Nuclear Power Plant: Significance for the Betterment of the Present Power Scenario in Bangladesh and Possible Solution for the Future

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ABSTRACT

Becoming concerned about nuclear power plant in Bangladesh, this paper documents the importance and future scopes for the effective energy solution provided by nuclear power plant in the context of power scenario in Bangladesh. In modern life, electricity is the most significant and essential element. The development of a country depends on electricity generation and consumption. Nuclear power has now become a highly used energy source that can contribute immensely in energy economy. It has the capacity to provide much of consumer energy. Nuclear power plant technology is a critical process. In the recent study, electricity supply aspects for 2041 have been proposed according to development and utilization of nuclear power. On the other hand, concern about cost of construction, climate change and air pollution, as well as growing demand for electricity is considerable issues for efficient power supply and mass distribution. This paper reviews the entry of nuclear energy generation in a future electricity system in Bangladesh, as well as its relationship with fossil fuel to supply economical energy.

“Keywords”- Bangladesh energy scenario, cost of energy, efficiency, energy generation, environment, Nuclear Power plant, sustainable development.

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1. Introduction

The main challenge of Bangladesh of the 21st century is to find the ways of sustainable Development for the growing economy. The development of energy and power infrastructure therefore pursues not only the quantity but also the quality to realize the long term economic development. Bangladesh has an aspiration to become a high-income country by 2041 [1]. The country needs to achieve continuous economic growth of 7.4% annually for the period from 2016 to 2020 to initially reach the standard of the medium to high income nations [2]. Energy appearance is the most important prospect for human development and economic growth. If supply energy increases along with the growth of population and demand, the sustainable economic growth will continue. Since in this country the number of industries increases, electricity based communication, agricultural services, and home appliances all are driven by power.
So, there is an acute need to generate more electric power. Most of energy come from Gas- 62.73%, Coal-1.2%, Hydro 1.75% Heavy fuel oil 21.25%, , High speed diesel 7.83%, Import 4.55% at 2017[3]. The power system depends on fossil fuel. Oil still dominates in the international markets. Gas production decreases year by year and that is why electricity production will decrease in our country. Nuclear energy is a new source for electrical power generation in this country. But in the world 11% electricity produced by nuclear energy is reliable base-load power, without carbon dioxide emissions [4].

One important mission of the government of Bangladesh is to produce electrical power as a safe, environmentally congenial and economically sustainable and this can be possible by nuclear energy to meet the increased energy need of the country.

2. History of Nuclear Power Plant in Bangladesh

Globally, nuclear power is considered to be one of the cheapest and reliable source of electricity. Virtually, it emits no greenhouse gases. Considering international experience, former East Pakistan has decided to develop its own nuclear power program. Pakistan was proposed to build nuclear power plant at Rooppur in Pabna district beside the Padma Riverat that time the government took 253.90 acresland. The government discussed with the then ruling governments of Canada, Sweden and Norway in 1964 and 1966. After the independence war of 1971, Bangladesh government discussed with Soviet Union in 1974 regarding nuclear power plant installation, but no agreement was achieved. In 1980 125MW nuclear power plant was approved by the government. In 2001 it adopted a national Nuclear Power Action Plan and in 2005 it signed a nuclear cooperation agreement with China. On 2009 and 2011 the International Atomic Energy Agency (IAEA) approved nuclear power plant for 1100MW [5], [6]. In April 2009 the government approved the Russian proposal to build a 1000 MW AES-92 nuclear plant at Rooppur. On November 2, 2011, a pact with Russia to build 2 units were signed that each unit is supposed to produce 1000MW electrical power [7]. In May 2012, Parliament proclaimed that construction of 5000MW nuclear power plant will be considered by 2030 [8].

