

Feasibility of “Rooppur Nuclear Power Plant” & Its Contribution to the Future Energy Sector

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Abstract

Digital Bangladesh is one of the most challenging decisions made by the government to transform the country to be a middle-income country by 2021. That's why the government implemented a large number of projects relating to digital technology. Rooppur Nuclear Power Plant (RNPP) project is one of them. In the recent past, the country faced an enormous electricity shortage with a great energy gap between peak demand and maximum energy generation. In Bangladesh, the present government promised to ensure the electricity to all the citizens by 2021. That's why the world's most lucrative Nuclear advanced technology is going on under Power Sector Master Plan (PSMP)-2016 (Vision 2041). In order to improve the security system of nuclear power, the bilateral project is not fully transparent for the public, which is understandable. That makes some political conflict with the anti-nuclear agenda. As a result, the general concerns are also involving in this project. Safety and Security systems by the world's most advanced Water-Water Energy Reactor (VVER-1200) is in full discussion by this paper in order to get rid of local concerns. Countries Power Profile is completely described and focuses on the current National Planning to overcome the power shortage through the use of Nuclear Power. This paper mainly discusses the feasibility of RNPP in Bangladesh and how it will play a major role in the national energy sector in future to become the “DREAM COME TRUE” project for Bangladesh.

Keywords

Digital Technology, RNPP, Energy Gap, PSMP, Feasibility

1. Introduction

In the recent past, Bangladesh is struggling very much in order to meet the energy demand. Day by day the situation got crazier. The huge population and

their upcoming demand for technological advancement made it very much tough for the power generating sectors to fill up the gap between energy demand and energy generation. As a result, the Government of Bangladesh took some responsible plans matched with some huge technological advancement like “Rooppur Nuclear Power Plant” project [1]. Rooppur Nuclear Power Project is one of the dream projects for Bangladesh. With the help of this project, Bangladesh will be the 33rd country has nuclear power profile. That can contribute 2400 MW power in the grid system to meet up the energy demand. The complex nuclear technology that has run under the financial and technological support of ROSATOM.

2. Energy Information

2.1. Structure of Electric Power Sector

In Bangladesh, Ministry of Power, Energy & Mineral Resource (MoPEMR) manages the electricity business. Where the power is generated by Bangladesh Power Development Board (BPDB), power plants that are departments and subsidiaries of BPDB, Independent Power Producer (IPP), and private power generation companies. Power is supplied through Power Grid Company of Bangladesh’s (PGCB) power transmission facilities to customers in local cities by BPDB, in the metropolitan area by Dhaka Power Distribution Company Ltd. (DPDC) and Dhaka Electric Supply Distribution Company (DESCO), and in rural areas by Palli Biddiyut Samities (PBS). And the distribution departments in local cities are being separated one by one [2].

2.2. Contribution of Different Power Generation Sectors

2.2.1. Energy Scenario

The conventional technique is applied by Bangladesh, as a reason energy is less sufficient and unorganized. Where Bangladesh has one of the least per capita utilization of about 332 KWh in the world [3]. Where Bangladesh has nearly 2000 mt reserves of coal and around 14.15 tcf amount of natural gas reserves. Which is not in the huge amount [4]. Natural gas, oil, hydropower, and coal are the commercial source of energy utilization. **Figure 1** shows the power generation scenario of Bangladesh [5].

2.2.2. Contributions of Public & Private Sector

In the current situation, both public and private power generation is equally important. Here is an overview by **Figure 2**. In Bangladesh private sectors provides almost 50% of the total power generation. Among the public sectors BPDP alone provides almost 4402 MW and private sectors IPPs provides 3245 MW. It is clear that the public sector does not generate sufficient load to meet the public demand. 3/5 years Rental plants are providing about 55% load from private sector generation which is very costly. Those cost 20 tk/Unit, which is a very high amount [5].

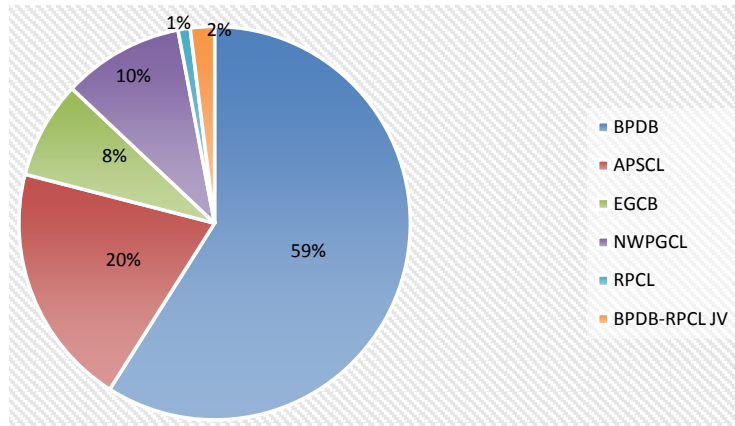


Figure 1. Energy scenario of Bangladesh.

