BCA Business Council of Australia

Australia 2035 – Maximising Our Potential

September 2025

Contents

This report addresses key issues highlighted by the BCA, including:

Executive Summary

The BCA is ambitious for Australia. We aspire to drive prosperity for all Australians, leveraging our collective expertise and influence to shape a bright and innovative future for businesses, industries and communities. We are committed to working towards an Australia that is globally competitive, productive and fair.

Background

In signing the Paris Agreement, Australia has committed to doing its part to limit global temperature increases to well below 2.0°C (and pursue efforts to limit temperature increases to 1.5°C) by reducing its emissions and achieving net zero by 2050. The BCA fully endorses Australia's participation in the Paris Agreement and fully supports Australia's climate legislation enshrining this participation.

Simply getting to net zero in the year 2050 will not be enough to limit global temperature increases to well below 2.0°C. An often overlooked fact is that the world economy must do so within the available emissions budget set by the Intergovernmental Panel on Climate Change between now and 2050. This is why interim emission reduction targets are so critical.

Among the most important challenges and opportunities facing our nation is facilitating an orderly transition to net zero by 2050 — one that best serves our economy and our community. How we transition will have a strong bearing not only on our emissions levels, but on our productivity growth, our competitiveness as a nation and living standards over the longer term.

Transitioning the economy presents an opportunity for Australia to develop new, competitive green export industries. The rate and pattern of global decarbonisation is uncertain and influenced by a great many factors well outside Australia's control. Our economy and its variously integrated sectors need to be ready to leverage the upside of global decarbonisation.

Escalating global uncertainty means that fundamentals like cost of living and national security are front of mind. The transition represents both challenges and opportunities at the household level, including on the cost and reliability of energy, on the way we use our land, on our patterns and modes of travel, on existing and new product choices, on the type and quality of jobs and on the wages received for doing those jobs.

Australia's 2035 emission reduction target needs to be both ambitious and achievable if we are to continue to do our part under the Paris Agreement while also serving our economy and our community. This is an enormously complex and important public policy issue and understandably there is a range of views about how best to strike this balance between ambition and achievability.

We hope that this report can make a valuable contribution in this regard.

Purpose

The purpose of this report is to inform the debate about Australia's emission reduction potential and to be constructive in the process for determining Australia's 2035 target settings under the Paris Agreement.

As an informative piece, this work is not prescriptive about the appropriate settings for Australia's 2035 emission reduction target. In our view, Government is best placed to consider the wide range of advice from different stakeholders, including its own agencies, and to integrate this advice with other national policy priorities in determining the most appropriate target settings for Australia.

With this in mind, the BCA has taken an investment perspective when assessing Australia's emission reduction potential from 2025 to 2035. To support this, McKinsey & Company (McKinsey) was engaged by the BCA to develop a 'bottom up' analysis (evidence base) to frame Australia's emission reduction potential to 2035. This analysis included extensive stress testing of technology cost and effectiveness assumptions, and real world barriers and enablers to the deployment and adoption of technologies by businesses across the economy.

Our approach is based on an assessment of potential investments in currently available technologies, and on current technology cost projections — site by site and asset by asset in some cases — to build up a picture of Australia's emission reduction potential over the next ten years. We acknowledge that there is always the possibility of new technologies emerging and cost reductions in existing technologies over the next ten years, that have not been captured by our approach. Positive technology surprises in this regard could increase Australia's emission reduction potential.

Put simply, this analysis is intended to estimate the investment costs associated with different levels of 2035 target ambition and to identify the critical areas where new or augmented policies are required to deliver on those different levels. We note that in some cases there are operational cost savings over time associated with new capital investment.

To be clear, we have not attempted to include any longer term considerations for the Australian economy in this 10 year analysis — in terms of the costs of climate inaction and climate impacts. Nor does this 10 year analysis attempt to measure GDP benefits associated with new investment in the economy. However, we fully recognise that these considerations are a critical part of this net zero challenge. The BCA's 2021 report, *Achieving a net zero economy* — a 'top down' analysis of all costs and benefits to the Australian economy from 2020 to 2070 — does include the costs of climate inaction and climate impacts and the GDP benefits associated with new investment in the economy.[1]

The evidence base presented in this report includes three emission reduction scenarios from 2025 to 2035 that ratchet in ambition based on rates of technology deployment and adoption, and changes in economic activity across the electricity and energy, resources, industry, transport, agriculture, buildings and land sectors of the economy.[2] It also includes the identification of key cross cutting enablers and critical unlocks for achieving emission reductions across these seven sectors.

At the commencement of this work the most recent emissions inventory available for Australia was the National Inventory Report 2022.[3] We note that Australia's emissions are slightly higher in the National Inventory Report 2023. We also note that Australia's most recent quarterly emissions projections reveal the return to a downward trend in national emissions.[4] The nature of economic activity means that emissions levels will continually rise and fall slightly across sectors and the national economy in the short term, irrespective of the long term trend in emission levels. The very minor variation between the three emission data sets referred to above is immaterial to this analysis and the findings of the work more generally.

This evidence base is the result of a 12 month collaborative effort between McKinsey and the BCA. While there is general alignment between our two organisations on the evidence base, the views expressed in this report are those of the BCA and as such are not intended to represent the views of McKinsey.

Insights

- While the electricity and energy sector and the land sector have driven the bulk of Australia's emission reductions over the last two decades, we can't continue to rely on these two sectors alone to do the heavy lifting forever — all sectors have an important role to play in achieving net zero by 2050.
- The bulk of the emission reduction task to 2035 will fall to electricity and energy, resources and industry with smaller contributions expected from transport, agriculture and buildings.
- While there is potential for scaling up Australia's land sector abatement substantially beyond the next 10 years, simply maintaining the size of Australia's existing carbon sink to 2035 — which is at an historical high — requires additional effort.

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[1] See the full report at https://www.bca.com.au/achieving_a_net_zero_economy
[2] The term 'land' refers to the land use, land use change and forestry sector.
[3] National Inventory Report 2022, The Australian Government Submission to the United Nations Framework Convention on Climate Change Australian National Greenhouse Accounts April 2024.
[4] National Greenhouse Gas Inventory Quarterly Update: March 2025.

