NSW Productivity and Equality Commission

Ensuring a cost-effective transition

Achieving net zero

Paper 1

November 2024

Acknowledgment of Country

We acknowledge that Aboriginal and Torres Strait Islander peoples are the First Peoples and Traditional Custodians of Australia, and the oldest continuing culture in human history.

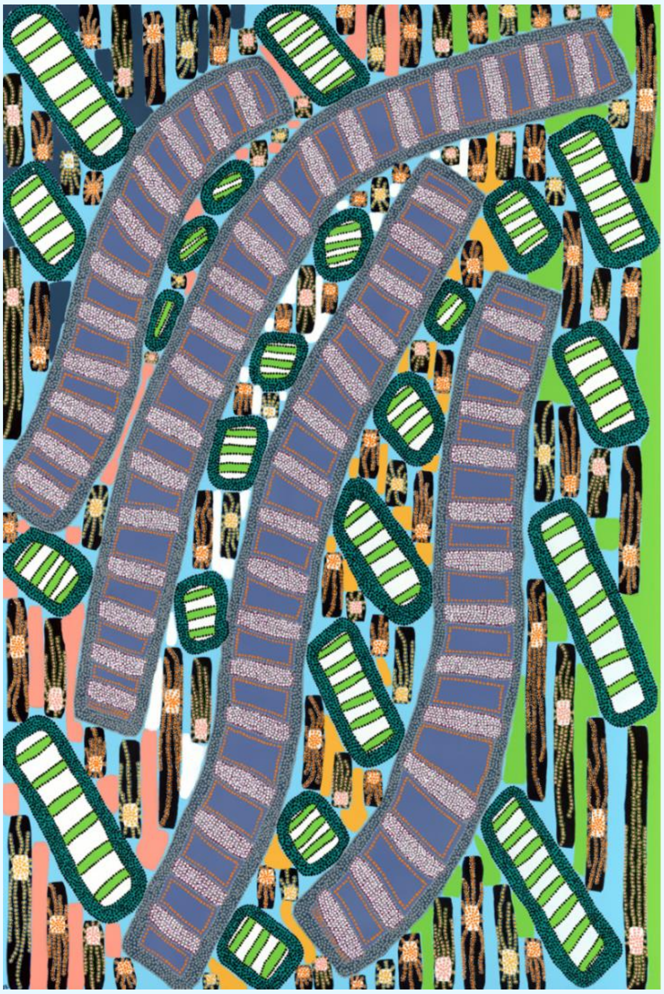
We pay respect to Elders past and present and commit to respecting the lands we walk on, and the communities we walk with.

We celebrate the deep and enduring connection of Aboriginal and Torres Strait Islander peoples to Country and acknowledge their continuing custodianship of the land, seas and sky.

We acknowledge the ongoing stewardship of Aboriginal and Torres Strait Islander peoples, and the important contribution they make to our communities and economies.

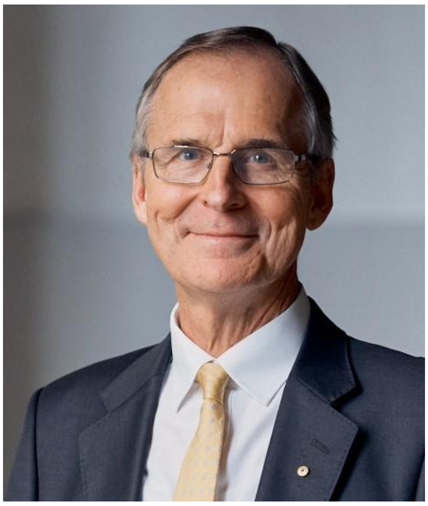
We reflect on the continuing impact of government policies and practices and recognise our responsibility to work together with and for Aboriginal and Torres Strait Islander peoples, families and communities, towards improved economic, social, and cultural outcomes.

Artwork:
Regeneration by Josie Rose



Commissioner's foreword

New South Wales has legislated ambitious greenhouse gas reduction targets, aiming to reach net zero emissions by 2050, with interim targets for 2030 and 2035.



But we have a problem. Based on current policy settings, the state is projected to fall short of all its targets – 2030, 2035, *and* 2050. Missing our early targets will leave us squeezing bigger, more costly change into a shorter time if we are to reach net zero by mid-century.

The clock is ticking. We need to focus on the policies and solutions that will drive this change. This will ensure that we can reach our targets while keeping productivity and living standards high.

This is the first paper in the NSW Productivity and Equality Commission's *Achieving net zero* series. It clearly sets out the course corrections we need to progressively decarbonise our economy. This paper examines the current state of the transition in New South Wales. The series will also explore how we can achieve net zero in a cost-effective way, in electricity generation, in freight and passenger vehicles, in industrial plants, and in buildings. Above all, it emphasises the need for governments, businesses, and households to make the right consumption and investment decisions.

While a comprehensive emissions price is the gold standard for coordinating economic activity to reduce emissions, no such comprehensive price system currently operates in Australia. This places us squarely in the world of second-best. It will require governments to take a more active role in guiding the transition. This paper explores how existing emissions pricing can be expanded and, alternatively, how best-practice policy evaluation can drive emissions reduction.

I believe that New South Wales can seize the opportunities presented by the net zero transition and emerge by 2050 as an even better place to live, work, and invest.

Peter Achterstraat AM

NSW Productivity and Equality Commissioner

About the NSW Productivity and Equality Commission

The NSW Productivity and Equality Commission (formerly the NSW Productivity Commission) was established by the NSW Government in 2018 under the leadership of its inaugural Commissioner, Mr Peter Achterstraat AM.

Productivity growth is essential to ensure sustained improvement in living standards for the people of New South Wales. It requires the best possible utilisation of our knowledge, skills, and experience, technological innovations, and capital and environmental assets. The Commission is tasked with identifying opportunities to boost productivity in both the private and public sectors.

The Commission's priorities include:

- efficient and competitive markets
- fit-for-purpose regulation
- innovation
- climate resilience
- sustainable economic development.

In 2024, Mr Achterstraat was reappointed for a further two years in the expanded role of Productivity and Equality Commissioner.

The Commission provides objective, evidence-based advice to the NSW Government. In performing its functions, the Commission considers equity – how the costs and benefits of economic reform are distributed across the community and over time. For instance, the Commission's research on housing examines the socioeconomic impacts of policies to improve housing affordability. It is also concerned with the environmental impacts of economic activity. This ensures its focus is broader than merely economic productivity, as measured in market activity.

The Commission regularly engages with stakeholders to ensure its research and recommendations are well-informed. Its goal is to encourage a public conversation on productivity reform.

Disclaimer

The views expressed in this paper are those of the NSW Productivity and Equality Commission alone, and do not necessarily represent the views of NSW Treasury or the NSW Government.

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Abbreviations and glossary

ACCU	Australian Carbon Credit Unit
AEMC	Australian Energy Market Commission The AEMC is the main rule-maker for Australian electricity markets.
AEMO	Australian Energy Market Operator AEMO manages electricity and gas systems and markets across Australia, including the National Electricity Market.
CER	(Australian) Clean Energy Regulator
CO_2-e	Carbon dioxide equivalent The CO_2-e measure is used to compare various greenhouse gases based on their global warming effect. For instance, a tonne of methane has an effect on global warming equivalent to approximately 28 tonnes of CO_2.
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEEW	(NSW) Department of Climate Change, Energy, the Environment, and Water Note: The federal Department of Climate Change, Energy, the Environment, and Water is referred to in this paper as DCCEEW (Commonwealth).
DNSP	Distributed network service provider A DNSP is an electricity distributor that owns and maintains an electricity network and its infrastructure, including power poles, wires, and transformers.
DPHI	(NSW) Department of Planning, Housing, and Infrastructure
DRI	Direct reduced iron This iron is created in a process which does not result in substantial greenhouse gases.
Electricity Infrastructure Roadmap	This is the NSW Government's 20-year plan for the electricity sector.
ESOO	*Electricity Statement of Opportunities* In this regularly updated AEMO publication, the market operator sets out the state of the electricity grid and electricity supply in the National Electricity Market.

EST	Energy Security Target This sets out the amount of reliable electricity that AEMO calculates is needed in New South Wales to meet maximum consumer demand.
Firmed renewables	These are variable renewable energy sources that are backed up by storage and peaking generation that can power the system when renewables generation is low.
IRM	Interim reliability measure
LCOE	Levelised cost of electricity
LTESA	Long-Term Energy Services Agreements These options contracts give generation investors the option to sell their output at an agreed minimum price, increasing investor certainty.
LULUCF	Land use, land-use change, and forestry
MAC	Marginal abatement cost In this paper, the MAC refers to the cost of removing the final unit of greenhouse emissions for a given technology.
Mt	Megatonne (one million tonnes)
NEM	National Electricity Market
NGERS	National Greenhouse and Energy Reporting Scheme
PDRS	Peak Demand Reduction Scheme This NSW scheme aims to reduce electricity demand at peak periods through incentives to businesses and households.
PV	Photovoltaic
REZ	Renewable Energy Zone
SMC	Safeguard Mechanism Credit
VPP	Virtual power plant VPPs are networks of behind-the-meter solar assets, such as batteries, that can be coordinated to work together like a power plant.

Executive summary

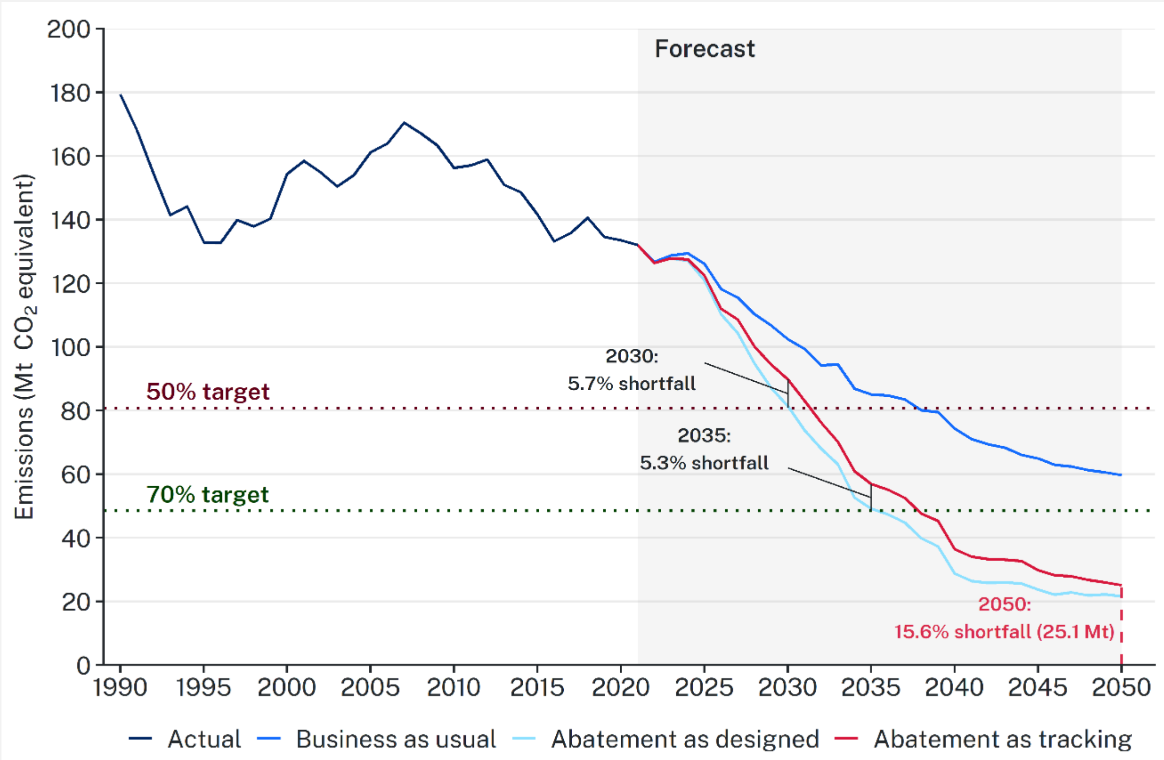
New South Wales needs policy change if we are to achieve our 2050 net zero target.

Main finding: we need more emissions reduction than we currently have planned.

New South Wales is gradually reducing greenhouse gas emissions.[1] Replacing coal with firmed renewables in the electricity system is among the easiest ways to cut emissions, and we are making progress.[2]

NSW's 2050 net zero target: the 25 megatonne shortfall

Annual NSW greenhouse gas emissions, in millions of tonnes of CO_2 equivalent (Mt CO_2-e)



Source: (DCCEEW, 2024a).

Current progress isn't enough. Our legislated, bipartisan targets say that by 2030 we should cut emission by 50 per cent from 2005 levels, with cuts reaching 70 per cent by 2035. But the latest NSW Government projections find us falling short of both. Moreover, we are well off track for net zero by 2050.

[1] All figures for emissions beyond 2021-22 are projections – that is, they are simply our best guesses about how emissions will change under current Australian and NSW Government policies. The paper acknowledges these projections are accompanied by significant uncertainty.

[2] 'Firmed renewables' denotes variable renewable energy sources that are backed up by storage and peaking generation that can power the system when renewables generation is low.

Many activities need policy change to reduce emissions. They range from trucking, rail, aviation, and coastal shipping to domestic gas use, to fugitive emissions from coal mining, and methane emissions from agriculture. Carbon offsetting — such as ‘rewilding’ and direct-air capture — cannot absorb emissions at a level that would allow these activities to carry on.

The economic transformation required to achieve net zero by 2050 will, on current settings, **stretch the construction sector** beyond its capacity. With the high level of public infrastructure spending and the need for more housing supply, we lack the capital and skilled construction workers for all these tasks.

Many decisions that will determine the level of 2050 emissions involve long-lived capital items. Current policy settings are blocking that investment. So, to shape 2050 outcomes, **Australian governments must make decisions as soon as possible**. Decisions needed include:

- new incentives for private investment in near-zero-emissions manufacturing processes, heavy freight, and passenger transport
- clear signals about how we use natural gas
- decisions about the future of coal mining.

The longer we wait, the more it will cost us to fix the emissions shortfall. The easy decisions have already been made.

An inefficient net zero transition will have broad, negative equity impacts on the people of New South Wales. The most financially disadvantaged and socially marginalised groups would be hit the most.

Better market signals will help

New South Wales has no economy-wide price on emissions. Wherever possible, we should adopt price-based mechanisms to encourage efficient investment. The closest equivalent is the Commonwealth Safeguard Mechanism, but this has limited application to the state’s emissions. The Electricity Infrastructure Roadmap and Capacity Investment Scheme are also reducing emissions in a relatively cost-effective way. They do not, however, explicitly price emissions.

A **comprehensive carbon dioxide-equivalent price** would provide households and businesses with a positive incentive to reduce their emissions wherever it is cheaper for them to do so. This would ensure abatement occurs at the lowest possible cost to the economy.

Prioritise electricity generation

All four remaining NSW coal generators are scheduled to close by 2040. The speed of our rollout of utility-scale renewables, firming capacity, and new transmission network infrastructure will largely determine whether we hit our targets for 2030. With a near-zero-emissions electricity system, we can lower emissions in other sectors by switching them to electricity in place of fossil fuels.

Maintain living standards through cost-effective policies

The scale of the changes needed underlines the need for policies to produce **the biggest possible emissions reductions for every dollar spent**.

If these changes are to happen, the prices we pay must reflect the costs we create. In electricity generation, this means supporting the emergence of a more digitalised electricity market where:

- more customers actively manage their electricity use
- prices reflect the full social and environmental cost of emissions and the need for reliability
- more customers have incentives to export energy to support efficient operation of the grid.

Further demand-side reforms in the electricity market will contain system costs, customer bills, and overall cost-of-living through the transition. This will be of particular benefit to lower-income earners.

The national challenge

Most of the principles and practical challenges discussed in our *Achieving net zero* series also apply to other Australian jurisdictions, including the Commonwealth. Australia signed the 2015 Paris Agreement, committing to the global goal of limiting the increase in the average global temperature to well below 2°C and pursuing ways to keep warming to less than 1.5°C. The Australian Government has legislated a target of net zero emissions by 2050, along with a 2030 target of a 43 per cent reduction on 2005 levels. Other states and territories have also legislated net zero for no later than 2050.

Summary of emissions sources

Electricity generation

46.6 Mt of CO_2-e in 2021, down from 58.1 Mt in 2005. Projected emissions in 2050: 2.8 Mt, or 11 per cent of total NSW emissions.

As coal-fired generators close, renewables will take over the vast majority of NSW electricity generation. Energy storage will ensure power can be dispatched to meet demand. This matters not just because it lowers emissions, but because the move to renewables will help other sectors to lower their own reliance on fossil fuels.

But the next steps will be challenging. We must:

- manage reliability and security risks as we experience large, 'lumpy' losses in capacity
- balance variable renewable energy with sufficient firming capacity such as storage and gas peaking generation
- ensure transmission network infrastructure comes online in time to link utility-scale renewables and storage into the system
- increase demand-side participation — through digitalisation, consumer energy resources, and cost-reflective pricing — to minimise system costs and risks to reliability.

Transport

25.2 Mt of emissions in 2021, up from 23.9 Mt in 2005. Projected emissions in 2050: 4.7 Mt, or 19 per cent of total NSW emissions.

Light vehicles like cars and utility vehicles will increasingly be electric. But emissions from rail, aviation, and shipping are all projected to rise, making the transport sector the third largest source of emissions by mid-century. Emissions reduction consistent with net zero by 2050 is unlikely without comprehensive carbon pricing.

Agriculture

19.4 Mt of emissions in 2021, down from 21.9 Mt in 2005. Projected emissions in 2050: 11.0 Mt, or 44 per cent of total NSW emissions.

While agricultural emissions have fallen in recent years, there are currently no commercially available technologies to drive significant further emissions cuts. By 2050, agriculture is projected to be the state's biggest source of greenhouse gas emissions, mostly methane emitted by cattle and sheep.

Fugitive emissions

11.0 Mt of emissions in 2021, down from 19.8 Mt in 2005. Projected emissions in 2050: 1.6 Mt, or 6 per cent of total NSW emissions.

These emissions depend heavily on coal mining activities and, therefore, on state licensing decisions.

Industrial processes and product use

13.0 Mt of emissions in 2021, down from 13.9 Mt in 2005. Projected emissions in 2050: 3.8 Mt, or 15 per cent of total NSW emissions.

Reducing emissions from the manufacture of materials such as steel, aluminium, and concrete depends on development of new, low-emissions processes. Electrification, energy efficiency, and green hydrogen will play important roles. But uptake will require broader and more ambitious emissions pricing.

Stationary energy

17.0 Mt of emissions in 2021, down from 17.4 Mt in 2005. Projected emissions in 2050: 5.0 Mt, or 20 per cent of total NSW emissions.

Stationary energy is projected to be the second largest emissions source by mid-century. Cutting emissions depends on getting homes and businesses off natural gas and reducing fossil fuel combustion in primary industries and manufacturing. Electrification, energy efficiency, and green hydrogen can help, but the size of cuts will depend on incentives, regulation, and the availability of skilled workers to retrofit existing buildings and alter processes.

Waste

4.0 Mt of emissions in 2021, down from 5.5 Mt in 2005. Projected emissions in 2050: 2.5 Mt, or 10 per cent of total NSW emissions.

Three-quarters of current waste emissions are due to solid waste disposal. Future waste emissions can be lowered by, among other methods, cuts in organic waste sent to landfill. Population growth, however, will put upward pressure on emissions. Achieving net zero will almost certainly require emissions pricing for the many small waste facilities in New South Wales.

