Power Games

Assessing coal to nuclear proposals in Australia: Cost, timing, consent and other constraints

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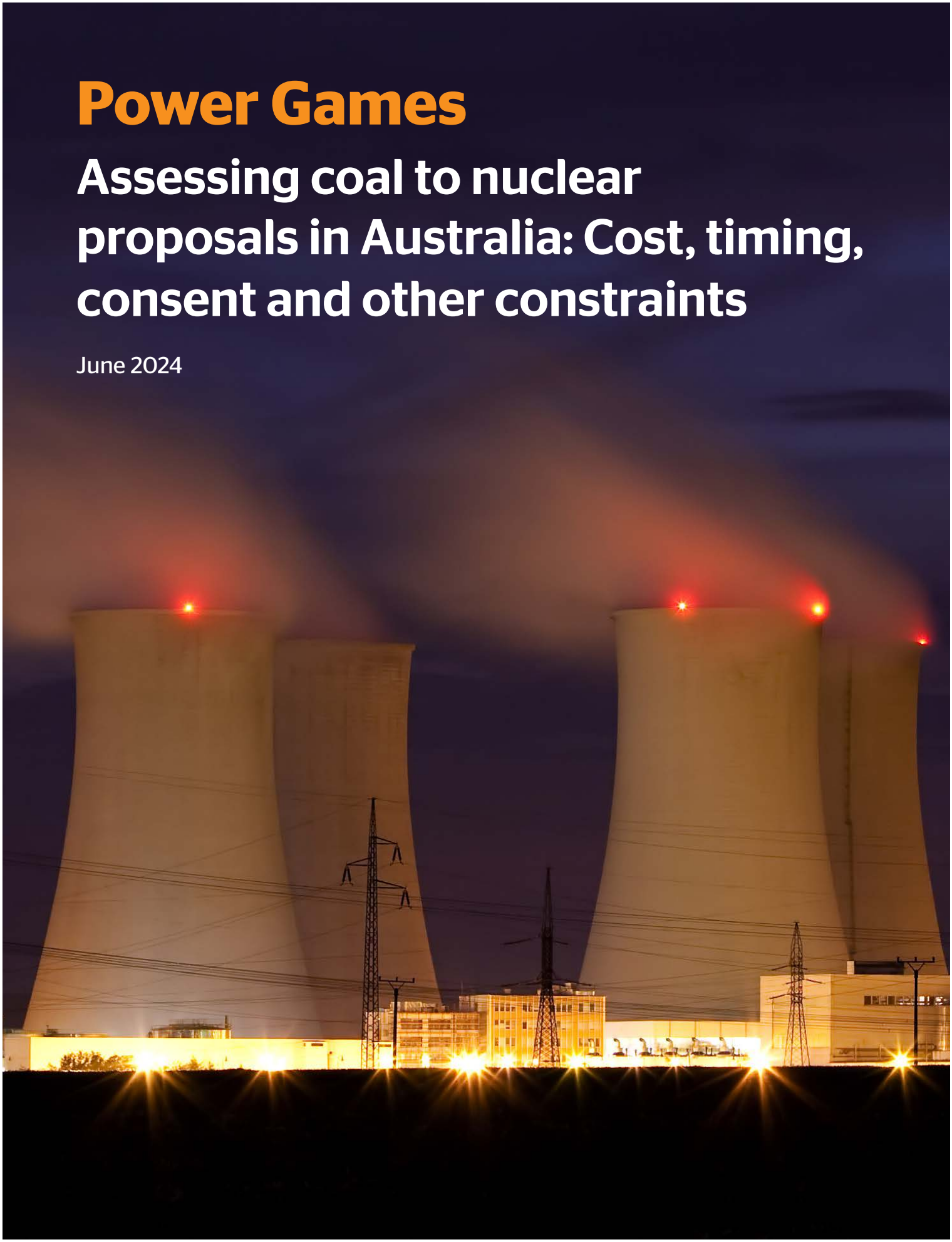

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We acknowledge the Traditional Owners of Country and their continuing connection to land, waters and community. **We pay respect to their Elders past and present** and to the pivotal role that First Nations Peoples continue to play in **caring for Country across Australia.**

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Cover. Nuclear power plant by night *Photo.* TTstudio / Shutterstock

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1. Executive summary

This report examines the impracticality of plans to introduce nuclear power to Australia in a timeframe commensurate with climate goals and the closure of most or all of Australia's remaining coal power plants over the next 15 years.

The report covers three main issues: the excessive cost of nuclear power; plausible timelines for the deployment of nuclear power in Australia; and proposals to repurpose retiring coal power plant sites as locations for nuclear power.

Section 2 of the report covers nuclear economics. It concludes that nuclear power would be uneconomic in Australia and far more expensive than continuing to build an energy system based on renewables. Lived global experience has shown that nuclear costs have escalated, sometimes dramatically, while renewable costs continue to fall.

Proposals to introduce nuclear power to Australia need to be seen against the backdrop of the massive cost overruns that have plagued reactor construction projects over the past decade including in the US, the UK and France. The failure of these and other large reactor projects has led to increased efforts to develop and promote small modular reactors (SMRs) but very few SMR projects have reached the construction stage, and none are in commercial deployment. Multi-year delays and massive cost blowouts have afflicted SMR projects, just as they have large reactor projects. Worldwide there are only two operating SMR plants and neither of the existing SMR plants are modular. The idea of modular mass production cannot be credibly advanced as the basis for a national energy system.

SMRs are not a near-term option given the lack of progress around the world and there is no certainty that this will change in the longer term. If Australia was to seriously pursue nuclear power it would necessarily involve large reactors, each costing several tens of billions of dollars, with planning and construction likely to take 20 years or more.

Taxpayer subsidies worth tens, perhaps hundreds of billions of dollars, would be required to establish a nuclear power industry in Australia. This would be the case whether pursuing small or large reactor technology.

Section 3 considers potential timelines for the deployment of nuclear power in Australia. It is unlikely nuclear power reactors could be operating in Australia in under 20 years from any decision to proceed. This would involve around 10 years for planning, licensing and other issues and a further 10 years for construction. Estimates of the time required for planning and construction of nuclear reactors overseas have consistently blown out by many years. Claims that SMRs could be built far more quickly than large reactors are not supported by real world evidence.

In 2021, the former Chair of the US Nuclear Regulatory Commission Prof. Allison Macfarlane put the situation clearly, stating that "when it comes to averting the effects of climate change, the cutting edge of nuclear technology will prove to be too little, too late".

Section 4 considers proposals to replace Australia's retiring coal power plants with nuclear plants. Coal-to-nuclear transitions could potentially reduce nuclear costs by using some existing infrastructure at coal plants, but nuclear power would still be far more expensive than firmed renewables (renewable systems with storage capacity). No coal power plants have been repurposed as nuclear plants in the US or the UK, so purported synergies and cost savings are speculative.

All or nearly all of Australia's coal plants will be closed by the time nuclear reactors could begin supplying electricity in Australia, creating a major timing problem for coal-to-nuclear proponents. As former Australian Chief Scientist Dr. Alan Finkel states, "Any call to go directly from coal to nuclear is effectively a call to delay decarbonisation of our electricity system by 20 years."

State Labor governments in the four states with operating coal plants do not support coal-to-nuclear proposals. Nor are they supported by Liberal/LNP leaders in those states. Focus group research recently carried out in the Hunter Valley in NSW and the Latrobe Valley in Victoria found voters are 'hostile' to plans for

reactors in their own areas. Private electricity generators including AGL Energy, Alinta, EnergyAustralia and Origin Energy do not support coal-to-nuclear proposals. A lack of interest from large institutional investors would also be highly problematic and a major impediment to nuclear promotion.

In addition to the issues addressed in this report, any assessment of nuclear power as an energy option for Australia should consider the following important problems:

Nuclear security: The conflict in Ukraine reminds us of the security issues that Australians would need to consider if nuclear power were to be introduced here. The Russian military's seizure of the Zaporizhzhia nuclear power plant – at a time when some of the plant's six reactors were operating – was the most dangerous incident so far. Off-site power to the Zaporizhzhia plant has been cut eight times since Russia seized control of the plant in 2022, increasing the risk of a major accident. International Atomic Energy Agency (IAEA) Director General Rafael Mariano Grossi warned in April 2024 that attacks on the Zaporizhzhia nuclear plant raised "the very real threat of a serious nuclear accident, which could have significant health and environmental consequences and benefit absolutely no one". No other energy system is as easily weaponised as nuclear power and reactors have been described as pre-deployed terrorist targets.

AUKUS nuclear-powered submarines: Coalition Senators argued in a 2023 report that Australia's 'national security' would be put at risk by retaining federal legislation banning nuclear power and that the "decision to purchase nuclear submarines makes it imperative for Australia to drop its ban on nuclear energy."

