SUBMISSION

Submission to the Select Committee on Nuclear Energy

Submission to the Inquiry into Nuclear Power Generation in Australia

15 November 2024

The Australian Academy of Technological Sciences and Engineering (ATSE) is a Learned Academy of independent, non-political experts helping Australians understand and use technology to solve complex problems. Bringing together Australia's leading thinkers in applied science, technology and engineering, ATSE provides impartial, practical and evidence-based advice on how to achieve sustainable solutions and advance prosperity.

Nuclear power may be an option for Australia in the coming decades, potentially occupying a supportive niche, providing dispatchable power in a high-renewables grid. While not presupposing the suitability of nuclear power for Australia, ATSE suggests that all technology options should be considered as part of Australia's urgent decarbonisation project. Nuclear energy should be weighed against the cost and benefits of competing and complementary forms of energy generation. Nuclear power can also be considered for specific use cases for industry, and for the low emissions energy mix beyond 2050.

ATSE recently published a report on Small Modular Reactors (SMRs) – a proposed nuclear power plant design with a smaller footprint and greater flexibility than a conventional reactor. The report summarised the state of technical development and suggested the lowest-risk pathway for Australia would be to procure SMRs once a mature market has been established in other OECD nations. Entering the SMR market at an earlier point carries greater cost and technology risks. The report also surveyed the legal context for nuclear power in Australia. ATSE encourages the Select Committee to consider the report findings, and here provides additional advice on the possibility of nuclear energy (including conventional nuclear reactors) for Australia.

ATSE makes the following recommendations to the Select Committee:

Recommendation 1: Accelerate the transition to net zero energy generation through low emissions electricity generation currently available to Australia.

Recommendation 2: Remove the legislated moratorium on nuclear power to allow the potential for a comprehensive analysis of viability.

Recommendation 3: If the government wishes to seriously consider nuclear power for Australia, it must first comprehensively investigate the financial, workforce, and engineering viability of a future nuclear industry.

Progressing the energy transition

Rapid global decarbonisation of energy generation is a crucial pathway to limit global warming to 1.5 degrees. The energy transition in Australia represents both an environmental imperative and opportunity for economic transformation (including a new clean energy trade). Low emissions technologies such as solar and wind energy generation are driving our energy transition because they are the lowest cost clean energy options. All technology options, including nuclear power, should be considered on their merits for potential contributions to decarbonisation.

The current timeframe for decarbonising energy generation in Australia does not align with the timeframe to deliver nuclear power plants. Large-scale conventional nuclear plants are proven technology, but the time to build is of the order of 10 years (presuming social licence to do so and an established nuclear regulatory framework). SMRs may have potential for Australia but there is considerable risk around costs and timeframes, as discussed in ATSE's report. If an Australian government were to pursue nuclear power, there would still remain an immediate need to continue scaling up cheaper and faster solar and wind energy generation as well as energy storage. New energy sources will be required to replace the output of retiring coal plants before nuclear can be built. Extending the lifetime of fossil fuelled power plants to enable establishment of a nuclear industry would be environmentally and economically irresponsible, creates risks of power shortages due to unplanned outages of failing thermal plants (especially under more extreme weather events), and does not consider the uncertainty associated with developing a nuclear industry. While retiring coal plants could be repurposed as suitable sites for nuclear power plants, it is extremely unlikely that nuclear power plants will be built in time to utilise existing infrastructure and replace their contributions to the grid. Enhancing efforts to roll out renewables is a necessity to decarbonise the grid by 2050 while providing reliable supply. Nuclear plants could be considered for maintaining a net zero grid beyond 2050.

Recommendation 1: Accelerate the transition to net zero energy generation through low emissions electricity generation currently available to Australia.