3. Energy Source

3.1 Gas

Natural gas is the most significant source for electricity produced in Bangladesh. In the figure 3.1.1 it shows 2679 MMCFD gas has been produced at FY 2016-2015 but 2449 MMCFD gas has been produced at FY 2015-14. At present power plant capacity in Bangladesh is 8267 MW of which 62.73% of power plant depends on gas [9]. At power sector gas demand is 1513.0 MMCFD (Million Cubic Feet per Day) but supply is 1034.7 MMCFD. Currently, the power sector suffering is 478.3 MMCFD shortage of natural gas. The Petrobangla forecast indicates that gas production may start decreasing from 2017. If the trend continues and new major gases findings are possible by 2021, the total production will come down to 1768 MMCFD. The gas demand in 2021 will grow up to 4632 MMCFD. The shortage will grow to 2864 MMCFD. In figure 3.1.2 it shows that gas demand significantly will increase in future but production of gas will also decrease. The first LNG will be introduced in 2019 at the rate of 500 MMCFD which corresponds to 17% of gas demand. This percentage will forecast to increase to 40% in 2023, 50% in 2028, and 70% in 2041.
3.2 Oil

Oil accounts for about 20% of the country energy supply, 1.07 percent power generation by oil. Bangladesh has 28 million barrels of oil reserve and it produces 4000 barrel per day. Bangladesh consumes oil 109000 barrel per day [12]. According to power sector master plan 2010, oil base power generation will be 5 percent of the peak demand of 17304 MW at 2020 in long term, the Bangladesh crude oil production is projected as 3.77 barrels per day. It created problem to supply large amount of oil. It needs to import refined and the import unrefined oil, unrefined oil are more costly than the refined oil.

Figure 3.2.1: shows the production of oil Bangladesh. At 2003, 6.9 thousand barrels per day maximum oil produced but oil production decreases day to day.

Figure 3.2.2: In the figure shows oil consumption of Bangladesh. At 2014, maximum of 109 thousand barrels per day oil consumes, but oil consumes increases day to day.

Figure 3.2.3: In the figure shows that in 2014 the annual oil demand is 5 million tons but in 2041 oil demand growth will be 33000 million tons. If Bangladesh wants expected development sustainable economy based industry sector and transport sector, demand will lead to a drastic oil demand growth: 6 times higher in 2041 than in 2016 (average growth rate is 7.4%) [20].

3.3 Coal

Government aim is to increase coal fired based power plant from 2 percent to 50 percent by 2021. A large portion of the coal is needed for this power generation which will come from domestic coal mines as mentioned in the vision 2021. In 2012, the production of coal was 1102.31 thousand short ton per year, it rises to 11.11 percent from last year, but Bangladesh coal demand was 2,204.62 thousand tons per year Five coal fields in the country contain 3.5 billion metric tons coal.
3.4 Renewable Energy

Renewable energy is used to generate electricity in Bangladesh. The current renewable energy comes from biogas, hydro power, solar and wind. The Renewable Energy Policy envisions that 5% of total energy production will have to be achieved by 2015 and 10% by 2020. Government starts to work to reach goal “500 MW Solar Program” & “Wind Resource Mapping” program [16].

4. Environmental Impact

Gas, coal, and oil plants can generate electricity by burning carbon fuels. They produce large amount of carbon dioxide, which causes climate change. They can also produce other pollutants, such as Sulphurous oxides, which cause acid rain. Hydro power plant can produce large amount of electricity but during dry period slow current flowing of the river water below the dam can have a serious impact on the ecology around the dam. In the nuclear power plant no greenhouse gases are produced in this fission process, and only small amounts are produced across the whole fuel cycle. Electricity generation from many renewable energy sources that no greenhouse gas emission is at the point of generation and very low amounts of greenhouse gas emissions happen across their entire lifecycle.

5. Cost

Capital costs including waste disposal and decommissioning for nuclear energy tend to be low for gas, oil and coal power plant; high for wind turbine, solar; very high for waste to energy, wave and tidal, solar thermal and nuclear.

Fuel cost is high for gas, oil and coal and biomass sources whereas it is low for nuclear and zero for many renewable solutions. Fuel cost can vary over the life of the generating equipment, due to political factor. Otherwise, in Bangladesh have not enough of fuel reserve to solve increase demand.