Land use, land-use change, and forestry (LULUCF)

In 2050, LULUCF will contribute 6.2 Mt of CO_2-e abatement, or -25 per cent of total NSW emissions.

This sector has become a net reducer of emissions, contributing a 4.0 Mt cut in CO_2-e in 2021. The turnaround comes from a halving of emissions from land converted to grassland and cropland. Greater CO_2-e sequestration by plantations, natural regeneration, and regrowth on deforested land also contribute to emissions reduction.

1 Introduction

New South Wales has legislated a commitment to reduce net greenhouse gas emissions to zero by 2050. This paper sets out the policy challenges in meeting that target.

1.1 New South Wales has legislated greenhouse gas emissions targets

With the *Climate Change (Net Zero Future) Act 2023*, New South Wales legislated a target of net zero greenhouse gas emissions by 2050. All other Australian states and territories and the Commonwealth have adopted similar targets.

New South Wales has also legislated interim targets. They are a 50 per cent reduction from 2005 levels by 2030 and a 70 per cent reduction by 2035. Policies to support the interim target are set out in the NSW Government's *Net Zero Plan Stage 1 (2020-2030)* (DPIE, 2020).

The Commonwealth has legislated a target of net zero by 2050 and an interim target to reduce emissions by 43 per cent below the 2005 baseline by 2030. It submitted this target to the 2022 Conference of Parties as Australia's 'nationally determined contribution' under the 2015 Paris Agreement of the United Nations Framework Convention on Climate Change.

Box 1: What is 'net zero emissions'?

The term '**net zero emissions**' refers to achieving a balance between greenhouse gas emitted into the atmosphere and greenhouse gas removed from it. 'Net zero' means **we add no more greenhouse gas to the atmosphere than we take out.**

Eliminating gross greenhouse gas emissions seems unlikely in the foreseeable future. But net zero is much more achievable. It can be reached by offsetting residual emissions by absorption through carbon sinks, such as increases in forest cover and other vegetation.

What this paper does

This paper:

- profiles NSW greenhouse gas emissions in 2020-21, the most recent year of comprehensive data, in aggregate and by sector
- analyses the most recent NSW Government emissions projections to 2050 by source
- provides a policy framework to close gaps between emissions projections and targets in a way that is cost-effective for New South Wales
- applies that framework to the electricity sector.

Other sources of emissions — agriculture, buildings, manufacturing, mining, transport, and waste — will be examined in subsequent papers in the *Achieving net zero* series.

1.2 About NSW emissions data

This paper uses emissions projections

It is important to note that ‘projections’ are *not* forecasts.

An emission ‘projection’ is contingent on *assumptions about future trends*.[3] It does *not* imply that these assumptions are certain to be correct. A projection can provide a no-change baseline to judge the value of possible interventions. However, we know that circumstances, policies, and outcomes will change. But we do not know exactly *how* they will change.

In contrast, a ‘forecast’ is an outcome that is estimated will happen in the near term with a high level of probability, subject to a specific margin for error. This methodological definition means forecasts beyond the near term are not possible.

How New South Wales makes emissions projections

In April 2024, the NSW Government’s Net Zero Emissions Modelling Program published updated projections for the state’s greenhouse gas emissions to 2050.[4] The projections allow policymakers to identify gaps between targets and the outcomes that current policies are expected to achieve. They also guide further policy design that will allow those targets to be hit.

In this paper, as with national greenhouse gas accounting, we focus on scope 1 emissions produced in New South Wales. Scope 1 emissions are produced by economic units from sources that they own or control.

The NSW Government scope 1 projections include three scenarios that are used to illustrate potential future outcomes:

- the ‘business as usual’ scenario
- a ‘current policy – abatement as designed’ scenario
- a ‘current policy – abatement as tracking’ scenario.

Section 2.2 below defines these scenarios in detail, including the assumptions used.

1.3 Australian and NSW targets and the Paris Agreement

Reaching net zero emissions by 2050 in advanced economies may not be consistent with global temperature targets adopted under the Paris Agreement. The United Nations Secretary General, echoing calls from the scientific community, has called for advanced economies to achieve net zero emissions by as close to 2040 as possible (United Nations, 2023). This would support an even chance of holding the global average temperature increase to 1.5 degrees Celsius.

[3] See, for instance, ‘Estimate and projection’ from the Australian Bureau of Statistics (2024).

[4] The data is available at the NSW Net Zero Emissions Dashboard: https://www.seed.nsw.gov.au/net-zero-emissions-dashboard.

The Commonwealth Safeguard Mechanism, Capacity Investment Scheme, and New Vehicle Efficiency Standard will contribute to national emissions falling by a projected 42 per cent below 2005 levels by 2030. The Commonwealth expects to announce its 2035 target in 2025, in line with Australia's Paris commitments.

2 Emissions to mid-century: projections versus targets

Even large projected reductions in electricity and light vehicle emissions will leave us well short of the state's 2050 net zero target.

2.1 NSW greenhouse gas emissions have been steadily declining

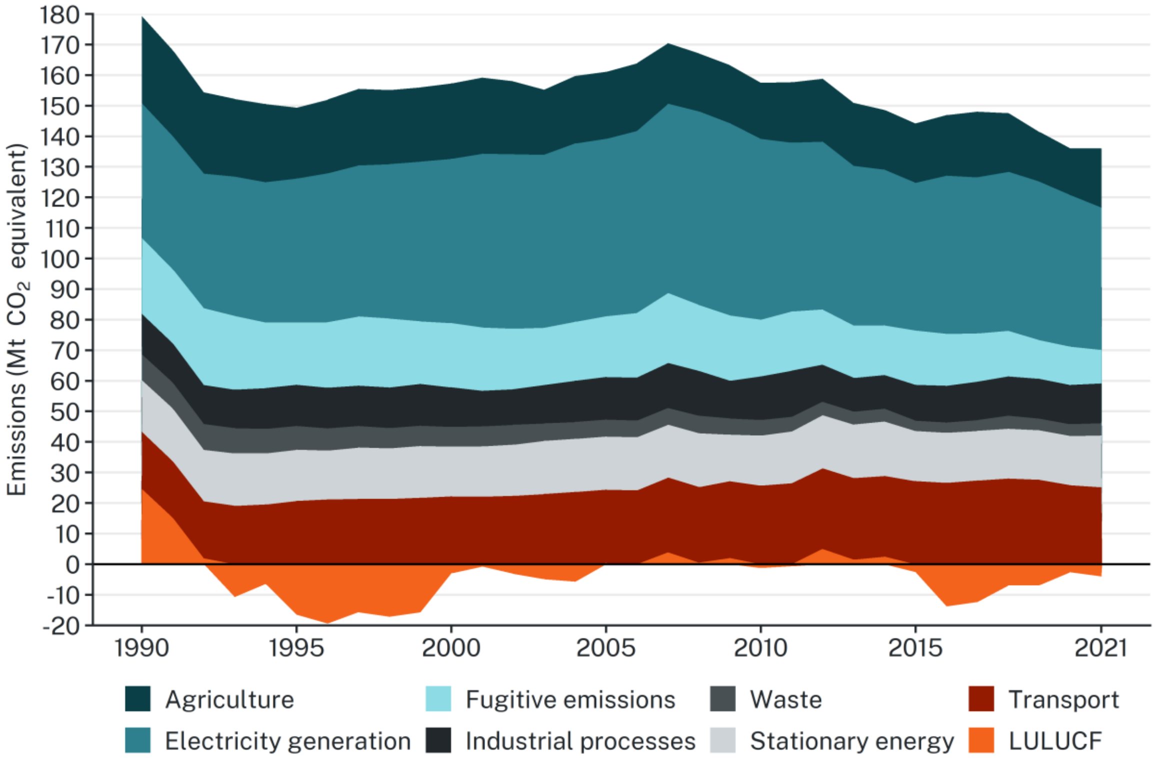
Total NSW emissions

Greenhouse gas emissions in New South Wales initially peaked at 179.4 megatonnes (Mt)[5] of carbon dioxide equivalent (CO_2-e) in 1990. Emissions gradually reduced somewhat in the years that followed, then peaked a second time at 170.5 Mt CO_2-e in 2007.

Emissions in 2005 — the baseline adopted by Australian governments — were 161 Mt CO_2-e. Since 2007, emissions have been steady or declining across all sources except transport, which has experienced consistent emissions growth.

Figure 1: Emissions have been slowly decreasing, mostly due to land use policy

NSW greenhouse gas emissions, total and by source, Mt CO_2-e, 1990-2021



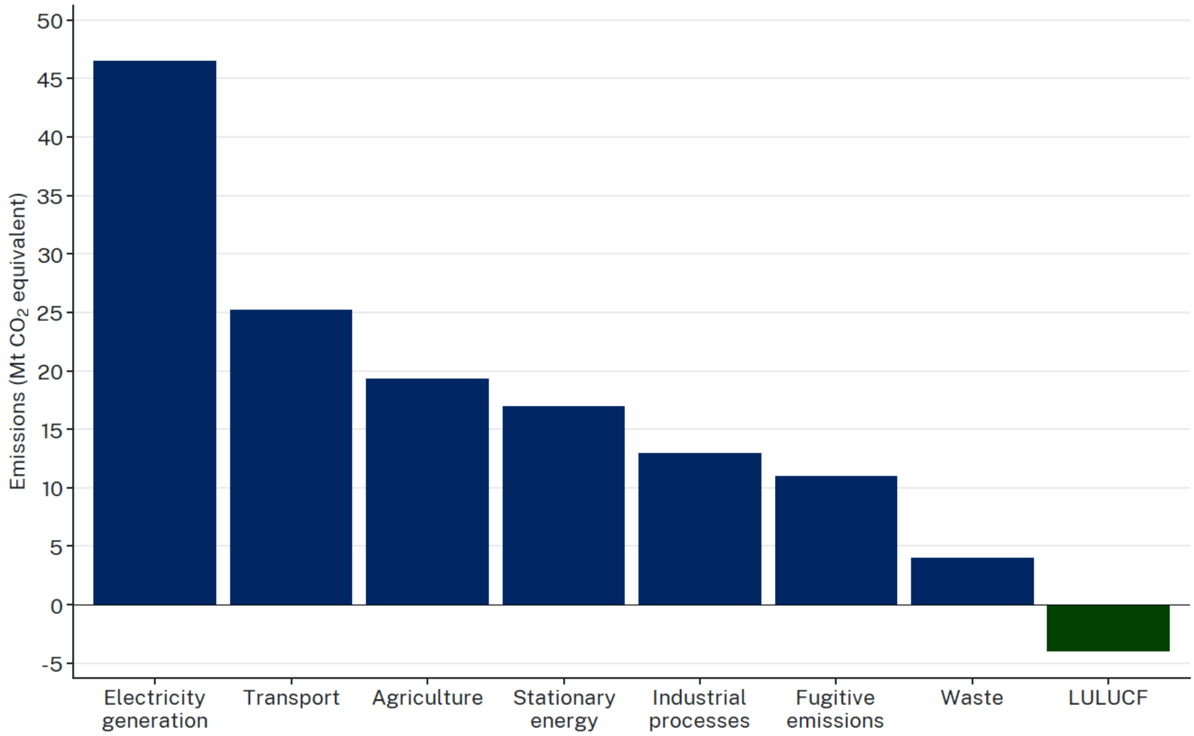
Source: (DCCEEW, 2024a).

[5] A megatonne is 1,000,000 tonnes.

In 2020-21 the state recorded net greenhouse gas emissions of 132 Mt CO_2-e – an 18 per cent reduction from 2005 levels.[6]

Figure 2: Electricity dominates current emissions, with transport a distant second

Components of NSW greenhouse gas emissions, by source, Mt CO_2-e, 2020-21



Note: While 2020-21 is the most recent year for which comprehensive NSW data is available, it took place during the COVID-19 pandemic, which changed consumption behaviours and slowed production processes.
Source: (DCCEEW, 2024a).

Emissions by greenhouse gas

Greenhouse gases vary by their ability to absorb infrared radiation – that is, their ability to trap heat from the sun. They also vary by the time they remain in the earth's atmosphere.

- Carbon dioxide (CO_2), the most common greenhouse gas in our atmosphere, can remain in the atmosphere for several hundred years.
- Methane (CH_4) is 25 times more potent at trapping heat than carbon dioxide but stays within the atmosphere for a much shorter time – seven to 12 years.
- Nitrous oxide (N_2O) is 298 times more potent than carbon dioxide and stays in the atmosphere for an average of around 120 years.
- Other, highly potent greenhouse gases that are released in very small amounts include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6). These greenhouse gases are between 124 and 23,000 times more potent than CO_2 and last for hundreds to thousands of years in the atmosphere.

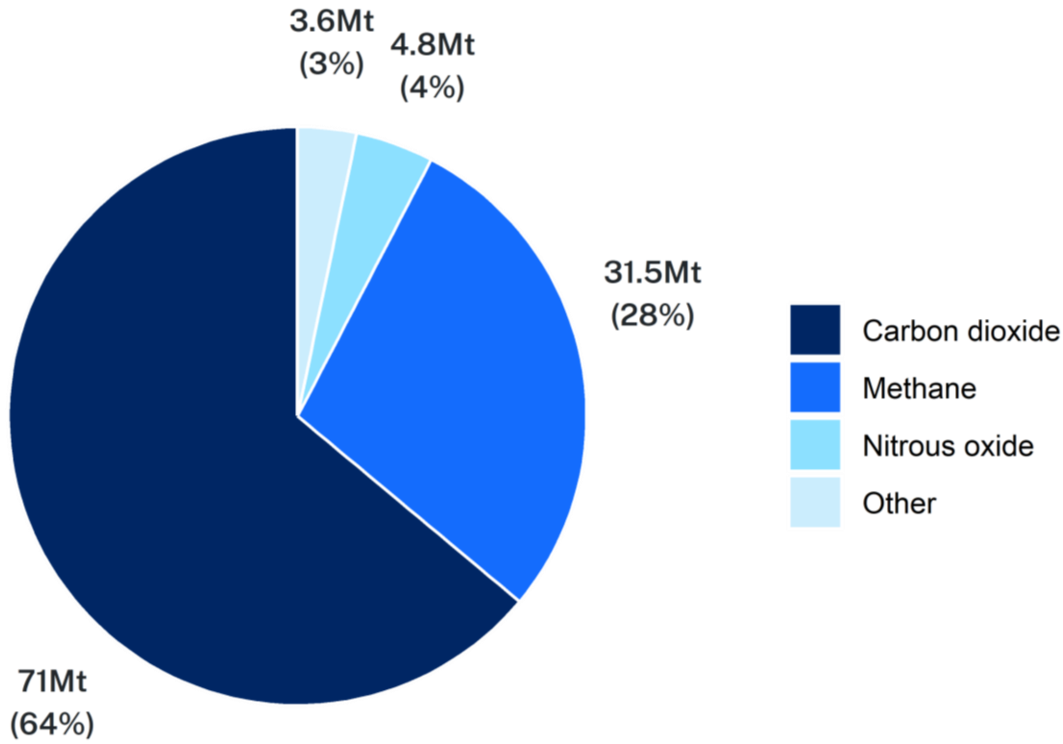
[6] 2020-21 is the most recent financial year for which detailed data is available.

We account for these differences by converting other greenhouse gases into their 'carbon dioxide equivalent' (CO_2-e).

Carbon dioxide accounted for 64 per cent of NSW emissions in 2021-22. These emissions came overwhelmingly from electricity generation, transport, stationary energy, and industrial processes. Methane accounted for 28 per cent of NSW CO_2-e emissions, primarily from agriculture, fugitive emissions, and waste. Nitrous oxide comprised roughly four per cent, with the remainder a combination of gases emitted in small quantities.

Figure 3: Carbon dioxide the largest category of greenhouse gas emissions, with methane second

Net CO_2-equivalent greenhouse gas emissions NSW 2021-22, share by gas



Note: Other includes PFCs, HFCs, and SF6.
Source: (DCCEEW (Commonwealth), 2024).

2.2 We are not on track to hit our legislated targets

The April 2024 update to the NSW Net Zero Emissions Dashboard presented three scenarios for how emissions might evolve over time under different conditions:

- The '**business as usual**' scenario accounts for past State policies but *excludes* any impacts from the *NSW Net Zero Plan Stage 1: 2020-30*.
- The '**current policy**' scenario took the 'business as usual' scenario and adjusted the emissions trajectory based on the designed abatement and timelines in existing NSW and Commonwealth policies, including:
    - policies under *NSW Net Zero Plan Stage 1: 2020-30*
    - future emissions reduction policies supported by the NSW Climate Change Fund under Stages 2 and 3 of the *NSW Net Zero Plan*

- the Australian Government's 2023 Safeguard Mechanism reforms.

'Current policy' is then split into two scenarios:

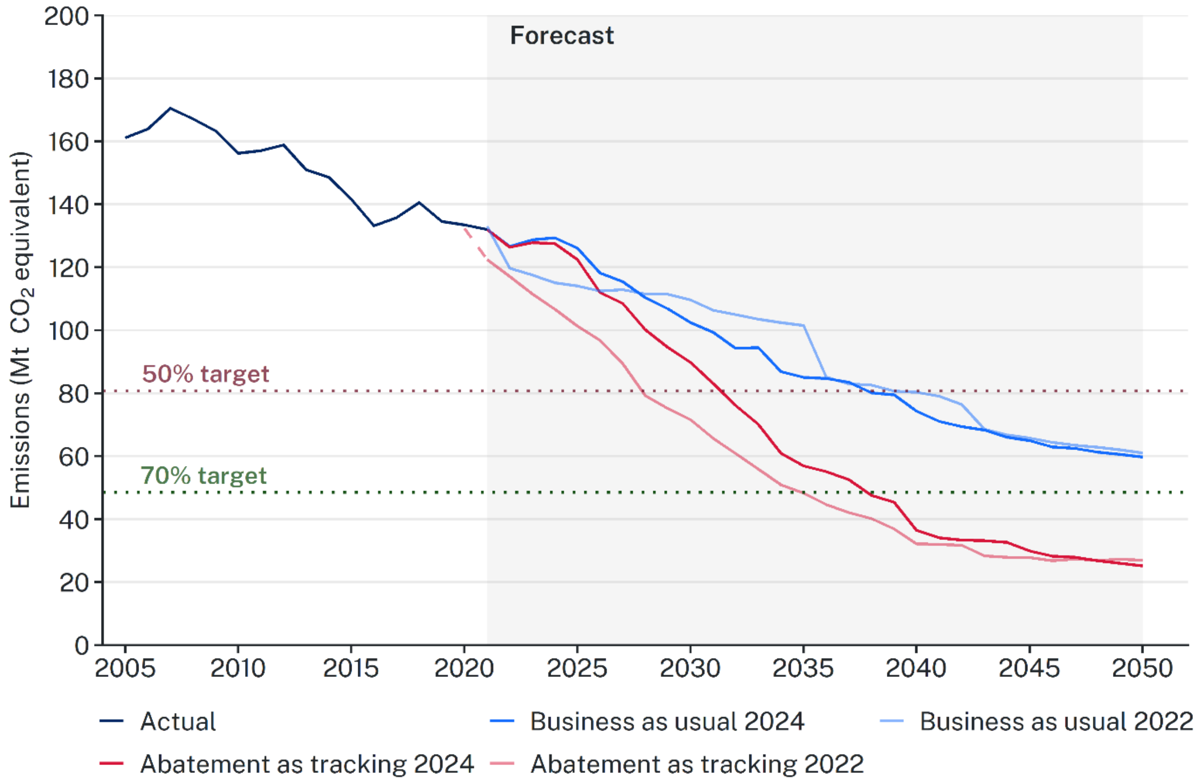
- the '**abatement as designed**' scenario adjusts the business-as-usual scenario based on the designed abatement and timelines in existing NSW and Australian Government policies and programs
- the '**abatement as tracking**' scenario adjusts the 'as designed' scenario to reflect increased uncertainties in expected emissions reductions under certain programs and policies.

