




CLIMATE
CHANGE
AUTHORITY

2023 ANNUAL PROGRESS REPORT

October 2023



The authority recognises the First Nations people of this land and their ongoing connection to culture and country. We acknowledge First Nations people as the Traditional Owners, Custodians and Lore Keepers of the world's oldest living cultures, and pay our respects to their Elders.

This report was printed on Ngunnawal land.

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27 October 2023

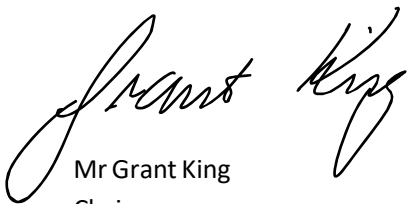
The Hon Chris Bowen MP
Minister for Climate Change and
Energy Parliament House
CANBERRA ACT 2600

Dear Minister Bowen

In response to your request of 21 July 2023, and in accordance with section 14 of the *Climate Change Act 2022*, the Climate Change Authority submits to you its advice to inform the second annual Climate Change Statement to Parliament, entitled *Second annual progress report*.

Section 14(6) of the *Climate Change Act 2022* requires the authority to publish a copy of its advice on its website no later than the day you table your annual Climate Change Statement in the Parliament. The authority is also required by the Act to cause its advice to be tabled no later than the day that you table your Statement, and within 15 sitting days after giving you the advice.

Yours sincerely



Mr Grant King
Chair



Mr Brad Archer
Chief Executive Officer

Acknowledgements

The authority would like to thank a number of government agencies and organisations for their assistance, including: the Department of Climate Change, Energy, the Environment and Water; the Clean Energy Regulator; the Department of Industry, Science and Resources; the Department of Infrastructure, Transport, Regional Development, Communications and the Arts; the Department of the Prime Minister and Cabinet; the Treasury; the Department of Foreign Affairs and Trade; the Bureau of Meteorology; and the Australian Bureau of Statistics.

The authority is also grateful to the individuals and organisations who contribute time and expertise to the Authority's broader work, including those who provide submissions and participate in consultation. These contributions help inform the authority's analysis and advice and will continue to shape our future Annual Progress Reports.

The views expressed in this Second Annual Progress Report are the authority's own and should not be taken as the views or positions of the entities listed above.



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Table of acronyms

Acronym	Meaning	Acronym	Meaning
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences	GW	Gigawatt
ABS	Australian Bureau of Statistics	GWP	Global Warming Potential
ACCU	Australian Carbon Credit Unit	HFC	Hydrofluorocarbons
AEMO	Australian Energy Market Operator	HTS	High Temperature Superconductors
AER	Australian Energy Regulator	ICCPR	International Covenant on Civil and Political Rights
APR	Annual Progress Report	ICE	Internal Combustion Engine
APRA	Australian Prudential Regulation Authority	IEA	International Energy Agency
ARENA	Australian Renewable Energy Agency	IPCC	Intergovernmental Panel on Climate Change
ASX	Australian Securities Exchange Ltd	IPPU	Industrial Processes and Product Use
CBAM	Carbon Border Adjustment Mechanism	IRA	<i>Inflation Reduction Act 2022</i> (United States)
CCA	Climate Change Authority	ISP	Integrated System Plan
CCS	Carbon Capture and Storage	ITMO	Internationally Transferred Mitigation Outcome
CCUS	Carbon Capture Utilisation and Storage	LNG	Liquified Natural Gas
CEC	Clean Energy Council	MERiL	Methane Emissions Reduction in Livestock
CEFC	Clean Energy Finance Corporation	MERNAP	Maritime Emissions Reduction National Action Plan
CFI	Carbon Farming Initiative	MLA	Meat & Livestock Australia
CO ₂ -e	Carbon Dioxide equivalent	MRV	Measurement, Reporting and Verification
COP	Conference of the Parties	Mt	Megatonne
CSIRO	Commonwealth Scientific and Industrial Research Organisation	MW	Megawatt
DAC	Direct Air Capture	NatHERS	Nationwide House Energy Rating Scheme
DAT Act	<i>Data Availability and Transparency Act 2022</i>	NDC	Nationally Determined Contribution
DAFF	Department of Agriculture, Fisheries and Forestry	NEM	National Electricity Market
DCCEEW	Department of Climate Change, Energy, the Environment and Water	NEPS	National Energy Performance Strategy
EPBC	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	NGER	National Greenhouse and Energy Reporting
FY	Financial year	NGFS	Network for Greening the Financial System
FPIC	Free, Prior, and Informed Consent	NRF	National Reconstruction Fund
GEMS	Greenhouse and Energy Minimum Standards	OECD	Organisation for Economic Cooperation and Development

PV	Photovoltaic
R&D	Research and Development
RD&D	Research, Development and Demonstration
REZ	Renewable Energy Zones
RIT-T	Regulatory Investment Test for Transmission
SRES	Small-scale Renewable Energy Scheme
STEM	Science, Technology, Engineering, and Mathematics
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNHRC	United Nations Human Rights Committee
USD	US Dollar
WEM	Wholesale Electricity Market

Key messages

Human activity is changing the climate in ways that are dangerous to our way of life. Current climate change policies around the world are taking the Earth to a 2.8°C temperature rise by the end of the century. We are already seeing dangerous impacts from 1.1°C of warming. Urgent action is needed to put the world on a much safer climate trajectory consistent with the Paris Agreement goals.

With broad government, business and community support, and the Parliament legislating emissions reduction targets, Australians have agreed to take strong action on climate change. Emissions must decline on average by 17 Mt CO₂-e a year from now until the end of the decade to achieve Australia's 2030 target.

Momentum in the form of emissions reduction targets and policies are yet to translate into the outcomes we need. Since 2020, emissions have been declining at only slightly more than half the required rate and, in the 12 months to June 2023, rose slightly.

Meeting or surpassing Australia's 2030 target is crucial – otherwise achieving the more ambitious but essential targets needed down the track will be that much harder. The authority's assessment is there are real risks of falling short, but working together we can succeed. The challenge is: 'are we willing to do what it takes?'

Now is the time to get serious about Australia's just transition to a prosperous, net zero economy. There are some hard decisions we, as a society and as individuals, need to make, including getting the balance right between accelerating action and involving communities and individuals in decisions that affect them.

The government's plans for reaching the 2030 target relies heavily on meeting its 82% renewable energy target. Renewables have been growing strongly – more than doubling in the share of electricity generation over the past seven years, from 14% in 2015 to 32% in 2022. To highlight the size of the challenge ahead, we have now until 2030 to increase the share of renewables from 32% to 82%. In other sectors of the economy, emissions have mostly been flat or, in some cases such as transport, have been rising.

The risk of falling short of Australia's 2030 target should be addressed by greater support, from governments at all levels and communities, for the development of renewables and related infrastructure and the pursuit of emissions reductions in other sectors.

With 2030 only seven years away, it is important that the many policies being put in place by the federal, state and territory governments are being implemented effectively. Timely and transparent reporting on policy implementation will lift community confidence that targets can be met.

Summary

Human activity is causing the world's climate to change in ways that are dangerous to humans and the natural ecosystems we rely on. Strong and urgent action is needed for a safer climate trajectory.

This is what 1.1°C degrees of warming has looked like this year: news about wildfires in countries such as Hawaii, Spain, Greece and Canada; floods in China, India, Pakistan and Nigeria; and heatwaves in the United Kingdom, Europe and India. July 2023 was the hottest month in over a century of global temperature records, and thousands of climate records have been exceeded worldwide. The risks of cascading effects and tipping points are mounting – winter sea ice in Antarctica was at a record low in 2023 and ocean currents are slowing. Only strong and urgent action to reduce greenhouse gas can get us on a much safer climate trajectory.

Earlier this year, the Intergovernmental Panel on Climate Change reported that current policies are taking the world to a 2.8°C temperature rise by the end of the century. The first Global Stocktake of progress towards meeting Paris Agreement goals is underway. It will provide a vital update for countries when they meet at the end of the year. The early signs are concerning. The United Nations Secretary-General, António Guterres, foreshadowed in a recent speech:

Countries are far off track in meeting climate promises and commitments. I see a lack of ambition. A lack of trust. A lack of support. A lack of cooperation. And an abundance of problems around clarity and credibility. ...

We are hurtling towards disaster, eyes wide open — with far too many willing to bet it all on wishful thinking, unproven technologies and silver bullet solutions.

It's time to wake up and step up. It's time to rebuild trust based on climate justice. It's time to accelerate the just transition to a green economy. Limiting the rise in global temperature to 1.5°C is still possible. We must consider this as a moment of hope. But it will require carbon emissions to be cut by 45 per cent [from 2019 levels] by 2030 (UN, 2023).

This stark warning and call to action sets the context for this Annual Progress Report. As a small, open and emissions-intensive economy, and one of the most vulnerable to the impacts of climate change among developed nations, it is critical that Australians work together to take strong and urgent action to reduce emissions and increase our resilience to climate impacts.



With broad government, business and community support for strong action and the Parliament legislating Australia's targets, Australians have agreed to act.

Australia has legislated targets of a 43% reduction in emissions in 2030 compared with 2005 and net zero emissions by 2050. Now we must – together – commit to and take the actions necessary to achieve these targets.

Governments hold the policy levers required, including regulatory, fiscal, market-based and informational, to guide businesses and individuals to choices that support Australia's climate change goals. Meeting federal, state and territory targets will require a national strategy, implemented locally. The necessary changes go beyond the reach of any government acting alone.

Companies need to plan and invest for markets, in which governments, investors and consumers are demanding low and zero emissions goods and services if they are to survive and prosper in a decarbonising world. They will need to inform investors of the decisions they make about new low- and zero-emitting production processes, when these new technologies will be implemented, and the quantity and type of carbon offsets they plan to use, if any.

Investors, particularly institutional investors, are demanding that climate risks be disclosed, managed and priced in key financial markets globally. To help ensure that flows of private finance align with Australia's net zero ambitions, the government is mandating corporate climate risk disclosures, leading the development of sectoral plans, supporting the creation of green investment guides (sustainable finance taxonomy), and issuing green bonds to support climate-related and environmental projects.

Communities and the people who live in them play an important role in granting companies and governments the 'social licence' to make the changes required for decarbonisation to proceed, such as supporting new renewable electricity projects and installation of transmission lines. Every individual makes important choices on a daily basis about how they will participate and live in a decarbonising world, such as how to travel, how their superannuation is invested, and what products they buy.

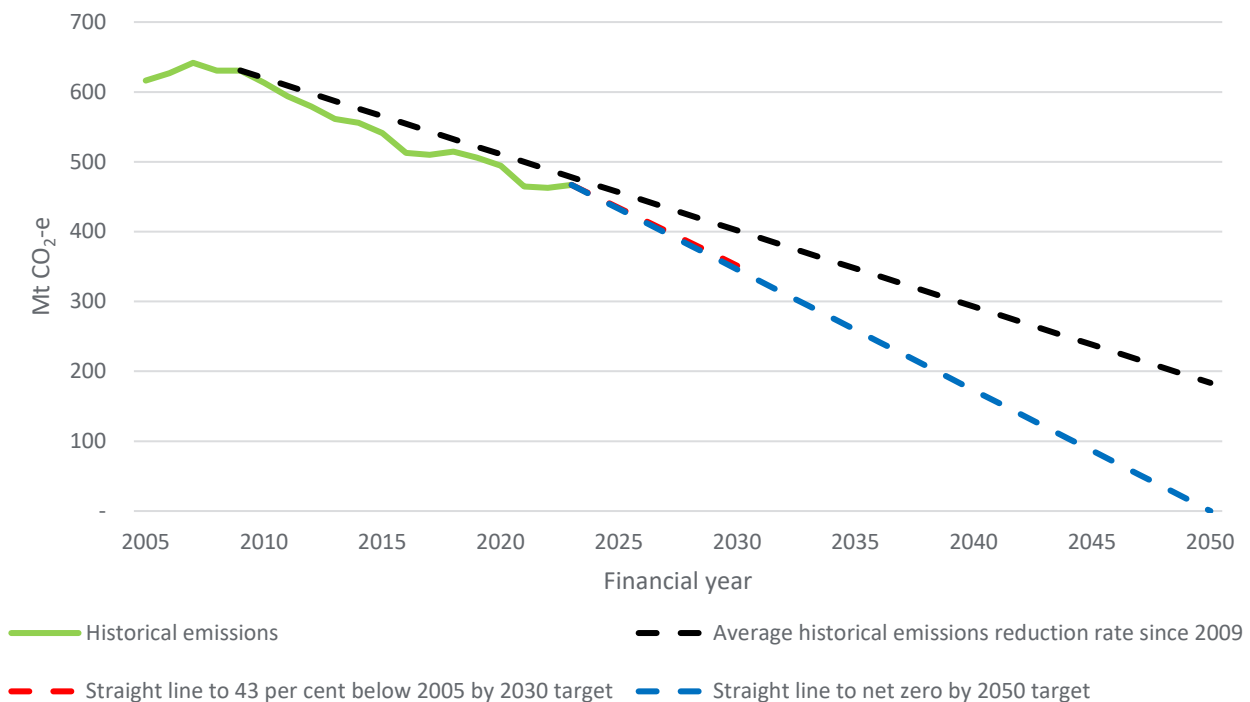


Australia is not yet on track to meet its 2030 targets. Ambition and momentum in the form of targets and policies must translate quickly into action and emissions reductions.

The Australian Government is pursuing a broad and deep climate change policy agenda, but that has not yet translated into the emissions reductions we need.

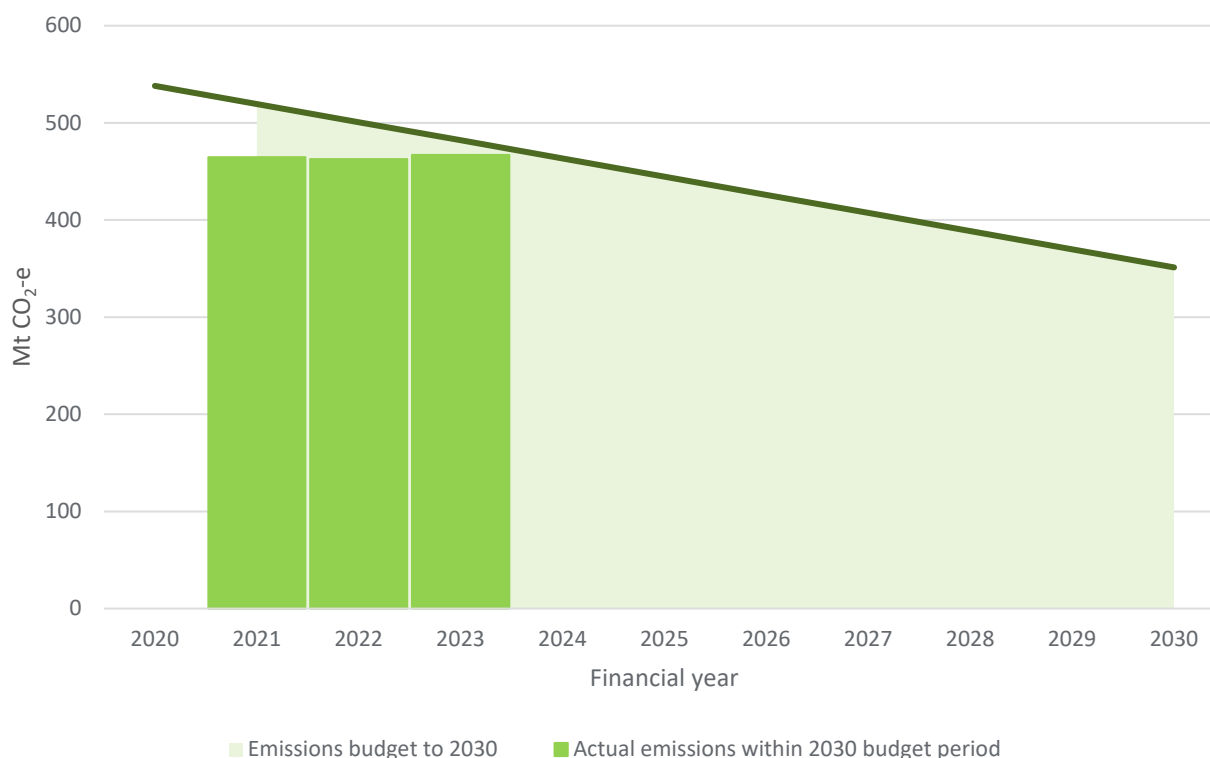
Australia emitted 467 million tonnes (Mt) CO₂-e in the year ending June 2023, which is 116 Mt CO₂-e more than the level we need to reach by 2030 if we are to meet the Paris Agreement target of a 43% reduction below the level of emissions in 2005. To achieve the 2030 target, Australia will need to decarbonise at an average annual rate of 17 Mt CO₂-e. In the year to June 2023, the government's preliminary estimates show emissions actually rose slightly.

Figure 1: Progress to Australia's 2030 emissions reduction target



As well as the 2030-point target of 43% below 2005 levels, Australia has another 2030 target under the Paris Agreement: an emissions budget for the decade 2021–2030 of 4,353 Mt CO₂-e. The emissions budget is defined to start from Australia's 2020 target emissions level, which was higher than actual emissions in that year. For the first few years of the decade Australia has been tracking under the straight-line trajectory used to calculate its emissions budget and is likely to be under it again this year. However, despite getting a head start, Australia will soon overshoot that trajectory unless emissions begin to decline rapidly.

Figure 2: Progress against Australia's 2021–2030 emissions budget



Notes:

- Includes preliminary estimates of emissions from April to June 2023.
- Source: (DCCEEW, 2023m)

It makes good sense to plan to decarbonise as quickly as possible because emissions reductions accumulate. Theoretically, Australia could leave action to meet the point target of 43% to ‘the last minute’ and make a steep, 116 Mt CO₂-e reduction in 2030. (For comparison, all the emissions from transport in Australia amount to just under 100 Mt CO₂-e.) Australia would achieve the point target but fail to meet its emissions budget. As set out above, Australia could instead reduce emissions by 17 Mt CO₂-e a year for the next seven years to 2030. This would result in 463 Mt CO₂-e less in the stock of greenhouse gases in the atmosphere by 2030, compared to leaving it to the last minute.

This annual progress report focuses on what it will take to meet Australia’s 2030 targets. Achieving them will enable even greater ambition for 2035 and pave the way for Australia to achieve its net zero target by 2050, or earlier. Failure to meet the 2030 targets will run the risk of a more expensive, disorderly and difficult task in the future, and some opportunities will likely pass Australia by.

Achieving Australia’s 2030-point target relies heavily on meeting the government’s 82% renewable energy target. The risks of falling short should be addressed by further action to support renewables and stronger pursuit of emissions reductions elsewhere in the economy.

The government intends the 2030 target to be met mostly from its 82% renewable energy target (roughly 37 Mt CO₂-e in 2030), and the reformed Safeguard Mechanism (also roughly 37 Mt CO₂-e in 2030) which applies to large industrial facilities (but also acts as an incentive for carbon offset projects under the Australian Carbon Credit Unit scheme).

Reducing emissions from electricity generation, which accounts for almost one-third of Australia’s total emissions, is critical in its own right and for facilitating emissions reductions in other sectors of the economy. This is because it opens up options for reducing emissions by switching away from emissions intensive coal, oil and gas and towards the use of clean electricity, such as in electric vehicles and electric hot water, cooking and heating, and in many industrial processes.

Electricity

Further action is needed to support the rapid deployment of renewables.

The combustion of coal and gas to generate electricity for public use accounts for 33%, or 153 Mt CO₂-e, of Australia's emissions.

Renewable energy provided 32% of Australia's electricity generation in 2022, (DCCEEW, 2023a). Achieving the government's 2030 target for renewables of an 82% share requires the rapid deployment of very significant amounts of wind and solar generation, together with the rollout of additional network infrastructure, adequate amounts of energy storage to provide reliability when there is insufficient wind and sun, an orderly exit of coal fired generation, and, where needed, solutions for ensuring electricity continues to be supplied safely and securely as the share of renewables rises.

The Australian and state and territory governments are pursuing a range of initiatives that are intended to ensure progress on these fronts. However, without further concerted action, Australia is likely to fall short of the 82% renewables target.

- The Australian Government does not currently have an active policy mechanism in place that ensures the necessary investment in renewables generation will be forthcoming. The states and territories own renewables targets collectively fall short of delivering 82% nationally.
- Deployment of large-scale renewable generation capacity – wind and solar farms – needs to at least double compared with the current rate. The authority's leading indicators point to an investment pipeline that is not as strong as it needs to be.
- Scheduled closures of coal fired power stations do not align with achieving 82% renewables.

Every percentage point we fall short of achieving 82% renewables equates to roughly 2 Mt CO₂-e that needs to be reduced elsewhere in the economy, if the overall target of a 43% reduction in emissions is to be achieved.¹ The risks of falling short should be addressed by further action to support the deployment of renewables, and the necessary investment in transmission and firming, and stronger pursuit of emissions reductions in other sectors of the economy.

Given shared responsibilities for the governance and regulation of electricity markets, there should be explicit agreement reached between the Australian Government and state and territory governments on the 82% target, with detailed plans and policies implemented to ensure all the conditions are in place for achieving it. The Australian Energy Market Operator's Integrated System Plan provides the starting point for such an agreement. There are various policy mechanisms already in place (for example, the federal Renewable Energy Target legislation, the Safeguard Mechanism, Rewiring the Nation and the Capacity Investment Scheme) that can be built upon to ensure there is sufficient investment in renewables and complementary infrastructure. In the absence of an agreed approach, the Australian Government will need to take more unilateral action.

The Australian Government is also developing a National Energy Performance Strategy. A strong strategy can accelerate energy efficiency savings in appliances, buildings and industrial equipment. Together with ongoing targeted support for small-scale renewables and storage, and continuing work on the integration of renewables into the electricity system, the strategy can contribute to the 2030 target and subsequent targets.

¹ In the Australian Government's 2022 Australia's emissions projections report electricity emissions are 16.78 Mt CO₂-e lower in 2030 in a scenario which assumes the 82% renewable electricity target is met compared to a scenario which reaches 73.42% renewable electricity generation in 2030. This equates to a 2.0 Mt CO₂-e per additional percentage point of renewable electricity generation in 2030.

Industrial facilities

The Safeguard Mechanism reforms are an important step towards reducing emissions from mining and manufacturing.

40% of Australia's annual greenhouse gas emissions (185 Mt CO₂-e) are associated with mining and manufacturing activity including: the burning of fuels for heating, steam and pressure; fugitive emissions released during the mining, processing and transport of coal and gas, and non-energy related emissions occurring during the manufacture of products such as iron, steel and cement.

138 Mt CO₂-e of these emissions are produced by around 215 large facilities that are covered by the Australian Government's recently reformed Safeguard Mechanism. As a result of the reforms, which represent a significant step forward in addressing emissions, covered facilities (those emitting more than 100,000 Mt CO₂-e per year) are required collectively to reduce their net emissions by 37 Mt CO₂-e to 100 Mt CO₂-e in 2029–30.

The international competitiveness of Australia's largest industrial facilities will increasingly be influenced by their ability to reduce their emissions as the world decarbonises. This is a national effort which will require dedicated investment from companies, support from the Australian Government, and the backing of the workforces and communities involved.

There are currently no limits on the use of offsets to meet baselines under the Safeguard Mechanism, meaning some of the abatement will be financed by Safeguard facilities but take place elsewhere in the economy, mainly in the land, agriculture and waste sectors under the ACCU Scheme. If a facility surrenders ACCUs equal to more than 30% of its baseline, it must submit a statement to the Clean Energy Regulator (CER) setting out why onsite abatement has not been undertaken. The authority will monitor the use of ACCUs under the Safeguard Mechanism each year. The Government has indicated it will seek the authority's advice on the extent to which on-site abatement is being driven by the reforms, and whether any additional incentives are required, as part of a review of the Safeguard Mechanism in 2026–27.

Beyond the Safeguard Mechanism, the government should continue to explore opportunities to accelerate emission reductions at industrial facilities, including with a view to increasing the contribution of the sector to the achievement of Australia's 2030 target. Such opportunities include mandating international best practice for reducing methane emissions from flaring and for methane leak detection and remediation, requiring the sequestration of reservoir CO₂ emissions at all natural gas extraction facilities and exploring options for reducing methane emissions from open cut coal mines.

Transport

Accelerating the take-up of electric vehicles will provide a much-needed boost to emissions reductions and save motorists money.

Emissions from transport account for 21% (98 Mt CO₂-e) of Australia's greenhouse gases. Over half of those emissions come from light vehicles such as cars, utes and SUVs, and these emissions are growing. Australia is well behind the United States, Europe and many other countries when it comes to regulating the greenhouse gas emissions from passenger motor vehicles.

Battery-powered electric vehicles provide the ready solution for addressing emissions from Australia's passenger motor vehicle fleet. Based on the projected emissions intensity of the electricity grid in 2030, the authority estimates that for every 5% greater share of electric vehicles, emissions are reduced by around 2.5 to 2.6 Mt CO₂-e.

The market for electric vehicles globally is maturing, with the range and availability of electric vehicles at a variety of price points increasing. In Australia, prices for electric vehicles are currently still higher than for comparable fuel-combustion engine vehicles. However, fuel and maintenance costs for electric vehicles are lower, so motorists can save money over time. The associated reduction in pollution from cars will also benefit society.

The authority's leading indicator of transport emissions – the share of plug-in hybrid and battery electric vehicles in annual motor vehicle imports – has risen strongly from almost zero in 2018 to an estimated 7% in 2023. However, this is obviously still very low. Accelerating the uptake of electric vehicles is crucial because of the time it takes for the vehicle fleet to turnover – people typically own their cars for up to 15 years. Fuel combustion engine vehicles purchased today will still be on the roads as we near 2040.

The authority strongly supports the introduction of the Australian Government's proposed Fuel Efficiency Standard. This can play a significant role in driving the transition to electric vehicles, by capping and reducing each year the emissions allowed from new cars on sale in Australia. The Fuel Efficiency Standard should be introduced as soon as possible, with the aim of achieving zero tailpipe emissions no later than 2040.

Continuing to support the roll-out of electric vehicle charging infrastructure is also important and should take a variety of forms, including working with the state and local governments to address unnecessary regulatory barriers; working with the industry to ensure the public has ready access to information about the location availability and status of chargers; and ensuring sufficient investment is taking place in charging infrastructure, including in regional and rural areas.



Agriculture and land

Further investment in innovation and changes to farming practices are needed to secure reductions in agricultural emissions.

The agriculture sector's emissions were 82 Mt CO₂-e in 2022–23, or 18% of Australia's total emissions. Livestock is the biggest contributor to agricultural emissions, with cattle contributing over half and other livestock another quarter. Most agricultural emissions are difficult for farmers to abate. Although new options are emerging, trends in agricultural emissions over the past decade have generally followed livestock numbers, which in turn track seasonal conditions. Emissions have been rising following the breaking of the drought in many areas in 2020.

Some measures to reduce emissions from livestock and increase the efficiency of production are available now, through changing animal diet, supplements and finishing strategy, and optimising the herd structure and breeding strategies. Undertaking rigorous herd management practices, supplementary feeding and grazing management could result in measurable reductions in emissions from cattle by 2030.

Emissions of nitrous oxide from agriculture have been relatively stable in Australia, at 14 Mt CO₂-e in 2020–21. Just over a quarter of these emissions are associated with the use of fertilisers. Farmers could lower emissions by using fertilisers more efficiently and using less emissions intensive fertilisers.

The Australian Government should offer direct support to farmers to pursue emissions reduction opportunities of the kinds described above.

In addition, the government should fund a program to help farmers measure and report on their on-farm emissions, de-risk carbon farming and provide the information investors and lenders are calling for to help decarbonise their portfolios. Currently the sector lacks a comprehensive standardised reporting framework to enable reporting of emissions, with emissions and energy use within the agricultural sector not captured within Australia's National Greenhouse and Energy Reporting Scheme (NGERs). The authority will investigate whether the sector should be brought within the scheme in its 2023 NGERs review.

The ACCU Scheme – supported by demand from the Safeguard Mechanism – is the primary government measure for reducing emissions in agriculture and land use. However, participation of the agricultural sector in the scheme is limited. Around 2 million ACCUs (1.5% of total ACCUs) have been issued for agriculture projects in total. In contrast, 154 million ACCUs have been issued to projects that store carbon in the land.

The land sector, which accounts for changes in the amount of carbon stored in trees, vegetation, soils and harvested wood products, removed more carbon dioxide from the atmosphere than it released in the year to June 2023. It contributed net negative emissions of 64 Mt CO₂-e. Much of the activity in the land sector occurred on agricultural land, with emissions coming from land clearing and forest harvesting, but more carbon dioxide was removed by forests regrowing on previously cleared land.

The amount of carbon Australia can sequester in the land sector is dependent upon several factors, not least of which is that it represents a finite resource for which there are very important, competing uses, such as producing food and fibre, and providing a sustainable source of natural capital – biodiversity, clean water, and healthy soils. Balancing these requirements needs to be informed by science and economics, as well as rural and regional communities including First Nations peoples.

Better recognition and valuing of co-benefits from the land sector is needed. Management practices that encourage greater species diversity in tree plantings and revegetation, better integration with catchment and natural resource management planning will continue to further reduce rates of land clearing.

There are some hard decisions and trade-offs we, as a society and as individuals, need to make together for a successful transition to a net zero economy. These decisions will bring benefits and opportunities.

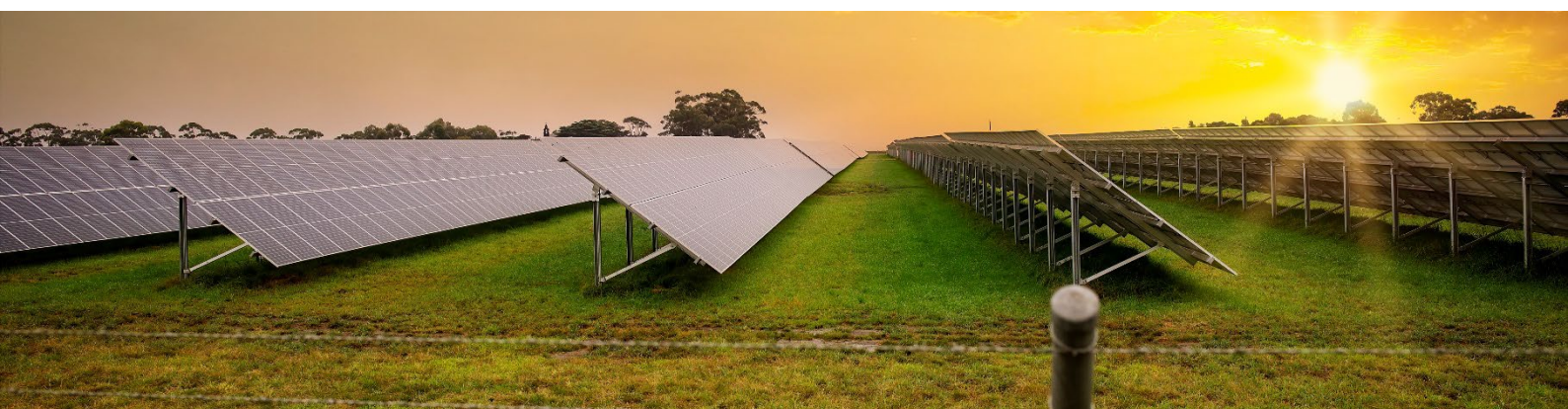
Australia will only achieve its emissions reduction targets if we, collectively as a society but also individually, are open to change. Australia's transition to net zero emissions is a transition all Australians need to participate in. For example, achieving Australia's climate goals will require the deployment of infrastructure at unprecedented scale and pace – such as solar farms and onshore and offshore wind farms, and the transmissions lines needed to carry the electricity they produce. However, not everyone wants poles, wires and batteries in their backyard or paddock, or offshore wind turbines interrupting their ocean view. Communities will need to choose between actions necessary to reduce climate change and other things they value. For Australia to play its part in the climate response, we collectively need to choose change and to change more quickly.

Gaining acceptance to develop and operate new infrastructure at the pace and scale required necessitates best practice consultation processes, fair, robust and transparent site selection processes, and equitable sharing of burden and benefits. For example, much of the additional electricity generation and transmission infrastructure to be constructed over the next decade will occur in regional areas and the First Nations estate. The Australian Government has committed \$5.5 million to develop the First Nations Clean Energy Strategy to help identify priority reforms and areas for investment (DCCEE, 2023t). The authority is of the view that the strategy should consider how to support best-practice consultation and benefit-sharing with First Nations Australians.

There's no doubting the important role planning and approval processes – including consultation and consents – play in allowing governments to take account of the economic, social and environmental costs and benefits of a project when making approval decisions. However, evidence is mounting to indicate approval processes are too slow. For its 2022 Integrated System Plan (ISP), the Australian Energy Market Operator's (AEMO) assumed development times (including planning and approvals) of 3 to 5 years for a windfarm and 2 to 3 years for a solar farm in scenarios.

In 2022 an EU Regulation granted renewable energy projects a 'public interest' status on a temporary basis, reversing the burden of evidence for certain environmental impact assessments, so that these assessments are only required in case of clear evidence of major adverse impacts on the environment.

Addressing delays in the planning and approvals processes in a way that appropriately balances competing objectives and ensures an equitable sharing of benefits and costs is the collective responsibility of governments across all levels, corporations – both developers and consumers – and communities and individuals. By cooperating, jurisdictions could accelerate implementation of renewable energy zones, permitting of grid related projects, and retirement of coal generators. With greater transparency, delays in the approval process could be identified sooner and addressed. Earlier and better consultation can guide actions that garner community acceptance and social licence to operate.



Time is running out for Australia to make a just transition to a prosperous, net zero economy - on our own terms.

Australia still has time to make a just transition to a prosperous, net zero economy, a transition made on Australia's own terms and that positions us to take advantage of the opportunities a net zero world presents. The longer we delay, the greater the risk that the transition will be dictated to us by the actions of others around the world.

As a small, open and emissions-intensive economy, reliant on inflows of foreign capital and export income as engines of growth, Australia can expect to feel the full force of the global transition to net zero emissions. Global momentum has never been greater, thanks in large part to the *Inflation Reduction Act 2022* in the United States, the European Union's Green Deal Industrial Plan and progress in implementing its Carbon Border Adjustment Mechanism. Other countries are also ramping up their action. More than three quarters of global emissions are now covered by national net zero targets.

On a trajectory to net zero emissions, governments, investors and consumers around the world will increasingly favour lower and zero emissions options. These changing preferences will reverberate along global supply chains for goods, services and finance, with important implications for the Australian economy.

Consequently, decarbonisation should not be viewed as a cost, but as a source of competitive advantage and one that we need to move quickly to realise. While some industries will decline, now is the time for Australia to seize the opportunity to attract and retain investment and to become a leading supplier of the critical minerals, low-carbon products and energy needed in a decarbonising world.

This includes lowering the emissions intensity of our exports, doing this at a faster rate than the countries we compete with, and anticipating and planning for the inevitable decline in demand for high emissions products, including our coal and gas exports.

Change isn't always easy but it's necessary if we are to leave a stable, hospitable climate for future generations. A well-managed transition should ensure the burdens and benefits are equitably shared. It should lead to new, well-paid, sustainable jobs, improve peoples' health, and restore the environment, nation-wide. The announced Net Zero Authority is a step forward towards preparing our communities for the transition. It could become a model for further preparation, planning and communication with communities about the changes we all need to make as the climate changes.

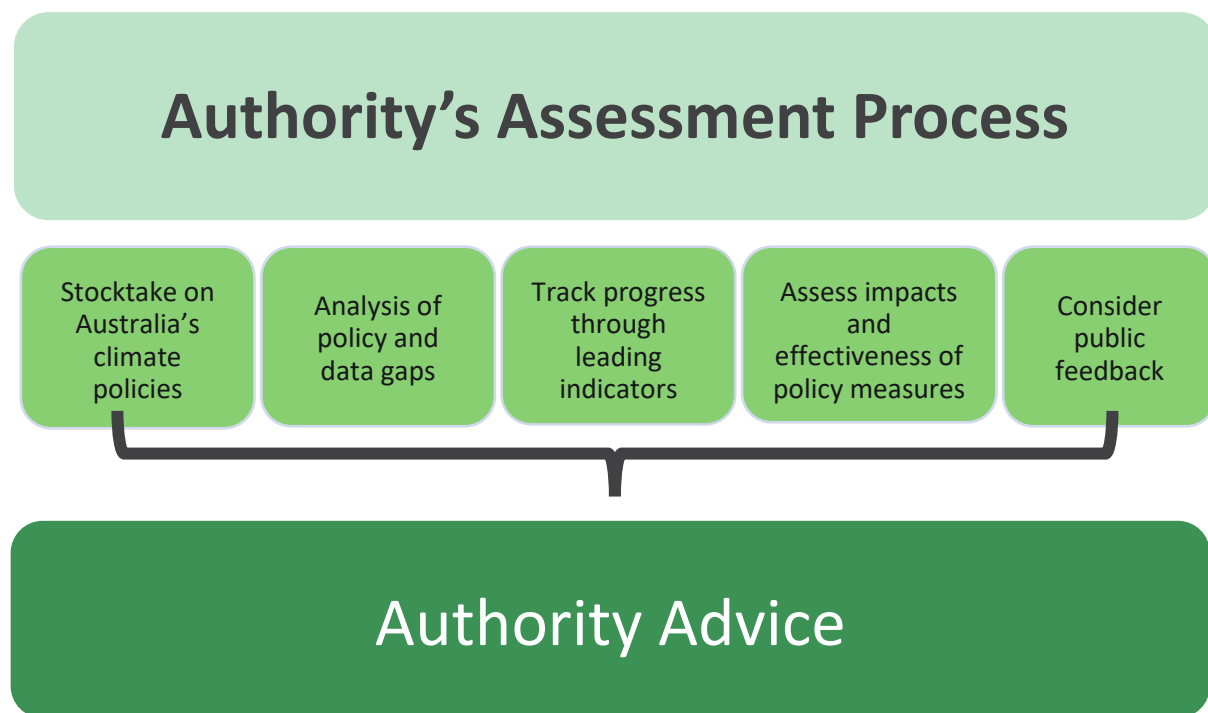
Next year the Climate Change Authority will examine many of these issues further as it undertakes a special review of sectoral technology and emissions pathways to net zero emissions by 2050 and provides advice on Australia's 2035 emissions reduction targets.

A new level of scrutiny and transparency will ensure accountability for Australia's progress.

The authority's annual progress reports play an important role in ensuring the government is held accountable to Parliament for its progress towards emissions reduction targets and for its climate change policies generally. Our advice and the government's annual climate change statements which our advice informs, help ensure the Australian community is kept up to date about Australia's progress, as well as about relevant international developments, climate change policy and the effectiveness of Commonwealth measures in contributing to the achievement of the targets.

To that end, we investigate policy settings, their effectiveness and barriers that stand in their way. By bringing a new level of scrutiny and transparency, we intend to embed accountability for the effectiveness of everyone's – including federal and state governments, corporations, investors and communities – response to climate change.

In its annual progress reports, the authority critically assesses Australia’s climate policy infrastructure. This year our focus has been a policy stocktake at the federal level and developing leading (or forward-looking) indicators of progress in the real economy (see Chapter 3). Australia’s climate policy landscape has expanded rapidly and with good intention, however achieving the 2030 target is not a given. Policy momentum needs to translate into actual emissions reductions, but there is a lag between the introduction of policy measures and measurable emissions outcomes. Australia can’t afford long delays between policy announcements and results.



The government has, and continues to, strengthen accountability and transparency in climate policy. Government reporting keeps Australians better informed on progress to implement our targets and priorities. This could be enhanced through the government:

- publishing detailed information on progress to implement each climate measure and the contribution of each measure to emissions reductions
- by enhancing the availability and transparency of climate-related information and data sets.

The authority intends to assist. Last year’s Annual Progress Report established baselines for targets, emissions and trends. In this year’s report we establish the baseline for policies that drive Australia’s progress towards its targets and what governments can do to get – and then keep – the nation on track for an ambitious, resilient, just and prosperous transition. In next year’s report, the authority will have a focus on assessing implementation of these policies. Towards this end, and for those interested, we have recently created a Climate Policy Tracker, which can be viewed at www.climatechangeauthority.gov.au.

Right now, there are risks to meeting the 2030 target, but we can respond to them. The 2030 target is still achievable. The challenge is: ‘are we willing to do what it takes?’

Recommendations

Chapter 1 – Climate change science, impacts and global policy developments

1. Provide further support for Australian climate change research through a coordinated, expanded national research program on climate science. Under the research program:
 - Australia's network of monitoring stations, buoys, and access to satellite data should be maintained and expanded.
 - Research focusing on compounding and cascading hazards, climate system tipping points, seasonal forecasting of extreme weather events, Southern Ocean science, Antarctic sea-ice and ice sheets should be given additional attention.
 - First Nations people should lead the incorporation of First Nations' knowledge into our understanding of the climate system and the solutions to climate change.
2. Lead the establishment of best-practice protocols for conducting extreme weather event attribution studies to ensure different studies are comparable and clearly understandable.

Chapter 2 – Climate-related wellbeing

3. Secure agreement with all levels of government on a framework to ensure that climate change risk and adaptation are factored into all policies and programs and their implementation, including but not limited to critical infrastructure, building codes, health, social services policies (such as those on public housing), transport, environmental protection, national security, and sectoral decarbonisation plans.
4. Legislate for the National Climate Risk Assessment to be undertaken, and the National Adaptation Plan updated, a minimum of every 5 years, and for ongoing monitoring and evaluation of the Plan.
5. Facilitate the development of a First Nations peoples-led framework to engage with First Nations people on decarbonisation and adaptation matters, building on the principle of free, prior and informed consent.
6. Facilitate a First Nations peoples-led action plan to enhance First Nations workforce opportunities in decarbonisation and adaptation and remove barriers to employment.
7. Support adaptation and transition decision-making, and improve transparency and accountability, by developing simple and accessible tools to explain climate and energy concepts.

Chapter 3 – Reducing Emissions

Electricity

8. Coordinate with state and territory governments on a comprehensive and integrated plan to reach the 82% renewable generation target, including development and implementation of a mechanism to ensure the necessary investment in the supply of renewable electricity.
9. Together with the state and territory governments provide the following information to the Australian Energy Market Operator each financial year for it to publish (in a similar format to the Connections Scorecard): number of renewable energy projects submitted for development approval or EPBC Act referral, number of renewable energy projects provided development consent or approval under the EPBC Act, and the average time from submission to approval.
10. Build on the recommendations in the Samuel Review to prioritise and expedite the EPBC Act assessment process for large-scale renewable energy generation projects, while maintaining rigorous consideration of environmental impacts.

11. Respond to the Community Engagement Review on energy infrastructure no later than 30 April 2024, and implement measures to support best practice community engagement and benefit sharing, including with First Nations communities, as soon as possible thereafter.
12. Work with state and territory governments to accelerate the rollout of network infrastructure to support the deployment of large-scale renewable energy projects.
13. Work with state and territory governments to provide incentives to ensure sufficient renewable energy storage projects that can provide between 4 to 12 hours of storage are deployed by 2030 (through the Capacity Investment Scheme or other mechanisms).
14. Provide funding via ARENA and the CEFC to accelerate the commercialisation and deployment of deep storage options.
15. Implement measures to ensure there is adequate abated domestic gas supply for firming renewable electricity generation and other purposes, while the domestic use of gas is phased down over time with the deployment of lower and zero emissions alternatives.
16. Coordinate with state and territory governments to agree on timing for the retirement of fossil fuel generators and measures to support local workforces and communities affected by closures.

Industry and resources

17. Accelerate the early phase-out of higher global warming potential refrigerants, where alternatives are available, including bans for pre-charged equipment imports.
18. Review the opportunities and report on barriers and incentives for pre-mine drainage of coal mine methane from open cut mines.
19. Introduce measures complementary to the Safeguard Mechanism for reducing fugitive emissions from the oil and gas sectors, including:
 - implementation of international best practice measures for reducing methane emissions from flaring activities that do not perversely encourage venting emissions.
 - development of standards in line with international best practice to support methane leak detection and repair across equipment, technologies and operational practices.
 - introduction of requirements for existing oil and gas facilities to sequester all CO₂ emissions produced.

Transport

20. Implement a Fuel Efficiency Standard for new light vehicles as soon as possible which progressively reduces the emissions intensity to zero by no later than 2040.
21. Complete a review of policy and regulatory settings for electric vehicles by 2024 (including subsidies to purchase electric vehicles, fees and charges to own and drive electric vehicles and taxes and tax concessions) to ensure incentives are effective and efficient in reducing emissions and driving electric vehicle uptake.
22. Develop metrics to monitor progress of the rollout of electric vehicle charging infrastructure in the first National Electric Vehicle Strategy annual review. This should take account of the infrastructure needs of regional and rural Australia in terms of the number, distribution and speed of chargers.
23. Work with the electric vehicle charging industry during the first National Electric Vehicle Strategy annual review to develop policies and if needed, regulation, to ensure that:
 - public electric vehicle chargers report in real time whether chargers are available,
 - there is a consistent approach to electric vehicle charging formats, including available plug types, payment systems and applications necessary to find and access chargers.
24. Consider immediate policy and regulatory options to reduce emissions in existing road vehicles such as by allowing and incentivising lower emissions fuel blends.
25. Encourage uptake of lower emissions heavy vehicles by:

- undertaking a cost benefit analysis for a Fuel Efficiency Standard for heavy vehicles by the end of 2024, to adopt a standard to reduce emissions from heavy vehicles over time.
- reviewing regulatory barriers to zero emissions truck uptake and addressing these by the end of 2024.

Agriculture

26. Fund an extensive challenge-based program of research and early-stage commercialisation of agriculture emissions reduction technologies.
27. Develop a program to support farmers to measure, reduce and disclose their emissions in line with an established government standard, provide advice on actions farmers can take to reduce emissions, and help them to implement high priority actions.
28. Explore the potential for time-limited incentives to support broad uptake of fertilisers with nitrification inhibitors.

Land Use, Land-use Change and Forestry

29. Enhance the delivery of impartial, practical guidance and support to landholders to enable them to make informed decisions on sequestering carbon on their farm to best suit their business, including retaining carbon for their own business, supplying the ACCU scheme offsets market, or establishing farm forestry and agroforestry.

Waste

30. Work with state and territory governments to update the national waste policy action plan to specify achievable actions to increase the avoidance, recovery and recycling of organic waste across its lifecycle to reduce organic waste going to landfill. These actions should clearly address the barriers limiting the diversion of organic waste from landfill, including government operated landfill sites.
31. Work with states and territories to require landfill gas capture at all landfill sites where there is sufficient gas flow. Where gas flow is not sufficient, regulation should require other treatment of landfill gas to oxidize methane, such as biocovers.

Chapter 4 – Cross-cutting issues

Carbon markets

32. Develop and publish a National Carbon Market Strategy.

Sequestration

33. Develop a sophisticated modelling capability to analyse and forecast sequestration, for example through a partnership between the government, industry, and academia.
34. Incentivise the development of long-lived and engineered forms of sequestration by supporting research and development and as technologies develop, through carbon markets or other financial instruments.
35. Take a leading role to reduce the domestic and international regulatory barriers preventing the uptake of engineered sequestration and carbon dioxide removal technologies methods.

Electrification of the built environment

36. Extend the Small-scale Renewable Energy Scheme post-2030 to ensure continued support for electrification and expand the scheme to include household batteries and private electric vehicle chargers.

37. Establish methods to track the numbers, locations and speed of private electric vehicle charger installations, to inform metrics on the successful roll-out of charging infrastructure. The government should publish these figures each year, and ensure the data is available to AEMO for grid management purposes.
38. Implement policies to increase the accessibility of electrification options. This includes, for example, through provision of zero interest financing to reduce up-front costs and provision of funding for public and Indigenous housing to convert to all-electric.
39. Work with state and territory governments to agree on a coordinated, nationally consistent approach to phasing out new gas connections for residential and small commercial buildings and phase-out for existing gas connections.
40. Identify and remove barriers to installing private vehicle chargers and vehicle-to-grid capability, while ensuring building codes adequately mitigate safety risks.

Research and development, technology and innovation

41. Include a Research, Development & Demonstration (RD&D) Strategy as a key feature of Australia's Net Zero Plan. The strategy should consider the need for dependable framework conditions that promote innovation, safeguards competitiveness, and amplifies co-operation between government and private sector, as well as tracking progress towards goals.

Federal, state and territory government cooperation

42. As part of development of the Net Zero Plan, develop a set of agreements with the state and territory governments for coordination and cooperation on climate change mitigation, adaptation and resilience, and Australia's transition to a net zero economy.



Report roadmap

This report is structured as follows:

- Chapter 1: Climate change science, global impacts and international developments
- Chapter 2: Climate-related wellbeing: impacts, adaptation and transition
- Chapter 3: Reducing emissions
- Chapter 4: Cross-cutting issues

Additional content and references are contained in a separate appendix.

This report addresses all elements of our analytical framework (Figure 3) and incorporates our independent research and analysis and consideration of the input we received through submissions, survey responses and conversations on a wide range of topics. The authority extends its thanks to the hundreds of contributors for their valuable input. You can see the non-confidential submissions on our website and see how we've used your input throughout this report. We will continue to consider it in developing our future reports, including sectoral pathways and 2030 targets next year.



Figure 3: Analytical Framework

WELLBEING	Progress towards a just transition and resilient nation			
	Economic impacts and opportunities Chapter 2 Section 2.2.3 Pages 44-45	Physical impacts and adaptation Chapter 2 Section 2.2.1 Pages 40-41 Chapter 2 Section 2.3 Pages 47-49	First Nations Chapter 2 Section 2.4 Pages 50-55	Regional and rural Australia Chapter 2 Section 2.6 and 2.7 Pages 57-62
EMISSIONS	Progress towards national greenhouse emissions reduction targets			
	Leading indicators of change Chapter 3 <u>Electricity:</u> Section 3.2.1 Pages 68-86 <u>Industry and resources:</u> Section 3.3.2 Pages 89-91 <u>Transport:</u> Section 3.4.2 Pages 99-100 <u>Agriculture:</u> Section 3.5.2 Pages 109-112 <u>Land:</u> Section 3.6.2 Pages 121-123 <u>Waste:</u> Section 3.7.2 Pages 131	Point target compliance Chapter 3 Section 3.1 Page 64	Emissions budget tracking Chapter 3 Section 3.1 Page 64-65	Emissions sectoral trends Chapter 3 <u>Electricity:</u> Section 3.2.2 Pages 70 <u>Industry and resources:</u> Section 3.3.3 Page 91-92 <u>Transport:</u> Section 3.4.1 Page 99 <u>Agriculture:</u> Section 3.5.1 Page 108 <u>Land:</u> Section 3.6.1 Page 120 <u>Waste:</u> Section 3.7.1 Page 130
POLICIES	Progress in implementing policies			
	Climate mitigation and adaptation policy tracker Appendix B Page 175	Policy gap analysis Appendix B Page 175	Indicators of direct effectiveness Appendix B Page 176	Indicators of indirect effectiveness Appendix B Page 176
CONTEXT	Developments in the broader operating environment			
	Climate science and global impacts Chapter 1 Section 1.1 Pages 20-25	Geopolitics Chapter 1 Section 1.3 Pages 29-32	International ambition and policies Chapter 1 Section 1.2 Pages 26-28	Voluntary corporate action Chapter 1 Section 1.3.3 Pages 32-33

1 Climate change science, impacts and global policy developments

Key information about Chapter 1



Global mean temperature is rising.

Many temperature records have been broken across the globe over the past year, especially during the 2023 Northern Hemisphere summer. The longer-term global mean temperature, including all the Earth's land and ocean areas, for the period 2011 to 2020 was 1.1°C above the 1850 to 1900 pre-industrial average.



Australia is warming and rainfall patterns are shifting.

Since the early 1900s, Australia's mean temperature over land has warmed by about 1.5°C and Australia's oceans have warmed by about 1°C. Rainfall patterns are also shifting across the Australian continent, with rainfall decreasing in the south, southwest and east, and increasing in the north.



Climate change has made extreme weather events more dangerous and frequent.

Anthropogenic climate change has made extreme events, such as the 2019–20 'Black Summer' bushfires, more intense. Extreme weather events (such as heatwaves, floods and bushfires) are projected to become more frequent and intense as atmospheric greenhouse gas concentrations continue to increase. Climate change research continues to reduce uncertainties and improve Australia's ability to anticipate the characteristics of future extreme events.



The carbon clock is ticking fast.

Analysis by the United Nations Framework Convention on Climate Change secretariat suggests that countries will have to quickly move well beyond their current Nationally Determined Contributions for the world to retain even a 50% chance of limiting global warming to 1.5°C.



Carbon trading under the Paris Agreement is emerging, while climate diplomacy and finance are extending beyond the UNFCCC.

Countries are increasingly engaging in bilateral and multilateral arrangements to drive rapid and targeted, often funded, decarbonisation actions. Partnerships are increasingly important in leveraging private finance to support climate action.



Australia must create and maintain conditions that will attract and support the unprecedented flows of finance needed to fund the transition to a prosperous net zero economy.

Implementation of a climate risk disclosure regime, and the development of a sustainable finance taxonomy and sectoral plans will help investors to invest with confidence.



Internationally, the next industrial revolution has begun.

Industrial policy reforms were significant in 2022–23, with the introduction of the United States' *Inflation Reduction Act 2022* and the European Union's Green Deal Industrial Plan.

1.1 Climate science and global impacts

In March 2023, the Intergovernmental Panel on Climate Change (IPCC) released the Sixth Assessment Synthesis Report (IPCC, 2023b), which represents the most comprehensive and authoritative synthesis of climate change knowledge currently available, covering science, impacts, adaptation and vulnerability, and mitigation.

Other work from the Bureau of Meteorology and CSIRO, such as their State of the Climate 2022 report, and outputs from the World Meteorological Organization, also provide comprehensive information about current and projected future climate change.

1.1.1 Climate changes globally and in Australia

Globally, 2023 has broken many heat records (NASA Climate Change, 2023) and it is almost certain (~98% chance) that the 5-year period from May 2023 will be the hottest 5-year period on record (WMO, 2023a). Human activities that emit greenhouse gases into the atmosphere have ‘unequivocally’ been the predominant cause of modern climate change (IPCC, 2023b). June to August 2023 has already been identified as the hottest 3-month period on record (Copernicus Climate Change Service, 2023b). According to the IPCC, the global mean surface temperature, including all the Earth’s land and ocean areas, was about 1.1°C above the 1850–1900 average for the period 2011 to 2020 (IPCC, 2023b). In 2022, this rose to 1.15°C above the 1850–1900 average (WMO, 2023b). It is more likely than not (~66% chance) that globally, the average temperature in one of the next 5 years will exceed 1.5°C of warming (WMO, 2023a).