However, this view is not shared by the Labor government, nor was it the view of the Morrison Coalition government. When announcing the AUKUS agreement in 2021, then Prime Minister Scott Morrison said, "Let me be clear: Australia is not seeking to establish…a civil nuclear capability." Mr Morrison also said that "a civil nuclear energy industry is not a requirement for us to go through the submarine programme."

Top. Yallourn Power Station in Victoria's Latrobe Valley could be selected as a coal-to-nuclear proposal by the Coalition, despite resistance from the local community. *Photo.* FiledIMAGE/ iStock

Above. The proposed Aukus nuclear submarines should not drive any move for domestic nuclear power *Photo.* noraismail

Nuclear accidents: Japan is still in the early stages of recovering from the 2011 Fukushima nuclear disaster. The environmental and human impact has been profound, particularly for the more than 190,000 evacuees displaced by the nuclear disaster. Direct costs amount to many hundreds of billion dollars; if indirect economic impacts are included, this figure rises to over one trillion dollars.

Weapons proliferation: The contribution of civil nuclear power programs to nuclear weapons proliferation used to be denied by the industry. However these dual-use connections are now openly acknowledged and have become a selling point to lobby for increased taxpayer subsidies for struggling nuclear power industries in the US, the UK, France and elsewhere.

Nuclear waste: There are currently no operating deep underground repositories for high-level nuclear waste anywhere in the world. There is one operating deep underground repository for long-lived intermediate-level nuclear waste – the Waste Isolation Pilot Plant (WIPP) in the US state of New Mexico. However, the WIPP repository was shut for three years following a chemical explosion in an underground radioactive waste barrel in 2014, a result of inept management and inadequate regulation. Efforts to establish a national radioactive waste repository in Australia have repeatedly failed. Decades of mismanagement of low and intermediate level waste do not inspire confidence that far more complex high-level nuclear waste from a nuclear power program (or a nuclear submarine program) would be responsibly managed in Australia.

Social licence: First Nations, community and political concerns: Over the past 25 years successive governments have unsuccessfully tried to establish a national radioactive waste repository and store against the wishes of Traditional Owners at multiple sites, particularly in South Australia and the Northern Territory.

In 2023, Dr. Marcos Orellana, the UN Special Rapporteur on Toxics and Human Rights, visited Australia. His end of mission report noted that these struggles over proposed radioactive waste facilities have left "a legacy of division and acrimony in the communities" and that "alignment of regulations with the UN Declaration on the Rights of Indigenous Peoples is a critical step in the path towards healing open wounds of past environmental injustices". The UN Declaration states that "no storage or disposal of hazardous materials shall take place in the lands or territories of indigenous peoples without their free, prior and informed consent."

While recent opinion polling has shown some support in the wider community for the concept of nuclear power in Australia this quickly turns to concern when respondents are asked about moving from a concept or conversation to an operating reality. Community support declines sharply when the nuclear debate moves from a keynote address to a residential address. Opinion polls over the past 20 years consistently show that a majority of Australians do not want nuclear power reactors built anywhere near where they live; that they are far more supportive of renewables than nuclear power; that nuclear power consistently ranks among the least popular energy choices and that most Australians are concerned about nuclear accidents and nuclear waste.

Nuclear power is unlawful at a federal level and subject to legal or political bans or constraints in most states and territories. There is no bi-partisan political support for nuclear power at a federal or state level.

Nuclear stagnation as opposed to record renewables growth: While nuclear power has been stagnant for more than 20 years, renewable energy is growing strongly around the world. In 2023, nuclear power suffered a net loss of 1.7 gigawatts (GW) capacity, while renewable additions amounted to a record 507 GW — record growth for the 22nd consecutive year. Nuclear power accounts for a declining share of global electricity generation (currently 9.2%) whereas the renewables share has grown to 30.2% and is continuing. The International Energy Agency expects renewables to reach 42% by 2028.

2.Nuclear power: The most expensive option for Australia

2.1 Large conventional reactors

A 2019 federal Parliamentary inquiry into domestic nuclear power included Coalition MPs who, in principle, were enthusiastic about nuclear power. However, the Committee's report argued that the government should retain legal bans prohibiting the development of conventional, large nuclear power reactors (Generation I, Generation II and Generation III). Committee chair Ted O'Brien said "Australia should say a definite 'no' to old nuclear technologies." The Committee's report called for a partial repeal of legal bans to permit the development of "new and emerging nuclear technologies", including SMRs. In early 2023, opposition leader Peter Dutton said "I don't support the establishment of big nuclear facilities here at all, I'm opposed to it" and he went on to promote SMRs.

That perspective seems to have been superseded due to the failure of SMRs to advance to commercial deployment. Coalition MPs' promotion of South Korea's construction of large AP1400 reactors in the United Arab Emirates (UAE) suggests the Coalition would support the construction of South Korean AP1400 reactors in Australia and presumably also comparable large reactors such as the Westinghouse AP1000 design or French EPRs (European Pressurised Reactors).

Reactor construction costs have risen dramatically over the past 20 years. Dr. Ziggy Switkowski, who headed the Howard government's 'UMPNER' (Uranium Mining, Processing and Nuclear Power Review) process in 2006, said in 2009 that the construction cost of a one gigawatt (GW) power reactor Australia would be A$4–6 billion. Compare that estimate to recent experience in the US, the UK and France:

USA: Construction of two reactors in South Carolina was abandoned after the expenditure of around US$9 billion (A$13.6 billion). The only remaining construction project, two AP1000 reactors in the state of Georgia (known as the Vogtle project), was recently completed at a cost of approx. US$17 billion (A$25.7 billion) per reactor or US$15.5 billion (A$23.4 billion)/GW.

UK: The cost of the two EPR reactors under construction at Hinkley Point (the only reactors under construction in the UK) has escalated to £23 billion (A$43.5 billion) per reactor or £14.4 billion (A$27.2 billion)/GW.

France: The latest cost estimate for the one and only reactor under construction is €19.1 billion (A$31.1 billion) or €11.9 billion ($A19.4 billion)/GW.

Above: The V.C. Summer nuclear project in South Carolina, USA under construction in September 2016. This project has now been abandoned and a number of utility and company executives have been charged with crimes - this is known as the 'nukegate' scandal.

These nuclear cost blowouts confirm the historical pattern identified in a 2014 study which found that 175 out of 180 nuclear power projects exceeded their initial budgets, by an average of 117%.

Clearly Dr. Switkowski's earlier estimate of A$4–6 billion/GW does not reflect the real-world experience in the US (A$23.4 billion/GW), the UK (A$27.2 billion/GW) or France (A$19.4 billion/GW). These three countries also all have long experience with nuclear power, extensive nuclear expertise and synergies across their civil and military nuclear programs, all factors which cannot be said about Australia. Moreover, the above-mentioned reactor construction projects are all on existing nuclear power sites with the advantages that brings, including ready access to infrastructure, transmission, licences, a trained workforce and more.

The 2006 Switkowski report concluded that nuclear power plants in Australia would initially be 10–15% more expensive than in the US because Australia has neither nuclear power construction experience, nor regulatory infrastructure. Applying that 10–15% loading to the cost of 1.1 GW AP1000 reactors in the US (US$17 billion or A$25.7 billion per reactor), a single AP1000 reactor in Australia would cost A$28.3–29.6 billion.

Dr. Switkowski has reassessed his views in light of the cost blowouts with reactor projects and the large reductions in the cost of renewable energy sources. He said in 2018 that "the window for gigawatt-scale nuclear has closed" and he noted that nuclear power is no longer cheaper than renewables, with costs rapidly shifting in favour of renewables. Dr. Switkowski noted in his evidence to the 2019 federal nuclear inquiry that "nuclear power has got more expensive, rather than less expensive," and that there is "no coherent business case to finance an Australian nuclear industry." He added that no-one knows how a network of SMRs might work in Australia because no such network exists "anywhere in the world at the moment."

Lazard investment firm's 2023 report demonstrates that construction costs and levelised costs for nuclear power are far more expensive than costs for wind and solar, even when energy storage costs are included. (Levelised costs include the costs of both building and operating a plant per unit of electricity generated over the assumed lifetime of the plant. Levelised costs are typically measured in cents per kilowatt-hour or dollars per megawatt-hour). Lazard's nuclear costs are based on the only project to begin and complete construction in the US this century — the Vogtle project in Georgia, comprising two AP1000 reactors, each with a capacity of 1.1 GW.