This paper concentrates on the 'current policy – abatement as tracking' scenario (hereafter shortened to 'abatement as tracking'). NSW Productivity and Equality Commission analysis finds this the scenario most relevant to discussion of additional policy measures.

Figure 4 shows the projected emissions projections for each of these scenarios, together with historical emissions from 2000 to 2020. It also indicates emissions projections from the previous round of estimates, published in 2022.

Figure 4: The 2024 updated projections are less optimistic for emissions reduction

Actual and projected NSW greenhouse gas emissions under 'abatement as tracking' scenario



Source: (DCCEEW, 2024a).

The 2024 projections update shows a deterioration in our path to net zero in both the 'business as usual' and 'abatement as tracking' scenarios (Figure 4). That is, abatement is expected to proceed more slowly than expected. Smaller projected falls in emissions over the next 25 years can be measured by sector and are largely attributed to changes in projected energy consumption. This means **reaching net zero will now require more change in the time still available to 2050**.

Emissions from electricity generation are now projected to be, on average, 3 Mt higher every year until 2050. This is a result of higher projected electricity demand and lower renewable penetration. (This increase in emissions does not include the extension of Origin's Eraring coal-fired power plant for up to four years to 2029.)

Stationary energy emissions are also projected to be 3 Mt higher, on average, every year until 2050 because of slower assumed rates of fuel switching and electrification.

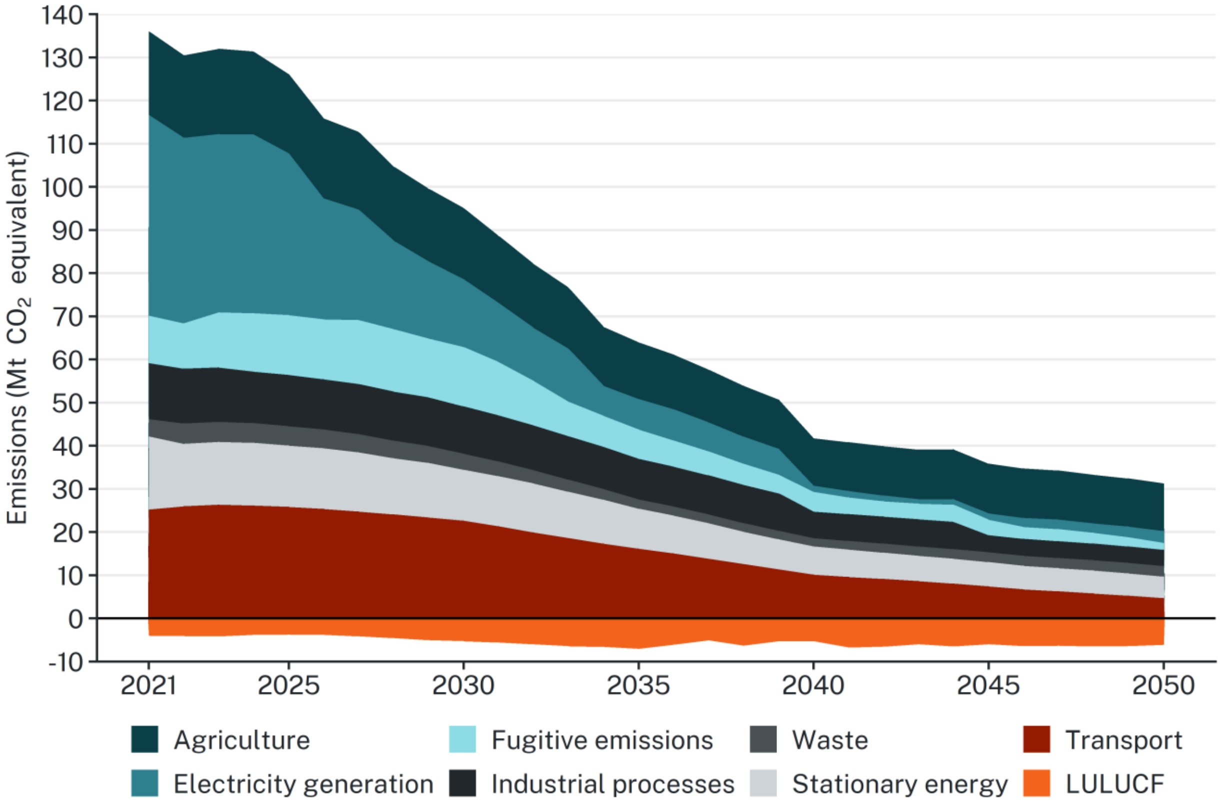
The rate at which land use, land-use change, and forestry (LULUCF) sequesters emissions is also projected to be lower until 2040. Emissions from grassland and cropland are as previously projected, but projected emissions from forested-land sinks have dropped.

Industrial process and product use emissions are projected to be between 1 and 4 Mt higher every year until 2045. This is because of higher projected output and higher emissions from chemical processes.

Fugitive emissions, and emissions in the agriculture, transport, and waste sectors are largely unchanged between the 2022 and 2024 projections.

Figure 5: Agriculture will be the biggest source of emissions by 2050

Projected NSW greenhouse gas emissions under 'abatement as tracking' scenario



Source: (DCCEEW, 2024a).

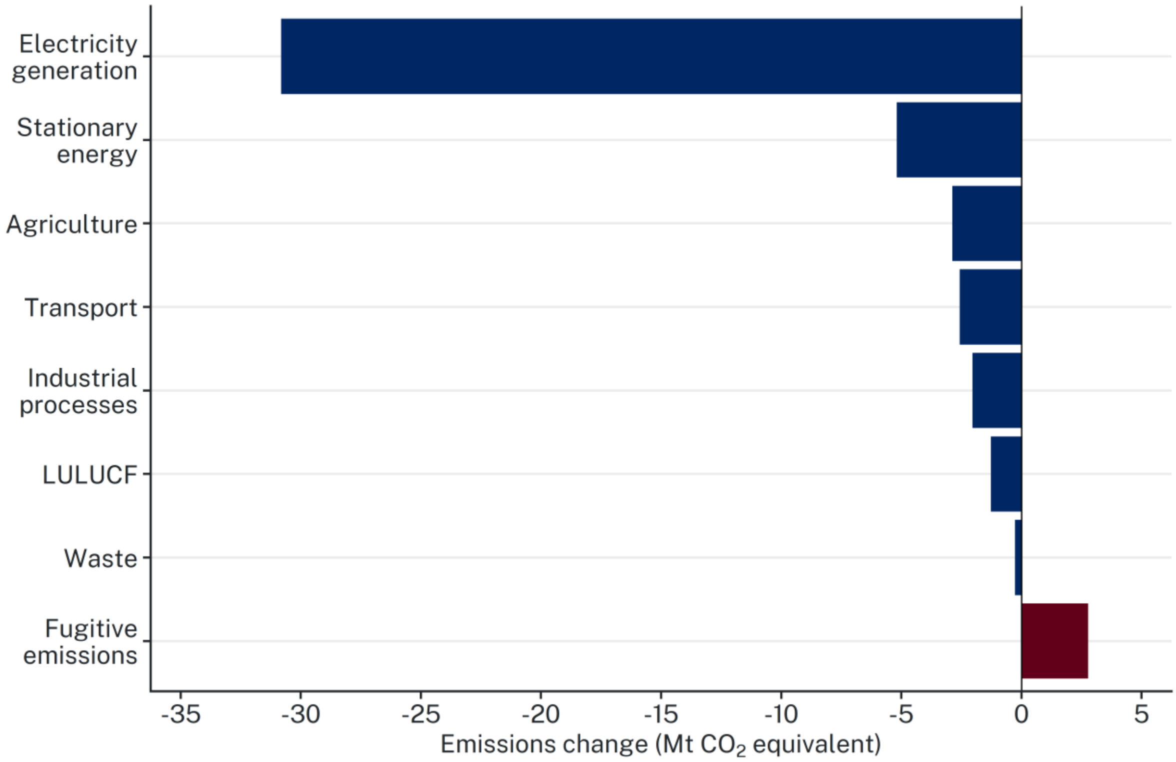
We are not on track for our 2030 target

By 2030, under the most likely scenario ('abatement as tracking'), NSW emissions are projected to have fallen to 90 Mt CO_2-e – a 44 per cent reduction from their 2005 level. This abatement is largely driven by changes in electricity generation. Coal generators are replaced with utility-scale renewables, firming capacity, and consumer energy resources (particularly rooftop solar and, increasingly, home batteries). The final thermal coal generation unit at Liddell closed in April 2023. Origin's Eraring generator, Australia's largest power station, is now scheduled to close no later than April 2029. More modest abatement is also projected for stationary energy, industrial processes, agriculture, and transport.

Projected abatement has fallen since the 2022 projections, when the State was projected to be 56 per cent below 2005 emissions in 2030. Along with higher electricity demand, this is also attributable to the extension of Vales Point Power Station's operations from 2029 to 2033. (This notification update was given by its owner, Delta Energy, to the market operator in 2022.) Continued operations are, however, contingent on the facility complying with stricter air and water pollution standards applied by the NSW Environment Protection Authority. It would also likely require a licensing extension of the adjacent Chain Valley coal mine.

Figure 6: What reduces emissions up to 2030?

Projected changes in emissions between 2021 and 2030, by source, in Mt CO_2-e, under 'current policy – abatement as tracking' scenario

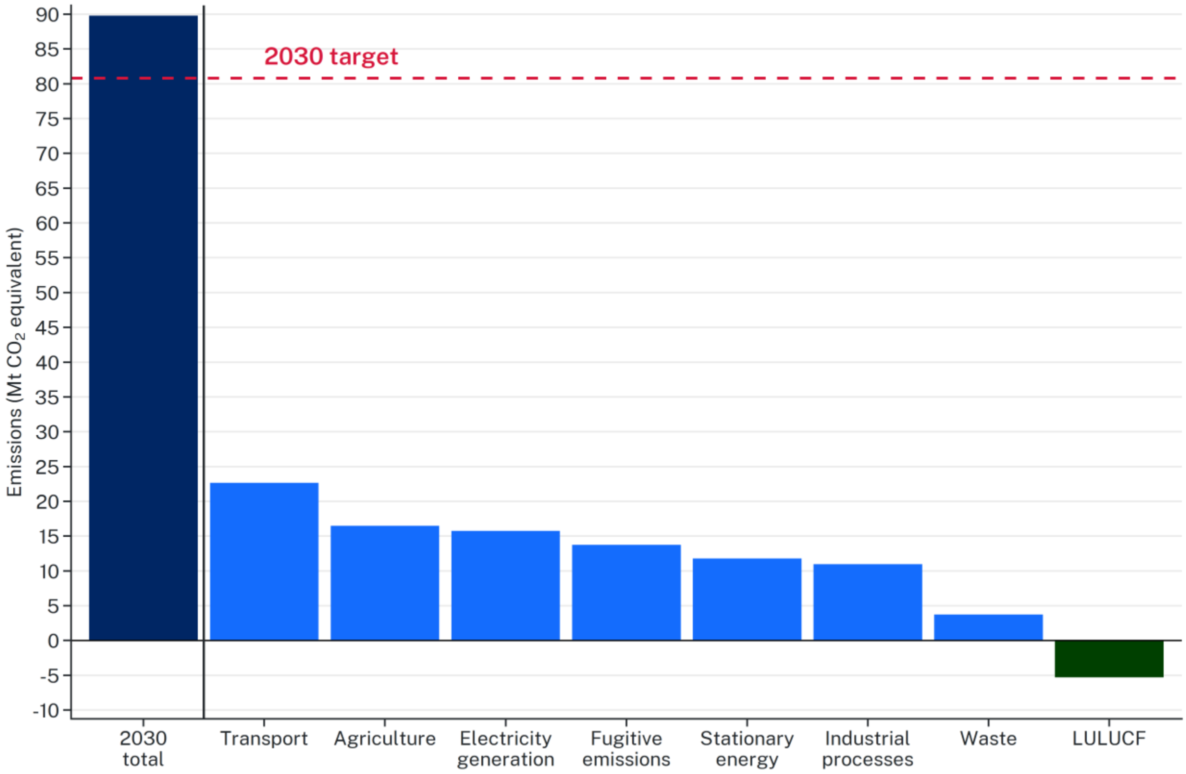


Source: (DCCEEW, 2024a).

Transport and agriculture are, nonetheless, projected to surpass electricity to become the two largest emissions sources by 2030, with only modest abatement projected for these activities. Emissions in stationary energy will be lower thanks to energy efficiency improvements and fuel switching from gas to electricity.

Figure 7: We are now projected to fall short of our 2030 target

Projected emissions components for 2030, by source, in Mt CO_2-e, under 'current policy – abatement as tracking' scenario



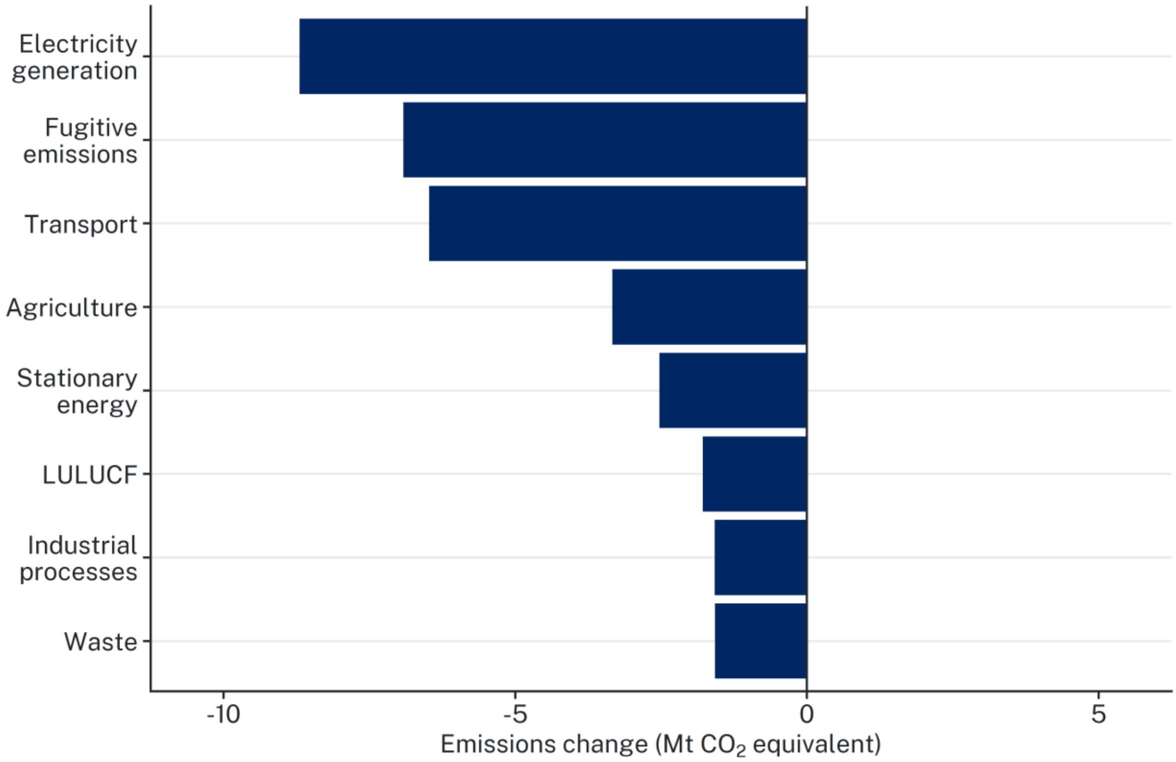
Source: (DCCEEW, 2024a).

2035 projections

Emissions will continue to fall beyond 2030, again driven mostly by abatement in the electricity sector. This will overwhelmingly be achieved by the closure of both the Vales Point B and Bayswater power stations, leaving just Mount Piper operational beyond 2033. The second area of progress is in fugitive emissions, with large projected falls because of reduced coal mining activity. Light electric vehicle uptake will also help drive abatement in transport.

Figure 8: Less coal, more electric vehicles drive abatement beyond 2030

Projected change in emissions between 2030 and 2035, by source, in Mt CO_2-e, under 'abatement as tracking' scenario



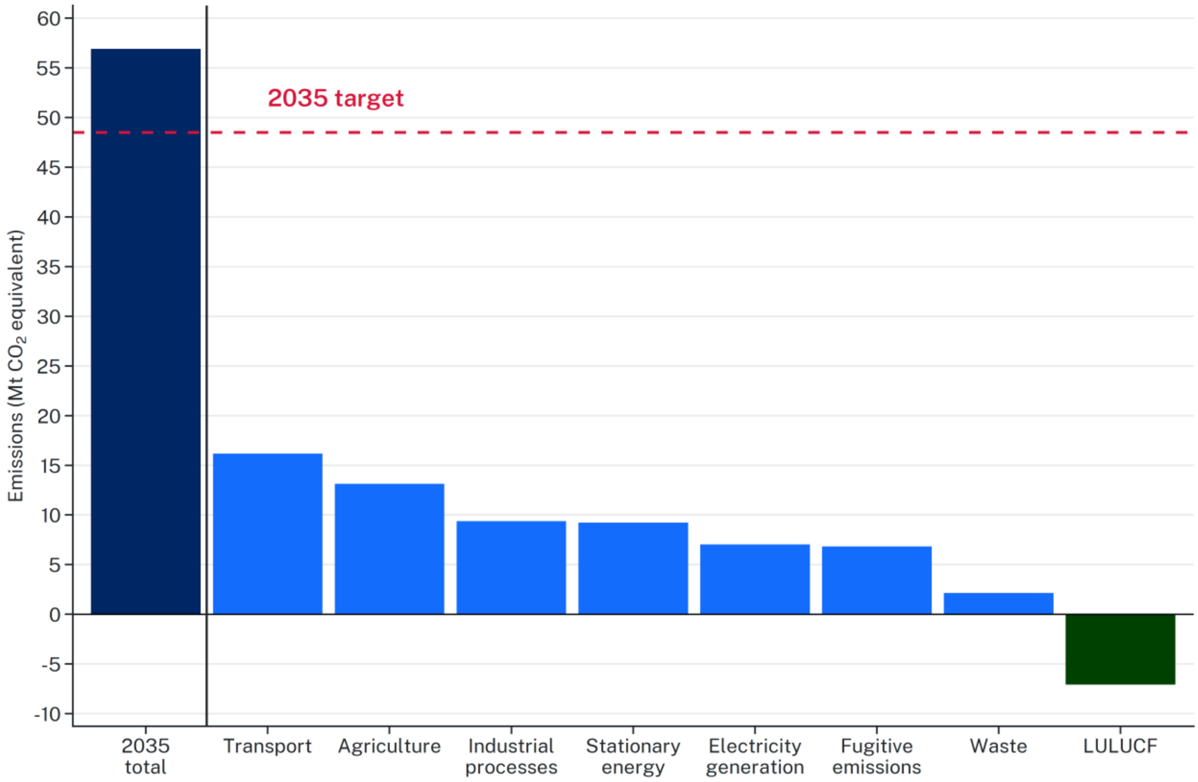
Source: (DCCEEW, 2024a).

