Can small modular reactors mitigate climate change?

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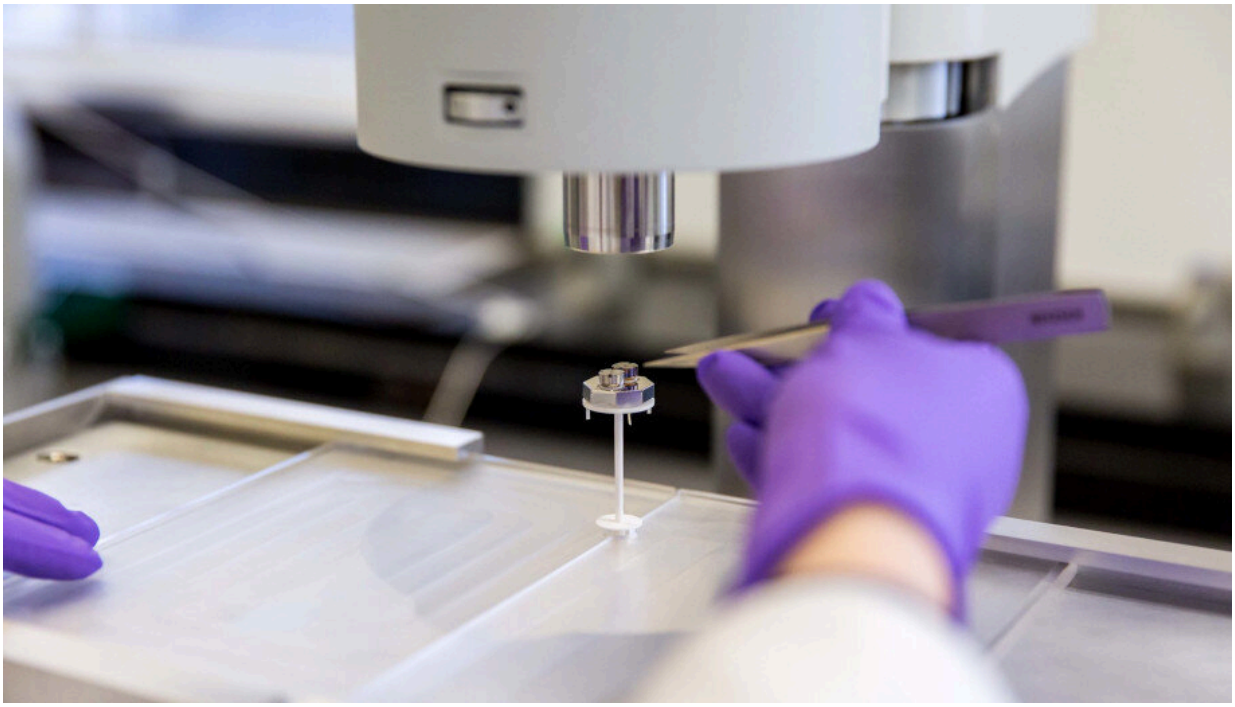

Research and development on small modular reactors and advanced reactors. Nuclear power is proposed as a greener alternative to fossil fuels. Credit: Canadian Nuclear Laboratories (https://flickr.com/photos/cnl_lnc/50827837168/), CC BY-NC-ND 2.0 (https://creativecommons.org/licenses/by-nd/2.0/)

As the world grapples with a climate emergency brought on by carbon emissions from the large-scale burning of fossil fuels, there is renewed

interest in nuclear energy, specifically in the new generation of small modular reactors.

The UN Intergovernmental Panel on Climate Change (IPCC) forecast in its Sixth Assessment Report, released 9 August, that global average air temperatures may rise by more than 1.5 degrees Celsius over pre-industrial levels by 2040. The latest report brings new urgency to cut emissions drastically.

Under the 2015 Paris Agreement all countries are required to set targets to help stay within the 1.5 degrees Celsius limit and work towards a carbon-neutral goal by finding alternatives to coal, oil, natural gas and other fossil fuels.

Of the many alternatives, small modular reactors—defined by the International Atomic Energy Association as nuclear reactors that are 300 megawatts or less in capacity (conventional reactors produce 1,000 megawatts or more) – win out for having minimal environmental footprint. They also take up far less space than conventional power plants or wind and solar farms that produce renewable energy.