Table 1

Construction cost figures from the Lazard 2023 report:

Construction Costs	US$/kW (A$/kW)
Utility scale solar PV	700-1400 (1060-2110)
Utility scale solar PV plus storage	1075-1600 (1620-2420)
Wind (onshore)	1025-1700 (1550-2570)
Wind (onshore) plus storage	1375-2250 (2080-3400)
Wind (offshore)	3000-5000 (4530-7550)
Nuclear	8475-13,925 (12,800-21,000)

As noted above, the latest estimate for the Vogtle project is US$15.5 billion/GW or US$15,500 (A$23,400)/kW — about 10% higher than the upper end of the range in the Lazard report.

Table 2

Levelised cost figures from the Lazard 2023 report:

Levelised Costs	US$/MWh (A$/MWh)
Utility scale solar PV	24-96 (36-145)
Utility scale solar PV plus storage	46-102 (69-154)
Wind (onshore)	24-75 (36-113)
Wind (onshore) plus storage	42-114 (63-172)
Wind (offshore)	72-140 (109-211)
Nuclear	141-221 (213-334)

Lazard's levelised cost for nuclear power (A$213–334/MWh) is multiple times higher than the 2006 Switkowski report's estimate of A$40–65/MWh.

More importantly, the levelised cost for nuclear power is several times higher than solar or wind plus storage in Lazard's estimates and several times higher than CSIRO's 2030 Australian estimate of A$69–101/MWh for 90% wind and solar supply to the National Electricity Market with integration (energy storage and transmission) costs included.

The South Australian Nuclear Fuel Cycle Royal Commission carefully studied nuclear power, including SMRs, and concluded in its 2016 Final Report:

"Taking into account the South Australian energy market characteristics and the cost of building and operating a range of nuclear power plants, the Commission has found it would not be commercially viable to develop a nuclear power plant in South Australia beyond 2030 under current market rules."

A 2023 article in *The Conversation* explains a fundamental problem with nuclear economics — its negative learning curve:

"Wright's law states the more a technology is produced, the more its costs decline. Wind and especially solar power and lithium-ion batteries have all experienced astonishing cost declines over the last two decades. For nuclear power, though, Wright's law has been inverted. The more capacity installed, the more costs have increased. Why? This 2020 MIT study found that safety improvements accounted for around 30% of nuclear cost increases, but the lion's share was due to persistent flaws in management, design, and supply chains."

Operating in a high-renewables grid would further worsen nuclear economics. A recent article co-authored by Steven Hamilton — assistant professor of economics at George Washington University and visiting fellow at the Tax and Transfer Policy Institute at the ANU — outlined:

"Labor sees nuclear power as a competitor to renewables. The Coalition sees nuclear power as a companion to renewables".

"The trouble is that nuclear is a terrible companion to renewables. The defining characteristic of being "compatible" with renewables is the ability to scale up and down as needed to 'firm' renewables. Even if we don't build a single new wind farm, in order to replace coal in firming renewables, nuclear would need to operate at around 60 per cent average utilisation (like coal today) to keep capacity in reserve for peak demand. This alone would push the cost of nuclear beyond $225/MWh. To replace gas as well, the cost skyrockets beyond $340/MWh."

Since this report was written, several other studies have confirmed the superior economics of renewable energy sources compared to nuclear power. These include:

- The latest version of CSIRO's GenCost studies;
- A report prepared for the Clean Energy Council by Egis, a leading global consulting, construction and engineering firm;
- A report on the economics of small modular reactors by the Institute for Energy Economics and Financial Analysis.

2.2 The ever-increasing need for taxpayer subsidies

In 2006, then UK industry secretary Alistair Darling said the private sector would have to "initiate, fund, construct and operate" nuclear power plants. This has not happened in the UK where no construction has occurred or will occur without taxpayer subsidy packages amounting to tens of billions of dollars.

The UK National Audit Office estimates taxpayer subsidies for the Hinkley Point project — primarily in the form of a guaranteed payment of £92.50 (A$175) / MWh (2012 prices), indexed for inflation, for 35 years — could amount to £30 billion (A$56.7 billion) for a plant with a capacity of 3.2 GW. Other credible estimates put the figure as high as £48.3 billion (A$91.3 billion).

South Korean utilities opted out of the Wylfa and Moorside reactor construction projects in the UK (as did Japanese companies Hitachi and Toshiba), despite offers of many billions of dollars of British taxpayer subsidies. Announcing the failure of the Wylfa project in 2019, then UK minister for Business, Energy and Industrial strategy Greg Clark said potential investors including South Korean companies were offered a "generous package of potential support that goes beyond what any government has been willing to consider in the past."

Two points are remarkable: the UK government's willingness to offer subsidies that go beyond the extraordinary Hinkley Point subsidies and the fact that potential vendors are declining to pursue nuclear projects even when such massive subsidies are on offer.

Above: Taxpayers costs could amount to £30 billion (A$56.7 billion) for the Hinkley Point project in Somerset, UK.
Photo. Wirestock Creators / iStock

The UK government hopes to progress the Sizewell C project in Suffolk, comprising two EPR reactors, and is once again offering very generous support. This includes taking an equity stake in the project and using a 'regulated asset base' model which foists financial risks onto taxpayers and electricity ratepayers and could result in consumers paying billions for failed projects — as it has in the US.

Vast subsidies have been offered to encourage the commercial development of nuclear power reactors in the US, resulting in nothing more than the abandoned V.C. Summer project in South Carolina and the massively over-budget Vogtle project in Georgia. Vast taxpayer subsidies are still on offer in the US but not a single reactor is under construction.

France has abandoned the idea of pursuing nuclear power as a commercial venture. By early 2023 the debt carried by Électricité de France (EDF), the centrepiece of France's nuclear reactor program, had ballooned to €64.5 billion (A$105 billion). EDF was fully nationalised later in 2023 due to its crushing debts.

The demise of nuclear power as a commercial venture was made clear at a Nuclear Energy Summit organised by the International Atomic Energy Agency (IAEA) in Brussels in March 2024. Nuclear industry representatives were "left humbled by the tepid reaction of bankers assessing the price tag of their ambitions," Bloomberg reported. Former US Energy Secretary Ernest Moniz said, "If the bankers are uniformly pessimistic, it's a self-fulfilling prophecy" after listening to a panel of international lenders explain why they are unwilling to provide the US$5 trillion the industry claims it needs by mid-century.

"The project risks, as we have seen in reality, seem to be very high," European Investment Bank Vice President Thomas Ostros told the IAEA conference, and the Bank recommends countries needing power quickly focus on renewables and energy efficiency. The European and US emphasis on private capital "will likely need to change if Western economies want to maintain nuclear's market share," Mr. Ostros said. "We need state involvement, I don't see any other model. Probably we need quite heavy state involvement to make projects bankable."

Based on recent experience in the UK, the US, France and other countries, Australia should assume the need for extraordinary taxpayer subsidies, likely in the tens of billions of dollars, if a decision was made to pursue nuclear power.

The pursuit of SMRs could further elevate taxpayer subsidies. A 2018 study published in the *Proceedings of the National Academy of Science* concluded SMRs would not be viable in the US without "several hundred billion dollars of direct and indirect subsidies" over the next several decades "since present competitive energy markets will not induce their development and adoption."

Moreover, the industry would seek to foist most of the costs of major nuclear accidents onto Australian citizens and taxpayers. In the US, this subsidy is provided by the Price-Anderson Act. This legislation provides a damages cap for nuclear utilities facing claims arising from a nuclear accident or incident. Commenting on the recent extension of the Act, Dr. Edwin Lyman from the Union of Concerned Scientists said "The nuclear industry's push for a 40-year Price-Anderson Act extension is a sure sign that it doesn't believe its own messaging about how safe the next generation of nuclear reactors is going to be."

Closer to home it is noteworthy that insurance policies from some of Australia's major insurers, including AAMI, CGU, Allianz, QBE and NRMA contain specific text excluding coverage for nuclear disasters. None of these will insure homes, cars or possessions against a nuclear accident or release.

2.3 Small modular reactors (SMRs)

Far from being a real-world nuclear technology suitable for Australia, SMRs increasingly appear to be a pipedream and expensive commercial failure. An important recent analysis of SMRs by Dr Edwin Lyman notes that much of the promotion of SMRs is 'rooted in misinformation'. Dr Lyman notes that SMRs are not more economical than large reactors; they are not generally safer or more secure than large reactors; they will not reduce the problem of what to do with radioactive waste; they cannot be counted on to provide reliable and resilient off-the-grid power; and they do not use fuel more efficiently than large reactors.

Just two SMR plants are said to be operating, although neither of them meets the 'modular' definition of serial factory production of reactor components (as opposed to the usual practice of construction being concentrated at the reactor site). These SMRs — one twin-reactor plant in Russia and another twin-reactor plant in China — exhibit problems familiar in the wider nuclear sector, including massive cost blowouts and multi-year delays.

