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Secondary Research Article

The Prospects of Nuclear Power in the Bangladesh

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Abstract

Bangladesh, one of the populous countries in Asia who is suffers from energy shortages. Years of under-investment, lack of maintenance and perpetual resource supply problems have elevated the situation to crisis levels. National policy makers have consequently expressed an interest in nuclear power as a source of stable electricity. Bangladesh's energy infrastructure is quite small, insufficient and poorly managed. The per capita energy consumption in Bangladesh is one of the lowest in the world. Non-commercial energy sources, such as wood fuel, animal waste, and crop residues, are estimated to account for over half of the country's energy consumption. Bangladesh has small reserves of oil and coal, but very large natural gas resources. Commercial energy consumption is mostly natural gas (around 66%), followed by oil, hydropower and coal. Nuclear power is desirable in Bangladesh, due to its underdeveloped and mismanaged energy infrastructure. Nuclear powers are much more rigorous than of other kinds of energy production. Moreover, Nuclear power is a unique source of energy for power production. It is also assume to have a wide application in hydrogen production. However, the future Nuclear power must be safe, much more efficient and no producing radioactive waste.

Keywords: Nuclear power, Safety, Demand in Bangladesh, Future plan of Bangladesh

1. Introduction

Electricity, the most usable form of energy, is one of the most important issues for the economic development of a country. The projection of demand for electricity is an integral part of the planning process as it enables the decisions-makers on the regarding matter. It is a vital ingredient to upgrade the socio-economic condition and to alleviate poverty. The supply of electricity has a great impact on the national economy. Therefore, uses of this electrical energy are rapidly increasing day by day. Human civilization has advanced by the versatile uses of electricity and demand for electricity is integrated with all aspects of development. Electricity is a typical form of energy. It is recognized that the pace of power development (especially electricity) has to be accelerated in order to achieve overall economic development of the country because a country's socio-economic development largely depends on it. However, currently, consumers cannot be provided with uninterrupted and quality supply of electricity due to the inadequate generation compared to the national demand. It is quite evident that the extensive dependence on electricity has put us under a strong challenge. For years, the matter of balancing the supply against the demand for electricity has remained largely an unresolved matter. The country faces a significant challenge in revamping its network responsible for the supply of electricity. Therefore, such policy formulations are to be done based on the results of realistic and practical researches regarding power sector. A credible and realistic demand forecast is necessary for any country regarding its electrical energy resources for the sake of better administration.

Efficient policies should be taken to ensure a stable and healthy economy. For this reasons it is high time to use the alternative resources of power generation for Bangladesh for increasing the supply of electricity. Nuclear energy can be used as one of the alternative resources. Nuclear power is the use of sustained nuclear fission to generate heat and electricity. Nuclear power plants provide about 6% of the world's energy and 13–14% of the world's electricity, with the U.S., France, and Japan together accounting for about 50% of nuclear generated electricity. The problem of energy production on a large scale for rapidly increasing world population is at the present of vital importance. Consequently, various ways of energy gain are now subjected to thorough and comprehensive analysis from the viewpoint of more and more rigorous and stringent criteria, the main are safe operation, commercial competition, reserves of energy sources and not devastating the earth. So, it becomes apparent that just in not distant future the energy production on a global scale should not consume oxygen and, consequently, not create carbon dioxide which accumulation in ocean waters could lead to catastrophic changes in the ecosystem of our planet the regenerative capabilities of which are constantly diminishing as a result of mankind activity. The unique way that can completely satisfies the above-mentioned conditions can be only nuclear power (NP). However, the future NP should be safe, much more efficient and no producing radioactive waste.

