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Nuclear power: is small really beautiful?

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Small modular nuclear reactors (SMRs) could play an important role in generating clean, affordable power. They promise faster construction than conventional nuclear plants at much lower cost, to provide electricity, heat and fresh water for cities and industries.

With global demand for electricity set to double by 2040, and climate change high on every government's agenda, nuclear power is increasingly seen as a viable, low-carbon option to traditional fossil fuels.

Nuclear reactors currently provide approximately one-tenth of the world's electricity, but, like gas- and coal-powered facilities, many are approaching the end of their lives. The overwhelming majority of current nuclear plants will need to be replaced by 2035–40, which presents governments with a huge financing challenge.

Smaller 'modular' reactors, or 'SMRs,' could help bridge the gap — especially in locations and countries where larger power stations are impractical, due to smaller populations. They are a useful way to power cities or districts, or large industrial users like data centers and mines.

SMRs are typically less than 300 megawatts (MW), compared to the 1000-plus MW output of most existing nuclear plants (some are more than 3000 MW). With a projected cost of around US$1 billion for a typical SMR, the required investment is projected to be far less than a traditional reactor, and roughly comparable with a large offshore wind farm. Initial studies suggest that SMRs could produce electricity at a similar or lower cost to conventional reactors.

SMRs don't just generate power. The excess heat produced by a plant can provide domestic heating for nearby urban areas or process heat for industry — indeed, this is one key attraction of a SMR. And, with water scarcity a growing reality in many parts of the world, the plants could offer a cost-effective way to drive desalination of sea water. Russia already uses a SMR to power a desalination plant on its Black Sea Coast.

The 'modular' approach to building SMRs is another positive. Many of the constituent parts (as much as 50 percent) could be assembled in a factory setting, and then transported to the site, which should enable faster and more efficient construction. This should allow costs to become repeatable and more predictable, with less chance of the overruns that have bedeviled conventional nuclear power stations.

A smaller, more flexible manufacturing process also enables manufacturers to match capacity more closely to demand curves, freeing up capital.

All of this makes SMRs attractive, in theory, to investors, who stand to gain returns sooner at lower risk, which should reduce the cost of capital. They'll be less exposed to inflation and be able to recycle capital over shorter periods of time. Such benefits could increase the number of interested developers and reduce the reliance on government support mechanisms to encourage investment.

Making SMRs a reality

By 2035, the potential size of the global SMR market could be 65GW-85GW according to some industry estimates; that's around 300 plants, which would require at least in excess of US$300 billion of investment. Desalination applications alone could be worth over a hundred billion dollars of investment. The highest demand is anticipated from the US, China and Russia, followed by the UK, Brazil and India.

In the past few years, a number of major nuclear reactor manufacturers have stepped up their SMR development, bringing this technology closer to fruition.

We are not quite there yet, though. Governments and manufacturers are still grappling with the details of larger-scale commercialization, ironing out various technical and regulatory issues. Developers are hopeful that none of these obstacles will damage the overall business case, particularly regarding the final cost of electricity from smaller reactors. And that the promised benefits of SMRs and attractiveness to investors, will materialize.

Government incentives for cleantech and nuclear (and disincentives for polluting energy sources like coal) can vary over time and between different countries, which creates further uncertainty for investors unsure where to place their bets. Different administrations in various countries have introduced and then withdrawn tax breaks for renewables, playing havoc with investment plans. Politicians are also wary of public attitudes towards nuclear power, and could be influenced by pressure groups, while incidents such as Fukushima can negatively impact overall nuclear policy.

And of course, there is competition from other energy sources, both traditional and renewable.

Another possible stumbling block for nuclear power development is the scarcity of specialists, in an industry that has been relatively dormant for some time. If governments commit firmly to a significant nuclear building program, more graduates should hopefully be drawn to the sector.

Recent falling oil and gas prices may have temporarily weakened the argument for nuclear in some countries, but there's no getting away from the global pressure to cut emissions — something that gas-, coal- and oil-fired plants are unable to achieve to a significant degree. Low-carbon sources will inevitably constitute a growing part of a country's energy portfolio, and small modular reactors could offer a clean, flexible and cost-effective alternative.

Country profile: UK announces SMR feasibility studies

The UK was the first country to successfully develop, deliver and safely operate civil nuclear power stations. To meet the ongoing challenge of decarbonization, it has an ambitious program to add more than 20 gigawatts (GW) of nuclear energy by 2030, delivered by large reactors.

There is also growing interest in small and simpler nuclear units, to reduce capital costs and shift from large, inflexible grid systems. In early 2016, the country's Department of Energy and Climate Change began a phase 1 consultation on a UK SMR, which could replace ageing gas-fired power stations and complement existing, larger nuclear reactors. Initial studies suggest a UK market for around 7GW of power from SMRs by 2035; equivalent to 20–25 plants.

SMRs are not just seen as a way to provide a reliable, secure, affordable and clean source of energy. It's hoped that the UK could eventually establish itself as a global center of manufacturing for this technology, forging a burgeoning national industry that serves the rest of the world and creates thousands of new jobs.

If the plan gets the go-ahead, it's likely that SMR development will involve public-private partnerships, to maximize innovation and bring much-needed finance. For example, existing institutions like the acclaimed UK National Nuclear Laboratory could drive the initiative, providing essential research and development, and forming joint-ventures with selected partners, through a transparent, competitive procurement process. Partnership also ensures that the UK can build and retain intellectual property, and have a stake in future revenues from the industry.

Talking points

- Which governments have a defined nuclear energy strategy?
- If so, are SMRs part of this plan?
- Should governments be buying in SMR technology or developing it themselves?

This article contains extracts and data from *Small Modular Reactors (SMR) Feasibility Study*, December 2014, produced by the UK National Nuclear Laboratory and a consortium including KPMG.

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