The construction cost of Russia's floating nuclear power plant (with two 35-MW reactors) increased six-fold from 6 billion Rubles to 37 billion Rubles (A$606 million). The OECD's Nuclear Energy Agency estimates that the electricity it produces costs US$200 (A$302)/MWh, with the high cost due to large staffing requirements, high fuel costs and the resources required to maintain the barge and coastal infrastructure. To put that in perspective, the Minerals Council of Australia states that SMRs won't find a market unless they can produce power at a cost of A$60–80/MWh — about one-quarter of the cost of electricity produced by the Russian plant.

The cost of electricity produced by the Russian plant also exceeds costs from large reactors – US$141–221 / MWh, according to the latest report by investment firm Lazard – even though SMRs are being promoted as the solution to the excessive costs of large nuclear plants.

The other operating SMR (loosely defined) is China's demonstration 210 MW high-temperature gas-cooled reactor (HTGR). The World Nuclear Association states that the cost of the demonstration HTGR was US$6,000 (A$9,060) per kW, three times higher than a 2009 cost estimate from Tsinghua University researchers, and two to three times higher than the cost-per-kW of China's larger Hualong reactors.

Wang Yingsu, secretary general of the nuclear power branch of the China Electric Power Promotion Council, said in 2021 that HTGRs would never be as cheap as conventional light-water reactors. China dropped plans to manufacture 18–20 HTGRs after levelised cost estimates rose to levels higher than conventional large reactors. There are reports of plans to build a larger 655 MW HTGR plant, but China's Institute of Nuclear and New Energy Technology at Tsinghua University expects the cost of a 655 MW HTGR will be 15–20% higher than the cost of a conventional 600 MW pressurised water reactor.

The so-called SMRs in Russia and China have not been built using serial, factory production methods. They could not even be called prototype SMRs since there are no plans to mass produce more of them.

Three SMRs are under construction – again with the qualification that there's nothing 'modular' about these projects.

The cost estimate for the small reactor under construction in Argentina is US$750 million (A$1.13 billion) for a reactor with a capacity of just 32 MW. That is over one billion Australian dollars for a plant with the capacity of a handful of large wind turbines.

In 2021, China began construction of a 125 MW pressurised water reactor. According to China National Nuclear Corporation, construction costs per kW will be twice the cost of large reactors while levelised costs will be 50% higher than large reactors. There is no expectation that HTGRs or conventional small reactors in China could compete economically with large reactors. Moreover, large nuclear reactors in China are not competitive with renewables. The cost differential is reflected in the relative growth of nuclear and renewables. In 2023, China's nuclear power program added only 1.2 GW capacity while combined wind and solar added 278 GW to China's electricity supply.

In 2021, construction of the 300 MW demonstration lead-cooled BREST fast neutron reactor began in Russia. In 2012, the estimated cost for the reactor and associated facilities was 42 billion Rubles but the estimate has more than doubled to 100 billion Rubles (A$1.64 billion).

2.4 Lessons from the NuScale SMR failure

Dozens of SMRs are said to be in the 'planning' stage; in other words, they have little to show except media releases and PowerPoint presentations. NuScale was closer than any other company to beginning construction of an SMR in the USA, but it spectacularly abandoned its flagship project in Idaho in 2023.

NuScale secured subsidies amounting to around US$4 billion (A$6 billion) from the US government but didn't come close to securing sufficient funding from other sources to get the project off the ground.

NuScale's most recent cost estimates were exorbitant: US$9.3 billion (A$14.0 billion) for a 462 MW plant comprising six 77 MW reactors. That equates to US$20,100 (A$30,300) per kW and a levelised cost of US$89 (A$134)/MWh. Without the Inflation Reduction Act subsidy of US$30/MWh, the figure would be US$119 (A$180)/MWh. That is not far short of the estimate of A$225/MWh in a report by WSP Parsons Brinckerhoff, commissioned by the 2015/16 South Australian Nuclear Fuel Cycle Royal Commission.

As referenced earlier, the Minerals Council of Australia states that SMRs won't find a market in Australia unless they can produce power at a cost of A$60-80/MWh. That is about three times less than the WSP Parsons Brinckerhoff estimate and the latest NuScale estimate.

Of course, NuScale's latest estimate does not reflect the inevitable cost increases if an SMR plant is ever constructed, such as the six-fold increase in the cost of Russia's floating nuclear power plant, or the three-fold increase in the cost of China's HTGR.

The likelihood of NuScale actually building any reactors appears to be diminishing by the day. The company is heading towards bankruptcy with a net loss of US$180 million in 2023. It sacked 154 staff in early 2024 and a class action may hasten the company's demise.

US nuclear specialist Linda Pentz Gunter commented on the aftermath of the decision to abandon the Idaho project, stating:

"Five months later, NuScale is 'burning cash at the rate of $185 million per year,' as reported by Motley Fool."

"NuScale's VOYGR nuclear power product has 'no secure customers' and is 'not cost competitive' says one analyst."

"Three days later the company's CEO, John Hopkins, sold 59,768 of his shares. This is the same CEO who declared NuScale's SMR project, aptly named VOYGR, 'a dead horse.' It's clearly on a journey to nowhere."

Above: NuScale's latest estimates do not reflect the inevitable cost increases if an SMR plant is ever constructed, such as the six-figure increase in the cost of Russia's floating nuclear power plant which cost 37 billion Rubles (A$606 million). *Photo:* Greenpeace

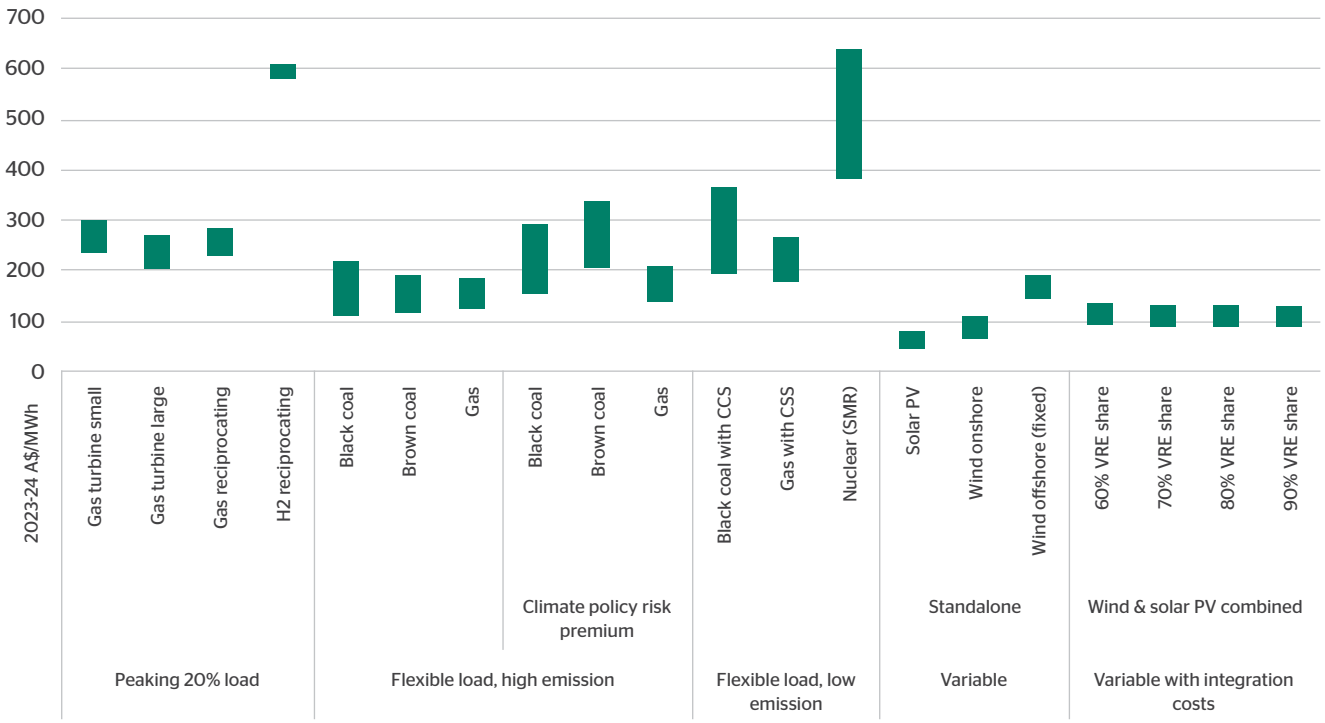
2.5 Independent estimates of SMR costs

CSIRO's *GenCost* 2023–24 report provides the following levelised cost estimates, with the nuclear SMR costs based on the NuScale project in the US:

Table 3

Nuclear SMR costs based on the NuScale project in the US comparing 2023 and 2030

	2023	2030
Nuclear SMR	A$382–636/MWh	A$212–353/MWh
90% wind and solar supply to the National Electricity Market with integration costs included (energy storage and transmission)	A$91–130/MWh	A$69–101/MWh



2023 levelised cost estimates in CSIRO's GenCost 2023–24 report.