2. Sources of Electricity

The main energy sources currently used on a global scale are fossil fuels (gas, oil, coal), fast enough flowing rivers producing the so-called hydroelectricity and the binding energy of heavy nuclei which is the base of nuclear power. However, the total potential of hydroelectric power is estimated as not exceeding of about 10% of total world's energy requirement whereas the current share of nuclear power approximated 15-17%. Contribution of other sources called as renewable (wind, tides, biomass, solar, wave and thermal water and geothermal) amounts to several percent of the total demands. Moreover, although very preferable and continually improving they are as a rule much more expensive and should be spread over large surfaces to collect a profitable quantity of energy. The same holds true for the profit from the magnitude of energy which now is simply squandered and can be saved, unless some new physics phenomena will be involved on the global scale, such as reliable room temperature superconductors or quite new fascinating and crazy approach to the use of electricity as, for example, by means of low-voltage devices supplied by local, even home, electrochemical sources [1]. In the last case the economy would be indeed significant - no dense high-voltage network, covering practically all surface of the earth, expensive to maintenance, material consuming, causing appreciable losses of electricity, spoiling landscapes and vulnerable to atmospheric, solar and sabotage activities. The fundamental significance for the world energy policy has the problem of reserves of energy sources. At present it is found reliably enough that fossil fuels (gas and oil) suffice for about 50 years and 200 to 400 years (coal and lignite). Nuclear fuel sources are much wealthier, both fissile (uranium and thorium) and fusion (deuterium). Moreover, In Bangladesh the sources of electricity are quite similar. According to Bangladesh Power Development Board 5823 MW power capacity, Power plants installed.

Table 1: Installed capacity of BPDB power plants (As on June'2010) [2]

Types of Plant	Installed Capacity MW	Percentage
Hydro	230	3.95%
Steam	2638	45.31%
Gas Turbine	1466	25.18%
Combined Cycle	1263	21.69%
Diesel	226	3.87%
Total	5823	100%

3. Development of Nuclear Power

The pursuit of nuclear energy for electricity generation began soon after the discovery in the early 20th century that radioactive elements, such as radium, released immense amounts of energy, according to the principle of mass–energy equivalence. However, means of harnessing such energy was impractical, because intensely radioactive elements were, by their very nature, short-lived (high-energy release is correlated with short half-lives). However, the dream of harnessing "atomic energy" was quite strong, even though it was dismissed by such fathers of nuclear physics like Ernest Rutherford as "moonshine." This situation, however, changed in the late 1930s, with the discovery of nuclear fission. In 1932, James Chadwick discovered the neutron, which was immediately recognized as a potential tool for nuclear experimentation because of its lack of an electric charge [3]. Afterwards the development of Nuclear energy begins. Installed nuclear capacity initially rose relatively quickly, rising from less than 1 gigawatt (GW) in 1960 to 100 GW in the late 1970s, and 300 GW in the late 1980s. Since the late 1980s worldwide capacity has risen much more slowly, reaching 366 GW in 2005. Between around 1970 and 1990, more than 50 GW of capacity was under construction (peaking at over 150 GW in the late 70s and early 80s) — in 2005, around 25 GW of new capacity was planned. During the 1970s and 1980s rising economic costs (related to extended construction times largely due to regulatory changes and pressure-group litigation) and falling fossil fuel prices made nuclear power plants then under construction less attractive. In the 1980s (U.S.) and 1990s (Europe), flat load growth and electricity liberalization also made the addition of large new baseload capacity unattractive. The 1973 oil crisis had a significant effect on countries, such as France and Japan, which had relied more heavily on oil for electric generation (39% and 73% respectively) to invest in nuclear power. Some local opposition to nuclear power emerged in the early 1960s, and in the late 1960s some members of the scientific community began to express their concerns. These concerns related to nuclear accidents, nuclear proliferation, and high cost of nuclear power plants, nuclear terrorism and radioactive waste disposal. In the early 1970s, there were large protests about a proposed nuclear power plant in Wyhl, Germany. The project was cancelled in 1975 and anti-nuclear success at Wyhl inspired opposition to nuclear power in other parts of Europe and North America. By the mid-1970s, anti-nuclear activist had moved beyond local protests and politics to gain a wider appeal and influence, and nuclear power became an issue of major public protest. Although it lacked a single coordinating organization, and did not have uniform goals, the movement's efforts gained a great deal of attention [3].

