September 2022

# SMALL MODULAR REACTORS INFOGRAPHICS

SMR NUCLEAR TECHNOLOGY PTY LTD

**Small Modular Reactors Infographics**

Sydney-based nuclear energy consultancy SMR Nuclear Technology Pty Ltd (SMR-NT) has issued a set of infographics to provide policymakers and the Australian community with a better understanding of the real differences between SMRs, solar, wind and fossil fuels for electricity generation.

Australians cannot afford a short-term view of generation costs. They need to take a measured approach which weighs up the costs of the different technologies over their lifetimes. Planners can then work out the real costs to the overall power system.

The cost of transmitting bulk electricity will be increased by the number of small solar and wind generators that needed to be connected to the grid.

A major advantage with nuclear generation in pursuing Australia's 2050 net zero goals, especially with the modern Small Modular Reactors (SMRs), is that they can be connected to the existing power grid and avoid much of the cost of new transmission infrastructure. This could generate national savings of billions of dollars.

All low emissions technologies will be needed to achieve Australia's net zero goals: Each low emissions technology brings different advantages - the big challenge is determining the right technology mix for the minimum long-term system cost. In this respect, SMRNT's infographics will be of value to both policymakers and the general public.

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## Small Modular Reactors (SMRs), Solar and Wind
## Which technology has more clear advantages (shown in green)?

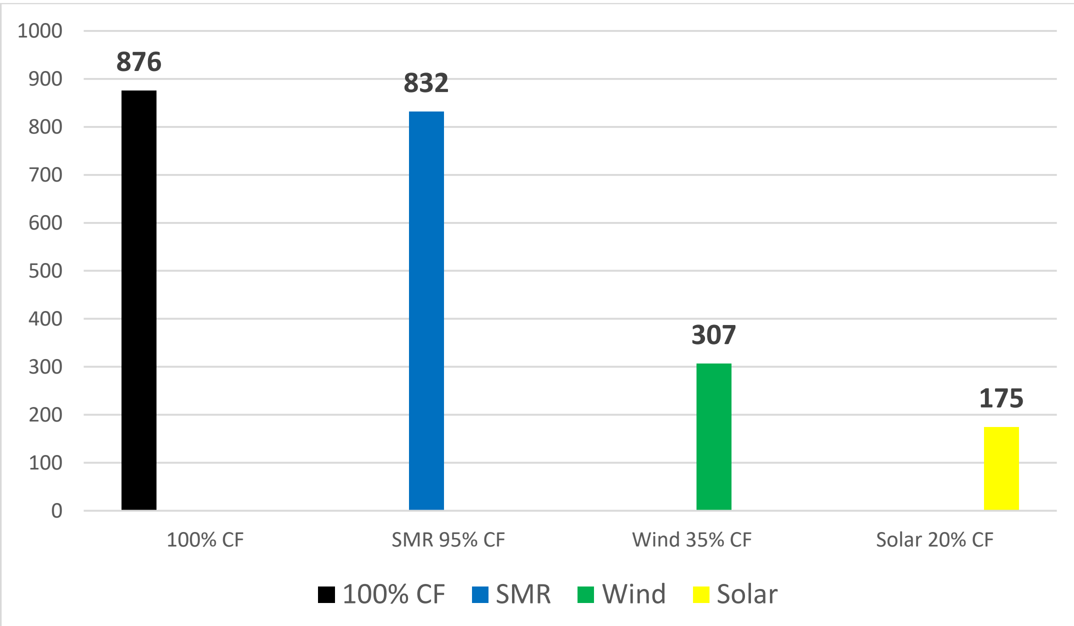
| Parameter | SMR | Utility Scale Solar | Onshore Wind |
|---|---|---|---|
| Reliability of generation | reliable | variable | variable |
| Independent of the weather | independent | dependent | dependent |
| Capacity factor | 95% | 22% - 32% | 35% - 44% |
| Load following capability | yes | no | no |
| Provides frequency control | yes | no | no |
| Provides system inertia | yes | no | no |
| Black start capability | yes | no | no |
| Direct process heat for industry | yes | no | no |
| Plant Design/Economic life years | 60 | 25 | 20 - 25 |
| Plant Technical/Operational life years | >60 | 30 | 20 - 30 |
| Land area required hectares/TWh | 2.4 | 1,295 | 7,203 |
| Visual impact | low | medium | high |
| Noise impact | low | low | high |
| Wildlife impact | low | medium | high |
| Major material required t/TWh | 1,190 | 2,516 | 5,976 |
| Critical minerals required t/TWh | 12 | 124 | 130 |
| Materials – concrete t/TWh | 1,058 | 1,216 | 4,466 |
| Materials – steel t/TWh | 134 | 938 | 1,447 |
| Lifecycle emissions g/kWh | 12 | 48 | 11 |
| Storage required | None | Typical Battery 4 hrs/ PHES 12 hrs | |
| Cost of storage $/kW | $0 | $1,629 battery/kW $2,711/kW PHES | |
| Additional transmission | none | >$12.7 billion | |
| Life waste included in cost | yes | no | no |
| O&M cost $/MWh | 11 | 9.7 | 8.2 |
| Fuel cost $/GJ | 0.5 | Free | Free |
| Construction time years | 3 | 0.5 | 1.0 |



SMR parameters: NuScale (USA) 12 module 924 MW plant estimate for Australia
Wind and solar: CSIRO GenCost 2021-22 Final report July 2022, transmission AEMO 2022 ISP
Pumped Hydro Energy Storage (PHES) and battery costs – CSIRO GenCost 2021-22 Table B.7
Material requirements: Bright New World (BNW) and IEA "The Role of Critical Materials in Clean Energy Transitions"
Land use: NEI April 2022
Lifecycle emissions: WNA and IPCC
O&M = Operations & Maintenance

# Capacity Factor

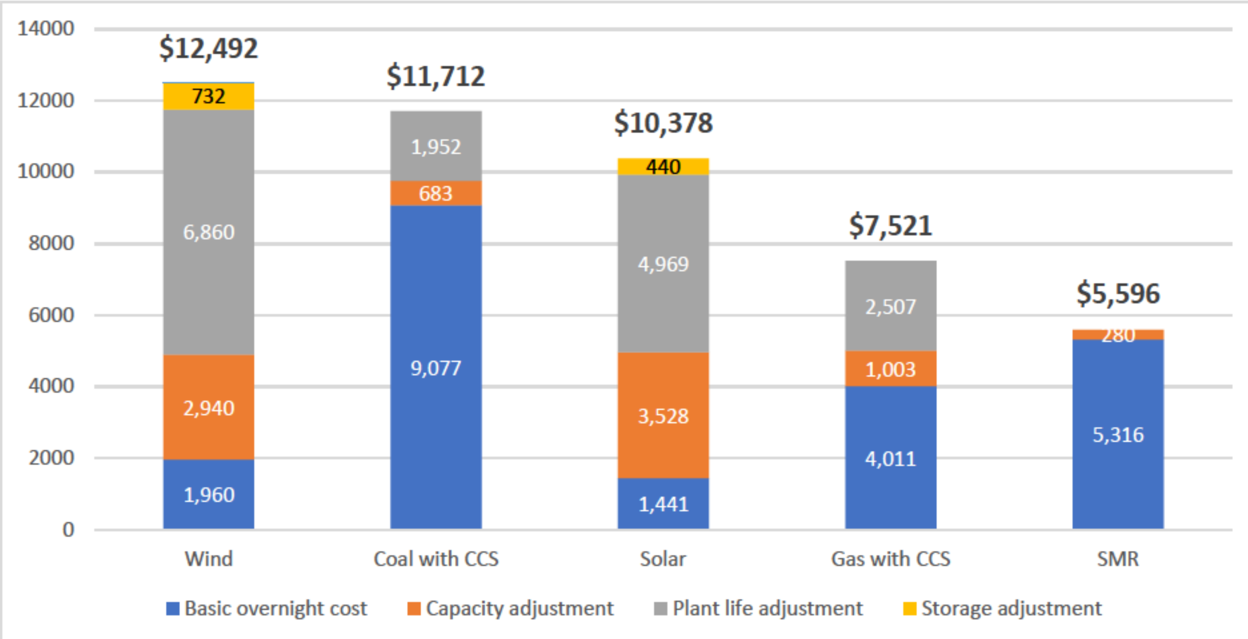
**Capacity Factor is the ratio of actual generation of a power plant compared to the generation that would be produced by continuous full power operation.**
For example a 100 MW plant at 100% capacity factor would generate 100 x 24 x 365 = 876 GWh/year
(GW = $10^9$ watts)




*When you contract for a 100 MW power plant you actually get the generated output of 95 MW for an SMR (832 GWh/y) or 35 MW for a wind farm (307 GWh/yr) or 20 MW for a utility scale solar plant (175 GWh/y)*

*Wind and solar capacity factors from Clean Energy Council, Clean Energy Australia report 2021, actual generation.*