SMRs are not cost-competitive with firmed renewables, according to CSIRO's estimates.

A study by WSP Parsons Brinckerhoff, commissioned by the 2015/16 South Australian Nuclear Fuel Cycle Royal Commission, estimated costs of A$180–184/MWh for large pressurised water reactors and boiling water reactors, and A$198–225/MWh for SMRs. The two SMR proposals subjected to detailed economic analysis were Generation mPower, which abandoned plans to build SMRs in 2017 and NuScale, which abandoned its flagship project in 2023 and faces an uncertain future.

A 2015 report by the International Energy Agency and the OECD Nuclear Energy Agency predicts electricity costs from SMRs will typically be 50–100% higher than for current large reactors, although it holds out some hope that large volume factory production of SMRs could help reduce costs.

A 2016 report by the consultancy firm Atkins for the UK Department for Business, Energy and Industrial Strategy found that electricity from the first SMR in the UK would likely be 30% more expensive than power from large reactors, because of diseconomies of scale and the costs of deploying first-of-a-kind technology.

A 2016 European Commission report notes that decommissioning and waste management costs of SMRs "will probably be higher than those of a large reactor (some analyses state that between two and three times higher)."

A 2014 study published in *Energy and Power Engineering* estimated fuel costs for integral pressurised water SMRs to be 15-70% higher than for large light water reactors and points to research indicating similar comparisons for construction costs.

Below: Plans to build SMRs are often abandoned, as was seen with the V.C. Summer nuclear expansion project in South Carolina, USA.

2.6 Non-independent estimates of SMR costs

The Minerals Council of Australia (MCA) claims 'robust estimates' using 'conservative assumptions' indicate SMRs will produce power at a cost of A$64–77/MWh by 2030. However, these estimates are from companies that haven't built a single SMR between them. Describing estimates provided by sources with a direct interest in a project as 'independent' is simply not accurate.

The MCA bolsters its SMR cost claims with reference to the Energy Information Reform Project (EIRP), which purports to have conducted a "standardized cost analysis of advanced nuclear technologies in commercial development." In fact, the EIRP study simply collates company estimates and presents them with this qualification:

"There is inherent and significant uncertainty in projecting NOAK [nth-of-a-kind] costs from a group of companies that have not yet built a single commercial-scale demonstration reactor, let alone a first commercial plant."

The MCA, in its submission to the 2019 federal Parliamentary nuclear inquiry, claimed SMRs could generate electricity for as little as A$60/MWh, based on a report by the Economic and Finance Working Group (EFWG) of the Canadian 'SMR Roadmap' initiative. However, the MCA is selective in its use of the EFWG estimates: among the many estimates it excludes is the C$162.67 (A$180)/MWh estimate for power from a first-of-a-kind 300 MW on-grid SMR or, at the upper end, the estimate of C$894.05 (A$987)/MWh for power from a first-of-a-kind 3MW remote community SMR.

In April 2024, Rolls-Royce claimed it could build a 470-megawatt reactor in Australia for A$3.5–5 billion, as reported in *The Australian*. That equates to A$7.4-10.6 billion/GW. For comparison, this table compares Rolls-Royce's claim with NuScale's latest SMR cost estimate, with Hinkley Point (the only construction project in the UK), and with the Vogtle project in the US.

Table 4

A comparison of nuclear reactor costs

Rolls-Royce	A$7.4-10.6 billion / GW
NuScale SMR	A$30.3 billion / GW (US$20.1 billion / GW)
Hinkley Point (UK)	A$27.2 billion / GW (£14.4 billion / GW)
Vogtle (USA)	A$23.4 billion / GW (US$15.5 billion / GW)

It is implausible that Rolls-Royce could build an SMR for as little as one quarter of the cost (per gigawatt) of the NuScale SMR proposal or one third of the cost of large reactor projects in the UK or the US. At this stage, Rolls-Royce does not even have a licensed design, let alone an operating SMR. Its cost claims should be seen in that context. Rolls-Royce's progress with SMRs in the UK is heavily dependent on taxpayer subsidies – as it would be in Australia – and it is far from certain to proceed to construction.

3. The timeline for deployment of **nuclear power in Australia**

3.1 Nuclear power within a decade?

Claims that Australia could have electricity produced by nuclear reactors 'within a decade' or 'by the mid-2030s' do not withstand scrutiny. Introducing nuclear power to Australia would necessitate:

- An estimated 10 years for: licensing approvals; a tender process and vendor selection; complex discussions and negotiations over the taxpayer subsidy package; financing and insurance arrangements; establishing a regulatory system; site selection, purchase and infrastructure development; establishing and maintaining a social license to operate; workforce recruitment and training; an environmental impact assessment process; removing a network of state and federal legal and policy bans and advancing agreements between Commonwealth and State/Territory jurisdictions; waste management planning; establishing nuclear safeguards arrangements; dealing with any legal challenges, etc.
- Around 10 years for construction (possibly less, probably more); and
- An estimated 6.5 years of reactor operation to repay the energy and carbon debts from construction.

Thus, even in the unlikely event that federal and state legal prohibitions were repealed in the near future, a nuclear power reactor could only begin operating around the mid-2040s and could only begin to contribute to reducing greenhouse emissions around 2050. Moreover, nuclear power would not reduce greenhouse emissions if it displaced renewables.

Former Australian Chief Scientist Alan Finkel says nuclear power is "too slow and too expensive" and could not be operating in Australia before 2040. Dr. Finkel states, **"Any call to go directly from coal to nuclear is effectively a call to delay decarbonisation of our electricity system by 20 years."**

A 2020 report by NSW Chief Scientist Hugh Durrant-Whyte, prepared for the NSW Cabinet, said introducing nuclear power would be expensive and difficult and that it would be naïve to think a nuclear plant could be built in less than two decades while the former Australian Energy Infrastructure Commissioner Professor Andrew Dyer has said it would take a minimum of 15 to 20 years for a nuclear plant to be built in Australia.

Above: At best, nuclear power could not contribute to Australian emissions reduction until around 2050. *Photo:* Dvorak Stepan / Shutterstock

A former Chief Scientific Adviser at the UK Ministry of Defence, Dr. Durrant-Whyte said:

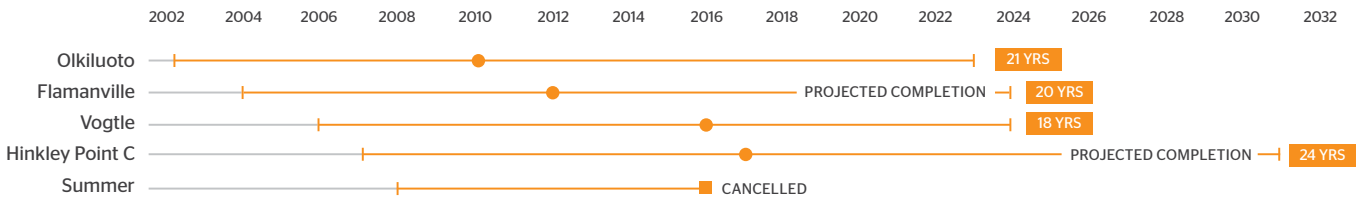
"The hard reality is Australia has no skills or experience in nuclear power plant building, operation or maintenance — let alone in managing the fuel cycle. Realistically, Australia will be starting from scratch in developing skills in the whole nuclear power supply chain."

Claims that "Australia could have nuclear up and running within a 10-year period" are not supported by the reality of any recent projects in North America or Western Europe, where:

- Construction of the two AP1000 reactors in the US state of Georgia took 10 and 11 years (2013 to 2023/24) despite initially promising a 3–4 year construction period. Georgia Power announced it was evaluating the project in 2005 (with the first license application submitted in 2006); if that is taken as the planning start-date, it was 18 years for planning and construction. Work on the AP1000 reactor project began in the 1990s so planning plus construction could be said to have taken 25+ years.
- In the UK, efforts to build new reactors date from 2006. Only the twin-reactor Hinkley Point project has reached the construction stage. Construction began in 2018 and the completion date has been pushed back to 2030/31, nearly a quarter of a century after the plan to build new reactors was announced. Construction will take at least 12-13 years.
- The only reactor under construction in France is the Flamanville EPR. Construction began in 2007 and the project remains incomplete 17 years later. Design work on the EPR reactor began in 1989 – 35 years ago.
- In Finland, construction of one EPR on Olkiluoto Island began in 2005 and completion was expected in 2009. However, grid-connection was not completed until 2022 (and getting from grid connection to commercial operation took one more year). A four-year construction project became a 17-year project. The first license application for the reactor was filed in the year 2000 so planning plus construction took 20+ years.

