Nuclear power for Bangladesh

Bangladesh has gone a long way in getting ready for nuclear power. Manpower has been trained, radiation safety bill has been passed, land for the first nuclear power station has been acquired, many feasibility studies have been made. If Bangladesh is to get out of the chronic power shortage problem and look for energy security, entry into a long term nuclear power program should not be delayed any more and decision has to be made by Bangladesh and not other countries.

DR. ANWAR HOSSAIN

A nuclear power plant.

BY nuclear power, I mean electricity produced from nuclear reaction. The first nuclear chain reaction produced electricity experimentally in a reactor in Chicago in 1945 and the first commercial nuclear power plant was built in 1954, nine years later. Since then, nuclear power reactors have grown fast and about 390 of them were built until 1986.

It is interesting to note that in spite of the decline in the construction of nuclear power plants following the Chernobyl accident (1986), the percentage of electricity produced by them all over the world has remained stable and nuclear power is now producing 16% of the world's electricity. Table 1 summarises the current status of nuclear power (until end 2004) in the world.

Although construction of nuclear power stations in the western countries declined, research and development work for safe nuclear power reactors continued and many new designs of such nuclear reactors have been made. The Director General of IAEA recently stated that in view of changing market requirements, particular attention has been made for small and medium sized reactors which allow a more incremental investment and match the grid capacity of developing countries. Such innovative designs can be more easily adapted to a broad range of dual purpose applications including sea-water desalination and manufacture of chemical fuels.

Table 1

Nuclear Power Reactors in Operation and Under Construction in the World (as of December 31, 2004) as given by IAEA in 2005.

COUNTRY	Reactors in Operation		Reactors under Construction		Nuclear Electricity Supplied in 2004	
	No of Units	Total MW (e)	No of Units	Total MW (e)	TW-h	% of Total
ARGENTINA	2	935	1	692	7.3	8.2
ARMENIA	1	376			2.2	38.8
BELGIUM	7	5 801			44.9	55.1
BRAZIL	2	1 901			11.5	3.0
BULGARIA	4	2 722			15.6	41.6
CANADA	17	12 113			85.3	15.0
CHINA	9	6 602	2	2 000	47.8	2.2
CZECH REPUBLIC	6	3 548			26.3	31.2
FINLAND	4	2 656			21.8	26.6
FRANCE	59	63 363			426.8	78.1
GERMANY	18	20 679			158.4	31.8
HUNGARY	4	1 755			11.2	33.8
INDIA	14	2 550	9	4 092	15.0	2.8
IRAN, ISLAMIC REPUBLIC OF			1	915		
JAPAN	54	45 468	3	3 237	273.8	29.3
KOREA, REPUBLIC OF	19	15 850	1	960	124.0	38.0
LITHUANIA	1	1 185			13.9	72.1
MEXICO	2	1 310			10.6	5.2
NETHERLANDS	1	449			3.6	3.8
PAKISTAN	2	425			1.9	2.4
ROMANIA	1	655	1	655	5.1	10.1
RUSSIAN FEDERATION		31	21 743	4	3	
775	133.0	15.6				
SLOVAKIA	6	2 442			15.6	55.2
SLOVENIA	1	656			5.2	38.9
SOUTH AFRICA	2	1 800			14.3	6.6
SPAIN	9	7 585			60.9	22.9
SWEDEN	11	9 469			75.0	51.8
SWITZERLAND	5	3 220			25.4	40.0
UKRAINE	15	13 107	2	1 900	81.1	51.1
UNITED KINGDOM	23	11 852			73.7	19.4
UNITED STATES OF AMERICA	104	99 210			788.6	20.0
Total (including Taiwan)	**440**	**366 311**	**26**	**20 826**	**2618.6**	**16%**

Recent developments

For many years after the Chernobyl accident, most developed countries had put a brake on the construction of power stations and concentrated on energy efficiency, so that need for additional electricity could be kept to the minimum. Meanwhile, the Kyoto Protocol to the UN Framework Convention on Climate Change entered into force in 2005, after the ratification of the Protocol by the Russian Federation.

