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Ensuring Food Security and Power Crisis Solution In Bangladesh Through Renewable Sources

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Abstract. Bangladesh is an agro-based country. Its economy is completely dependent on agriculture. Fertilizer is the most important element in cultivation. The raw material which is used to produce fertilizer is natural gas. Natural gas is also the fuel of our major portion of electricity production. In our country there is a large gap between the demand and production of electricity. This gap is increasing day by day. Due to high price of other conventional fuel and reduction of gas reserve government of Bangladesh cannot increase the production of electricity according to its requirement. On the other hand fertilizer production is also reducing due to lack of raw material. As a result government imports fertilizer to fulfill its demand which is creating pressure in the reserve of foreign currency. Cost analysis shows that Fertilizer import cost is 9.33 times higher than Gas cost. In this paper we proposed to preserve the present reserve of natural gas for fertilizer production and suggested that the use of renewable energy should be increased to produce electricity that is our demand.

Keywords: Fertilizer, Natural Gas, Renewable Energy, Food Security, Power Crisis.

Introduction.

The economic development of an agro-based country like Bangladesh mainly depends on the progress of the agriculture sector. Since food security, improvements of the living standard and creating of employment opportunities of the large population of the country are directly connected to the development of agriculture. Government is continuously trying for the development of this sector. There have been continued efforts by the government for the overall development of this sector. 76% of total population of Bangladesh living in the rural areas and 90% of the rural population directly connected with agriculture and around 50% of the labor force is directly engaged with agricultural activities [1]. To secure the food sector of Bangladesh it is required sustainable growth of agricultural sector and should proceed in a planned way. The main purpose of giving high importance in agricultural sector in Bangladesh is to provide sufficient food for her increasing population.

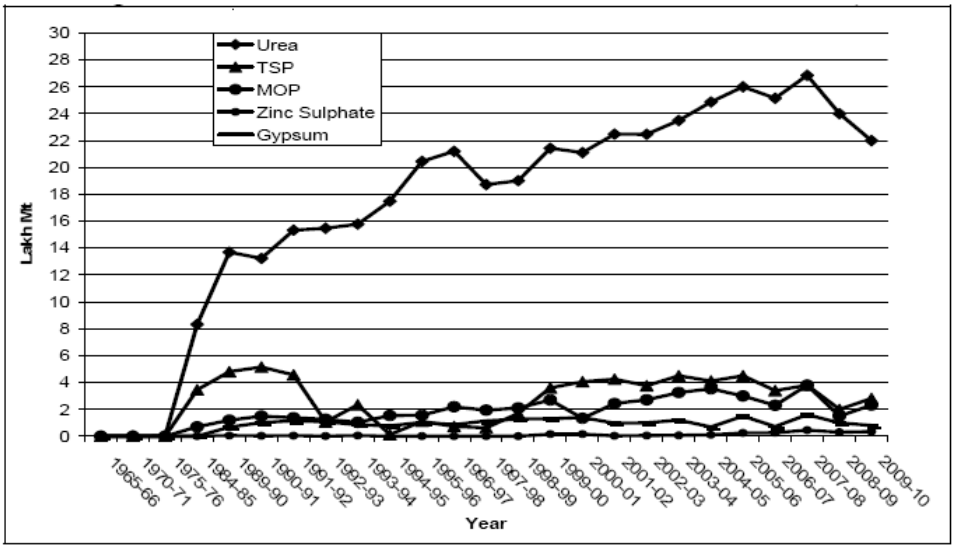
It is considered that fertilizer is one of the most important input for increasing crop production but the use of fertilizer should be balanced otherwise the use of fertilizer will be less efficient. Efficient use of fertilizer increases the sustainable high growth of crop. Bangladesh is a

densely populated country and population of it is increasing in a high rate. As a result its cultivating land is reducing day by day. So efficient use of fertilizer should be given highest priority to increase the food production of Bangladesh. Therefore by increasing irrigation facilities, proper timely supply and availability of fertilizer should give highest priority for the sustainable growth and increase the production of rice in Bangladesh. Various types of fertilizer such as Urea (Nitrogen), Triple Supper Phosphate (TSP), Muriate of Potash (MP), Gypsum and Dasta ($ZnSO_4$) are used in various proportions in the agricultural land of Bangladesh. Among this fertilizer Urea use is highest. The raw material of this Urea is natural gas. Natural gas is also the major fuel in our power generation. It is also used in household cooking and many vehicles also use natural gas as a fuel. At present 67.38 % of electricity is generated from natural gas [2]. But it's a matter of great sorrow that our reserve of natural gas is decreasing in an alarming rate. To provide food for the huge population of Bangladesh production of rice must be increased in a sufficient manner. In this sense Urea is the most important fertilizer for Bangladesh. If we can't provide gas for Urea production our food security might be at risk, then we might have to look out from to the foreign countries. So it is mandatory to keep the natural gas for fertilizer production as much as possible.

Electric power supply is the key for the economic development of any country. Without electricity any kinds of economic development is imaginable. To sustain the economic development huge amount of electricity is required in all sectors such as agriculture, industry, SME etc. Agriculture sector and other income generating sector of rural areas in Bangladesh demand of electricity is increasing day by day. However, there is a huge gap between the supply and demand of electricity. Maximum demand served so far 6066 MW [2] against peak demand of 7518 MW [3]. In 2030 it is expected that the peak demand will be 33,708 MW [3]. Government has given highest priority to the development in Power Sector and has committed to make electricity available to all by 2021. For this reason Government took several mini and mega projects to fulfill the demand. According to Government perspective plan at 2021 major portion (53%) of electricity will be produced from coal, oil 3%, Hydro 1%, Nuclear 10% and renewable sources 3%.

