House Select Committee on Nuclear Energy
Parliament House
Canberra ACT 2600

CLIMATE CHANGE AUTHORITY

By email: nuclear.reps@aph.gov.au

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Dear Committee Members,

The Climate Change Authority is pleased to provide a submission for consideration as part of your *Inquiry into nuclear power generation in Australia*.

The authority is a statutory agency established under the *Climate Change Authority Act 2011* to provide independent, evidenced-based advice to the Australian Government on climate change policy.

The authority helps guide action to transform the Australian economy and protect communities from dangerous climate change, by providing evidence-based advice about what is possible and necessary now to:

- accelerate emissions reductions and position Australia as a leader in the global effort to limit temperature increases
- embrace new opportunities and new ways of doing things, to sustain Australia's prosperity as the world transitions to net zero emissions
- prepare for and adapt to the impacts of climate change, which have already begun and will continue to increase.

Based on the best available evidence, it is clear that only mature and proven technologies like wind and solar electricity, backed by firming and storage like peaking gas and batteries, can substantially reduce Australia's emissions in the next two decades. In the near-term, nuclear power is unlikely to be ready at scale or be cost-effective relative to other readily available options.

We trust you find this submission helpful. Our representatives would be happy to appear before the committee during public hearings to discuss the key insights from this submission further.

Regards,

Matt Kean

Chair

Brad Archer

CEO

Executive Summary: Cutting emissions as far and fast as possible now is an urgent priority

Genuine action to tackle climate change means cutting greenhouse gas emissions as far and fast as possible now. Our climate is warming rapidly because of human activities, particularly the burning of coal, oil and gas for energy. Significant further emissions, and the associated warming, put at risk the health of systems we rely on for our wellbeing, prosperity and way of life.

Communities in Australia and around the globe are already bearing the brunt of a hotter and more volatile climate – through dangerous and destructive extreme weather events like floods, fires, heatwaves and droughts. To protect communities from escalating climate impacts, we must collectively cut emissions as fast as possible to net zero by the middle of this century.

In the global effort to halt dangerous warming, reaching net zero by 2050 or earlier represents the first of two necessary phases of action. In the second half of this century we will likely need to withdraw more pollution from the atmosphere than we produce, to deal with the historic build-up of atmospheric emissions.

Decarbonising Australia's electricity supply as soon as possible will address our largest source of emissions and is vital to unlocking emissions reductions in other sectors through electrification – replacing vehicles, appliances and industrial equipment powered by fossil fuels with new, efficient electric versions. Australia's coal-fired generators are also reaching end-of-life and many are expected to close within the next decade – driven by economics and engineering, not just policy.

Only mature and proven technologies like wind and solar electricity, backed by firming and storage like peaking gas and batteries, can substantially reduce Australia's emissions this decade. They represent the lowest-cost way forward and accelerating their deployment is the 'low-hanging fruit' of the net zero transition.

The authority's focus is on providing evidence-based advice. The scientific and economic evidence at present is that nuclear power is a high-cost option for the Australian context, and would not be ready at scale in the timeframe that our current coal-fired power fleet will retire.

Australia has no existing nuclear power industry, and the development of nuclear generation facilities would need to overcome a range of significant legislative, capital, labour and community acceptance challenges. It is simply not feasible that nuclear energy could be brought online fast enough to replace Australia's retiring coal-fired power stations and contribute to cutting emissions in the next two decades – the critical window for limiting climate harm while also maintaining grid reliability and security.

The Climate Change Authority has recently published the *Sector Pathways Review,* bringing together detailed modelling done in partnership with the CSIRO and ground-up analysis by authority staff to identify possible pathways to net zero. In conducting the review, the authority consulted widely with Australian businesses, peak bodies, experts and community groups. These diverse consultation inputs, the insights of the Sector Pathways Review and the authority's broader analysis of scientific, economic and technological developments, have all informed this submission to the committee.

Cumulative emissions are fuelling dangerous climate change

Human activities – particularly the burning of coal, oil and gas – have created a significant build-up of greenhouse gas emissions in the earth's atmosphere over the past two centuries. These gases are primarily CO_2, methane and nitrous oxide, together with fluorinated gases. Some emissions of these gases can be gradually absorbed by our earth systems, through natural processes like photosynthesis when plants pull carbon from the air.