- Achieving around a 50 per cent 2035 emission reduction target requires ongoing effort and progress — Australia's current electricity and energy infrastructure build rate remains a significant challenge.
- Achieving around a 60 per cent 2035 emission reduction target would require a significant policy push from governments, and sustained investment actions from the private sector to encourage widespread deployment and adoption of low emission technologies, and to breakthrough bottlenecks in attaining project approvals, social licence and skilled workforce scaling.
- Achieving around a 70+ per cent 2035 emission reduction target would necessitate deeper rates of deployment and adoption for some low emission technologies prematurely, and could risk trade offs in Australia's export activity and associated carbon leakage, depending on global demand for emissions intensive goods and the effectiveness of carbon leakage policies.
- New capital investment to deliver emission reductions to 2035 is substantial, ranging from $200 billion to over $500 billion for all sectors.
- The economic return for investing in low emission technology and infrastructure is positioning Australia to grow competitive green export industries to offset the decline in our emission intensive exports as the global economy decarbonises.
- The business case for many low emission technologies needs significant additional funding support before these technologies can be deployed and adopted commercially, notwithstanding the possibility of new technologies emerging and cost reductions in existing technologies over the next ten years.
- The efficiency and effectiveness of Australia's regulatory approvals system needs to improve significantly to enable a rapid acceleration in build rates of electricity and energy and other low emission technology and infrastructure.
- A comprehensive approach to scaling skilled labour capacity through cross industry reskilling, international migration, vocational education and training and university programs, is a critical enabler to the transition.
- While Australia's 2030 emission reduction target is achieved in all scenarios in this analysis, addressing challenges to achieving the 2030 target is absolutely critical to building the momentum needed to achieve a more ambitious 2035 target.
- Electrification is the largest and broadest decarbonisation lever at our disposal, but the economy also needs natural gas and liquid fuels to transition in an affordable, secure, reliable and competitive way.
- Australia needs a nonpartisan national Net Zero Roadmap to coordinate, prioritise and target action and investment that can unlock its full emission reduction potential.
- If target ambition is not matched with policy ambition, if we do not get the fundamentals right and if we fail to attract the investment needed over the next decade, then Australia risks squandering its green economic opportunity and locking itself into a disorderly and more costly transition to net zero.

1. The challenge we face

1.1 Global context

As the world economy continues to grow, so to do emissions levels, energy consumption and average surface temperatures.

1.1.1 Climate and emissions

State of the climate[5]

WMO's 2024 State of the Global Climate report finds the following.

- In 2023, the atmospheric concentration of carbon dioxide, as well as those of methane and nitrous oxide, reached the highest levels in the last 800 000 years.
- The annually averaged global mean near-surface temperature in 2024 was 1.55 °C ± 0.13 °C above the 1850–1900 average used to represent pre-industrial conditions.
- The year 2024 was the warmest year in the 175-year observational record, clearly surpassing the previous warmest year, 2023 at 1.45 °C ± 0.12 °C above the 1850–1900 average.
- For global mean temperature, each of the past ten years, 2015–2024, was individually the ten warmest years on record.
- In 2024, ocean heat content reached the highest level in the 65-year observational record, exceeding the previous record high set in 2023.
- The rate of ocean warming over the past two decades, 2005–2024, is more than twice that observed over the period 1960–2005.
- In 2024, global mean sea level reached a record high in the satellite record (from 1993 to present).
- Acidification of the ocean surface has continued over the past 39 years as shown by the steady decrease of global average ocean surface pH and regionally, ocean acidification is not increasing uniformly.
- Glacier mass loss represents the most negative three-year glacier mass balance on record, and seven of the ten most negative annual glacier mass balances since 1950 have occurred since 2016.
- The minimum daily extent of Arctic sea ice in 2024 was the seventh lowest in the observed record (since 1979) and the 18 lowest Arctic sea ice extent minima in the satellite record all occurred in the past 18 years.

Finding 1: In 2024 global surface temperatures exceeded 1.5°C but long term warming — averaged over decades — remains below 1.5°C.

[5] WMO, State of the Global Climate 2024.