4. Producing Electricity Using Nuclear Power

Just as many conventional thermal power stations generate electricity by harnessing the thermal energy released from burning fossil fuels, nuclear power plants convert the energy released from the nucleus of an atom via nuclear fission that takes place in a nuclear reactor. The heat is removed from the reactor core by a cooling system that uses the heat to generate steam, which drives a steam turbine connected to a generator producing electricity. And the energy comes from the nuclear fission chain reaction. While typical chemical reactions release energies on the order of a few eVs (e.g. the binding energy of the electron to hydrogen is 13.6 eV), nuclear fission reactions typically release energies on the order of hundreds of millions of eVs.Two typical fission reactions are shown below with average values of energy released and number of neutrons ejected:

$$^{235}U + \text{neutron fission} \rightarrow \text{fragments} + 2.4 \text{ neutrons} + 192.9 \text{ MeV} \quad \ldots\ldots\ldots\ldots (1)$$

$$^{239}Pu + \text{neutron fission} \rightarrow \text{fragments} + 2.9 \text{ neutrons} + 198.5 \text{ MeV} \quad \ldots\ldots\ldots\ldots (2)$$

Chain reactions naturally give rise to reaction rates that grow (or shrink) exponentially, whereas a nuclear power reactor needs to be able to hold the reaction rate reasonably constant. To maintain this control, the chain reaction criticality must have a slow enough time-scale to permit intervention by additional effects (e.g., mechanical control rods or thermal expansion). Consequently, all nuclear power reactors (even fast-neutron reactors) rely on delayed neutrons for their criticality. An operating nuclear power reactor fluctuates between being slightly subcritical and slightly delayed-supercritical, but must always remain below prompt-critical [4].

Uranium is a fairly common element in the Earth's crust. A nuclear reactor is only part of the life-cycle for nuclear power. The process starts with mining (see Uranium mining). Uranium mines are underground, open-pit, or in-situ leach mines. In any case, the uranium ore is extracted, usually converted into a stable and compact form such as yellowcake, and then transported to a processing facility. Here, the yellowcake is converted to uranium hexafluoride, which is then enriched using various techniques. At this point, the enriched uranium, containing more than the natural 0.7% U-235, is used to make rods of the proper composition and geometry for the particular reactor that the fuel is destined for. The fuel rods will spend about 3 operational cycles (typically 6 years total now) inside the reactor, generally until about 3% of their uranium has been fissioned, then they will be moved to a spent fuel pool where the short lived isotopes generated by fission can decay away. After about 5 years in a spent fuel pool the spent fuel is radioactively and thermally cool enough to handle and it can be moved to dry storage casks or reprocessed [3].

5. Present Condition of Nuclear Power in World

Currently, nuclear energy produces slightly less than 14% of the world's electricity supplies and 5.7% of total primary energy used worldwide. The global energy supply and energy use per capita are increasing. The total energy requirements of the world rose by a factor of 2.5 between 1970 and 2010, from 4.64 billion tons of oil equivalent (toe) to 11.9 billion toe (195 to 499 exajoules (EJ))1. Over the past few decades, the share of electricity in total energy use has steadily increased. Energy mix over this period. The share of nuclear grew from just below 0.5% in 1970 to above 7% in the 1990s and declined to 5.7% by 2008. Fossil fuels remain the dominant energy source. 1 1 EJ = 1018 J or 2.78 ×105 GW·h (th) or 31.7 GW·a.4 Nuclear power has been used to produce electricity for public distribution since 1954. Since that time, nuclear power plants have been operated in 32 countries2. Currently, 29 countries operate 441 plants, with a total capacity of 375 GW(e). A further 60 units, totaling 58.6 GW(e), are under construction3. During 2009, nuclear power produced 2558 billion kWh of electricity. The industry now has more than 14 000 reactor years of experience. The contribution of nuclear energy to total electricity generation varies considerably by region (Table 2). In Western Europe, nuclear generated electricity accounts for almost 27% of total electricity. In North America and Eastern Europe, it is approximately 18%, whereas in Africa and Latin America it is 2.1% and 2.4%, respectively. In the Far East, nuclear energy accounts for 10% of electricity generation; in the Middle East and South Asia it accounts for 1.4% Nuclear energy use is concentrated in technologically advanced countries. Over the past two years the contribution of nuclear generation to world electricity production has declined from 15% to less than 14%, largely due to a rise in total electricity generation worldwide without an increase of nuclear generation. The number of reactors under construction increased from 33 with a total capacity of 27 193 MW (e) at the end of 2007 to 60 with a total capacity of 58 584 MW (e) on 26 August 2010. In many countries with existing nuclear power programs, there are significant increases in investment in future nuclear power plants. Of these 60 plants, 11 have been under construction since before 1990, and of the 11 possibly only three are predicted to be commissioned in the next three years. There are a few reactors which have been under construction for over 20 years and which currently have little progress and activity. In 2008, there were 10 construction starts and in 2009, there were 12, extending a continuous upward trend that started in 2003. All 22 of the construction starts in 2008 and 2009 were pressurized water reactors (PWRs) in three countries: China, Republic of Korea and Russian Federation. Since the accident at Chernobyl in 1986, industry safety records have improved significantly. Unplanned automatic scrams continue at the low level of 0.5 per 7000 hours critical. The improved availability and safety records are, in part, attributable to increased information sharing of best practices and lessons [5].

