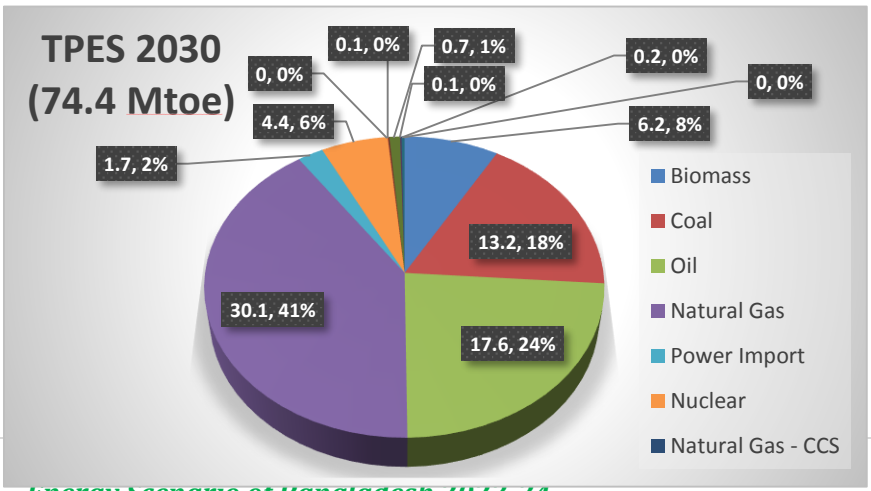
Traditional biomass consumption, mainly firewood, is being replaced with modern fossil fuels such as coal, oil or natural gas. This trend continues and traditional biomass consumption will almost disappear by 2050. On the other hand, clean energies such as solar PV, wind, CCS, nuclear, ammonia and hydrogen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

