Research Report on

Energy Economics

Hydrocarbon Unit

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

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HYDROCARBON UNIT
Energy and Mineral Resources Division

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Preface

"Energy Economics" is being prepared and published by Hydrocarbon Unit (HCU) in June 2022. This report tends to highlight the primary energy, commercial energy, energy mix, economic aspects etc. for local and global perspectives.

This report also contains comparative analysis among different countries on required energy parameters, per capita GPD, per capita energy supply vs. consumption etc. It also shows the trend analysis of energy consumption pattern, supply vs. demand forecasting etc. These findings can be examined to make viable for the policymaker.

It is also expected that this report will be an element of interest for the concerned technical personnel for developing their expertise in their respective fields.

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

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Acknowledgement

We are privileged to express our token of gratitude to several persons who helped directly or indirectly to accomplish this informative technical report on “Energy Economics”.

We deliver our heart-full indebtness and owe a deep sense of thankfulness to the Hon’ble State Minister of MoPEMR and the Senior Secretary of EMRD for their enthusiastic support and guidance to make it an effective publication for the professionals related to this industry. Sincere gratitude and appreciation for BBS, Petrobangla and its companies, BPC and its companies, agencies of EMRD and power division, World Bank, IEA, EIA for their data to prepare this report. We cannot thank enough with this little gratitude note to all those people who time to time had substantial intervention for making this report a significant one. Please accept our apology in this regard.

We also thank Hydrocarbon Unit office staffs for their numerous contribution to the preparation of this meticulous task, especially, Mr. Md. Nazmul Haque, Assistant Director (Planning) and Mr. Debbrath Das, Assistant Director (Administration and Accounts).

We look forward to having the opportunity to enrich this report with all of your valuable comments and feedback over this edition.

Abul Khayer Md. Aminur Rahman
Director General (Additional Secretary)
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Message from the Director General

It is an honor to announce that Hydrocarbon Unit (The Think Tank of EMRD) has published "**Energy Economics**" aimed at comparative data analysis of energy sector rgarding local vs. global perspectives and ongoing technical knowledge sharing on the current world energy market scenario.

We have strived to make this report a high-quality publication. We have tried to accumulate all valued relevant data addressing concurrent energy issues, supply vs. demand forecasting, economic growth, economic aspects etc. I hope all the readers including researchers specially respective stakeholders of Energy and Power sector will thrive with a new inspiration to deliver a better service at their own for the betterment for the own nation.

Contributions from any corner and critical commentaries has been duly noted and incorporated for the betterment of the next publication. Hydrocarbon Unit will look forward to continuing and updating this report on an annual basis.

Abul Khayer Md. Aminur Rahman
Director General (Additional Secretary)

Executive Summary

Primery Energy in Banlgdesh is aproaching towards import dependance day by day. But to ensure energy security and inclusive development we have to adopt right decision on fuel mix. Being technical arm of Energy and Mineral Resources Division, Hydrocarbon Unit (HCU) is concerned about future energy security, primary energy trends, energy mix and sustainable development in the energy & power sector. In our country, entire total gas transmission and distribution pipeline, metering stations should be under proper online monitoring system (e.g. SCADA) for developing transparency, reducing corruption and efficient operation. Development of LNG grid pipeline for receiving full capacity from FSRU is becoming an important issue. Investment of private entities (local) in national grid pipeline may be considered with the corresponding stakeholders. Incentives for voluntary Energy Efficiency & Conservation action plan for industries [e.g., tax incentives and low interest loans for industrial energy efficiency measures] should be considered. Promoting combined heat and power (CHP, also known as cogeneration) through tax. Energy efficiency standards and labelling for passenger vehicles [through tax incentives and low interest loans for EV etc.] On the contrary, according to Paris Agreement, rising of World's temperature should not exceed 2 degree within the following century. To reduce carbon emission, clean & modern energy should play an important role for healthy environment but it needs to be affordable at price. Hydrogen fuel is an alternate and sustainable options addressing renewable energy to reduce carbon emission & Green House Gas (GHG). Harvesting microalgae from our ample marine sector (Sea, River and Canal) is a new prospect for Bangladesh ensuring blue economy. Research work on renewable energy should be industrialized (tagged with Govt. or private entities) for a sustainable energy solution. Identifying cyber risks and vulnerabilities need to be addressed properly in energy and power sector. Continuous assessment and development on the existing networking system is required to ensure effective and efficient operation in the energy and power industry. To ensure technology transfer every stakeholders should work together with proper coordination. Policy maker, Industry and academia should be cooperated and collaborated to develop a sustainable Energy Pricing and subsidies for the nation's inclusive development.

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List of Acronym

- MPEMR- Ministry of Power, Energy and Mineral Resources
- EMRD- Energy and Mineral Resources Division
- PD- Power Division
- HCU- Hydrocarbon Unit
- BBS- Bangladesh (Bangladesh Bureau of Statistics)
- EE& C- Energy Efficiency and Conservation

1.1 Introduction

Energy has a key function in economic growth of a country. It improves the efficiency and productivity of the country and also has a very important role for individual and house hold. The role of energy in economic development is well recognized in the energy economics literature. It is one of the driving forces for development. It is consumed to meet energy requirement for subsistence (e.g. cooking, lighting, room heating etc. at household level) needs and for productive activities (e.g. agriculture, industries, transport, commercial etc.)

Economic Development depends on reliable energy supply. Bangladesh continues to face a number of major challenges, including poverty, political instability, overpopulation and vulnerability to climate change. However, it has been praised by the international community for its significant progress on the Human Development Index. Through various government pragmatic program and NGO-led social programs, the country is improving living standards and life expectancy, promoting education and women empowerment, stemming population growth, achieving self-sufficiency in food production and building healthcare infrastructure. The country is also undergoing rapid industrialization, with globally competitive industries in textiles, shipbuilding and pharmaceuticals. Bangladesh has been identified as a next emerging economy. Behind all energy is playing the vital role in all economical activities.

1.2 Methodology

Methodology is of very important in any methodical inquiry as the validity and reliability of the facts primarily depend upon the system of investigation.The committee sat in series of meeting formally after the formation of the committee to discuss the issues. Besides that so many informal discussion also held with the eminent personalities in this sector and sought their suggestion.

For this study work information were collected as secondary source of information from different related agencies and report like Planning Commission, Perspective Plan Of Bangladesh (2010-2021),Power Division,EMRD, BBS, Petrobangla and its subordinated companies, BPC and it's subordinated companies, PDB, Power Cell ,concerned study report, annual report etc. By surfing internet Global/Regional energy & economy related data of different developed, under developed and developing countries were used and analyzed. World Bank data were used as reference. Beside that EIA, IEA data also used for analysis..

1.3 Limitation of the work

This report has been prepared on the basis of information and data obtained from EMRD, Petrobangla, BPC, PDB, Power Cell, HCU and other agencies like World Bank, IEA & EIA. This is just an exercise on the basis of data provided by the agencies and surfing internet. Assurance or warranty cannot be given, that any of the future results or achievements, expressed or implied, contained will be realized.

1.4 Literature Review

Bangladesh is coping with a serious energy crisis which is the result of sluggish growth in energy supplies while the demand for energy has grown up reasonably to attain higher economic growth. To realize Government vision 2021 , Planning Commission has prepared a Perspective Plan of Bangladesh (2010 – 2021): Making Vision 2021 a Reality" is a strategic articulation of the development vision, mission, and goals of the Government in achieving a prosperous Bangladesh grounded in political and economic freedoms a reality turning it a middle income country by 2021.

Energy security will be one of the critical element for realizing the vision. The Plan aims to develop an integrated and developed energy sector with a diversified fuel mix that will be the key driver of a sustainable local and national economy, while attaining global competitiveness in all sectors by 2021. The Plan will ensure prompt and timely decisions to steadily encourage greater private sector role in the energy sector; ensure transparent governance of energy-related public sector institutions; enhance the development of human capital; support development of the energy sector through physical and systemic structures; and contribute to the protection and enhancement of the natural environment. It will also promote renewable energy, such as solar and biogas; and ensure access to power and energy to all.

2.0 Comparative Energy Scenario

Table 1: Global Comparative Energy Scenario 2021

Country	GDP/Capita (USD)	TES/pop (kgoe/cap)	Self sufficiency	Energy Intensity (kgoe/000 USD)
Bangladesh	1498	260	81.6	170
China	9605	2300	80.1	240
Germany	43129	3640	36.9	80
Italy	31512	2490	23.1	80
Japan	35780	3370	11.8	90
Luxemburg	105667	6410	5.6	60
Korea	30971	5470	15.8	180
Singapore	60571	6690	2.4	110

[Source: KEY WORLD ENERGY STATISTICS 2020, IEA UN Energy Statistics Pocketbook 2021]

3.0 Energy Scenario of Bangladesh:

Bangladesh is located in the most energy deficit region (Asia Pacific) of the world. Almighty Allah has blessed this small populous country with significant potential of primary energy resources. Out of which explored traditional indigenous fossil fuel like natural gas, coal and small amount of oil and significant potential of unexplored hydrocarbon in off shore and on shore. There is also potential of unconventional form of energy like CBM, Shale gas and synthetic gas as UCG. As renewable energy there is huge prospect of solar energy, hydro and wind. At present energy crisis has taken an acute shape due to the lack of proper initiatives in the energy sector during the regime of past government. As a result, acquiring overall growth of the industry and other production sectors including power generation has been hampered. To overcome the stagnant situation of the country the government is working to ensure energy supply to expedite the motion of economic development and to achieve this goal mid-term and long-term plan has been undertaken for exploration, development and production of domestic primary fuel such as gas and coal.

Considering the shortage of domestic commercial energy, multi-dimensional approach has been taken to import different commercial energy: (i) Electricity, (ii) Coal, (iii) Petroleum via pipeline (iv) Natural Gas via pipeline, (v) Natural gas as LNG, vi) Liquefied Petroleum Gas (LPG).

Table **2**: Bangladesh Energy Mix calculation for 2020-21(MTOE).

[Source: HCU Data Bank]

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

Natural gas is presently the principal source of primary energy supply followed by the biomass. A share of primary energy by different fuel sources in Bangladesh is presented in the Figure 1.

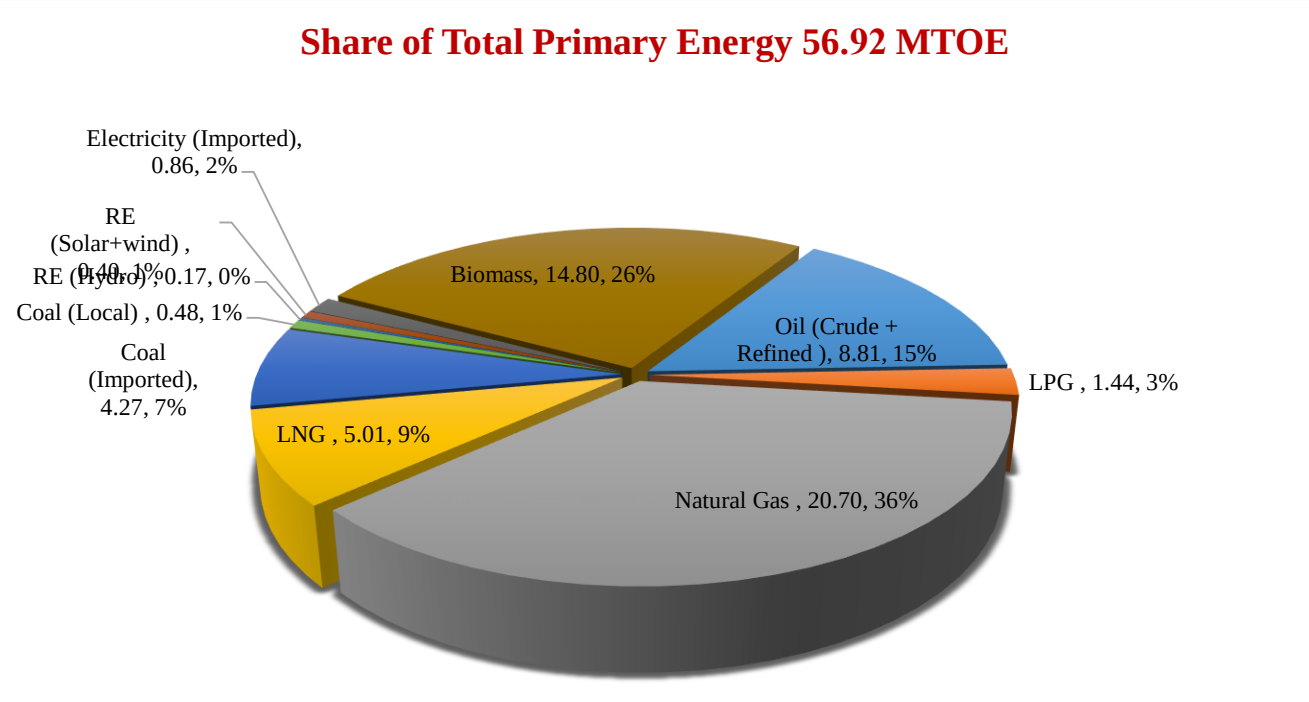

Figure 1: Share of Total Primary Energy (2020-21) [Source: HCU Data Bank]

As known commercial energy resources in Bangladesh include indigenous natural gas, coal, imported oil, Imported electricity and renewable energy hydro& solar electricity. Biomass accounts for about 30% of the primary energy and the rest 71% is being met by commercial energy. Natural gas accounts for about 69%, petroleum product contribute 23%, coal 6% and renewable energy 1% of the commercial energy. In the 2014-15 total primary energy supplied was 42.53Mtoe. The energy mix (Figure 1 & Figure 2.) is heavily dependent on domestic resource, natural gas. The reserve of which is diminishing quickly. Then petroleum product mostly of which is imported. Contribution of coal is very less (6% only), which is the most significant to explore.

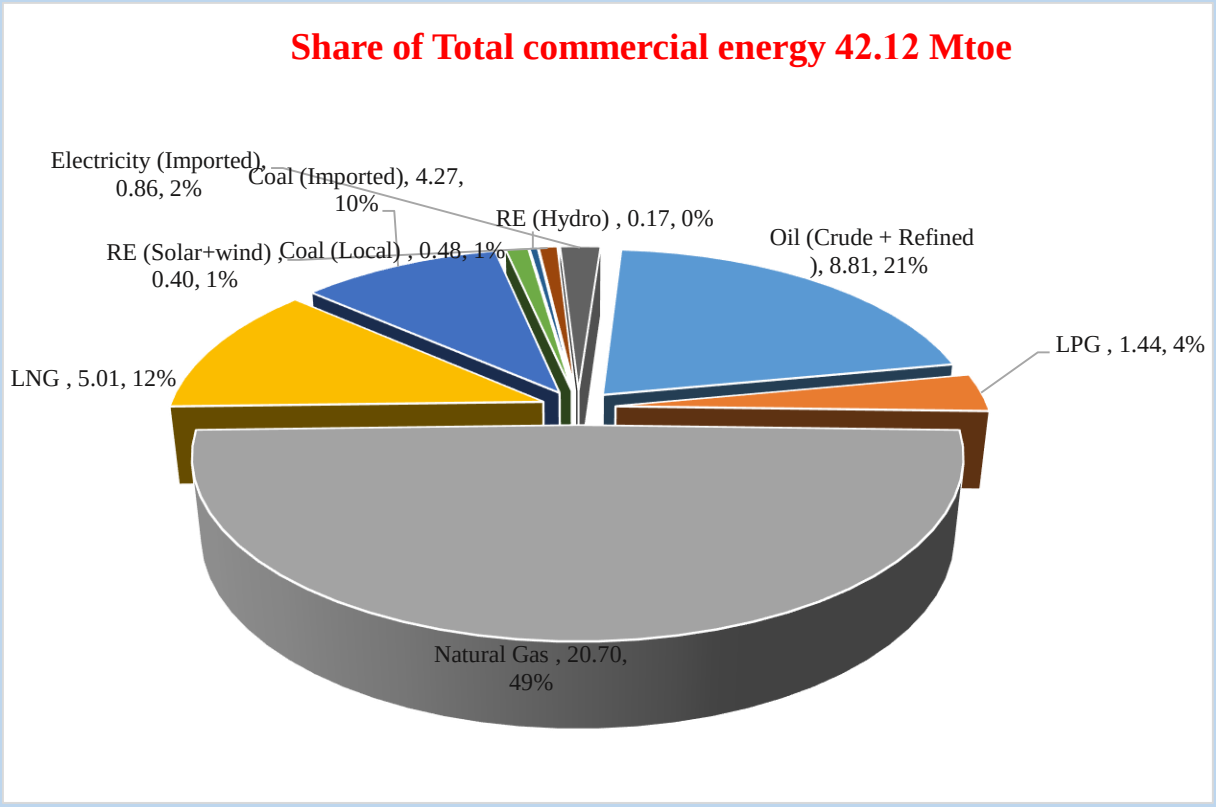

Figure 2: Share of Total Commercial Energy (2020-21)

[Source: HCU Data Bank]

3.1 Natural Gas Sector

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 the Energy and Mineral Resources is entrusted with the responsibility of exploration of oil and gas, and production, transmission and marketing of natural gas in the country.

