WILL AUSTRALIA REQUIRE NUCLEAR ENERGY TO ACHIEVE CARBON ZERO EMISSIONS BY 2050?

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ABSTRACT

Whether Australia can have a reliable baseload power network in the future without nuclear power with aging coal-fired power stations being retired is one of the most pressing current issues. Answering this question is the purpose of writing this article. The number one National Science and Research priority is "transitioning to a net zero future," while the number four priority is "protecting and restoring Australia's environment." This topic falls squarely within these two national priorities. The current debate is largely political, with the two main parties taking diametrically opposed positions based on political ideology. The renewable energy industry trumpets solar and wind power, and points to the length of time it takes to build a nuclear power station, while organisations like the Minerals Council of Australia argue Australia is short-changing itself by not allowing nuclear power and pointing to Canada's nuclear industry as an example to follow. However, there is little written about the subject outside of the Commonweatlh Scientific and Industrial Research Organisation's (CSIRO's) annual GenCost report on the costs of different generation technologies and two reports written by Frontier Economics assessing the relative costs of nuclear power in the National Energy Market (NEM). The GenCost 2023-24 report concluded nuclear would be at least 50% more expensive than solar and wind and would not be available any earlier than 2040, while Frontier Economics estimated that the inclusion of nuclear power in the NEM in the Australian Energy Market Operator's (AEMO) preferred Step Change scenario is 25% cheaper than AEMO's renewables and storage approach. This article objectively examines whether Australia will require nuclear energy to achieve carbon zero emissions by 2050.

INTRODUCTION

To use an old saying, there are lies, damn lies and statistics. And then there is Chris Bowen.¹

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¹ Chris Uhlmann, *Bowen plan threatens to leave us in the dark*, THE WEEKEND AUSTRALIAN (Nov. 30-Dec. 1, 2024). (The Honourable Chris Bowen, MP, is the Federal Minister for Climate Change and Energy.)

This article examines the social, economic, legal, environmental, and planning issues associated with the feasibility of Australia achieving its target of zero carbon emissions by 2050 without fossil fuels or nuclear energy. The article is divided into four parts.

The first part deals with the background to the energy landscape in Australia in 2025, comprising projected future population growth and energy demand, the Australian Energy Market Operator's 2024 Integrated System Plan, and the Commonwealth government's net zero plan by 2050. The latter covers a review of the Commonwealth government's milestones in place between 2025 and 2050, including the viability of the assumptions that underpin these milestones, such as the percentage share of the National Energy Market generated from renewable sources and emissions reduction targets.

The second part considers existing and future Australian energy sources: (a) Coal and whether Australia's coal fired power stations which are all due to close by 2038 and whose planned closures require variable renewable energy capacity to triple by 2030 and increase sevenfold by 2050, will be needed to continue operating past 2038; (b) Gas and whether gas is the critical power source to transition to net zero; (c) Pumped hydro and Snowy Hydro 2.0 and whether Australia has enough water for pumped hydro to have an impact as an energy supplier; (d) Green hydrogen and whether, in light of its abandonment as a viable source of energy under current technology by both Fortescue and Origin Energy, a pathway for Green hydrogen will emerge before 2050.

The third part examines the viability of nuclear energy in Australia and, in particular, reviews CSIRO's GenCost 2023-2024 report,² which estimates the cost of building new electricity generation, storage, and hydrogen production in Australia out to 2050, and the two reports produced by Frontier Economics in November and December 2024. The first Frontier Economics report developed a base case to assess the relative costs of nuclear power in the NEM,³ while the second Frontier Economics report undertook an economic analysis of including nuclear

² Graham P, Hayward J, and Foster J, *GenCost: cost of building Australia's future electricity needs 2023-2024 Report* (CSIRO 2024). CSIRO and the Australian Energy Market Operator (AEMO) collaborate with industry stakeholders to update GenCost annually. CSIRO's GenCost 2024-25 Consultation Draft has been released and the final GenCost 2024-25 report will be released in the second quarter of 2025.

³ Developing a base case to assess the relative costs of nuclear power in the NEM, Report No. 1, Frontier Economics (Nov. 14, 2024), <u>https://www.frontier-</u> economics.com.au/wp-content/uploads/2024/11/Report-1-Base-case-report-Nov-14-2024 v2.pdf. [https://perma.cc/QPW4-KSV2] power in the NEM.⁴ The GenCost report determined nuclear power was 50% more expensive than renewables and would take at least 15 years to develop including construction, the validity of which has been criticised on the basis that the CSIRO should re-run its modelling to account for longer lifespans and running times of nuclear generators in other countries with nuclear programs.

The fourth part will review the environmental and planning issues involved in the transition to carbon zero emissions by 2050, focusing on an examination of the proposed locations of the seven nuclear power plants and disposal sites for nuclear waste, and the proposed locations of large-scale solar panel farms and wind farms. This part will compare the costs of nuclear with the true costs of renewables,⁵ such as the environmental impact of large-scale solar panel farms and wind farms on prime agricultural land and sensitive coastal marine areas, including consideration of the impact of community opposition to both nuclear and renewable energy locations, as well as the placement of thousands of kilometres of transmission lines.

This part will also consider the legal issues involved in establishing a nuclear industry in Australia, including the need to repeal s 140A(1)(b) of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) which states: "(1) The Minister must not approve an action consisting of or involving the construction or operation of any of the following nuclear installations ... (b) a nuclear power plant." An associated legal issue is allowing uranium mining in the States and Territories. Currently, uranium exploration and mining are allowed only in South Australia, the Northern Territory and Tasmania. Exploration for uranium is allowed in Queensland and New South Wales but not mining.

The conclusion will seek to provide an objective answer based on evidence to the question of whether it is feasible for Australia to achieve its target of zero carbon emissions by 2050 without fossil fuels or nuclear energy or whether in planning to achieve its target Australia is relying on green technology that is presently unavailable.

⁵ For example, three 81 metre rotor blades of a Siemens Gamesa offshore wind turbine contain a total of six tons of balsa wood or the equivalent of 40 trees. Rainforest Rescue highlight that 90% of the balsa wood traded worldwide comes from rainforests in Ecuador and the felling of balsa is devastating for local ecosystems, https://www.rainforest-rescue.org/petitions/1255/dont-plunder-the-rainforest-for-wind-energy. [https://perma.cc/PAY3-ZYFV] In another example, Joel Merriman, a wind specialist at the charity the American Bird Conservancy, has modelled the death rate of birds and concluded that 1.17 million birds are killed by wind turbines in the United States each year, https://www.energymonitor.ai/renewables/weekly-data-how-many-birds-are-really-killed-by-wind-turbines/?cf-view.. [https://perma.cc/8TJE-PSXV]

⁴ *Economic analysis of including nuclear power in the NEM*, Report No. 2, *Frontier Economics* (Dec. 13 2024).

I. BACKGROUND TO THE ENERGY LANDSCAPE IN AUSTRALIA IN 2025

*Do not listen to what nations say at yearly climate jamborees, watch what they do.*⁶

A. Australian Population Forecast by 2046

The Australia population forecast for 2024 is 27,265,000, and is forecast to grow to 34,610,000 by 2046, which represents a 26.90% increase in population.⁷ On the basis of this forecast, to achieve net zero carbon emissions by 2050, renewable energy sources will have to supply power to an additional 7,345,000 people living in Australia. The Australian Bureau of Statistics (ABS) prefers to use the term projections rather than predictions or forecasts. The ABS projects Australia's population in 2022 (26 million) will reach between 34.3 and 45.9 million people by 2071.⁸ The ABS explains that the assumptions underlying these projections "do not specifically attempt to allow for non-demographic factors (such as major government policy decisions, economic factors, catastrophes, wars, epidemics or significant health treatment improvements) which may affect future demographic behaviour or outcomes."⁹ The ABS goes on to point out that because "future levels of fertility, mortality, overseas migration and internal migration are unpredictable, two or more assumptions have been made for each component and projections have been produced for all combinations of the assumptions."¹⁰ This accounts for the range of ABS population projections to 2071. However, it appears reasonable to conclude that Australia's energy needs will have increased by between 25% to 30% by 2050 based on the available population growth figures.

B. Australian Energy Market Operator's 2024 Integrated System Plan

Of course, population growth is but one aspect of Australia's future energy demands. The Australian Energy Market Operator (AEMO)

⁶ Chris Uhlmann, *Coal comfort for the energy illiterate*, The Weekend Australian (Nov. 23– Nov. 24 2024).

⁷ These forecasts were created in August 2024 by the National Forecasting Program and are prepared by .id (informed decisions) on behalf of Australia. Forecasts are available for each year from 2021 to 2046, <u>https://home.id.com.au/forecastreview/australia</u>. [https://perma.cc/MG3K-RWE8]

⁸Population Projections, Australia 2022 - 2071, Australian Bureau of Statistics (Nov. 23, 2023) <u>https://www.abs.gov.au/statistics/people/population/population-projectionsaustralia/latest-release</u>. [https://perma.cc/CNL6-WWHV] ⁹ Id

has released the 2024 Integrated System Plan (ISP).¹¹ Under the scenario that AEMO considers most likely, Australia's National Energy Market (NEM) will need to almost triple energy generation.

The NEM will need to almost triple its generating capacity, as variable renewable generation typically operates at less than full capacity. At the same time, industry, business and households will need more electricity as they switch from fuel and gas.¹²

AEMO's 2024 ISP goes on to predict that "[f]uture energy consumption from the NEM will rise by approximately 108% by 2050, largely from business and industry, as households increasingly meet their own electricity needs."¹³ This translates into a forecast that electricity consumption across the NEM will rise to over 410 terawatt hours (TWh) in 2049-50, up from 200 TWh in 2024, based on the assumption that residential consumption will be significantly offset by the uptake of rooftop solar and energy efficiency, while it is assumed business consumption will grow with the economy, its electrification and the inclusion of hydrogen loads.¹⁴

The essence of AEMO's 2024 ISP is an Optimal Development Path (ODP) which AEMO describes as its preferred *Step Change* scenario (a pace of energy transition that supports Australia's contribution to limit global temperature rise to less than 2 degrees centigrade) and is designed to fulfil Australia's emission reduction commitments in a growing economy. This ODP is predicated on the phasing out of brown and black coal by 2034-35 and the uptake of rooftop solar, utility solar and wind generation to provide approximately 400 TWh in 2049-50, with a further 100 TWh to be provided by a combination of consumer energy resources storage (batteries and electric vehicles), utility storage, hydro, biomass and flexible gas (gas-powered generation and potential hydrogen capacity), for a total of 500 TWh in 2049-50.¹⁵

However, AEMO has identified four tensions which must be managed if AEMO's ISP roadmap through the energy transition is to retain accuracy and relevance.

¹¹ AEMO 2024 Integrated System Plan for the National Energy Market, *Australian Energy Market Operator*,

²⁰²⁴⁻integrated-system-plan-isp.pdf. [https://perma.cc/D9TR-VKRL] ¹² *Id.* at 22.

¹³ Id. at 24.

¹⁴ *Id.* at 25, depicted in Figure 5 Electricity consumption, NEM (TWh, 2009-10 to 2049-50, *Step Change*).

¹⁵ *Id.* at 30, depicted in Figure 9 Generation mix, NEM (TWh, 2009-10 to 2049-50, *Step Change*).

The first tension is that lights must be kept on and the gas flowing while the new system is put in place.

. . . .

The second tension is about integrating the diverse range of technologies, small and large, that a multi-gigawatt clean energy system needs.

• • • •

The third tension is about the social license needed to deliver secure and affordable electricity for all.

. . . .

The fourth tension is that Australia is not the only country transforming its energy system; the whole world is competing for the same investment, equipment and engineering skills.¹⁶

Before examining each of the above four tensions identified by AEMO, some general observations are in order. In discussing the first tension, there is a brief but telling admission of the need to keep the gas flowing, which is a recognition that there must be a baseload energy source for the periods when the sun does not shine, or the wind does not blow. Indeed, Daniel Westerman, the Chief Executive Officer of AEMO, noted in his preface to AEMO's 2024 ISP, "[a]s coal-fired power stations retire, renewable energy connected with transmission and distribution, firmed with storage, and backed up by gas-powered generation is the lowest-cost way to supply electricity to homes and businesses through Australia's transition to a net zero economy."¹⁷ Whether AEMO's ODP is the lowest-cost way to supply electricity will be dealt with in the third part of this article which examines CSIRO's 2023-2024 GenCost report.¹⁸

Under the second tension, in terms of integrating the diverse range of technologies for a clean energy system, nuclear power is specifically excluded. Attention with be focused on the third tension given the significance of the environmental and planning issues associated with

¹⁶ *Id.* at 33-35.

¹⁷ *Id.* at 3. (Perversely, under Victoria's Gas Substitution Roadmap, from January 1, 2024, new gas connections for new dwellings, apartment buildings, and residential subdivisions requiring planning permits are being phased out. This policy has been implemented through amendment VC250 to the Victoria Planning Provisions and all planning schemes in Victoria. Victoria builds over 50,000 new homes each year, with approximately 40,000 connecting to the gas network.)

¹⁸ Graham P et al, GenCost: cost of building Australia's future electricity needs 2023-2024 Report, n 2. (As Jennie George has pointed out "the brief to the market operator, AEMO, is to devise the lowest-cost pathway to achieve the legislated 2030 emission reduction targets, as distinct from devising a system that provides the cheapest energy to consumers"); Jennie George, *Rethink energy transition or face economic disaster*, The Weekend Australian (Feb. 8-9, 2025).

social license and the 10,000 kms of new transmission needed by 2050 under the *Step Change* scenario, with about 5,000 kms of this transmission delivery to be in the next decade, creating about 4,000 kms of new transmission corridors and upgrading about 1,000 kms of existing lines.¹⁹ As to the fourth tension and competing against the whole world, Australia is the only country in the world attempting to transition to net zero by 2050 without nuclear power.

1. First tension: lights must be kept on and the gas flowing

AEMO acknowledges that the NEM must operate safely and reliably, which is both a complex technical challenge and a social and economic one. However, in the following statement AEMO does not appear to recognise the implications of its own ODP. "Coal generators have been retiring earlier than initially announced, and a 'just in time' transition to replacement infrastructure risks reliable supply."²⁰ The main reasons why coal generators are retiring early are because (a) coal power stations are ageing,²¹ and (b) renewable energy has been heavily subsidised by taxpayers.²² This has led to the owners of coal generators accelerating plans for alternative uses of their generation sites.²³

The danger of such acceleration can be seen in the decision of the government of New South Wales (NSW) in May 2024 to reach an agreement with Origin Energy to extend the operation of the 2.92GW Eraring coal-fired power station at Lake Macquarie by at least two years until August 2027, at an estimated cost of \$150 million per annum. Eraring's 6 TWh of power represents 3% of the total generation in the eastern states' NEM, and AEMO had indicated that without Eraring, NSW would face energy reliability risks starting in 2025.²⁴

¹⁹ AEMO, *supra* note 11 at 56.

²⁰ Id. at 33.

²¹ "The average lifetime of a coal powered plant is 29 years although its design life is 40 to 50 years": Monishka Narayan, *The Demise of Coal, Energy Insider*, Energy Networks Australia (July 18, 2019).

²² Michael Wu, *Counting the Cost: Subsidies for Renewable Energy*, The Centre for Independent Studies (June 6, 2024) ("[O]ver the past decade, over \$29 billion in subsidies have been provided by the federal government to the renewable energy sector. The dominant source of subsidies has been the Renewable Energy Target scheme, which has seen around \$2.7 billion per year channelled towards large-scale and small-scale renewable energy.")

²³ Options include large scale batteries, converting to biomass fuel, and small modular nuclear reactors (SMRs).

²⁴ NSW government to extend life of Origin's Eraring coal plant to 2027, *Power Technology* (May 23, 2024), <u>https://www.power-technology.com/news/nsw-origin-eraring-coal-plant-2027/</u>. [https://perma.cc/5GFF-5M54]

Thus, in a supreme irony, NSW taxpayers are subsidising both renewable energy and coal generators, which is a direct result of the risks to reliable energy supply inherent in AEMO's ODP and in turn reflects the Commonwealth government's commitment to reduce greenhouse gas emissions to 43% below 2005 levels by 2030. On the one hand, AEMO recognises the need to "make sure the new generation and firming capacity comes in ahead of coal retirements," while on the other hand accepting that "rushing the transition is also risky."²⁵

In recognition of the risks of "just in time" transition identified by AEMO, the newly elected Queensland Liberal National Party (LNP) government announced in November 2024 that it had committed \$1.4 billion over five years towards an "energy maintenance guarantee" to keep Queensland's coal generators online, and in good working order to boost energy reliability. The LNP cited the explosion on 25 May 2021 at Unit C4 of the Callide C power station operated by CS Energy as justification for the guarantee.²⁶ The Brady Heywood review of the cause of the 2021 explosion found that the key organisational factor related to the incident can be summarised as a failure to implement effective process safety practices.²⁷ Significantly, CS Energy is a Queensland government owned corporation and is obliged to meet shareholder mandates which "focused on cost savings, and performance indicators were dominated by financial and production metrics. . . .".²⁸

By contrast with Queensland's approach and arguably pointing to the shape of events to come, on 27 November 2024, the NSW Premier Chris Minns asked Sydney residents to turn off appliances between 3 pm and 8 pm to avoid possible load shedding and blackouts due to the hot temperatures.²⁹ On the same day, Chris Bowen, Federal Minister for Climate Change and Energy, in a reference to a number of NSW coal-

²⁵ AEMO, *supra* note 11 at 33. 'Firming' means grid-connected assets that can provide dispatchable capacity when variable renewable energy generation is limited by weather, for example storage (pumped hydro and batteries) and gas-powered generation (ibid 90).

²⁶ Giles Parkinson, Coalkeeper, Queensland style: LNP commits \$1.4 bn, sets utility KPIs, to keep coal generators on line, *RenewEconomy* (November, 28 2024) <u>https://reneweconomy.com.au/coalkeeper-queensland-style-lnp-commits-1-4-bn-sets-</u>utility-kpis-to-keep-coal-generators-on-line/. [https://perma.cc/D599-F7W3]

 ²⁷ Brady S, "Technical and Organisational Investigation of the Callide Unit C4 Incident," Brady Heywood (July 2024) 11. See also Miles J and McKenna K, Damning report into 2021 Callide C power station explosion finds CS Energy failed to implement effective safety practices, ABC News (June 25, 2024).
²⁸ Id. at 10.

²⁹ Chris Minns asks Sydney residents to keep washing machines off to avoid heatwave outages, THE GUARDIAN (Nov. 27 2024) <u>https://www.theguardian.com/australia-news/2024/nov/27/heatwave-bom-weather-forecast-sydney-power-outage-blackouts-temperature#:~:text=The%20premier%2C%20Chris%20Minns%2C%20said,AEDT%5 D%2C%E2%80%9D%20Minns%20said. [https://perma.cc/J7CV-A729]</u>

fired power stations operating at reduced capacity to complete planned maintenance stated, "the least reliable part of our energy grid at the moment is coal-fired power, that's just a statement of fact," despite the inconvenient fact that on the day in question 60% of the NEM's power was provided by coal with a further 10% provided by gas.³⁰

2. Second tension: integrating the diverse range of technologies needed for a clean energy system

Somewhat obliquely, AEMO almost sidles up to one of the most critical aspects of its ODP, with this elliptical reference to integration, namely, "connecting generation or storage assets to the whole system."³¹ In Chris Bowen's own words, "there's no transition without transmission."³² In a more realistic appraisal of the connectivity hurdles, Transgrid, the operator of the most important electricity transmission network in Australia,³³ has clearly spelt out the problems.

