Nuclear Power as a Tool for Sustainable Development in Energy Sector in Bangladesh

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***Abstract*— Bangladesh is a fast developing country and it is one of the densely populated nations not in Asia but all around the globe. In Bangladesh, per capita electricity generation is very low as compared to other developing country, which is about 321 KWH. Emphasis on maintaining high GDP growth primarily accounts for the energy shortage in Bangladesh as it increases demand through high-energy consumption industries. Converting primary energy to electricity is one of the biggest challenges that Bangladesh is facing right now. Still now, energy sector of Bangladesh is highly reliant on natural gas. About 89% electricity is now produced by natural gas. In 2025, electricity demand will be about 25000MW. This amount cannot be supplied by natural gas, oil, due to fuel cost and availability of fuel. This paper presents a study in energy sector in Bangladesh and the necessity of nuclear power in future. This study also tries to find ways for increasing efficiency and reducing electricity generation cost in Bangladesh. Though nuclear power plants need high capital cost, its generation costs are stable and predictable and also it is cheap to operate. It can also be considered as a renewable energy. For sustainable development in energy sector along with finding a power source that is stable, cost effective and will be able to meet the future demand, nuclear power source may be one of the best options Bangladesh has right now.**

Keywords*— *Power sector in Bangladesh; Electricity demand; RNPP; Generation cost

I. INTRODUCTION

Bangladesh is a developing country. Bangladesh, with its 150.5 million People in a land mass of 147,570 sq. km, has shown tremendous growth in recent years. Bangladesh has a good probability to increase its economic condition by using its resources in a well manner. In 2012, Bangladesh Real GDP growth was 6.3 and 29% of it was industry (percentage of GDP) [1].For Bangladesh economic development is directly proportional to the electricity generation. In Bangladesh, 62% people have access to electricity and per capita electricity generation is 321 KWH, which is very low as compared to other developing countries (source Power Division Bangladesh). Electricity generation in Bangladesh is now dependent on natural gas because of its low generation cost (BDT 2.5-3.0/KWH [2]) and enough supply. In Bangladesh remaining gas reserve is about 16Tcf but annual consumption is about 1Tcf [3]. For this in future, Bangladesh will suffer scarcity of natural gas. In this situation, nuclear energy can be considered as a good energy source. It is a green energy and also be considered as a renewable energy. Its electricity production is reliable because of availability of Fuel and low operating cost.

II. PRESENT CONDITION OF POWER SECTOR IN BANGLADESH

In Bangladesh, power sector is mostly dependent on natural gas. Now Bangladesh has a power generation capacity of 10213MW. According to the Bangladesh Power Development Board, power generation capacity is given in Table I.

Power generation of Bangladesh is now completely dependent on natural gas. Bangladesh has 23 gas fields. About 89% power is generated from natural gas and the rest is from liquid fuel, coal and hydropower. The present share of renewable energy is only 0.5%. Due to use of Furnace oil and high-speed diesel, electricity generation cost is increasing day by day. In 2009, the average electricity generation cost was around Tk.3/kWh. Now it is near about is Tk.6.25 per unit (kilowatt-hour) and BPDB supplies the electricity at Tk.5.75 (average) per unit. The balance is subsidized [2].

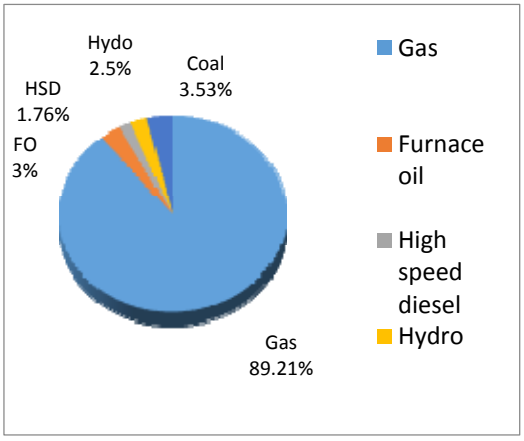

Fig. 1. Fuel used in generation (Source Power Division Bangladesh)

TABLE I: Installed Capacity of BPDB Power Plants as on January 2014

Unit Type	Capacity(Unit)	Total (%)
Coal	250MW	2.45%
Gas	6587MW	64.5%
Heavy Furnace Oil	1963MW	19.22%
High speed diesel	683MW	6.69%
Hydro	230MW	2.25%
Imported	500MW	4.9%
Total	10213.00MW	100%

III. ELECTRICITY PRODUCTION IN WORLD BY NUCLEAR POWER

Global nuclear capacity grew at a fast pace from 1960 to the 1980s. Share of global electricity generation reached 16% in 1986 by nuclear power. The present situation in nuclear power generation throughout the world is different for various countries. Now 31 countries have nuclear power generation capacity. Among them percentage of electricity coming from nuclear reactors is 78 % in France and 2 % in China. At present, nuclear energy produces little bit less than 14% of the world's electricity production and 5.7% of total primary energy used worldwide [5].