## Real Overnight Capital Cost - $/kW for New Build



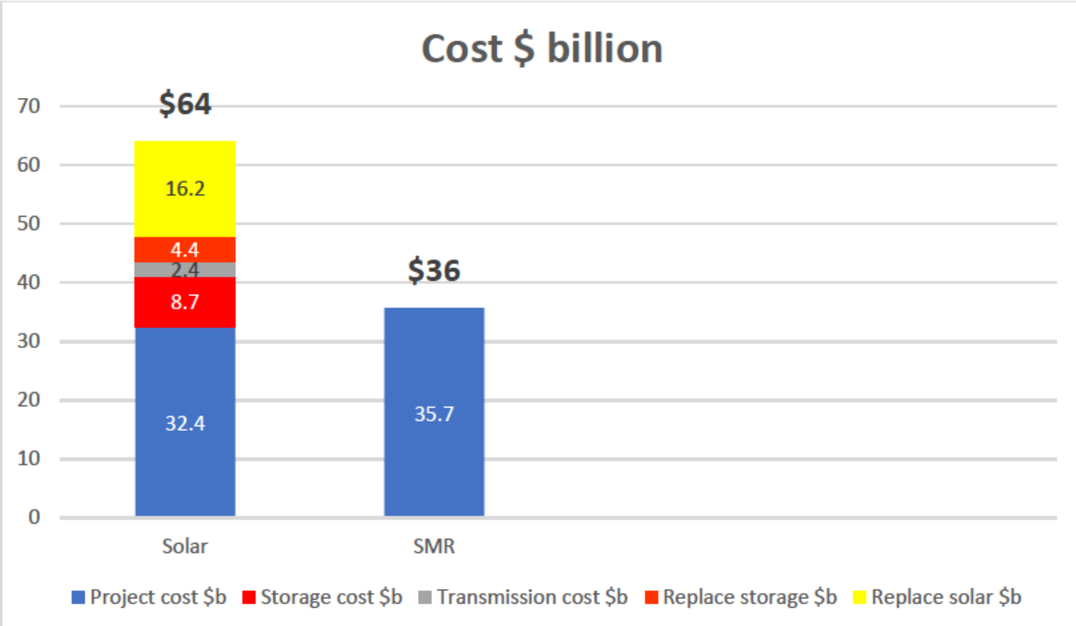

Wind > $12,492/kW, Solar > $10,378
(Solar and Wind have connection and interstate transmission costs in addition to these costs)
Coal with CCS = $11,712/kW, Gas with CCS = $7,521/kW
Costs: CSIRO GenCost 2021-22 Table B.8 for 2021

Operational capacity factors for new build: solar = 29%, wind = 40%, coal 93%, gas 80%
Operational lifetimes: solar = 30 years, wind = 25 years, coal 50 years, gas 40 years.

Storage requirements and costs from CSIRO GenCost report 2021-22 – average 0.27 kW storage capacity for each kW of wind and solar installed.

SMR $5,596/kW (NuScale estimate for 12 module 884 MWe Net in Australia), operational life > 60 years.

## Coal Fired power stations in NSW generated 49,110 GWh in 2021. What would be the cost of replacing this generation with utility scale solar or SMRs to2050?



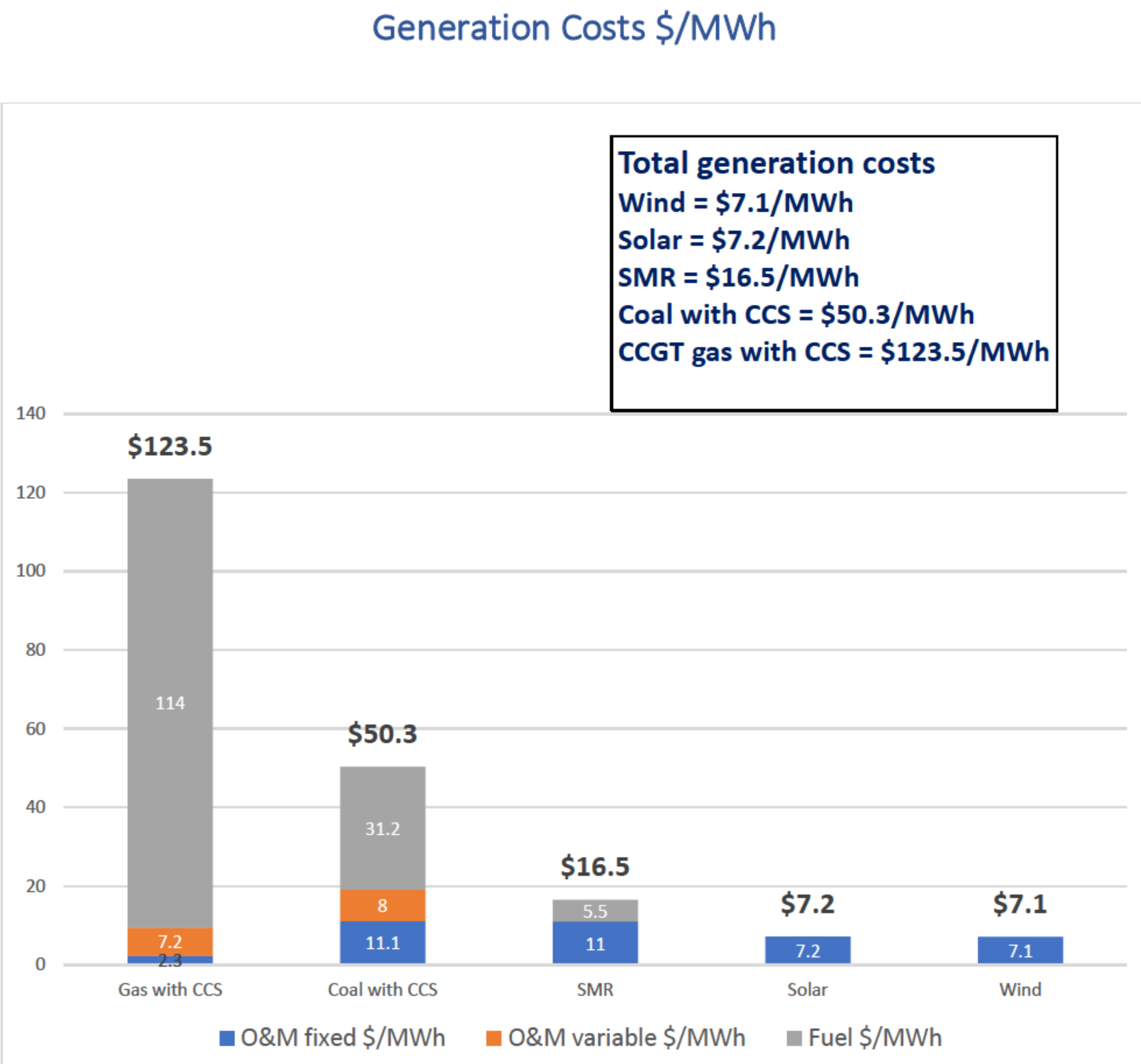

**To 2050**
**Total solar cost = $64.05 billion**
Solar based on Darlington Point (NSW) 333 MWdc/275 MWac, capacity factor 28.4%
Annual generation 685 GWh/year (Edify website)
72 solar plants required at a cost of $0.45 billion each.

**Total SMR cost = $35.7 billion**
SMR based on NuScale 12 module 884 MWe net. 7 plants required at a cost of $5.1 billion each.

Storage requirements and cost based on CSIRO GenCost GenCost 2021-22 report, average 0.27 kW storage capacity for each kW of solar installed.

Additional transmission required based on a proportion of AEMO ISP 2022 (2050) – 10,000 km required for total variable renewable energy (wind and solar)
Solar cost includes storage (4 hr battery), additional transmission cost and replacement of the solar plant and battery during lifetime at half cost.
No allowance for battery round trip losses or transmission losses.

(No additional storage or transmission or replacement required for SMR – 60 year design life).

