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Including Nuclear is Cheaper than Renewables Only

Frontier Economics has modelled the overall costs to transition the National Electricity Market (NEM) from coal by 2050 and found that including nuclear with renewables is cheaper than renewables only.

Report 1 - Developing the base case to assess the relative costs of nuclear power in the NEM (14 Nov 2024) established that the Frontier Economics model produced similar results to the Australian Energy Market Operator (AEMO) Integrated Systems Plan (ISP) results when restricted to only renewables and storage.

Report 2 - Economic analysis of including nuclear power in the NEM (13 Dec 2025) used the Frontier Economics model to assess the economics of including nuclear in Australia's National Electricity Market (NEM).

The model assumed:

- capital cost of nuclear was $10,000 per kilowatt of capacity,
- first nuclear will be added to the grid in 2036 with 13 GW added by 2050,
- new nuclear capacity is commissioned as coal plants close.

Modelling in Report 2 concluded that the future cost of the Australia's electricity system would be cheaper if nuclear energy is included. The total system costs including transmission go down from $594 billion in the AEMO Step Change scenario to $446 billion in the nuclear alternative (25% cheaper), and down from $437 billion in the AEMO's Progressive scenario to $331 billion in the nuclear alternative (also 25% cheaper). AEMO consider the Step Change the most likely outcome.

The deployment of nuclear in the report modelling was associated with strong growth of renewables and storage in the NEM. Indeed, renewables continue to dominate the provision of electricity to consumers even with nuclear power. By 2051, nuclear capacity in the model accounts for just over 8% of total capacity but produces nearly 30% of the electricity.

Danny Price, Managing Director of Frontier Economics, said "I stand by the analysis that shows on a system-wide average economic cost basis, including nuclear remains cheaper than a renewables only system".

John Harries ANA

Information sourced from World Nuclear News https://www.world-nuclear-news.org/ .

New Builds and Life Extensions

United States: The US Department of Defence has broken ground for the USA's first electricity generating Generation IV reactor. The Pele prototype mobile microreactor being built at Idaho National Laboratory is designed to be transported in four 20-foot shipping containers. The reactor is designed to supply 1-5 MWe for a minimum of three years of full power operation. The reactor is a mobile high temperature gas cooled reactor using HALEU TRISO fuel.

United States: A construction permit has been granted to Kairos Power for the Hermes 2 Demonstration Plant. The permit allows construction of a facility with two 35 MWt molten salt-cooled reactors. Hermes 2 was the first electricity-producing Generation IV plant to be approved for construction in the US.

Japan: Two more reactors have restarted in Japan after extended shutdowns – Onagawa-2 and Shimane-2. These are the 13th and 14th reactors restarted since 2011.

China: The first of two demonstration Guohe one (CAP1400) reactors has been connected to the grid. Construction started in June 2019. The plan is for 50-month construction periods as the design is deployed in large numbers across China. Unit 1 at Zhangzhou (a HPR1000) has also been connected to the grid.

United Kingdom: Life extensions have been announced for four UK plants – Heysham 1 (2027), Hartlepool (2027), Heysham 2 (2030), Torness (2030). When EDF acquired these sites in 2009, they were planned to end generation in 2023.

Flamanville 3 in foreground, Flamanville 2 and 1 in rear. (Image EDF)

France: Flamanville 3 has commenced supplying electricity to the grid. Flamanville 3 is a 1.63 GW EPR, the fourth to come online internationally. Two more EPRs are under construction at Hinkley Point C.

Policy

Poland: The polish government intends to allocate USD15.7 billion to fund the country's first nuclear power plant. The Polish government selected the Westinghouse AP1000 technology, with the aim for the first unit to be in operation in 2033.