But coal has an adverse environmental effect [4]. It will have more adverse environmental effect for the climate vulnerable country like Bangladesh. Moreover conventional fuel price is increasing day by day which will increase the price of electricity as well. This will create total imbalance in the economy. So we must generate electricity in such a way that is environment friendly and keep the fuel available to fulfill the demand of electricity. In this sense without renewable energy there is no good alternative. In renewable energy solar energy is highly available, environment friendly and has no fuel cost without initial investment and some maintenance cost. As an agro based country like Bangladesh biomass is also available here in a huge amount, which is a good source of renewable energy. So our government should increase power generation from renewable sources instead of other conventional sources. If we can generate significant amount of power from renewable sources then it will not be necessary to hike to high the price of electricity so frequently and in this process emission of significant amount of CO_2 and other green house gases can be reduced.

Present and Future Demand Of Natural Gas for Fertilizer Production: Fertilizer is the most important nutrient element in soils and plays the most vital role in crop production in Bangladesh. Fertilizer application mainly depends on the soil types, growing season, irrigation applications and the cultivars used and agro-climatic conditions of the locations. High yielding varieties of rice are highly responsive and need adequate supply of fertilizer to achieve targeted production [5]. Fertilizer is a must for producing a desired level of rice. And among all the various types of fertilizers, Urea is the most useful one in Bangladesh because for major portion of paddy rice production it is the vital element. Production of Urea is directly dependent on natural gas(NG). This natural gas is also used by the power plants nowadays. Uses of natural gas in the power sector has effects on the lessening of its stock. To ensure food security we must ensure the usage of Natural gas for Urea production and increase the uses of renewable source of energy in power sector.



[1 Lakh Mt = 0.1 Million Mt]

Figure 1**: Consumption of Fertlizers in Bangladesh [6]**

From figure 1 it is clear that Urea is the highest amount of consuming fertilizer in Bangladesh. The study over Urea Fertilizer at present and upcoming years for Bangladesh-is a very much apprehensive issue. About 350 Million Standard Cubik Feet Per Day (MMSCFD) natural gas is required for the yearly production of about 3 million metric ton Urea .This is about 17% [7] of today's daily gas production of the Country. Ensuring guarantee gas supply and improving the Plant Reliability; Bangladesh total requirement of Urea could be achieved. Besides, if we can ensure the power generation from renewable sources to decrease the load on gas, we can achieve our desired Food Security.

Year	Population (million)	Paddy rice req. (million tons)	Boro rice (million tons)	T.Aman rice (million tons)	Aus rice (million tons)
2007	157.75	36.93	19.20	15.14	2.59
2020	191.65	44.87	23.33	18.40	3.14
2030	220.24	51.56	26.81	21.14	3.61
2040	253.09	59.25	30.81	24.29	4.15
2050	290.83	68.09	35.41	27.92	4.77

TABLE-1: Paddy rice demand in Bangladesh in year wise (average) [8]

Rice production systems play an important role to the reduction of hunger and poverty in Bangladesh. If the annual population growth continues at usual rate (1.4 percent annually), it is estimated that the total population would be 191.65 million by 2020, 220.24 million by 2030, 253.09 million by 2040 and 290.83 million by 2050. Table 1, shows the paddy rice demand in Bangladesh for next 40 years. Therefore, huge amount of food will be necessary for the future generation to meet their food demand and major part of the demand will be provided by rice. From the analysis of the last 40 year's data, it is found that the per capita rice consumption rate in Bangladesh is 153.02 Kg per person per year. If the current rice consumption rate is continued to 2050, the total demand of rice would reach to 68.09 million tons which is more than 1.8 times compared to 2007. The total demand of rice would reach to 51.56 million tons in 2030 which is more than 1.39 times compared to 2007. [9]

Total rice production in Bangladesh was 34.28 million tons in the year of 2008-09, where Boro rice contributed more than 55% (18.5 million tons). From the analysis of the last few years' data we found that its contribution in total rice production follows a increasing trend. Urea is the most important fertilizer for production of Boro rice [5].

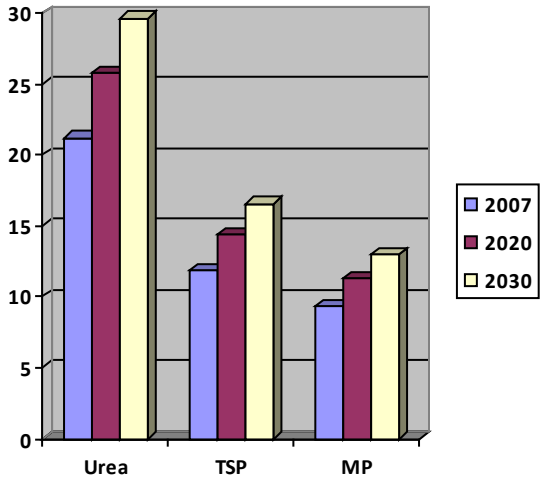


Figure 2**: Fertilizer Recommended Dose**

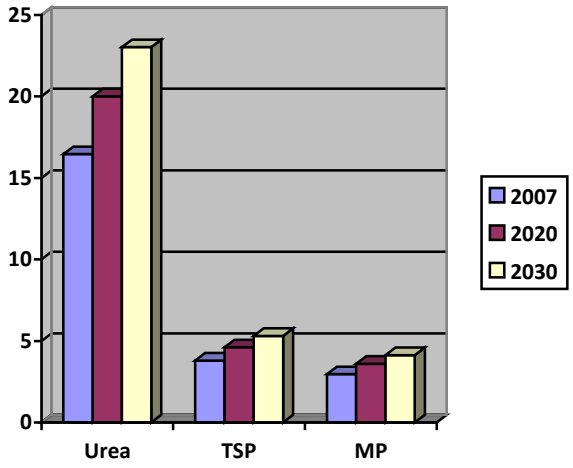


Figure 3: **Fertilizer Actual Dose**

According to the fertilizer recommended dose, requirement of urea fertilizer would be 2.963 million tons, TSP 1.651 million tons and MP 1.297 million tons (calculation based on average rice production data) in 2030. Considering the actual dose in field level, the total demand of urea, TSP and MP in 2030 might be 2.302, 0.531 and 0.431 million tons, respectively (calculation based on average rice production data) [9].