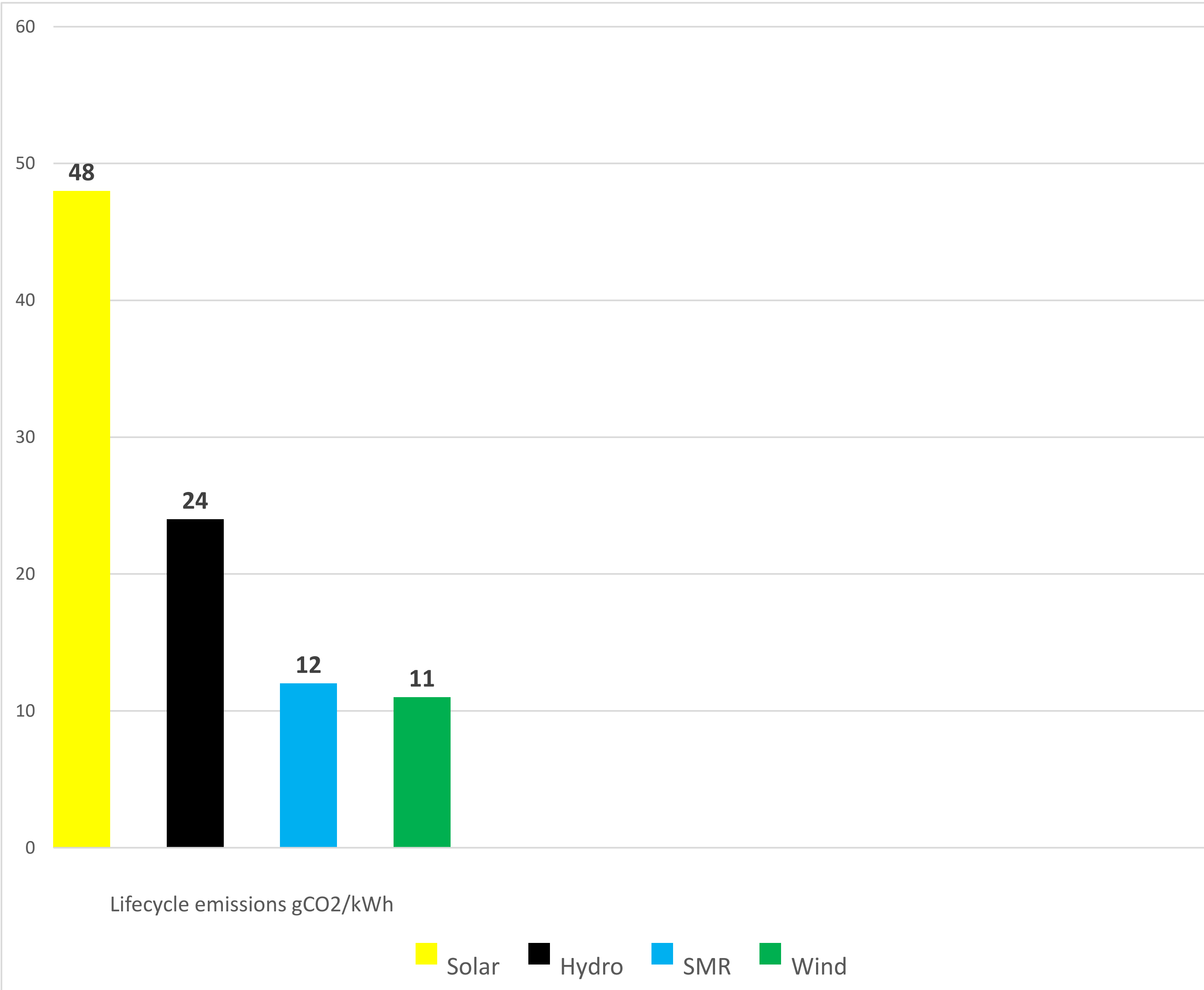



SMR costs: NuScale estimates for Australia

Other technology costs: CSIRO GenCost 2021-22 report table B.8 for 2021

O&M = Operations and Maintenance.
Fixed costs are incurred regardless of the generated electricity.
Variable costs relate to the MWh of generation.
Fossil fuel costs are very sensitive to fuel costs.
Nuclear fuel costs are a smaller proportion of generation costs and are more predictable

## Life Cycle $CO_2$-equivalent Emissions $gCO_2/kWh$




## Low Emissions Technologies:

All these technologies have zero emissions during operation. Whole of life cycle emissions include mining, materials, construction, decommissioning, waste management.

Utility scale solar = 48 $gCO_2/kWh$

Hydro = 24 $gCO_2/kWh$

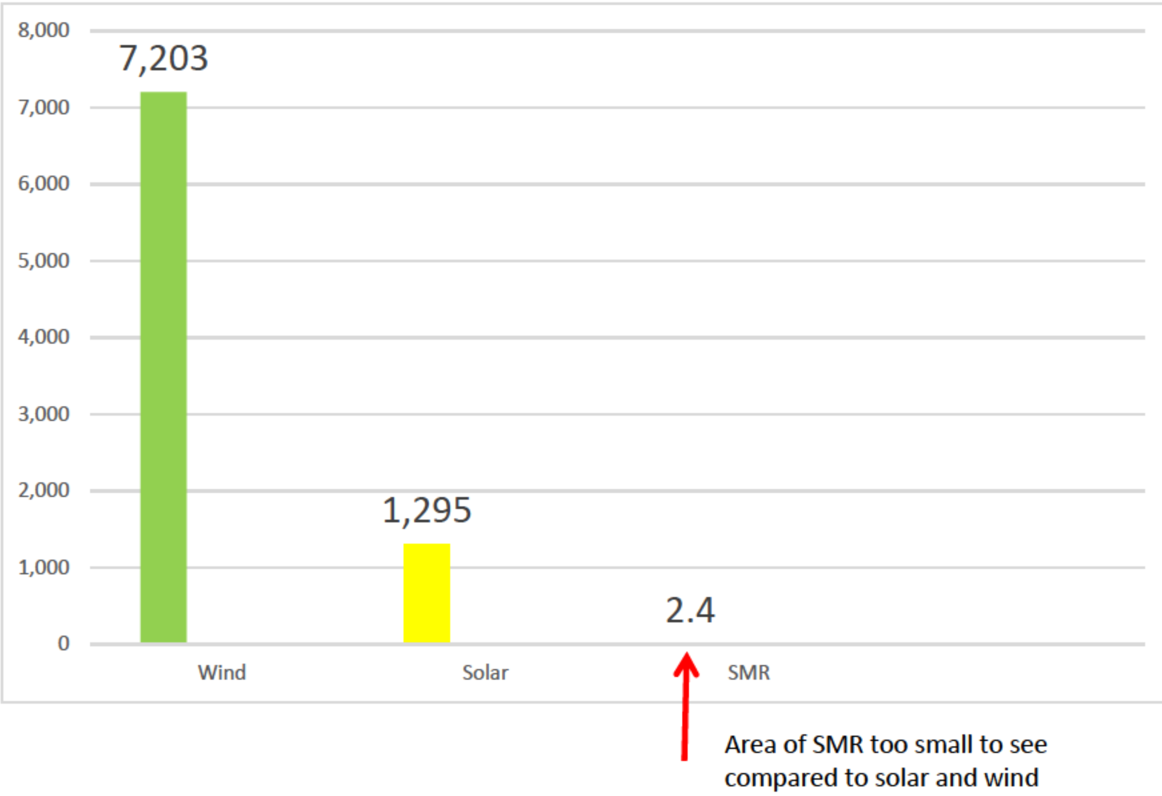
SMR = 12 $gCO_2/kWh$

Onshore wind = 11 $gCO_2/kWh$

United Nations Economic Commission for Europe (UNECE) report 2022

Nuclear = 5.1 – 6.4 $gCO_2/kWh$, reducing due to less emissions from latest mining/enrichment technologies

# Land Requirements hectares/TWh

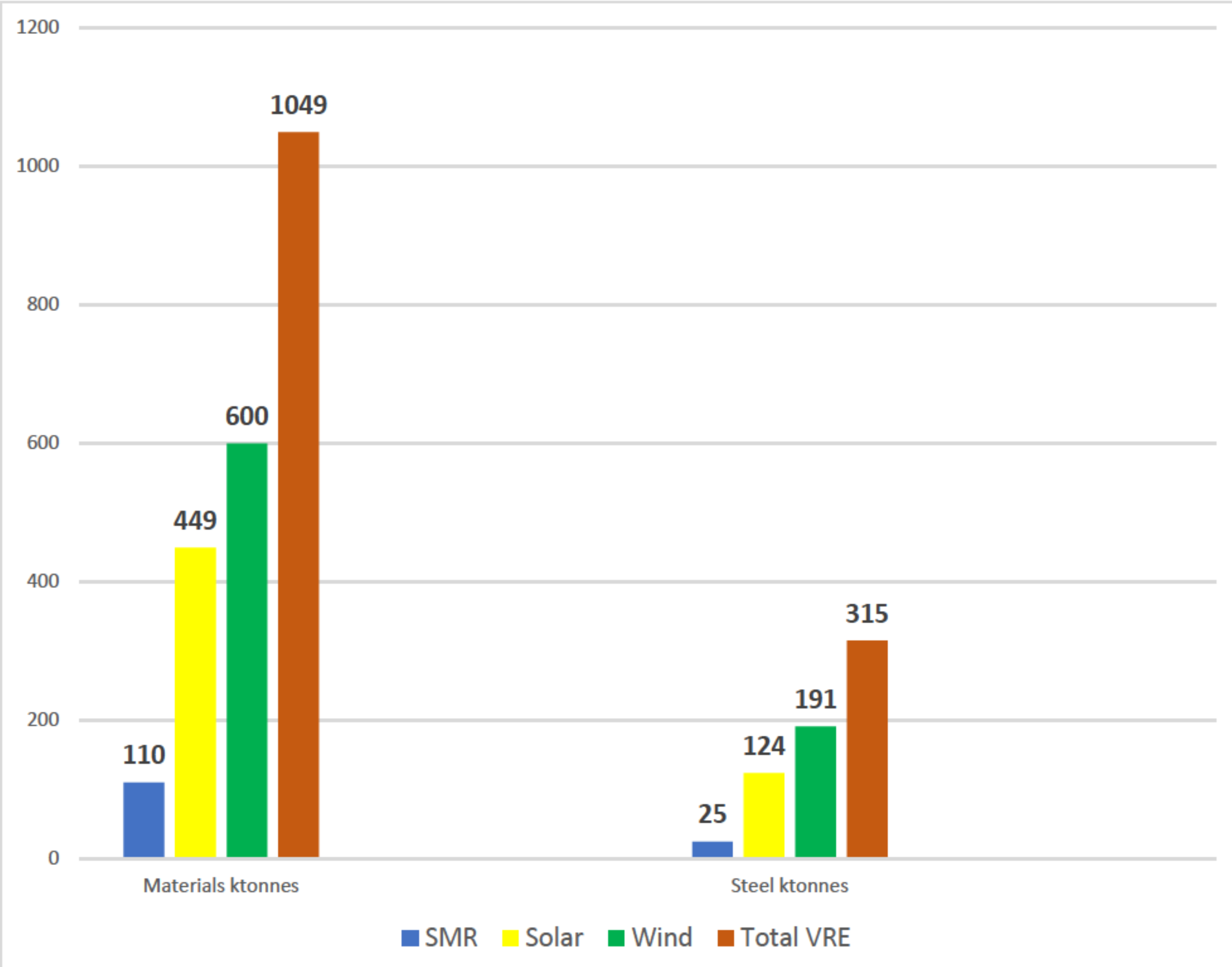



Ref: Wind and solar – NEI April 2022

SMR: NuScale 12 module 924 MWe (Gross) on 18 hectares, annual generation 7,357 GWh/year

Solar example: Darlington Point (NSW)
275 MWac on 1,000 hectares, annual generation 685 GWh/year
1 million SAT (single axis tracking) solar panels