United States: Global technology companies have announced deals for the use of nuclear energy in the coming years:

- **Microsoft** has signed a 20-year power purchase agreement with Constellation that involves the restart of Three Mile Island Unit 1. Microsoft will use the entire output of Unit 1, starting from 2028. A licence renewal to at least 2054 is also planned. Unit 1 was closed in 2019 for economic reasons.
- **Google** has agreed to purchase energy from Kairos Power from multiple SMRs. The first of the reactors is planned for 2030, to be extended to a fleet totalling 500 MW capacity by 2035. The reactors will supply energy, ancillary services and other environmental attributes to Google. The Kairos Power reactor is a fluoride salt-cooled high temperature reactor.
- **Amazon** announced a series of agreements that will result in it taking a stake in reactor developer X-energy and the rollout of the Xe-100 SMR. Amazon will have the right to purchase the 320 MW of electricity to be generated from the first four-unit project.
- **Meta** is targeting 1 – 4 GW of nuclear in the US (small or large) by the early 2030s to help meet innovation and sustainability objectives.

Sweden: Environmental approval has been granted for Sweden's final geological repository for used fuel. The repository is expected to be in operation from the mid-2030s.

Canada: A site has been selected for Canada's deep geological facility for used nuclear fuel. Canada followed a community-driven, consent-based site selection process that took 14 years to complete. The site is located at the Wabigoon Lake Ojibway Nation and the Township of Ignace.

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The Canadian regulatory decision-making process for the facility consists of two aspects. The first is the process of the Canadian Nuclear Safety Commission. The second is an indigenous led regulatory assessment and approvals process. Potential impacts will be assessed against Wabigoon Lake Ojibway Nation's Anishinaabe values, and conditions to mitigate any impacts will be designed by the Wabigoon Lake Ojibway Nation and complied with by the Nuclear Waste Management Organization.

Switzerland: An application has been lodged for a general permit for the construction of a deep geological repository. The path to operations is extended with steps including a Federal Council decision (expected 2029), Parliament decision (2030), Referendum (2031), geological studies, building permit and operating permit. Operations are planned to commence from 2050.

World: Six more countries have signed the declaration to triple nuclear capacity by 2050. The new countries are El Salvador, Kazakhstan, Kenya, Kosovo, Nigeria and Turkey. Notable absent countries are China (who has the largest number of plants under construction) and Russia (who are a large exporter of nuclear technologies). 31 countries have now signed the declaration.

Ukraine: Chernobyl is being considered as one of the potential locations for Ukraine's future rollout of SMRs. Ukraine has plans for up to nine new AP1000 reactors and dozens of SMRs.

United States: The US Government has developed a roadmap that sees the deployment of 200 GW of nuclear capacity by 2050.

Other

United Kingdom: Scientists have invented what they say is the world's first carbon-14 diamond battery. With a half-life of 5700 years, these batteries could power devices for thousands of years. The batteries would operate in the microwatt range and have applications such a powering devices in space, medical devices and everyday electronic devices and watches.

Jo Lackenby ANA

ARPANSA Approves First Stage of HIFAR decommissioning

On 04 December 2024, Gillian Hirth AO, CEO ARPANSA, approved the first stage of decommissioning the HIFAR research reactor at Lucas Heights, about 40 km southwest of the centre of Sydney NSW.

Prime Minister Menzies launches Australia's first nuclear reactor, HIFAR, on April 18, 1958

This approval relates to Phase A-I (the first of three stages in Phase A) of decommissioning relating to utilisation equipment, neutron beam instruments and irradiation rig support equipment.

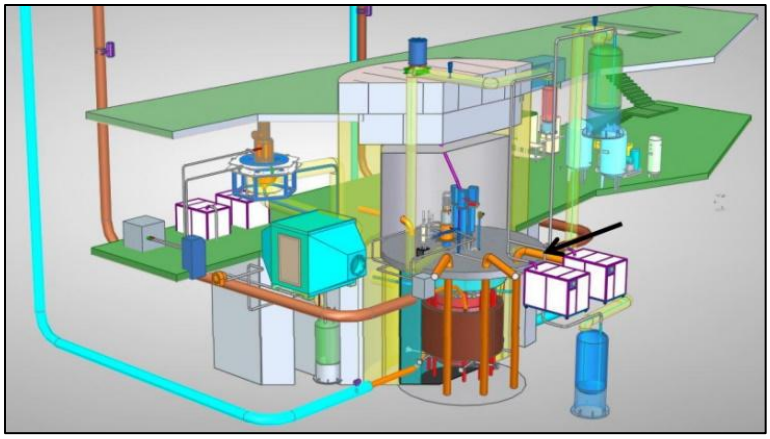
The reactor core and containment building will be decommissioned later and will require separate approval from ARPANSA's CEO.