It is studied from the Fertilizer recommended dose and actual dose data that, increase in application of urea is increasing more rapidly than other fertilizers.

Financial Year	Import in MT	Total Consumption in MT
2005-06	771521	2451375
2006-07	651972	2527795
2007-08	1162823	2762783
2008-09	1440341	2532966
2009-10	1465582	2408000
2010-11	1813671	- 2655044

TABLE 2: Consumption and Import of Urea [7]

At this stage, we've to look over the scenerio of production of urea. We know that after our local production remaining fertilizer requirements of the country such as urea, TSP, MOP etc are met through import. The total urea fertilizer production in 2008-09 was 1.5 million tons in six urea factories of Bangladesh and total demand was 2.850 million tons. Domestic production covered 52.6% to the total demand of urea. Similarly, TSP domestic production was 50,000 tons, which covered 10%, MOP demand was 0.4 million tons which was completely imported from foreign countries [1]. It is quite evident that fertilizer demands are heavily dependent on imported fertilizer. Therefore, any disruption in the supply chain, it is quite possible to affect the total production system.

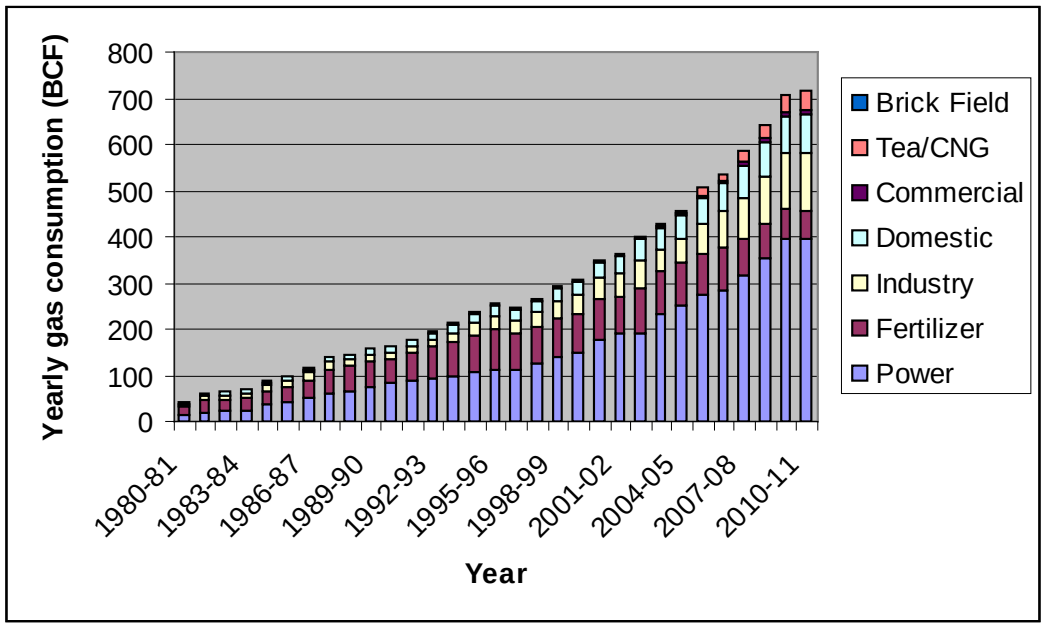


Figure 4: **Consumption of natural gas in different sector of Bangladesh 1980-2011 [10]**

From the Figure 4 it is clear that the highest amount of natural gas is consumed in power sector. Though, fertilizer production is consuming significant amount of Natural gas, but it is not enough to fullfill the demand of total consumption of fertilizer.

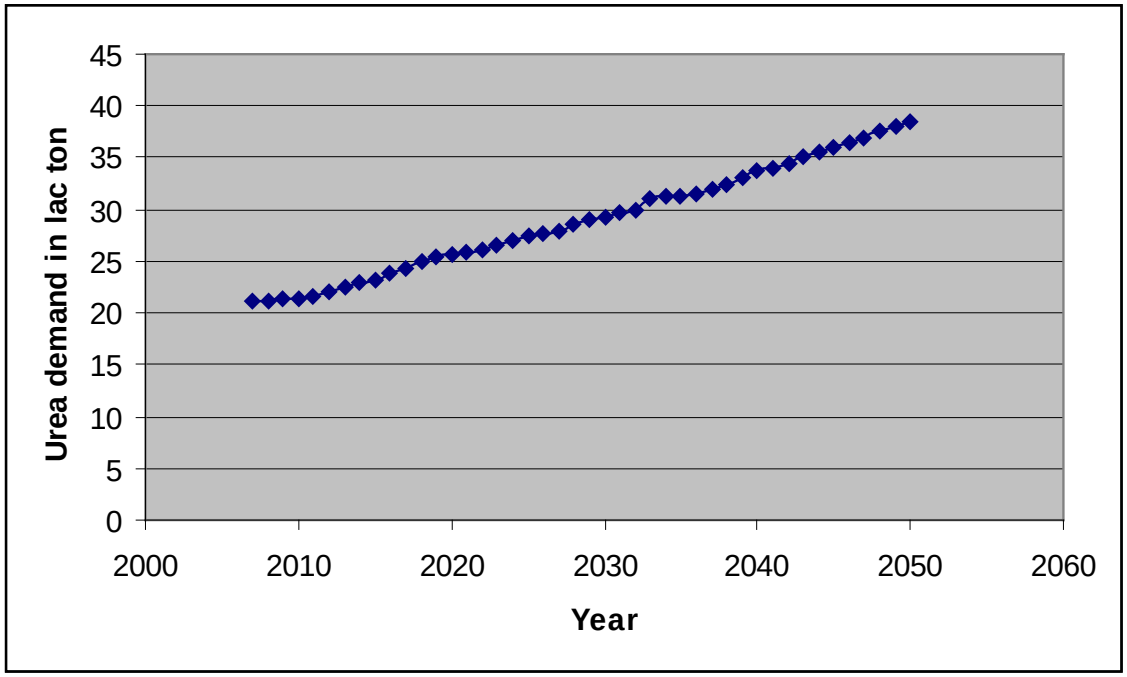


Figure 5: Future projected Urea demand of Bangladesh in lac ton (1 million = 10 lac) [9]