3.1.2 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 17.79 Tcf gas has already been produced leaving only 12.26 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 2020-21 [Source: HCU Data Bank]

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

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

3.1.3 Natural Gas Consumption

The current average production of natural gas is about 2978 MMcfd. A total 994 billion cubic feet (BCF) of natural gas was produced in 2019-20 which was used by power 46%, fertilizer5%, captive power15%, industry 16%, domestic 13%, CNG 4% and others very small amount. Natural gas accounts for the 71.82% grid electricity generation while all the 7 urea fertilizer factories are dependent on natural gas for feedstock. Natural gas has made tremendous contribution towards industrial growth in the country as fuel for heating and captive power generation at very favorable price. While the whole nation has been benefitted by this resource, about 13% of the populations have directly been benefitted by using piped natural gas for household purposes. Compressed Natural Gas is being used as automobile fuel by about 504,293 motor vehicles in the country. Expansion of CNG facilities early last decade dramatically improved air quality in large cities especially in the capital Dhaka as well as lot amount of foreign exchange has been saved due to less amount of oil import.

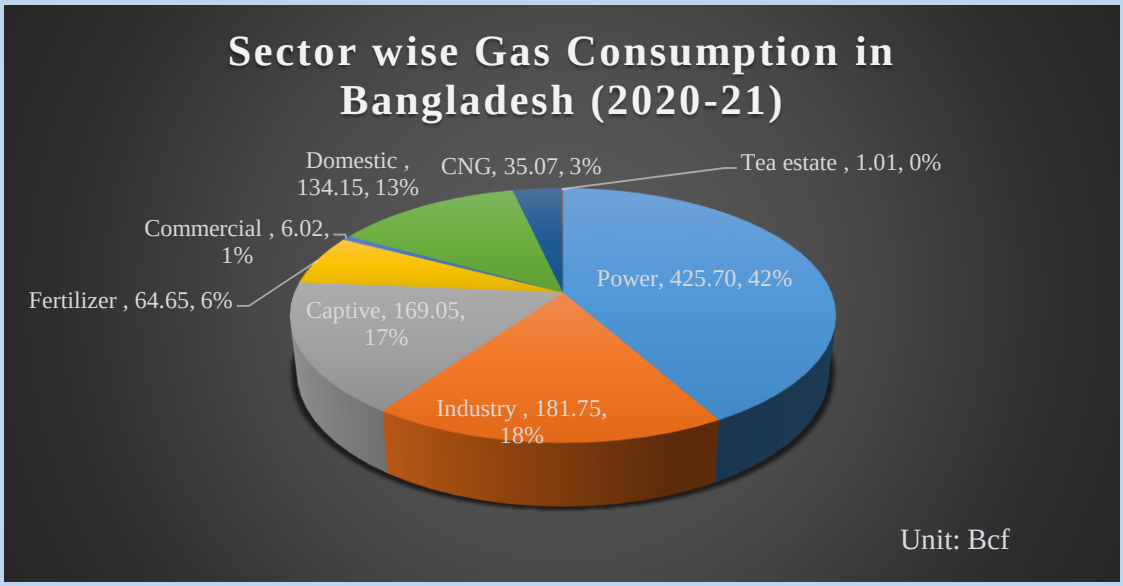

Figure 6: Sector wise Gas Consumption in Bangladesh (2020-21)

3.1.4 Natural Gas Demand

Being almost single indigenous sources of commercial energy demand for natural gas experienced vary fast growth over the last three decades often outstripping the supply. Present demand for gas in the country is about 3508 MMscfd whereas supply is 2978 MMscfd (Gas + imported LNG) indicating a shortage of about 530 MMscfd. It is estimated that demand for natural gas will rise to about 4622 MMscfd by the 2030. Natural gas demand projection in the country is shown in the figure below:

Table 3: Natural Gas Supply & Demand [Unit: MMcfd]

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

3.1.5 LNG import to Supplement Indigenous Supply

As seen from the figure above, existing demand supply gap will widen with time, if large reserves cannot discovered shortly. Foreseeing the uncertainty in new discovery, government has undertaken a project to import LNG equivalent to 500 MMscfd in the first phase to offset demand supply gap. It is expected that re-gasified LNG will be fed to the network in early 2017 after installation of a floating storage re-gasification unit (FSRU) at Maheshkali in Cox's Bazar district by a private entrepreneur on build, own, operate and transfer (BOOT) basis, and construction of a 30 inches dia 91 km transmission pipeline from re-gasification facilities to Chittagong ring-main by the national gas transmission company, GTCL.

Table 4: LNG Scenario 2020-21 [Source: Petrobangla]

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

3.1.6 Exploration Activities

The exploration activities in Bangladesh are mostly limited to eastern folded belt and surrounding areas. On the basis of previous geo-scientific study, it seems that the middle part of the country geologically knows as Bengal Fore deep and Eocene shelfal region popularly known as Hinge Zone also have high Potential for hydrocarbon exploration. The objective of 2D seismic survey is to explore remaining potential of the Bengal Fore deep hydrocarbon- geological province in the least explored part of the country. In this regard, two projects on 2D seismic survey being financed by the Gas Development Fund have been approved by the Govt. Besides, with a view to identify new locations for drilling well in the exploration gas fields of structures for mitigating the ever- growing crisis of gas, 3D seismic data were gathered during 2018-19 field-season over Fenchuganj and Rupganj gas fields. Moreover, a joint study with Mitsui Oil Exploration Company Ltd. (MOECO), Japan and BAPEX for interpretation of 20 possible leads and prospects in block 8 & 11.

2D seismic Survey Activities:

To detect the place of exploratory able wells drilling under the scope of project titled "Rupkalpa-9: 2D Seismic Project" financed by gas development fund (GDF), 2,190lkm 2D seismic data have been collected during the year in Kishoreganj, Narsingdi, Tangail, Gazipur, Netrokona, Jamalpur, Sherpur and Sunamganj districts. With a view to exploring blocks 8 and 11, a total of 3,000 lkm 2D seismic survey has been completed to till date under the project. Processing and analysis activities of the collected data is in progress. Till 30 June 2019 a total of Tk. 745.90 million has been spent out of the total allocated amount of Tk. 985.50 million in favor of the project (financial progress 75.69%). 2D seismic survey have been carried out over the exploration blocks 3B, 6B and 7 under the project of "2D Seismic Survey Over Exploration Blocks 3B, 6B and 7" with the financed of the gas development fund (GDF) by an international seismic service provider. A total of 3,000 lkm 2D seismic survey has been completed to till date.

Based on the results of 2D seismic data processing and analysis, approximately 10 potential seismic leads have been identified. The identified leads will be helpful in determining exploratory well drilling locations. Until 30 June 2019, Tk. 1,501.20 million has been spent out of the allotted amount of Tk. 1,519.50 million in favor of the project (financial progress- 98.80%).

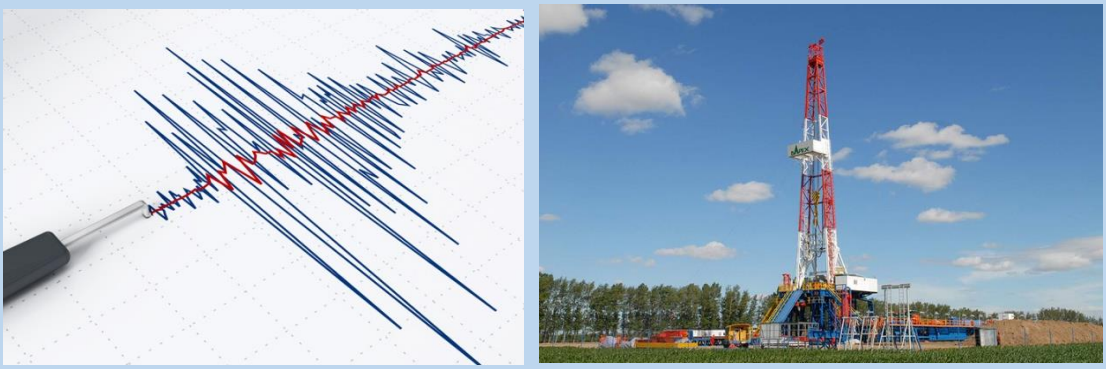

Figure 2: 2-D Seismic Survey by BAPEX

3D Seismic Survey:

With a view to identifying new well drilling locations in the discovered gas fields/structures, 50 sq. kms 3D seismic survey has been completed in Semutang Gas Field / Land formation in this fiscal year under the scope of the project titled "3D Seismic Project of BAPEX" financed by GDF. A total of 2,450 sq. kms

3D seismic survey has been completed under the project so far. Data analysis activities of Fenchuganj Gas Field and data processing work of Rupganj gas field is in progress.

Figure 3: 3-D Seismic Survey by BAPEX

Out of the total allocated Tk. 2,303.00 million a total of Tk. 2,269.00 million has been spent until 30 June 2019 (Financial progress-98.52 %).

3.1.7 Drilling Activities

Rupkalpa-1 Drilling Project (2nd Revised):

With a view to implementing of Government's "Vision-2021" the project was approved by the Energy and Mineral Resources Division for drilling wells of Srikail East-1 and Salda North-1 financed by the gas development fund (GDF). Salda North-1 exploratory well was started to drill by BAPEX's Bijoy-10 rig and manpower on 11 May 2018 and the drilling work was completed up to the depth of 2,814 meters on 23 October 2018. No gas was found from the well. On the other hand, transfer of the Bijoy-10 Rig and incidental activities have been completed after finalizing the well location of Srikail East-1 exploratory well with the purpose of drilling wells including all infrastructures. Till 30 June 2019 a total of Tk. 1,075.10 million has been spent out of Tk. 1,171.00 million allocated to the project (financial progress-91.81%).

Rupkalpa-2 Drilling Project (1st Revised):

The project was approved by the Department of Energy and Mineral Resources, financed by GDF for the implementation of drilling Semutang South-1 and Zakiganj-1 exploratory wells. Contractor M/s. Socar AQS started drilling of the Semutang South-1 exploratory well on 26 July 2018 on turn-key basis and completed

the drilling work up to the depth of 3,020 meters on 4 January 2019. Although presence of gas was confirmed in the well, it is not commercially viable to production; therefore, the well has been kept closed. Under the project, local and foreign procurement, land development and civil construction activities have been carryout to drill the Jakiganj-1 exploratory well by BAPEX's own rig. Till 30 June 2019, a total of Tk.1,310.90 million has been spent out of the total allocated amount of Tk.1,318.30 million in favor of the project (financial progress-99.44%).

Rupkalpa-3 Drilling Project (1st Revised):

Energy and Mineral Resources Division approved the project financed by gas development fund (GDF), for the drilling of Kasba-1 and Madarganj-1 exploration wells. Kosba-1 exploratory well drilling was started by BAPEX's own Bijoy-12 rig and manpower on 4 May 2018 and completed drilling to the depth of 2,975 meters on 23 October 2018. Although there is the presence of gas in the well, it is not commercially viable; therefore, keeping the opportunity of re-entry, all activities were kept closed at the well after doing cement plugging on 18 October 2018. Though an agreement was signed with Socar AQS to complete the drilling activities of Madarganj-1 exploratory well on turn-key basis, the said contractor sent a letter on March 2019 to cancel the contract. Land development and construction of link roads have been completed in the well area. Till 30 June 2019, a total of Tk. 736.60 million has been spent out of the total allocated amount of Tk. 946.00 million in favor of the project (financial progress-77.86%).

3.1.8 Development

Rupaklpa-5 Drilling Project (1st Revised):

Financed by GDF, the project was approved by Energy and Mineral Resources Division for drilling of Begumganj-4 appraisal/development well and completion of Begumganj-3 workover. Though an agreement was signed between BAPEX and M/s. Socar AQS for drilling of Begamganj-4 appraisal/ development well, the said company transferred the mining equipment to the well area and terminated the contract by a letter on March 2019. As a result, it was not possible to complete the activities of drilling of the said well. As such, a total of Tk. 211.70 million has been spent out of the total allocation of Tk. 1,566.70 million until 30 June 2019 (financial progress-13.51%).

3.1.9 Workover Activities

Begumganj-3 well:

Workover work of Begumganj-3 well has been successfully completed by BAPEX's own rig under the scope of Rupkalpa-5 drilling project. From this well, 6 MMscfd of gas is being supplied to the national grid. Bakhrabad-1 well: Under the scope of an agreement signed between BAPEX and BGFCL, the workover work of the well was started on 20 February 2019 by Bijoy-12 rig and completed successfully on 16 May 2019. About 14 MMscfd of gas is being supplied to the national grid from the well.

Titas-6 well:

Under the scope of an agreement signed between BAPEX and BGFCL, the workover work of the well was started on 5 May 2019 by Ideco rig and was completed successfully on 1 June 2019. About 28 MMscfd of gas is being supplied to the national grid from the well.

Narsingdi-1 well:

Under an agreement signed between BAPEX and BGFCL, the workover work of the well was successfully completed by Bijoy-11 rig. About 11 MMscfd of gas is being supplied to the national grid from the well.

3.1.10 Offshore Planning (Current & Future):

- ✓ **Block SS-11 (**Santos-Kris-Bapex): 3,146 km 2D seismic survey and 305 sq. km 3D seismic survey completed. 1 search wells will be excavated by March, 2021.
- ✓ A total of 5,081-line km 2D seismic survey were completed in two blocks. At the end of the data analysis, 2 drilling locations have been assigned to SS-04 and 1 to SS-09. On December 2019, 1 drilling will be done on Block SS-04 and the remaining two drilling will be done by February, 2021.
- ✓ **Block DS-12 (**POSCO-Daewoo): 5 probable leads were identified after analyzing 3,580 km 2D Seismic Survey. 2D seismic data processing is currently underway to gain a better understanding of the identified leads. Based on this, the next 1000 sq. km. 3D seismic survey will be done.
- ✓ Notice of Award has been sent to TGS-SCHLUMBERGER JV for conducting 2D Multi-Client Survey at sea. Negotiations are underway to sign a contract with the company.

Draft Onshore Model PSC 2019 and Draft Offshore Model PSC 2019 have been approved at a meeting of the Cabinet Committee on Economic Affairs dated 24/07/2019.

3.1.11 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".

3.2 Oil (Petroleum) Sector

3.2.1 Organizational Structure

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

3.2.2 Supply and Consumption of Oil

Petroleum products viz. diesel, petrol, octane furnace oil etc., account for about 20 % commercial energy supply in the country. Liquid fuel used in Bangladesh is mostly imported. Locally produced gas condensate shares only 6% of total liquid fuel consumption. Bangladesh imports about 1.26 million metric tons of crude oil along with 4.04 million metric tons (approx.) of refined petroleum products per annum. About 0.52 million metric tons per year locally produced gas condensate, which is fractionated mainly into petrol, diesel and kerosene, is the only domestic source of liquid fuel. Major consumer of liquid fuel is transport followed by

power, agriculture, industry and commercial sectors. Sector-wise consumption of petroleum products is transport- 62.89%, power 6.84 %, agriculture 19.51 %, industry 6.48 %, domestic 3.02 % and others 1.26 %.

Table 5: Petroleum Sector at a Glance (2020-21) [Source: HCU Data Bank, BPC, NBR]

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

Table 6: Sale of Petroleum Products by BPC during last 8 Year [Quantity in MT]

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

[Source: BPC Annual Report 2020-21]

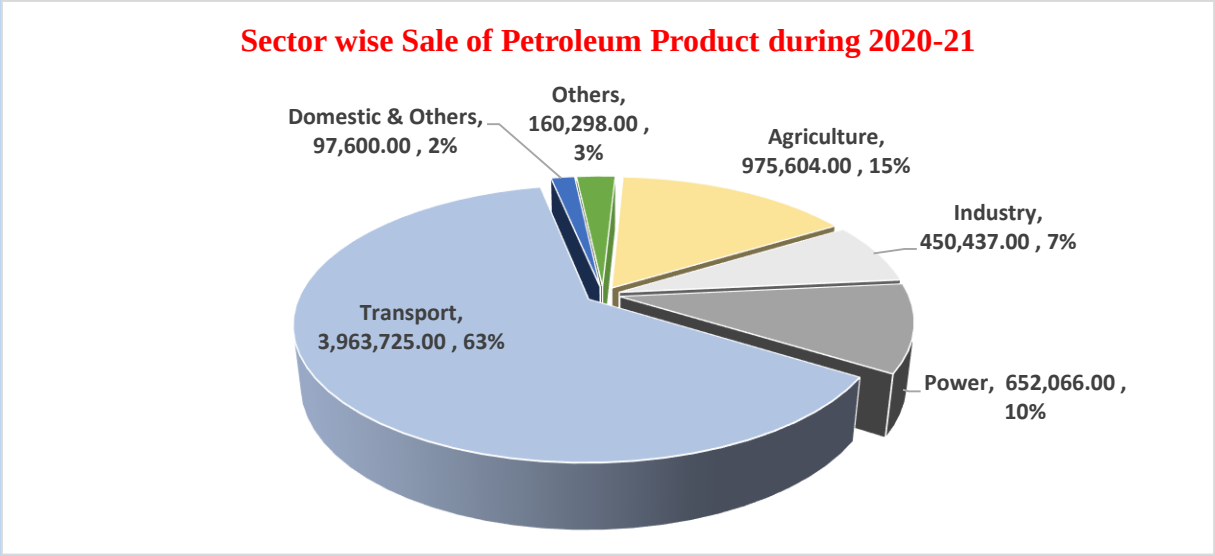

Figure 4: Sector wise Liquid Fuel Consumption in Bangladesh (2020-21)

3.2.3 Capacity Enlargement Projects

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

Table 7: ERL Process plant scenario

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

[Source: ERL Website]

A Project has taken for installation of 2nd unit of the existing refinery with annual refining capacity of 3 (three) million tons. Besides the state initiative, government allowed private entrepreneurs to establish

Condensate Fractionation Plants to split Natural Gas Condensate (NGC) received from various gas fields in Bangladesh as well as imported NGC. Total storage capacity of different grades of petroleum is around 1.3 million metric tons across the country. It may be mentioned that, according to the national energy policy, 60 days' stock of petroleum products to be maintained for energy security of the country. However, at present BPC is able to maintain 35 to 40 days' stock of petroleum products due to lack of storage capacity as well as involvement of huge amount money for procuring petroleum. BPC has completed a project for construction of **Mongla Oil Installation** as 2nd main installation to enhance 0.10 million metric tons with 14 oil storage tanks.