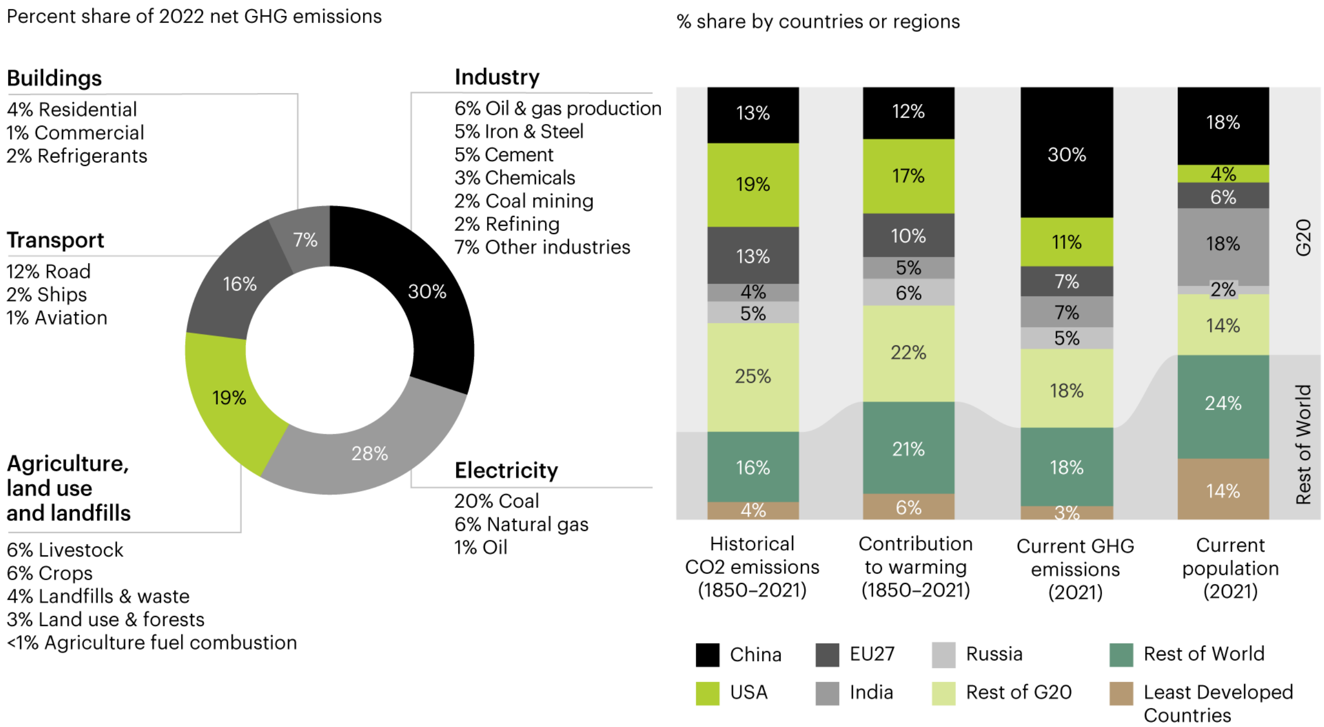
Emissions by sector

Emissions from human activity grew about 66 per cent between 1990 and 2023, primarily due to human activities, with the energy sector being the largest contributor.

Global GDP grew about 179 per cent over the same period, reflecting a relative decoupling of emissions and economic growth and declining emissions intensity of GDP over time.[6]

The four largest emitting nations, China, the United States, India and Russia, are responsible for about half of total global emissions.

Figure 1: Global emissions by sector and by region (2022)



1. Rhodium Group, Global Greenhouse Gas Emissions: 1990-2022 and Preliminary 2023 Estimates, 2024.
2. UN Environment Programme, Broken Record Temperatures hit new highs, yet world fails to cut emissions, Emissions Gap Report 2023.

1.1.2 Energy demand and supply

Global energy demand grew by 2.2 per cent in 2024 — faster than the average rate over the past decade.[7]

- Demand for all fuels and technologies expanded, led by electricity demand driven by record temperatures, expanding industry output, the electrification of transport, and the expansion of the data centre sector.
- Renewables accounted for the largest share of the growth in global energy supply (38 per cent), followed by natural gas (28 per cent), coal (15 per cent), oil (11 per cent) and nuclear (8 per cent).
- Emerging and developing economies accounted for over 80 per cent of global energy demand growth, led by China and India.
- Advanced economies also saw a notable return to growth in energy demand after several years of declines, led by the United States and with the European Union returning to growth for the first time since 2017.
- Global oil demand growth slowed and oil's share of total energy demand fell below 30 per cent for the first time ever, 50 years after peaking at 46 per cent.

[6] Our World in Data, 2025.
[7] International Energy Agency, Global Energy Review 2025, 2025.

- Natural gas saw the strongest demand growth among fossil fuels, increasing 2.7 per cent, led by China and the United States.
- Global coal demand rose by 1 per cent, as high temperatures pushed up electricity consumption for cooling, particularly in response to intense heatwaves in China and India.
- China remained the largest coal consumer globally, accounting for a record 58 per cent of global coal use.
- Global electricity consumption rose by nearly 1 100 TWh, more than twice the annual average increase over the past decade, with China making up more than half of the global increase in electricity demand.
- Rising global electricity use was driven by factors such as increasing cooling demand resulting from extreme temperatures, growing consumption by industry, the electrification of transport, and the expansion of the data centre sector.

Finding 2: The growth in global demand for both renewable and non renewable sources of energy remains strong, particularly from China and India.

1.1.3 The Paris Agreement

Global carbon budget

The Intergovernmental Panel on Climate Change (IPCC) found that limiting global warming to 1.5°C (with a 50 per cent probability) with no or limited overshoot in temperatures would require deep, rapid and sustained interim reductions in emissions and reaching net zero around 2050.

In their Sixth Assessment Report (AR6) synthesis, the IPCC recommends a global greenhouse gas reduction of 60 per cent below 2019 levels by 2035 to limit warming to 1.5°C with no or limited overshoot.[8] For Australia, achieving a 60 per cent reduction in emissions on 2019 levels is equivalent to a 2035 target of 67 per cent below 2005 levels.

Simply getting to net zero by 2050 will not be enough to limit global temperature increases to well below 2.0°C. The world economy has to do so within the available emissions budget between now and 2050.

According to the United Nations, temperature rises well above 2.0°C (2.5 to 2.9) are expected by the end of the century based on countries' current Paris Agreement pledges, and this assumes these pledges are supported by action and achieved.[9]

McKinsey's Global Energy Perspective report for 2024 explores a global 1.5°C pathway and examines three bottom up energy transition scenarios reflecting varying levels of technological progress and policy momentum. McKinsey finds that despite policy innovations, increasing global consensus, and growing private sector commitments, emissions are not declining at the rate required for a 1.5°C pathway with fossil fuel use expected to meet 40 to 60 per cent of global energy demand by 2050.

> *While significant progress has been made in the nine years since the landmark Paris Agreement, the global energy transition is entering a new phase, marked by rising costs, complexity, and increased technology challenges. To successfully navigate this next phase and meet the Paris Agreement goals, urgent action will be needed, and the pace of change must accelerate. The clean energy transition will also need to be balanced with affordability, energy system resiliency, and energy security in an increasingly uncertain macroeconomic environment.*[10]

[8] IPCC, Climate Change 2022 Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, 2022.
[9] UN Environment Programme, Broken Record Temperatures hit new highs, yet world fails to cut emissions, Emissions Gap Report 2023.
[10] McKinsey and Company, Global Energy Perspective 2024, September 17, 2024.