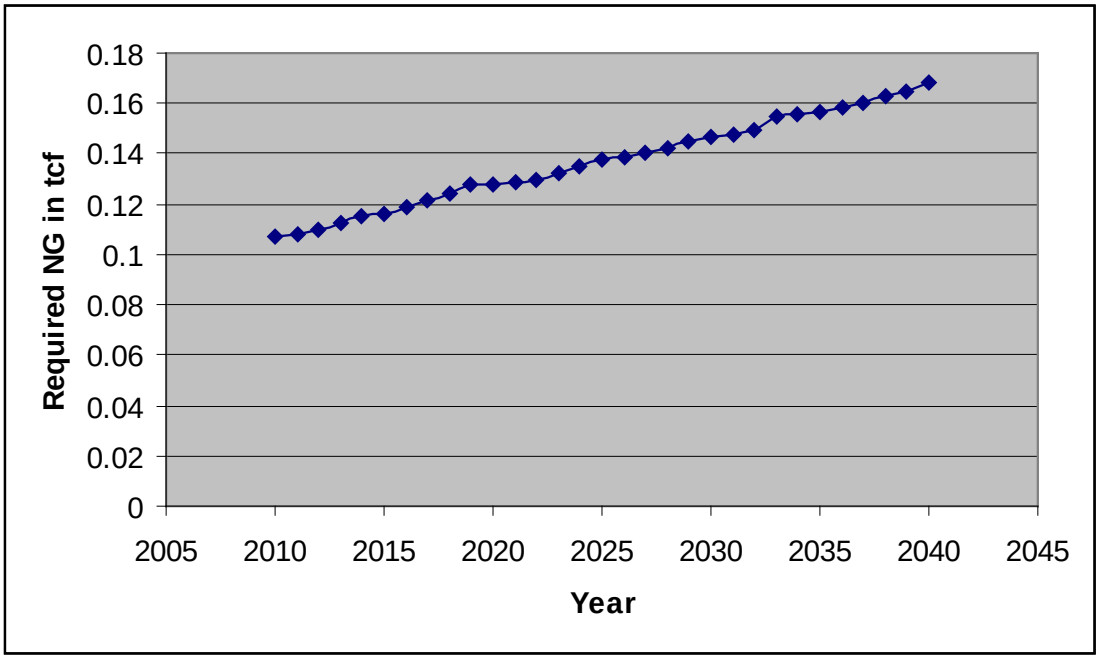


Figure 6: Required Natural Gas to fulfill the future fertilizer demand in Bangladesh

Figure 5 shows the projected Urea demand in Bangladesh till 2050. Figure 6 shows the required Natural gas demand to fulfill the future fertilizer demand. To produce 1 ton Urea it is required 50 MSCF NG in Bangladeshi plant. To ensure total food security we recommended the total fertilizer is done by our domestic Natural gas not depending on imports from foreighn country and increasing the power generation from renewable sources.

Present Status of electricity demand, generation and load shedding: Electricity is mandatory for the technological development and economic growth of a nation. Bangladesh has been facing a severe power crisis for about a decade. Known reserves (e.g., natural gas and coal) of commercial primary energy sources in Bangladesh are limited in comparison to the development needs of the country. Power generation in the country is almost entirely dependent on fossil fuels, mainly natural gas that accounted for 82.12% of the total installed electricity generation capacity in 2011. At present 50% people of the country have access to electricity with vast majority being deprived of a power supply. The government of Bangladesh has prepared power system master plan PSMP-2010 covering a plan period of 20 years (2010-2030) to realize the goal to provide access to electricity to all, although at present there is high unsatisfied demand for energy, which is growing by more than 10 % annually [3].

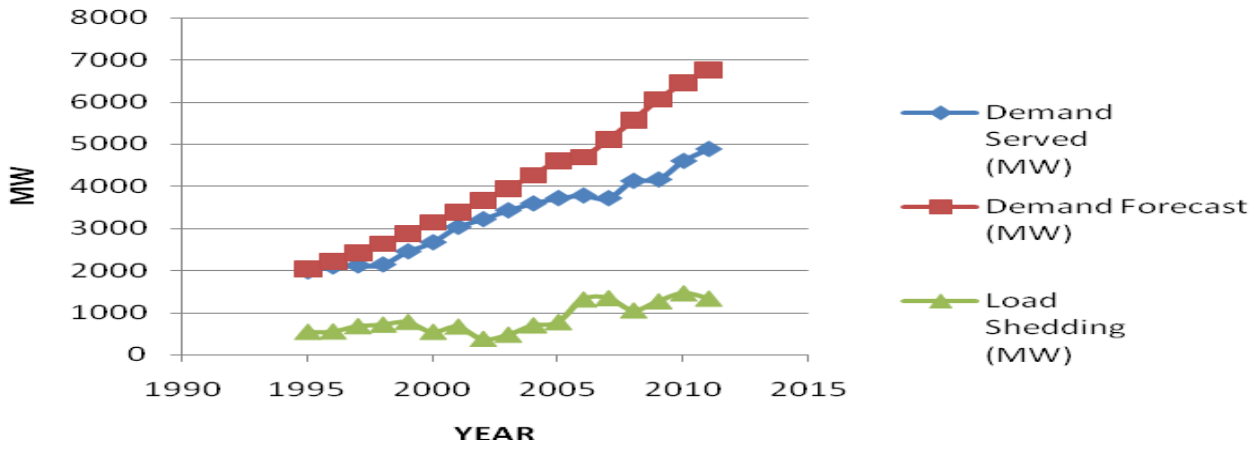


Figure 7: Power demand-supply gaps and load shedding in Bangladesh [2]

