

## **Present Scenarios of Energy Utilization in Bangladesh**

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### **Abstract**

Natural gas is the most important indigenous source of energy that has been continuously produced and consumed in significant quantities since 1947. About 75% of the commercial energy of the country comes from the natural gas. So far 27 gas fields have been discovered of which two of the gas fields are located in offshore area. The paper shows the dependency of Bangladesh on gas alone and negligence on other resources like coal, solar, wind, biomass etc. Though Bangladesh has considerable amount of gas yet it is not enough for 50 more years at current demand and extraction rate. The analysis suggests to reduce dependency on natural gas by introducing alternative energy sources. Moreover, a comprehensive energy policy should be developed with a proper regulatory body that has oversight responsibilities. Efficient gas marketing is the key to derive numerous benefits from the gas reserves of Bangladesh. Lastly, Bangladesh government need to explore ocean area that has been acquired from India & Myanmar in 2014.

### **1. Introduction**

Though the serious attempt to find oil and natural gas started in the first decade of previous century, the first gas field discovery was made by Pakistan Petroleum Limited (PPL) in 1955 at Haripur. But the rapid expansion and integration of petroleum companies started to accelerate in the early 1970s spurred by the rising oil prices. The last (26th) discovery was in Roopganj (Narayanganj) in June, 2014. Natural gas is the most important fuel for Bangladesh, both in terms of energy and diversity of use. Natural gas burns more cleanly than other fuels, such as oil and coal, and produces less carbon dioxide per unit of energy released. For an equivalent amount of heat, burning natural gas produces about 30% less carbon-dioxide than burning petroleum and about 45% less than burning coal. Bangladesh Oil, Gas and Mineral Resources Corporation, Petrobangla, is entrusted with the responsibilities of the gas and coal sectors of Bangladesh. Subsidiaries under Petrobangla are responsible for exploration, production, transmission, distribution and marketing of natural gas to the end users. In 1993, there were 17 gas fields in the country with an estimated total initial gas reserve of 12.43 TCF and remaining reserves of 10.55 TCF. In 2003, the number of gas fields was 22 and the total initial gas reserve was estimated at 20.51 TCF and a remaining reserve of 15.4 TCF. In 2014, the number of gas fields grew to 26 with an estimated initial gas reserve of 26.84 TCF and a remaining reserve of 16.74 TCF. In 2016, remaining gas reserve is 12.88 TCF [1]. Bangladesh also has good amount of coal along with natural gas as its main resources reserved in its territory. But the extensive portion of the demand is met by gas alone and it is about 75% of the total consumptions.

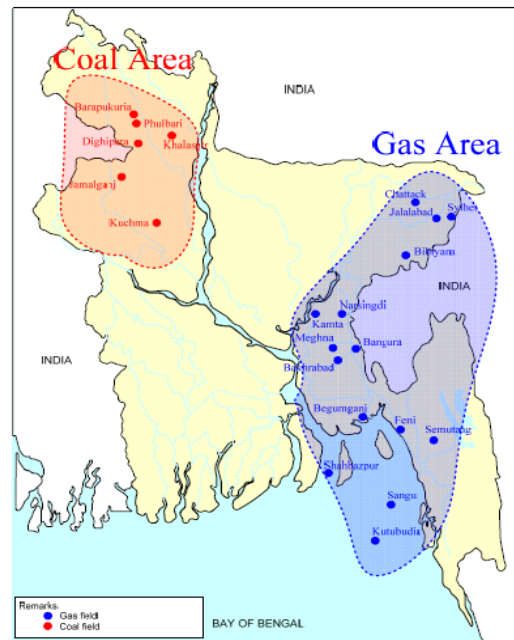


Figure 1: Discovered Coal and natural-gas fields in Bangladesh[8].

Gas, the main source of commercial energy, plays a vital role in the economic growth of Bangladesh. The natural gas consuming sectors in Bangladesh are: i) Power, ii) Industry, iii) Fertilizer, iv) Captive power, v) Domestic, vi) Commercial, and vii) Transportation (CNG). The major consumers of gas are the power and industrial sectors, which account for 43% and 17% respectively. Per capita primary commercial energy consumption in Bangladesh is still one of the lowest in the world: 205 (kg of oil equivalent per capita) in Bangladesh compared

to 482 and 614 in Pakistan and India respectively in 2011 [2]. Hence, the real potential of natural gas has yet to be realized for the economic development of Bangladesh.