Table 2: Use (in EJ) and percentage contribution (percentage) of Different types of fuel for electricity generation in 2008

Region	Thermal (a)		Hydro		Nuclear		Renewables(b)		Total	
	Use (EJ)	%	Use (EJ)	%	Use (EJ)	%	Use (EJ)	%	Use (EJ)	%
North America	25.13	66.15	2.32	13.32	9.76	19.04	0.76	1.09	37.98	100
Latin America	5.14	39.15	2.56	57.54	0.32	2.38	0.39	0.93	8.41	100
Western Europe	16.06	52.45	1.89	17.06	8.97	26.68	0.72	3.81	27.64	100
Eastern Europe	18.18	64.59	1.12	17.04	3.64	18.30	0.03	0.07	22.96	100
Africa	5.73	80.51	0.37	16.95	0.14	2.11	0.05	0.43	6.29	100

Middle East & South Asia	19.09	87.54	0.62	11.47	0.16	0.99	0	0.00	19.87	100
Southeast Asia and the Pacific	6.78	88.92	0.25	9.29			0.39	1.79	7.41	100
Far East	43.46	74.27	2.65	15.23	5.35	10.15	0.49	0.35	51.95	100
World Total	139.57	67.15	11.7	17.66	28.3	14.03	2.83	1.16	182.5	100

(a)The column headed 'Thermal' is the total for solids, liquids, gases, biomass and waste
(b) The column headed 'Renewables' includes geothermal, wind, solar and tide energy

6. Accidents and Safety of Nuclear Power Plants

6.1 Accidents

Some serious nuclear and radiation accidents have occurred. Nuclear power plant accidents include the Chernobyl disaster (1986), Fukushima Daiichi nuclear disaster (2011), and the Three Mile Island accident (1979). Nuclear-powered submarine mishaps include the K-19 reactor accident (1961), the K-27 reactor accident (1968), and the K-431 reactor accident (1985). International research is continuing into safety improvements such as passively safe plants, and the possible future use of nuclear fusion. Nuclear power has caused far fewer accidental deaths per unit of energy generated than other major forms of power generation. Energy production from coal, natural gas, and hydropower has caused far more deaths due to accidents. In comparison, nuclear power plant accidents rank first in terms of their economic cost, accounting for 41 percent of all property damage attributed to energy accidents.

6.2 Safety

In the 1990s, performance and safety records improved significantly, and they have remained high. Well run nuclear power plants have proven quite profitable. The improvement in the global average energy availability factor and reduction in the number of unplanned reactor trips reflect this improvement. The good safety and performance records over the past two decades, the resulting increased profitability, and the expectation of further improvements all contribute to rising expectations for nuclear power. The main issue of Nuclear Power safety is the waste disposal. Disposal of nuclear waste is often said to be the Achilles' heel of the industry. Presently, waste is mainly stored at individual reactor sites, and there are over 430 locations around the world where radioactive material continues to accumulate. Some experts suggest that centralized underground repositories which are well-managed, guarded, and monitored, would be a vast improvement There is an "international consensus on the advisability of storing nuclear waste in Deep geological repository", with much confidence in the safety of the method coming from the analysis of the lack of movement of nuclear waste in the numerous 2 billion year old Natural nuclear fission reactors in Oklo Gabon [6].