The challenge for the energy network is that new renewable energy sources may be built in locations that have not been connected to the electricity grid before. That's why we need new transmission to connect lower-cost renewable generation to consumers. The growing diversification of the energy generation will require a significant expansion of the transmission network and new storage solutions. Our current energy system is not prepared for an accelerated coal retirement - and the consequences of not bringing on renewable generation quickly enough could be dire. . The current scale of the new transmission needed to support the accelerating transition is unprecedented. Despite the many renewable energy projects on the drawing board, planned investment is still behind what is needed to help replace coal power plants while keeping energy supply reliable and affordable.³⁴

AEMO's description of the connectivity hurdles as a 'tension' grossly understates the obstacles which Transgrid more accurately classifies as 'dire' as well as pointing out the scale of the transition is 'unprecedented'. The impact of the 10,000 kms of new transmission

³⁰ Kenny C, Climate Gaslighting, and a Wealth of Mod Cons, *The Weekend Australian* (Nov. 30 -Dec. 1 2024).

³¹ AEMO, *supra* note 11 at 34.

³² George J, *Is Labor finally realising the folly of its energy plan?*, The Australian, (Oct. 24, 2024).

³³ Transgrid's transmission projects include EnergyConnect, HumeLink and VNI West. Transgrid is also the company responsible for maintaining the transmission lines to Broken Hill in NSW, whose 20,000 residents were without power for two days after a storm on 17 October 2024 when seven transmission towers came down. One of the city's two backup generators was not operating, and the other failed.

³⁴ Why there is no transition to renewables without transmission, Transgrid (March 23, 2023), <u>https://www.transgrid.com.au/energy-transition/why-there-is-no-transition-to-renewables-without-transmission</u>. [https://perma.cc/YU3D-7AF5]

needed by 2050 will now be considered under the third tension of social license.

3. Third tension: the social license for a clean energy system

AEMO has identified two places of tension in achieving the social license to deliver secure and affordable electricity: "The first is where communities are asked to host infrastructure for Australia's energy future ... and the second ... is where households, businesses and communities have invested in their own energy resources."³⁵ The former involves community acceptance of transmission projects, while the latter deals with the oversupply of rooftop solar to the NEM at certain times of the day requiring action to ensure power system security.

a. Hosting renewable infrastructure

According to the Commonwealth Department of Climate Change, Energy, the Environment and Water, "[s]ocial licence is about landholders and communities supporting energy infrastructure affecting their lives."³⁶ The Australian Government has developed guidelines to set a nationally consistent community engagement approach for transmission projects.³⁷ The guidelines specify that transmission companies should try to avoid or minimise impacts as much as possible when choosing where to locate transmission lines, and "must consider impacts to First Nations land, biodiversity and important social and economic land use including agriculture," and at the same time acknowledging that they "must also balance these impacts with technical and cost factors."³⁸ Globally, five

³⁷ Energy Ministers release National Guidelines for Community Engagement and Benefits for Electricity Transmission Projects, Commonwealth Dep't of Climate Change, Energy, the Env't and Water (July 19, 2024). The guidelines expect transmission developers to improve the way they: engage with communities; gather local knowledge to inform project design and construction; identify and manage project impacts; understand and help mitigate local concerns; deliver meaningful benefits to the local community and First Nations groups; monitor how communities respond to their engagement activities and tailor them if needed,

https://www.energy.gov.au/energy-and-climate-change-ministerial-council/workinggroups/transmission-working-group/community-engagement-guidelines-fortransmission-projects. [https://perma.cc/YJL4-FE4X]

³⁸ Community Engagement for Energy Projects, Commonwealth Department of Climate Change, Energy, the Environment and Water (May 1, 2025)

https://www.dcceew.gov.au/energy/renewable/community-engagement/transmission. [https://perma.cc/ZS8Y-LHHQ]

 $^{^{35}}$ AEMO , *supra* note 11 at 34.

³⁶ Community Engagement For Renewable Energy Infrastructure, Commonwealth Dep't. of Climate Change, Energy, the Envn't and Water (2024), https://www.dcceew.gov.au/energy/renewable/community-

engagement#:~:text='Social%20licence'%20is%20about%20landholders,energy%20inf rastructure%20affecting%20their%20lives. [https://perma.cc/MXQ3-XHF4]

principles to earn a social license for renewables projects have been identified. First, understand the values of the community. Secondly, harness community knowledge. Thirdly, share benefits. Fourthly, build trust. Fifthly, set clear timelines and expectations.³⁹

Guidelines and principles are helpful in theory but putting them into practice is more challenging. Thus far, the Australian experience of the renewable transmission rollout has been sluggish. As Tony Wood from the Grattan Institute has identified, the reasons why the renewable transmission rollout timelines are stalling is "not because there is no demand for cheap power, but because regulatory approvals are too slow and there is no way to get the power to the cities and heavy industries."⁴⁰ Wood specifically singled out community resistance as a primary cause of the delay, "[a] big part of the issue is community pushback and process. Local farmers and communities are resisting many of the planned new transmission lines."⁴¹

A good example of community pushback can be seen in opposition from farmers to AusNet's new transmission line, called the Western Renewables Link, which is needed to move electricity from green power sources like solar and wind farms in Victoria's west to a terminal station in Melbourne. One farmer, Ms. Aganetti-Fraser, was quoted as saying farmers were not opposed to green energy but were opposed to the power lines running through their properties as it will disrupt farming operations and devalue their land. The farmers want the transmission line to run along the highway, but AusNet claimed that option was not economically viable.⁴²

The above example of a more widespread 'bush revolt' against the proposed 10,000 kms of transmission lines led to the Federal Minister for Climate Change and Energy commissioning Andrew Dyer, the Australian

³⁹ Five Principles to Earn a Social License for Renewables Projects, WSP (July 26, 2022), <u>https://www.wsp.com/en-au/insights/five-principles-to-earn-a-social-license-for-renewables-projects</u>. [https://perma.cc/E65D-4ZL2]

⁴⁰ Wood T, *The Great Transmission Challenge*, Grattan Institute (August 31, 2023), https://grattan.edu.au/news/the-great-transmission-challenge/.

[[]https://perma.cc/KTW7-TH38]

⁴¹ *Id*.

⁴² Nadia Daly, *Community pushback against renewable energy projects could see Australia miss its emissions targets and climate goals*, ABC News (Nov. 28, 2023), <u>https://www.abc.net.au/news/2023-11-28/renewable-energy-transition-communitypushback-emissions-targets/103154364</u>. [https://perma.cc/WJP9-L9JC] Wind farms are also dividing farming communities between those who see wind farms as assisting farm enterprises with high debt survive droughts and those who are concerned about the long-term nature of rural Australia allied with 'taxpayers subsidising each wind turbine to the tune of more than \$850,000 through various government grants and subsidies': Thompson P, *Wind farm fury pitting mate against mate*, The Weekend Australian (Feb. 8-9, 2025).

Energy Infrastructure Commissioner, to undertake a *Community Engagement Review* which reported in December 2023.⁴³ The review report painted a bleak picture of a grossly under-performing transmission sector which had paid little attention to the federal guidelines, and is best summed up by the following extract.

The potential for new transmission lines and associated corridors has unleashed a plethora of wind and solar farm developers, descending on the planned routes to attempt to sign up nearby landholders with exclusive contracts over their land.

As a result, there are far more potential renewable generation projects being pursued by developers than the proposed transmission lines may actually accommodate, which can unnecessarily create uncertainty, anxiety and consultation fatigue. These scenarios can also lead to vigorous opposition to the proposed transmission lines, based largely on perception of the amount of generation it may enable, rather than the actual facts.⁴⁴

The notion of a 'plethora' of renewable developers descending on landowners near to planned transmission routes conjures up images of latter-day carpetbaggers.⁴⁵ The review report recognised the need to only select reputable developers by operating a developer rating scheme, which followed from this excoriating assessment of developer engagement with the relevant local community.

For many developers, the skills, experience and knowledge of engagement personnel and management are below community expectations, as are their supporting processes, collateral and the overall governance of the developer's engagement function.⁴⁶

The review report made six recommendations, all of which were accepted by the federal government. These recommendations ranged from improving developer performance and selection of the best sites to the reform of environmental and planning approvals and better complaint management. The impact of these recommendations is yet to emerge, although the evidence is mounting that the transmission costs are rising steeply and will likely impact on energy bills.

The cost of building the three largest electricity transmission lines vital to Australia's transition to clean energy has doubled to at least \$16 billion since they were first announced. Further increases are feared,

 ⁴³ Andrew Dyer, *Community Engagement Review Report* (Dep't of Climate Change, Energy, the Environment and Water, (Feb. 2, 2024).
⁴⁴ *Id.* at 9.

Ia. at 9.

⁴⁵ A 'carpetbagger' is an expression which emerged in the aftermath of the Civil War in the United States to describe Northerners who came to the defeated South to exploit the local populace for their own financial, political, or social gain.

⁴⁶ Dyer, *supra* note 43 at 8.

stoking concerns of a hit to power bills from projects vital to decarbonisation . . . The three big projects are the Central-West Orana Renewable Energy Zone in NSW, Queensland's CopperString line from Townsville to Mount Isa, and the HumeLink transmission line which will connect Wagga Wagga, Bannaby and Maragle and support the Snowy 2.0 pumped hydro battery project.⁴⁷

Completion of these transmission lines is essential if the federal government's 2030 targets of 82% of the NEM being provided by renewables and a 43 per cent cut in greenhouse gas emissions from 2005 levels are to be met. Leaders in the energy sector, such as Matthew Rennie, the co-chief executive of Rennie, which advises on the energy transition, has been quoted as saying: "Nothing is being built on time, with almost every transmission line project already delayed and the prospects of further delays almost inevitable, and development timelines for renewable projects now averaging more than four years."48 Both Origin Energy CEO Frank Calabria and Brett Redman, the CEO of NSW high-voltage grid owner TransGrid, have described the federal government's 2030 targets as "very challenging."49 As the Climate Change Authority (CCA) has acknowledged, "[a] massive construction effort is required to install renewable capacity, and poles and wires, to supply two-to-three times more electricity than generated today by 2050."50

b. Oversupply of rooftop solar to the NEM

The complexities of the energy market are well illustrated by the perversity that the growth in rooftop solar output (about 3 million households in the NEM have a cumulative capacity of more than 20 gigawatts) has led AEMO to issue warnings, known as minimum system load notices, as to its ability to keep the NEM from being overloaded at certain times. AEMO was concerned that when the oversupply of solar was acute, AEMO might be forced to intervene because "demand for power from the grid would fall below a threshold critical for keeping the

⁴⁷ Macdonald-Smith A, *Energy bill fears grow as transmission costs blow out*, Financial Review (Nov. 8, 2024), <u>https://www.afr.com/companies/energy/energy-bill-fears-grow-as-transmission-costs-blow-out-20240916-p5katm</u>.

[[]https://perma.cc/XV6N-GKM8]

⁴⁸ *Id.* ⁴⁹ *Id.*

⁵⁰ Sector Pathways Review, *Climate Change Authority* (2024), at 7, fig. S.1: ("Sector insights and potential pathways, Electricity and Energy"), <u>https://www.climatechangeauthority.gov.au/sites/default/files/documents/2024</u>

^{09/2024}SectorPathwaysReview.pdf. [https://perma.cc/ZT53-RZZV]

electricity system on an even keel."⁵¹ In other words, AEMO cannot allow the rooftop solar juggernaut to overwhelm the grid because if the grid turns off turbines in response to low demand, then this will lead to breaches of system security and power instability.

If there can be no energy transition without transmission, then it is equally true that there can be no NEM security without storage of renewable energy. The fundamental problem is that at present renewable energy cannot flexibly respond to changes in system demand such as the evening load peak.

4. Fourth tension: Australia competing with the whole world in transforming its energy system

AEMO sees Australia to be in competition with the whole world for the "same investment, equipment and engineering skills," using the vehicle of government funded incentives to attract private investment, citing the International Energy Agency as the source of the allocation of US\$1.34 trillion to clean energy investments since 2020, and US\$130 billion in the six months to June 2023.⁵² However, there is a major omission in AEMO's analysis of world trends in energy transition, namely, a widespread worldwide commitment to advancing the uptake of nuclear power as a clean energy source.

At the United Nations Climate Change Conference in Dubai in 2023 (COP 28), "25 nations pledged to triple nuclear generation by 2050, with another six signing on at COP 29 in Baku in November 2024, showing nuclear energy has become mainstream in international climate negotiations."⁵³ There is a growing awareness that energy transition is complex and requires an "all of the above" multifaceted approach encompassing fossil fuels, wind, solar, nuclear, and geothermal aimed at reducing energy bills and protecting nations from foreign energy coercion. The head of the World Nuclear Association summed up the situation in these terms: "If our goal is to build more solar and wind, we are doing okay. But if our goal is to decarbonise faster, we are not doing

[https://perma.cc/GJ8U-QB9R]

 ⁵² AEMO 2024 Integrated System Plan for the National Energy Market, n 11, 34-35.
⁵³ Talacko C, 'COP message clear: nuclear inevitable, so what's our problem?', *The Australian* (Nov. 22, 2024), <u>https://www.theaustralian.com.au/commentary/cop-</u> message-clear-nuclear-is-inevitable-so-whats-our-problem/news-

story/bbf8483d43337a3b042739a5e1a39558. [https://perma.cc/LG87-PC94]

⁵¹ Mercer D, 'Rooftop solar 'juggernaut' risks grid overload as AEMO issues rare lowdemand warning', *ABC News* (Sept. 2024), <u>https://www.abc.net.au/news/2024-09-</u> 27/solar-juggernaut-sparks-first-low-demand-warning/104406680.

so well. And if our goal is to generate 24/7 cheap, reliable energy, we need nuclear."⁵⁴

The Australian government's decision to put all its energy eggs in the renewables basket rather than adopt an 'all of the above' multifaceted approach was underlined by Chris Bowen's announcement at COP 29 of Australia's withdrawal from the Generation IV International Forum (GIF). Established in 2001, GIF was created as a co-operative international endeavour seeking to develop the research necessary to test the feasibility and performance of fourth generation nuclear systems (Gen-IV systems), and to make them available for industrial deployment by 2030. A new GIF agreement will come into force from March 1, 2025, but "Bowen said Australia would not sign because we had no plans for a civilian nuclear industry."⁵⁵

C. Australia's 2030 Emissions Reduction Targets

The Commonwealth Department of Climate Change, Energy, the Environment and Water's 2023 emissions projections for Australia made the following revealing admission: "Under the baseline scenario, the 2023 emissions projections indicate Australia will achieve a 37% reduction on 2005 levels by 2030."⁵⁶ This is 6% below the target emissions figure of 43%. However, the Department's 2024 emissions projections for Australia have revised the reduction figure under the baseline scenario to "42.6% below 2005 levels in 2030, just shy of the 2030 target".⁵⁷

Regarding the strength of the 2024 emissions projections, the Federal Minister for Climate Change and Energy, Chris Bowen, declared in November 2024 that Australia was "on track" to meet its climate change targets.⁵⁸ But one commentator disagreed, arguing "the federal government has released four reports on Australia's greenhouse gas

⁵⁷ *Australia's emissions projections 2024'* Commonwealth Dep't of Climate Change, Energy, the Env't and Water (Nov. 2024) at 16.

⁵⁴ Id.

⁵⁵ Lloyd, G, *Nation's technological edge is about to get a lot duller*, *The Weekend Australian* (Nov. 23-24, 2024), <u>https://www.theaustralian.com.au/inquirer/nations-technological-edge-about-to-become-much-duller/news-</u>

story/c0c6bce3c5dfc0df27a89a23d13ca6ca. [https://perma.cc/N6DY-FED3]

⁵⁶ Australia's emissions projections 2023, Commonwealth Dep't of Climate Change, Energy, the Env't and Water (Nov. 2023) at 3.

https://www.dcceew.gov.au/sites/default/files/documents/australias-emissionsprojections-2023.pdf. [https://perma.cc/M28Z-ZWVA]

https://www.dcceew.gov.au/sites/default/files/documents/australias-emissions-projections-2024.pdf. [https://perma.cc/G78G-CYVW]

⁵⁸ Michelle Grattan, *Australia on track to meet 2030 43% emission's reduction target, on latest figures*, The Conversation (Nov. 26, 2024).

https://theconversation.com/australia-on-track-to-meet-2030-43-emissions-reductiontarget-on-latest-figures-244642. [https://perma.cc/R9S8-R7Z7]

pollution that highlight just how far away we are from meeting those targets".⁵⁹

Also pouring cold water on Mr Bowen's parade was Matt Kean, chair of the government's independent Climate Change Authority, who said: 'Emissions need to fall faster to reach Australia's 2030 target.' As Mr Kean noted, emissions will need to fall at a rate that is 500 per cent as fast as the rate seen in 2023-2024 to meet our 2030 target.⁶⁰

The basis for Mr Kean's observations was the Quarterly Update of Australia's National Greenhouse Gas Inventory: June 2024.⁶¹ Australia's emissions, by quarter, from September 2004 to June 2024, have flatlined since 2020.⁶² More importantly, the decline in emissions between 2005 and 2020 was driven almost exclusively by Land Use, Land Use Change and Forestry (LULUCF) rather than any reduction in the burning of fossil fuels.⁶³ Consequently, the assertion by the Commonwealth Department of Climate Change, Energy, the Environment and Water that electricity emissions in the next six years will more than halve is startling.

In the electricity sector, emissions are projected to more than halve in the 6 years between 2024 and 2030. This is driven by the expanded Capacity Investment Scheme, which is included in the baseline emissions projections for the first time.⁶⁴

The critical assumption underpinning Chris Bowen's "on track" declaration is set out in a Table that projects electricity emissions in the baseline scenario to fall from 144 Mt CO2-e in 2025 to 59 Mt CO2-e in 2030.⁶⁵ Implicit in this baseline scenario is a further assumption, namely, that the federal government's 82% renewable electricity generation target for on-grid electricity generation is met by 2030.

⁵⁹ Michael Slezak, *These six charts tell the story of Australia's (slow) progress on climate change*, ABC News (Dec. 9, 2024). <u>https://www.abc.net.au/news/2024-12-09/australias-climate-change-policy-problem-in-charts/104689682</u>

[[]https://perma.cc/NS3X-DB3V]

⁶⁰ Id.

⁶¹ Quarterly Update of Australia's National Greenhouse Gas Inventory: June 2024, Commonwealth Dep't of Climate Change, Energy, the Env't and Water,

https://www.dcceew.gov.au/sites/default/files/documents/nggi-quarterly-update-june-2024.pdf [https://perma.cc/G5XH-ESZH]

⁶² *Id.* at 8, fig.1.

⁶³ *Id.* at 12, fig.3.

⁶⁴ *Australia's emissions projections 2024, supra* note 56, at 6. The Capacity Investment Scheme (CIS) is an Australian Government revenue underwriting scheme to accelerate investment in clean dispatchable capacity (dispatchable), such as battery storage. The scheme provides a long-term revenue safety net that decreases financial risk for investors.

⁶⁵ *Id.* at 51, tbl.17.

