Challenges and Opportunities to Introduce the First Nuclear Power Plant in Bangladesh

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Abstract: Nuclear activities were first started in Bangladesh in 1964 through the establishment of Atomic Energy Centre at Dhaka. Since then development of the nuclear activities for sustainable future is progressing gradually. Bangladesh Atomic Energy Commission (BAEC) is responsible for developing and promoting nuclear activities for peaceful purposes with assured safety and support for nuclear power program in the country. The Government of Bangladesh has decided to set up the country's first nuclear power plant with a generation capacity between 600 MW and 1,000 MW at Rooppur in Pabna district, 125 km North-West of the capital city, Dhaka. In this context, the challenges and opportunities to introduce the first Rooppur nuclear power plant (RNPP) project are identified and then discussed in this paper. It is finally concluded that nuclear power is an inevitable option for Bangladesh.

Keywords: Nuclear power, Safety, Rooppur, Challenges and Opportunities, Inevitable

1. INTRODUCTION

There is a strong correlation between the per capita energy use and per capita gross domestic products (GDP). To raise the GDP figure to two digits, per capita energy consumption is needed to be about 500 kWh. At present per capita generation of electricity in Bangladesh is very low (about 165 kWh) and suppressed by constraints of supply. Inadequate system capacity is also affecting the quality of supply as manifested in load shedding, grid instability and fluctuations in voltage and frequency. Therefore, there is a felt need to improve generation in order to help meeting the goals of overall national development viz. millennium development goals (MDGs). It is estimated that about 6,000 MW additional capacity needs to be added over the period up to 2015, which would increase the per capita availability of electricity to 200 kWh [3]. It is understood that on an average 1,000 MW electricity generation is needed in every year to access electricity for all by 2020. Indigenous natural gas supply now is the principal fuel and accounts for about 86% of electricity generation. Thus, even if capacity addition proceeds as envisaged, Bangladesh would have to import fuel in the future, especially as natural gas has demands in other sectors of the economy. Moreover, the entire deposit of gas (20.63 TCF) is located in the Eastern Zone, which is separated from the Western Zone by major rivers. This situation has compelled to develop a system where the Western Zone has to depend on inter-zone tie lines for importing energy from the other zone or to build plants based on imported fuel even to meet its base load. It is therefore vital for the country to look for alternative fuel or power generation. In Bangladesh context, nuclear power technology is identified as a viable option in overall energy mix.

Due to limitation of natural resources and high demand for power for industrialization, poverty alleviation, millennium development goals (MDGs), Bangladesh Atomic Energy Commission (BAEC) selected a site on 292 acres of land way back in early 1960's at Rooppur in the Pabna district for installation of the first nuclear power plant in the country. Generally, construction of the first nuclear plant takes longer time, 8-15 years, from inception in developing countries [2]. In order to implement the project, a number of feasibility studies have been conducted so far. These studies have identified technical and economic merit of nuclear power in Bangladesh and that the site, in general, met the conditions for building the nuclear power plant. For introduction of a nuclear power plant, the stability

of the national electricity grid is an important prerequisite. Necessary measures to minimize any fluctuation of frequency and voltage during normal operation have to be identified and implemented.

BAEC, with the assistance of the International Atomic Energy Agency (IAEA), developed the nuclear power action plan, which was approved by the government on 18th January 2000. At the request of the Government, IAEA had sent several missions at different times, which had identified certain actions that are needed in the pre-implementation phase of building a 600-1000 MW nuclear power plant at Rooppur. The option is left open for building additional units on the same site in future.

BAEC, as a part of its endeavor to acquire nuclear technology, has been operating the 3 MW TRIGA Mark-II nuclear research reactor for RI production, various R& D activities and man power training program since 1986. BAEC has constructed a central waste processing and storage facility at one of its largest establishment called Atomic Energy Research Establishment (AERE), Savar, Dhaka, where the research reactor and RI production laboratories are located. The waste processing and storage facility also acts as the national facility for the treatment and storage of all radioactive wastes generated in any part of the country.

BAEC has also established a regulatory wing known as Nuclear Safety and Radiation Control (NSRC) Division, which is responsible for ensuring the safe use of radiation sources /equipment and the management of radioactive waste both in the public and private sectors under NSRC Act, 1993 and NSRC Rules-1997. The nuclear safety and radiation control (NSRC) act 1993 was passed in the National Assembly in 1993. The nuclear safety and radiation control division (NSRCD) is working with the IAEA for reforming, updating nuclear safety and radiation control rules so as to facilitate implementation of the Rooppur nuclear power plant project in the country. Moreover, Bangladesh has signed all treaties, convention, bilateral agreements, safeguards agreements, protocol additional to the safeguards agreements for peaceful applications of nuclear energy in the country.