Nevertheless, the State is still projected to miss its legislated 2035 emissions target of a 70 per cent reduction below the 2005 level – no more than 48 Mt CO2-e total emissions. Emissions are projected to be 65 per cent below 2005, or 57 Mt CO2-e. This is more modest progress than the 70 per cent reduction projected in 2022.

By 2035, transport is projected to be the largest emissions source, at 16 Mt CO2-e, or 28 per cent of total emissions. This is followed by agriculture, emitting 13 Mt CO2-e, or 23 per cent of total emissions.

Figure 9: We also expect to miss our 2035 target

Projected emissions components for 2035, by source, in Mt CO_2-e, under 'abatement as tracking' scenario



Source: (DCCEEW, 2024a).

2050 projections

No one can predict accurately the course of technological change over multiple decades. Internationally, cost reductions for renewable energy have confounded expectations. But there is no guarantee these trends will continue without action. Moreover, prices in global and domestic construction markets can be subject to significant shocks, pushing costs up and delivery timelines out.

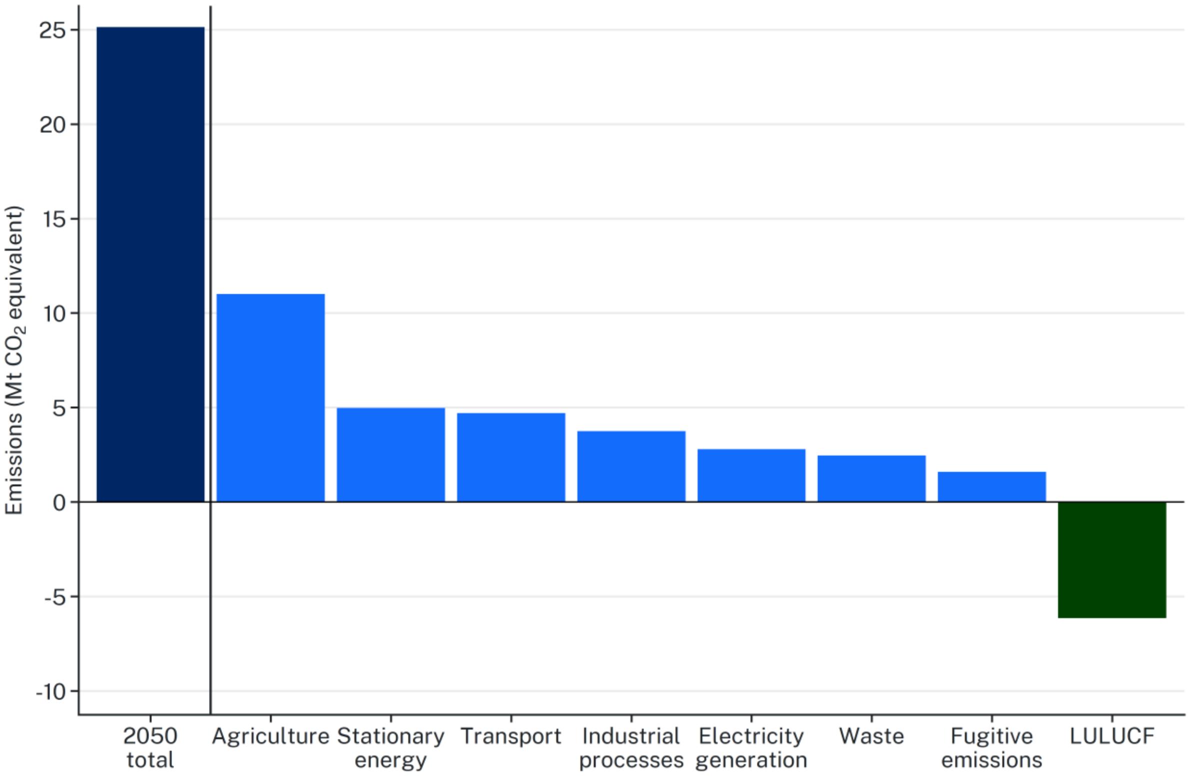
As of 2024, more global emissions are priced than ever before – 23 per cent, according to the World Bank (2023). Substantial public subsidies are now provided for investment in renewables and for research and development. But it is hard to project how these policies will induce further innovation and economies of scale in zero-emissions technologies.

Projections beyond the medium term — that is, after 2035 — should, therefore, be treated with caution. They, nonetheless, paint a cautionary picture of risks to achieving a net zero outcome if we don't have cost-effective policies to drive it.

The 'abatement as tracking' scenario projects 25 Mt CO_2-e will be remaining in 2050. Agriculture — primarily methane emitted by cattle and sheep — is projected to be the largest emissions source by mid-century, at 11 Mt CO_2-e, or 44 per cent of total emissions. Stationary energy is now projected to be the second-largest emissions source because of slower rates of fuel switching and electrification.

Figure 10: A lack of comprehensive policies means significant emissions are projected for 2050

Projected emissions components for 2050, by source, in Mt CO_2-e, under 'abatement as tracking' scenario



Source: (DCCEEW, 2024a).

Transport emissions are projected to fall as light electric vehicle adoption becomes widespread. But significant emissions would continue because heavy passenger and freight transport — aviation, rail, road, and shipping — continue to be dependent on fossil fuels. Zero-emissions technologies are projected to expand in industrial processes and product use but not by enough to eliminate emissions. Meanwhile, electricity emissions continue because of the use of gas generation as a firming technology.

Australian Government emissions projections

Achieving net zero is a national challenge. The Australian Government's November 2023 emissions projections track progress toward the *Climate Change Act 2022* (Commonwealth) interim target of 43 per cent below 2005 by 2030 and a cumulative carbon budget. Projections only extend to 2035.[7]

In these projections, the 'baseline' scenario accounts for those current Commonwealth and state policies that were in place at the time of publication. These include the 2023 changes to the Safeguard Mechanism, progress to date on the NSW Electricity Infrastructure Roadmap, and renewable energy targets in Victoria and Queensland. The Commonwealth's baseline scenario projects a 37 per cent emissions reduction below 2005 levels by 2030 and 49 per cent by 2035.

[7] Australia's Nationally Determined Contribution for that year – a quantity defined in the Paris Agreement – is to be set in 2025.

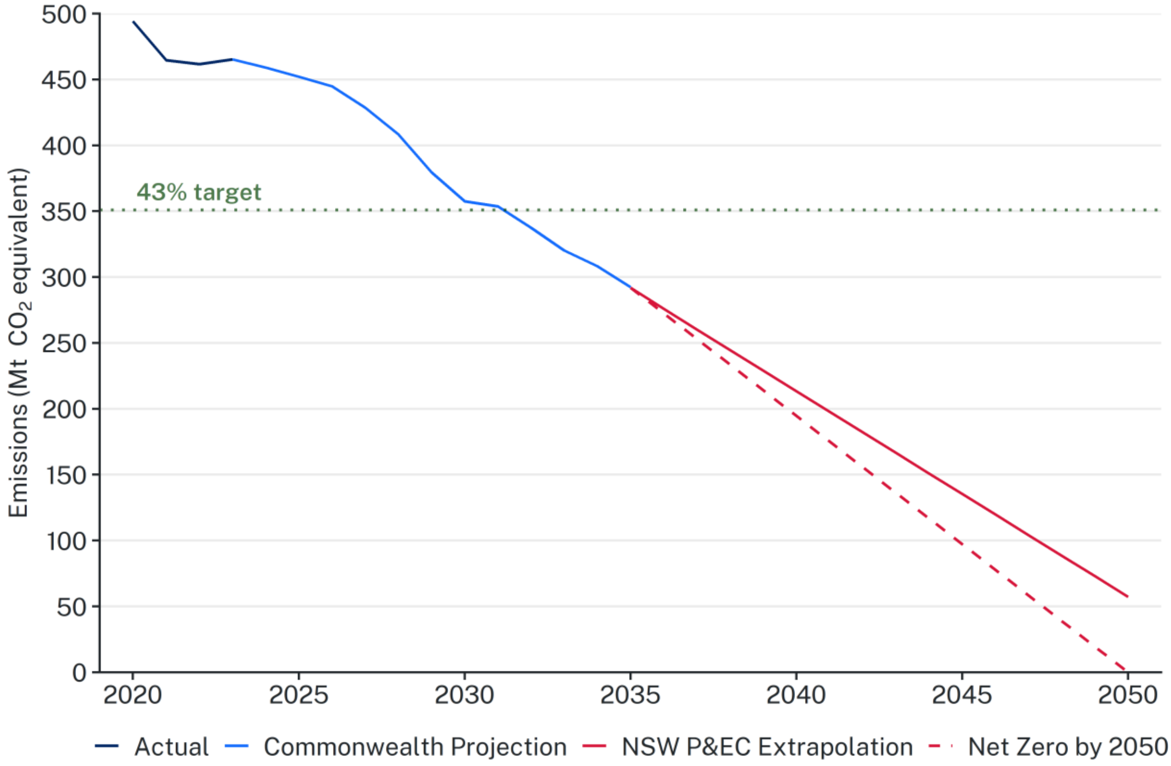
The more ambitious 'with additional measures' scenario includes new policies not fully designed or implemented. The main component is a future round of the Capacity Investment Scheme (see Appendix B for further discussion), aimed at achieving 82 per cent renewable electricity generation (including storage) nationally. This scenario projects a 42 per cent reduction in emissions below 2005 levels by 2030 — nearly on target — and a 53 per cent reduction by 2035.

On average, the rate of abatement per year between 2023 to 2035 under the Commonwealth's 'with additional measures' scenario is 16 Mt CO_2-e. Continuing this pace beyond 2035 (Figure 11) suggests Australia would miss its net zero target by around 57 Mt. Conversely, achieving the 2050 target would require increasing abatement to 18 Mt CO_2-e per year beyond 2030.

Slower abatement in the medium term will increase pressure for action in the years closer to 2050 to achieve net zero. This would possibly require more expensive and disruptive abatement measures to be implemented later, with significant negative impacts on living standards.

Figure 11: Commonwealth projections suggest Australia's current rate of abatement is insufficient for net zero by 2050

National emissions projections to 2035 ('with additional measures'), extrapolated to 2050



Source: (DCCEEW (Commonwealth), 2024), NSW Productivity and Equality Commission calculation, 2024.

3 A cost-effective net zero transition

Without an economy-wide carbon price, we must rely heavily on second-best government policies to deliver on the state's emissions reduction targets.

Achieving our legislated emissions reduction targets at the lowest possible cost is one of the most important productivity challenges facing New South Wales. It requires replacement of significant amounts of our private capital stock and retrofitting of our public infrastructure. It also requires changes to our behaviours as consumers and our approach to land use.

If New South Wales is to meet its 2050 net zero target, we will need policies to accelerate the transition. Government needs to provide businesses with sufficient incentives to make timely investments in large, long-term assets stretching to 2050 and beyond. It must also incentivise households to adopt energy saving and zero emissions technologies – 'consumer energy resources'.

To maximise living standards through the transition, businesses and governments must prioritise and sequence abatement options, implementing those that are lowest cost per tonne of abatement first. This will be challenging. But the alternative — adopting a wait-and-see approach — poses larger challenges by:

- raising the probability that the State will miss its legislated targets
- increasing costs today, because businesses will require a higher return on capital to compensate for the prospect that investments they make now will be 'stranded' later if policies change.

Government should also bear in mind net zero by 2050 may not prove ambitious enough to deliver on the Paris Agreement's global temperature target of 'as close as possible to 1.5°C'. This target remains an ambition in international diplomatic forums:

- in Rome in 2021, G20 leaders agreed that countries must take meaningful action to keep the world from warming by no more than 1.5°C
- the Glasgow Climate Pact at COP26 in 2022 reaffirmed this goal.

There is no obvious, specific time by which New South Wales and the rest of Australia must reach net zero if the world is to meet a 1.5°C warming target. But the UN has suggested developed countries need to reach net zero by 2040 – a much more ambitious trajectory than at present. Some domestic stakeholders have urged even more ambition, with Climateworks proposing net zero by 2039 (Skarbek, Malos, & Li, 2023) and the Climate Council arguing for a 2035 date (Rayner, 2024).

For the time being, both the NSW and Australian Governments remain committed to existing emissions reduction targets. But the more ambitious global temperature targets under the Paris Agreement accentuate policy risk and uncertainty in the ongoing net zero transition.

3.1 Implications of policy risk and uncertainty for productivity in the net zero transition

Energy policy uncertainty limits productivity and lowers living standards

Uncertainty in climate-related energy policy can limit private investment. AEMO publishes its Australian energy sector Inputs, Assumptions, and Scenarios database once every two years (AEMO, 2024a). Its 2023-24 release illustrates how the trajectory of climate policy has a causal relationship to the level and pace of technological change, costs, demand, and demand-side engagement.

Costs of firmed renewables and other zero-emissions technologies have fallen substantially (Graham, Hayward, Foster, & Havas, 2024). Yet this is not sufficient to drive structural change consistent with state and national targets. Insufficient clarity on how targets will be achieved adds risk and uncertainty to private sector activities. To compensate, investors must add a risk premium to the returns they demand. This effectively means investors are paying a 'shadow price' for carbon. But this shadow price is based on judgements that are different for each investor. They are also hidden from households and policymakers.

There are consequences of policy uncertainty creating a need for higher investment returns:

- **Projects do not happen.** Some proposals will now simply not reach the minimum rates of expected return needed for approval, reducing overall investment.
- **People are less productive.** Because smaller investment flows leave the economy with a smaller future capital stock, the capital-labour ratio will be lower than it would have otherwise been. With less capital to work with, labour productivity is lower.

Box 2 shows an example of how uncertainty affects investors.

Box 2: How policy uncertainty cuts investment and productivity

Investor A (a 'first mover') is ready to make significant investments in renewable energy and storage. It anticipates the energy transition will be relatively fast, so expects large medium-run payoffs from these investments.

Investor A is factoring a large shadow carbon price into its investment decision.[8]

Investor B anticipates the energy transition to be slower and bumpier than projected by Investor A. It makes small maintenance investments now to extend the useful life of its fossil fuel assets, ensuring they are profitable over the medium run. It defers more substantial investment in renewable energy.

Investor B is factoring a very low shadow carbon price into its investment decisions.

Investor C is 'risk averse'. It has tested a range of carbon prices and cannot identify one with a high degree of confidence as the basis for either new or maintenance investment decisions. It avoids *all* investment decisions now – either in new, zero-

[8] A *shadow carbon price* is an estimate of the internal cost of greenhouse gas emissions to a business' investment decision, factoring in expectations about the transition to a low-emissions economy.

emissions assets or maintenance of existing fossil fuels assets. Instead of investing, it will wait until policy circumstances become clearer. It lets existing assets run to the end of their useful lives.

In this scenario, only Investor A is making new investment decisions now. And, in the end, either Investor A or Investor B will have made the right strategic decision (but not both).

Each investor's situation changes when the government introduces a carbon price. The need for (varying) estimates of shadow carbon prices is removed for all firms:

- It confirms Investor A's earlier decisions, but also gives it the option to make further, similar investments, because the cost of finance no longer includes a premium for the risk of default.
- Investor B revises its strategy, as it now knows that maintenance investments will not yield the expected returns.
- It lowers the risk and uncertainty premium facing Investor C, which now decides to make significant new investment decisions that it had previously deferred.

Construction sector capacity will impact the cost and timing of the energy transition

The scale and scope of the energy transition should not be underestimated. It includes the need to plan and deliver:

- utility-scale renewables
- short- and long-duration storage (batteries and pumped hydro)
- new and upgraded transmission and distribution networks – including towers, substations, and poles and wires
- installations of consumer energy resources, including rooftop solar, home batteries, and smart meters
- electrification and insulation of existing residential and commercial premises
- installation of charging sites for both heavy and light passenger and freight electric vehicles
- electrification of agricultural, mining, manufacturing, and construction sites.

Each of these transformations will draw on the skills, construction materials, and capital equipment (including the freight network) available to our domestic construction sector. State and local governments also need other work from the same sector – to plan and deliver housing, major projects, and smaller infrastructure programs.

Housing has become a focus for all Australian governments. In 2023, the Commonwealth signed the National Housing Accord with the states and territories, committing to deliver 1.2 million well-located homes over five years to 2029. New South Wales has committed to delivering 377,000 dwellings as part of this task. The NSW Government also seeks to maintain housing supply momentum beyond the 2020s to keep a lid on housing costs and avoid further deterioration in affordability.

Public infrastructure requires significant resources. Australian governments are investing record amounts to build major road, rail, and energy projects. A large pipeline of projects in New South Wales is soaking up limited resources. Victoria has its own record infrastructure program, concentrated in large rail projects. The Queensland

Government had committed to significant public transport investments in south-east Queensland, while also pursuing a $62 billion 'Queensland Energy and Jobs Plan' but the future of the plan is uncertain.

Smaller projects to maintain minimum acceptable service levels in arterial and local roads, public transport, schools, and water will also demand construction sector resources.

Not everything can be built at once. Constraints in labour, materials, and equipment have been the subject of significant stakeholder commentary, as an overstretched construction sector suffers surging costs and delivery delays (Infrastructure Australia, 2023). Reports of delays and cost blowouts on major projects have become commonplace inside and outside of the energy sector. One prominent example is Snowy Hydro Limited's Snowy 2.0 pumped hydro project. All this activity is raising costs for both the public and private sectors, making prospective investments less feasible.

Decisions of the NSW Government can have a major impact — positive or negative — on how we use our resources. The State already has a record $119.4 billion capital program over the 2024-25 Budget and Forward Estimates period. This includes many commitments from the predecessor government that are high-risk, with value for money outcomes that remain unclear.

Capacity affects labour

The transition is facing challenges recruiting and retaining skilled workers because of this unprecedented pressure. Many tradespeople can move between infrastructure projects — energy, water, roads, freight, and public transport — and private residential, commercial, and industrial developments. Examples include earth movers, builders, concreters, electricians, boilermakers, heating, ventilation, and air conditioning technicians, plumbers, carpenters, bricklayers, and removalists. Box 3 highlights the transferable nature of trade certifications and skills for electricians.

This transferability is not limited to trades. Workers in professional roles such as engineering, architecture, and procurement are also able to move between construction subsectors. An energy project will necessarily compete for some of the same skilled people sought by public infrastructure and private development projects, whether in the trades or the professions.

Box 3: Transferability of electrical skills

The Clean Energy Council (2022), in its *Skilling the Energy Transition* report, explains that a Certificate III in Electrotechnology – Electrician qualification provides a preferred pathway into the renewable energy sector. This certificate is the same basic qualification that anyone seeking to work as an electrician in any sector must hold.

For example, a Transgrid electrical apprentice will receive training in the installation, inspection, maintenance, and repair of assets at a high-voltage substation. At the end of their apprenticeship, they will receive a Certificate III in Electrotechnology – Electrician. Holding this certificate and an appropriate licence is sufficient for emerging electricians to find employment across all subsectors. Specialised knowledge can be acquired on the job and/or through additional certifications.

Capacity affects materials

The continued, affordable supply of raw and refined materials and their efficient allocation is essential to the energy transition. Steel, concrete, copper, glass, and batteries are just some examples of the materials needed. New South Wales is not selfsufficient in the production of many of these materials and is exposed to volatile global supply chains and competitive domestic markets. The Berrima cement works, the state's only cement kiln, produces just 60 per cent of the cement used within New South Wales, with the rest imported from other states.