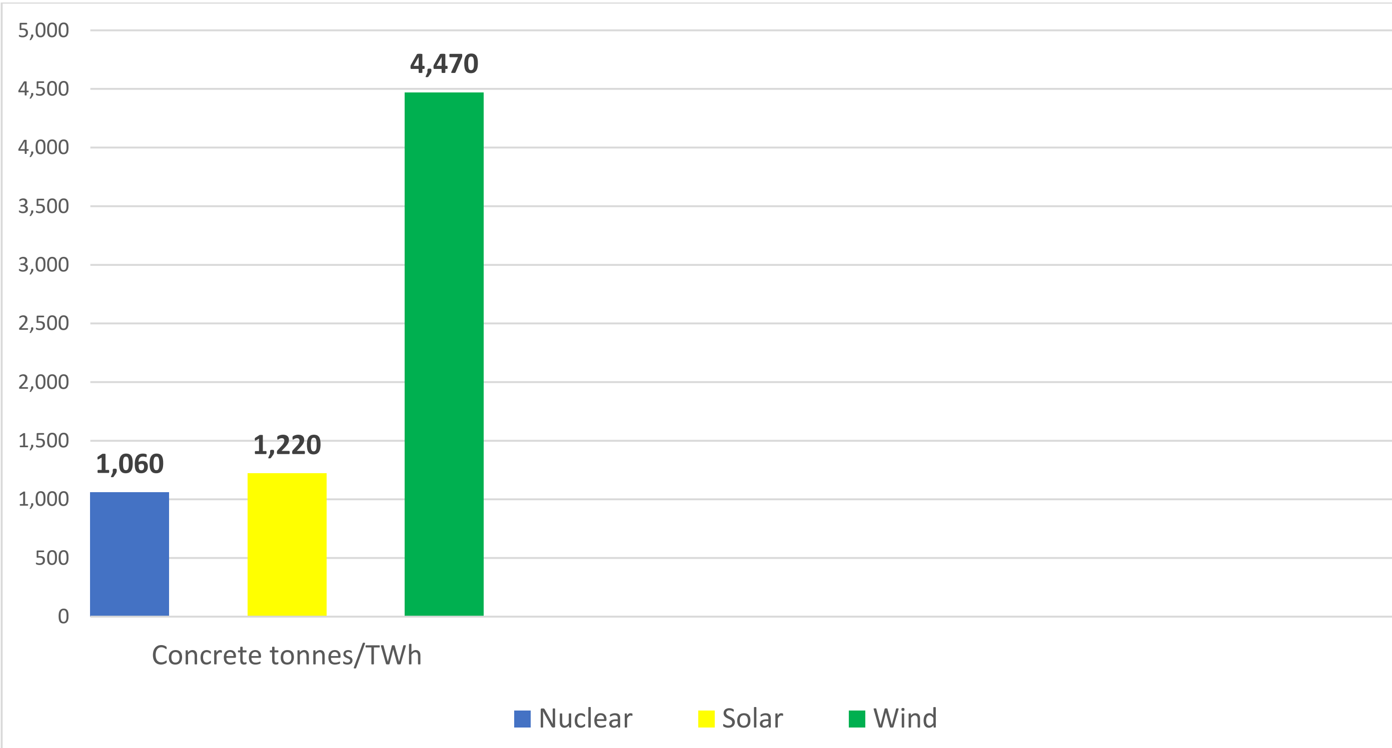
AEMO 2022 Integrated System Plan (ISP) requires 60 GW of additional wind and 64.1 GW of additional solar for the most likely scenario.
What are the quantities of critical materials required for these GWs of solar and wind compared to required GWs of SMR?




**Nuclear 5,000 kg/MW,** critical materials chromium, copper, nickel
**Utility Solar 7,000 kg/MW,** critical materials silicon, copper, silver
**Onshore wind 10,000 kg/MW**, critical materials copper, zinc, manganese, chromium, nickel, molybdenum, rare earths

Ref: IEA "The Role of Critical Materials in Clean Energy Transitions" May 2021
Steel quantities: Bright New World (BNW) June 2021

## How much concrete is required per TWh of electricity generated?




Quantities Ref: Bright New World (BNW)

Wind example:
Kennedy Energy Park, Hughenden, QLD
12 x 3.45 MW Vestas wind turbines, design life 20 years
Foundations for each wind turbine: 1,667 tonnes concrete + 67 tonnes reinforcing steel.
Supports 132m high tower (hub height), 600 tonnes turbine

There are 47 operating coal-fired units in the NEM on 16 sites, total capacity 22,701 MW.
AEMO lists announced closure dates and expected closure years.

| Region | Name | Owner | Capacity MW | Closure date |
|---|---|---|---|---|
| NSW | Liddell | AGL | 4 x 500 | Unit 3 shutdown 1/4/2022<br>Units 1, 2, 4 closure 1/4/2023 |
| NSW | Eraring | Origin Energy | 4 x 720 | 18/8/2025 |
| VIC | Yallourn | Energy Australia | 2 x 350<br>2 x 375 | 2028 |
| QLD | Callide B | CS Energy | 2 x 350 | 2028 |
| NSW | Vales Point B | Delta Electricity | 2 x 660 | 2029 |
| NSW | Bayswater | AGL | 3 x 660<br>1 x 685 | 2033 |
| QLD | Gladstone | Gladstone PS | 6 x 280 | 2035 |
| QLD | Tarong | Stanwell Corporation | 4 x 350 | 2036/7 |
| QLD | Tarong North | Stanwell Corporation | 1 x 450 | 2037 |
| NSW | Mount Piper | Energy Australia | 1 x 730<br>1 x 660 | 2040 |

**All the coal-fired power stations in NSW are scheduled to be shut down by 2040.**
**They generated 49,110 GWh in 2021 = 70% of NSW generation.**

| Region | Name | Owner | Capacity MW | Closure date |
|---|---|---|---|---|
| QLD | Kogan Creek | CS Energy | 1 x 744 | 2042 |
| QLD | Stanwell | Stanwell Corporation | 4 x 365 | 2043-46 |
| VIC | Loy Yang | AGL | 3 x 560<br>1 x 530 | 2045 |
| VIC | Loy Yang B | Gippsland Power | 2 x 580 | 2047 |
| QLD | Millmerran | Millmerran Power | 2 x 426 | 2051 |
| QLD | Callide C | Callide Energy | 2 x 420 | 2051 |

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# A Just Transition to Low-Emissions Technology - Repowering Coal-fired Power Stations in Australia with SMRs

**April 2023 Update**

***The retirement of coal-fired power stations in the NEM provides an opportunity to re-use or re-purpose the infrastructure, retain jobs and maintain the life of local communities by repowering the sites with Small Modular Reactors.***

*Image: NuScale Power SMR, 12 x 77 MWe modules, 924 MWe total on an 18 hectare site.*

# EXECUTIVE SUMMARY

There are 43 remaining coal-fired power plants in the NEM on 16 sites and most of these will be retired before 2040.These sites have valuable infrastructure, particularly the transmission connections, that can be reused.

Also equally valuable is the highly skilled workforce.

These 16 sites could be repowered with Small Modular Reactors providing reliable, low emissions power just where it is needed.

**Re-using the existing infrastructure makes the best use of the assets and reduces costs but, more importantly, retains jobs and keeps the local community alive.**

**This will facilitate a "Just Transition".**

**There needs to be a shift from public acceptance to community involvement. Governments can assist in making this happen by providing finance to communities to enable them to explore all the options.**

**Australia has an opportunity to achieve better outcomes for communities and the climate.**

## Contents



## Tables and Figures

## Abbreviations

| | |
|---|---|
| AEMO | Australian Energy Market Operator, manages electricity and gas systems and markets across Australia |
| ANSTO | Australian Nuclear Science and Technology Organisation, Australia's nuclear research organisation |
| ARPANSA | Australian Radiation Protection and Nuclear Safety Agency, the Australian Federal nuclear regulator |
| BWR | Boiling Water Reactor, the second most common type of power reactor |
| NEM | National Electricity Market, the Australian east coast electricity system stretching from Queensland to South Australia, including Tasmania |
| NRC | Nuclear Regulatory Commission, the US nuclear regulator |
| OPAL | ANSTO's research reactor at Lucas Heights, produces medical and industrial isotopes, irradiates silicon for the semi-conductor industry and uses neutron beams for research. OPAL does not generate electricity. |
| PWR | Pressurised Water Reactor, the most common type of power reactor |
| SANFCRC | South Australia Nuclear Fuel Cycle Royal Commission, 2016 major study of the opportunities for South Australia in the nuclear fuel cycle including nuclear generation |
| SMR | Small Modular Reactor, the usual accepted definition is a power reactor with an output of up to 200 MWe |

## 1. Coal-fired Power Stations in the NEM

There are 43 existing coal-fired units in the NEM on 16 sites, with a total generating capacity of 20,701 MW. Individual units range in output capacity from 280 MW to 744 MW. Many plants are old and will be retired, most will be shut down by 2040. AGL has already shutdown Liddell unit 3 and the remaining three units shut down in April 2023. In addition to providing reliable, dispatchable generation, these plants also contribute to system inertia, stability and frequency control.

The main disadvantage of coal-fired power stations is their operating emissions. Typical subcritical black coal emissions are 940 $kgCO_2$-e/MWh and subcritical brown coal 1,140 $kgCO_2$-e/MWh[1]. If the plants were replaced with the latest ultra-supercritical black coal this would only reduce the emissions to 700 $kgCO_2$-e/MWh which is still far too high. Any new coal-fired power stations would have to be equipped with carbon capture and storage and the cost of this would have to be assessed.

The only low emissions technology that is reliable, dispatchable and independent of the weather and provides the same system inertia and resilience as coal is nuclear power. For Australian conditions, SMRs would be a very suitable technology to repower coal-fired power station sites as coal-fired plants are retired.