There is a plan to develop human resources in the field of design, construction and safety for successful implementation of the Rooppur nuclear power project. Several workshops, seminars, symposium and physical measures are being conducted by the BAEC for nuclear knowledge transfer, preservation and management against workforce ageing. Recently BAEC has established a Nuclear Safeguards and Security Division at its head office to oversee the country’s nuclear materials accounting, control and security systems.

Fuel availability, initial high investment, waste disposal, safety, long construction time and high decommissioning cost are the major concern with nuclear power plant projects. However, its overall per unit cost is competitive with coal and if safety is ensured nuclear will be a prospective candidate for future power generation. Still there are many challenges: these include lack of adequate trained manpower for licensing of sites for nuclear power plants, licensing of design and construction of the plant and associated civil works and infrastructure and finally licensing the commissioning, operation and decommissioning of such nuclear plants. It is equally important that our regulators must possess enough technological expertise to demonstrate competence in the strict adherence to the international safeguards and safety regime. If Bangladesh is to get rid of chronic power shortage problem and look for long-term energy security and sustainable development, entry into a long-term nuclear power program should not be delayed anymore. The objective of this paper is to highlight the present status for successful implementation of the RNPP project and identify the impediments that require to be solved.

2. STATUS OF THE ROOPPUR NUCLEAR POWER PLANT (RNPP) PROJECT

The need for nuclear power has been established in the National Energy Policy of Bangladesh. Nuclear power was identified as a viable option for Bangladesh as early as in 1960. A site was selected by considering the applicable criteria and land for the project (292 acres) was acquired. After independence in 1971, considering the role of nuclear power program in the long-term electricity generation-mix of the country, the government revived the project. Some progress was made during

the last few years in preparation of draft request for proposal document and draft site safety report for the proposed Roopppur Nuclear Power Project. Bangladesh submitted the work plan to the IAEA last October 2008, giving details on how the country planned to install the nuclear power plant at Rooppur and maintain safeguards with proper management of nuclear waste. The present state of the RNPP project comprises four parts as stated in the following sub-sections.

2.1. Feasibility Study

The proposal for building a Nuclear Power Plant in the western zone of the country was first conceived in 1961. Since then a number of feasibility studies were conducted, each of which established that the project was technically and economically feasible. The Rooppur site in Ishwardi of Pabna was selected in 1963 and 292 acres of land was acquired for the project. Then the Pakistan Government gave formal approval for 70 MW, 140 MW and 200 MW plant in 1963, 1966 and 1969, respectively. In 1978-78, the government considering the role of nuclear power in meeting energy demands of the country conducted a feasibility study on the project. The study clearly identified nuclear option as appropriate and viable for Bangladesh. Following liberation the ECNEC had approved the PP for a 125 MW nuclear power plant in 1980. The follow-up study, conducted in 1986-87 also reconfirmed the findings on technical, economic and financial viability of the project, and two units of 300 MW were recommended for implementation [1]. During 1996-2001, several meetings of the Implementation Committee on Rooppur Nuclear Power Project were held chaired by he Head of the Government and decisions were taken to expedite implementation of the Project. It was decided that in the first stage, a 600 MW(e) nuclear power plant is to be constructed on the designated site, which is to be followed by a repeat unit on the same site. Accordingly, pre-implementation phase activities for construction of two units of 600 MW(e) sized reactors on the Rooppur site with a time lag of two years were conducted during 1999-2002.

2.2. Nuclear Power Action Plan

The government of Bangladesh adopted the Bangladesh National Nuclear Action Plan (BANPAP) in 2000 for implementation of the nuclear power project in the country. The BANPAP highlights the National Position and Govt. policy for implementation of RNPP. The plan was examined by the IAEA before the Government of Bangladesh (GOB) formally accepted it. The Action Plan identified viz,

- various activities needed for implementation of the nuclear power program and
- the agencies responsible for each of these activities.

2.3. Request for Proposal (RFP)

A draft request for proposal has been prepared, which will be used for inviting bids from intending suppliers and financiers.

2.4. Ongoing activities

- Conducting/Reviewing design basis parameters and engineering solutions for suitability of the site for heavy construction of 600 MW to 1000 MW NPP
- Topography, morphology and ground stability.
- Geology, structural geology and soil mechanics.
- Seismology of the area.
- The availability of water for steam generation, cooling and other uses.
- The possible hazards on public health and environment under normal operation and in case of accident.
- Developing nuclear licensing procedure.
- Finalization of project implementation plan.
- Human Resources Development (HRD).