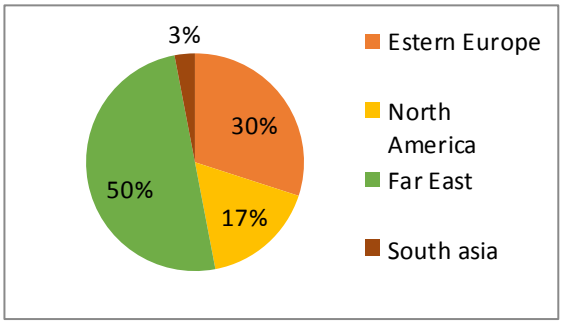

Fig. 2. NPP Status in the World

Now USA has about 104 reactors providing 19% of its electricity by nuclear power. In south Asia, India gets less than 3% of its electricity from nuclear energy. India has a future plan to increase 10% of the electricity supply in 2022 and 26% in 2052 by nuclear power. Another Asian country South Korea has 20 reactors in operation and three more under construction. In South Korea, nuclear power already supplies nearly 40% of electricity. [4].

IV. NUCLEAR POWER AS A SOURCE OF ENERGY FOR BANGLADESH IN FUTURE

In Bangladesh power sector is mostly dependent on natural gas, oil (HFO, HSD) and coal. Now Bangladesh has 23 gas fields. 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 (Petrobangla 1993). 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 (Petrobangla 2004). In 2011, the number of gas fields grew to 23 with an estimated initial gas reserve of 26.84 Tcf and a remaining reserve of 16.74 Tcf (Petrobangla 2012). Interestingly, the estimated remaining reserve of the country over the years has not decreased but has increased from 10.55 Tcf in 1993, to 15.4 Tcf in 2003 and to 16.74 Tcf in 2011[3]. This is in spite of the fact that both demand and production of gas have increased over the years. 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. In other words, Bangladesh is likely to exhaust its gas reserve by about 2025[3]. If gas production rate increases, this time will also shorter and Bangladesh will suffer gas crisis and the government will fail in future to ensure supply of natural gas. For generating power quickly Bangladesh government has focused on quick rental power plant in recent years. But it's so costly. In 2012, PDB has purchased power from 17 small power plants, mainly run on diesel, at the rate ranging between Tk 17 and Tk 22 per unit. If power generation from quick rental power plant continues, Bangladesh government will have to give Tk 20,700 core yearly if it takes 2,000 MW power from quick rental and rental power plants and this cost will go up with increasing power needs. Bangladesh Power Development Board estimated that it incurred a loss of Tk 596.34 core during November-December 2011 for buying electricity from the costly rental power plants. This takes the lion's share of the subsidy. As demand of power increases, Bangladesh government needs to find alternate power sources. Power sources that are suitable for Bangladesh are natural gas, oil, coal, hydro, nuclear energy, renewable energy such as wind power, solar power, tidal power etc. But government needs to ensure the supply of fuel. Until Bangladesh ensures the primary fuel supply security the large investment for power will remain a challenging task. For reducing energy crisis and to ensure sustainable development government needs to full fill the demand. Demand forecast of power by BPDB is given in Table II. For reducing pressure on gas, coal and oil as fuel nuclear power can make a good role in future. Though construction of nuclear power plan is costly, it can minimize electricity production cost. For Bangladesh, nuclear power can provide a good role in energy sector. Now in Bangladesh natural gas is the main source of energy. If we consider oil as fuel for electricity generation, it will increase generation cost. For this in Bangladesh nuclear power can be considered as a good energy source.

TABLE II: Demand forecast of power by BPDB.