Single Point Mooring (SPM) project is now in progress which will enable BPC to receive Crude Oil and Diesel from large size vessels of 120,000 metric tons carrying capacity through subsea pipeline, from near Kutubdia of the Bay of Bengal, within 48 hours instead of present required time of 9/10 days.

Figure 5: Single Point Mooring (SPM) with Double Pipeline

Storage facility will be constructed of 0.24 million metric tons, for crude oil 0.15 million metric tons and for diesel 0.09 million tons, at Maheshkhali under SPM Project for smoothing receiving of petroleum. Operational flexibility will improve amazingly after completion of the SPM project.

Upcoming major projects of BPC:

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

3.2.4 Demand

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, and 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.

3.2.5 Source Countries for Imported Oils

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

3.3 Liquefied Petroleum Gas (LPG)

Demand of Liquefied Petroleum Gas (LPG) in Bangladesh is very high. In the public sector 13,414 MT is produced during 2019-20 FY whereas 835,027 MT is imported thru private entity. Therefore, public and private sector combining do the marketing of 848,441 MT of LPG in 2019-20, which is meeting a certain portion of LPG demand of the country.

Table 8: LPG scenario of last 5 year

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

[Source: HCU Data Bank]

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

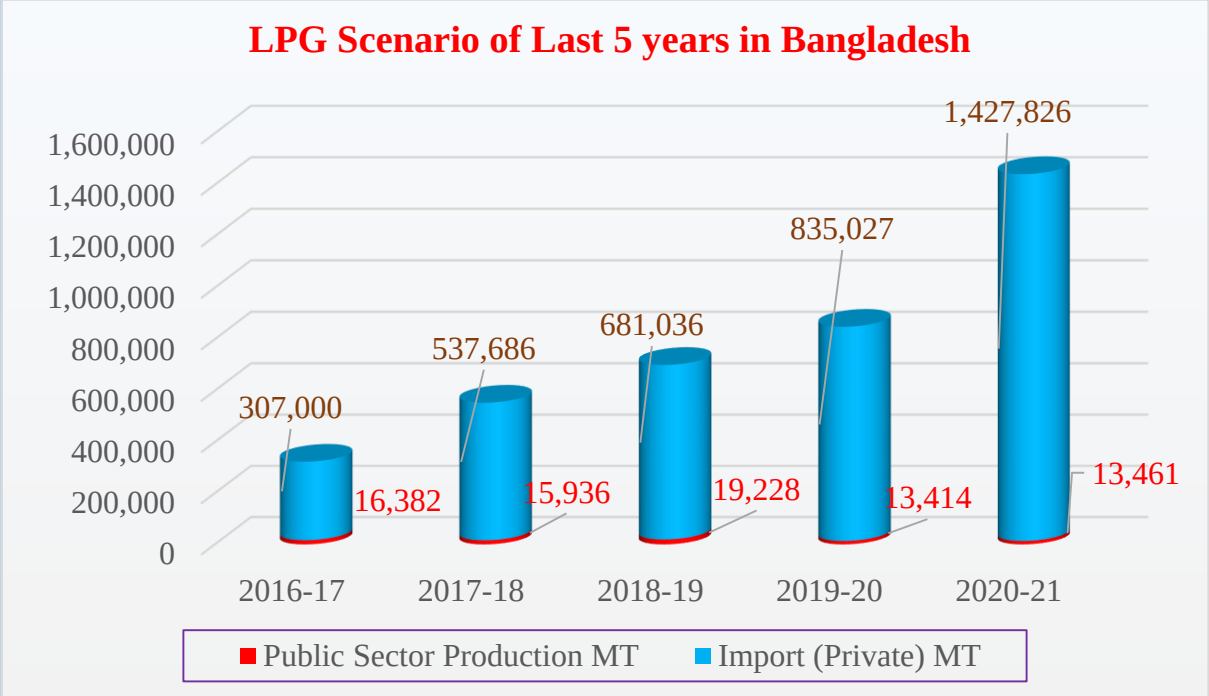

Figure 6: LPG Scenario in Last 5 years in Bangladesh

3.4 Coal Sector

3.4.1 Coal

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

5 coal fields so far discovered, namely Barapukuria, Khalaspir, Phulbari, Jamalganj and Dighipara. If initiatives are taken for exploration all over the country, there are enough possibilities to discover more coal

mines. Out of the discovered mines, coal from 4 de-posits (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. Energy is the main indicator of economic growth for a country and constitutes one of the vital infrastructural inputs in socio-economic development. At present, natural gas is the main indigenous primary energy source of Bangladesh. Several studies reveal that domestic production of natural gas will be depleting soon in the near future. Considering the uncertainty of sustainable supply of primary energy, it is imperative to diversify the primary energy sources in the country. In that case, domestic coal can be a major alternative energy source for the energy security of the country. At present 2.55 % of electricity has been produced from domestic coal.

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Table 9: Coal Fields of Bangladesh

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

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

Table 10: Coal scenario of last 5 year

Year	Public Sector Production	Import (Private)	Total (Metric Ton)
2014-15	675,775.50	1,812,030	2,487,806
2015-16	1,021,638	3,812,060	4,833,698
2016-17	1,160,657.81	2,801,407	3,962,065
2017-18	923,276.00	3,394,534.24	4,317,810
2018-19	803,315.00	5,754,025	65,57,339
2019-20	808,358	6,828,032	7,636,390
2020-21	753,973.00	6,751,000.00	7,504,973.00

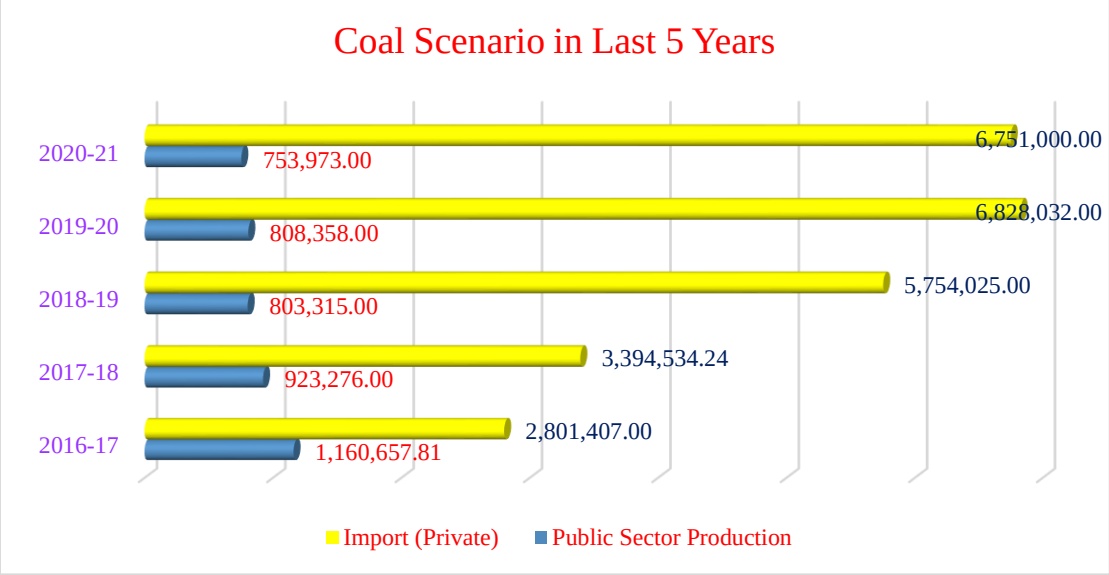


Figure 7: Coal scenario of last 5 year

Commercial production of Barapukuria Coal Mine commenced from 10 September 2005 using underground mining method with the targeted capacity of one million metric tons per year. Almost 65% of the production is being used by 250 MW (2x 125 MW) Coal fired power station operated by Power Development Board of Bangladesh near Barapukuria coal mine. Remaining 35% coal is being used in brick fields and other domestic purposes which have an impact of reducing deforestation. A total of 808,358 MT 10.75 million metric ton of coal has been extracted in the FY 2019-20 and 6,828,032 MT has been imported. As a result, 7,636,390 MT coal has been consumed in this FY.

Out of these 5 coal fields, Petrobangla has developed the first and only coal mine of the country at Barapukuria. Commercial production started from September 2005 and currently this mine is producing 3,000-3,500 metric tons of coal per day. From the beginning of the mine total 11.39 million metric tons of coal has been produced till December, 2019. In the year 2019, total 0.908 million metric tons of coal has been produced and the entire amount of produced coal are being used to operate the Barapukuria 525 MW coal fired power plant.

3.5 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-Chandabeel under Madaripur and Gopalganj district, Kola Mouza of Khulna district, Chatalbeel area of Moulavibazar district, Pagla, Dirai and Shalla area of Sunamganj district, Chorkai area of Sylhet district, BrahmanbariaSadarupazila of Brahmanbaria district and Mukundapur area of Habiganj district. It has a carbon content of 50-60% and has a calorific value between 5500 Btu/lb and 7000 Btu/lb.

The peat occurs at the surface or at shallow depths below the surface. The total peat reserve (dry peat) discovered in Bangladesh is 146.36 million ton. There is no commercial utilization of peat in Bangladesh at present. Peat can be conveniently used in the form of briquette, ovoid and compressed tablets as an alternative fuel to household work, in brick and lime industries and in small capacity thermal power plant (10 MW) in rural areas. Three exploration licenses of peat is granted in RajoirUpazila of Madaripur and KotaliparaUpazila of Gopalganj district.

3.6 Condensate and Natural Gas Liquids (NGL)

Some of the gas fields located in north - eastern part of Bangladesh contains high percentage of liquid hydrocarbon. Extraction of this liquid, especially value added by-products, is becoming a growing activity. Apart from the condensate fractionation plant installed in different gas fields, Rashidpur Condensate Fractionation Plant with a capacity of 3,700 bbl./day is producing petrol, diesel and kerosene by fractioning the condensate received from Bibiyana Gas Field.

During 2019-20, a total of 453,863.35 barrels of condensate was produced by SGFL, BGFCL and BAPEX and 3,384,009.59 barrels by IOCs as a by-product of gas. During the same period, SGFL, BGFCL and BAPEX extracted 22,110,000 litre or 139,068 barrels of NGL from the gas processed at its Mole-Sieve Turbo Expander plant at Kailashtila. On the other hand, a total of 187,861,463 litre of petrol, 43,369,875 litre of diesel and 23,268,332 litre of kerosene was produced by fractionating the condensate at the fractionation plants located at different fields of SGFL, BGFCL and BAPEX.

4.0 Power Sub-Sector

4.1 Primary Energy Mix for Power Generation

As of June 2020, the total power generation capacity combining public and private sector was 23,548 MW, leaving 20% capacity for maintenance and forced outage, available generation capacity should be about 18,838 MW without fuel constraint.

Maximum generation actually obtained till 30 June 2020 was 12,738MW, which was less than 18,838 MW. It might have occurred due to fuel supply constraint. Of the total generation capacity, distribution between public sector and private sector entities are 52% and 43% respectively and from import 5%. Bangladesh has started importing 500MW electricity from India (started in October 2013) additional 100 MW from March'16 and 560 MW from December 2018 which contributed 9% of total power generation.

Table 11: Bangladesh's Power Sector: At a Glance (2020-21)

Types	Amount
Electricity Growth	6.8%
Installed Capacity (MW)	23,548
Maximum Generation (MW)	12738
Total Consumers (in Millions)	37.30
Transmission Lines (km)	12,283
Distribution Lines (km)	577,000
Grid Substation Capacity (MVA)	45,194
Per Capita Generation (including Captive)	512 Kwh
Access to Electricity (including Off-Grid Renewable)	97%

[Source: Power Division Annual Report 2019-20]

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

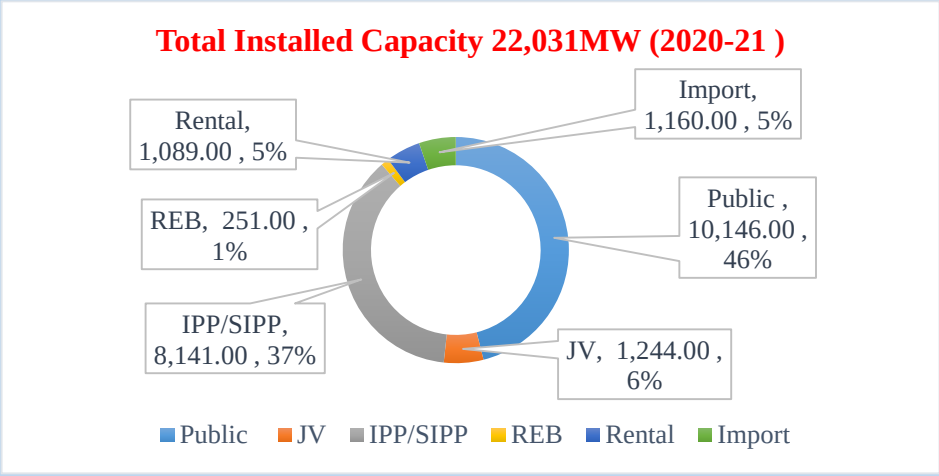


Figure 8: Total Capacity (22,031 MW) Scenario of Bangladesh

[Source: Power Division Annual Report 2020-21]

Table 12: Power Production Capacity (Technology wise) in MW 2020-21

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

[Source: Power Division Annual Report 2019-20]

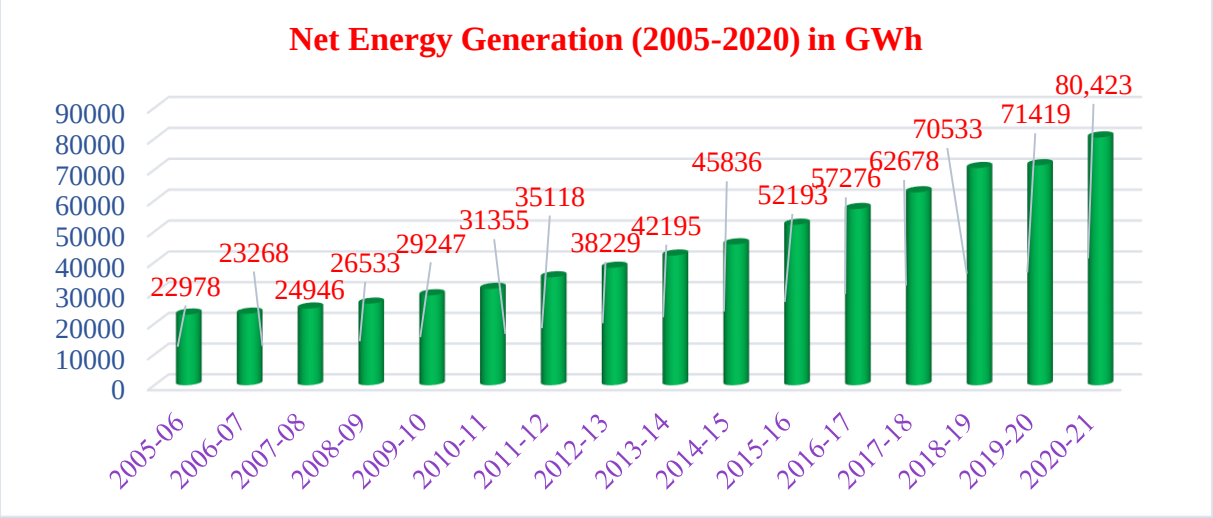


Figure 9: Historical Net Electricity Generation (GWh) in Bangladesh
[Source: Power Division Annual Report 2019-20]