3.2 Pricing emissions is the best pathway

Today, market participants generate greenhouse gas emissions as they demand and supply goods and services. Those emissions impose a long-term cost on society through climate change. But this social cost is hidden from market participants, as it is not reflected in prices. By contrast, a carbon price creates signals for participants to produce and consume in ways that do not unduly cost society at large.

To ensure we hit our targets, policy would ideally impose a uniform constraint on greenhouse gas emissions. Consistent with our interim and long-run targets, we would allow the market to set a single, economy-wide price on carbon dioxide equivalent emissions.[9] This cost signal would be agnostic to the source of emissions and form of abatement.

Broad-based carbon prices give markets an incentive to abate emissions wherever the cost of abatement is lower than the price itself. Simultaneously, this approach induces:

- **behavioural change** by consumers, so that they buy less emissions-intensive goods and services
- **technological change** by businesses in favour of low- and zero-emissions production processes
- **innovation** by both the public and private sectors to research and develop new ways of avoiding future carbon price liabilities.

A carbon price is a systemic remedy: it is taken into account in decisions all through the production and consumption chain. It is an impactor-pays approach: those who create the most greenhouse gas emissions pay the highest cost.

Box 4 outlines the three main mechanisms for pricing greenhouse gas emissions.

[9] The technical term is a carbon dioxide equivalent (CO_2-e) emissions price; hereafter 'carbon price' or 'emissions price'.

Box 4: Carbon pricing mechanisms

There are, broadly, three mechanisms available to governments to price carbon, all of which internalise the social cost of greenhouse gas emissions.

A **carbon tax** directly sets a fixed price on emissions. The amount of emissions that a carbon tax prevents depends on its level and how markets respond.

A **baseline-and-credit system** sets a maximum amount of emissions per unit of a business's output ('baseline'). Businesses that emit below their baseline earn 'credits', which must be purchased by businesses emitting above their baseline. Baselines decline over time to achieve abatement objectives. Businesses that continue to emit face rising costs, while businesses that increasingly abate enjoy rising revenues.

Emissions outcomes for both carbon taxes and baseline-and-credit systems cannot be predicted exactly. They can, however, be forecast with reasonable accuracy over time.

An **emissions trading 'cap-and-trade' system** caps the total level of emissions in covered sectors, issuing permits either through an auction or free allocation. Businesses can either change their technologies to avoid the cost of permits or purchase permits. Permits can also be traded between businesses as market conditions change.

Each of these approaches to pricing carbon ensures that the lowest-cost abatement opportunities are exploited first, either through consumer or producer decisions. Moreover, carbon pricing creates an incentive for businesses to undertake research and development. This creates profit-making opportunities as innovations can be patented and sold to other businesses.

NSW emissions are only partly covered by pricing mechanisms

Under the **Australian Carbon Credit Unit (ACCU) Scheme**, businesses, organisations, and individuals are paid to reduce their emissions via a competitive auction process. Activities that are eligible for ACCUs — subject to verification — include:

- energy efficiency improvements
- land-use changes ('carbon farming') and vegetation projects
- methane capture and destruction
- waste management projects.

Each ACCU earned by participants represents one tonne of CO_2-e stored or avoided. Participants can then sell these ACCUs to generate income.

In 2023, the Commonwealth Government implemented changes to the existing **Safeguard Mechanism** to manage greenhouse gas emissions from large industrial facilities. Emitting facilities already report annual energy demand and emissions to the Clean Energy Regulator via the National Greenhouse Gas Reporting Scheme (NGERS). Facilities reporting scope 1 net emissions of more than 100,000 tonnes CO_2-e annually have new compliance requirements under the changes. The electricity sector is treated separately – as a sector, rather than by facility.

The Safeguard Mechanism is a carbon pricing scheme of the baseline-and-credit type. Of 219 non-electricity generating facilities in Australia subject to the Safeguard Mechanism in 2022-23, 35 are in New South Wales (Clean Energy Regulator, 2024). These facilities extend across the mining, manufacturing, transport, oil, gas, and waste industries, and produce approximately 21 per cent of the state's emissions. Including the electricity sector, the Mechanism covers 60 per cent of New South Wales' emissions.

Baselines had originally been set based on historical emissions, generally at high levels. Under the 2023 reforms, baselines will ratchet down over time by 4.9 per cent each year until 2030. Facilities that emit under their baseline can generate Safeguard Mechanism Credits (SMCs), a tradeable financial product equivalent to one tonne of CO_2-e not emitted. Facilities that exceed their baseline must buy and surrender either one SMC or one ACCU for each tonne of CO_2-e above their legal limit.

NSW emissions covered by the Safeguard Mechanism will fall from an estimated 24 Mt CO_2-e in 2022-23 (the last full year before implementation) to 17 Mt CO_2-e by 2030. Post-2030 decline rates will be set in predictable five-year blocks, subject to updates to Australia's Nationally Determined Contribution under the Paris Agreement. Decline rates for 2030-31 to 2034-35 financial years are to be set by 1 July 2027.

The Safeguard Mechanism, as reformed in 2023, has a range of weaknesses:

- its baselines are generous, limiting the abatement task between now and 2030
- the high, sector-wide baseline for electricity emissions means individual facilities do not face a carbon price, limiting their incentive to abate
- its coverage is limited only to facilities with high emissions, so small- and medium-sized facilities do not face a price incentive
- it fails to include coke oven gas emissions from BlueScope's Port Kembla Steelworks
- it does not impute transport emissions, limiting abatement in the transport sector.

These design elements close off potentially lower-cost abatement opportunities.

The Commonwealth Productivity Commission made several recommendations to strengthen the Safeguard Mechanism in its 2023 *5-year Productivity Inquiry Report* (Productivity Commision, 2023a). Four that have not been implemented to date were to:

- lower the facility threshold to 25,000 tonnes of CO_2-e
- improve the efficiency of the electricity sector's coverage by applying baselines at the facility level or lowering the baseline substantially
- expand coverage of the transport sector by imputing downstream emissions to wholesalers
- ensure any previously covered facility that falls under the threshold remains covered.

The Australian Government has committed to a review of the Safeguard Mechanism in 2026-27. It has also, however, ruled out adopting further changes before the review beyond those implemented in 2023. This leaves open the possibility of state-based carbon pricing to reduce or eliminate gaps in coverage and provide the economy with broad-based abatement incentives.

3.3 Policy evaluation for emissions reduction

Piecemeal carbon prices as a 'second-best' solution

In the absence of an economy-wide carbon price, disparate policy interventions seem certain to continue. Each of these interventions incur a different, but measurable, cost of abatement per tonne of CO_2-e, even though these costs may not be explicitly set out. This approach means abatement will be more expensive than it would be under comprehensive carbon pricing.

Some policies help to abate emissions relatively cheaply even though abatement is not necessarily the principal objective of the policy. Tradeable certificates under state energy efficiency schemes, for example, carry an estimated implicit carbon price of $41 per tonne of CO_2-e. At the other end of the spectrum, the original NSW Electric Vehicle Strategy implied a carbon price of between $271 and $4,914 per tonne of CO_2-e (Productivity Commission, 2023b).

Policy evaluation through cost-benefit analysis

Cost-benefit analysis (CBA) is the preferred method for policy decision-making in infrastructure investment, regulation, and recurrent programs. The *NSW Government Guide to Cost-Benefit Analysis* (NSW Treasury, 2023a) requires a CBA for every capital, recurrent, and ICT proposal with an estimated total cost higher than $10 million.

Australian governments may decide to opt for mitigation policies other than carbon pricing. These should be evaluated via CBA. CBA should also be used to evaluate the impact of regulations that complement carbon pricing.

The cost of emissions — and the benefits of emissions reduction — should be included where their impacts are likely to materially affect the outcomes of the CBA. The NSW Government recently published a technical note on carbon values for use in cost-benefit analysis. The values were derived from a model of marginal abatement costs (MAC)[10] specific to New South Wales that were consistent with the state's emissions reduction targets.[11]

The Australian Energy Regulator (AER) has released guidance that includes a value of annual emissions reduction (VER) for use in Regulatory Investment Tests. This involves cost-benefit analysis of electricity network infrastructure investments. The AER values range from $70 per tonne CO_2-e reduced in 2024 to $420 by 2050 (AER, 2024).

But regulatory and expenditure interventions for the purpose of emissions reduction — even when evaluated via CBA — are considered a second-best approach to carbon pricing. The key limitations:

- Governments evaluate policy proposals on a case-by-case basis. For a given carbon value, this does not necessarily mean all cost-effective abatement options have been prioritised. By contrast, carbon pricing provides an incentive for all cost-effective abatement measures to be taken up.
- Cost estimates used in CBA can never be prepared from perfect information. Estimates inevitably carry errors. Technologies and their costs change over time,

[10] The cost of reducing the final tonne of CO_2-e using a particular solution.

[11] Carbon values are used in CBAs to value the cost of emissions and the benefit of reducing emissions stemming from policy proposals (NSW Treasury, 2023b).

sometimes significantly and rapidly (e.g. solar photovoltaics, wind turbines, and batteries). Ongoing abatement programs would have to be re-evaluated regularly to ensure they most accurately reflect the abatement landscape. But public agencies do not necessarily have the resources or the incentive to do this.

Carbon prices, by contrast, leave it to individuals, households, and businesses to determine whether it is cheaper to abate, based on the private information available to them.

3.4 Principles for navigating the world of the second-best

Without a broad-based carbon price, the burden falls on government to assess abatement costs right across the economy and then to prioritise and sequence interventions to achieve emissions reduction. This is a very difficult task that requires high levels of evidence and agility.

Several principles can help guide government decision-making:

1. We should prefer carbon dioxide equivalent pricing that replicates the Safeguard Mechanism and that allows acquittal of either tradeable SMCs or offsets under the ACCU program. This approach must be careful to avoid double-counting SMCs and ACCUs.
2. Should government decide not to price emissions from a particular activity, cost benefit analysis should be performed on policy proposals to reduce greenhouse gas emissions (NSW Treasury, 2023a). Any marginal abatement cost (MAC) forecasts used in these analyses should be up to date (DCCEEW, 2024b). Policymakers should carefully assess any risk of unintended consequences and take account of these risks in policy design.
3. Interventions should be technologically agnostic and competitively neutral.
4. Policy overlaps — where multiple policy interventions target the same objective — should be avoided, except where policies are clearly complementary. This will ensure compliance costs neither are unduly high nor distort incentives.
5. Whether the Australian or the NSW Government takes the lead in emissions reduction policies depends on which jurisdiction is both willing and best-placed to design and implement policy.

4 Electricity generation

The path to net zero in the electricity sector is well-defined, but New South Wales will need to navigate challenges to ensure reliability and affordability during the transition.

4.1 Technological costs and emissions scenarios

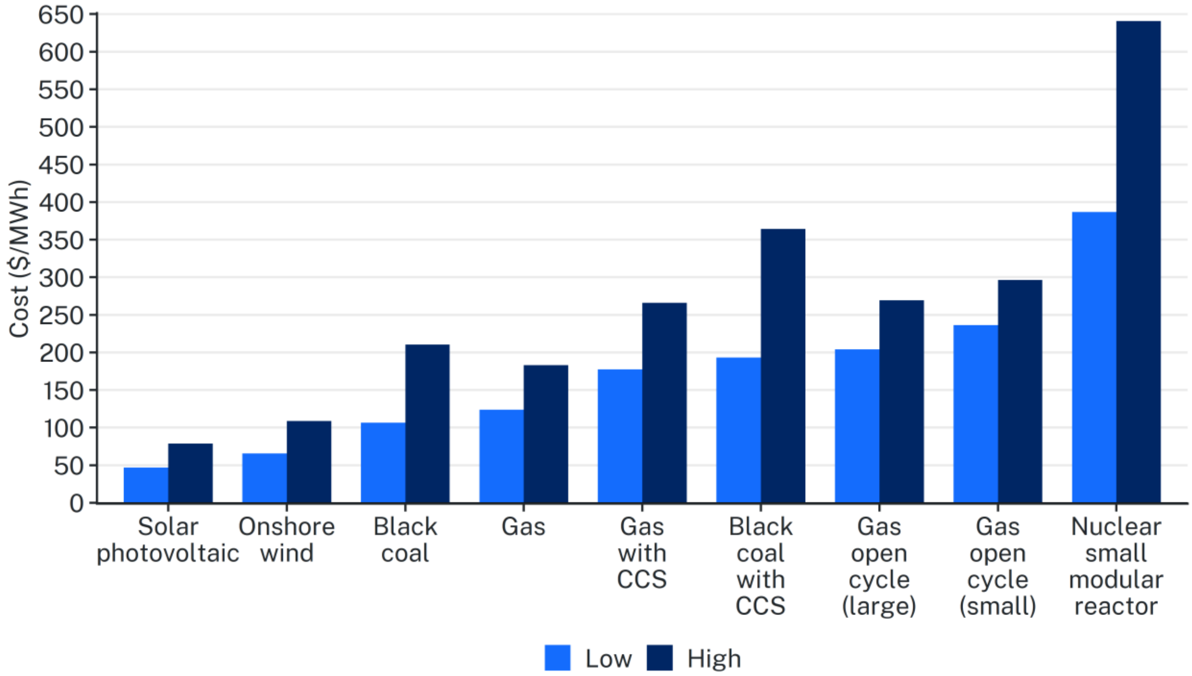
The cost of generation technologies

Renewables are the cheapest available source of electricity based on the CSIRO's *GenCost 2023-24* report (2024). The report estimated utility-scale solar photovoltaic (solar PV) and onshore wind turbines as having the lowest levelised cost of energy in Australia (Figure 12). In the best-case scenario for fossil fuels, black coal is estimated as more than twice as expensive per megawatt-hour as solar PV. When combined with carbon capture and storage technology (CCS), black coal is even more expensive. Small modular nuclear reactors (nuclear SMR) — the costliest technology modelled — were more than eight times more expensive as solar PV. The estimates include the cost of additional transmission and storage capacity to ensure a reliable electricity system.

The levelised cost of energy estimates for solar and wind are robust to a system dominated by renewables. Utility-scale solar and wind (complete with necessary transmission upgrades and additional firming capacity) are the lowest-cost new-build technologies. This holds even when solar and wind make up 90 per cent of the generation mix. This research also applies an additional risk premium to fossil fuel generation to account for the possible future application of a carbon price or some other restriction on emissions.

Figure 12: Solar and wind have the lowest levelised cost of energy

Levelised cost of energy (LCOE) by generation type in Australia, 2023-24



Note: The LCOE data presented are estimates based on different assumptions for capital costs, fuel costs, and capacity factors (such as generator utilisation). CCS is carbon capture and storage.
Source: (Graham, Hayward, Foster, & Havas, 2024).

The International Energy Agency has made similar findings for Australia.[12]

Electricity generation emissions scenarios

Emissions from electricity generation were 43 Mt CO_2-e in 2021-22, a decline of 15 Mt CO_2-e (26 per cent) from 2005 levels. As set out in section 2.2 above, the 'abatement as tracking' scenario in the NSW Net Zero Emissions Dashboard is considered the most likely scenario. It accounts for the announced generator closure dates as of mid-2024 and for NSW's Energy Security Target, Electricity Infrastructure Roadmap, and Energy Security Safeguard.

'Abatement as tracking' is more optimistic in the near term and less optimistic in the medium term for emissions reduction than AEMO's 'step change' scenario. The latter was considered most likely by stakeholders that gave feedback on AEMO's 2024 *Integrated System Plan* (Figure 13).[13]

Under both scenarios, emissions will drop rapidly over the next ten years as Eraring, Bayswater, and Vales Point B close as scheduled. By 2040, when the final coal-fired power plant, Mount Piper, is scheduled to close, electricity generation in New South Wales is projected to produce only 1.4 Mt of emissions. In 2050, electricity generation in

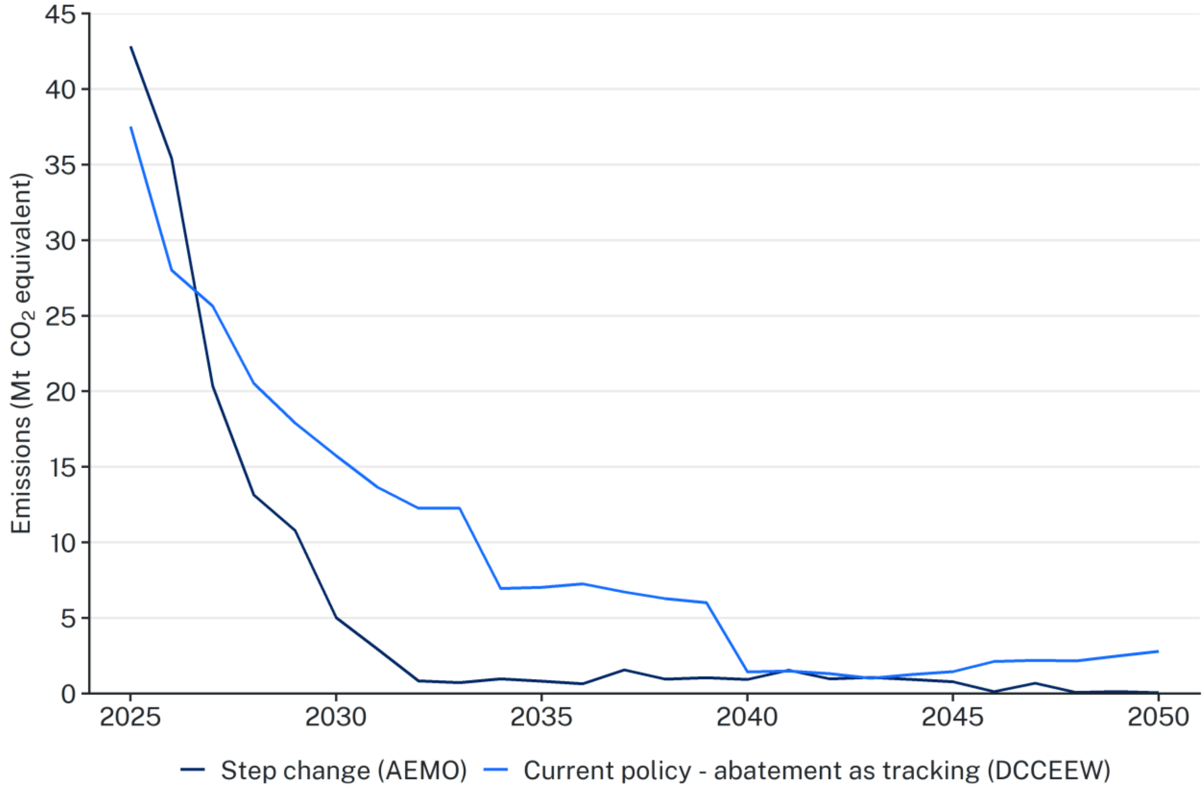
[12] This is based on a levelised cost of electricity calculator tool provided by the International Energy Agency. Assumptions included a discount rate of five per cent, a carbon price of zero, a heat price of $37.06 USD/MWh, and coal and gas prices at 100 per cent (International Energy Agency, 2020).

[13] The decision to support Origin's Eraring power station to remain open for an additional two years, until 2027, will increase the expected emissions of the NSW electricity system through to 2027. Neither the 'abatement as tracking' or 'step change' scenarios take account of Eraring's extension.

New South Wales is projected to produce 2.8 Mt of emissions — mostly from gas — and account for 11.1 per cent of total NSW emissions.

Figure 13: AEMO has projected a more optimistic path for NSW electricity generation emissions

NSW electricity generation emissions by scenario, 2025-2050



Source: (AEMO, 2024b); (DCCEEW, 2024a).