This will have a long term effect on the future prospects of nuclear power production, as the global warming issue has caused prominent environmentalists to rethink their opposition to nuclear power because of its very low greenhouse gas emissions (from mining to waste disposal) as contrasted to those from conventional power stations which could lead to a global temperature rise of 2 degrees to 5 degrees celcius (less at the equator and more at the poles). It may be mentioned that the present 440 nuclear reactors are saving 600 million tons of carbon every year (twice the total amount estimated to be avoided by Kyoto Protocol by 2010)

Keeping such prospects of nuclear power in mind, a World Nuclear Association (WNA) has been formed in 2001 with member companies involved not only in the construction of nuclear power stations but mining, conversion, enrichment and fabrication of nuclear fuel.

According to John Ritch, Director General of WNA, not only fossil supplies may simply be inadequate to meet world energy needs, but a massive shift towards nuclear power is now environmentally indispensable. The technology has matured for safe operation and feasible waste disposal, while efforts could be made for internationalization of the nuclear fuel cycle and a progress towards a "carbon-constrained" economy should make nuclear power increasingly attractive.

Present electricity situation

As nuclear power can only contribute to the electricity generation part in the power supply system, it may be worthwhile to recollect the present electricity generation current base case. A rationalized electricity consumption, better management of peak demand and improvement in the end-use efficiency could reduce the need for new addition by 3000 MW. Natural gas could thus be saved further, but this would still mean that production of coal should be over 10 million tons per year by 2015 and 40 million tons per year by 2025 (assuming 50% export of coal) for power production only, which appears ambitious.

Even then, this low generation target in 2025 will be less than the present per capita power production in India or Pakistan. Beyond 2025, it will be harder to maintain the electricity growth target. It is, therefore, vital for the country to look for alternative fuel for power production and nuclear power technology is at our doorsteps.

It may be noted that it takes in long time to complete a nuclear power station (5 years). Starting with a modest nuclear power station of 600 MW (to supply power from, say 2011- 2012), the target could be to produce 15% of electricity from nuclear power by 2030.

At present (2004), 22 countries in the world consume more than 15% of nuclear electricity (Table 1). Nuclear power stations are usually situated in a load dispatch centre and act as a base load station (above 85% plant factor) and should thus provide reliable electricity in a grid system.

The present peak load generation, which is stated to be about 4500 MW (draft background document of National Energy Policy, March 2006) is fluctuating due to faulty performance of individual power plants, many of which are too old and should be replaced. The power sector reform road map aims to accommodate 8% growth in electricity generation with a 25% reserve margin, encourage private sector power development and improve the sector performance. The present estimate of base peak generation in 2025 is about 20,000 MW to produce over 100,000 GWh of electrical energy.

If natural gas is used for power generation at the present rate, this would result in complete depletion of existing reserves within 10-12 years. A generation mix of coal-fired power generation (1500 MW in 2015 and about 10000 MW by 2025) could substitute 124 million tons of coal for 2.3 tcf of gas and would halve the annual natural gas consumption.

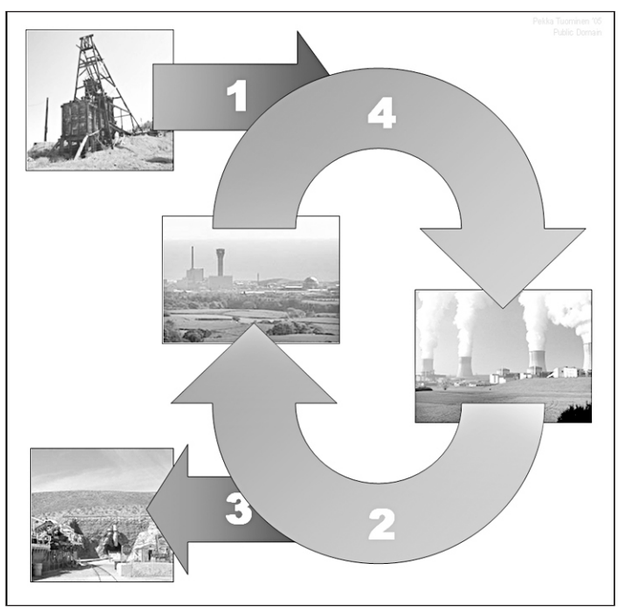

Diagram demonstrating the nuclear fuel cycle.

History of nuclear power in Bangladesh

Nuclear power in Bangladesh may be termed as a story of missed opportunities. Not long after the first nuclear power station was built in UK, the then government started feasibility studies for possible nuclear power in Bangladesh in 1961. The International Atomic Energy Agency supported such a possibility in 1962 and an US firm recommended the setting up of a 50 MW(!) station in 1963.