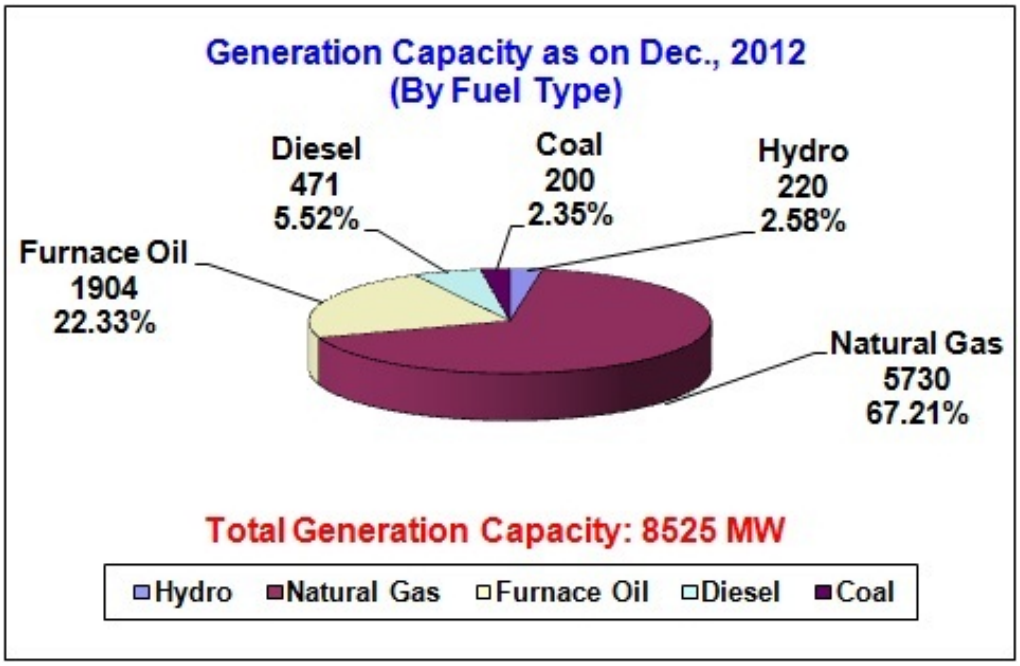


Figure 8: Fuel Wise power generation [2]

Future Demand Forecast and Generation Plan of the Government: Bangladesh is mainly an agrarian country with a population of 161.083 million [11]. Only 22.88% live in urban areas, while the remaining 77.12% live in rural areas. At present electricity demand growth is about 10% which is expected to be more in coming years [3]. Generation shortage forces Bangladesh Power System (BPS) for massive load shading hindering nation's development activities.

The preliminary demand forecast was made according to Power System Master Plan (PSMP) -2010 based on 7 % GDP growth rate. The actual demand could not be supplied for the last few years. The maximum demand served so far is 6066 MW as on 22 March 2012 against the peak demand 7548 MW [2]. The electricity development is required to be accelerated to increase access and attain economic development. The desirable economic growth rate would be about 7% per annum. Based upon this preliminary study the anticipated peak demand would be about 10,283 MW in FY2015, 17,304 MW in FY2020 and 25,199 MW in 2025. According to PSMP- 2010 Study year-wise peak demand forecast is shown in below figure.

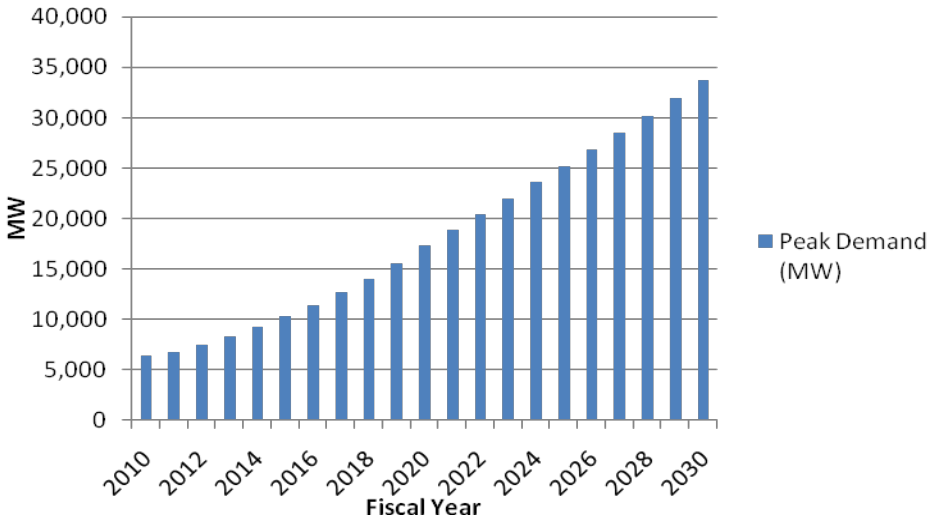


Figure 9 : Year wise peak Electricity demand [3]

Energy	Bangladesh	
	2010	2021
Gas	87.5%	30%
Oil	6%	3%
Coal	2.5%	53%
Hydro	2.7%	1%
Nuclear	0%	10%
Renewable	0.5%	3%

Table 3: Perspective plan of Bangladesh power generation 2010-2021 [3]

From the Perspective plan of Bangladesh power generation 2010-2021 is given in Table 3, we can say that coal is expected to be the main fuel for future power generation in Bangladesh. The government of Bangladesh has planned to generate 2900 MW power from coal in the next 5 years [12], although coal power has adverse environmental effects and coal reserves are limited. The government has also focused on furnace-oil-based peaking power plants. As a result, the share of CO2 emissions coming from fossil-fuel-based power plants in the national CO2 inventory is expected to grow, and there is a growing dependency on imported fossil fuels for power generation. Increasing the use of fossil fuels to meet the growing worldwide electricity demand, especially in developing countries, not only counteracts the need to prevent climate change globally but also has negative environmental effects locally. In Bangladesh, the power sector alone contributes 40 % to the total CO2 emissions [13, 14]. In this case, it is necessary to develop and promote alternative energy sources that ensure energy security without increasing environmental impacts.