## 2. Objectives

The objectives of this paper are:

- (i) To study the current energy mix, present energy crisis in Bangladesh
- (ii) To analysis the existing reserve and production of natural gas in Bangladesh
- (iii) To find out the way to overcome such energy crisis in Bangladesh by utilizing alternative energy sources such as biomass, solar, wind and small-scale hydropower energy, in the context of Bangladesh.

## 3. Present Scenarios of Natural Gas Production in Bangladesh

Production of natural gas by national and international oil companies from different gas wells in Bangladesh has been analyzed here. The consumption rate of natural gas since 1992 to 2017 has been collected. Relative consumption of natural gas by different sectors has also been analyzed from data of previous years (1992 to 2017). Analyzing these data and current condition of different sectors, proper utilization methods have been proposed in this paper. The production of gas till December 2016 was 14.243 trillion cubic foot and 12.87 trillion cubic foot of gas was in reserve for production. The reserve of natural gas as per December, 2016 is shown in the table 1(a), 1(b) and 1(c):

Table 1(a): Gas field in production (in BCF) [1].

Sl.No.	Field	Cumulative Production (Dec,16)	Remaining Reserve (Jan,17)
1	Titas	4221.34	2145.66
2	Habiganj	2273.03	359.97
3	Bakhrabad	803.87	427.65
4	Kailashtilla	647.07	2112.93
5	Rashidpur	585.81	1847.19
6	Sylhet/Haripur	211.27	107.63
7	Meghna	61.32	8.58
8	Narshingdi	180.92	95.88
9	Beani Bazar	94.66	108.34
10	Fenchuganj	148.34	232.66
11	Shaldanadi	87.70	191.30
12	Shahbazpur	26.86	363.14
13	Semutang	12.10	305.60
14	SundalpurShahzadpur	9.98	25.12
15	Srikail	54.84	106.16
16	Begumganj	0.88	69.12
17	Jalalabad	1046.70	137.30
18	Moulavi Bazar	289.54	138.46
19	Bibiyana	2530.04	3223.96
20	Bangura	359.05	162.95
	Sub-Total a:	13645.32	12169.60

Table 1(b): Non-production gas field (in BCF) [1].

Sl. No.	Field	Cumulative Production	Remaining Reserve
21	Kutubdia	0	45.5
22	Rupganj	0	33.6
	<b>Sub-Total b:</b>	<b>0</b>	<b>79.1</b>

Table 1(c): Suspended production gas field (in BCF)[1].

Sl. No.	Field	Cumulative Production	Remaining Reserve
23	Chattak	26.46	447.54
24	Kamta	21.1	29.2
25	Feni	62.4	62.6
26	Sangu	487.91	89.85
	<b>Sub-Total c:</b>	<b>597.87</b>	<b>629.19</b>

Grand Total (a+b+c) in BCF	14243.19	12877.89
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Figure 2 shows the historical production of gas from 1993 to 2016. It shows that gas production was significantly increasing from 1993 to 2016. But in recent years, the gas production rate has started to decline.

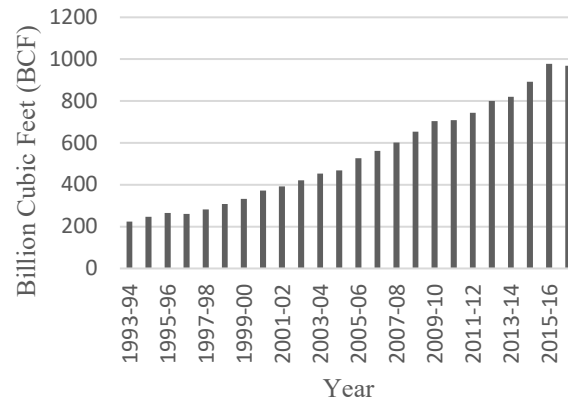


Figure 2: Historical production of gas [5].

Three national companies; Bangladesh Gas Fields Company Limited (BGFCL), Bangladesh Petroleum Exploration & Production Company Limited (BAPEX), Sylhet Gas Fields Limited (SGFL) and four international oil companies; Chevron, Cairn, Tullow and Niko are in charge of exploration and production of gas in Bangladesh. Three national companies are operating with a production capacity of 1137 MMCFD while the international oil companies are operating with a production capacity of 1160 MMCFD[3].

#### 4. Consumption of Natural Gas

Bangladesh being one of the world's most densely populated countries has been facing supply to demand gap of natural gas for a long time. Among all the countries which use natural gas, Bangladesh ranks at 34th position [4]. In Bangladesh, natural gas is mainly used for power generation, urea fertilizer production,

industrial process heating, captive power generation, and household cooking. It is also being used as the fuel vehicles in the form of compressed natural gas (CNG) since 2005. The table 2 shows the consumption of natural gas by different sectors in the year 2016-2017.