Targets and progress

There are 195 signatory nations or Parties to the Paris Agreement — the legally binding international treaty on climate change. Article 2 of the Paris Agreement sets out its aims with respect to strengthening the global response to climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

- holding the increase in the global average temperature to well below 2°C above preindustrial levels; and pursuing efforts to limit the temperature increase to 1.5°C above preindustrial levels;
- increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;
- making finance flows consistent with a pathway towards low greenhouse gas emissions and climate resilient development.

The Paris Agreement requires countries to determine their own contribution to meeting the global temperature goals, guided by the principles of equity and 'common but differentiated responsibilities and respective capabilities' in the light of their different national circumstances.

Under the Paris Agreement, national targets set out in Nationally Determined Contributions (NDC) are designed to ratchet up over time and together with other countries cumulatively meet the global temperature goals. New targets must be submitted at least every five years and each target must be more ambitious than the one before.

Of the 195 signatory nations under the Paris Agreement, 20 have submitted NDCs for 2035, including the United States which has since withdrawn from the Paris Agreement. Nations have until September 2025 to submit their NDC to the United Nations Framework Convention on Climate Change.

Figure 2: 2035 NDCs of Australia's trading partners

Nation	2030 target	2035 target
United Kingdom	68 per cent below 1990 levels by 2030	81 (78) per cent below 1990 (2005) levels by 2035[11]
United States	50 to 52 percent below 2005 levels by 2030	61 to 66 percent below 2005 levels by 2035[12]
Canada	40 to 45 percent below 2005 levels by 2030	45 to 50 percent below 2005 levels by 2035
New Zealand	50 percent below 2005 levels by 2030	51 to 55 percent below 2005 levels by 2035
Singapore	60 million tonnes reduction by 2030	45 to 50 million tonnes reduction by 2035
Japan	46 percent below 2013 levels by 2030	60 percent below 2013 (2005) levels by 2035[13]
Brazil	50 percent below 2005 levels by 2030	59 to 67 percent below 2005 levels by 2035

Finding 3: Countries' 2035 targets are reflecting a wide range of ambition — from Canada's 45 per cent to the United Kingdom's 78 per cent below 2005 levels by 2035.

[11] The 78 per cent on 2005 base year was derived from GOV.UK, 2020 UK greenhouse gas emissions: final figures - data tables (Excel).
[12] This target was submitted before the United States President signed an executive order for the United States to withdraw from the Paris (a second time) in January 2025, to take effect January 2026.
[13] Japan's emissions in 2005 and 2013 were about the same.

1.2 Domestic context

The transition to net zero 2050 is both a challenge and an opportunity for Australia.

1.2.1 Australia's climate and emissions

State of the climate

CSIRO's 2024 biennial State of the Climate report finds the following.[14]

- Australia's climate has warmed by an average of 1.51 ± 0.23 °C since national records began in 1910.
- Sea surface temperatures have increased by an average of 1.08 °C since 1900.
- The warming has led to an increase in the frequency of extreme heat events over land and in the oceans.
- In the south west of Australia there has been a decrease of 16 per cent in April to October rainfall since 1970.
- Across the same region, May to July rainfall has seen the largest reduction, by 20 per cent since 1970.
- In the southeast of Australia, there has been a decrease of 9 per cent in April to October rainfall since 1994.
- Heavy short term rainfall events are becoming more intense.
- There has been a decrease in streamflow at most gauges across Australia since 1970.
- There has been an increase in rainfall and streamflow across parts of northern Australia since the 1970s.
- There has been an increase in extreme fire weather, and a longer fire season since the 1950s.
- There has been a decrease in the number of tropical cyclones observed in the Australian region since 1982.
- Snow depth, snow cover and number of snow days have decreased in alpine regions since the late 1950s.
- Oceans around Australia are becoming more acidic, with changes happening faster in recent decades.
- Sea levels are rising around Australia, including more frequent extreme high levels that increase the risk of inundation and damage to coastal infrastructure and communities.