Renewable energy potential in Bangladesh: Bangladesh is known to have a good potential for renewable energy. Whereas fossil energy sources are fixed in stock, renewable energy sources are not limited, but usually are not in ready-to-use forms for power generation. To convert renewable energy into electricity, energy-converting systems are needed. Therefore, the potential renewable energy is dependent on the technical ability of this conversion system.

Solar Energy: Bangladesh is situated between 20.30° and 26.38° north latitude and 88.04° and 92.44° east longitude with an area of 147500 Km^2, which is an ideal location for solar energy utilization. The GeoSpatial Toolkit provides the solar map of Bangladesh and it shows that the solar radiation is in the range of 4 - 5 $kWh/m^2/day$ on about 94 % of Bangladesh (Figure 10). Data on average sunny hours per day (Figure 11) and monthly solar radiation (Figure 12) were taken from NASA for 14 widely distributed locations in Bangladesh using the Hybrid System Optimization Model for Electric Renewables (HOMER) software. The average sunny hours per day are 6.5, and the annual mean solar radiation is 0.2 kW/m^2. This indicates that Bangladesh theoretically receives approximately 69751 TWh of solar energy every year, i.e., more than 3000 times higher than the current (2006) electricity generation in the country [15].

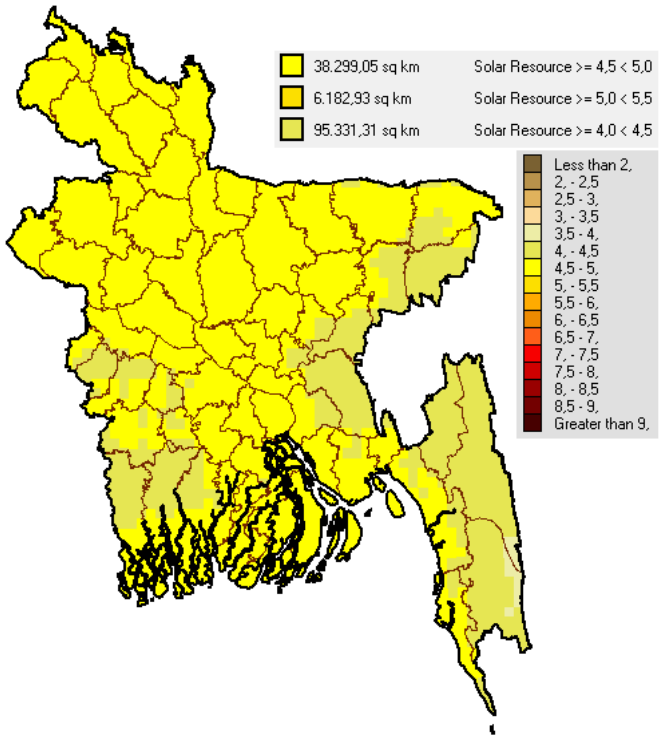
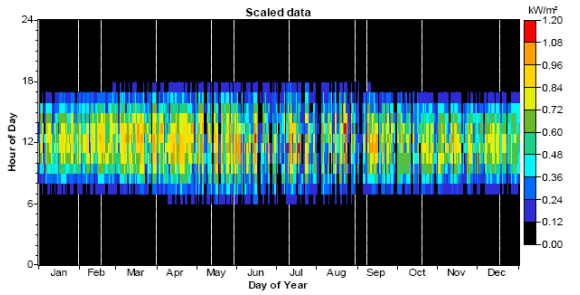


Figure 10: Solar radiation (kWh/m²/day) and area of Bangladesh with highest potential for solar energy utilization.



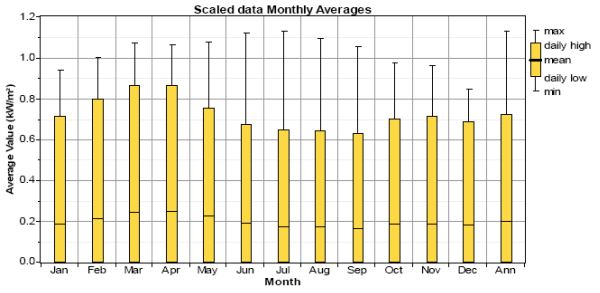


Figure 11: Monthly average sunshine hours in Bangladesh **Figure 12:** Monthly average solar radiation in Bangladesh

The average annual power density of solar radiation is typically in the range of 100 – 300 W/m². Thus, with a solar PV efficiency of 10 %, an area of 3 – 10 km² is required to establish an average electricity output of 100 MW, which is about 10 % of a large coal or nuclear power plant [16]. A study suggests that 6.8 % (10,000 km²) of the land in Bangladesh is necessary for power generation from solar PV to meet the electricity demand [17]. Another study states that the total household roof area is about 4670 km² [18] which is about 3.2 % of the land area. In urban areas (Dhaka city), 7.86 % is suitable for solar PV electricity generation [19]. Considering the grid availability, only 1.7 % of the land in Bangladesh is assumed technically suitable for generating electricity from solar PV [20].The capacity of grid-connected solar PV is derived using the annual mean value of solar radiation (200 W/m²) and a 10 % efficiency of the solar PV system. Thus, the technical potential of grid-connected solar PV in Bangladesh is calculated as about 50174 MW [15].

Another potential solar energy technology are Solar Home Systems (SHSs). Households can use SHSs without access to the national grid network, especially those in remote and mountainous areas. According to a survey report, a market of SHSs of approximately 0.5 million households reaching 4 million in the future is envisioned in Bangladesh [21]. Considering an average standard 50-Wp solar panel for each household [22], the technical total capacity will be equivalent to 200

MW. The same capacity is applicable for the hybrid system, as this system is suitable only for rural non-electrified remote areas. Economic viability of SHS was discussed in [23], and techno economic analysis of hybrid system was explained in [24].