Table 2: Sector wise gas consumption in 2016-17 [5].

Sector	Consumption Percentage
Commercial	0.88%
Domestic	15.64%
Tea State	0.1%
Industry	16.52%
Electricity	40.88%
Fertilizer	4.97%
Captive	16.26%
CNG	4.76%

Power generation as expected is the dominant sector and industrial sector, together with fertilizer and captive power uses about 40% of the total gas which is the second largest share. CNG sector had modest beginning with only 1.3% during 2005-06, but rapidly increased to the current level of 5%. Domestic consumption of gas also takes a large share of total consumed gas and this is a sector which has hardly an alternative source to gas. With increasing population and urbanization, the use of domestic use of gas is expected to increase [6].

Table 3: Sector wise demand of natural gas in Bangladesh (Billion Cubic Feet) [29].

Sector	2013-14	2014-15	2015-16	2016-17
Electricity	337	416	458	504
Captive power	143.5	234	258	284
Fertilizer	53.8	94	94	94
Industry	53.8	259	280	307
Brick field	0	0	0	0
Household	101.5	148	168	185
Tea Garden	0.51	1	1	1
CNG	40.1	121	153	168
Commercial	8.9	8.9	14	14
Total	827.8	1,276.5	1,424	1,557

Table 3 shows sector wise demand of Natural Gas in Bangladesh (billion cubic foot). Historical consumption of natural gas by different sectors has been shown in figure 3 below. Separate data for the consumption of natural gas is 1315.88 MMCM for the year 2015-16 and 1329.67 MMCM for the year 2016-17.

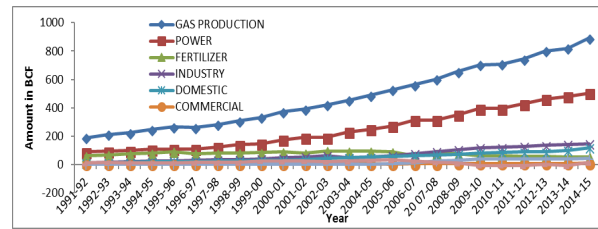


Figure 3: Historical Consumption of Gas in Different Sectors [29].

#### 4.1. Electricity Generation

Bangladesh's power sector is mostly dependent on supply of natural gas. Almost 86% power plants use natural gas as their fuel. As a result, almost 40% of gas produced is used in this sector. In 2017, total installed capacity was 13,555 MW. The maximum peak generation was 9,479 MW which was 4.90% higher than that in the previous year [7]. Only 62% of the population has access to electricity with a per capital availability of 321 kWh per year [8].

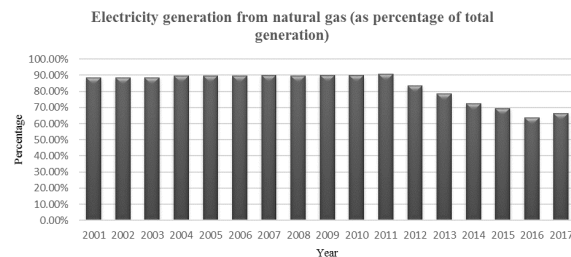


Figure 4: Electricity production from natural gas (percentage of total)[7].

Electricity production from natural gas sources in Bangladesh was 91.5% as of 2011. Its highest value over the past 42 years from 2011 was 91.5% in 2011, while its lowest value was 34.69% in 1973. Electricity production from natural gas sources (kWh) in Bangladesh was last measured at 40308000000 in 2011, according to the World Bank. As the power sector is dangerously dependent on natural gas, decentralization strategies are under research.

## 4.2. Industrial Sector

The major industries of Bangladesh which consume natural gas are textile and leather, iron & steel, food processing, beverages & tobacco, nonmetallic minerals, chemicals, pulp, paper & print non-ferrous metal, machinery and some non-specified industry. But newer industries are emerging, some existing ones are flourishing and some are diminishing. So the industrial sector is hard to define in terms of energy consumption. Relatively small increase in the number of these industries can have a significant impact on the overall scenario. As of 2017 about 17% of produced natural gas was consumed by this sector.

## 4.3. Captive Power

Captive Power Plant (CPP) is a plant which produces electricity for its owner's own uses or for a group for their own use. The gas demand for power generation at present has reached nearly 1,200 MMCFD and Petrobangla can supply maximum 900 MMCFD for the power plants

## 4.4. Fertilizer Productions

Bangladesh has a large agrarian base with 76 percent of total population living in the rural areas and 90 percent of the rural population directly related with agriculture. Fertilizer is considered to be one of the main inputs for increasing crop yields and farm profit for any country. Fertilizer consumption (% of fertilizer production) in Bangladesh was last measured at 231.51 in 2009, according to the World Bank. Fertilizer consumption measures the quantity of plant nutrients used per unit of arable land [9].