So, far from being a meaningful projection about how the electricity system will lower its emissions, the cut is simply assumed - and so are state-based renewable targets. But that's far from a sure thing.⁶⁶

The reasons why lowering emissions is "far from a sure thing" are twofold. First, as AEMO has recognised, under AEMO's *Step Change* scenario, by 2034-35, the NEM is forecast to need approximately 83 GW of utility-scale wind and solar, and 127 GW by 2049-50, which is six times the current NEM capacity of 21 GW utility-scale wind and solar.⁶⁷ Secondly, as the CCA has acknowledged, "across all sectors, a significant and urgent ramp up in effort, investment and coordination is required and there are barriers that will need to be overcome if Australia is to achieve its target."⁶⁸

D. Australia's 2035 Emissions Reduction Targets

The CCA is in the process of developing advice on the 2035 emissions reduction targets for Australia's next Nationally Determined Contribution (NDC) under the Paris Agreement.⁶⁹ Under the *Climate Change Act 2022* (Cth), the Australian Government must receive the CCA's advice before submitting Australia's next emissions reduction targets which are due in 2025.

The authority is committed to developing 2035 targets advice that positions Australia to play a responsible role in global emissions reduction efforts and supports Australia's economic and community prosperity. Our advice will be evidence-based and achievable, to drive more ambitious climate action.

Development of the 2035 targets advice is currently underway. This includes complex whole-of-economy modelling, policy analysis, consultation and consideration of international trends in climate action.⁷⁰

A CCA issue paper indicates its likely advice: ⁷¹ "The evidence to date suggests the CCA consider targets broadly within the 65% to 75%

⁶⁶ Slezak, *supra* note 59.

⁶⁷ AEMO, *supra* note 11, at 51, fig 7. ("Share of generation from renewable sources, NEM (2017-18 to 2049-50)").

⁶⁸ Sector Pathways Review, *supra* note 50, at 9.

⁶⁹ Paris Agreement, Dec. 12, 2015, T.I.A.S No. 16-1104 (The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at the UN Climate Change Conference (COP21) in 2015.)

⁷⁰ 2035 Emissions Reduction Targets, Climate Change Authority (Oct. 25, 2024), <u>https://www.climatechangeauthority.gov.au/2035-emissions-reduction-targets</u>. [https://perma.cc/EQU8-A6ZJ]

⁷¹ 2024 Issues Paper: Targets, Pathways and Progress, Climate Change Authority (Apr. 3, 2024).

range."⁷² As an alternative, the CCA plotted a straight line trajectory from 2030 targets to net zero in 2050, and arrived at a figure of 57% for Australia's 2035 emissions reductions relative to 2005 levels.⁷³ The Australian Department of Climate Change, Energy, the Environment and Water's figures are more conservative. Under their baseline scenario, emissions in 2035 are projected to decline by 51%, reaching 56% by 2040.⁷⁴ These projections are based on Australia achieving its 43% emissions reduction targets by 2030, which, as established above, is overly optimistic and potentially lacks credibility.

E. Summary

Recently, federal, state, and territory energy ministers adopted the Orderly Exit Management Framework (OEMF),⁷⁵ which is a process that commences when a retiring coal or gas-fired generator brings forward its planned closure date. Under the OEMF, if after an independent assessment a temporary energy shortfall results with no available solution, a minister can enter voluntary negotiations with the generator to continue operating under the agreement or 'mandate the temporary extension of the closing date of a retiring coal or gas-fired generator to ensure reliable supply and keep the lights on'.⁷⁶

On December 6, 2024, the Energy and Climate Change Ministerial Council issued a communique saying 'For jurisdictions that opt in, the OEMF will provide an important additional capability to better manage the retirement of thermal generation.'⁷⁷ As previously mentioned in Section B, the NSW Labor government has already intervened to extend the closure date of the Eraring coal-fired power station, as has the Victorian Labor government for the Yallourn and Loy Yang A coal-fired power stations.

Victoria's secret agreements underwrite EnergyAustralia's Yallourn coal-fired power generator until mid-2028 and the operation of AGL Energy's coal-fired Loy Yang A power station until 2035. The deals

⁷² *Id.* at 13, fig.2.

⁷³ *Id.* at 14 fig.3.

⁷⁴*Australia's emissions projections 2024*, Dep't of Climate Change, Energy, the Env't and Water, 4 (Nov. 2024).

⁷⁵ Geoff Chambers, *Chris Bowen's reliance on coal slammed by Coalition as "dishonest,"* The Australian (Dec. 12, 2024)

⁷⁶ *How the Orderly Exit Management Framework will work - text alternative*, Energy and Climate Change Ministerial Council, Commonwealth Dep't of Climate Change, Energy, the Env't and Water,

https://www.energy.gov.au/energy-and-climate-change-ministerial-council/workinggroups/system-planning-working-group/orderly-exit-management-framework-draftexposure-bill-and-rule-june-2024/how-the-oemf-will-work-text-alternative (last visited March 25, 2024). [https://perma.cc/PZK5-564Q]

⁷⁷ Chambers, *supra* note 75.

seek to avert the risk of blackouts and price rises if the ageing coal generators, which provide 60 per cent of Victoria's power, shut down before replacement energy supply is built.⁷⁸

In this context, the federal Opposition "has questioned Australian Energy Market Operator targets released last year predicting 90 per cent of the current 21GW of coal capacity will be retired by 2034-35, and that all coal will be gone by 2038."⁷⁹

In sum, the renewable energy debate hinges on the assumptions built into the modelling and the projections. The purpose of this article is to test the validity of those assumptions, commencing in Part III with the forecasts made under AEMO's 2024 ISP such as the capacity of the NEM and the generation mix of the NEM under the *Step Change* scenario.

II. EXISTING AND FUTURE AUSTRALIAN ENERGY SOURCES

Surely our energy transition must be based on a strategy that is grounded in reality, is accountable for costs, accepts the need for baseload power 24/7, recognises that renewables cannot power the economy, and avoids potential harm?⁸⁰

In this Part, four existing and future Australian energy sources will be examined: (a) coal; (b) gas; (c) pumped hydro; and (d) green hydrogen. Nuclear energy will be examined in Part IV and compared with the true costs of renewable energy sources.⁸¹

A. Coal

The future of coal is a doubled edged sword for the Australian economy. because coal mining is flourishing, but coal-fired power stations are being phased out. Since May 2022, the Federal Environment Minister has approved ten new coal mines or expansions.⁸² Australia is the fifth largest producer, the second largest exporter, and has the third largest reserves of

⁷⁸ Patrick Durkin, *AGL, EnergyAustralia coal power deals with Victoria kept secret*, Financial Review (Oct. 21, 2024), <u>https://www.afr.com/companies/energy/agl-</u>energyaustralia-coal-power-deals-with-victoria-kept-secret-20241018-p5kji8.

[[]https://perma.cc/Y9VU-LL62]

⁷⁹ Chambers, *supra* note 75.

⁸⁰ George J, *Is Labor finally realising the folly of its energy plan?*, The Australian (Oct. 24, 2024).

⁸¹ True Cost Accounting (TCA) is an accounting approach that measures and values the hidden impacts of economic activities on the environment, society and health. TCA is also referred to as "full cost accounting" (FCA) or "multiple capital accounting" (MCA).

⁸² Coal Mine Tracker, *The Australia Institute*,

https://australiainstitute.org.au/initiative/coal-mine-tracker/ (last visited March 26, 2024). [https://perma.cc/N4LY-8GRY]

coal in the world.⁸³ Between 2021 and 2022, export earnings from black coal totalled \$113.8 billion.⁸⁴ At the same time as coal mining has expanded, the Australian economy is still reliant on coal as the backbone of affordable, reliable electricity.

Coal supplied 62.6 per cent of electricity to the National Electricity Market in 2022-23, while gas supplied 4.5 per cent, hydro 8.3 per cent and other renewable energy (wind, grid solar and batteries), 24.1 per cent.⁸⁵

As discussed in Part II, a combination of over \$29 billion in subsidies to the renewable energy sector by the federal government,⁸⁶ and the ageing of coal-fired power stations, has led the owners of coal-fired generators to accelerate plans for alternative uses of their generation sites. The economics of the energy industry is further complicated by the inability of renewable sources of energy in the form of wind and solar to provide baseload power. Verrender has helpfully explained the problem for coal-fired generators created by the nearly 4 million households and businesses who have solar panels attached to their roofs.

It's a phenomenon that has accelerated the demise of coal-fired generators, which have found their profits undercut by a flood of cheap solar power throughout the day. As solar energy feeds into the system throughout the day, the wholesale cost of electricity plunges, occasionally to zero, which plays havoc with coal-fired generators, forcing them to operate at a loss. That's because, as baseload generators, they can't shut down. So, they keep burning expensive coal and funnelling power into the grid even though they're racking up losses.⁸⁷

https://www.ga.gov.au/aecr2024/coal#:~:text=Australia%20is%20the%20fifth%20larg est,Science%20and%20Resources%2C%202023b). [https://perma.cc/XQJ9-WPLL] ⁸⁵ Coal: building Australia's future, Minerals Council of Australia.

⁸³ Australia's Energy Commodity Resources 2024 Coal, GEOSCIENCE AUSTRALIA, AUSTRALIAN GOVERNMENT (July 15, 2024), <u>https://www.ga.gov.au/aecr2024/coal</u>. [https://perma.cc/NNY2-RM9P]

⁸⁴ *Australia's Energy Commodity Resources 2024: Coal*, Geoscience Australia (last updated July 15, 2024). During 2022, Australia had 93 operating black coal mines, 3 operating brown coal mines, and more than 200 known coal deposits. In 2021–22, Australia's production of saleable black and brown coal was 11,631 PJ, which accounted for 55% of total energy production. Over the past decade, coal production has increased by an average annual rate of 0.9%.

https://minerals.org.au/about/mining-facts/mineral-coal/. [https://perma.cc/LZV5-8EHS]

⁸⁶ WU, *supra* note 22, at 8.

⁸⁷ Ian Verrender, *Deciding who is right in nuclear debate depends on your assumptions*, ABC NEWS (Dec. 16, 2024, 12:41 PM),

https://www.abc.net.au/news/2024-12-17/baseload-power-energy-transition-nuclear-policy/104721322. [https://perma.cc/G9T9-NYTQ]

Verrender was writing in the context of nuclear power plants facing the same problem from solar generation as coal-fired power stations. Verrender made the important point that "if the technology improves and the costs drop, households and businesses are likely to add battery storage, which would greatly diminish demand from the grid."⁸⁸ Whether rooftop solar and nuclear energy are compatible will be explored in Part IV. For present purposes, the immediate question is whether AEMO's ODP forecasts on the phasing out of brown and black coal by 2034-35 is realistic,⁸⁹ which in turn is dependent on successfully addressing the four tensions discussed in Part II.

Clearly, the governments of New South Wales, Queensland and Victoria have taken steps to extend the life of coal-fired power stations for fear of renewable energy sources not keeping the lights on, at least until battery storage is both reliable and affordable to households and businesses. Indeed, as previously mentioned, AEMO had warned the government of New South Wales that without the Eraring coal-fired power station, NSW would face energy reliability risks commencing in 2025.

The necessity of extending the operating life of coal-fired power stations has focused attention on a process known as "two-shifting." The accepted norm is that a coal generator cannot be stopped and started, as is possible with a gas generator, but required to be cooled down and then restarted gradually. However, in October 2024, AGL at its Bayswater coal-fired power station in the Hunter Valley north of Sydney successfully switched off an entire unit and switched it on again five hours later. Bayswater's general manager, Mr McLachlan, described the process of "two-shifting" as a harbinger of the future.

> Two-shifting . . . was a way for coal plants to capitalise on high prices in the evening peak while avoiding bearish prices in the middle of the day when solar power was most abundant. It was a way to give flexibility to a type of generation that was not designed to be flexible. . . . "This level of precision on our first attempt is extraordinary and sets a new benchmark for our operations."⁹⁰

While "two-shifting" is still at an experimental stage, Mr Leitch, an energy industry analyst, said the process held open the possibility in the future that "the minimum generation level of coal could theoretically

⁸⁸ Id.

⁸⁹ AEMO, *supra* note 11, at 49.

⁹⁰ Daniel Mercer, Australian Coal Plant in 'Extraordinary' Survival Experiment as Solar, Funding Woes Stalk Industry, ABC NEWS (Oct.12, 2024), https://www.abc.net.au/news/2024-10-13/australian-coal-plant-in-extraordinary-

survival-experiment/104461504. [https://perma.cc/NS28-9EK4]

fall all the way to zero."⁹¹ Thus, consistent with the federal Opposition's plan to extend the life of coal-fired power stations until nuclear power plants became operational, the successful introduction of 'two-shifting' could favourably alter the economics of coal generation. By the same token, while the Labor government of NSW is committed to a renewables transition, Penny Sharp, the NSW Climate Change, Energy and Environment Minster recognised that "to keep the lights on and prices down, we need to make sure new renewable infrastructure and storage capacity is online before coal-fired generators reach the end of their life."⁹²

As a holistic approach to energy transition is necessary to assess the viability of achieving carbon zero emissions by 2050, the role of gas as a baseload energy source needs to be considered, particularly if AEMO's ODP forecasts on the phasing out of brown and black coal by 2034-35 eventuate.

B. Gas

The federal government's *Future Gas Strategy*,⁹³ lets the cat out of the bag that gas is an integral component of Australia's future energy requirements. This reality is acknowledged by the federal resources Minister, Madeleine King, in the foreword to the future gas strategy.

Under all credible net zero scenarios, natural gas is needed through to 2050 and beyond, though its production and use will change over this period. Gas will be essential to the transition because our energy system needs gas to achieve net zero. Gas will be a transition fuel that firms renewable power generation and is required for manufacturing and minerals processing until such time as alternatives are viable.⁹⁴

The *Future Gas Strategy* sets outs four objectives: (1) support decarbonisation of the Australian economy; (2) safeguard energy security and affordability; (3) entrench Australia's reputation as an attractive trade and investment destination; (4) help our trade partners on their own paths to net zero. The federal resources Minister highlighted the third objective in the foreword.

Australia is and will remain a reliable and trusted trade and investment partner, including for liquified natural gas (LNG). Our trade partners

⁹¹ Id.

⁹² NSW Government to Extend Life of Origin's Eraring Coal Plant to 2027, supra note 24.

⁹³ Future Gas Strategy, DEP'T OF INDUS., SCI. AND RES. (June 25, 2024),

https://www.industry.gov.au/publications/future-gas-strategy. [https://perma.cc/78RG-74NH]

⁹⁴ *Id.* at 4.

have made large investments over decades in Australia's resources industry.95

A further indication of the kernel of the *Future Gas Strategy* can be found in the third guiding principle for Australia's gas.

> New sources of gas supply are needed to meet demand during the economy-wide transition. Government policies to enable natural gas exploration and development should focus on optimising existing discoveries and infrastructure in producing basins.96

So, notwithstanding the first objective above of gas supporting the decarbonisation of the Australian economy, it would appear Professor Hepburn is correct in arguing that "[w]e cannot open new gas projects and still meet our climate goals."97 Hepburn pointed to the option of reserving a portion of Australia's export gas if the objective was to ensure sufficient domestic gas supply on the east coast.

> The fact the government is not pursuing this option means the supply crisis is of our own making. Cynics would say the domestic supply issue is a cover for vastly larger interests, namely the A\$17 billion liquefied natural gas (LNG) industry which sells about 90% of our gas overseas with demand for LNG in the Asian region expected to continue until 2050.98

The "cynics" may well be right as evidenced by this observation in the Analytical Report of the Future Gas Strategy: "Gas underpins a wide range of economic activity in Australia and globally, with secure gas supplies being a core component of energy security for many economies."99 Under the Step Change scenario, east coast demand for gas "is projected to fall by around 8% by 2043."¹⁰⁰ This is minimal over a 20 year time period. Hepburn identified export income and geopolitical influence as the two drivers of the federal government's Future Gas Strategy.

> So, our Future Gas Strategy will continue to be aligned with the production and export of gas, despite our Net Zero commitments.

⁹⁵ Id.

⁹⁶ *Id.* at 6.

⁹⁷ Samantha Hepburn, Australia Can Have a Future for the Gas Industry, or Meet Its Climate Commitments - but Not Both, The Conversation (May 12, 2024),

https://theconversation.com/australia-can-have-a-future-for-the-gas-industry-or-meetits-climate-commitments-but-not-both-229700. [https://perma.cc/5YW7-B5E2] $\overline{}^{98}$ Id.

⁹⁹ Office of the Chief Economist, Future Gas Strategy: Analytical Report, Dep't of Indus., Sci. and Res., at 3, (Aug. 12, 2024),

https://www.industry.gov.au/publications/future-gas-strategy-analytical-report. [https://perma.cc/LZ7E-FRZB]

 $[\]overline{100} \,\overline{Id}.$

What's also clear in the report is the importance this government places on gas as a geopolitical tool.¹⁰¹

Naturally, the gas industry and the Business Council of Australia fully support the *Future Gas Strategy*, while climate groups have been scathing in their criticisms of the strategy.

The Climate Council's Dr Jennifer Rayner called the strategy "a regressive echo of the past". "Today's announcement is more Back to the Future than Future made in Australia. Australia is already using less gas, so the suggestion we need more of it sounds like Scott Morrison's 'gas led recovery', not Anthony Albanese's 'renewable energy superpower'."¹⁰²

The federal government is relying on carbon capture and storage (CCS)¹⁰³ to meet its legislated emissions targets while at the same time encouraging new sources of gas supply. This is a risky strategy as CCS remains controversial and unproven. Critics of CCS, such as the Climate Council, view CCS as a licence to pollute and an expensive attempt to prolong the role of fossil fuels in the energy system.¹⁰⁴

C. Pumped hydro

Pumped hydro moves water between two or more reservoirs to store and generate energy.

A power station houses turbines that are linked to 2 or more reservoirs at different heights. When electricity demand is high, water is released from the upper reservoir and the force of the falling water spins the turbines. When the turbines spin, electricity is generated and fed into the grid. Water that passes through the turbines is kept in the lower reservoir until it can be pumped back. When there is excess electricity supply in the grid, the turbines use this excess energy to pump water from the lower reservoir back to the upper reservoir. This process is

¹⁰¹ Hepburn, *supra* note 95.

¹⁰² Amy Remeikis, *Labor's Gas Strategy: What Is It and Why Do Critics Call It "Back to the Future"*? The Guardian (May 9, 2024), <u>https://www.theguardian.com/australia-news/article/2024/may/09/labor-albanese-government-gas-strategy-emissions-</u>reduction-policy-net-zero-targets-renewable-energy. [https://perma.cc/Z25K-8WJQ]

¹⁰³ Carbon capture and storage (CCS) is a process by which carbon dioxide (CO2) from industrial installations is separated before it is released into the atmosphere, then transported to a long-term storage location.

¹⁰⁴ Climate Council, *What is Carbon Capture and Storage?* (Feb. 8, 2023), https://www.climatecouncil.org.au/resources/what-is-carbon-capture-andstorage/#:~:text=Carbon%20capture%20and%20storage%20(CCS,gases%20back%20i nto%20the%20ground. [https://perma.cc/L7RD-TJQ6].

usually repeated every 24 hours to help maintain the security and reliability of the electricity grid.¹⁰⁵

Under AEMO's *Step Change* scenario, the ODP forecasts the need for a quadrupling of firming capacity from sources other than coal, which can respond to a despatch signal such as pumped hydro.¹⁰⁶ The purpose of firming is to smooth out variations in renewable supply and is, therefore, essential to keeping the lights on in the transition to achieving carbon-zero emissions by 2050. AEMO has calculated that in the summer (Q1) of 2024, hydro contributed 5.3% of the NEM's total generation.¹⁰⁷ Under AEMO's *Step Change* scenario, hydro's contribution to the NEM's total generation is projected to increase significantly.¹⁰⁸

According to Tim Jordan, Commissioner of the Australian Energy Market Commission (AEMC), '[o]f the 46 GW of dispatchable storage required by 2050, about one-third –16 GW – will come from utility-scale batteries and pumped hydro.¹⁰⁹ However, as Jordan has highlighted, Australia has not had a new pumped hydro development in almost 40 years, and there are only two pumped hydro projects under construction: the Kidston Pumped Storage Project in far-north Queensland and Snowy Hydro 2.0.

