RSIS S. RAJARATNAM SCHOOL OF INTERNATIONAL STUDIES
Nanyang Technological University, Singapore

RSIS COMMENTARY

www.rsis.edu.sg No. 143 – 30 September 2024

The Transition to Net Zero Emissions: Competing Perspectives on the Use of Nuclear Power

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SYNOPSIS

Climate change, geopolitical risks linked to fossil fuel imports, and dependence on unreliable energy-exporting countries have revived plans for expanding nuclear power use worldwide. However, the global dependence on Russia's nuclear fuel supply chain, cost-competitiveness, and uncertain promises of Small Modular Reactors have also raised doubts about whether the global nuclear plans will be realised.

COMMENTARY

The share of nuclear power in global electricity generation has declined by almost half from its record of around 17 per cent in 1996. However, global discussions on climate change have spurred a new worldwide interest in this energy source, including Europe.

Nuclear power has been recognised as a strategic and clean energy resource. Unlike renewables like wind and solar, it does not have an intermittency problem. It can also enhance energy supply security by reducing the demand for fossil fuel imports from geopolitically unstable countries and unreliable energy exporters.

Currently, 415 nuclear reactors with a combined capacity of 375 GW are operating worldwide. Europe still has around 100 of them, which generate some 97 GW – about one-fourth of the continent's electricity supply. Across Europe, two new nuclear reactors are currently being constructed, seven new ones are planned, and another 25 are proposed.

While Germany closed its last three nuclear power plants in April 2023, France, the UK, the Czech Republic, Hungary, Bulgaria, Romania and Sweden want to increase their nuclear capacity. The Netherlands and Poland, which do not operate nuclear power plants, have declared that they will build them. Italy, which phased out nuclear

power in 1990, also wants to revitalise it in its national energy mix. France aims to build at least six new nuclear reactors, which could expand to 14 in the future.

The biggest expansion is taking place in Asia as China becomes the country with the most electricity generated by nuclear reactors. China seeks to expand the nuclear share of its primary energy mix from five per cent in 2021 to 18 per cent by 2060. Together with Russia's, their reactors account for more than two-thirds of those in existence. Globally, over 60 nuclear reactors are under construction (21 in China alone), and there are plans for another 110 (70 in China).

Nuclear power's global share of energy production might reach a new record next year, which is aligned with the COP28 summit in November 2023, where over 20 countries had pledged to triple global nuclear power capacity by 2050. However, in contrast to the US$2 trillion invested in clean energy projects, only US$80 billion is currently being spent on fission nuclear power projects – only half of what is needed to triple the worldwide nuclear capacity.

Small Nuclear Reactors

The capital costs of conventional large-scale nuclear power plants are very high and require state subsidies for their construction. However, based on prefabricated units, the new Small Modular Reactor (SMR) is expected to be much cheaper, safer, and produce less nuclear waste. SMRs can produce up to 300 MW of power each, which is about one-third of the generating capacity of traditional nuclear power reactors.

Their supporters hope that SMRs can acquire a market share of 10 per cent of the world's nuclear power capacity by 2050. They can also contribute to the global demand for green hydrogen, another clean energy source. Presently, more than 70 SMRs are being developed in 18 countries.

Challenges Facing Nuclear Power Projects

High Cost Compared with Renewables and Battery Storage Solutions

Many critics have warned that nuclear power is too expensive compared with renewable energy sources in combination with battery storage solutions for electricity and that the costs of storing nuclear waste have been underestimated or not included in cost comparisons. Indeed, almost all new nuclear reactors worldwide have faced years of construction delays and heavy cost increases, as the following examples show.

• In the US, its first new nuclear reactor began commercial operation in July 2023 after a delay of seven years and at the cost of US$30 billion and a budget overrun of US$16 billion;

• In Finland, its 1.6 GW OL3 reactor started operation in 2023 after a delay of 14 years and at the cost of US$11 billion and a budget overrun of US$8 billion;

• In France, its six new EDF reactors have seen costs jumping up 30 per cent to €67 billion;

• In the UK, the construction of the 3.3 GW Hinley Point C reactor is seven years behind schedule, and the cost, estimated initially at £20 billion, is expected to rise to £33 billion.

Supporters of SMRs hope that the new technology will lower the cost of electricity from US$120/MWh to US$40-65/MWh. However, critics claim that SMRs are too expensive, still under development, not constructed, and too risky to play a significant role in the global energy transition away from fossil fuels. For instance, the target price for power from the proposed NuScale SMR has already soared from US$58/MW in 2021 to US$89/MW at the beginning of 2023 despite including an estimated US$30/MW subsidy in the US Inflation Reduction Act.

However, their cost comparisons – in anticipating that nuclear power costs 50 per cent more than solar and wind power – often overlook the fact that intermittent renewables need to be backed up by fossil fuel or nuclear power when there is no sun or wind. Furthermore, the existing electricity grid must be modernised to become more digitalised, smarter and flexible. But cost comparisons also often underestimate the cost of storing nuclear waste.

Rebuilding a Resilient Nuclear Fuel Supply Chain

However, the renaissance of nuclear power use is being questioned in Europe and Western OECD countries as they would become even more heavily dependent on Russia's nuclear fuel supply chain (as they previously were on Russian pipeline gas) and be fueling Russia's war budget. Rosatom, a Russian state-owned enterprise, is also a leading supplier of enriched uranium to the US. Although the Kremlin has not used its uranium exports as a geopolitical weapon as it did with its gas exports to European countries, it could do so at any time.

Russia and Rosatom control almost half of the world's uranium processing capacities and 36 per cent of enrichment, making them the world's leaders in the nuclear fuel supply chain. Russia also holds some two-thirds of the reactor export market and supplies 78 nuclear power plants in 15 countries (17 per cent of the world's nuclear fuel market).

Most EU countries and the US aim to reduce their nuclear fuel imports from Russia and build alternative nuclear fuel supply chains in preparation for a complete ban on Russian imports.

However, many other countries will remain dependent on Russia's fuel exports, as the Rosatom subsidiary Tenex is currently the only company selling the new nuclear fuel, Haleu (high-assay low-enriched uranium). This fuel is enriched by 5-20 per cent to power a new generation of smaller and more efficient reactors.

Conclusion

The competing perspectives discussed above demonstrate different perspectives for regions and countries regarding the use of nuclear power. By providing a reliable and stable 24-hour supply of electricity, nuclear power may have the advantages of competitiveness and cost-effectiveness.

On the other hand, it remains to be seen whether new nuclear reactors such as SMRs will really become cost-competitive with renewables in combination with battery storage options as technological innovations progress in the world's energy markets. Thus, the world, including Europe, needs to be pragmatic and technologically neutral.

Any worldwide or regional nuclear phase-out in the short- and medium-term perspective (as Germany did in April 2023 by closing its last three nuclear reactors) would make the global energy transition to net-zero emissions much more risky, unpredictable and costly, besides threatening energy supply security.

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