Climate trends in Australia broadly parallel global trends in land and ocean warming, sea-level rise, and changes in rainfall patterns (CSIRO & BoM, 2022). Since records began in the early 1900s, Australia’s climate over land has warmed by an average of 1.47°C and Australia’s oceans have warmed by 1.05°C (CSIRO & BoM, 2022). Rainfall has decreased in the southeast and southwest and increased in the north (CSIRO & BoM, 2022). Australia is experiencing fewer tropical cyclones, consistent with model-based climate projections which also suggest more cyclones will be of high severity in the future (CSIRO & BoM, 2022).

1.1.2 Extreme weather events globally

Records that span the past several centuries have not shown globally-averaged temperature anomalies of the scale seen over the past year (NASA Goddard Institute for Space Studies, 2023). On a regional and local scale, there have also been many extreme weather events, several of which have broken historical records as well (Figure 1.1).

In the United States, extreme temperatures have been pushed to new, record-shattering levels (NOAA, 2023). Meteorological droughts, which have recently occurred in Kenya, Ethiopia and Somalia (WMO, 2023c), and their negative impacts, are exacerbated in warmer conditions (IPCC, 2022c). In Canada, its worst-ever fire season burnt 135,000 km² as of August 2023 (NASA Earth Observatory, 2023), and caused high levels of air pollution across North America (NASA Earth Data, 2023). Extreme rainfall events, like the record-breaking summer event experienced in Aotearoa New Zealand (National Institute of Water and Atmospheric Research, 2023), are projected to become more common as global temperatures rise (IPCC, 2021a).

The world’s oceans are also experiencing new extremes not seen in the historical record. This year, sea surface temperatures in the north Atlantic Ocean broke previous records by a large margin, with ‘beyond extreme’ marine heatwaves declared in the northeast Atlantic, west of Ireland, and ‘extreme’ marine heatwaves in the Baltic Sea (NOAA Satellite and Information Service, 2023). The Arctic Ocean has warmed nearly four times faster than the rest of the globe since 1979, faster than originally reported in the scientific literature (Rantanen, et al., 2022).

1.1.3 Extreme weather events in Australia

In Australia, there has been a trend towards a greater number of high-intensity, short-duration rainfall events, especially across northern Australia (CSIRO & BoM, 2022). Since the 1950s, there has also been an increase in extreme fire weather and a longer fire season across large parts of the country (CSIRO & BoM, 2022).

Globally, sea levels have been rising at an average rate of over 3 cm per decade since 1993, however this varies considerably around Australia's coastline (CSIRO & BoM, 2022).

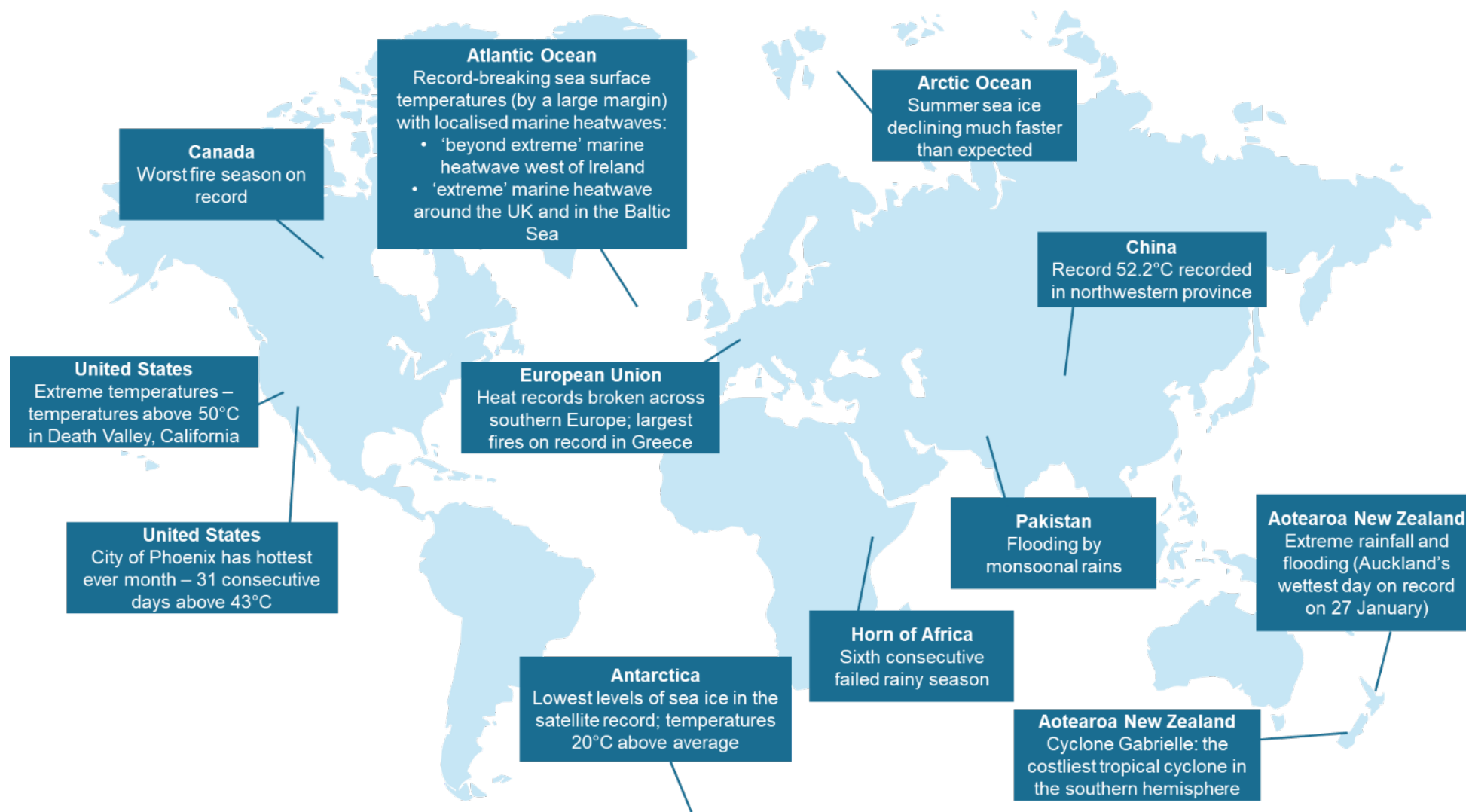
BOX 1.1 – Communicating the probability of extreme climate-related events

Hazards such as extreme heat are becoming more frequent due to climate change. Extreme event frequency is often communicated through the concept of 'return periods' (e.g., a '1-in-100-year heat wave'). This concept is often misunderstood. The term '1-in-100-year heat wave' does not mean a heat wave that would be expected to occur every 100 years. Rather it is a heat wave that has a 1% chance of occurring in any given year. This is also known as the annual exceedance probability.

Another way of thinking about this probability is through a relatable time frame. Over 30-years, a common household mortgage length, there is a 26% chance of a 1-in-100-year heat wave occurring (Jolly & Green, 2019). Climate change is causing extreme weather events with historically long estimated return periods to occur more often than expected.



Figure 1.1 Recent climate-related hazards around the globe



Source: (ABC News, 2023; Agence France-Presse, 2023; Associated Press, 2023; Copernicus Climate Change Service, 2023; Copernicus Climate Change Service, 2023; McClure, 2023; NASA Climate Change, 2023; NASA Earth Observatory, 2023; NOAA, 2023; Prior, 2023; Ramirez, 2023; Reuters, 2023; Sullivan, 2023; The Copernicus Programme, 2023; World Meteorological Organization, 2023c; World Meteorological Organization, 2023)

1.1.4 Future climate research

Scientific understanding of climate change and the sophistication of climate models and computing capacity has progressed significantly over recent decades. State-of-the-art models now explore a range of scenarios of the future that consider socioeconomic changes over time (shared socioeconomic pathways), rather than just greenhouse gas emissions. This is leading to improved, better integrated and more detailed climate projections (O'Neill, et al., 2016).

In furthering knowledge, it is critical that the scientific community work with First Nations people to incorporate traditional knowledge into the understanding of the climate system and the solutions to climate change. This was reflected in the authority's consultation:

'Western Science is nothing without Indigenous Knowledge.' Northern Territory participant

It is critical this occurs within the Australian and in the international literature and scientific processes, including the IPCC 7th Assessment Cycle. A key factor preventing the incorporation of First Nations knowledge and data in the IPCC reports is its comparatively limited publication in peer reviewed literature (Lansbury, et al., 2023). Actions that could contribute to better incorporating of traditional knowledge in climate research and IPCC processes include (Lansbury, et al., 2023):

- Promoting First Nations-led research on climate change and engagement in climate change information
- Promoting traditional knowledge, for example by lobbying the IPCC for a dedicated First Nations chapter or Australasian sub-chapter
- Recognising Indigenous knowledge as a system and integrating it equivalently with Western knowledge



Figure 1.2: Climate Science research areas



Climate scientists in Australia and globally are researching the areas described above to add more confidence to findings.

The confidence of results in Australian climate change research is currently limited by the amount of available data in our region – such as atmosphere and ocean observations (Ashcroft, Gergis, & Karoly, 2014). As Australia’s network of monitoring stations and ocean buoys grow and expand, confidence in the findings of Australian climate research will also grow.

1. RECOMMENDATION

Provide further support for Australian climate change research through a coordinated, expanded national research program on climate science. Under the research program:

- Australia's network of monitoring stations, buoys, and access to satellite data should be maintained and expanded.
- Research focusing on compounding and cascading hazards, climate system tipping points, seasonal forecasting of extreme weather events, Southern Ocean science, Antarctic sea-ice and ice sheets should be given additional attention.
- First Nations people should lead the incorporation of First Nations' knowledge into our understanding of the climate system and the solutions to climate change.

BOX 1.2 – Attribution science

Attribution science is a relatively new subfield of climate change research that studies the contributions of human-induced climate change and natural factors to weather events and climate. This area of science is also a key step in understanding and quantifying the drivers of specific extreme events such as heatwaves, floods and droughts (National Academies of Sciences, Engineering, and Medicine, 2016).

Policymakers are particularly interested in attribution science because it can help inform decision making for climate change mitigation and adaptation (Rosenzweig & Neofotis, 2013). These studies can help assess climate-related risks and guide infrastructure planning and disaster management, however 'best-practice' protocols for researchers need to be established so that these studies can be more easily compared.

The latest IPCC report has 'unequivocally' attributed human activities as the predominant cause of warming over recent decades (IPCC, 2023b). One recent Australian attribution study links an increase in the area burnt from fires and an increased frequency of megafires (>1 megahectare burnt) to anthropogenic climate change (Canadell, et al., 2021). However, the scientific meaning of these findings can be lost during public communication.

2. RECOMMENDATION

Lead the establishment of best-practice protocols for conducting extreme weather event attribution studies to ensure different studies are comparable and clearly understandable.

1.2 Targets and policy developments

1.2.1 Ambition of collective action

At COP28 in 2023, the UNFCCC will deliver its first Global Stocktake. The Global Stocktake will assess the progress of all countries towards achieving the goals of the Paris Agreement across mitigation, adaptation and finance. The Global Stocktake is intended to encourage further efforts to raise ambition in new Nationally Determined Contributions (NDCs) due in 2025.

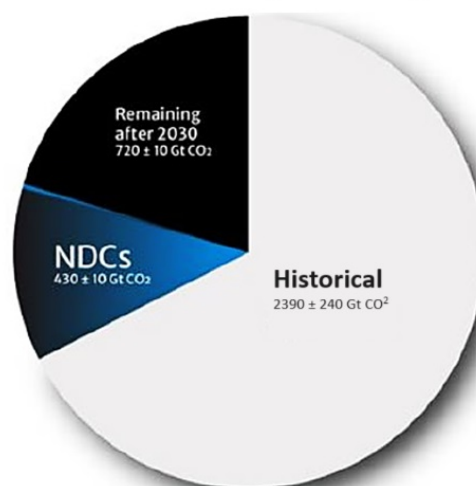
In April 2023, a UNFCCC report that provides input to the Global Stocktake found that total emissions could peak before 2030 if all NDCs² were implemented in full (UNFCCC, 2023b). However, this would only leave the equivalent of approximately two years of emissions (70 ± 10 gigatonnes CO₂) to achieve net zero (see Figure 1.3) (UNFCCC, 2023b).

Figure 1.3: Estimates of historical carbon dioxide emissions and remaining carbon budgets from beginning of 2020 assuming implementation of Nationally Determined Contributions (NDCs) as at 23 September 2022.

Carbon budget for a 50 per cent chance of limiting warming to 1.5 °C



Carbon budget for a 67 per cent chance of limiting warming to 2 °C



Source: Extracted from (UNFCCC, 2023b).

Current policies collectively in place put the world on track to warming of about 2.8°C by the end of this century (UNEP, 2022a). If all countries committed to and achieved net zero targets, the world is closer to limiting temperature rise to 1.8°C.

Not only do existing NDCs need to be delivered in full, ambition needs to be enhanced consistent with the requirements of the Paris Agreement. The actions taken in the next 18 months are crucial to staying within the temperature goals of the Paris Agreement. New NDCs will either set the world up to stay under the Paris Agreement temperature goals or to push beyond them. The authority will consider the Global Stocktake in its 2024 advice to government on Australia's next emissions reduction target.

² Including conditional elements such as those that require finance from other countries.

Almost half (44%) of countries have submitted long-term mitigation visions, strategies or targets (UNFCCC, 2023b). Of these, few have specified the policies and pathways to achieving their long-term targets (UNEP, 2022a). This includes Australia, which has a legislated target of net zero by 2050 but has limited policy mechanisms in place to achieve that goal (see Chapter 3).

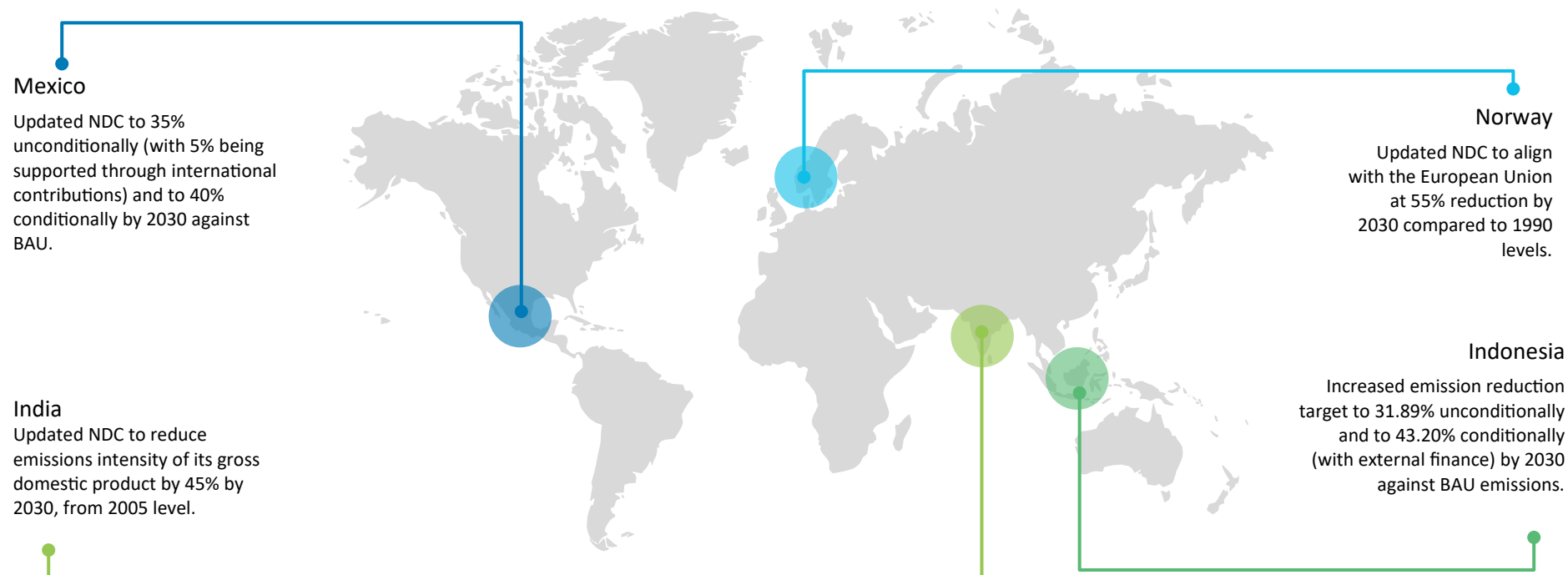
Last year the authority recommended to the government that it develop a long-term strategy for achieving net zero (CCA, 2022a). The government accepted this recommendation and has announced plans to develop sectoral plans which will form part of a Net Zero plan (Minister for Climate Change and Energy, 2023). The authority will be providing advice on sectoral pathways and Australia's 2035 target in 2024 (Appendix A).

For Australia to be a global leader on climate change action, the authority considers that the NDC must be Paris-aligned, emissions reductions policies that support the NDC must be in place, and Australia should be partnering with other countries to achieve global emissions reductions. These will be key considerations for the authority in developing its advice on Australia's 2035 target.



1.2.2 UNFCCC developments

Figure 1.4: Snapshot of UNFCCC updates including from COP27 and NDCs across 2022–2023. In 2022–2023, 27 countries have strengthened their NDCs, mostly in the lead up to COP27. For a full list beyond the four captured here, see (UNFCCC, 2023).



NDC Updates

COP27 Updates

Sharm el-Sheikh Implementation Plan

The Sharm el-Sheikh Implementation Plan decision text retained much of the same language as agreed in the 2021 Glasgow Climate Pact, including the 'phase-down' of unabated coal power. Requests for the 'phase out' of fossil fuel use were not reflected in the text. Beyond COP27, countries of the G7 agreed to an acceleration of 'the phase-out of domestic unabated coal power generation in a manner consistent with keeping a limit of 1.5°C temperature'².

Global Methane Pledge

Australia signed up to the Global Methane Pledge launched at COP26, a voluntary agreement between a total of 150 countries to lower global methane emissions by 30% below 2020 levels by 2030. Lowering methane emissions will have significant immediate benefits for reducing emissions, helping to achieve the Paris Agreement temperature goals, given its significant atmospheric warming contributions. Australia is building its capability to measure and report on methane in 2022-23 however further actions for reduction in methane emissions is required (see Chapter 3).

Loss and damage

A loss and damage fund was established as described in Article 8 of the Paris Agreement to compensate for emergent risks by addressing climate finance gaps in existing funding mechanisms. The relevant text says parties decide to 'establish new funding arrangements for assisting developing countries that are particularly vulnerable to the adverse effects of climate change, in responding to loss and damage'⁴. A transitional committee will advise on the arrangement at COP28 including who will benefit and who will pay.

Notes: In 2022–23, 27 countries have strengthened their NDCs, mostly in the lead up to COP27. For a full list beyond the four captured here, see (UNFCCC, 2023c). Source: 1. (UNFCCC, 2023d); 2. (European Council, 2023); 3. (Global Methane Pledge, 2023); 4. (UNFCCC, 2023d).

1.3 International developments and geopolitics

Consistent with the authority's 2022 Annual Progress Report, significant concerns remain about potential risks in global clean energy technology supply chains for importers of technologies crucial for the net zero transition. Reflecting this challenge, the authority has focused on the international industrial policy developments in the United States and European Union in this Annual Progress Report, given the impact these policies will have on Australia in the immediate and longer term.

As reported by the authority in last year's Annual Progress Report, the war in Ukraine has affected short-term energy security. While global supply times have generally reduced (Federal Reserve Bank of New York, 2023), dependencies on key suppliers for inputs or stages of a supply chain remain. China currently dominates global manufacturing and production of most clean energy technologies (IEA, 2023b). While China's investment in clean energy supply chains has been fundamental to lowering the costs of many technologies required for decarbonisation, diversification of origin for these materials and manufacturing reduces supply chains risks for national economies (IEA, 2023a). Countries, led by the United States and the European Union, are increasingly responding by encouraging domestic manufacturing and setting up agreements with partners to secure their supply chains.

One of the most significant global policy shifts in the past year was the introduction by the United States of the *Inflation Reduction Act 2022* (IRA), which became law in August 2022. This was followed by the *CHIPS and Science Act 2022* in September 2022. The United States Government is estimated to have committed USD370 billion towards clean technologies, although the commitment is difficult to pinpoint as it is mostly in the form of tax credits that are uncapped and extend over a 10-year period (The White House, 2023a). Through various financial instruments (e.g. tax credits, loans, grants), the IRA aims to channel investment into clean energy industries, science research and cutting air pollution within the United States (The White House, 2023a). The legislation has already had a catalysing effect: at least USD110 billion in clean energy manufacturing investments have been announced since August 2022 (The White House, 2023c). The *CHIPS and Science Act 2022* will primarily support research and development leading to commercialisation with a focus on sovereign manufacturing of semiconductors and developing skilled STEM labour (The White House, 2022) – critical inputs to the clean energy technology chain.

The effects of the IRA can already be seen beyond the nation's borders. Canada has secured its qualification as a battery metals supplier for electric vehicles eligible for consumer tax credits under IRA metal content rules (The White House, 2023d) while Japan and the US signed a Memorandum of Understanding in March 2023 to strengthen critical minerals supply chains (Office of the United States Trade Representative, 2023).

On 20 May 2023, Australia and the United States announced a Climate, Critical Minerals and Clean Energy Transformation Compact to accelerate the expansion and diversification of clean energy supply chains; promote stable supply of critical minerals; drive the development of emerging battery technologies; and support the development of emerging markets for clean energy hydrogen (Prime Minister of Australia, 2023a). To achieve these objectives, the two countries intend to engage their key industries to identify and address financial and non-financial barriers to accelerate development and deployment; collaborate on projects and standards for clean energy supply chains; and promote emissions accounting methodologies for key sectors such as hydrogen and green metals (Prime Minister of Australia, 2023a).

In the last 12 months, the European Union has introduced several key policy measures under the European Green Deal to support achievement of the bloc's target of 55% below 1990 levels by 2030 (European Commission, 2023a). The European Union's Green Deal Industrial Plan includes four focus areas: improving regulation to fast track strategic projects and facilitate access to critical minerals; facilitating investment in domestic manufacturing; developing a skilled workforce; and ensuring resilient supply chains by developing Free Trade Agreements and other partnerships.

The European Union's Carbon Border Adjustment Mechanism (CBAM)³ regulation entered into force on 16 May 2023 (European Commission, 2023a), imposing reporting obligations on importers from 1 October 2023. The CBAM aims to ensure local products are not out-competed by carbon-intensive imports and that European Union businesses are not encouraged to move carbon-intensive production overseas to avoid local carbon pricing. Certain imports will face a similar carbon price as domestic products. The CBAM will initially apply to cement, iron and steel, aluminium, fertilisers, electricity and hydrogen but will eventually cover more than 50% of the emissions in the European Union's Emissions Trading System (European Commission, 2023b).

Separately, from 29 June 2023 new regulations oblige entities to ensure certain products sold in, or exported from, the European Union are not linked to deforestation and have been obtained legally in the source country (European Commission, 2023c). A key objective of the new regulation is to 'reduce carbon emissions caused by EU consumption and production of the relevant commodities by at least 32 million metric tonnes a year' (European Commission, 2023c).



³ A Carbon Border Adjustment Mechanism seeks to limit carbon leakage through trade, by imposing import tariffs and export rebates depending on the climate policy of trading partners.

1.3.1 Implications for Australia

The ramp up in activity on industrial and trade policy is creating global competition for investment and skills. Australia cannot compete with the scale of subsidies being introduced by major economies in the northern hemisphere, but the government can pursue targeted measures to incentivise local investment in the net zero transition. This includes leveraging Australia's advantages of renewable energy and critical minerals as well as building on the activities catalysed by the investment of other governments. The authority will provide more detailed advice in its sectoral pathways work due to the government in 2024.

The government has taken some initial steps. The government's National Reconstruction Fund has \$15 billion in committed funding to finance projects, particularly those which contribute to net zero, and \$2 billion was recently allocated to hydrogen (Australian Government, 2023a). The government announced \$57.1 million in the 2023–24 Budget to develop a Critical Minerals International Partnerships program. The program aims to secure critical mineral supply chains and develop strategic and commercial partnerships (Australian Government, 2023a). This builds on the partnership on critical minerals between Australia and Japan in October 2022 (Minister for Resources and Northern Australia, 2022). The Australian Government also announced in the Budget funding for a \$2 billion Critical Minerals Facility and an allocation of \$1 billion from the National Reconstruction Fund to fund investments in value-adding in resources (Australian Government, 2023a).

Australia needs to ensure its industries are not negatively impacted by international developments or disadvantaged relative to imports by the introduction of the Safeguard Mechanism. This means considering an Australian CBAM and exploring the possibility of entering into more international partnerships and carbon clubs.

- The government has announced it will deliver a review by 30 September 2024 assessing carbon leakage risks, policy options to address any identified risks and an assessment of the feasibility of an Australian CBAM focused on the steel and cement sectors (DCCEEW, 2023n).
- In 2023, Australia joined the newly formed Climate Club (Group of Seven, 2022). The Climate Club, to be launched formally at COP28, includes three principles: keeping 1.5°C within reach; transforming industries; and boosting cooperation. However, there are limited details on implementation of the terms of reference.



1.3.2 International climate finance

A substantial finance gap remains to achieve global decarbonisation (UNEP, 2022a). Climate finance refers to local, national or transnational financing drawn from public, private and alternative sources of financing to support mitigation and adaptation actions addressing climate change (UNFCCC, n.d.). Australia has a role to continue to provide and accelerate climate finance available to support the global effort of decarbonisation.

Spending on climate-related development goals will need to increase four-fold to USD2.4 trillion per year by 2030 for emerging markets and developing countries (Bhattacharya, Songwe, & Stern, 2023). However, even in 2020⁴ the committed USD100 billion goal of developed countries mobilising this level of finance was not achieved (UNFCCC, 2023a).

Over 2022–23, there has been a push for more innovative finance measures including those that seek to leverage private finance or free up sovereign capital tied up in interest repayments on loans (Government of Barbados, 2022), (Asian Development Bank, 2023), (World Bank, 2023), (IMF, 2023).

Three new Just Energy Transition Partnerships were entered into with Indonesia (USD20 billion), Vietnam (USD15.5 billion) and Senegal (EUR5 billion). These partnerships differ for each country but are aimed at supporting countries in their clean energy transition and backed by public and private finance (European Commission, 2022), (UK Government, 2022), (European Commission, 2023e).

The innovative financing measures being delivered at an international level are in line with the government's Development Finance Review delivered in August 2023 (DFAT, 2023). The review recommended that climate finance is scaled up, including through blended finance to allow the mobilisation of private sector finance. The government has also indicated its intention to rejoin the Green Climate Fund in October 2023, following withdrawal from the Fund in 2019. The authority will consider the role of climate finance in responding to climate change in its national emission reduction targets advice due to government in 2024.

1.3.3 International carbon markets

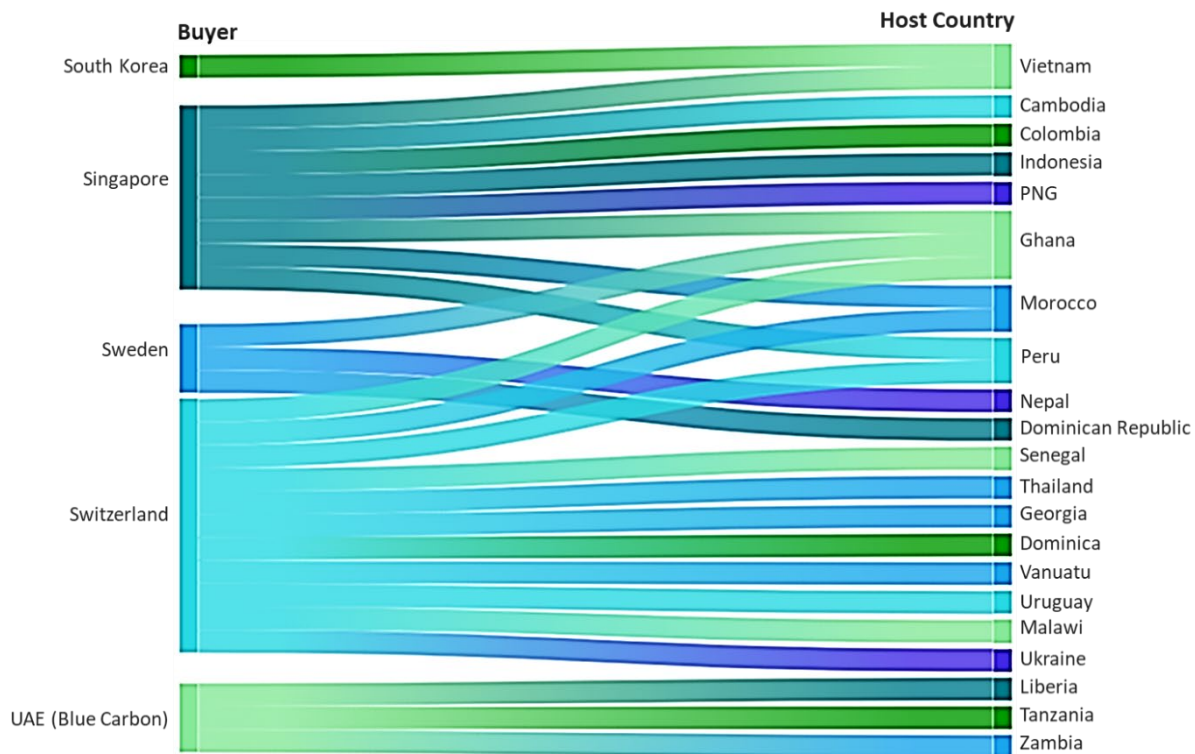
To help countries meet their targets, Article 6 under the Paris Agreement provides for cooperative approaches, including the use of market-based mechanisms. Under Article 6, abatement can be traded between countries in the form of an Internationally Transferred Mitigation Outcome (ITMO).

Australia's current NDC leaves open the possibility of using ITMOs under the Paris Agreement, but there is currently no clear policy direction from the government on how it intends to use international units. Domestically, Australian Carbon Credit Units (ACCUs) have the potential to be used in the international market but the Australian carbon market is not yet ready to participate in the Paris Agreement trading framework either through importing or exporting of units. This is due to a lack of regulatory architecture necessary to track and trade international units under the Paris Agreement (CCA, 2022b).

The government has expressed its intention to consult on establishing the legislative framework that would enable high integrity and target-contributing international units to be used in Australia towards compliance (DCCEEW, 2023l). In 2022–23, several other countries began to operationalise bilateral agreements under Article 6.2, through developing pilot projects and entering into memoranda of understandings (Figure 1.5). The United Nation's centralised trading mechanism under Article 6.4 was still under development in 2022–23 (UNFCCC, 2022).

⁴ Most recent reporting year was 2020.

Figure 1.5: International cooperative approaches under Article 6.2 as at July 2023



Source: (IETA, 2023). Reproduced with author approval. NB: Buyers of units are listed on the left-hand side while host countries are listed on the right-hand side.

The voluntary market has responded to the development of the Article 6 Rulebook over 2022–23. The Integrity Council for the Voluntary Carbon Market released their Core Carbon Principles and supporting assessment framework (ICVCM, 2023). The Voluntary Carbon Markets Integrity initiative, which aims to standardise emissions reduction claims made in relation to the use of offsets from the voluntary carbon market, released its Access Strategy Toolkit in May 2023 followed by their Claims Code of Practice in June (VCMI, 2023). Both tools aim to support the carbon market actors make transparent and informed claims about voluntary credits.



2 Climate-related wellbeing: impacts, adaptation and transition

Key information about Chapter 2

Wellbeing is a necessary condition for an orderly transition to a prosperous, resilient net zero economy.



Households, businesses, communities and governments all need to adapt to changing climate and its effects, to reduce the risk and the impact of climate-related hazards, and to maintain wellbeing.



First Nation Peoples are, and wish to be, active in reducing the impacts of climate change as well as accessing and contributing to the opportunities created by the transition to a net zero economy.



Planning is necessary to support workers and regional and rural communities in the transition.



Access to simple tools that explain climate and energy concepts would help people, communities and businesses understand and respond to the risks they face.

2.1 Introduction

Wellbeing is a necessary condition for durable change in a democracy. It is integral to achieving Australia's economy-wide, societal-level transition to a resilient, prosperous net zero economy.

Wellbeing means 'meeting various human needs, some of which are essential, and includes the ability to pursue one's goals, to thrive and feel satisfied with their life' (OECD, 2013). When needs are met, people are more likely to have the capacity and resources to 'buy in', choose their own decarbonisation pathways and provide the 'license' for others to take action. When needs aren't met, governments and other proponents of the transition can expect communities to withhold or withdraw their support for change.

In the context of responding to climate change, the government's pursuit of Australia's wellbeing must extend beyond securing community acceptance for the net zero transition. Climate change is already causing suffering in Australia. The ongoing and increased frequency of many types of climate-related weather extremes are taking a toll on Australia's physical and mental health and, especially for First Nations communities, cultural health as well. These impacts need to be recognised and addressed.

And while rapid decarbonisation brings opportunities for new jobs and new industries, these opportunities are not evenly distributed. What constitutes a 'just transition' in these circumstances is examined below.

Wellbeing is an important lens through which governments make tough decisions about trade-offs and allocate resources equitably, in the public interest, and for the long term. In July 2023 the Australian Government released Australia's first National Wellbeing Framework – Measuring What Matters, which aims to:

- track Australia's progress to better align our economic and social goals in our communities and right across our country.
- put people and progress, fairness and opportunity at the very core of Australia's thinking about our economy and our society, now and into the future.

It identified five broad themes that are important to Australians' individual and collective wellbeing: healthy, secure, sustainable, cohesive and prosperous as well as cross-cutting dimensions of inclusion, equity and fairness. The themes of the framework are supported by 50 key indicators, to monitor and track progress, which will be updated over time. The authority looks forward to making use of and contributing to Measuring What Matters in the future.

The authority has developed a climate-related wellbeing framework to give effect to requirements set out in relevant legislation:

- The *Climate Change Authority Act 2011* requires the authority to have regard to the principle that any measures to respond to climate change should, among other things, be equitable; in the public interest; take account of the impact on households, business, workers and communities; and boost economic, employment and social benefits, including for rural and regional Australia.
- The *Climate Change Act 2022* requires the authority to advise on the social, employment and economic benefits of any new or adjusted greenhouse gas emissions reduction targets and associated policies, including for rural and regional Australia; and the physical impacts of climate change on Australia, including on rural and regional Australia.

The authority's framework considers wellbeing in the context of:

- a changing climate (physical impacts), such as heatwaves, floods and droughts.
- a changing economy (transition impacts resulting from global economic shifts and domestic policy measures), such as job losses and workforce transitions as industries decline and new opportunities arise.
- policy measures responding to physical risks (adaptation policies)
- policy measures addressing transition risks (just transition policies).

BOX 2.1: What is 'adaptation'?

Adaptation in human systems is the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, adaptation is the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects (IPCC, 2021b).

BOX 2.2: What is 'just transition'?

Although there is no universal definition of a just transition, many jurisdictions have adopted the term to refer to a process and/or outcome that is fair, distributes benefits evenly, and leaves no one behind. Having reflected on the examples set out in Table 2.1 and taking account of our purpose and principles, the authority takes just transition to mean:

The process and the outcome in which burdens and benefits are shared equitably as Australia accelerates emissions reductions, adopts new ways of doing things, and prospers as the world transitions to net zero emissions.

Table 2.1: Jurisdictional approaches of a just transition

Jurisdiction	Approach to just transition
Collie, WA	The purpose of a just transition is to create a strong and sustainable future for Collie as it shifts away from a dependence on coal and coal-fired energy production (WA Government, 2020a).
New Zealand	A strategy to move a region toward a low carbon future. It is about a region leading their own transition to ensure that the impacts and opportunities that may arise from the transition are more evenly distributed (Ministry of Business, Innovation & Employment, 2023).
Scotland	A just transition is both the outcome – a fairer, greener future for all – and the process that must be undertaken in partnership with those impacted by the transition to net zero. Just transition is how we get to a net zero and climate resilient economy, in a way that delivers fairness and tackles inequality and injustice (Scottish Government, n.d.).
Wales	Delivering a just transition will mean, that as we move to a cleaner, stronger, fairer Wales, we leave no-one behind. We will develop a clear understanding of the impacts of change, positive and negative, and how to make sure these are fairly distributed in society. In doing so, we have committed to learning lessons from the past and building a future for Wales that supports a wellbeing economy (Welsh Government, 2022).
European Union	The European Union maintains a Just Transition Mechanism as 'a key tool to ensure that the transition towards a climate-neutral economy happens in a fair way, leaving no one behind' (European Commission, n.d.).

This chapter presents an assessment of physical and transition impacts on wellbeing and recent progress in policy responses to physical risks (adaptation policies) and transition risks (just transition policies). This chapter focuses on communities at higher risk, particularly First Nations communities, regional and rural Australia, and low-income earners. It is based on our recent consultation and research into the lived experiences of Australians, and is structured as follows:

- Impacts of climate change
- Strengthening adaptation action
- Supporting First Nations communities
- Supporting regions and rural communities
- Improving communication
- Improving employment outcomes.



2.2 Impacts of climate change

'Human-caused climate change is already affecting many weather and climate extremes in every region across the globe. This has led to widespread adverse impacts on food and water security, human health and on economies and society and related losses and damages to nature and people. Vulnerable communities who have historically contributed the least to current climate change are disproportionately affected.'

Intergovernmental Panel on Climate Change (IPCC, 2023a)

'Australians are on the frontline of climate change impacts. We are experiencing more severe bushfires, hotter and longer heatwaves, rising sea levels that are exacerbating hazards along our coastlines, cyclones that are projected to intensify and possibly track further southwards and an increase in rainfall intensity and associated flooding as the climate warms.'

Insurance Council of Australia (ICA, 2023a)

The climate has already changed dramatically (Australian Academy of Science, 2021) (see also Chapter 1). Australia's climate has changed since the early 1900s and the pace of many climate trends, such as sea-level rise, has accelerated in recent decades (CSIRO & BoM, 2022). Even under a global mitigation scenario that limits warming to around 2°C, Australia is projected to experience further climate change which is likely to worsen many hazard characteristics (IPCC, 2022a).

Climate change risk and impacts do not only arise due to acute hazards like floods, and chronic hazards like changes in rainfall. Climate risks and impacts are a combined outcome of the interaction between hazards, exposed elements, and vulnerabilities. All Australians are exposed to climate impacts in some way (e.g. through increased food prices after hazard events). However, for any given hazard, some areas and populations are more at risk than others due to different exposure and vulnerability.

Rural, regional and remote communities, First Nations communities, and low-income earners are in particularly exposed and vulnerable situations (ACOSS, 2023; NSW Health, 2023). Other groups such as some culturally and linguistically diverse subgroups, people with disabilities or health conditions, and people of marginalised genders (including women) face their own distinct risks and impacts from climate-related hazards (Gutnik & Roth, 2018; Hansen, et al., 2013; Hazeleger, 2013). Many individuals belong to more than one of these groups, resulting in multi-dimensional and magnified risk.

'Climate change impacts increase financial stress, can lead to loss of employment, homelessness, increase risk of domestic violence, negative physical health and worsens long-term mental health, deepening disadvantage' Australian Council of Social Service

'[I am] overwhelmed by my need to continue to prepare for the next fire.' Comment from
Anonymous in East Gippsland, Victoria

Importantly, climate risk and impacts are not always linear. Feedback loops, compounding hazards and cascading risks can also amplify impacts (IPCC, 2019). For example, as climate change contributes to more frequent extreme heatwaves, demand for air conditioning is projected to increase (Sherman, Lin, & McElroy, 2022). Drawing from an electricity system dominated by fossil fuels, increased demand for air conditioning will increase greenhouse gas emissions which cause climate change and place increased pressure on the stability of the system. Compound hazard events occur when hazards occur at the same time, trigger other hazards or increase the likelihood that another hazard will occur (IPCC, 2021b).

This happened in 2019–20 where drought increased the likelihood of fires and the ‘Black Summer’ fires occurred (Kemter, et al., 2021). Cascading risk is the potential for one event to trigger another in human or natural systems, whereby the resulting impact is significantly larger than the initial impact and is often associated with vulnerability and interconnected critical infrastructure (IPCC, 2019; Pescaroli & Alexander, 2018). The Royal Commission into National Natural Disaster Arrangements identified cascading impacts from the 2019–20 fires. Road closures affected emergency response and the transportation of essential goods such as food across the country (Australian Government, 2020). Power and telecommunications outages affected ATMs and EFTPOS terminals, preventing people from buying fuel to evacuate during the event, and food and other essential goods from shops after the event (Australian Government, 2020).

Power and telecommunications outages also hampered communication with people in fire zones, leaving people unable to access fire status information, emergency operation centres unable to coordinate, and local governments unable to contact their constituents to understand the support needed (Australian Government, 2020).

In line with the IPCC (IPCC, 2018), the Australian Government’s Intergenerational Report recognises that further temperature increases, even those of less than a degree (which would take average temperatures to 1.5°C to 2°C above preindustrial levels), would result in more severe climate impacts (Treasury, 2023d). With climate-related hazards already contributing to devastating impacts for communities and businesses around Australia, the likelihood of more severe and frequent hazard events underlines the urgent need for adaptation that reduces current and future climate exposure and vulnerability and builds resilience.



2.2.1 Physical impacts

The Department of Home Affairs maintains a database of ‘declared natural disasters’ where households, businesses or local councils are eligible for disaster-recovery assistance (Department of Home Affairs, 2023). For the 2022–23 financial year, there were 38 disaster events declared across Australia. The most common declaration was for a flood and storm (13 events), followed by flood (8 events) and bushfire (8 events). Box 2.3 provides more detail on the Fitzroy River storm and flood disaster in Western Australia that occurred in late 2022 and early 2023.

Some hazards, such as extreme heat, drought and coastal erosion were not recorded in the Department of Home Affairs database in 2022–23 because they are not categorised as a disaster type in the database, or did not trigger disaster recovery assistance in the 2022–23 financial year. While some hazard events do not result in disasters or loss or damage, disaster databases such as the one maintained by the Department of Home Affairs are prone to common deficiencies, such as excluding some hazards, particularly slow onset or chronic hazards (hazard bias), not considering losses of all sizes (threshold bias) and not considering all types of losses (accounting bias) (Gall, Borden, & Cutter, 2009). Therefore, they should not be assumed to be a complete account of all disasters that occurred in a time and place.

Australia did experience some extreme heat events in 2022-23 (BoM, 2022b). Extreme heat can have disastrous impacts on infrastructure, human health and the natural environment (IPCC, 2022a; WHO, 2023) and is one of the key issues identified by stakeholders during the authority’s consultation process.

*‘Australia is already experiencing the impacts of climate change... Extreme heat days, longer dry spells, and harsher fire weather will become increasingly common’ -
Environmental Defenders Office*

‘Australia is totally unprepared for impending climate impacts... The impacts are going to be severe. Most worrying is deadly heat’ - Australian Institute of Landscape Architects

Coastal erosion is also a concern for Australia (Australian Government, 2021c) and has been recognised by the United Nations as having impacts on Torres Strait Islanders and their culture (Views adopted by the Committee under article 5 (4) of the Optional Protocol, concerning communication, 2022) (see Box 2.4).

The frequency and severity of coastal erosion and inundation is projected to increase due to climate change-driven sea-level rise over the coming decades (CSIRO & BoM, 2022). This is likely to increase the during- and post-disaster assistance needed by coastal communities and businesses unless significant adaptation and resilience-building activities are undertaken to reduce vulnerability and exposure before the hazards occur.

BOX 2.3: Ex-Tropical Cyclone Ellie, flooding, and the Fitzroy River

From the last week in December 2022 to the first week in January 2023, exceptional amounts of rain fell over the Kimberley region in Western Australia, delivered by ex-Tropical Cyclone Ellie, resulting in widespread flooding (BoM, 2022a; BoM, 2023). The Fitzroy River at Fitzroy Crossing peaked at around 15.81 metres, exceeding the previous record of 13.95 metres set in 2002 (based on records extending back more than 50 years) (BoM, 2023). The flow rate was estimated to reach 60,000 cubic metres per second, exceeding the estimated normal full flood rate of 23,000 cubic metres per second at the Fitzroy Crossing townsite and well in excess of the estimated 8,000 cubic metres per second of water that normally flows through the river (Fears for remote WA towns as Fitzroy River records one of highest flow rates in Australia, 2023; Hastie, 2023). The quantity of water flowing through the river per day was estimated to be equivalent to Perth's water use over 20 years (Fears for remote WA towns as Fitzroy River records one of highest flow rates in Australia, 2023).

The event had widespread, long-lasting, and cascading impacts. As a limited snapshot, the Fitzroy River Bridge was severely damaged and main roads were impassible for months (Minister for Infrastructure, Transport, Regional Development and Local Government, 2023). The damage disconnected the East and West Kimberley regions by road, isolating many remote communities including First Nations communities and limiting movement to ferries and barges (Minister for Infrastructure, Transport, Regional Development and Local Government, 2023; O'Connor, ABC News, 2023). By April 3 2023, access via four-wheel drive had been established with a single-lane rock causeway (Minister for Infrastructure, Transport, Regional Development and Local Government, 2023) and on 31 May 2023, a two lane crossing was opened catering for all vehicles including road trains, five months after access was cut off (WA Government, 2023b). During this period, the cost of transport to the region ballooned with one freight company doubling its freight fees to cover the additional 4,500km required to make the return journey from Perth to the East Kimberley (O'Connor, Sinclair, S, & Mitsopoulos, ABC News, 2023). This caused stress for many business owners operating in and out of the region including local mechanics, supermarkets, and farmers (O'Connor, Sinclair, S, & Mitsopoulos, ABC News, 2023), however the Commonwealth-State Disaster Recovery Funding Arrangements were activated to assist businesses to reduce freight costs (DPIRD, 2023). Damage to roads and bridges also restricted access to schools with some staff needing to take a helicopter to travel to and from their school (Bieundurry & Williams, 2023).

Beyond transport and associated cascading impacts, many houses that were damaged in the flood were still not repaired as of July 2023 and people living in temporary housing were yet to return to their communities (Murphy & Bieundurry, 2023). Many of these people were First Nations people. One Indigenous person described the effect of her long-term relocation from her home and Country – 'When it comes to country, it's like having a vital organ taken away from you' (Murphy & Bieundurry, 2023).

2.2.2 Consequential impacts

Climate change is having serious impacts on the physical and mental health of Australians. Consultation reinforced that health impacts from climate change are a key concern for many.

In Australia, extreme heat is the deadliest natural hazard. (Coates, Haynes, O'Brien, McAneney, & de Oliveira, 2014; DIT, 2013). Climate change has already contributed to an increase in heatwave days and even under a 1.5°C scenario, this trend is projected to continue (Australian Academy of Science, 2021). Heat contributes to and worsens physical and mental health issues (Hughes, Hanna, & Fenwick, 2016; Hansen, et al., 2008). The impacts of extreme heat events are exacerbated by poor or overcrowded housing conditions, which have flow-on effects on physical and mental health (Buergelt, et al., 2019; Quilty, Jupurrurla, Bailie, & Gruen, 2022; Lea, et al., 2021).

One survey of houses in rural or remote areas found that several factors contributed to poor thermal performance, including (Healthabitat, n.d.):

- little to no insulation
- inadequate shading system
- lack of active cooling systems (fans and air conditioning).

In urban areas, heat is magnified by the urban heat island effect whereby temperatures may be several degrees warmer than surrounding non-urban regions due to the presence of more infrastructure that absorbs and traps heat than green (e.g. gardens or parks) or blue (e.g. rivers and lakes) surfaces (Australian Government, 2021c). Many houses in urban areas, particularly those occupied by low-income earners, are also poorly insulated, have limited shading, and do not have cooling systems (Barnett, et al., 2013; Haddad, et al., 2022). Of the limited existing dwellings (primarily in Victoria) that have been assessed under the Nationwide House and Energy Rating Scheme across urban to remote areas, the most common energy rating, which includes consideration of thermal performance, is 1 out of a possible 10 stars (CSIRO, 2023f). This means that many Australians live in houses with poor thermal performance and are at risk of impacts to their health from high temperatures.

The 2019–2020 east Australian fires caused major health issues. They resulted in 33 deaths (Parliament of Australia, 2020) and the associated smoke from the fires has been estimated to be responsible for 417 excess deaths between 1 October 2019 and 10 February 2020 (Arriagada, et al., 2020). In the Riverina region of New South Wales, where the Dunns Road fire burned at Emergency Level for many days, emergency department data shows that respiratory presentations increased by 86% compared to the same week the previous year (AIHW, 2020). Similarly, inhaler sales increased by 144% on the Mid North Coast when multiple fires were burning in the area compared to the same week the previous year (AIHW, 2020).

Health impacts may not arise during or immediately after a disaster but may emerge months later. For example, there is often a higher incidence of mosquito-borne diseases after flooding (Vardoulakis, et al., 2022). Short- and long-term health impacts can be exacerbated by damage to or evacuation of medical centres affected by disasters as well as chronic shortages of health professionals, particularly in regional, remote and very remote communities (AIHW, 2022; Australian Government, 2022b).

Disasters, and the anticipation of increasing disasters due to climate change, are also affecting mental health. After the February to March Eastern Australia floods in 2022, UNICEF Australia and Royal Far West conducted a children's Needs Assessment on children under 12 years old and identified multiple mental health concerns, including heightened anxiety, grief and loss, regression in developmental skills and sleep disturbance (Royal Far West and Australian Committee for UNICEF, 2022).

Multiple studies and reports have linked mental health concerns such as distress, anxiety, depression, and probable post-traumatic stress disorder to climate-related disasters and climate change in Australia (Gergis, Blashki, Gardner, & Bradshaw, 2023; Parliament of NSW, 2022; Matthews, et al., 2019; Fitzgerald, et al., 2020; Rodney, et al., 2021).



2.2.3 Economic impacts

Climate change and climate-related hazards pose high risks to the Australian economy as well as to the financial wellbeing of Australian households and businesses.

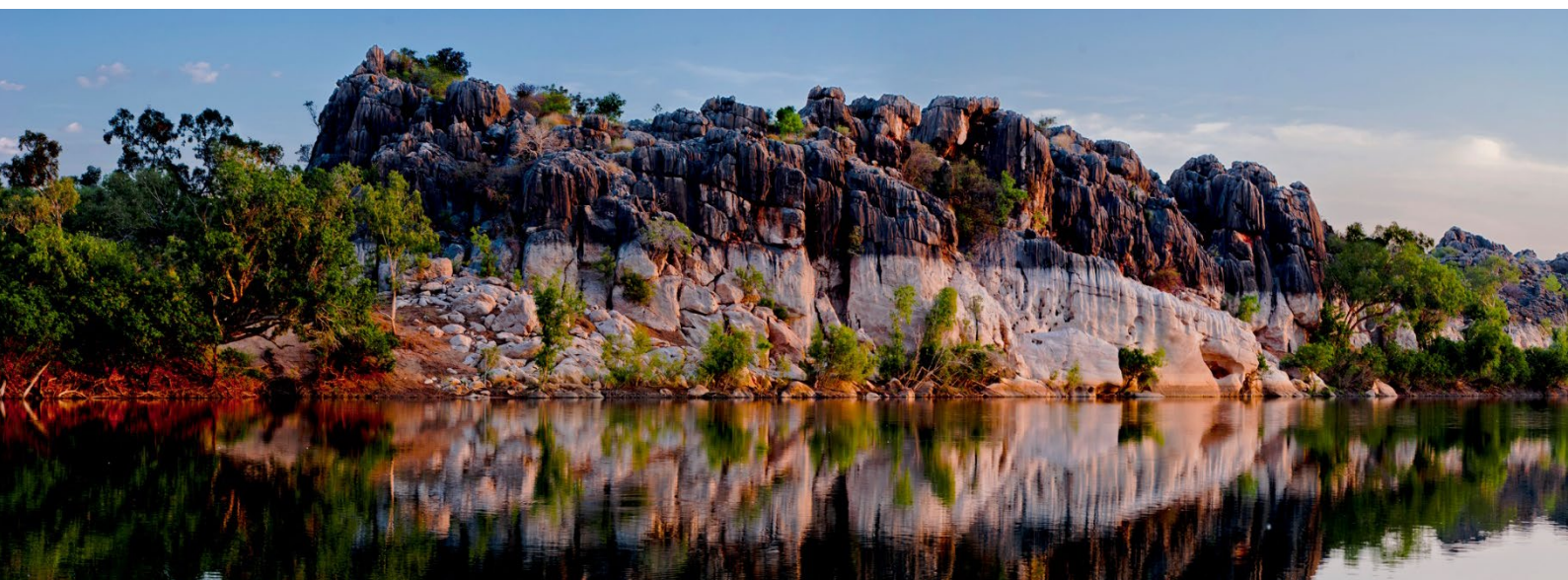
2.2.3.1 Impacts on the broader economy

Multiple submissions from financial institutions highlighted the greatest risk for investors is from damage to physical assets caused by climate change (IGCC, HESTA), with the Investor Group on Climate Change stating:

'Unless climate change is addressed in an orderly and just way, the long-term retirement savings of millions of Australians are under threat'. Investor Group on Climate Change

Modelling for the world's central banks by the Network for Greening the Financial System (NGFS) show that 'for all [NGFS] scenarios and time scales, physical risks outweigh transition risks globally (Boele & Martens, 2022). The SOAS Centre for Sustainable Finance has mapped how climate risk transmits to sovereign risk, which is the risk a government is unable to meet its debt obligations. This mapping has shown transmission occurs through channels such as depletion of natural capital and natural services, fiscal impacts of climate-related disasters and fiscal consequences of adaptation and mitigation policies (Volz, et al., 2020). Other research has shown that Australia's credit rating is at risk under high emissions scenarios (Klusak, Agarwala, Burke, Kraemer, & Mohaddes, 2021).

In 2020, disasters (climate and geophysical) were estimated to cost the Australian economy up to \$38 billion per year and projected to rise to at least \$73 billion per year in 2060 under a low emission scenario, or \$94 billion under a high emissions scenario (Deloitte Access Economics, 2021). Increasing costs were associated with population growth, property value growth, and climate change. In a single event in late 2022, flooding in south-east Queensland was estimated to cost the state \$7.7 billion in social, financial, and economic impacts. Damage to commercial and residential buildings was the largest tangible cost at approximately \$2 billion, while the cost from mental health, disease, and social issues was estimated to reach around \$4.4 billion. Treasury's Intergenerational Report also projects that with each degree of temperature rise, expenditure through the Disaster Recovery Funding Arrangements would increase as well (Treasury, 2023d).