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Assessing the viability of nuclear energy for Australia

As Australia transitions to low-emissions energy generation and coal-fired power plants reach the end of their operational lives, it is prudent to consider the energy sources that will serve the nation's needs over the coming decades. Nuclear power plants, included proposed SMR designs, could provide a stable and secure form of energy generation supplementing renewable sources in the latter stages of electricity decarbonisation. On its current trajectory, Australia has missed the opportunity to establish a nuclear power industry to supply a large portion of residential and industrial electricity. Investment in renewables has and will continue to fill this role, with Australia now being one of the leading nations in solar and wind generation per person (Blakers & Ruther, 2024). Once the rollout of wind and solar generation has decarbonised the majority of energy generation, the question remains of how to decarbonise the remainder. This is where a potential role for nuclear may exist.

ATSE's view is that the moratorium on nuclear power in Australia stifles debate on this issue, including restricting the opportunity for a comprehensive investigation of nuclear power. Lifting the legislated ban would enable genuine consideration of nuclear power and its suitability for the Australian context. Removing the legislated ban does not presuppose that nuclear power will be suitable for Australia but it removes an unnecessary obstacle to a comprehensive examination of its advantages and disadvantages.

Further work is needed to explore if the considerable hurdles to establishing domestic nuclear power in Australia can or should be overcome. A comprehensive study of nuclear power in Australia was last conducted in 2006, chaired by Dr Ziggy Switkowski AO FTSE FAA (Department of the Prime Minister and Cabinet, 2006). There have been many technological developments since then, including the energy transition underway, as well as developments in nuclear generation technologies and the emergence of SMRs. At the time of that review, renewables provided only around 10% of electricity generation, compared with around 40% today.

ATSE recommends that the Australian Government should commission a deep, independent, study on establishing a nuclear energy industry, investigating national skills and workforce capability, timeframes to build, future energy requirements, operational lifetimes, waste management and long-term storage, comparative impacts on environment and biodiversity, land usage requirements, and other opportunities and challenges. Some of the issues that this study would need to investigate are summarised later in this submission. This must all be considered within the Australian context, and within the parameters of reliability standards and the net zero by 2050 commitment. Such an investigation will require expertise from industry, learned Academies such as ATSE, and major Australian agencies including the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Energy Market Operator (AEMO) – to an extent not possible via a Select Committee process.

Recommendation 2: Remove the legislated moratorium on nuclear power to allow the potential for a comprehensive analysis of viability.

Recommendation 3: If the government wishes to seriously consider nuclear power for Australia, it must first comprehensively investigate the financial, workforce, and engineering viability of a future nuclear industry.

Nuclear use cases in Australia

Nuclear power could become part of the future energy mix providing electricity for households and industry.

Domestic uses

With solar and wind energy being intermittent and weather-dependent, nuclear power may be one of the potential options to complement renewables by providing dispatchable power (sources that can reliably be switched on to supply electricity when input from solar and/or wind does not meet the grid's needs). Other options for a high-renewables grid include pumped hydro storage, hydrogen, geothermal power, gas peaking plants and sophisticated battery technologies. Output from nuclear power plants can be adjusted over several hours, but cannot be readily adjusted faster than this - viable dispatchable power to complement to a high-renewables grid must be able to be adjusted more quickly than is currently possible with nuclear. The potential advantages of SMRs are discussed in ATSE's report on the topic.

Nuclear power has been proposed as a power generation alternative that may make fewer demands than renewables on critical minerals. There are abundant critical mineral reserves globally which are expected to

be able to continue to meet demand as mining them becomes economically viable in future. Recycling can also be drawn upon as technologies for extraction become more sophisticated.

Industrial uses

Nuclear power plants - and in particular SMRs once fully developed - could present a viable technology to provide power onsite for energy-intensive activities such as desalination plants, mine sites, and data centres. Technology companies such as Amazon and Google have committed to participating in SMR development for their data centres in the United States, noting these developments are in early stages. Nuclear power plants could also potentially have a role in supplying energy to remote areas.