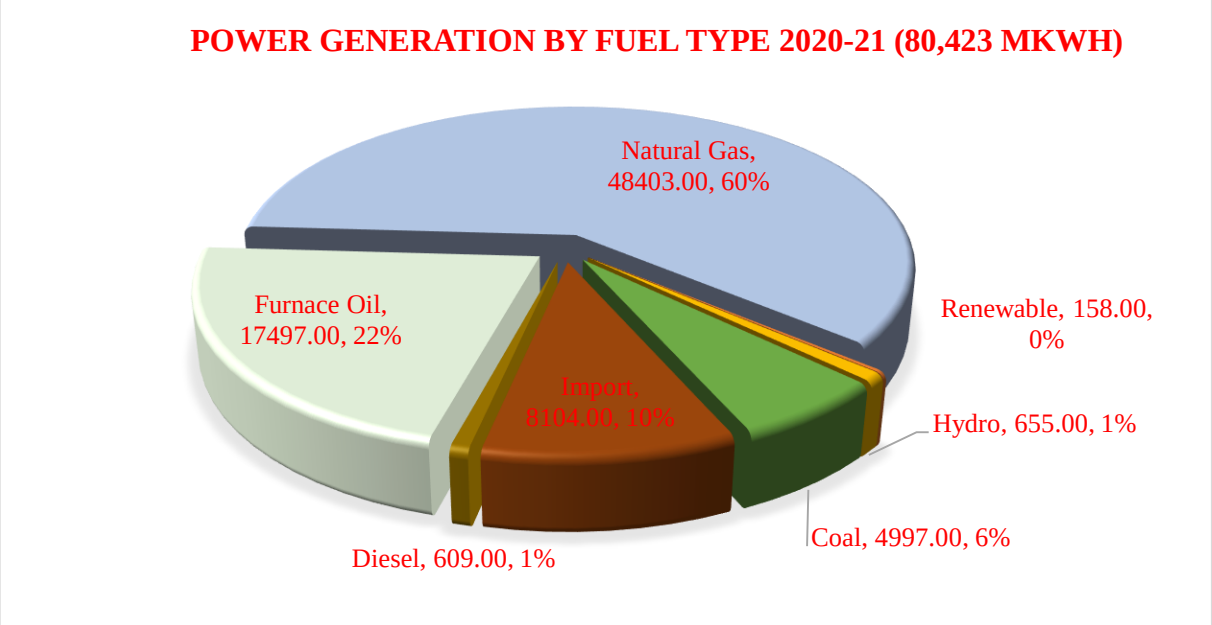


Figure 10: Power Generation by Fuel Type (2019-20)

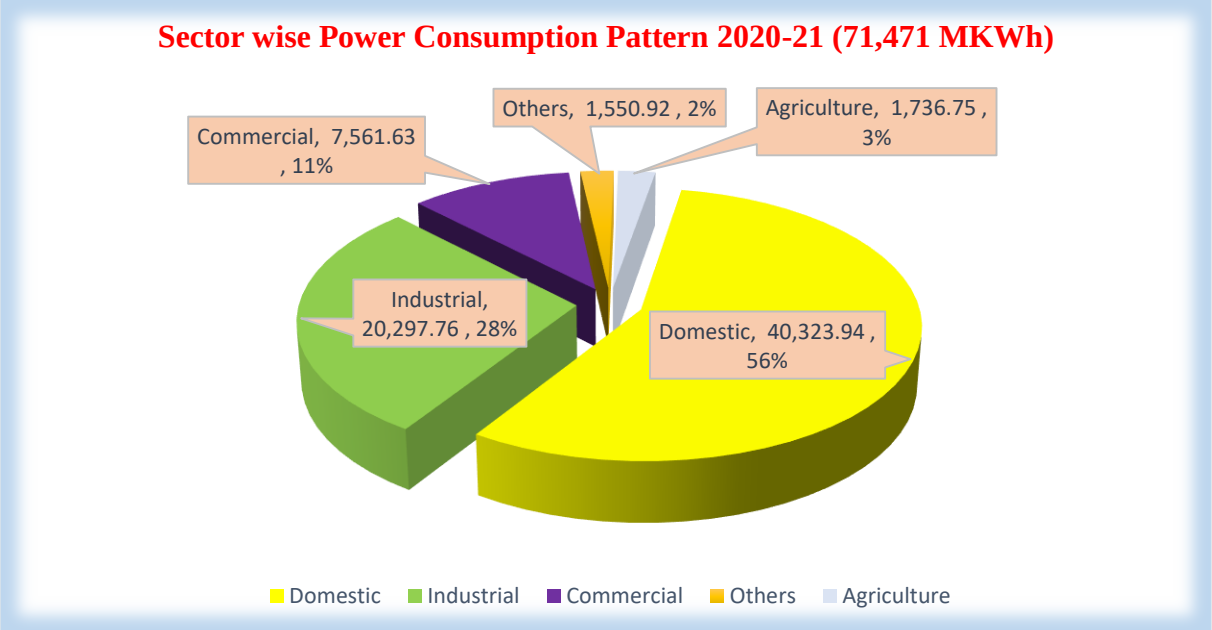


Figure 11: Sector wise Power consumption Pattern (2020-21)

4.2 Electricity Import

Bangladesh has entered into the era of cross border energy trade in October 2013 by importing electricity from India. Additional 100 MW from March 2016 from Tripura at present 1160 MW electricity is being importing from India and in near future it will increase considerably.

Figure 12: Bangladesh India Power Transmission Plant, Bheramara (Kustia)

Table 13: Electricity Import Scenario 2019-20

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

[Source: Power Division Annual Report 2019-20]

4.3 Renewable Energy Resources

Renewable energy resources could assist in the energy security of Bangladesh and could help reduce the natural gas demand. Regions of the country without supply or access to natural gas or the electric grid use biomass for cooking and solar power and wind for drying different grains and clothes. Biomass is currently the largest renewable energy resource in use due to its extensive noncommercial use, mainly for cooking and

heating. Biomass comprises 29 percent of the total primary energy use in Bangladesh. The country has a huge potential for generating solar power. Moreover the use of renewable energy has become popular worldwide in view of the depleting reserves of non-renewable fossil fuels. Renewable energy is environmentally friendly.

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

4.4 Traditional Biomass fuel

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 13: 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.

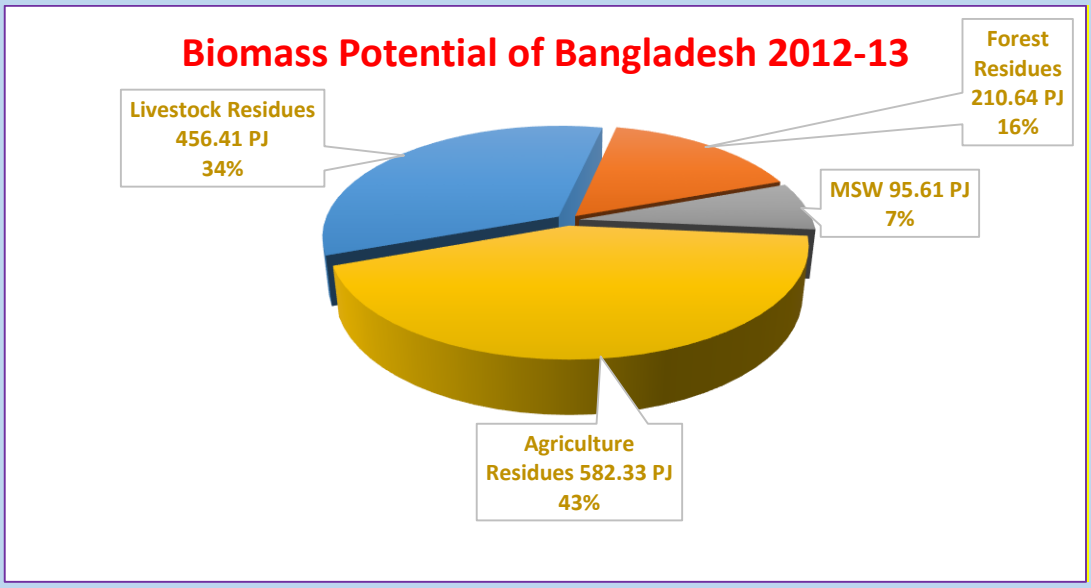


Figure 14: Biomass Potential of Bangladesh (2012 –13)

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 to373.71 TWh of electricity.

4.5 Conventional Hydropower

Total hydropower potential of the country was reported as 1500 MkWh/year at Kaptai (1000MkWh/year). Matamuhury (300MkWh/year) and Sangu (200MkWh/year) (GOB 1996). In 2013, total generation capacity of 5 hydropower units installed at Kaptai was 230MW and electricity generated was 8934 MkWh. Depending upon rainfall, yearly electricity generation capacity of hydro plants varies between 700 MkWh to 1000 MkWh. Total electricity generated in 2019-20 was 71,419 MkWh, of which the share of hydro power (primary electricity) was only 1.16 percent.

It was reported that a feasibility study was undertaken in 1998 to establish additional hydropower units (Nos. 6 & 7) at Kaptai with generation capacity of 100MW. There is potential to install hydropower plant at the Sangu and the Matamuhury rivers in the Chittagong Hill Tracts and possibility of constructing a second dam, six kilometers downstream of existing Kaptai dam to generate hydropower. Though in Chittagong Hill Tracts local population are already conscious about the negative impacts of existing hydropower plants at Kaptai proper rehabilitation 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.

4.6 New-Renewable Energy Resources

It was mentioned in the Renewable Energy Policy 2008 that 5% and 10% of total electricity would be generated using renewable energy by 2015 and 2020 respectively (GOB 2008). SREDA Act 2012 was enacted for the establishment of Sustainable & Renewable Energy Development Authority (SREDA) for promotion of efficient energy and renewable energy technology. The authority (SREDA) is in the process of institutionalization. Total generation of electricity from renewable energy sources (e.g. solar PV, biomass, biogas etc.) up to June 2019 was 368 MW. Total generation from RE including hydropower (230MW) was 648 MW, which was 2.75% of total electricity generation capacity (23,548 MW) of the country including off grid, RE and Captive in the FY 2019-20.

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.

4.6.1 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 15: Bangladesh's Largest (73 MW) Solar Power Plant, Mymensingh

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

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

[Solar Home System (SHS)]

Solar Home System (SHS) provides reliable power for lighting and operating low powered appliances such as radio, television, small electric fans. The electricity provided by a SHS can also be used to run Direct Current (DC) driven equipments such as DC shouldering irons, drilling machines etc and to charge the battery of mobile phones. Larger systems can run computers, refrigerators, pumps etc. IDCOL and BREB are distributing Solar Home System (SHS) to the people living in the off-grid areas. IDCOL through different partner organization has already distributed about 55 lakh (installed capacity 250 MW) SHS and BREB distributed about 15 thousand SHS throughout the country.

[Solar Irrigation System]

Solar powered irrigation is the breakthrough technology for energy stricken agro-based economy. Solar powered irrigation is the innovative and environment friendly solution for the irrigation system, which currently depends on hugely inefficient electric and diesel pumps. Gradually replacing the electric and diesel pumps for irrigation with solar water pumps could save significant capacity of electricity and huge investment cost. Upto June ’19 1158 nos solar irrigation pumps has been installed by IDCOL.

4.6.1 Bio fuel

Biofuels 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:
the Jamal gota (Jatropha curcas) and Verenda (RicinusCommunis). Both of these trees can grow virtually anywhere in any soil and geo- climatic condition.

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

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

4.6.3 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. 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 renewables-based systems increasingly cost-competitive in coming decades (IEA 2011).

4.6.4 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, specially at Cox's Bazar and at the islands of Moheshkhali 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, Moheshkhali, 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 2x73 kva 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.

4.6.5 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 specially 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 height 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.

4.6.6 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.

4.6.7 Waste to Electrical Energy

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

4.6.8 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.

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.

Table 14: Planned Nuclear Power Reactors

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

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.

5.0 Comparison with other country

Bangladesh is one of the less consuming primary energy country. Primary energy potential is not bad, but that should be explored. The country is facing a huge energy crisis. There is no alternative to increase primary energy supply. As per global and regional context we are far behind of energy supply vis a vis energy consumption. There should be a comprehensive plan to capitilaize coal (Local & Imported) as primary fuel due the concern of carbon emission and GHG mitigation in our country to meet the energy demand of SDG 2030 as well as vision 2021.

5.1 Energy mix of India

India was the fourth-largest energy consumer in the world after China, the United States, and Russia despite having notable fossil fuel resources, the country has become increasingly dependent on energy imports.

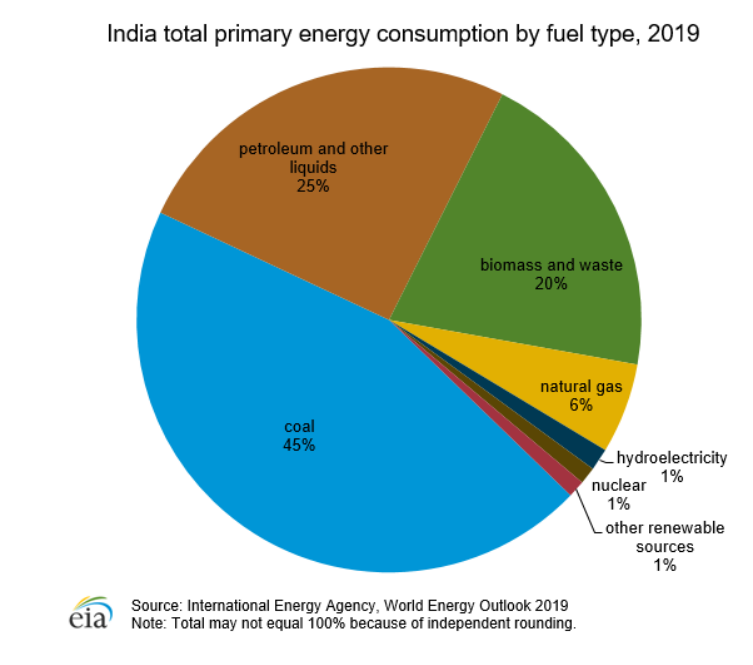


Figure 7 :Energy Mix of India [Source: U.S Energy Information Administation]

Total energy consumption in 2019 was 31.783 quadrillion Btu (equivalent to 800.92 Mtoe) with a per capita of 23.23 million Btu . Highest percentage came from coal 45%, petroleum product contributed 25%, biomass 20% natural gas 6% , hydroelectric 1%, nuclear 1% and other renewal 1%. Heavily dependent on fossil fuel (70% of total consumption). [Source: U.S Energy Information Administation]

Despite having large coal reserves and a healthy growth in natural gas production over the past two decades, India is increasingly dependent on imported fossil fuels. Primary energy consumption in India has more than doubled between last couple of decades.

5.2 Energy mix of China

China is the world's most populous country with a fast-growing economy that has led it to be the largest energy consumer and producer in the world. Rapidly increasing energy demand, especially for liquid fuels, has made China extremely influential in world energy markets.

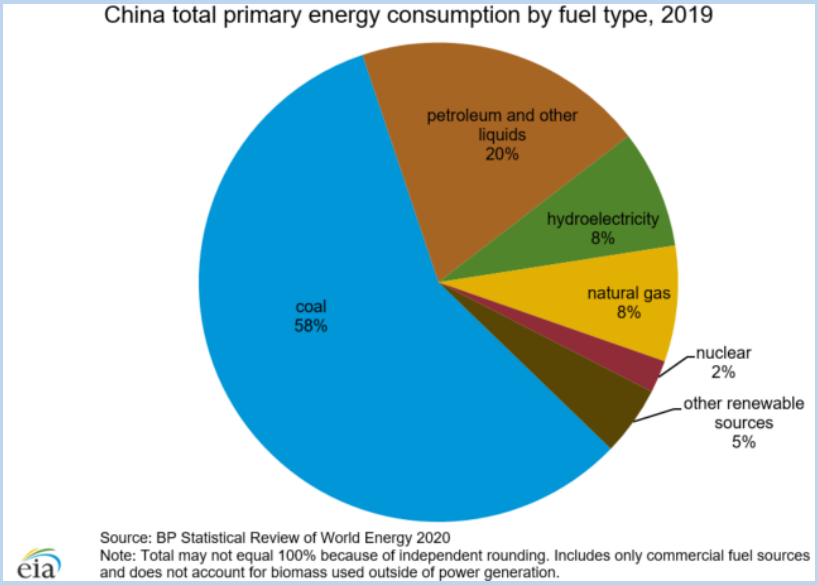


Figure8: Energy Mix of China [Source: U.S Energy Information Administation]

Coal supplied the vast majority (58%) of China's total energy consumption in 2019. Oil was the second-largest source, accounting for 20% of the country's total energy consumption. While China has made an effort to diversify its energy supplies, hydroelectric sources (6%), natural gas (8%), nuclear power (nearly 2%), and other renewables (5%) accounted for relatively small shares of China's energy consumption. [Source: U.S Energy Information Administation]

5.3 Energy mix of South Korea

South Korea relies on imports to meet about 97% of its energy demand as a result of insufficient domestic resources, and the country is one of the world's leading energy importers.The U.S. Energy Information Administration (EIA) estimates that South Korea was the world's ninth-largest energy consumer in 2011. Korea is one of the top energy importers in the world and relies on fuel imports for about 97% of its primary energy demand because the country lacks domestic energy reserves.