BAEC-Bangladesh University of Engineering and Technology (BUET) agreed informally on following Site Specific Study (June, 2009) under the Annual Development Project (ADP).

- 1-D site response analysis (Site specific) study and Development of site specific response spectrum
- Review of geology and fault information; compilation of earthquake database
- Analysis of seismic source and seismicity characteristics and Probabilistic seismic hazard assessment (for different return periods)
- Assessment of liquefaction potential of the site
- Government Commitment: 2009 - 2011
- Annual Development Project (ADP): Accomplishment of necessary activities for construction of medium size Rooppur Nuclear Power Plant
- IAEA's Commitment: 2009 – 2011
- Technical Cooperation (TC) Project: Establishing Nuclear Power in Bangladesh
- IAEA Observation and Status of RNPP Project

Table 1 Present Status of the RNPP

STEP 1 (a) Justification of Necessity of an NPP	→	STEP 1(b) FS on Introduction of an NPP	→	STEP 1(c) Establishment of Nuclear Power Project Plan
				↓
STEP 2(c) Finalization of mode of construction (2009-2011)	←	STEP 2(b) Preparation for NPP Construction (2009-2011)	←	STEP 2(a) Govt. Decision on Introduction of an NPP (2009-2011)
↓				
STEP 2(d) Concluding Major Contracts (2009-2011)	→	STEP 3 NPP Construction (2011 – 2016)	→	STEP 4 Commercial Operation (2016)

The present status of the RNPP project is shown in Table 1. It is worthwhile to mention here that present status of the RNPP is at STEP 2 according to the observation and assessment of the IAEA.

- Financing Plan

Bangladesh is in contact with potential suppliers in order to obtain from them comprehensive proposals on technology and finance. Packaging of financing tied with sources of supply is considered a possible way to mobilize funds for the project. Financing package for the project need to be determined in association/consultation with potential suppliers and their governments and may take the form of suppliers' credit/soft loan/grant or a combination thereof, depending on the nature of the suppliers.

Project implementation package(s) / Option(s) for financial schemes may be as follows.

- BOO (Built Own Operate)
- BOT (Build Own Transfer)
- Joint Venture
- Any other innovative financial scheme

3. LEGAL AND REGULATORY ASPECTS

A developing country embarking on its first NPP often lacks the necessary legal and regulatory structure to ensure proper design, construction and safe operation of its nuclear facility. Since the consequences of failure of a nuclear facility can go well beyond its national boundaries, one cannot let the operator of such a facility to regulate itself. On the other hand, it is not practical to ask a developing country to set up a totally independent regulatory body to monitor its first NPP. The compromise that is often made is to set up a separate group within the atomic authority to implement the regulatory aspects. At present, Nuclear Safety and Radiation Control Division (NSRCD) is now working as the regulatory wing of BAEC. However, there is a plan to form an independent regulatory body. In this regard, a new act has already been submitted to the Government entitled "Bangladesh Atomic Energy Regulatory Authority-06"with a view to establishing a suitable organization having adequate independence to meet the IAEA/National obligations for ensuring nuclear safety and radiation control in the country.

Existing Act & Rules for Installation and Operating a NPP in Bangladesh are

- NSRC Act (1993)
- NSRC-Rules (1997)

The Nuclear Regulatory Body of Bangladesh includes

- A Directorate on Nuclear Safety and Radiation Control is working effectively as the secretariat for the regulatory body for performing all regulatory activities under the NSRC Act and Rules

- The Nuclear Safety & Radiation Control Division (NSRCD) is responsible to the BAEC for facilitating implementation of the provisions of the Rules (1997)

- Chairman, BAEC is the head of the regulatory body

Since Bangladesh has signed all conventions, treaties, agreements, etc, as shown in Table. 2 which means firm commitment of the government to introduce the nuclear power plant in the country for peaceful applications.

Table 2. Agreements with the IAEA

NPT related safeguard agreement INFCIRC/301	Entry into force:	11 June 1982
Additional Protocol	Entry into force:	30 March 2001
Improved procedures for designation of safeguards inspectors	Accepted on:	25 April 1995
Supplementary agreement on provision of technical assistance by the IAEA	Entry into force:	31 December 1979
RCA	Entry into force:	24 August 1987
Other Relevant International Treaties etc.		
NPT	Entry into force:	31 August 1979
Convention on physical protection of nuclear material		2005
Convention on early notification of a nuclear accident	Entry into force:	7 February 1988

Convention on assistance in the case of a nuclear accident or radiological emergency	Entry into force:	7 February 1988
Convention on nuclear safety	Entry into force:	24 October 1996
Bangladesh has bilateral agreements on nuclear cooperation with USA, France and China.		

