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# Onward to thorium

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The start of fuel-loading into the 500-MWe Prototype Fast Breeder Reactor (PFBR) earlier this month is an important milestone that signifies the successful completion of a long journey of commissioning trials and rectification of a whole range of first-of-their-kind equipment that constitute the fast breeder reactor technology. We must congratulate BHAVINI, the company set up to build and operate the PFBR, the Indira Gandhi Centre for Atomic Research (IGCAR), the Bhabha Atomic Research Centre (BARC), and the industries involved for this achievement.

One now looks forward to the PFBR becoming operational, heralding India into the second stage of its three-stage nuclear power programme sooner rather than later. This is of singular importance for the long-term energy security of India. It opens the gateway to meeting our energy needs for a long time into the future, leveraging our vast thorium resources that are the largest in the world. There is no other clean energy source available on the Indian landmass that can cope with our energy needs. Renewable energy, including large hydropower projects, can at best meet current energy needs. To become Vikasit Bharat, India needs around three-and-half times more energy, which can come only from nuclear in general, and specifically thorium. How much progress we make towards becoming a developed country will, in fact, be determined by the level of nuclear energy deployment we make.

Much more work needs to be done going forward, however, before the thorium dream comes firmly within our grip. Technology matures with experience. There is always a learning curve that one must negotiate to reach a robust capability, as has been the case with the first stage Pressurised Heavy Water Reactors (PHWR) and many other technologies.

To consolidate sodium-cooled fast reactor technology, a key feature of the second stage of our nuclear programme, we must build a few more reactors on the PFBR model. Then, there is a question of growth of fast reactor capacity. While a high-enough rate of growth in the initial phase of
the second stage can be sustained through fuel fed from the first stage, one needs fast reactor systems with faster growth based on inherently better breeding performance.

From the mixed oxide fuel that the PFBR uses, therefore, we need to graduate to metallic fuel, along with the related fuel-cycle technology. Fuel recycling in fast reactors must be a concurrent process, unlike in thermal reactor systems. A Fast Reactor Fuel Cycle Facility (FRFCF) that would work alongside the PFBR is coming up. Once a sizeable fast breeder reactor capacity is built up and adequate inventory of uranium-233 starts accumulating, we must bring in reactors specifically designed for thorium and the related fuel-cycle facilities, which would constitute the third stage of our nuclear power programme.

One must realise that given the size of our population and our economy, our energy demands would be among the largest in the world, leading to serious challenges to our energy security. This is why thorium is critical. We have been dependent on energy imports all along. Thorium presents to us a unique opportunity to be energy self-sufficient.
We must move on the thorium path though it has no parallel anywhere else in the world.

Our pathway to realising the thorium dream has literally been a minefield so far. But the autonomous pursuit of our goals has been possible, thanks to the spirit of self-reliance ingrained by Homi Bhabha. The development
of critical nuclear technologies in the face of technology denial regimes is no mean achievement. Our three-stage strategy was designed to realise a large-scale thorium-based energy programme beginning with our modest uranium resources.

While that rationale remains valid, the need to decarbonise the energy supply, the largest contributor to the climate change-related existential threat we face, has created an immediate demand for large-scale deployment of nuclear power plants.

That obviously can only be done based on available and readily deployable technologies. Luckily, we already have them in the form of 700-MWe and 220-MWe PHWRs. We are also able to import uranium required to fuel them. While nuclear power deployment must be rapidly scaled up to decarbonise our power system, we must also recognise the potential for advancing thorium deployment.

The realisation of large-scale utilisation of thorium requires a large-enough operational fast reactor capacity as a prerequisite. But now that we can accelerate PHWR deployment based on imported uranium, it makes immense sense to advance thorium utilisation in the PHWRs and help advance the deployment of third-stage thorium reactor systems while also deriving advantages like shrinking spent-fuel inventory, proliferation-resistance, and improved safety and economy. This requires high-assay low-enriched uranium (LEU) and thorium fuel capable of delivering a seven-times larger fuel burn-up than currently with little or no change in the PHWR design. Such a fuel, named ANEEL, has been designed and is set to be available shortly. ANEEL fuel concept could also bring the Advanced Heavy Water Reactor, (AHWR300-LEU), a fully developed design immune to any severe accident-related anxiety, to reality.

Another area where thorium utilisation can be advanced with advantage is the high-temperature reactor that would be required to produce low-cost hydrogen with little carbon footprint. This has become a priority to decarbonise the industry and the heavy cross-country transportation sector. The technology and wherewithal for such an endeavour already exists. The sooner we make this technology available, rather than developing near-total dependence on hydrogen electrolysers, the better. Besides, direct production of hydrogen without having electricity in between would make hydrogen production cheaper.

The start of fuel-loading in PFBR, to my mind, is a significant milestone that must be celebrated to motivate our scientists and prepare them for the bigger tasks ahead. Our scientific community has time and again demonstrated their capability and delivered required technologies whenever they have been challenged, given clear policy directions and support. The comprehensive nuclear reactor and fuel-cycle development, the competitive first stage of our nuclear programme that is world-class and already in commercial domain, and several related achievements are testimony to this fact. Sustained encouragement, duly backed up by a demanding but conducive framework around them, is the need of the hour.

*(The writer is a former Chairman, Department of Atomic Energy)*

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