North America & Western Europe - 21st Century

Average 21 years from project announcement to commercial operation



Source: X/Simon Holmes à Court

3.2 Is the UAE's nuclear power program a model for Australia?

International experience has shown that nuclear projects are routinely subject to extensive cost and time overruns. This is also true in relation to nuclear development in the UAE which is often promoted by nuclear proponents.

The decision to build reactors in the UAE was announced in 2008, construction began in 2012, and the four reactors were grid-connected in 2020, 2021, 2022 and 2024. Thus, the time from announcement to grid connections ranged from 12 to 16 years. Construction to grid connection averaged 8.4 years. The first reactor was expected to be supplying power in 2017 and the others in 2018, 2019 and 2020. The project was three years behind schedule, and the fourth reactor was four years behind schedule.

Claims that the "UAE went from a decision to having nuclear on the grid within 10 years" and that the project (delivered by South Korea) was "on time and on budget" are not supported by the facts. Further, Australian economist Prof. John Quiggin notes that Australia could not match the timeline achieved in the UAE for a myriad of reasons:

"Would it be possible to match the UAE schedule? The UAE had no need to pass legislation: it doesn't have a parliament like ours, let alone a Senate that can obstruct government legislation. The necessary institutions, including a regulatory commission and a publicly owned nuclear power firm, were established by decree.

"There were no problems with site selection, not to mention environmental impact statements and court actions. The site at Barakah was conveniently located on an almost uninhabited stretch of desert coastline, but still close enough to the main population centres to permit a connection to transmission lines, access for workers, and so on. There's nowhere in Australia's eastern states (where the power is needed) that matches that description.

"Finally, there are no problems with strikes or union demands: both are illegal in the UAE. Foreign workers with even less rights than Emirati citizens did almost all the construction work.

"Despite all these advantages, the UAE has not gone any further with nuclear power. Instead of building more reactors after the first four, it's investing massively in solar power and battery storage."

Above: The rollout of nuclear in the UAE has been costly and autocratic.
Photo: Yasni / Shutterstock

Multi-year delays inevitably result in major cost overruns. A lack of transparency makes it impossible to state with confidence the cost of the UAE nuclear power project. The stated aim of completing the four reactors at a total cost of US$20 billion was not achieved. The 2016 edition of the World Nuclear Industry Status Report states that the cost of the 5.2GW nuclear plant could be as much as US$40 billion (A$60.4 billion) including fuel management and operation.

The agreement between South Korea and the UAE also included non-quantifiable components such as a secret military side-agreement, signed without the knowledge or approval of South Korea's National Assembly.

The UAE is now prioritising renewables and the UAE Energy Strategy 2050 aims for a 44% renewable electricity share compared to a 6% nuclear share.

South Korea's ambition to secure overseas orders for 80 power reactors by 2030 has not progressed. South Korea has not secured any export orders whatsoever since the 2009 UAE deal. An industry-wide corruption scandal has severely diminished both domestic and international confidence in South Korea's nuclear industry.

In addition to increased safety risks due to corruption — such as the installation of safety-related equipment on the basis of falsified documentation — the design of South Korea's AP1400 reactors has been challenged. In 2010, Areva CEO Anne Lauvergeon likened the AP1400 design to "a car without airbags and safety belts."

3.3 SMR planning and construction timelines

Promoters of SMRs claim that a key advantage is their short construction timeframe, with a figure of 3–5 years typically cited. Such claims are speculative and implausible:

- Planning for China's HTGR began in 2001, initial approval was granted in 2005, construction began in 2012 and the expected completion date of 2016 was pushed back several times. The twin reactors achieved first criticality in 2021 with commercial operation commencing in December 2023. Thus, planning to commercial operation spanned 22 years, and construction took nine years as opposed to the initial four-year construction estimate.
- When construction of Russia's floating nuclear power plant began in 2007, completion was anticipated in 2010 but it was not completed until 2019. A three-year construction project became a 12-year project. Planning went back to at least the year 2000 and possibly earlier.
- Construction of Argentina's CAREM plant began in 2014, at which time completion was expected in 2017. But the reactor remains incomplete and the expected completion date has been pushed back to 2028. A three-year construction project has become a 14-year project. Further slippage is certain as construction has stalled due to budget cuts. Development began in 1980 so if the reactor is ever completed, it is likely to be a 50-year project.
- In Canada, SMRs have been promoted for around 20 years but there is still not a single operating SMR, nor any under construction.
- Development of NuScale SMR technology in the US dates from 2003. In 2023, the company abandoned its flagship project in Idaho before construction began. NuScale is now celebrating its 21st birthday with no reactors in operation, none under construction and the looming threat of bankruptcy.

Prof. Quiggin has traced the source of widespread claims of a 3–5 year construction timeline for SMRs. The Australian Nuclear Science and Technology Organisation (ANSTO), operator of the research reactor at Lucas Heights in southern Sydney, notes that short construction times could be achieved using "series-production methods" without noting that no country has the capacity to deploy series-production methods. In defence of its implausible claims, ANSTO cites (or blames) a University of Leeds paper. Prof. Quiggin discusses ANSTO's "sloppy treatment of an issue that should be a central focus of ANSTO analysis":

"The University of Leeds paper is more interesting. It turns out to be a literature survey covering the period 2004-19. The three- to five-year estimate for the construction time for SMRs is taken from a non-peer-reviewed 2016 report by consulting firm Ernst and Young (which worked with one of the authors on the University of Leeds study). The information used to compile the report is even older, going back to 2014 or earlier. To put it bluntly, this is worthless.

"Rather than complying with its legal obligation to keep abreast of nuclear power technology and inform the public of its findings, ANSTO has relied on decade-old, unverified claims, made by a consulting company."

Prof. Quiggin further notes that even if SMR proposals "work as planned – a big if – they will arrive too late to replace coal power in Australia."

According to reports in *The Australian*, Rolls-Royce claims it could build a 470-megawatt reactor in Australia in four years and that its reactor technology could be ready for the Australian market by the early to mid-2030s. The claims are implausible. Rolls-Royce does not yet have a licenced design let alone an operating SMR. The company hopes to begin operating its first SMR in the UK by 2030. However, it is far from certain any SMRs will be built and the 2030 goal is unrealistic.

Assuming construction of a Rolls-Royce SMR in Australia did not begin until after one was completed in the UK or elsewhere, it would not be possible for Rolls-Royce SMRs to provide power in Australia in the mid-2030s. Alternatively, a decision to build Rolls-Royce SMRs in Australia could make Australia the testing ground for these reactors given the lack of progress elsewhere. Prof. Quiggin notes:

"Australia could be in the unenviable situation of building "first of a kind" (FOAK) reactors with an untested design. Even more than nuclear plants in general, FOAK projects are notorious for delays and cost overruns. For a country like Australia, with no established nuclear industry or regulatory structure, it would be madness to try such a thing."

Former Chief Scientist Dr. Alan Finkel provides this reality check regarding SMRs:

"In Australia, we would be looking to use SMRs because of the enormous cost and construction delays of large-scale nuclear plants. But we will want the reassurance of first seeing SMRs work safely and well in the UK, Europe, Canada, the US or another OECD country.

"The trouble is, there are no SMRs operating in the UK, Europe, Canada, the US or any other OECD country. Nor are any SMRs under construction or approved in an OECD country.

"There is no data to support any claims about how much SMRs will cost when deployed as operating power stations."

NSW Chief Scientist Hugh Durrant-Whyte points to the extreme delays and cost overruns associated with the Hinkley Point reactor construction project in the UK and notes that it "would be naive to expect that any new reactor designs – including SMRs – in a completely new environment, like Australia, will be any cheaper or any quicker to approve and get operational."

Dr. Durrant-Whyte says SMRs are "not likely to be the panacea people are expecting – they still entail regulation, fuel supply, maintenance and operation – and are currently estimated to cost at least as much per conventional reactors per Megawatt delivered."

In 2021 the former Chair of the US Nuclear Regulatory Commission Prof. Allison Macfarlane put the situation clearly, stating that **"when it comes to averting the effects of climate change, the cutting edge of nuclear technology will prove to be too little, too late".**

4. Could coal-to-nuclear work in Australia

4.1 Lessons from the US experience

Citing experience in the US, shadow energy minister Ted O'Brien told The Australian: "The evidence keeps mounting that a coal-to-nuclear strategy is good for host communities, and especially workers as zero-emissions nuclear plants offer more jobs and higher paying ones."

However, 290 coal power plants closed in the US from 2010 to May 2019, and many more have closed since then. Not one of them was replaced by nuclear power. The only three reactor construction projects in the US this century have been on existing nuclear sites: the Vogtle project in Georgia, the V.C. Summer projected in South Carolina, and the Watts Barr-2 project in Tennessee.