However, the rate at which emissions are produced by human activities far exceeds the capacity of natural processes to remove them (NOAA, 2024). This means a share of these gases remain in the atmosphere for periods of time that can range from decades to thousands of years, depending on the gas (USA EPA, 2024). This cumulative build-up of gases in the atmosphere absorbs radiative heat, slowing its release back into space – like a blanket insulating the earth.

There is an approximately linear relationship between the cumulative amount of CO_2 emitted because of human activity since the 1850s, and the progressive increase in the earth's surface temperature. Estimated warming is increasing at the rate of 0.2 degrees Celsius (°C) per decade because of past and ongoing emissions (IPCC, 2018). The extent of warming experienced in the future will be determined by the amount of cumulative emissions that build up in the atmosphere before countries collectively end new contributions (CSIRO and BoM, 2024).

Because *cumulative emissions* determine the extent of warming, cutting greenhouse gas emissions as far and fast as possible – in Australia and globally – is an urgent priority. Maximising emissions cuts now can reduce the amount of temperature rise we experience going forward.

Under the Paris Agreement, Australia has joined with the global community in setting the goal of limiting warming as close as possible to 1.5°C above pre-industrial levels, and well below 2°C (UNFCCC, 2015). These thresholds were chosen because they maximise the likelihood of avoiding the worst impacts of climate change, like rising sea levels, species and habitat loss, and increasingly volatile extreme weather. These and other dangerous impacts become more likely as global average temperatures rise.

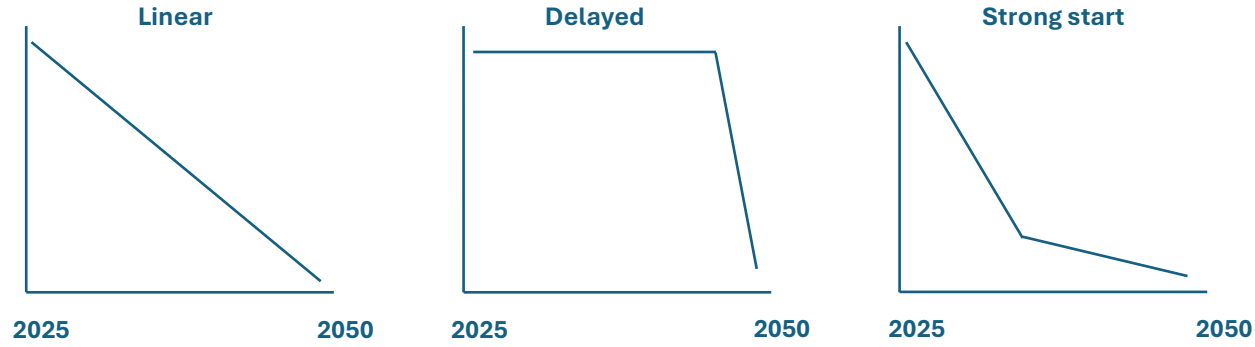
With this temperature goal in mind, it is possible to determine a carbon budget that is consistent with halting further additions to the cumulative build-up of greenhouse gas emissions. Parties to the Paris Agreement have determined that a 1.5°C aligned carbon budget requires reaching 'net zero' globally by 2050 – within the next 25 years.

Net zero is the point at which any new emissions are balanced by removals from the atmosphere, halting the addition of more cumulative emissions. If emissions do not decline steeply and rapidly on the way to net zero by 2050, the continuing build-up of cumulative emissions will make it impossible to prevent temperature rise above 1.5°C to 2°C.

This context highlights why Australia and global partners need to cut emissions as far as possible, as soon as possible. Achieving net zero by 2050 is an important global milestone, but the pathways we take to get there will determine how much more dangerous pollution is added to the atmosphere in the next 25 years.

This point is demonstrated by the three stylised emissions reduction pathways provided below.

Figure 1: Extent of cumulative emissions produced with different pathways to net zero



The area under the line represents the cumulative emissions added during the transition to net zero. Delayed action results in significantly more cumulative emissions being added to the atmosphere between now and 2050 than a linear pathway. A 'strong start' approach which prioritises cutting emissions as far as possible, as soon as possible, sees the least additions to cumulative emissions, and therefore provides the best chance of limiting warming as close as possible to 1.5°C.

