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

June 2024 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: GE Hitachi BWRX-300 SMR

EXECUTIVE SUMMARY

There are 44 remaining coal-fired power plants in the NEM on 15 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 15 sites (and other sites where coal-fired power stations have already been retired) 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.

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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
FEIS	US Nuclear Regulatory Commission (NRC) Final Environmental Impact Statement
GDA	UK Office of Nuclear Regulation (ONR) Generic Design Application for a new 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 300 MWe

1. Coal-fired Power Stations in the NEM

There are 44 existing coal-fired units in the NEM on 15 sites, with a total generating capacity of 21,176MW. 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 all four Liddell units. 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	Eraring	Origin Energy	ERO1 720 ERO2 720 ERO3 720 ERO4 720	19/8/2027 19/8/2027 19/8/2027 19/8/2027
QLD	Callide B	CS Energy	B1 350 B2 350	2028 2028
VIC	Yallourn W	Energy Australia	YWPS1 350 YWPS2 350 YWPS3 375 YWPS4 375	2028 2028 2028 2028
NSW	Bayswater	AGL	BWO1 660 BWO2 660 BWO3 660 BWO4 685	2033 2033 2033 2033
NSW	Vales Point B	Delta Electricity	VP5 660 VP6 660	2033 2033
QLD	Gladstone	Gladstone PS Participants	GSTONE1 280 GSTONE2 280 GSTONE3 280 GSTONE4 280 GSTONE5 280 GSTONE6 280	2035 2035 2035 2035 2035 2035
VIC	Loy Lang A	AGL	LYA1 560 LYA2 530 LYA3 560 LYA4 560	2035 2035 2035 2035

[1] Finkel report Appendix D

Region	Name	Owner	Nameplate Capacity MW	Expected closure year and closure dates
QLD	Tarong	Stanwell Corporation Ltd	TARONG1 350 TARONG2 350 TARONG3 350 TARONG4 350	2037 2037 2037 2037
QLD	Tarong North	Stanwell Corporation Ltd	TNPS1 450	2037
NSW	Mt Piper	Energy Australia	MP1 730 MP2 660	2040 2040
QLD	Kogan Creek	CS Energy	KPP1 744	2042
QLD	Stanwell	Stanwell Corporation Ltd	STAN1 365 STAN2 365 STAN3 365 STAN4 365	2043 2044 2045 2046
VIC	Loy Yang B	Gippsland Power	LOYYB1 580 LOYYB2 580	2047 2047
QLD	Millmerran	Millmerran Power Partners	MPP1 426 MPP2 426	2051 2051
QLD	Callide C	Callide Energy + IG Power	CPP3 420 CPP4 420	*2051** *2051**

*Callide C – closure year not submitted to AEMO – 2051 based on 50 year life (commissioned 2001)
Source: AEMO NEM Generation Information May 2024
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 on an existing coal-fired power station (brownfield) site. This does not include savings such as the cost of transmission and upgrading the roads for access to a greenfield site. NuScale have estimated that overnight cost of a 12 module plant in Australia would cost US$3.6 billion on a greenfield site.
WSP/Parsons Brinckerhoff for the SA Nuclear Fuel Cycle Royal Commission found the difference in capital costs for an SMR at a Greenfield – Brownfield site was ~ A$400 million.
Repowering a coal-fired site could save US$100-$500 million.

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 a large 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 probably the best nuclear option for Australia, because a modern 1,100+ MW nuclear reactor would be the largest single unit on the Australian grid system and not all States have the capacity to accommodate a unit of this size. The largest single unit on the NEM is Kogan Creek, QLD, 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]

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 enable 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

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

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

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 guidance document "Stakeholder Engagement in Nuclear Programmes".

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. ANSTO's OPAL research reactor at Lucas Heights has a reactor simulator for initial and refresher staff 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

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

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.

In April 2024 the US Department of Energy issued two useful documents on coal to nuclear conversions:

Coal-To-Nuclear Transitions: An Information Guide
https://www.energy.gov/sites/default/files/2024-04/24_DOE-NE_Coal%20to%20Nuclear%20Report_04.01_digital%20%281%29.pdf

Stakeholder Guidebook for Coal-to-Nuclear Conversions
https://fuelcycleoptions.inl.gov/SiteAssets/SitePages/Home/C2N_Guidebook_2024.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 was planned to be sited near Idaho Falls, USA. The Idaho Department of Labor had forecast that the SMR would 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 expected direct construction jobs to peak at 1,100 employees and this would last for much of the three-year site build.

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

The project was mutually terminated in November 2023 by NuScale and Utah Associated Municipal Power Systems (UAMPS) when the number of UAMPS subscribers to the project was insufficient to continue.[5]

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 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.[6]

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[7].