The same points apply in the UK where 20 coal or oil power plants have closed since 2012, none were replaced with nuclear power, and the only nuclear construction project is on an existing nuclear site.

Mr. O'Brien has promoted nuclear startup Terrapower's plan to replace coal with nuclear in Kemmerer, Wyoming. But Terrapower is at the very early stages of a long and expensive licensing process for a first-of-a-kind reactor belonging to a class of reactors – sodium-cooled, fast-neutron reactors – with a history of failure. The coal plant near the town of Kemmerer will close in 2025. The projected startup of Terrapower's 'Natrium' reactor has been pushed back from 2028 to 2030 and will likely slip further.

The Wyoming coal-to-nuclear project could easily collapse. David Schlissel from the Institute for Energy Economics and Financial Analysis authored a 2022 analysis of the NuScale reactor project in Idaho and accurately predicted its demise. He predicts trouble in Wyoming: "There's every reason in the world to believe that [the Wyoming project] is going to be a bigger financial disaster."

Ominously, TerraPower CEO and president Chris Levesque recently declined to provide an updated cost estimate for the Wyoming project. In 2020, the estimate was US$1 billion for a 345 MW reactor; in 2022 the estimate was US$4 billion.

Above: Eraring coal-fired power station in the Hunter Valley, NSW, Australia, is one of many sites that could be considered for nuclear power.
Photo: zetter / iStock

4.2 The trouble with timelines

The Australian reports that under a plan taken to the Coalition shadow cabinet in March, seven coal regions have been identified as potential locations for nuclear power plants. Presumably those regions are Collie in WA, the Latrobe Valley in Victoria, the Hunter Valley and Lithgow in NSW, and three regions in Queensland – the Darling Downs, Gladstone and Central Queensland.

The Australian reports that a shadow cabinet subcommittee will produce 'economic impact statements' to assess the potential economic impacts of the nuclear plan in the seven regions. The Coalition will likely try to win local support by using taxpayer funds to reduce electricity bills for people living near the proposed nuclear plants. Workers will be offered higher-paid jobs, presumably at taxpayers' expense. Further, taxpayers will also be on the hook for workforce training, regulation, waste disposal and much more. The plan "will involve the creation of new precincts for advanced manufacturing centred on cheap energy from small nuclear reactors", *The Australian* reports. A "community engagement process" will be rolled out once the coal sites have been identified, Opposition leader Peter Dutton says.

"There is every reason to be optimistic about bringing small modular net-zero emission nuclear into the power mix in the 2030s," Mr Dutton says. However, it would be impossible to introduce nuclear power in Australia by the mid-2030s as discussed in the previous section. Nuclear power could not be operating in Australia before the mid-2040s, and this creates a major timing problem for those proposing to replace coal power plants with nuclear power. All or nearly all of Australia's remaining coal-fired power plants will be closed by the mid-2040s. Alternative power sources will need to be operating well before nuclear power reactors could possibly replace coal.

The energy transition is already underway at coal and gas sites in Australia and will be much further advanced before nuclear reactors could possibly begin operating. For example:

- The last SA coal power plant, near Port Augusta, was shut down in 2016 and the region has since become a renewables hub.
- AGL is developing coal and gas power station sites into low-emissions industrial energy hubs.
- Yancoal Australia has published a scoping report for the Stratford Renewable Energy Hub, which proposes to transition the coal mine to a 330 MW solar farm and 3.6 GWh of pumped hydro energy storage at the end of its working life.
- The renewable energy transition is in full swing in the Darling Downs region of Queensland.
- In the Collie region of WA, a large battery is under construction and contracts have been signed to add a second stage battery to help flatten the growing solar duck curve and replace coal.

Above: Gladstone is one of seven coal regions identified as potential locations for nuclear power plants in Australia.. *Photo:* Tom Kinsman

4.3 Political and public division and opposition

Current and former Coalition MPs, including former Prime Minister Scott Morrison, have conceded nuclear power would require bipartisan support. This important pre-condition clearly does not exist in Australia. In some states, including those that might be targeted in a coal-to-nuclear plan, there is bipartisan opposition to nuclear power.

Coal-to-nuclear proposals have been rejected by state Labor governments in the four states operating coal plants, and have not been supported by Liberal opposition leaders and parties in those four states:

- Victorian Liberal leader John Pesutto says he does not support building a nuclear power station in the Latrobe Valley and shadow energy minister David Davis says "the Victorian Liberals and Nationals support a commonsense transition to renewables that ensures affordability and security of supply".
- Queensland LNP leader David Crisafulli says the state LNP does not support Peter Dutton's push for nuclear power. Shadow environment minister Sam O'Connor has publicly guaranteed that nuclear power will not be a part of the LNP's energy transformation plan.
- Whilst supportive of uranium mining, WA Liberal opposition leader Libby Mettam says she has made it clear to her federal colleagues that nuclear power does not stack up in WA.
- NSW opposition leader Mark Speakman has been more circumspect, saying he is awaiting the details of the coal-to-nuclear proposal and that "at the end of the day we have to have energy sources that are clean, cheap and reliable". He says the NSW Liberal Party remains committed to "achieving net zero emissions by 2050, with interim targets" and that "while other technologies could be important, renewables will play the major role in achieving this." Mr. Speakman said in April this year, "We can't wait for nuclear, so in the meantime, here in NSW, we should be going ahead with our electricity road map, which will have heavy reliance on renewables."

Three of the four states with coal plants — Queensland, NSW and Victoria — have state legislation banning nuclear power.

There is also significant dissent and even cynicism among current and former Coalition MPs about the coal-to-nuclear push:

- NSW Liberal MP and former deputy premier Matt Kean states, "I not only regard advocacy for nuclear power as against the public interest on environmental, engineering and economic grounds, I also see it as an attempt to delay and defer responsible and decisive action on climate change in a way that seems to drive up power prices in NSW by delaying renewables."
- Former Liberal Prime Minister Malcolm Turnbull says nuclear power's only utility is as "a means of supporting fossil fuels by delaying and distracting the rollout of renewables" and that nuclear power "is exactly what you don't need to firm renewables."
- Former Liberal leader John Hewson says Peter Dutton may be promoting nuclear "on behalf of large fossil-fuel donors knowing nuclear power will end up being too expensive and take too long to implement, thereby extending Australia's reliance on coal and natural gas".
- Liberal MP Bridget Archer says nuclear power should be pursued only if coupled with a rapid surge in renewables and nuclear power should not be used as an excuse to prolong reliance on fossil fuels. "There is no point even having a nuclear discussion if you don't accept a need to decarbonise, to transition away from coal and gas," she said.

Those comments by current and former Coalition MPs reflect concerns about the Coalition's opposition to the federal government's target of 82% renewables by 2030, its opposition to the government's target to cut emissions by 43% by 2030, and the Coalition's plans to expand gas and prolong the use of coal. There are concerns that a Coalition government would rip up contracts signed by the Commonwealth in its Capacity Investment Scheme.

There are also concerns that a Coalition government would abandon Australia's legally binding 2030 target under the Paris Agreement, adopted by 196 countries at the UN Climate Change Conference in 2015. The Nationals are calling for a moratorium on the rollout of large-scale renewables. At the December 2023 COP28 UN climate conference, the Labor government joined 120 countries in backing a pledge to triple renewable energy and double the rate of energy efficiency by

2030 — a pledge opposed by the Coalition. A Coalition government would however sign Australia on to a pledge supported by just 22 countries to triple nuclear power generation by 2050.

Economist Prof. John Quiggin notes that, in practice, support for nuclear power in Australia is **support for coal. He has described nuclear advocacy in Australia as a dog whistle to climate denialists**.

The SA Liberal opposition is more supportive of nuclear power than Liberal/Coalition parties in other states/territories. Mr. Dutton says it is 'clear' to him that SA Labor Premier Peter Malinauskas "would be the first to sign up" to a nuclear power proposal. However, Premier Malinauskas doesn't see nuclear power as an option in SA, stating:

"Every single objective, independent analysis that has looked at this has said nuclear power would make power more expensive in Australia rather than cheaper. Why we would impose that burden on power consumers in our country is completely beyond me."

A nuclear power program in SA would be a poor fit. SA has leapt from 1% renewable electricity supply to 74% over the past 16 years and aims to reach 100% net renewables by 2027. According to the SA government, SA has attracted over A$6 billion investment in large-scale renewable energy and storage projects to date with over A$20 billion in the investment pipeline. As noted above, the last SA coal power plant, near Port Augusta, was shut down in 2016 and the region has since become a renewables hub. A coal-to-nuclear plan in SA could only be a renewables-to-nuclear plan.