Australia is on the frontline of climate change, with the nation's average land temperatures having increased by 1.5°C since national records began in 1910 (CSIRO and BoM, 2024). While this does not yet mean the Paris Agreement goal for *global* average temperatures has been breached, Australians are already bearing the brunt of impacts from a changing climate which harm our economy, communities and way of life.

For example, lower rainfall in southern Australia is increasing the risks and disruptions of drought, particularly for agricultural communities. At the same time, increased rainfall and more frequent extreme weather events across Northern Australia are leading to flooding, disruptions to food production and supply chains, and risks to important industries like tourism (CSIRO and BoM, 2024).

In early 2024, food supplies to Perth were limited for more than a month by flooding across the Nullarbor Plain which cut off road and rail transport links. The same essential rail link was also closed for several weeks just two years earlier because of extensive floods (Lucas, 2024).

Australia is already the most-fire prone continent on earth (Sharples et al, 2016), and the number and length of dangerous fire weather periods is increasing with a changing climate (Abram et al, 2021). The Black Summer bushfires of 2019-20 caused deep national trauma because of the scale of environmental and property destruction, and impact on communities far beyond the fire front in air quality and health risks.

But in 2023 bushfires destroyed an area estimated to be eight times as large as that burned during Black Summer, primarily across the Northern Territory and Western Australia (Fisher, 2024). The risks and costs of major fires will continue to mount if Australia and international partners do not work to reduce emissions rapidly this decade.

The duration and frequency of heatwaves has also increased, with a six-fold increase in very high maximum monthly temperatures in the period 2007 to 2021 compared with 1960 to 1989 (CSIRO & BoM, 2022). In January and February 2024, Western Australia experienced three heatwave events in two months, which set new records for the consecutive number of days with temperatures above 40°C (Poncet and Rowe, 2024).

In August this year a range of temperature records were also broken when communities experienced unseasonably hot spring weather across northern and south-eastern Australia,

with daily highs ranging from over 35°C in parts of New South Wales (BoM, 2024a) to almost 37°C in South Australia (BoM, 2024b).

These are among the impacts that Australia is already experiencing from a changing climate. Compared with a 1.5°C scenario, global temperature rise of 2°C is projected to see:

- twice as many communities regularly exposed to extreme heat
- twice as much loss of animal and plant species
- more than twice as large a reduction in crop yields for key harvests.
  (Climate Council, 2023; based on IPCC, 2023)

Acting together with global partners now to slow and eventually stop adding to cumulative emissions is essential for Australia to play our part in preventing more dangerous climate change. Stakeholders from across the business, community and environmental sectors have consistently emphasised this point through the authority's public consultation processes over the past two years.

Australia needs to bring new sources of clean energy online as quickly and cost-effectively as possible

Alongside the need to cut emissions now to protect lives and livelihoods, Australia faces an urgent task to renew our electricity system within the next 15 years. There are currently 18 coal-fired power generators operating around Australia; only 5 were built this century.

These coal-fired power facilities provide 22 gigawatts (GW) of nameplate generation capacity nationally.[1] Under a scenario consistent with current Australian and state government policy, 90% of this capacity is expected to exit the market by 2034-2035, and all of it by 2038 (AEMO, 2024a; WA Government, 2022).

Even under a slower transition approach which only considers the closure dates already announced by owners:

- half the coal fleet is planned to close by 2035 – withdrawing around 13.8 GW from the system
- two-thirds is planned to close by 2040 – withdrawing a total of 17.1 GW (AEMO, 2024b).

These assets are being scheduled for closure by their owners because they are reaching the end of their economic life. Attempting to keep them running after their nominated closure dates is likely to be both costly and create mounting risks to energy reliability.

Ensuring retiring coal-fired generators are replaced in an orderly and timely way is essential for Australia's energy security. It is also an important opportunity to make early gains on our pathway to net zero. The electricity and energy sector currently produces almost 35% of Australia's national emissions (DCCEEW, 2024). The authority's Sector Pathways Review found that electricity generation can do the heavy lifting on reducing emissions to 2030, while other sectors ramp up for deeper emissions reductions in the following decade. Access to zero emissions energy is also a critical enabler of these further emissions reductions in other sectors

[1] Includes coal generation in the National Energy Market serving Australia's eastern states and South Australia, and the South West Interconnected System serving Western Australia. Nameplate capacity refers to the maximum possible output from a facility when operating at full capacity. In practice, generators may provide significantly less output on any given day because of maintenance, system faults, and economic decisions by their operator.