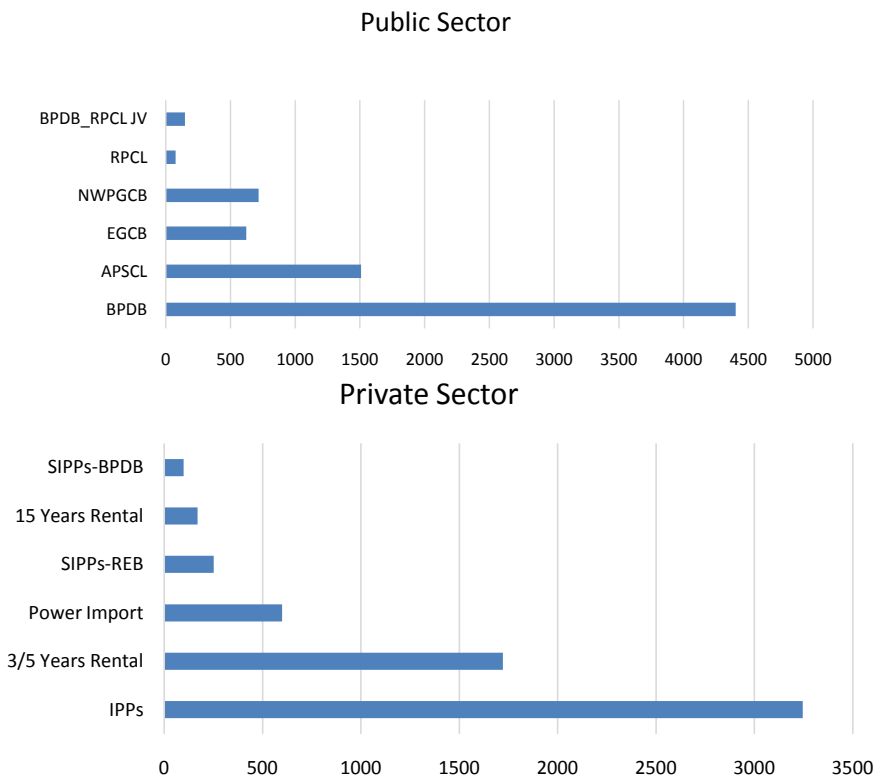


Figure 2. Public & private sector contribution in national grid.

2.3. Power Stations in Bangladesh

Bangladesh is so much dependent on its tradition energy technology leading by the natural gas (62.39%). Although furnace oil (20.49%), diesel (7.97%), coal (2.33%), hydro (2.15%) makes a vital role in energy generation [6]. Until the mid-1990s demand for fertilizer was the top priority. But, now a day’s demand for the gas power generation has risen. The fastest-growing demand is from the industry, with 13% annual increase [7] shown in the Table 1. Power contributions and the National energy statistics are also described briefly by the Table 2 and Table 3 correspondingly.

Table 1. Demand of natural gas, 1991-2007.

Sector	Average annual growth rate
Power	8.2%
Fertilizer	3.9%
Industry	12.6%
Domestic	12.0%
total	7.7%

Table 2. Power station summary.

Fuel Type	Running Power Plants			Plant Under Construction			
	Power Stations	Capacity (MW)	Ref.	Power Stations	Capacity (MW)	Expected Operations	Ref.
Coal Fired	Barapukuria	525	[8]	Matarbari	1200	2024 [8]	[9]
				Payra Thermal	1320	1st unit in August, 2019 [10]	[11]
				Rampal	1320		[11]
	Ashuganj	1627	[12] [13]	Feni Lanka Power Limited	114	September, 2019	
Oil & Gas Fired	Ghorasal	950	[14]	Manikganj Power Generations Limited	162	January, 2020	
	Shikalbaha	150		Bhairab Power Limited	55	January, 2020	
	Siddhirganj	260		Payra LNG Power Plant	3600	1 st phase-December, 2022 2 nd phase-December, 2023	[11]
	Orion Group	4*100					
	Lakdhanavi Bangla	52.2					
	Desh Energy Chandpur	200					
	Doreen Power Generations	165					
Gas Turbine	Meghnaghat	450	[15]				
	Ashuganj	146	[13]				
	Haripur	360					
	Golpara	265					
	Mymensingh	210					
	Siddhirganj	240					
	Baraka Power Ltd.	51	[16]				
Gas Engines	Dhaka	7					
	Gazipur	53					
	Gopalganj	100					
	Maona	35					
Hydroelectric	Raozan	240					
	Ghorashal Regent	108					
	Baghabari	50					
	Karnafuli	230	[17]				

Continued

	Teknaf	200
Solar PV	Sutiakhali	50
	Mymensingh	32
Nuclear	Rooppur Nuclear Power Plant	2400

Table 3. Electricity production & installed capacity [2].

