SMR Nuclear Technology Pty Ltd
Governor Macquarie Tower
Level 23, 1 Farrer Place
Sydney NSW 2000
ABN: 88 160 242 428
www.smrnuclear.com.au

The Contribution of Nuclear to a Reliable, Affordable and Low Emissions Energy Future for Australia

A Submission to the Australian Energy Security Board

Nuclear power is making a critical contribution to reliable, affordable and low emissions power systems. This has been demonstrated in 31 other countries.

Small Modular Reactors (SMRs) have become a game-changer in power system planning. It would be imprudent not to factor SMR nuclear generation into Australia's energy security plan at this time.

1. Reliability

Modern nuclear power plants are reliable, dispatchible and safe, with capacity factors in excess of 90%.

SMRs with unit outputs of 50-300 MW are particularly suitable for the Australian grid. SMRs are designed with load following capabilities to work with variable renewables.

One example is the NuScale (USA) SMR. Up to twelve 50 MW modules can be accommodated in one power plant to provide a gross output of 600 MW. The NuScale plant is specifically designed to load follow in three ways:

- For a 12 x 50 MW module plant, taking one module off-line reduces the output by 8%. A module can be returned to service in a few hours.
- Each module is able to independently vary its output by 40%/hour. A 12 module plant has 12 independent degrees of freedom by modulating the output of each module.
- Each module has a 100% turbine bypass. The module can be maintained at full power and all the steam dumped to the condenser enabling a fast load change.

Modern SMRs are inherently safe, avoiding Fukushima-type accidents.

The NuScale module sits in a large "swimming pool" enabling the reactor to be cooled indefinitely without attention.

2. Affordability

Detailed analysis by Fluor for the NuScale SMR gives a total overnight price of US$5m/MW net for FOAK (first of a kind) plant falling to US$4.3/MW for NOAK (nth of a kind). Depending on the source of financing, the levelised cost of electricity (LCOE) is US$72-$106/MWh for FOAK.

As with wind and solar energy, nuclear costs are coming down, with important strategic implications for the NEM and the entire economy. The most recent cost analysis by the UK Energy Options Network shows the LCOE for nuclear as an average of US$60/MWh and as low as US$36/MWh. At the lowest level, new nuclear plants could be the lowest-cost generation available.

We are able to provide on a commercial-in-confidence basis LCOE calculations depicting the present-day competitiveness of SMR nuclear energy in an Australian jurisdiction.

3. Emissions

Australia has not yet been successful in significantly reducing emissions from electricity generation.

Australia's annual emissions from electricity generation for the year December 2012 were 191 million tonnes CO2-e (National Greenhouse Gas Inventory).

Five years later, and billions of dollars spent on wind and solar, Australia's annual emissions from electricity generation for the year March 2017 were 188 million tonnes CO2-e.

Australia has one of the world's highest emission intensities, typically 820 kg CO2-e /MWh (Finkel Review). Countries with low emissions intensities have large hydro resources (Norway) or have nuclear as part of their energy mix (France, Belgium).

Nuclear makes a significant contribution to reducing emissions from electricity generation worldwide.

In 2016, 2,490 TWh was generated by nuclear power reactors worldwide, saving over 2 billion tonnes CO2-e emissions (World Nuclear Association).

In 2015/16, Australia exported 8,417 tonnes of uranium oxide concentrate (ASNO Annual Report) which would have generated ~280 TWh and saved the recipient countries more than 250 million tonnes CO2-e, yet Australia does not take advantage of this valuable resource.

Nuclear has zero operating emissions and whole of life cycle emissions comparable with renewables.

Nuclear power, like wind and solar, has zero operating emissions. The South Australia Nuclear Fuel Cycle Royal Commission examined in detail the whole of life cycle emissions for

different electricity generation technologies. The median value for nuclear is 12kg/MWh, the same as wind. Solar is slightly higher at 18-50 kg/MWh.

The Finkel Review reported a very large difference between low emissions technologies (wind, solar, hydro, nuclear) that have zero operating emissions and the lowest intensity fossil technology - CCGT with an operating emission intensity of 370 kg/MWh.

4. System Planning

In our view, subject to legislative facilitation, it will be feasible to develop an initial 300 MW SMR nuclear generator by 2030 and around 3000 MW by 2040.

The construction and operation of a nuclear power plant in Australia is presently prohibited by two Commonwealth Acts:

- Environmental Protection and Biodiversity Conservation Act 1999 S.140A
- Australian Radiation Protection and Nuclear Safety Act 1998 S.10.

Similar prohibitions were legislated in Queensland, NSW, Victoria and WA. These prohibitions were put in place at a time when there was no real appreciation of the contribution that modern, safe nuclear power plants could make to energy security, affordability and emissions reduction in Australia.

In May 2016 the South Australia Nuclear Fuel Cycle Royal Commission recommended that the prohibitions be removed:

> *Recommendation 8 - Pursue removal at the federal level of existing prohibitions on nuclear power generation to allow it to contribute to a low-carbon electricity system, if required.*

The present legislative prohibitions do not preclude consideration of the obvious merits of nuclear power generation in system planning in Australia. SMR vendors will however be unlikely to treat Australia as a potential market whilst the prohibitions remain in place.

Although successive government reports have endorsed the merits of "technology neutrality", the legislative prohibitions still effectively prevent its accomplishment.

We respectfully agree with the ESB's advice of 17 October 2017 to Minister Frydenberg that recommended in relation to the ESB's proposed Reliability Guarantee:

> *… as outlined in AEMO's recent advice there is an increasing concern that there is currently insufficient incentive to both drive investment in new flexible, dispatchable resources and maintain existing such resources. This will be exacerbated in future years as current dispatchable generation (such as coal and gas) exits the market.*

The ESB is proposing the development of an obligation on retailers to meet a percentage of their load requirements with flexible and dispatchable resources, that is, resources that can be scheduled by the market operator depending on the real time operating needs of the system.

This would allow both new and existing generation to meet the dispatchability requirement, and provide a greater incentive to maintain existing plant which is necessary for the secure and reliable operation of the power system. The resources which comply with the system needs would be carefully defined and include any form of technology, generation, batteries and demand that can respond to a request by the operator to increase or decrease their output over a defined time interval.
(underlining provided)

In the national interest, the ESB must, we would submit, plan for the short, medium and long terms. Australia can underwrite its system reliability, as well as affordability and lower emissions, from 2030 by including load-following nuclear generation in the defined generation mix and allowing all technologies to compete. Indeed, we consider it would be imprudent not to do so.

Tony Irwin
Technical Director
SMR Nuclear Technology Pty Ltd

16 November 2017