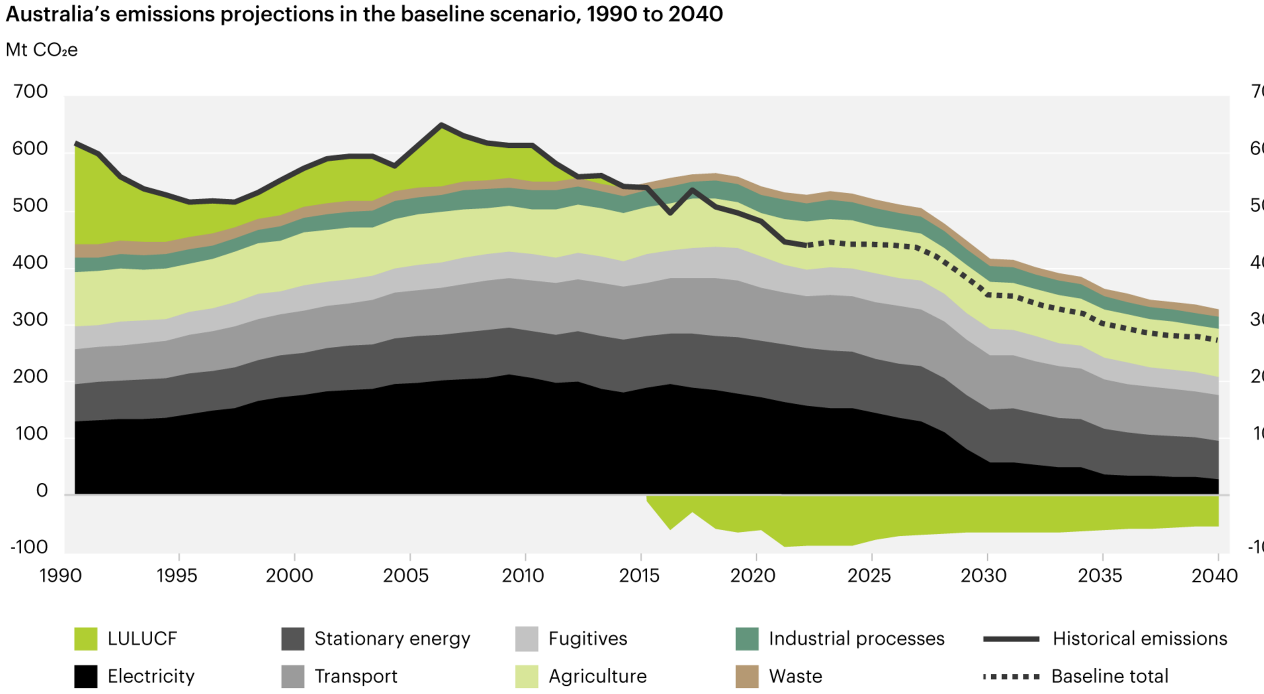
Emissions by sector

In 2024 Australia's domestic emissions were 441 Mt CO_2e, compared to 609 Mt CO_2e in 2005, which is a 28 per cent reduction. Australia has managed to reduce its emissions while growing it population and economy substantially — from 2005 to 2024 the emissions intensity of the economy was down 56 per cent and emissions per capita decreased by 46 per cent.[15]

This drastic reduction has been driven by land sector activities which serve as a significant carbon sink — decreasing by 217 per cent from 2005 to 2024 (from +75 Mt CO_2e to -88 Mt CO_2e per year). This was due to reductions in land clearing and native forest harvesting, increases in plantations and native vegetation, and improvements in soil carbon over the period.

[14] CSIRO, State of the Climate 2024.
[15] Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2024, Australian Government Department of Climate Change, Energy, the Environment and Water.

Figure 3: Australia's emissions by sector



Source: Department of Climate Change, Energy, the Environment and Water (DCCEEW), Australia's emissions projections 2024, November 2024

1.2.2 Australia's climate targets and policy framework

Australia's Paris commitment

In signing the Paris Agreement, Australia committed to doing its part to hold the increase in the global average temperature to well below 2°C above preindustrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre industrial levels.

Australia's current (2030) NDC includes three emissions reduction targets:

- a commitment to reduce greenhouse gas emissions to 43 per cent below 2005 levels by 2030, implemented as a single-year point target.
- a multi year emissions budget for the period 2021 to 2030, with an indicative value of 4381 million tonnes CO2-e, corresponding to the 43 per cent target.
- net zero by 2050.

In 2022 the Australian Government's Climate Change Bill enshrined in law Australia's 2030 target and net zero by 2050 target. The Bill also:

- requires the minister to prepare and table an annual climate change statement;
- requires the Climate Change Authority to give the minister advice in relation to the annual statement and future greenhouse gas emissions reduction targets;
- provides for periodic reviews of the operation of the Act.

In its 2024 Issues Paper: Targets, Pathways and Progress, the Climate Change Authority stated that:

> *The authority's preliminary view is that while Australia should strive to reduce emissions as quickly as possible, going too fast would risk significant levels of economic and social disruption.*

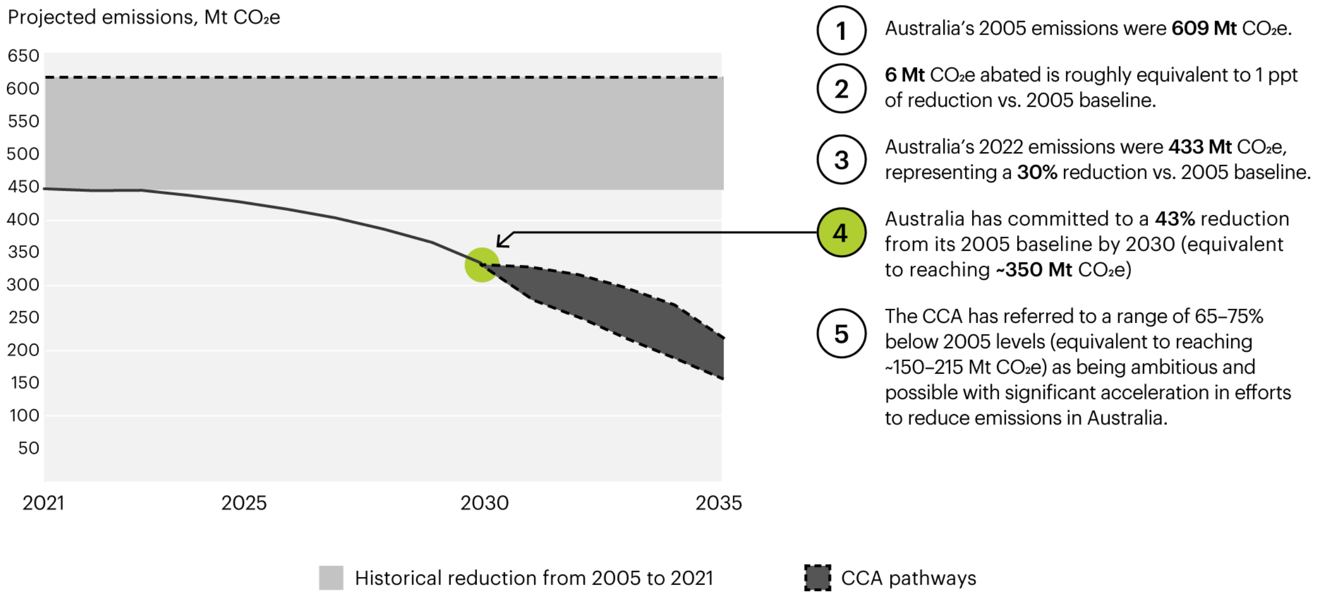
With respect to Australia's 2035 target, the CCA also stated that:

> *The evidence to date suggests the authority consider targets broadly within the 65 to 75 per cent range* [and that] *achieving a target in the range of 65 to 75 per cent below 2005 levels would require a significant acceleration in efforts to reduce emissions in Australia.*

The Climate Change Authority outlines the basic arithmetic for these emission reduction targets as follows:

- Since 2010, Australia's emissions have declined by 11 Mt CO_2e per year, on average, and this would need to increase to 15 to 16 Mt CO_2e per year on average if Australia is to meet its 2030 target of 43 per cent below 2005 levels.
- If Australia achieves its 2030 target and emissions continue to decline at that same rate for another five years, emissions would be 56 per cent below 2005 levels in 2035.
- Australia would need to reduce its emissions by 27 to 39 Mt CO_2e each year, on average, from 2031 to 2035 to achieve a 2035 target of 65 to 75 per cent below 2005 levels.