6.4 Primary Energy Supply Forecasting- HCU Version

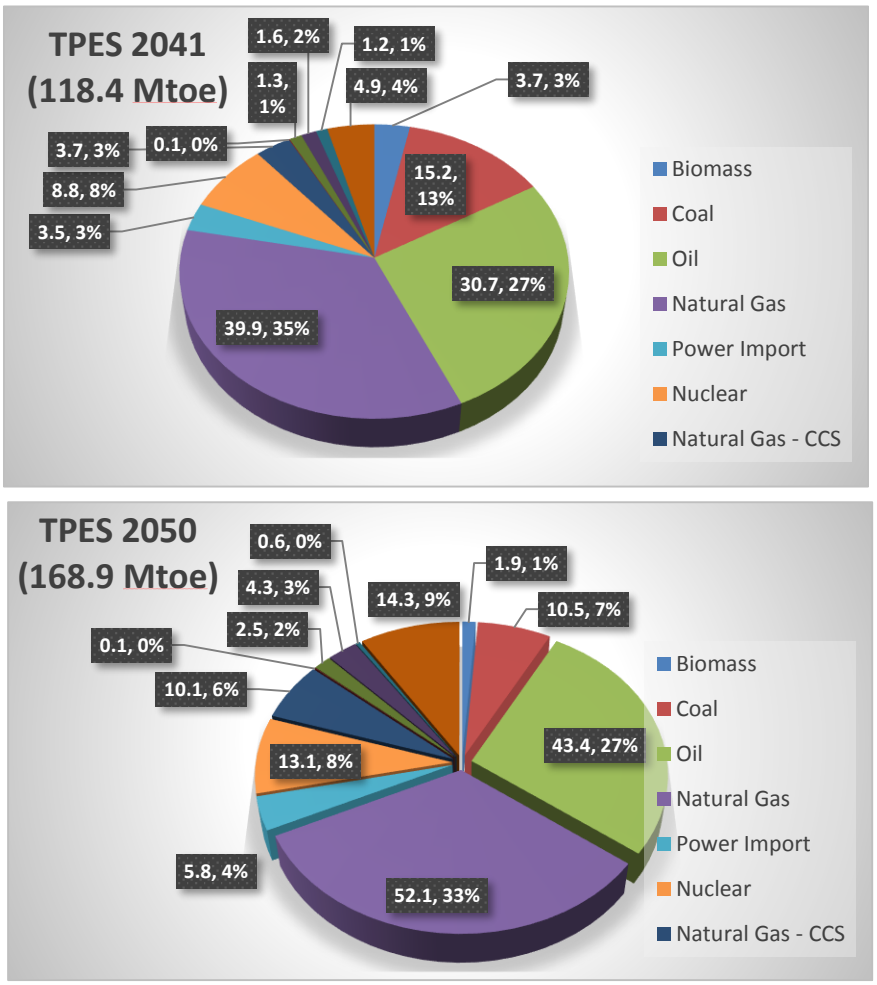


Total Primary Energy Supply of Bangladesh (TPES) in 2022 is 57.2 Mtoe.

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)



[Source: Energy Data Center, Hydrocarbon Unit and IEPMP 2023]

Figure 21: Primary Energy Supply forecasting by HCU

6.5 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) respective plans and mandates etc**.** The following table represents addressing the urgency of low carbon pathway of Bangladesh.

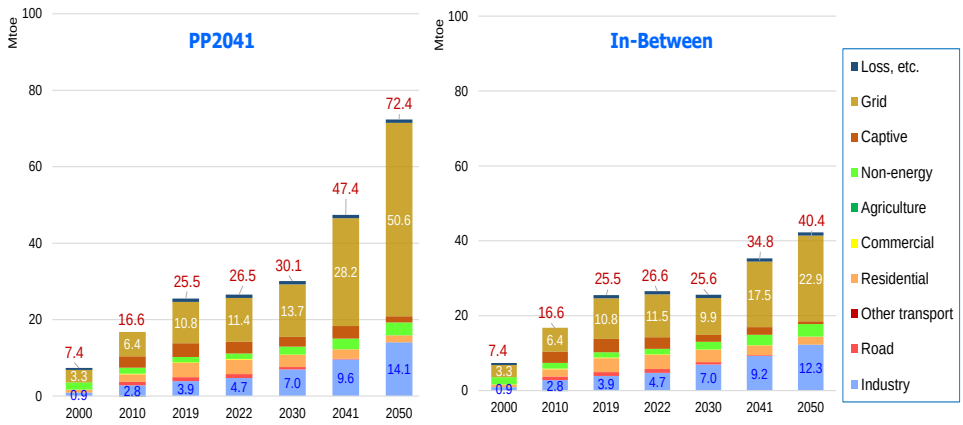
Table 14: Projected Total Primary Energy of Bangladesh (in terms of percentage)

	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

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

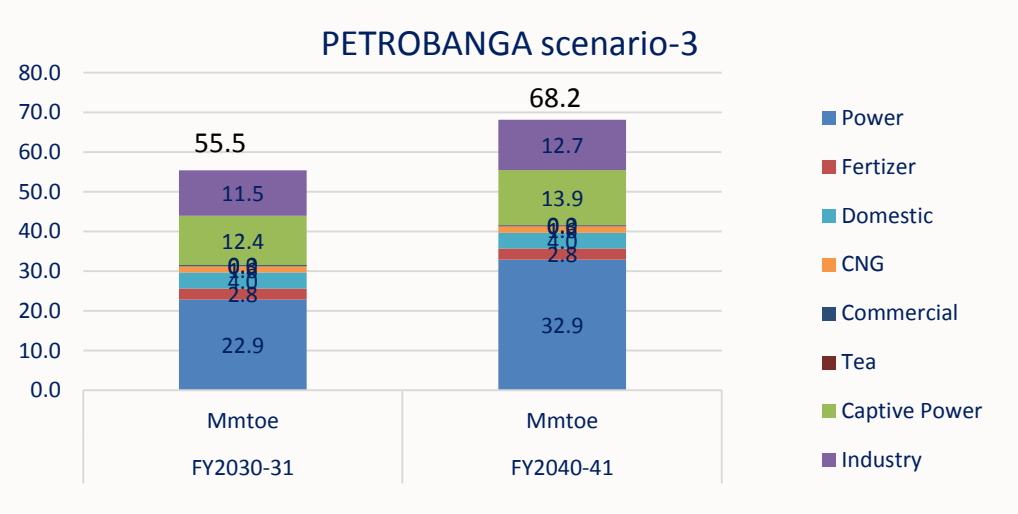
6.5.1 Natural Gas Demand & Production

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.