– particularly transport, the built environment and parts of industry (Climate Change Authority, 2024).

To keep electricity reliable, available and affordable while cutting emissions, Australia must progressively replace coal capacity between now and 2040 with alternative sources of firmed and dispatchable generation. With our abundant wind, solar and land resources, Australia is very well placed to take advantage of renewable energy technologies to build a cleaner electricity system.

Analysis from expert bodies like the Australian Energy Market Operator (AEMO) and the CSIRO has consistently found renewables are the fastest to deploy and most cost-effective sources of new generation available now (AEMO, 2024a; CSIRO, 2024a). This was also a consistent theme of input provided to the authority through consultation on the Sector Pathways Review.

Renewables can roll out quickly to replace coal-fired generators as these progressively close

A recent study of development times for different types of generation capacity in Australia found that large-scale solar projects are currently being completed in an average of 3.4 years. Onshore wind projects have a slightly longer average delivery timeframes at 4.5 years (Clapin and Longden, 2024). These utility-scale onshore wind and solar projects typically deliver new electricity generation capacity ranging from several hundred megawatts to more than one gigawatt, and are increasingly being backed up by batteries or other firming technologies (Clean Energy Council, 2024).

Smaller scale generation capacity is even faster to deploy, as it can be installed on individual sites in just a matter of weeks. A total of 3.1 GW of rooftop solar was installed around Australia in 2023 alone, across households and commercial and industrial facilities (CERa, 2024).

Not all jurisdictions around Australia are currently deploying new capacity within these timeframes, and Australia's roll-out of renewable energy infrastructure is currently experiencing a range of practical and social acceptance challenges. Work is underway between the Australian and state governments to address bottlenecks and barriers to efficient deployment (ECMC, 2022). The authority will provide a range of recommendations to further accelerate the renewables roll-out in the 2024 Annual Progress Report due in late November.

Current progress on replacing Australia's coal-fired generators needs to accelerate, and this further underlines why nuclear is not a suitable solution for this country now. The authority has reviewed development timeframes for new nuclear power facilities that are expected to commence operations this decade. This indicates timeframes can extend up to 20 years (World Nuclear Association, 2024). These timeframes have been seen even in countries with existing nuclear energy industries, such as England and France.

The CSIRO has estimated that a 15-year timeframe would be necessary at a minimum to deliver *the first* new nuclear electricity generation facility in Australia, given the lack of an established industry (CSIRO, 2024a). This timeframe acknowledges that it would be necessary to:

- develop appropriate regulatory frameworks to ensure its safe operation
- identify secure arrangements for the handling and storage of toxic waste
- source, train and accredit a suitably-skilled workforce
- design, procure, deliver and commission facilities as major pieces of public infrastructure.

To replace all of Australia's confirmed retiring generation capacity with nuclear as a zero-emission alternative would require deploying at least 15 to 17 large-scale nuclear facilities, or more than 50 proposed Small Modular Reactors, by 2040.[2]

Alternatively, relying on other fossil fuel generation sources until nuclear facilities can be built would keep Australia's greenhouse gas emissions higher for longer. The authority has calculated that for every percentage point Australia falls short of achieving 82% renewables by 2030, roughly 2 million additional tonnes of harmful emissions would be added to the atmosphere (Climate Change Authority, 2023).

Even keeping *some* individual coal power stations open for longer would significantly add to Australia's emissions burden, as the reported annual emissions for these facilities in Table 1 below demonstrates.