2.2.3.2 Economic impacts on households

All Australians bear the costs of climate- and weather-related disasters, either through direct damage, cost of living and price spikes or through taxes which government use to pay for disaster relief (Lefebvre & Reinhard, 2022). Preparing for climate change can also entail cost pressures, but the savings and benefits in the longer term can be substantial, even intergenerational.

Households in vulnerable situations, such as those with low incomes, experience more severe consequences from the economic impacts of climate change and extreme weather events and are the least able to cope, adapt and recover (ACOSS, BSL, TSI, 2017).

During consultation, the authority heard about other economic costs experienced in rural and regional areas. For example, some farmers in NSW need to use small planes or helicopters to transport food and other goods during flood periods. While this cost may be planned for and absorbed without major consequences for some time, more frequent or ongoing need to access essential household goods and transport products to market via helicopter or plane would become unaffordable.

Rising insurance premiums have also been a focus for many households and insurance institutions, with research from the Actuaries Institute finding approximately one in eight households are experiencing home insurance affordability stress, driven by the exposure to climate-related natural perils, particularly cyclones and floods (Paddam, Liu, & Philip, 2023). This research also found that low-income households were particularly exposed to flood (Paddam, Liu, & Philip, 2023).

The Insurance Council of Australia (ICA) notes that '[t]he impact of extreme weather on Australian shores is increasing the global cost of reinsurance. Reinsurance costs rose to 20-year highs this year, with Australian insurers facing cost increases of up to 20 to 30 per cent.' (ICA, 2023b). The ICA goes on to state that 'when – not if – extreme weather events strike large population centres in the future we can expect them to have a greater impact and be more costly ... We can't wait until disaster strikes, we need to act now by investing more to make communities more resilient, reform land-use planning and building codes and, in some cases, move people and homes out of danger altogether' (ICA, 2023b). The ICA's report and comments highlight the need for risk mitigation and adaptation to manage the costs of climate and extreme weather impacts (ICA, 2023b).

2.2.3.3 Economic impacts on businesses

Businesses are bearing substantial costs because of climate change and climate-related disasters.

The 2022 flooding in south-east Queensland was estimated to cost small businesses \$324 million in direct physical damage and disrupted operations due to road and public transport closures (Deloitte Access Economics, 2022). Sixty-two per cent of businesses that responded to the Small Business Survey by the Queensland Department of Employment, Small Business and Training had to close for a period including 23 businesses that closed permanently (Deloitte Access Economics, 2022). These permanent and temporary business closures were estimated to affect 4,145 workers.

Tourist operators are likely to be affected by climate change as well. In Queensland the viability of more than 60,000 jobs supported by marine tourism businesses may be affected due to more frequent, intensive, extensive and longer marine heatwaves in the future that cause coral bleaching (GBRMPA, 2022).

Treasury's Intergenerational Report also finds that tourism demand in Australia is projected to be negatively affected by temperature increases (Treasury, 2023d).

2.2.4 Other impacts

Many other risks associated with climate change were raised during the authority's consultation. These include: the degradation of the natural environment and its impacts on flora, fauna, land and water; damage to infrastructure; damage to social cohesion; migration within Australia and to Australia; and climate impacts on Pacific neighbours. The authority considers these important issues to address in risk assessments and adaptation planning.

The effects of physical impacts of climate change on First Nations people are discussed at 2.4.



2.3 Strengthening adaptation action

To reduce the risk and the impact of climate-related hazards and maintain wellbeing, households, businesses, communities and governments need to adapt.

Adaptation can involve physical, tangible changes to the natural and built environment or social or economic activities and adjustments (IPCC, 2022b). Physical adaptation could include actions such as constructing desalination plants to manage low rainfall and associated water shortages or planting drought resistant crops (Howden, Schroeter, Crimp, & Hanigan, 2014). Economic adaptation could involve taking out insurance against a climate risk (Jarzabkowski, et al., 2019). Social adaptation activities could include actions such as those that improve education levels (IPCC, 2022b) or social cohesion (Carmen, et al., 2022). The Paris Agreement aims to strengthen the adaptation response of all Parties by encouraging appropriate adaptation planning and implementation to reduce impacts and foster resilience (UN, 2015).

In Australia, adaptation delivery is mostly undertaken by state, territory and local governments as well as private businesses (COAG's Select Council on Climate Change, 2012). However, the Australian Government has a role in national leadership, providing science and information, managing Commonwealth assets and programs, and maintaining a strong economy and social safety net (COAG's Select Council on Climate Change, 2012).

The Defence Strategic Review highlighted that climate change is now a national security issue and that 'state and local governments, in partnership with the Commonwealth, must have in place the necessary plans, resources and capabilities to deal with all but the most extreme domestic disaster operations' (Department of Defence, 2023). From 2005 to 2022 the Australian Government spent \$23.99 billion (at 2022 prices) on disaster relief (\$1.4 billion per year on average) compared to only \$0.51 billion on disaster resilience (Lefebvre & Reinhard, 2022). The Australian Government recently announced up to \$1 billion for the Disaster Ready Fund over 5 years from 1 July 2023 (NEMA, 2023a). However, if distributed equally over the 5 years this will be about \$200 million spent on preparedness and adaptation per year compared to the estimated \$1.4 billion spent on relief per year on average between 2005 to 2022.



2.3.1 Mainstreaming adaptation

Some government frameworks, strategies and programs do consider climate change, particularly regarding nature, health and disaster risk management, however this must extend to all policy areas, programs, investments and assets. National examples of where climate change is considered include:

- The National Disaster Risk Reduction Framework (Department of Home Affairs, 2018) and Second National Action Plan on implementation (NEMA, 2023b) link climate impacts and adaptation to disaster risk reduction
- The Disaster Ready Fund Guidelines (NEMA, 2023a) for the first round of funding included mandatory statements on enabling adaptation and avoiding maladaptation (defined as increased risk of adverse climate-related outcomes (IPCC, 2021b)
- The National Disaster Mental Health and Wellbeing Framework aims to provide guidance on how governments and recovery partners can consistently support mental health and wellbeing before, during and after disasters in the context of a changing environment driven by climate change (National Mental Health Commission, 2023)
- Australia's Strategy for Nature 2019–2030 incorporates consideration of climate change risk, impacts, and adaptation across 2 of its 3 goals and 3 of its 12 objectives and progress measures (Australia's Nature Hub, 2023).

Climate change is a long-term issue requiring long-term solutions. Therefore, where possible, consideration of climate change should be incorporated into legislation and regulation as well, to overcome short-term political cycles where strategies, policies, and plans can be quickly defunded or superseded, leading to uncertainty, and a lack of strategic implementation of adaptation activities.

3. RECOMMENDATION

Secure agreement with all levels of government on a framework to ensure that climate change risk and adaptation are factored into all policies and programs and their implementation, including but not limited to critical infrastructure, building codes, health, social services policies (such as those on public housing), transport, environmental protection, national security, and sectoral decarbonisation plans.

The Australian government is developing the Climate Risk and Opportunity Management Program (CROMP) which aims to develop the capabilities and systems needed for the Australian Public Service to identify, manage and disclose climate risks (DCCEEW, 2023j). The need to integrate climate risk considerations across all policy areas was emphasised by multiple stakeholders during consultation, particularly regarding the National Construction Code and building standards. However, the level of influence that the CROMP will have across policy areas and different levels of government is unclear. This is important to consider as most of the remit for adaptation implementation sits with sub-national governments.

2.3.2 Monitoring climate risk and adaptation responses

The Australian Government is undertaking a National Climate Risk Assessment and developing a new National Adaptation Plan (DCCEEW, 2023j). The risk assessment is planned to be finalised by the end of 2024 (DCCEEW, 2023p). However, the government is yet to commit to periodic reviews or updates of either document. Reviews and updates would be in line with the approaches of some international peers on risk assessments and adaptation plans including the United Kingdom (UK Government, 2008), New Zealand (NZ Government, 2019) and advice from the UNFCCC that defines the adaptation cycle as an ‘iterative approach’ of risk assessment, planning, implementation and monitoring, evaluation and learning (UNFCCC, 2023a).

Climate change risk changes depending on adaptation action, global emissions trajectories and other social and demographic factors (IPCC, 2022b). Additionally, new research and modelling capability is likely to improve understanding of climate change risk (see Chapter 1.1.4). Therefore, the National Climate Risk Assessment and the National Adaptation Plan should be revised periodically to ensure they remain up to date, relevant, and effective. These activities should be planned with sufficient time and resources to consult widely. Legislating the requirement to repeat the National Climate Risk Assessment and National Adaptation Plan process through amending the *Climate Change Act 2022* would elevate consideration of adaptation and promote a commitment to ongoing action.

Measuring the effectiveness of adaptation policy at the national level is a key question for many countries, driven in part by the Paris Agreement and the Global Goal on Adaptation (Christiansen & Martinez, 2018). Stakeholder consultation that identifies outcomes and indicators that matter to stakeholders has been recognised as an important component when developing monitoring and evaluation frameworks (Karani, 2018; Leiter, 2018; Flood, Dwyer, & Gault, 2018). The authority recommends the government establish an ongoing process to assess implementation of the National Adaptation Plan, which ensures that the effectiveness of the Plan is assessed regularly and adjustments to adaptation measures are made in a timely manner in response to the available evidence.

4. RECOMMENDATION

Legislate for the National Climate Risk Assessment to be undertaken, and the National Adaptation Plan updated, a minimum of every 5 years, and for ongoing monitoring and evaluation of the Plan.



2.4 First Nations people in Australia

2.4.1 Process to develop this advice

In preparation for the 2023 Annual Progress Report, the authority sought to engage with First Nations people, organisations and representative bodies in order to listen to their needs and experiences and to understand their climate change challenges. The information we obtained is highly valuable and greatly appreciated but represents only a small sample of First Nations perspectives. The themes discussed below are the main ones identified through our consultation process for the 2023 Annual Progress Report. We hope to continue improving our First Nations engagement to inform our future advice.

2.4.2 First Nations people and their connection to land

Australia's First Nations people have a deep connection with land and waters, plants, animals, heritage, cultural ancestors, laws and more (Murawin, 2023). First Nations peoples are the world's first engineers, scientists and agriculturalists. They have been, and continue to be, experts at Caring for Country and navigating the changing climate for thousands of years (Australian Government, 2021c). Caring for Country is fundamental to spiritual identity, culture, economy, social and holistic health (Murawin, 2023). The authority heard how Caring for Country means looking after the health of the land because 'if you look after the country, the country will look after you' (Murawin, 2023).

'As a proud Gureng Gureng (Aboriginal) man, my love and care for Country is what makes me who I am. Our country and environment is critical to our identity and way of life'

Anonymous submission



2.4.3 Impacts of climate change on First Nations people

Through our engagement process, the authority heard about the substantial effect of climate change on First Nations people and communities.

First Nations people's connection to Country places them in a unique position where damage to the natural environment caused by climate change and climate-related events contributes to significant cultural harm (Murawin, 2023). Flora and fauna are being damaged or are disappearing as the climate changes (Australian Government, 2021c). Many cultural practices have had to change or cease due to the impact of climate change on Country.

'A lot of the seasons are out of whack. For example, plants are starting to flower later, the emus are starting to lay eggs later. So that's certainly been an impact from a cultural perspective' Southwest Queensland participant (Murawin, 2023).

Climate change is affecting some cultural practices that are supported by government policies as well, such as Savanna Burning under the Carbon Farming Initiative.

There are also concerns about the protection of cultural heritage, sacred sites and ceremonial grounds from climate-related impacts. Some participants from coastal communities noted burial sites are being exposed due to washouts and anticipate the impacts of coastal inundation and erosion to increase over the next 20–30 years (Murawin, 2023). They are thinking about how to conserve their burial grounds (Murawin, 2023).

Loss of culture is impacting the physical health and social and emotional wellbeing of communities.

'Climate change is causing significant ecological grief for Indigenous Australians by harming our country and our connection to it. This is re-traumatising after the impacts of colonisation.' Lyrebird Dreaming

The authority also heard in rural and remote areas climate change is affecting food and water security and housing quality. These impacts have flow-on consequences for health as well.

'Hunting is impacted. I'm hearing my mob saying they got to chuck an extra half a tank of petrol in and drive another two hours to get kangaroo. Five years ago that wasn't the case' (Northern Territory participant (Murawin, 2023).

The authority heard from some participants that water sources are becoming too salty to drink, with some communities forced to buy water that is more expensive than sugary drinks (Murawin, 2023). Increased salinity in the earth is affecting housing quality too, which impacts the residents' health (Murawin, 2023).

Other research and work points to the disproportionate exposure to climate-related hazards for First Nations communities. For example, one study noted that First Nations people in New South Wales were more likely to experience a high numbers of heatwave days, live in areas with moderate to high rainfall variability making them more prone to drought and flood or live in areas with higher fire risk, compared to non-First Nations people both now and in the future (Standen, et al., 2022). The impacts of coastal inundation and changing weather patterns, including increased rainfall intensity, is also affecting Torres Strait Islanders' way of life. In 2022, the United Nations Human Rights Committee found that Australia failed to uphold the International Covenant on Civil and Political Rights by inadequately protecting indigenous Torres Strait Islanders against the adverse impacts of climate change (ClientEarth, 2022; Faa, 2022) (see Box 2.4).

Scholarship on Indigenous experiences of urban climate impacts and adaptation is limited (Nurse-Bray, Parsons, & Gienger, 2022; Choy, et al., 2013; HEAL Network & CRE-STRIDE, 2021). Given most First Nations people live in urban or regional parts of Australia rather than rural and remote parts (ABS, 2022a), this is an area of research that must be expanded.



BOX 2.4: United Nations Human Rights Committee finds in favour of Torres Strait Islanders

Globally, compensation and restitution for losses and damages resulting from climate related impacts are growing issues for litigation and diplomacy. In 2022, UNFCCC COP27 heralded a breakthrough on the issue with countries agreeing to establish dedicated funding arrangements to assist developing countries to respond to loss and damage (UN, 2022a). These funding arrangements, however, will not assist those within Australia, like the Torres Strait Islanders, in responding to climate-related impacts and other avenues for compensation and restitution are likely to be pursued.

In 2019, 14 Torres Strait Islanders submitted a petition against the Australian Government to the United Nations Human Rights Committee (UNHRC) (Human Rights Law Centre, 2022). The petition claimed that as some of ‘the most vulnerable populations to the impact[s] of climate change’, changes in weather patterns and climate have had direct harmful consequences on their livelihood and culture (Human Rights Law Centre, 2022). For example, the petition submitted that coastal inundation has destroyed family graves and increasing intensity of rainfall and storms has degraded the natural landscape and consequently reduced the amount of food available for traditional diets (Human Rights Law Centre, 2022). The petition argued that their fundamental human rights under the International Covenant on Civil and Political Rights (ICCPR) had been violated as Australia had failed to adapt to and mitigate climate change.

In 2022, the UNHRC found Australia failed to uphold the ICCPR by inadequately protecting Indigenous Torres Strait Islanders against the adverse impacts of climate change (ClientEarth, 2022; Faa, 2022). The Committee’s remedy to Australia’s non-compliance requires adequate compensation, meaningful consultation, additional actions to secure the communities’ safe existence on their respective islands, and monitoring, review and resolution of deficiencies of measures as soon as practicable (Human Rights Law Centre, 2022).

The decision is the first-time:

- an international tribunal has found a country has violated human rights law through inadequate climate policy
- a nation state has been found responsible for their greenhouse gas emissions under international human rights law
- that peoples’ right to culture has been found to be at risk from climate impacts (ClientEarth, 2022).

While the decision of the UNHRC is not legally binding, the Australian Government has an obligation to provide an effective remedy (Human Rights Law Centre, 2022). In March 2023, the Australian Government published its response to the views of the UNHRC, available on the Attorney-General’s Department website (Attorney-General’s Department, 2023).

2.4.4 Many First Nation Peoples are, and wish to be, an active part of finding adaptative solutions and accessing opportunities in the carbon transition

We need more recognition of our right to protect our water and bush tucker.' Northern Territory participant (Murawin, 2023)

'It is time that everyone sits up and takes notice, (including) the carbon and energy movement, that the rightful place for Aboriginal people is managing country and receiving the economic benefits and independence that it provides' Central Australia Participant (Murawin, 2023)

2.4.5 Importance of meaningful engagement

Recognising and incorporating Indigenous knowledge and perspectives through meaningful engagement can enhance Australia's adaptive capacity, resilience and transition. In the authority's consultation process, many participants spoke of the need for more substantial and comprehensive engagement based on ongoing relationships with government (Murawin, 2023). Ongoing relationships require participatory consultation through partnerships, transparency, and communication throughout the decision-making process. The authority heard that First Nations people, including Traditional Owners, continue to feel locked out of the decision-making process and not provided with appropriate opportunities to both participate in or benefit from caring for country activities. There was also a general perception that government systems are set up to impede Indigenous and environmental interests. For example, First Nations people are grouped as clans, dialects or individual language groups and nations' boundaries are defined by waterways and landscape: they can cross multiple jurisdictions.

'It's not an environment issue, it's a communication issue.' Canberra participant (Murawin, 2023)

Working with First Nations people through cooperative processes where expertise and lived experience are both recognised, respected and used to inform the final products of the process may achieve greater outcomes for the environment and First Nations people. Recognising and respecting the history, wisdom and First Nation systems can help support self-determination. The Australian Government has taken steps to strengthen engagement and partnerships with Aboriginal and Torres Strait Islander communities and advocacy organisations such as the First Nations Clean Energy Network, which has partnered with the Australian Government to develop the First Nations Clean Energy Strategy (DCCEEW, 2022b).

Engagement must be built on United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) principles of free, prior, and informed consent (FPIC), which Australia endorsed in 2009 (AHRC, 2021). FPIC is the right of Indigenous peoples to give or withhold their consent for any action that would affect their lands, territories, or rights. It promotes genuine inclusion, disclosure and respect for First Nations peoples decision-making processes (AIATSIS, 2020). FPIC must form part of best practice engagement with First Nations peoples and is central the First Nations Clean Energy Network's Aboriginal and Torres Strait Islander Best Practice Principles for Clean Energy Projects (FNCEN, 2022). As at October 2023, the Australian Senate is conducting an ongoing inquiry into the application of UNDRIP in Australia (Parliament of Australia, 2022).

A lack of access to culturally safe, accessible data on matters that impact communities poses a barrier to participation in current and future economic opportunities. One participant noted that we need ‘one trusted source of information’ to go to, stating some government websites were not being updated regularly (Murawin, 2023). Indigenous organisations and people who work or live in areas impacted by the transition today are in many cases working with outdated, or incomplete datasets maintained by government.

The 2023 Commonwealth Closing the Gap Implementation Plan presents an opportunity to address these barriers, if implemented successfully. The plan includes a path forward for Priority Reform Four of the 2023 Closing the Gap Agreement: shared access to data and information at a regional level. Implementation actions, including the establishment of six community data portal sites; fully established measurement frameworks and data development timelines for socioeconomic outcomes and for Priority Reforms; and an Australian Public Service-wide Framework for Indigenous Data and Governance are all due for delivery end of 2023 or mid-2024. If successfully implemented, these actions will support the commitment under Priority Reform Four that ‘Aboriginal and Torres Strait Islander people have access to, and the capability to use, locally relevant data and information to set and monitor the implementation of efforts to close the gap, their priorities and drive their own development’ (NIAA, 2023b). The authority will monitor the progress of this reform in future reports.

5. RECOMMENDATION
Facilitate the development of a First Nations peoples-led framework to engage with First Nations people on decarbonisation and adaptation matters, building on the principle of free, prior and informed consent.

2.4.6 Supporting First Nations economies

Employment provides financial and economic security and can facilitate First Nation self-determination. While First Nations employment remains persistently lower than non-First Nations people, a target of 62% First Nations people aged between 25 and 64 employed by 2031 is on track to be met under Closing the Gap Target 8: Strong economic participation and development of people and their communities, although this is based on limited data (Productivity Commission, 2021). However, participation in the renewable energy workforce is minimal. The 2021 Census shows 29 First Nations people reported to be working in ‘other electricity generation’, which captures wind, solar and other renewable forms of generation, and 30 reporting to be working in hydro-electricity generation. First Nations employment in fossil fuel extraction and energy generation is more significant. There were 2,715 First Nations people reporting to work in coal mining, 596 in oil and gas extraction, and 142 in fossil fuel electricity generation (ABS, 2022a).

Some opportunities for First Nations employment are being realised within Australia’s carbon farming industry, land management and Caring for Country initiatives, and these have demonstrated effective social, economic, environmental and cultural outcomes (Social Ventures Australia, 2016) (Weir, Stacey, & Youngetob, 2011). In the 2022–2023 Federal Budget, the Australian Government extended the Indigenous Rangers Program from 2021 to 2028, with \$746 million provided to 80 Indigenous ranger organisations over seven years to 2028. At 1 June 2023, the program employed approximately 1,900 people (NIAA, 2023a), and the Indigenous Land and Sea Corporation’s Real Jobs Program continues to fund 109 full time equivalent positions primarily within Indigenous ranger groups in the Northern Territory (ILSC, 2023).

6. RECOMMENDATION
Facilitate a First Nations peoples-led action plan to enhance First Nations workforce opportunities in decarbonisation and adaptation, and remove barriers to employment.

2.5 Improving communications and transparency

In submissions to the authority's issues paper and during consultation, multiple respondents noted the need for accessible and transparent communication of climate matters, including data and terminology.

'But this other stuff like 'Net Zero... (and) 'carbon markets' it is so confusing, it's scary, it's scientific. (We know) our world has changed... (but) there is a lack of understanding of these terms and these scientific concepts.' Central Australia participant (Murawin, 2023)

'Educate the public on what the transition is, how it will work, what are clear and practical things they can implement themselves as part of the transition and the benefits of the transition.' Anonymous individual submission

Access to information on climate change supports people, communities and businesses to understand their vulnerability and to plan and take action to reduce or overcome its impacts. Accessible, complete, consistent, up to date and transparent information ensures decision-makers can make informed choices to share the opportunities in decarbonisation, while contributing to the nation-wide effort to lower carbon emissions. Providing material in language for First Nations people and culturally and linguistically diverse people will also improve accessibility.

Open and clear climate information helps build trust between governments, industry and the Australian community. Building trust through improving access to information is key to develop and maintain social licence across Australia. In the authority's engagement process, an emphasis was placed on improving the transparency of, and equitable access to, data on transition impacts. Consultation participants noted that communication and transparency is essential to informed decision making, building trust and facilitating better data-driven analysis and outcomes.

In 2022, the Australian Government published the Australian Data Strategy (Australian Government, 2022c) and commenced the *Data Availability and Transparency Act 2022* (the DAT Act). The authority is committed to alignment with the Australian Data Strategy and its requirements under the DAT Act, including the Strategy's commitment to breaking down unnecessary barriers and simplifying data sharing. In future advice the authority will further consider data transparency and equitable access to data.

7. RECOMMENDATION

Support adaptation and transition decision-making, and improve transparency and accountability, by developing simple and accessible tools to explain climate and energy concepts.

2.6 Supporting regional and rural communities

Australia's transition has unique social, employment and economic benefits and risks for rural and regional Australia. In consultation, many organisations expressed concern for this disproportionate impact on these communities:

'Declines in rural incomes has and will have the flow on effect of mental illness, including rising levels of depression' Environmental Justice Australia

'Mining communities will be those most affected by decarbonisation, threatening their very existence...' Australian Mining Cities Alliance

Several submissions called for targeted support for regional and rural communities that is tailored and responsive to community needs (ACOSS submission), based on plans for affected regions, industries and occupations including efforts to establish new industries and support for retraining (Brotherhood of St Lawrence submission), and focused on investment through initiatives such as Renewable Energy Industrial Precincts (Climateworks; BZE; CPD; WWF submissions).

'The Authority and Governments should not stereotype mining communities, but instead acknowledge the diversity of circumstances and outlooks.' Australian Mining Cities Alliance

2.6.1 Australia's Net Zero Authority

In May 2023 the Australian Government committed to establishing a Net Zero Authority that will 'ensure the workers, industries and communities that have powered Australia for generations can seize the opportunities of Australia's net zero transformation', through a mission that 'is aligned to the Paris Agreement and is about making sure that no one is held back as the economy changes' (Australian Government, 2023b).

Multiple submissions to the authority, including those from Climateworks, ACOSS, Committee for Sydney, Beyond Zero Emissions and Melbourne Climate Futures discussed avenues for achieving an equitable transition. A recurring theme was that a whole-of-government approach would be necessary to effectively co-ordinate transition planning, and several submissions referenced the importance of the Net Zero Authority to this task. Some respondents emphasised that clear, transparent and coordinated policymaking across different levels of government is critical to ensuring an equitable and accessible distribution of opportunities inherent to transition.

A whole of government approach must clearly establish the roles of each level of government. As guided by the Productivity Commission's findings in its Transitioning Regional Economies report (Productivity Commission, 2017), the Australian Government should focus on national economic development and coordinating between tiers of government to ensure services meet the needs of communities. Reviews of previous approaches to regional development have assessed the implications of a lack of coordination, finding that region-specific spending by state, territory or federal governments is often incorrectly targeted, and the effectiveness of regional development planning and expenditure has been impacted by confusion and overlap between jurisdictions (Productivity Commission, 2017; Smith, 2016; Pugalís & Tan, 2017).

Guided again by the Transitioning Regional Economies Report (Productivity Commission, 2017), a priority for the Australian Government should be working with state and territory governments to establish regional institutions that work in partnership with community, industry and government stakeholders to develop and implement community-led transition plans, advocate for investment and act as a coordination point for community. The Latrobe Valley Authority and Collie Transition Unit are operational examples of regional institutions that have delivered transition plans in partnership with local industry, government, business, and community (LVA, 2023a) (WA Government, 2020a). Effective representative regional institutions should be viewed as enablers for implementation of the Australian Government’s Regional Investment Framework, which is guided by a commitment to place-based decision making and valuing local voices (DITRDCA, 2023e).

The Climate Change Authority intends to consider the progress of Australia’s regional transitions in future reports.



BOX 2.5 – Regional and rural consultation

For this report, the authority sought to understand how regional and rural communities are experiencing climate change impacts, transition risks and opportunities. Consultations were conducted with 260 people in Bourke (NSW), Katherine (NT), Gladstone (QLD), Mid-North (SA) and East Gippsland (VIC).

Government action on climate change

Most respondents expressed concerns that:

- policy makers are not acting in the best interests of the community
- there was not enough policy action on climate change
- current policy will not achieve the outcomes required to mitigate climate impacts.

A handful of respondents expressed dissatisfaction in the government acting to reduce the causes and impacts of climate change, citing other priorities or general scepticism in human induced climate change.

‘Not serious. Fooling around the edges while Rome burns.’ (Katherine participant)

‘Governments wasting their money. Climate Change has been happening for years.’ (Katherine participant)

Renewable energy

The authority also received feedback from consultation participants on renewable energy projects. They included concerns about reliability, cost, effectiveness and environmental impacts and positive messages around its adoption and implementation more broadly.

‘Batteries aren’t affordable. Solar isn’t useful if you can’t afford batteries’ (Katherine participant)

‘I have solar on my house but bills remain high’ (Gippsland participant)

Natural hazards

The severity of natural hazards emerged as a significant issue, where it featured among the top five themes mentioned for Bourke and East Gippsland. It is evident that those interviewed felt that regional communities were overwhelmingly experiencing a rise in the severity of natural hazards, including floods, bushfires, and droughts. In addition to the immediate environmental consequences, these respondents from regions identified subsequent impacts such as economic trade decline resulting from crop and livestock loss, property damage, mental health impacts and community isolation due to damaged transportation infrastructure.

‘Floods impacted economic trade & transport of goods and freight...for months tourist impact was devastating’ (Bourke/Cobar participant)

‘Trauma in community. Science disasters and eco grief’ (Mid North SA participant)

‘Overwhelmed with my need to continue to prepare for the next fire’ (Gippsland participant)

Implications of the net zero transition for regional communities

There is concern about the potential repercussions of the transition to net zero on regional communities, with a substantial portion of responses expressing apprehension that policy makers and representatives in major urban areas do not understand the unique requirements of regional and rural communities. The general sentiment indicated a need to foster unity among communities by actively involving them in planning to address climate change impacts and transition strategies. A high proportion of respondents expressed their sense that information about climate change, net zero and the transition is lacking or is too complicated for them to understand.

‘No awareness around net zero, less jargon needed’ (Gladstone participant)

‘Net zero not a conversation at the BBQ in the community’ (Gladstone participant)

‘Message around climate change not getting through’ (Gladstone participant)

2.7 Energy transition employment pressures

This section of the authority's report looks at the progress, opportunities, and challenges impacting sections of Australia's energy workforce in 2022–23. The Australian Parliament has requested the Climate Change Authority review potential technology transition and emissions pathways for six sectors by 1 August 2024. As part of this, the authority will further consider workforce matters, including skills and opportunities for women.

2.7.1 Coal mining and oil and gas extraction

In August 2023, the number of people in full time equivalent (FTE) employment in coal mining was approximately 44,900, which is 2,700 more people than the year prior. FTE employment in oil and gas continued a four-year decline since reaching a high of 26,900 people in 2020, with 20,800 people employed (FTE) in August 2023 (ABS, 2023). The National Skills Commission (NSC, 2022) projects a decline in both industries in the medium term, to approximately 39,000 coal mining jobs and 20,000 oil and gas jobs in 2026. The projections are highly dependent upon assumptions about overseas demand for these commodities, including for coking coal used in the production of steel. Australia exported most of its gas, at 74% of total production in 2019–20 (GA, 2022a) and most of its black coal, at 90% of total black coal production (GA, 2022b).

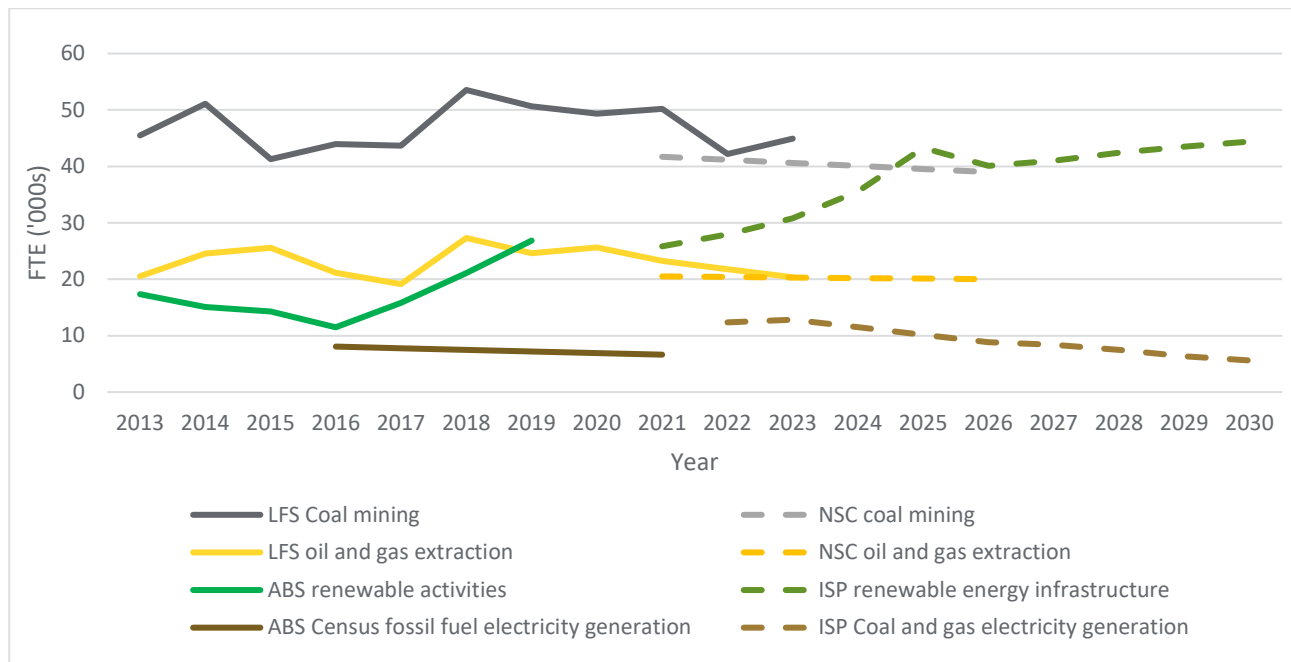
As Figure 2.1 below shows, approximately 6,600 people reported to be employed in fossil fuel electricity generation in the 2021 Census of Population and Housing, down from approximately 8,000 people in 2016 (ABS, 2022b). Analysis for the 2022 Integrated Systems Plan (ISP) projects coal and gas electricity generation to account for approximately 13,000 jobs (FTE) in 2023, 10,000 in 2025 and 6,000 by 2030 under the 'Step Change' scenario, AEMO's optimal development path for the National Electricity Market (Rutovitz, Langdon, Mey, & Briggs, 2023).

2.7.2 Renewable energy employment

In 2018–19, there were approximately 26,850 jobs across the renewable energy industry (ABS, 2020). Since this time, analysis for the 2022 ISP projects renewable energy infrastructure labour demand to reach approximately 31,000 roles in 2023 and continue increasing to approximately 43,000 roles in 2025 and 45,000 roles in 2030 (Rutovitz, Langdon, Mey, & Briggs, 2023). This estimate does not include energy efficiency, demand and energy management and electrification due to a lack of data and suitable datasets. Figure 2.1 demonstrates how employment in renewable energy, coal, oil and gas is projected to change over time.

The Australian Government is assessing the current and future capacity of Australia's energy workforce, including through the Australian Energy Employment Report (AEER) (DCCEEW, 2023k) and the Clean Energy Capacity Study (CECS) which has produced The Clean Energy Generation Report (JSA, 2023). Regional institutions and state governments are also undertaking targeted exercises for their jurisdictions, including the Latrobe Valley Authority's Gippsland Energy Skills Mapping Report (LVA, 2023b) and the Queensland State Government's Future Energy Workforce Roadmap (Queensland Government, 2023a).

Figure 2.1: Australia's Transitioning Energy Workforce



Notes:

- Coal mining and oil and gas extraction figures are a four-quarter moving average of ABS Labour Force Survey data. Averaged quarters are November – August. The final quarter assessed is August 2023.
- The authority has undertaken linear regression between: ABS Census fossil fuel electricity generation years 2016 and 2021; and NSC coal mining and NSC oil and gas extraction years 2021 and 2026, due to no available data between start and end years.
- Source: (ABS, 2020; ABS, 2023; Rutovitz, Langdon, Mey, & Briggs, 2023; NSC, 2022; ABS, 2022b).

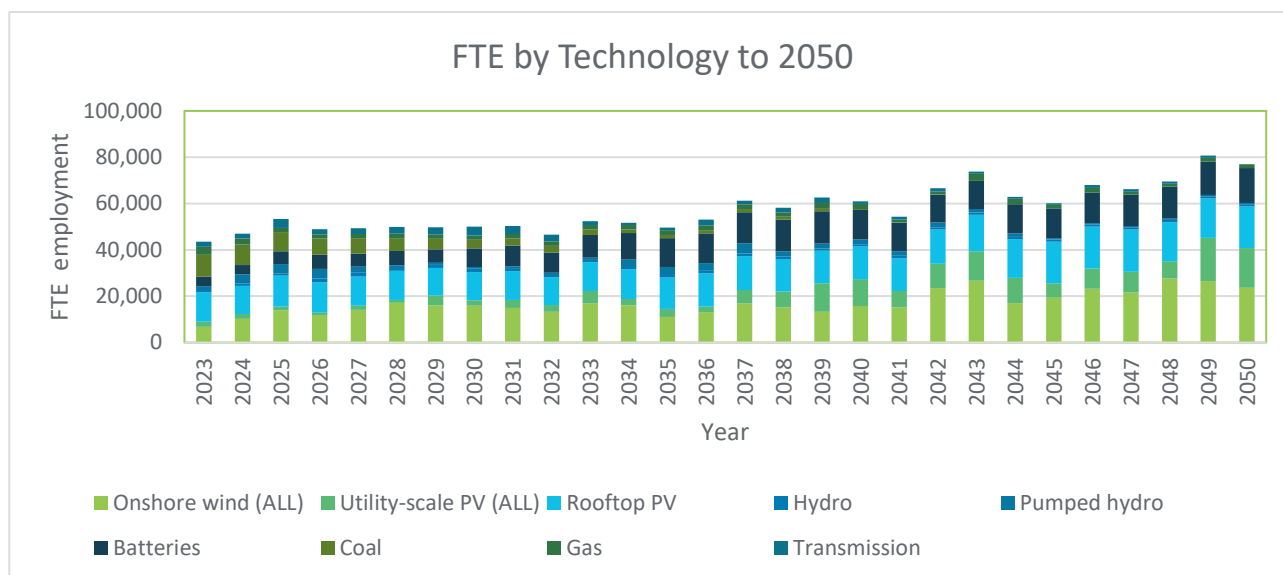
2.7.3 Impact on communities

Transition opportunities should not be expected to replace job losses in regions on a one-to-one basis and many regions remain particularly exposed to international decarbonisation pressures on Australia's fossil fuel exports, with little certainty that jobs and job quality will be replaceable (Export Finance Australia, 2022; Smith & Phillips, 2022; Accenture, 2021).

Both short and long-term concentrated job losses are likely to have material impacts on communities (Burke, Best, & Jotzo, 2019). While state government-led schemes, such as the Queensland Government's Energy and Jobs Plan (2022a) can provide much needed certainty to transitioning regions, a gap remains in planning certainty at the national level. The authority notes that the Australian Government has committed for the Net Zero Authority to 'support workers in emissions-intensive sectors to access new employment, skills and support as the net zero transformation continues' (Australian Government, 2023b).

Transferrable occupations, such as machine operators, project managers, electricians, labourers and construction workers can provide significant opportunities for workers and communities transitioning from traditional energy jobs (Briggs, Rutovitz, Dominish, & Nagrath, 2020). However, many roles require long training (or retraining) lead times of four years or more (Infrastructure Australia, 2021) and are regarded as difficult jobs to recruit for (Rutovitz, Langdon, Mey, & Briggs, 2023). There is already significant demand pressure for these roles, which is forecast to continue rising. As Figure 2.2 demonstrates, labour demand for energy infrastructure, including fossil fuel electricity generation, is forecast to rise from 44,000 positions in 2023 to 53,000 positions in 2025 and remain at approximately 50,000 until 2035 before continuing to steadily increase, peaking at approximately 81,000 in 2049.

Figure 2.2: Projected Full Time Employment by Technology under Optimal Development Path



Source: (Rutovitz, Langdon, Mey, & Briggs, 2023).

Early certainty and planning support for regions and workers to address this demand pressure is essential. Skill shortages are posing a high risk to the optimal deployment of infrastructure plans such as the Integrated Systems Plan (Rutovitz, Langdon, Mey, & Briggs, 2023). Further, renewable energy projects are prone to boom-bust cycles (Briggs, et al., 2022a). For example, in the New England Renewable Energy Zone, labour demand for utility solar generation infrastructure is forecast to remain well within current supply until 2027. However, labour demand in 2027 is forecast to ‘boom’, increasing significantly to exceed supply by approximately 750 jobs in 2027 and 900 jobs in 2028. Following this, total demand is projected to ‘bust’, immediately declining from approximately 2,550 jobs in 2028 to 550 in 2030 (Briggs, et al., 2022b). This volatility creates several immediate challenges: investment in local workforce long-lead time training and upskilling for temporary opportunities is unlikely to be substantial and local unemployment impacts are pronounced when demand reduces; fly-in, fly-out or drive-in, drive out workforces create unsustained local demand cycles; and projects are exposed to delays which create decarbonization bottle necks (Briggs, et al., 2022b).

These challenges, alongside others such as the capability of the Vocational Education and Training system to educate and train Australia’s clean energy labour capacity (ISA, 2023), and developing datasets for energy efficiency and electrification labour demand should be addressed through national energy workforce transition planning. The authority will contribute to this planning in our sectoral emissions reduction and technology transition pathways review in 2024.

3 Reducing emissions

Key information about Chapter 3



Australia is not reducing emissions at the rate needed to reach the 2030 target.

Australia needs to reduce its emissions on average by 17 Mt CO₂-e per year to reach its 2030 emissions reduction target. Over 2022–23, Australia’s emissions increased by 4 Mt CO₂-e.



Leading indicators show momentum is likely building in parts of the energy sector.

The authority’s leading indicators in the electricity and transport sectors show growth in low emissions technology rollout, but the pace needs to accelerate.

Certainty and speed are essential, particularly for the electricity sector given its significant contribution to Australia’s emissions.



The government needs to build on its Powering Australia policies to ensure the sector meets the goal of 82% renewable electricity by 2030. The government should co-ordinate with states on the mechanism to incentivise renewable capacity deployment to reach the target.



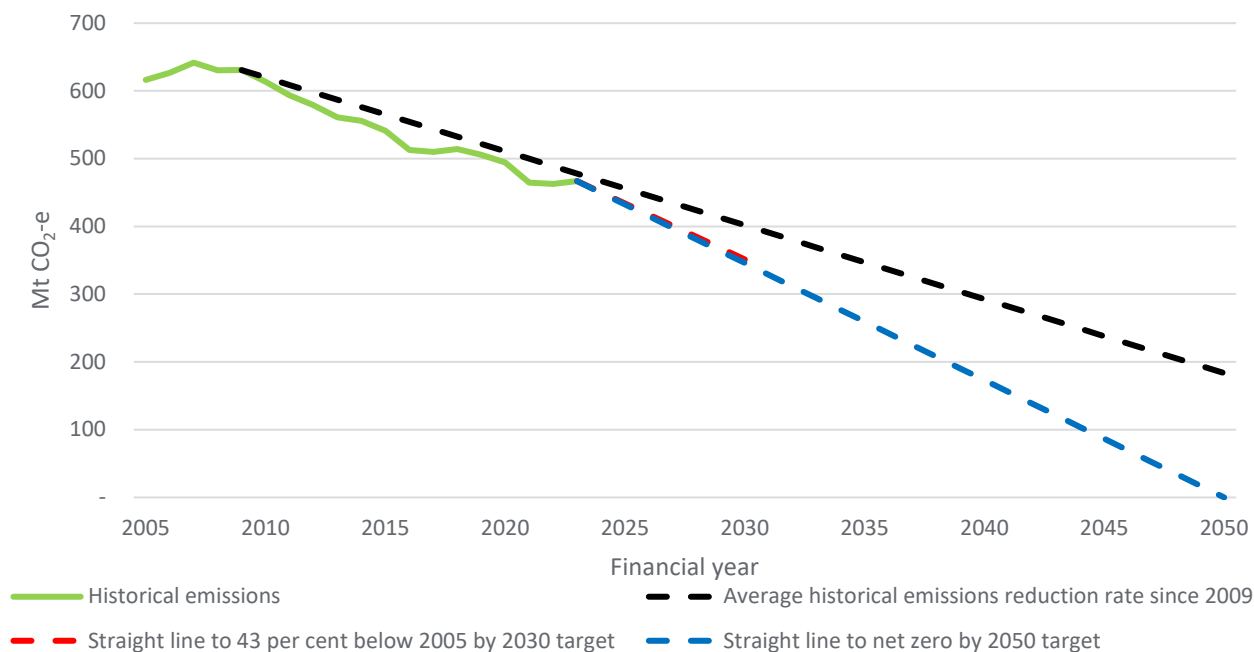
Capacity building to support on-farm emissions reductions should yield big dividends.

The Government should offer advice and support to farmers on options for managing their emissions at a farm level. Farm business will need to strike a balance between meeting emerging supply-chain requirements for low emissions products and deriving income from supplying offsets to other sectors.

3.1 Australia is not on track to meet its 2030-point target

Australia is not reducing emissions at the rate needed to reach the 2030 target. Over 2022–23 Australia's emissions did not decline, they increased by 4 Mt CO₂-e. Australia needs to decarbonise at an average annual rate of 17 Mt CO₂-e to reach its 2030 emissions reduction target. As stated in our 2022 Annual Progress Report, this required rate of decarbonisation is 40% faster than the average annual rate of decarbonisation over the period 2009–2023 (CCA, 2022a).

Figure 3.1: Progress to Australia's 2030 emissions reduction target

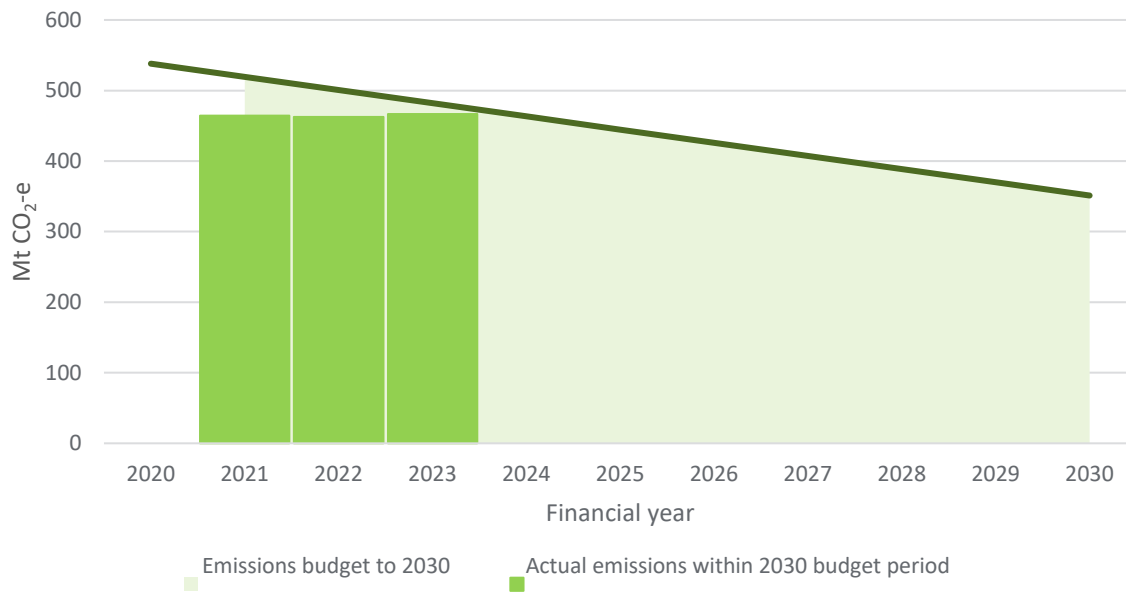


Notes: Includes preliminary estimates of emissions from April to June 2023.

Source: (DCCEEW, 2023m; DCCEEW, 2023cc)

When viewed on an emission budget basis, Australia is tracking ahead of its target trajectory (Figure 3.2). Australia's target trajectory starts at our 2020 target, which was overachieved due to a range of factors including the effects of the global COVID-19 pandemic. However, unless emissions reductions accelerate quickly towards the authority's benchmark of 17 Mt CO₂-e on average per year, emissions are likely to breach the target trajectory in 2024 or 2025.

Figure 3.2: Progress against Australia's 2021–2030 emissions budget



Notes: Includes preliminary estimates of emissions from April to June 2023.

Source: (DCCEEW, 2023m)

The upwards trend in Australia's emissions during 2022–23 was driven by the ongoing increase in transport emissions following the COVID-19 pandemic, and the recovery of agricultural activity following drought conditions early in the current decade (Table 3.1). This occurred against the background of ongoing declines in electricity sector emissions, which fell by 4% in 2022–23. The industry and resources sectors, which are responsible for 40% of Australia's emissions, recorded an increase in emissions of less than 1%. Emissions in the waste and land sectors were stable.

Table 3.1: Emissions in the year to June 2022 and the year to June 2023 by sector

Sector	Emissions in year to June 2022	Emissions in year to June 2023	Annual change in emissions
	Mt CO ₂ -e	Mt CO ₂ -e	Per cent
Electricity	158	152	-4
Industry and resources	184	185	0
Transport	92	99	8
Agriculture	79	82	3
Waste	14	14	0
Land	-64	-64	0
Total	463	467	1

Notes: Includes preliminary estimates of emissions from April to June 2023. Source: (DCCEEW, 2023m)

The following parts of this chapter explore the opportunities in specific emitting sectors to contribute to getting Australia on track towards its 2030 target, and the risks and barriers to achieving these reductions.

3.2 Electricity

3.6% decrease in electricity emissions from 2021–22 to 2022–23

Decarbonising the electricity sector is critical to meeting the 2030 target. Electricity is the largest emitting sector and can support decarbonisation in other parts of the economy. The strong uptake of renewable energy generation and the withdrawal of significant fossil fuel generation capacity have already resulted in a considerable fall in electricity sector emissions (DCCEEW, 2022a). However, Australia is not on-track to meet the government's 2030 target of 82% renewable electricity. Renewables accounted for 32% of Australia's electricity generation in 2022 (DCCEEW, 2023a), leaving a gap of 50 percentage points to meet the 82% renewable electricity target.

State targets for renewables do not align with the 82% renewable electricity target, with targets for the largest electricity generating states (Queensland, Victoria and New South Wales) below 82% (see Table 3.2). The latest official emissions projections show that under current policies, renewable generation in the electricity sector is projected to grow to 76% in 2030 and 82% in 2035 (DCCEEW, 2022a). Additionally, there has been delayed transmission infrastructure build-out, slower than required deployment of renewable generation and storage and slow phase-out of coal plants. A challenge that governments need to come to grips with is accelerating the roll-out of the necessary infrastructure while providing early and meaningful engagement with communities, including First Nations communities, and upholding environmental objectives.

8. RECOMMENDATION

Coordinate with state and territory governments on a comprehensive and integrated plan to reach the 82% renewable generation target, including development and implementation of a mechanism to ensure the necessary investment in the supply of renewable electricity.



Table 3.2: State and territory 2030 renewable electricity targets

State or territory	Target
Australian Capital Territory	The Australian Capital Territory has a 100% renewable electricity target which it has met since 2020 (ACT Government, 2021). The majority of this target is met through contract arrangements the ACT has in place with renewable energy power stations which are located in New South Wales and Victoria.
Tasmania	Tasmania met its 100% renewable electricity target in 2022 and has a 2040 renewable electricity target of 200% (Tasmanian Government, n.d.).
South Australia	South Australia has a goal of achieving 100% net renewables by 2030 (SAFA, 2020). This target relies on imports from states with fossil fuel generation as a back-up (SA Government, 2021).
Northern Territory	The Northern Territory has a 2030 renewable electricity target of 50% (NT Government, 2020).
Queensland	Queensland has a 2030 renewable electricity target of 50% (Queensland Government, n.d.). This target has been described as a consumption target which is not equal to 50% renewable electricity generation within the state (Queensland Government, n.d.).
Victoria	Victoria has legislated a 2030 renewable electricity target of 50% (Victorian Government, 2021) with an ambition to legislate an increase to a 65% target, announced in 2023 (Victorian Government, 2023c).
New South Wales	New South Wales has a 2030 target expressed in absolute terms as 12 GW of additional renewable electricity generation capacity and 2 GW of long duration storage (EnergyCo, 2023a).
Western Australia	Western Australia does not have a 2030 renewable electricity target (WA Government, 2020b).

The authority notes there are considerable challenges to achieving the government's 82% target. The Australian Energy Council, in its submission in response to the authority's issues paper, argued that supply chain limitations, skill shortages, social licence questions and slow approvals will put the 82% target out of reach by 2030. The Council proposed that the only realistic option for government is to postpone attainment of an 82% target into the 2030s.

Submissions from the Grattan Institute and the Australian Energy Council suggested it would be challenging to achieve the 82% target. In comparison, the submission from the Climate Council called for a 100% renewable electricity target by 2030.

The authority is of the view that Australia must overcome the practical challenges and barriers to delivering 82% renewables if the sector is expected to deliver an even higher share of renewables after 2030. This chapter recommends coordinated actions between the Australian Government and state and territory governments to build consensus on the plan for renewable energy infrastructure deployment in Australia.

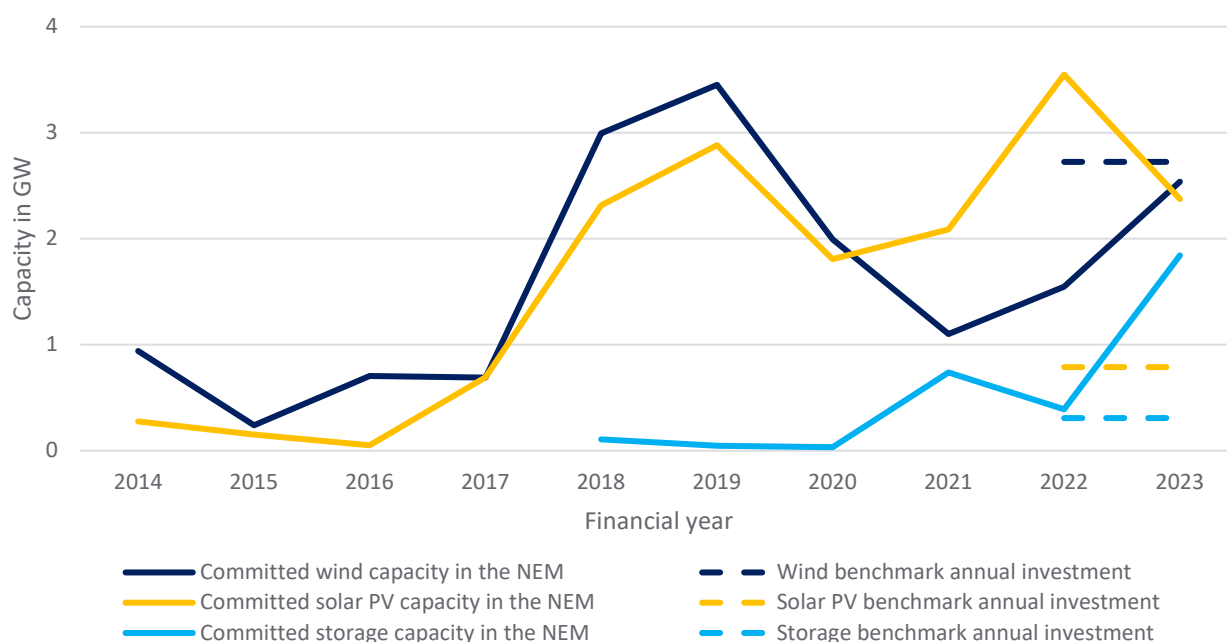
3.2.1 Leading indicators of change

3.2.1.1 Committed large-scale solar PV, wind generation and shallow and medium storage capacity in the National Electricity Market

Utility-scale solar photovoltaic (PV) needs to roughly double and wind capacity triple in the National Electricity Market (NEM) between July 2022 and June 2030 for an 82% renewable share to be achieved (AEMO, 2023a); (AEMO, 2022c). The authority is tracking the capacity of committed⁵ wind, solar and shallow and medium storage projects to gauge if there are sufficient projects in the pipeline to meet the 82% target by 2030.

