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# Can nuclear SMRS meet Malaysia's baseload energy needs?

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Since September 2024, the government has expressed interest in reviving its nuclear energy ambitions to meet Malaysia's decarbonisation goals under the New Energy Transition Roadmap (NETR), with small modular reactors (SMRs) at the forefront of discussions.

SMRs are still not wholly commercially viable, however, and there is only a handful of greenlit projects globally. Against this backdrop, a key question emerges: Do SMRs represent Malaysia's green energy future? And, in theory, can this emerging technology meet the country's baseload electricity demand?

For Mohd Idzat Idris, associate professor of nuclear science and engineering at the Universiti Kebangsaan Malaysia (UKM), the short answer is "yes". "SMRs can be a viable option to support Malaysia's future energy mix, particularly in providing continuous baseload electricity and grid stability support — especially if it's used to complement renewable energy sources," he says.

Idzat adds that the strong interest in SMRs is largely driven by the need to address the intermittency of renewable energy sources such as solar.

He emphasises that meeting this baseload energy requirement is crucial, not only to ensure reliable and sustainable local energy supply, but also to support future economic growth, particularly as the government seeks to attract more energy-intensive industries such as data centres.

The rapid expansion of artificial intelligence, cloud computing and hyperscale data centres will significantly increase future electricity demand, particularly for a stable and continuous power supply.

Azrudi Mastapha, managing director of local SMR design company Clean Energy Xpeditions, is confident that SMRs could, in theory, meet Malaysia's baseload energy needs and replace fossil fuels.

"On average, SMRs are estimated to produce 300mw of energy, with some designs like the British Rolls-Royce producing 450mw. For comparison, a typical large conventional reactor (LCR) produces around 1,400mw, or 1.4gw, meaning it would take about four SMRs to produce the same amount of energy as a conventional one," says Azrudi.

He adds that the technology generates high-pressure steam to produce electricity by spinning a turbine; therefore, current fossil fuel plants can be converted into SMRs.

In addition, certain SMR designs can be integrated into existing coal plant infrastructure, potentially accelerating deployment timelines and enabling faster commissioning of new plants.

Idzat concurs, saying that a huge benefit of SMRs is that they can be connected directly to an existing grid infrastructure with less extensive upgrades compared to LCRs.

Senior professor at Universiti Tenaga Nasional and former nuclear engineer consultant Muhammad

Abdullah Rahmat is less optimistic, though.

Abdullah notes that the NETR projects Malaysia's energy demand to grow to about 97gw by 2050, with 30%, or 29gw, making up the baseload.

"Even if we halve that, that's 15gw of nuclear-powered installed capacity needed, which would require at least 50 SMRs. In these circumstances, SMR may not be the best option, as the resources needed in contrast to its generation output are not favourable," he says.

Last year, the Nuclear Energy Agency SMR Dashboard: Third Edition identified at least 127 SMR designs globally, with roughly 74 still actively under development. Only a small number have reached advanced deployment stages.

At least five SMRs are under construction, while only two — Russia's Akademik Lomonosov floating nuclear power plant and China's HTR-PM high-temperature gas-cooled reactor — have entered commercial operation.

### SMRS COULD BE CHEAPER TO BUILD AND EASIER TO EXPAND

In terms of adopting nuclear energy in Malaysia, SMRs dominate the conversation primarily because of their smaller and cheaper nature, according to Azrudi, who explains that most of the excitement surrounding SMRs is their potential reduction in upfront capital cost.

"The cost [of LCRs] comes mostly from construction expenses, which carry significant risks, especially if construction is estimated to be completed within five years but end up being delayed to seven or even eight years. These delays push down the revenue stream, making its net present value suffer tremendously," says Azrudi.

By contrast, SMRs can be built within two to three years. The modular design means the reactor can be expanded even after the initial construction.

For example, he says, a single SMR unit with a capacity of 300mw may require an investment of US\$1 billion to US\$2 billion, whereas conventional LSRs of 1,000mw to 1,400mw may cost US\$10 billion to US\$15 billion.

This price differential, combined with the potential for SMRs to use existing coal plant infrastructure, makes them an attractive option for nuclear energy development. Azrudi cautions, however, that adopting SMRs will not be straightforward.

"What people often misunderstand about SMRs is that they think they are simpler. In reality, SMRs are just as complex as LCRs, only condensed into a smaller footprint. This means piping and maintenance spaces are extremely compact — sometimes only large enough for an arm — whereas you could fit an entire person in LCRs," says Azrudi.

As a result, the levelised cost of electricity (LCOE) for SMRs is typically higher than that of LCRs. In short,



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Abdullah, Universiti Tenaga Nasional

Azrudi says, while SMRs may reduce upfront capital costs, they could ultimately be more expensive in terms of maintenance and electricity generation.

Idzat notes that, in general, SMRs can be categorised into major reactor types such as water-cooled reactors (land-based and marine-based), gas-cooled reactors, molten salt reactors, liquid-metal fast reactors, and microreactors.

"The most suitable near-term option for Malaysia would be land-based, water-cooled SMRs, particularly those based on light water reactor technology. This is because they are derived from proven conventional nuclear reactor systems already operating worldwide, but with smaller modular designs and enhanced passive safety systems," he says.

"These reactors also benefit from stronger regulatory familiarity, more established fuel supply chains, and lower technological risk."

One important point Malaysians should understand, given nuclear energy's often-troubled reputation, is that both LCRs and SMRs incorporate stringent passive safety features, says Abdullah. These systems rely on natural principles such as gravity to keep reactor cores cool, even in the event of a power outage.

### CONVENTIONAL LARGE NUCLEAR PLANTS MIGHT BE MORE VIABLE

The current challenge with SMRs is how far the technology still is from widespread commercial viability. Only two reactors are currently in commercial operation — the Russian floating SMR, which began operations in 2020, and a Chinese unit expected to commence operations by year's end. As Azrudi notes, the technology therefore remains largely unproven, particularly across different climatic and operating conditions.

"Many of the new SMRs do not use conventional reactors. Conventional nuclear energy technology uses water to cool the core. Some of them don't; they can use helium or molten salts," he explains.

The concern is the long-term viability of SMRs, particularly in climates like Malaysia's. For example, molten salt SMRs use salts that are highly corrosive, meaning further research is needed to ensure they remain safe and cost-effective to operate and maintain over several decades.

For Azrudi, the best way to assess whether a reactor type is safe and viable is only after a full fuel cycle, once the reactor has used up its initial fuel load — a process that can take at least five years. So, before a country like Malaysia considers following other nations into SMRs, it would need to wait at least two years, and potentially up to five for a full cycle, before drawing meaningful conclusions — including the Russian floating SMR, unless Malaysia opts for a similar design.

This means Malaysia should wait until 2031 to even consider SMRs. Azrudi argues that, in that time, it could easily establish the regulatory framework and start opening LCRs across the country. Abdullah agrees, noting that LCRs have had time to mature, streamline and optimise. This long operational experience is reflected in more predictable project costs, clearer risk assessments, and better understood national economic impacts.

He adds that, when considered alongside the extensive international guidelines and standards developed for LCRs, this long operational experience suggests that proven reactor designs may be more reliable for countries just beginning to introduce nuclear power into their energy mix, a view shared by Azrudi.



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Artist's impression of Clean Energy Xpedition's SMR, which eliminates the need for redundant coolant pumps and emergency injection systems to deliver a lower-cost, carbon-free energy source

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