Figure 5.1: In the figure shows the unit cost of Electricity Generation in Bangladesh in
Tk/KWh. Higher running cost in diesel power plant that is 35.84 Taka per KWH but 1.3 taka per unit lowest fuel cost in hydro power plant. (BPDB=Bangladesh Power Development Board, HFO = Heavy Furnace Oil, IPP=Independent Power Plants. Source: Annual Report. 2014-2017, Bangladesh Power Development Board, Dhaka.)

**Figure 5.2:** shows the combination of Power plant in America using Levelized cost of energy (LCOE). LCOE is the combination of construction, fuel, operation, owner cost, financial period, taxation, and depreciation of all kinds of energy sources. The natural gas and nuclear power plant are the cheapest and more reliable energy sources in the U.S.A. [17].

6. **Lifetime of Power Plant**

Renewable technologies – geothermal, wind, and solar – have lifetimes in the range of 20 to 30 years. Gas, oil and coal power plants have lifetimes in the range of 30 to 60 years. Nuclear plants in most data sets have a lifetime of 60 years (30-40 year initial license plus one 20-30 year license renewal).

7. **Efficiency of power plant**

Efficiency related to the use of all inputs to producing any output. Efficiency is the measurable concept that can be determining the ratio of useful output to total input. Coal fired power plants operate on the modified Rankine thermodynamic cycle. The efficiency is dictated by the parameters of this thermodynamic cycle. The overall coal plant efficiency ranges from 32 % to 42 %.

Gas fired power plants use Gas Turbines or Gas Turbine based combined cycles. Gas turbines in the simple cycle mode, only Gas turbines running, have an efficiency of 32 % to 38 %.

Hydro turbines, the oldest and the most commonly used renewable energy source, have the highest efficiency. There are no energy conversion losses, only the mechanical and copper losses in the turbine and generator and the tail end loss. The efficiency is in the range of 85 to 90 % Wind turbines have an overall conversion efficiency of 30 % to 45 %. Other renewable power plants efficient are dependent on availability of the energy source.

The efficiency of nuclear plants is little different. On the steam turbine side they use the Rankine thermodynamic cycle with steam temperatures at saturated conditions. This gives lower thermal cycle efficiency than the high temperature coal fired power plants. Thermal cycle efficiencies are in the range of 38 %. Since the energy release rate in nuclear fission is extremely high, the energy transferred to steam is a very small percentage only around 0.7 %. This makes the overall plant efficiency only around 0.27 %. But one does not consider the fuel efficiency in nuclear power plants; fuel availability and radiation losses take center stage.
Table 7.1: In the figure show the comparison of difference type of power plant[18].

8. Rooppur Nuclear Power Plant in Bangladesh

Bangladesh Government wants to reconstruct the power plant based on gas. It causes crisis of gas. Government wants to raise production of electricity. So they have built new power plant base on coal, oil and nuclear.

Government is going to build nuclear power plant at Rooppur in Pabna district beside the Padma River. Rooppur power plant is a 2400 MW nuclear power plant. It will be the first nuclear power plant in our country. It has two units, the first unit is 1200 MW ruppur-1 construction will start from 2017 and operation will start from 2023/2024. Other unit Ruppur-2 construction will start from 2018 and operation will start from 2024/2025. It will be built by the Russian Rosatom State Atomic Energy Corporation. All fuel for Rooppur power plant is being provided by Rosatom and all used fuel is to be repatriated to Russia. According to agreement in August 2012 Bangladesh would borrow $500 million for a two year technical and economic study together with design, documentation and training at 4.5% interest rate.

Figure 9.1: Up to 01 March 2017, worldwide 451 nuclear reactors are operable from where the electricity production is 392 GW. In US 99 number of reactors are operable whose capacity is 99.52 GW. In US 19.50% electricity is produced from nuclear power plant.

Figure 9.2: In the figure shows the nuclear under construction in the world. China is a fast growing country in the world on nuclear energy. China has 36 operable reactors with 21 reactors under construction also 40 reactors are planned with 139 reactors are proposed. China master plans to give up to the doubling of nuclear power capacity to at least 58 GW by 2020-21 then up to 150 GW by 2030 and much more by 2050[23].