Table 1: Coal-fired generators – reported annual emissions 2022-23

Facility name	State	Total annual emissions (t CO2-e)	Grid	Primary fuel
Bayswater Power Station	NSW	12,598,357	NEM	Black Coal
Eraring Power Station	NSW	11,873,649	NEM	Black Coal
Tarong Power Stations	QLD	10,298,248	NEM	Black Coal
Stanwell Power Station	QLD	8,039,069	NEM	Black Coal
Vales Point Power Station	NSW	6,974,635	NEM	Black Coal
Gladstone Power Station	QLD	6,481,445	NEM	Black Coal
Mt Piper Power Station	NSW	5,141,322	NEM	Black Coal
Millmerran Power Station	QLD	5,010,580	NEM	Black Coal
Callide B Power Station	QLD	4,031,816	NEM	Black Coal
Kogan Creek Power Station	QLD	3,791,943	NEM	Black Coal
Muja Power Station	WA	2,869,748	SWIS	Black Coal
Bluewaters Power 2	WA	965,569	SWIS	Black Coal
Callide C Power Station	QLD	933,761	NEM	Black Coal
Collie Power Station	WA	778,044	SWIS	Black Coal
Bluewaters Power 1	WA	713,670	SWIS	Black Coal
Loy Yang Power Station and Mine	VIC	16,360,431	NEM	Brown Coal
Yallourn Power Station	VIC	11,609,708	NEM	Brown Coal
Loy Yang B Power Station	VIC	9,812,258	NEM	Brown Coal

Source: CER, 2024b

Relying primarily on electricity from fossil fuels for longer would also delay necessary and achievable cuts to emissions in other sectors like transport and industry, which depend on the availability of zero emission energy for their own decarbonisation pathways (Climate Change Authority, 2024).

Renewables are the most cost-effective form of new electricity generation infrastructure

Renewable energy backed by storage and peaking gas is already dominating the proposed project pipeline for new generation capacity because it is the most cost-effective form of new

[2] Based on the standard capacity range for conventional nuclear reactors of 900 MW to 1.4 GW, and 300 MW for Small Modular Reactors (World Nuclear Association, 2024; International Atomic Energy Agency, 2023).

electricity infrastructure to deliver now. The CSIRO's GenCost (2024a) analysis provides the following estimates for different generation technology capital costs in 2025 and 2040:

Table 2: CSIRO GenCost current and projected generation technology capital costs – Current policies

Technology	2024 $/kW	2040 $/kW
Large scale solar PV	$1,386	$994
Rooftop solar panels	$1,318	$896
Onshore wind	$2,842	$1,962
Offshore wind fixed	$5,456	$4,936
Gas with CCS	$4,544	$3,831
Nuclear large-scale	$8,253	$7,683
Nuclear SMR	$22,689[3]	$15,337

Source: CSIRO, 2024a

Capital costs are just one factor when considering the relative cost efficiency of different energy sources. The CSIRO's analysis indicates that on a 'levelised cost of energy' basis,[4] the cost gap between nuclear and other generation types is reduced somewhat, but it remains the most expensive source apart from generators running on hydrogen (CSIRO, 2024a).

This is why estimates of the cost impact of nuclear on energy bills have consistently indicated its deployment in Australia would drive up power prices for families and businesses. Recent expert assessments of these potential bill increases have estimated the cost impact could be as high as $665 a year, and significantly more for larger energy consumers (IEEFA, 2024). This would represent a significant increase on current energy bills, and on expected prices in the counterfactual with a renewables-led grid.

The benchmarks for choosing technologies must be competitiveness and capacity to support decarbonisation

Based on our in-depth modelling and ground-up analysis to date, the authority's view is that current and emerging low and zero emission technologies are the best way to meet Australia's energy system needs and support the nation's decarbonisation objectives.

Current nuclear generation technologies are more expensive, inflexible and will take at least 15 years to develop. This timeframe will not only lead to system reliability and affordability issues, but risk delaying the urgent and necessary cuts to emissions that are needed now.

Strong and focused action to cut emissions and renew Australia's electricity grid with available and proven renewable energy infrastructure must be a shared national priority. Delay is not a viable energy strategy, and excuses for delay will not protect Australians from the climate harms that will be locked in if Australia and the world waits to act.

[3] The CSIRO GenCost report notes that near-term cost estimates for Small Modular Reactors are subject to considerable uncertainty because this technology is not currently being commercially deployed.
[4] The Levelised Cost of Energy metric takes into account capital, operation and financing costs over an asset's lifetime, to compare the cost of electricity generation for assets which may have different operating lifespans and different ratios of upfront and ongoing costs.

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