4.2 Challenges in the NSW National Electricity Market

The NSW electricity system is a region of the wholesale National Electricity Market (NEM), which also covers Queensland, Victoria, South Australia, Tasmania, and the Australian Capital Territory. The NSW region is dominated by coal-fired generation, which produced around 60 per cent of total electricity over 2023.

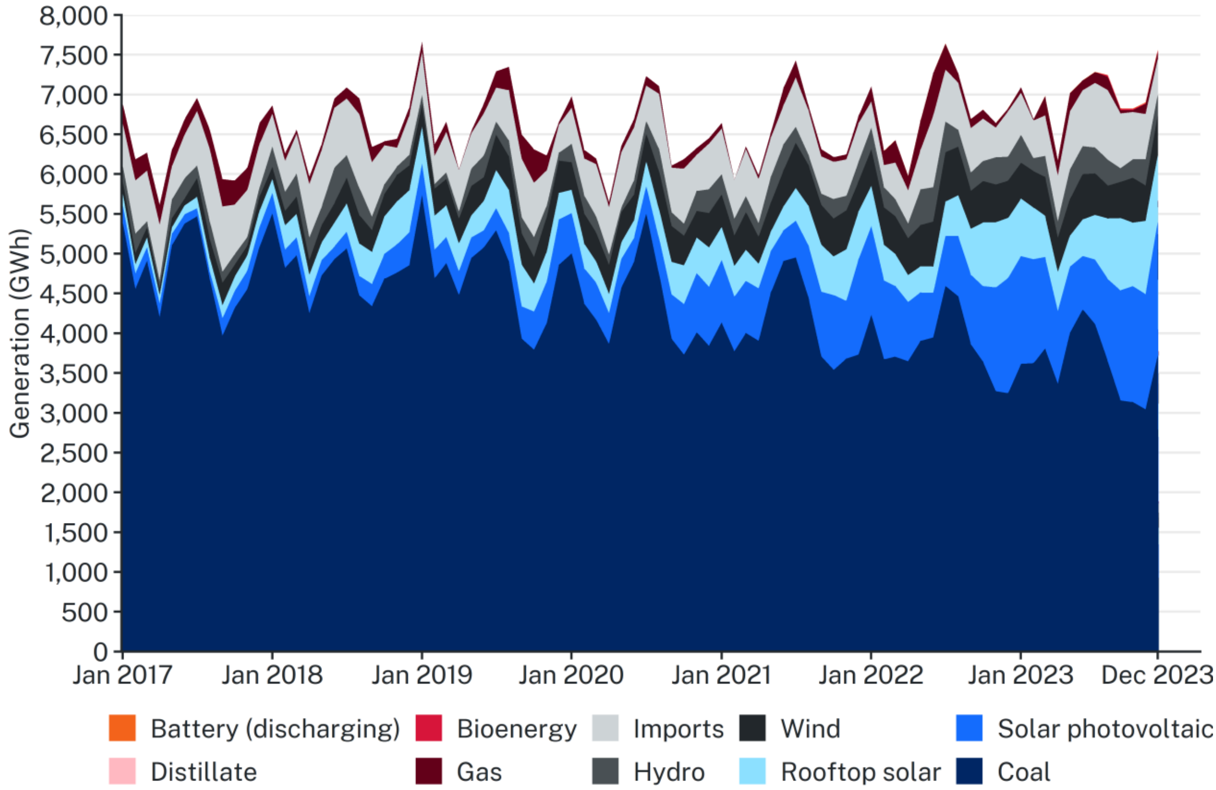
This share has diminished over the past decade. Wind and solar generation have slowly crept upward, initially thanks to policies such at the Commonwealth's Renewable Energy Target and, more recently, because of the falling costs of these technologies.

Meeting a minimum level of electricity reliability is essential to ensuring the transition to a net zero system does not unduly impact economy-wide productivity and living standards. But very high reliability comes with additional costs. Sufficient generation and firming capacity and new transmission and distribution network infrastructure are required to meet a reliability standard with a high level of confidence. This capacity, in turn, carries capital and operating costs, which are ultimately borne by customers.

In short, the higher the desired level of reliability, the higher the costs for electricity faced by consumers. During the transition, a balance must be maintained between reliability and the expected cost of reaching it.

Figure 14: Coal still generates most of our electricity, but its share is falling

Share of NSW electricity generation by technology, 2017-2023



Source: (AEMO, 2024c).

The transition in progress

Thermal coal generators, currently totalling 8.3 gigawatts of capacity, remain operational in New South Wales. But their retirements are being driven primarily by market forces:

- reduced **revenue** from 'stop-start' operations where coal-fired electricity is out-competed by variable renewable energy
- the age of assets increasing **maintenance costs**
- **falling reliability**, including unplanned outages
- increasing **operating costs** because of rising thermal coal prices.

The challenge for the net zero transition in electricity is to have enough replacement generation and transmission capacity online when coal power stations close. Under the NEM's original design, a step reduction in generation capacity prompts a sustained spike in NEM wholesale spot prices. This, in turn, feeds through to wholesale contract prices, signalling the need for investment. The NEM's governing bodies also provide information about when more capacity is needed. These include the NEM's register of intended generator closures and its 42-month notice of closure requirement.

Consumers reasonably expect policymakers to ensure a reliable electricity system during the net zero transition. The National Electricity Rules adopt a reliability standard requiring at least 99.998 per cent of forecast consumer demand is met each year. The 0.002 per cent maximum unserved energy is forecast and projected by AEMO through its annual *Electricity Statement of Opportunities*, with updates given after material changes in market conditions.

Presently, a more stringent 'interim reliability measure' (IRM) is in place until 30 June 2028 to maintain reliability during a one-in-10-year summer event and reduce the risk of load shedding in the NEM.[14] The IRM sets a lower benchmark of 0.0006 per cent of expected unserved energy demanded in any region per year. Exceeding the IRM can trigger the interim reliability reserve (an amount of out-of-market capacity that AEMO can procure in periods of high demand) and the retailer reliability obligation.

Overlapping this is the NSW Energy Security Target, legislated in 2020, which guides State interventions. The Energy Security Target (EST), adopted as the trigger for actions by the NSW energy minister, is set at:

- *capacity* needed to meet forecast NSW maximum consumer demand in summer (measured using a 10 per cent probability of exceedance) plus
- *a reserve* to account for an unexpected loss of the state's two largest generating units.

As of 2023-24, the two largest generating units in New South Wales were Mount Piper Power Station Unit 1 (MP1, with a 705 MW summer peak rating) and Eraring Power Station Unit 2 (ER02, with a 680 MW summer peak rating). (Further information on the EST and the Electricity Infrastructure Investment Roadmap is available in Appendix B and Appendix C.)

A test case for the transition: the Eraring extension

Both the NSW and Victorian Governments have displayed a willingness to intervene in previously privatised electricity generation markets. These interventions have aimed to extend the life of coal power stations and to smooth what these governments have perceived as hiccups in the transition. The effect is to contain wholesale prices and the signals these provide to market participants to make investment decisions.

Each intervention poses new issues for investor certainty, overall system costs, and the speed of the transition. This raises the question of whether expected or temporary gaps in supply can be filled in more strategic, cost-effective ways. These issues are illustrated by the prospect of extending the life of the Eraring Power Station (the 'Eraring extension'). This subsection explores that example.

Closing the Eraring gap

In February 2022, Origin Energy gave AEMO a 42-month notice of closure of its Eraring Power Station at Lake Macquarie, bringing forward its closure by seven years to August 2025. The NSW Government responded with an assessment of the state's ability to fill the resulting gap in power supply when Eraring closed. Among the measures to close the gap were the following:

- The NSW Minister for Energy directed Transgrid to be the network operator of the new 850 MW/1,680 MWh[15] Waratah Super Battery. This battery, at the site of

[14] Load shedding involves instances where demand exceeds supply to the extent that it poses a risk to system security.

[15] This designation signals that the battery can deliver 850 megawatts of power for almost two hours, providing a total 1,680 megawatt-hours of energy.

the former Munmorah Power Station on the Central Coast, was designed to ensure essential system services after Eraring's closure.

- Additional generation capacity would come from the growth of renewable energy — particularly rooftop solar — and greater use of peaking gas generation. Demand is also expected to be moderated through the Peak Demand Reduction Scheme.
- The Minister also issued a new 'firming' tender under the NSW Electricity Infrastructure Roadmap to meet the need for dispatchable capacity after Eraring's closure. The tender was later supported by the Commonwealth as the first phase of its new Capacity Investment Scheme.
- The tender results, announced in September 2023, totalled 1,075 MW of firm capacity. The successful project proposals were three battery energy storage systems and one demand response agreement:
    - Akaysha Energy's 415 MW/1,660 MWh (four-hour) **Orana battery** energy storage system
    - AGL Energy's 500 MW/1,000 MWh (two-hour) **Liddell battery**
    - Iberdrola's 65 MW/130 MWh (two-hour) **Smithfield battery**
    - Enel X Australia's combined three **virtual power plants** of 50 MW, 20 MW, and 25 MW (each with a minimum dispatch duration of two hours).

An enduring Eraring shortfall

Of the investment solutions to the Eraring gap, only the Waratah Super Battery remains on schedule at time of writing.[16] The Orana and Liddell batteries are delayed until 2026 and 2028, respectively. A 460 MW/920 MWh battery, announced by Origin for the Eraring site, is also being delivered, with AEMO modelling a 2026 commissioning date for the project.

AEMO cited the slippage of these key projects in the May 2024 update to its 2023 *Electricity Statement of Opportunitie*s, which had already forecast significantly greater system demand growth than in the prior year. The NSW reliability outlook deteriorated under the ESOO's conservative 'central' scenario because of revisions to demand distributions and project delays.

The market operator has a high bar for classifying investments as 'committed'. Under AEMO's definition, projects at an advanced stage of planning may still fail to qualify. They can, however, qualify as 'actionable and anticipated', ready for reclassification as 'committed' when investment decisions are made.

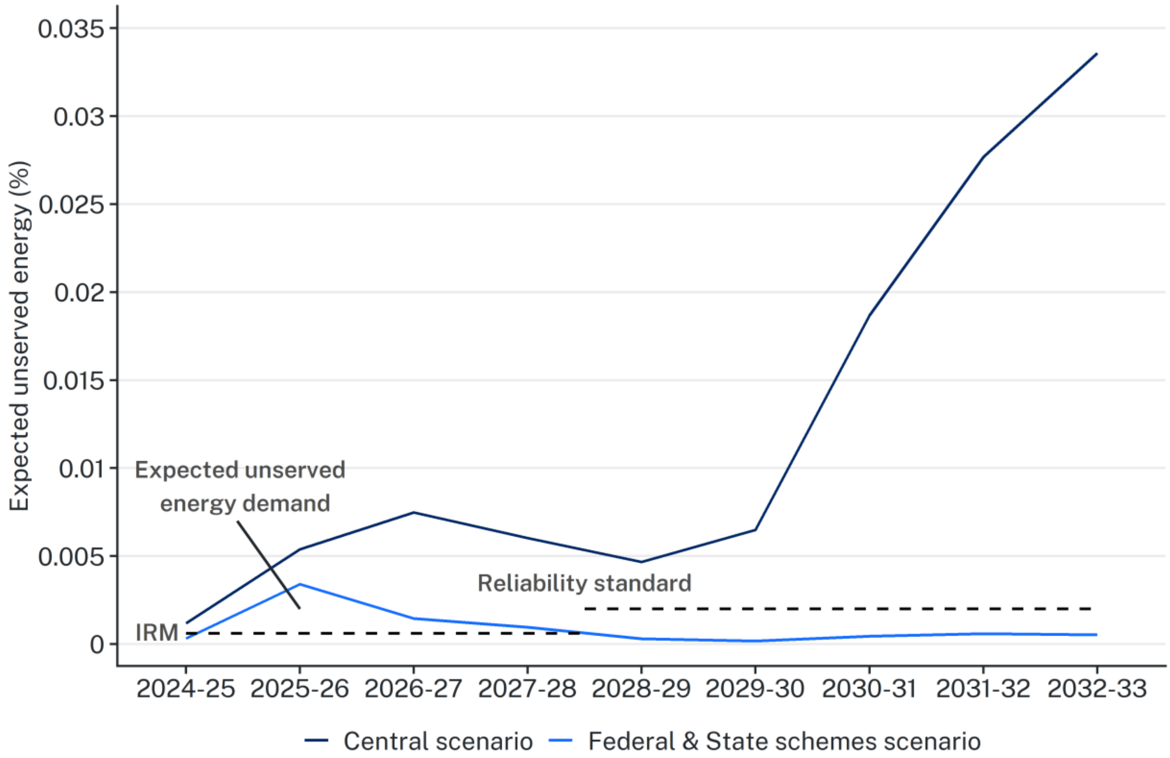
The construction sector's limited capacity contributes to these delays. The sector is being stretched by many large public infrastructure projects. In coming years, the national push to accelerate housing supply will worsen this capacity crunch.

In the additional 'federal and state schemes' scenario — which includes additional investments in generation, dispatchable capacity, and transmission — the 2023 ESOO update saw an improvement from the 'central' scenario (Figure 15). Adding in these projects shrunk the gap between expected unserved energy and the interim reliability measure (IRM). But though reduced, a reliability gap still existed in 2025-26, 2026-27, and 2027-28.

[16] The Waratah Super Battery is expected to begin operating in 2025.

Figure 15: Prospects for an IRM breach fall with NSW and Commonwealth measures

Expected unserved energy in NSW



Source: (AEMO, 2024d).

Extending Eraring's life

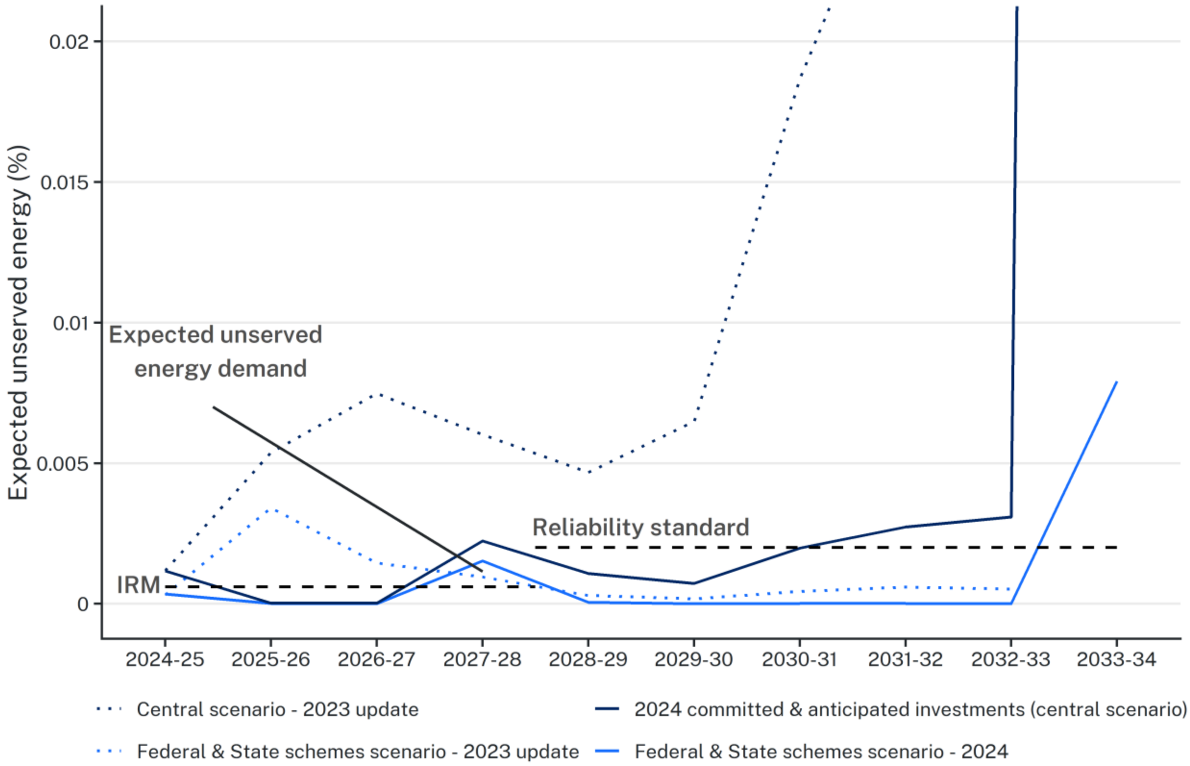
In May 2024, the NSW Government responded to this forecast IRM breach by offering to underwrite Origin Energy to operate its Eraring facility for two additional years beyond August 2025. The decision to support Origin was informed by AEMO's Energy Security Target Monitor (ESTM) 2023 update (AEMO, 2023), which forecast a breach of the EST were Eraring to close in 2025 (see Appendix C).

Origin's option with the State allows it to opt in for both, one, or none of the years covered by the May 2024 agreement. If Origin opts in, Eraring will be obligated to produce six terawatt-hours of electricity a year, about a third of the 16 terawatt-hours that the facility produced in 2023. The State would compensate Origin for up to 80 per cent of any losses, to a maximum to $225 million a year, that Eraring may incur producing those six terawatt-hours. Conversely, the State would be allowed to share a portion of any profit up to $40 million in either year.

Origin's option to extend Eraring with the underwrite will resolve reliability gaps for the near term. The 2024 ESOO found that Eraring's extension and additional generation projects moving to 'committed' has lowered the risk of an IRM breach in the near term. However, in 2027-28, when Eraring is now expected to close, there is still a breach of the IRM because of delays in several key projects.

Figure 16: Eraring's extension and new projects delay IRM breaches

Expected unserved energy in New South Wales

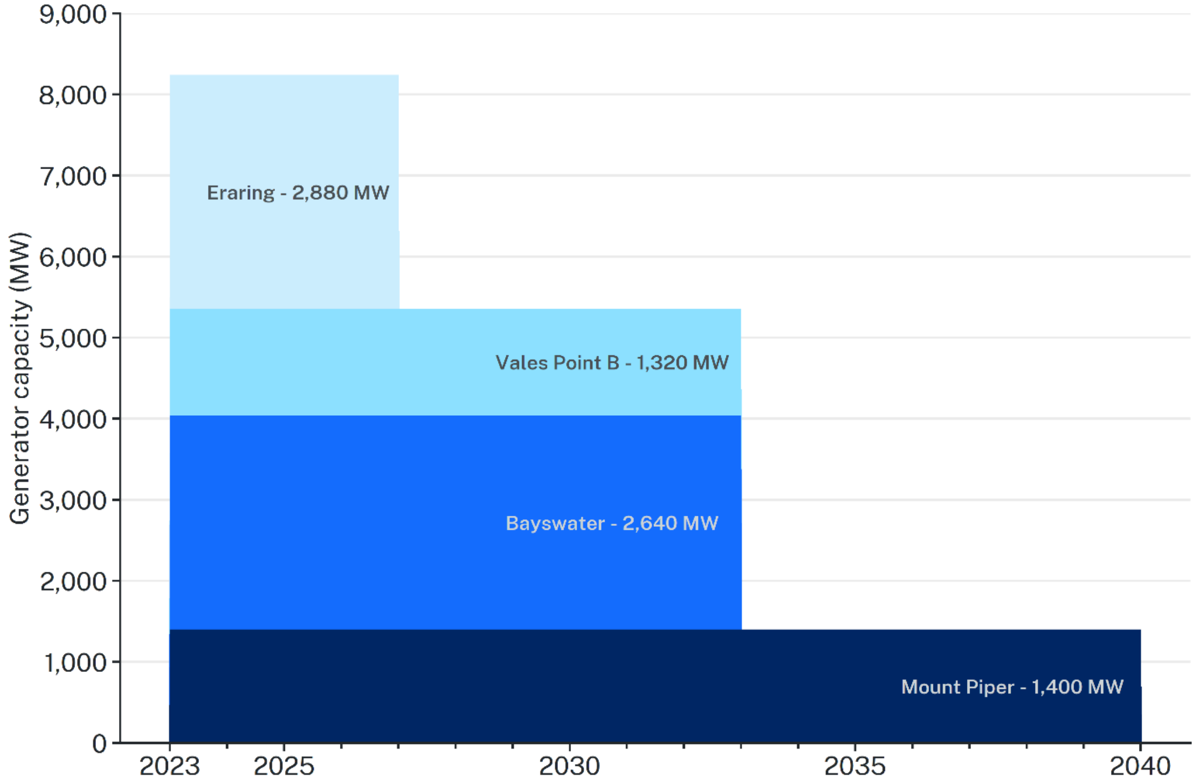


Source: (AEMO, 2024d), (AEMO, 2024g).

