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INDIA'S CIVIL NUCLEAR POWER PROGRAMME: A GLIMPSE INTO THE FUTURE

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Civil nuclear energy has always been an important facet to India's energy basket. Over the last ten years, there has been a drastic expansion in India's civil nuclear power programme owing to various reasons. First, India is on a path of steady economic growth with its Gross Domestic Product (GDP) consistently rising at a rate of 7-8%.[1] The common discourse on a country's economic growth is its correlation to energy requirements. The basic assumption is that the rate of economic growth is directly proportional to the growth of energy requirements. Second, global warming and drastic climatic changes have created a global resurgence for a more immediate need of clean sources of energy. According to a *World Resources Institute* report, India ranks third, after China and the United States, on the global greenhouse gas emitters' graph.[2] Civil nuclear energy, in its resurgence in the global south, can therefore be a game changer.

India is currently on a path of expanding its civil nuclear power programme on a massive scale, perhaps, second only to China's ambitions. After years of isolation from the global nuclear commerce, India had a daunting task of developing indigenous civil nuclear technology, coupled with a strategy to push for international cooperation with the global nuclear commerce. Recent trends have also indicated that India is becoming a leader in the closed Nuclear Fuel Cycle.[3] To summarise, India has developed an innovative closed nuclear fuel cycle, which uses a three-stage Nuclear Power Programme. The first stage involves the using of indigenous uranium in Pressurised Heavy Water Reactors (PWHRs), which produces energy and also fissile plutonium as by-product. The second stage involves Fast Breeder Reactors (FBRs), by reprocessing the spent nuclear fuel and using recovered plutonium. The non-fissile depleted uranium and thorium can breed additional nuclear fuel, plutonium and Uranium-233,

respectively. In the third stage, thorium, which India has in abundance, and Uranium-233 based nuclear reactors have been slated to meet India's long-term energy requirements.[4] Theoretically, it would be in this stage that India is believed to have the potential in becoming self-reliant in generating power via atomic energy.

Currently, India has 21 nuclear power plants with an installed total capacity of 5,780 MW.[5] The second unit of the Kudankulam Nuclear Power Plant will become operational in December 2016which will increase the country's total generating capacity to a total of 6,780 MWe. India stands as one of the forerunners in the development of indigenous technology for nuclear power generation with 14 out of its 21 reactors having been built indigenously. Though India started its nuclear programme nearly 50 years ago, the power production is still limited. The existing plants do not have the capacities large enough to bridge the gap between demand and supply of energy quick enough. Yet, India is looking at an ambitious plan of generating 25 per cent of its energy from atomic power by 2050. While it is premature to assess India's future trajectories, current trends have indicated that India is on a productive route towards expanding its nuclear power programme.

Presently, there are five nuclear reactors under construction under the Nuclear Power Corporation of India Limited (NPCIL). One is Unit-2 in Kudankulam (KKNPP) which uses a Russian-made VVER-1000 Pressurised Water Reactor with a capacity of 1000 MW. The expected date of commercial operation has been set between December2016- January 2017. Another two reactors will be Unit-7 and 8 of the Rajasthan Atomic Power Station (RAPS). Two Pressurised Heavy Water Reactors are under construction at Rawatbhata, Rajasthan. Both reactors have a capacity of 700 MW. The first reactor was expected to become commercial in June 2016 and the second in December 2016. However, these deadlines have not been met. Two more reactors are being set up at the Kakrapar Atomic Power Station (KAPS). The reactors are of Pressurised Heavy Water Reactor type also having a capacity of 700 MW each. This will contribute 1000MW at KKNPP, with 1400 MW at both RAPS and KAPS, with a total of 3800MW, which would take India's nuclear power generation capacity to 9580 MW, if the procedures are executed accordingly.