**Table 1: Existing coal-fired power plants in the NEM**

| Region | Name | Owner | Nameplate Capacity MW | Expected closure year and closure dates |
|---|---|---|---|---|
| NSW | Bayswater | AGL | BWO1 660<br>BWO2 660<br>BWO3 660<br>BWO4 685 | 2033<br>2033<br>2033<br>2033 |
| QLD | Callide B | CS Energy | B1 350<br>B2 350 | 2028<br>2028 |
| QLD | Callide C | Callide Energy + IG Power | CPP3 420<br>CPP4 420 | *2051**<br>*2051** |
| NSW | Eraring | Origin Energy | ERO1 720<br>ERO2 720<br>ERO3 720<br>ERO4 720 | 19/8/2025<br>19/8/2025<br>19/8/2025<br>19/8/2025 |
| QLD | Gladstone | Gladstone PS Participants | GSTONE1 280<br>GSTONE2 280<br>GSTONE3 280<br>GSTONE4 280<br>GSTONE5 280<br>GSTONE6 280 | 2035<br>2035<br>2035<br>2035<br>2035<br>2035 |
| QLD | Kogan Creek | CS Energy | KPP1 744 | 2042 |
| NSW | Liddell | AGL | LDO1 500<br>LDO2 500<br>LDO3 500<br>LDO4 500 | Shutdown 29/4/2023<br>Shutdown 28/4/2023<br>Shutdown 1/4/2022<br>Shutdown 24/4/2023 |

[1] Finkel report Appendix D

| | | | | |
|---|---|---|---|---|
| VIC | Loy Lang A | AGL | LYA1 560<br>LYA2 530<br>LYA3 560<br>LYA4 560 | 2035<br>2035<br>2035<br>2035 |
| VIC | Loy Yang B | Gippsland Power | LOYYB1 580<br>LOYYB2 580 | 2047<br>2047 |
| QLD | Millmerran | Millmerran Power Partners | MPP1 426<br>MPP2 426 | 2051<br>2051 |
| NSW | Mt Piper | Energy Australia | MP1 730<br>MP2 660 | 2040<br>2040 |
| QLD | Stanwell | Stanwell Corporation Ltd | STAN1 365<br>STAN2 365<br>STAN3 365<br>STAN4 365 | 2043<br>2044<br>2045<br>2046 |
| QLD | Tarong | Stanwell Corporation Ltd | TARONG1 350<br>TARONG2 350<br>TARONG3 350<br>TARONG4 350 | 2036<br>2036<br>2037<br>2037 |
| QLD | Tarong North | Stanwell Corporation Ltd | TNPS1 450 | 2037 |
| NSW | Vales Point B | Delta Electricity | VP5 660<br>VP6 660 | 2029<br>2029 |
| VIC | Yallourn W | Energy Australia | YWPS1 350<br>YWPS2 350<br>YWPS3 375<br>YWPS4 375 | 2028<br>2028<br>2028<br>2028 |

yellow highlight – closure date provided to AEMO

*Callide C – closure year not submitted to AEMO – 2051 based on 50 year life (commissioned 2001)

Source: AEMO NEM Generation Information March 2023

https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information

## 2. The Advantages of Reusing Existing Infrastructure

There are many advantages to repowering an existing electricity generation site:

- The transmission system was developed to make best use of these sites.
- Each site is already classified as an industrial site, avoiding some planning applications.
- Each site has already been assessed by the EPA for electricity generation. (There would have to be a new Environmental Impact Assessment for use as a nuclear facility).
- The local community is used to living near to the site. The site provides jobs in regional areas and brings significant economic benefits from the need for goods and services. The sites are located in rural areas where there are few other options for employment.
- The remaining coal-fired power plant sites in the NEM have large installed capacities ranging from 450 MW to 2,665 MW. They have strong transmission connections. The existing transmission connections are particularly valuable because:
    - They connect the existing large generators to load centres
    - New transmission lines are expensive. The Parsons Brinckerhoff report for the SANFCRC (2016) estimated $344m for a 1,600 MW, 500kV, 50km transmission connection.

  - The approval process for new HV transmission lines can be long and complex. There will always be some opposition to new HV transmission lines
  - The HV switchyard on site is also a valuable asset.
- The existing coal-fired power plants have steam turbine generators with cooling water supplies under licence from the sea/lake/river for the turbine condensers. Most SMRs also use steam turbines and the existing cooling water supplies and licences can be used.
- The existing coal-fired power plants use demineralised water for boiler feed water. Most SMRs also use demineralised water
- Many existing buildings on the site can be reused, for example the administration building, stores and workshops
- The site firefighting system can be reused
- The existing transport links are also valuable. The roads would have already been upgraded to take heavy machinery. Some sites also have rail or barge access which is also very useful.

A study by NuScale estimated that, on average, US$100m worth of infrastructure assets could be reused for a NuScale power plant.

Re-using the existing infrastructure makes the best use of the assets and reduces costs, but more importantly retains jobs and keeps the local community alive.

## 3. The Advantages of Repowering or Re-purposing Sites with SMRs

Nuclear is the best option to repower a coal site because it provides reliable power with zero operating emissions and can work in a system with wind and solar.

The low emissions technology options for repowering a coal-fired power plant are solar, wind, hydro and nuclear.
Solar has a very low energy density and requires a lot of flat land, for example Darlington Point is the largest solar farm connected to the NEM. It occupies 1,000 hectares and only produces 275MWac maximum output.
Wind farms have to be located in an area of good wind and require even more area than solar.
Hydro plants require a mountain type environment unlike a flat coal site.

Nuclear is the best option to repower a coal site. Nuclear is reliable with zero operating emissions. SMRs are the best nuclear option for Australia, because a modern 1,100 MW nuclear reactor would be too large a single unit for the Australian grid system. The largest single unit on the NEM is Kogan Creek 744MW.

SMRs have a high output capacity per land area. An SMR would fit easily on any power station site, for example a NuScale 12x77 MW (924 MW total) plant would occupy only 18 hectares. For comparison, the Liddell coal-fired power station site occupies 116 hectares and Vales Point B 88 hectares.

Bryden Wood has created a new digital platform for making the replacement of coal-fired boilers at existing power plants with advanced SMRs[2]

[2] Bryden Wood digital platform https://www.world-nuclear-news.org/Articles/Digital-platform-launched-for-repowering-coal-plan

Modern SMRs have become a game-changer for nuclear safety. The NuScale SMR does not require any operator action, back-up electrical supplies or water supplies to keep the reactor safe and would have survived even the Fukushima accident. The passive safety systems enables decay heat to be removed indefinitely without attention.

The enhanced safety characteristics of SMRs, such as smaller reactor cores, simpler systems and built-in passive safety features, mean that safety arrangements can be proportionate with these reduced risks. For example, the US NRC has a mandatory requirement for a 10-mile emergency planning zone (EPZ) around a large light-water reactor. This can be reduced to the site boundary for an SMR. This was confirmed when Tennessee Valley Authority (TVA) applied in 2016 for an Early Site Permit (ESP) for the potential use of its Clinch River site for an SMR. The NRC found that an SMR plant based on the NuScale design would meet the conditions for a site boundary EPZ.[3] The NRC issued the ESP on 19 December 2019. An ESP certifies that a site is suitable for the construction of a nuclear power plant from the point of view of site safety, environmental impact and emergency planning.

This decision recognises the inherently lower risk profile of SMRs, simplifies the licensing and provides greater flexibility for siting. In particular this characteristic would allow an SMR to be sited on an existing coal-fired power station site.

Advantages of SMRs:

- Provide reliable, dispatchable generation independent of the weather
- Provide system inertia, resilience, frequency control and can load follow to work in a system with variable renewable energy
- Compact, factory built, transportable module reduces on-site construction time and reduces the risk of construction delays
- Lower initial capital cost than a large reactor and modules can be added as demand increases
- Zero operating emissions and low lifetime emissions comparable to wind and less than solar

## 4. Local Communities and the Need for a Just Transition

Replacing a coal-fired power station with an SMR would have an immediate effect on the health of the local community. There would be no more coal dust blown into their homes, no more breathing problems, no emissions of nitrous oxides, sulphur and heavy metals.

Community consultation, including with local Indigenous peoples, is crucial to any project and will also be a key factor in siting nuclear power plants. The local community must voluntarily agree to have their coal-fired power station site re-powered by an SMR. The agreement of the clear majority of local inhabitants is essential. This will require the local community to have access to factual information and independent experts to allow them to come to a knowledgeable decision. In this regard, the information available from the International Atomic Energy Agency (IAEA) will be very useful. In December 2021, the IAEA issued their latest guidance document “Stakeholder Engagement in Nuclear Programmes”.

[3] NRC ESP for an SMR at TVA’s Clinch River site https://www.nrc.gov/reactors/new-reactors/smr/clinch-river.html

The Australian nuclear regulator, ARPANSA (Australian Radiation Protection and Nuclear Safety Agency) can also be asked to clarify any issues. In accordance with international best practice, ARPANSA is a completely independent agency, in the Federal Health Department, totally removed from industry.

Communities are looking for a "Just Transition" having devoted their lives to mining coal and operating coal-fired power stations. SMRs would provide this "Just Transition" for power station staff.

There needs to be a shift from public acceptance to public involvement.

## 5. Creating Jobs and Facilitating Economic Development

In addition to the existing valuable infrastructure, the other major site asset is the existing highly trained workforce.

A coal-fired power station consists of a coal-fired boiler to produce steam and a steam turbine generator which converts the steam into electricity.