Wind energy: The theoretical potential of wind energy output for Bangladesh in the form of hours with full power is relatively high in only coastal regions. Assuming that 1000 h of full power is the feasible threshold for the exploitation of wind energy, the areas that satisfy this condition in Bangladesh would be sufficient for the installation of 4614MW of wind power [15].

Biomass energy: Biomass energy such as rice husks, Municipal solid waste (MSW), poultry droppings and bagasse are useful for electricity generation, as field residues are used for fertilizer and animal waste as a cooking fuel in Bangladesh. 50% of the rice husks are used for energy applications such as domestic cooking and steam production for rice parboiling. Therefore, theoretically only 50% of the rice husks can be used for power generation. MSW and bagasse can be used to 100% for grid power generation, as sugar mills are connected to the grid network. A study found that only 57% of poultry droppings are viable for small-scale power generation [25]. It can be estimated that a ton of rice paddy could produce 282 kg dry rice husks with a calorific value of 16.3 MJ/kg [24]. For gasification in gas turbine systems, this residue would generate about 10.6 kW. A survey [26] found that 540 rice mills exist in Bangladesh, and that the capacity ranges from 30 to 120 tons/day. Counting only rice mills with a capacity higher than 30 tons/day, the technical potential of electrical power is about 171 MW [15].

Bangladesh has installed 14 sugar-mill-based cogeneration plants using bagasse. Average crushed-cane capacity per sugar mill is about 1400 tons/day in Bangladesh, and could generate up to 12.75MW and in total about 178.5 MW [15].

MSW have a good potential for power generation. Dhaka city alone has a capacity higher than 5000 tons/day [27-29]. Per capita waste production 0.4 to 0.71 kg/day and in other large cities it varies from 0.36 to 0.43 kg/day [30]. Considering the four major city corporation Dhaka, Chittagong, Rajshahi and Khulna average waste generation per day 0.5 kg/day, a total of 8300 tons waste are generated daily. The average recovery rate of MSW is 70% [30], i.e., 2.12 million tons per year. From this waste the potential of power generation is about 33 MW [28-29].If the considering area can increase the potentiality of this sector will be increased also.

Over 25,000 fixed-dome biogas plants have been installed and some large farms produce electricity using biogas technology. For heating purposes, a medium-size farm is suitable, while larger farms could also produce electricity. Poultry farms that have more than 500 birds could generate about 360 GWh per year which is equivalent to 197 MW considering to run the plants 5 h/day [31].

Hydro Power: Bangladesh has not much opportunity to generate hydropower due to its flat land. It has some hydropower generation opportunity in hilly area. Different ranges hydropower generation potentials are categorizes in two divisions i.e. small hydropower potential, large hydropower potential. Small hydropower means plant which has capacity less than 10 MW. This also further categorizes into small hydro- (>3MW<10 MW), mini hydro- (>300 kW<3 MW), micro hydro- (>5 kW<300 kW), and pico hydro- (<5 kW) power plants that differ with respect to investment cost and annual hydropower availability.

Capacity range	Number of sites	Location/ region	Total capacity (KW)
Small hydro (3–10MW)	14	Northeastern region	111000
Mini hydro (300kW to 3MW)	11	Mainly at Teesta barrage, Rangpur and northeastern region	12900
Micro hydro	32	Chittagong hill tracts, Sylhet, Dinajpur, Rangpur	798
Pico hydro	11	Lake Fiaz, Chittagong	4
Total			124702

Table 4: Small hydropower potential [32]

Large hydropower means plant which has capacity greater than 10 MW. At present, 230MW of hydropower are generated at the Karnafuli hydropower plant, which is the only hydro-electric power plant in Bangladesh; it is operated by the Bangladesh Power Development Board (BPDB). The BPDB is considering extension of this power plant to add another 100MWcapacity. The additional energy will be generated during the rainy season. Two other prospective sites for large hydropower plants at Sangu and Matamuhuri have been identified by the BPDB. It estimates that the potential capacity is 140MW at Sangu river and 75MW at Matamuhuri river.

Solution of Power Crisis through Renewable Energy and Ensuring Food Security: According to PSMP-2010 it is predicted that power demand of Bangladesh at 2030 will be 33,708 MW. To fill up this huge amount of demand government of Bangladesh is trying to generate power at its earliest time. As a result government set many oil based quick rental power plant. But due to high oil price and its fluctuating market our economy is in high pressure due to this quick rental power plant. Inflation rate is increasing and foreign currency is also under pressure to import huge amount of oil for power generation. Bangladesh government planned at 2021, 53 % of its total electricity will be generated from coal, 30% from Natural gas, 3% from Renewable energy against its 18838 MW total power demand [3]. Although apparently coal has low production cost but it has adverse environmental effect. Moreover we have not huge reserve of coal. If we continue with coal based power generation after a few years we have to import coal for power generation. If we consider import cost and its environmental impact during the production time plus import time, production cost of electricity from coal based power plant will be no longer remain low.

If the Government trying to generate 30% of total electricity power from Natural gas it will be around 5651.4 MW. In Bangladesh around 10.22 thousand standard cubic feet (MSCF) gas is required for 1MWh electricity generation [2], total gas demand to fulfill the demand at 2021 will be around 1386.18 MMSCF per day.

At 2021, in Bangladesh Urea fertilizer demand will be 2.613 Million Tons [33]. The average requirement of Natural gas to produce 1 ton Urea fertilizer in Bangladeshi plant is about 50 MSCF. To fulfill the present fertilizer demand 350MMSCFD gas is required and at 2021 it will be 365.82 MMSCFD [7].

