

## Small reactors can play a big role in India's push for clean energy

- *By Amitabh Kant and Adil Rana Chhina\**

As the world rapidly shifts towards a low-carbon energy landscape, India's pursuit to increase its Small Modular Reactor (SMR) sector aligns well with its broader vision for sustainable energy security. The recent government focus on SMRs signals a transformative approach to nuclear energy that addresses the unique geographic, economic, and industrial demands of the nation. By design, SMRs offer a smaller and more flexible nuclear solution with a power capacity of up to 300MWe and have the potential to play a pivotal role in the global reduction of carbon emissions. Their modular format allows for faster construction and scalable deployment across varied locations. They can also act as a flexible complement to renewable energy sources like solar and wind, addressing their intermittency. However, when it comes to nuclear power generation, several critical areas remain underexplored ranging from private sector participation to public perception, safety, and security. By approaching these areas strategically, India can leverage SMRs to drive a sustainable and secure energy future.

**Need for Private sector involvement:** India's nuclear energy sector has traditionally been restricted to state ownership and control, governed by the Atomic Energy Act of 1962, which prohibits private companies from owning or operating nuclear power plants. Currently, nuclear plants are owned and operated solely by public sector entities such as the Nuclear Power Corporation of India Limited (NPCIL) under the Department of Atomic Energy (DAE). In India, expanding private sector participation in the nuclear space, particularly with SMRs, could introduce competitive efficiency, accelerate project timelines, and foster the development of advanced nuclear technologies. Therefore, the Govt's pursuit to partner with the private sector for development of Bharat Small Reactors is a significant step in the right direction. Next steps will require the amendment of Atomic Energy Act to allow private companies to contribute to India's nuclear power sector. The Atomic Energy Commission should also aim to segregate the strategic and commercial nuclear sectors, framing a distinct policy for private sector regulation.

**Safeguarding against proliferation:** Any talk of nuclear power must address security concerns. Ensuring SMRs are proliferation-resistant—designed to prevent the diversion of nuclear materials for military use—is extremely vital for security. Unlike traditional nuclear reactors, SMRs can be deployed more widely, including in remote areas, increasing the importance of advanced safeguards. Proliferation resistance typically involves the use of sophisticated reactor designs that prevent the production of weapons-grade materials. It is therefore critical to introduce safeguards into SMR designs to decrease proliferation risk.

To address this, India could focus on innovative reactor designs that integrate proliferation-resistant features ranging from making spent nuclear fuel unattractive for

proliferation; sealed reactors; longer core lifetimes; and infrequent refuelling. To develop secure SMR models, India can work in close interaction with the International Atomic Energy Agency (IAEA). The need to prioritize non-proliferative SMR design and technologies is crucial so that India can align with global nuclear safety standards.

**Hydrogen Production and Desalination:** The applications of SMRs extend beyond electricity, opening new avenues for industrial use, particularly in hydrogen production and desalination. The demand for clean hydrogen is only set to increase and nuclear-produced hydrogen could significantly advance India's low-carbon hydrogen goals, offering a clean, consistent alternative to traditional fossil-fuel-based hydrogen production.

Clean hydrogen production involves electrolysis which needs ultrapure water as feedstock. One kilogram of hydrogen requires anywhere between 12 to 30 litres of water depending on the water source. In water-scarce regions, particularly along India's coasts, SMRs could support large-scale desalination, providing sustainable water solutions for hydrogen production. Co-locating industries near SMR sites can optimize these reactors' capabilities, delivering affordable clean energy for industrial processes and addressing water needs simultaneously.

**Nuclear Waste Management and Recycling:** Effective nuclear waste management is central to the responsible deployment of SMRs. Establishing a National Radioactive Waste Management Agency would centralize efforts to manage, recycle, and dispose of nuclear waste, enhancing both safety and public trust. For most SMRs using conventional light-water reactor (LWR) technology, existing waste management practices, including the use of spent fuel pools followed by dry storage, can generally be applied. However, other SMR designs will likely require research and development efforts to establish new waste management practices and disposal approaches. India must invest in responsible waste management and recycling to align with global best practices reinforcing its commitment to sustainable nuclear development.

**Nuclear Safety and Transparency:** Adapting India's nuclear regulatory framework to accommodate SMRs is vital for safe and efficient deployment given that existing regulations, designed for large reactors, may not fully cover the unique safety requirements of SMRs. A Nuclear Regulatory Innovation Office can be established within the Department of Atomic Energy which can enable more flexible, SMR-specific policies while ensuring safety. To ensure that SMRs are designed, manufactured, installed, operated and maintained according to appropriate safety standards, India must develop a comprehensive safety assessment methodology.

Public trust in nuclear energy hinges on transparency which in turn is a necessary part of accountability. Transparent regulatory processes and open communication will be

essential to India's nuclear success and would serve to strengthen public confidence in SMR technology.

SMRs present an opportunity to meet energy demands sustainably and establish India as a key player in the global nuclear industry. India must foster a culture of innovation and transparency which will enable the setting up of new standards in nuclear energy that not only power the nation but inspire the world toward a balanced and resilient energy future.

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