70 years of Independence

Special Feature – I-Day 2017

India's Atomic Energy Programme

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India entered the atomic age, more correctly the nuclear age, on 4th August 1956 when Apsara, India's first nuclear reactor, went into operation. This reactor was designed and built by India with the nuclear fuel supplied from the United Kingdom under a lease agreement. Our second reactor for research purposes, CIRUS, was built with cooperation with Canada and went into operation in the early 1960's. The research reactors were platforms for conducting research in neutron physics, studies in the behaviour of materials under neutron irradiation and for production of radio isotopes. The latter are very useful for diagnostics and treatment of various ailments, especially cancer, and also very useful in industrial applications, especially for the purpose of non-destructive testing.

Electricity production using nuclear energy commenced in October 1969 when the two reactors at Tarapur were put into service. The Tarapur Atomic Power Station (TAPS) was built by General Electric of USA and is now in its forty-eighth year of service. Tarapur supplies the lowest cost non-hydro electric power in the country. India's second nuclear power station came up in Rajasthan, near Kota, the first unit of which went into operation in August, 1972. The first two units at Rajasthan were built in collaboration with Canada, who pioneered reactors that could use natural uranium as fuel. They, however, required heavy water, present in extremely small quantities in ordinary water and can be extracted through complex processes.

India's third nuclear power station came up at Kalpakkam, near Chennai. This station was designed and built by India, on its own. All the material and equipment were produced in the country. This was a huge challenge as Indian industry at that time, had no experience in making complex equipment required for nuclear applications. Special materials like nuclear fuel, zirconium components and heavy water production required extensive work in the laboratories of the Bhabha

Atomic Research Centre (BARC). Pilot plants were built and later scaled up to industrial plants. Industry had to be trained in special manufacturing processes and novel quality testing procedures introduced. Thus, when the first unit of the Madras Atomic Power Station (MAPS) started up in July 1983, India joined a small group of countries which could design and build nuclear power units on their own.

Our fourth nuclear power station came up at Narora, on the banks of river Ganga. This site has experienced earthquakes in the vicinity. So we evolved designs capable of withstanding any foreseeable earthquake that could visit the site. We also standardized the design of a 220 MW unit that could be built at a number of sites in the country. The first unit of Narora started up in October 1989. In the next twenty years, India built and commissioned eleven 220 MW units and two 540 MW units, all based on its own technology called 'Pressurised Heavy Water Reactors'. To accomplish this task, India also built up a strong heavy water production capability and fuel production, including mining of uranium in Jharkhand. Indian industry was mobilized to produce the entire range of equipment and materials to support the nuclear power programme.

Since India was keen to augment the nuclear capacity rapidly, it entered into a collaboration with the former Soviet Union in 1988 to build two 1000 MW reactor power units using enriched uranium as fuel. Due to the implosion of the Soviet Union in 1990 and the economic difficulties India faced at the time, the Indo-Russian project was put on the back burner. In 1998, India and Russia decided to embark on this project, and work at site commenced in 2003. When the commissioning activities on the first unit were in progress, the accident in Fukushima, Japan, occurred in March 2011. This triggered a strong opposition to the project amongst people living in the neighborhood. It took considerable time and patient explaining to inform the public at large about the safety features at Kudankulam and also how the site conditions there were completely different from those at the Japanese site. The first unit at Kudankulam went into operation in 2014 and the second in 2016.

India now has twenty-one reactor units in service. The first unit at Rajasthan supplied by Canada has been out of service due to some equipment deficiencies. The other units with a total capacity of 6700 MW have been operating reliably. The plant load factor for the five years from 2011 to 2016 has been about 78%. The nuclear power units have been supplying power at Rs. 2 to Rs. 3.50 per kwh (Kilowatt hour). In fact the cost of power from Tarapur has been less than Rs. 1/kwh. For Kudankulam units 1 and 2, it is about Rs. 4 per kwh.

The cost of installing Indian designed and built nuclear power unit is about Rs. 16.5 crores/MW. For the Russian reactors, the cost is about Rs. 22 crores/MW. Since the fuelling cost of the Russian reactors is lower than those of the Indian reactors, both of them produce power at about Rs. 5/kwh. This cost, when escalated to the time horizon of 2023-24, will come to about Rs. 6.5 per kwh. Coal based power in regions far away from coalfields would cost more in the same time horizon. Solar power for recent projects costs about Rs. **2.5/kwh**, but an expenditure of Rs. 2 /kwh is needed to connect the solar units to the grid system, taking the total cost to **Rs. 4.5/kwh.**

India signed cooperation agreements with the USA and France in 2008 and they provided for building nuclear power units designed in these countries to be set up in India. Negotiations have been going on from then on. However, the leading nuclear power plant builder in the US, namely Westinghouse filed for bankruptcy a few months ago. AREVA of France lost a lot of money on their nuclear fuel business following the Fukushima accident. The French government allocated the nuclear reactor business to their national electric utility, Electricite' de France. There is considerable uncertainty, therefore, with regard to cooperation with USA and France.

Given this scenario, the Government of India decided to build ten India designed 700 MW Pressurized Heavy Water Reactors in June 2017. The Nuclear Power Corporation had scaled up the 540 MW size units to 700 MW and started work, two at Kakrapara (Units 3 and 4) and two at Rajasthan (Units 7 and 8). This is one of the biggest single commitments in nuclear power, after the Fukushima accident of 2011. This programme will provide Indian industry with sustained workload for a period of a decade and establish India firmly as an important player in this field.

Work has commenced on Units 3, 4, 5 and 6 at Kudankulam. Russia has offered to build six 1200 MW units at a second site to be identified by India. As a parallel activity, India has designed the 'Indian Pressurised Water Reactor' of 900 MW capacity, using enriched uranium as fuel. Work on two such units may be taken up soon, to be followed thereafter by series building. At Kalpakkam, the Prototype Fast Breeder Reactor of 500 MW is in the process of commission. Two reactors of 600 MW of similar design may follow. The Bhabha Atomic Research Centre has completed the design of a 300 MW reactor called 'Advanced Thermal Reactor' which would use thorium. Our long term plans to use thorium depend on fast reactors and thorium based systems.

Not elaborated in this article are activities in the field of research, reprocessing of spent fuel, development of accelerators and so forth. The department of Atomic Energy has been actively engaged in supplying radio isotopes to hospital and industry, in the use of radiation technologies for preventing spoilage of marine foods, spices and for enhancing the shelf life of onions, mangoes and other food articles, as well as in sterilization of medical products.

We may thus foresee, in the decades ahead, nuclear energy making an important contribution as carbon-free energy, and nuclear technologies offering benign solutions in enhancing the quality of life of our people.

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Views expressed in the article are author's personal.

(The feature has been contributed by PIB Chennai)

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