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Power Plant Technology</th>
<th>Capacity Factor %</th>
<th>Thermal Efficiency %</th>
<th>Water (K/L/Mw)</th>
<th>CO2 Gas Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>NGCC</td>
<td>85.0</td>
<td>50.2</td>
<td>0.96</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>NGCC/ccs</td>
<td>85.0</td>
<td>42.8</td>
<td>1.91</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>GTSC</td>
<td>85.0</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Coal and Bio-</td>
<td>Coal</td>
<td>85.0</td>
<td>35</td>
<td>2.5</td>
<td>1.9</td>
</tr>
<tr>
<td>mass</td>
<td>Coal and biomass</td>
<td>85.0</td>
<td>32.8</td>
<td>2.5</td>
<td>1.9</td>
</tr>
<tr>
<td>Wind</td>
<td>Onshore Conventional</td>
<td>30.0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Nuclear</td>
<td>Existing</td>
<td>70.3</td>
<td>31.6</td>
<td>105</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Gas III</td>
<td>94.0</td>
<td>34.2</td>
<td>4.3</td>
<td>2.7</td>
</tr>
<tr>
<td>Hydro</td>
<td>Conventional Dam</td>
<td>3.70</td>
<td>N/A</td>
<td>6.85</td>
<td>6.83</td>
</tr>
<tr>
<td>Geo-thermal</td>
<td>Flash Steam</td>
<td>90.0</td>
<td>17.1</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Solar-thermal</td>
<td>Parabolic Trough</td>
<td>27.4</td>
<td>N/A</td>
<td>0.41</td>
<td>0.35</td>
</tr>
</tbody>
</table>

9. Nuclear Power Plant in the World [20] [21] [22]
Figure 9.3: In the world planned to construct 164 reactors. China is a prudent planner of nuclear power plant and about 40 new reactors are planned. But second highest 25 reactors construction under planned of Russian. They are also proposing 23 reactors for construction. Russian government plans to double electricity generation capacity from 225 GW in 208 to 355 GW-445 GW in 2030.

Figure 9.4: In the figure shows the number of reactors which is proposed to build, 35 countries propose to build 350 reactors; therefore, china will construct 139 reactors and the second highest, 44 reactors will be built by India. India has a master plan to electricity generation by nuclear energy 14.6 GW at 2024 and 63 GW at 2032 [24]. They forecast 25% of electricity comes from nuclear power plant. On 2015, India contributes 3.53% of nuclear energy share with domestic generation.

Figure 9.5: The known recoverable Resources of Uranium. Uranium is the main source of nuclear power plant, 29% of world uranium reserve in Australia, 5718.4 thousand tons of uranium is recoverable in the world at 2015 [25].

Figure 9.6: In the figure shows the world uranium mining production from 2007 to 2015 and percentage of uranium supply world demand. Uranium production has increased graphically. Largest amount of uranium produces at 2015. Kazakhstan produces the largest share of uranium from mines (39% of world supply from mines in 2015), followed by Canada (22%) and Australia (9%) [26].

10. Electricity Scenario in Bangladesh
power. It is require six more energy after 26 years. As a result there is requiring large infrastructure and skilled manpower. Although, Bangladesh signs an agreement with Russian to grow up skill manpower for nuclear power plant. It not seem to be difficult, if given opportunity to develop nuclear power plant, search source of uranium and enhance the quality of uranium.

**Figure 10.1:**[27] [28], In the figure show the comparison between to power sector master plan 2010 and actual power generation in Bangladesh, therefore at 2015 power shortage was 2466 MW, but 13.87%,[29] power generation progression on 2016, But It not proportion to PSMP 2010.

**Figure 10.2:** shows the installed capacity of power plant. Bangladesh has total of 13179 MW plant capacity which takes place 63% gas that the capacity is 8267 MW, on the other hand 21% Heavy Furnace Oil, 8% high speed diesel and 2% coal and hydro base power plant [30].