There may be a use case for supplying industrial process heat (such as for hydrogen production) at a reduced cost compared to other sources. This has been posited for some SMR designs that operate at comparatively high temperatures. The commercial viability of this remains to be seen as these designs are in their infancy. Technologies such as solar thermal may also prove to be a cost-effective approach to this challenge once developed.

Uranium

ATSE suggests that, as part of this review, the Select Committee also reviews opportunities in uranium mining. There is unrealised comparative advantage, with Australia possessing one third of global resources of uranium. Currently, the lack of supply chain for nuclear fuel within Australia would make fuel supply dependant on imports. Our uranium reserves would be an asset if nuclear power is pursued in the future, but this needs to be weighed against the cost of developing a supply chain. Harmonising state policies on mining, transport and export of uranium would be a starting point, but it is unclear if there is an economic case for developing a domestic fuel supply chain. The South Australian Nuclear Fuel Cycle Royal Commission Report found in late 2015 that there are significant barriers to entering these markets, and that markets were over-supplied (Government of South Australia, 2016, p. xiv).

Health, safety and security

Navigating the health, safety and security challenges posed by nuclear reactors is paramount if the government wishes to obtain community acceptance. Australia would also need to consider pathways to develop the regulatory regime and skills base necessary for a nuclear energy industry. Due to the long lifecycles of nuclear power plant construction and operation, and waste storage, Australia would require bipartisan support for the continuity of a nuclear energy industry. There are potentially learnings on safety assessment and management from other highly regulated industries such as offshore oil and gas.

While nuclear power plants globally have a strong safety record, safety is a key community concern. Health system preparedness for nuclear accidents – no matter how unlikely – would be an important failsafe. The ability to establish plants that are resilient to natural disasters and cybersecurity threats should be investigated as part of the proposed study. In this regard, we note that SMR designs are proposed to have inherent safety features.

Plans for nuclear waste treatment and disposal must be advanced prior to the construction of any nuclear power facility in Australia. Safe disposal of nuclear waste is a social, political and economic challenge for all nuclear nations. Research and development will be required to select safe, long-term waste storage and reprocessing solutions that address public and environmental concerns. This has already been an ongoing challenge for Australia over recent decades, with a failure to agree on suitable offsite storage for the Lucas Heights reactor waste. The cost of storing nuclear waste would also need to be accounted for as is currently done in levelised cost calculations in OECD countries. The best estimate of costs in Australia is from the South Australian Nuclear Fuel Cycle Royal Commission Report, which considered the possibility of storing high-level waste from other nations, for economic returns. This report estimated the combined capital and operating costs of a high-level waste storage facility at $145.3 billion, for the 120-year life of the project, in 2015 dollars (Government of South Australia, 2016, p. 295).

Prerequisites for a nuclear industry in Australia

International experiences with nuclear power can provide some basis for assessing the risks and benefits for developing nuclear power in Australia. Currently there are 439 reactors operating in 31 nations, and an increasing number of new countries planning for nuclear power introduction and expansion. It is possible that other OECD nations provide the most comparable experiences for Australia to learn from. The recent UAE experience of initiating a nuclear power industry has a vastly different political and legal context as compared with OECD nations, including with respect to migrant workers. Australia is a high-cost

environment for major engineering construction projects. This has been mitigated for solar, wind and storage installation with incremental rollout. The experiences of comparable nations such as Canada, Finland, France and the UK in procuring conventional nuclear power plants would suggest risks around financial and timeline nuclear project overruns, in some cases driven by first-of-a-kind constriction. The prefabricated components of SMRs are proposed to reduce the risk of project overruns.