Soon, tender was floated for such a station and simultaneously, a site along the Padma River, measuring 262 acres of land in Rooppur and another 12 acres of land, a few miles away for residential colony were acquired. Although the tender response was good with three proposals for a boiling water or a pressurised water (BWR/PWR) reactor of size 67-70 MW costing only Rs. 12.26 crore.

The project was abandoned because the expected US aid was not available. Since then many other projects proposals, including one from the Soviet Union (offered by Prime Minister Mr. Kosygin himself) in 1968 and a private sector offer from Belgium in 1969 were not considered for various reasons by the government.

After liberation, due to urgent pressing problems at home, nuclear power was not considered until Bangladesh Atomic Energy Commission (BAEC) was constituted in 1973. Following this, a fact-finding mission was sent to Europe. After considering their report, which recommended three alternatives (from 125 MW to 600 MW plant), Bangladesh government decided go for a 125 MW French power reactor with a Japanese turbo-generator. Although the project was approved by ECNEC in 1980 at a cost of Tk 603 crore, it could not be taken up for want of necessary funds. Instead, a 3 MW(t) research reactor was set up in Atomic Energy Research Establishment (AERE), Savar.

Following Chernobyl accident, adverse international opinion started building up against nuclear power in spite of which an attempt was made for a nuclear power station in late eighties. A feasibility study was conducted by Motor Columbus (Switzerland) and Lahmeyer International (Germany) and they recommended a combination of three small and safe power reactors (each of size 80 MW) fuelled by a conglomeration of small, tennis-ball sized uranium dioxide kernels developed by Germany. The project was again abandoned for want of funds. The Bangladesh government, however, continued to support a nuclear power program and formed a high-level implementationcommittee in preparation for nuclear power. A Nuclear Safety and Radiation Control Act was passed by the Parliament in 1993 and collaboration with IAEA continued.

Table 2

Comparative costs estimates from recent studies

	MIT a	University of Chicago b	Royal Academy of Engineering c	DGEMP France d	METI Japan e	CERI Canada f	NEA/IEA g
Levelized Cost	euro cents/kWh h	euro cents/kWh	euro cents/kWh	euro cents/kWh	euro cents/kWh	euro cents/kWh	euro cents/kWh
Nuclear	5.2	3.2-5.5	3.3	2.8	3.8	3.4-5.8	1.6-5.3
Coal	3.3	2.6-3.2	3.6-5.0	3.2-3.4	4.1	3.1-3.8	1.2-5.3
natural gas	2.9-4.3	2.7-3.5	3.1-4.0	3.5	4.5	4.7-4.9	2.9-5.0
Oil					7.8		
hydropower						3.1-18.8	
Poultry litter		9.7					
Onshore Wind			5.3-7.7				2.4-11.2
Offshore Wind			7.9-10.3				4.0-9.5
wave/marine		9.4					
solar PV							9.4-145.4
Overnight Cost i	euros/kW(e)	euros/kW(e)	Euros/kW(e)	euros/kW(e)	euros/kW(e)	euros/kW(e)	euros/kW(e)
Nuclear	1550	930-1395	1642	1413	2026	1525-1931	832-1945
Coal	1008	916-1132	1042-1171	1000-1100	1975	1040	557-1819
natural gas	388	388-543	428	505	1191	462	329-1001
Oil					1953		
hydropower							1194-5413
Poultry litter			2628				
Onshore Wind			1057				756-1266
Offshore Wind			1314				1269-2032
Wave/marine			1999				

a.The Massachusetts Institute of Technology, *The Future of Nuclear Power,* The Massachusetts Institute of Technology, Cambridge, Mass., USA (2003)

b.The University of Chicago, *The Economic Future of Nuclear Power*, The University of Chicago, Chicago, Illinois, USA (2004)

c.The Royal Academy of Engineering, *The Cost of Generating Electricity*, London, UK (2004)

d.General Directorate for Energy and Raw Materials (DGEMP), French Ministry of the Economy, Finance and Industry, Paris, France (2003)

e.Ministry of Economy, Trade and Industry, Tokyo, Japan (2004)

f.Matt Ayres, Morgan MacRae and Melanie Stogran, *Levelised Unit Electricity Cost Comparison of Alternate Technologies for Baseload Generation in Ontario*, Canadian Energy Research Institute (CERI), Calgary, Alberta, Canada, 2004

g.Nuclear Energy Agency and International Energy Agency, *Projected Costs of Generating Electricity: 2005 Update*, Organisation for Economic Co-operation and Development, Paris, 2005

h.The levelized cost of electricity is the price at the busbar needed to cover the operating plus annualized capital costs of a power plant. National currencies used in different studies have been converted to euros.

i.The overnight cost is the amount that would be paid out if all capital expenses occurred simultaneously. It includes no interest charges.