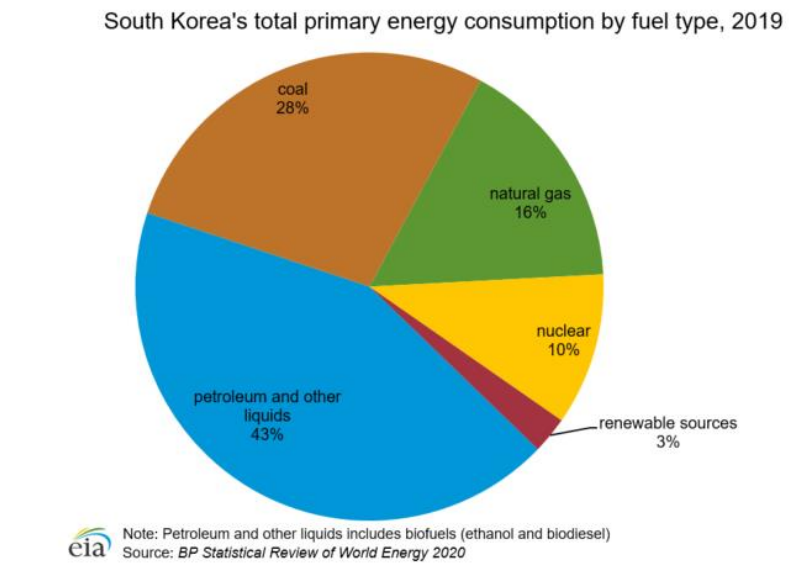


Figure 9: Energy Mix of South Korea [Source: U.S Energy Information Administation]

In 2019 the total consumption of energy was 12.414 quadrillion Btu. Out of total consumption of energy petroleum product contribute highest 43%, then coal 28% , natural gas 16%, nuclear 10% and other renewables 3%.

South Korea's highly developed economy drives its energy consumption, and economic growth is fueled by exports, most notably exports of electronics and semiconductors. The country also contains one of the world's top shipbuilding industries. [Source: U.S Energy Information Administation]

5.4 Energy mix of Malaysia

Malaysia is the world's second-largest exporter of liquefied natural gas and the second-largest oil and natural gas producer in Southeast Asia, and is strategically located amid important routes for seaborne energy trade.

As Malaysia targets economic development and increased manufacturing, the country is focused on securing energy through cost-effective means and diversifying its fuel supply portfolio. Petroleum and other liquids and natural gas are the main primary energy sources consumed in Malaysia, with estimated shares of 37% and 36%, respectively in 2012.

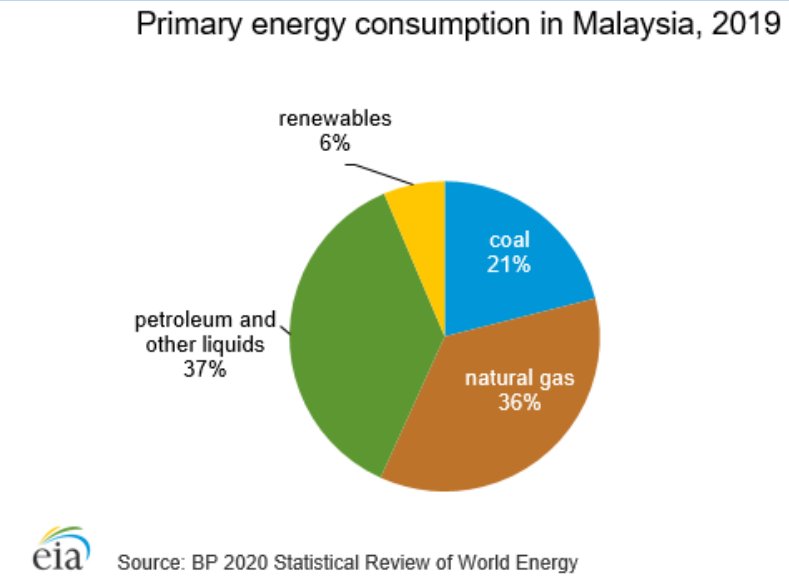


Figure 10 : Energy Mix of Malaysia [Source: U.S Energy Information Administation]

About 21% of the country's energy consumption is met by coal. Renewable energy contributes 6% to total consumption. Malaysia's heavy reliance on oil and natural gas to sustain its economic growth is causing the government to emphasize fuel diversification through coal imports and to promote investments in renewable energy. [Source: U.S Energy Information Administation]

5.5 Energy mix of Russia

Russia is the second-largest producer of dry natural gas and third-largest liquid fuels producer in the world. Despite its significant reserves of coal, it produces only modest amount of coal. Russia's economy is highly dependent on its hydrocarbons, and oil and gas revenues account for more than 50% of the federal budget revenues.

Russia is a major producer and exporter of oil and natural gas, and its economy largely depends on energy exports. Russia's economic growth continues to be driven by energy exports, given its high oil and gas production and the elevated prices for those commodities.

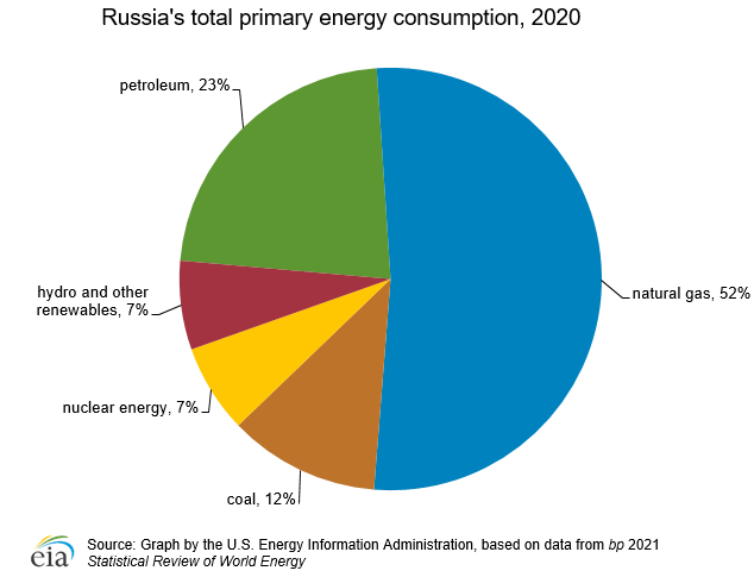


Figure 11 : Energy Mix of Russia [Source: U.S Energy Information Administation]

Among total primary energy consumption, natural gas contains 52%, petroleum 23%, coal 12%, hydro and other renewables contain 7% and nuclear energy 7%. Russia consumed 33.245 quadrillion Btu of total energy with per capita consumption 227.9 million Btu per person (Equivalent to 5,747.638 Kgoe in 2019). Energy consumption per GDP of Russia is 8.8 thousand Btu per USD at purchasing power parities. [Source: U.S Energy Information Administation]

5.6 Energy mix of Australia

Australia, rich in hydrocarbons and uranium, was the world's one of the largest coal exporter and the one of the largest liquefied natural gas (LNG) exporter in the world. Australia has experienced limited energy demand growth because of lower levels of energy intensity compared to a few decades ago. Energy efficiency measures in many end-use sectors, technological advances, and a shift from heavy industries to a more service-sector oriented economy have resulted in a decrease in Australia's energy intensity.

Australia is heavily dependent on fossil fuels for its primary energy consumption. In 2019, petroleum and other liquids accounted for an estimated 38% of the country's total energy used. The share of oil consumption has risen in the past few years as it supports the country's commodity production growth, mining, and petrochemical industry as well as the transportation sector.

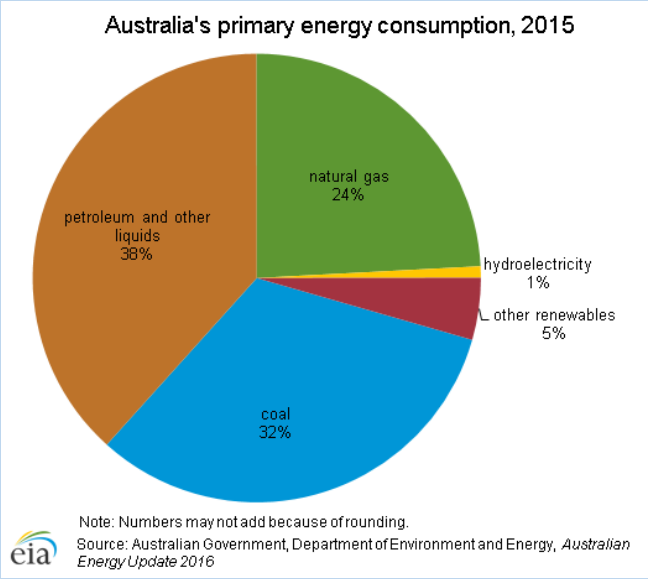


Figure 12 : Energy Mix of Australia [Source: U.S Energy Information Administation]

Coal and natural gas account for 32% and 24% of the energy demand portfolio, respectively. Renewable sources, including hydroelectricity, wind, solar, and biomass accounted for more than 6% of total consumption.

5.7 Energy mix of USA

The United States is the 2nd largest energy consumer in terms of total use. The majority of this energy is derived from fossil fuels: in 2019, data showed 37% of the nation's energy came from petroleum, 11% from coal, and 32% from natural gas. Nuclear power supplied 8% and renewable energy supplied 11%, which was mainly from hydroelectric dams and biomass but also included other renewable sources such as wind power, geothermal and solar energy.

In the Renewable Energy (11%) share, biomass accounts for 43%, wind 24%, hydroelectric power contains 22%, solar 9%, geothermal 2% share respectively.

[Source: U.S Energy Information Administation]

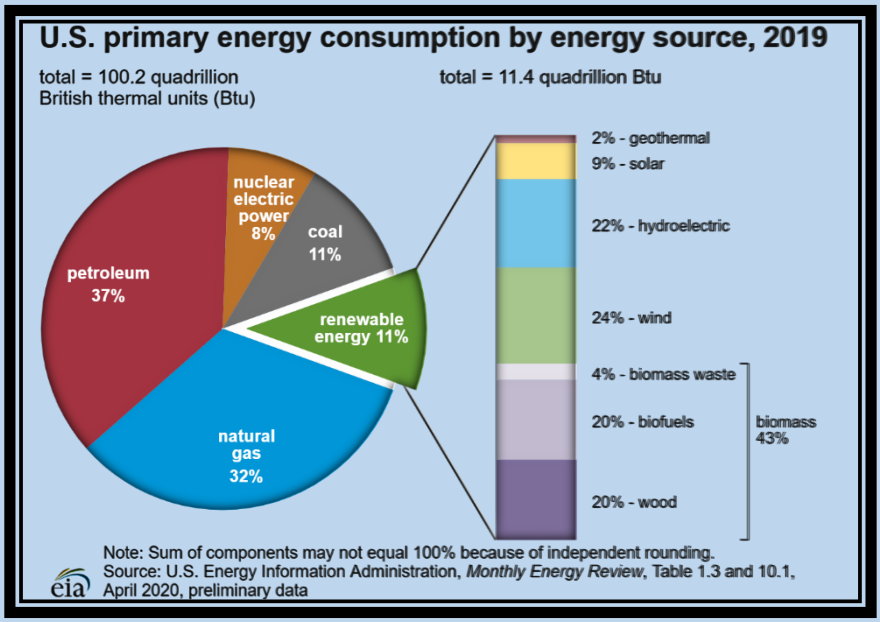


Figure 13 : Energy Mix of USA [Source: U.S Energy Information Administation]

5.8 World Energy mix

World energy consumption refers to the total energy used by all of human civilization. Typically measured per year, it involves all energy harnessed from every energy source applied towards humanity's endeavors across every industrial and technological sector, across every country.

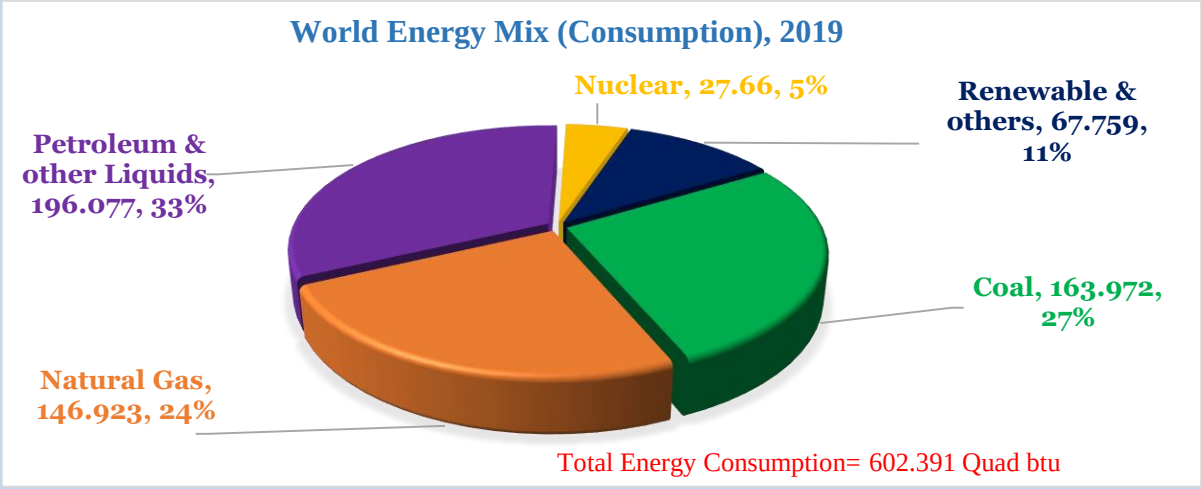
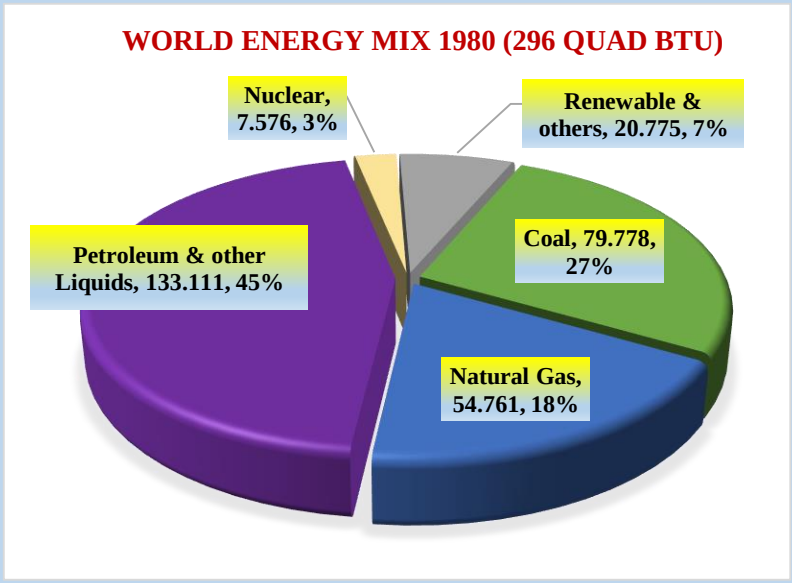


Figure 14 :Energy Mix of World [Source: U.S Energy Information Administation]

As per U.S Energy Information Administation 2019, the total primary energy supply was 602.391 Quad btu (Equivalent to 15,192.30 mtoe). Highest supplier of primary energy was petrolieum oil 33%, second highest coal 27 %, then natural gas 24%, nuclear 5% , renewable & others is 11%. A comparision of fuel shares of world total primary energy supplies between 1980 and 2012 as per U.S Energy Information Administation is shown in the following Figure 15.



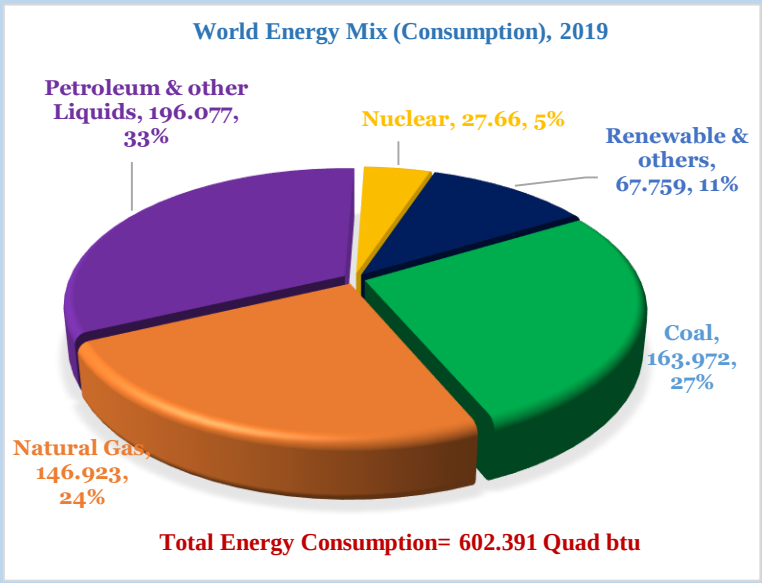


Figure 15 : Fuel Shares of TPES (1973 & 2019) [Source: U.S Energy Information Administation]

5.9 Projection of World Energy

Total global energy consumption in 2035 is projected as 18,301mtoe and the projected energy mix is: fossil fuels 80%, nuclear 6% and renewable 14% (Figure 17).