In addition to the legislated moratorium, the cost of nuclear power is a major obstacle to nuclear power in Australia. The capital costs of establishing nuclear power in Australia would represent a considerable public investment and use of industry capacity and human resources. A study into nuclear energy in Australia would need to consider if there is a case for developing this industry to support energy security or other use cases. Australia's power generation companies have not telegraphed interest in developing a nuclear power industry, due to the lack of commercial viability and the uncertainty of political support. In the short-term, nuclear power would be more expensive than renewable energy sources such as solar and wind. This has been well-established including by the CSIRO 2023-24 GenCost report, which used estimated costs from conventional nuclear power in South Korea to impute a levelised cost of electricity for nuclear power in Australia (Graham, Hayward & Foster 2024). Also, fluctuating wholesale prices impact the financial viability of less flexible thermal generation sources, including nuclear, if unable to switch to other uses. At times when the wholesale price of energy is low or even negative (when there is an oversupply of energy in the network), coal-fired power stations operate at a financial loss. The same economic factors would influence the financial viability of nuclear power stations. We note that the impact of subsidies (both for renewables, and proposed for nuclear power) change the calculation of cost to consumer.

SMRs have been proposed as a cheaper alternative that also will take less time to build and have less project risk compared with large-scale nuclear. Due to Australia's comparatively limited capability to build and maintain conventional nuclear power plants, SMRs may be an appropriate option for Australia following global SMR market maturity, if nuclear power is pursued. SMRs generally have passive cooling features to improve safety. It is crucial to note that no SMR is commercially operating at present in an OECD nation. While there are some well-advanced concepts, none have been built or operated in the OECD. Unlike conventional nuclear reactors, SMRs have not been proven at scale. ATSE's report on SMRs concluded that commercial releases in other OECD countries could be possible by the late 2030s to mid-2040s, with a mature market emerging by the late 2040s. Closer to that time, an Australian government may determine that it is advantageous or economical to procure SMRs. Development of a regulatory regime and skilled workforce in the short-term would be important preparation for this decision.

Australia has no experience or expertise in planning, construction, commissioning and operation of nuclear power plants. There is a limited skills and knowledge base provided by the Lucas Heights nuclear reactor for research and medical isotope production. The lack of skills base would suggest that if Australia wishes to establish a nuclear power industry, it would need to begin preparing a nuclear-ready workforce in the next few years to enable the development of a nuclear power industry in the coming decades. A reliable strategic workforce plan is a critical success factor for any energy policy, and especially so for nuclear power. However, we note that the operating workforce for the Lucas Heights reactor was successfully trained and developed during the construction period. Developing nuclear talent in Australia would enable consideration of future nuclear proposals. It would also be synergistic with AUKUS commitments and the continued operation of the Lucas Heights nuclear facility, and the need for high-level nuclear waste storage. Similarly, increasing research and development on social acceptance would be beneficial both for delivering on AUKUS and supporting a future nuclear industry.

In developing the workforce and research underpinning nuclear, it is important not to cannibalise resources for renewable energy industries. Already, Australia is facing a shortage of experienced engineers to meet current demand. If Australia embarks on a nuclear power commitment at the same time as it tries to integrate renewables into our energy mix (and deliver on numerous other objectives requiring engineers), without an appropriate and effective strategic workforce plan for the nation, skills and workforce shortages will become a key failure point for both reducing emissions and any potential new energy industry.

Another hurdle to be considered for nuclear energy in Australia is water usage. Water supply for steam generation, neutron moderation and plant cooling is a key consideration for Australia given the existing pressures on our water and frequency of droughts. A power plant would need to be appropriately located to have sufficient water supply (in addition to other factors in site selection). Thermal fossil fuel power plants can also have considerable water needs. Nuclear reactors require around 15% more water than coal-fired power plants.

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As Australia seeks to decarbonise its energy system, the potential roles of all of technologies should be evaluated based on evidence, data, and local context including availability, feasibility, social licence, workforce pressures and economics. This will enable national transformation to an optimised long-term, low-carbon energy system.

ATSE thanks the Select Committee on Nuclear Energy for the opportunity to respond to the Inquiry into Nuclear Power Generation in Australia. For further information, please contact academypolicyteam@atse.org.au.

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