## 4.5. Household Sector

Domestic sector is incurred by the most number of customers and it consumes about 11% of the total natural gas produced. The Bangladesh government's priority is to increase gas supply to power plants to be followed by industries and fertilizer factories. Fresh household gas connection does not feature in the Government's priority agenda. The domestic sector slowed down as piped gas connections to household was suspended from July 2010 to 2013. Some 15 MMCFD of gas has been earmarked for new household gas connections. Still the country is facing huge gap in supply and demand of natural gas in household sector and the government is planning to import LPG to cope with gas supply shortfall.

## 4.6. Compressed Natural Gas

CNG as a vehicle fuels were first introduced to Bangladesh in 1982 through a World Bank pilot project. CNG was promoted by the government in 2005 to address the severe air pollution in Dhaka during the 90's. It had a modest beginning with only 1.3% natural gas consumption in the initial year, but quickly became popular and increased to the current level of 4.76% rapidly.

## 5. Prediction of Remaining Natural Gas Reserve

At present, the amount of remaining gas reserve in Bangladesh is 12.88 TCF. This reserve is forecasted by using moving average technique taking the data from the year 2014 to 2017 which is shown in figure 6. From figure 6 it has been depicted that if the gas consumption rate remains same, this reserve can be consumed until 2032. After 2032, demand of natural gas will need to be met by another energy sources or by importing energy.

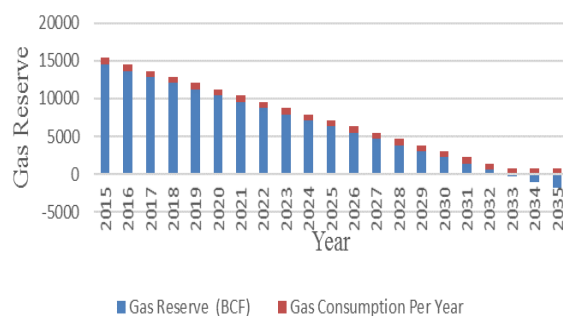


Figure 6: Prediction of remaining natural gas.

Although this forecast shows that, the gas reserve will sustain till 2032, but the real scenario is different. According to table 3 sector wise demand of natural gas is increasing significantly. So there is a possibility that the remaining gas reserve will barely sustain 2032.

## **6. Power Sector**

A major hurdle in efficiently delivering power is caused by the inefficient distribution system. It is estimated that the total transmission and distribution losses in Bangladesh amount to one-third of the total generation, the value of which is equal to US \$247 million per year and 25% of the current capacity is more than 20 years old resulting in temporary shutdown or outage and high maintenance cost. The efficiency of older government-owned power plants is much less than the newer ones and they need to be significantly improved. Dispatch of generation plant should be based on the most efficient plant available, and a concerted effort is needed to replace old and inefficient plants. The power utilities should be establishing time-bound plans to replace inefficient generation units with more efficient ones. This could involve converting open cycle generation units to combined cycle where possible and shutting down gas-fired and diesel engine generation units. Moving towards power sustainability will require development not only in the way power is supplied, but in the way, it is used as well. So, it is not enough to only ensure efficient power production in the plants, the consumers of electricity also need to make sure that minimal wastage is produced by them. Additional demand-side measures could also be introduced, addressing the efficiency of household gas appliances and promoting more efficient boilers in the case of commerce and industry.

It is a good option to use coal. The coal reserves in five fields of Bangladesh are estimated at 3.0 billion tons equivalent to 67 TCF of gas, which can conveniently serve the energy needs of Bangladesh for 50 years. Right now, there is only one coal-based power plant active producing 250MW of electricity. There should be provision for dual fuel in power plants or coal-based power plants wherever in Bangladesh is possible. To meet the surfeit demand, government is about to buy 500 MW electricity from India.

## **7. Oil**

Bangladesh has no significant **oil** reserve except the Haripuroil reserve which was discovered in 1989 at northwest of Sylhet district. Estimated reserves 1.4 Mtoe, out of which 0.84 Mtoe was supposed to be recovered as of year 2004 but the exploitation was abandoned due to poor oil quality and presence of water in the oil zone.