[Source: Natural Gas Demand Outlook, page- 116, Integrated Energy & Power Master Plan (IEPMP), 2023]

Figure 22: Natural Gas Demand Outlook



[Source: Petrobangla Scenario, Natural Gas Demand Outlook, page- 116, Integrated Energy & Power Master Plan (IEPMP), 2023]

Figure 23: Natural Gas Demand Outlook

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.

It is very clear that indigenous gas production from onshore is decline stage as per the following figure.

	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

[Source: Forecast of Domestic Natural Gas Production, page- 117, Integrated Energy & Power Master Plan (IEPMP), 2023]

Figure 24: Forecast of Domestic Natural Gas Production

Table 15: Outlook of Natural Gas Supply Balance

	2019	2022	2025	2030	2035	2040	2045	2050
Gas Demand	mmcfd	mmcfd	mmcfd	mmcfd	mmcfd	mmcfd	mmcfd	mmcfd
Petrobangla (Scenario-3)	3955	4957	5492	6240	6941	7675	-	-
PP2041	2870	2987	2566	3384	4008	4985	5823	8142
In-Between	2870	2989	2394	2879	3213	3717	3982	4545
Production								
Low Risk Potential	2494	2386	2625	1779	1221	768	580	470
High Risk Potential				200	900	930	1080	1230
Total	2494	2386	2625	1979	2121	1698	1660	1700
LNG Demand (mmscfd)	mmscfd	mmscfd	mmscfd	mmscfd	mmscfd	mmscfd	mmscfd	mmscfd
Petrobangla: Base	1461	2571	2867	4261	4820	5977		
Without High Risk Potential	1461	2571	2867	4461	5720	6907		
PP2041: Base	376	601	-59	1405	1887	3287	4163	6442
Without High Risk Potential	376	601	-59	1605	2787	4217	5243	7672
In-Between: Base	376	603	-231	900	1092	2019	2322	2845
Without High Risk Potential	376	603	-231	1100	1992	2949	3402	4075

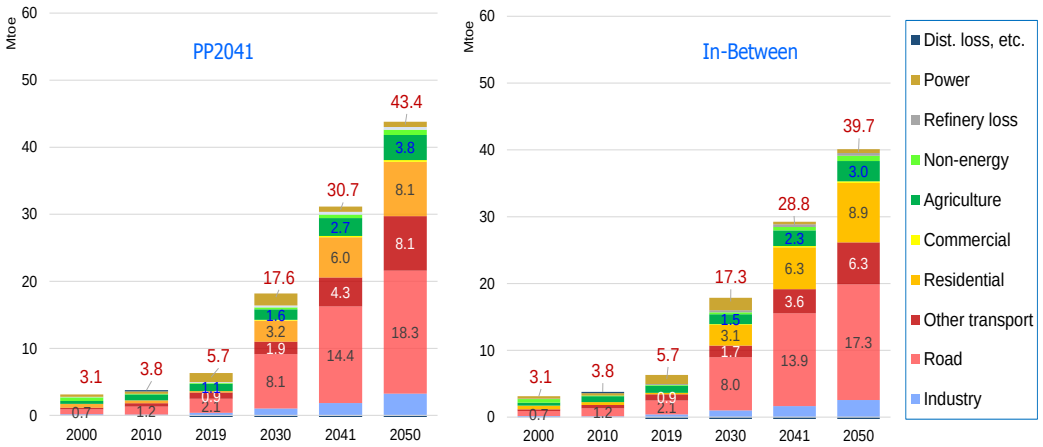
[Source: Outlook of Natural Gas Supply Balance, page- 119, Integrated Energy & Power Master Plan (IEPMP), 2023]

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 25: LNG Supply Plan

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.