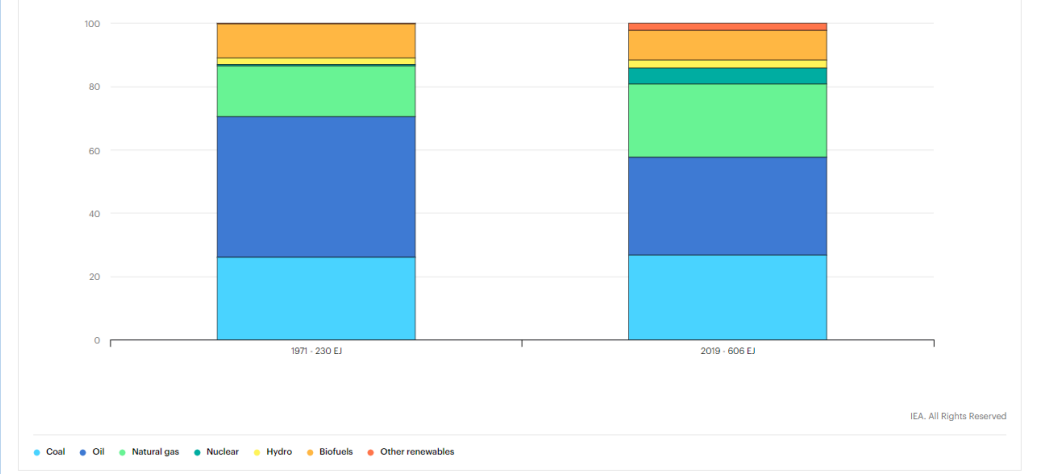


Figure 16: World total primary energy supply (1971– 2019) [Source: IEA]

It is generally opined that the reserves of non-renewable fossil fuels are finite in quantity; future energy demand of the country should be met by nuclear and renewable sources of energy. Above analyses indicate that in 2035 major portion of world energy will be met by fossil fuels.

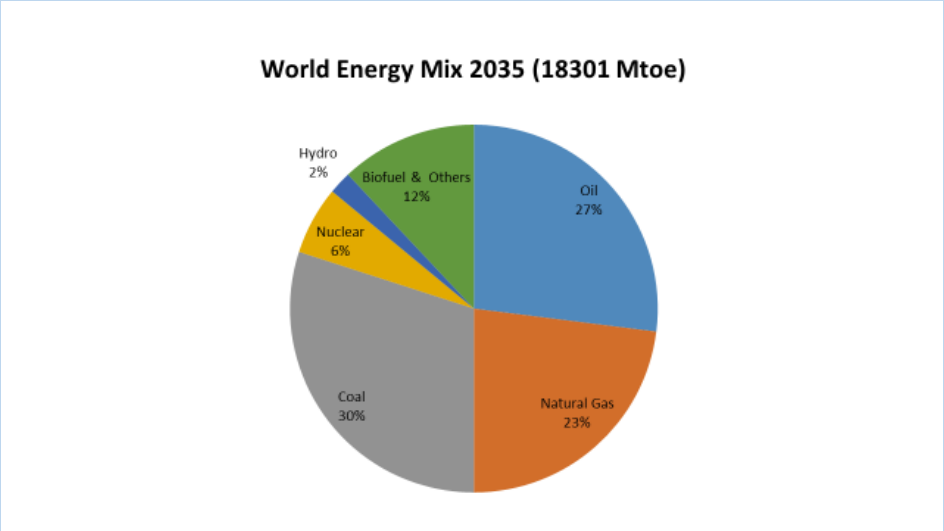


Figure 17 :World Energy Mix 2035 [Source: U.S Energy Information Administation]

It may be inferred that in future fossil fuels will continue to play more important role in meeting the total energy need of Bangladesh, compared to nuclear and renewable energy.

6.0 Energy Economic Relationship

6.1 Energy and Social Development

Energy is an essential commodity for most human activities, directly (as fuel) or Indirectly (to provide power, light, mobility). In traditional societies, populations rely on their own physical strength for labour, then on the power of domesticated animals, such as horses and oxen, then on water and wind, steam engines, hydrocarbons (fuel motors for land, sea and air vehicles) and finally - electricity. Energy combined with technology multiplies human force (e.g. motor fuel for cars, electricity for Household appliances), thereby playing a crucial role in pre- and post-industrial and then IT societies. For other essential needs such as space heating and cooking, the transition has been from local biomass (e.g. firewood, agriculture waste) to industrialized fuels (e.g. LPG, natural gas) and also electricity . Poor access to reliable and affordable modern energy services therefore acts as a barrier to economic and social development.

6.2 Energy-Economy Nexus

Energy is a critical input for socio-economic development. It is consumed to meet energy requirement for subsistence (e.g. cooking, lighting, room heating etc. at household level) needs and for productive activities (e.g. agriculture, industries, transport, commercial etc.). In the Least Developed Countries (LDCs) major portion of total energy is consumed to meet subsistence need and the demands are met mainly by traditional energy sources including biomass fuels; and smaller portion is consumed in productive sectors by using commercial energy resources (e.g. coal, oil, natural gas and hydropower). When a country moves upward in the economic ladder, simultaneously it also move up in the energy ladder (inferior energy to superior energy). With the increase of per capita commercial energy consumption, proportion of energy used for subsistence needs decreases and productive needs increases. In industrialized countries major portion of energy is consumed to meet productive needs and smaller portion to meet subsistence needs.

Economic growth of a country mostly depend on it. Energy consumption, Economic growth, Capital, Manpower are co integrated. It is seen that there is positive correlation between per capita commercial energy consumption and per capita GNI; it means that increase in per capita consumption of commercial energy is necessary to increase per capita GNI. This correlation is different among the developing, under developed and developed countries.

6.3 Energy Economic relation in Bangladesh

In Bangladesh, some spokes person of the civil society desired to increase the economic level of the country to that of the middle-income countries by 2021, high income economies by 2041 without mentioning increasing needs of energy. According to World Bank, per capita GNI of Bangladesh, low-income, lower-middle-income, upper middle-income and high income economies were US$ 2,030, GNI >US$ 1045, GNI 1,046 – 4,095 US $, GNI 4,126-12,745 US $ and GNI >12,746 US $ respectively.

A plot of Energy Consumption per capita (Million Btu/Person) vs. Energy Consumption per GDP (Thousand Btu/USD at PPP) of some selected Countries in 2019 is shown in Figure 19. Energy Consumption per capita (Million Btu/Person) of Bangladesh is 9.92 MBtu/person.

It is very appreciable that Bangladesh has alrady attained lower middle-income level and aspires to attain upper middle income economy (US$ 4,126 – 12,745) by 2031. Policy planners and decision makers need to recognize increasing need of energy to achieve higher per capita GNI level. It will be challenging tasks to increase projected consumption of energy on sustainable basis.

6.4 Energy Economic Relation in others Countries

Advanced industrialized societies use more energy per unit of economic output and far more energy per capita than poorer societies, especially those remaining in a pre-industrial state. Energy use per unit of output does seem to decline over time in the more advanced stages of industrialization, reflecting the adoption of increasingly more efficient technologies for energy production and utilization as well as changes in the composition of economic activity. And energy intensity in today's developing countries probably peaks sooner and at a lower level along the development path thanwas the case during theindustrialization of today's developed world. But even with trends toward greater energy efficiency and other dampening factors, totalenergy use and energy use per capita continue to grow in the advanced industrialized countries and even more rapid growth can be expected in the developing countries as their incomes advance.Development involves a number of other steps besides those associated with energy, notably including the evolution of education and labor markets, industrialization, employment generation,financial institutions to support capital investment, modernization of agriculture, and provision of infrastructure for water, sanitation, and communications. Nevertheless, it is hard to imagine overall economic development succeeding without energy development being an integral part of the evolution.

Energy Economic Relation in Different Countries, 2019			
No.	C ountry's Name	Energy Consumption per capita (Million Btu/Person)	Energy Consumption per GDP (Thousand Btu/USD at PPP)
1	Bangladesh	9.92	2.03
2	India	23.23	3.41
3	Pakistan	15.86	3.3
4	Srilanka	17.27	1.33
5	Japan	149.67	3.54
6	Indonesia	29.68	2.49
7	Malaysia	123.76	4.36
8	Taiwan	160.67	3.08
9	Vietnam	36.39	3.83
10	Hongkong	172.01	2.9
11	Singapore	639.95	6.68
12	China	105.69	6.56
13	South Korea	242.35	5.75
14	Qatar	723.58	8.29
15	Kuwait	382.71	8.88
16	Saudi Arabia	296.95	5.74
17	UAE	471.79	6.95
18	Brazil	59.44	4.13
19	SouthnAfrica	96.26	7.19
20	UK	121.14	2.7
21	Sweden	208.85	4.14
22	Norway	333.83	5.41
23	France	151.05	3.48
24	Germany	162.83	3.24
25	Italy	112.22	2.87
26	Australia	251.68	5.21
27	Turkey	79.13	2.83
28	Russia	227.91	8.82
29	Canada	398.34	8.62
30	USA	304.31	5.04

[Source: Report on “Key World Energy Statistics 2021”]

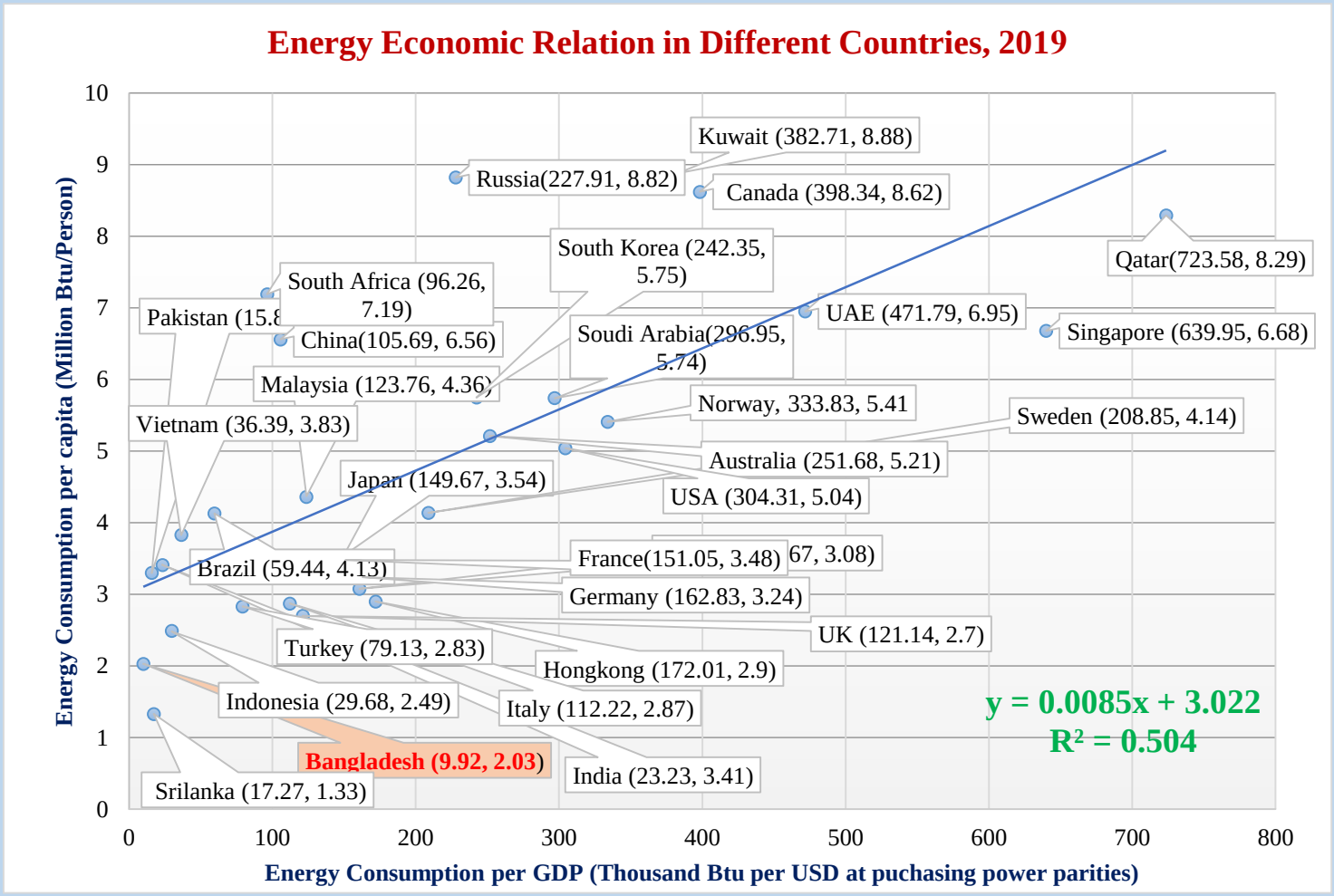


Figure 19 :Energy – Economy Relation in Different Developed & Developing Countries'2012

[Source: Report on "Key World Energy Statistics 2021"]

GDP/Capita vs. TES/Capita, 2019			
No.	**Country's Name**	**GDP/Capita (USD)**	**Total Energy Supply/Capita (GJ/Capita)**
1	Bangladesh	1,604.29	11.20
2	India	1,988.29	28.70
3	Pakistan	1,487.07	21.50
4	Srilanka	4,229.36	23.20
5	Japan	36,416.34	137.80
6	Indonesia	3,877.68	37.30
7	Malaysia	11,365.63	120.40
8	Vietnam	2,603.11	39.60
9	Hongkong	44,466.67	78.60
10	Singapore	60,649.12	252.70
11	China	10,243.83	101.50
12	Qatar	607,142.86	611.30
13	Kuwait	27,190.48	369.10
14	Saudi Arabia	19,784.26	262.20
15	UAE	395,795.92	225.50
16	Brazil	8,573.19	58.10
17	South Africa	5,569.97	100.20
18	United Kingdom	46,637.72	107.00
19	Sweden	53,378.64	199.70
20	Norway	76,773.58	214.70
21	France	40,258.46	150.50
22	Germany	43,155.23	148.30
23	Italy	31,752.90	103.40
24	Australia	52,700.79	212.50
25	Turkey	12,076.27	74.50
26	Russia	10,010.39	224.10
27	Canada	449,497.34	340.30
28	USA	60,805.18	282.00

Total energy consumption per capita of Bangladesh in 2019 was 9.92 MBtu/person, India 23.23 MBtu/person, Pakistan 15.86 MBtu/person, Srilanka 17.27 MBtu/person, China 105.69 MBtu/person, Vietnam (697 Kgoe) Indonesia (857 Kgoe), Malaysia (2639 Kgoe), Brazil (1371 Kgoe) . In Figure19 & 20 Energy Economy Relation in different developing countries for 2012 is shown. We are far behind of Asia Standard (890 Kgoe) and Global Standard (1880 Kgoe).

6.5 Energy consumption per capita of some countries on income level

a. Low income country (GNI per cap < 1045 US $)

Country	Energy Consumption per Capita (million Btu per person)	Energy Consumption per GDP (thousand Btu per USD at PPP)
Afganistan	3.23	1.55
Ethopia	3.22	1.56
Benin	8.47	2.63

[Source: US Energy Information Administration]

b. Lower Middle income country (GNI per cap 1,046 – 4,095 US $)

Country	Energy Consumption per Capita (million Btu per person)	Energy Consumption per GDP (thousand Btu per USD at PPP)
Bangladesh	9.92	2.05
Pakistan	15.86	3.28
Srilanka	17.27	1.33
India	23.23	3.42

[Source: US Energy Information Administration]

c. Upper Middle income country (GNI per cap 4126 - 12745 US $)

Country	Energy Consumption per Capita (million Btu per person)	Energy Consumption per GDP (thousand Btu per USD at PPP)
Maldives	59.69	3.15
Thailand	76.71	4.28
China	105.69	6.56
Malaysia	123.76	4.36

[Source: US Energy Information Administration]

d. High income country (GNI per cap > 12746 US $)

Country	Energy Consumption per Capita (million Btu per person)	Energy Consumption per GDP (thousand Btu per USD at PPP)
Japan	147.11	3.49
France	151.05	3.48
Australia	241	5
Singapore	639.95	6.67

[Source: US Energy Information Administration]

On the top of this low level of consumption, there isalready a serious energy crisis which is the result of sluggish growth in energy supplies while thedemand for energy has grown by leaps and bound attendant with higher economic growth.Clearly, the situation calls for an urgent but well-crafted sustainable long-term strategy toaddress the energy crisis and increase the energy supply to support Bangladesh's development. Energy options from domestic sources needs to be complemented with possible options for energy trade. Specifically, the strategy will address what the government can do about gas and power, and will look at options for diversification of fuels for generation. The strategy will also explore alternative solutions such as increased electricity imports from neighboring countries and LNG trade. Furthermore exploration of domestically available resources, such as coal and oil and gas from offshore drilling will be intensified. The supply side options will be balanced with policies for demand management that conserve energy and discourage inefficient use of energy.