To reach the 82% target by 2030 committed generation needs to either equal or exceed the annual investment benchmarks for wind and solar shown in Figure 3.3 below. During 2022–23, there was an uptick in committed wind and shallow and medium storage. However, wind commitments were below the required annual investment and solar commitments declined towards the end of the financial year. These results across all benchmarks indicate that during this year, Australia’s committed solar and shallow and medium storage project levels are on track to reach 82% renewables in 2030, while wind commitments are off-track. These benchmarks need to be sustained across the decade for Australia to achieve this target. The Clean Energy Regulator has noted challenges to renewable investment include higher costs, connection and permitting, and lack of revenue certainty (CER, 2023c).

Figure 3.3: Committed large-scale solar PV, wind generation and shallow and medium storage in the NEM, 2014–2023



Notes: AEMO produces NEM Generation Information every three months or less. The authority has used a data point aligned most closely with the end of each financial year. Solar PV excludes rooftop PV installations.

Source: (AEMO, 2014; AEMO, 2015; AEMO, 2016; AEMO, 2017; AEMO, 2018; AEMO, 2019; AEMO, 2020a; AEMO, 2021a; AEMO, 2022e; AEMO, 2023a); Climate Change Authority analysis.

⁵ Committed projects have secured land, contracts for supply and construction, planning consents and connection contracts, financing, and construction must either have commenced or a firm commencement date been set (AEMO, 2022e).

According to CSIRO, onshore wind and solar PV remain the lowest cost new-build technologies in 2022–23 (CSIRO, 2023d). The 2022–23 GenCost report stated that the capital costs of all technologies being considered for construction have increased, as the COVID-19 pandemic had led to global supply chain constraints. The constraints have caused increases in the prices of raw materials needed in technology manufacturing and in freight costs (CSIRO, 2023d). CSIRO assumed that the inflationary cycle is at its peak in 2022–23 and that costs will return to normal in 2027, under current global climate policy commitments (CSIRO, 2023d).

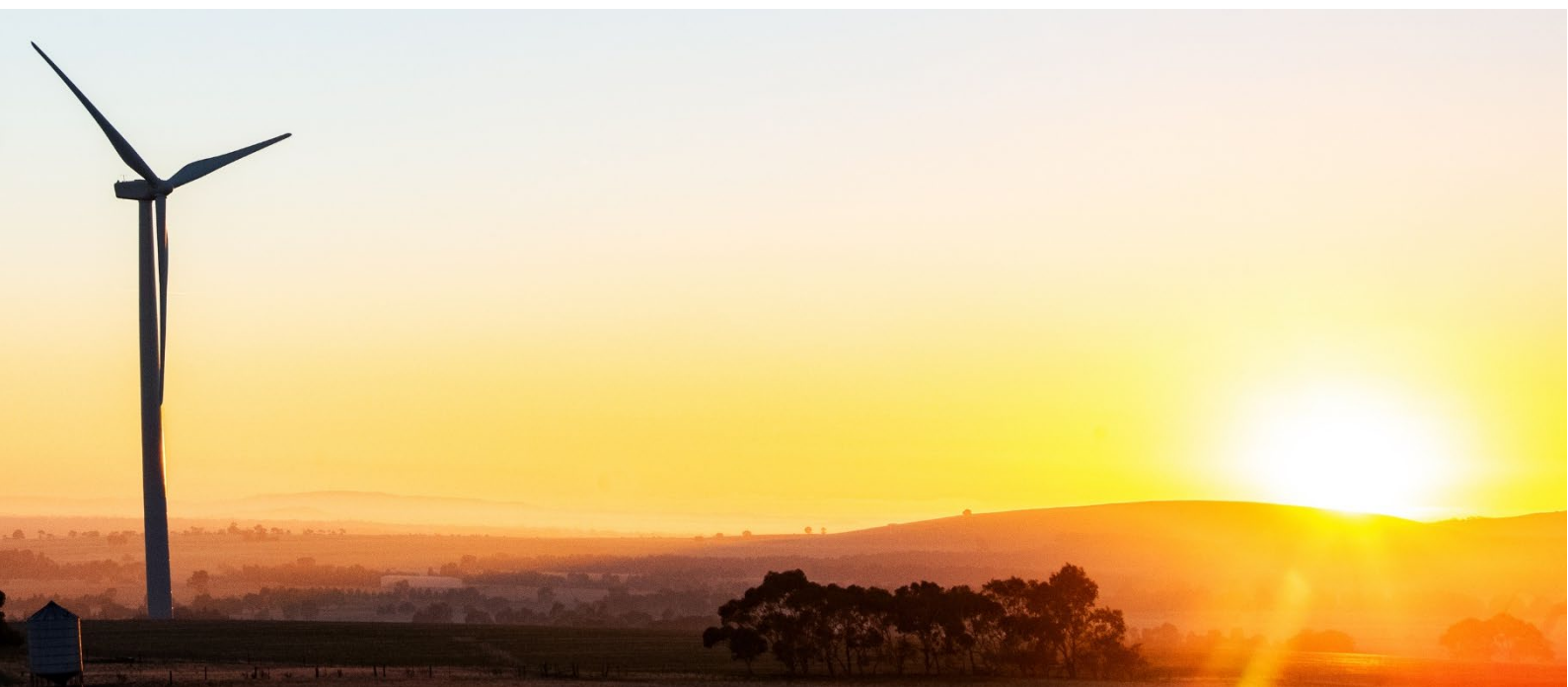
3.2.1.2 Suggested leading indicators

Submissions to the authority's issues paper suggested a range of leading indicators for decarbonisation of the electricity sector, including the pipeline of committed and proposed renewable energy projects (Climate Council, Greenpeace) and projects that reach final investment decision (EnergyAustralia). The Australian Conservation Foundation supported a leading indicator on the scale-up of energy storage and demand management.

Stakeholders also proposed leading indicators relating to:

- fuel mix (BSI Group, Greenpeace, Australian Conservation Foundation and GreenPower)
- installed capacity. For example, an indicator on renewable energy capacity (Australian Conservation Foundation), renewable infrastructure built (AGL) or the percentage of installed capacity in the grid (BSI Group)
- transmission, including data on delays, built capacity, investment and time required to achieve approvals (EnergyAustralia, AGL and the Australian Conservation Foundation)
- the levelised costs of electricity for renewable technologies (AGL and GreenPower).

The authority has settled on committed renewable energy capacity as its primary leading indicator of electricity sector decarbonisation for its 2023 advice. However, many of the matters identified in submissions are critical to a successful outcome and are further discussed in this chapter.

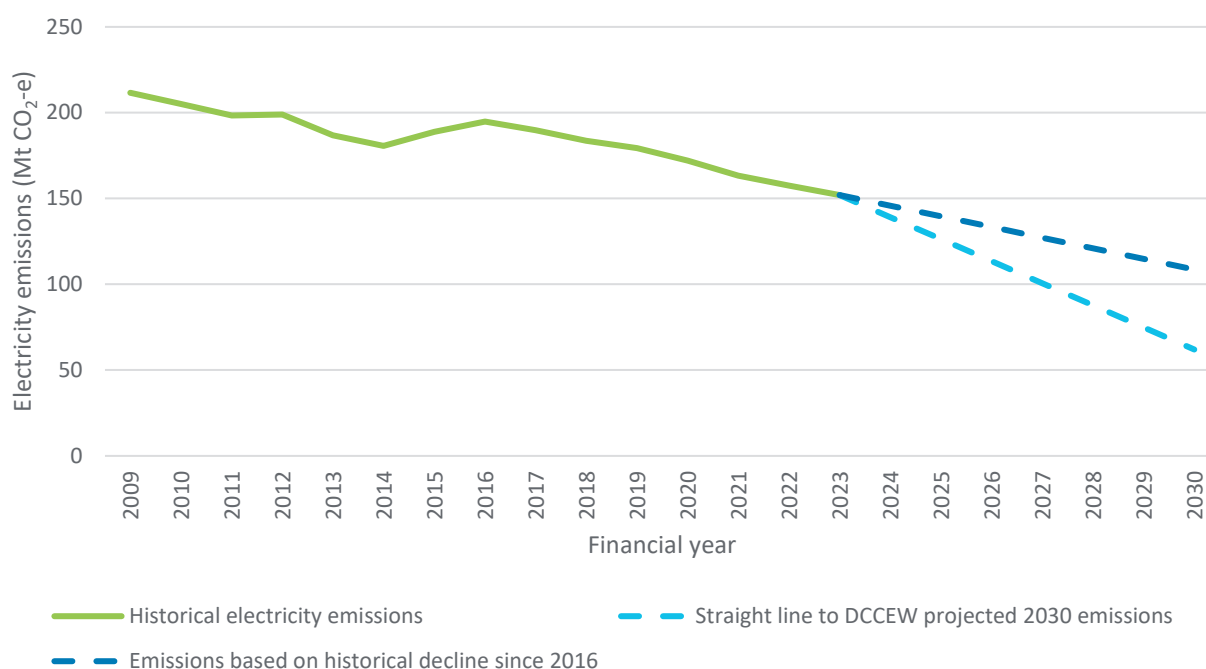


3.2.2 Sectoral issues, context and trends

Electricity emissions decreased by 5.6 Mt CO₂-e over the year to June 2023, reaching 152 Mt CO₂-e (DCCEEW, 2023m)⁶. This 3.6% reduction is consistent with annual declines in the electricity sector since 2016 (Figure 3.4). Renewables reached 32% of Australia's electricity generation in 2022, while coal accounted for 47% and gas for 19% (DCCEEW, 2023a).

Under a scenario which assumes a national renewable electricity target of 82% by 2030, electricity emissions are projected to decline to 62 Mt CO₂-e in 2030 (DCCEEW, 2022a). The implied straight-line trajectory is shown in Figure 3.4 and requires electricity emissions to decline on average by 13 Mt CO₂-e per year. Although emissions have been declining steadily since 2016, this has been at less than half the rate (6 Mt CO₂-e per year) than that required to achieve the renewable energy target in 2030.

Figure 3.4: Historical electricity emissions and projected decline



Source: (unpublished data provided by DCCEEW); (DCCEEW, 2022a).

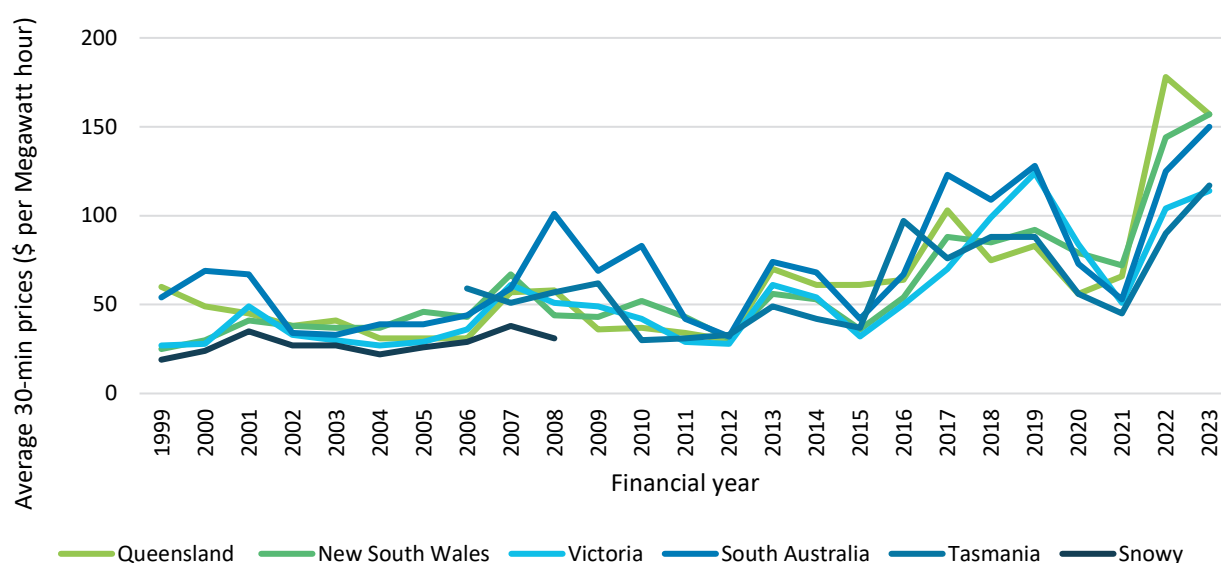
⁶ This includes preliminary estimates for April to June 2023.

3.2.3 Innovations and developments

Achieving the 82% renewable electricity target requires accelerated deployment of large-scale solar PV, wind generation and battery storage, maintaining rooftop solar PV near record levels, increasing small-scale battery installation rates, rapid construction of transmission infrastructure and further investment in energy storage. Noting the levels of capacity in the committed pipeline under the authority's leading indicator, it is essential that these projects move from committed to installed as fast as possible.

Figure 3.5 below shows weighted average wholesale electricity prices in the NEM, which have risen sharply since 2001. Wholesale prices account for approximately one third of household electricity bills (AER, 2015). Energy affordability is discussed further in Chapter 4 – Electrification of the Built Environment.

Figure 3.5: Annual volume weighted average 30-minute prices – regions, 1999–2023



Source: (AER, 2023c)

3.2.3.1 Utility-scale renewable generation and storage

The authority has established benchmarks for the quantity of renewable electricity generation capacity and storage capacity needed to meet the 82% renewable electricity target by 2030 (Table 3.3). In 2022-23 utility-scale solar PV and shallow and medium storage installed in the NEM in 2022–23 exceeded the required average annual increase, while wind fell significantly short of the benchmark (Table 3.3).

Table 3.3: Installed utility-scale solar PV, wind and utility-scale shallow and medium storage capacity in the NEM, MW and the gap between current installed capacity and the capacity needed to meet the 82% renewable electricity target

Technology	Total capacity in June 2022	Capacity required by June 2030	Annual increase required to 2030	Increase in capacity in 2022–23	Gap between required and actuals
Utility -scale solar PV	5,897	12,204	788	1,291	+503
Wind	9,729	31,523	2,724	430	-2,294
Utility-scale shallow and medium storage	1,271	3,734	308	565	+257

Notes: Increase in capacity in 2022–23 shows new generation registered in the NEM. Shallow storage includes durations with less than 4 hours and medium storage includes durations between 4 and 12 hours (inclusive) (AEMO, 2022a). For example, batteries or pumped hydro storage projects.

Source: (AEMO, 2022e); (AEMO, 2022c); (AEMO, 2023b).

The Wholesale Electricity Market (WEM) supplies electricity to the south-west of Western Australia via the South West Interconnected System (AEMO, 2022f). The South West Interconnected System Demand Assessment has modelled a scenario with over 80% renewable electricity generation by 2030 (WA Government, 2023f). Based on this modelling around 250 MW of utility-scale solar, around 400 MW of wind and 50 MW of utility scale battery storage need to be installed in the WEM between now and 2030 to reach 80% renewables in this grid. The authority will be monitoring the rate of utility scale installations in the WEM to test whether these benchmarks are met in future annual progress reports.

The Darwin-Katherine Electricity System Plan models a 50% renewable energy scenario in the Darwin-Katherine Interconnected System by 2030 (NT Government, 2021), which assumes that most of the target will be met by large-scale solar and large-scale batteries under the scenario considered most likely (NT Government, 2021).

Aurecon has estimated the total development and construction timeframe for renewable energy and battery storage projects (Table 3.5). Development activities generally include securing land agreements, wind monitoring (for wind projects), consulting with communities, obtaining development consent, grid connection approval, financing, and a power purchase agreement, and procuring an engineering, procurement and construction (EPC) contractor. Table 3.5 shows the estimated development and EPC program timeframe for wind, large-scale solar PV and large-scale lithium-ion battery projects. It is not unusual for projects to exceed these estimated timeframes, for example the Bango Wind Farm (see Table 3.6).

Table 3.5: Development and engineering, procurement and construction (EPC) timeframes for wind, large-scale solar PV and battery projects

Item	Wind	Large-scale solar PV	Large-scale lithium-ion battery
Assumed project size (MW)	300	240	200
Time for development (years)	3–5	2–3	1–2
EPC programme (years)	2	1.5	1.6–2.2
Total	5–7	3.5–4.5	2.6–4.2

Source: (Aurecon, 2022)

The authority has not undertaken any detailed consideration of nuclear power for this report. There is no prospect of nuclear power contributing to the achievement of Australia’s 2030 targets and significant uncertainty about any role it could play in the longer term. Nuclear power plants are currently prohibited in Australia under Sections 21 and 140A of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and Section 10 of the Australian Radiation Protection and Nuclear Safety Act 1998. There is also a range of other legislation, including state and territory legislation, which regulates nuclear and radiation-related activities (Cronshaw, 2020). It is also the case that the costs of nuclear fuelled electricity generation are projected to be higher than for other electricity generation technologies (CSIRO, 2023d).

3.2.3.2 Planning and approvals processes

The authority is concerned that planning and approvals processes may be delaying the necessary expansion of renewable energy generation in Australia. The following section discusses this issue.

3.2.3.2.1 State and territory level - development approval

Timeframes and costs of development approval processes vary considerably between jurisdictions. Anecdotal evidence indicates that the starkest difference existed about half a decade ago when proposals for windfarms took as little as 12 months to receive approval in Queensland compared to four years or longer in New South Wales. Since then, approval timeframes have increased somewhat in Queensland. Anecdotal evidence from stakeholders suggests that Queensland is still considered ‘quicker’ and easier to navigate than New South Wales.

This difference is partly due to wind projects assessable under the Queensland State code 23: Wind farm development not being placed on public exhibition for comment (DSDILP, 2017). In 2023 the Queensland Government began reviewing State code 23: Wind farm development and its associated Planning Guidance (Queensland Government, 2023b). In September 2023, the New South Wales Government announced that it would streamline planning and approvals processes (NSW Government, 2023b). The New South Wales Government also committed to reviewing approval processes once the Central-West Orana Renewable Energy Zone reaches financial close, which it expects to occur in 2024 (NSW Government, 2023b). At the time of writing, the state government has announced no further details beyond recognition of ‘a need to enhance the planning regime for renewable energy projects through greater consistency, clearer guidelines, better resourcing for assessments and streamlined processes for critical projects’ (NSW Government, 2023b).

Timelines also vary between projects. Table 3.6 shows the timeline from submitting an Environmental Impact Assessment to receiving development consent for 3 projects in New South Wales. The timelines for the selected projects ranged from just over one to nearly 3 years.

Table 3.6: Development approval timelines, New South Wales

Milestone	New England Solar Farm	Bango Wind Farm	Hills of Gold Wind Farm
Time from Environmental Impact Assessment submission to receiving development consent (months)	13	19	34
Time from Environmental Impact Assessment submission to first generation (months)	46	79	Not known

Notes: The assessment process for the Hills of Gold Wind Farm is ongoing. Timeframes for the Hills of Gold Wind Farm are as at 30 September 2023.

Source: (UPC Renewables, 2019; NSW Government, 2023a; ACEN Australia, 2022; CWP Renewables, 2016; NSW Government, 2018; Squadron Energy, 2023; Engie, 2020; Engie, 2023).

While some project-specific data is available, there is no disaggregated information about the length of development approval processes that preceded the commencement of operations for renewable energy projects. AEMO also publishes information about projects at various stages of development, including existing, committed and proposed projects, but does not publish information about development approval milestone dates or length of development approval processes (AEMO, 2022e). Submissions from Hydro Tasmania and GreenPower called for a more transparent renewable energy project pipeline.

The absence of comprehensive statistics about the duration of past development approval processes makes it difficult to ascertain how many projects are on track to reach the ‘committed’ stage. More transparency on numbers of projects being considered and approved could assist proponents and policymakers with planning and tracking progress.



3.2.3.2.2 Federal level – EPBC Approval

The Australian Government assesses project impacts on matters of national environmental significance under the EPBC Act (DCCEEW, 2022c). The 2020 Samuel Review suggested that the EPBC approval process could be considerably improved in terms of its duration, transparency and overall efficiency with EPBC approval processes for some projects taking 3 years or more (Samuel, 2020). The Australian Government is revising Australia’s environmental laws in response to the Samuel Review (DCCEEW, 2023s).

Providing more granular information in EPBC quarterly reporting (DCCEEW, 2023w) that disaggregates decision timelines by industry type would enhance understanding of approval timelines for renewable project decisions. Industry consultation has suggested that EPBC timeframes for renewable energy projects may still take up to three years.

Further options to expedite renewable energy projects going through the EPBC process could include processes to streamline applications by granting renewable energy a ‘public interest’ status in line with international practice (see Box 3.1).

BOX 3.1: Case study: EU Regulation to accelerate the deployment of renewable energy

In 2022 an EU Regulation granted renewable energy projects a ‘public interest’ status on a temporary basis. This status simplifies environmental assessments by member states and reverses the burden of evidence for certain environmental impact assessments, so that these assessments are only required in case of clear evidence of major adverse impacts on the environment (EU Council, 2022) (EU council, 2022b). It sets maximum deadlines for approval processes for renewable energy projects (EU Council, 2022c) and applies the principle of ‘positive administrative silence’ which allows smaller projects (below 50 MW capacity) to proceed without further approval within one month of notifying the approving authority unless the approving authority responds (EU Council, 2022).

9. RECOMMENDATION

Together with the state and territory governments provide the following information to the Australian Energy Market Operator each financial year for it to publish (in a similar format to the Connections Scorecard): number of renewable energy projects submitted for development approval or EPBC Act referral, number of renewable energy projects provided development consent or approval under the EPBC Act, and the average time from submission to approval.

10. RECOMMENDATION

Build on the recommendations in the Samuel Review to prioritise and expedite the EPBC Act assessment process for large-scale renewable energy generation projects, while maintaining rigorous consideration of environmental impacts.

3.2.3.3 Grid connection process

To scale up deployment of large-scale wind and solar PV, grid connection processes need to be timely and efficient. According to AEMO, in 2022–23 it took an average of 2 years and 9 months for projects to achieve the four stages of the grid connection process tracked by the Connections Scorecard, compared to an average of 3 years and one month in 2021–22 (AEMO, 2022b); (AEMO, 2023b). The most time-consuming step across both financial years was connection application approval taking approximately one year (AEMO, 2022b); (AEMO, 2023b). The Connections Scorecard does not track earlier stages in the grid connection process, for example submitting a Connection Enquiry and receiving a response.

Industry consultation suggested that long and complex processes and competition for network capacity were key issues for completing grid connection. The submission from Beyond Zero Emissions suggested that ‘our current grid is the handbrake on delivery of new renewable energy’.

The Connections Reform Initiative is a joint initiative formed in 2020 between the Clean Energy Council (CEC), AEMO, CEC members, network service providers and industry stakeholders to address concerns with the delays and the increasing complexity in connections (CEC, 2023).

BOX 3.2: Case study: Renewable Energy Zones

Renewable Energy Zones (REZ) can also help address the future needs of the power system by creating additional network capacity. The New South Wales REZs are most progressed, however, the New South Wales Government has revised the timeframes for deploying the Central-West Orana (CWO) and New England (NE) REZ. The timing for reaching an additional 5 GW of capacity in the CWO REZ has been delayed from 2031–32 to 2038, and the first phase of the NE REZ has been reduced in size and slightly delayed (AEMO, 2022d); (EnergyCo, 2023a). This timing is no longer in line with AEMO’s modelling for an 82% grid (see Table 3.7). The New South Wales Government has provided more certainty on the timing for the South West, Hunter-Central Coast and Illawarra REZ.

Table 3.7: New South Wales REZ progress to 2030

REZ	Date REZ declared	Date Access scheme declared	Rewiring the Nation funding	Anticipated timing, AEMO ISP	Revised timing, New South Wales Network Infrastructure Strategy
Central-West Orana	Nov 2021	Dec 2022	Yes	2028–29: 3.7 GW	2027–28: 4.5 GW
New England	Dec 2021		Yes	2028–29: 5 GW	2029: 2.4 GW
South West	Nov 2022		Yes	N/A	2026: 0.8 GW 2028: Additional 1 GW
Hunter-Central Coast	Dec 2022		Yes	N/A	2027: 0.95 GW
Illawarra	Feb 2023		No	Developments later in study horizon	Under consideration

Source: (EnergyCo, 2023b); (EnergyCo, 2023c); (EnergyCo, 2023d); (EnergyCo, 2023e); (EnergyCo, 2023f); (Prime Minister of Australia, 2022); (AEMO, 2022d); (EnergyCo, 2023a)

3.2.3.4 Network infrastructure

Much of the additional generation and transmission infrastructure to be constructed over the next decade will occur in regional areas and Indigenous Estate. The Australian Government has committed \$5.5 million to develop the First Nations Clean Energy Strategy to help identify priority reforms and areas for investment (DCCEEW, 2023t). The authority is of the view that the strategy should consider how to support best-practice consultation and benefit-sharing with First Nations communities.

Submissions emphasised the need for social licence to be in place for the necessary transmission infrastructure to be built (EnergyAustralia, AGL, Principles for Responsible Investment). Suggestions for ensuring this included providing compensation (EnergyAustralia, Australian Conservation Foundation), for example to landowners and others who are disproportionately affected by transitional costs (EnergyAustralia), consultation (Australian Conservation Foundation) and governments building community awareness of the need for these assets (AGL).

The government's Australian Energy Infrastructure Commissioner (AEIC) is currently undertaking a review of community engagement practices (DCCEEW, n.d.). The Community Engagement Review is considering the impacts of electricity transmission and renewable energy infrastructure in a range of areas, including First Nations, the environment, communities, business and local industry. It will provide advice to the government on maximising community engagement and benefit in the planning, development and operation phases of energy infrastructure projects. The report of the Review is due to be delivered to the government by 31 December 2023.

11. RECOMMENDATION

Respond to the Community Engagement Review on energy infrastructure no later than 30 April 2024, and implement measures to support best practice community engagement and benefit sharing, including with First Nations communities, as soon as possible thereafter.

The NEM incorporates approximately 40,000 km of transmission infrastructure (AEMO, n.d.). According to AEMO, at least 3,612 km of new transmission infrastructure is needed by 2030 to support the additional renewable energy generation required to meet the 82% renewables generation target (AEMO, 2022c). The Australian Government committed funds of \$20 billion into the Rewiring the Nation policy to upgrade and expand Australia's transmission grid, of which \$12 billion was allocated in the May 2023 budget (Treasury, 2023b). This includes funding for the nationally strategic projects HumeLink, Marinus Link and VNI West (DCCEEW, 2022d); (Prime Minister of Australia, 2022).



Table 3.8 below shows that HumeLink, Marinus Link and Project EnergyConnect are anticipated to be completed by 2030. The AEMO ISP anticipates that VNI West will be delivered by 2031, or earlier with additional support (AEMO, 2022a).

Table 3.8: Progress of nationally strategic projects to 2030

Project	Approximate length (km)	Rewiring the Nation funding	Project timing
EnergyConnect	900	No	2021: Regulatory Investment Test (RIT-T) process completed 2022: project approvals completed 2022: construction commenced 2026: anticipated delivery date
HumeLink	360	Yes	2021: Regulatory Investment Test (RIT-T) process completed Sept 2023: anticipated date for public display of Environmental Impact Statement 2024: anticipated planning approval 2024: anticipated commencement of construction 2026: anticipated completion of construction
Marinus Link	345 ⁷	Yes	2024: anticipated completion of planning and approvals and final investment decision 2028: anticipated delivery of cable one

Source: (Transgrid, 2023b); (Transgrid, 2023a); (Marinus Link, 2022); (Australian Government and Tasmanian Government, 2023); (AEMO and Transgrid, 2023); (DCCEEW, 2022d); (Prime Minister of Australia, 2022); (AEMO, 2022a)

Several submissions referred to Rewiring the Nation, as a positive step (Investor Group on Climate Change), an important measure to realising the benefits of an interconnected system (Hydro Tasmania) and a tool that should be used to progress to 100% renewables (Climate Council). GreenPower suggested that the Australian Government accelerate the rollout of renewable energy by urgently progressing transmission projects under the Rewiring the Nation program. Feedback was provided that additional government policies are needed to accelerate network infrastructure (Clean Energy Investor Group, Investor Group on Climate Change) and one submission suggested that the government reserve land for transmission (Planning Institute of Australia).

12. RECOMMENDATION

Work with state and territory governments to accelerate the rollout of network infrastructure to support the deployment of large-scale renewable energy projects.

⁷ Comprising approximately 255 kilometres of undersea High Voltage Direct Current (HVDC) cable and approximately 90 kilometres of underground HVDC cable in Victoria.

BOX 3.3: Regulatory Investment Test for Transmission process

The Minister for Climate Change and Energy has announced the intention to reform the Regulatory Investment Test for Transmission (RIT-T) process, the approvals process for transmission infrastructure projects. The reform aims to improve the RIT-T's current focus on cost-benefit analysis by adding a focus on best-practice community consultation (Bowen, 2023). At the time of writing, it is too early to foresee the outcomes of these reforms. More transparent and tangible timelines for transmission construction projects and their anticipated completion will allow for better benchmarking against the government's 2030 goals and identify any delays and their potential impacts.

The South West Interconnected System comprises 7,660 km of network infrastructure (Western Power, 2022). According to the South West Interconnected System Demand Assessment conducted by the Western Australian Government, more than 4,000 km of new high-capacity transmission lines could be needed over the next 20 years (WA Government, 2023e). In May 2023, the Western Australian Government committed \$126 million of additional funding for Western Power to commence delivery of the first stage of network investments identified in the Demand Assessment (WA Government, 2023f), including an approximately 210 km estimated network build (WA Government, 2023e). In August 2023, the Australian Government announced an agreement with the Western Australian Government to provide up to \$3 billion through concessional loans and equity investments to Western Australia through the CEFC for major upgrades to transmission in the South West Interconnected System and the North West Interconnected System (Prime Minister of Australia, 2023b).

3.2.3.5 Shallow, medium and deep storage

A scenario of greater than 80% renewable energy generation modelled by AEMO indicated the quantity of storage likely to be required to support large quantities of renewable energy generation (Table 3.9). The authority has used these modelling results to establish working benchmarks for the quantity of storage that will be needed in the national electricity market by 2030 (Table 3.9).

Table 3.9: Shallow, medium and deep storage capacity in the NEM, MW

Storage depth	Installed battery capacity as at July 2023	Installed pumped hydro capacity as at July 2023	Capacity required by 2029–30	Gap between required and actuals
Shallow	1,013	0	747	+266
Medium	0	570	2,986	-2,416
Deep	0	160	160	0
Snowy 2.0	0	0	2,040	-2,040

Notes: Shallow storage includes durations with less than 4 hours, medium storage includes durations between 4 and 12 hours (inclusive), and deep storage includes storage with durations greater than 12 hours (AEMO, 2022a).

Source: (AEMO, 2023a); (AEMO, 2022c).

Several submissions supported Government investment in, or incentives for, energy storage projects (Clean Energy Investor Group, Business Council for Sustainable Development Australia, Council of Capital City Lord Mayors), the adoption of energy storage targets (Climateworks, AustralianSuper) or battery storage targets accompanied by a roadmap (Committee for Sydney). Table 3.9 shows that 2.4 GW of medium storage will be needed by 2030, as well as the completion of Snowy 2.0.

3.2.3.5.1 Shallow and medium storage

On 8 December 2022, the Australian Government, state and territory ministers agreed in principle to establish the Capacity Investment Scheme, planned to include \$10 billion of new investment and 6 GW of dispatchable power (DCCEE, 2023q).

Hydro Tasmania raised high capital costs and long construction timeframes as two challenges in deploying new hydropower projects (including pumped hydropower projects) and suggested that the Capacity Investment Scheme is likely to be a good example of the role that the Government can play in de-risking investments. However, it is notable that in 2022–23, the only successful storage project in AEMO Services' first competitive tender under the New South Wales Infrastructure Roadmap was for an 8-hour lithium-ion battery (AEMO, 2023c). The New South Wales Electricity Infrastructure Roadmap also included commentary that these tender processes may not attract tenders from pumped storage noting their lead times (NSW Government, 2020).

13. RECOMMENDATION

Work with state and territory governments to provide incentives to ensure sufficient renewable energy storage projects that can provide between 4 to 12 hours of storage are deployed by 2030 (through the Capacity Investment Scheme or other mechanisms).

3.2.3.5.2 Deep storage

Snowy 2.0 is the only committed pumped hydro project with the capacity to provide deep storage in Australia (AEMO, 2023a). In August 2023, Snowy Hydro announced a revised cost to complete of \$12 billion, an increase in capacity from 2,000 MW to 2,200 MW, and that full power is expected in December 2028.

The 1,998 MW Borumba Pumped Hydro project (Queensland) is an anticipated⁸ pumped hydro project with the potential to provide deep storage (AEMO, 2023a). Detailed project studies are underway, and the project is targeting operations by the end of the decade (Queensland Hydro, 2023). This will be challenging given the significant development and construction timeframes for pumped hydro energy storage projects, with Snowy 2.0 being the prime example.

Tasmania's Battery of the Nation pumped hydro project has the potential to provide deep storage, yet has not progressed passed the 'publicly announced' stage in AEMO NEM Generation Information since 2020 (AEMO, 2023a); (AEMO, 2020a). The project is dependent on the Marinus Link transmission project under development (Hydro Tasmania, 2022). The Australian Government recently announced that it would work with the CEFC to provide low-cost debt to the Battery of the Nation project (Australian Government and Tasmanian Government, 2023).

AEMO's ISP models a scenario where additional deep storage projects are required from 2030–31 (AEMO, 2022c). To achieve this, projects need to be under construction before 2030. In the lead-up to 2030, it is important for research and investment in deep storage projects to occur to ensure timely deployment of projects in the next decade. The Australian Government has allocated an additional \$19 billion to the CEFC to help deliver the Rewiring the Nation program, with investments expected to include long duration grid storage (CEFC, 2023c). The CEFC has already committed \$100 million to accelerate the development of the 850 MW and 1680 MWh Waratah Super Battery (CEFC, 2023e), which could dispatch approximately 210 MW for an 8-hour duration.

⁸ Anticipated projects included in the AEMO NEM Generation Information are sufficiently progressed towards meeting at least three of the five commitment criteria (AEMO, 2023a, Background Information).

In 2022–23, ARENA announced funding for the Yuri Renewable Hydrogen to Ammonia Project which includes an 8 MW battery (ARENA, 2023h). ARENA funding for current projects includes \$136 million for battery storage projects, \$47 million for the Kidston Pumped Hydro Energy Storage project and \$34 million for concentrated solar thermal projects (ARENA, 2023d).

The significant capital costs of deep storage projects suggest these projects will require significant policy support to be deployed.

14. RECOMMENDATION

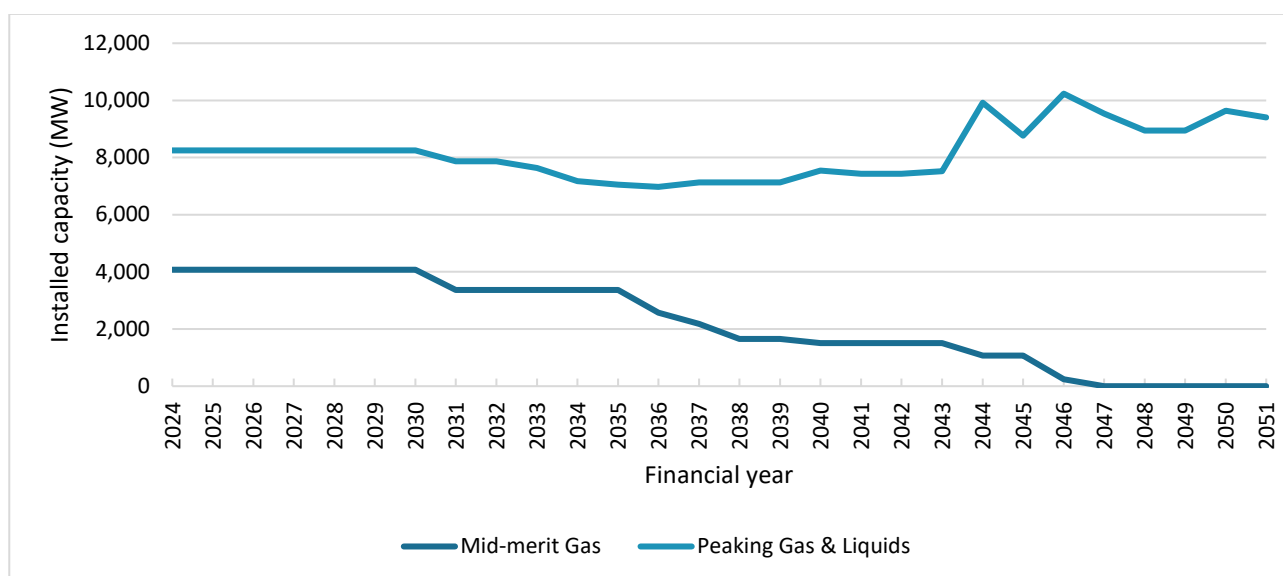
Provide funding via ARENA and the CEFC to accelerate the commercialisation and deployment of deep storage options.

3.2.3.6 The role of gas

In 2022–23, installed gas capacity in the NEM increased from 11.8 GW to 12.0 GW (AEMO, 2022e); (AEMO, 2023a). An additional 1.6 GW of gas closures is anticipated in or prior to 2030 (AEMO, 2023d). There are currently 1 GW of gas projects in AEMO’s pipeline of committed projects (AEMO, 2023a). Towards 2030, modelling shows an expectation that gas capacity remains relatively stable.

Figure 3.6 shows for AEMO’s scenario consistent with 82% renewables by 2030, and net zero by 2050, a decline in both mid-merit and peaking gas in the NEM in the 2030s is met with an increase in peaking gas and liquids capacity from 2044.

Figure 3.6: Forecast installed gas capacity in the NEM, 2024–2050^a



Notes: AEMO defines ‘peaking’ as generating units that are relatively expensive to run and generally only run for a few hours per day during high demand. Mid-merit gas generators are ‘intermediate’ units, which generally do not fall into either the baseload generation or peaking generation categories. (AEMO, 2023e). Source: (AEMO, 2022c).

This relative stability of gas capacity in the NEM aligns with expectations that gas continues to be used in the grid to balance intermittent sources over the long-term. The rise in gas consumption for electricity generation in 2022 is forecast to persist in 2023, before trending down to 2026 as more wind and solar generation comes online (AEMO, 2023f). Several submissions provided feedback that gas will continue to be needed throughout the transition (APA, BP, Woodside, EnergyAustralia, AGL).

The authority is of the view governments need to prioritise the adequate supply of gas to ensure this fuel can provide a balancing role. The 2023 Gas Statement of Opportunities (which covers adequacy of gas supply in all jurisdictions except Western Australia) noted continued risks of short-term gas supply shortfalls, for example due to extreme weather conditions (AEMO, 2023f). Electrification is forecast to reduce natural gas consumption from residential and small commercial consumers by 158 PJ, down to 75 PJ by 2042 (AEMO, 2023f). Speeding up this process would provide some additional gas supply, however, is unlikely to be adequate to cover potential shortfalls. AEMO forecasts that in the absence of development of additional supply, up to 107 PJ of liquified natural gas supply shortages may emerge in 2026 increasing to 342 PJ in 2028 (AEMO, 2023f). Liquified natural gas exports may need to be supplied to domestic customers from 2026 to maintain domestic supply adequacy, without expanded domestic supply (AEMO, 2023f).

15. RECOMMENDATION

Implement measures to ensure there is adequate abated domestic gas supply for firming renewable electricity generation and other purposes, while the domestic use of gas is phased down over time with the deployment of lower and zero emissions alternatives.

3.2.3.7 Coal plant closures

In 2022–23, installed coal capacity in the NEM decreased from 22.7 GW to 21.3 GW (AEMO, 2022e); (AEMO, 2023a). Units 1, 2 and 4 of the Liddell Power Station (totalling 1.5 GW) closed in April 2023 (AEMO, 2023g); (AGL, 2023a).

AEMO modelling most consistent with a renewable share in the NEM of 82%⁹ forecasts the withdrawal of 14 GW of the 23 GW current coal capacity in the NEM by 2029–30 (AEMO, 2022a). To date only 8.4 GW of coal plant withdrawal has been announced for this period (AEMO, 2022a). Since the release of the AEMO ISP, the anticipated closure of the 1.3 GW Vales Point B project was changed from 2029 to 2033, which decreased the anticipated withdrawal of coal capacity by 2030 to approximately 7 GW.

The latest Electricity Statement of Opportunities released by AEMO forecast reliability gaps in all mainland NEM regions over the next decade when considering only those developments that meet AEMO’s commitment criteria (AEMO, 2023h). The 2023 Electricity Statement of Opportunities stated that ‘in addition to the need for new generation, transmission and other solutions, the ongoing availability of coal, gas and distillate fuels’ will be critical to the reliability of the NEM (AEMO, 2023h). AEMO noted that while delaying generator retirements may be effective in reducing reliability risks, coal generators expect rising outage risks as they approach retirement (AEMO, 2023h).

States are targeting varying dates for phasing out coal plants, have not provided clear expectations for when coal generation will cease in their state, and in certain cases have (or are considering) negotiated with operators to ensure plants do not retire earlier than announced.

Table 3.10 shows the announcements by the Western Australian and Queensland governments to retire state-owned coal power stations by 2030 and 2035 respectively, while the New South Wales and Victorian governments have not set expectations for coal exits in their states.

⁹ AEMO’s Step Change Scenario.

Table 3.10: State targets for coal closures

State	Government coal closure announcements
Western Australia	In June 2022, the Western Australian government announced the closure of all State-owned coal power stations by 2030 (WA Government, 2022). In August 2023, the Western Australian government announced that it was extending the retirement date for Muja C Unit 6 by 6 months to April 2025, but that this would not impact the planned retirement of the State's remaining coal-fired units by 2030 (WA Government, 2023c).
New South Wales	No announced date for coal closures. In September 2023, the New South Wales Government stated that it will engage with Origin on its plans for Eraring, while pursuing alternative solutions to deliver renewable generation, transmission and storage solutions (NSW Government, 2023c).
Victoria	No specific date set for coal retirements. In August 2023, AGL announced that it had entered into an agreement with the Victorian Government to keep Loy Yang A operating until 2035 (AGL, 2023b).
Queensland	The Queensland Energy and Jobs Plan includes a commitment to convert all of Queensland's publicly-owned coal-fired power stations into clean energy hubs by 2035, backed by a Job Security Guarantee for workers (Queensland Government, 2023c).

Note: This will include the following closures in the WEM: Muja C Unit 6 (2024) Collie Power Station (2027) and Muja D (2029) (AEMO, 2023i).



The varying dates for the phase-out of coal plants across states shown in Table 3.10 and the actions by state governments to intervene to prolong the life of specific projects creates uncertainty for coal generators and for renewable energy proponents. Several submissions referred to the need for an orderly or managed transition (Institute for Energy Economics and Financial Analysis, Ember, Climate Council, BSI Group) and national coordination of coal closures (Clean Energy Investor Group, Ember). The Australian Conservation Foundation commented:

‘there has never been a national coal closure plan in Australia or a national plan to phase out gas and this has made managing the phase-out more difficult, more dependent on state and territory governments and less certain than it would be with overarching national plans.’

The authority is of the view that further coordination is needed between federal and state governments to provide certainty on the timing for coal closures and to develop measures to support local workforces and communities affected by closures.

16. RECOMMENDATION

Coordinate with state and territory governments to agree on timing for the retirement of fossil fuel generators and measures to support local workforces and communities affected by closures.



3.2.3.8 Social licence for renewable energy deployment

AGL pointed out in its submission that governments can assist with overcoming social licence issues through building community awareness and trust and through putting a premium on community engagement ‘so communities are part of the process, feel heard and set to benefit’. The submission from the Australian Conservation Foundation points towards an inclusive and consultative approach as the best way to overcome social licence issues, including fair compensation where impacts cannot be reasonably minimised.

3.2.3.9 Supply chain and workforce constraints

Some submissions discussed the effects of supply chain and workforce constraints in slowing the deployment in renewables. Please see Chapter 1 - Climate change science, impacts and global policy developments for further discussion on renewable energy supply chains.

Hydro Tasmania supported recommendations in the Clean Energy Council’s Skilling the Transition report to alleviate workforce constraints on renewable energy deployment. An anonymous submission suggested that waiving tuition fees for the most critical energy transition skills to increase the pool of skilled renewable energy sector workers. In addition, the Australian Academy of Technological Sciences and Engineering recommended a national skills taxonomy. Please see Chapter 2 – Climate-related Wellbeing for further discussion of renewable energy employment.

3.2.3.10 Artificial intelligence

AEMO has recognised opportunities for artificial intelligence and machine learning in its 2020–21 Corporate Plan (AEMO, 2020b). However, these technologies have significant energy requirements (European Commission, 2019). Future electricity system planning will need to consider the potentially significant impacts of significant growth in the use of artificial intelligence for electricity demand.



3.2.4 Policy opportunities and recommendations

The government's 82% renewables target is the key policy objective underpinning not only emissions reductions in the electricity sector, but significant opportunities for emission reductions elsewhere in the economy and ultimately the achievement of the 2030 emissions reduction target. While the renewables target is supported by many complementary policies, such as the government's Rewiring the Nation policy and the capacity investment scheme, there is currently no direct policy intervention that will ensure the renewables target is met.

In the absence of a national sector strategy or policy intervention to achieve target, the target rests on the renewable electricity targets of individual states and territories (see Table 3.2 above). Although state-level targets have been strengthened in recent years, they fall short of achieving a cumulative effect of 82% renewable generation based on current projections (DCCEEW, 2022a).

While the Renewable Energy Target was met in 2020, the Large-scale Renewable Energy Target continues to operate until 2030 (CER, 2023a); (CER, 2023f).

The Guarantee of Origin Scheme, if enacted, would operate alongside the Renewable Energy Target until the target's sunset date in 2030 (DCCEEW, 2022e). Eligible participants could generate a tradable certificate representing one megawatt hour of eligible renewable electricity generation (DCCEEW, 2022e). The Scheme would also include storage if it came from renewable electricity, offshore generation and generation for export, and 'below-baseline' generation meaning generation installed prior to 1997 (DCCEEW, 2022e).

Economist Ross Garnaut has argued that the Renewable Energy Target helps to reduce domestic electricity prices (Garnaut, 2022). Garnaut continues: 'One could develop various mechanisms to serve these purposes, but none would be as straightforward as extension of the [Renewable Energy Target], and others are more likely to be more expensive' (Garnaut, 2022).

Submissions showed no strong consensus about a policy mechanism to support the 82% renewable target or beyond 2030 when the Renewable Energy Target expires. As an anonymous stakeholder pointed out in their submission, policy certainty will be required for Large Generation Certificates and their replacement beyond the Renewable Energy Target sunset, given the healthy growth of the surrender market driven by voluntary corporate action. The Carbon Market Institute's submission suggests that the government contemplate its approach to driving renewable uptake past the 2030 conclusion of the Renewable Energy Target to ensure continued electrification. The Grattan Institute supports modification of the Renewable Energy Target to support the 2030 target.

Extending the Renewable Energy Target to 2035 could send signals to investors that will assist the 82% by 2030 target. Submissions from AustralianSuper and Climateworks emphasised that government targets and regulations function as policy signals for investors. They provide frameworks for long-term planning, stability and incentives for investments 'with the strongest signal being the ones connected to market mechanisms such as the Renewable Energy Target' (Climateworks).

The authority is of the view that irrespective of whether the Renewable Energy Target is extended past 2030 or not, the government needs a policy mechanism that incentivises utility scale and small-scale renewables to 2030, and a certification mechanism for beyond 2030 for ensuring energy has been sourced through renewable generation.

Table 3.11: Policy effectiveness in the electricity sector^a

Aspect	Analysis
Scope	<p>The Australian Government has set a target of 82% renewable electricity generation by 2030 (DCCEEW, 2022f). Because there is no national sector strategy or policy intervention to achieve the target, the target rests on the legislated renewable generation targets of individual states and territories (see Table 3.2 for an overview of state-level targets). Notwithstanding increasing ambitions by the states, these targets still fall short of cumulatively achieving 82% renewable generation by 2030 (see Table 3.2).</p> <p>The 82% target is supported by the Rewiring the Nation policy which has secured \$20 billion in funding to upgrade and expand the country's electricity grid (DCCEEW, 2022f). The policy is only targeting transmission infrastructure while renewable generation deployment needs to increase in speed and scale.</p> <p>Although a number of other policies and governmental initiatives exist that aim to support the 82% target –the National Energy Transformation Partnership, the NEM emissions reduction objective and the Capacity Investment Scheme – they still leave a gap in the area of renewable generation deployment.</p>
Impact	Government projections indicate that achieving emissions reductions of 41% below 2005 levels by 2030 will depend on achieving an 82% renewable target and reforms to the Safeguard Mechanism (DCCEEW, 2022a).
Efficiency	As there is no specific policy mechanism to ensure the target is reached, it is not possible to evaluate efficiency.
Relevance	The target in and of itself does not incentivise emissions reductions, investment or innovation and does not close key gaps in the sector. The Rewiring the Nation policy is only concerned with electricity transmission and not generation and while implementing it is necessary to meet the target, implementation will not be sufficient to close the gap in electricity generation.
Coherence	The intervention lacks coherence as it is not sufficient on its own to reach 82% renewable electricity, and cannot be scaled without firm commitments. Also, the government needs to set longer-term expectations (i.e. beyond 2030) for the sector achieving higher shares of renewables to support the decarbonisation of other sectors and the achievement of net zero.
Sustainability	The benefits of the intervention, if achieved, will be durable. Because the power generation infrastructure, once built, will remain generating throughout their lifecycles, the benefits, if achieved, will be permanent, barring the necessity to recommission existing generation infrastructure or replace facilities by new deployments.

^a See Appendix B for notes on the authority's Climate Policy Tracker and approach to analysing the effectiveness of climate policies.

3.3 Industry and Resources (excluding electricity generation)

Less than 1% increase in industry and resource sector emissions from 2021–22 to 2022–23¹⁰

Australia's industry and resources sectors include LNG production, oil and gas extraction, mining and manufacturing industries. Reported domestic emissions from the industry and resources sector were 185 Mt CO₂-e in 2022–23¹¹.

The Australian Government's recent reform to the Safeguard Mechanism is designed to drive down emissions in these sectors. However, significant coordinated public and private investment will be required to roll out the abatement technologies necessary to achieve on-site abatement. The authority will be tracking the progress of the Safeguard Mechanism in future Annual Progress Reports and will examine technology deployment opportunities as part of the sectoral pathway work in 2024.

3.3.1 The Safeguard Mechanism

The Safeguard Mechanism is the Australian Government's policy for reducing emissions at Australia's largest industrial facilities. Facilities which emit more than 100,000 t CO₂-e per year of Scope 1 emissions are covered under the policy (DCCEEW, 2023dd). The reformed Safeguard Mechanism came into effect on 1 July 2023.

The top 10 emitting facilities covered by the Safeguard in 2021–22 are listed in the table below.

Table 3.12: Top 10 emitters covered under the Safeguard Mechanism 2021–2022

Facility	Reporting entity	Emissions in 2021–22 (Mt CO ₂ -e)
Gorgon LNG	Chevron	8.3
Ichthys LNG	INPEX	6.7
North West Shelf Project LNG	Woodside Energy	6.4
Port Kembla Steelworks	Blue Scope Steel	6.2
Wheatstone Operations LNG	Chevron	3.9
Worsley Alumina	South 32	3.6
Queensland Alumina refinery	Queensland Alumina	3.1
Qantas Airways	Qantas	3.1
Moomba Gas Plant	Santos	2.2
Whyalla Steelworks	Onesteel Manufacturing	2.2

¹⁰ (DCCEEW, 2023m) This includes preliminary estimates for April to June 2023.

¹¹ Emissions estimate includes emissions associated with on-site electricity generation at industrial facilities that also export to the grid, and stationary energy emissions from the agriculture or buildings sector.

3.3.2 Leading indicators

In the industry and resources sectors, fuel switching, flaring of methane and carbon capture and storage will be important emissions reduction technologies.

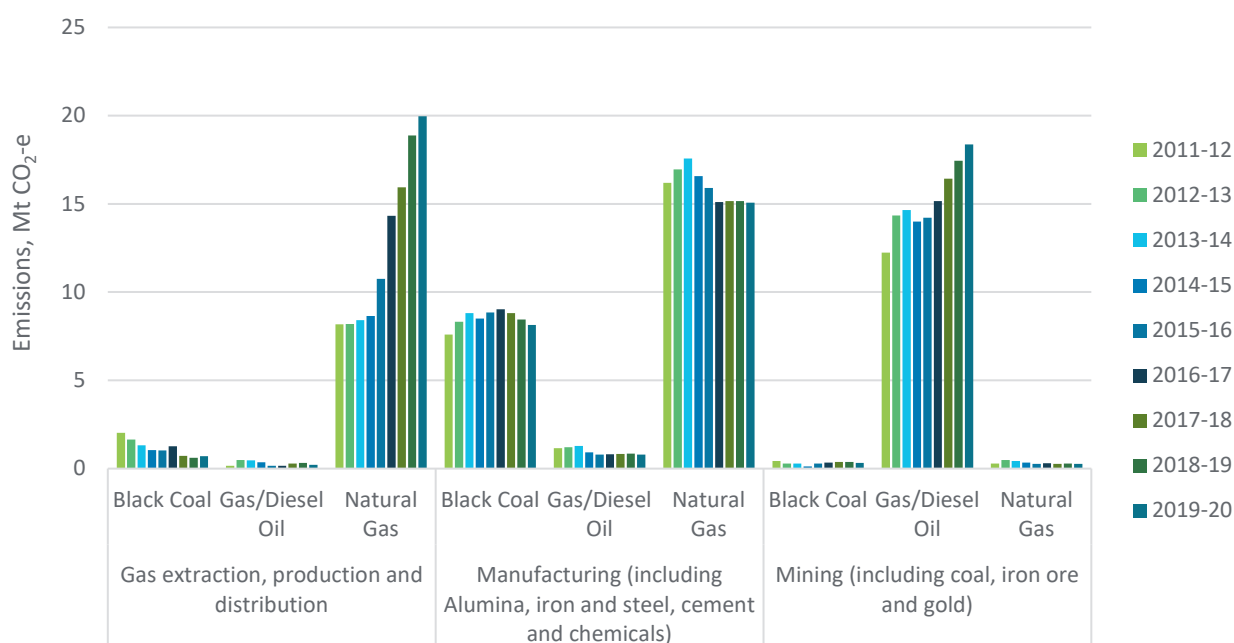
3.3.2.1 Stationary energy

Fuel switching from natural gas, diesel or coal to low- or zero emissions alternatives presents a major decarbonisation opportunity for stationary energy emissions in the industry and resources sector.