## **8. Coal**

In Bangladesh, **coal** shares 3.25% of the actual generation of electricity. National coal policy is under process, and it is expected that realistic planning and allocation of national budget could provide meaningful development in the sector which was previously, long halted due to administrative and technological barrier. So far, five coal deposits have been discovered at the north-west part of Bangladesh. Current estimated reserve is approximately 3300 million MT which is equivalent to 45–50 TCF of natural gas. Most of the coal deposits contain bituminous type of coal and that has high calorific value. Coal deposits found in Bangladesh consist of bituminous type of coal, and among the deposits, Barapukuria coal has the calorific value ranges from 5546 to 7202 kilo calories per kilogram (kcal/kg), which is considerably optimum for electricity generation. National coal policy has to be implemented to have net gain from the coal reserve [11].

## **9. Prediction of Remaining Coal Reserve**

At present, Bangladesh has a huge coal reserve. Five coal mine has been discovered till now. But only Barapukuria coal mine is active in Bangladesh. Coal reserve in these discovered coal mines are shown in table 4.

Table 4: Coal reserve in different discovered coal mines in Bangladesh [30].

Sl.No.	Name of the Coal Field	Reserve in Million Metric Ton
1	Barapukuria, Dinajpur	390
2	Khalaspir, Rangpur	685
3	Jamalganj, Joypurhat	5450
4	Fulbari, Dinajpur	572
5	Digipara, Dinajpur	865
	Total	7962

Barapukuria coal mine had 390 metric ton coal reserve initially. Coal production started from 2004 and at 2016-17 the remaining reserve is around 381 million metric ton. Remaining coal reserve in Barapukuria coal mine has been forecasted which is shown in figure 7. This forecasting shows that if the consumption rate of coal remains same then this reserve will sustain more than the year 2040. Though Bangladesh has a massive amount of coal reserve, it is not being used to meet the extra demand of energy. It is because coal is not a cleansource of energy. It has a tremendous negative impact on environment.

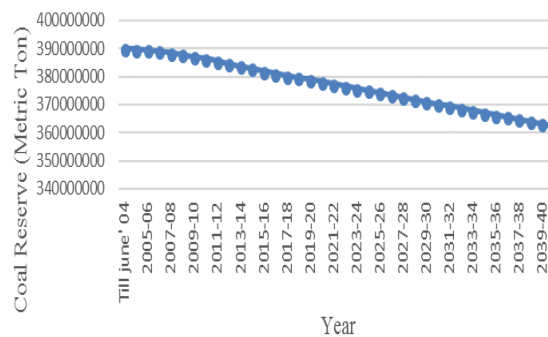


Figure 7: Prediction of remaining coal reserve in Barapukuria coal mine.

## 10. Renewable Energy in Bangladesh

Renewable energy sources are defined as those that are abundant in nature and derive from natural process with no depletion in the course of utilization. Bangladesh is blessed with renewable energy sources such as biomass, wind, solar and small-scale hydropower energy. Among the renewables, solar and biomass found promising and effective in the context of Bangladesh. Due to flat terrain and low water head, small scale hydropower found little interest; however, potential of small hydropower energy source is found 500MW. Utilization of wind energy is limited due to insufficient ground data. At present, renewable energy shares only 0.5% of total energy mix. Bangladesh is still at initial stage to utilize renewable energy at commercial scale.



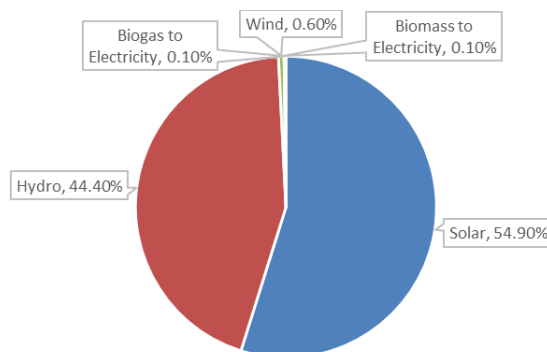


Figure 8: Renewable energy share in Bangladesh [12].

### 10.1. Hydropower

Bangladesh has limited hydropower potential. Hydro power contribution for electricity generation is less than 4%, in Bangladesh. The only large-scale hydropower plant is located at Karnafuli River, Kaptai in Chittagong district.

### 10.2. Solar power

Solar radiation varies from season to season in Bangladesh. So, we might not get the same solar energy all the time. Daily average solar radiation varies between 4 to 6.5 KWh per square meter. Maximum amount of radiation is available in the month of March-April and minimum in December-January.