	1980	1990	2001	2008	2012	2014	Average annual growth rate (%) 2001 to 2014
Capacity of electrical plants (GWe)							
Thermal	0.91	2.29	3.48	4.972	7.88	9.60	8.12
Hydro	0.08	0.23	0.23	0.23	0.22	0.22	-0.34
Nuclear	0	0	0	0	0	0	
Wind					0	0	
Geothermal	0	0	0	0	0	0	
Other Renewable					0	0	
Total	0.99	2.35	3.711	5.202	8.100	9.82	7.78
Electricity Production (TWh)							
Thermal	2.07	7.17	14.48	23/361	34.341	41.607	8.46
Hydro	0.58	0.88	1.08	0.949	0.776	0.588	-4.57
Nuclear	0	0	0	0	0	0	
Wind					0	0	
Geothermal	0	0	0	0	0	0	
Other Renewable					0	0	
Total	2.65	7.73	15.56	24.31	35.118	42.195	7.98
Total Electricity consumption (TWh)		4.704	14.002	22.622	30.098	40.296	8.47

2.4. Energy Statistics

Current electricity production and installation capacity of Bangladesh are described here by **Table 3**, where electricity transmission losses are not deducted.

2.5. Electricity Access across the Population

Bangladesh has made significant progress in access to electricity as its electrification coverage reached 88% in 2017. The World Bank mentioned that among the countries with the largest population without access to electricity Bangladesh, Kenya, Myanmar, and Sudan have made the most progress. World Bank, Sustainable Energy for all database shows the progress in the following **Figure 3** [18].

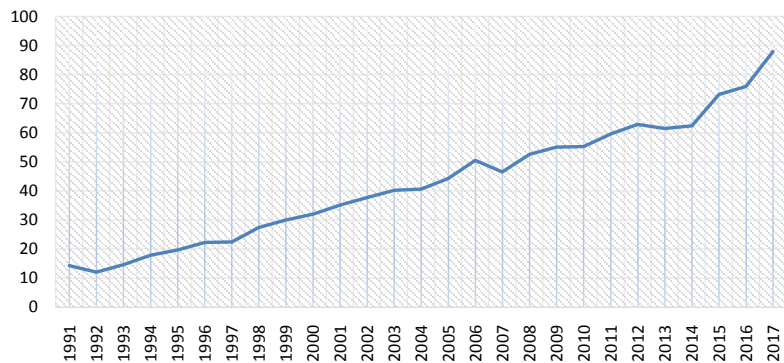


Figure 3. Electricity access across the population (%) corresponding to year.

2.6. Energy Conversion

Energy conservation is one of the most important issues of the sector due to economic and environmental reasons. However, until a very recent past no serious attempts were made to take up and implement energy conservation programs which have been given due importance in the National Energy Policy of Bangladesh (1996) [7].

2.7. Specifications System Loss

System loss of more than 4% in power generation is not acceptable. It has been stated that the average system loss of power generation by the PDB is 6.35%. The government will plan to reduce system loss to a specified limit [7].

2.8. Generation Lag

In the past situation, Bangladesh faced an enormous electricity shortage that affected non-agricultural employment. So, there was a great energy gap between peak demand and maximum energy generation. Those gaps are said to be the generation lag. In Bangladesh, the present government promised to ensure the continued supply of electricity to all the citizens by the year 2021. According to the Power System Master Plan (PSMP) 2010, the forecasted demand for the power based on 7% GDP growth rate shows the only Nuclear Power Plant can full fill the demand of the nation, that is illustrated in **Figure 4** by showing the exponential increase of peak demand (MW) [19].

2.9. Energy Import

In order to fill up the gap in between demand and generation, every year Bangladesh imports power from neighbor country. Which costs huge. The import of electricity from India and Bhutan are worth exploring. Myanmar has satisfactory gas reserves. Bangladesh could negotiate for import of gas from Myanmar [7].

3. Government Vision

3.1. Brief Story

Bangladesh is a country with no shortage of well-written policies. It is the

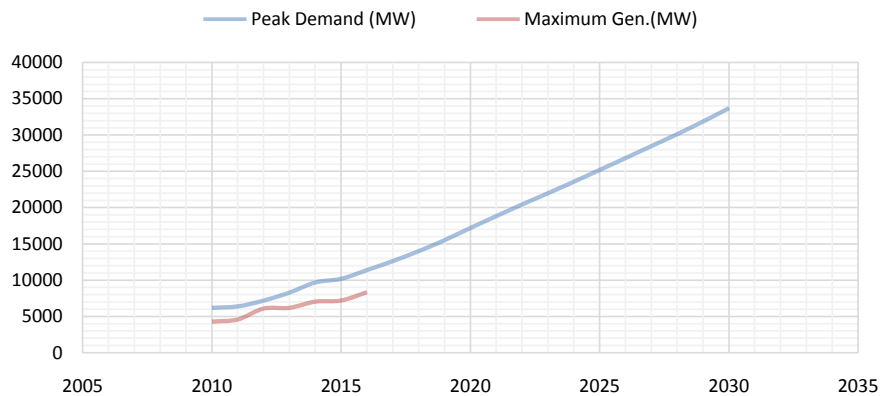


Figure 4. Difference in between peak demand & maximum generation.

implementation of these where the problem begins. This is not only an isolated problem for Bangladesh alone. Sometimes the reality shows that that convincing an idea is often easier than putting it into practice. The energy sector have is no different in having some well-constructed ideas and policies. Some of the policies of recent years are given below [20]:

- National Energy Policy-2004,
- Renewable Energy Policy of Bangladesh-2008,
- The Sixth Five-year plan of Bangladesh (2011-15)-2011,
- Perspective plan of Bangladesh (2010-2021) Vision 2021-2012,
- The National Sustainable Development Strategy-2013,
- Intended National Determined Contributions-2015,
- The Seventh Five Year Plan (2016-2020)-2015,
- Energy Efficiency and Conservation Master Plan up to 2030-2015,
- Power System Master Plan-2016.