Kidston is owned by Genex Power Ltd, and the project construction cost is \$777 m, which includes a contribution to the construction cost of the 186 km transmission line from the Kidston site to Mt Fox¹¹⁰ and is scheduled to commence operation in 2025 with a 250-megawatt (MW) capacity in an eight-hour generation cycle. The finance for the project was underpinned by a \$610 m 15-year debt facility from the Northern Australia Infrastructure Facility (NAIF), in addition to a \$47 m funding grant provided by the Australian Renewable Energy Agency (ARENA).¹¹¹ NAIF is the federal government financier, providing concessional loans for the development of infrastructure projects in

¹⁰⁵ Queensland Gov't, *Pumped Hydro Energy Storage* (Feb. 5, 2025), https://www.energyandclimate.qld.gov.au/energy/types-of-renewables/pumped-hydro-

stored-energy. [https://perma.cc/QTQ6-8DY2]

¹⁰⁶ AEMO, *supra* note 11 at 12.

 $^{^{107}}$ Id.

¹⁰⁸ Id.

¹⁰⁹ Tim Jordan, *Energy Storage Systems and the NEM*, Australian Energy & Battery Conference (March 7 2023), <u>https://www.aemc.gov.au/news-centre/speeches/energy-storage-systems-and-nem</u>. [https://perma.cc/35YL-QKVM]

¹¹⁰ Genex, 'Financial Review: Green Energy's Holy Grail Takes Shape 220 Metres Underground' (August 8, 2023), https://genexpower.com.au/financial-review-greenenergys-holy-grail-takes-shape-220-metres-underground/. [https://perma.cc/VEM8-XC5R]

¹¹¹ Genex, 250MW Kidston Pumped Storage Hydro Project, (date visisted), <u>https://genexpower.com.au/250mw-kidston-pumped-storage-hydro-project/</u>. [https://perma.cc/R8VH-QEWE]

northern Australia. ARENA is a federal government agency, established in 2012 to manage Australia's renewable energy programs, with the objective of increasing supply and competitiveness of Australian renewable energy sources. Thus, without federal government financial support the Kidston Pumped Storage Project would not have come to fruition.

By comparison to Snowy Hydro 2.0, Kidston is a minnow pumped hydro project. Snowy Hydro 2.0 is the largest committed renewable energy project in Australia and involves linking two existing dams, Tantangara and Talbingo, through 27 kms of tunnels and building a new underground power station. Snowy 2.0 will provide an additional 2,200 MW of dispatchable, on-demand generating capacity and approximately 350,000 MWh of large-scale storage to the National Electricity Market.¹¹² The revised cost of Snowy 2.0 is estimated to be \$12 billion with a completion date of December 2028.¹¹³ Given the project's troubled history, particularly the performance of 'Florence', the tunnelling machine, there is good reason to doubt the accuracy of the estimated cost and the completion date (commercial operation of all units). Commenting on the release of the updated Snowy 2.0 Business Case in May 2024, Woodley caustically observed 'like every aspect of this hapless, overhyped project it is late, inadequate, and unrealistically optimistic'.¹¹⁴

As with Kidston, the federal government is paying for Snowy 2.0. 'Once again, the federal government has meekly accepted Snowy 2.0's updated estimates and dutifully kicked in \$7.1 billion in the 2024-25 budget, on top of \$1.4 billion previously provided.'¹¹⁵ The reason for this meek acceptance is the sunk cost–the federal government has already spent over \$4 billion on Snowy 2.0. Furthermore, the total cost of Snowy 2.0 could exceed \$20 billion once the new transmission lines through the controversial HumeLink and VNI West transmission projects are included.¹¹⁶

¹¹² About Snowy 2.0, Snowy Hydro, <u>https://www.snowyhydro.com.au/wp-content/uploads/2020/09/SH1764_Updated-fact-sheets_Snowy-2.0_website.pdf</u> [https://perma.cc/9TM7-EGK4]

¹¹³ Snowy Hydro, *Snowy 2.0 Updated Business Case* (May 24, 2024). https://www.snowyhydro.com.au/wp-content/uploads/2024/05/Snowy-2.0-Updated-Business-Case.pdf. [https://perma.cc/LPC5-XUYT]

¹¹⁴ Ted Woodley, *Snowy 2.0's updated business case is flawed, again*, Renew Economy (May 30, 2024). <u>https://reneweconomy.com.au/snowy-2-0s-updated-business-case-is-flawed-again/. [https://perma.cc/F835-3T2Q]</u> ¹¹⁵ *Id*

¹¹⁶ Ted Woodley, *Pushing water uphill: Snowy 2.0 was a bad idea from the start. Let's not make the same mistake again*, The Conversation (24 October 2023), <u>https://theconversation.com/pushing-water-uphill-snowy-2-0-was-a-bad-idea-from-the-start-lets-not-make-the-same-mistake-again-216170. [https://perma.cc/MSU7-TK4B]</u>

As regards the transmission lines, one of the strongest critics of Snowy 2.0 is the National Parks Association of NSW.

The case for Snowy 2.0 doesn't stack up economically, technically or environmentally. Simply, it is the wrong project in the wrong location. There are better alternatives, ones that avoid catastrophic impacts on Kosciusko National Park.¹¹⁷

The comment about 'catastrophic impacts' refers to the transmission lines which comprise two sets of steel lattice towers up to 75 metres tall, located in a cleared easement of 120 to 140 metres wide and spanning more than 8 kilometres of Kosciuszko National Park.

The overhead lines will clear over 100 ha of pristine national park, destroying valuable ecosystems and habitat. The powerlines will fragment intact habitats and compromise ecosystem integrity. The Kosciuszko Plan of Management stipulated that any new transmission must be underground, for good reason. What possible justification could there be to exempt Snowy 2.0, other than save Snowy Hydro some costs. The transmission lines should be underground, as is most of the Snowy 2.0 project.¹¹⁸

In December 2023, the NSW Land and Environment Court ruled in favour of the Snowy 2.0 pumped hydro project after a challenge by the National Parks Association of NSW to a ministerial decision to allow overhead power lines in Kosciuszko National Park for Snowy 2.0.¹¹⁹ The court found the "National Parks Association of NSW has not established that the Minister's decision, on 1 September 2022, to amend the Kosciuszko National Park Plan of Management 2006 was vitiated by a failure to comply with s 73B(7) and s 72AA of the *National Parks and Wildlife Act 1974* (NSW)".¹²⁰ The decision was based on evidence that the Minister had taken into account the matters listed in s 72AA(1), and therefore there was no breach of s 73B(7), which requires specified sections of the Act "apply to and in respect of an amendment, alteration or substitution of a plan of management." T¹²¹

118 National Parks Ass'n of N.S.W, *NPA takes court action against the Snowy 2.0 transmission connection*, (Aug. 1, 2023), <u>https://npansw.org.au/2023/08/01/npa-takes-court-action-against-the-snowy-2-0-transmission-connection/</u>. [https://perma.cc/ZT5K-L3M6]

¹¹⁷ National Parks Ass'n of N.S.W, Snowy 2.0 Doesn't Stack Up,

https://npansw.org.au/campaigns-2/protect-our-parks/kosciuszko-national-park/snowy-2-0/. [https://perma.cc/GN44-M4EZ]

¹¹⁹ National Parks Association of NSW Inc v. Minister for Environment and Heritage (2023) 149 NSWLEC. 1 (Austl.).

¹²⁰ Id. at 87.

¹²¹ Id. at 83. .

Clearly, the decision to amend the Kosciuszko National Park Plan of Management 2006 was a political one, designed to facilitate the Snowy 2.0 pumped hydro project, and was based on avoiding the higher costs of putting the transmission lines underground. In December 2024, the federal environment minister, Tanya Plibersek, approved Transgrid's massive HumeLink transmission line.

The contentious \$4.8 billion project involves 365 kms of new 500 kilovolt high-voltage transmission lines between Wagga Wagga, Bannaby and Maragle... The main concerns... with HumeLink have centred on the project's environmental and community impacts. In particular, the battle for grassroots support and refusal of underground wires through prime farmland and Kosciuszko National Park has been closely watched. Transgrid had estimated a subterranean line would cost up to \$11.5 billion and would take too long.¹²²

The environmental and planning issues involved in the transition to carbon zero emissions by 2050, and in particular the estimated 10,000 kms of transmission lines, will be further considered in Part V of this article.

The difficulties involved in bringing large scale pumped hydro projects to completion are well illustrated by the cancellation in November 2024 of the Burdekin Pumped Hydro Energy Storage (PHES) Project located 70 kilometres west of Mackay in north Queensland by the newly elected LNP Queensland government "because it is not financially viable, not environmentally appropriate and the community was never consulted".¹²³ The executive summary of the Pioneer-Burdekin Detailed Analytical Report found a 5,000 MW PHES scheme was "not considered viable and should be modified to a smaller capacity".¹²⁴

Premier David Crisafulli says a briefing the government received within 48 hours of taking office revealed that the project's \$12 billion cost had ballooned to \$36.77 billion – more than triple what was

nttps://reneweconomy.com.au/contested-humelink-transmission-line-gets-federalgreen-tick-to-connect-snowy-2-0-to-the-grid/. [https://perma.cc/3LL6-KQVP]

- ¹²³ The Honourable Jarrod Bleijie, *Media Statement: Pioneer-Burdekin Pumped Hydro*, The Queensland Cabinet and Ministerial Directory (Nov. 5, 2024),
- https://statements.qld.gov.au/statements/101593. [https://perma.cc/S6XJ-K37U] ¹²⁴ Queensland Hydro, Pioneer-Burdekin Pumped Hydro Energy Storage Project Detailed Analytical Report E11 (Nov. 5, 2024),

https://www.epw.qld.gov.au/__data/assets/pdf_file/0021/72570/PB003_PB-DAR-Executive-Summary-0411.pdf. [https://perma.cc/6M8E-GKTQ]

¹²² Sophie Vorrath, *Contested HumeLink transmission line gets federal green tick to connect Snowy 2.0 to the grid*, Renew Economy (Dec. 19, 2024), https://reneweconomy.com.au/contested-humelink-transmission-line-gets-federal-

originally forecast – and likely to be the biggest cost blowout of any energy project in the country. 125

The incoming LNP Queensland government is committed to delivering smaller, more manageable pumped hydro projects such as the 2,000 MW proposed Borumba Pumped Hydro Project at Lake Borumba, located near Imbil, west of the Sunshine Coast. However, while the previous Labor government budgeted \$6 billion towards the project, the total cost of the Borumba Pumped Hydro Project is now estimated to be \$14.2 billion, with Queensland Hydro targeting first power in 2030.¹²⁶

Other pumped hydro projects under consideration across Australia include EnergyAustralia's Lake Lyell Pumped Hydro Project in NSW, which is in the planning and development stage with a decision on proceeding likely in late 2025. The earliest a pumped hydro facility at Lake Lyell could be operating is 2030.¹²⁷ Renew Economy has helpfully produced a pumped hydro storage map of Australia,¹²⁸ which identifies more than 20 different projects although only three of them are in operation – Tumut, Wivenhoe and Shoalhaven – and two more under construction, Kidston and Snowy 2.0. The remaining 15 or so projects, like Lake Lyell, are in various stages of development with some waiting for possible funding initiatives from ARENA or the federal government's Underwriting New Generation Investments Program (UNGI).

Four conclusions can be drawn at this stage. First, whether under AEMO's *Step Change* scenario, hydro's projected significant increase in contribution to the NEM's total generation eventuates is an open question. Secondly, in all probability, none of the pumped hydro projects presently under consideration will come to fruition without substantial federal and state government financial support. Thirdly, judged by past experience, costs for pumped hydro projects can be expected to balloon from the initial cost estimates. Fourthly, there will be significant environmental damage from the installation of the transmission lines required to connect the pumped hydro projects to the NEM grid.

https://reneweconomy.com.au/queensland-premier-says-costs-of-dumped-pioneerpumped-hydro-project-blew-out-to-37-billion/. [https://perma.cc/U7C3-7RSX] 126 Queensland Hydro, *Borumba Pumped Hydro Project*, (April 17, 2025), https://qldhydro.com.au/projects/borumba/. [https://perma.cc/L6KD-Z4LR] 127 Lake Lyell Pumped Hydro, ENERGYAUSTRALIA,

https://reneweconomy.com/au/PUMPED-HYDRO-ENERGY-STORAGE-MAP-OF-AUSTRALIA/. [https://perma.cc/HL3T-KF6N]

¹²⁵ Meacham S, *Queensland premier says costs of dumped Pioneer pumped hydro project blew out to \$37 billion*, RENEW ECONOMY (Nov. 4, 2024),

https://www.lakelyellpumpedhydro.com.au/. [https://perma.cc/2ZJP-BGUH] ¹²⁸ Pumped Hyrdo Energy Storage Map of Australia (Illustration), in Pumped Hydro Energy Storage Map of Australia, RENEW ECONOMY (2025),

D. Green hydrogen

Green hydrogen is produced by the electrolysis of water using renewable energy, whereas grey hydrogen is derived from fossil fuels without carbon capture. The essence of the problem with green hydrogen is that splitting hydrogen from oxygen using large scale electrolysis of water is expensive.

> Barely five months after the federal government committed more than \$22 billion over 10 years to boost green hydrogen as an alternative fuel, two major projects have hit the skids. Andrew Forrest's Fortescue Mining pulled the pin on its ambitious plans to produce the clean energy source in July 2024 and in October 2024, Origin Energy backed away from an ambitious joint venture with chemicals giant Orica in the NSW Hunter Valley.¹²⁹

In the case of Origin Energy, CEO Frank Calabria explained the decision to withdraw from the green hydrogen project was made on the basis it had "become clear that the hydrogen market is developing more slowly than anticipated, and there remain risks and both input cost and technology advancements to overcome".¹³⁰

AEMO's 2024 ISP "forecasts only a small contribution from [hydrogen] technology, as hydrogen is still a relatively expensive fuel to use at scale".131 This is reflected in AEMO defining "flexible gas" as "including gas-powered generation and potential hydrogen capacity".¹³² The use of the word "potential" is significant, especially in the context of AEMO's recognition that "even more electricity will be needed as hydrogen production and other new energy industries emerge",¹³³ which for emerging hydrogen AEMO estimates "would add at least 55 TWh".¹³⁴ This crucial qualification in any future contribution to the NEM from hydrogen technology is acknowledged by AEMO with this revealing caveat: "If hydrogen becomes a cost-efficient fuel, or there is greater government support for hydrogen turbines, they will make a greater contribution."135

¹²⁹ Ian Verrender, Two major green hydrogen projects have hit the skids. Does it still have a future?, ABC NEWS (Ultimo), Oct. 4, 2024. Another project in doubt is the \$593 green hydrogen plant based in Whyalla, South Australia as a result of the ongoing financial difficulties of GFG Alliance which owns the Whyalla steelworks, 'with the economic case for a hydrogen-fired power station hinging on its provision of power to the steelworks for the production of so-called "green steel". Penberthy D, '600m hydrogen project in doubt', The Weekend Australian (8-9 February 2025). 130 Id

¹³¹ AEMO, *supra* note 11, at 71.

¹³² *Id*.at 11 fig.2, 30 fig.9, 48, fig.15.

¹³³ *Id.* at 24.

¹³⁴ *Id.* at 26.

¹³⁵ Id. at 71.

In that context, the federal government has produced a *National Hydrogen Strategy 2024*,¹³⁶ which categorises hydrogen as "a critical element of the global energy transition".¹³⁷ The strategy identifies renewable hydrogen as "a priority industry in the government's \$22.7 billion *Future Made in Australia* plan, through which it is the focus of targeted investment and other assistance",¹³⁸ and includes a hydrogen production tax incentive, a Hydrogen Headstart program, a Future Made in Australia Innovation Fund, Hydrogen Hubs, ARENA support, and concessional finance through federal government special investment vehicles, including the Clean Energy Finance Corporation and the National Reconstruction Fund.¹³⁹

As with pumped hydro, green hydrogen projects will not come to fruition without substantial federal and state government financial support. However, there is one significant difference: pumped hydro operates with proven technology, whereas green hydrogen has "technology advancements to overcome".

E. Summary

The foregoing analysis leads to the conclusion that coal and gas are likely to be required to supply energy generation into the NEM for longer than AEMO's 2024 ISP forecasts, with coal going beyond 2034-35 and gas going beyond 2050. In sum, AEMO's assumptions are overly optimistic as exemplified by the fact that only two pumped hydro projects are presently under construction. While it is true, AEMO has forecasted only a small contribution from hydrogen technology, the whole renewable energy edifice is constructed around taxpayer funded support and is almost entirely reliant on wind and solar renewable generation. As regards wind and solar, the vexed questions of the development of economical battery storage and public opposition to 10,000 kms of transmission lines place further strain on the validity of AEMO's assumptions and forecasts, which also exclude any consideration of nuclear energy.

III. THE VIABILITY OF NUCLEAR ENERGY IN AUSTRALIA

¹³⁶ Australian Dep't of Climate Change, Energy, the Env't and Water, National Hydrogen Strategy: 2024 (2024)

https://www.dcceew.gov.au/sites/default/files/documents/national-hydrogen-strategy-2024.pdf. [https://perma.cc/ZD97-9JV8]

¹³⁷ *Id.* at 5.

¹³⁸ Id. at 7.

¹³⁹ Id. at 9.

Once treated as the Voldemort of emissions reduction, nuclear power has steadily moved from being sidelined to playing a key role in decarbonisation discussions.¹⁴⁰

A. GenCost reports

An assumption is defined as a thing that is accepted as true or as certain to happen, without proof, and it is fair to say the whole energy debate in Australia is predicated on the validity of assumptions, none more so than when considering the viability, if any, of nuclear energy in Australia. The federal government has largely based its strategy to achieve carbon zero emissions by 2050 on CSIRO's GenCost reports, which are updated annually and are an important input into AEMO's ISP.

1. GenCost 2023-24 report

In the GenCost 2023-24 report, for the first time the authors included large-scale nuclear in addition to nuclear small modular reactors (SMR), and while accepting there was no known technical constraint to deploying generation units of this size, concluded "due to the current state of the development pipeline in Australia, that the earliest deployment would be from 2040".¹⁴¹ The reference to 2040 requires comment as the federal government has seized on this date as a reason for dismissing nuclear energy as being too far in the future to be worthy of consideration. The author takes issue with such a narrow timeframe and argues the real problem is the artificiality of selecting 2050 for zero carbon emissions when the true time scale of zero carbon emissions is far more likely to be well after 2050.

The GenCost 2023-24 report turned to South Korea as an appropriate comparative source for large-scale nuclear costs for Australia, adjusted for differences in Australian and South Korean deployment costs.