To determine energy – economy relation of 42 developed, underdeveloped and developing countries are shown in figure20. From the figure it is clear that though the relation is not linear, per capita GNI of a country is depend on consumption of energy per capita.

6.6 Energy – Economy Relation in Different Developed & Developing Countries

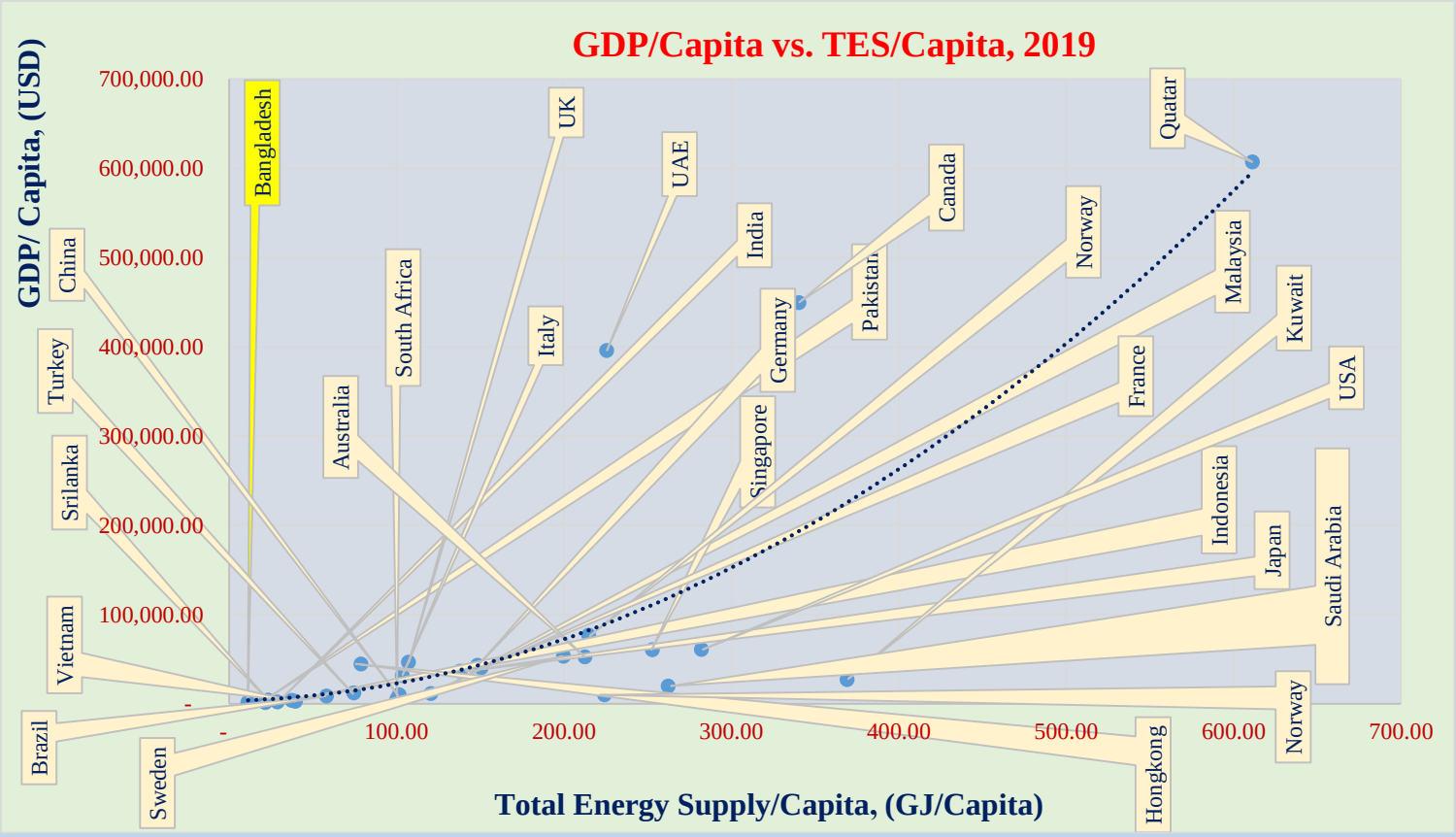


Figure 20: Energy – Economy Relation in Different Developed & Developing Countries'2019

To realize vision 2021 of Government of Bangladesh **Energy security** will be one of the critical element. The Plan aims to develop an integrated and developed energy sector with a diversified fuel mix that will be the key driver of a sustainable local and national economy, while attaining global competitiveness in all sectors by 2021. The Plan will ensure prompt and timely decisions to steadily encourage greater private sector role in the energy sector; ensure transparent governance of energy-related public sector institutions; enhance the development of human capital; support development of the energy sector through physical and systemic structures; and contribute to the protection and enhancement of the natural environment. It will also promote renewable energy, such as solar and biogas; and ensure access to power and energy to all.

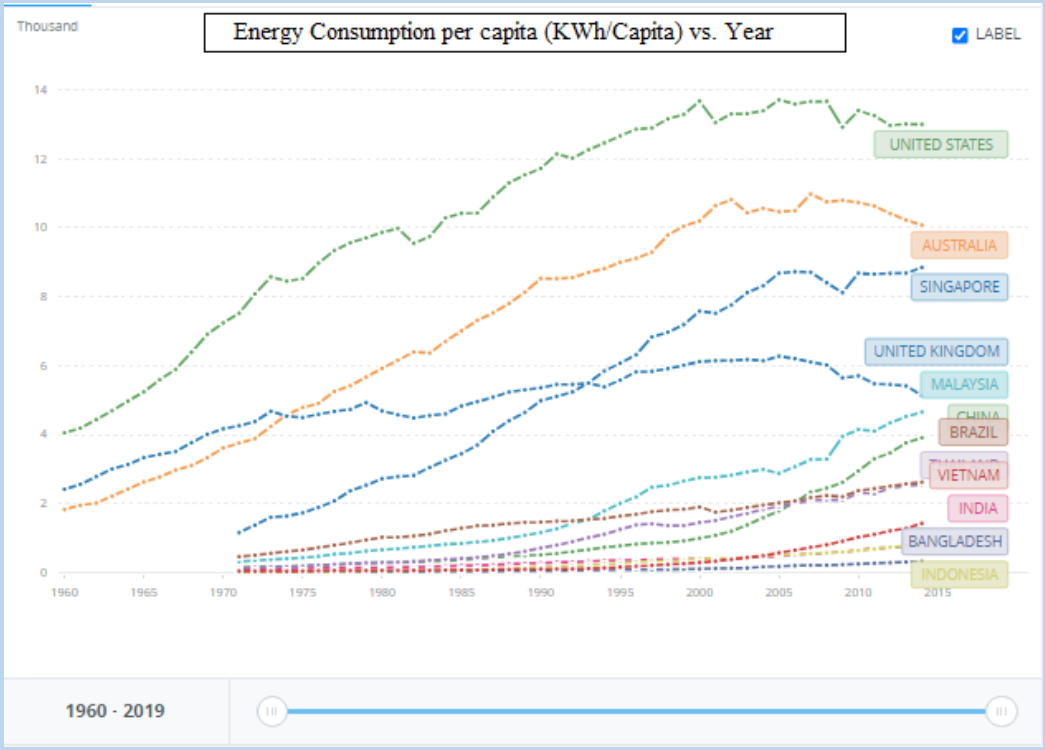


Figure 21: Year wise per capita Energy consumption (KWh/Capita) in Different Developed & Developing Countries

[Source: data.worldbank.org]

6.7 Efficient Energy Use

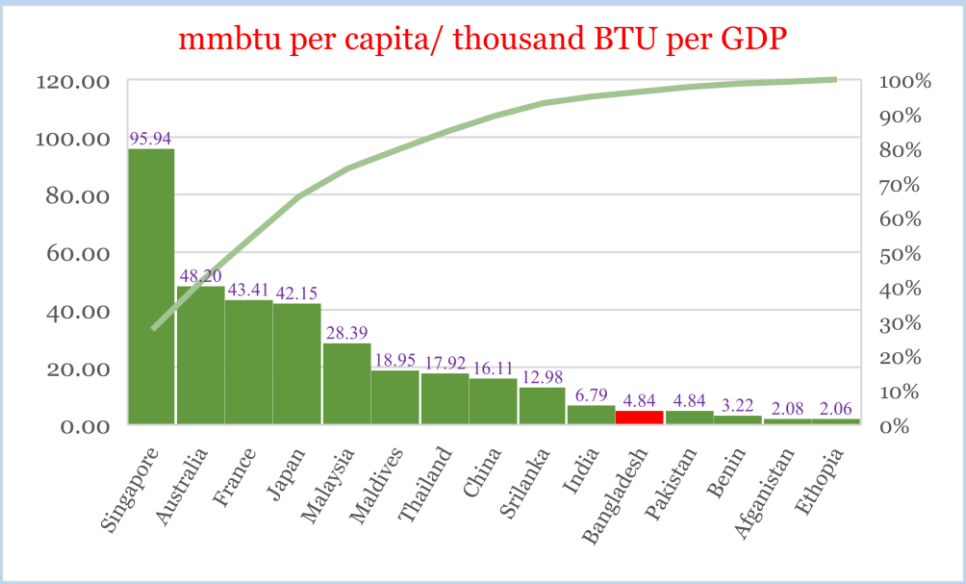


Figure 23 : Efficient Energy Use in Different Developed & Developing Countries'2019

[Source: U.S. Energy Information Administration]

7.0 Economic Status of Countries

World bank classify the member states every year for the purpose of lending issue on the basis of income level in the category of Low Income, Lower Middle Income , Upper Middle Income and High Income. In Table 10 the classification criteria is shown. In table 9 list of some countries on different income level are shown. As per BBS our GNI per cap is 1314 US$ in 2014-15 , we are now on the level of lower middle income. Though as per world bank our GNI I is 1080 US$. As a result World Bank has categorized our country as a Lower Middle Income country.

7.1 World Bank Classification of Countries

Table 10 :World Bank Classification of Countries

Group	July 1, 2021 (new)	July 1, 2020 (old)
Low income ($)	<1,045	
Lower-middle income ($)	1,046 – 4,095	1,035 – 4,045
Upper-middle income ($)	4,096 -12,695	4,046 -12,535
High income ($)	> 12,695	> 12,535

[Source: Data Help Desk-World Bank]

Economy Types	Income Level	Name of the Countries
Low Income Economies (27 Countries)	$1,045 or Less	Afghanistan, Guinea-Bissau, Somalia, Burkina Faso Korea, Dem. People's Rep South Sudan, Burundi, Liberia, Sudan, Central African Republic, Madagascar, Syrian Arab Republic, Chad, Malawi, Togo, Congo, Dem. Rep, Mali, Uganda, Eritrea, Mozambique, Yemen, Rep. Ethiopia Niger, Gambia, The Rwanda, Guinea, Sierra Leone.

[Source: Data Help Desk-World Bank]

Economy Types	Income Level	Name of the Countries
Lower-Middle Income Economies (55 Countries)	$1,046 to $4,095	Angola, Honduras, Philippines, Algeria, India, Samoa, Bangladesh, Indonesia, São Tomé and Principe, Belize, Iran, Islamic Rep, Senegal, Benin, Kenya, Solomon Islands, Bhutan, Kiribati, Sri Lanka, Bolivia, Kyrgyz Republic, Tanzania, Cabo VerdeLao, PDR, Tajikistan, Cambodia, Lesotho, Timor-Leste, Cameroon, Mauritania, Tunisia, Comoros, Micronesia, Fed. Sts., Ukraine, Congo, Rep. Mongolia, Uzbekistan, Côte d'Ivoire, Morocco, Vanuatu, Djibouti, Myanmar, Vietnam, Egypt, Arab Rep. Nepal, West Bank and Gaza El Salvador, Nicaragua, Zambia, Eswatini, Nigeria, Zimbabwe, Ghana, Pakistan, Haiti, Papua New Guinea.

[Source: Data Help Desk-World Bank]

Economy Types	Income Level	Name of the Countries
Upper Middle Income Economies (55 Countries)	$4,096 to $12,695	Albania, Gabon, Namibia, American Samoa,Georgia, North Macedonia, Argentina, Grenada, Panama, Armenia, Guatemala, Paraguay, Azerbaijan, Guyana, Peru, Belarus, Iraq, Romania, Bosnia and Herzegovina, Jamaica, Russian Federation, Botswana, Jordan, Serbia, Brazil, Kazakhstan, South Africa, Bulgaria, Kosovo, St. Lucia, China, Lebanon, St. Vincent and the Grenadines, Colombia, Libya, Suriname, Costa Rica, Malaysia, Thailand, Cuba, Maldives, Tonga, Dominica, Marshall Islands, Turkey, Dominican Republic Mauritius, Turkmenistan, Equatorial Guinea, Mexico, Tuvalu, Ecuador, Moldova, Fiji, Montenegro.

[Source: Data Help Desk-World Bank]

Economy Types	Income Level	Name of the Countries
Upper Income Economies (80 Countries)	$12,696 or above	Andorra, Greece, Poland, Antigua and Barbuda, Greenland, Portugal, Aruba, Guam, Puerto Rico, Australia, Hong Kong, SAR, China, Qatar, Austria, Hungary, San Marino, Bahamas, The Iceland Saudi Arabia, Bahrain, Ireland, Seychelles, Barbados, Isle of Man, Singapore, Belgium, Israel, Sint Maarten (Dutch part), Bermuda, Italy, Slovak Republic, British Virgin Islands, Japan, Slovenia, Brunei Darussalam Korea, Rep. Spain, Canada, Kuwait St. Kitts and Nevis, Cayman Islands, Latvia St. Martin (French part), Channel Islands, Liechtenstein, Sweden, Chile, Lithuania, Switzerland, Croatia, Luxembourg, Taiwan, China, Curaçao, Macao, SAR, China, Trinidad and Tobago, Cyprus, Malta Turks and Caicos Islands, Czech Republic, Monaco, United Arab Emirates, Denmark, Nauru, United Kingdom, Estonia, Netherlands, United States, Faroe Islands, New Caledonia, Uruguay, Finland, New Zealand, Virgin Islands (U.S.), France, Northern Mariana Islands, French, Polynesia, Norway, Germany, Oman, Gibraltar, Palau.

[Source: Data Help Desk-World Bank]

7.2 Energy Requirement

To achieve the vision 2021 turning the country to a middle income country with a per capita income of 2000 US$ there should be a drastic increase in energy consumption consequently the energy supply should increase. In Fig.. from energy economic relation of some developing countries it is seen that there is a linear relation between them and the relation may be represent by the equation y = 0.0085x + 3.022 with R square of 0.504 . From the diagram for 200 thousand btu/USD of a country energy consumption per capita should be around around 4.00 mmbtu.