3.2. The Power Sector Master Plan (PSMP)-2016 (Vision 2041)

The PSMP is a document that aimed to assist the Bangladesh Government in formulating an extensive energy and power development plan up to the year 2041. It highlights the country's desire to become a high-income country by 2041, so the quantity and quality of the power infrastructure must also reflect that status. Due to the upcoming depletion of domestic gas the Plan highlights the issues of sustainable development harmonizing with economic optimization, improvement of power quality for the developing high-tech industries and the operation and maintenance of power plants to be all addressed holistically. It should be noted that the current form of the paper is not set in stone and further development is likely to take place. The factor of energy subsidies was also highlighted as being a tough challenge due to the concern that a drastic increase of fuel and energy prices may trigger another negative effect on the national economy. A meticulous analysis is required to find the best route to attaining the balance of energy sustainability and economic growth. The 2016 version of the PSMP covers why that the energy development predicted in the 2010 PSMP is

not on track. It cited various assumptions about expected sources of base load energy having changed, and the vast increase of oil based rental power plants, and the lack of control over their power production. This has created a very unstable production network with no real central control to dictate country wide production schedules. The plan lays out five key goals of the vision 2041 [20]:

- Enhancement of imported energy infrastructure and its flexible operation.
- Efficient Development and utilization of domestic natural resources (gas and coal).
- Construction of a robust, high-quality power network.
- Maximization of green energy and promotion of its introduction.
- Improvement of human resources and mechanisms related to the stable supply of energy.

3.3. Energy Mix Concept

Due to the low current state of primary energy resources, demand is not being met. In this context, the Government is formulating the “Five-Fuel strategy,” of which the priorities are given below [2].

- Undertake immediate exploration of hydrocarbon and identify additional reserves that can meet the growing demand of gas by all consumer sectors.
- Develop alternative commercial energy supplies suitable for power generation, especially coal, to ease the burden of fast-growing electricity demand on gas resources. Thus, a two-fuel (gas and coal) strategy is required for both resource diversification and energy security.
- Ensure efficient use of energy by using energy-saving appliances, plants and equipment in order to effectively increase the stock of available energy supplies.
- The resource potential of renewable energy is significantly larger than its present consumption and is a promising source of clean, convenient energy supply, especially in rural areas.
- Considering the limitation of fossil fuel supplies, nuclear fuel could be a potential energy option for the country, as it is a proven technology for economic, reliable and sustainable electricity generation.

At present, almost 88% of the country’s power is dependent on gas and almost 50% of the consumed commercial energy is used for power generation. To ensure energy security more balance is needed. Present energy mix in Bangladesh and target mix of energy is shown here by **Table 4** and also those data are compared with the global position [7]. Projection of the primary energy supply shown by the **Table 5**.

3.4. Electricity Supply Expansion Plan

In order to decrease the pressure on natural gas, oil and biofuel it is wiser to develop alternative plan so that ensure the efficient use of different energy sources. That’s why their Power System Master Plan-2016 suggests a projection of energy supply.

Table 4. Energy mix comparison in between Bangladesh and global [7].

Energy	Bangladesh		Global	
	Current (%)	2021 (%)	Current	2030
Gas	87.5%	30%	18%	28%
Oil	6%	3%	10%	5%
Coal	3.7%	53%	37%	38%
Hydro	2.7%	1%	17%	4%
Nuclear	0%	10%	17%	19%
Renewable	0.5%	3%	1%	6%

Table 5. Projection of primary energy supply [4].

Primary Energy Sources	2014		2041		Annual growth rate (2014-2041)
	kote	(Share%)	kote	(Share%)	
Natural Gas	20,726	56	50,149	38	3.3%
Oil	6263	17	32,153	25	6.2%
Coal	1361	4	26,273	20	12.7%
Nuclear Power	-	-	11,942	9	-
Hydro, Solar, Wind Power and Others	36	0	197	0	6.5%
Biofuel and waste	8449	23	4086	3	-2.7%
Power (Import)	377	1	6027	5	10.8%
Total	36,888	100	130,827	100	4.8%

4. Rooppur Nuclear Power Plants

4.1. History

Bangladesh is in the stage to become the 33rd Nuclear Power producing nation. The Rooppur Nuclear Power Plant (RNPP) is expected to generate 2400 MW of power, helping the nation to address the expanding demand for electricity. The project is done by the financial and technical support of the Russian State Energy Commission (ROSATOM). The idea of building a nuclear power plant was developed in the year 1961. Only after the chosen primary site, Pakistan government shifted the nuclear power plant project to Karachi. After independence, the government of Bangladesh again took over the project and decided to set up a nuclear power plant that has a capacity of 200 MW.

Some of the key milestones of Bangladesh national Power program is given below here [2]:

- 1963: Rooppur site selected for implementation of Nuclear Power Plant (NPP).
- 1971-78, 1987-88: Feasibility studies for site and first NPP conducted. Further feasibility studies for site and first NPP conducted.
- 1996: National Energy Policy identifies nuclear power as an option.
- 2000: BANPAP approved by the government.