The estimated electricity cost range for large-scale nuclear under current capital costs and a continuous building program is \$155/MWh to \$252/MWh. This is expected to fall by 2040, after current inflationary pressures resolve, to \$136/MWh to \$226/MWh.¹⁴²

As for the cost of nuclear SMR, the GenCost 2023-24 report significantly increased its previous cost estimates based on the experience of UAMPS (Utah Associated Municipal Power Systems), which was the developer of a nuclear SMR project called the Carbon Free Power Project (CFPP) with a gross capacity of 462MW that was cancelled in November 2023.

 142 Id at xi.

¹⁴⁰ Talacko, *supra* note 53.

¹⁴¹ Graham P et al, *supra* note 2, at x.

After conversion to 2023 Australian dollars, project costs were estimated in 2020 to be 18,200/kW which is only slightly below the [theoretical] level that GenCost had been applying (19,000kW) ... In late 2022 UAMPS updated their capital cost to 28,580/kW citing the global inflationary pressures that have increased the cost of all electricity generation technologies.¹⁴³

Consequently, the GenCost 2023-24 report adjusted current capital costs for nuclear SMR in line with the more recent UAMPS estimate which it considered to be more reliable because it was based on a real project.

The measure used to compare the relative competitiveness of generation technologies is levelized costs of electricity (LCOEs). Under the GenCost 2023-24 report's assumptions, "the LCOE cost range for variable renewables (solar PV and wind) with integration costs is the lowest of all new-build technologies in 2023 and 2030."¹⁴⁴ Solar PV and wind with firming is shown in Figure 0-3 Calculated LCOE by technology and category for 2023 and 2030 as coming within a range of \$100/MWh to \$120/MWh. This cost range overlaps with the lower end of the cost range for coal and gas generation, but the latter are excluded as being inconsistent with Australia's current climate change policies. According to the GenCost 2023-24 report, "the next most competitive generation technologies are solar thermal, gas with carbon capture and storage, large-scale nuclear and coal with carbon capture and storage."¹⁴⁵

For comparative purposes, for 2030, the LCOE cost range for nuclear large-scale is calculated at \$150/MWh to \$225/MWh and nuclear SMR at \$225/MWh to \$380/MWh. Given that neither type of nuclear generation can be operational by 2030, "the inclusion of large-scale and SMR nuclear in the 2030 cost comparison is only as a point of interest rather than practicality."¹⁴⁶

Thus, by virtue of the GenCost 2023-24 report's assumptions and restrictions (ruling out fossil fuels without carbon capture and treating nuclear as impractical), solar PV and wind with firming have the lowest LCOE of \$100/MWh to \$120/MWh. Effectively, the GenCost 2023-24

¹⁴³ *Id.*

¹⁴⁴ *Id* at xii., ES Figure 0-3 Calculated LCOE by technology and category for 2023 and 2030. Dick Smith has criticised CSIRO for 'greatly underestimating' the amount of storage required and 'if the CSIRO claim that wind, solar and storage is the cheapest form of energy is correct, these facilities would include batteries': Kenny C, 'Truth time: nuclear power is the only solution to our energy dilemma', *The Weekend Australian* (16-17 November 2024).

¹⁴⁵ *Id.*, ES Figure 0-3 Calculated LCOE by technology and category for 2023 and 2030.

¹⁴⁶ Id. at xiii.

report concluded that Australia has a Hobson's choice¹⁴⁷ as regards renewables being the only viable energy source.

2. GenCost 2024-25 consultation draft report

In December 2024, CSIRO released its GenCost 2024-25 consultation draft report, which highlighted three areas of contention with GenCost's approach to nuclear generation since the GenCost 2023-24 report was released.

• The capital recovery period should be calculated over the entire operational life (e.g. 60 years), and not the industry standard of 30 years used in GenCost.

• Due to US experience, capacity factors of below 93% should not be considered (GenCost uses the range 53% to 89%).

• The nuclear development lead time should be 10 to 15 years, not 15 years or greater as proposed by GenCost.¹⁴⁸

The authors addressed each of these areas of contention and found no reason to change GenCost's approach. On nuclear technology's long operational life, the 2024-25 consultation draft report found "there are no unique cost advantages arising from nuclear technology's long operational life [because] substantial refurbishment costs are required, and without this new investment nuclear cannot achieve safe long operational life."¹⁴⁹ Based on an International Energy Agency report in 2019, the authors estimated the costs to extend a nuclear energy plant from 40 to 60 years to be \$2765/kW or \$43-80/MWh,¹⁵⁰ which is "almost a third of the upfront cost of building the plant."¹⁵¹

On nuclear generation capacity factors, the 2024-25 consultation draft report found "a single point estimate of 93% does not adequately capture the plausible range achievable in Australia."¹⁵² On nuclear development lead time, the 2024-25 consultation draft report found "*at least* 15 years remains the most plausible lead time" (original

https://www.theaustralian.com.au/business/renewable-energy-economy/csiros-gencostreport-finds-no-benefit-to-longerlife-nuclear-power/news-

 ¹⁴⁷ A Hobson's choice is a free choice in which only one thing is actually offered.
¹⁴⁸ Graham P et al, 'GenCost 2024-25: Consultation draft', CSIRO, Australia, ix.
<u>https://publications.csiro.au/publications/publication/PIcsiro:EP2024-6152</u>

[[]https://perma.cc/9QNM-896Y].

 $^{^{\}overline{1}49}$ Id. at ix.

¹⁵⁰ *Id.* at 18.

¹⁵¹ Giuseppe Tauriello, *Costs cloud Dutton's nuke plan*, THE AUSTRALIAN (Dec. 13, 2024). The online article was published under a different title on Dec. 9, 2024: *CSIRO's GenCost report finds no benefit to nuclear power*.

story/6f3eb17d33f3e6135700e64f7a389287 ¹⁵² Graham P et al, *supra* note 148, at ix.

emphasis),¹⁵³ which was based on Australia being a democracy and having no previous experience in building a nuclear energy plant. The consultation draft report founded its estimate of *at least* 15 years on western democracies like Finland and the United States having construction times of 17 and 21 years respectively as opposed to autocratic countries like Pakistan, China and the UAE with the fastest construction times of 6 to 8 years.¹⁵⁴

The GenCost 2024-25 consultation draft report found that the extension of the modelling from 30 years to 60 years led to an estimated cost of "\$136-222/MWh which is a 9% reduction in costs relative to the costs for a single 30-year generation project."¹⁵⁵ By contrast, the 2024-25 consultation draft report estimated "the full timeline costs of the 60-year solar PV project, including a complete rebuild in the second half, to be equivalent to a constant cost to consumers of \$40-68/MWh which is a 7% reduction in costs relative to a single 30-year project."¹⁵⁶ The equivalent figures for a 50-year onshore wind project were estimated to be "\$65-108/MWh which is also a 7% reduction in costs relative to a single 25-year project."¹⁵⁷ Thus, the GenCost 2024-25 consultation draft report concluded that extending the modelling from 30 years to 60 years made no difference to its previous calculations showing renewables remained the cheapest energy source.

As commentators have pointed out, the GenCost 2024-25 consultation draft report estimated that "once a mature nuclear industry is established, a single large-scale nuclear plant with a 1-gigawatt capacity would cost more than \$8.9 billion, up from earlier estimates of \$8.6 billion,"¹⁵⁸ and confirmed the previous GenCost 2023-24 calculation that nuclear plants would "produce electricity at roughly twice the cost of renewable sources."¹⁵⁹ Furthermore, the GenCost 2024-25 consultation draft report warned that examples of first-of-a-kind (FOAK) costs in the vicinity of 100% more than planned included "the Vogtle large-scale nuclear plant in the US and the Snowy 2.0 pumped hydro project in

¹⁵⁷ Id.

 $^{^{153}}$ *Id.* at x.

¹⁵⁴ Id.

¹⁵⁵ *Id.* at 18. See Figure 2-1 Costs for long-lived multi-stage projects and the subsequent cost reduction achieved for electricity consumers, 19.

¹⁵⁶ *Id.* at 20. See Figure 2-1 Costs for long-lived multi-stage projects and the subsequent cost reduction achieved for electricity consumers, 19.

¹⁵⁸ Tauriello, *supra* note 151.

¹⁵⁹ Jane Norman, The Coalition's nuclear power plan misses one key component: the cost, ABC News (June 19, 2024), <u>https://www.abc.net.au/news/2024-06-19/cost-of-going-nuclear-missing-in-coalitions-nuclear-plan/103997284</u>. [https://perma.cc/T79K-4XCH]

Australia."¹⁶⁰ Such an outcome would result in the first large-scale nuclear plant in Australia costing \$17-18 billion.

B. Frontier Economics reports

The work presented in the two Frontier Economics reports was funded and directed solely by Frontier Economics "because of the large amount of ill-informed and misleading cost comparisons being publicly made about nuclear power and we feel Australia deserves better quality analysis and commentary on this important issue."¹⁶¹ The first Frontier Economics report developed a base case to assess the relative costs of nuclear power in the NEM,¹⁶² while the second Frontier Economics report was an economic analysis of including nuclear power in the NEM.¹⁶³

1. First Frontier Economics report

At the beginning of the first Frontier Economics report, the authors made the important point that AEMO refers to its modelling as least-cost modelling thereby conveying the impression there are no constraints in finding the lowest cost approach in meeting electricity demand which is not the case.

The least cost modelling solution is found subject to the model satisfying a wide array of technical constraints and policy requirements (also specified as modelling constraints). Most notably in the case of AEMO's modelling, the modelling outcome must conform with meeting government emission reduction targets and targets to have a given amount of electricity demand supplied by renewable generation. These constraints also include meeting State renewable targets. The model will minimise costs subject to meeting these types of constraints.¹⁶⁴

Frontier Economics modelled AEMO's two main scenarios - *Step Change* and *Progressive*,¹⁶⁵ – and aside from AEMO's demand forecasts, Frontier's modelling also adopted AEMO's ISP assumptions because the authors aimed to replicate the ISP modelling outcomes as closely as possible. Frontier Economics also sought to calculate the costs of transmission projects included in AEMO's ISP "in an effort to determine

¹⁶⁰ Graham P et al, supra *note* 148, at 27.

¹⁶¹ Developing a base case to assess the relative costs of nuclear power in the NEM, supra note 3 at 4.

 $^{^{162}}$ *Id.* at 3.

¹⁶³ Economic analysis of including nuclear power in the NEM, supra note 4.

¹⁶⁴ Developing a base case to assess the relative costs of nuclear power in the NEM, supra note 3 at 5.

¹⁶⁵ *Id.;* AEMO, *supra* note 11. AEMO's *Progressive Change* scenario also reflects Australia's current policies and commitments to decarbonisation, but more challenging economic conditions and supply chain constraints mean slower investment in utility-scale assets and consumer energy resources (CER).

the relationship between transmission costs and the quantity of generation capacity so we can estimate how much lower transmission costs could be if less capacity is required in a NEM that includes nuclear power."¹⁶⁶

Frontier Economics concluded its own modelling was sufficiently close to that of AEMO's modelling to provide "a reasonable basis for analysing the effect of including nuclear power into the NEM."¹⁶⁷ For example, when Frontier Economics compared AEMO's net present value (NPV) on equivalent terms to its own modelling, they were about 97% the same.¹⁶⁸

However, when it came to transmission costs, Frontier Economics found AEMO's project cost estimates to be "highly unreliable and show that these estimates tend to exceed their initial project costs by over 100%."¹⁶⁹ Frontier Economics concluded that at a minimum currently approved and planned transmission projects are expected to cost \$62 billion compared to the current regulated asset base of the transmission system of about \$26 billion, thereby expanding the asset base of the transmission networks by about 240%.¹⁷⁰ Frontier Economics supported these findings by comparing AEMO's 2020 ISP and 2024 ISP transmission cost estimates.

> In some cases, the 2024 ISP lower ranges are now higher than the 2020 ISP upper range for the same project (see for example VNI West, Humelink, Gladstone Grid Reinforcement, Queensland SuperGrid South and, almost, New England [Renewable Energy Zone] REZ Network Infrastructure Project).¹⁷¹

Frontier Economics took the increase in generation capacity under AEMO's Step Change scenario of 130,000 MW which, based on the estimate of \$62 billion in transmission costs, leads to a figure of about \$500,000 of transmission costs to support each megawatt of new electricity supply.¹⁷²One implication of this is that to the extent that the required electricity supply capacity is significantly less with the introduction of nuclear power in the NEM, there is likely to be significant transmission cost savings.173

Frontier Economics also criticised the treatment of transmission costs in AEMO's ISP because these costs "do not include the large-scale

¹⁶⁶ Developing a base case to assess the relative costs of nuclear power in the NEM, supra note 3 at 6.

¹⁶⁷ *Id.* at 8.

¹⁶⁸ *Id.* at 6.

¹⁶⁹ *Id.* at 8.

¹⁷⁰ *Id.* at 8, tbl.6.

¹⁷¹ *Id.* at 41. *See also Id.* at 42, fig.13.

¹⁷² Developing a base case to assess the relative costs of nuclear power in the NEM,

supra note 3 at 42. 173 *Id.* at 8.

projects that are so-called commissioned, committed or anticipated as these are treated as sunk costs, even though most have yet to be commenced."¹⁷⁴ Frontier Economics convincingly argued that "when considering the costs of the energy transition, it is important to include the costs of transmission transparently with the generation costs rather than treating it as sunk."¹⁷⁵

Frontier Economics concluded its first report by highlighting that the real costs of AEMO's preferred *Step Change* scenario over the period from 2024/25 to 2050/51, which does not include the costs of consumer energy resources, "is the sum of the real costs of the electricity supply options of \$580 billion plus the \$62 billion in transmission costs - or a total of \$642 billion."¹⁷⁶ Frontier Economics considered the \$642 billion figure to "likely be an underestimate of the costs given the propensity for project costs, and particularly transmission projects, to blowout and because we do not believe that we have captured all the likely transmission project costs."¹⁷⁷

2. Second Frontier Economics report

The second Frontier Economics report built on the first report's foundational premise that the appropriate basis of comparison between energy sources is the total cost of a power system -generators, storages and transmission - to reliably and securely meet demand. The second Frontier Economics report commenced by making the important point that it is simplistic and erroneous to compare the cost of a renewable generator such as wind or solar or pumped hydro including the costs of back-up generation with the capacity and operating costs of a nuclear power station.

Such a crude assessment is an incorrect and misleading basis of comparison because it does not account for the fact that much more renewable capacity is required to produce the same amount of electricity compared to a nuclear power station. Nor does it account for the requirement to store surplus electricity from renewable sources as well as the back-up generation. Such simple comparisons also neglect to take into account the enormous amount of investment required to connect renewable generators located in areas where there is presently no or inadequate transmission network capacity.¹⁷⁸

These comparative costs also exclude the economic costs of externalities imposed on rural and regional communities such as the loss

¹⁷⁴ *Id.* at 34.

¹⁷⁵ *Id.* at 43.

¹⁷⁶ *Id.* at 8, 25, 26.

¹⁷⁷ Id. at 8.

¹⁷⁸ Frontier Economics, *supra* note 4, at 4.

of amenity due to adjacent wind and solar farms and the extensive new and augmented transmission networks across farmland. The economic costs of externalities will be considered in Part V covering environmental and planning issues.

Frontier Economics made three modelling assumptions about nuclear power:

- Capital costs are \$10,000 per kilowatt of capacity.
- Capital costs improve 1% per year based on conservative learning rates for repeated commissioning of a technology type.
- Variable and non-capital fixed costs of \$30 per megawatt hour, including decommissioning costs.¹⁷⁹

Frontier Economics modelled an assumed pattern of NEM nuclear generators being commissioned from 2036 onwards in NSW, Queensland and Victoria, reaching 13,000 MW of nuclear power capacity by 2050, with new nuclear generation capacity being commissioned as coal generators were decommissioned.¹⁸⁰ Another assumption in Frontier's modelling is that "some existing coal fired generators in the NEM are maintained beyond AEMO's early closure dates to ensure that there is sufficient generation capacity to meet the system reliability requirements."¹⁸¹ Frontier's justification for modelling later closure dates for coal fired generators is "AEMO's assumed coal closure timetable is well in advance of the closure dates announced by the generators."¹⁸²

The results of the second Frontier Economics report modelling showed that "including nuclear in the NEM results in substantial costs savings compared to AEMO's approach of using mainly renewables and energy storage to meet Australia's growing electricity demand."¹⁸³ The second report depicted a Figure that summarised Frontier's findings of the sum of annual costs of AEMO's *Step Change* and *Progressive Change* scenarios for the period from 2025 to 2051, including the impact of different transmission costs.¹⁸⁴

For AEMO's *Step Change* scenario, using nuclear power, the total NEM system costs can be reduced by about \$150 billion from \$594 billion to \$446 billion, or about \$5.5 billion per annum. The inclusion

¹⁷⁹ Id. at 7.

¹⁸⁰ *Id.; See also* Figure 1: Assumed pattern of NEM nuclear generator commissionings, 7, which displays a stepped increase in MW of nuclear capacity installed as each nuclear power plant is commissioned between 2036 and 2050.

¹⁸¹ *Id.* at 8.

¹⁸² *Id.; See also* Figure 2: Comparison of closures assumed for modelling and generator announced closures, 8, which shows if coal generators are closed according to the dates announced by the owners there will not be much of a difference in the emissions under these conditions as compared to the second Frontier Economics report modelling. ¹⁸³ *Id.* at 9.

¹⁸⁴ Id. at 10.

cheaper than AEMO's renewables and storage approach.

For AEMO's *Progressive* scenario, using nuclear power, the total NEM system costs can be reduced by \$106 billion from \$437 billion to \$331 billion, or about \$4 billion per annum. The inclusion of nuclear power in the NEM in the Progressive scenario is also 25% cheaper than AEMO's renewables and storage approach.¹⁸⁵

Thus, on Frontier's modelling AEMO's Step Change solar and wind renewables scenario is the most expensive scenario with combined generation and transmission costs of \$594 billion as compared with the Progressive Change scenario including nuclear power of \$331 billion, which is 44% cheaper. Based on these cost differences, Frontier claim that even with a doubling in the costs of nuclear capacity assumed in the modelling it is "very unlikely that the inclusion of nuclear power in the NEM would, in practice, ever be more expensive than AEMO's approach."¹⁸⁶ Furthermore, Frontier emphasised the report modelling did not include "the costs of consumer energy resources (rooftop solar panels and behind-the-meter batteries) nor the costs of Demand Side Participation nor the costs of upgrades and extensions to the distribution networks, nor the costs to consumers to switching appliances and equipment that use gas to electricity."¹⁸⁷ These costs were excluded by Frontier to be consistent with AEMO's ISP. However, when these costs were taken into account they took the total cost of the transition of the electricity sector above a trillion dollars over the next 25-30 years under AEMO's ISP.¹⁸⁸

As for NPV, Frontier Economics calculated that the relative costs between the scenarios were the same as for the sum real costs.AEMO's Step Change Base case is, by far, the most expensive scenario (NPV cost of \$225 billion), and almost twice that of the Progressive Nuclear alternative scenario (NPV cost of \$124 billion).¹⁸⁹On the question of whether Frontier's modelling of significant cost savings resulting from the inclusion of the nuclear power into the NEM will translate into lower power prices, Frontier Economics did not present any results for electricity prices on the basis this will depend on how the costs of new generation capacity will be treated in the future.

¹⁸⁵ Frontier Economics, Nuclear Power Analysis 4, at 9 (2024), https://www.frontiereconomics.com.au/wp-content/uploads/2024/12/Report-2-Nuclear-power-analysis-Final-STC.pdf. [https://perma.cc/D6XU-SA3D]

¹⁸⁶ Id.