The main sources of stationary energy emissions in 2022–23¹² were manufacturing¹³ (32 Mt CO₂-e), coal and metal ore mining (22 Mt CO₂-e) and LNG and gas extraction and distribution¹⁴ (24 Mt CO₂-e).

Diesel is the energy source that drives Australia’s mining industry. It fuels heavy trucks and powers the onsite crushing and milling processes. Natural gas drives Australia’s industrial manufacturing sector, particularly alumina and chemical production, and is also used heavily in the gas production chain itself.

Figure 3.7: Fuel combustion emissions from natural gas, diesel and coal in major industries, 2011–12 to 2019–20



Source: Climate Change Authority Analysis using internal Inventory data, disaggregated by fuel type, for 2011–12 to 2019–20.

Achieving Australia’s 2030 targets, and beyond, will require the industry and resources sectors to transition their primary energy source from fossil fuels to lower carbon alternatives, such as through electrification, use of biofuels or green hydrogen later in the decade and beyond 2030. The abatement opportunities for stationary energy emissions differ according to the specific end-use and sector. As such, this analysis will be a focus of the authority’s sectoral pathways work in 2024.

¹² Based on internal disaggregated data from Quarterly update of Australia’s National Greenhouse Gas Inventory: March 2023, which includes preliminary estimates for April to June 2023

¹³ Includes all manufacturing industries and construction, except other mining and quarrying.

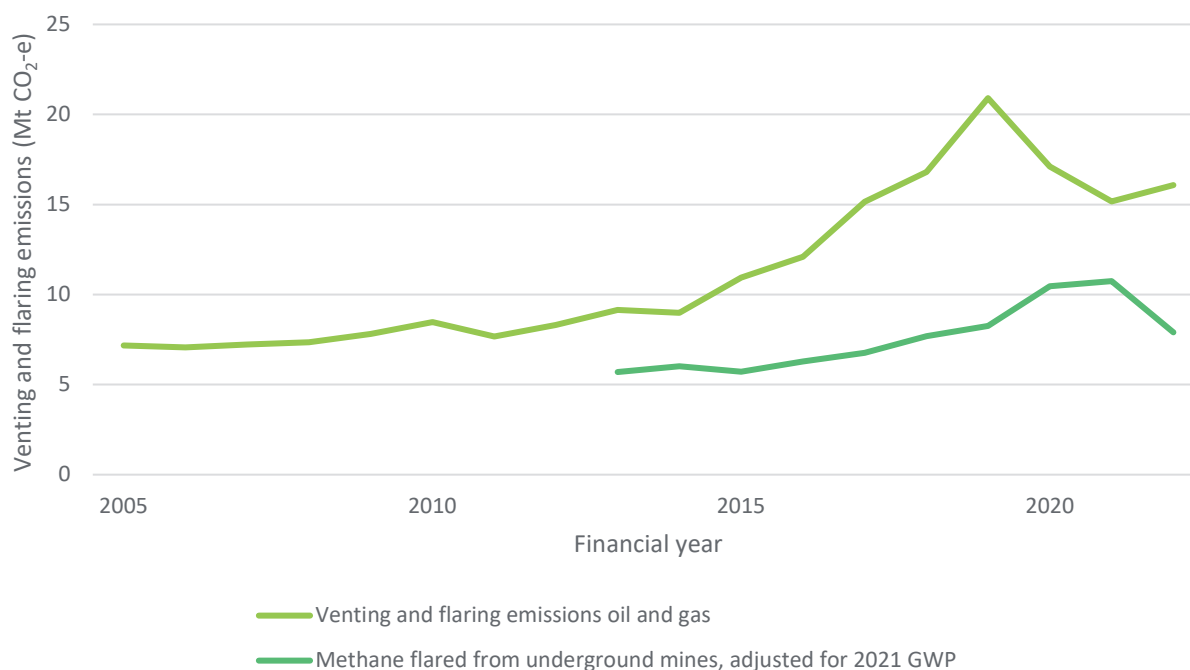
¹⁴ Includes oil and gas extraction and gas production and distribution.

3.3.2.2 Fugitive emissions

3.3.2.2.1 Venting and flaring emissions from oil and gas and underground coal mining activities

Venting and flaring emissions in 2022 from oil and gas activities have increased by 124% since 2005¹⁵. Similarly, emissions from flaring of methane from underground coal mining activities have increased by 89% between 2012–13 to 2020–21¹⁶, noting reduced fugitive emissions from coal production in 2021 and 2022 due to events such as flooding (DCCEEW, 2022a).

Figure 3.8: Flaring and venting emissions from oil and gas and flaring emissions from underground coal mining activities



Source: (unpublished data provided by DCCEEW); NGER MTBI report, 2012–13 to 2021–22

3.3.2.3 Industrial Processes and Product use (IPPU)

Reducing the 10 Mt CO₂-e¹⁷ of emissions associated with leakage of hydrofluorocarbons from refrigeration and air-conditioning through the adoption of alternative and lower global warming potential refrigerants should be a focus of government and industry.

Commercially available alternative refrigerants include ammonia, carbon dioxide, hydrocarbons (e.g. propane and isobutane), as well as hydrofluoroolefins (Project drawdown, 2020; US EPA, 2021); all with global warming potential of less than 5 (DCCEEW, 2021a).

The phase down of HFCs has already resulted in a move to lower GWP refrigerants, for example, in the small split system air-conditioning segment, HFC-32 (GWP 675) is displacing the use of higher GWP HFC-410A (GWP 2088), with the installed refrigerant bank of HFC-32 increasing by 35% in 2021 compared to 2020 levels (DCCEEW, 2023r).

¹⁵ Based on Climate Change Authority analysis of internal disaggregated data from Quarterly update of Australia's National Greenhouse Gas Inventory: March 2023 (DCCEEW, 2023), which includes preliminary estimates for April to June 2023

¹⁶ Based on Climate Change Authority analysis of NGER MTBI report, data extracted for 2012–13 to 2021–22 with updates to methane global warming potential (GWP) made for data pertaining to 2012–13 to 2019–20

¹⁷ Based on internal disaggregated data from Quarterly update of Australia's National Greenhouse Gas Inventory: March 2023

The share of products that use refrigerants with low global warming potential (less than 5 GWP in number) registered under the *Greenhouse and Energy Minimum Standards Act 2012* (GEMS Act) can be tracked as an indicator of a shift towards refrigerants with low global warming potentials.

Air-conditioners are an example of products that are registered under the GEMS Act. Out of the total registered products under the GEMS Act for air-conditioner models available in Australia, only 8%¹⁸ currently use refrigerants with a global warming potential of less than 5 with the remaining using refrigerants with global warming potential between 675–3922.

At the time of writing, historical data of all products registered under the GEMS Act was not available for a time series analysis.

3.3.3 Sectoral issues, context and trends

Emissions from the industry and resources sectors increased by 0.04% (0.1 Mt CO₂-e) to 185 Mt CO₂-e in the year to June 2023. Over the longer term, emissions in these sectors have increased 10% (17 Mt CO₂-e) between 2014–15 to 2022–23.

3.3.4 Innovation and developments

3.3.4.1 2023 reforms to the Safeguard Mechanism

Reforms to the Safeguard Mechanism, under the *Safeguard Mechanism (Crediting) Amendment Act 2023*, were passed by the federal parliament on 30 March 2023 and new arrangements took effect from 1 July 2023. The reforms included changes to associated subordinate legislation to implement the package.

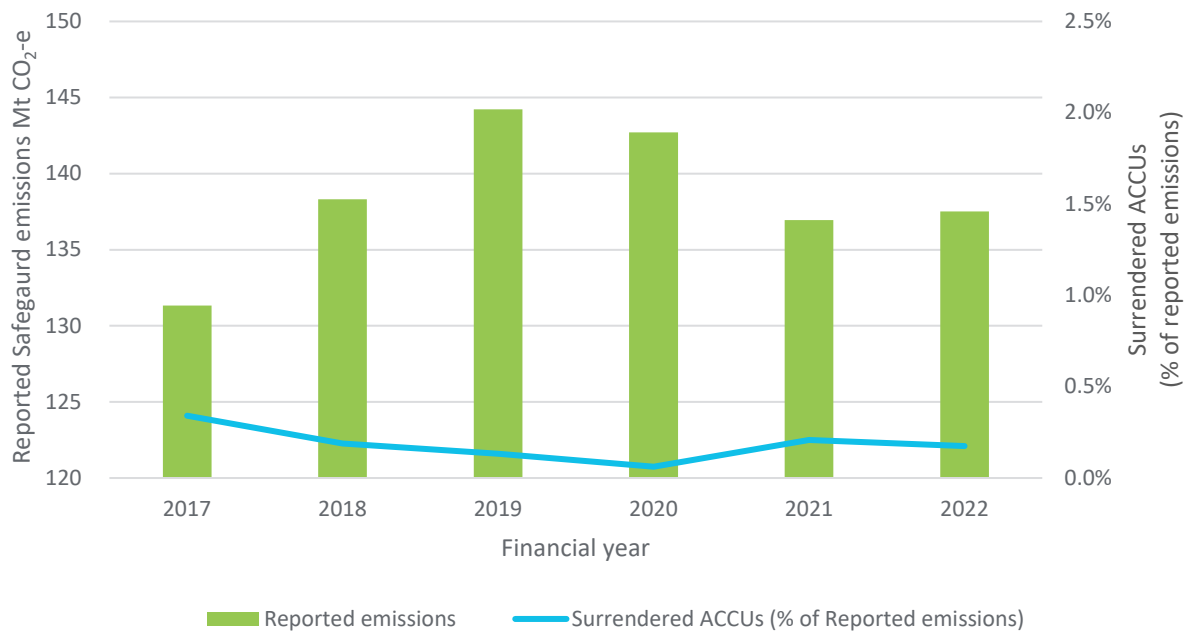
Prior to the reforms, the Safeguard Mechanism set baselines in a manner that allowed business-as-usual operations and aggregate emissions to grow. The authority's analysis shows covered emissions under the Safeguard Mechanism were 4.7% higher in 2021–22 than in 2016–17 (see Figure 3.9).

Surrendered ACCUs never reached more than 0.5% of reported emissions under the Safeguard Mechanism during this same period.



¹⁸ Based on data downloaded for 'Air conditioners' as the product, as of 04/07/2023 from GEMS Registration Database, for models currently available in Australia.

Figure 3.9: Historical Safeguard emissions 2016–17 to 2021–22 - Reported emissions and surrendered ACCUs as a share of reported emissions



Source: (CER, 2023g) Climate Change Authority analysis using Safeguard facility reported emissions 2016–17 to 2021–22

In line with the authority’s previous advice, the government’s reforms apply a decline rate to facilities’ baselines over time so that they are reduced predictably and gradually (4.9% per year to 2030). The reforms allow for differential trade exposed baseline adjusted facility rates to be set for eligible trade exposed facilities.

Importantly, the *Safeguard Mechanism (Crediting) Amendment Act 2023* also inserted new ‘Safeguard outcomes’ into the objects of the *National Greenhouse and Energy Reporting Act 2007*.

These Safeguard outcomes include requirements for:

- net emissions from Safeguard facilities over 1 July 2020 to 30 June 2030 to not exceed 1,233 Mt of CO₂-e.
- two point-in-time targets for emissions from Safeguard facilities, net emissions in 2029–2030 to not exceed 100 Mt of CO₂-e, and net zero from 2049–2050.
- gross emissions from Safeguard facilities, measured as a five-year rolling average, to reduce over time.

The baseline decline rate of 4.9% also accounts for a built-in reserve for higher-than-expected production growth at Safeguard facilities and any higher-than-expected use of trade exposed baseline adjustments. Any potential impacts of protections for trade-exposed baseline adjusted facilities on baseline settings, and progress against Australia’s emissions reduction goals, will be a consideration in the authority’s annual advice to the government as well as the authority’s advice to inform the Government’s review of the Safeguard mechanism, scheduled for 2026–27.

The Safeguard Mechanism reforms also add flexibility for facilities to comply with their obligations.

Following the reforms, the range of compliance options includes:

- ability to trade over- and under- achievement of baselines, in the form of Safeguard Mechanism Credits (SMCs) whereby Safeguard facilities will automatically generate tradeable SMCs when their emissions fall below their baselines.
- ability to purchase and surrender ACCUs to meet their compliance obligations.
- ability to enter into five-year multi-year monitoring periods (up to 2030).

While the reformed scheme continues to allow for the use of offsets, facilities that surrender ACCUs equal to or more than 30% of their baselines, will be required to provide a statement to the Clean Energy Regulator setting out why onsite abatement has not taken place. Similarly, approval for a facility to enter into a multi-year monitoring period will require facilities to provide a firm and credible plan to reduce emissions intensity before the end of the five-year period.

The use of offsets to meet Safeguard compliance obligations will be a focus of the authority's analysis in future advice to government.

3.3.4.1.1 Funding support for industry and resource sector decarbonisation

The Australian Government has announced several measures to assist Safeguard facilities to reduce their emissions. Around \$1 billion in funding for the manufacturing sector and trade-exposed industries will be provided through the Powering the Regions Fund, including:

- \$600 million Safeguard Transformation Stream to support decarbonisation investments at trade-exposed industrial facilities covered by the Safeguard Mechanism
- \$400 million for industries that provide critical inputs to clean energy industries (including steel, cement, lime, aluminium and alumina) (DCCEEW, 2023I) (Treasury, 2023a).

Funding to support innovative emissions reductions efforts in existing industrial facilities (including facilities covered under the Safeguard Mechanism), and grow new, clean energy industries in regional areas is available through the \$400 million Industrial Transformation Stream to be delivered by ARENA (ARENA, 2023g). Additional government support is available through ARENA's \$43 million Industrial Energy Transformation Studies Program (ARENA, 2022a), the Clean Energy Finance Corporation, and the National Reconstruction Fund.

Public investment alone will not be sufficient to drive down this sector's emissions. The scale of the Australia's industrial decarbonisation challenge will require coordinated investment from the public and private sectors.

The authority notes the need for a timely and effective roll out of announced public funding measures to accelerate deployment of on-site emissions mitigation, in time for meeting Australia's 2030 emissions reduction targets. The authority will be monitoring the roll out of the government's funding support and will be watching for the companies involved to bring their resources to the table as well.

3.3.4.1.2 New tasking for the Climate Change Authority under the Safeguard reforms

Ongoing analysis of the performance of the reformed Safeguard Mechanism will be a key workstream for the authority.

Amendments made to the *Climate Change Act 2022*, stipulate the authority must, as part of its annual advice to the Minister for Climate Change and Energy, advise on whether gross and net Safeguard emissions are declining consistently with Safeguard outcomes specified in the *National Greenhouse and Energy Reporting Act 2007* (see above). This new role applies to the authority's advice relating to the 2023–2024 financial year and following.

The authority's new reporting obligations must take into account:

- the impact of any expanded Safeguard facilities, or new Safeguard facilities for the financial year.
- the impact of any expected expanded Safeguard facilities or expected new Safeguard facilities for future financial years.
- any emissions estimates that are provided to the authority by the Minister for the Environment and Water relating to approvals under the EPBC Act.

If the authority finds Safeguard emissions, or net Safeguard emissions for the financial year are not declining in line with the Safeguard outcomes, the authority's advice to the Minister must also consider whether any amendments to the Safeguard rules are needed in order to achieve those outcomes.

The authority is also expected to have a role in the Government's 2026-2027 review of the Safeguard Mechanism, including advising on the extent to which on-site abatement is being driven by the Safeguard reforms, and whether any additional incentives are required.

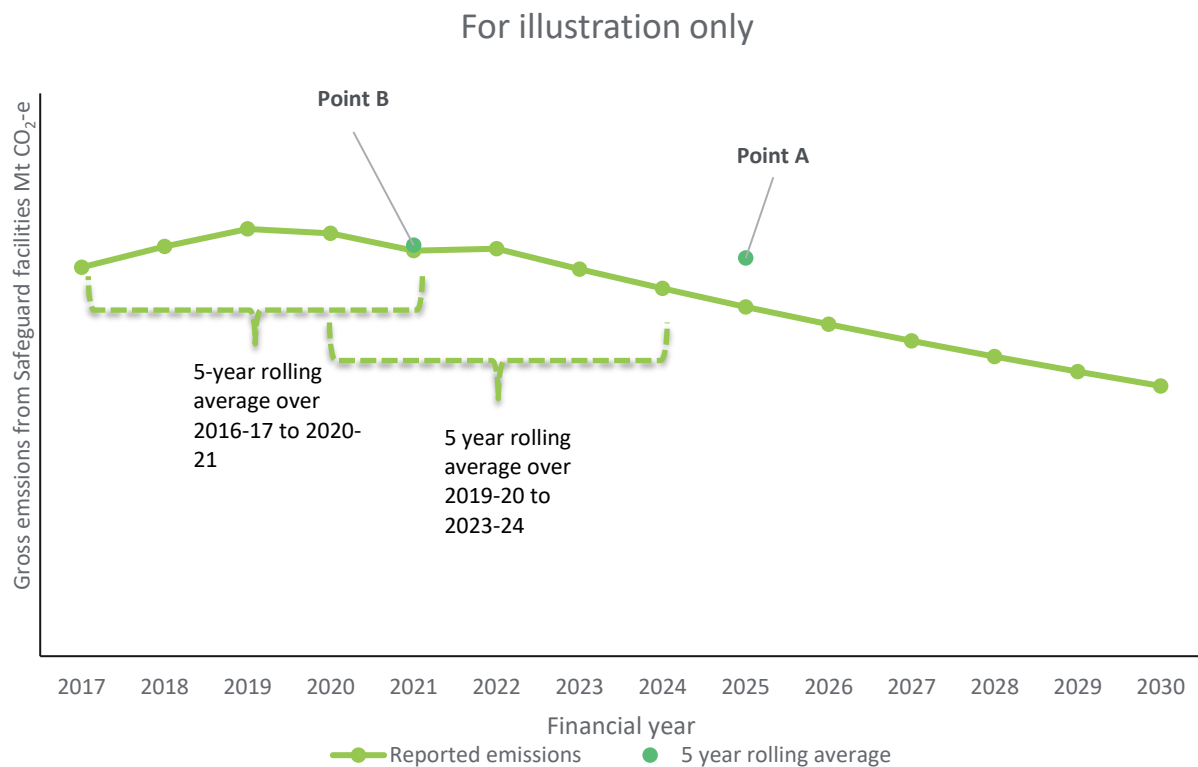


BOX 3.4: Illustrative example of comparison of 5-year Safeguard Mechanism rolling averages (for the purposes of paragraph 3 (2)(d) NGER Act)

The figure below provides an illustrative example of how 5-year rolling averages will be tracked over time in the authority's advice to Government for 2024-25. Two rolling averages are computed over point A and B: point A provides an average over 5 years between 2019–20 to 2023–24, and point B provides an average over 5 years between 2016–17 to 2020–21, noting assessment of achievement of the relevant Safeguard outcome for a financial year will require comparison of averages over time periods offset by three years (for a financial year ending before 30 June 2027) or two years (from 1 July 2027).

In the following illustrative example, the emissions trajectory in 2024-25 meets the new Safeguard outcome of ensuring gross emissions are trending down as the 5-year rolling average in 2024-25 (point A - average emissions for the 5 previous financial years) is lower than the past 5-year rolling average (point B - the average emissions for the period of 5 financial years that ended 3 years before the start of that financial year, i.e. before 1 July 2025, offset by 3 years).

Figure 3.10: Illustrative example of 5-year rolling average



3.3.5 Policy opportunities and recommendations

The authority has heard through submissions to its issues paper that sectoral decarbonisation pathways, including for the industry and resources sectors, should be developed as a matter of priority.

As announced by the Minister in July 2023, the Climate Change Authority will be undertaking work on sectoral pathways to support the government's development of sectoral pathways (Minister for Climate Change and Energy, 2023). This work will include a comprehensive assessment of decarbonisation opportunities for the industry and resources sectors, including an analysis of existing and prospective technologies to achieve emissions reductions.

The authority has however identified immediate opportunities to mitigate industrial product emissions associated with refrigerant gases, and fugitive methane emissions from Australia's coal mining and oil and gas operations.

3.3.5.1 *Accelerate progress on mitigation emissions associated with refrigerant gases*

As a party to the Kigali amendment, Australia began a phase down of hydrofluorocarbon imports in January 2018. However, the 'phase out' of hydrofluorocarbons does not apply to refrigerant gas imported in pre-charged equipment such as air conditioners and refrigerators.

Despite the availability of highly efficient and ultra-low greenhouse warming potential alternatives, market penetration of these products has been low, with restrictive product safety standards identified as a major barrier to uptake of alternative refrigerants (Environmental Investigation Agency, 2021).

Measures for improved containment and effective recovery of refrigerants will also be key for limiting the environmental impacts of Australia's existing refrigerant bank, estimated to have a total global warming potential of around 100 Mt CO₂-e in 2021 (DAWE, 2021).

17. RECOMMENDATION

Accelerate early phase-out of higher global warming potential refrigerants, where alternatives are available, including bans for pre-charged equipment imports.

3.3.5.2 *Introduce targeted measures to reduce fugitive methane emissions in Australia's resources sector*

While abatement technologies exist for mitigation of methane emissions from underground mines through recovery and utilisation of coal mine waste gas, there are limited opportunities for abatement of fugitive methane for surface mines once mining has commenced (Wasimi, Webby, & Seow, 2022). In 2020, around 23% of the fugitive methane released from underground coal mining activity was captured for electricity generation and 29% for flaring (DCCEE, 2022g). Pre-mine drainage from undeveloped coal seams is a potential option for methane mitigation from open-cut mines (IEA, 2023e). The authority, however, notes the lack of an evidence base examining opportunities for methane mitigation from pre-drainage in open-cut mines.

18. RECOMMENDATION

Review the opportunities and report on barriers and incentives for pre-mine drainage of coal mine methane from open cut mines.

The International Energy Agency estimates that around 70% of global fugitive methane emissions from oil and gas operations can be effectively mitigated by implementing well-known measures, including a 40% reduction in emissions possible at no net cost (IEA, 2023d). These existing mitigation measures include leak detection and repair programs, installation of emission control devices, and technology standards for equipment where lower or zero emissions alternatives exist (Clean Air Task Force, n.d.).

Under the reformed Safeguard Mechanism, baselines for new facilities and existing facilities that begin producing new products will be set at international best practice, adapted for the Australian context (DCCEEW, 2023aa). Importantly, for new gas fields supplying LNG projects, the Safeguard reforms set the international best practice as net zero reservoir CO₂ emissions (*National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015*, s 35A), reflecting opportunities for CCS. Similarly, for shale gas extraction developments, such as from the Beetaloo Basin, a zero baseline will be applicable (*National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015*, ss 10, 54).

Carbon capture and storage (CCS) can be applied where the carbon dioxide from natural gas is separated, transported by pipelines, and pumped back into geological formations. Opportunities for CCS exist in gas processing, where concentrated streams of carbon dioxide can be recovered, and potentially transported and stored. CCS also finds application at LNG plants where carbon dioxide is separated from natural gas before it is cooled down.

For example, the Gorgon LNG facility, operational since 2019, sequesters CO₂ emissions from the facility's industrial processes and stores it permanently in geological formations. Similarly, the Moomba CCS project, under development and scheduled to start injection in 2024, plans to sequester 1.7 million tonnes of CO₂-e from the Moomba gas processing facility (Santos, 2023). Another example is the proposed Bayu Undan CCS project – located in Timor-Leste – expected to commence operations in 2027 (Fitzgerald, 2023), noting the project also requires development of a regulatory framework to facilitate cross-border carbon capture and storage. Earlier this year, the authority published a comprehensive assessment of opportunities for carbon sequestration in Australia – *Reduce, remove and store – The role of carbon sequestration in accelerating Australia's decarbonisation* (CCA, 2023).

19. RECOMMENDATION

Introduce measures complementary to the Safeguard Mechanism for reducing fugitive emissions from the oil and gas sectors, including:

- implementation of international best practice measures for reducing methane emissions from flaring activities that do not perversely encourage venting emissions.
- development of standards in line with international best practice to support methane leak detection and repair across equipment, technologies and operational practices.
- introduction of requirements for existing oil and gas facilities to sequester all CO₂ emissions produced.

Table 3.13: Policy effectiveness table - Safeguard Mechanism

Aspect	Analysis
Scope	<p>The Safeguard Mechanism is a legislated framework that is designed to limit the emissions from facilities that produce more than 100,000 tonnes of CO₂-e each year (scope 1).</p> <p>In 2020–2021, Safeguard facilities were responsible for 28% of national emissions.</p>
Impact	<p>The Safeguard Mechanism was established in 2016 to regulate emissions of Australia’s large industries.</p> <p>Since its commencement in 2016, the Safeguard Mechanism has been ineffective in reducing emissions from Australia’s large industrial facilities.</p> <p>In 2023, the Australian Government reformed the scheme and new arrangements commenced on 1 July 2023.</p>
Efficiency	<p>The Clean Energy Regulator is responsible for the monitoring, compliance and enforcement of the Safeguard Mechanism.</p> <p>The baseline decline rates apply to all existing and new facilities, except for emissions intensive trade exposed businesses based on comparative impact on competitiveness. Monitoring arrangements have been put in place as part of the reforms to ensure the new legislative emissions objectives are achieved.</p> <p>The Safeguard Mechanism includes a range of enforcement measures, including enforceable undertakings, infringement notices, a court injunction or a civil penalty.</p> <p>Through the 2023 Safeguard reforms, the Government updated the civil penalty to base it on both the quantity of excess emissions and the number of days of non-compliance.</p> <p>The 2023 reforms also included anti-avoidance measures to ensure businesses would not be able to define or redefine a facility with the intention to avoid coverage</p> <p>To address competitive distortions for emissions intensive trade-exposed facilities, the Mechanism allows for targeted funding support and discounted decline rate based on a comparative scheme impact metric.</p> <p>There are several public financing vehicles aimed at accelerating the development, demonstration and commercialisation of low emissions technologies for the industry and resources sectors.</p>
Relevance	<p>The intervention creates a financial incentive for facilities to invest in onsite emissions mitigation activities to reduce emissions.</p> <p>Safeguard facilities have access to domestic offsets (ACCUs) to offset their emissions.</p>
Coherence	<p>The intervention is scalable as it allows for a recalibration of policy settings based on a planned review in 2026 - 2027. As part of this review, the Authority will advise the Government on the extent to which on-site abatement is being driven by the reforms, and whether any additional incentives are required.</p> <p>The reforms allow for flexible compliance options, including offsets, banking and borrowing provisions and multi-year monitoring periods.</p> <p>The reforms require the Minister for Climate Change to act if emissions are expected to breach the scheme’s emissions targets, such as by amending the scheme rules or taking other policy actions.</p>
Sustainability	<p>The reformed scheme is in its first few months of operation. The authority will review progress of the scheme on an annual basis and will form a view on the sustainability of this mechanism over time.</p>

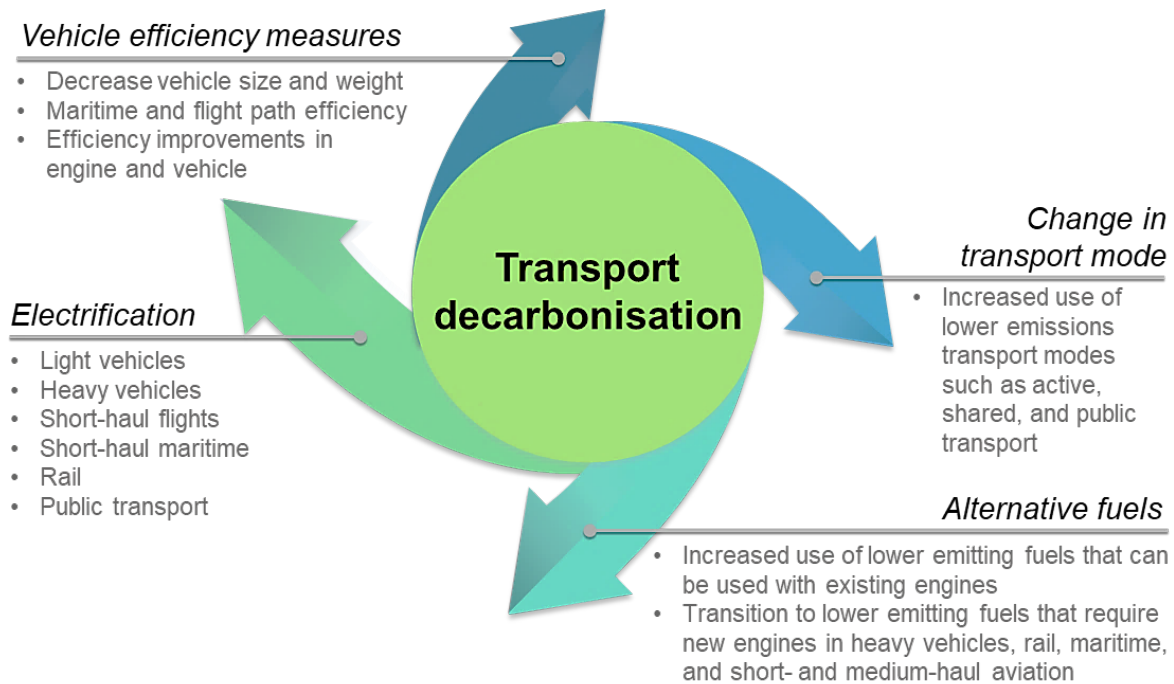
3.4 Transport

6% increase in transport emissions during 2022–23

3.4.1 Sectoral issues, context and trends

Transport emissions were 98 Mt CO₂-e emissions in 2022–23 (DCCEEW, 2023m). Light vehicles were the source of 59% of Australia's transport emissions (unpublished data provided by DCCEEW), and there is a mature technology to address these emissions, in the form of electric vehicles. This makes accelerating the take-up of electric vehicles a high priority for meeting Australia's 2030 target.

Figure 3.11: Measures to decarbonise the transport sector



Source: Climate Change Authority

3.4.2 Leading indicators of change

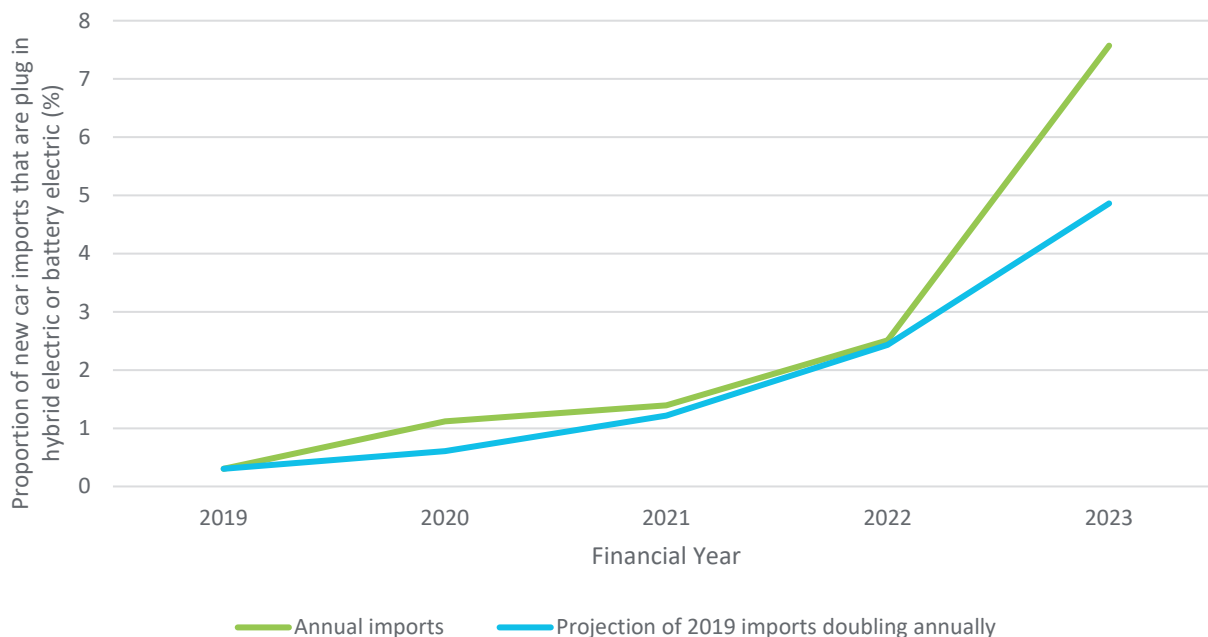
Growth in electric vehicle imports and the successful roll out of charging infrastructure are early indicators of the take-up of, and potential barriers to, electric vehicle growth.

Electric vehicles include both battery electric vehicles and plug in hybrid electric vehicles. Plug in hybrid electric vehicles also require charging infrastructure, so they are included as electric vehicles in this phase of the transition. Long-term, Australia will need to phase out all sources of road transport tailpipe emissions, including plug in hybrid electric vehicles.

3.4.2.1 Electric vehicle imports

Australia imported over 1.2 million passenger vehicles in 2023, of which over 7% (96,957 vehicles) were electric vehicles (battery electric vehicles and plug in hybrid electric vehicles), up from less than 1% in 2019. Electric vehicle imports as a proportion of all car imports have more than doubled every year since 2019 (Figure 3.12).

Figure 3.12: Electric vehicle imports as a proportion of total car imports

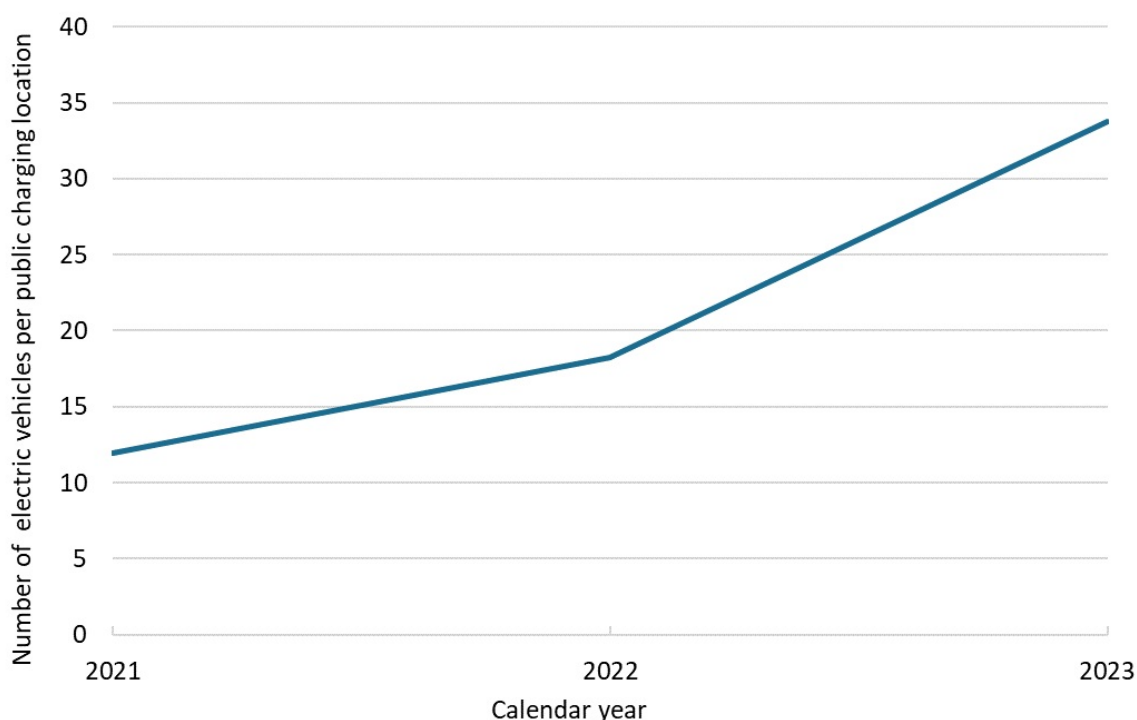


Source: Based on unpublished Australian Bureau of Statistics data supplied to the authority.

3.4.2.2 Vehicle charging infrastructure

While the number of publicly accessible charging stations has increased, the number of electric vehicles per public charging location has more than doubled since 2021. If this trend continues it has the potential to reduce the accessibility of public charging infrastructure which will impact the transition to electric vehicles. The metrics for a successful roll out of electric vehicle charging infrastructure still need to be determined and are explored further below.

Figure 3.13: The number of electric vehicles per public charging locations



Source: (EVC, 2022b) and unpublished Bureau of Infrastructure and Transport Research Economics data provided to the authority.

3.4.3 Road Transport

Tailpipe emissions from road transport contribute 83% (82 Mt CO₂-e) of Australia's transport emissions (unpublished data provided by DCCEEW).

Road transport emissions can be reduced by:

1. increasing the use of low emissions liquid fuels, such as some biofuels, in internal combustion engine (ICE) vehicles, and
2. transitioning to zero tailpipe emissions vehicles including, electric drive trains for light vehicles and electric or hydrogen for heavy vehicles such as trucks and buses.

While electric vehicles run on electricity supplied by the grid, the emissions intensity of electricity on a tonnes of CO₂ per kilometre travelled basis is lower than emissions from equivalent ICE vehicles (DCCEEW, 2023e). The emissions intensity of electric vehicles will reduce further as the proportion of renewable energy generation in the grid increases.

3.4.3.1 Passenger vehicles

In 2023, the Australian Government released the National Electric Vehicle Strategy which applies to passenger and light commercial vehicles (Table 3.14). The major policy commitment in the Strategy is to legislate a Fuel Efficiency Standard; a mechanism used in other jurisdictions such as the European Union, United States and New Zealand to drive down vehicle emissions (DITRDCA, 2023d).

In its submission to the authority, the Electric Vehicle Council suggested the Fuel Efficiency Standard be designed so that Australia could catch up to similar markets by 2030. Several stakeholders (Climate Council, Australian Conservation Foundation, Business Council for Sustainable Development Australia, Queensland Conservation Council, Climateworks, Grattan Institute, Better Futures Australia) called for Australia's planned Fuel Efficiency Standard to reach zero emissions by 2035, and Greenpeace called for zero emissions by 2030.

Whilst the authority acknowledges these calls for increased ambition, it also recognises the impact supply chain issues may have on the achievability of this target. There have been emerging challenges for global electric vehicle manufacturing that could hamper the continued growth of electric vehicle imports in Australia. The prices of minerals for manufacturing electric vehicles such as lithium and cobalt have risen in price significantly over the last few years, and there have been supply chain issues for major components such as semi-conductor chips (IEA, 2022).

The authority made a submission on the design of the Fuel Efficiency Standard which emphasised the need for Australia to decrease the tailpipe emissions intensity of new vehicles to zero by 2040 or earlier, as soon as the market is capable of doing so, given CSIRO modelling projected 99% of all vehicle sales are electric by 2038 and 2042 in two scenarios with strong climate action (CSIRO, 2022a). Based on the projected emissions intensity of the grid in 2030, the authority found that for every 5% greater share of electric vehicles, there is an additional 2.5–2.6 Mt CO₂-e in emissions reduction¹⁹.

¹⁹ Calculations were based on Australia's emissions projections 2022 data (DCCEEW, 2022a). The projections differ from other data sources:

- higher number of kilometres per car in 2030 than in ABS data.
- higher emissions intensity for ICE vehicles than other sources such as those presented by DITRDCA. If ICE vehicles had a lower emissions intensity the savings from electrification would be less.

20. RECOMMENDATION

Implement a Fuel Efficiency Standard for new light vehicles as soon as possible which progressively reduces the emissions intensity to zero by no later than 2040.

The price difference between new electric and ICE vehicles is a significant barrier to uptake, particularly for low-income earners. Affordability of electric vehicles is a major wellbeing consideration for Australia. States and territories have disparate electric vehicles purchase incentives, with developments over 2022–23 including:

- The Victorian Government announcing its \$3,000 purchase incentive would end in June 2023, (Energy Victoria, 2023) a year earlier than initially announced.
- The Queensland Government announcing increased incentives for businesses and consumers to purchase electric vehicles (Queensland Government, 2023d).

As of October 2023, the state or territory which provides the largest rebate to purchase an electric vehicle is Queensland, which offers \$6,000, (Queensland Government, 2023d) while the Australian Capital Territory offers the largest up-front financing in the form of an up to \$15,000 no-interest loan (ACT Government, 2023a). States and territories also offer other incentives, such as exemptions from stamp duty and discounted registration.

There is currently no publicly available national analysis to guide the level of purchase incentives that most efficiently reduce transport emissions, drive uptake of electric vehicles and ensure states and territories meet their electric vehicle targets. Purchase incentives, road user charges and taxation settings (e.g. Fringe Benefit Tax) should be calibrated to achieve fast enough uptake of electric vehicles.

21. RECOMMENDATION

Complete a review of policy and regulatory settings for electric vehicles by 2024 (including subsidies to purchase electric vehicles, fees and charges to own and drive electric vehicles and taxes and tax concessions) to ensure incentives are effective and efficient in reducing emissions and driving electric vehicle uptake.

With increasing use of electric vehicles, the Australian community requires the roll-out of significantly more infrastructure to ensure recharging stations are accessible and locatable (Doctors for the Environment, Australia Institute of Landscape Architects, Australian Academy of Technological Sciences and Engineering, Grattan Institute, Committee for Sydney, Planning Institute Australia).

The authority welcomes the announcement by the Australian Government that it will develop a national electric vehicle infrastructure mapping tool. This mapping tool should expand on the Electric Vehicle Council map (EVC, 2023) to show the charging speeds at different locations. The government should establish a framework for measuring the rollout of charging infrastructure, with timebound benchmarks for urban, regional and remote locations as well as for different classes of roads.

22. RECOMMENDATION

Develop metrics to monitor progress of the rollout of electric vehicle charging infrastructure in the first National Electric Vehicle Strategy annual review. This should take account of the infrastructure needs of regional and rural Australia in terms of the number, distribution and speed of chargers.

Ensuring electric vehicle public charging stations are reliable and have a consistent approach for plug types and payment applications will be important features of a successful charging infrastructure rollout. Recent surveys in the United States have shown frustration from chargers being inoperable across different charging networks (Plug In America, 2022). This has led to stronger regulation requiring chargers to be in working order 97% of the time, and that publicly funded charging stations must offer publicly accessible data on price, availability and accessibility on mapping applications, provide certain plug types and accept contactless payment (The White House, 2023b). PlugShare provides electric vehicle charger data on plug type in Australia, and relies on community members to report availability (PlugShare, n.d.).

23. RECOMMENDATION

Work with the electric vehicle charging industry during the first National Electric Vehicle Strategy annual review to develop policies and if needed, regulation, to ensure that:

- public electric vehicle chargers report in real time whether chargers are available
- there is a consistent approach to electric vehicle charging formats, including available plug types, payment systems and applications necessary to find and access chargers.

Issues such as private vehicle charging and integration with the electricity grid through features such as Vehicle to Grid (V2G) are explored in Chapter 4.

3.4.3.1.1 The decarbonisation of road transport requires a multi-faceted approach

While transitioning all passenger vehicles to electric drive trains, it is important to minimise ICE vehicle emissions and maintain transport accessibility (Styring, Duckworth, & Platt, 2021). Directing people to alternative transportation modes, including public transport, active transport and shared mobility can reduce emissions and increase transport accessibility (International Transport Forum, 2023). With population increase in urban areas (ABS, 2018; Centre for Population, 2023), more private vehicles lead to more congestion, and less accessibility and mobility (International Transport Forum, 2023). The authority welcomes the Australian Government's announcement to develop the Transport and Infrastructure Net Zero Roadmap and Action Plan in 2023, which promises to include active transport planning and supporting infrastructure. The authority received 14 submissions to its issues paper that discussed the need to better consider public and active transport to reduce the reliance on private cars. The authority will consider mode shifting opportunities further in its future advice.

Alternative fuels can be used to accelerate decarbonisation of Australia's fleet of ICE vehicles while the share of electric vehicles is growing. Many submissions to the authority's issues paper consultation expressed the view that low carbon fuels are necessary to decarbonise legacy road vehicles, or where electric vehicles are not suitable (bp, Grattan Institute, Australian Institute of Petroleum, 2 anonymous submissions).

In Australia, there are two alternative fuels available in limited capacity, ethanol blended fuels (such as E10) and biodiesel. Ethanol blended fuel sales in Australia were 40% lower in 2022 compared to 2010 (calculations based on (DCCEEW, 2023h)). Further analysis is needed to understand the factors behind lack of E10 use. Alternative road transport fuels face cost premium and scale barriers (CEFC and ARENA, 2019) as well as meeting legislative requirements for fuel quality (DCCEEW, 2023y).

24. RECOMMENDATION

Consider immediate policy and regulatory options to reduce emissions in existing road vehicles such as by allowing and incentivising lower emissions fuel blends.

Policies for lower emissions fuel blends should consider Australia's existing domestic refining capacity. Australia's two operating oil refineries are covered under the Safeguard Mechanism. Emissions associated with fuel refineries are discussed in Industry and Resource section (excluding electricity generation).

3.4.3.2 On-road trucks

On-road trucks were the source of 22% of transport emissions (20 Mt CO₂-e) in 2021 while only representing 3.2% of road vehicles in Australia (DCCEEW, 2023o; Bureau of Infrastructure and Transport Research Economics, 2022). Trucks have larger engines that consume more fuel, and drive a greater average distance than cars. Trucks had an average age of 11–16 years in Australia in 2021 (Bureau of Infrastructure and Transport Research Economics, 2022), resulting in higher emissions due to older more inefficient vehicles being used for longer (Electric Vehicle Council & Australian Trucking Association, 2022).

To reduce emissions, the government should explore measures for transitioning the truck fleet to zero tailpipe emissions vehicles as soon as possible, such as battery electric or hydrogen fuel cell electric vehicles. Stakeholders expressed concerns that heavy vehicle decarbonisation policy is lacking or requires prioritisation (Grattan Institute, Carbon Market Institute, Committee for Sydney, Greenpeace, Australian Institute of Landscape Architects, Australian Conservation Foundation, Australian Academy of Technological Sciences and Engineering, and Bushfire Survivors for Climate Action).

There is currently no Fuel Efficiency Standard for heavy vehicles such as trucks, and limited policies to encourage adoption of lower emissions technology. Delaying action to encourage lower emissions technology will lock in emissions for a long period given the length of time each truck spends on the road. A well-designed Fuel Efficiency Standard for heavy vehicles could be used to allow the market to consider solutions and deploy the best technology for the situation. Some stakeholders (Committee for Sydney, Grattan Institute, Carbon Market Institute) suggested a Fuel Efficiency Standard or carbon emission requirements be applied to new trucks.

The Electric Vehicle Council, Committee for Sydney and the Grattan Institute observed there are regulatory barriers holding back the transition to lower emissions heavy vehicles. The Grattan Institute recommended the government 'should scrap regulations requiring Australian trucks to be 2% narrower than the global norm, and update regulations that limit allowable loads based on tyre configurations and tyre widths'.

25. RECOMMENDATION

Encourage uptake of lower emissions heavy vehicles by:

- undertaking a cost benefit analysis for a Fuel Efficiency Standard for heavy vehicles by the end of 2024, to adopt a standard to reduce emissions from heavy vehicles over time.
- reviewing regulatory barriers to zero emissions truck uptake and addressing these by the end of 2024.

3.4.3.2.1 Supporting infrastructure

Similar to light vehicles, one of the barriers to electric and hydrogen truck uptake is the lack of charging or refuelling infrastructure (Electric Vehicle Council & Australian Trucking Association, 2022) and the charging time. Australia currently has 5 public hydrogen refuelling stations (CSIRO, 2023e), station numbers will need to grow strongly for hydrogen to be a viable alternative road transport fuel. The government should consider measures to encourage building recharging and refuelling infrastructure for electric and hydrogen trucks to increase the uptake of these vehicles. This could be considered by the Hydrogen Review Taskforce as part of the National Hydrogen Strategy Review (DCCEEW, 2023z).

BOX 3.5: Electrification of trucks case study – Janus Electric

Trucks travel long distances and are energy intensive, creating challenges for electrification. The time required to stop and recharge sufficiently can disrupt operations or, if charging is done quickly, has the potential to strain the electricity grid (National Grid, 2022). Battery swap networks could overcome this. An Australian company, Janus Electric, is converting diesel powered trucks to electric and using battery swap stations and has one operating in the Brisbane suburb of Hemmant (Graham, 2022). There are plans to expand between Sydney and Brisbane (Janus Electric, 2021). Each battery provides between 400-600 km of charge and the battery can be swapped in four minutes (Janus Electric, 2023). Batteries are often charged during off peak times.

3.4.4 Shipping and aviation

Domestic shipping was a source of 2 Mt CO₂-e and aviation 8 Mt CO₂-e, or together 11% of total transport emissions in 2022–23 (unpublished data provided by DCCEEW). Pre-COVID-19, Australia’s international aviation and shipping emissions were 18 Mt CO₂-e (DCCEEW, 2023cc).

Shipping and aviation emissions are harder to abate than emissions associated with road transport. Ships are at sea for up to 20 days (Maersk, n.d.) and planes travel up to 18 hours non-stop (World Economic Forum, 2019). While aircraft fuelled with hydrogen or powered by battery electric drive trains are future prospects, sustainable aviation fuels²⁰ are the only mature lower emissions alternative for medium to long distance flights. The CSIRO Sustainable Aviation Fuel Roadmap, which was released in mid-2023, noted that sustainable aviation fuel is the main immediate and direct decarbonisation option for the aviation industry (CSIRO, 2023c).

Qantas stated in its submission to the authority’s issues paper that supporting policies are required to incentivise the development infrastructure and supply chains for sustainable aviation fuel production in Australia. The authority will explore this further in its future advice.

3.4.5 Adaptation and wellbeing

Climate extremes may disrupt transport and impact transport decarbonisation. Weather- and climate-related hazards already disrupt the transport sector across Australia. Floods caused by ex-Tropical Cyclone Ellie in 2022–23 significantly damaged the Fitzroy River Bridge and parts of the Great Northern Highway through far north-west WA, cutting off access for many First Nations communities east of the river (WA Government, 2023d). The impacts of ex-Tropical Cyclone Ellie are discussed further in Chapter 2. Heat has continued to play a role in rail service delays and need for coach replacements across rural and regional Vline train services in Victoria to 2017 (Victorian Auditor-General's Office, 2017).

²⁰ Sustainable Aviation Fuel is an umbrella term to describe aviation fuels with lower emission profiles than conventional jet fuel, such as biogenic fuels and synthetic fuels.

3.4.6 Policy opportunities and recommendations

The authority has included the Fuel Efficiency Standard as the main policy considered in its analysis of policy effectiveness for the transport sector, recognising it is the most developed policy to tackle transport emissions. However, transport emissions come from varied transport modes not covered by this standard, and the authority has noted announced plans for different mode types (where available).

Table 3.14: Policy effectiveness in the Transport sector

Aspect	Analysis
Scope	Light road vehicles (59% of transport emissions (unpublished data provided by DCCEEW) are covered under the National Electric Vehicle Strategy (DCCEEW, 2023e) including a commitment to develop a Fuel Efficiency Standard. The government established the Australian Jet Zero Council which brings together a cross-section of senior stakeholders from across the aviation sector and its supply chains to lead efforts to deliver net zero aviation in Australia. The council will also coordinate across the sector to provide advice to government on issues related to the aviation industry's transition to net zero emissions (DITRDCA, 2023b). Rail and heavy vehicles do not have sector specific announced plans for decarbonisation beyond their inclusion in the Transport and Infrastructure Net Zero Roadmap and Action Plan.
Impact	Current policies are not having the required impact, as transport emissions are projected to increase by 2030 (DCCEEW, 2022a). An effective Fuel Efficiency Standard can provide policy certainty for the light vehicle sub-sector with a relevant long-term target. The authority will watch with interest in the finalisation of the Fuel Efficiency Standard design and planned implementation.
Efficiency	There are no transport sector emissions reductions targets. Notably: <ul style="list-style-type: none"> the National Electric Vehicle Strategy does not have a clear timebound objective for electric vehicles reaching a set percentage of sales, the percentage of Australia's car fleet that are electric or for the rollout of infrastructure targets. the Australian Government has committed \$7.8 million over 4 years from 2022–23 to develop the Transport and Infrastructure Net Zero Roadmap and Action Plan and \$0.6 million in 2023–24 for the Maritime Emissions Reduction National Action Plan, but has not committed funding for other subsectors (DITRDCA, 2023a; Treasury, 2023a).
Relevance	The National Electric Vehicle Strategy aims to drive supply and demand of passenger electric vehicles, and build the charging infrastructure to enable the uptake of electric vehicles (DCCEEW, 2023e). The success of electric vehicle uptake depends on many enablers which the strategy considers. However, the strategy does not address the issue of accessibility, reliability and interoperability of different chargers for users.

Coherence	<p>The National Electric Vehicle Strategy addresses barriers to the uptake of new electric vehicles to decarbonise the light vehicle fleet (DCCEEW, 2023e), but excludes heavy road vehicles. An appropriate Fuel Efficiency Standard could also be used to decarbonise these vehicles.</p> <p>There is still a lack of coherence as there are no material plans to reduce the other transport emissions.</p>
Sustainability	<p>The Australian Government plans to legislate the Fuel Efficiency Standard (DITRDCA, 2023c).</p> <p>Electrification of the transport network will have impacts on the electricity grid that need to be managed, noting that electric vehicles can be used to store energy for houses and the electricity grid (DCCEEW, 2023e). The National Electric Vehicle Strategy partially supports wellbeing by reducing air and noise pollution for health, and potentially increasing local manufacturing and recycling jobs. However, lower car running costs are only beneficial to those that can afford electric vehicles, thus creates inequity for low-income households.</p>



3.5 Agriculture

4% emissions increase in agriculture emissions in 2022–23

Agricultural emissions increased to 82 Mt CO₂-e in 2022–23, up from 79 Mt CO₂-e in the previous year (unpublished data provided by DCCEEW). This was primarily due to increased livestock numbers and crop production (DCCEEW, 2023m). Of the total, 57 Mt CO₂-e is methane produced by enteric fermentation primarily from pasture cattle and sheep. Dairy cattle and feedlot cattle are also a source of enteric fermentation emissions but are collectively a 4 times smaller source of emissions than pasture cattle.

There are limited existing solutions for deeply cutting emissions from livestock, the largest agricultural emissions source. Further investment in technological innovations and changes to farming practices are needed to provide future opportunities for reducing emissions.