- 2010: National Parliament approves first NPP project and new structure for NP program development (equivalent NEPIO) were formed (National Committees, Technical Committee, Working Group).
- 2011: IGA with Russian federation signed for the first NPP with two VVER units, each of 1000 MW.
- 2012: Bangladesh Atomic Energy Regulatory Act 2012 was passed in the National Parliament on 19th June 2012.
- 2013: Bangladesh Atomic Energy Regulatory Authority was formed as a separate entity on 12th February 2013.
- 2015: General contract was signed with Russian Federation for main stage construction of Rooppur NPP.
- 2016: Inter-Government State Credit Agreement for financing the main stage construction of Rooppur NPP.

4.2. Why Nuclear Power?

4.2.1. Heating Value

Bangladesh needs a stable and powerful alternative energy source to produce electricity. Alternative energy source means the type of source which is alternative to fossil fuel. Among all Nuclear Energy is the most effective and powerful. At this energy source is capable of producing enormous power ensuring the least fuel consumption. A comparison between heating values of different fuels are given below in **Table 6** [5].

4.2.2. CO₂ Emission

Greenhouse gases (Carbon dioxide, nitrous oxide, methane) surround the Earth like a blanket. As we use to burn more coal, natural gas, and oil, the blanket becomes excessively thick, dense, and less likely to allow heat to escape. Heat gets trapped inside the blanket of greenhouse gases and the Earth becomes too warm. Nuclear power is a much better choice than conventional gas or coal-based power plant. Where Nuclear power plants emit greenhouse gases less than any other, **Figure 5** gives a clear idea about this statement.

4.2.3. Comparison among Different Methods of Energy Generation

The nuclear power plant is relatively a good choice when we are only on CO₂

Table 6. Heating value of different fuels.

Fuel	Heating Value (MJ/kg)
Fire Wood	16
Brown Wood	9
Black Coal (Lower grade)	13 - 20
Black Coal (Higher grade)	24 - 35
Natural Gas	40
Crude Oil	45
Uranium	500,000

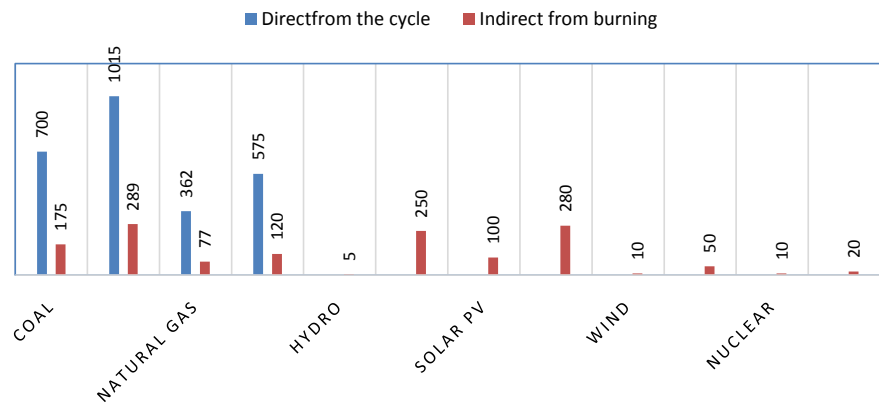


Figure 5. Greenhouse gas emission from different energy sources [5].

emission and heating value produced by burning the nuclear fuel. But Nuclear power plants are relatively expensive to build. Especially it takes 75% cost only for machinery, setup and capital cost. So the nuclear power plant is cheaper to run. **Table 7** shows a comparison among different methods of energy generation technologies.

4.3. Nuclear Power Development Strategy

4.3.1. Target Power Production

Bangladesh is evolving an energy mix diversification, where nuclear is one of the best choices. Right now the Bangladesh government has the plan to set up 2 units of Rooppur Nuclear Power Plan, described by the **Table 8**.

4.3.2. Project Funding

On 2 November 2011, the Government of the Russian Federation and the Government of the People's Republic of Bangladesh signed an agreement on cooperation for the construction of an NPP on the territory of the People's Republic of Bangladesh. An agreement was signed on 15 January 2013 between the Government of the People's Republic of Bangladesh and the Government of the Russian Federation on the extension of a state export credit to the Government of Bangladesh for financing of the preparatory stage for construction of an NPP in the People's Republic of Bangladesh. The credit shall be used by Bangladesh during 2013-2016 [2].

4.3.3. Project Management

Bangladesh Atomic Energy Commission (BAEC) has been appointed as the owner organization of NPP by:

- The prudential order 15, 1973,
- Bangladesh Nuclear Power Action Plan, 2000,
- Inter-Government Agreement (IGA) between Russian Federation and Bangladesh, 2011,
- Nuclear Power Plant Act, 2015 and
- All other Relevant policy documents.

Table 7. Comparison among different methods of energy technique [5].