**Figure 10.3:** Power system master plan (PSMP) 2016 [31], [32]. The master plan of Bangladesh government wants to achieve goal vision 2041 to balmy and prosperous Bangladesh. Whatever, if continue GDP growth 7% to need 52.40 GW electrical

<table>
<thead>
<tr>
<th>Primary Energy Sources</th>
<th>2014 ktoe</th>
<th>share %</th>
<th>2041 ktoe</th>
<th>share %</th>
<th>Annual Growth rate % (14-41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>20,728</td>
<td>57</td>
<td>49,783</td>
<td>38</td>
<td>3.3</td>
</tr>
<tr>
<td>Oil</td>
<td>6,060</td>
<td>17</td>
<td>32,162</td>
<td>25</td>
<td>6.4</td>
</tr>
<tr>
<td>Coal</td>
<td>1,038</td>
<td>3</td>
<td>25,401</td>
<td>20</td>
<td>12.6</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0</td>
<td>0</td>
<td>12,029</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Hydro, Solar, Wind, Power and Others</td>
<td>36</td>
<td>0</td>
<td>319</td>
<td>0</td>
<td>6.6</td>
</tr>
<tr>
<td>Biofuel and Waste</td>
<td>8,449</td>
<td>23</td>
<td>1,089</td>
<td>3</td>
<td>-2.7</td>
</tr>
<tr>
<td>Import</td>
<td>377</td>
<td>1</td>
<td>6,027</td>
<td>5</td>
<td>10.8</td>
</tr>
</tbody>
</table>

**Figure 10.4:** It shows the comparison of energy initiation source that there is 56% energy produced from gas on 2014, but in 2041 it reduction 38%, as well as biofuel and waste energy narrow. Although, energy creation from oil and coal enhancement respectively 25% and 20%. It is not eco-friendly, and is more costly than other energy, at same time nuclear energy increases 9% [33].

**11. Effect of Climate Change on Bangladesh**

From research analysis and data inspection, a lot of information have been gathered on climate change by 2020, from 500 to 750 million people will be affected by water stress caused by climate change around the world [34]. Bangladesh is one of the vulnerable countries in the world to climate change. Low-lying coastal regions, such as Bangladesh, are vulnerable to sea level rise and increased occurrence of intense, extreme weather conditions such as the cyclones from 2007 to 2009. Rising sea levels will increasingly inundate Bangladesh’s coast, and dramatic coastal and river erosion will destroy land and homes. The Economy of Bangla-
Desh is agricultural base although effects by climate change are high. Temperature and rainfall already effect on agricultural products production. The surface and groundwater resource are also affected by climate change; that is alarming for growth of sustainable economic.

12. Conclusion
This paper focuses on three main aspects which are energy source, world nuclear power plant and cost of power plant. One, energy sources are Gas, coal, oil, renewable energy, and uranium those are use in power plant to produce of electricity. Gas, coal and oil power plant are harmful for our health and environment because the power plant will produce electricity by burning gas, oil and coal. Burning gas oil and coal much produce carbon dioxide, and overall cost of power plant is higher than the nuclear power plant and lifetime of power plant is less than the nuclear power plant. In 2003 Massachusetts institute of technology suggested that the four options to reduce emissions of Carbon dioxide for electricity; increasing efficiency, expanding renewable energy, capture carbon dioxide and increasing use of nuclear power plant.

In this paper we see the increased number of nuclear power plant in the world. China is one growing country in the world and India will be increased number of nuclear power plant. Concluding Remark from the above findings, the country is facing energy source shortage right at this moment. Sustainable energy growth is a must for the sustainable economic growth. But the country have less renewable source of energy that is not enough for economic development. According to the provisional estimate of GDP for the fiscal year 2014-15 the share of broad Agriculture and Industry and Service sectors were 15.96%, 30.42% and 53.62% respectively.

Overall consideration is that nuclear power plant is the best energy solution for Bangladesh to achieve the goal for GDP 7 and economic development.

References:

Author completed Diploma in Electrical Engineering from Rajshahi Polytechnic Institute in 2012. Now, he is pursuing Bachelors in Electrical and Electronic Engineering in Daffodil International University. He is interested to study and implement research works on Power sector, especially Nuclear Power Plant.