Above: South Australia is a poor fit for a nuclear power program, where renewable electricity supplies 74% of the state's power. *Photo:* Joniquelife

SA transmission company ElectraNet says the switch to renewables has led to unprecedented inquiries from energy intensive industries to set up in the state. ElectraNet CEO Simon Emms said in a recent planning document, "As we enter the next phase of the energy transformation, South Australia is now seeing a level of interest from new, large electricity loads not seen for a very long time."

In addition to political division, moves to introduce nuclear power to Australia would generate significant public opposition, particularly from those living near proposed reactor sites. Opposition to locally-built nuclear power reactors has been clear and consistent in opinion polls published over the past 20 years. For example, a 2023 AFR/Freshwater Strategy Poll found that around one-quarter of voters would tolerate a nuclear plant being built within 50 km of their home, while a majority (53%) would oppose it.

In February 2024 national representative research from Glow polling identified that 72% of Australians believe we should continue to the shift to renewable energy rather than build new nuclear energy (17%) or new coal (11%), while 76% of Australians would prefer to live near renewable energy like wind and solar farms, than nuclear (12%) or coal (11%).

In April, it was reported that focus group research in the Hunter Valley in NSW and the Latrobe Valley in Victoria found that voters are 'hostile' to plans for nuclear power reactors in their own areas. Likewise, recent polling in Gippsland by Redbridge Group found that participants are overwhelmingly against the idea of having a nuclear power plant constructed in their region. Redbridge Group Director Kos Samaras said, **"Overwhelmingly, most people were of the view that there's too much risk associated with it, it's expensive, and those with children indicated strongly that if one was to be built in the area, they will leave the area."**

4.4 Costing coal-to-nuclear proposals in Australia

In 2023, the federal Labor government released an energy department estimate that it would cost A$387 billion to replace the 21.3 GW capacity of Australia's retiring coal fleet with around 71 SMRs, each with a capacity of 300 MW. Whether small or large reactors were chosen (or some combination of both), the figure could be much higher.

For SMRs, the most recent, credible costing is NuScale's estimate of A$30.3 billion/GW.

For the Vogtle project in the US, the estimate is A$23.6 billion/GW. For the Hinkley Point project in the UK, the estimate is A$27.8 billion/GW. The following table uses those figures to estimate the cost of 21.3 GW of nuclear capacity:

Table 5

Cost of 21.3 GW of nuclear capacity

	A$ / GW	Cost for 21.3 GW
SMR – NuScale	30.3	A$645 billion
US – Vogtle	23.4	A$498 billion
UK – Hinkley Point	27.2	A$579 billion

Below: Replacing Australia's retiring coal fleet (such as Bayswater Power Station in the Hunter Valley, NSW, Australia) with SMRs would not be feasible or cost effective. *Photo.* zetter

This cost would amount to at least half a trillion dollars even without considering the vast costs associated with training nuclear workers; establishing and maintaining a regulatory system; security considerations, nuclear waste management and more.

Ted O'Brien cites a US Department of Energy report estimating that leveraging existing infrastructure at coal sites could reduce reactor costs by 30%. In fact, the report estimates cost reductions of 15–35% compared to construction on a greenfield site. Would a 30% reduction make nuclear power economically viable in Australia? The following calculations suggest not.

Table 6

Economic viability of nuclear power in Australia with a 30% reduction

Cost estimates	A$ / MWh
Lazard's levelised cost estimate for large reactors (US$141–221 / MWh, A$213-334 / MWh), minus 30%	149-234
CSIRO 2030 estimate for SMRs (A$212–353 / MWh), minus 30%	148-247
CSIRO 2030 estimate for 90% wind and solar with integration costs (energy storage and transmission)	69–101

Even with a speculative 30% cost reduction, nuclear power is still far more expensive than firmed renewables.

Even if nuclear costs were reduced by 50%, nuclear power would not be competitive.

Table 7

Economic viability of nuclear power in Australia with a 50% reduction

Cost estimates	A$ / MWh
Lazard's levelised cost estimate for large reactors (US$141–221 / MWh, A$213-334 / MWh), minus 50%	107-167
CSIRO 2030 estimate for SMRs (A$212–353 / MWh), minus 50%	106-177
CSIRO 2030 estimate for 90% wind and solar with integration costs (energy storage and transmission)	69–101

Nuclear costs for large or small reactors would need to be reduced by two thirds for nuclear power to compete with firmed renewables. There is no reasonable expectation that this could or would ever occur.

4.5 Industry and investor uninterest and scepticism

Australia's major energy utilities are very sceptical about prospects for a nuclear-powered future. *Guardian Australia* reported on 19 March 2024 that Australia's big private electricity generators — AGL Energy, Alinta, EnergyAustralia and Origin Energy — have dismissed nuclear energy as a viable source of power for their customers for at least a decade. Instead, they say they will remain focused on developing renewable sources as coal and gas plants exit the grid. One senior executive told *The Guardian* power bills would triple if the nuclear path was pursued.

AGL chief executive Damien Nicks warns the nuclear debate risks derailing critical investment in the energy transition. The company reportedly plans 12 GW of new renewable and firming capacity by 2035. Nicks said: "**There is no viable schedule for the regulation or development of nuclear energy in Australia, and the cost, build time and public opinion are all prohibitive…** AGL is already developing our coal and gas power station sites into low-emissions industrial energy hubs… As the owner of these sites, nuclear energy is not a part of these plans."

Pitching nuclear power in Australia to board rooms and investors is like "looking for unicorns in the garden," Alinta Energy boss Jeff Dimery said in an April 2024 address to the National Press Club. Similarly, then NSW Treasurer Matt Kean said in 2021 that nuclear power is like "chasing a unicorn" because it is several times more expensive than renewables backed up with energy storage.

The Business Council of Australia argues for a rapid, renewables-led decarbonisation. Tennant Reed from the Australian Industry Group says Australia's energy future almost certainly lies in large-scale solar and wind rather than nuclear because solar and wind are cheap, abundant and open doors to developing green export industries.

Rio Tinto says it is not interested in nuclear power and has launched one of the country's biggest ever tenders for wind and solar to repower its Boyne Island and Tomago aluminium smelters and two key refineries, as zinc refiner Sun Metals has done before it.

Former Reserve Bank deputy governor Dr Guy Debelle says the economic argument against nuclear power is clear; introducing SMRs "just doesn't work in any reasonable timeframe" and the costs of large reactors in the US and the UK are "going through the roof."

Kerry Schott, chair of the Energy Security Board, says nuclear power is the most expensive energy option "by far" and that firmed renewables are "by far the cheapest and easiest" option.

A recent survey by the Investor Group on Climate Change asked large institutional investors with $37 trillion under management which energy and climate solutions they believed had good long-term returns. **Nuclear power was ranked last of the 14 options. Renewable energy was first. Nuclear power's last placing was due to its "very high cost, and the lack of maturity and deployment in next-generation technologies,"** the Investor Group said.

5. Conclusion

Proposals to introduce nuclear power to Australia make no sense. Nuclear power would be far more expensive than firmed renewables and would increase household power bills. Nuclear costs for both large and small reactors would need to be reduced by two thirds for nuclear power to compete with firmed renewables.

Large, conventional reactor projects have been subject to extraordinary cost overruns, while small modular reactors do not exist and would be even more expensive than conventional nuclear power.

If Australia was to seriously pursue nuclear power in the near future, it would necessarily involve large reactors costing several tens of billions of dollars each, with planning and construction likely to take 20 years or more. SMRs are not a near-term option given the lack of progress around the world and there is no certainty that this will change in the longer term.

Taxpayer subsidies worth tens, perhaps hundreds, of billions of dollars would be required to establish a nuclear power industry in Australia. This would be the case whether pursuing small or large reactor technology.

It is unlikely nuclear power reactors could be operating in Australia in under 20 years from any decision to proceed. All or nearly all of Australia's coal plants will be closed by the time nuclear reactors could begin supplying electricity in Australia, creating a major timing problem for coal-to-nuclear proponents.

Repurposing retired coal power plants as nuclear plants could reduce nuclear costs by using some existing infrastructure, but nuclear power would still be far more expensive than firmed renewables.

In addition to the problems addressed in this paper, nuclear power would pose troubling nuclear security issues; leave a legacy of high-level nuclear waste; and raise the spectre of catastrophic nuclear accidents.

Nuclear power lacks a social licence in Australia. There is clear, compelling evidence that Australians do not want nuclear reactors built anywhere near where they live. In the four states with coal plants that might be repurposed as nuclear plants, coal-to-nuclear proposals lack support from Labor governments and from Coalition leaders.

The ongoing development of renewable energy sources offers an energy pathway that is cheaper, quicker and safer than nuclear power and enjoys social licence.

Australia's energy future is renewable, not radioactive.

Nature needs us, now

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