Fiscal Year	Peak Demand (MW)
2015	10,283
2017	12,644
2020	17,304
2023	21,993
2025	25,199
2030	33,708

V. FUTURE PLAN OF BANGLADESH GOVERNMENT FOR NUCLEAR POWER AND CURRENT PROGRESS

Bangladesh needs to achieve and sustain an annual economic growth rate of at least 6/7 percent to alleviate poverty and realize desirable socioeconomic and human development. To achieve the growth target of GDP, it is absolutely essential that the minimum electricity growth rate is maintained at a factor of 1.5 of GDP growth. In 2025, electricity demand of Bangladesh will be near about 25000MW. If no new natural gas field is discovered, this power must be met by coal, nuclear power and imported oil. Bangladesh has good deposits of coal about 2 GT or more.

Barapukuria coalmine is now in production but its performance together with that of a pithead coal-fired power plant has been unsatisfactory due to poor planning and management. Now Bangladesh government has started the construction work of a nuclear power plant called Rooppur Nuclear Power Plant. In October 02, 2013 foundation stone of a RNPP has been laid at rooppur in pabna district. The government signed a US$ 500 million “test credit deal” with Russia for the primary work to install two-units of the power plant, each of 1,000 MW capacities. Bangladesh Atomic Energy Commission will implement the project and the total cost of it has been estimated between at $1.5 billion and $2 billion. The RNPP is projected to produce 1,000 MW of electricity by June 2017 and another 1,000 MW by 2022. According to the plan of Bangladesh government in 2021 near about 10% electricity will be produced by nuclear power.

TABLE III: Prospective plan of electricity generation in 2021 and 2030[6]

Energy	2021 Total %	2030 Total %
gas	30	28
coal	53	38
oil	3	5
hydro	1	4
Nuclear	10	19
Renewable	3	6

Bangladesh Government wants to make maximum utilization of gas, oil and coal after 2015, introduction of nuclear power from 2015 and also introduction of solar power from 2020. Though nuclear energy does not give a magic solution in power sector on Bangladesh but it can reduce pressure on gas, oil.

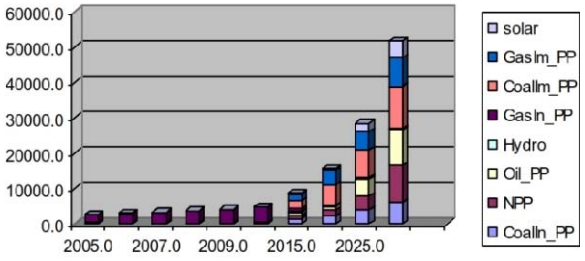

Fig. 3. Power and energy system planning [6]

VI. ROOPPUR NUCLEAR POWER PLANT (RNPP)

RNPP is located at Rooppur, 200 km north-west of Dhaka, in the Ishwardi sub district of Pabna District, in the northwest of Bangladesh. The proposal was first raised in 1961. Government took 253.90 acre of land of current place at that year to build the plant. In 1963, the plant was approved. In 2009, the Bangladesh government again started discussion with Russian government and on 13 February the two governments signed a MoU.

Fig. 4. Nuclear power plant at Rooppur under construction

Construction work of RNPP has been started from October 02, 2013. Two unit of RNPP will go on operation on 2020-2021[7]. Total project cost of this plant stands about Taka 5,300 core. The water-water energy reactor (VVER or WWER)-1200 would be installed at the Rooppur nuclear power plant to produce 1,000 MW of electricity(source BAEC).This reactor type is Pressurized Water Reactor (PWR) and the coolant and moderator used is Light Water. Its thermal capacity is about 3200.00 MW and Gross Electrical capacity is 1170.00 MW.

Bangladesh government is hopeful that one unit of RNPP will produce 1,000 MW of electricity by June 2017 and another 1,000 MW by 2022 and the life span of the plant will be 60 years.

TABLE IV: Specifications of VVER-1200 reactor [8]

Specifications	Value
Reactor nominal thermal power	3200 MW
Number of loops	4 pcs
Primary pressure	16,2 MPa
Secondary pressure,	7,00 MPa
Reactor coolant temperature, (Inlet , outlet):	298,2°C ; 328,9°C
Reactor coolant flow rate	86 000 m3/h
Steam capacity	4 x 1602 t/h