7. Present Electricity Scenario in Bangladesh

Bangladesh, with its 160 million people in a land mass of 147,570 sq km, has shown tremendous growth in recent years. A booming economic growth, rapid urbanization and increased industrialization and development have increased the country's demand for electricity. Presently, 50% of the total population has access to electricity and per capita generation is 252 KWh, which is very low compared to other developing countries. Recognizing the fact the present government has prioritized the power sector right from its election manifesto. As per the manifesto, electricity generation in the country was supposed to be 5000 MW by the year 2011 and 7000 MW by 2013. The government has been successful in meeting these targets and has even been able to achieve higher level of precedents. The government aims to generate additional 15,000 MW electricity, within 2016 under short, medium and long-term plan. Assessing the current state of electricity in Bangladesh, government disseminates on how to develop and communicate various strategies and plans and implement moderate growth in demand through increased efficiency. It also investigates on how to combine environmental goals into planning and operation and tries to find ways on how to ensure sufficient supply wherever and whenever it is required, as well as on how to handle various other challenges in the power sector. The government has further extended its vision targeting the upcoming years up to 2030 and prepared the Power Sector Master Plan 2010 (PSMP). This plan states that in 2030 the demand of power would be around 34,000 MW while the generation capacity would be about 39,000 MW. Presently, the generation capacity is nearly 7,000 MW that implies that much endeavor is required to achieve the goal. Considering the country's future energy security, the government has rightly given due importance on renewable energy, energy efficiency as well as energy conservation [7].

8. Future Plan of Bangladesh Government for Nuclear Power

8.1 Future Plans

Bangladesh plans to have two 1000 MWe Russian nuclear power reactors in operation from 2018. This is to meet rapidly increasing demand and reduce dependence on natural gas. Bangladesh produced 38 billion kWh gross in 2009 from some 6.1 GWe of plant, giving per capita consumption of 250 kWh/yr. About 88% of electricity comes from natural gas. Electricity demand is raising rapidly, with peak demand 7.5 GWe, and the government aims to increase capacity to at least 7 GWe by 2014, meanwhile importing some 250 MWe from India. New small coal-fired plants are envisaged for 2 GWe of that, and for 3 GWe more by 2016. However, about half the population remains without electricity, and the other half experience frequent power cuts. Some 5.0% of government expenditure is being allocated to 'power and energy'. The capacity target for 2021 is 20 GWe. Building a nuclear power plant in the west of the country was proposed in 1961. Since then a number of reports have affirmed the technical and economic feasibility. The Rooppur site in Pabna district about 200 km north of Dhaka was selected in 1963 and land was acquired. The government gave formal approval for a succession of plant proposals, then after independence a 125 MWe nuclear power plant proposal was approved in 1980 but not built. With growth in demand and grid capacity since then, a much larger plant looked feasible, and the government in 1999 expressed its firm commitment to build this Rooppur plant. In 2001, it adopted a national Nuclear Power Action Plan and in 2005, it signed a nuclear cooperation agreement with China. In 2007 the Bangladesh Atomic Energy Commission proposed two 500 MWe nuclear reactors for Rooppur by 2015, quoting likely costs of US$ 0.9-1.2 billion for a 600 MWe unit and US$ 1.5-2.0 billion for 1000 MWe. In April 2008 the government reiterated its intention to work with China in building the Rooppur plant and China offered funding for the project. The International Atomic Energy Agency (IAEA) approved a Technical Assistance Project for Rooppur Nuclear Power Plant to be initiated between 2009 and 2011, and it then appeared that an 1100 MWe plant was envisaged. Russia, China and South Korea had earlier offered financial and technical help to establish nuclear power, and in March 2009 Russia made a formal proposal to build a nuclear power plant in the country. In May 2009 a bilateral nuclear cooperation agreement was signed with Russia. In April 2009 the government approved the Russian proposal to build a 1000 MWe nuclear plant at Rooppur for about $2 billion, and a year later this had become two such reactors by 2017. A nuclear energy bill was introduced into parliament in May 2012, with work to begin in 2013, and setting up a Bangladesh Atomic Energy Regulatory Authority. Parliament was told that 5000 MWe of nuclear capacity was envisaged by 2030, and a second plant would be built in the south once Rooppur was operating. In May 2010 an intergovernmental agreement was signed with Russia, providing a legal basis for nuclear cooperation in areas such as siting, design, construction and operation of power and research nuclear reactors, water desalination plants, and elementary particle accelerators. Other areas covered included fuel supply and wastes. An agreement with Rosatom was signed in February 2011 for two 1000 MWe-class reactors to be built at Rooppur for the Bangladesh Atomic Energy Commission. In line with standard Russian practice this included fuel supply and return of used fuel to Russia. Another intergovernmental agreement was signed in November 2011. In February 2012 the Ministry of Science and Technology signed an agreement with Russia's Rostechnadzor related to regulation and safety "and the provision of advisory support to the Bangladesh Nuclear Regulatory Commission on regulation, licensing and supervision". Staff will be trained in Russia. A further agreement will be for Russian finance. Construction of the first unit is expected from 2013, with operation in about 2018. In August 2012 a financing agreement was finalized under which Bangladesh would borrow $500 million for a 2-year technical and economic study together with design, documentation and training, at not less than 4% interest. Russia will then fund 85% of the estimated $1.5 billion for the first unit's construction. The $500 million loan will be repaid in 12 years with five years grace period, and the final construction cost will be repaid in 28 years with 10 years grace period. The IAEA continues its close involvement with the project [8].

