RESOURCE PAPER - 11

INDO-JAPAN CHAMBER OF COMMERCE & INDUSTRY

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**L.V. Krishnan**
Former Director,
Safety Research & Health Physics Group,
IGCAR, Kalpakkam.

# PREFACE

Nuclear power is the fourth largest source of electricity in India - after thermal, hydroelectric and renewable sources of energy. As of 2016, India has 21 nuclear reactors in operation in 7 nuclear power plants and 6 more reactors are under construction which are expected to generate an additional 4,300 MW.

The Resource Paper on Indo-Japan Civil Nuclear Cooperation is an effort by the Indo-Japan Chamber of Commerce and Industry (IJCCI) to enlighten the discerning readers about the developments made by India-Japan recently.

Mr. L.V. Krishnan, the author, carries with him four decades of rich experience in the Atomic Energy programme of India and was associated with the safety evaluation of nuclear facilities and the field of radiation protection, also known as Health Physics. He was the Director of Safety Research and Health Physics Programmes in the Indira Gandhi Centre for Atomic Research, Kalpakkam, which focuses on development of fast reactors. Mr. Krishnan continues his professional interests as part of the Centre for Study of Science, Technology and Policy (CSTEP) and the National Institute of Advanced Studies, both in Bengaluru.

We hope this Resource Paper will create more interest among readers to know about civil nuclear energy and the cooperation between India-Japan in this field.

5th March 2017

**Suguna Ramamoorthy**
Secretary-General

# Indo-Japan Civil Nuclear Cooperation

The International Atomic Energy Agency, IAEA, recognises both India and Japan as advanced nations in nuclear technology. Soon after the demonstration of nuclear energy as a source of electricity sixty years ago, the two initiated a programme to develop indigenous capability. But there is a difference in how they achieved results and in the present state of the technology in the two countries. That provides a context for the civil nuclear cooperation agreement they recently signed.

Japan's all-round progress was far quicker because its political alignment provided easy access to nuclear technology and related materials. Rapid economic growth provided the necessary funds. The government's policy of allowing Electricity Utilities to build and operate nuclear reactors was a facilitating factor. Japan built

fifty-four operating reactors that run on enriched uranium fuel and use water as coolant. These are known as Light Water Reactors (LWRs). They are large in size, each generating about 1000 MW of electricity. They produced about a third of the country's electricity needs. Japan was ranked third among countries producing nuclear electricity in the world, behind the US and France.

The Great East Japan Earthquake of March 2011 and the tsunami that followed, changed all that. Four reactors in Fukushima were irreparably damaged. Negligence in safety matters was said to be the cause. But ten others on the same East coast of Japan shut down safely. As a result of the environmental radioactive release from the damaged reactors, several thousand citizens had to move out of their homes in the vicinity of those reactors. Many have been unable to return. Effectiveness of safety regulations for all reactors came under question. The Government instituted a new Nuclear Regulatory Authority (NRA) for more rigorous enforcement of safety. This, and public fear of possible recurrence of a similar accident in a reactor led to total shutdown of all nuclear power plants.

Meanwhile, Japan has had to import natural gas to produce electricity to make up for the lost supplies from nuclear power stations. While Japan could manage to do so quickly enough, the cost has been dear. Its trade surplus took a big hit, diving from the earlier surplus of $38 billion to a deep deficit of $115 billion. The people and the government have acted admirably in accepting the situation and taking countermeasures. Electricity has become expensive, but people have put up with it. Measures to increase

energy efficiency and reduce consumption have also helped. But, the nuclear industry including Utilities running reactors have lost sources of revenue. Utilities are awaiting the newly formed Nuclear Regulatory Authority to clear restart of reactors after safety checks. The government is considering a downward revision of the earlier plans for nuclear power. Firms manufacturing components for nuclear plants will therefore, have to look for opportunities outside the country. On its part, the Government appears to have recognised the need. Since the accident in the Fukushima reactors in 2011, Japan has concluded Nuclear Cooperation Agreements ( NCA) with several countries including South Korea, Vietnam, Jordan and Turkey. The latter three have expressed plans for nuclear power stations with outside help. The nuclear industry expects new contracts.

For India, the programme began with assistance from the US and Canada in building four reactors. But shortly after, the door closed on access to technology and materials, due to India's decision not to sign the Nuclear Non-Proliferation Treaty (NNPT) and to test a nuclear device. Since then, on its own India has developed the capability to design, build, operate and maintain nuclear reactors described as Pressurised Heavy Water Reactors (PHWRs) that are based on natural uranium as fuel and heavy water as coolant. Sixteen of these reactors are now running, but they are of a modest 220 MWe capacity and contribute about 3% of electricity generated in the country. Four larger ones are under construction and several more are planned.

Japan is able to import uranium from several countries. India's uranium resources are presently not sufficient even to meet the

needs of the reactors operating now. With plans to build more of them, it had to look for outside sources of supply and received help from the US in this context. India offered reactors for inspection by IAEA, in what is known as an India-specific Safeguards Agreement. The Nuclear Suppliers Group (NSG) then exempted India from restrictions on civil nuclear trade imposed on non-NPT countries and the US signed a Nuclear Cooperation Agreement (NCA) with India. Following this, India signed NCA with other countries including Australia and Canada, which are uranium producers.