Technology	Time (Unit)	Time (lead)	Cost (Capital)	Cost (Operational)	Fuel Necessity	Sustainability
CCGT	Medium	Short	Low	Low	High	NO
Nuclear	Huge	Long	High	Low	Low	OK
Coal	Large	Long	High	Low	Medium	NO
Hydro	Huge	Long	Very High	Very Low	N/A	OK
Wind	Small	Short	High	Medium	N/A	OK

Table 8. Planned nuclear power plants [2].

Power Station	Type	Capacity (MW)	Expected Construction Year	Expected Commercial Year
Unit-I	VVER	1200	2017	2023
Unit-II	VVER	1200	2018	2024

Nuclear Power Company of Bangladesh Limited (NPCBL) is the operating organization which clearly reflects in NPP Act 2015 [2].

4.4. VVER-1200 (Generation III+ Design) & Safety

4.4.1. VVER

The VVER is a pressurized water reactor (PWR), the commonest type of nuclear reactor worldwide, employing light water as coolant and moderator. However, there are some significant differences between the VVER and other PWR types, both in terms of design and materials used. Distinguishing features of the VVER include the following [21]:

- Use of horizontal steam generators,
- Use of hexagonal fuel assemblies,
- Avoidance of bottom penetrations in the VVER,
- Vessel,
- Use of high-capacity pressurizers.

4.4.2. VVER Generations

VVER is one of the oldest type reactor technology used in nuclear technology by the Russian. Starting from 1964 (Gen I), VVER now is in nuclear market with its new technology which is called generation III+ VVER-1200 with lots of improvement. Different generations of VVER reactor are mentioned here by **Table 9**.

4.4.3. VVER-1200

Main principles of VVER-1200 (AES-2006) design are [21]:

- Maximum use of proven technologies,
- Minimum cost and construction times,
- Balanced combination of active and passive safety system in general to manage beyond basis accidents,
- Reduction in the influence of human factors on overall safety.

Table 9. VVER generations [21].

Gen I (1964-1966) VVER	Gen II (1966-1980) VVER-440	Gen II/Gen III (1980-2006) VVER-1000	Gen III+ (2006-) VVER-1200
V-210 Russia, Novovoronezh1	V-179 Russia, Novovoronezh 3-4	V-187 Russia: Novovoronezh 5	V-392M Russia, Novovoronezh II 1-2
V-365 Russia, Novovoronezh1	V-230 Russia, Kola 1-2 East Germany, Greifswald 1-4 Bulgaria, Kozloduy 1-4 Slovakia, BohuniceI 1-2	V-302 Ukraine, South Ukraine 1	V-491 Russia, Baltic 1-2 Leningrad II 1-2 Belarus, Belarus 1
	V-213 Russia, Kola 3-4 Ukraine, Rovno 1-2 Hungary, Paks 1-4 Czech Rep., Dukovany 1-4 Finland, Loviisa 1-2 Slovakia, Bohunice II 1-2 Mochovce 1-2 Mochovce 3-4	V-338 Ukraine, South Ukraine 2 Russia, Kalinin 1-2	
	V-270 Armenia, Armenia-1 Armenia-2	V-320 Russia, Balakovo 1-4, Kalinin 3-4, Rostov 1-2, Rostov 3-4 Ukraine, Rovno 3-4, Zaporozhe 1-6, Khmelnitski 1-2, South Ukraine 3 Bulgaria, Kozloduy 5-6 Czech Rep, Temelin 1-2	
		V-428 China, Tianwan 1-2, Tianwan 3-4 V-412 India: Kudankulam 1, Kudankulam 2	
		V-466 Iran: Bushehr 1	

4.4.4. Fundamental Safety Functions

1) Control of Reactivity

- Preventing uncontrolled reactor power increase.
- Ensuring fast safe shutdown of the reactor when needed [21].

2) Decay Heat Removal

- Cooling of the shutdown reactor.
- Cooling of used nuclear fuel [21].

3) Containment of Radioactive Material

- Preventing significant radioactive releases to the environment [21].

4.4.5. Protection from External Impacts

1) Seismic Loads

Protection against seismic hazards is provided taking into account the site-

specific seismic conditions. For instance, in the terminal 3 - 4 VVER-1200 offer, the buildings are designed to stay intact if the horizontal maximum ground acceleration caused by an earthquake does not exceed 0.25 g [21].

2) Hurricanes & Tornados

Safety-related components are designed to cope with a wind load corresponding to a wind velocity of 30 m/s at a height of 10 m. Design loads are those corresponding to a whirlwind of class 3.60 according to the Fujita scale [21].

3) Aircraft Crash

This VVER-1200 is designed to withstand a small airplane crash, with a design basics aircraft weight of 5.7 t. Protection against the impact of larger aircraft, depending on customer requirements, can be achieved by increasing the thickness of the outer containment wall and of some other buildings. A large (400 t) passenger plane crash was included in the design basis for the terminal 3 - 4 offer, and the ability to withstand such a crash demonstrated by detailed analysis supported by model testing [21].

4) Snow and Ice Loads

Design peak snow load is 4.1 kPa [21].

5) External Explosions

VVER-1200 safety-related components are designed taking into account a shock wave arising from an external explosion. The pressure at the shock wave-front is taken to be 30 kPa, with a compression stage time of 1 second [21].