6.5.2 Oil Demand & Supply



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

Figure 26: Oil Demand Outlook

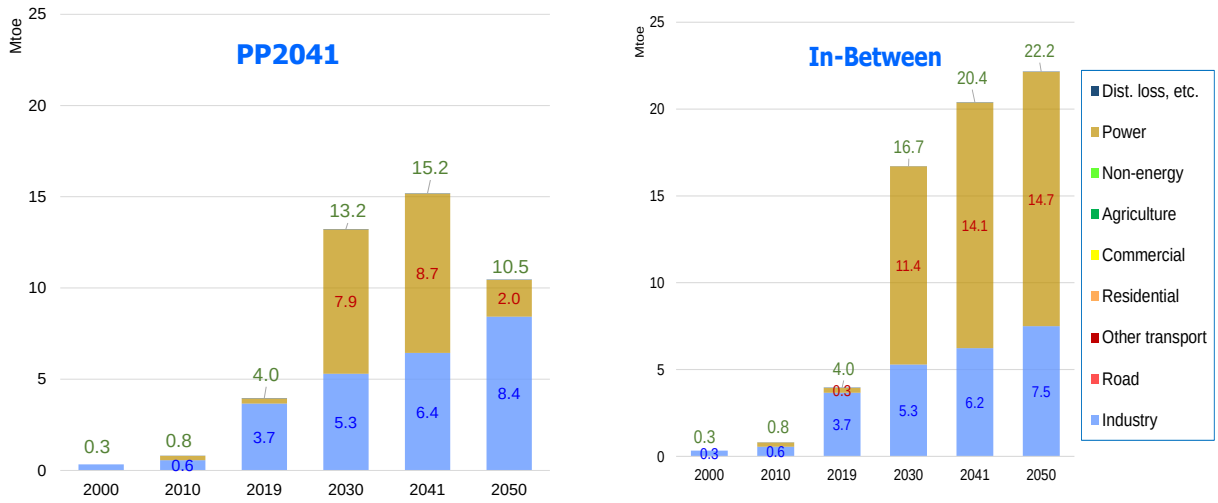
Consumption of petroleum products is forecast to expand 7.6-folds between 2019 and 2050 for the PP 2041 GDP case and 7.0-folds for the In-Between Case. The increase will be mainly led by motor fuel such as gasoline and diesel oil in response to increasing demand for mobility. Diesel and fuel oil are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

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

[Source: Petroleum Supply Plan, page- 127, Integrated Energy & Power Master Plan (IEPMP), 2023]

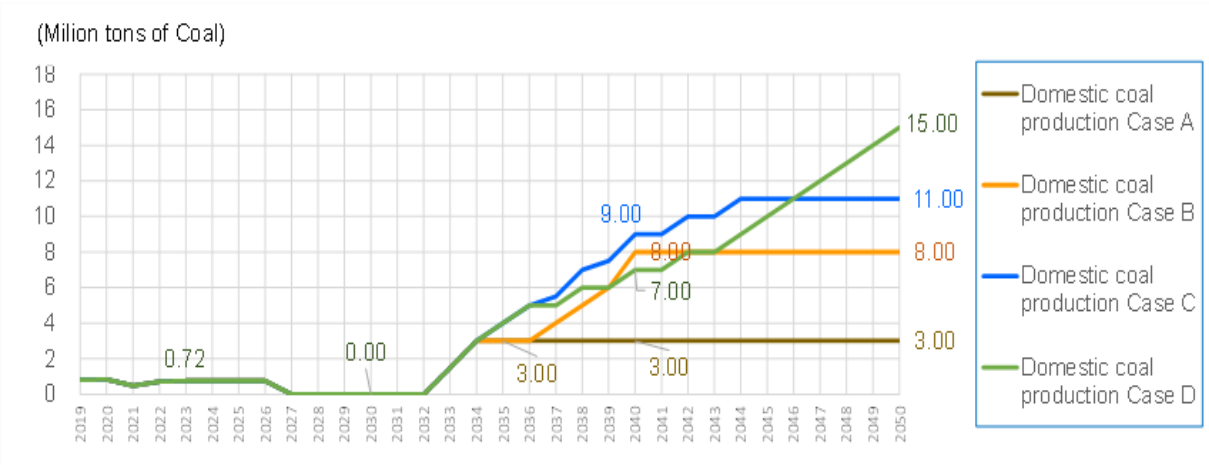
Figure 27: Petroleum Supply Plan

6.5.3 Coal demand and indigenous production outlook



[Source: Coal Demand Outlook, page- 129, Integrated Energy & Power Master Plan (IEPMP), 2023]

