

## INQUIRY INTO URANIUM MINING AND NUCLEAR FACILITIES (PROHIBITIONS) REPEAL BILL 2019

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## **The Advantages of Safe Nuclear Power for a Reliable, Affordable and Low-Emissions Power System in New South Wales and for the Wider Economy**

*An Additional Submission by SMR Nuclear Technology Pty Ltd to the NSW Legislative Council's Standing Committee on State Development, October 2019*

**SMR-NT has lodged this additional submission to address particularly the information provided in the Issues Paper section 12.2 Economics**

### **The Economics of Small Modular Reactors (SMRs)**

Although there are three SMRs under construction worldwide<sup>1</sup>, these are all prototypes and are not typical of a modern commercial SMR. The economics of SMRs is therefore based on estimates and some of these are included in the Issues Paper.

This additional submission examines the examples in the Issues paper and provides additional latest information.

#### **South Australia Study for the Royal Commission**

Parsons Brinckerhoff provided the calculations for the 2015 Royal Commission. For a large PWR they took the cost of the very expensive AP-1000 under construction in the USA, added 5% for a single reactor and converted to A\$.

For the small SMR, based on a 285 MWeN six module plant, they took this figure and added a further 5%. This produced a figure of \$11,689/kW. They used a weighed average cost of capital (WACC) of 10% which is a commercial rate of return normally expected by a private project developer. For comparison the CEFC are providing capital to VRE projects at 3-4%.

Construction costs included the costs of roads, rail, water supply, HV transmission connections and substation upgrades.

The LCOE was calculated to be \$225/MWh, including \$172/MWh for the cost of construction and development. For the fuel cost they took the costs for a PWR and added 20%. The refuelling outage

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<sup>1</sup> Russia 70 MW floating SMR, Argentina 27 MW Carem, China 211 MW Shandong Shidaowan HTR-PM

was taken as 30 days as a large PWR whereas for a small SMR it is actually estimated as 10 days. Due to the lack of information about SMRs at the time that this report was compiled in 2015, it is understandable that a percentage increase on a current (very different) project was used to determine costs, but much more accurate information is now available which indicates much lower costs.

### CSIRO/AEMO GenCost 2018 Report

This recent report has been widely taken as evidence that "nuclear is three times more expensive than renewables". CSIRO commissioned GHD to provide the technical analysis for their report. GHD produced a LCOE figure for an SMR of \$250-\$325/MWh. However this was based on:

- \$16,000/kW overnight cost. The source of this figure is given as the World Nuclear Association. The WNA do not recognise this figure which is not in any of their reports and they confirm that they were not consulted on this matter (WNA submission 259 to the 2019 Federal Nuclear Inquiry).
- 300 MW Gen IV reactor constructed in 2035. Gen IV is the next generation of advanced reactors, currently in the R&D stage. The most likely SMR to be deployed in Australia would be a Gen II+ light water reactor based on existing known technology

The \$16,000/kW figure is clearly not appropriate for a SMR that would most likely be deployed in Australia. The WNA stated in their Federal submission "We can therefore say categorically that the figure of \$16,000 AUD/kW is not in concordance with current international expectations".

### More up to date costs

IEA World Energy Outlook 2018 gives the average capital cost of new nuclear in the USA as US\$5,000/kW.

The 2017 SMR Start report<sup>2</sup> estimates SMR capital costs of US\$4,600 - \$5,150/kW.

Fluor (the international engineering company) has recently carried out a "bottom up" detailed cost estimate of the NuScale 720 MWe 12 module plant. This estimate conforms to the American Association of Cost Engineers class 4 cost estimates and is based on over 14,000 line items priced using Fluor's extensive cost data or actual vendor quotes. For a Nth of a Kind plant (that would most likely be deployed in Australia) the cost<sup>3</sup> is US \$3,600/kW equivalent to ~ A\$5,100.

Large scale solar PV capital cost in the GenCost 2018 report is \$1,500/kW at ~25% capacity factor. Levelised to the NuScale 95% capacity factor, this equates to \$ 5,700/kW for large scale solar PV. Nuclear capital costs are competitive with large scale solar PV even without including firming costs.

It would be appropriate to compare the LCOE cost of nuclear with firmed VRE.

The CSIRO/AEMO Gen Cost 2018 report fig 4-2 (page 28) shows the LCOE in 2020 for solar PV firmed with 6 hrs pumped hydro energy storage (PHES) as \$95-\$130/MWh. A nuclear LCOE of ~\$100/MWh would therefore be competitive with firmed solar.

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<sup>2</sup> SMR Start, September 2017, The Economics of Small Modular Reactors, <http://smrstart.org/wpcontent/uploads/2017/09/SMR-Start-Economic-Analysis-APPROVED-2017-09-14.pdf>

<sup>3</sup> NuScale submission to the NSW Standing Committee on State Development Nuclear Inquiry

The SMR Start report shows a LCOE of US\$70-\$90 for an investor owned utility and US\$62-\$70 for a municipal owned utility in the USA.

Projected LCOE costs in Canada<sup>4</sup> are CDN\$58-\$90/MWh.

Modern SMRs look to be competitive with firm VRE. Certainly the “nuclear is three times more expensive than renewables” is not true for the SMRs that are about to be deployed in the USA and would most likely be deployed in Australia.

The costs of SMR deployment in Australia will only be accurately determined by a feasibility study, but indications from the USA are that SMRs will be competitive with firm renewables.

*SMR Nuclear Technology Pty Ltd has been pleased to provide this additional submission to the NSW Standing Committee on State Development and stands willing to expand on these and any other issues that the Committee may wish to raise in evidence to the Committee.*

**Tony Irwin**  
Technical Director  
October 2019

SMR Nuclear Technology Pty Ltd (SMR-NT) is an independent Australian-owned specialist consulting company based in Sydney.

SMR-NT was established in 2012 to advise on and facilitate the siting, development and operation of safe nuclear power generation technologies, principally by Small Modular Reactors (SMRs).

SMR-NT’s directors have over 100 years of combined experience in power generation, including nearly 50 years of nuclear power generating experience.

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<sup>4</sup> Canadian Small Modular Reactor Roadmap, November 2018, [https://smrroadmap.ca/wpcontent/uploads/2018/11/SMRroadmap\\_EN\\_nov6\\_Web-1.pdf](https://smrroadmap.ca/wpcontent/uploads/2018/11/SMRroadmap_EN_nov6_Web-1.pdf)