¹⁸⁷ Id.

¹⁸⁸ *Id.* at 4, 9- 10.

¹⁸⁹ *Id.* at 4, 41, 44 tbl.10.

The current NEM price setting mechanism is no longer fit for purpose irrespective of the whether Australia's energy future is with or without nuclear power. The NEM pricing design no longer serves the purposes it was designed to achieve. In particular, NEM prices no longer drive generation investment decisions in the way it was designed to. In practice, governments have supplanted the role of NEM spot prices in deciding new generation investments and generator exits. If governments make uneconomic decisions, then taxpayers and/or consumers are forced to pay the costs.¹⁹⁰

Frontier Economics pointed out that even with the inclusion of nuclear energy, renewables and storages remain the dominant energy sources. Under Frontier's modelling, for the nuclear-inclusive *Step Change* scenario the assumption is made that "wind and solar capacity grows from 24,000 MW in 2025 to 72,000 MW by 2051", by which time "13,000 MW of nuclear capacity" has also been added representing "just 8% of NEM capacity".¹⁹¹ In this scenario, "wind and solar generate 60% of . . . electricity."¹⁹² For the nuclear-inclusive *Progressive* scenario, wind and solar is modelled to grow more modestly from "24,000 MW to 46,000 MW by 2051", with "wind and solar [generating] 50% of electricity and nuclear [generating] 38% of electricity with just 13% of total [NEM] capacity."¹⁹³

On emissions, as mentioned above, Frontier's modelling applied an operational life to coal generators consistent with those anticipated by the owners of the coal generators. Self-evidently, if, as under AEMO's scenarios, coal generators are assumed to close early and be fully replaced by renewables 'then the modelling will estimate less emissions than if coal is closed later'.¹⁹⁴ Consequently, Frontier's modelling showed emissions intensity measured in tonnes per MWh between 2025 to 2051 staying higher for longer than under AEMO's scenarios, but "in the nuclear alternative scenarios, emissions continue to fall over the modelling period and achieve lower average emissions in the last few years and maintain this lower level of emissions compared to AEMO's approach."¹⁹⁵ The reason why by 2051 the nuclear power option has lower emissions than under AEMO's scenarios is because "less gas is required to maintain reliability and there is sufficient nuclear power to provide reliable power supplies."¹⁹⁶

¹⁹⁰ *Id.* at 4, 18.

¹⁹¹ Frontier Economics, Nuclear Power Analysis 4, *supra* note 185 at 4, 18.

 $^{^{192}}$ *Id.* at 4, 10.

¹⁹³ Economic analysis of including nuclear power in the NEM, supra note 4, at 10.

¹⁹⁴ *Id.* at 4, 34.

¹⁹⁵ *Id.* at 4, 34-35.

¹⁹⁶*Id.* at 4, 35, 35 fig.16.

Frontier Economics concluded its summary by highlighting that not only was nuclear generation cheaper than a power system made up almost entirely of renewables and energy storages, but also "including nuclear power in the NEM could also help lower the economic costs imposed on rural and regional Australians by avoiding the loss of amenity from having so many wind and solar farms and new and augmented transmission networks on their land."¹⁹⁷

C. Critical analysis of the modelling undertaken by Frontier Economics

Predictably, the assumptions underpinning the modelling undertaken by Frontier Economics have been subjected to considerable criticism both from the federal government and by independent experts. The Federal Minister for Climate Change and Energy, Chris Bowen, "claimed the [second] Frontier Economics report contained 'fundamental errors' and 'heroic assumptions'", pointing out the report assumed Australia would consume less power than AEMO's modelling forecasts, while also criticising the report for factoring into the modelling lower prices to produce nuclear power than the figures adopted by CSIRO and AEMO.¹⁹⁸

The underlying criticism of the second report by Frontier Economics is that its nuclear options do not compare apples with apples against AEMO's renewables scenarios. As has been seen, Frontier Economics has calculated the nuclear option under the *Progressive Change* scenario is 44% cheaper than AEMO's preferred *Step Change* solar and wind renewables scenario.

Tristan Edis, director of Green Energy markets, says the "progressive change" scenario "involves total electricity consumption in 2052 of 311TWh, whereas *step change* is 450TWh or almost 45% greater electricity demand"...

Clearly, a system producing more power will cost more. Dr Dylan McConnell, an energy systems expert at UNSW, says without adding nuclear, AEMO's "progressive change" costs are about \$133bn less than for "step change."¹⁹⁹

This criticism is valid as it regards a 45% greater electricity demand under the renewables *Step Change* versus nuclear *Progressive*

¹⁹⁸ Graham Readfearn & Josh Butler, *The glaring gaps and unanswered questions in the Coalition's nuclear plan and costings*, THE GUARDIAN (Dec. 13, 2024), <u>https://www.theguardian.com/australia-news/2024/dec/13/australia-nuclear-power-costings-frontier-economics-plan-peter-dutton-coalition-policy</u>.

[https://perma.cc/NZ5F-DZH3]

¹⁹⁷ *Id.* at 4, 11.

¹⁹⁹ *Id*.

Change comparison but not for the renewables *Step Change* versus nuclear *Step Change* comparison, where it will be recalled Frontier Economics calculated there would be a 25% cost saving in favour of nuclear.

A further criticism is Frontier's timeline for the construction of nuclear reactors, the first of which is assumed to enter the NEM in 2036, as opposed to AEMO's estimate that it would take at least 15 years to build and commission a nuclear reactor.

Energy expert Simon Holmes à Court laid out his own timeline this week saying there was 'not a hope in hell' a nuclear reactor could be working before 2040. He said his own optimistic scenario put the date in 2044.²⁰⁰

Allied to criticism of Frontier's assumed timeline for the construction of nuclear reactors is the challenge to Frontier's assumptions as to the cost of building a large-scale nuclear plant identified in the GenCost 2024-25 consultation draft report discussed in section A above, where based on international comparisons the likely cost of the first large-scale nuclear plant in Australia would be \$17-18 billion. Frontier's modelling used a \$10 billion per gigawatt (GW) cost figure for large-scale nuclear reactor construction as opposed to international experience showing actual nuclear construction costs of \$15-28 billion per GW excluding financing costs.

To really understand the full costs of nuclear, the financing costs incurred during construction need to be considered as well. The modelling has forecast energy system costs of \$331 billion in total, which would include the cost of building and running all technologies. However, the Institute of Energy Economics and Financial Analysis (IEEFA) calculates that the cost to build the nuclear reactors alone - which are said to provide 38% of generation in 2051 - could exceed \$300 billion when financing cost during construction is included. This is based on the cost of the recently constructed Vogtle nuclear power plant, which was \$23 billion per 1 GW of capacity (including financing cost during construction), scaled up for the 13GW proposed in the NEM. So, the nuclear reactor cost will likely be far higher than has been put forward.²⁰¹

Furthermore, Frontier Economics treated capital costs as being amortised over a 50-year period (2036 to 2086),²⁰² resulting in the Institute of Energy Economics and Financial Analysis (IEEFA) expecting "much of

²⁰⁰ Id.

²⁰¹ Bowyer J, *Opposition's nuclear costings are unrealistic*, Inst. of Energy Econ. and Fin. Analysis (Dec. 13, 2024), <u>https://ieefa.org/articles/oppositions-nuclear-costings-are-unrealistic</u>. [https://perma.cc/2EPU-UA9X]

²⁰² Economic analysis of including nuclear power in the NEM, *supra* note 5.

the nuclear cost will still not be repaid at the end of the Frontier report modelling period, 2051."²⁰³ Also, it is unclear whether nuclear plant refurbishment costs have been considered by Frontier Economics, notwithstanding the GenCost 2023-24 report "explaining that refurbishment of nuclear reactors is needed beyond the 40-year mark."²⁰⁴

Along with criticisms of Frontier's assumed timelines and costs of nuclear reactors, there is the issue of Frontier's apparent omission of coalfired power station refurbishment extension costs and taxpayer subsidies to extend the operating life of coal power plants such as Eraring in NSW and Yallourn and Loy Yang A in Victoria in Frontier's modelling. Similarly, it would appear Frontier Economics has not explored the cost of nuclear waste disposal and the liability for nuclear accidents.²⁰⁵

It will be recalled from Part B that Frontier Economics did not present any results for electricity prices on the basis this will depend on how the costs of new generation capacity will be treated in the future. By contrast, IEEFA has undertaken such modelling based on overseas reactor projects where IEEFA found nuclear power would cost 1.5 to 3.8 times the current cost of electricity in Eastern Australia.

For nuclear power plants to be commercial and operating 24/7, the wholesale price would need to rise to these higher levels in order to enable nuclear cost recovery. This means household power bills would have to go up by \$665 for a typical household and \$972 for a four-person household per year. If nuclear costs were not recovered through the wholesale market and on power bills, then nuclear would require subsidies to remain commercial, and it appears these have not been included in the modelling.²⁰⁶

Frontier Economics has not been shy in responding to critics, most noticeably to an opinion piece by Steven Hamilton who *inter alia* attacked Frontier's modelling for assuming (a) the high capacity factor for nuclear of 90% and (b) the capital cost of nuclear would fall by 1% per annum, and for excluding the additional costs of emissions resulting from keeping the coal generators for running years longer.²⁰⁷

Danny Price, Frontier's Managing Director, replied to Hamilton with his own opinion piece three days later in the same newspaper.

²⁰³ Bowyer, *supra* note 201.

²⁰⁴ *Id*.

²⁰⁵ *Id*.

²⁰⁶ *Id*.

²⁰⁷ Steven Hamilton, *Economics of Coalition's nuclear modelling are worth nothing*, The Australian Fin. Rev.(Dec. 15, 2024), <u>https://www.afr.com/policy/energy-andclimate/economics-of-coalition-s-nuclear-modelling-are-worth-nothing-20241214p5kydg</u>. [https://perma.cc/2NS5-GFCZ]

It seems Hamilton's big point is that the modelling must be doing something wrong because the annual average utilisation of renewables does not change with the introduction of nuclear and there must be a lot of spilled renewable electricity ... The first point to note is that we get spilling of excess renewable energy already - that is, where renewables are turned down because there is too much generation. Given the high cost of storage, it is usually cheaper to spill this surplus electricity than store it ... In a renewables-only system, this spill gets larger and larger as the share of renewables increases...

When we did this modelling, we forced nuclear power into the system and then the model was re-run to re-optimise everything around the nuclear power stations to find the lowest cost solution. When nuclear is included, the model obviously builds less renewable capacity. Of course, there will be some spill, but the model optimisation explicitly minimises this spill.²⁰⁸

Having dealt with Hamilton's claim that Frontier Economics had ignored spill in determining the total system costs, Price described as 'absurd' Hamiton's argument that it is invalid to assume that nuclear costs will improve from now onwards by an assumed 1% per annum because "engineers, technical advisers, technology suppliers and construction companies are learning all the time from the experiences of other projects around the world."²⁰⁹ As to the omission of the cost of emissions based on the regulator's value of emissions reduction (VER), Price noted that "Minister Bowen, rightly, does not include the VER when he reports his \$122 billion present value transition cost and the additional emissions are measured against AEMO's unrealistic early closure schedule, which clearly is not going to happen."²¹⁰ In other words, the additional emissions will be overstated.

More globally, it is accepted by both AEMO and Frontier Economics that another form of generation is required given the current state of storage technology. For AEMO it is gas while for Frontier it is nuclear. As has been observed, the capital cost of gas is approximately one fifth of nuclear, but gas has considerably higher running costs and emits carbon dioxide.²¹¹ With all the uncertainty in relation to nuclear costs, one commentator has suggested 'the sensible way forward is to

 ²⁰⁸ Danny Price, Why the critics are wrong about nuclear costings, The Australian Fin.
Rev. (Dec. 18, 2024), <u>https://www.afr.com/policy/energy-and-climate/why-the-critics-are-wrong-about-nuclear-costings-20241216-p5kynk</u>. [https://perma.cc/H5JT-RVT6]
²⁰⁹ Id.

²¹⁰ Id.

²¹¹ Stephen Grenville, *Counting Nuclear Costs*, The Australian (Jan. 6, 2025). The online article was published under a different title on Jan. 5, 2025: *Nuclear-fuelled electricity won't cut costs*.

https://www.theaustralian.com.au/commentary/nuclearfuelled-electricity-generation-wont-cut-costs/news-story/f576c47c6a04893d1849b6646953e70a

minimise capital expenditure and maximise flexibility to adapt the grid to changing circumstances'.²¹² Unsurprisingly, this strategy is closely aligned to AEMO's ODP, because 'nuclear may well have a place in Australia's longer-term grid, but the urgent need is to replace fossil-fuel generation'.²¹³ Whether phasing out coal generation is 'urgent' is open to debate and depends both on values and assumptions.

Notwithstanding the critics, the economic analysis undertaken by Frontier Economics has garnered some support for improving the nuclear discussion by making the comparison between all energy sources.

> In doing so Frontier attempts to take into account full systems costs and recognises along with the rest of the world, with the exception of the CSIRO and similar organisations, that without this levelised cost of electricity data is worth very little. Timing matters and not every unit of energy or output capacity is equivalent. Frontier also recognises that the system has physical constraints.²¹⁴

In this respect, Frontier has avoided the pitfalls of previous analyses which have mostly focused "on accounting costs pretending to be economic costs."²¹⁵ Here, accounting cost means "the sticker price of different technologies while economic costs depend on what we are trying to maximise such as the impact of different energy trajectories on the environment."²¹⁶ The attack is redirected from Frontier to CSIRO and AEMO who are branded as organisations engaging in some DIY accounting with no serious capacity in theoretical and applied economics and engineering: "Even if nothing else, Frontier demonstrates that, using AEMO assumptions, it is bordering on silly to simply claim a weather dependent system will be cheaper than one with some nuclear energy."²¹⁷

D. Summary

Until the publication of the two Frontier Economics reports in November and December 2024 on the costs of nuclear power in Australia, the assumptions in the annual CSIRO GenCost report were largely unchallenged and broadly accepted. Frontier has changed the energy debate in Australia for the better by exposing the limitations in CSIRO's analysis on the costs of different generation technologies.

²¹² Id.

²¹³ *Id*.

²¹⁴ Coram A, *Transition calls for serious analysis, not DIY economics*, The Weekend Australian (Dec. 22 2024), <u>https://www.theaustralian.com.au/inquirer/transition-calls-for-serious-analysis-not-diy-economics/news-</u>

story/bcad8f82ba4be3057d702017357c2bff. [https://perma.cc/G5Y2-FFRC]²¹⁵ *Id.*

²¹⁶ *Id*.

 $^{^{217}}$ Id.

Even among the sceptics of the value of nuclear energy there is grudging agreement that (a) a renewables-based strategy results in substantial excess capacity which will need transmission into the NEM; (b) comparisons of levelised costs are simplistic and the proper approach is to examine the energy system capacity mix as a whole; (c) the longer life of nuclear energy compared with renewable energy sources needs greater consideration; (d) the NEM is no longer fit for purpose; (e) the energy transition will cost far more than CSIRO's and AEMO's estimates irrespective of whether, after more thorough economic analysis, the current renewables only strategy is considered the optimum way forward.²¹⁸

The author takes the view that the most sensible manner to resolve the debate over the place of nuclear energy in Australia is to remove the legal restrictions to the development of nuclear power and then let the market decide if nuclear is financially viable. Even if the market was favourably disposed to developing nuclear power plants, any decision to proceed would be a political one, subject to the satisfaction of community concerns over safety, the management of nuclear waste and social license, which will be considered in the next Part.

IV. ENVIRONMENTAL, PLANNING AND LEGAL ISSUES INVOLVED IN TRANSITIONING TO CARBON ZERO EMISSIONS BY 2050

In a world where arable land and wilderness are at a premium, Labor, the Greens and the teals are adopting a plan that will destroy and despoil vast areas of countryside and bushland.²¹⁹

The federal Opposition has proposed building seven nuclear power plants in five states on retiring or retired coal sites if elected. The seven sites are: Tarong in Queensland, north-west of Brisbane; Callide in Queensland, west of Gladstone; Liddell in NSW, in the Hunter Valley; Mount Piper in NSW, near Lithgow; Port Augusta in SA; Loy Yang in Victoria, in the Latrobe Valley; and Muja in WA, near Collie. The federal Opposition has publicly stated the seven locations offered "important technical attributes needed for a zero-emissions nuclear plant, including cooling water capacity and transmission infrastructure, that is, we can use

²¹⁸ Grenville, *supra* note 211.

²¹⁹ Chris Kenny, *Stuck on a horse-drawn buggy as world speeds past*, THE AUSTRALIAN (Jan. 18, 2025), <u>https://www.theaustralian.com.au/inquirer/stuck-on-a-horsedrawn-buggy-as-world-speeds-past/news-story/ca4a11713912fe340588180db1b9ac63</u>. [https://perma.cc/8DC6-N2D8]

Herein lies the nub of the difference between the two major parties as to the extent of the environmental damage caused by transmission lines: Labor is wedded to a renewables only approach which by virtue of the rural and coastal locations of the extensive solar farms and wind turbines requires 10,000 kms of transmission lines, while the Coalition has highlighted the benefits of introducing nuclear power on existing coal sites already connected to the grid thereby reducing the length of transmission lines needed for the transition to carbon zero emissions. Of course, the environmental divide between the two major parties is far more extensive than simply the quantum of environmental damage caused by transmission lines, but the debate has brought the whole question of social license to the fore.

A. Environmental and planning issues involved with renewable energy rollout

As mentioned previously in Part II when discussing the third tension of the social license for a clean energy system, the widespread 'bush revolt' against the proposed 10,000 kms of transmission lines led to the Federal Minister for Climate Change and Energy commissioning Andrew Dyer, the Australian Energy Infrastructure Commissioner, to undertake a Community Engagement Review which painted a bleak picture of a grossly under-performing transmission sector. In a sad irony, the fight against the speed of development within renewable energy zones (REZs) is being led by environmentalists and scientists. The former chief scientist, Alan Finkel, outlined a vision of the future in 2023 which is coming to life, with new 3D mapping showing the speed and scope of the rollout of renewables: "Forests of wind farms carpeting hills and cliffs from sea to sky; endless arrays of solar panels disappearing into the desert."221 Finkel has said the quantum of the task to generate 82% of power from renewables by 2030 (40 wind turbines per month, 22,000 solar panels per day and 6 gigawatts of new renewable energy per year)

²²⁰ Tom Crowley & Jane Norman, *Peter Dutton reveals seven sites for proposed nuclear power plants*, ABC NEWS (June 18, 2024), <u>https://www.abc.net.au/news/2024-06-19/dutton-reveals-seven-sites-for-proposed-nuclear-power-plants/103995310</u>. [https://perma.cc/F7RD-5J8Q]

²²¹ Christine Middap, 'Can't keep track': New mapping shows size and scope of the green energy rush, THE AUSTRALIAN (Nov. 1, 2024),

https://www.theaustralian.com.au/nation/cant-keep-track-new-mapping-shows-sizeand-scope-of-the-green-energy-rush/news-

story/38ce4dd4762eb96d11a3fbe9e43e4680. [https://perma.cc/7HPD-HN7J]

is one of "barely imaginable proportions."²²² Armidale Mayor Sam Coupland has described the scale of the change on the rural landscape in these colourful and caustic terms:

It's going to be the biggest change since white man turned up with sheep in the 1840s. "That fundamentally changed our landscape, and this will too – and it's happening whether people like it or not."²²³

The new 3D national mapping platform developed by environmentalist Steven Nowakowski and Canberra energy workers has provided a picture of the change being wrought on regional and rural areas.