The Origin transaction is based on conservative scenarios that are, in turn, built on conservative modelling of reliability and security risks. These conservative models reflect a high social value placed on reliable electricity supply. Figure 17 shows the new timeline of planned closures to the state's coal-fired electricity generators.

Figure 17: The revised outlook for thermal coal generator closures

Coal generator capacity and scheduled closure dates



Note: The 2027 closure date for Eraring assumes Origin will opt into the Government underwrite for both years but will not elect to operate until 2029.
Source: (AEMO, 2024e).

Possible unintended consequences from the Eraring extension

While it may have addressed immediate reliability risks, the Origin transaction does, however, carry the risk of unintended consequences. An additional 12 terawatt-hours of electricity generated over two years should put significant downward pressure on wholesale prices in the NSW region of the NEM. This could threaten the viability of other coal generators for three reasons:

- The parent company of Vales Point Power Station, Sev.en, purchased Vales Point owner, Delta Energy, based on the August 2025 Eraring closure schedule. At the time, Sev.en signalled it was willing to invest in the power station to comply with looming pollution standards and extend its operations to 2033. (Vales Point Power Station is also located on the Central Coast, not far from Eraring.) The prospect of a publicly underwritten extension of Eraring's operation poses downside risks to Vales Point's profitability. This could see its owner reconsider, and potentially bring forward, Vales Point's closure.
- The Mount Piper Power Station's main sources of coal supply is increasingly insecure, posing risks to its continued operation. These risks would be accentuated by lower wholesale prices arising from Eraring's extended operation. This could prompt owner Energy Australia to wind up Mount Piper's operations much earlier than the currently planned 2040 closure date.
- Unanticipated interventions such as the Origin transaction can pose risks to new investment. The private sector might hesitate to invest if its assets could be

unexpectedly stranded by agreements to extend the operation of otherwise unviable generators.

In summary: interventions such as the Eraring extension may create new problems. Added to this risk and uncertainty are the costs of complying with multiple state and Commonwealth policies, particularly for maintaining very high system reliability. Policymakers need to be cognisant of these additional risks and uncertainties as the electricity transition progresses through a relatively tight timeframe.

4.3 Managing demand and containing costs in the electricity transition

As discussed, coal generators are increasingly costly, inflexible, and unreliable. But it is also clear the speed of the exit of coal-fired generation from the electricity system cannot be projected with high accuracy.

AEMO's 2024 *Integrated System Plan* depicts the scale of the investment task across the NEM, justifying the diversity of stakeholder views and its use of scenario planning. The challenges for the system's transition include:

- **New capacity** – producing a ninefold increase in utility-scale renewables, a fivefold increase in distributed solar, a tripling of firming capacity, and 10,000 kilometres of transmission lines.
- **Demand-side participation** – providing two-way electricity flow and digital innovations to support cost-reflective pricing, demand response, and smart 'behind-the-meter' virtual power plants.

The need to efficiently sequence economy-wide decarbonisation further complicates the transition in electricity. The NEM needs to transition to near-zero emissions while maintaining high reliability. At the same time, other sectors — buildings, manufacturing, mining, and transport — must shift to electricity to reduce their own reliance on fossil fuels. But if we electrify other sectors while coal still dominates electricity generation, we could unduly prolong the lives of coal power stations. This, in turn, could jeopardise our ability to meet near-term emissions reduction targets.

The problem of emissions reduction in electricity generation therefore cannot be divorced from broader considerations:

- meeting state and national reliability standards (such as the NSW Energy Security Target and the National Electricity Market's interim reliability measure)
- minimising costs to consumers
- prioritising electricity decarbonisation *before* other emitting sectors substantially electrify and decarbonise
- ensuring emissions fall fast enough to meet our interim legislated targets
- providing policymakers with flexibility to ramp up climate change mitigation efforts, including Australia's 2035 Nationally Determined Contribution.

Above all, this requires a strategic approach to policy that avoids undue risk and uncertainty to private investment.

State and Commonwealth policies supporting the net zero electricity transition are discussed in detail in Appendix B. But additional actions are needed. The next section discusses potential actions.

Further reforms to minimise transition costs in the electricity sector

In August 2023, the Australian Energy Market Commission (AEMC) released its final report, *Review of the Regulatory Framework for Metering Services* (AEMC, 2023). It found significant net economic gains are possible from speeding up digital 'smart' meter installation in New South Wales and the ACT, with the aim to give all users smart meters by 2030. This followed the NSW Productivity Commission's May 2021 recommendation to evaluate a quicker rollout of smart meters in the state, coupled with mandatory cost-reflective retail pricing.

Mandating cost-reflective retail electricity tariffs

Most NSW retail electricity customers pay a flat rate tariff for their electricity regardless of when it is used, comprising:

- a daily fixed charge
- a flat electricity usage charge per kWh.

This pricing approach has traditionally been used because analogue meters could only tell *how much* electricity a customer used, not *when* it was used.

Smart meters offer opportunities to move beyond this model. These devices measure when customers use electricity and how much. Energy use is recorded in 30-minute intervals and this information is transmitted directly to retailers. Smart meters are complemented by other digital innovations — online platforms and applications — that signal near-term prices to consumers. Smart household appliances are also an emerging technology.

Depending on the extent of consumer behavioural change, households and businesses could achieve significant bill savings from digital technologies. For example, customers with smart meters can enjoy reduced 'solar soaker' tariffs offered by distributed network service providers (DNSPs) when variable renewable energy is abundant.

Despite the rollout of smart meters, many customers still opt for flat-rate tariffs. This is perhaps because it gives them more certainty over their bill or because they have an aversion to change. But flat rate tariffs are not reflective of the system costs of electricity at specific times. They don't provide consumers with the incentive to smooth energy demand over time. The electricity system — generation, storage, and transmission and distribution infrastructure — must therefore be built to ensure high reliability during periods of mostly unmitigated peak demand.

Mandatory, cost-reflective electricity tariffs would allow comprehensive management of demand by all users. It would have the following benefits:

- consumers would receive the power they need in peak periods while deferring non-essential usage into the off-peak period in exchange for bill savings
- containing system demand in peak periods would reduce stress on current assets, maximising reliability, minimising maintenance costs, and moderating new capital expenditure
- system-wide cost savings would minimise pressure on customer bills, limiting pressure for *ad hoc* interventions in the market that risk unintended consequences and additional costs.

The NSW Government should investigate retailer regulation to support transitioning all electricity customers onto mandatory cost-reflective tariffs. Box 5 shows there are a variety of pricing options. (It may be more appropriate to set minimum requirements rather than mandating specific tariffs.)

Box 5: More cost-reflective residential tariffs

There are options available for electricity retailers to charge customers for electricity in a more cost-reflective way. Examples include:

- **Time-of-use tariffs**: the retailer sets higher usage charges for peak evening and seasonal periods and lower charges during off-peak periods. Many customers in Australia already have time-of-use tariffs, with some retailers offering it as a default for smart meter customers.
- **Critical peak pricing**: the retailer charges a higher usage charge on days with very high demand, typically 10-15 days a year. Often this is communicated to customers a day in advance via text message.
- **Demand tariffs**: include a third charge to the bill based on the highest amount of power used during peak periods. Demand tariffs are already used for large commercial customers and are available for residential customers from some retailers.
- **Real time tariffs**: the retailer passes through the cost of wholesale electricity directly. Around half of electricity customers in Spain currently current receive electricity using a real time tariff (Red Eléctrica, 2024).

Smart meters are already required in all residential and business developments and when existing metering systems are replaced. But as of April 2024 DCCEEW estimates New South Wales to have the lowest smart meter penetration of NEM-participating states, at 44.3 per cent. This is slightly behind Queensland and South Australia — at 45.2 and 47.9 per cent respectively — and well behind Victoria, with greater than 99 per cent.

An effective demand management approach will improve system efficiency only when several challenges are overcome. Among them is the need for a critical mass of smart meters providing detailed data on the retail market. This will provide retail businesses with the information they need to pass through bill savings when customers change their usage to low-cost periods. This will ensure the benefits of lower costs flow to consumers. But regulatory intervention is needed to expedite the rollout. Moreover, regulation that mandates cost-reflective pricing is essential to maximising savings in system costs digital technologies and demand management offer.

As the NSW Productivity Commission's 2021 White Paper flagged, v*oluntary* cost-reflective pricing limits the demand management benefits of peak pricing, and so contributes little to containing system costs. Inefficiencies arise from such a system as follows:

- lower off-peak tariffs benefit users with relatively high off-peak use, so these customers would choose the cost-reflective offer
- but if standard offers continue, they would be chosen by customers with high peak use who are unwilling and/or unable to shift much demand into the off-peak period
- the system would therefore continue to be built for largely unmitigated peak demand, with no significant containment of overall system costs.

Implementing virtual power plants

The potential of consumer energy resources to moderate costs should not be understated. More recent modelling by AEMC (2024a) estimated cost savings of up to $2 billion (net present value). Box 6 illustrates how virtual power plants (VPPs) can enhance the two-sided electricity market now emerging to reward customers while containing utility-scale generation and network investment. AEMO (2024b) estimates that without effective coordination of consumer batteries, the grid will need $4.1 billion of additional investment. That extra cost would ultimately be borne by energy consumers.

In July 2024 the AEMC made a draft determination (2024b) on price-responsive resources for the NEM. The draft determination proposes three changes:

1. allowing aggregated consumer energy resources, including VPPs and community batteries, to be scheduled and dispatchable
2. creating a short-term incentive payment to drive participation in dispatch
3. introducing monitoring and reporting functions to better understand the forecasting challenges and errors from unscheduled price-responsive resources.

Box 6: The potential of VPPs

As the electricity sector decarbonises and becomes more reliant on variable renewable energy, harnessing the capacity of behind-the-meter energy assets will play an important part in maintaining grid reliability.

A VPP connects disparate behind-the-meter assets — home batteries, electric vehicles, and solar panels — and allows them to be centrally controlled, effectively functioning as a standalone power plant. A VPP can be activated very quickly to address frequency and voltage imbalances and local disruptions or disturbances. This helps to keep the electricity grid stable. A VPP can also be deployed in a standard manner to provide cheap, renewable energy to the grid.

One of the successful projects in the NSW Firming Tender Round 2 was a combined three VPPs with total capacity of 95 MW and minimum duration of two hours. This project is currently slated to be Australia's largest of its kind when it begins operating in 2025-26. The three VPPs will help New South Wales manage the exit of its ageing coal-fired power plants.

Allowing the full integration of these technologies — including through the Roadmap and CIS — will support a more efficient, reliable, and secure system, containing costs as the NEM decarbonises.

These reforms would be in addition to those established by the NSW Consumer Energy Strategy, with similar benefits. The Strategy is a suite of policies to support households and small businesses to reduce their energy consumption and invest in consumer energy resources. Programs and incentives established under the Strategy include:

- helping apartment residents invest in solar systems
- energy saver and appliance energy performance initiatives
- home battery incentives.

Construction sector capacity and the electricity transition

Construction sector constraints will have a large effect on the speed of electricity decarbonisation. The May 2024 ESOO (AEMO, 2024g) update shows the possible risks to timely delivery of replacement generation and transmission capacity. The market operator now registers delays to already committed generation and network projects, including the following:

- **EnergyConnect** – a transmission link with South Australia. Stage 1 has been delayed by four months, and Stage 2 by 12 months.
- The **Central-West Orana transmission** link to the pilot renewable energy zone has been delayed by 11 months from September 2027 to August 2028.
- The **Orana** and **New England Solar Farm Battery Energy Storage Systems** has been delayed by 13 months, and 30 months respectively.
- The **Riverina solar farm** and **Sapphire wind farm**, both delayed by 18 months.

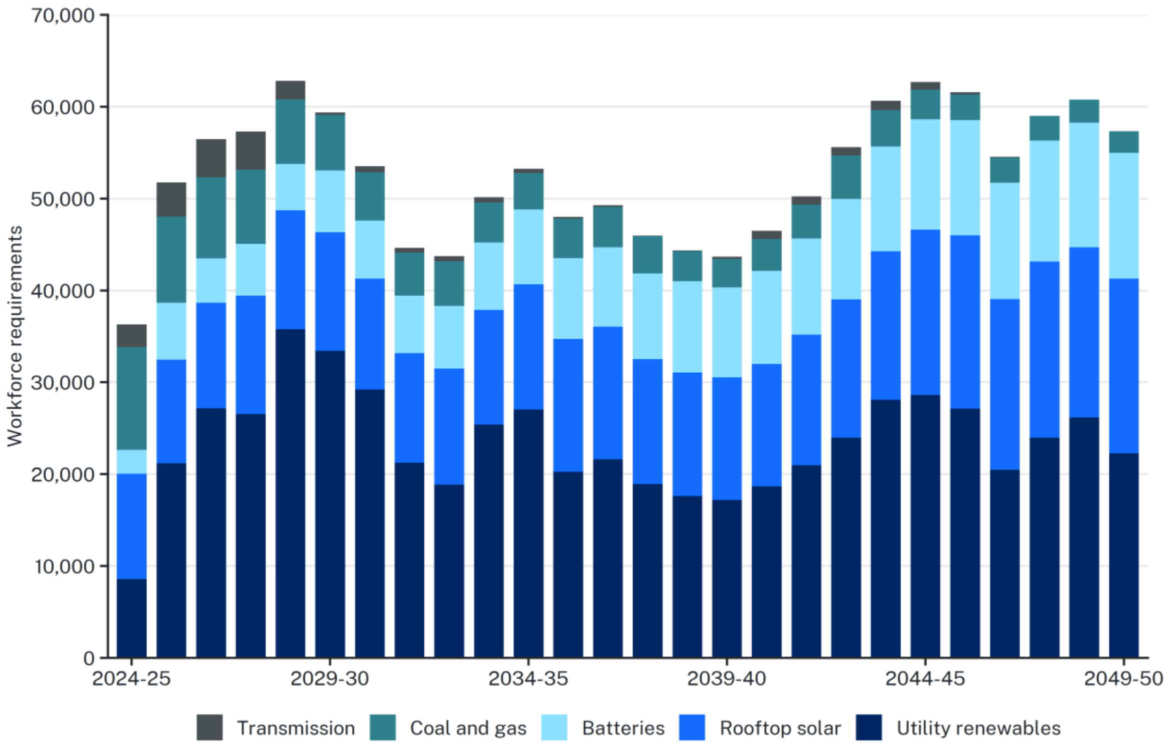
AEMO has already seen the cost of new transmission capacity rise by 30 per cent since 2022. This is attributed to global competition for materials and capital and to domestic labour supply constraints.

Scarcity of construction sector resources has second-round impacts that can adversely impact the cost of living. The electricity transition is an investment task that must be paid for. The more public infrastructure expenditure competes with the private sector for limited capacity, the higher the costs that must be recovered from households and businesses.

The 2024 *Integrated System Plan* (ISP) estimates more than 60,000 skilled workers will be needed to build and maintain an increasingly low emissions NEM (Figure 18). This represents an increase of up to 30 per cent in projected labour demand in most years compared to AEMO's 2022 estimates. As the most populous state, New South Wales will employ a significant proportion of these workers, if they can be induced here.

Figure 18: The net zero transition will require additional highly skilled workers

Workforce needs for delivery of utility-scale capacity and consumer energy resources, NEM (2024-25 to 2049-50)



Source: (AEMO, 2024b).

Stakeholder feedback on the ISP called for a 'delivery risk' scenario that included supply chain constraints and shortages of skilled labour. Stakeholders also asked AEMO to publish detailed electricity sector workforce projections sooner. This reflected concerns that labour might not be available to deliver energy projects in a timely and cost-effective manner. To support the electricity transition, New South Wales needs to take action to secure a reliable supply of construction-sector workers, across all qualifications and skills levels.

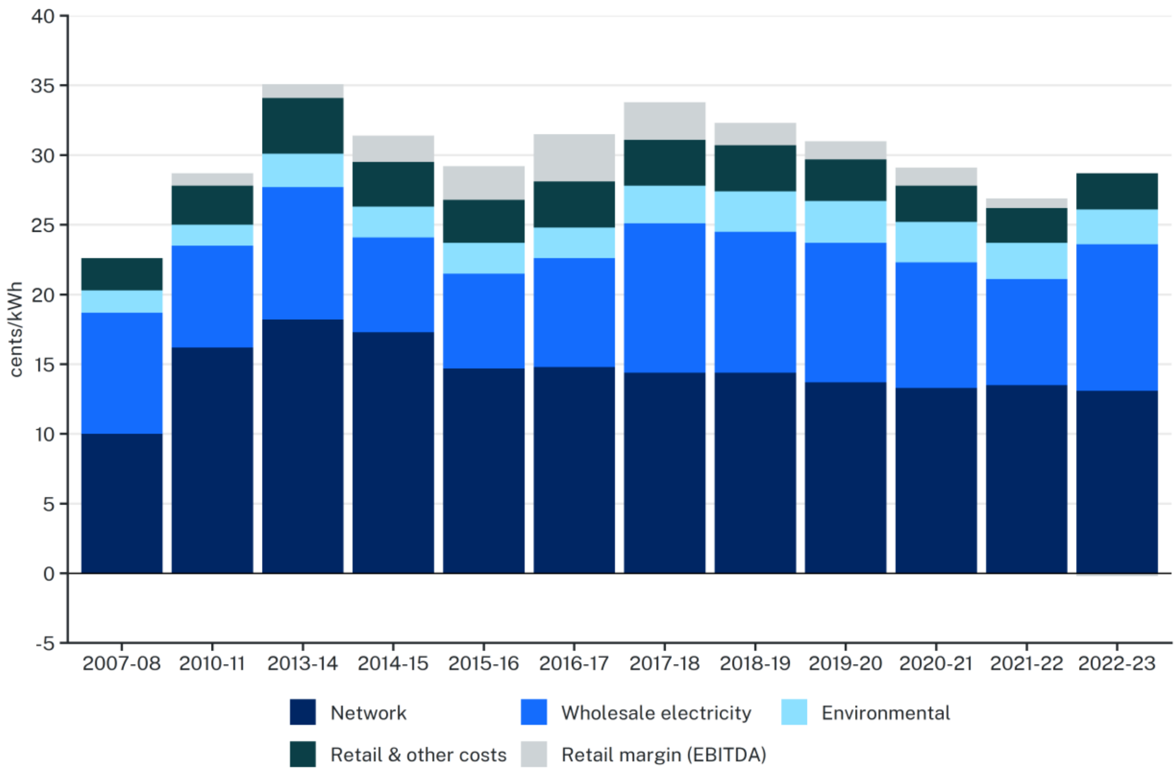
Supply chain constraints and capital availability also limit the speed of electricity's net zero transition. New South Wales is competing domestically and internationally for solar panels, wind turbines, batteries, high-voltage transmission lines, synchronous condensers, and transformers. The ISP estimates, in a supply chain-constrained scenario, the total renewable energy share could be as low as 68 per cent by 2030. This would be well less than the Commonwealth's 82 per cent target. Access to these inputs over the next decade will help determine whether the State's interim legislated emissions reduction targets can be met.