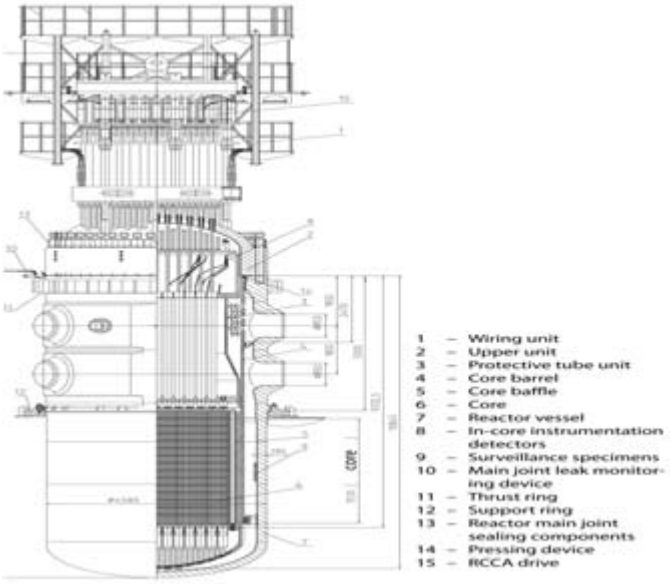

Fig. 5. VVER-1200 (V-491) reactor [8]

VII. ELECTRICITY GENERATION COST IN BANGLADESH

Now electricity generation of Bangladesh is completely dependent on natural gas. Gas reserve of Bangladesh will probably run out in 2025. For this Bangladesh needs to depend on other electricity source such as coal, oil, renewable energy in future. But oil based power plant increases the production cost. Average electricity generation cost was BDT 5.35/KWH in 2012. But because of increasing cost of furnace oil and diesel, average electricity generation cost has been increased about BDT 6.25/KWH.

The increase in generation cost is due to the increase in share of liquid fuel based power plants and also the increase in prices of liquid fuel. Cost to generate electricity with the use of high-speed diesel is BDT 18-20 KWH and that with furnace oil is BDT 13-14/KWH. Electricity generation cost for coal is now around BDT 5/KWH and for hydro power plant it comes around BDT 1/KWH. Generating electricity with gas is much cheaper and is around BDT 2.5-3.0/KWH [2].

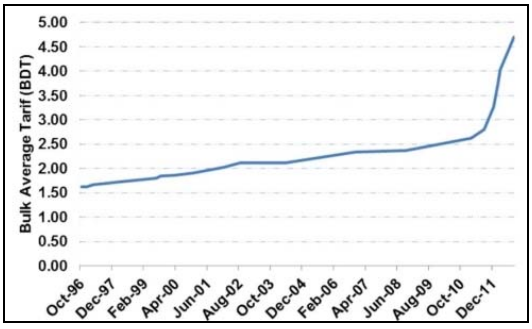

Fig. 6. Electricity tariff in Bangladesh [2]

VIII. ADVANTAGE AND DISANVANTAGE OF NUCLEAR POWER

Nuclear power can be considered as a renewable energy. In 1987, the World Commission on Environment and Development (WCED) classified fission reactors that produce more fissile nuclear fuel than they consume and it is called breeder reactor. It can also be considered a low carbon power generation source. The main advantages of nuclear power plant are cheap to operate, stable and predictable generating cost, long life time, low external cost and low fuel cost. But disadvantages are high capital cost, Long lead times (planning, construction, etc.) and Regulatory/policy risks. But considering disadvantages it's a good source for generating electricity and it can provide sustainable development in the economy of a country. It can reduce pressure on fossil fuel.

IX. COST ANALYSIS

If Bangladesh wants to attain 8% of GDP growth then Bangladesh would have demand of 34000MW in 2030. Cost analysis of a nuclear power is given below

1. Let us consider a power plant that's generation capacity is 2000MW and 90% availability at a running time of 20 hours. If its life time is 60 years, then total amount of electricity supplied is 1800x1000x365x20x60=788400000KW

2. Again consider Rooppur nuclear power plant. Total cost of RNPP project is about TK 5300 core. By taking only project cost, per KW cost is BDT 4.03(5300 core / 788.4GW).

3. Fuel cost of a nuclear power plant is much less than gas, oil, coal. It is generally consist 25% of total KW generation cost

4. Operating cost and maintenance of NPP is low as compared to coal plant.

X. CONCLUSION

Nuclear energy can provide sustainable development both in energy sector and in economy of Bangladesh by reducing pressure on fossil fuel, making utilization of gas, oil in other sector, making availability of electricity supply. In 2030, electricity demand of Bangladesh will be 34000MW.If in future 50% electricity is provided by nuclear power and rest of them by coal, hydro and renewable energy, sustainable development of Bangladesh may be possible. Bangladesh government should build more nuclear power plant. Though nuclear power does not give a magic solution, it can reduce power crisis.

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