Intense clusters of wind and solar farms are growing along the forested ridges and agricultural valleys hugging the Great Dividing Range ... The projects bunch along existing and planned transmission corridors supplying the main population centres, leaving the Outback, which has many good sources of wind and sun but inadequate connection, largely untouched. Dedicated renewable energy zones, the equivalent of modern day-day power stations, attract many projects but a good number of proposals bleed well outside those boundaries.²²⁴

A good example is the New England REZ centred around Armadale, an area of rich agricultural land hemmed in by the Great Dividing Range, which is Australia's largest REZ and has an intended network capacity of 8 gigawatts. As far as the necessary transmission lines are concerned, the New England REZ network infrastructure project has been declared a critical state significant infrastructure (CSSI) project by the NSW Minister for Planning and Public Spaces as it considered "essential for the State for economic, environmental or social reasons."²²⁵ EnergyCo is leading the development of the REZ transmission network infrastructure as the Infrastructure Planner for the REZs in NSW.

Under the *NSW Environment Planning and Assessment ACT 1979*, CSSI applications must be approved by the NSW Minister for Planning and Public Spaces following a comprehensive assessment process. This includes extensive community consultation and the preparation of an Environmental Impact Statement (EIS).

EnergyCo is committed to long-term ongoing engagement with the community as we develop the New England REZ.

Work to develop the Environmental Impact Statement (EIS) for the REZ network infrastructure project will continue throughout 2024 and

²²² Id.

²²³ Id.

²²⁴ Id.

²²⁵ New England REZ network infrastructure project, EnergyCo, NSW Gov't. <u>https://www.energyco.nsw.gov.au/ne</u>. [https://perma.cc/TZ75-RLC3]

2025. During this time, we will continue carrying out field investigations and consultation with landowners and communities to refine the transmission corridor and assess its impacts.²²⁶

Despite the honeyed words, the implications of the New England REZ network infrastructure project being declared a CSSI are clear, as in the words of Armidale Mayor Sam Coupland quoted above "it's happening whether people like it or not."²²⁷ Indeed, the scale of the transmission connection is obliquely admitted by EnergyCo: "Some of this infrastructure will need to be built outside the New England REZ geographical area to connect the REZ to the main backbone transmission network."²²⁸

As previously discussed in Part III Section C Pumped hydro in the context of the Snowy Hydro 2.0 project, aside from concerns about highly productive agricultural land being lost to large scale renewable projects, "there is growing alarm at the damage to sensitive landscapes and areas close to national parks, world heritage areas, protected wetlands and migratory bird flight paths."²²⁹ For example, Rainforest Reserves Australia "has warned that the most significant threat to remnant habitats along the Great Dividing Range – home to vulnerable species such as koalas and greater gliders – comes from poorly placed renewable developments."²³⁰ Three wind farms located in Queensland, Lotus Creek with 46 wind turbines (20 kms west of St Lawrence), Clarke Creek with 100 wind turbines (65 kms south-west of Ingham), each threaten the habitat of vulnerable species such as koalas, greater gliders, squatter pigeons and Sharman's rock-wallabies.²³¹

The central issue is one of biodiversity versus cost which has been succinctly spelt out by Brendan Wintle, director of Melbourne University's Biodiversity Institute: "The general story is that the further west you go, the lower the impact on nature and high productivity land, and the lower the general conflict."²³² In other words, by placing the wind farms west of the Great Dividing Range nature and biodiversity are better protected. The federal environment minister, Tanya Plibersek, in

https://www.theaustralian.com.au/nation/scientists-sound-alarm-over-renewablesimpact-on-nature/news-story/ef761b13c6744b5e59326cc891329ceb

²²⁶ Id.

²²⁷ Id.

²²⁸ Id.

²²⁹ Christine Middap, *Energy rethink to "save our nature"*, THE AUSTRALIAN (Nov. 2, 2024). The online article was published under a different title on Nov. 1, 2024: "*Out of control": scientists plead over wind and solar farm destruction*.

²³⁰ *Id*.

²³¹ Id.

²³² Id.

approving the Gawara Baya wind farm, sought to placate concerns by claiming "the approval of the wind farm is subject to strict conditions to protect the Sharman's Rock-Wallaby and northern Greater Glider, and follows a rigorous assessment process."²³³ These allegedly 'strict conditions' allow the "removal of 598 hectares of Sharman's rock-wallaby habitat, 614 hectares of koala habitat and 581 hectares of northern great glider habitat."²³⁴ As the former Queensland Chief Scientist, Hugh Possingham, has lamented: Maybe 150 hectares disappear here, 200 hectares there. It's small relative to land clearing in NSW and Queensland, but you end up getting death by a thousand cuts.²³⁵

Similar sentiments have been expressed by Steven Nowakowski who considers "we have magnificent mountains that should not be fragmented and smashed for wind farms,"²³⁶ a view endorsed by Bob Brown :who has warned that the impacts of some wind farms on critical habitat outweigh the benefits and could contribute to the extinction crisis."²³⁷

As regards offshore wind projects, Chris Bowen, the Minister for Climate Change and Energy announced the identification of six priority areas in Australia for offshore wind in August 2022: Gippsland, Victoria (15,000 square kilometres); Hunter, NSW (1,854 square kilometres); Southern Ocean, Victoria (1,030 square kilometres); Illawarra, NSW (1,022 square kilometres); Bass Strait, Northern Tasmania (7,100 square kilometres); and Indian Ocean off Bunbury, Western Australia (3,995 square kilometres). These areas have been chosen as they: have strong and consistent winds; are close to areas of high electricity demand; have existing electricity transmission infrastructure; have existing transport and port infrastructure; and industry is interested in developing projects in these areas.²³⁸

Bowen has said that "offshore wind represents a huge opportunity for regional Australia, providing reliable renewables to power homes and heavy industry while creating highly skilled and well-paid jobs now and

https://minister.dcceew.gov.au/plibersek/media-releases/new-wind-farm-northqueensland-power-240000-homes. [https://perma.cc/8X9U-GM3A]

https://www.dcceew.gov.au/energy/renewable/offshore-wind/areas. [https://perma.cc/2DVK-CCHC]

²³³ Tanya Plibersek, Commonwealth of Austl., *New wind farm in North Queensland to power 240,000 homes*, Media Release (June 18, 2024),

²³⁴ Middap, *supra* note 229.

²³⁵ Id.

²³⁶ Id. ²³⁷ Id.

²³, Id

²³⁸ Australian Gov't, Dep't of Climate Change, Energy, the Env't and Water: Australia's offshore wind areas,

in the future."²³⁹ However, this rosy picture of the benefits of offshore wind is not universally shared. One organisation actively campaigning against offshore wind is the Australian Fishing Trade Association (AFTA) who have listed the following potential negative impacts: noise pollution; habitat loss; displacement and mortality of sea birds; visual impact;²⁴⁰ collision risk; underwater disturbance; exclusion of fishing activity; marine life; and defence issues such as military operations and national security.²⁴¹

More specifically, the Southeast Trawl Fishing Industry Association and Southern Fishery Alliance "accuse the federal government of ignoring data-backed submissions in designing the Gippsland (Victoria) and Illawarra (NSW) offshore wind zones."²⁴² The Alliance believes a more thoughtful zone design is required, but instead the federal government has "given the wind industry as much area as possible for exploration."²⁴³ The federal government argues that offshore wind zones have been specifically designed to be mixed use, which the Alliance disputes because "fishing with large nets from large nets could not safely or practically be done around turbines with accompanying infrastructure and cabling."²⁴⁴ For the Alliance, fishing and offshore wind zones are mutually exclusive.

The new federal legislative licensing regime for offshore wind zones was tested in *Seadragon Offshore Wind Pty Ltd v Minister for Climate Change and Energy*,²⁴⁵ where the issue was whether the Minister for Climate Change and Energy had the power to grant Seadragon a licence over a reduced area than specified in the original application which had overlapped with another licence application of greater merit.

https://todayspaper.theaustralian.com.au/html5/reader/production/default.aspx?pnum= 9&edid=46259636-7ae7-442e-ab29-19f1d6750ac7&isshared=true ²⁴³ Id.

²³⁹ Graham Lloyd, *Throw caution to the wind*, THE WEEKEND AUSTRALIAN (Nov. 2, 2024). The online article was published under a different title on Nov. 1, 2024: "*Model is broken*": *off-shore wind's towering hype faces reality check*.

https://www.theaustralian.com.au/nation/model-is-broken-offshore-winds-toweringhype-faces-reality-check/news-story/431187ae3bf9a49c2751c5aa3c2979f7

²⁴⁰ The newest 15MW wind turbines are approximately 260 metres tall with blades that are up to 115 metres long.

²⁴¹ Austl. Fishing Trade Ass'n, 'Offshore Wind Farms -- The Impacts (June 30, 2023) <u>https://afta.net.au/offshore-wind-farms-the-impacts/</u> [perma.cc/3PYN-EVHV]; see also Denholm, Angry fishers despair at "Plibersek's green tide", The Weekend Australian (Feb. 22, 2025), https://www.theaustralian.com.au/nation/angry-fishers-despair-attanya-pliberseks-green-tide/news-story/f4d11106b87ef8fde3a5d5f87704d827. [https://perma.cc/6AQ2-JGAH]

²⁴² Matthew Denholm, Offshore wind farms "will destroy fisheries", THE WEEKEND AUSTRALIAN (Jan. 25, 2025).

 $^{^{244}}$ Id.

²⁴⁵ [2024] FCA 1290.

The Minister had rejected the amended request because he considered a feasibility licence could only be granted over the entire proposed area. Justice Perram found the Minister had made an error of law, as he did, in fact, have the power to grant Seadragon a licence over a reduced area, and remitted the matter to the Minister for reconsideration in accordance with the law.²⁴⁶ Justice Perram concluded that "the topic of overlapping claims of unequal merit needs to be regulated."²⁴⁷

This case sets important precedent for determining how feasibility licences will be granted where bids of different levels of merit feature overlapping areas, which is likely to be a common occurrence given that offshore wind farms are restricted to declared zones ... Enabling the Minister to grant licences over smaller areas with overlapping parts excised means that more projects will be able to be approved. This should come as welcome news to developers, as offshore wind is likely to be a key part of Australia's plans for achieving its net-zero target for 2050.²⁴⁸

All offshore wind projects are assessed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).²⁴⁹ An assessment under the EPBC Act includes construction, operation and decommissioning of wind turbines, cables, substations and associated infrastructure. Yet, the best protection may prove to be the future economics of offshore wind. GE Vernova chief executive Scott Strazik has said offshore wind "is never going to be economically competitive with onshore wind and solar but it will be competitive with new nuclear or carbon capture and gas ... GE is increasingly turning its attention to nuclear."²⁵⁰ In the same vein, Google energy chief executive Enrique Frances has observed "big tech, with a high demand for energy to power artificial intelligence, increasingly is putting its bets on nuclear."²⁵¹

The overwhelming sentiment from concerned environmentalists and scientists is the need for better mapping and planning of renewable

 ²⁴⁶ Ord., Fed. Ct. of Austl., Aug. 22, 2024 Seadragon Offshore Wind Pty Ltd v Minister for Climate Change and Energy [2024] FCA 1290 [35]-[36] (Perram J).
²⁴⁷ Id. at 49.

²⁴⁸ Riviere F and Ng L, *Australian ruling plugs gap in the offshore power infrastructure regulatory framework*, Pinsent Masons (Nov. 25, 2024), <u>https://www.pinsentmasons.com/out-law/news/ruling-plugs-gap-offshore-power-infrastructure-regulatory-framework</u>. [https://perma.cc/B7E4-534D]

²⁴⁹ Guidance - Key environmental factors for offshore windfarm environmental impact assessment under The Environment Protection and Biodiversity Conservation Act 1999, Department of Climate Change, Energy, the Environment and Water (July 2023), <u>https://www.dcceew.gov.au/sites/default/files/documents/key-environmentalfactors-offshore-windfarm-environmental-impact-assessment-under-EPBC-Act.pdf.</u> [https://perma.cc/9F9A-UBLQ]

 $^{^{250}}$ Lloyd, *supra* note 239.

²⁵¹ Id.

energy locations. Andrew Dyer's *Community Engagement Review* discussed in Part II recommended:

States and territories to support and expedite sourcing information that is necessary for contemporary land use planning. Mapping of this information will assist with better identification of highly preferred locations for new projects, as well as provide confirmation regarding 'no-go' or inappropriate zones. Planning authorities, developers and other stakeholders should carefully review this information and associated maps before commencing any prospecting or development activity at a site.²⁵²

The author takes the view that the headlong almost lemming like stampede to achieve the legally mandated renewable energy targets by 2030 has precipitated poor land use planning for renewable energy locations and negatively impacted on biodiversity, particularly on the fragile ecosystems and habitats in the Great Dividing Range.

B. Environmental, planning and legal issues involved with nuclear energy

There are numerous barriers to nuclear power in Australia, two of which have already been discussed: legal impediments and cost. Other significant obstacles include the lack of a local nuclear industry or skill base excluding the Lucas Heights facility for nuclear medicine;²⁵³ concerns over safety in the event of a nuclear accident and social license; and the disposal of nuclear waste.

1. Legal ban on nuclear power

Nuclear power is prohibited in Australia by two pieces of federal legislation: the *Australian Radiation Protection and Nuclear Safety Act* 1998 (Cth) and the *Environment Protection and Biodiversity* Conservation Act 1999 (Cth). These two federal Acts effectively prevent the construction or operation of nuclear facilities for power generation, as well as facilities for the fabrication of nuclear fuel, uranium enrichment and the reprocessing of nuclear waste. Similar prohibitions exist under the

²⁵² Dyer, *supra* note 42, at 21.

²⁵³ Australia's Nuclear Science and Technology Organisation (ANSTO) is home to Australia's only nuclear reactor, OPAL, in Lucas Heights, Sydney. OPAL stands for 'Open Pool Australian Lightwater' which is 20-megawatt multi-purpose nuclear reactor that uses low enriched uranium (LEU) fuel to achieve a range of nuclear medicine, research, scientific, industrial and production outcomes. ANSTO has over 60 years of experience in nuclear science and technology.

laws of every state and territory.²⁵⁴ The first step to developing an Australian nuclear power industry would be the removal of these federal and state bans.

Such a step was attempted in 2022 with the tabling in the Senate of the Environment and Other Legislation Amendment (Removing Nuclear Energy Prohibitions) Bill 2022 by National MP Matt Canavan. This Bill sought to repeal s 10 the *Australian Radiation Protection and Nuclear Safety Act 1998* (Cth) and to repeal s 37J, s 140A, s 146M and ss 305(2)(d) of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

The Bill would have amended the Australian Radiation Protection and Nuclear Safety Act 1998 (Cth) to remove the prohibition on the construction or operation of certain nuclear installations, and the Environment Protection and Biodiversity Conservation Act 1999 (Cth) to remove the prohibition on the Minister for Environment and Water declaring, approving or considering actions relating to the construction or operation of certain nuclear installations. The Bill was referred to the Senate's Environment and Communications Legislation Committee.

The majority of the members of the Committee (Labor and the Greens) predictably found there was no basis for lifting the legislative prohibitions on nuclear energy for civilian use "for a multitude of reasons" which ranged from nuclear energy being expensive, unproven and inflexible to safety risks, water scarcity and the lack of social license.²⁵⁵ On water scarcity, because nuclear power plants require significant volumes of water from uranium mining and processing through to reactor cooling, the majority concluded that "establishing a civil nuclear industry in the drought-prone country of Australia is untenable."²⁵⁶ On the lack of social license, the majority said there was no mandate to overturn the existing laws as "there is a long history of public support for the prohibition on civil nuclear power in Australia, and this support is ongoing."²⁵⁷ The majority position boiled down to the view that there was no need to consider nuclear energy because renewable energy was both

²⁵⁶ *Id.* at 4.13.

²⁵⁴ See, for example, the *Nuclear Facilities Prohibition Act 2007* (Qld), the *Uranium Mining and Nuclear Facilities (Prohibitions) Act 1986* (NSW), and the *Nuclear Activities (Prohibition) Act 1983* (Vic). Under s 21(3) of the *Nuclear Facilities Prohibition Act 2007* (Qld), if the Commonwealth takes steps for a prohibited nuclear facility the Minister must take steps for the conduct of a plebiscite in Queensland to obtain the views of the people of Queensland about the construction of a prohibited nuclear facility in Queensland.

²⁵⁵ Senate Standing Comm. on Envt. & Comms., *Environment and Other Legislation Amendment (Removing Nuclear Energy Prohibitions) Bill 2022*, Report, Parliament of Australia (Aug. 2023), at Ch. 4 – Committee View.

²⁵⁷ *Id.* at 4.15.

sufficient and the cheapest technology to transition Australia to carbon zero by 2050. In other words, the majority supported the analysis in CSIRO's GenCost annual reports.

Coalition Senators on the Senate's Environment and Communications Legislation Committee issued a dissenting report which reflected the arguments put by the Australian Nuclear Association Inc (ANA) in its submission to the Legislation Committee.

Australia needs access to all available clean zero-carbon technologies to meet the challenge of decarbonising our energy system. An essential step is the amendment of legislation to remove prohibitions on nuclear energy in Australia. The historic prohibitions still in the EPBC Act 1999 and the ARPANS Act 1998 are barriers to the proper assessment of the merits of nuclear power as an affordable, reliable and low carbon part of Australia's energy system. Removing the prohibitions is not a decision to build nuclear power plants but a decision to allow nuclear power to be considered on its merits. Any decision to build nuclear power plants in Australia would have meet environmental standards, be supported by communities and demonstrate financial viability. Using nuclear energy in conjunction with wind, solar and hydropower would help provide reliable, affordable low carbon energy system for Australia into the future.²⁵⁸

Similar arguments to those made by the ANA were put by the Minerals Council of Australia (MCA) in its submission to the Senate's Environment and Communications Legislation Committee.