4.5. Electric Grid Development

PGCB maintained the gridline of Bangladesh, where different power generation company contributes their power either in 230 kV or 132 kV line. At present 10,000 MW is the maximum load that can be handled by the grid line. According to the plan, a 400 kV line is going to be hooked up in order to import power from India. At present, the dependable generation capacity of the country will be about 12,000 MW against a maximum demand of about 11,000 MW in 2017. But the contribution of nuclear power will be about 2000 MW by the year 2020 and will be increased by about 5000 MW in 2030. So the installed capacity is projected to increase about 33,000 MW by 2030. So, PGCB needs to upgrade the national grid [2].

4.6. Public Concern

4.6.1. Fuel Cycle & Waste Management

Bangladesh believes that a healthy market exists at the front end of the fuel cycle. Currently, all reprocessing plants are state-owned and any guarantee from a supplier would have the implicit or explicit agreement with the corresponding government. Based upon the existing nature of the nuclear business worldwide, Bangladesh is considering a long-term contract and transparent suppliers' arrangements with supplier(s) through backing of the respective government in order to ensure the availability of fuel for the nuclear power reactor of the country. Examples would be fuel leasing and fuel take-back offers, commercial offers

to store and dispose of spent fuel, as well as commercial fuel banks. On the other hand, at present, there is no international market for spent fuel disposal services [2].

4.6.2. Earthquakes

The number of earthquakes (magnitude between 4 and 6) occurred in the last decade inside the country or near the borders. That has raised awareness among the general public and the government. But the good news is these earthquakes are located far away from the Rooppur site [2].

4.6.3. Security of the Nuclear Materials

Nuclear materials will be strictly supervised by the government of Bangladesh. However, remains a certain concern due to the increasing terrorist activities in the region. However, the government of Bangladesh has not made any clear statements on the issues of non-proliferation policy and measures from the part of the government [19].

4.6.4. Shortage of U Resources

The world has around 5.47 million tU of uranium resources, costing approximately US\$130/kgU to produce. Among them, just 30% are in Australia, about 14% in Kazakhstan, followed by 16% in Russia and Canada, and in South Africa, China, Niger, Brazil all of them have 5% in Uranium resources [22]. By comparison, Bangladesh's share 0.25%.

4.6.5. Power Plant Cost

We already noticed that the fuel is at high prices in the world market. Although for Nuclear Power Plant fuel only takes 20% of the total power plant cost. On the other hand, Capital cost of land, machinery and set up will take 75% (with interest) of total cost and 5% cost is reserved for maintenance cost [5]. Which seems like to be a huge cost Bangladesh have to carry out only for nuclear power plant set up. It can be said a high investment risk.

4.6.6. Cost of Electricity

It shows that the purchase, operation, and maintenance of plants at the generation stage, will lead to increased spending on the generation and consequent higher cost of power supply. Ultimately, the price per unit of electricity needs enhancement. Strong Energy Regulatory Commission will have to address these issues.

4.6.7. Water Supply

The Rooppur NPP site was chosen even before the creation of Bangladesh. At that time the Padma (Ganga) river was selected for the water supply source of the power plant. But when in 1975 India completed the Farakka barrage, it affected Bangladesh's water supply, including the river level in the area of the Rooppur NPP. Water supply is a really serious technological challenge for the Rooppur NPP, that likely to be resolved via a protected water-catchment area in

the Padma River [23].

4.6.8. Cyber Threats

The digital security system of Bangladesh is not safe enough. On 1st February 2017 a seminar was organized named “Entering the world of Nuclear Energy” about the cyber-security where Dr. Petr Topychkanov stated ‘Digital security must be guaranteed. Generally, there may be a tremendous hazard. In the event, there is no activity taken and it ought to be taken as right on time as possible’ [5].

4.7. Research & Development

Under the assistance of the International Atomic Energy Agency (IAEA), BAEC has engaged in lots of activities to develop not only the manpower for future work but also develop the nuclear power concept all over Bangladesh since 1960. BAEC built the country’s largest nuclear research center called “Atomic Energy Research Establishment”. Where the 3 MW TRIGA Mark-II research reactor has been operating especially for radioisotope production and developing manpower training projects.

For developing the manpower for a very complex and modern RNPP project, Bangladesh Government has developed a contract with the Russian Government to develop almost 2100 personnel for both technical and non-technical training purpose. In the same way, every year twenty students from Bangladesh are coming to Nuclear Engineering of MEPHI University for higher studies.

4.8. Public Acceptance

It was 1963 when the Rooppur site was selected for the nuclear power plant project. After a long gap in 2016 Inter-Government agreement was done for main stage construction of RNPP. Although there was a huge gap of time to implement the ideas in the real working field, but the local people are so concern about the power situation in that time of the country. They also thought in quiet differently that, the power station may create a huge job opportunity for them and also the overall developing of that specific area of the country. So, it was so much easy task for the Government to spread the Nuclear technology to all over the country.

But in general, will be always a political conflict with the anti-nuclear agenda. That makes some concerns on the public’s minds. So BAEC and the Russian contractors arranged lots of awareness programs for the public. BAEC arranged international seminar which was inaugurated by the Honourable Prime Minister Sheikh Hasina. They also arranged art competitions, booklet distribution, opinion sharing meeting, etc. [2]. All of those attempts make a great sense in public the mind.