Bangladesh produced and consumed about 0.7 Tcf gas in 2011, and the annual gas consumption is likely to increase to about 1 Tcf within three to four years. Assuming an average production and supply rate of about 1 Tcf gas per year, the 16 Tcf of remaining reserve (as of Dec 2011) should run for about 16 years [34]. In 2011, Power Sector Master Plan prepared by Japan International Cooperation Agency (JICA), forecast long-term production forecast gas production is expected to reach a peak in 2017 and then decline. Taking the base case scenario as reference, production is expected to peak at 3320 MMSCF per day in 2017 and then start to decline (JICA 2011). As the production continues to decline, the gap between demand and supply will continue to widen. However, gas production is expected to continue to 2030 and perhaps beyond, although lesser and lesser in volume over time. According to this projection, gas as a fuel will contribute to 25% of the total electricity generation in 2030 (compared to 88% in 2010) while coal's contribution at that time would be 50% (compared to 4% in 2010).[4] According to this projection , if no new reserve is discovered or if the existing reserve is no more develop Bangladesh present proven reserve of Gas will exhaust by 2030. Although Electricity can be generated from other sources but what will happen for Fertilizer after 2030. In that case we have no alternative without importing the whole demand of Urea Fertilizer. This will make our foreign currency reserve completely imbalance and also our economy. So to keep the food sector secured we must reduce the utilization of gas for power generation in a significant amount as early as possible and should keep this Gas for fertilizer production.

If we can reduce the utilization of Natural Gas in electricity generation within 5% of total demand by 2021, required gas demand for 941.9 MW (5% of 18838 MW) electricity generation will be around 232 MMSCF per day. For the production of total Urea demand required gas demand will be 365.82 MMSCF per day and considering other industrial and domestic demand, yearly total demand of Natural Gas will be around 500 billion cubic feet (bcf).

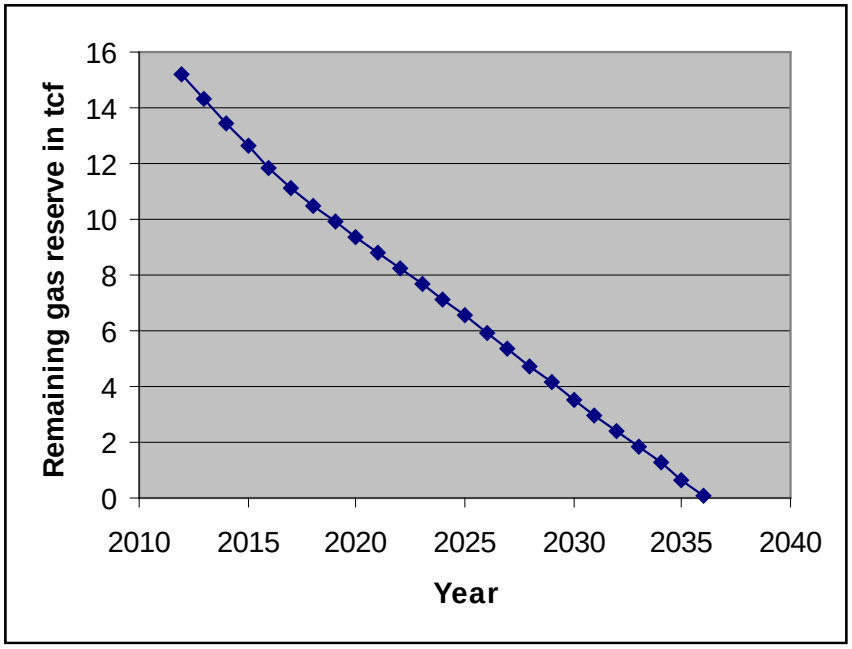


Figure 13: Natural Gas reserve decreases with time

If we can continue the reduction of using Natural Gas in other sector and provide the full demand for fertilizer production present proven reserve of the Natural Gas will continue up to 2040. Figure 13 shows the how present reserve of Natural gas decreases with time. By developing the reserve of Natural Gas, increasing the Fertilizer plant reliability and reducing the system loss of Gas we can easily continue our Natural Gas reserve for many years.

Among many others alternative for power generation renewable energy is the most effective. From the assessment of renewable energy we have seen that if we can use solar and other renewable sources properly our country will get a permanent solution in power sector.

Cost Analysis: In The Fiscal Year 2010-2011 total demand of Urea fertilizer was 2.5 million ton. But due to gas shortage local production was 1 million ton, rest of the 1.5 million ton fertilizer demand served via import. 1 ton Bag urea import costs US$ 560 [7]. So 1.5 million ton Urea import cost is 1.5 m x 560 =840 million US $ = 6619.2 core taka for Urea only. In worst case if we have to import all fertilizer the import cost will be 2.5 m x 560 US $ = 1.4 b US $ = 11032 core taka. [1 US $ = 78.8 taka] If we consider the gas cost for shortage amount of fertilizer which we had imported is Gas cost for 1.5 m ton urea [1 ton urea = 50MSCF; 1 MSCF = US$ 2] =150 million US $ = 1182 cr Tk. So for saving 150 million US $; we are paying 1.4 b US $ or 1400 million US $. In other words to save 1 US $ Gas we are paying 9.33 US $ to import Urea.

Conclusion: Bangladesh is one of the worst environmentally vulnerable countries in the world. It has a large population. To ensure food security government should concentrate to the local production of fertilizer. So it is necessary to preserve natural gas for fertilizer production as much as possible. It is shown that if the contribution of Natural Gas as a fuel for power generation can be made 5% of the total country demand by 2021 our existing proven reserve of Natural gas will continue up to 2040. Otherwise our food security will be in danger. But at the same time we have to increase our power generation also for the development of our growing economy. Among many other alternative fuels renewable energy is the only environment friendly. It is available in nature, so there is no tension for fuel availability. Although it's initial investment cost is high but if we imagine after 20-30 years later situation then it will no longer seem costly. From various surveys we have seen that to fulfill our present and upcoming power demand renewable resources is sufficient. If we want a permanent solution for our power crisis renewable energy especially solar energy will be the most effective solution.

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