An SMR has a nuclear reactor to produce steam. The rest of the plant is the same as a coal-fired power station. This means that if you are a turbine operator at a coal-fired power station you could easily transition to a job as a turbine operator at an SMR. The same transition applies to maintenance staff. Many systems are similar, including condensate and feed pumps, air compressors, cooling water pumps, water treatment plant, electrical and control systems.

Staff will need familiarisation with the new systems and some staff will require additional training to be licenced to operate the nuclear reactor and carry out maintenance on reactor systems.

This would be achieved with the support of universities and technical colleges, SMR vendor training and experience at operating nuclear power plants overseas. The use of simulators (as in the aircraft industry) is an important training tool. Most nuclear power plants have simulators for initial and on-going training.

It is essential that the operating staff are appointed at the same time as construction of the facility commences. This enables the future operating staff to see the plant as it is built and gain valuable experience by participating in commissioning. This is the practice in the UK, and was very successfully adopted for ANSTO's new OPAL research reactor.

NuScale has issued a report on repurposing US coal plants including the transition of workers to similar positions.[4]

NuScale has assessed that a 12 module, 924 MW NuScale plant will employ 270 staff.
This includes ~200 operations/maintenance/outage/technical staff. A large two-unit coal-fired power station would have around the same number of these staff, including around the same number of shift operations staff. NuScale estimate 45 operations staff will be required (5 shifts x 9).

Nuclear plants provide high quality, long-term, well-paid jobs. New SMRs have a design life of 60 years providing good long-term employment and career prospects.

[4] http://www.smrnuclear.com.au/wp-content/uploads/2021/04/nuscale-smr-technology-an-ideal-solution.pdf

### Table 2: List of coal plant positions with comparable NuScale SMR positions (table provided courtesy of NuScale Power)

| Department | Coal Power Plant Position | NuScale Equivalent Position |
|---|---|---|
| **Senior Management** | Plant Manager | Plant Manager[1] |
| | Operations Manager | Operations Manager[1,2] |
| | Maintenance Manager | Maintenance Manager[1] |
| | Engineering Manager | Technical Services Director[1,2] |
| | Common Facilities Manager | Site Support Services Supervisor |
| **Operations** | Assistant Ops Manager | Shift Manager[2] |
| | Shift Supervisor | Control Room Supervisor[2] |
| | Control Room Operator | Reactor Operator[3] |
| | Field Operator | Non-licensed Operator |
| **Outage Planning** | Outage Manager | Generation & Planning Manager[1] |
| | Planner | Planner |
| **Maintenance Planning** | Maintenance Supervisor | Maintenance Supervisor |
| | Foreman | Work Control Lead |
| | Planner | Planner |
| | Engineering Technician | Work Control Scheduler |
| **Maintenance Planning** | Boilermaker | Mechanic |
| | Steam Fitter | Mechanic |
| | Mechanic | Mechanic |
| | I&C Technician | I&C Technician |
| | Electrician | Electrician |
| | Heavy Equipment Operator | Site Support Craftsman |
| | Auto Mechanic | Mechanic |
| | Labor Foreman | Site Support Craftsman |
| | Laborers | Site Support Craftsman |
| | Metal Fabricator/Welder | Site Support Craftsman |
| | Tool Room Specialist | Tool Crib Attendant |
| **Engineering** | Thermal Station Engineer | Design Engineer |
| | System Engineer | System Engineer |
| | Site Project Engineer | Component Engineer |
| | Shift Engineer | Staff Technical Advisor |
| | Project Manager | Supply Chain Specialist |
| **Environmental** | Environmental Board Operator | Radwaste Operator |
| | Environmental Operator | Non-licensed Operator |
| | Plant Chemist | Chemistry Technician[4] |
| **Coal Yard and Railroad** | Coal Yard Specialist | Site Support Craftsman |
| | Coal Handler | Site Support Craftsman |
| | Railroad Specialist | Site Support Craftsman |
| | Railroad Train Operator | Site Support Craftsman |
| **Security** | Security Guard | Nuclear Security Officer |

Notes for table 2 (as applicable in the USA):
1. Nuclear power plant experience requirement of 4 years
2. Senior reactor operator experience required
3. Reactor operator licence required
4. Limited to secondary and auxiliary water chemical analyses

The first NuScale SMR is planned to be sited near Idaho Falls, USA. The Idaho Department of Labor has forecast that the SMR will generate 12,800 local jobs during construction and 1,500 during operations.

The 1,000 direct construction jobs would create or support an additional 11,800 jobs through 'inter-industry' trade and local services for the new workforce. NuScale expects direct construction jobs to peak at 1,100 employees and this would last for much of the three-year site build.

The new plant will also support long term employment in Idaho Falls. NuScale expects the plant to directly employ 270 workers when it is online and the Department of Labor expects this will support 1,500 local jobs, equating to annual revenues of US$389 million for local industry in this regional area.

### *Trade unions recognise the value of the high-quality jobs that nuclear power can provide Australians.*

Trade unions are amongst the strongest supporters of nuclear energy in countries that already have operating nuclear power plants. Unions in Australia are already recognising the merits of SMRs in replacing existing dispatchable generation. Coal plant workers and their communities demand a 'Just Transition' of their industry, a transition where their livelihoods are not unwittingly destroyed by the rush to reduce emissions.

Social costs of job losses from the closure of coal plants and mines in regions such as the Latrobe and Hunter Valleys will be immense. Many claim that renewables can provide a transition in employment for coal plant workers. However, jobs in wind and solar are often in a different region and do not provide the same level of sustained income as coal jobs. SMRs utilise similar equipment to coal plants on the secondary side of the plant and therefore can transfer jobs more directly and at the same location.

The Mining & Energy Union Victoria (a Division of the CFMMEU) has also stated concern about a renewables-only approach to emission reduction because it would lead to 'major blackouts, unaffordable electricity and the future economic shutdown of Victoria's industry; resulting in massive job losses and citizen wealth decline.' Australia already has the skilled people needed for a nuclear power industry but a 7-year lead time will be required to build SMR replacements for Australia's aging coal power plants. Therefore, the green light needs to be given sooner rather than later.[5]

An expanded domestic nuclear industry with nuclear power generation would give many communities across Australia the opportunity for economic development. All sites should develop an Indigenous employment strategy including training, mentoring, apprenticeship support for local students, and incorporating unique cultural skills, especially in environmental management.

In 2019, Colorado, USA, established an "Office of Just Transition" specifically to help coal communities move into new, well-paid jobs[6].

[5] https://www.energypolicyinstitute.com.au/images/2-20__Geoff_Dyke_PP.pdf

[6] About the Office of Just Transition," Colorado Department of Labor and Employment, https://cdle.colorado.gov/offices/the-office-of-just-transition/about-the-office-of-just-transition

## 6. Examples of SMRs Suitable for Repowering Coal Sites

**Table 3: SMRs suitable for repowering coal sites in Australia**

| Vendor/country | Reactor | Module/plant size MW | Status |
|---|---|---|---|
| NuScale<br>USA | VOYGR | 77 MW<br>4 module 308 MW<br>6 module 462 MW<br>12 module 924 MW | US NRC GDA<br>Funding from US DOE<br>First deployment for UAMPS at INL.<br>Site fieldwork completed Feb 2022, first module operating 2029.<br>Several countries evaluating. |
| GE-Hitachi<br>USA | BWRX-300 | 300 MW | Topical reports being assessed by NRC.<br>2022 Construction licence application for deployment at Ontario Power Generation (OPG) Darlington site, Canada.<br>Tennessee Valley Authority (TVA) already has an early site permit (ESP) for Clinch River site, USA – now preparing construction licence application.<br>Agreements with several countries. |
| Holtec<br>USA | SMR-160 | 160 MW | Topical reports to NRC. 2023 agreement to deploy up to 21 units in Ukraine.<br>Czech Republic evaluating |
| Rolls Royce SMR<br>UK | Rolls-Royce SMR | 440 MW | 2022 UK GDA application.<br>Funding from UK Government. Several sites in UK being assessed.<br>MOUs with several countries |
| Terrestrial Energy<br>Canada | IMSR (Integrated Molten Salt Reactor) | 195 MW<br>2 module 390 MW | CNSC Phase 2 review completed April 2023.<br>Extensive supply agreements.<br>First deployment expected in Canada. |
| Moltex Energy<br>UK/Canada | SSR-W300 | 150 MW<br>2 module 300 MW | CNSC Phase 1 VDR completed<br>Canadian Government investment<br>Proposed deployment at New Brunswick Power Point Lepreau site |
| Kairos Power<br>USA | KP-FHR (Triso fuel, fluoride salt cooled) | 140 MW | Four stage development program.<br>US DOE award $269 million<br>2021 construction application to deploy a test version at East Tennessee Technology Park in 2023 |
| Terrapower + GEH<br>USA | Natrium SFR with molten salt energy storage | 345 MW + storage boost to 500 MW | First deployment at retiring Naughton coal-fired power plant, Kemmerer, Wyoming. Operating by 2030. Two more coal-fired sites identified. |
| X-Energy<br>USA | Xe-100 | 80 MW<br>4 module 320 MW | DOE funding to demonstrate a 4-module plant at Energy Northwest's Columbia nuclear plant.<br>2022 agreement with DOW chemicals for supply of power and process heat. |

### Figure 1: NuScale Power SMR

*Image: NuScale Power SMR, 12 x 77 MWe modules, 924 MWe total on an 13 hectare site. US Nuclear Regulatory Commission (NRC) Final Safety Evaluation Report issued in August 2020 - first SMR to achieve NRC design approval.*