Improving equity by containing costs in the electricity transition

Focusing too heavily on supply-side solutions to maintain reliability during the electricity transition could incur system costs higher than is necessary to keep the lights on. Ultimately, the burden of cost recovery in the electricity system falls on consumers. Network costs (transmission lines, substations, and poles and wires) and wholesale costs (generation, peaking, and storage capacity) overwhelmingly determine the size of customer bills. Of the two components, network costs are the largest, comprising 46 per cent of the average NSW electricity customer bill in 2022-23 (Figure 19). Economically disadvantaged and socially marginalised consumers will be impacted the most by over-investment in network infrastructure.

Figure 19: Network costs are almost half of the average NSW electricity bill

Components of average NSW electricity bill, cents/kWh 2022-23



Source: (ACCC, 2023).

The alternative, cost-effective approach is to efficiently balance investment in the supply side with management of the demand side of the electricity market. It has been shown that disadvantaged groups use as little energy as possible even if it impacts their wellbeing (PIAC, 2024). Conversely, accelerating energy efficiency improvements, maximising the potential of digital technologies, and mandatory cost-reflective pricing can disproportionately benefit them. By efficiently transitioning both sides of the market, the journey to net zero can maximise the welfare of consumers and minimise impacts on lower-income groups.

The role for gas in a net zero electricity system

To maintain reliability, variable renewable energy must be balanced — or 'firmed' — with dispatchable electricity. Based on the successful 2023 Commonwealth-NSW 1,075 MW firming tender, much of the capacity needed is likely to be provided by grid-scale batteries and demand response. Batteries are enjoying declining generalised costs. Pumped hydro projects, however, are riskier, given their large capital costs and long planning and delivery times. Delays and cost overruns in the delivery of the Snowy 2.0 project are illustrative: originally announced with a 2022 delivery date, it is now scheduled to come online in 2028.

AEMO's 2024 *Integrated System Plan* (2024b) affirms that the lowest cost electricity through the energy transition will come from renewables firmed with a combination of storage and peaking generation. There may, therefore, remain a role for gas for firming capacity for a long time to come, especially if long-duration storage delivery times continue to disappoint.

Renewables and batteries can still achieve a very high share of generation capacity — close to 100 per cent in some scenarios — even when combined with gas peaking generation. But attempting a 100 per cent renewables system may prove prohibitively expensive (Wood & Ha, 2021). A net zero electricity system could require gas generation as a firming technology for the foreseeable future, with its emissions offset by Australian Carbon Credit Units.

AEMO's 2024 *Integrated System Plan* estimates having sufficient gas generation capacity to back up renewable energy will require $230 million for fuel and fuel storage. (The gas stored might be a combination of natural gas and renewable fuels such as 'green' hydrogen.)

The *2024 Gas Statement of Opportunities* (AEMO, 2024f) forecasts seasonal gas supply gaps to emerge from 2026 and annual supply gaps from 2028. Growth in gas-generated electricity demand is expected from the early 2030s, with significant growth in peak consumption, as is declining gas supply. This is expected to more than offset declining gas demand from residential, commercial, and industrial consumers.

A combination of solutions will be required to mitigate shortfalls. This could include acceleration of efforts to electrify residential, commercial, and industrial premises. State levers available to quicken this transition will be discussed further in later volumes of the *Achieving net zero* series.

Appendix A: Marginal abatement costs, carbon values, and policy evaluation

The *marginal abatement cost* (MAC) of a decarbonisation solution is equal to the net present value of the solution's cost (including both capital and operation expenditures) divided by the emissions reduction achieved over the solution's lifetime. This calculation produces the marginal cost of abatement per tonne of emissions. The carbon value for a particular year is then derived from the maximum marginal abatement cost for that year. This is the cost associated with the last (and most expensive) solution required to meet that year's emissions reduction target.

Importantly, these carbon values are consistent with the cost to meet our net zero targets; they do not price the cost of damage to the environment caused by greenhouse gas emissions. As a result, carbon values should not be used to determine the costs of emissions or any level of government subsidy or tax. Carbon values are highly sensitive to changes in baseline emissions projections and so only the most up-to-date carbon values should be used.

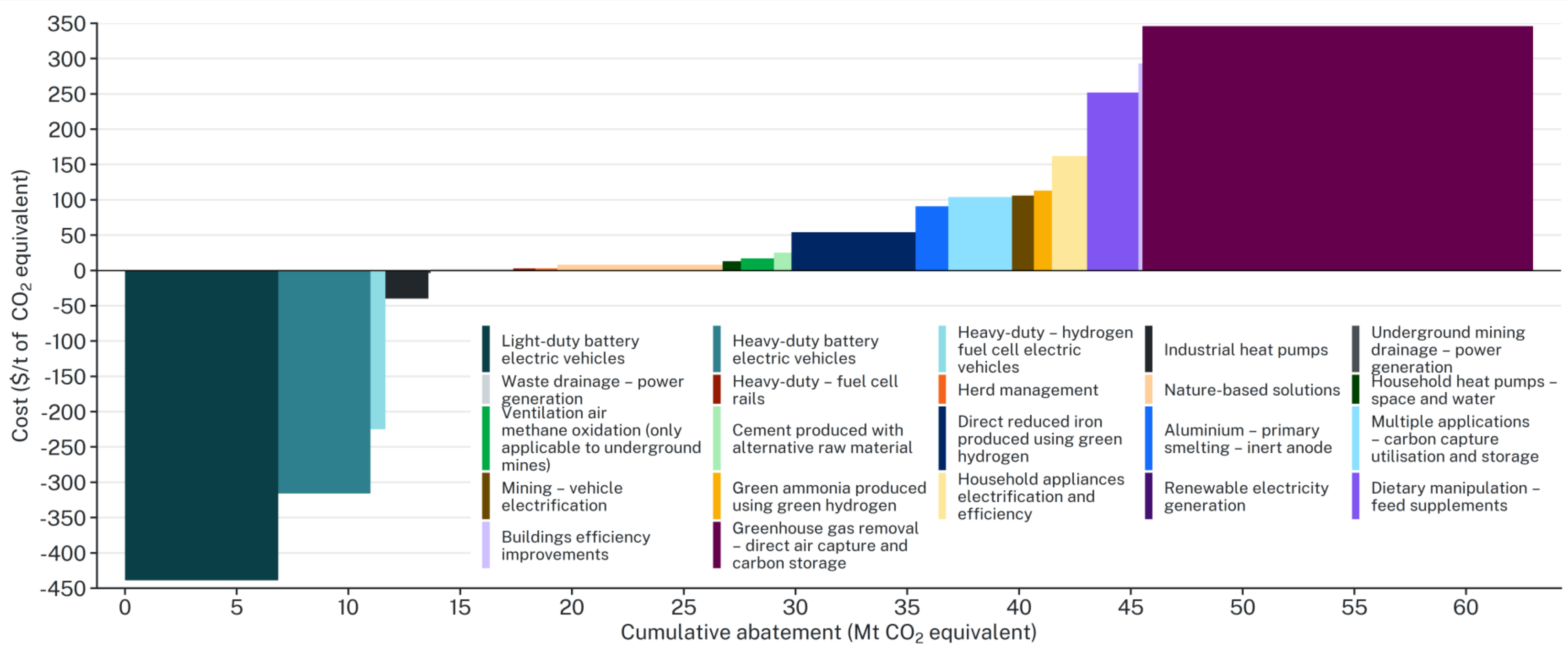
Box 7 provides an example of this approach using the 2050 net zero target.

Box 7: Closing the 2050 net zero gap using carbon values

Using the most recent baseline emissions projections for New South Wales, the gap to net zero in 2050 will be 60 Mt. Based on the 2050 MAC curve, the carbon value is around $350/tonne. This is the marginal cost of direct air carbon capture and storage, an inefficient and expensive abatement method. In total, it would cost $2.4 billion to abate the final 60 Mt of emissions fully utilising all available abatement solutions.

Figure 20: Marginal abatement cost curves allow us to estimate the cost of emissions reduction

Marginal abatement cost curve, 2050



Note: This MAC curve is for illustrative purposes only; marginal abatement costs and abatement volumes are liable to change.
Source: (DCCEEW, 2024b).

Appendix B: Commonwealth and State policy to support the electricity transition

In August 2022, the Commonwealth, state, and territory energy ministers agreed to include emissions reduction in the **National Electricity Objective**, National Energy Retail Objective, and National Gas Objective within the national energy legislative framework. This requires AEMO, the Australian Energy Regulator and AEMC to consider the achievement of Commonwealth, state, and territory emissions reduction targets alongside existing objectives, including reliability, security, price, quality, and safety, in relevant decision-making processes.

In November 2023, Australia's energy ministers agreed to expand the **Capacity Investment Scheme** (CIS) to support delivery of 9 GW of zero-emissions dispatchable capacity and 23 GW of utility-scale variable renewable energy. This built upon the first pilot competitive auction delivered in collaboration with New South Wales in 2023 to procure 1,075MW of new firming capacity. Successful projects include a 415MW/1,660MWh four-hour battery in Orana and the 500MW/ 1,000MWh two-hour battery at Liddell.

The CIS acts as a guarantee on returns. If energy prices fall below an agreed 'floor', energy companies will be subsidised for this shortfall. Equally, if prices rise above an agreed ceiling, these supernormal profits will be returned to government. This effectively removes risk and gives some certainty to investors. However, the costs and prices floors and ceilings will remain commercial-in-confidence. The scheme will be effective in bringing online renewables in the short term. But it is likely that the costs will not be felt until later in the decade, when more renewables are online, and energy prices are more likely to fall below the agreed floor.

The CIS is modelled on **Long-Term Energy Services Agreements** (LTESAs) awarded through competitive auctions by AEMO Services as the NSW Government's Consumer Trustee.[17] LTESAs give generation investors the option to sell their output at an agreed minimum price to a scheme financial vehicle, which on-sells output to retailers. Any losses incurred by the vehicle are passed on to distribution companies for recovery – ultimately from consumers.

LTESAs are also available for investors in long- and short-duration storage and demand response projects. These LTESAs are made as financial derivative contracts to access annuity payments.

LTESAs are one component of the **NSW Electricity Infrastructure Roadmap**, enacted by the *Electricity Infrastructure Investment Act 2020* (NSW). The Roadmap requires a minimum 12 GW of generation and 2 GW of long-duration storage to be constructed by 2030. It coordinates investment in generation, firming, and transmission infrastructure, timed for delivery when, or before, coal generators close. Other components of the Roadmap:

[17] AEMO Services is a subsidiary of AEMO and was created that way to be independent and transparent in carrying out its functions as the NSW Government's Consumer Trustee. Shareholders in 'AEMO Limited' are AEMO and NSW Government.

1. **Renewable Energy Zones** (REZs) are located in five regions: Central-West Orana (the first 'pilot' REZ), followed by Hunter-Central Coast, New England, Illawarra, and Southwest.
2. **Transmissions rights** will be competed on by new generation projects within or supporting REZs to secure access rights to new transmission.

The **Energy Security Safeguard** complements the CIS and Roadmap as a cost-effective abatement program. It comprises four elements:

1. The **Energy Savings Scheme** provides financial incentives to install energy-efficient equipment and appliances in households and businesses. The estimate for the cost of abatement is very low at $41 per tonne of CO_2-e.
2. The **Peak Demand Reduction Scheme** (PDRS) moderates system demand when it is otherwise at its peak, containing overall costs, and providing incentives for the uptake of small-scale storage.
3. The **Renewable Fuel Scheme** was established to encourage the production of green hydrogen in New South Wales. The Scheme sets a target for green hydrogen production that will gradually increase to eight million gigajoules by 2030. Producers will earn certificates for each gigajoule and can sell them to liable parties to meet their obligations under the *Electricity Supply Act 1995* (NSW). Liable parties are natural gas retailers and large users who do not purchase gas through a retailer.
4. Finally, in November 2023, Australia's energy ministers agreed to develop an opt-in **Orderly Exit Management Framework** for NEM-participating generators. The Framework is scheduled to be enacted in South Australia before the end of 2024.

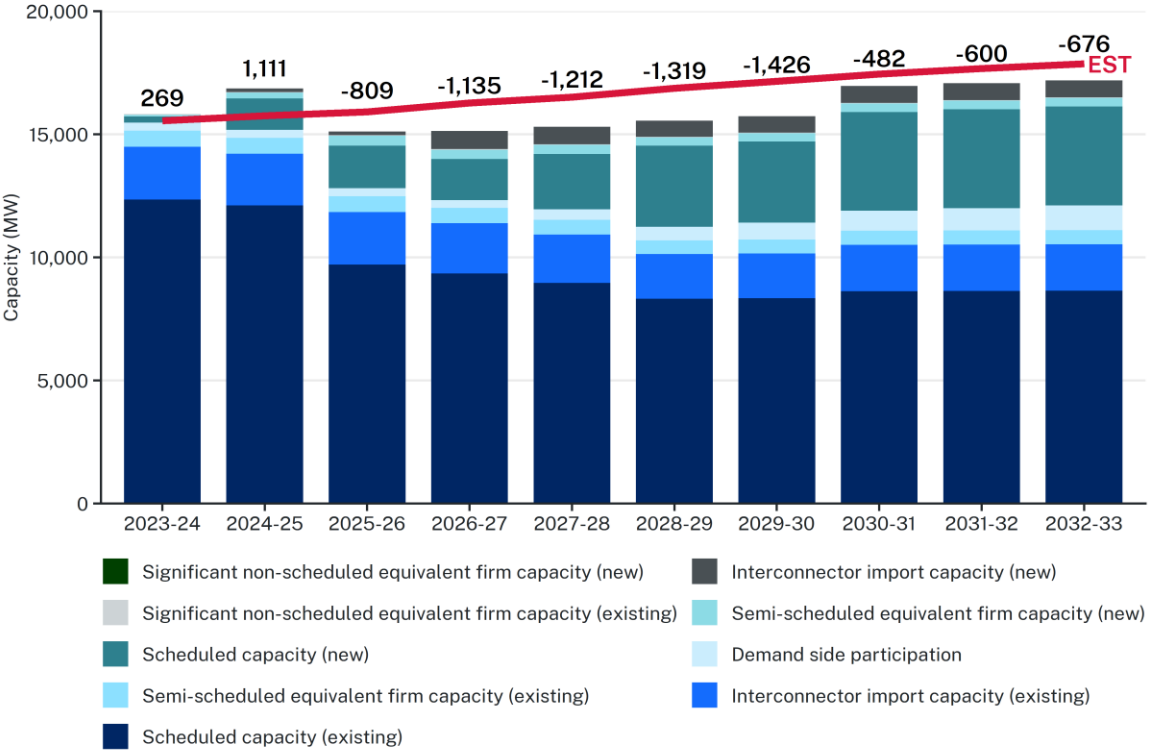
   The Framework provides options to replace the capacity of the thermal generator or temporarily seek an extension to maintain the reliability and security of the energy system. When a generator's planned closure date is brought forward, the relevant minister can seek an assessment of whether an electricity shortfall will emerge and what options are available to close it. Any estimated shortfall will be filled by the lowest-cost solution available. This can include voluntary negotiations to delay the generator's closure.

Appendix C: NSW Energy Security Target & Eraring

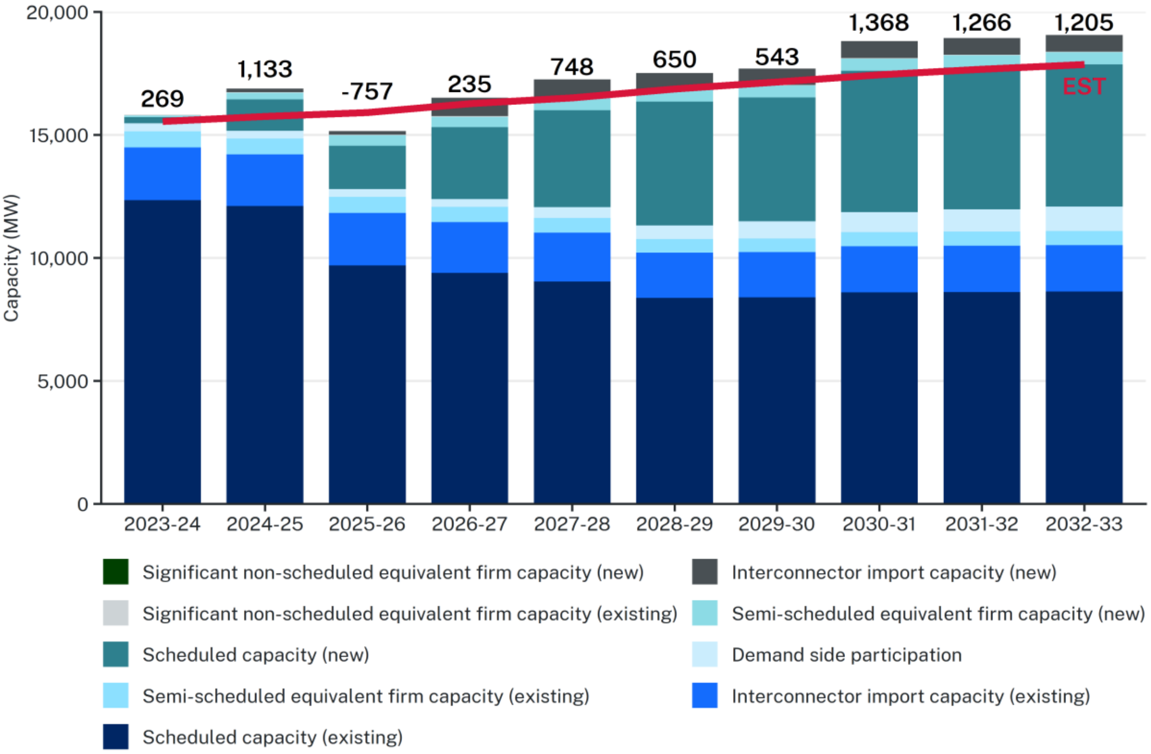
Incorporating an assumption that Eraring would close in August 2025 led AEMO to forecast a breach of the Energy Security Target (EST) from 2025-26 to 2032-33 in the 'central' scenario (Figure 21). The 'infrastructure tenders 2 and 3 with project development delays applied' scenario showed a breach would only occur in 2025-26. (It is important to note that the 757 MW gap in 2025-26 includes delays to projects which are currently proceeding *on or ahead* of schedule, such as the 850 MW Waratah Super Battery.)

Figure 21: Delays to infrastructure commissioning risk an electricity shortfall

ESTM 'central' scenario. Figures above bars indicate extent to which capacity exceeds Energy Security Target or falls short (negative numbers).



ESTM 'infrastructure tender 2 and 3 with project development delays applied' scenario. Figures above bars indicate extent to which capacity exceeds Energy Security Target or falls short (negative numbers).



Source: (AEMO, 2023).

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