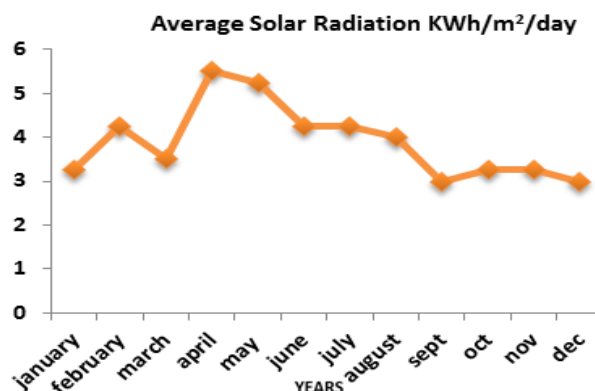


Figure 9: Monthly average solar radiation profile in Bangladesh [27].

So, to meet the domestic electricity demand Solar home system has become very popular to the rural areas. Nowadays, more or less 45 lacks people are using solar power. SHS program was launched to ensure access to clean electricity for the energy starved off-grid rural areas of Bangladesh. The program supplements the Government's vision of ensuring 'Access to Electricity for All' by 2021. Solar home system can be future of electricity production and this system has the ability to change the total energy scenario in Bangladesh.

Table 5: Information on solar home system (SHS) in Bangladesh [13].

Content	Amount
Installed SHS	About 4.5 Million
Beneficiaries of SHS	About 13 Million
Amount of SHS are being installed per month	About 65,000
Average year to year installation growth	58%
Amount of kerosene replaced by the SHS per year	180,000 tons (USD 225 Million)

### 10.3. Biogas

Bangladesh has a wonderful climate for biogas production. The ideal temperature for biogas is around 35°C. The temperature in Bangladesh usually varies from 6°C to 40°C and also the raw materials for biogas are easily and cheaply available everywhere in this country. Bangladesh being an agricultural country, raw materials for biogas are easily and cheaply available everywhere. The Government along with several NGOs is working together for development of power production from Biogas. Grameen Shakti has completed 13,500 biogas plants. Recently Seed Bangla Foundation has proposed a 25 KW Biogas based Power Plant in Rajshahi.

### 10.4. Wind Power

Wind can be the next generation power source if it is harnessed in a proper way. Wind of speed 2.3 ms<sup>-1</sup> to 2.5 ms<sup>-1</sup> has the capability to produce electricity through windmills. It has been studied that in Bangladesh the average wind speed is maximum during the month of April which is approximately 5.3 ms<sup>-1</sup> and minimum in the month of December which is around 2.6 ms<sup>-1</sup>. There is a good opportunity in island and coastal areas for the application of windmills for pumping and electricity generation. A number of small wind generators have been installed by several agencies in coastal areas [15].

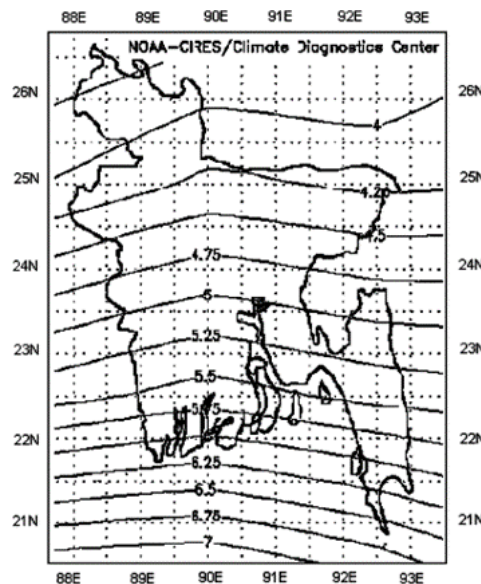


Figure 10: Wind map of Bangladesh at surface level (m/s) with CDC Derived GFDL Data for Surface Wind Speed [28].

## 11. Alternative Energy Sources

From this study, it is found that the increasing demand of the energy is unable to meet by the existing energy sources. So, Bangladesh government has taken initiatives i.e. importing liquefied natural gas from Qatar, building nuclear power plant of capacity 2.4 GW.