### Figure 2: GE Hitachi BWRX-300 SMR (300 MWe) December 2019 started regulatory process with NRC

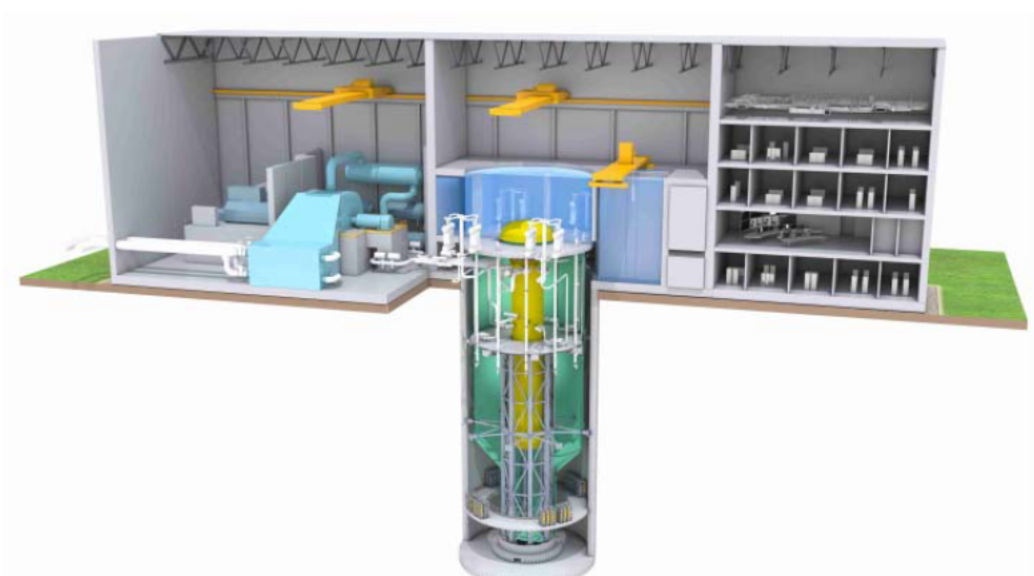

Image: GE Hitachi Nuclear Energy

## 7. Cost of SMRs

NuScale estimate[7] the overnight capital cost of their 12 module 924 MW plant will be US$2,850/kW installed capacity for the Nth of a kind plant. This would make it the least cost reliable technology in Australia.

The modular approach, factory manufacture and standardised and simplified design results in a significant capital cost reduction compared to large reactors. The simplified design also leads to lower operations and maintenance costs.

GE Hitachi is targeting US$2,250/kW installed capacity[8] for the overnight capital cost of their BWRX-300 SMR.

## 8. International Projects for Repowering Coal Sites

Terrapower (USA), backed by Bill Gates, is planning to deploy its Natrium reactor at the Naughton retiring coal-fired plant at Kemmerer, Wyoming owned by Rocky Mountain Power, a subsidiary of PacifiCorp[9]. The site was chosen following an extensive evaluation process and community meetings. Natrium is a 345 MW sodium cooled fast reactor combined with a molten salt storage that boosts the output to 500 MW when required, enabling the plant to follow daily demand changes and work with variable renewable generation. Terrapower estimates the plant would operate with 250 permanent staff and the existing 230 Rocky Mountain Power staff could transfer to the nuclear plant.

Wyoming currently generates 90% of its electricity from fossil fuels. The two-remaining coal-fired plants on the Naughton site are due to retire in 2025. Terrapower aims to submit a construction permit application to the NRC in 2023.

Poland, like Australia, is heavily dependent on coal-fired generation. In December 2021 GE Hitachi Nuclear Energy (GEH), BWXT Canada and Poland's Synthos Green Energy (SGE) signed a Letter of Intent to cooperate in deploying BWRX-300 SMRs in Poland. SGE plan to deploy at least 10 BWRX-300 SMRs in Poland by the early 2030s with the first to be operational in 2029.[10]

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[7] http://www.smrnuclear.com.au/wp-content/uploads/2021/04/nuscale-smr-technology-an-ideal-solution.pdf

[8] https://nuclear.gepower.com/content/dam/gepower-nuclear/global/en_US/documents/product-fact-sheets/GE%20Hitachi%20BWRX-300%20Fact%20sheet.pdf

[9] https://www.world-nuclear-news.org/Articles/Wyoming-site-chosen-for-Natrium-plant

[10] https://www.world-nuclear-news.org/Articles/Collaboration-for-Polish-deployment-of-BWRX-300

## 9. Utility Owners in Australia with International Nuclear Experience

Whilst nuclear power continues to be prohibited by two Federal and some State laws in Australia, there will be little enthusiasm to explore opportunities for the deployment of SMRs.

When the bans are removed and the market conditions are suitable, there will be an interest in SMR deployment by overseas companies, as there has been by overseas companies to deploy solar and wind in Australia. The market will need to recognise the value of SMR low emissions generation, both for its reliable electricity production and for its contribution to system inertial and stability.

Experience worldwide is finding that net zero by 2050 will be more difficult and costly without reliable, low-emissions nuclear. Also repowering retiring coal enables a just transition for communities and would demonstrate a caring and efficient government with a long-term vision.

There are some utility owners in Australia with nuclear experience who will no doubt become interested, particularly those with existing power station sites.

**Table 4: Utility Owners in Australia with Nuclear Experience**

| Company | Australia activities | Owner | Nuclear |
|---|---|---|---|
| Energy Australia | Electricity generation, electricity and gas retailer | Wholly owned by China Light and Power | CLP is part owner of the Daya Bay nuclear power plant in Guangdong, China |
| ENGIE | Owns and operates wind and gas-fired generation plant | French multinational energy utility | Pioneer in nuclear energy for 55 years in Europe. Operates 7 nuclear reactors in Belgium. |

## 10. Conclusions

Low-Emissions Generation Technology selection requires 'horses for courses' – that is, it requires the selection of technologies that will enable the reusing or repurposing of existing infrastructure. The selection process cannot be conducted by a desk-top study and requires the participation of affected communities.

This report elaborates on the merits of selecting the most suitable low-emissions generation technology to replace coal-fired power plants as they may be retired in Australia over the coming two decades. The report follows an earlier report by SMR Nuclear Technology Pty Ltd in August 2021 'The Case for SMRs in Australia'[11].

The report advocates to the Australian government not to search for, or attempt to select, the 'best' low-emissions generation technology on paper but to instigate a process to support those technologies that are suitable for repowering existing power station sites, retaining jobs, preserving local and regional communities and providing for a Just Transition for all Australians.

[11] http://www.smrnuclear.com.au/wp-content/uploads/2021/07/The-case-for-SMRs-in-Australia_Aug2021.pdf

There needs to be a shift from public acceptance to community involvement. Governments can assist in making this happen by providing finance to communities to enable them to explore all the options.

Australia has an opportunity to achieve better outcomes for communities and the climate.

## General References

Good Energy Collective "Opportunities for coal communities through nuclear energy – an early look" Dec 2021 https://www.goodenergycollective.org/policy/coal-repowering

NuScale SMR Technology – An Ideal Solution for Repurposing US Coal Plant Infrastructure and Revitalizing Communities, 2021 http://www.smrnuclear.com.au/wp-content/uploads/2021/04/nuscale-smr-technology-an-ideal-solution.pdf

Minerals Council of Australia "SMRs small modular reactors in the Australian Context' Dr Ben Heard, October 2021 https://www.minerals.org.au/sites/default/files/Small%20Modular%20Reactors%20in%20the%20Australian%20Context%202021.pdf

SMR Nuclear Technology Pty Ltd "The Case for SMRs in Australia", August 2021, http://www.smrnuclear.com.au/wp-content/uploads/2021/07/The-case-for-SMRs-in-Australia_Aug2021.pdf

University of Michigan "Fastest Path to Zero Initiative" https://fastestpathtozero.umich.edu/ (technology neutral tools to aid community-based decision making)

IAEA Stakeholder Engagement in Nuclear Programmes, Nuclear Energy Series NG-G-5.1 https://www.iaea.org/publications/14885/stakeholder-engagement-in-nuclear-programmes

What would be required for nuclear energy plants to be operating in Australia from the 2020's University of Queensland http://www.smrnuclear.com.au/wp-content/uploads/2022/01/WhatWouldBeRequired-FINAL-002.pdf

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SMR Nuclear Technology Pty Ltd (SMR-NT) is an independent Australian-owned specialist consulting company established in 2012.

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

Questions about this report may be directed to:

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## Appendix A: Siting Considerations for Nuclear Power Plants

Although an SMR would physically fit on any coal-fired power station site in the NEM, any site would have to be assessed for its acceptance for a nuclear power reactor. The IAEA has issued the *2019 Specific Safety Requirements SSR-1 Site Evaluation for Nuclear Installations*[12]. It is an international safety requirement that the site is evaluated such that the site-specific hazards and site related safety characteristics are adequately taken into account. This includes evaluation of external hazards including seismic, flooding, geotechnical characteristics and the evaluation of potential effects of the nuclear installation in the region.

In addition, *Specific Safety Guide SSG-35 Site Survey and Site Selection for Nuclear Installations*[13] provides recommendations and guidance in meeting the safety requirements of SSR-1.

The ARPANSA Regulatory Guide – Siting of Controlled Facilities (ARPANSA-GDE-1756WEB)[14] makes reference to the IAEA documents and advises of the issues to be addressed by an applicant when applying for a licence under the ARPANS Act to prepare a site in Australia for a controlled facility. Currently the ARPANS Act only allows for the licencing of a Research Reactor in Australia. Licensing of a power reactor is prohibited by the ARPANSA Act and the EPBC Act. These prohibitions must be removed to allow Australia to make use of all available low emissions technologies.