India is also developing its own Prototype Fast Breeder Reactor (PFBR) under Bharatiya Nabhikiya Vidyut (BHAVINI) Nigam Limited that is believed to be in "advance stage of commissioning."[6] This would be a boost to initiating India's second stage of its three-stage nuclear power programme. "FBR requires highly sophisticated and extensive analytical capabilities in core physics, radiation shielding, thermal-hydraulics, structural mechanics and safety. Such capabilities have been developed at IGCAR during the last decade."[7] The Prototype

Fast Breeder Reactor has a capacity of 500 MW and its "components have been installed successfully."[8] The emerging transition into the second stage, which appears to be under process, is another positive indication for India's nuclear power programme. This could perhaps make projections of meeting energy security more viable. This has certainly demonstrated the success and maturity that India has achieved in terms of its civil nuclear programme, particularly in the fields of research, design, developments and commercialisation of nuclear energy. Presently, and the future prospect that lay ahead for India is the research and development on the planned Fast breeder Reactors for the second stage. Yet, there is work that needs to go into the usage of thorium in the third stage of the programme that would meet India's long-term energy requirement.

Considering the current situation, the likely scenario for India's civil nuclear power programme, with its emerging capabilities, holds promise in the short-term projections. With an array of opportunities that have opened for India, it comes down to speculation as to how India will capitalise on them. With several obstacles, such as bureaucratic red tapes, India may need to look towards the future of its civil nuclear power programme with seriousness in terms of mitigating these problems. There appears to be several potholes including having enough man power, public perception, land acquisition, and so on, which the key policy community has not been able to manoeuvre around. A quicker approach to reaching decisions could be beneficial, particularly in site selection and outlining the type of reactors that would boost India's requirements at a pace that is much needed. India is following a dual approach in strengthening and expanding its civil, nuclear power network. It is investing largely in its indigenous efforts in Research and Development (R&D) in clean technology. For India to further augment its plans, stronger international cooperation would prove beneficial. India has been pushing its diplomatic limits to consolidate civil nuclear cooperation with foreign players including Russia, the United States, Japan, the United Kingdom, and so on.

However, recent trends have indicated that the already existing seriousness on the present discourse indicates positive prospects for short-term plans. As for India's long-term trajectory, in its nuclear power programme, the unfolding of its expansion would be most productive on a mixed approach of bilateral as well as multilateral cooperation in the global nuclear order, and intense indigenous research and development. To reiterate, the expectations that India would meet its ambitious goals has been expressed with optimism by key-policy makers, in terms of short term as well as long term projections.

(Disclaimer: The views and opinions expressed in this article are those of the author and do not necessarily reflect the position of the Centre for Air Power Studies [CAPS])

Notes

[1] "Economy and Growth Data", *The World Bank*, 2015, see http://data.worldbank.org/country/India. accessed on 17 November 2016.

[2] MengpinGe, Johannes Friedrich and Thomas Damassa, "6 Graphs Explain the World's Top 10 Emitters", *World Resources Institute*, 25 November 2014, see http://www.wri.org/blog/2014/11/6-graphs-explain-world%E2%80%99s-top-10-emitters , accessed on 18 November 2016.

[3] The various activities associated with the production of electricity from nuclear reactions are referred to collectively as the nuclear fuel cycle. The nuclear fuel cycle starts with the mining of uranium and ends with the disposal of nuclear waste. (World Nuclear Association)

[4] "Atomic Energy in India", *Pursuit and Promotion of Science: The Indian Experience*, (INSA: Bangalore), see http://www.iisc.ernet.in/insa/ch29.pdf, accessed on 17November 2016.

[5] 5 Plants Under operation, Nuclear Power Corporation of India Limited, see http://www.npcil.nic.in/main/AllProjectOperationDisplay.aspx. Accessed on 17November 2016.

[6] "Present Status of 500 MW Prototype Fast Breeder Reactor (PFBR)", BharatiyaNabhikiyaVidyut Nigam Limited website, see: http://www.bhavini.nic.in/Userpages/ViewProject.aspx , accessed on 17 November 2016.

[7] S. B. Bhoje, "Fast Breeder Reactor Technology", Department of Atomic Energy, Government of India, see http://dae.nic.in/?q=node/179, accessed on 18 Nnovember 2016.

[8] "Present Status of 500 MW Prototype Fast Breeder Reactor (PFBR)", BharatiyaNabhikiyaVidyut Nigam Limited website, see: http://www.bhavini.nic.in/Userpages/ViewProject.aspx , accessed on 17 November 2016.