5. Conclusion

In order to make the world green and safe for the future generation with lots of

energy resources, every country should have to pick up the lifeline of Sustainable Energy. But huge technological advancement makes nuclear energy so much better than any other choices with huge energy production limelight and less GHG emission. So, in the first stage, there should be some confusion going on to the mind of local people. But, when the Rooppur Power Plant will provide the energy in the national grid system, then they will definitely say nuclear power is the best choice among all. This is not only for providing power for the near future, but also securing lots of families by providing job opportunities and make socio-economic development. By seeing the nation's vision and recent technological advancements on the nuclear side makes it so much easier choice for the country like Bangladesh to choose VVER-1200 for reducing the energy gap and ensuring the electricity to all the citizens in near future.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Rahman, L. (2015) Digital Bangladesh: Dreams and Reality. The Daily Star. <https://www.thedailystar.net/supplements/24th-anniversary-the-daily-star-part-1/digital-bangladesh-dreams-and-reality-73118>
- [2] IEAE (2016) Country Nuclear Power Profiles Bangladesh. <https://cnpp.iaea.org/countryprofiles/Bangladesh/Bangladesh.htm>
- [3] (2015) World Energy Statistics Asia. <https://www.worlddata.info/asia/bangladesh/energy-consumption>
- [4] Bangladesh Power System Master Plan 2016. [http://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/\(E\)_FR_PSMP2016_Summary_revised](http://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/(E)_FR_PSMP2016_Summary_revised)
- [5] Sabhasachi, S., Koushik, R., Souvik, R., Asfakur, R.Md. and Zahid, H.Md. (2018) Rooppur Nuclear Power Plant: Current Status & Feasibility. *Journal of Mechanical Engineering*, **68**, 167-182. [https://content.sciendo.com/configurable/contentpage/journals\\$002fscjme\\$002f68\\$002f3\\$002farticle-p167.xml](https://content.sciendo.com/configurable/contentpage/journals$002fscjme$002f68$002f3$002farticle-p167.xml)
<https://doi.org/10.2478/scjme-2018-0033>
- [6] Taheruzzaman, M. and Janik, P. (2016) Electric Energy Access in Bangladesh. *Transactions on Environment and Electrical Engineering*, **1**. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwiH_77br4jmAhUolIsKHcT9B_0QFjABegQIBRAB&url=http%3A%2F%2Fwww.researchgate.net%2Fpublication%2F306047475_Electric_Energy_Access_in_Bangladesh&usg=AOvVaw2jg8mCGseQqUQwWvTeewdN
<https://doi.org/10.22149/tee.v1i2.13>
- [7] General Economics Division Planning Commission, Government of the People's Republic of Bangladesh (2012) Perspective Plan of Bangladesh 2010-2021.
- [8] Barapukuria Coal Power Plant, Global Energy Observatory (2014). <http://globalenergyobservatory.org/geoid/40466>

- [9] CPGCBL (2018). <http://www.cpgcbl.gov.bd>
- [10] NWPGL (2019) Ongoing Projects. <http://www.nwpgcl.org.bd>
- [11] NWPGL (2018). <http://www.nwpgcl.org.bd>
- [12] Power Plants around the World (2014) Oil- and Gas-Fired Plants in Bangladesh.
- [13] Global Energy Observatory (2014) Ashuganj Gas Power Plant. <http://www.apscl.gov.bd>
- [14] Global Energy Observatory (2014) Ghorasal Gas Power Plant.
- [15] Power Plants around the World (2013) CCGT Power Plants in Bangladesh.
- [16] Power Plants around the World (2014) Diesel and Gas-Engine Power Plants in Bangladesh.
- [17] Global Energy Observatory (2014) Karnafuli Hydroelectric Power Plant.
- [18] World Bank, Sustainable Energy for All (SE4ALL) Database from the SE4ALL Global Tracking Framework Led Jointly by the World Bank, International Energy Agency, and the Energy Sector Management Assistance Program. <https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS>
- [19] Karim, R., Karim, M.E., Muhammad-Sukki, F., Abu-Bakar, S.H., Bani, N.A., Munir, A.B., Kabir, A.I., Ardila-Rey, J.A. and Mas'ud, A.A. (2018) Nuclear Energy Development in Bangladesh: A Study of Opportunities and Challenges. *Energies*, **11**, Article No. 1672. <https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b&scp=85051239091&origin=inward>
<https://doi.org/10.3390/en11071672>
- [20] Power Division, Ministry of Power, Energy and Mineral Resources, Government of the People's Republic of Bangladesh (2016) Power System Master Plan 2016 Summary.
- [21] The VVER Today: Evolution, Design, Safety, ROSATOM.
- [22] OECD-NEA & IAEA, Uranium (2018) Resources, Production and Demand ("Red Book"). World Nuclear Association, the Nuclear Fuel Report 2015, 2017 & 2019.
- [23] Topychkanov, P. (2017) Why the Bangladeshi Public Has Concerns over the Rooppur Nuclear Project. <https://carnegie.ru/2017/02/27/why-bangladeshi-public-has-concerns-over-rooppur-nuclear-project-pub-68116>