Figure 4: Possible emission reduction pathways for Australia to 2035



Source: National Inventory Report 2022, DCCEEW, April 2024; 2024 Issues Paper: Targets, Pathways and Progress, Climate Change Authority, April 2024; and Sector Pathways Review 2024, Climate Change Authority, September 2024

Australia's climate policy framework

The Australian Government is developing a Net Zero Plan — supported by six sectoral emissions reduction plans and the Future Made in Australia agenda — to build on the existing suite of emissions reduction policies and measures.

The Australian Government's most recent emissions projections[16] shows that with existing Commonwealth policies, including state and territory policies as at September 2024, meets Australia's the 2030 target.

> *Australia is 45 per cent of the way through the Paris Agreement target period and has generated emissions equivalent to 45 per cent of the emissions budget to 2030.*

[16] Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2024, Australian Government Department of Climate Change, Energy, the Environment and Water.

However, the Climate Change Authority in its Annual Progress report[17] notes that:

> *Emissions are falling but not yet at the rate required to meet Australia's 2030 emissions reduction target. To reach its 2030 target, Australia's emissions must fall by an average of 15 Mt CO_2-e each year, starting now. Australia's emissions declined by 3 Mt CO_2-e over 2023–24 and have declined by an average of 12 Mt CO2-e per year since 2006.*

Transitioning our economy is challenging and critical to the achievement of Australia's 2030 target. Addressing key enablers, such as improving the approvals system by fixing the EPBC Act, is essential to accelerate infrastructure build rates to achieve this target.

Figure 5: ***Emission projection scenarios***[18]

The Government's baseline 2030 emission reduction scenarios (policy inclusions and exclusions)

- the expanded Capacity Investment Scheme
- the New Vehicle Efficiency Standard
- Safeguard Transformation and Critical Inputs to Clean Energy Industries Stream of the Powering the Regions Fund
- the Safeguard Mechanism reforms.

The Australian Government's 'with additional measures' scenario includes:

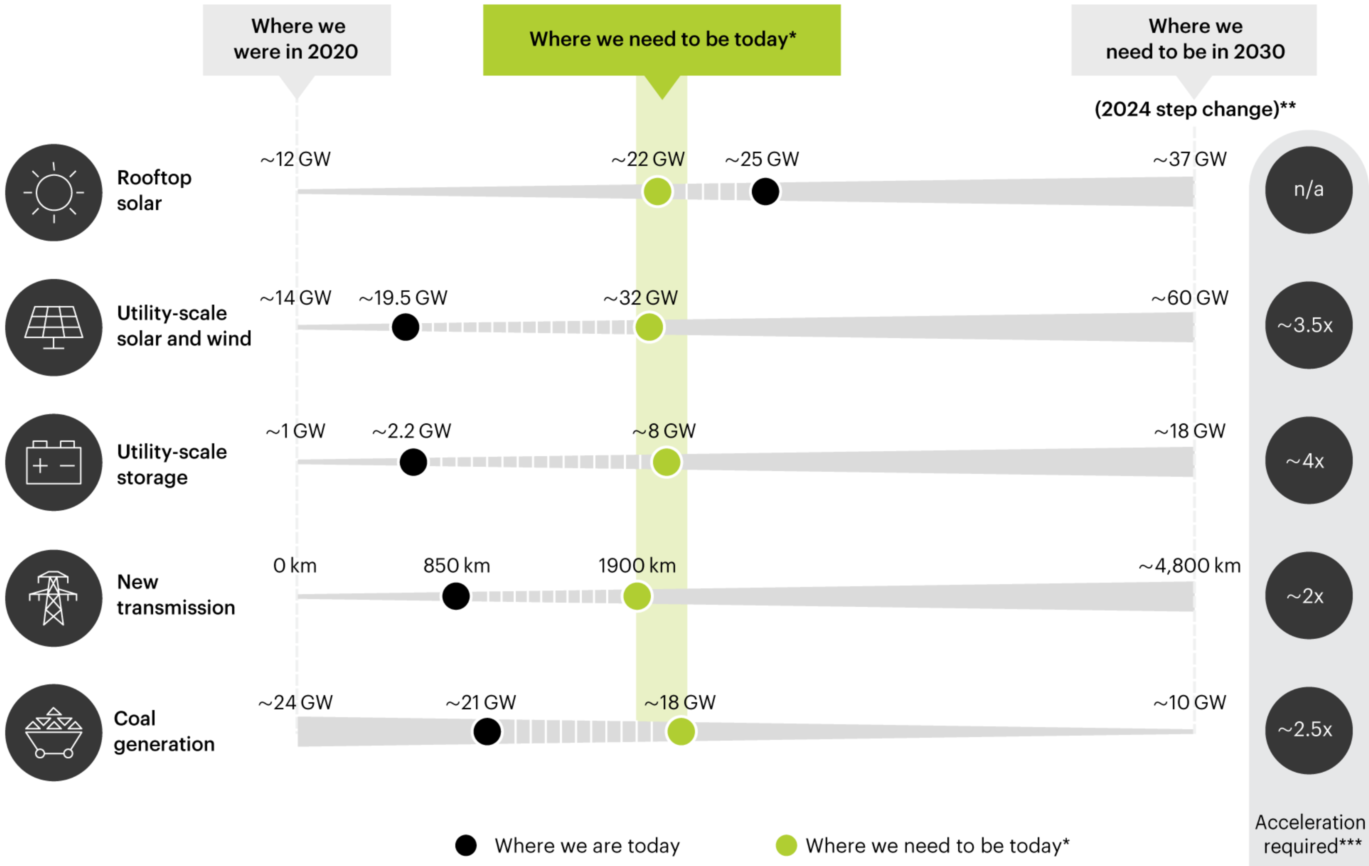
- the National Hydrogen Strategy, supported by Hydrogen Headstart and the Hydrogen Production Tax Incentive
- the Critical Minerals Production Tax Incentive
- the Industrial Transformation Stream of the Powering the Regions Fund.