### 11.1. Liquefied Natural Gas (LNG)

Bangladesh is currently importing LNG from Qatar. The import of LNG is part of the government's efforts to eliminate gas shortages and power outages and unlock the potential of the economy. Bangladesh will buy LNG on its own from RasGas of Qatar under a government-to-government purchase agreement. In 2017, Bangladesh signed a 15-year contract with RasGas, which would supply 2.5 million tons of LNG every year. Apart from Qatar, Bangladesh will also import LNG from Oman. A supply agreement with Oman Trading International has recently gained the government's approval [25]. Moheshkhali Floating LNG (MLNG) is an integral component to ensuring the vitality of Bangladesh's energy future. The project will utilize state-of-the-art technology to provide the critical infrastructure required for the country to access natural gas from global markets. With up to 500 million standard cubic feet of gas per day (MMscf/d) of regasification capacity [25], Moheshkhali Floating LNG will provide much-

needed clean energy to promote power reliability, industrial development, and job creation in a sustainable manner. In April 4, 2018 a vessel named 'Excellence' with capacity of 1.37 Lakh Cubic Feet docked at Moheshkhali which will be used as provisional floating station [26]. To carry the LNG to national grid a 91-kilometer pipeline has been established from terminal to Anwaraupazilla, Chittagong and a 30-km pipeline from Karnaphuli to Sitakunda is being set up.

### **11.2.Nuclear Energy**

The Government of Bangladesh is building its first nuclear power plant in Rooppur on the east side of the river Padma near Ishwardi in the Pabna district of Bangladesh. The capacity of the power plant is 2.4 GW [28]. The project is being implemented by the Bangladesh Atomic Energy Commission (BAEC), under the guidance of Science and Technology Ministry of the Government of Bangladesh. The nuclear power plant (NPP) will include two units namely Rooppur Unit-1 and Rooppur Unit-2 with a capacity of 1.2GW each. Rooppur Unit-1 is scheduled to commence operations in 2023, while Rooppur Unit-2 is due to come online in 2024. The nuclear power plant will use cutting-edge technologies and follow the safety guidelines of the International Atomic Energy Agency (IAEA). The project will provide low-cost electricity and create new jobs in Bangladesh. The power production in Bangladesh currently exceeds 4GW a year. The new plant will increase the country's power production and enable it to achieve energy independence.

## **12. Summary**

Gas being the primary source of energy, the first concern for Bangladesh is to ensure sustainable gas supply for a long time. One of the most important prospects on increasing the supply of natural gas is to enhance drilling both onshore and offshore. So, discovering new gas fields should be prioritized. Also, a long-term strategic plan is required for carrying out systematic exploration and proper appraisal of discoveries of gas fields. Even if Bangladesh government is successful in finding consistent supply of gas for a long time, utilization in different gas consuming sector is a must. Bangladesh desperately needs to increase energy utilization to foster economic growth and increase its per capita commercial energy level. The government is bound to monitor the utilization of gas in important sectors like power generation, fertilizer industry, captive power generation, and household consumption and CNG sector. But it is not only government's duty; the consumers must also make sure that efficient consumption is taking place. Wastage in energy means less energy in times of need. Coal and limited hydropower energy also shares limited percentage in the total power generation. Economic growth and continual prospect in socio-economic development fundamentally relates to efficient and effective dissemination of, not only primary conventional energy sources but also alternative energy, as the formers are depleting. Only 20–30% of the total population is currently under electric 2020. More than 70% of the population resides in the rural areas where biomass could be the top contributor to sustainable energy source if it is appropriately harnessed considering contextual identification of technology, culture and mass awareness [9,16,17].

## **13. Recommendations**

Gas being the primary source of energy, the first concern for Bangladesh is to ensure sustainable gas supply for a long time. One of the most important prospects on increasing the supply of natural gas is to enhance drilling both onshore and offshore. So, discovering new gas fields should be prioritized. Also, a long-term strategic plan is required for carrying out systematic exploration and proper appraisal of discoveries of gas fields. Even if Bangladesh government is successful in finding consistent supply of gas for a long time, utilization in different gas consuming sector is a must. Bangladesh desperately needs to increase energy utilization to foster economic growth and increase its per capita commercial energy level. The government is bound to monitor the utilization of gas in important sectors like power generation, fertilizer industry, captive power generation, and household consumption and CNG sector. But it is not only government's duty; the consumers must also make sure that efficient consumption is taking place. Wastage in energy means less energy in times of need[18].

In 2012 Bangladesh won its maritime dispute with Myanmar and in 2014 with India. As a result, Bangladesh gained access to several additional offshore oil and gas blocks. Facing a gas crisis of 500 million cubic feet a day (mmcf), which is one fifth of the demand had prompted the government to go for off-shore exploration bids in 2008 and 2012. There are 28 blocks in offshore area of Bangladesh after the borderline has been set in 2014, each having exploration area of between 3,000 to 7,000 sq-km. Deep sea exploration and development of a gas prospect is very

costly, risky and technologically very challenging than onshore operation. Still these new gas blocks are expected to play a crucial role in country's energy crisis scenario. To meet increasing demand of natural gas, production of gas has been increasing every year. But the consumption of natural gas in the country in the last 15 years has been much more than the discovery of natural gas which is a concerning issue.