Nanda Kumar Janardhanan, who teaches energy studies at the Jawaharlal Nehru University, New Delhi, and operations coordinator in South Asia for the Institute for Global Environmental Strategies, Japan, says that "unlike conventional large nuclear power facilities, which can take a decade or more to build and become operational, small reactors can be ready in a fraction of that time" as they are small enough to be manufactured in a factory and transported to the operating site.

"Countries that need clean energy supply can possibly use small modular reactors as an alternative to depending on environmentally damaging thermal power. This is one of the direct benefits that it offers towards climate mitigation," Janardhanan says. As the demand for hydrogen as a

fuel for transportation and industry grows, small modular reactors could also provide the energy needed to generate hydrogen, he adds.

"Despite these advantages, the wider usage of small modular reactors will demand a transformative change in safety measures so as to build public confidence and gain acceptance," says Janardhanan, referring to disasters like Chernobyl and Fukushima "which have led to anti-nuclear perceptions among certain societies or people."

Nuclear industry role

Nuclear power offers an opportunity to advance towards the Paris Agreement goals, says the World Nuclear Association (WNA). A white paper released on 27 May by the WNA suggests that the fear of risks associated with nuclear power have led to acceptance of fossil fuels despite causing millions of premature deaths from air pollution and contributed to climate change.

Reacting to the IPCC's sixth assessment report, WNA director-general Sama Bilbao y León, reiterated demands in the white paper that governments, regulators and industry work together to accelerate deployment of new nuclear projects, including small modular reactors, to help rapid decarbonisation.

Karthik Ganesan, fellow and director of research at the Council on Energy, Environment and Water in New Delhi, says Asia is one region where nuclear power capacity is increasing. "Developing Asia (China, India) and developed Asia (Korea and Japan), which already manage large civilian nuclear programs, must remain invested in small modular reactor technology," says Ganesan.

"But for the small modular reactors concept to succeed in Asia, it must satisfy the primary requirements of increased safety, simplicity in

construction and operation and be comparable in economic terms with conventional nuclear power plants," says Ganesan.

Other top experts are less sanguine about the prospects for small modular reactors playing a significant role in decarbonisation over the next decade.

"Humanity does not have the time to invest in small modular reactors—the climate problem is urgent," says M. V. Ramana, a physicist at the Nuclear Futures Laboratory, Princeton University, who works on nuclear power in the context of climate change and nuclear disarmament.

"Entire supply chains would need to be established after the first small modular reactors have been built, tested, and proven," Ramana tells SciDev.Net. "There is no realistic prospect that it can make a significant dent in the need to transition rapidly to a carbon-free electricity system."

In a paper published in July in the *Bulletin of the Atomic Scientists*, Ramana argues that nuclear power reactors that generate enough electricity to contribute to climate mitigation will need complex technologies to control the reactions and deal with products of radioactive fission.

Proliferation risks

Ramana is also concerned that since small and medium reactor projects typically involve clusters of several small reactor modules, there is a heightened risk of nuclear proliferation.

"Every reactor is a potential source of plutonium or enriched uranium or both—the more the number of nuclear reactors, the more the potential to make nuclear weapons. Anyone with access to these materials is that

much closer to a nuclear weapon," he says.

Like their larger counterparts, small modular reactors will also produce radioactive nuclear waste, the safe disposal of which is yet to be resolved satisfactorily. Ramana's paper says that the 1982 Nuclear Waste Policy Act in the US envisaged deep geological burial by 1998 but the US government continues to pay billions of dollars in fines for failing to take charge of spent fuel.

Such concerns have not stopped the development of small modular reactors. According to the International Atomic Energy Agency (IAEA), over 70 SMR designs are either under construction or being developed in 18 countries.

The world's first small modular reactor plant, located in Russia's remote Chukotka region, has been operational since 2019 December, while Argentina is developing a 25-megawatt plant, intended for small grids, according to IAEA. A small modular reactor plant in China's Shidao Bay is slated to begin operation in 2021.

India, which has an advanced nuclear power program with an installed capacity of 7,480 megawatts, has plans to develop small modular reactors partly based on its vast reserves of thorium, according to Sunil Ganju, a member of the nuclear controls and planning wing of India's Department of Atomic Energy.

Speaking at a February webinar on small modular reactors, organized by the India Energy Forum, Ganju said a 500-megawatt "protype fast breeder reactor" being developed at Kalpakkam, Tamil Nadu state, could be classified as a small reactor.

According to Janardhanan, the advantage of nuclear power is that it is a mature technology with a proven history of investment of millions of

research hours. "The fact that there is hardly any other mature technology available makes it important for clean energy supply."

Provided by SciDev.Net