3.5.1 Emissions trends

Agriculture sector emissions consist primarily of methane and nitrous oxide emissions from the production of livestock and crops. Over three quarters of the sector's emissions are from livestock (enteric fermentation and manure management), with emissions from agricultural soils, and minor sources making up the remainder (DCCEEW, 2023cc). Emissions and removals from changes in the carbon stored in vegetation and soils on agricultural land are counted in the land sector, and the land sector section should be read together with this section particularly in the context of farm-based offsets. On-farm energy use is covered separately in the industry and resources section.

Enteric fermentation from cattle is the largest single source of emissions, accounting for over half of the sector's total emissions in 2022–23 (Table 3.15) (DCCEEW, 2023m). Emissions from enteric fermentation are driven by the number of livestock.

Table 3.15: Sources of enteric fermentation in 2022–23

Emissions from enteric fermentation in 2022–23 by source (Mt CO ₂ -e)				
Cattle	Sheep	Pork	Other livestock	Total
43	14	Less than 1	Less than 1	57

Source: (DCCEEW, 2023m)

The emissions intensity of meat production varies significantly based on the meat source with the highest intensity of emissions from enteric fermentation in cattle (Table 3.16). A five-year average has been calculated to reduce the influence of fluctuations in beef cattle stocking rates compared to slaughter rates (in response to environmental and market conditions) on the emissions intensity of cattle.

Table 3.16: 5-year average emissions intensity of meat production (2016–17 to 2020–21)

5-year average emissions intensity by source (t CO ₂ -e/t product)		
Beef	Pork	Chicken
18	4	Less than 1

The calculation of the emissions intensity of beef aligns with ABARES method (ABARES, 2023a). The values shown in Table 3.16 incorporate emissions from enteric fermentation and manure management and use.

Livestock numbers are expected to remain high in 2023–24 (DAFF, 2023c). Drier El Niño conditions in 2023–24 are expected to reduce crop production from the record levels of 2022–23 (DAFF, 2023b).

3.5.2 Leading indicators of change

3.5.2.1 Enteric fermentation

In consultation with peak bodies, industry and research organisations the authority was unable to identify a suitable leading indicator for emissions from enteric fermentation in livestock in response to changes to feed and herd management practices, due to a lack of data.

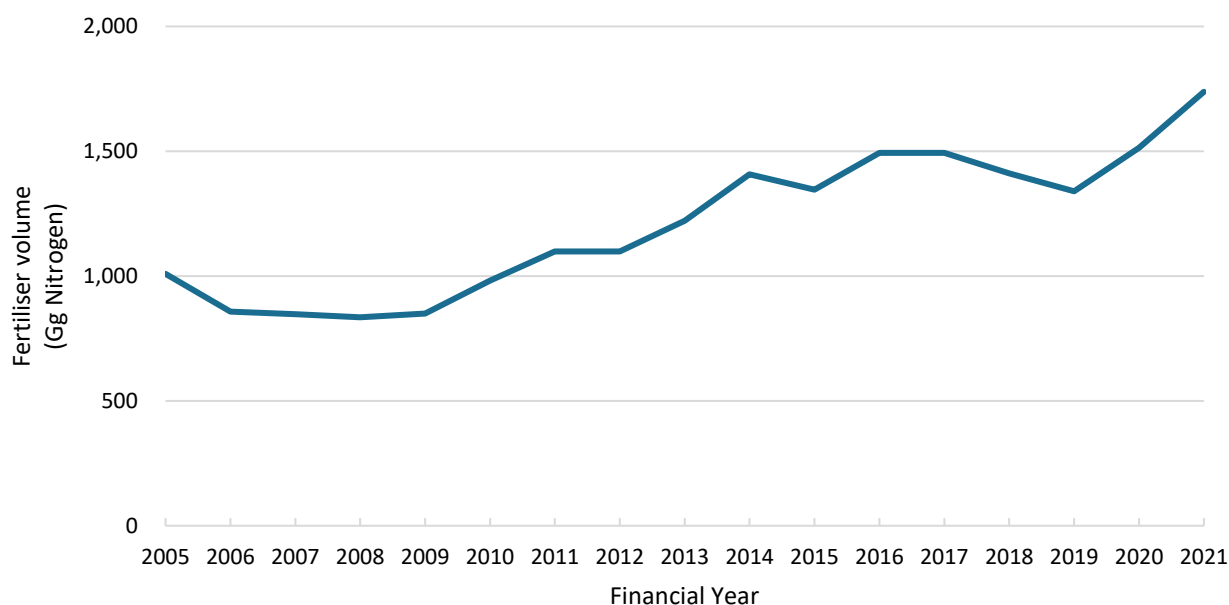
In future years, the authority aims to include a leading indicator on the volume of use of *Asparagopsis* and other feed supplements to estimate emissions reductions from enteric fermentation from their uptake. The authority is working with the industry to facilitate access to these data. To date, FutureFeed has issued 5 licences for the production of *Asparagopsis* in Australia and New Zealand (FutureFeed, 2023).

3.5.2.2 Fertiliser use

The agriculture sector is Australia's primary source of nitrous oxide emissions. Within the agriculture sector, most nitrous oxide emissions arise from agricultural soils, mainly direct emissions associated with the application of nitrogen fertilisers, crop residues, dung and urine (DCCEEW, 2023c).

Fertiliser use for crops and pasture has increased in recent years as drought has been followed by improved growing conditions (DCCEEW, 2023c). Total nitrogen fertiliser emissions were 6 Mt CO₂-e in 2022–23 (unpublished data provided by DCCEEW) compared to 5 Mt CO₂-e in 2021–22 (DCCEEW, 2023m).

Figure 3.14: Nitrogen fertiliser sales in Australia



Source: (DCCEEW, 2023cc), (unpublished data provided by DCCEEW)

3.5.2.3 *Other technologies and policies*

The authority will continue to monitor emerging technologies that may reduce emissions through displacement of traditional food production. For example, there are at least five synthetic biology start-ups established in Australia with a focus on biomanufacturing food or beverage products, including dairy (CSIRO, 2021).

Increasing consumption of plant-based protein could affect demand for animal-based protein and, therefore, emissions from livestock. The domestic market for plant-based proteins grew by \$45 million between the 2018–19 and 2019–20 financial years to \$185 million (Food Frontiers, 2021). However, globally, there are signs that the expanding plant-based protein market is not resulting in significant displacement of traditional meat products (Lusk et al, 2022; Neuhofer et al, 2022), and consumption of beef and sheep in Australia remained relatively stable at 25 kilograms per capita from 2019 to 2021 (ABARES, 2022).

The authority will also consider whether criteria under the Australian Agricultural Sustainability Framework can provide a leading indicator of change in farming practices as reporting starts in coming years. The framework is coordinated by the National Farmers' Federation and funded by a \$4 million Government grant. The Framework is intended to provide a basis to track the sustainability performance of Australian agriculture at a national level and develop sustainability goals for Australia's agriculture industry, including on reducing greenhouse gas emissions (DAFF, 2023a). Industry specific sustainability frameworks such as the Australian Beef Sustainability Framework and Sheep Sustainability Framework currently have indicators on emissions intensity. The users of these frameworks must work with the data available and currently lag data in the National Inventory report, reporting emissions from 2020 or 2021 in their 2023 reports (Australian Beef Sustainability Framework, 2023; Sheep Sustainability Framework, 2023).

The Australian Government made a \$38.3 million budget commitment over 4 years from 2023–24 that includes funding to improve regional data sources (DAFF, 2023d). This may contribute to the development of future leading indicators.



BOX 3.6: Case Study: Emissions from red meat and wool production

Emissions from red meat and wool arising from enteric fermentation and manure management in 2022–23 were 55 Mt CO₂-e (unpublished data provided by DCCEEW).

The Australian red meat and livestock industry has set a target for the meat and livestock sector to be carbon neutral by 2030 (MLA, 2020). A recent report prepared for Meat and Livestock Australia (MLA) proposed the industry consider adopting a climate neutral target, which would set a goal for the industry to make no net contribution to future warming (MLA, 2023a).

Under MLA's carbon neutral plan, there are two broad categories for the reduction of emissions from livestock:

- Increasing the efficiency of production.
- Offsetting emissions through land-based sequestration.

To date, most of the emissions reduction in Australian livestock systems has been through improved vegetation management on agricultural lands (see 'Area of land cleared' in the Land Use, Land-Use Change and Forestry section), and further emissions reductions will be difficult to achieve without targeting emissions from enteric fermentation (MLA, 2022b).

Some strategies to reduce emissions from enteric fermentation and increase the efficiency of production are available now, through changing animal diet, supplements and finishing strategy, optimising the herd structure through reducing breeder turnover, increasing sales of steers and unmated (spayed) heifers, reducing steer sale age, and increasing weaning rates (Harrison et al, 2016). Undertaking culling of unproductive animals, supplementary feeding and grazing management, could feasibly result in a 15% reduction in emissions from the cattle herd by 2030 compared to a 2020 baseline and assuming an 80% adoption rate (NSW DPI, 2021).

Emerging solutions to reduce livestock emissions include the use of feed supplements such as *Asparagopsis* and 3-NOP. The emissions impact of *Asparagopsis* supplements can be variable, with studies showing methane reduction potential from 9 to 98% (Wassan et al, 2022). Australian-based research has reported on methane emissions reductions from *Asparagopsis* supplements of 33 to 44% in dairy cattle (Alvarez-Hess, 2023), 55 to 95% in Angus cattle (MLA, 2023b) and 22% in Wagyu cattle (MLA, 2023c). 3-NOP feed supplements have been shown to reduce emissions by 8 to 30% (Black et al, 2021).

Currently, feed supplements could be included in feedlot and dairy cattle production systems, where the supplement can be delivered with feed on a regular basis (Ridout, 2022). Feedlot cattle account for approximately 4% of the Australian beef herd, and based on feedlot numbers, potential emissions reductions from use of *Asparagopsis* have been estimated to be 0.6–2.0 Mt CO₂-e (Ridout, 2022). Further research, including an effective dose rate, is required before feed supplements can become an effective emissions reduction solution for the livestock industry (Ridout, 2022). *Asparagopsis* supplements have only been commercially available since June 2022 (MLA, 2022a), and the cost of growing the industry (and flow on costs to farmers) is relatively uncertain (AgriFutures Australia and CBA, 2022).

A solution and delivery mechanism for grazing cattle is needed before feed supplements can extend beyond feedlot and dairy application (Ridout, 2022). The Government has invested over \$30 million in research and development of *Asparagopsis* and delivery mechanisms for grazing cattle, including through the National Reconstruction Fund and the Methane Emissions Reduction in Livestock program (DCCEEW, 2023ee).

Future solutions to reducing enteric fermentation in livestock could include the use of a vaccine. However, commercial availability of a vaccine is estimated to be 5 to 10 years away (Soder and Brito, 2023) or 7–10 years after demonstration of a prototype (Reisinger, 2021).

International demand plays a significant role in driving the size of the domestic livestock herds with 78% of beef and sheep production (3-year average, 2017–18 to 2019–20) being exported (ABARES, 2023b). Climate also strongly influences production levels and pricing, with long-term temperature and rainfall patterns key factors in determining the production system employed by producers (ACCC, 2017).

BOX 3.7: Case Study: CEFC invests in reducing on-farm methane intensity

The Clean Energy Finance Corporation (CEFC) announced it has made a \$75 million equity commitment through an agricultural fund managed by Macquarie Asset Management, to support efforts by Paraway Pastoral Company to reduce on-farm methane intensity.

The company operates 28 pastoral and cropping farms over more than 4.5 million hectares across Australia and has capacity to run more than 220,000 cattle and 250,000 sheep, as well as a mixture of dryland and irrigated cropping. Using emissions factors derived from national greenhouse accounts data, the authority estimates these capacity figures could result in potential emissions of 0.4 Mt CO₂-e and 0.05 Mt CO₂-e respectively for cattle and sheep. These estimates do not consider the effects on emissions from factors such as feed type, climate and herd management practices.

The CEFC investment is planned to allow the company to trial and showcase new technologies and practices to cut emissions, including altered herd management and genetics selection, changes to feed additive and farm practices, vegetation management and enhanced emissions measurement. Progress will be shared with other producers to encourage further emissions reduction across the agriculture sector (CEFC, 2022).



3.5.3 Physical climate impacts

Australia's agriculture industry is more vulnerable to the effects of physical climate change than most other economic sectors (DAFF, 2022). Prolonged droughts and heatwaves are exacerbated by climate change and have had adverse effects on agricultural activities, crop yields, and livestock health.

These physical impacts pose considerable challenges for the sector as they may lead to decreased agricultural productivity and profitability, and may also affect sectoral decarbonisation efforts. ABARES' modelling of changes in seasonal conditions, including the timing and extent of rainfall and increase in average maximum temperature over the period 2001 to 2020 showed a reduction in simulated annual average farm profits relative to 1950 to 2000 (Hughes, Lu, Soh, & Lawson, 2022). The Australian government allocated \$302 million in the 2023–24 Budget to the Climate Smart Agriculture package which aims to address these challenges and potential impacts as well as supporting other natural resource management objectives.

3.5.4 Innovations and developments

Australia's agricultural production reached a record \$92 billion gross value in 2022–23 due to favourable environmental conditions and high commodity prices (ABARES, 2023c). This result was primarily driven by the highest crop production on record. Strong pasture growth also supported a buildup in stock numbers (ABARES, 2023d).

Key innovations and developments in the sector for 2022–23 were:

- the release of the Australian government's first National Statement on Climate Change and Agriculture in July 2023 (DAFF, 2023f)
- continued trials of feed supplements to reduce enteric fermentation from livestock, including through the Methane Emissions Reduction in Livestock program (see *Case Study: Emissions from red meat and wool production*)
- increasing requirements by investors, supply-chains and markets for future emissions reductions from agricultural production (UN, 2021) (SBTi, 2023) (see section *Support farmers to accurately measure, reduce and disclose their emissions*), and
- Growing availability of farm-based tools that allow farmers to calculate their emissions (see section *Support farmers to accurately measure, reduce and disclose their emissions*).



3.5.5 Policy opportunities and recommendations

3.5.5.1 *Establish clear expectations for the agriculture sector*

State governments, including New South Wales, Victoria and Queensland, have undertaken significant work to set strategies and begin enhanced emissions reductions in the agriculture sector (NSW DPI, 2023) (Independent Expert Panel, 2023) (Queensland Government, 2022b).

In July 2023, the Australian government released the first National Statement on Climate Change and Agriculture which outlined a unified vision on climate change and agriculture (DAFF, National Statement on Climate Change and Agriculture, 2023f). At the Commonwealth level, the sector is served by a range of Commonwealth funded programs (DAFF, 2023h) which are designed to improve adaptation and resilience to climate change impacts and informed by the National Climate Resilience and Adaptation Strategy (DCCEEW, 2021b).

The authority's view is the Australian government's Net Zero Plan and agriculture and land sectoral decarbonisation plan should set expectations for the agriculture sector and map out policies needed to support this transition. It should build on the National Statement on Climate Change and Agriculture by setting a clear transition pathway that includes plans for the magnitude of emissions reductions, with a focus on pathways for reducing methane emissions from livestock. It should guide the investment and research needed for the transition, building on the authority's recommendations below. It should also consider the close connection between the agriculture and land sectors as farmers manage their business as a whole, including both emissions from production and emissions and removals from the land sector.

3.5.5.2 *Enhanced funding to support net zero agriculture solutions*

Rural Research and Development Corporations provide vehicles through which the Australian Government and primary producers co-invest in research and development in the agriculture sector, according to agreed priority areas of investment (DAFF, 2023e). Emissions reduction was not a priority area under the last agreement reached in 2021. Rural Research and Development Corporations are working to determine the carbon footprint of relevant commodities through calculating baseline production emissions, and in some cases, setting commodity specific emissions reductions targets, however progress is varied (CRDC, 2022a) (MLA, 2020) (Dairy Australia, 2020) (CRDC, 2022b).

As of June 2023, the CEFC has made \$335 million of direct investments in agricultural opportunities, with a further \$384 million committed across more than 1,500 smaller-scale asset finance loans to Australian farmers through its co-finance programs (CEFC, 2023f). The CEFC's focus is on projects that are closer to commercialisation and have a higher likelihood of generating financial returns. While this support should continue, research and development, and early-stage deployment will be crucial in advancing low emissions agriculture technologies and practices.

There are also recent examples of non-government, private and blended finance models supporting the development of low emissions agriculture solutions. For example, new methane-reducing livestock feed companies have received millions of dollars of seed funding from private investors and philanthropic organisations (Rumin8, 2023).

Investments in research into low emissions agriculture are currently being made by the Australian government, such as the Methane Emissions Reduction in Livestock program (Australian Government, 2022a) and through state government and university funded research (UTAS, 2022). However, this research is not connected by a nationally coordinated program of work. The Carbon Farming Futures program (2012 to 2016) is an example of a successful coordinated program of national research on low emissions agriculture. It comprised three core workstreams: (1) research into new technologies and practices to reduce emissions, increase carbon sequestration and manage climate change; (2) funding to support on-farm trials; and (3) dedicated extension and outreach (DAFF, 2023g). This program built a comprehensive base of research and on-farm applications and should inform the design of future programs of work.

The draft National Science and Research Priorities (DISR, 2023) identifies scalable emission reduction technologies as a critical area for national research focus. Stakeholders, including Meat and Livestock Australia, share the authority's view that a need exists for dedicated funding and investment to support nationally coordinated research, demonstration and commercialisation of emissions reduction technologies tailored to the agriculture sector.

The agricultural industry is faced with specific emissions reduction challenges that do not yet have commercially viable technological solutions. The magnitude of Australia's agricultural emissions and the current state of technologies to reduce these emissions mean an extensive, long-term funding program for supporting challenged-based research and commercialisation is needed before significant emissions reductions can be realised (see *Case Study: Emissions from red meat and wool production*).

Development of such a program's research agenda would need the active participation of external stakeholders, should aim for sectoral impact and seek to build the long-term sustainable partnerships that are required to develop and embed emissions reductions solutions and practices.

26. RECOMMENDATION

Fund an extensive challenge-based program of research and early-stage commercialisation of agriculture emissions reduction technologies.



3.5.5.3 *Support farmers to accurately measure, reduce and disclose their emissions*

Farmers will increasingly need to understand their on-farm emissions to meet supply-chain and market requirements whilst managing risks to their businesses (DAFF, 2023f).

Australia's big four banks have signed the Net-Zero Banking Alliance, which includes agriculture as a carbon-intensive sector and requires alignment of financial investments with a pathway limiting global temperature rise to 1.5 degrees (UN, 2021).

In September 2022, the Science-Based Targets Initiative launched guidance on setting forest and agriculture targets. Woolworths and McDonalds are large purchasers of Australian red meat, and each have Science-Based Targets Initiative commitments (SBTi, 2023), which may increasingly influence their supply chain requirements. Agriculture industry submissions to the authority's Issues Paper have also highlighted the growing need to support farmers to measure and report their emissions to meet industry-led emissions reduction commitments (Australian Dairy Industry Council and Pork Australia submissions). The authority also heard concerns from stakeholders about the potential cost burden for farmers to measure and report their emissions.

There are currently no government-endorsed standards for emissions reporting that will meet the requirements of climate disclosures in alignment with the government's sustainable finance reforms and there are no specific National Greenhouse and Energy Reporting scheme methods for major sources of agricultural emissions. The Australian Banking Association (ABA) has called for an independent entity to coordinate data collection and provision, and 'government support via the provision of existing data and the creation of new data' (ABA submission).

BOX 3.8: Consumer labelling

Information collected about the emissions associated with agricultural production can also support consumers to make more informed choices when purchasing food and fibre products. This could be through labelling products to disclose their relative emissions.

There are currently a range of standards and schemes that label, verify or certify products based on aspects of their environmental sustainability. For example, Climate Active provides carbon neutral certification for businesses and products (Climate Active, 2019).

Labelling of food products to indicate their environmental impacts is currently voluntary (Food Standards Australia New Zealand, 2015), and consumers may find the various voluntary sustainability labels challenging to navigate (Choice, 2022). Therefore, the authority considers that more consistent and transparent disclosure of the emissions impact of food and fibre products may better support consumers to make informed choices.

To address the need for farm-level emissions data, some private companies and Rural Research and Development Corporations are developing tools for estimating and calculating on-farm emissions (MLA, 2023d) (MyFootprint, 2023) (Agricultural Innovation Australia, 2023). FarmPrint, with CEFC support, is another example with a focus on broadacre cropping (CEFC, 2020). However, these tools are not required to meet minimum standards.

As these sustainable supply-chain pressures increase, farmers may also need to increasingly rely on carbon sequestration for their own purposes, meaning that energy and industry sectors may not necessarily be able to rely on significant farm-based offsets from the land sector (Net Zero Australia, 2023).

The Australian government should fund a program to help farmers measure and report their on-farm emissions, de-risk carbon farming and provide the information investors and lenders are calling for to help decarbonise their portfolios.

The program should include:

1. the development of a standard that sets a clear benchmark for calculations of on-farm emissions and supply-chains.
2. an extensive outreach program to support farmers' ability to understand and quantify their farms' emissions and how to integrate technology and practice change to reduce emissions, and
3. support to inform farmers' land management decisions and approaches to achieve emissions reductions in their production and supply-chain processes (see Farm-level capacity building recommendation of the Land Sector section).

The authority will investigate whether the National Greenhouse and Energy Reporting scheme (NGERs) is an appropriate place for the recommended standard in its 2023 NGERs review.

The design of this program should integrate with and build upon existing tools, frameworks, and measures. The program should expand on existing work being undertaken by the Australian Government and recent commitments made in the 2023–24 Budget, through a focus on farm-level outreach and engagement. The program would be an adjunct to the \$20.3 million Carbon Farming Outreach Program and \$40 million allocated to Sustainable Agriculture facilitators. It should also be designed to integrate or coordinate with similar state and territory government programs, such as Agriculture Victoria's On-Farm Emissions Action Plan Pilot (Agriculture Victoria, 2023a).

Program design should also take into consideration international initiatives such as New Zealand's 'Know your numbers' program, which helped farmers in New Zealand to understand their emissions by 2022 and requires them to have a written plan in place for measuring and managing their emissions by 2025 (Ag Matters, 2023). The program should be designed for Australia's specific context and ensure an appropriate process to stage rollout and uptake. The government could set a clear requirement that some larger businesses must report their emissions through the program. Reporting of agriculture emissions could also be considered under the NGERs scheme, and this is being considered as part of the authority's 2023 NGER review.

The message from the agriculture industry is that more needs to be done to help farmers turn willingness to change into action. The program should include support for farmers and key stakeholders through enhanced outreach that builds understanding of the available decarbonisation opportunities, pathways for action and risk management approaches within the carbon market. Managing the physical risks from climate change would not be the focus of this program, as there are existing programs where this is a key focus, such as the Climate Services for Agriculture program through the Future Drought Fund. However, any advice given to farmers on actions they can take to reduce emissions should also consider climate resilience.

The government should also consider arrangements to facilitate farmers' uptake of high priority actions identified under the program, such as through working with banks and financiers to link to green loan opportunities.

27. RECOMMENDATION

Develop a program to support farmers to measure, reduce and disclose their emissions in line with an established government standard, provide advice on actions farmers can take to reduce emissions, and help them to implement high priority actions.

3.5.5.4 *Reducing nitrous oxide emissions from fertiliser use*

Nitrogen fertilisers contributed 6 Mt CO₂-e of emissions to Australia's 2022–23 national inventory (unpublished data provided by DCCEEW). One method to reduce emissions from use of nitrogen fertilisers is through nitrification inhibitors, which are often coatings applied during manufacture that slow the release of nitrogen from fertiliser to the atmosphere or waterways (Agriculture Victoria, 2023b).

Application of nitrification inhibitors can more than halve emissions from nitrogen fertilisers (Meng, et al, 2021). Nitrification inhibiting fertilisers are more expensive than untreated fertiliser, which can discourage broad uptake by farmers (Folina, 2021). This issue was also raised with the authority during consultation.

28. RECOMMENDATION

Explore the potential for time-limited incentives to support broad uptake of fertilisers with nitrification inhibitors.



3.5.6. Policy effectiveness

The following table provides an assessment of the agriculture sector considering the key emissions reduction policies operating in 2022–23.

Table 3.17: Policy effectiveness in the agriculture sector

Aspect	Analysis
Scope	<p>The Australian Carbon Credit Unit (ACCU) scheme is the primary government measure for reducing agriculture emissions. The government’s \$20.3 million Carbon Farming Outreach Program will support participation and begin operation in 2023–24 (DCCEEW, 2022i).</p> <p>As of June 2023, the CEFC has made \$335 million of direct investments in agricultural opportunities with a further \$384 million committed across more than 1,500 smaller-scale asset finance loans to Australian farmers through its co-finance programs (CEFC, 2023f).</p> <p>Government co-funded Research Development Corporations have a focus on climate resilience but investment in emissions reductions is not a priority area. The Methane Emissions Reduction in Livestock program invests in feed supplements to reduce emissions.</p>
Impact	<p>The ACCU scheme provides several methods for reducing emissions in the agriculture sector, however uptake has been very limited. There are currently only 26 manure management and 14 beef cattle herd management projects registered to reduce agriculture sector emissions. To date, there have been no projects registered under the fertiliser efficiency method or for the nitrate supplements method. Around 2 million ACCUs (1.5% of total ACCUs) have been issued from 40 projects registered under agricultural abatement methods (CER, 2023b).</p> <p>A number of Rural Research and Development Corporations are supporting emissions reduction goals for agriculture commodities, but this is not comprehensive. The government is supporting trials of feed supplements.</p> <p>Emissions from the sector are still driven by livestock numbers and fertiliser use.</p>
Efficiency	<p>There are no expectations set by the government for emissions reductions from agriculture, other than voluntary participation in the ACCU scheme and encouraging farmers and landholders to reduce emissions when it is feasible.</p>
Relevance	<p>While the government is supporting some research into low emissions agricultural, emissions from livestock and fertiliser use are still tied to production.</p>
Coherence	<p>More needs to be done by the government to align agriculture production with a net zero pathway.</p>
Sustainability	<p>The ACCU scheme requires that projects comply with existing environmental laws.</p>

3.6 Land Use, Land-Use Change and Forestry

0% change in land use, land-use change and forestry emissions during 2022–23

Australia's land sector will be critical to Australia achieving its emissions reduction targets. The land sector removed more carbon dioxide from the atmosphere than it released in 2022–23 – resulting in net emissions of -64 Mt CO₂-e²¹ equivalent to removing 14% of Australia's national total (unpublished data provided by DCCEEW). The size of the net sink reflects the long-term decline in the rate of land clearing and the influence of La Niña conditions (unpublished data provided by DCCEEW).

3.6.1 Emissions sectoral trends

The Land Use, Land-Use Change and Forestry sector (land sector) accounts for changes in the amount of carbon stored in trees, vegetation, soils and harvested wood products. Emissions from this sector are reported on a 'net' basis because it accounts for losses and gains in forests and woody vegetation, the primary drivers of change in this sector. The sector also includes losses and gains in carbon in soils and wood products.

The land sector includes losses and gains on agricultural land. This section should be read with the agriculture sector section which covers emissions from agricultural production. Many actions in the land sector are led by farmers on agricultural land, and the two sectors are therefore interlinked.



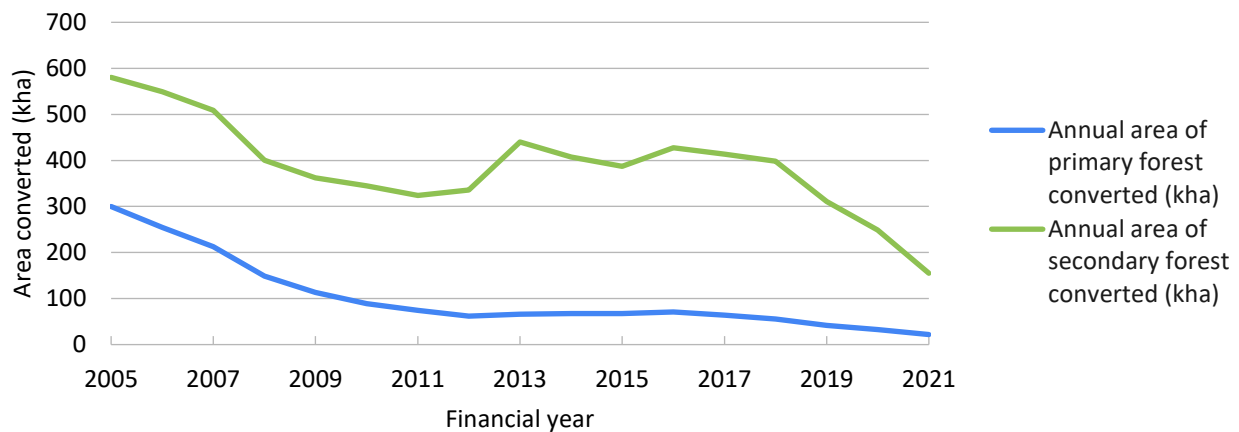
²¹ The latest estimate of Australia's net emissions in the land sector is -64 Mt CO₂-e. Over the past year the Department of Climate Change, Energy, the Environment and Water (DCCEEW) has recalculated the sink to be around 20 Mt CO₂-e larger (a higher negative number) than previously estimated due to an update in the data source of the Normalised Difference Vegetation Index (NDVI). Further information on this change is available in Australia's National Inventory Report 2021 on the DCCEEW website.

3.6.2 Leading indicators of change

3.6.2.1 Area of land cleared

In 2020–21, clearing of primary and secondary forest was at its lowest since 1990 (Figure 3.15). Most primary forest conversion, re-clearing and regrowth occurred on lands used for grazing (DCCEEW, 2023d).

Figure 3.15: Total area of primary and secondary forest conversion from 2004–05 until 2020–21



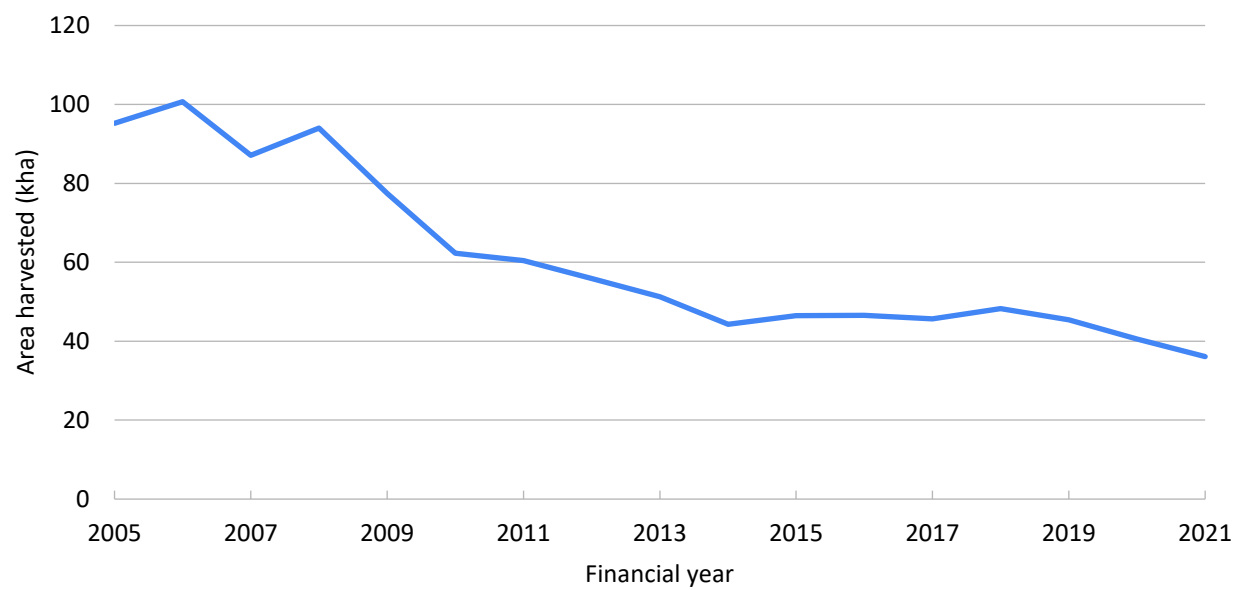
Source: (DCCEEW, 2023d, Table A5.6.12.6)

The authority has noted concerns raised by stakeholders during consultation regarding the transparency and accessibility of national land clearing datasets, and comparability with state-level datasets (Queensland Conservation Council, 2023). The authority will continue to engage with stakeholders on these aspects and monitor government and non-government efforts to improve these datasets.

3.6.2.2 Area of native forest harvested

A decline in the area of native forest harvested for timber since 2004–05 has resulted in significantly lower direct emissions from timber harvest and has enabled greater emissions removals from the atmosphere from native forests (Figure 3.16). In 2004–05, harvested native forests provided -18 Mt CO₂-e. By 2020–21, emissions removals had increased to -36 Mt CO₂-e, a twofold increase in emissions removals (DCCEEW, 2023c).

Figure 3.16: Total area of native forest harvested from 2004–05 until 2020–21.



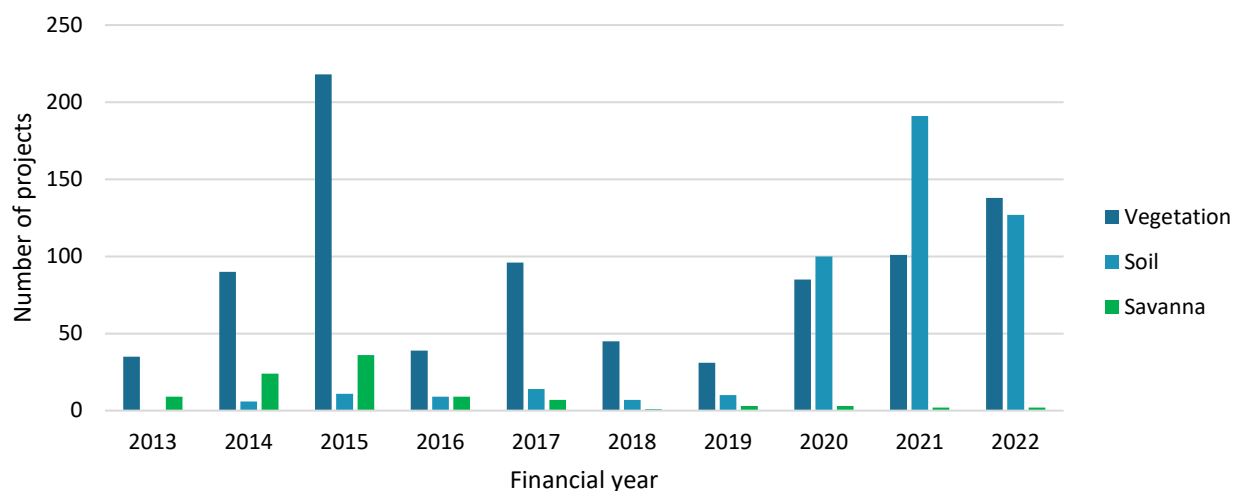
Source: (DCCEEW, 2023c, Table 6.4.16)



3.6.2.3 Number of new land-based ACCU scheme projects

The numbers of new land-based carbon sequestration projects registered under the Australian Carbon Credit Unit (ACCU) scheme, are an indicator of land-based action to reduce or remove emissions which will be realised when the projects commence offset reporting and ACCU crediting (Figure 3.17).

Figure 3.17: New Australian Carbon Credit Unit (ACCU) scheme projects registered in land sector



Source: (CER, 2023b)

Land sector projects under the ACCU scheme, for the purposes of this analysis, are those that use a method that would contribute abatement to the land use, land-use change and forestry sector in Australia's national inventory. As such, projects using methods that sequester carbon in vegetation and soils and methods that reduce emissions from savanna burning are included.

3.6.3 Impacts of climate change

Australia's land sector is highly vulnerable to climate change and impacts are already being observed. A prominent example is the intensity of the drought from 2017 to 2019, which was followed by the catastrophic bushfires during the summer of 2019 and 2020, known as the 'Black Summer' (Williams, Hunter, Schmidt, Woodward, & Cresswell, 2021). Approximately 23% of temperate forests in south-east Australia were burned (Trewin, Morgan-Bulled, & Cooper, 2021).

The impacts of climate change are also being seen in other important ways. For example, climate impacts can reduce the productivity and health of Australia's plantation forests (Pinkard, 2017), many of which are already under pressures from weeds, pests and disease (ABARES, 2018). These impacts all affect the magnitude and permanence of removals that can be sustained by Australia's land sector (Roxburgh, Paul, & Pinkard, 2020).

3.6.4 Innovations and developments

3.6.4.1 *Increasing demand for carbon offsets*

The voluntary and compliance markets for ACCUs have been growing (see Chapter 4 and (CER, 2023b). This is reflected in an uptick in land-based project registrations from 2020–21 onwards (Figure 3.17). With the passing of the Safeguard Mechanism reforms (Chapter 4), market demand is likely to increase.

In 2022–23, 267 land-sector projects were registered under the ACCU scheme. These new projects can be expected to generate future offsets for Australia’s carbon market once they commence offset reporting and crediting (CER, 2023b).

There is uncertainty regarding the magnitude of offsets that will be available from soil carbon projects, which make up 127 (48%) of newly registered land-sector projects in 2023. The first large scale issuance of over 150,000 ACCUs to two soil carbon projects in June 2023 shows the potential for landholders to build soil carbon and generate ACCUs (CER, 2023b).

The strong uptake in soil carbon projects has been supported by the Government’s advance payments of up to \$5,000 for up-front soil sampling costs for these projects. The Government has also committed \$49 million for grants under the National Soil Carbon Innovation Challenge (DCCEEW, 2023v) (DCCEEW, 2022j). These grants support the development of improvements in measurement techniques to bring down the cost and increase the accuracy of measuring changes in soil carbon levels. Soil carbon is inherently variable, is influenced by environmental factors such as rainfall, and is at risk from climate change. Therefore, it is important that offsets generated reflect durable improvements in soil carbon levels (Roxburgh, Paul, & Pinkard, 2020). The 2021 soil carbon method has mechanisms that discount the ACCUs issued under the method that aim to address this variability (CER, 2023h). Over the next few years, the authority will analyse the outcomes from these projects in future annual progress reports or the next legislative review of the ACCU scheme.

State- and territory-based incentives have increased take-up of ACCU scheme projects. Uptake in Queensland in particular has in part been due to its inclusion of verified co-benefits as part of ACCU scheme projects under the Queensland government’s Land Restoration Fund (Carbon Market Institute, 2023). There have also been recent developments in Western Australia, with legislative changes to allow ‘diversification leases’ potentially enabling expansion of carbon farming activities to new areas of the state (WA Government, 2023a).

3.6.4.2 *Net zero agricultural supply-chain commitments*

3.6.4.2.1 *Mandatory commitments*

New EU legislation that prevents deforestation in the supply chain of key commodities including cattle and beef products, and paper and wood products, passed the European Parliament in April 2023 (see Chapter 1). In 2021–22, Australia exported approximately 6,600 tonnes of beef and 17,000 tonnes of forestry products to the EU (ABARES, 2023e). Suppliers to the EU will have 18–24 months from the legislation’s passing to demonstrate compliance, depending on the size of the business. In 2020–21, 13,500 kha of primary forest was cleared for grazing (DCCEEW, 2023c). As market expectations continue to develop rates of land clearing will come under greater scrutiny by markets (ACF, 2023). The Australian Government has released a National Agricultural Traceability Strategy to support growing market access requirements (DAFF, 2023i).

3.6.4.2.2 Voluntary commitments

The October 2022 Science-Based Targets Initiative guidance on setting forest and agriculture targets includes a requirement to commit to no gross deforestation in supply chains by the end of 2025 (SBTi, 2022). This is discussed in detail in the agriculture sector.

3.6.4.2.3 Nature-related commitments

There was a growing emphasis on land being used to enhance carbon sequestration and strengthen natural systems in 2022–23.

In May 2023, the Science Based Targets Network released a mechanism for companies to set nature targets alongside the Science-Based Targets Initiative climate targets (Science Based Targets Network, 2023).

Nature-based disclosure requirements are also following similar, earlier trends as climate-related disclosure requirements in international markets, with the release of a set of disclosure recommendations and guidance for organisations to report on by the Taskforce on Nature-related Financial Disclosures in September 2023 (TNFD, 2023).

These developments support previous recommendations by the authority that climate and nature issues be addressed together by policy makers (CCA, 2018; CCA, 2020).



3.6.5 Policy opportunities and recommendations

3.6.5.1 *Understanding land-based sequestration to support a net zero Australia*

Australia has the opportunity to be a world leader in land sector sequestration – using it judiciously to meet net zero commitments and to grow regional economies. However, for this to occur Australia needs to develop a good understanding of realisable land-based sequestration from plantation, environmental and farm forestry type plantings, as highlighted in the authority’s paper *Reduce, remove and store: The role of carbon sequestration in accelerating Australia’s decarbonisation* (CCA, 2023). This also includes emissions and removals associated with ‘teal carbon’ in the landscape, such as freshwater wetlands and dams on farms. For example, emissions from farm dams can be relatively significant without particular management techniques (Blue Carbon Lab, n.d.)

Comprehensive analysis is needed to understand the magnitude of Australia’s realisable, human-induced, land-based sequestration, including from farm-based offsets. The authority is considering sequestration potential as part of its advice on Australia’s next Nationally Determined Contribution, and further work will be needed to map this to 2050 and beyond.

Australia’s realisable land sector sequestration is a function of the multiple requirements for Australia’s land, including adapting to climate change, producing food, and providing a sustainable source of natural capital – biodiversity, clean water, and healthy soils. This balance should be informed by First Nations peoples and rural and regional communities as well as by science and economics.

The Australian Government is establishing a national net zero plan (Minister for Climate Change and Energy, 2023) (DCCEEW, 2022f). This strategy, and associated sectoral plans, must consider the role of land-based sequestration through to 2050. The net zero strategy should also consider how land-based sequestration could support decarbonisation of different sectors while meeting food production and environmental objectives. It will be vital for the net zero strategy to consider emissions reduction and sequestration in land and agriculture in tandem, as the two are strongly interlinked and often occur on the same areas of land and changes are driven by the same land managers. The agriculture section of this report likewise recommends that a national net zero strategy set expectations and implications for emissions reductions in the agriculture sector.

Nearly all of Australia’s current sequestration is in the land sector (see Chapter 4). There is currently an expectation that land-based offsets will be used by Safeguard liable entities to achieve their emissions obligations. In parallel, market expectations for production and supply chains are increasing for farmers to reduce emissions from agricultural production. Balancing these demands was a concern raised by submissions to the authority’s Issues Paper (Australian Pork submission; anonymous submission). More work needs to be done to determine if there is sufficient supply of land-based sequestration to fully meet the sequestration needs of both groups to 2050 (see Chapter 4 on Sequestration).

3.6.5.2 *Farm-level capacity building*

The land sector will be an important source of carbon sequestration and offsets for:

- responsible emitters under the Safeguard Mechanism
- agricultural producers, as they demonstrate their green credentials to markets and supply-chains
- businesses meeting voluntary commitments to reduce their emissions.

Farmers need support now to understand their current emissions (see agriculture sector section) and how to best reduce them (DAWE, 2022). Landholders need impartial guidance on the most effective use of their sequestered carbon – including whether to supply offsets generated on farm for other businesses or their own business emissions (Davis, 2023), and balance this with the need to maintain farm output and profitability.

29. RECOMMENDATION

Enhance the delivery of impartial, practical guidance and support to landholders to enable them to make informed decisions on sequestering carbon on their farm to best suit their business, including retaining carbon for their own business, supplying the ACCU scheme offsets market, or establishing farm forestry and agroforestry.

3.6.5.3 *Supporting a sustainable forest industry*

Sustainable forest practices supported by the establishment of new forestry plantations have an important role to play in achieving Australia's net zero target, as trees sequester carbon as they grow, store it in long-lived products and can substitute for higher emissions products in buildings. However, the area of plantation forest in Australia remained relatively stable, with no increase in area in 2020–21 (DCCEE, 2023c).

New land management practices, including integrated farm forestry and agroforestry need to be implemented to support growing Australian and global demand for high-value wood products and carbon offsets (DAWE, 2022). It is critical to get the right tree species planted in the right place and at the right time to achieve this, as timber resources can take decades to mature and be available for a stable product supply chain.

There are a number of near-term challenges facing the sector, including high land prices, longer investment cycles, and concerns about changing from agricultural to forested land use.

Better recognition and valuing of co-benefits from forestry plantations under varied circumstances is needed with management practices that encourage greater species diversity in plantations, and better integration with catchment and Natural Resource Management planning. Consideration could also be given to exploring opportunities for a broader range of carbon abatement methods under the ACCU scheme (CSIRO, 2019).

Better information for farmers, landholders and regional communities is needed on what tree species are suitable for their local area, with guidance on market demand, and what products are in demand from supply chains. This would empower farming communities to work with regional forestry hubs and maximise the benefits to regional communities (DAFF, 2023j).

The authority recommends the Australian Government integrate practical and tailored information on the establishment of farm forestry and agroforestry as part farm-level capacity building actions.

3.6.5.4 Continuing to refine the ACCU scheme

The policy effectiveness assessment at the end of this chapter finds that the ACCU scheme has worked well to establish a carbon offset mechanism, however further reforms are needed to enhance and widen participation in the ACCU scheme.

The authority's 2023 review of the *Carbon Credits (Carbon Farming Initiative) Act 2011* will consider the functioning of the ACCU scheme, and whether it is fit for purpose as Australia moves towards net zero emissions. It will also consider if greater coordination is needed to align carbon and biodiversity incentives, and opportunities to better value First Nations peoples' knowledge and improve opportunities for their participation in the scheme.

3.6.5.4.1 Supporting effective vegetation management regulations

State governments have an important role to play in managing land sector emissions through properly monitoring and enforcing compliance with their land clearing regulations, as identified by the authority in its 2020 report *Prospering in a Low-emissions World*.

The Australian Government may soon have an increasing role to play in this space, with the proposed legislative reforms to the EPBS Act. Stronger regulations for environmental protection and biodiversity conservation associated with land sector activities, including land clearing of primary native forest will potentially come under EPBC Act consideration, particularly where agricultural lands encompass vegetation or habitat that is considered under Matters of National Environmental Significant (MNES) (DCCEEW, 2023s).

The authority will keep under review the impact of these changes and whether they accelerate the long-term trend of reduction in the land area of primary forest clearing and regrowth forest clearing.



3.6.6 Policy effectiveness

The following table presents an assessment of the key emissions reduction policies impacting the land sector in 2022–23.

Table 3.18: Policy effectiveness in land-use, land-use change and forestry sector

Aspect	Analysis
Scope	<p>The ACCU Scheme is currently the key measure for reducing land sector emissions and increasing sequestration.</p> <p>The Government is supporting improved soil carbon data and measurement approaches through the National Soil Carbon Innovation Challenge and other policies and programs. The National Soil Strategy includes an objective to increase and maintain soil carbon (Australian Government, 2021b).</p> <p>The Carbon + Biodiversity Pilot is trialling ACCU scheme projects with biodiversity outcomes (DCCEEW, 2023g) with plantings expected to commence in pilot regions throughout 2022–23.</p> <p>The Carbon Farming Outreach program will start delivering in 2023–24.</p>
Impact	<p>9 million ACCUs were issued in 2022–23 to land sector methods (vegetation, soil and savanna methods).</p> <p>While Australia’s total forest cover increased overall in 2021, Australia is still losing primary forest cover and experiencing soil degradation (DCCEEW, 2023c) (Australian Government, 2021c).</p>
Efficiency	<p>The ACCU scheme is underpinned by comprehensive legislation and auditing and compliance mechanisms.</p> <p>There have been a limited number of soil carbon projects that have been issued ACCUS from soil carbon projects in 2022–23. The magnitude of benefits achieved from Government support for baselining soil carbon projects is expected to become apparent over the next 2–5 years.</p> <p>In addition, 138 vegetation-based emissions reduction projects were registered in 2022–23 (CER, 2023b).</p>
Relevance	<p>The ACCU scheme is an important component of a national net zero transition, as it provides carbon sequestration for hard to abate emissions. Through the CFI the land sector can help Australia meet these commitments while creating new income opportunities for land managers.</p>
Coherence	<p>While the ACCU scheme is a world-leading offsets scheme, Australia needs to develop a comprehensive approach to managing its land to support a net zero transition.</p>
Sustainability	<p>ACCU scheme projects have had some environmental, social and productivity benefits. The ACCU scheme requires that projects comply with existing environmental laws.</p>

3.7 Waste

0% change in waste emissions in 2022–23

Greenhouse gas emissions from landfill have been relatively stable over the past decade and were 14 Mt CO₂-e in 2022–23 (DCCEEW, 2023m). This is consistent with the stable trend in the amount of organic waste going to landfill over this time. The dumping of organic waste, such as food and garden waste in landfills, is the key driver for greenhouse gas emissions from landfills.

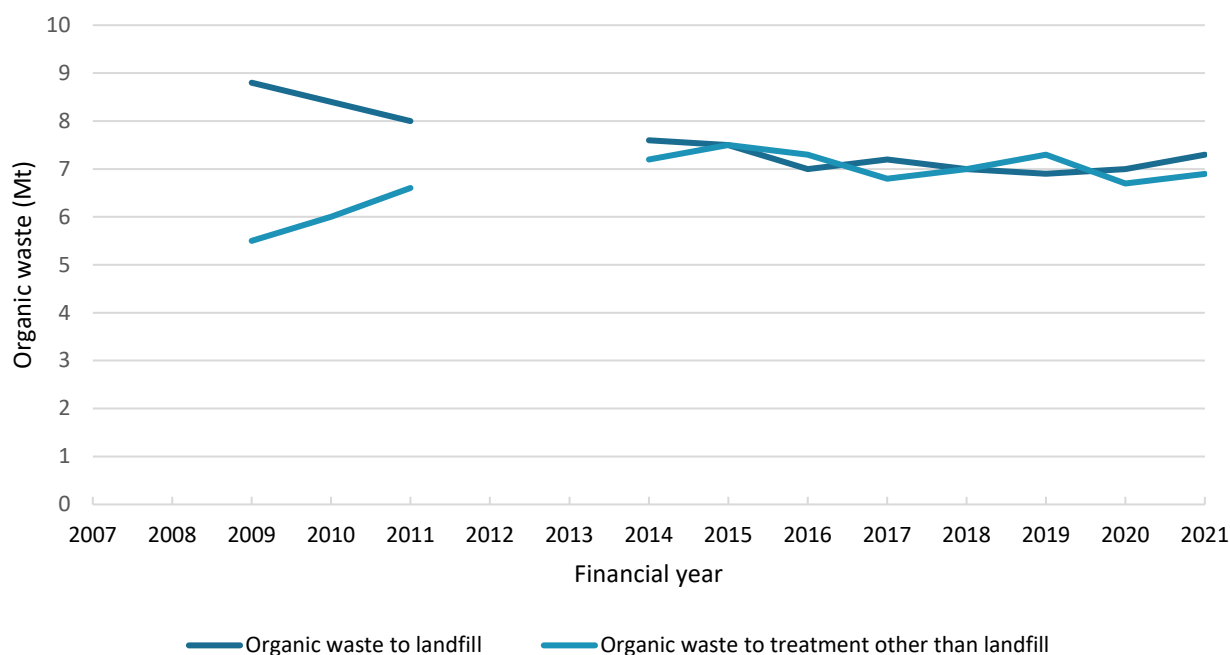
3.7.1 Emissions trends

Emissions from solid organic waste deposited in landfills comprise the majority of emissions from the waste sector (DCCEEW, 2023b). Other important sources of emissions in the waste sector are incineration and wastewater treatment.

Landfill gas capture rates have remained relatively stable as a proportion of landfill gas generated since the 2012–13 financial year (Figure 3.19) (DCCEEW, 2023c).

Emissions in the waste sector are projected to decline from 13 Mt CO₂-e (2.6% of total emissions) in 2020 to 11 Mt CO₂-e (2.6%) in 2030, and 10 Mt CO₂-e (2.6%) in 2035 (DCCEEW, 2022a). The projected decline in emissions from the waste sector is based on assumptions of increased landfill gas capture and federal, state and territory policies to reduce the amount of organic waste going to landfill (DCCEEW, 2022a).

Figure 3.18: Treatment of organic waste



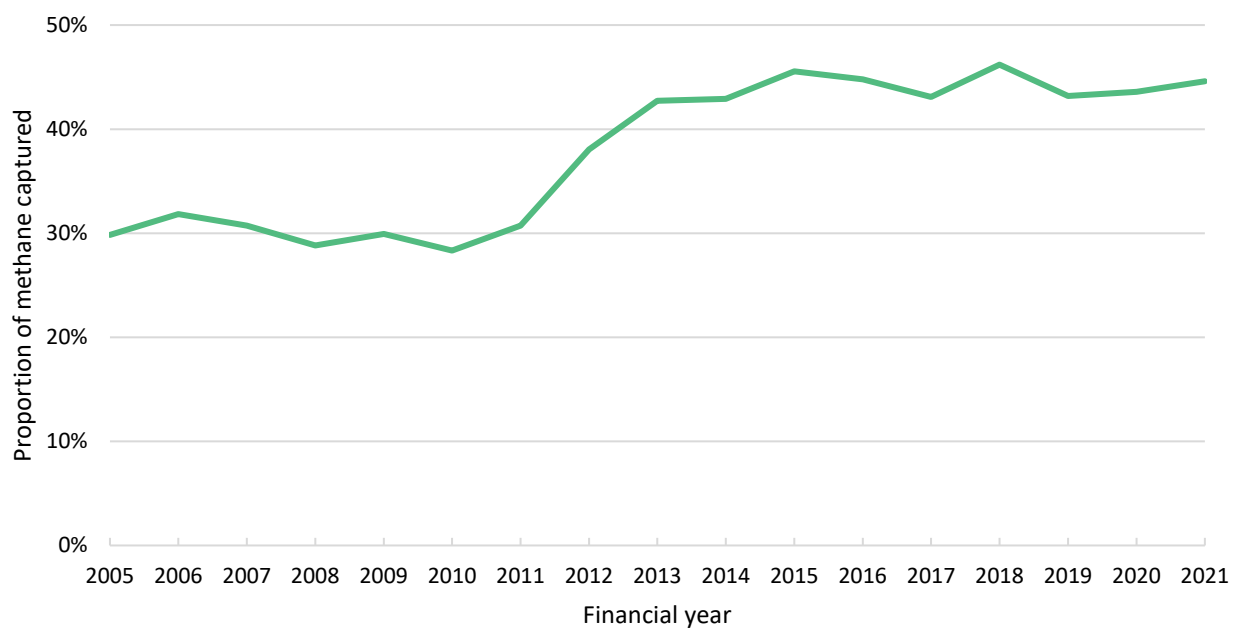
Source: (Blue Environment, 2022)²²

²² No data available for years 2007, 2012 and 2013

3.7.2 Leading indicators of change

The release of methane emissions from landfill can be prevented by capturing the methane and combusting it onsite to convert it to carbon dioxide. There has been a static trend in methane capture at landfill over the past decade (Figure 3.19). This indicates that further policy intervention is likely needed to move methane capture up towards its technical potential in Australia. Figure 3.19 shows methane capture rates at landfill have remained relatively stable at around 45% of methane generated. The United Kingdom and USA have reported total methane capture rates of over 60% (US EPA, 2023) (UK Climate Change Committee, 2013). Methane capture rates of 80% or greater can be achieved at modern, optimally designed landfill sites (UK Climate Change Committee, 2013).