8.2 Research

Bangladesh has had a Triga 3 MW research reactor operational since 1986 [8].

8.3 International agreements and Non-proliferation

Bangladesh has had a safeguards agreement in force with the IAEA since 1982, and an Additional Protocol in force since 2001 [9].

9. Results & Discussion

This research is completely a theoretical framework. From this, the result is obtained that it is high time that Bangladesh should use alternative source of energy. In addition, nuclear Power is the best way. The initial cost of the plant is high but it will sustain for long time. Moreover, the total amount of electricity production is high than renewable sources. Bangladesh is mainly using natural gas for electricity production, and natural gas is using for other purposes. By using this way the natural gas will finish one day, so nuclear power should be introduced in Bangladesh. Moreover, Nuclear Power has an exclusively important advantage of no creating carbon dioxide and, therefore, no consuming oxygen. Therefore, it does not disturb the equilibrium of the echo-system of our planet. Nuclear power possess considerable potential possibilities, far to be exhausted till now, which will be set in motion as the necessary results of investigation in the field of applied nuclear physics, radiation material physics and radiation chemistry are accumulated. Nevertheless it is now almost certain that the future nuclear arrangements based on splitting nuclear reactions will be in the form of systems of fast reactors operating in deeply subcritical regime fuelling and driven by spallation neutrons produced in heavy extended targets by relativistic proton beams from accelerator (ADS). Such arrangements are able to burn up practically all-natural uranium in the closed nuclear cycle and, in addition, to transmute and incinerate the radioactive waste from other sources used in medicine, industry, scientific research and military applications [10]. The main problem of thinking Nuclear power was radioactive disposal but now it can be used and dangerous to people. So, analyzing all perspectives Nuclear Power should be introduced in Bangladesh.

10. Conclusion

As Bangladesh is a poor country, it is very important to reduce the cost of electricity. In this country, the demand of electricity is increasing, and most of power plants are now depending on natural gas, furnace oil and diesel. Using this kind of fuels, the rate of electricity is also increasing, and the resources are now decreasing. Taking into account of knowledge of Nuclear Power and the experience gained during about fifty years of functioning of nuclear power stations, the current and future needs in energy from the viewpoint of energy sustainable development, one can conclude that even the present state-of-the-art technology in this important branch of economy is quite competitive as compared to other ways of energy production on the large scale. So, it is necessary to use alternative sources of electricity like Nuclear Power.

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