In order to strengthen nuclear regulatory infrastructure suitable for nuclear power program, a draft "Nuclear Law" has been prepared by BAEC. BAEC has sent the draft "Nuclear Law" to IAEA for necessary reviews before submission for governmental final approval.

4. POWER SYSTEM STABILITY

The principal objective of a utility is to deliver power to the consumer with voltage and frequency within limits. To supply quality power, steady state solution (load flow study) of the power system network is very important. Information obtained from the load flow study is essential to know the present state of the system and for future plan to meet the increased demand. Also under normal or abnormal conditions, the synchronous machines of the system must operate in synchronism. So, power system engineers must take decisions at the operational and at the planning levels and should conduct the following studies

- Load flow study
- Short circuit calculation
- Stability assessment
- Automatic generation control
- Economic load dispatch
- State estimation
- Reliability studies
- Security assessment
- Relay co-ordination
- Load forecasting and so on

The study of power distribution, transmission, and its system stability are the sole responsibility of the Bangladesh Power Development Board (BPDB). Design, develop and construction of the national grid size is the responsibility of the Power Grid Company of Bangladesh (PGCB). BAEC is working together with these organizations how to supply quality and stable nuclear electricity to the national grid. For a reliable and quality power supply, it is imperative that a power system be designed to be stable under any conceivable disturbance. Information obtained from the stability studies are, thus, essential for an effective and economical planning and an efficient and safe operation of the power systems.

5. INDUSTRIAL AND COMMUNICATION INFRASTRUCTURE

A developing country often lacks the necessary industrial and communication infrastructure needed for implementing a NPP. While roads, bridges and railroads can be strengthened to carry the large loads associated with pressure vessel, heat exchangers etc of a NPP, improving the industrial infrastructure is not that easy. However it should be seen as an opportunity for technology transfer from the supplier country to the recipient country that will ultimately benefit the latter. BAEC is working with the government in developing industrial and communication infrastructure for implementing the first RNPP project successfully in the country. It is worthwhile to note that investment by the South Korean government in a sustained nuclear power program has ultimately resulted in the country joining the ranks of the developed world and becoming a member of the Nuclear Supplier Group (NSG) [4& 5].

6. HUMAN RESOURCES

BAEC has a good number of professionals in various branches of nuclear technology to be involved in different implementation phases of RNPP. The Core Manpower for pre-implementation phase of the Rooppur Nuclear Power project is available in BAEC. A separate Division of BAEC named Nuclear Power and Energy (NPED) with qualified professionals under direct supervision of Chairman, BAEC is conducting necessary activities for implementing RNPP. Services of additional professionals at senior level, who have gone on retirement or are now residing abroad, may be available for RNPP. Manpower for operation and maintenance of the nuclear power plant may be trained in cooperation with the plant supplier. A team on design aspects can be planned as part of the overall contract with the main supplier. Fresh professionals are to be appointed, as soon as the contract is signed, Fresh professionals for RNPP will be available from the general universities, Universities of Engineering & Technology and Technical Institutions during implementation phase from annual out put. The number of professionals of BAEC who have background and training in following branches of nuclear technology can be directly involved in different implementation phase of the RNPP.

- Nuclear Engineering
- Mechanical Engineering
- Electrical Engineering
- Heat Transfer
- Control and Instrumentation
- Chemical Engineering
- Chemistry (Nuclear, Analytical and Water Chemistry)
- Nuclear Safety
- Reactor Physics
- Non Destructive Testing and Q/A
- Radwaste Management
- Health Physics
- Civil Engineering
- Architecture

7. PUBLIC ACCEPTANCE

Public acceptance is one of the most important aspects for implementing the nuclear power program in the country. Due to the public acceptance and demand, the successful applications of nuclear technology for mankind in different sectors are substantially increasing day by day. Public acceptance of nuclear power program in the country is in general very good. Seminar, exhibition, press meeting/release, publication, public visits are made on public information in order to develop the public understanding and public acceptance on peaceful applications of nuclear energy.

8. CONCLUSION

The Rooppur Nuclear Power Project, as confirmed by feasibility studies conducted in the past, has been considered to be technically, economically and financially viable and environmentally acceptable as an option in the long-term electricity generation mix of the country. The government is willing to take necessary steps to implement the project for secured electricity supply to sustain the economic development of the country.

In this regard, it is important to note the following challenges and opportunities are there in the path of implement of the first Nuclear Power Project in Bangladesh:

The challenges are

- Technology transfer between reactor supplier and recipient
- Fuel security
- Geopolitics
- Funding
- Waste management
- Human resources

The opportunities are

- No other potential alternatives except nuclear.
- A site suitable to accommodate multiple nuclear reactors is there at Rooppur.
- Very good public acceptance

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