Figure 3.19: Methane capture at landfill



Source: (DCCEEW, 2023c, Table 7.2)



3.7.3 Innovations and developments

Treatments such as composting and anaerobic digestion of organic waste are well-developed and well-known alternatives to landfill. Energy from waste through incineration, gasification and pyrolysis are technologies that provide another alternative to landfill, but utilisation in Australia has been low (Blue Environment, 2022). In part this is likely due to regulatory uncertainty and lack of community acceptance (Infrastructure Partnerships Australia, 2020).

3.7.3.1 *Biological methane oxidation treatments*

Biocovers, biofilters and biowindows are a biologically active layer designed to enhance oxidation of methane as it migrates to the surface of the landfill. These systems may present an opportunity to reduce emissions where landfill gas capture is not an option (Gebert et al, 2022). The effectiveness and applicability of biocovers can differ due to individual landfill conditions (Environment Agency, 2017) and there are few studies on the effectiveness of biofilters in the Australian context. Cleanaway, Zeotech and Griffith University are investigating the use of Zeolite, a porous material that could trap and oxidise methane as the filter medium (Cleanaway, 2022).

3.7.3.2 *Source Separated Organics*

Food and garden organics kerbside collection is increasingly common among Australian local Governments and increased organics collection has led to more development in the organics recycling sector. Some state governments support or even mandate household organics collection, however recovery of food waste from sectors such as retail remains underdeveloped. Household awareness of appropriate use of organics bins and contaminants in the composted product remain key challenges to increasing rates of organics collection and composting (Blue Environment, 2022).

3.7.3.3 *Government support for recycling infrastructure*

The Australian government's recycling modernization fund has co-funded five paper and cardboard recycling facilities that will be commissioned in the 2023–24 financial year, increasing Australia's paper and cardboard processing capacity (DCCEEW, 2023x). The recycling of paper and cardboard diverts this waste stream from landfill, avoiding emissions from being produced in landfill. This would avoid approximately 0.8 Mt CO₂-e of emissions per year if capacity is fully utilised.

The Australian government's food waste for healthy soils fund has provided over \$38.9 million for 25 projects to either build new composting infrastructure or expand existing infrastructure (DCCEEW, 2022k). This will result in an additional 974,000 tonnes of additional organic waste processing capacity per year (DCCEEW, 2022k).

The ACCU scheme allows for the generation of carbon credits for diverting organic waste from landfill to other treatments through the alternative waste treatment and source separated organic waste methods. There are currently 40 projects registered to these methods and over 4 million ACCUs have been issued since 2015 (CER, 2023b). Through consultation, the authority has heard that the requirement for additionality and the need to navigate regulations at several levels of government can be complex, creating a barrier to registration of ACCU scheme projects (Private stakeholder consultation activity). Landfills are also covered by the safeguard mechanism if emissions from waste deposited before 1 July 2016 exceed the 100,000-tonne carbon dioxide equivalent threshold. Four emitters reported landfill emissions to the safeguard mechanism in the 2021–22 financial year (CER, 2022).

3.7.4 Policy opportunities and recommendations

3.7.4.1 *Reducing organic waste going to landfill*

Responsibility for regulation of waste management in Australia lies primarily with state and territory governments, while local governments are responsible for providing waste management services to their constituents.

The 2018 national waste policy was agreed by all Australian governments. The policy is implemented through the 2019 National Waste Policy Action Plan that guides investment and supports policy reform to better manage Australia's waste and resource recovery. The action plan sets seven targets underpinned by actions to be delivered by governments, industry and the community. The National Waste Policy is primarily a waste reduction strategy, not an emissions reduction policy. However, as it commits all levels of government to halve organic waste to landfill by 2030 it is a key policy for reducing emissions from the waste sector (DCCEEW, 2019).

BOX 3.9: Circular economy

A circular economy uses resources for as long as possible through avoiding, reusing, recycling, and reprocessing waste, as opposed to the linear model of take-use-dispose. Although emissions reductions are not the primary goal of the circular economy, more efficient use of resources can lead to reduced emissions throughout the economy.

The Circular Economy Ministerial Advisory Group has been established to guide Australia's transition to a more circular economy, by 2030 (DCCEEW, 2023i). The International Labour Organisation estimated that in working towards a circular economy by 2030, nearly 78 million jobs will be created and almost 71 million destroyed (ILO, 2019), showing the importance of upskilling workforces for a circular economy.

In a circular economy, waste is reduced to a minimum, and materials are recycled when a product reaches the end of its life. By retaining materials in the economy for longer, the use of natural resources can be reduced along with the emissions associated with extraction and processing of raw materials. Shifting to a circular economy would see increased recovery of organic waste, reducing emissions from landfill, but it could also reduce emissions elsewhere in the economy.

For example, in a circular economy plastic waste would be collected, sorted and reprocessed into a source of materials for manufacturing. This would reduce emissions from the extraction and processing of fossil fuels into plastic.

As the electricity sector transitions towards renewable generation and storage, it is also important that manufacturers use recyclable materials where possible, and that there are adequate recycling facilities. One example in Australia is the Lotus Energy solar PV recycling facility (Lotus Energy, 2020). In October 2022, Australia's environment ministers agreed to work with the private sector to design out waste and pollution, keep materials in use and foster markets to achieve a circular economy by 2030 (DCCEEW, 2022i).

In October 2022, Environment Ministers agreed to work towards a more circular economy by expanding the national waste policy action plan and strengthen efforts towards achieving the targets set out in the plan, including the better design, and more efficient production processes (DCCEEW, 2022i). The authority considers that these actions should be consistent with a net-zero emissions future for the waste industry and should give greater focus to diverting organics from landfill.

30. RECOMMENDATION

Work with state and territory governments to update the national waste policy action plan to specify achievable actions to increase the avoidance, recovery and recycling of organic waste across its lifecycle to reduce organic waste going to landfill. These actions should clearly address the barriers limiting the diversion of organic waste from landfill, including government operated landfill sites.

3.7.4.2 *Incentivising greater methane capture from landfill*

The Australian government incentivises landfill gas capture on landfill sites through the ACCU scheme. The ACCU scheme credits emissions reduction from the capture and combustion of methane from landfill and wastewater, and the diversion of waste from landfill. Landfill gas projects have been a significant source of ACCUs with over 35 million issued since 2012, and almost 5 million issued in 2022–2023 (CER, 2023b). Although landfill gas project registrations have grown since 2015, landfill gas capture rates have remained relatively stable since 2017 (DCCEEW, 2023c). Further policy initiatives may be required to achieve higher rates of landfill gas capture

The final report of the independent review of Australian carbon credit units found the landfill gas methods do incentivise the capture of methane at some landfills that would otherwise not occur (Chubb et al, 2022). The review of Australian Carbon Credit Units recommended the project baselines, representing the methane capture that would have occurred due to state and territory regulation, should be adjusted to represent the likely increase in regulatory standards and expectations that methane capture will increase (Chubb et al, 2022). Some stakeholders in the landfill gas industry noted the importance of ACCUs in incentivising landfill gas capture and see a need for expansion of eligible feedstocks under the ACCU scheme biomethane methods, alongside a renewable fuel standard to increase the incentive for the use of biomethane from waste to displace natural gas in hard to abate sectors (Anonymous submission to issues paper consultation).

The authority heard from other stakeholders that crediting landfill gas capture is effectively a subsidy for the landfilling of waste, and that removing this subsidy and mandating landfill gas capture would reflect the true cost of landfilling (Private stakeholder consultation activity). This would increase costs of waste disposal to landfill (Anonymous submission to issues paper consultation) but may also reduce the cost differential between landfill and alternative treatments (Private stakeholder consultation activity).

Given landfill gas capture rates have been relatively stable, strengthening landfill gas capture requirements at the state and territory government level will provide further impetus to increase the level of landfill gas capture. In addition, biocovers can capture methane that is not economic to capture in other ways (as discussed under innovations and developments).

31. RECOMMENDATION

Work with states and territories to require landfill gas capture at all landfill sites where there is sufficient gas flow. Where gas flow is not sufficient, regulation should require other treatment of landfill gas to oxidise methane, such as biocovers.

3.7.5 Policy effectiveness

This is an assessment of the waste sector considering the key emissions reduction policies operating in 2022–23.

Table 3.19: Policy effectiveness in the Waste sector

Aspect	Analysis
Scope	<p>The 2018 national waste policy action plan includes a target to halve the amount of organic waste to landfill by 2030, which if achieved, would also reduce landfill gas emissions. It is primarily a waste reduction strategy, and not an emissions reduction policy.</p> <p>Over 39 million ACCUs have been issued for emissions reductions in the waste sector under the ACCU scheme.</p>
Impact	<p>Waste emissions data reported in the National Inventory show emissions from the waste sector have continued to increase.</p> <p>Organic waste to landfill is increasing. The national waste policy action plan has not led to an absolute reduction in the amount of organic waste to landfill.</p> <p>The number of projects registered under waste emissions methods under the ACCU scheme has increased over time.</p>
Efficiency	<p>The actions set out in the National Waste Policy Action Plan cover actions across all levels of government and are appropriately targeted to achieve greater organics waste diversion. However, three of the five actions originally aimed at reducing organic waste to landfill have been delivered and actions have not been updated to ensure they are appropriately stringent.</p> <p>The Independent review of the ACCU scheme found without the ability to generate credits, some landfill gas projects would not be viable.</p> <p>The food waste for healthy soils fund has supported 25 projects to either build new composting infrastructure or expand existing infrastructure (DCCEEW, 2022k).</p>
Relevance	<p>While actions have been taken, they have not led to enough change, and organic waste to landfill is increasing.</p> <p>Landfill gas capture rates have stayed relatively stable since 2017.</p>
Coherence	<p>The national waste policy provides a framework for collective action by relevant actors until 2030. It engages all levels of government and private entities as well as individuals. The national waste policy adopts emerging international circular economy principles. However, emissions have remained largely stable and organic waste to landfill has increased.</p>
Sustainability	<p>When well implemented, reducing waste to landfill is positive for the society, economy and the environment.</p> <p>The national waste policy action plan recognises the need for compost standards to ensure waste diverted to compost is free from harmful chemicals to avoid contamination of soil.</p>

4 Cross-Cutting issues

Key information about Chapter 4



Carbon markets are poised to play a vital role in realising Australia's net zero ambitions.

As the emphasis in the market for Australian Carbon Credit Units switches from Government purchasing to private demand, driven by the Safeguard Mechanism reforms, ensuring the carbon market is functioning well with high integrity is crucial.



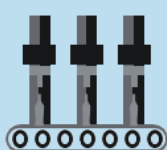
Limiting warming to the Paris Agreement temperature goals will require both deep emissions reductions and an increase in carbon removals from the atmosphere. Time has run out to rely on reductions alone.

Australia needs to better understand its carbon sequestration potential and plan to significantly scale-up deployment of sequestration solutions to support the transition to net zero and ultimately net negative emissions in Australia. Carbon removed from the atmosphere will need to be stored in biological or geological 'sinks,' or used in long-lived products.



Australia should aggressively pursue opportunities for electrification of and improved energy efficiency in the built environment.

There are barriers to overcome to ensure the opportunities and benefits are widely available, including to low-income households, renters and small businesses.



A research, development & demonstration (RD&D) strategy should feature as part of the government's Net Zero Plan.

The technologies and solutions available today will underpin achievement of Australia's 2030 target, while emerging technologies can complete the net zero emissions picture. A RD&D strategy should promote innovation, safeguard competitiveness, and amplify co-operation between the government and private sector, while tracking progress towards goals.



The urgency, scale and importance of the response to climate change calls for much greater involvement of and cooperation and coordination between the Australian and state and territory governments.

A new agreement, or set of agreements, on reducing emissions, climate adaptation and the net zero transition will help drive the outcomes and behaviours Australia needs to be prosperous and resilient in a net zero world.

4.1 Domestic carbon markets

Australia's domestic carbon market is undergoing major change. The Safeguard Mechanism reforms commenced on 1 July 2023. The government has responded to the Independent Review of Australian Carbon Credit Units (ACCU) (Australian Government, 2023c) and is currently implementing the recommendations (DCCEEW, 2023u). The authority is also currently undertaking its review of the ACCU scheme which it is required to complete by the end of the year. Among other issues, the authority's review will build on the Chubb Review and consider the role of the government within the ACCU scheme in its 2023 review of the *Carbon Credits (Carbon Farming Initiative) Act 2011*.

The private sector, particularly facilities covered by the Safeguard Mechanism, will become the primary buyer of Australian carbon credit units (ACCUs) (CER, 2023c). Until recently, the Australian Government was the primary purchaser of ACCUs. The Clean Energy Regulator reported some Safeguard Mechanism entities are accumulating ACCUs, with Safeguard Mechanism account holdings increasing from 2.2 million over the financial year to 3.1 million by 30 June 2023 (CER, 2023c). Intermediaries, such as carbon traders, are also increasing their participation in the market – accounting for 35% of private ACCU holdings indicating potential liquidity of the market in future years (CER, 2023c). The government will continue to purchase under the ACCU scheme including to support the cost containment measure under the Safeguard Mechanism.

The supply of ACCUs in the next several years is forecast to be sufficient to meet expected Safeguard Mechanism compliance demand (CER, 2023c). The amount and type of supply of ACCUs available in the market will be heavily dependent on factors such as price, available methods under the ACCU scheme and available land for sequestration projects. The government also plans to launch the Australian Carbon Exchange in 2024 which will provide a platform for the purchase of ACCUs (CER, 2023i).

The authority's view is that the government should undertake and release analysis as part of its Net Zero Plan that outlines:

- anticipated emissions reductions from each sector in sectoral plans
- demand for offsets and parameters for their use
- potential realisable supply of both biosequestration offsets and geological sequestration.

The authority will support this analysis as part of its work on sectoral pathways. As mentioned in the discussion of the agricultural and land sector in this report (Chapter 3), there is significant pressure on the land sector to supply offsets while farmers must also look to sequestration to address the emissions from their own operations.

The authority has previously called for such analysis as part of a National Carbon Market Strategy (CCA, 2022b). Such a strategy could clarify the role of high integrity domestic and international units in the mix of voluntary and compliance related mitigation action, and help build confidence and trust in the markets that are essential to supporting Australia's transition to net zero.

32. RECOMMENDATION

Develop and publish a National Carbon Market Strategy.

4.2 Sequestration

Time has run out to achieve agreed limits to warming by reducing emissions alone. In addition to the rapid reductions of emissions, deployment of carbon dioxide removal (CDR) technologies is unavoidable if net zero CO₂ or net-zero GHG emissions are to be achieved (IPCC, 2022d). The authority's insights paper on carbon sequestration (CCA, 2023) calls for the scaling up of sequestration in Australia through a portfolio of approaches, as no single technology can achieve the scale of sequestration needed.

4.2.1 What is sequestration?

Carbon sequestration is the capture and storage of CO₂. It can be captured either through removal from the atmosphere (whether through photosynthesis or engineered technologies such as direct air capture (DAC)), or through separation from other gases at the point of origin, such as from industrial smokestacks. Carbon can then be stored in biological materials such as trees, in geological formations, minerals, long-lived products, or oceans (CCA, 2023). While sequestration may be associated with offsetting of carbon emissions, it is essential in itself for the long-term necessity to achieve net negative emissions by the second half of this century through drawdown and storage of carbon dioxide from the atmosphere.

In Australia, demand for sequestration is likely to grow. Not only is the demand for offsets likely to increase as industries such as cement pursue decarbonisation targets (Australian Government, 2021a), but Australia will require sequestration to meet its current emissions reduction targets, including net zero emissions by 2050 (CCA, 2023).

4.2.2 Recent developments

4.2.2.1 *International policy developments*

International support for sequestration has increased substantially in the past year, with a step change in government investment. Some of the most significant developments have been:

- The United States' *Inflation Reduction Act 2022* (IRA) raising the '45Q' tax credit to USD85 per tonne sequestered and to USD180 per tonne for DAC for facilities that meet specific eligibility criteria (The White House, 2023a), while USD2.54 billion has been allocated to the Carbon Capture Demonstration Projects Program (US DoE, n.d.). In August 2023, funding was announced for two DAC facilities which together are intended to remove more than 2 Mt CO₂ a year from the atmosphere, 250 times more than the largest DAC facility currently operating globally (US DoE, 2023).
- The European Union, through its Carbon Removal Certification Framework, proposes to establish a voluntary framework to certify high quality carbon removals and to monitor, report and verify the authenticity of these removals (European Commission, n.d.).
- The private sector is providing significant financial support to meet global sequestration goals. Examples include Microsoft's USD1 billion Climate Innovation Fund and the XPRIZE Foundation's USD100 million Prize for Carbon Removal, which aim to drive both commercialisation and scale (Microsoft, n.d.; XPrize, 2023).

4.2.2.2 *Developments in Australia*

In Australia, 64 Mt CO₂-e was sequestered in the land sector in 2022–23 (unpublished data provided by DCCEEW) (in net terms, see Chapter 3), while in 2020–21 slightly over 2 Mt CO₂-e was sequestered through carbon capture and storage or ‘CCS’ by the Gorgon offshore LNG project in Western Australia (DCCEEW, 2023c). The Gorgon project committed to sequestering at least 80% of the CO₂ from gas processing operations that would otherwise have been vented over the period 2016 to 2021, an amount estimated to total 12.3 Mt CO₂-e (IEEFA, 2022)). However, the project fell well short of this target, reporting a shortfall of 5.23 Mt CO₂-e over the period (Chevron, 2021).

The Department of Climate Change, Energy, the Environment and Water (DCCEEW) has released projections for the rates of sequestration in 2030. If realised, the rate of sequestration would decline to 38 Mt CO₂-e by 2030, comprising net removals of 33 Mt CO₂-e from the land sector and 5 Mt CO₂-e from CCS from the Moomba and Gorgon projects (DCCEEW, 2022a). Even by 2050, Australia is projected to produce around 87 Mt CO₂-e per year of ‘non-technologically abatable’ emissions, indicating an ongoing demand for offsets (Australian Government, 2021a).

A recent report by the CSIRO, commissioned by the authority and the Clean Energy Regulator, provided detailed information on the state of and potential for sequestration in Australia (CSIRO, 2022b). The report found that Australia has good potential to sequester carbon, but that no single technology would be sufficient to deliver sequestration at the necessary scale. A portfolio of approaches will be needed. The report found that Australia’s realisable sequestration potential is unknown as there are substantial knowledge gaps, but that sequestration is a resource limited by inputs such as competition for land, water, energy and capital.

4.2.2.3 *Develop a sophisticated modelling capability on sequestration*

The realisable scale of sequestration in Australia is currently uncertain. Australia needs to rapidly build analytical capabilities, including modelling, to assess its sequestration potential. This analytical capability must take into account factors such as economic and environmental trade-offs in relation to land-use, energy and water availability. This analytical capability could be built through partnerships between government, industry and academia.

33. RECOMMENDATION

Develop a sophisticated modelling capability to analyse and forecast sequestration, for example through a partnership between the government, industry, and academia.

4.2.2.4 *Ramp up investments in long-lived and engineered forms of sequestration*

Significantly more investment is needed in long-lived sequestration. The engineered removal industry is currently in its infancy. Research, development and demonstration (RD&D) projects are needed to enable the rapid scaling up of engineered forms of carbon removal (CCA, 2023). Initiatives like the Future Energy Exports Cooperative Research Centre (Fenex CRC), the CO2CRC and CSIRO's CarbonLock Future Science Platform, are well placed to support the development of engineered sequestration.

The government could help build a market for currently high-cost engineered forms of sequestration by incentivising net-zero and carbon capture-derived products in compliance markets and Commonwealth procurement policies. This could gradually lead to lower costs as market demand increases. The government could also draw on market mechanisms including advance market commitments, contracts for difference and concessional loans to promote engineered sequestration. The authority intends to examine the role of the ACCU scheme in supporting long-lived and engineered forms of sequestration in its review due later this year.

34. RECOMMENDATION

Incentivise the development of long-lived and engineered forms of sequestration by supporting research and development and as technologies develop, through carbon markets or other financial instruments.

4.2.2.5 *Ensure that fossil emissions are increasingly offset by long-lived forms of sequestration*

The authority's insights paper noted that biological and geological sequestration are currently treated as equivalent in carbon markets, where no distinction is made between the carbon credits issued for the sequestration. The insights paper argued that for emissions to be counterbalanced by sequestration, carbon should be stored in a quantity and for a duration equivalent to the nature of the emissions (CCA, 2023). Geological sequestration can last thousands or even millions of years, but the vulnerability of biological sequestration (for example to droughts and bushfires, exacerbated by climate change) means it may only last decades to centuries unless continually renewed (CSIRO, 2022b; IPCC, 2022d).

In addition, where fossil emissions are offset by biological sequestration, the Earth's natural carbon cycles are altered through the transfer of carbon from the geosphere (the inactive geological fossil carbon cycle) to the biosphere, atmosphere and hydrosphere (the active carbon cycle) (Bellona Foundation, 2022). A 2022 study argues that offsetting emissions from fossil fuels in the biosphere at best provides only temporary stabilisation of the global temperature. For long-term climate stability, 'geological net zero' is required, namely, that geological emissions are matched by geological sequestration and biological emissions are matched by biological sequestration (Allen, 2022).

To address these problems, and in line with the Oxford Offsetting Principles and the ISO's Net Zero Guidelines, Australia should increasingly shift towards offsetting fossil fuel emissions in long-lived forms of storage that permanently remove CO₂ from the atmosphere (University of Oxford, 2020; ISO, n.d.). This would be particularly applicable to facilities covered under the Safeguard Mechanism. It means that over time, they would need to increasingly offset their emissions with long-lived, in most instances geological, forms of sequestration.

4.2.2.6 *Address regulatory barriers to enable greater uptake of sequestration*

A range of barriers to the rapid uptake of sequestration currently exists, both domestically and internationally. In the domestic context, engineered forms of sequestration are currently not financially incentivised, such as through the *Carbon Credits (Carbon Farming Initiative) Act 2011*, which only includes sequestration via living biomass, soil, or dead organic matter, and does not cover engineered. This means that engineered technologies are unable to generate funds through the creation of ACCUs. In addition, these technologies are currently not distinctly covered in Australia's national inventory and the IPCC has not developed new reporting guidelines, where CDR could be treated as a distinct category alongside traditional sectoral categories found within greenhouse gas inventories (DCCEEW, 2022g).

The authority's insights paper suggested removals could be a distinct category in national decarbonisation plans, emissions reporting, projections and the authority's annual progress reports (CCA, 2023). There are also opportunities for Australia to work with like-minded countries and the IPCC to update international inventory reporting rules. In relation to onshore and offshore geological storage, legislative and regulatory environments can be complex, including containing duplications, uncertainties, and inconsistencies in the application of state and territory and Commonwealth legislation and regulations. These complexities should be assessed and streamlined to ensure regulatory objectives are achieved while also creating an enabling environment for the deployment of sequestration.

35. RECOMMENDATION

Take a leading role to reduce the domestic and international regulatory barriers preventing the uptake of engineered sequestration and carbon dioxide removal technologies.

4.2.2.7 *Establish separate targets for emissions reduction and removals*

The authority's insights paper argued that carbon dioxide removal (whether by biological or engineered forms) should be a distinct category in national decarbonisation plans, and that separate targets for emissions reduction and removal should be set to incentivise future demand (CCA, 2023). This concept is being discussed around the world. For example, responses to recent public consultation on the European Union's 2040 climate target found that 'most respondents advocated for three separate targets for GHG emission reductions, nature-based carbon removals, and industrial removals' (European Commission, 2023d). Academic research has also highlighted the need to guard against removals being used to delay emissions reductions (McLaren, 2019; Dooley, Nicholls, & Meinshausen, 2022). The authority will continue to work on these issues.



4.2.2.8 *Other measures*

Other measures proposed in the insights paper, which could assist in the rapid growth of sequestration, include:

- Australia should work with like-minded countries and the IPCC on the development of a science-based sequestration taxonomy and terminology, through the development of national standards and international guidelines.
- Sectoral pathways and targets for decarbonisation could help build a more rigorous framework for anticipating future sequestration demand.
- Carbon dioxide removal should be included as a distinct category in national decarbonisation plans, emissions reporting, projections, and the authority's annual progress reports.
- Separate targets for emissions reduction and removal should be set to help incentivise future demand and help guard against sequestration being used to delay emissions reductions.

4.2.3 *Indicators of progress*

Progress on scaling up sequestration in Australia could be measured through the following indicators. The authority will look to report against these in future annual progress reports:

- Annual expenditure on RD&D for engineered sequestration
- Policies to encourage fossil fuel emissions to be offset through geological forms of sequestration, while biological sequestration is increasingly used to offset land-based emissions.



4.3 Electrification of the built environment

4.3.1 Issues, context and trends

Greenhouse gas emissions associated with Australia's built environment, including commercial and residential structures, were 97 Mt CO₂-e in 2020–21, or 21% of Australia's total emissions that year.²³ This figure includes 18 Mt CO₂-e of emissions associated with direct combustion including gas combustion for space and water heating and cooking, and 79 Mt CO₂-e associated with the generation of electricity to supply these buildings.²⁴ The built environment also contributes indirectly to emissions, for example through embedded emissions in purchased materials such as concrete, steel and glass (UNEP, 2022b).

In this section, the authority focuses on the electrification of the built environment as it presents a significant opportunity for decarbonisation towards 2030. The authority will consider the issues relating more broadly to the contribution of the built environment to reducing Australia's emissions in its future work, in particular as one of the sectors in the authority's review of sectoral technology transition and emission pathways.

Decarbonisation of Australia's built environment will depend upon the decarbonisation of electricity supply and electrification to address the emissions associated with gas combustion in buildings. Opportunities for electrification include transition from gas to electricity for heating, hot water and cooking (AEMO, 2023f).

The pace of rooftop solar installations needs to continue to meet modelled outcomes for the high shares of renewables in electricity supply consistent with Australia's emissions reduction targets, and household battery installations need to accelerate. However, the government's subsidy for small scale solar installations (the Small-scale Renewable Energy Scheme) is progressively reducing each year as it moves towards its close in 2030 (CER, 2023k). In the lead up to 2030, incentives will also likely be needed to ensure that small-scale batteries are installed in much greater numbers to assist with grid stability challenges. The government should consider what measures for rooftop solar installations and complementary small-scale battery storage will be required to maintain the required pace of installations.

If Australia follows international trends, buildings will be the location of most of the recharging infrastructure needed for electric vehicles (ChargeUp Europe, 2022; Blonsky, Munankarmi, & Balamurugan, 2021). The roll out of this infrastructure needs to be monitored and supported through the removal of unnecessary regulatory barriers. Technological innovations should be prioritised such as vehicle to grid, where electric vehicles can provide stability to the grid (ARENA, 2021).

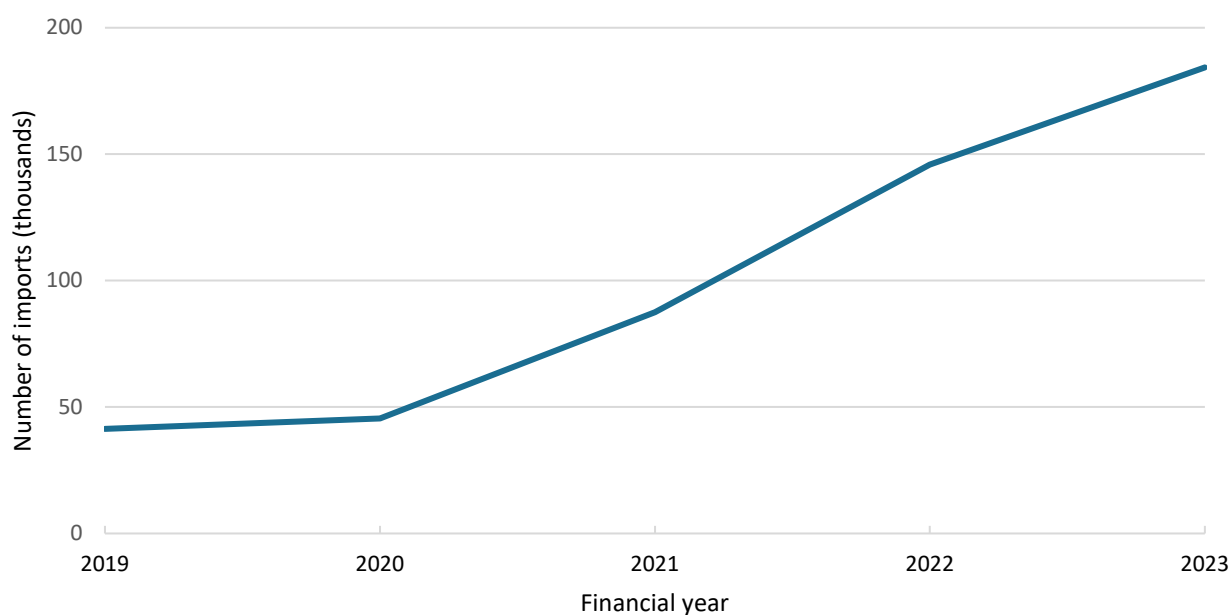
²³ This figure includes emissions from direct fuel combustion under IPCC sectors 1.A.2.g.iv Construction, 1.A.4.a Commercial/Institutional and 1.A.4.b Residential; 2 Mt, 5 Mt and 11 Mt respectively in 2020–21 (DCCEEW, n.d.). This figure also includes emissions relating to the purchase of electricity from ANZSIC economic sectors DIV E Construction, DIV F-H, J-S Commercial Services and Residential; <1 Mt, 37 Mt, and 42 Mt respectively in Data Table 2 (DCCEEW, n.d.). Australia's total emissions in 2020–21 were 465 Mt (DCCEEW, n.d.). This is the latest data available for built environment emissions as this data is not included in the DCCEEW National Greenhouse Gas Inventory: Quarterly updates.

²⁴ See previous footnote.

4.3.2 Leading indicators

Efficient electrification will be essential for the built environment to deliver its fair share of emissions reductions to 2030. Heat pumps (for example to heat water) are a ready technology. Imports of heat pumps have been growing rapidly over the last few years, however from a relatively low base (see Figure 4.1). One of the barriers to accelerated uptake of heat pumps is the difference in cost between gas and electric appliances (Grattan Institute, 2023). Grattan Institute analysis of retail data found that heat pump hot water heaters were approximately \$1,550 more expensive than instantaneous gas hot water heaters (Grattan Institute, 2023).

Figure 4.1: Heat pump imports, 2019–2023



Notes:

- Number of heat pump imports includes domestic heat pump hot water systems and domestic heat pump air conditioners.
- Source: Unpublished ABS data

Submissions suggested leading indicators relevant to electrification, including specific indicators on people changing their gas stoves to electric ones (Individual submission); and solar panels being placed on roofs (Individual submission). GreenPower suggested tracking the number of household and business gas connections. The authority considers that the number of rooftop solar PV installations and numbers of household and business gas connections are important historical indicators, rather than leading indicators.

Other submissions suggested broader themes for indicators, such as household and business decline in gas use (Climate Council), electrification (Australian Conservation Foundation) and increasing energy efficiency (Australian Conservation Foundation, Climate Council). The authority will consider how to use these themes to build on leading indicators for the 2024 Annual Progress Report.

4.3.3 Innovations and developments

4.3.3.1 *Distributed energy resources*

As at 30 June 2023, there was 18,043 MW of small-scale solar PV installed in the NEM under the Small-scale Renewable Energy Scheme.²⁵ It is difficult to find data on actual installed capacity of distributed storage and coordinated DER storage in the NEM as small-scale batteries are not an eligible technology under the Small-scale Renewable Energy Scheme, the main mechanism for data collection on small scale installations. The 2023 AEMO Inputs Assumptions and Scenarios Workbook estimated that in 2022–23 there was 786 MW of embedded small-scale battery storage and 139 MW of aggregated (e.g., in a Virtual Power Plant) small-scale battery storage in the NEM (AEMO, 2023j).

Distributed energy resources such as rooftop solar PV units, battery storage, electric vehicles and chargers and smart meters are changing Australia's electricity grid. ARENA has noted that 'rather than electricity being generated by big, centralised power stations, it is now starting to come from many places, including millions of homes and businesses' (ARENA, 2023b). ARENA is providing over \$18 million in funding across seven current distributed energy resources projects. These include the Smart CER Consumer Uptake Tool project which commenced during 2022–23, to develop an online consumer Smart Energy Tool to provide households with an economic assessment of DER options (ARENA, 2023d); (ARENA, 2023e).

ARENA is also investing in demand response projects to help facilitate the voluntary reduction or shift of electricity use by customers to support grid stability, including providing \$16.5 million across four current projects which commenced in 2022–23 (ARENA, 2023a); (ARENA, 2023d). ARENA should continue to support DER and demand response projects as more DER resources enter the grid. The Clean Energy Finance Corporation has been allocated an additional \$19 billion to help deliver the Rewiring the Nation program, with investments expected to include distributed energy resources (CEFC, 2023c).

In developing the National Energy Performance Strategy, the government should have regard to AEMO's Integrated system Plan and coordinate with AEMO, ARENA and CSIRO to incentivise the best mix of distributed energy resources for a stable grid. The Strategy should also support continued investment in distributed energy resources and demand response.

The submission from Greenpower suggested the 'Australian Government could provide funding for significant public awareness and education campaigns which highlight some of the most impactful practical actions that households and businesses can take to reduce their carbon footprint and save money', including as examples, installing rooftop solar, buying or leasing an electric vehicle, and insulating and electrifying homes and businesses. In the authority's view, the National Energy Performance Strategy could also include education campaigns about electrification and load shifting.

²⁵ Calculated by adding the installed capacity in the Australian Capital Territory, New South Wales, Queensland, Tasmania, South Australia and Victoria in the CER Postcode data for small-scale installations (CER, 2023c).

4.3.3.2 *Data gaps*

Electrification opportunities for the built environment include the installation of heat pumps and solar water heaters, rooftop PV and batteries and electric vehicle chargers. Heat pumps, solar water heaters and rooftop PV are eligible technologies under the Small-scale Renewable Energy Scheme (CER, 2023k). Under this scheme, the Clean Energy Regulator collects and publishes monthly installation numbers for eligible technologies, and monthly installed capacity in kilowatts for rooftop solar. Data is available from 2001 onwards and is disaggregated by postcode. The Clean Energy Regulator does not collect or publish data on installations by electricity grid.²⁶ An additional limitation on this data is that the Small-scale Renewable Energy Scheme is planned to end in 2030 (CER, 2023k), which presumably will halt data collection for eligible technologies.

Tracking the progress of household batteries and electric vehicle chargers is more challenging as these are not eligible technologies under the Small-scale Renewable Energy Scheme. The Clean Energy Regulator provides data on the number of rooftop PV installations under the Small-scale Renewable Energy Scheme which include a battery (CER, 2023e). Battery data is reported to the Clean Energy Regulator on a voluntary basis, typically when eligible Small-scale Renewable Energy Scheme installations occur. The Clean Energy Regulator does not collect or publish data on the installed capacity of household batteries, or numbers of electric vehicle charger installations.

The National Energy Performance Strategy consultation paper states that meeting the future needs of the energy market requires strengthening the role of demand-side considerations in energy system planning (DCCEE, 2022h). Improved data collection and reporting for distributed energy resources would assist AEMO in modelling energy demand and developing system plans. For example, expanding the scheme to include household batteries or electric vehicle chargers would incentivise the installation of these technologies and facilitate data collection on their installation and capacity numbers. Continued and more detailed data collection would also provide important information to the government in tracking progress towards the 2030 emissions reduction target.

4.3.3.3 *Heat pump and solar water heater installations*

In 2022–23, 110,000 air source heat pumps were installed in Australia that were eligible to generate certificates under the Small-scale Renewable Energy Scheme, a significant increase from 71,880 installed in 2021–22 (CER, 2023c). Only 30,476 solar water heaters were installed in 2022–23²⁷ (CER, 2023j) down from 36,360 in 2021–22 (CER, 2021).

System owners typically assign the right to sell small-scale technology certificates on their behalf to an agent (i.e. their installer) in return for a lower upfront purchase price (CER, 2023k). The upfront financial benefit received is generally based on the market price of the small-scale technology certificates at the time of installation (CER, 2019), which was \$37.10 per small-scale technology certificates on 5 October 2023 (Greenbank, 2023). This benefit could equate to a reduction of approximately \$864 on the price of a heat pump hot water heater (SolarHub, 2023).

Some state and territory governments have also offered rebates for the installation of heat pumps and solar hot water systems. For example, the Victorian Government offers owner-occupiers a rebate of up to \$1,000 on eligible heat pumps and solar hot water systems (Victorian Government, 2023a). The New South Wales Government Energy Savings Scheme also incentivises hot water system upgrades (NSW Government, 2023d).

²⁶ Postcode data can be used to disaggregate installations by grid, by correlating postcodes with maps of electricity grids, however this is a time-consuming process.

²⁷ CER website data for small-scale installations is current as at 31 August 2023.

Even with discounted costs, it may be difficult for low-income households to afford the installation cost of these technologies. Two additional components of the cost of transitioning away from gas appliances include fees to disconnect or remove a gas connection, and the potential cost of upgrading to three-phase power due to the increased electricity load (Grattan Institute, 2023). Costs for abolishing gas supply vary, for example \$770–\$800 in the Australian Capital Territory, and approximately \$1,150 in New South Wales (ACT Government, 2023b); (Jemena, 2023). The Australian Energy Regulator issued a decision in June 2023 to cap certain gas abolishment tariffs over the 2023–28 period in Victoria (AER, 2023b). Renters can also face the barrier of not having permission to electrify certain appliances.

4.3.3.4 Rooftop solar photovoltaic (PV) and batteries

In 2022–23 3,046 MW of small-scale solar was installed in Australia²⁸ (CER, 2023c). Of the small-scale solar systems installed in the 2022 calendar year, approximately 7% included battery storage (CER, 2023d); for the calendar year up to 30 June, 2023, this figure amounted to only 2% (CER, 2023e). A scenario modelled by AEMO of greater than 80% renewable energy generation indicates the quantity of small-scale solar and battery storage needed to be deployed on average per year to 2030 (Table 4.1). This scenario shows that, approximately one MW of small-scale battery storage is needed for every 3 MW of rooftop PV installed in the NEM by 2030²⁹ (AEMO, 2022g).

Table 4.1: Installed rooftop solar PV in the NEM, MW

	Total capacity in June 2022	Capacity required by June 2030	Annual increase required to 2030	Increase in capacity in 2022–23	Difference between required and actual increase
Rooftop solar PV	15,410	30,396	1,873	2,632	+759

Source: (AEMO, 2022g); (CER, 2023j).

The 2022–23 GenCost report noted that the COVID-19 pandemic has led to higher capital costs for all technologies considered (including rooftop solar PV) (CSIRO, 2023d). The Small-scale Renewable Energy Scheme discount could equate to a reduction of up to \$408 per kW³⁰ in a moderately sunny area of Australia (Greenbank, 2023). However, the total subsidy provided by the Small-scale Renewable Energy Scheme will reduce towards 2030 as the number of years during which a system can generate small-scale technology certificates will diminish under the rules of the scheme.

The Guarantee of Origin Scheme, if enacted, would operate past 2030 and in the lead up to 2030, would operate alongside the Renewable Energy Target (Australian Government, 2022d). Eligible participants could generate a tradable certificate representing one megawatt hour of eligible renewable electricity generation (Australian Government, 2022d). However, it is unclear how certificates would be priced by the market, and whether the scheme would offer the same reduction in upfront cost as the Small-scale Renewable Energy Scheme.

²⁸ Calculated by adding the installed capacity in NEM postcodes.

²⁹ The Rooftop PV sheet of AEMO's Inputs assumptions and scenarios workbook shows 30 gigawatts (GW) of rooftop PV installed cumulatively across NEM states by 2030 under the 'Step Change' scenario, and the Embedded energy storage sheet shows 9 GW of small-scale batteries in 2030 under the same scenario.

³⁰ Based on an installation date of 1 October 2023, system capacity of 1 kW, postcode of 2601 and small-scale technology certificate price of \$37.10. According to the Greenbank calculator, this would equate to 11 small-scale technology certificates.

The authority is of the view that the government should consider extending the Small-scale Renewable Energy Scheme deeming period past 2030 and expanding the types of technologies eligible for support. If the scheme is extended past 2030, the authority considers that it would be useful for data to be collected on installations by grid as well as by postcode to help track the decarbonisation of each grid. Expanding eligible technologies to include household batteries and electric vehicle chargers would incentivise their deployment and provide valuable data on the roll-out of these technologies.

36. RECOMMENDATION

Extend the Small-scale Renewable Energy Scheme post-2030 to ensure continued support for electrification and expand the scheme to include household batteries and private electric vehicle chargers.

If the Small-scale Renewable Energy Scheme ends as planned in 2030, the government should consider alternative options to continue incentivising small-scale installations and maintaining safety and quality standards. For example, expanding the Community Battery scheme and Solar Banks program discussed below or developing new incentives.

Even with discounted costs under the Small-scale Renewable Energy Scheme, it may be difficult for all stakeholders to have equitable access to rooftop PV. Barriers identified in First Nations consultations included lack of access to rooftop solar for renters, housing standards (as some dwellings could not support rooftop solar), lack of information on diesel subsidies making it difficult to make an informed decision about switching to solar and a lack of a skilled workforce in remote areas for installing and maintaining systems. First Nations stakeholders suggested a mandate for government to support rooftop solar on social housing and ensure that tenants benefit from rooftop solar as well. The submission from the Committee for Sydney recommended mechanisms to encourage property owners to install rooftop solar in rented properties, expanding solar for low-income housing and updating strata rules to make it easier to install apartment solar systems.

The authority is of the view that the National Energy Performance Strategy should give particular consideration to supporting low-income households, renters, public housing tenants, apartments and regional, remote and First Nations communities.

4.3.3.5 *Electric vehicle charging*

Chapter 3, Electricity provides commentary on the growth of publicly available electric vehicle chargers. However, private vehicle chargers (such as household chargers) will be an important part of the infrastructure required for electric vehicles. Over 80% of charging in the European Union and in the United States of America occurs at home or at work (ChargeUp Europe, 2022; Blonsky, Munankarmi, & Balamurugan, 2021) and a similar trend might be expected in Australia. There are currently no statistics for private charger installations in Australia despite their role in supporting the transition to electric vehicles and effect on grid stability (CSIRO, 2022a). Understanding the numbers, location and speed of private vehicle chargers will be relevant for managing the grid in the future (AEMO, 2021b). As more behind-the-meter solar PV is installed, and more batteries and electric vehicles charge and discharge, the demand profiles for grid-supplied energy shifts (AEMO, 2022a). For example, if electric vehicles are charged during the day, they could potentially store excess solar generation, while charging at night would increase evening peaks (AEMO, 2022a).

If the recommendation to extend and expand the Small-scale Renewable Energy Scheme is adopted, installation numbers would be reported to the Clean Energy Regulator and published. If this recommendation is not adopted, the authority recommends the government establish methods to track figures instead under the Electric Vehicle Strategy, to inform the metrics to monitor the progress of charging infrastructure.

37. RECOMMENDATION

Establish methods to track the numbers, locations and speed of private electric vehicle charger installations, to inform metrics on the successful roll-out of charging infrastructure. The government should publish these figures each year, and ensure the data is available to AEMO for grid management purposes.

The National Electric Vehicle Strategy indicates that the government will undertake research to inform and enable electric vehicle uptake for residents of existing multi-residential buildings (DCCEEW, 2023e). This research should be complemented by actions to track private charger installations and to identify and remove barriers to the roll out.

4.3.4 Policy opportunities and recommendations

4.3.4.1 *Energy performance*

The government is investing \$15.2 million to develop a Commonwealth-led National Energy Performance Strategy (DCCEEW, 2023bb). The Strategy will provide a national plan to accelerate demand-side action, including energy efficiency and electrification (DCCEEW, 2023bb). The National Energy Performance Strategy Consultation Paper released in November 2022 anticipated that the Strategy would be delivered in mid-2023 (DCCEEW, 2022h). As at 10 October 2023 the Strategy has not been released.

In the authority's view, the Strategy should provide a framework for action that encompasses the electrification of the built environment, behaviour change, load shifting and energy efficiency. The authority recently advised, in its submission to the Fuel Efficiency Standards consultation, that the impacts of an increase in transport electrification be considered in energy transition policy development processes, such as the post-2025 electricity market design project and the development of the National Energy Performance Strategy.

4.3.4.2 *Electrification*

Many submissions supported measures for the uptake of electrification technology in residential or commercial buildings (Australian Energy Council, EnergyAustralia, Committee for Sydney, Australian Conservation Foundation, Beyond Zero Emissions, Doctors for the Environment, Grattan Institute, Council of Capital City Lord Mayors, individuals) such as water heating, cooking, space heating, cooling, electric vehicle charging, rooftop solar and distributed battery storage. Several submissions supported incentives to decrease the upfront installation costs of electric appliances (EnergyAustralia, Australian Institute of Landscape Architects).

The authority has provided commentary on the Small-scale Renewable Energy scheme above, which is currently the most significant mechanism to encourage electrification through the installation of heat pumps, solar hot water heaters and rooftop solar PV.

In the May 2023 budget, the government announced \$1.3 billion in funding for a Household Energy Upgrades Fund to support home upgrades that would improve energy performance and save energy (Treasury, 2023a). This included \$1 billion for the Clean Energy Finance Corporation to provide low-interest loans for energy-saving home upgrades (Treasury, 2023a). The Household Energy Upgrades Fund also includes \$300 million to support upgrades to social housing (Treasury, 2023a).

The government has committed \$200 million for the Community Battery scheme to 'deploy 400 community-scale batteries for up to 100,000 Australian households' (DCCEEW, 2022f).

In 2022, the government announced the Community Solar Banks program with investments of \$102 million targeting 25,000 recipients living in apartments, rental accommodation or low-income households (DCCEEW, 2022f). At June 2022, there were 418,400 households in the four main social housing programs: public housing, community housing, Indigenous community housing and state-owned and managed Indigenous housing (AIHW, 2023). The Community Solar Banks program would need to be scaled up significantly to ensure access to the benefits of rooftop solar for residents in public housing alone.

Stakeholders expressed support for government measures to electrify social, community and Indigenous housing (Grattan Institute, Doctors for the Environment, Committee for Sydney). Some submissions specifically noted difficulties for renters or low-income households to shift away from gas (Brotherhood of St Laurence, Beyond Zero Emissions, Melbourne Climate Futures). Submissions recommended introducing tax incentives for landlords (Grattan Institute), or more generally, actions towards landlords and investors so renters don't miss out (Melbourne Climate Futures).

The authority is of the view that the National Energy Performance Strategy should give particular consideration to supporting low-income households, renters, public housing tenants, apartments and regional, remote and First Nations communities.

4.3.4.3 Energy efficiency and affordability

The cost of energy is increasing. To protect customers from high energy prices, the Australian Energy Regulator (AER) has maintained a default market offer since 2019, which acts as a safety-net price cap (AER, 2023a). However, the default market offer must be set to allow retailers to cover their costs. As a result, residential customers in Queensland, New South Wales and South Australia on standard plans could still face price increases of between 19.6% to 24.9% in the next financial year (AER, 2023a). Victoria's regulator has also proposed an increase of around 25% for customers on default offers, with typical bills increasing from \$1,403 to around \$1,829 per year (Essential Services Commission, 2023).

Rising energy bills disproportionality impact low-income households with those in the National Energy Market consistently paying approximately double what an average income household pays as a proportion of household income (AER, 2022). The rising cost of energy and overall cost of living has contributed to one in five Australians surveyed by the Melbourne Institute reporting not being able to afford to adequately use their heating or cooling, with the disadvantage being more pronounced for those who are financially stressed. Further, 12% reported having skipped a meal or eaten less to be able to pay their energy bills (Melbourne Institute: Applied Economic & Social Research, 2023).

The implications of rising costs of energy consumption are increased by energy inefficient housing. Several submissions to the authority's issues paper (Planning Institute of Australia, Greenpeace Australia Pacific, Joint submission from 19 built environment peak bodies, Council of Capital City Lord Mayors, Australian Institute of Landscape Architects) recognised this and supported further investment in energy efficiency measures, or energy saving mechanisms (ARENA, the Australian Conservation Foundation). The Energy Efficiency Council indicated that energy efficiency opportunities are available for immediate deployment. However, there are persistent barriers preventing a market and/or regulatory environment that improves the energy performance of Australia's residential building stock. Key barriers include:

- a lack of data on a home's energy performance
- market environment for energy efficiency options
- access to energy efficiency options.

4.3.4.4 Lack of data on a home energy's performance

Most home occupiers are not equipped with information on the energy performance of their home, which includes information on their appliances and the thermal shell of their home. As part of the National Household Energy Rating Scheme (NatHERS) energy performance ratings for 15,658 class 1 homes has been recorded (as of 5 October 2023). It is important to note that, 97% these homes were in Victoria. The average energy performance rating for homes within the NatHERS database is a very low score of 2.2 NatHERS stars out of 10 (CSIRO, 2023b). This indicates very poor energy performance for the homes included in the database.

At the national scale there is little to no information on the performance of the 6 million class 1 dwellings built prior to the introduction of minimum energy efficiency standards 2003 (NatHERS, 2022). Updates to the National Construction Code in 2022 included a requirement that all new homes have a minimum star rating of 7 (ABCB, 2022).

There have been regulatory challenges that have driven this data gap. In 2009, the Council of Australian Governments agreed to phase in mandatory disclosure of residential building energy performance at the point of sale or lease (COAG, 2009). As of October 2023, this had not been implemented. Another challenge is technical; there is currently no NatHERS-accredited tool to rate existing homes. In May 2023, the Australian Government announced \$36.7 million in funding to deliver NatHERS-accredited ratings for existing homes (Australian Government, 2023d). This is a promising development and the authority will monitor the implementation of the commitment.

Disclosing energy performance information is not likely to deliver notable energy efficiency improvements on its own. A market environment for energy efficiency upgrades must accompany this information to motivate home occupiers to invest in energy performance.

4.3.4.5 Market environment for energy efficient upgrades

The upfront cost of investment in energy performance is a challenge for many property owners. Exemplifying this, Sustainability Victoria found that an average energy efficiency upgrade cost of \$2,809 reduced a household's energy cost by approximately \$87 over the measured winter period and a modelled cost of \$124 over a calendar year (Sustainability Victoria, 2022), resulting in an estimated 22.6-year payback period. However, electricity and natural gas prices along with cost-of-living increases are shifting the economics of decarbonisation options and make the issue of energy affordability a top priority in the short term (AER, 2022).

4.3.4.6 Access to energy efficient upgrades

The 31% of Australians that rent their home face barriers to accessing energy efficiency improvements and are likely to live in energy inefficient homes (ABS, 2022c) (O'Neill, 2020). Renters are largely unable to replace fixtures and fittings or the thermal shell without landlord permission, and a split-incentive exists in which renters are unlikely to be tenanted a property long enough to recoup expenditure on energy efficient upgrades. Landlords are unlikely to experience material benefits from energy efficient upgrades and, aside from minimum requirements in the Australian Capital Territory (ACT Government, 2023c) and Victoria (Consumer Affairs Victoria, 2023), are not required to invest in upgrades to property energy performance to lease a property. Providing tax incentives to landlords to invest in energy efficient upgrades was suggested by the Grattan Institute in response to the authority's issues paper.

Poor energy performance producing unhealthily cold homes is a prevalent issue for Australia's renters. In a 2022 study, 74 rental properties, tracked using smart thermometers, failed to reach the World Health Organisation's recommendation of a minimum 18°C indoor temperature to protect health during 75% of a recorded winter period (Dignam & Barrett, 2022). This problem is not just impacting renters; another study of 100 homes between June and August 2022 found that 81% of the homes surveyed failed to meet an 18°C average indoor temperature (Barlow, Daniel, & Baker, 2023).

38. RECOMMENDATION

Implement policies to increase the accessibility of electrification options. This includes, for example, through provision of zero interest financing to reduce up-front costs and provision of funding for public and Indigenous housing to convert to all-electric.



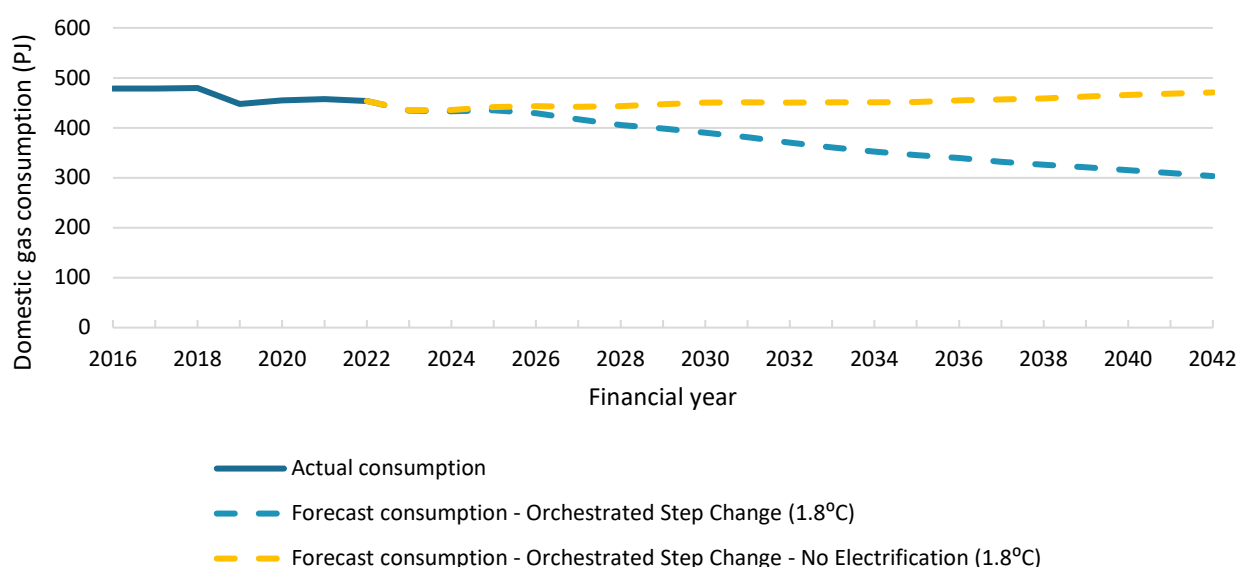
4.3.4.7 The role of gas

Chapter 3 – Electricity provides commentary on the role of gas in the National Electricity Market and the importance of maintaining adequate domestic supply.