The Government's projections don't include policies that have been announced but are yet to be fully implemented:

- initiatives announced at the 2024–25 Budget
- initiatives to expedite the emergence of Australia's green metals industry
- projects under the Future Made in Australia Innovation Fund
- further work on low carbon liquid fuels
- new government purchases of ACCUs under the Powering the Regions Fund
- working with regulators and industry to reduce, and where possible, eliminate venting and flaring of gas
- further regulated improvements to the emission intensities of new vehicles beyond currently legislated standards to 2029.

[17] Climate Change Authority, 2024 Annual Progress Report, November 2024.
[18] Department of Climate Change, Energy, the Environment and Water, Australia's emissions projections 2024 November 2024.

Figure 6: The energy transition journey for the national electricity market (2024)



* Shown assuming straight line progress to end calendar year 2024 (i.e. linear growth from 2020 to 2030)
** Calendar year 2030 shown as average of FY29-30 and FY30-31 in ISP step change
*** Acceleration defined as annual increase in build rate vs 2024 rate; for coal decommission defined as annual increase in decommissioning rate vs. average from 2020 to current.

Source: CEC Clean Energy Australia Report Series, AEMO 2024 ISP, AER State of the Energy Market reports, AEMO Generator Information

1.2.3 Net zero and the economy

Australia's productivity growth and investment attractiveness is a central consideration in how we approach rebuilding our energy and industrial infrastructure and reducing emissions.

Dr Alan Finkel recently wrote:[19]

> *The transition to net zero emissions is the most difficult economic transition undertaken by humanity. Not the most difficult transition since the Industrial Revolution. Not the most difficult since the Second World War. This economic transition is the most difficult, ever. It is driven by externalities, not convenience or economic benefits.*

The Intergenerational Report 2023: Australia's future to 2063 concluded that:

> *Climate change will affect the shape of Australia's economy, where and how Australians live, work and travel, the health of the population, migration patterns, food and energy security, and the state of our environment. These effects, and the way households, businesses and governments respond to them, will drive innumerable changes in the size and structure of Australia's economy, presenting*

[19] Engineers Australia, Calling on engineers to detour the social license barriers to the clean energy transition, Accelerating Energy Transition Series, June 2024.

new opportunities and economic challenges. This all carries economic and fiscal implications.[20]

Two recent reports by the BCA argued that the key to achieving our broader economic goals and the net zero goal is to make Australia one of the most attractive investment destinations in the world, by becoming a more competitive place to do business. The Government's Future Made in Australia Agenda is one important policy dimension in this regard but getting other fundamental policy settings right, such as the taxation system and the industrial relations system, is also critical.

BCA Report: Achieving a net zero economy (2021)

In a report released in 2021 — Achieving a net zero economy — the BCA concluded that:[21]

> *Decarbonisation is central to Australia's economic transformation and meeting the challenges of a rapidly changing world. It must run in tandem with the nation realising greater economy wide productivity gains, lifting international competitiveness and improving the ability to attract investment in order to accelerate economic growth and secure Australia's long term prosperity.*

The report's analysis concluded that:

> *Over the next 50 years, modelling by Deloitte Access Economics estimates that the economic dividend from a smooth transition to net zero emissions by 2050 — aligned to our proposed strategy — is estimated to be a $890 billion increase to GDP (net present value) due to higher productivity levels and over 195,000 additional jobs by 2070.*

We note that substantial progress has been made by government on the seven point policy architecture proposed in this report to attract investment to decarbonise our economy.

- Climate targets and budgets — Australia's climate targets and budgets and the process for setting these under the Paris Agreement have been enshrined in legislation.
- Carbon investment signals — the Safeguard Mechanism sets declining emissions baselines on Australia's largest industrial facilities in line with national emission reduction targets.
- Offset markets — the integrity of the Australian Carbon Credit Units Scheme has been reviewed and fortified by the implementation of recommendations from an independent panel.
- Innovation and technology — strategic support is being provided from a range of sources, including Hydrogen Headstart, the Critical Minerals Strategy, and the Capacity Investment Scheme.
- Low carbon regional roadmap — the Net Zero Economy Authority is being established to support workers, communities, regions and industry to realise and share in the benefits of the transition.
- Adaptation planning — Australia has a National Climate Resilience and Adaptation Strategy and National Adaptation Policy Office to oversee implementation of this Strategy.
- Policy integration and coordination — the Climate Change Authority (CCA) has been further resourced to advise government on Australia's climate policy framework and achieving a net zero economy.

BCA Report: Seize the moment (2023)

In a report released in 2023 — Seize the moment — BCA concluded that:[22]

> *The country faces global uncertainty and the urgent need to decarbonise our economy and is witnessing other nations embarking on policies that risk shifting investment and activity away from*

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[20] The Australian Government, Intergenerational Report 2023 Australia's future to 2063, 2023.
[21] See the full report at https://www.bca.com.au/achieving_a_net_zero_economy
[22] See the full report at https://www.bca.com.au/seize_the_moment

> *our shores. Australia has tremendous endowments including our natural resources, skilled and educated population, stable institutions, and proximity to the emerging Asian markets that will drive new forms of prosperity.*

The big shifts recommended in this report, which are broader than climate and energy policy, are crucial for getting the fundamentals right and attracting investment to decarbonise our economy. Chapter five of this report, 'energy and the road to net zero' calls on the Australian Government and the State and Territory Governments to Commit to a detailed 10 year national Net Zero Roadmap based on a whole of system approach to decarbonising the economy to 2050.

This approach would recognise that the electricity sector, the gas sector, the industrial sector and major infrastructure need to work together. It would also recognise the importance of:

- focusing on reducing emissions as the underlying goal of the Net Zero Roadmap and being agnostic to the range of technologies that can best achieve this goal;
- getting the policy and regulatory settings right and creating the right environment for investment to attract the vast amounts of private capital needed to decarbonise the economy;
- the need to ensure bipartisanship so we can stay the course on the decarbonisation journey, given that making progress is likely to get harder before it gets easier.