A multi-client survey was about to be conducted in 2015 but later foiled due to the intervention from government. The ministry of power, energy and mineral resources takes a project themselves to conduct the survey. A blue economy cell has been comprised with 10 members to supervise the deep ocean investigations, researches and extractions. On the contrary, Myanmar is extracting gas commercially from A-1 and A-3 block since 2013 and proclaimed in 2016 that at Thalin-1 block has a reserve of 4.5 TCF. In Indian side the Krishna-Godavari block is expected to conceive a reserve of 500 TCF gas. Due to the possession of similar geographical structure the blocks on Bangladesh side are also promising at the same context.

It is important to inform mass consumers of natural gas about the crisis of gas. They should know that if they waste gas and other energy sources, they will completely run out of gas in no time. Government can create campaigns and use media to enlighten people. Initiatives have been taken in order to build awareness amongst the students, by incorporating Energy Efficiency and Renewable Energy issues in the academic curricula of schools, madrasas and colleges.

Figure 8 shows possible availability of natural gas in Bay of Bengal. Bangladesh has the scope to explore the area bordering Burma in the Bay of Bengal (see figure 8). Burma already explored and found available of gas in their side of border in sea. Bangladesh needs to explore their side of the border in the Bay of Bengal for gas existence.

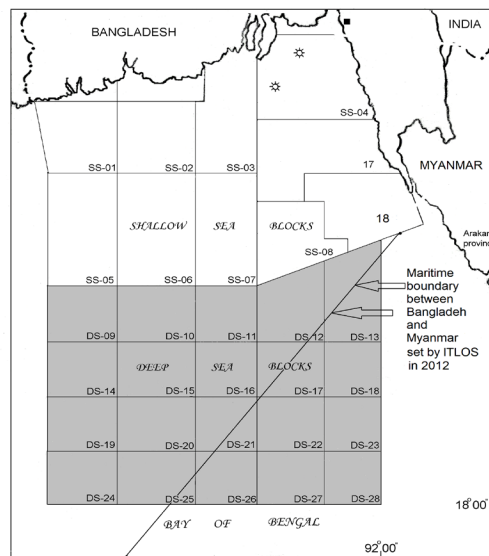


Figure 8: Possible availability of Natural Gas in Bay of Bengal [29].

Coal and limited hydropower energy also shares limited percentage in the total power generation. Economic growth and continual prospect in socio-economic development fundamentally relates to efficient and effective dissemination of, not only primary conventional energy sources but also alternative energy, as the formers are depleting. Only 20–30% of the total population is currently under electric 2020. More than 70% of the population resides in the rural areas where biomass could be the top contributor to sustainable energy source if it is appropriately harnessed considering contextual identification of technology, culture and mass awareness.

This study depicted that natural gas is the main source of energy in Bangladesh. But at present reserve of natural gas is at stake. The study also predicted that the remaining gas reserve can serve the energy demand until 2032. After 2032, we will have to depend on other energy sources. Another main fossil fuel energy source is coal. This study found that Bangladesh has a promising amount of coal which can serve the country more than 50 years. But coal could not be used in a clean & safe manner due to several reasons including coal extraction technology and the

negative environmental effect. Stakeholders of coal are tied up with wide-range of controversies since ages from extraction to power generation technology. So far Bangladesh has only one state-owned coal power project with capacity of 250 MW whereas 40% of global power generation is sourced from coal which accounts for 22% of CO<sub>2</sub> emission [31].

Bangladesh is importing liquefied natural gas (LNG) to meet extra demand of energy. LNG can be a great source of clean energy. However, there are questions about the investment required in the LNG import and distribution network, cost of LNG at the consumer levels etc. Impact of cost increase is already being felt by people as government recently has increased the price of electricity. The government has indicated that the prices of gas and electricity will continue to increase as the cost of LNG will be about 3 times higher than NG. LNG could be a new hope to continue to run such investment but definitely there are concerns about the cost and impact of major policy shifts that the energy sector has seen in Bangladesh [32].

## 15. Conclusion

This study examined the current energy mix, present energy crisis and its way to overcome such scenario by utilizing alternative energy sources such as LNG, nuclear energy, biogas, solar, wind and small-scale hydropower energy in the context of Bangladesh. A contemporary scenario of Bangladesh's renewable energy sector has been presented. The study shows Bangladesh dependency on gas alone and negligence on other resources. The analysis suggests reducing the dependency on natural gas by introducing alternative energy resources and exploring new gas fields in ocean areas.

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