Figure 28: Coal Demand Outlook



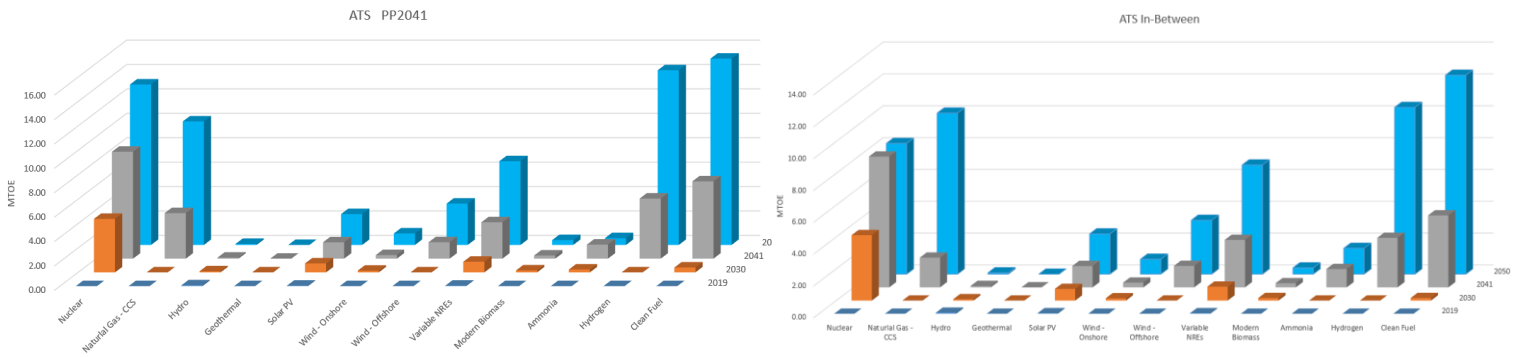
[Source: Coal Production Outlook by scenario, page 131, Integrated Energy & Power Master Plan (IEPMP), 2023]

Figure 29: 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.

6.5.4 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.

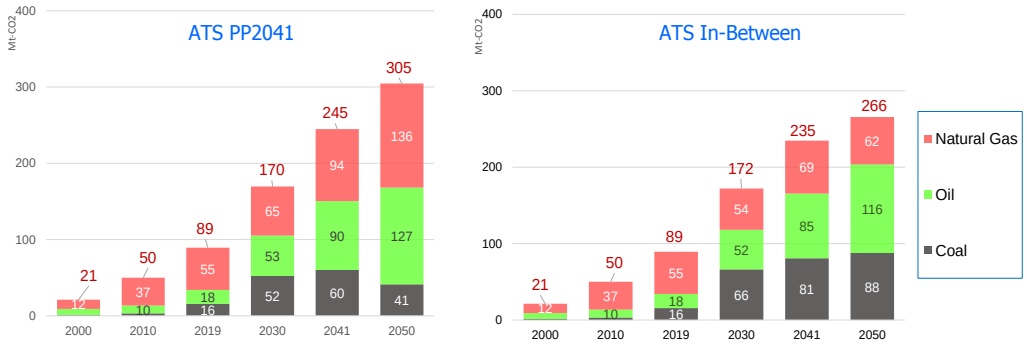


[Source: Outlook of Clean Energy Supply, page 135, Integrated Energy & Power Master Plan (IEPMP), 2023]

Figure 30: Outlook of Clean Energy Supply

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.

6.5.5 CO_2 emission



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

Figure 31: Energy-Related CO2 Emissions by Source

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.

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

Table 16: Energy intensity measured in terms of primary energy and GDP

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
2022-23	57.27	44908.42	1.28

In FY 2022-23 it was 1.28 while in FY 2015-16 it was 2.22; therefore, energy intensity is reduced by 42% over this period.

Chapter 7

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 40% share (with LNG) in the primary energy mix (FY 2023-24). 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. In the context of 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.

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.[1]

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 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).[2]

1 Page no-14, Integrated Energy and Power Master Plan (IEPMP) 2023
[2] Page no-113, Integrated Energy and Power Master Plan (IEPMP) 2023

7.1 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)[3], 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.