The International Atomic Energy Agency and the International Energy Agency recognise the role for nuclear energy in a decarbonised world. As such, Australia should be technology agnostic in its aim to achieve net-zero emissions by 2050. As Australia looks to decarbonise its energy networks, small modular reactors (SMRs) offer advantages as they provide constant and variable energy to support grid resilience and can be deployed near existing transmission infrastructure. It is anachronistic to retain a prohibition on this suite of zero carbon energy technologies in an era requiring carbon dioxide emissions reduction. Low emission SMRs enable the redeployment of existing energy generation skills and capabilities, provide high-value employment and support the economic viability of regional communities; all near valuable and expensive existing transmission infrastructure.²⁵⁹

²⁵⁸ Submission to Envt. & Comms. Legislation Comm., Inquiry into *Environment and Other Legislation Amendment (Removing Nuclear Energy Prohibitions) Bill 2022*, Australian Nuclear Ass'n Inc., at 1. ttps://www.nuclearaustralia.org.au/wp-content/uploads/2023/03/ANA-Submission-to-Inquiry-on-Removing-Nuclear-Prohibitions.pdf. [https://perma.cc/F2MU-65A4]

²⁵⁹ Submission to Environment and Communications Legislation Committee, Inquiry into Environment and Other Legislation Amendment (Removing Nuclear Energy Prohibitions) Bill 2022, Minerals Council of Australia (16 January 2023), 3

Essentially, the position of the ANA and the MCA was that the prohibition on nuclear energy in Australia was anachronistic and anomalous with the views of international energy agencies. The ANA mounted a strong argument that removing the prohibition was simply an opportunity to consider nuclear energy on its merits. More recently, the MCA has argued there is "absolutely no mandate today for retaining the legislative ban on nuclear energy … no scientific, technical or economic justification for the ban".²⁶⁰

2. Safety and social license

Historically, since the testing of nuclear weapons in remote areas of South Australia in the 1950s, Australia has been concerned with the health, safety and environmental impacts of radioactive material, especially in light of the nuclear accidents at Three Mile Island in Pennsylvania in the United States in 1979,²⁶¹ at Chernobyl in northern Ukraine in 1986, and at Fukushima in Japan in 2011.²⁶² Politically, the federal Labor Party and the trade union movement have been opposed to nuclear proliferation, as evinced by Labor's 1984 three uranium mine policy which restricted uranium mining in Australia to three existing mines: Ranger, Nabarlek and Olympic Dam.²⁶³

The International Atomic Energy Agency provides guidance to countries who are developing a nuclear energy program,²⁶⁴ including the establishment of a national regulatory body covering the construction and operation of nuclear energy plants and the nuclear fuel cycle.²⁶⁵ Australia

²⁶⁰ Rosie Lewis, *Miners claim uranium ban "negligent, nonsense policy*", The Australian (Dec. 17, 2024). The online article was published under a different title on Dec. 16, 2024: *Minerals Council of Australia CEO Tania Constable fronts Labor nuclear inquiry, says "no mandate" for ban.*

https://www.theaustralian.com.au/nation/minerals-council-of-australia-ceo-taniaconstable-fronts-labor-nuclear-inquiry-says-no-mandate-for-ban/newsstory/834b20abb02a8a449a9fed5c0d9a02ee

²⁶¹ The Three Mile Island nuclear plant closed in 2019 due to operating losses but is expected to go back into service by 2028 as part of a deal with Microsoft to power its data centres.

²⁶² Tillement et al, *Three Mile Island, Chernobyl, Fukushima: the role of accidents in nuclear governance*, I'Mtech (June 30, 2021),

<u>https://imtech.imt.fr/en/2021/06/30/three-mile-island-chernobyl-fukushima-the-role-of-accidents-in-nuclear-governance/</u>. [https://perma.cc/B697-GVX5]

²⁶³Three-mine policy, *Wikipedia* <u>https://en.wikipedia.org/wiki/Three-</u> mine_policy#:~:text=The%20three%20pmine%20policy%20was,Ranger%2C%20Naba

rlek%20and%20Olympic%20Dam. [https://perma.cc/H5JB-7DXK]; Australia's Uranium, World Nuclear Association https://world-nuclear.org/information-

<u>library/country-profiles/countries-a-f/australia</u>. [https://perma.cc/GYE3-KMLG] ²⁶⁴*International Atomic Energy Agency*, Milestones in the Development of a National Infrastructure for Nuclear Power, IAEA Nuclear Energy Series (2015).

²⁶⁵*International Atomic Energy Agency*, Responsibilities and Functions of a Nuclear Programme Implementing Organisation, Nuclear Energy Series, (2019).

would have to set up a national regulatory body similar to the United Kingdom's Office for Nuclear Regulation,²⁶⁶ the Canadian Nuclear Safety Commission,²⁶⁷ and the United States Nuclear Regulatory Commission.²⁶⁸

Social license may prove to be the most significant obstacle to nuclear power. This follows because the optimal locations of large-scale nuclear plants and SMRs are on the sites of decommissioned coal-fired power stations near to local communities such as those in the La Trobe Valley in Victoria, the Central Coast in NSW, and the Hunter Valley in NSW. The lack of political bipartisanship across the federal and state tiers of government will be a major hurdle to securing social license for nuclear power, which to be successful will need, at a minimum, to encompass transparency, trust and ongoing community consultation. Ultimately, Australians will be motivated to support nuclear power if independent research can demonstrate (i) a clear need for nuclear power to deliver reliable base load power into the grid and (ii) competitive whole of system costs for nuclear power compared to alternative energy sources.

3. Disposal of nuclear waste

The *National Radioactive Waste Management Act 2012* (Cth) sets out a legislative framework for selecting and establishing the national radioactive waste management facility.²⁶⁹ The federal government has expressed an intention to build a single, purpose-built facility to permanently dispose of low-level radioactive waste and temporarily store intermediate-level radioactive waste.²⁷⁰

After a seven-year site selection process, in November 2021, the then Minister for Resources and Water declared the property at Napandee, near the town of Kimba in South Australia as the proposed site for the

²⁶⁶The Office for Nuclear Regulation is the UK's independent nuclear regulator. Its mission is to protect society by securing safe nuclear operations.

²⁶⁷The Canadian Nuclear Safety Commission regulates the use of nuclear energy and materials to protect health, safety, security and the environment.

²⁶⁸The United States Nuclear Regulatory Commission is an independent agency of the United States government tasked with protecting public health and safety related to nuclear energy.

²⁶⁹ The object of the Act is set out in s 3: (1) The object of this Act is to ensure that controlled material is safely and securely managed by providing for: (a) the selection of a site for a radioactive waste management facility on land in Australia; and (b) the establishment and operation of such a facility on the selected site.

²⁷⁰ Australian Government Department of Industry, Science and Resources, Decision on the National Radioactive Waste Management Facility (NRWMF) (Aug. 23, 2023) <u>https://www.industry.gov.au/news/decision-national-radioactive-waste-management-facility-nrwmf-site</u>. [https://perma.cc/E5JY-U4G4]

nuclear waste facility.²⁷¹ The Minister's declaration was challenged in the Federal Court in *Barngarla Determination Aboriginal Corporation RNTBC v Minister for Resources*,²⁷² where Charlesworth J ruled the declaration invalid on the basis of procedural defects in the decision making, namely, apprehended bias.

On 10 August 2023, the Minister for Resources stated that the government does not intend to pursue Napandee as a potential site for the facility. Nor is the government intending to pursue the previously shortlisted Lyndhurst and Wallerberdina sites ... The Australian Radioactive Waste Agency has started work on alternative proposals for the storage and disposal of the Commonwealth's civilian low-level and intermediate-level radioactive waste.²⁷³

Consequently, at present, there is no proposed site for the disposal of low-level radioactive waste which is predominantly generated by nuclear medicine activities.²⁷⁴ As a result, the object of the *National Radioactive Waste Management Act* has not been met. Australia could take a leaf out of Finland's nuclear playbook; both as regards nuclear waste and generation.

Australia can look to Finland, which is developing long-term repositories capable of storing up to 6,500 tonnes of high-level nuclear waste. The Finnish facility under the forests of Olkiluoto, an island off Finland's west coast, has been designed to store nuclear waste for at least 100,000 years, encasing spent nuclear fuel in copper canisters to be placed in tunnels drilled into bedrock 430 metres below ground and 420 metres below sea level. Unlike our European counterparts, Australia has the advantage of abundant land for such a facility.²⁷⁵

As to nuclear generation, Finland has embraced the carbon-free energy source with two of the country's four reactors located on Olkiluoto, and

https://www.minister.industry.gov.au/ministers/king/media-releases/statement-nationalradioactive-waste-management-facility [https://perma.cc/96WR-XTFT]

https://www.aspistrategist.org.au/where-will-australia-store-its-nuclear-waste/. [https://perma.cc/YTQ9-EQA4]

²⁷¹The Hon Madeleine King, Minister for Resources, Statement on the National Radioactive Waste Management Facility (August 10, 2023),

²⁷² Barngarla Determination Aboriginal Corporation RNTBC v Minister for Resources [2023] FCA 809 (Austl.).

²⁷³ Australian Government Department of Industry, supra note 270.

²⁷⁴ Each year Australia produces about 45 cubic metres of radioactive waste arising from usage of radioisotopes in medicine, research and industry and from the manufacture of the isotopes – about 40 m³ low-level waste (LLW) and 5 m³ intermediate-level waste (ILW). This LLW is now stored at over a hundred sites around Australia.

²⁷⁵ Raelene Lockhorst, *Where will Australia store its nuclear waste?*, Australian Strategic Policy Institute: The Strategist, (Sept. 12, 2023)

The logic was simple: the goal of reducing carbon emissions is more important than the means by which this is done. Studies by prominent groups like the Intergovernmental Panel on Climate Change and the United Nations Economic Commission for Europe were showing that the life-cycle emissions of nuclear power plants are the lowest of all low-carbon energy sources.²⁷⁷

Whether such logic ever prevails in Australia is an open question, but in the near future Australia will need to decide on a single, purpose-built facility to permanently dispose of low-level radioactive waste and Finland has demonstrated how such a facility can be built safely.

CONCLUSION

Senator Macdonald: "In Australia, we emit less than 1.3 per cent of the world's carbon emissions."

Dr Finkel (Chief Scientist): "About that."

Senator Macdonald: : If we reduce the world's carbon emissions by 1.3 per cent, what impact would that have on the changing climate of the world?"

Dr Finkel: "Virtually nothing." 278

There is a supreme irony, if not monumental hypocrisy, in Australia attempting to achieve carbon zero emissions by 2050 while at the same time exporting significant quantities of coal to countries like China and India who are building new generation coal-fired power stations.²⁷⁹ At the same time, the newly elected President of the United

²⁷⁶ El-Showk S, *Final resting place*, Science (Feb. 24, 2022).

²⁷⁷ Tormanen T and Visscher M, *How Finland's Green Party chose nuclear power*, Governance Futurism, *Palladium* (Oct. 28, 2022).

²⁷⁸ Economics Legislation Committee, Estimates, Industry, Innovation and Science Portfolio, Parliament of Australia (1 June 2017),

https://www.aph.gov.au/Parliamentary_Business/Hansard/Hansard_Display?bid=com mittees/estimate/e3ddf88b-3e9c-4546-9d90-8f646689a98c/&sid=0001.

[[]https://perma.cc/7AVG-W3D8] (The five countries that produce the world's highest carbon dioxide (CO2) emissions are China, the United States, India, Russia, and Japan, according to the most recent data from the Global Carbon Atlas. China is by far the worst offender.)

²⁷⁹ Hummer L, Lim J, Babajeva J, Pitre C, and Zhang X, *Guest post: Just 15 countries account for 98% of new coal-power development*, CarbonBrief (Sept. 3, 2024). (All

States, Donald Trump, is encouraging American companies to "drill baby, drill."²⁸⁰

Considering the twin international energy trends of large polluters like China and India expanding fossil fuel production and a growing number of countries embracing carbon zero nuclear energy,²⁸¹ it is the more surprising that Australia is currently pressing ahead with seeking to meet very challenging renewable energy targets by 2030 and in so doing excluding any consideration of nuclear power.

This article has sought to objectively examine whether Australia will require nuclear energy to achieve carbon zero by 2050. As has been discussed, in reaching a conclusion much depends on the assumptions built into the modelling. However, aside from the nuclear versus renewables debate, it does seem clear that coal and gas are likely to be required to supply energy generation into the NEM for longer than AEMO's 2024 ISP forecasts, with coal going beyond 2034-35 and gas going beyond 2050. More generally, AEMO's assumptions for pumped hydro and green hydrogen appear overly optimistic. The overarching problem is to manage the zero output hours from wind and solar because historically electricity systems are dispatchable technologies matching frequency of demand.

CSIRO's GenCost 2023-24 report concluded the levelised costs of electricity (LCOEs) for solar PV and wind came within a range of \$100/MWh to \$120/MWh, as compared with the LCOE cost range for nuclear large-scale and for nuclear SMR which CSIRO calculated at \$150/MWh to \$225/MWh and at \$225/MWh to \$380/MWh respectively.²⁸²

²⁸² Graham P et al, *supra* note 2, at xii.

the coal-power capacity under development (98%) is now concentrated in just 15 countries, with China and India alone accounting for 86%. Despite the concentration of coal-plant development in fewer countries, new coal-fired power station proposals continue to outpace cancellations.)

²⁸⁰ 'Drill baby, drill' is Trump's prime agenda in his second term. What is it?, ECONOMIC TIMES (January 21, 2025),

https://economictimes.indiatimes.com/news/international/global-trends/drill-baby-drill-is-trumps-prime-agenda-in-his-second-term-us-oil-energy-gas-policies-paris-

agreement-landmark-climate-law-what-is-it/articleshow/116362482.cms?from=mdr. [https://perma.cc/N6GK-3FXL] (noting President Trump's campaign slogan, "Drill baby, drill" has become synonymous with his plan to boost fossil fuel production and reverse climate policies and regulations aimed at reducing carbon emissions in the United States.)

²⁸¹ See 'Emerging Nuclear Energy Countries', *World Nuclear Association* (26 April 2024), <u>https://world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries</u>. [https://perma.cc/YW24-EAZR] (About 30 countries are considering, planning or starting nuclear power programmes. These range from sophisticated economies to developing nations. Bangladesh, Egypt and Turkey are all constructing their first nuclear power plants.)

The GenCost 2024-25 consultation draft report confirmed the previous GenCost 2023-24 calculation that nuclear plants would" produce electricity at roughly twice the cost of renewable sources."²⁸³ Furthermore, the GenCost 2024-25 consultation draft report warned that examples of first-of-a-kind (FOAK) costs for a single large-scale nuclear plant with a 1-gigawatt capacity would be in the vicinity of 100% more than planned which would result in the first large-scale nuclear plant in Australia costing \$17-18 billion.

By contrast, Frontier Economics in its two reports in November and December 2024 attacked the GenCost 2023-24 report as simplistic, arguing the appropriate basis for comparison between energy sources is the total cost of a power system to reliably and securely meet demand. On this basis, Frontier Economics modelled AEMO's *Step Change* solar and wind renewables scenario as the most expensive scenario with combined generation and transmission costs of \$594 billion as compared with the *Progressive Change* scenario including nuclear power of \$331 billion, which is 44% cheaper. A key aspect of Frontier's analysis was that AEMO's transmission cost estimates were highly unreliable. Frontier concluded that at a minimum currently approved and planned transmission projects are expected to cost \$62 billion compared to the current regulated asset base of the transmission system of about \$26 billion, thereby expanding the asset base of the transmission networks by about 240%.

Following the publication of the two Frontier Economics reports, criticism crystallised around Frontier's assumption that the first nuclear plant would enter the NEM in 2036 rather than the mid-2040s and Frontier's omission of any results for electricity prices whereas IEEFA found nuclear power would cost 1.5 to 3.8 times the current cost of electricity in Eastern Australia. Nevertheless, by exposing CSIRO and AEMO as engaging in calculating accounting costs rather than economic costs and showing the energy transition will cost far more than CSIRO's and AEMO's estimates, Frontier Economics has expanded the energy debate from a one-track fixation on renewable energy sources.

This expansion of the energy debate is timely given the growing environmental and planning concerns with the renewable rollout, doubts about the level of energy contribution from pumped hydro and green energy into the NEM, and the Coalition's policy commitment to exploring nuclear energy. The extent of the potential environmental damage flowing from the proposed 10,000 kilometres of transmission lines has motivated a wide cross-section of interest groups to criticise the poor land use mapping and planning for renewable energy locations which have

²⁸³ Norman, *supra* note 156.

negatively impacted on biodiversity and productive arable land. These interest groups range from the National Parks Association of NSW to the National Farmers' Federation (NFF).²⁸⁴ As for offshore wind farms, bodies like the Australian Fishing Trade Association and the Southeast Trawl Fishing Industry Association and Southern Fishery Alliance hotly dispute the federal government's claim that fishing and offshore wind farms can co-exist in offshore wind zones.

The author takes the view that the debate over the place of nuclear energy in Australia is best progressed by undertaking further research into the financial viability of nuclear energy utilising research institutes with greater economic modelling expertise than CSIRO and without being clouded by anachronistic legal prohibitions on the development of nuclear power. This amounts to no more than leaving all energy options on the table. Investment in nuclear power will not be forthcoming unless the nuclear power option has secured social licence, which in turn depends on a clear need for nuclear power to deliver reliable base load power and competitive whole of system costs for nuclear power.

The Australian public is likely to continue to rank reliability and cost of their domestic energy as critical to their choice of government. The public is also likely to look for job opportunities and will not necessarily rank emissions reductions as a decisive factor in who to vote for ... It will of course take some time to develop a nuclear power industry in Australia, but it seems clear that it could usefully complement other generation technologies and facilitate industrial development.²⁸⁵

Furthermore, the Australian public is aware "nuclear plants work, have tiny footprints, minimise transmission needs, are reliable and last upwards of 75 years."²⁸⁶ Nuclear power is already used for electricity generation in 32 countries and 30 newcomer countries are now considering introducing nuclear power. At the very least, there is a clear need to avoid irreparable harm to Australia's fragile environment and biodiversity by ceasing the scramble to achieve unrealistic and ultimately

²⁸⁴ The NFF has long called for the Commonwealth to develop an enforceable code to ensure future transmission lines are not implemented without proper consultation, compensation and adversely impacting existing land use: 'Farmers welcome review to power up renewables engagement', *National Farmers' Federation* (July 5, 2023).

²⁸⁵ Robert Pritchard, *Time to consider nuclear*, THE AUSTRALIAN (Jan. 20, 2025). The online article was published under a different title on Jan 19, 2025: *What Australia can learn from Trump's NEC initiative*.

 $[\]label{eq:https://www.theaustralian.com.au/commentary/what-australia-can-learn-from-trumps-nec-initiative/news-story/6b2f40494236fb167f6daa34d00d110e$

²⁸⁶ Chris Kenny, *Powerhouse of modern cities was always going to be nuclear*, THE WEEKEND AUSTRALIAN (Jan. 18, 2025).

https://todayspaper.theaustralian.com.au/html5/reader/production/default.aspx?pnum= 19&edid=5e0c0a46-565c-4933-9c0f-2ecc9a03f87b&isshared=true

pointless legally mandated renewable energy targets by 2030, and by abandoning an artificially imposed timeframe of 25 years to 2050 for carbon zero emissions.

The author will leave the final comment to Woodside chief executive Meg O'Neill:

One of things that I think has been challenging is we're not using the data to have a conversation. We're using aspiration. We're using goals. But the fundamental data that will help us understand what's required to get to the place we want to be, that's not been laid up for the Australian people.²⁸⁷

The purpose of this article is to further the nuclear energy debate using data and not political ideology by engaging in an adult conversation rather than childish scare campaigns featuring Blinky the three-eyed fish, "Danger Dutton" and from the Prime Minister of Australia, Anthony Albanese, instead of Snow White and the Seven Dwarfs, this is "Peter Dutton and the seven nuclear reactors."²⁸⁸

[https://perma.cc/H89K-SWF3]3

https://www.news.com.au/technology/environment/antinuclear-scare-campaigncommences-as-peter-dutton-implores-for-adult-conversation/news-

²⁸⁷ Chris Uhlmann, *The astonishing cost of net zero*, THE WEEKEND AUSTRALIAN (Nov. 16, 2024), <u>https://www.theaustralian.com.au/inquirer/the-astonishing-cost-of-our-netzero-delusion/news-story/3fc40d39e4c55ce263ac811255f91bc9.</u>

²⁸⁸ Jack Quail, Antinuclear scare campaign begins as Peter Dutton implores for "adult conversation", NEWSWIRE (June 20, 2024),

story/303024137ee215cb026ad9f3059639c5. [https://perma.cc/RS83-69XH]