The High Flux Australian Reactor (HIFAR) research reactor was a 10 MW heavy water moderated and cooled reactor, of the DIDO class. HIFAR went critical for the first time on 26 January 1958. It was a multi-purpose nuclear reactor used for research; production of radioactive isotopes for Australian nuclear medicine and industry; materials testing; neutron beam experiments, and for silicon irradiation.

HIFAR was permanently shut down on 30 Jan 2007, after 49 years of operation, when it was replaced by the OPAL reactor which was commissioned in 2006.

Molten Salt Reactors are Back

In 2023, twelve years since China began research in molten salt reactors (MSRs), the Shanghai Institute of Nuclear Applied Physics (SINAP) successfully commissioned TMSR LF-1, a 2 MW-thermal experimental MSR. The test reactor uses high-assay low-enriched uranium (HALEU) tetrafluoride fuel dissolved in the core's salt coolant to demonstrate the feasibility and safety of the MSR design.



Schematic of Chinese TMSR-LF1 molten-salt reactor [Graphic from SINAP]

As reported by WNN, the TMSR LF1 is designed to operate continuously for 5 to 8 years before the primary coolant inventory is reprocessed to separate out fission products from the remaining fuel. It is also possible the graphite must be renewed due to accumulated damage from neutron flux exposure. This major overhaul every 5 to 8 years is similar to Terrestrial Energy's Integral Molten Salt Reactor (IMSR) design currently under development in Canada.

With the successful demonstration of the TMSR LF-1, China plans to build a commercial molten salt reactor, reported to have a thermal power of 373 MW. Assuming a conversion efficiency of 40%, this will put its electric output at 150 MW. Plans are for construction to start in 2025 and commissioned by 2030, coinciding with China's five-year plan.

A molten salt reactor (MSR) is very different from a pressurised water reactor (PWR), in that it does not use water as the coolant but molten salt, specifically fluoride-lithium-beryllium containing the dissolved fuel. However, the light elements of the salt alone do not offer sufficient neutron moderation and requires the assistance of nuclear graphite to achieve criticality.

MSR's remote online refuelling allows the use of radioactive U-233 which is bred from Th-232 either in the reactor's breeding blanket or in a separate reactor. This can greatly increase the global nuclear fuel supply as thorium is roughly 4 times as abundant as uranium.

The high operational temperature of MSRs of about 650°C allows the use of a >40% high efficiency Brayton cycle turbine for power conversion compared to the 33% efficiency of PWR steam turbines. This high temperature allows air cooling which makes it ideal for deployment in arid environments.

Molten salt reactors were originally conceived in the 1950s in the US to miniaturize reactors so that they could be light and compact enough for aircraft propulsion. To do so required an efficient heat transfer medium with an exceedingly high boiling point that remained liquid without pressurization. The aircraft reactor experiment (ARE) contemplated using sodium-zirconium-fluoride with 6% molar fraction HEU to convey heat at a power density at 1 MW per litre! This technology was shelved but found its way into terrestrial based molten salt reactors.

First demonstrated by ORNL (Oak Ridge National Labs) in 1965, MSR research was abandoned in 1973 before its revival by SINAP. SINAP originally contemplated both a solid fuel design using TRISO fuel (TMSF SF-1) as well as a liquid fuel design with reactor characteristics similar to Oak Ridge's MSRE in the 1960s.

The revival of molten salt reactor technologies is also at pace in the US. Terrestrial Energy is reportedly working on a fast neutron spectrum molten salt reactor which can recycle accumulated spent fuel from US PWR operation. The fast-MSR's chloride salt can dissolve a higher actinide loading, making the fast (neutron) spectrum reactor feasible.

Kairos Energy (US) also received funding to build Hermes - a 35 MWth solid-fuel based test reactor and Copenhagen Atomics in Denmark are designing a thorium fuel breeder reactor called 'the onion' for its dual zoned design with a reactor interior and breeder-blanket exterior.

See also earlier ABC interview of Mark Ho on MSRs at https://www.youtube.com/watch?v=3OXzmR5RmFY

Mark Ho ANA