These developments were instrumental in the culmination of an NCA between India and Japan signed in November 2016 after many years of negotiations. It will take effect after it is voted on by the Diet in Japan. This Agreement is noteworthy in some respects. India is the third non-signatory State of NNPT with which Japan has signed the NCA, the others being France and China. But these two signed the NNPT long after the agreement. The Indo-Japan NCA justifies the description as a full agreement, as it covers the complete spectrum of non-weapons applications and includes exchange of experiences in nuclear security matters of mutual interest.

India is allowed by the Agreement to reprocess within its territory, any by-product of material supplied by Japan under IAEA safeguards. It means that India can reprocess spent fuel from plants with Japanese inputs and recover residual uranium and plutonium as long as it is done within India. India's NCA with other countries has similar provision. Besides, the NCA with Japan allows India to enrich uranium transferred under this

agreement and specifies an upper limit of 20%. At the same time, the two Governments have been having consultations on Nuclear Non-proliferation and Disarmament. The fifth one was held in August 2016.

Article 9 specifically asks for implementation of the Agreement in a manner to facilitate nuclear trade between the two, with neither attempting to secure commercial advantage or to interfere in the commercial relations of the other party. This recognises that there are offers to India from different quarters to set up nuclear plants and also that India may be a potential exporter of nuclear reactors.

In 2000, Japanese Prime Minister Mr. Yoshiro Mori on a visit to India signed a 'Global Partnership' with India. Since then, the relations between the two countries have got closer leading to the signing of a 'Global and Strategic Partnership', when Prime Minister Manmohan Singh visited Tokyo in 2006. More recently in 2014, Prime Minister Mr. Narendra Modi signed a 'Special Strategic and Global Partnership' in Tokyo. It is no surprise therefore, that the Agreement in the Preamble expresses the desire to strengthen the Special Strategic and Global Partnership between the two countries.

In what may be seen as an exception, the Agreement has been given a forty-year life if all goes well, with automatic renewal for a ten-year period at a time. Clearly, both countries expect the relationship between them to be an enduring one. Other Agreements recently signed by Japan specify a life of 10-25 years.

Considering the keenness of both parties in making the NCA a reality, we may expect its entry into force to be smooth. There are benefits for both. India has been planning to build a series of large LWRs. India, like Japan, faces difficulties in finding public support for suitable sites. It is therefore an advantage to generate more power at a given site with LWRs of 1000 MWe as against the current PHWR design of 700 MWe. While India is currently developing an indigenous LWR design of 900 MWe, there are offers from other countries to build them here. Barring the many Russian LWRs being built in India, the others that are proposed depend considerably on supply of major components from Japanese manufacturers. The NCA with Japan removes any possible hurdles for such supplies.

Japan has accumulated a large stock of plutonium, about 40 tons, recovered from used nuclear fuel. With no domestic uranium resource, Japan has plans for plutonium fuelled fast reactors in the longer term. A test reactor was built and operated for over two decades. A Prototype reactor for power generation was also commissioned, but experienced two accidents. They involved no release of radioactive materials, yet led to public concerns. In deference, the reactor was scrapped without raising power, though the local Government was not for it. Work continues on development of an advanced design that is compact and can burn plutonium. The Strategic Energy Plan published in 2014 includes R&D on fast reactors in association with France and the US, which are likewise engaged.

From the very beginning, India's plan was for fast reactors in the second and third stages following the PHWRs. India has made

significant advances working all by itself. After trouble-free operations of the Fast Breeder Test Reactor, a Prototype Fast Breeder Reactor of 500 MWe is to be commissioned this year at Kalpakkam. Two more have been sanctioned. India's plutonium stock is very small in comparison, and production is quickly converted as fuel for reactor.

Both India and Japan consider fast reactors to be important. They are good for energy security and for eliminating long-lived radioactive species in spent fuel. Japan's plutonium is not of weapon grade, nevertheless storing it is a security burden. Japan plans to use it up as fuel in fast reactors. India, sees plutonium fuelled fast reactors as a path to thorium utilisation.

For some years in the near future, India and Russia will remain the only operators of power generating fast reactors that could also be used for testing new fuel and equipment. China is seeking the help of Russia to draw even. There is great potential for India and Japan to cooperate in establishing a safe and reliable fast reactor programme in addition to the building of Light Water Reactors.

India also needs to watch and learn from the efforts of Japan in winning public acceptance for restart of the shutdown reactors.

Nuclear reactors are a source of uninterrupted supply of electricity over most of the year, with low fuel cost. A single nuclear reactor of 1,000 MW capacity can generate in a year 3.5 times as much electricity as a solar park of the same capacity. Nuclear reactors have a much longer life than solar plants and offer a sound return on capital invested, after an initial waiting period. Eternal vigilance is the price for their safe operation.

Large scale dependence on solar plants warrants a detailed study of the environmental impact of the chemicals used in panel production and storage batteries.

Neither India nor Japan can afford to disregard any practical source of energy including oil, gas and coal. They wisely pursue active programmes to increase the share of renewable sources of energy. They have had eight Ministerial Dialogues so far on coal and renewable sources of energy. Nuclear power too is inevitable from considerations of energy self-sufficiency and carbon emission reduction. The NCA is a great step forward in this context.


**INDO-JAPAN CHAMBER OF COMMERCE & INDUSTRY**

No. 21, Kavignar Bharathidasan Road, Teynampet, Chennai - 600 018.
Tel: 91-44-2435-2010 / 2435-4779, E-mail: indo-japan@ijcci.com Website: www.ijcci.com