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

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.

[3] Global Hydrogen Review 2022, IEA

- 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.

7.2 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.

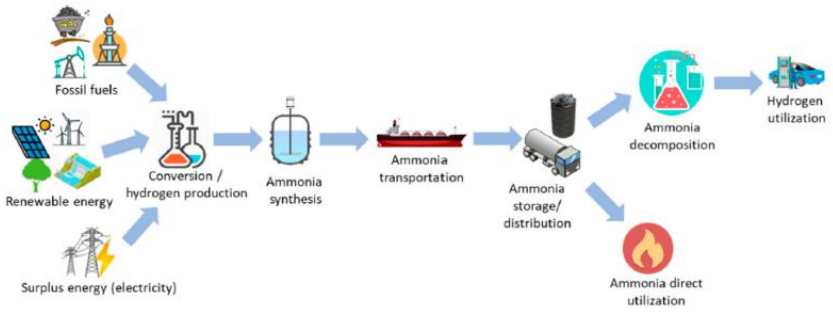


Figure 32: Production and utilization routes of ammonia in the energy sector[4]

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

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

• 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.[5]

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).[6] 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.

[5] 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.

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

7.3 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.

7.4 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[7] 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[8]. 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.

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

Chapter 8

Critical/ Emerging Technologies

8.1 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

8.2 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.

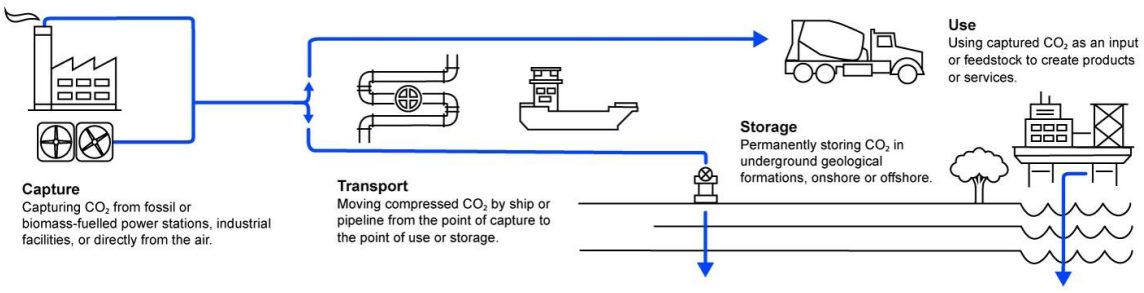


Figure 33: CCUS (source: IEA) [9]

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.[10]

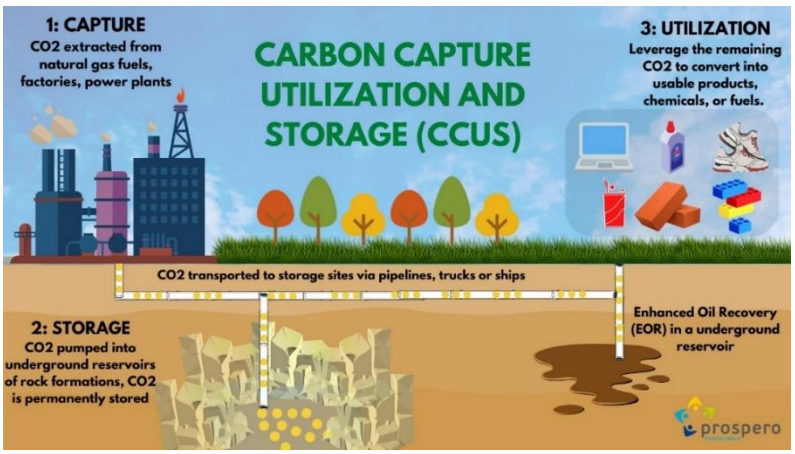


Figure 34: General schematic of Carbon Capture, Utilization and Storage [11]

[9] https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage
[10] https://www.iea.org/reports/tracking-clean-energy-progress-2023
[11] 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.

8.3 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

Overall 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 is getting momentum. It is expected that Bangladesh will adopt all the required measures to ensure national energy security. Currently, Bangladesh is ardent to address energy transition complying the global decarbonization mission and mandates.