Present situation

In view of the failure of the past nuclear projects, mainly for lack of funds, IAEA had recommended that Bangladesh should try for implementation of nuclear power projects by private sector, who could organise both technology and funding for an IPP project. The recovery of the cost will be made through a power purchase agreement (PPA) with an agency of the government.

Keeping private sector entrepreneurship in mind, an IAEA mission visited Bangladesh in 1997 when a time bound action plan for pre-implementation phase of the first nuclear project was defined and several follow-up actions were taken. A training workshop for nuclear power project planning was held in Dhaka in 1999. This was not only the largest training program focused on a country but extra-budgetary funds of the agency was made available for it.

Further, an expert group meeting in Vienna was convened in which a draft National Nuclear Power Action Plan for Bangladesh was reviewed. IAEA agreed to provide assistance for training of manpower, evaluation of an updated site report as well as the preparation of a Request for Proposal (RFP) document. A revised Site Safety Report (especially considering low surface water in Rooppur, as at present) and a comprehensive "Bid Evaluation Document" comprising of technical and financial offers for the implementation of the project on a BOO or BOOT basis have been prepared by BAEC. IAEA has been wanting a stamp of priority by the government before the RFP could be sent to pre-qualified manufacturers. This is awaited for some years now.

A comparative cost estimate for nuclear power vis-a-vis cost from other means is given in Table 2. It may be seen that except the estimate made by M.I.T., all other studies favour nuclear power. Because of recent interest in nuclear power, uranium market price has gone up, but this will make a small difference in the cost of power production as fuel plays a small part in estimating generation cost. It is, therefore, necessary to complete the uranium purchase for the whole period of nuclear power operation (easily 30 years).

Final analysis and recommendation

Bangladesh has gone a long way in getting ready for nuclear power. Manpower has been trained, radiation safety bill has been passed, land for the first nuclear power station has been acquired, many feasibility studies have been made. Energy policy has clearly stated the necessity for energy security and keep all options for power production open.

Bangladesh has impeccable credential for non-proliferation, which are manifested in signing of NPT (Nuclear Non-proliferation Treaty), Comprehensive Test Ban Treaty (CTBT), Safeguards Agreement, Protocol Additional to the Safeguards Agreement and Bilateral Agreements on peaceful uses of atomic energy with different countries.

IAEA has always supported Bangladesh in her search for nuclear power and will provide more help in implementing a nuclear power program. The fear of nuclear accident, as happened in Chernobyl, is receding with safer designs for nuclear power reactors. The initial cost, though high, will still produce electricity at a comparable generation cost. Problem of waste disposal has also its solution.

If political will is there, the opponents of nuclear power will honour the will, as long as commitment to peaceful uses of atomic energy remains and sufficient precautions have been made for safety and safeguards. After all, 75% of electricity in France is generated from nuclear power stations and there is no dearth of nuclear fuel in the world, with prospect of endless new fuel from fast breeder reactors.

It is therefore, recommended that instead of waiting to obtain foreign aid for constructing a nuclear power station (preferably 600 MW), which would cost about $1 billion, international bids should be invited, as per suggestion of IAEA and in collaboration with them, so that joint evaluation can also be made. The prospective bidders, ready with new designs for nuclear power are eagerly a waiting for such a call.

For financiers, a large project, with assured return (and it will be so for a power station), is preferable to many smaller projects. Land is available and many other preparatory studies have already been made by BAEC. The developer has to arrange fuel for the entire period of operation of the power reactor and take back the burnt fuel so the Bangladesh does not have the problem of the main waste disposal.

If Bangladesh is to get out of the chronic power shortage problem and look for energy security, entry into a long term nuclear power program should not be delayed any more and decision has to be made by Bangladesh and not other countries. Safety and safeguards issues can be dealt with by BAEC and IAEA.

Dr. Anwar Hossain is Chairman, Bangladesh Atomic Energy Commission.