According to AEMO, there were 4,691,013 household and commercial gas connections in the NEM in 2020–21. AEMO modelling of a scenario most closely aligned with the 82% renewable energy target includes the removal of 801,548 gas connections by 2029–30 (AEMO, 2023k). This equates to the electrification of 89,061 connections per year. AEMO revised forecasts of residential and commercial gas consumption due to a slower pace of electrification than was previously forecast in the 2022 Gas Statement of Opportunities (AEMO, 2023f).

AEMO’s 2023 Gas Statement of Opportunities notes the uncertainties in the speed and extent of gas sector transformation and uses scenarios and sensitivities to explore the needs of gas consumers and the adequacy of gas infrastructure to meet those needs (AEMO, 2023f). Figure 4.2 below shows the forecast of domestic gas consumption under the Orchestrated Step Change (1.8°C) scenario (the scenario most closely aligned to the Step Change scenario), and the Orchestrated Step Change (1.8°C), No Electrification scenario assumes a halt on electrification (AEMO, 2023f). A clear phase out of new connections and plans for the electrification of existing connections would provide more certainty on future demand for generators and the market operator in anticipating domestic gas consumption needs.

Figure 4.2: Domestic gas consumption, 2019–2042



Source: (AEMO, 2023k)

State governments have taken different approaches to phasing out gas. For example, the Australian Capital Territory Government’s *Climate Change and Greenhouse Gas Reduction Act 2010* (ACT) was amended in June 2023 to prohibit gas distributors from providing new gas connections for natural gas (see Section 13A(1)). This Act includes setting targets to reduce greenhouse gas emissions in the Australian Capital Territory as one of its objects in Section 5 and implements measures to meet these targets. In July 2023, the Victorian Government announced that from 1 January 2024, new homes and subdivisions requiring a planning permit will only be able to connect to electric networks (Victorian Government, 2023b), drawing on the role of states and territories in the planning and permitting of buildings.

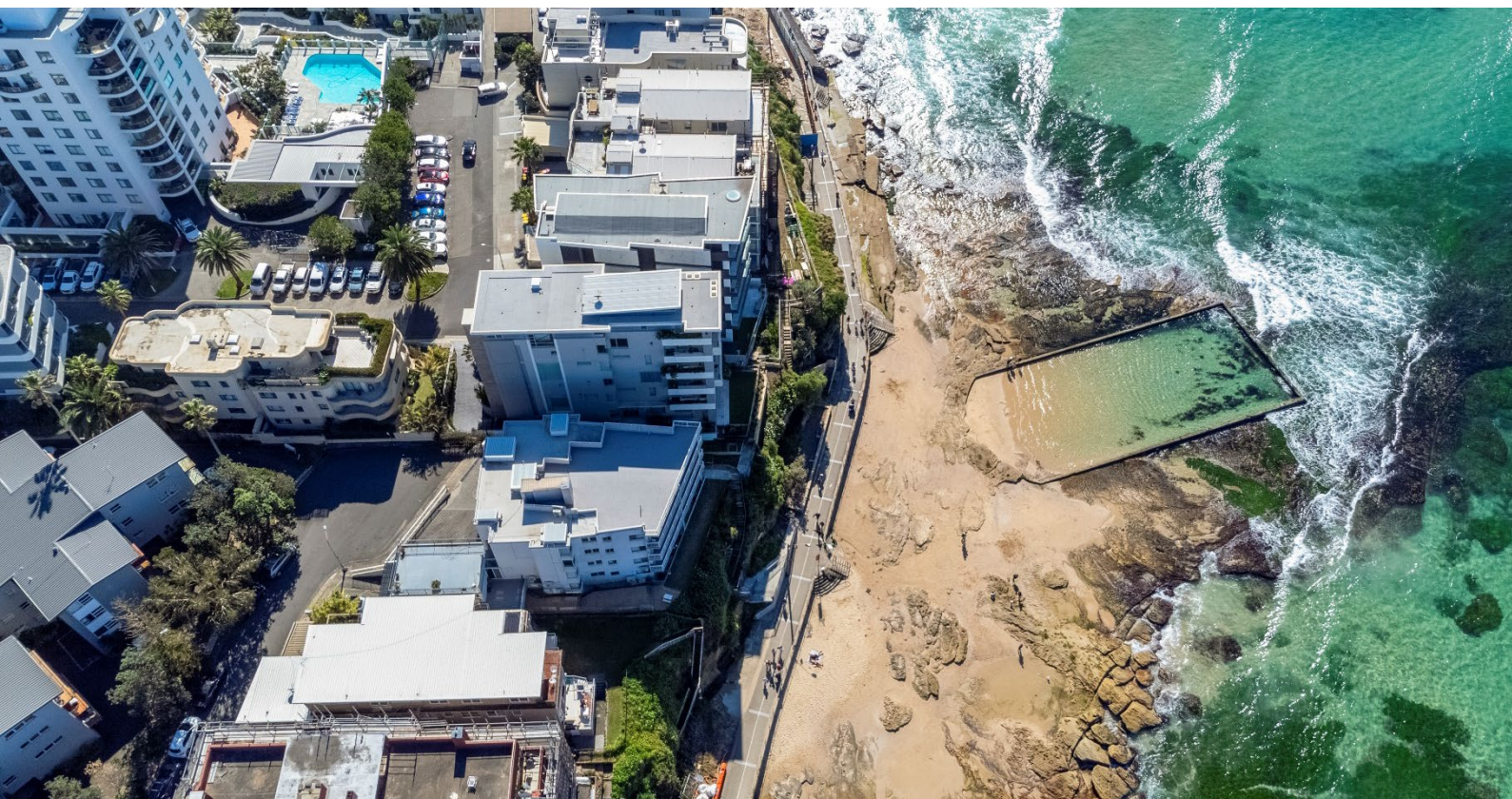
The City of Sydney has passed a motion requesting the Council’s CEO investigate the opportunities and challenges with amending the City of Sydney’s planning controls to require all new residential developments to be all electric, and report back to Council (City of Sydney Council, 2023). Several submissions supported banning new gas connections (Grattan Institute, Planning Institute of Australia, Greenpeace Australia Pacific, Australian Institute of Landscape Architects) or setting dates for banning connections in new buildings (Committee for Sydney).

The authority is of the view that the phase out of gas should be coordinated between the Australian Government and state and territory governments. Where states and territories do not take action to set clear dates on gas phase-out, it is likely that local Councils will take on this role leading to an inconsistent approach.

39. RECOMMENDATION

Work with state and territory governments to agree on a coordinated, nationally consistent approach to phasing out new gas connections for residential and small commercial buildings and phase-out of existing gas connections.

Some submissions further supported phasing out or banning the sale of gas appliances (Grattan Institute, Australian Institute of Landscape Architects, Committee for Sydney). The authority is of the view that there are still significant barriers for some households in transitioning from gas to electric appliances. The authority has made a recommendation above supporting mechanisms to increase the accessibility of electrification opportunities.



4.3.4.8 *Electric vehicle charging infrastructure*

There are opportunities to improve the regulation of electric vehicle charging infrastructure for which the Australian Government could coordinate a national approach. States and territories have differing service and installation rules (EVC, 2022a) (EVC, 2022a), allowing different amp and phase chargers to be installed. It would be beneficial to have a clear and consistent approach to charging installations nationally where possible.

Certain electric vehicle chargers can return electricity back to the grid when paired with a compatible vehicle (vehicle to grid technology). This technology has the ability to deliver lower priced charging, reduced residential electricity costs to electric vehicle users and support stability of the electricity grid (ARENA, 2023c; ARENA, 2021). In 2022–23, South Australia became the first jurisdiction to approve this technology across pilot sites (SA Power Networks, 2022). Appropriate national regulation for this technology could help increase the uptake rate of vehicle to grid chargers and increase the interest from car manufacturers to incorporate the technology into a wider range of vehicles. The authority received 2 submissions (EnergyAustralia, individual) that discussed the benefits of emerging technology like bidirectional electric vehicle charging (Vehicle to Grid or Vehicle to Load) and smart charging.

4.3.4.9 *Private electric vehicle charging and multi-dwelling housing*

The transition to electric vehicles may be held back by barriers to the roll out of private electric vehicle chargers including homes with no off-street parking, dwellings that require strata approval (e.g. apartment buildings) and the lack of incentives for chargers to be installed in rental properties (ARENA, 2022b).

There is anecdotal evidence of barriers to installing electric vehicle chargers in buildings with strata or owners corporation arrangements (Sydney Morning Herald, 2022) (Terzon, 2022), and homes with no off-street parking (The Age, 2022). Updates to the National Construction Code in 2023 to make new buildings ready for electric vehicle charging (Australian Building Codes Board, 2023) is a welcome announcement, but more work is needed to remove barriers for existing buildings (Sydney Morning Herald, 2023) (Bleby, 2023). The authority also received submissions (Planning Institute of Australia, individual) that discussed the need for policies to increase charging access in offices, multi-unit housing and for renters.

There are still some safety concerns about charging electric vehicles in large apartment blocks in the rare instance there is a fire (strata community association, 2023). Fire and Rescue NSW is currently leading a collaborative research program on the Safety of Alternative and Renewable Energy Technologies (Fire and Rescue NSW, 2023). Relevant learnings from this research could be incorporated into clear national advice on safety protocols for buildings with strata or owners corporation arrangements.

40. RECOMMENDATION

Identify and remove barriers to installing private vehicle chargers and vehicle-to-grid capability, while ensuring building codes adequately mitigate safety risks.

4.4 Sustainable finance and corporate action

4.4.1 Corporate action and sustainable finance

Corporate action is crucial to shift investment away from high-emitting sectors and projects, and towards growing net-zero-aligned industries (World Economic Forum, 2022). This includes:

- improving how corporations understand, manage, value and disclose climate-related risks
- standardising how corporations measure and report their emissions
- aligning domestic practices with international standards to build long-term, sustainable trading relationships
- ensuring corporations deliver on their public commitments and comply with new standards and regulations.

4.4.2 Disclosure regime developments

In June 2023, the Australian Government released its second consultation paper on the design and implementation of the Government's commitment to standardised, internationally-aligned requirements for disclosure of climate-related financial risks and opportunities in Australia (Treasury, 2023c). The consultation paper proposed a phased approach, which by 2027–28 would require entities that lodge financial reports under Chapter 2M of the *Corporations Act 2001* to make climate-related financial disclosures if two of the following criteria are met:

- the consolidated revenue of the company for the financial year and any entities it controls is \$50 million or more
- the value of the consolidated gross assets at the end of the financial year of the company and any entities it controls is \$25 million or more, or
- the company and any entities it controls have 100 or more employees at the end of the financial year.

The disclosure regime will be finalised following the release of draft legislation and the release of the final International Sustainability Standards Board framework (Treasury, 2023c).

4.4.3 Net Zero claims

Alongside mandatory disclosure regimes, there is increasing guidance available on substantiating net zero claims. For example, in 2022 the United Nations' High Level Expert Group on Net Zero Emissions of Non-State Entities (UN, 2022b) launched a report into net zero commitments by businesses, financial institutions, cities and regions, which set out ten recommendations focusing on establishing standards of integrity, transparency and accountability for pledging, planning and transitioning to net zero.

Some Australian corporates are engaging in voluntary verification of their net zero plans through the Corporate Emissions Reduction Transparency (CERT). The CERT has participants from a broad cross-section of the economy, and participating companies represented 21% of scope 1 emissions and 8% of scope 2 emissions in the 2021–22 financial year (CER, 2023I).

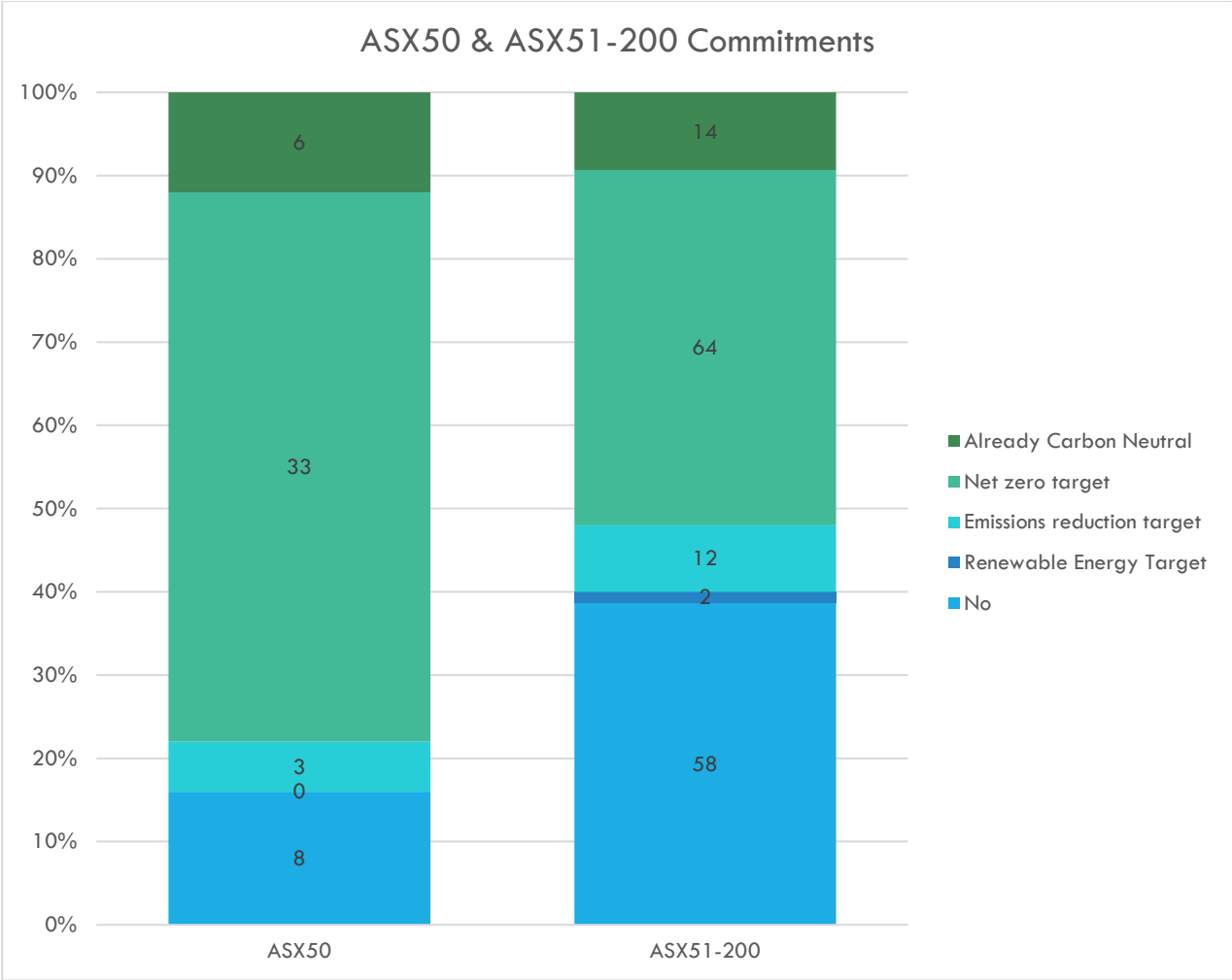
There are a growing number of Australian entities committing to net zero emissions, carbon neutrality and other kinds of climate commitments and targets. The authority's research indicates that as at July 2023, 97 companies in the ASX200 have net zero targets that capture scope 1 and 2 emissions, and 20 report they are carbon neutral (Figure 4.3). This is an increase from Climateworks' findings of 84 out of 187 ASX200 companies reporting net zero scope 1 and 2 emissions targets in December 2022 (Climateworks, 2022), and ASCI's findings of 49 ASX200 companies reporting these targets in August 2021 (ACSI, 2021). However, over 35% of ASX200 listed corporations with net zero targets or carbon neutral status are in the software, communications, financial services, or real estate investment trusts (REITs) sectors. Corporations within these sectors typically have lower scope 1 and 2 emissions when compared to Australia's highest emitters, but have potentially significant scope 3 emissions as a result of upstream and downstream activities along value chains that are not captured in net zero scope 1 and 2 emission targets (Klaaßen & Stoll, 2021).

The credibility of these commitments and claims has been questioned by several experts and research groups. Climate Action 100+ noted that net zero targets are not often supported by strategies to deliver them, with only 19% of assessed companies quantifying key elements of their decarbonisation strategies with respect to the major sources of their emissions (Climate Action 100+, 2022). Policies, frameworks and regulations are needed to ensure that markets can trust the commitments and claims of corporations, and that those companies who are delivering on their commitments are not unfairly disadvantaged by the lack of integrity of claims made by others.

More transparent reporting on climate transition plans and emissions would help to improve corporate accountability and investor confidence. Enhanced corporate ambition in line with Treasury's proposed climate-related financial risk disclosure policy would improve the clarity and robustness of corporate commitments.



Figure 4.3: Proportion of ASX50 and ASX51–200 companies with net zero commitment as of end of 2022–23 Financial Year



Source: Climate Change Authority analysis. ASX200 as of June 30, 2023. Net zero commitments retrieved from publicly available company documents. Net zero target defined as a target of net zero scope 1 and 2 emissions.

4.4.4 Sustainable finance

The government has taken a positive step in supporting scalable sustainable finance architecture, committing \$1.6 million in 2023–24 to support the initial development of a sustainable finance taxonomy in partnership with the Australian Sustainable Futures Institute (ASFI) (The Treasurer, 2023) (Treasury, 2023a). Sustainable finance taxonomies are important tools for market transparency and the development of sustainable assets. These can provide a set of common definitions and criteria that enable a shared understanding between investors, companies, government and other stakeholders of what economic activity is considered sustainable and in support of the transition to net zero (CCA, 2021). When appropriately designed, sustainable finance taxonomies can facilitate investment and supporting policy action and enable easier tracking of sustainable finance flows (OECD, 2020).

Internationally there is growing standardisation of green taxonomies (OECD, 2020), including through platforms such as International Platform on Sustainable Finance (IPSF) which aims to exchange best practice approaches and enhance international coordination where appropriate (European Commission, 2021). Australia is not a member of the IPSF. However, the design of Australia's taxonomy will need to account for shared understanding internationally to take advantage of cross-border financial opportunities.

The government has also committed \$8.3 million over four years from 2023–24 to establish a sovereign green bond program, to raise capital for environmental and climate change related programs, although insufficient detail has been published on the design of the program to enable the Authority to evaluate its effectiveness in this report (Treasury, 2023a). The Australian green bond market is small but is growing quickly. In the first half of 2023 approximately \$13 billion in green bonds were issued, which is higher than the annual amount of any previous year on record. Green bonds are also important drivers of Australia's net zero transition; proceeds from Green Bonds have been used to fund over \$50 billion in clean transport, energy efficiency, green buildings and climate change adaptation projects (Armour, Hunt, & Lwin, 2023). The CEFC has been heavily involved Australia's green bond market to date, investing more than \$900 million in green bonds across its first decade of investment, which have raised almost \$6 billion in investment (CEFC, 2023a).

The CEFC's role was expanded in June 2023 with the government allocating an additional \$20.5 billion to it for three programs: the Rewiring the Nation program, the Household Energy Upgrades Fund and the Powering Australia Technology program (CEFC, 2023d). This is on the back of private sector leverage for CEFC investment commitments reaching an all-time high in 2022–23, with each \$1 in finance provided by the CEFC attracting \$5.02 of additional private sector capital (CEFC, 2023b). The authority advised in its 2020 report, *Prospering in a low-emissions world: An updated climate policy toolkit for Australia*, to expand the remit of the CEFC to allow it to invest in emissions reduction technologies in all sectors to help overcome barriers to finance (Recommendation 32) (CCA, 2020).

4.4.5 Regulation

Beyond reporting, in 2022–23 Australian competition and financial regulators are also stepping up monitoring and enforcement action with respect to sustainability-related claims through their existing powers. In February 2023, the Australian Securities & Investment Commission (ASIC) announced its first court action against alleged greenwashing conduct, commencing civil proceedings against Mercer Superannuation (Australia) Limited for allegedly making misleading statements about the sustainable nature and characteristics of some of its superannuation investment options (ASIC, 2023).

The Australian Competition and Consumer Commission³¹ has also completed a stock take of environmental

³¹ Misleading and deceptive conduct under Australian competition and consumer law protects against false or misleading sustainability claims.

claims, finding 57% of businesses reviewed made concerning sustainability claims that lacked clarity, without sufficient evidence, unsupported goals and/or used third-party certifications in confusing ways to support the claim (ACCC, 2023). Other regulators such as the ASIC and Australian Prudential Regulation Authority are engaging in educational functions to support compliance. APRA conducted a Climate Vulnerability Assessment for of Australia's five largest banks with climate scenario analysis finding a measurable impact on lending losses, but likely to be absorbed by lenders (APRA, 2022).

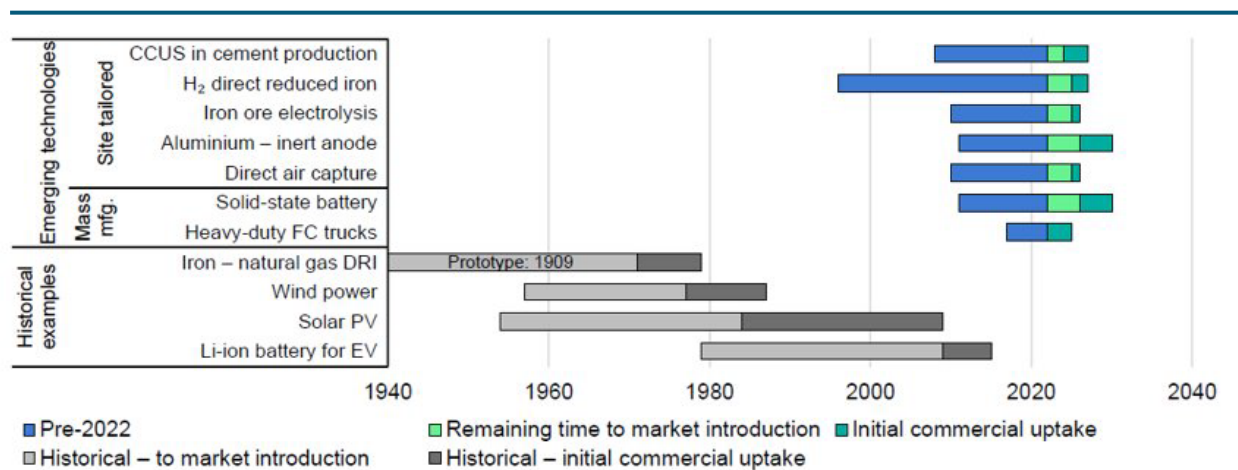


4.5 Research and development, technology and innovation

Technologies and solutions are available today to immediately reduce emissions, while emerging technologies will be required to achieve the longer-term goal of reaching net zero emissions. While the emissions reductions to 2030 can be delivered with existing technologies, the IEA concludes that about half of the emissions reductions in 2050 will come from technologies at prototype or demonstration stages today (IEA, 2023a). Reliance on technologies still under development is higher for harder-to-abate activities, such as aviation and heavy industry (IEA, 2023a).

The time available to bring emerging technologies to market to meet net zero targets is much shorter than was the case previously (see Figure 4.4). For example, 15–30 years for technologies such as green steel, heavy duty fuel cell trucks and CCUS in cement production. This compares to existing technologies, including solar, where the innovation process has taken 20 to 70 years from prototype to commercialisation (IEA, 2023a).

Figure 4.4: Time frame for prototype to market introduction and early adoption for selected clean energy technologies in the past and the NZE Scenario



IEA. CC BY 4.0.

Notes: mfg. = manufacturing; DRI = direct reduced iron; H₂ = hydrogen; FC = fuel cell; Li-ion = lithium-ion. Initial commercial uptake is defined as the time until take-up in 1% of the market and market introduction as when the first commercial model is available on the market. Direct air capture is assumed to reach initial commercial scale at 1 Mt of CO₂ per year and market introduction at 1% of the market. Historical figures are calculated for selected market-leading countries (Norway for Li-ion batteries; Germany for solar PV; Denmark for wind power; and the United States for natural gas DRI).

Sources: IEA analysis based on Gross et al. (2018); Worldsteel Association (2020); Comin & Hohjin (2004). Also see IEA (2020a).

The IEA has highlighted the importance of shortening of innovation cycles and recommended that this be supported by improving the commercial advantage of clean energy technologies; increased global co-operation and international knowledge transfer; as well as the importance of tracking progress towards goals (IEA, 2023a).

4.5.1 Innovation – through deployment at scale

Australia has long been at the forefront of solar PV innovation and deployment. Innovations in PV panel technology and manufacturing, and the increasing scale of solar farm installations have contributed to cutting the cost of solar PV generation by 85% over the past ten years, and it is already mature and sufficiently cost effective to deploy at scale (ARENA, 2023f). It requires no significant technology breakthroughs to achieve Australia's 2030 goals. (ARENA, 2023f).

Nevertheless, there are ongoing innovations emerging through deployment at scale that can provide benefits and savings to new projects. In particular, the development of modular, prefabricated and pre-configured solar panel products that enable rapid deployment in a range of location types. The prefabricated, compact design improves efficiencies in procurement, transport and installation. For example, in transport the design allows for an increase in the number of panels per load, improving logistics and reducing costs in remote locations. The modular design also enables rapid installations which can be disassembled and redeployed for new projects, contributing to sustainable practices at the end of operations.

NSW-based company 5B has been able to demonstrate installation rates of its modular PV technology at 1.1 MW per day of solar power capacity with 20 people (PV Magazine, 2023a). A development from a UK company has now also included solar tracking systems in prefabricated modules, which maximise energy yield while at the same time reducing construction time and costs, improving the overall business case. These units were recently installed in a pilot project, a 2.3 MW system to provide power to a gold field operation in Kalgoorlie. The design and innovative anchoring system also eliminates the need for piles and concrete (PV Magazine, 2023b), providing a reduced carbon footprint.

4.5.2 Innovation – emerging and needing development

Decarbonisation of electricity generation together with electrification of many end-use activities is necessary to achieve net zero emissions. Electricity storage plays a critical role in balancing electricity supply and demand and can provide other services needed to keep decarbonised industrial systems reliable and cost-effective (MIT, 2022).

Battery technologies with high energy density are suited for use in electric vehicles and mobile electronics. The private sector has provided significant venture capital for storage technologies generally, and for lithium-ion batteries, particularly in vehicles (MIT, 2022).

Technologies with lower energy density can be used for storage in electricity system applications where space is less important. Technologies such as pumped storage hydro and some thermal storage options are proven and available for commercial deployment (MIT, 2022). However, there are a wide range of emerging technologies, particularly in thermal storage, requiring further research, development, and demonstration to be commercially available at scale in the 2030s or 2040s (MIT, 2022).

Recent developments in Australia include the release of the 2023 CSIRO Renewable Energy Storage Roadmap (CSIRO, 2023a) which identifies a mix of technologies across sectors to meet Australia's energy storage needs. Higher levels of renewables in Australia's energy system will result in a greater role for renewable energy storage technologies. The report advises that Australia will need to rapidly develop a pipeline of projects across a portfolio of energy storage technologies to address key technology challenges across different end-use applications and geographical locations (CSIRO, 2023a).

Emerging applications of thermal storage include for electrification in sectors using gas for heat production, allowing replacement of fossil fuels with renewable energy and recycling of waste heat. A food and beverage manufacturer in the Netherlands has launched a pioneer installation to replace gas heating with electrification and heat storage provided by Kraftblock net-zero heat system (Eneco, 2023). Using excess renewable energy, the unit heats air up to 800 degrees celsius, which can then be stored in heat-retaining pellets which use 85% recycled material (Koolen Industries, 2022). The heat can then be accessed when needed in the production process. The first phase is expected to provide a 50% emissions reduction, with future expansion targeting a 98% reduction (Eneco, 2023).

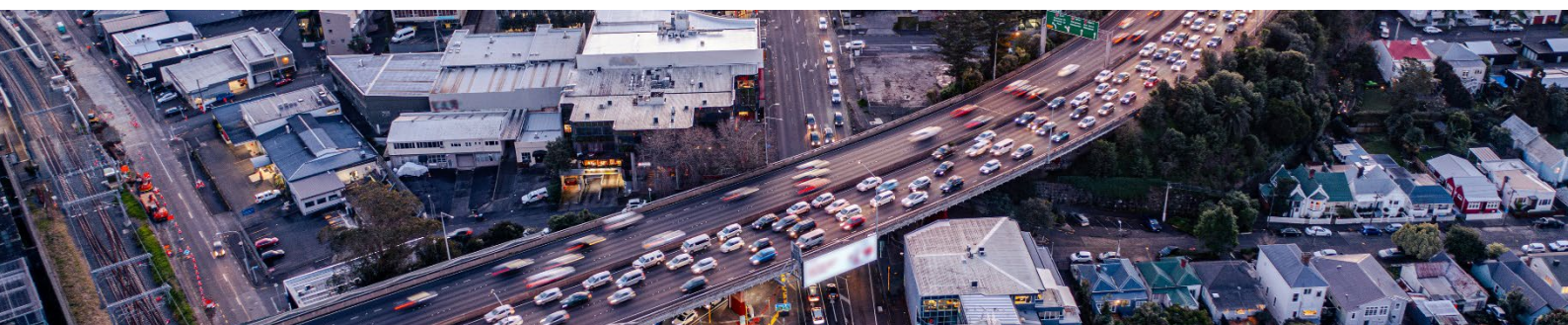
Another technology being developed is superconducting transmission lines aimed at distributing electricity with lower losses. Nexans has deployed superconducting cables in the US and Germany and is participating in the National Grid Superconductor Applications for Dense Energy Transmission project to identify applications for superconductors in cities (Nexans, 2022). US-based company Veir has suggested that existing High Temperature Superconductors (HTS) perform well over short distances in dense urban centres, but that deployment costs have proven too high for HTS to meet its potential for providing long-distance transmission (Veir, 2023). Veir has developed a cooling system with the aim of enabling long-distance HTS transmission (Veir, 2023).

4.5.2.1 Decarbonising heavy industries

In the near to medium term, decarbonisation pathways are less certain for hard-to abate sectors such as cement, steel and chemicals. Emissions come from necessary chemical reactions (such as calcination of limestone for cement) or because zero emissions versions of industrial equipment (such as high temperature furnaces) are ineffective and/or costly. Innovation has driven down costs and introduced new technologies and this must accelerate with significant technological and financial investment to deliver solutions to 2030 and beyond.

The decarbonisation of cement production, one of the most energy intensive materials, is another example of the ongoing need for innovation. Around 60% of emissions come from chemical reactions, the majority of the rest is produced by fuel combustion. Production facilities are capital intensive and are generally long-term assets which creates a barrier to timely response to energy or emission related priorities. Demand for cement is growing, and emissions reduction strategies, such as novel/substitute materials that require less heat to produce and the potential for carbon capture and storage located within cement manufacturing facilities are being explored but are not fully mature and need large scale demonstration projects to develop further (VDZ, 2021).

Technologies and solutions are available today that can kickstart the transition while emerging ones can complete the process – solutions can utilise new production methods, alternative energy sources and feedstocks, emissions-abatement technologies e.g. CCS and circular/recycling practices. Combined together across the production chain these innovations can collectively deliver to net zero goals.



4.5.3 Investment finance - strategies now and in future

A complete picture of recent government research, development and demonstration (RD&D) funding relevant to climate change is complex to collate, however a snapshot of funding for energy, which is reported regularly to the IEA, suggests funds are increasing, with a strong focus on clean energy transition. Australia's RD&D spend relative to GDP remains comparatively low amongst OECD economies (IEA, 2023f); (IEA, 2023c).

The government is considering the broader research and development (R&D) and innovation environment in Australia through the *Australian Universities Accord* process, scheduled to report at the end of 2023, which will make recommendations on the university research system's ability to meet Australia's current and future needs (Department of Education, 2023). The Australian Council of Learned Academies (ACOLA), has a focus on energy transition. In 2021 they developed a comprehensive research agenda, the *Australian Energy Transition Research Plan* as a pathway to net-zero by 2050 (ACOLA, 2021).

Public spending on research and development has been on a steady upward trend, as has corporate spending (IEA, 2023f). Public spending on research and development has been on a steady upward trend, as has corporate spending (IEA, 2023f). The IEA reported that globally, estimated public spending on energy R&D grew by 10% in 2022 to USD44 billion, with around 80% (USD35 billion) directed to clean energy (IEA, 2023f). In addition, early-stage Venture Capital (VC) reached a new high of USD6.7 billion in 2022 (IEA, 2023f).

The IEA also noted that corporate R&D budgets of companies in energy-related sectors had risen to an estimated USD120 billion (IEA, 2023f). Growth in 2022 was high relative to recent years despite higher cost of capital and economic uncertainty, this is interpreted as a response to the threats and opportunities of the energy transition (IEA, 2023f). R&D is a central strategy for growing or maintaining market share, for example in the automotive market, where growth in R&D impacts the overall trend. Outside the energy sector corporate R&D is also rising in the related hard-to-decarbonise sectors (IEA, 2023f).

Corporate venture capital (CVC) funding for emerging clean energy technologies also reached a high of USD 8 billion in 2022, growing quickly since 2015. CVC can provide a company with a lower-cost and quicker means of acquiring new knowledge, new technologies and business models in an energy sector facing disruption from modular and quick-to-scale technologies.

The OECD reports an increase in flows to investment funds that are mandated to invest in green or sustainable investments (RBA, 2023). Data compiled by the OECD show global sustainable funds at around USD3 trillion in 2022, (OECD, 2023).

The Reserve Bank of Australia has reported that Australia is very much part of the global increase in clean energy investment, including wind and solar renewable energy where investment has already grown strongly in recent years (RBA, 2023).

Green bonds are bonds issued to fund projects beneficial to the environment or climate. In Australia the main uses of green bonds to date have been for the deployment of clean transportation solutions, energy efficiency and green construction. To date issuers and investors have used voluntary guidelines for classification such as the Climate Bonds Initiative's 'Climate Bond Standard'. Bonds issued into the Australian market by a non-resident organisation – Kangaroo green bonds – make up around one-third of total issuance (RBA, 2023). In Australia, the green bond market has grown quickly since 2014.

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In Australia, the green bond market has grown quickly since 2014. Over \$10 billion of green bonds were issued in 2022. In the first 6 months of 2023 alone, that amount was exceeded as new issuers continued to enter the market.

IEA global analysis has highlighted that for clean energy alone, by 2030 annual investment will need to be three times the current rate, which has already increased substantially in recent years (IEA, 2023f). As well as further rapid deployment of available technologies to 2030, reaching net zero by 2050 requires widespread use of technologies that are currently not yet on the market. Major innovation efforts must occur in order to bring these to market in time (IEA, 2021).

The authority will further consider technology and innovation, including the role for public and private finance, in its work on sectoral pathways, and in developing its advice on emissions targets in 2024.

Given the critical importance of technology in achieving Australia's emissions reduction targets, the government should incorporate a Research, Development & Demonstration (RD&D) Strategy as a key feature of its Net Zero Plan. The strategy should consider the need for dependable framework conditions that promote innovation, safeguards competitiveness, and amplifies co-operation between government and private sector, as well as tracking progress towards goals.

41. RECOMMENDATION

Include a Research, Development & Demonstration (RD&D) Strategy as a key feature of Australia's Net Zero Plan. The strategy should consider the need for dependable framework conditions that promote innovation, safeguards competitiveness, and amplifies co-operation between government and private sector, as well as tracking progress towards goals.

4.6 Federal, state and territory government cooperation

The changes needed in the Australian economy and in society for meeting our emissions reductions targets, and ensuring our future prosperity and resilience, are immense and urgent.

Given the many overlapping and complementary responsibilities held by the Australian and the state and territory governments, a successful net zero transition will require much greater levels of government intervention, coordination and cooperation than currently exist, to drive the decisions and behaviours by governments, businesses and households towards the outcomes required. And the approach will need to be flexible and adaptive, given the inherent uncertainties of the future.

Many of the authority's recommendations in this report call on the Australian Government to work with the states and territories to achieve a range of policy objectives. A disjointed approach runs the risk of much less timely and effective policy responses, and unnecessarily adding to regulatory costs and burdens for businesses and consumers.

The authority's views is that the time is right for a new, Commonwealth-State reform agreement (or set of agreements) on climate change mitigation, adaptation and the net zero transition.

Developed in parallel to the work on sectoral plans, the 2035 target and the Net Zero Plan, the agreement would provide a framework for cooperation on the response to climate change, including principles and actions on a range of matters where consistent and/or coordinated action is in the national interest. However, Australia cannot afford protracted negotiations to delay action – the focus should be on areas where agreement can be reached quickly important areas, with the agreement reviewed and expanded regularly as appropriate.

4.6.1 Mitigation

The federal and all state and territory governments have adopted the target of achieving net zero emissions by 2050 or earlier. There is an enormous amount of work already underway, but also considerably more to be done to ensure we are on a trajectory to net zero, meeting our 2030 and subsequent interim targets. Emissions reduction targets and other climate change and related policies across jurisdictions are not yet fully aligned with Australia's Paris Agreement targets, and likely future targets.

A new agreement, or set of agreements, could establish a framework that includes a commitment to work together to meet Australia's 2030 and subsequent interim Paris Agreement targets, as well as net zero by 2050, and identifies key mitigation policy goals (e.g. for sector plans), and specific policy approaches to achieving those goals where appropriate, including roles and responsibilities.

Major policy reforms are required in areas where the Commonwealth and the states share responsibilities and/or in areas where cross-cutting issues arise – such as electricity supply, environmental protection and approvals and land use, and reforms to revenue raising and sharing to both drive and respond to the transitioning economy. Without collaborative and coordinated approaches on the big issues, failure is likely.

There is a need for a comprehensive review of, and response to, unnecessary regulatory barriers to effective mitigation and adaptation action across the economy. And there is a need to ensure that where new regulations are introduced, nationally consistent approaches are adopted wherever appropriate, to avoid the imposition of unnecessary regulatory burdens and costs on businesses and consumers.

With respect to government operations, there is an opportunity to develop agreed principles and guidelines for consistent and robust approaches to the valuation of carbon for government planning and decision-making, for climate related financial disclosures and risk management across government agencies, and for government procurement policies that are 'net zero consistent'.

Taking an integrated, place-based approach to the challenges and opportunities of the net zero transition will enhance Australia's prospects for success. For example, identifying regional 'zones' or 'precincts' where facilitating projects in renewables generation, hydrogen production, critical minerals extraction and carbon capture and storage creates the ingredients for decarbonising existing activities and facilitating new, green industries. Coordinating across levels of government will be essential, including for successful workforce and community transitions.

A new agreement could also provide the framework under which emerging policy challenges and opportunities are identified and responded to. For example, the net zero transition raises significant implications for tax bases and revenue sharing between the Commonwealth and the states and territories. As an example, significant taxation revenue is currently raised from activities associated with high levels of emissions (extraction and use of fossil fuels such as coal, oil and gas) and these will decline over time. Analysing and planning for these changes should commence sooner rather than later.

4.6.2 Adaptation

Adaptation is an issue of national significance – vital for economic performance and the wellbeing of Australians generally. The Australian Government is developing its National Climate Risk Assessment and National Adaptation Plan.

The Australian Government will have a key role as a provider of information on climate trends and risks to assist others make informed decisions to adapt to global warming. The physical impacts of climate change have specific consequences for the Australian Government in terms of its role as the 'lender of last resort' for the costs of extreme, climate-related events and as a significant funder of Australia's health system. The Australian Government is also responsible for commitments made on adaptation in our Nationally Determined Contributions under the Paris Agreement.

State and territory governments deliver a broad range of services and are primarily responsible for service delivery and infrastructure, such as emergency management, transport infrastructure, land-use planning, health and education services and public housing. Local governments have an important role to play through local planning and regulations and managing the risks and impacts of climate change on local service delivery.

With respect to government operations generally, there is an opportunity to develop agreed principles and guidelines for consistent and robust approaches to the valuation of carbon for government planning and decision-making, for climate related financial disclosures and risk management across government agencies, and for government procurement policies that are 'net zero consistent'.

Ensuring clarity and agreement on the respective roles of the three tiers of government will be crucial for ensuring Australia effectively manages the risks and impacts of climate change. A new agreement on adaptation roles, responsibilities and implementation, updating a decade old COAG agreement, would complement the National Adaptation Plan currently under development by the Australian Government, and provide a vehicle for an agreement to incorporate climate change in all government decision-making, as recommended in Chapter 2.



4.6.3 Further considerations

A successfully negotiated agreement would send a strong signal to the Australian community, and the rest of the world, about the net zero emissions path we are on, and contribute to a virtuous cycle already established as a result of legislating Australia's emissions reduction targets. A more unified approach will help build the necessary levels of 'social licence' that are essential for a successful transition, by supporting a consistent, overarching narrative from governments.

The agreement would need to respect the different circumstances of each state and territory and not get in the way of early, no regrets actions to respond to climate change. The Prime Minister, Premiers and Treasurers, supported by their departments, should drive the agenda, given the national significance, whole-of-economy and whole-of-society nature of responding to climate change.

The agreement could include a framework for consistent reporting on progress with, and outcomes from, the implementation of climate change measures, which is necessary for ensuring transparency and accountability in relation to the achievement of emissions reduction and adaptation targets.

42. RECOMMENDATION

As part of development of its Net Zero Plan, the government develop a set of agreements with the state and territory governments for coordination and cooperation on change mitigation, adaptation and resilience and Australia's transition to a net zero economy.



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A. Appendix – Purpose and context

Statutory Reporting Requirements of the Climate Change Authority

The Climate Change Authority is an independent statutory agency, established under the *Climate Change Authority Act 2011* to provide expert, evidence-based advice to the Government on Australia's climate change targets, policies and progress. The authority is made up of a Chair, the Chief Scientist and seven other members appointed for their substantial experience or knowledge and significant standing in fields that contribute to responding to the climate challenge.

Independent Advice to Government on the Preparation of the Annual Climate Statement

Following the commencement of the *Climate Change Act 2022* the authority's functions were expanded, including to provide advice to the Minister for Climate Change in preparation for the annual climate change statement. The annual climate change statement addresses progress towards achieving Australia's greenhouse gas emissions reduction targets, international developments, climate change policies (including their effectiveness in contributing to targets and their impact on rural and regional Australia), and risks to Australia from climate change impacts. The authority has opted to provide this advice in the form of its Annual Progress Report, with the First Annual Progress Report published in November 2022.

The authority's functions have been further expanded following the commencement of the *Safeguard Mechanism (Crediting) Amendment Act 2023* on 11 April 2023. These Safeguard Reforms have been implemented through amendments to legislation and legislative instruments including the *National Greenhouse and Energy Reporting Act 2007*, the *Climate Change Act 2022* and the Safeguard Rules.

These reforms require the annual climate change statement to address whether emissions from the operation of facilities under the Safeguard Mechanism are declining consistently with these outcomes. It also requires the Minister for the Environment and Water, after having approved an action under the EPBC Act that is relevant to the Safeguard Mechanism, to provide any relevant estimates of emissions to the authority.

As a result, the authority is now required to include within its advice, relating to the annual climate change statements, an assessment on whether emissions of designated large facilities under the Safeguard Mechanism are declining consistently with the updated outcomes. This advice must take into account the impact of new or expanded facilities for current and future years, as well as any emissions estimates provided to the authority by the Minister for the Environment and Water (for projects approved under the EPBC Act). The authority would look to the necessity of amendments to the Safeguard Rule if there was a risk to the achievement of the Safeguard outcomes, taking into consideration whether policy changes outside of the Safeguard Rules are more suitable and whether the risk is due to temporary factors. As these Safeguard Reforms came into effect during 1 July 2023 (DCCEEW, 2023I), this assessment is not included within this year's advice however it will be included from next year.

Legislative Reviews

The *Climate Change Authority Act 2011* requires the authority to undertake periodic reviews of the legislation underpinning the Emissions Reduction Fund (the *Carbon Credits (Carbon Farming Initiative) Act 2011* (CFI Act)) and the *National Greenhouse and Energy Reporting Act 2007* (NGER Act). This year the authority has been conducting concurrent reviews of both pieces of legislation.

The NGER Act establishes the NGER Scheme and the Safeguard Mechanism. This year the authority's review will cover all aspects of the NGER Act but will focus on the NGER scheme, recognising the Safeguard Mechanism has just gone through a significant consultation and reform process. As part of the review of the NGER scheme, the authority has been asked to review methane measurement, reporting and

verification (MRV). Methane is one of the gases companies must report under the NGER scheme. The NGER Act and the instruments under the Act provide methods for companies to calculate their methane emissions. The authority will consider these methods in the context of recent international developments in methane MRV, including the work of the Oil and Gas Methane Partnership 2.0 and the Metcoal Methane Partnership. The authority's review of the NGER Act will be completed by December 2023.

The authority's review of the CFI Act will build on the recent Independent Review of ACCUs (the Chubb Review), including consideration of the merit of a mechanism to provide further assurance of additionality and conservativeness of the CFI Act, and issues raised through the authority's consultation process. Supporting integrity and transparency remain key issues for the CFI Act. This review is also due to be completed by December 2023.

Advice on Australia's Current and Future Nationally Determined Contribution (NDC) and sectoral pathways

Section 15 of the *Climate Change Act 2022* also separately requires the authority to 'advise the Minister on greenhouse gas emissions reduction targets to be included in a new or adjusted nationally determined contribution' or 'NDC'. Australia's next NDC is due in 2025.

The authority's advice will take account of how sectors, communities, governments and individuals can work together to prosper in the face of the decarbonisation challenge. The advice will consider consultation outcomes across all elements of its development, including social, employment and economic impacts, and opportunities that arise from the recommended targets and associated policies for Australia, including for rural and regional areas.

The Australian Parliament has also requested that the Climate Change Authority review the potential technology transition and emissions pathways that best support Australia's transition to net zero by 2050 for the following sectors:

- Electricity and energy
- Transport
- Industry and waste
- Agriculture and land
- Resources
- Built environment.

The authority must identify opportunities, technologies, barriers, workforce matters, information gaps, and the role of public and private finance in its review of sectoral pathways.

The review was requested under Section 59 of the *Climate Change Authority Act 2011* and will be delivered by 1 August 2024.

Future Work

The Government has committed to undertake a review of the Safeguard Mechanism in 2026–27 to assess initial reform impacts and ensure policy settings are appropriately calibrated. As part of the review, the authority will advise Government on the extent to which on-site abatement is being driven by the reforms, and whether any additional incentives are required.

About this report

The report is guided, at a minimum, by the requirements for the annual climate change statements in Section 12 of the *Climate Change Act 2022*, as well as Section 12 of the *Climate Change Authority Act 2011*, which sets out principles to which the authority must have regard in performing its functions.

Framework underpinning the authority's advice

To understand how Australia is progressing towards net zero, the authority has developed its methodology for preparing its advice, including data collection, consultation and analysis, guided by the framework set out in Figure A.1. It shows how the Annual Progress Report addresses each of the components the Minister must report on in the annual climate change statement, as described in Section 12 of the *Climate Change Act 2022*. The methodology includes assessments and analysis across four core elements: wellbeing, emissions, policies and context.

Figure A.1: Framework for tracking progress

	<i>Climate Change Act 2022</i>				
WELLBEING	s 12(e), s 12(1)f	Progress towards a just transition and resilient nation			
		Economic impacts and opportunities	Physical impacts and adaptation	First Nations	Regional and rural Australia
EMISSIONS	s 12(1)a	Progress towards national greenhouse emissions reduction targets			
		Leading indicators of change	Point target compliance	Emissions budget tracking	Emissions sectoral trends
POLICIES	s 12(1)c, s 12(1)d	Progress in implementing policies			
		Mitigation and adaptation policy stocktake	Policy gap analysis	Indicators of direct effectiveness	Indicators of indirect effectiveness
CONTEXT	s 12(1)b	Developments in the broader operating environment			
		Climate science and global impacts	Geopolitics	International ambition and policies	Voluntary corporate action

Wellbeing:

The impacts of climate change and climate-related policies affect the wellbeing of Australians in different ways. Climate-related wellbeing in turn affects social licence to proceed with policies to guide the changes Australians need to make. The authority assesses social, environmental and economic impacts, positive and negative, through the concept of wellbeing. This includes considering the impacts in Australia of the response to climate change – policies and decisions implemented here and abroad – as well as the physical impacts of climate change.

Emissions:

The authority uses indicators to assess progress towards Australia's emissions targets, realising opportunities and managing risks. Indicators are data about the actions and outcomes necessary to achieve objectives, such as skills and jobs, secure supply chains, and investment needed for the transition. Leading indicators are useful to anticipate how the economy and its emissions intensity are likely to change, including early notice of the sectors and regions on track for economic growth or decline. A single leading

indicator often lacks predictive power. However, when taken together and used in conjunction with other sources of information, leading indicators provide a picture of progress and future developments.

Policies:

The annual climate change statement advice must canvass 'climate change policy'. Climate change requires a whole-of-economy transition. Fundamental to the task of considering Australia's progress towards achieving its greenhouse gas emissions reduction targets is understanding the cumulative effectiveness of its policies. The authority considers assessing effectiveness goes beyond just considering actual emissions reductions achieved in one year but must also consider the qualitative impacts associated with policies, both positive and negative. The authority considers effectiveness can be categorised as direct or indirect. A primary measure for establishing direct effectiveness is how many tonnes of carbon dioxide equivalent (tCO₂-e) have been mitigated, that is, reduced, or removed due to a particular policy. As Australia's emissions reduction targets are a mix of both point targets and emissions budgets, this report considers both the quantity of emissions abated in one particular year, cumulative abatement over time, and likelihood of future abatement in assessing the effectiveness of climate policies.

It is also important to consider the broader impacts and benefits climate change policies have on the economy, the environment, and society, which the authority broadly considers indirect effectiveness. Assessing indirect effectiveness involves a range of data including environmental valuation, financing, innovation, supply chain, demand, workforce and co-benefits, among others.

Context:

There are factors that affect Australia's progress but are largely beyond the direct control of Australian governments and citizens, such as geopolitics, the science and global impacts of climate change, decisions of other nations, and voluntary corporate action. The authority's advice will be developed with an understanding of the context in which outcomes are to be delivered, as set out in the second core element of the framework, as well as opportunities to influence the context (e.g. through international engagement).

Consultation

The authority committed to consult on its progress framework in its 2022 Annual Progress Report. The authority presented this framework in its Issues Paper titled *Setting, Tracking and Achieving Australia's Emission Reduction Targets*, and separately undertook targeted First Nations and regional consultation processes. The authority recognises that the consultation processes the authority undertook are not comprehensive of all viewpoints across Australia, and targeted consultation groups were not large enough to be statically significant. The authority asks readers to be mindful of this when reading consultation content but recognises the contribution responders have provided to the authority's growing base of information.

The authority will consider the feedback it received in evolving the framework for future reports.

B. Climate Policy Tracker and effectiveness analysis

Policy stock take and tracker

The Climate Change Authority has undertaken a stock take of the Australian Government's climate-related policies and published a new Climate Policy Tracker on its [website](#). The authority intends to update this Climate Policy Tracker and expand it to include state and territory government policies in the future.

Reporting

Regular reporting and progress-tracking helps ensure governments are held accountable for the climate action they commit to. The Australian Government has several publicly available reporting activities on climate change including but not limited to:

- Annual Climate Change Statements under the *Climate Change Act 2022*
- quarterly updates of Australia's National Greenhouse Gas Inventory
- annual National Inventory Reports to the United Nations Framework Convention on Climate Change (UNFCCC)
- annual emissions projections reports
- National Communications on Climate Change and Biennial reports to the UNFCCC.

These reports contribute to the authority's assessment of climate policy effectiveness (outlined below).

The government has also committed to strengthening reporting activities, including by:

- improving transparency on corporations' reporting on climate transition plans and emissions through implementing standardised internationally aligned requirements for disclosing climate-related financial risks and opportunities in Australia
- improving reporting on climate risks following the National Climate Risk Assessment and through the Commonwealth Climate Risk and Opportunity Management Program.

While these mechanisms show Australia's commitment to transparent reporting on our progress, further information could be publicly available, including:

- progress in implementing each measure (e.g. expenditure, contracting)
- the contribution of each measure to Australia's progress towards net zero and the goals of the Paris Agreement (e.g. abatement, clean economy jobs, clean exports)
- barriers in implementing policy measures
- availability and transparency of climate information and datasets, including disclosing and tracking scope 3 emissions.

The authority will further consider transparency and data availability in other reviews in 2023 and 2024.

Policy effectiveness analysis

Method

As part of assessing progress, the authority provides an evaluation of how various sectors and their key measures support Australia's emissions reductions targets and where possible, wellbeing and adaptation.

The authority referred to sectoral strategies and/or key policies and their cumulative effect on supporting the sector transition to net zero.

The authority developed a new policy effectiveness analysis approach for this report, borrowing from our earlier work on *Prospering in a Low Emissions World* (CCA, 2020) and the OECD framework on policy effectiveness analysis (OECD, 2021). The policy effectiveness tables contained in this report each include six key criteria against which measures were analysed to provide insight on the sector's progress in decarbonising. The policy effectiveness assessment has six key criteria against which measures were assessed to determine overall progress for each sector.

- **Scope** - the coverage of the measure.
- **Impact** - the impact of the measure on achieving emissions reductions and alignment with Australia's national targets. Other considerations including the policy certainty of the measure and the authority's principles in section 12 of *the Climate Change Authority Act 2011*.
- **Efficiency** - how well the measure is being operationalised. It considers the use of resources (time and money) and whether sufficient governance, including compliance, measures are in place.
- **Relevance** - how well the policy is achieving the intention/objectives it was designed to solve. It considers how credible the measure is and what gaps remain.
- **Coherence** - refers to how well the measure fits the policy problem of climate change by considering the scalability and flexibility of the measure. It considered whether this measure is the right one for the policy problem at large (climate change).
- **Sustainability** - the durability of the measure. It also considers any potential adverse impacts of the measure.

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**All legislation cited in this report is Commonwealth legislation unless otherwise indicated.
Commonwealth legislation can be found on the Federal Register of Legislation: www.legislation.gov.au**

For more information about the work of the Climate Change Authority, visit our website at <https://www.climatechangeauthority.gov.au/>.

You can also contact us at: <mailto:enquiries@climatechangeauthority.gov.au>