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[5] https://www.smrnuclear.com.au/_files/ugd/c733f6_07f46df69535475fbd3885bce307bbb4.pdf
[6] https://www.energypolicyinstitute.com.au/images/2-20__Geoff_Dyke_PP.pdf
[7] 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 USA	VOYGR	77 MW module 4 module 308 MW 6 module 462 MW 12 module 924 MW	US NRC GDA for 50 MW module, Funding from US DOE Several countries evaluating.
GE-Hitachi USA	BWRX-300	300 MW	2022 Construction licence application for deployment at Ontario Power Generation (OPG) Darlington site, Canada. Start of construction expected 2025. 2023 – OPG planning for three more BWRX-300 SMRs on same site Tennessee Valley Authority (TVA) already has an early site permit (ESP) for Clinch River site, USA – now preparing construction licence application. Agreements with several countries.
Holtec USA	SMR-160	160 MW	Topical reports to NRC Czech Republic evaluating
Rolls Royce SMR UK	Rolls-Royce SMR	440 MW	2022 UK GDA application, progressed to step 2 in April 2023. Funding from UK Government. Several sites in UK being assessed. MOUs with several countries
Terrestrial Energy Canada	IMSR (Integrated Molten Salt Reactor)	195 MW 2 module 390 MW	April 2023 CNSC Phase 2 review completed. Extensive supply agreements. First deployment expected in Canada.
Moltex Energy UK/Canada	SSR-W300	150 MW 2 module 300 MW	CNSC Phase 1 VDR completed Canadian Government investment Proposed deployment at New Brunswick Power Point Lepreau site
Kairos Power USA	KP-FHR (Triso fuel, fluoride salt cooled) Hermes 35 MWt test version	140 MW	Nov 2021 construction application for Hermes test reactor at East Tennessee Technology Park, Oak Ridge. NRC FEIS completed Aug 2023 – recommends permit issued. Dec 2023 NRC issued construction permit.
Terrapower + GEH 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. Site preparation started 2024. Operating by 2029.
X-Energy USA	Xe-100 HTGR	80 MW 4 module 320 MW	DOE funding to demonstrate a 4-module plant at Energy Northwest's Columbia nuclear plant. Aug 2022 Agreement with Dow Chemicals for supply of power and heat to US Seadrift plant, South Texas.

Figure 1: Terrapower Natrium 345 MWe + storage boost to 500 MWe
First deployment at retiring coal-fired power station, Wyoming

Image: Terrapower

Figure 2: GE Hitachi BWRX-300 SMR (300 MWe)
2022 Construction licence application for deployment at Ontario Power Generation Darlington site, Canada

Image: GE Hitachi Nuclear Energy

7. Cost of SMRs

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.

The big advantage of SMRs over solar and wind is that the SMRs do not require the additional electricity storage and large transmission extensions required to deploy solar and wind in the NEM. This makes the system costs of deploying SMRs much less, particularly when deployed on a retiring coal-fired power station site with all the existing infrastructure and transmission lines.

The IEA *Projected Costs of Generating Electricity – 2020 edition* table 3.1 has a mean overnight capital cost figure of US$ 3,606/kWe for current nuclear build.

The 2019 Canada Economic and Finance Working Group (EFWG) SMR Roadmap report has a median capital cost in 2030 of CDN $7,098/kW for SMRs based on current water-cooled technology and CDN 3,245 for advanced (Gen IV) SMRs.

In 2020, SMR Nuclear Technology Pty Ltd commissioned Fluor to produce a detailed cost estimate for deploying a 12 module, 924 MWeG NuScale plant in Australia. Rates for Australian labour, concrete and international supply chain were derived from experience on multiple Fluor project bids in Australia. The estimate, for a FOAK (First of a Kind) facility on a generic greenfield site, was US$4,067/kW.

SMRs in the Australian context (Oct 2021) published by the Minerals Council of Australia Table 3 has estimated capital costs of A$5,100 for NuScale NOAK, target A$3,200 for BWRX-300 NOAK and estimated A$4,100 for Terrestrial Energy Integrated Molten Salt Reactor FOAK.

In January 2023, the first commercial contract for a grid-scale SMR in the Western world was signed to deploy a BWRX-300 SMT at Ontario Power Generation (OPG) Darlington site in Canada. We will soon have an actual FOAK project cost that will give an indication of the cost in Australia.
It is expected that this will be in the region of A$4,000 – A$7,000/kW installed capacity.

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[8]. 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 submitted a construction permit

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

application to the NRC in 2024 and also started non-nuclear site preparation. Nuclear constructed expected to start in 2026.

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.[9]

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 inertia 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.

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

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'[10].

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.

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.

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

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

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).

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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*[11]. 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*[12] provides recommendations and guidance in meeting the safety requirements of SSR-1.

The ARPANSA Regulatory Guide – Siting of Controlled Facilities (ARPANSA-GDE-1756WEB)[13] 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.[14] 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.

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

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

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

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