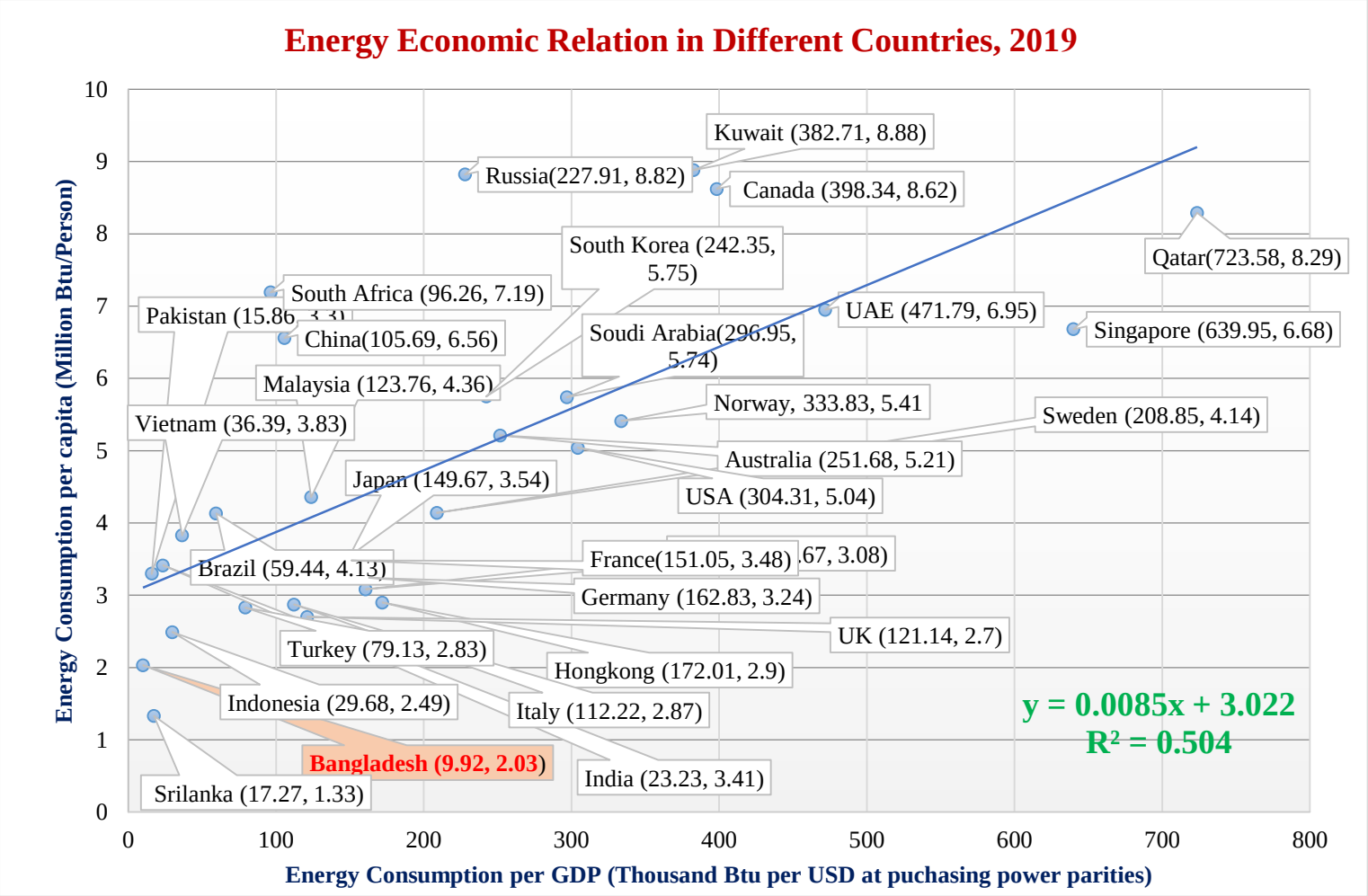


Figure 24 :Energy – Economy Relation in Different Developed & Developing Countries, 2019

7.3 Demand Forecast (2015 – 2021)

7.3.1 Natural Gas

Present demand for natural gas is 3200 mmcfd where supply is 2700 mmcfd with a deficit of 500 mmcfd. The demand will grow further in future. The Demand and Supply scenario is shown in Figure 25. The production forecast is shown in Table 12.To turn the country middle income country by 2021 the demand for natural gas will have to meet not only by limited natural gas reserve also through importing LNG. In that case Bangladesh will enter in the new world of energy and to face a new challenge to cope with the high cost

of energy. But the scenario will be different if there is some discovery in the offshore (though it will take minimum 7 – 8 years to develop), which is very prospective in the settlement of maritime boundary with Myanmar and India. Interim period LNG is the alternative.

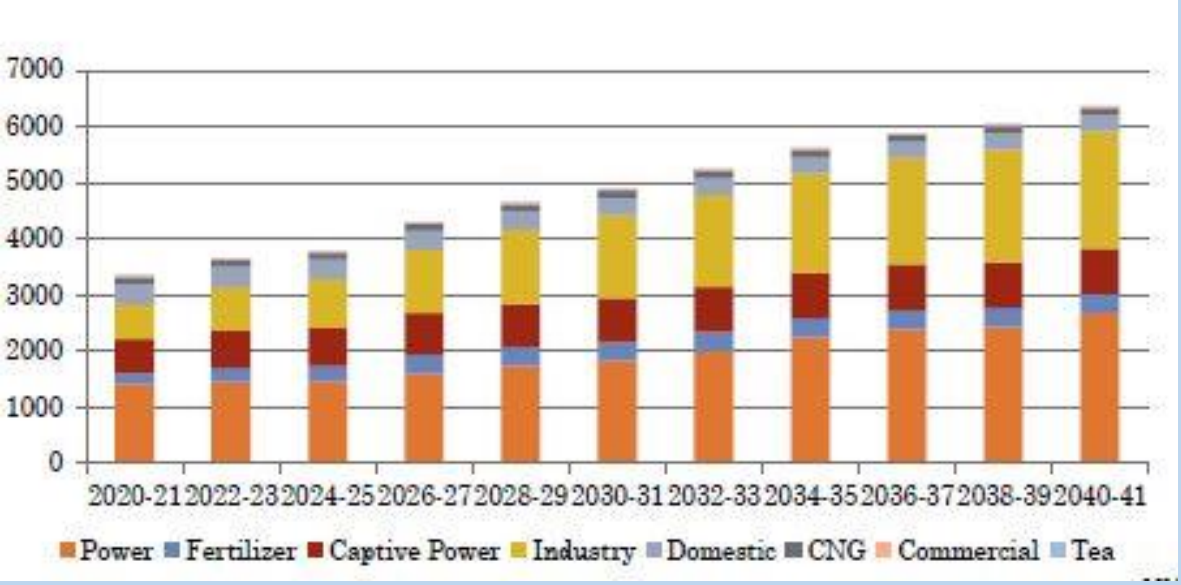
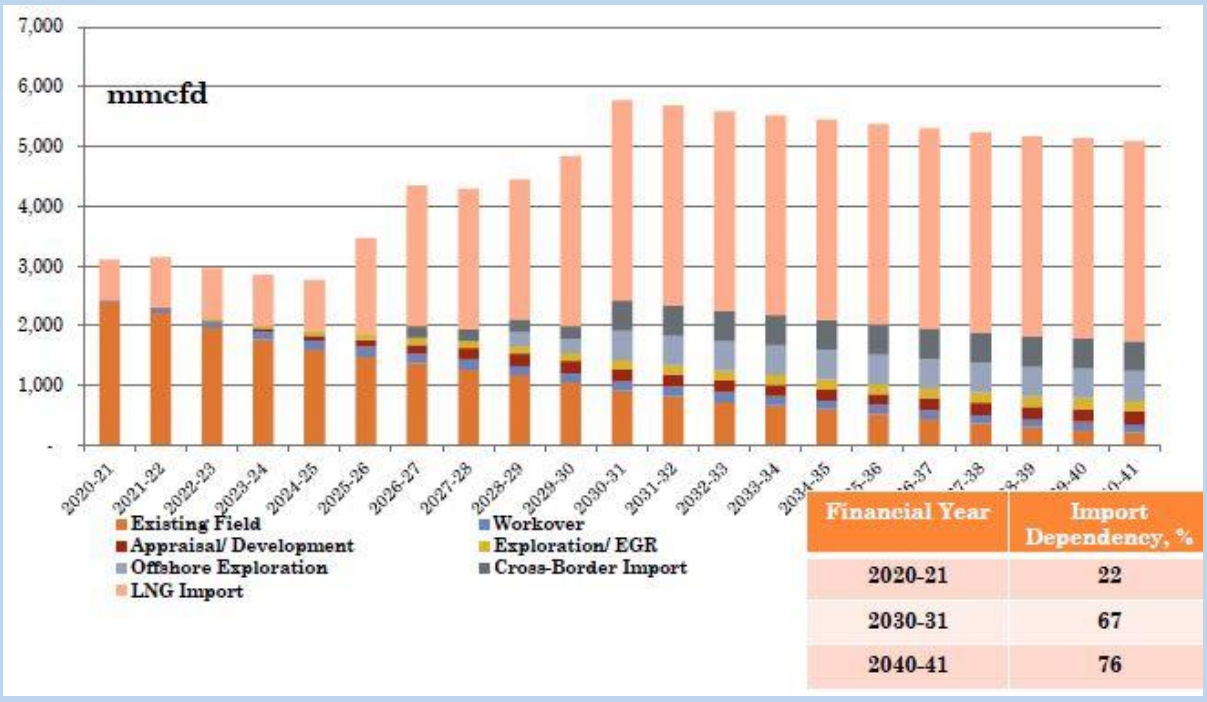


Figure 25 :Gas demand (Sector wise) forecast 2020– 41 [Source: Petrobangla]

Table 11: Forcast of Gas Supply (Source wise)



Financial Year	Import Dependency, %
2020-21	22
2030-31	67
2040-41	76

Figure 26: Gas Supply forecast 2020– 41 [Source: Petrobangla]

7.3.2 Power sector

The installed capacity for power generation will get huge boom during 2015 – 2021 to ensure electricity for all by 2021. Demand forecast of electricity is given in table 12. The projection of increasing installed generation capacity by 2021 is shown in figure 26. To meet the energy requirement for this purpose the energy mix should be change with great contribution from coal based power generation. Focusing coal as main primary source of energy. Power generation by liquid fuel will continue. Private sector will play important role in this respect.

Table 13: Year-wise Demand including Captive Demand & Growth Rates

(National Grid 132 kV Level) from 2017 to 2041

Year	Demand (MW)	Growth rate (%)	Captive power to grid
2017	11,637		300
2018	13,260	14	400
2019	15,041	13	600
2020	17,015	13	700
2021	19,034	12	800
2022	21,193	11	1,099
2023	23,417	10	1,193
2024	25,762	10	1,284
2025	28,231	10	1,376
2026	30,765	9	1,471
2027	33,398	9	1,566
2028	36,106	8	1,663
2029	38,946	8	1,759
2030	41,890	8	1,860
2031	45,045	8	1,967
2032	48,367	7	1,967
2033	52,018	7	1,967
2034	55,542	7	1,967
2035	59,275	7	1,967
2036	62,818	6	1,967
2037	66,436	6	1,967
2038	70,185	6	1,967
2039	74,037	5	1,967
2040	78,118	5	1,967
2041	82,292	5	1,967

[Source: Revisting PSMP 2016]

Table 14: Electricity & GDP Growth Rate through Collected Peak Demand case and PSMP2016 Peak Demand in high case (without EE&C measures)

Year	Electricity and GDP growth rate (Demand collected from Utilities) in high case		Electricity and GDP growth rate GDP growth rate (PSMP 2016) in high case		Macroeconomic Framework for the Perspective Plan of Bangladesh (2021-2041): Growth Outlook up to 2041	
					Macro Projections Perspective Plan scenario	Macro Projections BAU scenario
	Electricity G.R (%)	GDP G.R (%)	Electricity G.R (%)	GDP G.R (%)	GDP G.R (%)	GDP G.R (%)
2017						
2020	13	10	10	8.0	8	7.3
2021	12	9	10	7.8	8.1	7.3
2025	10	8	9	7.1	8.5	7.3
2026	9	7	9	6.9	8.6	7.3
2030	8	6	7	6.2	8.9	7.2
2031	8	6	7	6.1	9.0	7.1
2035	7	5	6	5.4	9.4	6.7
2036	6	5	6	5.2	9.5	6.6
2040	6	4	6	4.9	9.8	5.8
2041	5	4	5	4.9	9.9	5.5

[Source: Revisting PSMP 2016]

Table 15: Forecasted Energy Generation Demand, Peak Demand and Load Factor

Year	High Case			Base Case			Low Case		
	Peak Demand (MW)	Load Factor (%)	Energy Generation Demand (MkWh)	Peak Demand (MW)	Load Factor (%)	Energy Generation Demand (MkWh)	Peak Demand (MW)	Load Factor (%)	Energy Generation Demand (MkWh)
2019	15,041	60.63	79,883	13,975	60.63	74,222	13,044	60.63	69,277
2020	17,015	60.63	90,367	15,809	60.63	83,962	14,757	60.63	78,375
2021	19,034	60.63	101,090	18,023	60.63	95,721	16,823	60.63	89,348
2022	21,193	60.63	112,557	20,067	60.63	1,06,577	18,731	60.63	99,481
2023	23,417	60.63	124,369	22,173	60.63	1,17,762	20,697	60.63	109,923
2024	25,762	61.63	139,087	24,393	61.63	1,31,696	22,769	61.63	122,928
2025	28,231	61.63	152,417	26,731	61.63	1,44,319	24,952	61.63	134,714
2026	30,765	62.63	168,781	29,130	61.63	1,59,811	27,191	62.63	149,174
2027	33,398	62.63	183,226	31,623	62.63	1,73,488	29,519	62.63	161,946
2028	36,106	63.64	201,276	34,188	63.64	1,90,584	31,912	63.64	177,896
2029	38,946	63.64	217,108	36,876	63.64	2,05,568	34,422	63.64	191,888
2030	41,890	64.62	237,113	39,663	64.62	2,24,507	37,024	64.62	209,570
2031	45,045	64.62	254,972	42,651	64.62	2,41,421	39,812	64.62	225,351
2032	48,367	65.66	278,216	45,797	65.66	2,63,433	42,748	65.66	245,894
2033	52,018	65.66	299,217	49,254	65.66	2,83,318	45,976	65.66	264,463
2034	55,542	65.66	319,488	52,590	65.66	3,02,507	49,090	65.66	282,375
2035	59,275	65.66	340,961	56,125	65.66	3,22,841	52,389	65.66	301,351
2036	62,818	65.66	361,341	59,480	65.66	3,42,140	55,521	65.66	319,367
2037	66,436	65.66	382,152	62,905	65.66	3,61,841	58,718	65.66	337,757
2038	70,185	65.66	403,717	66,456	65.66	3,82,267	62,032	65.66	356,820
2039	74,037	65.66	425,875	70,102	65.66	4,03,240	65,436	65.66	376,400
2040	78,118	65.66	449,349	73,607	65.66	4,23,401	68,708	65.66	395,221
2041	82,292	65.66	473,359	77,540	65.66	4,46,025	72,379	65.66	416,338

[Source: Revisting Study Team JICA]

Table 10: Per Capita Generation and Consumption Projection up to 2041

[High, Base & Low case]

	Year	2020	2025	2030	2035	2041
	Population (Million)	170	179	186	193	198
	Average growth rate (p.a.)	1.1	1.0	0.8	0.6	0.5
High Case	Energy Generation Demand (MkWh)	90,367	152,417	237,113	340,961	473,359
	Per Capita Generation (kWh)	532	851	1,275	1,767	2,391
	Energy Consumption Demand (MkWh)	79,885	136,032	212,928	307,103	426,638
	Per Capita Consumption (kWh)	470	760	1,145	1,591	2,155
Base Case	Energy Generation Demand (MkWh)	83,962	144,319	224,507	322,841	446,025
	Per Capita Generation (kWh)	494	806	1,207	1,673	2,253
	Energy Consumption Demand (MkWh)	74,223	128,805	201,608	290,783	402,002
	Per Capita Consumption (kWh)	437	720	1,084	1,507	2,030
Low Case	Energy Generation Demand (MkWh)	78,375	134,714	209,570	301,351	416,338
	Per Capita Generation (kWh)	461	753	1,127	1,561	2,103
	Energy Consumption Demand (MkWh)	69,284	120,232	188,194	271,427	375,245
	Per Capita Consumption (kWh)	408	672	1,012	1,406	1,895

[Source: Revisiting Study Team JICA]

8.0 Energy Efficiency and Conservation

"Energy conservation" and "energy efficiency" are often used interchangeably, but there are some differences. At the most basic level, energy conservation means using less energy and is usually a behavioral change, like turning your lights off or setting your thermostat lower. Energy efficiency, however, means *using energy more effectively*, and is often a technological change. Energy efficiency measures the difference between how much energy is used to provide the same level of comfort, performance or convenience by the same type of product, building or vehicle.

Conservation certainly reduces energy use, but it's not always the best solution because it may impact comfort or safety as well. Efficiency, on the other hand, maintains the same level of output (e.g. light level, temperature) but uses less energy to achieve it.

A combination of both energy conservation and energy efficiency measures yields an ideal solution.

9.0 Concluding Remarks

The following measures should be taken for energy efficiency and conservation of energy:

- ✓ Energy conservation act should be enacted and that should be strictly implemented.
- ✓ Energy Audit should be performed in energy intensive industries like Power, Fertilizer and manufacturing and process industries.
- ✓ Adaption of latest generation energy efficient technology in all energy intensive industries.
- ✓ Replacement and Rehabilitation of inefficient, aged installations should be phase out by modern latest generation energy efficient plant and appliances.
- ✓ Action program me should be taken to standardize modern latest generation technology based plants and appliances in different energy consuming sector.
- ✓ Energy efficient green building technology should be encouraged and include in National Building Code.
- ✓ Promotion of energy efficient vehicle like hybrid car.

- ✓ Optimal utilization of natural gas in all sectors should be ensured..
- ✓ Domestic use of natural gas should be gradually phase out instead of LPG should be encouraged.
- ✓ Natural gas in captive power sector should be restricted and phase out gradually.
- ✓ Energy price should be made rational and target group may get the privilege of subsidy but not common to all.
- ✓ Energy taxes may be introduce for conservation of energy.

10.0 References

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