The enhanced safety characteristics of SMRs, such as smaller reactor cores, simpler systems and built-in passive safety features, means that safety arrangements can be proportionate with these reduced risks. For example, the US NRC has a mandatory requirement for a 10-mile emergency planning zone (EPZ) around a large light-water reactor. This can be reduced to the site boundary for an SMR. This was confirmed when Tennessee Valley Authority (TVA) applied in 2016 for an Early Site Permit (ESP) for the potential use of its Clinch River site for an SMR. The NRC found that an SMR plant based on the NuScale design would meet the conditions for a site boundary EPZ.[15] The NRC issued the ESP on 19 December 2019. An ESP certifies that a site is suitable for the construction of a nuclear power plant from the point of view of site safety, environmental impact and emergency planning.

[12] SSR-1 https://www.iaea.org/publications/13413/site-evaluation-for-nuclear-installations

[13] SSG-35 https://www.iaea.org/publications/10696/site-survey-and-site-selection-for-nuclear-installations

[14] https://www.arpansa.gov.au/regulation-and-licensing/licensing/information-for-licence-holders/regulatory-guides/regulatory-guide-siting-controlled-facilities

[15] NRC ESP for an SMR at TVA's Clinch River site https://www.nrc.gov/reactors/new-reactors/smr/clinch-river.html

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*A Submission by* ***SMR Nuclear Technology Pty Ltd*** *to*

**GenCost 2022-23 Consultation Draft**

*February 2023*

**EXECUTIVE SUMMARY**

**SMR-NT is concerned that the Australian Governments, Federal and State, are not receiving the complete up-to-date information to make an informed choice about the engineering and economic factors for the best mix of technologies for electricity supply.**

**As demonstrated by recent statements by Energy Minister Chris Bowen that SMRs will cost > $16,000/kW and are therefore too expensive to consider, Australia is neglecting a reliable, low emissions technology that is independent of the weather and is being actively considered by several countries.**
**Chris Bowen's statement was based on the GenCost 2021-22 report of $16,487/kW as the high figure for the capital cost of an SMR in 2030.**
**This inaccurate figure (adjusted to 2022) has again appeared in the GenCost 2022-23 Consultation draft and will continue to be inappropriately used to try to demonstrate that SMRs are too expensive to consider.**

## Source of the high figure for the capital cost of an SMR in 2030

GenCost 2022-23 Consultation draft table B.8 *Data assumptions for LCOE calculations* for Nuclear SMR in 2030 has a low figure of $7,355/kW and a high figure of $15,853/kW.

At the CSIRO GenCost 2022-23 webinar on current costs held on 20/10/2022, Aurecon showed their technology cost updates. Since this did not include SMRs, I asked the question "Which company will CSIRO contract to provide nuclear costs?" The response from Paul Graham was that they had no plans to update nuclear costs. He expected the next data would be from the IAEA project "Economic Appraisal of SMRs" in 2024.

The last year that CSIRO contracted a company to produce SMR capital costs was GHD in 2018.

The high estimate of $16,000/kW is from GHD (2018), for a Gen IV (advanced reactor) to be constructed in 2035, with the source of the $16,000/kW said to be the WNA. The GHD figure was disputed in Federal and State nuclear inquiries and denied by the WNA. It is inappropriate to use this figure and CSIRO admitted that 'the source was unclear". In the 2020-21 report CSIRO stated that the IEA *"Projected costs of electricity generation 2015 report* proposed that nuclear SMR typically costs 50% to 100% more than large scale nuclear and CSIRO claimed that using the 100% and recent nuclear costs justified the $16,000/kW figure.

The IEA updated their report in 2020 in their *Projected costs of electricity generation 2020 report.* This takes a more positive view of SMRs and instead of identifying an increase of cost of 50%-100% over large nuclear, the report now identifies that SMR costs could be lower. The IEA state this is due to:

"Simplification – passive mechanism improvements and greater design integration would reduce the number of components and result in containment building savings.

Standardisation – the lower power output of SMRs reduces the need to adapt to local site conditions, raising the level of design standardisation compared with large reactors.

Modularisation – smaller SMR size means that transporting their modules would be easier than for large reactors. In fact the degree of modularization increases considerably for power outputs of less than 500 megawatts of electrical capacity (MWe). This trend could be improved with more aggressive modularization techniques tailored to the logistical constraints and transport standards of each country. It is estimated that 60 – 80% factory fabrication levels are possible for SMRs (with power outputs below 300 MWe)(Lloyd, 2019)."

The continued use of this high figure due to a misinterpretation by GHD of an SMR project and an out-of-date IEA report is therefore now inappropriate.

CSIRO claim that this figure is also supported by the Economic and Finance Working Group SMR Roadmap EFWG 2019 Canada report.
This report surveys many countries. Table C-2: On Grid Inputs and Outputs Table for SMR-Evolutionary in 2030 has a high cost figure of CDN $9,476/kW = AUD 9,949/kW (current rate 1 CDN = 1.05 AUD).
Thus the EFWG report does not support a figure of anywhere near $16,000/kW, even with escalation and any additional allowance for Australian labour costs etc.

The Canadian report also states a 2030 low cost of CDN 4,837/kW = AUD $5,079/kW.
If CSIRO want to rely on the Canadian report, then it would be logical to use this low figure rather than the low figure of $7,355 for 2030 quoted in GenCost 2022-23 report table B.8.

I can understand that CSIRO would prefer not to use vendor estimates, but I suggest that a detailed vendor estimate backed by an associated AACE class would be more accurate than the current CSIRO estimates.
In 2020, our company, SMR Nuclear Technology Pty Ltd, a Sydney based consultancy, commissioned Fluor to produce a detailed cost estimate of deploying a SMR in Australia.
This is for a standard 12 module NuScale plant with a capacity of 924 MWeG, 884 MWeN output.
The cost is for a generic greenfield site in Australia and estimated as a first-of- a-kind (FOAK) facility.
Rates for Australian labour, concrete and international supply chain were derived from experience on multiple Fluor project bids in Australia.
The estimate includes:
Direct field costs - all plant, equipment and construction costs including commissioning
Indirect field costs - temporary construction buildings and field staff
Home office costs - detailed site specific engineering, procurement and contracts
The estimate does not include owners costs including land acquisition.
**Overnight capital cost: USD 3,595,720,000**. (USD 2020 costs)
884 MWe nett output, cost = USD 4,067/kW installed capacity
At the current exchange rate of 0.72, cost = **AUD 5,649/kW.**
This is a detailed bottom up AACE level 4 cost estimate. AACE class 4 is -30% to +50%.
At the +50% maximum range, this is **AUD 8,474**. Again this is far away from the >16,000/kW and I suggest this would be a more appropriate high cost figure.
This is for a FOAK plant. Because 12 modules would be built in the first plant, the learning curve for SMRs will be better than for large nuclear plants. NuScale estimate an NOAK plant built in the USA would cost USD 2,850/kW.

In January 2023, the first commercial contract for a grid-scale SMR in the Western world was signed to deploy a BWRX-300 SMR at Ontario Power Generation (OPG) Darlington site in Canada. We will soon have an actual FOAK project cost that can be used, adapted for Australia, as an SMR figure for the GenCost report. It is expected that this will be in the region of AUD 4,000/kW – AUD 5,000/kW installed capacity.

CSIRO has continued to use the $16,000/kW figure arguing that nothing has changed. What has changed is CSIRO's knowledge that the figure is not supported by evidence from any project. This figure is also not supported by any cost analysis published by any other organisation worldwide.

With regard to nuclear O&M costs, the GenCost 2022-23 draft report Apx Table B.8 Data assumptions for LCOE calculations has SMR O&M fixed $200/kW, O&M variable 5.3/MWh as the previous report.

The US EIA Feb 2021 report (Levelised costs of New Generation Resources in the Annual Energy Outlook 2021) includes O&M figures for new nuclear build in 2026:
Fixed O&M USD 15.51/MWh = AUD 22.2/MWh (rate 0.7)
Variable O&M USD 2.38/MWh = AUD 3.4/MWh (rate 0.7)

SMRs are expected to have lower costs because of the simple systems and passive safety systems requiring less maintenance.
I have previously supplied you with the NuScale O&M costs:
Fixed O&M USD 64/kW = AUD 91/kW (rate 0.7)
Variable O&M = 0
I suggest you could review your AUD 200/kW fixed O&M figure for new build.

As a more general comment, the comparison of overnight costs was appropriate when the technical capacity factor of the different technologies was not greatly different. Now that we have technologies with greatly different capacity factors, it is misleading to compare simple $/kW overnight capital costs.
For example, Figure 2-1 provides current cost estimates for electricity generation technologies. Onshore wind appears to be >50% more expensive than large scale solar, but taking into account the actual electricity produced because of the difference in capacity factor, the cost/kW is actually nearly the same.
LCOE figures are supposed to compensate for this, but it then becomes more complex due to the many variables, especially integration costs of VRE in the system.

## Some Concluding Points

All Australian governments and organisations look at the CSIRO-AEMO GenCost report as the authority on the costs of available technologies for electricity generation and base the economics of their energy policies on this document.
It is therefore vitally important that the GenCost report provides the best available information for all technologies. For many years, this has not been the case for SMRs. The last year that CSIRO engaged a company to produce a cost estimate for SMRs was in 2018 and the figures produced by GHD were widely considered to be inaccurate.
SMRs may not be deployed in Australia before 2030, but policy makers are planning on a much longer timescale and need to be fully aware of all the options.

SMR Nuclear Technology Pty Ltd has been pleased to provide this submission to the CSIRO GenCost 2022-23 Consultation Draft and as in previous years would be happy to clarify any issues.

**Tony Irwin**
Technical Director
January 2023