A Net Zero Roadmap should assist in navigating the key policy and investment levers needed to achieve Australia's 2030 emission reduction target, set ambitious but pragmatic emission reduction targets beyond 2030 and ensure an efficient and orderly transition to net zero 2050.

BCA Response: Future Made in Australia Agenda (2024)

The Future Made in Australia (FMIA) agenda reflects the Government's intent to craft an Australian response to the US Inflation Reduction Act, as called for by the BCA.

In our submission to the Senate inquiry into the Future Made in Australia Bill 2024, we argued that:[23]

> *Australia should not sit still while other countries are increasing their incentives, nor while they are growing their competitiveness at a foundational level. To best grow our economy we must, as a point of national urgency, become a more competitive place to do business. The net zero transformation and fragmentation of the global economy mean that the resilience and competitiveness of Australian business — more than ever — is dependent on its ability to be flexible and adaptable to change.*
>
> *This requires a focus on getting the fundamentals right to make Australia an attractive investment destination through reform of our tax system, easing the burden of regulation, a streamlined project approvals process, a high quality skills and education system, a well managed migration program, a streamlined foreign investment screening regime, and improvements to the workplace relations system.*

FMIA needs to be just one component of a reinvigorated and contemporary industry policy where we ensure a future still made in Australia by optimising across the entire economic system, not just focusing primarily on the early stages of a new industry. Any activity currently in Australia that is lost to a more competitive environment overseas risks being lost forever, with the resulting loss in innovation, investment, productivity, jobs, and revenue.

Finding 4: Australia's productivity growth and investment attractiveness is a central consideration in how we reduce emissions — getting the broader macro fundamentals right will be key.

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[23] See the full submission at https://www.bca.com.au/submission_to_senate_inquiry_into_the_future_made_in_australia_bill_2024

2. Framing our potential

2.1 The evidence base

This evidence base is the result of a 12 month collaborative effort between McKinsey and the BCA. While there is strong alignment between our two organisations on the evidence base, the views expressed in this report are those of the BCA and as such are not intended to represent the views of McKinsey.

This evidence base represents a granular, ground up perspective of all relevant technologies and enablers for reducing emissions across seven sectors of the Australian economy as defined by the Government's sectoral emissions reduction plans being developed in support of its Net Zero Plan.

Our approach is based on an assessment of potential investments in currently available technologies, and on current technology cost projections — site by site and asset by asset in some cases — to build up a picture of Australia's emission reduction potential over the next ten years. We acknowledge that there is always the possibility of new technologies emerging and cost reductions in existing technologies over the next ten years, that have not been captured by our approach. Positive technology surprises in this regard could increase Australia's emission reduction potential.

These seven sectors have been decomposed into 72 segments, 15 energy sources and over 250 individual technologies. The analysis draws on baseline emissions of the 240 sites covered under the Safeguard Mechanism and review of over 70 published decarbonisation strategies from Australian companies. The analysis benefits from deep engagement and stress testing with many large Australian businesses and other experts.

The evidence base frames Australia's emission reduction potential between 2025 and 2035 using three scenarios that ratchet in ambition.

1. Scenario one — Australia's emission reduction efforts are maintained from a 29 per cent reduction in 2022 and passing through a 43 per cent reduction in 2030, to achieve around a 50 per cent reduction in 2035.
2. Scenario two — Australia's emission reduction efforts are accelerated beyond scenario one to achieve around a 60 per cent reduction in 2035.
3. Scenario three — Australia's emission reduction efforts are accelerated beyond scenario two to achieve around a 70+ per cent reduction in 2035.

The evidence base provides insights into what it will take for Australia to achieve the 2035 emission reduction in each scenario in terms of the following.

- Critical assumptions and levers — activity levels by sector, and the penetration and timing of deployment and adoption of specific low emission technologies by sector, from 2025 to 2035.
- Practical challenges and key enablers — physical and economic barriers to the deployment and adoption of low emission technologies, in the timeframes and at the penetration levels required.
- Economic impacts and opportunities — implications for Australia's national productivity, investment and comparative advantages in traditional export industries and new green industries.

The evidence base analyses the seven sectors of the economy — electricity and energy, resources, transport, industry, buildings, agriculture and the land use, land use change and forestry (land) sector — as broadly defined by the Government and the Climate Change Authority.

At the commencement of this work the most recent emissions inventory available for Australia was the National Inventory Report 2022. We note that Australia's emissions are slightly higher in the National Inventory Report 2023. We also note that Australia's most recent quarterly emissions projections reveal the return to a downward trend in national emissions. The nature of economic activity means that emissions levels will continually rise and fall slightly across sectors and the national economy in the short term, irrespective of the long term trend in emission levels. The very minor variation between the three emission data sets referred to above is immaterial to this analysis and the findings of the work more generally.

In the 2022 base year for this analysis Australia's net emissions were 433 Mt CO_2e and its gross emissions were 521 Mt CO2-e. The difference of -88 Mt CO_2e is land sector emissions (Australia's carbon sink).

- 433 Mt CO2e is 29 per cent below Australia's 2005 emission level of 609 Mt CO_2e.
- A one percentage point reduction below 2005 emission levels is equivalent to 6 Mt CO_2e abated.
- Australia's 2030 emission reduction target (43 per cent) is equivalent to 350 Mt CO_2e emitted in 2030.
- A 2035 target range of 65 to 75 per cent is equivalent to 213 to 152 Mt CO_2e emitted in 2035.

While the focus of the analysis for each of the three scenarios is the level of emissions in 2035, emissions are projected for each year from 2025 to 2035. Emissions in the year 2030 in all three scenarios are consistent with the Australian Government's commitment to reduce emissions to 43 per cent below 2005 levels and the corresponding budget value of 4381 million tonnes CO_2-e for the period 2021 to 2030.

2.2 Emission reduction scenarios

The evidence base is framed using the three emission reduction scenarios for Australia from 2022 to 2035.

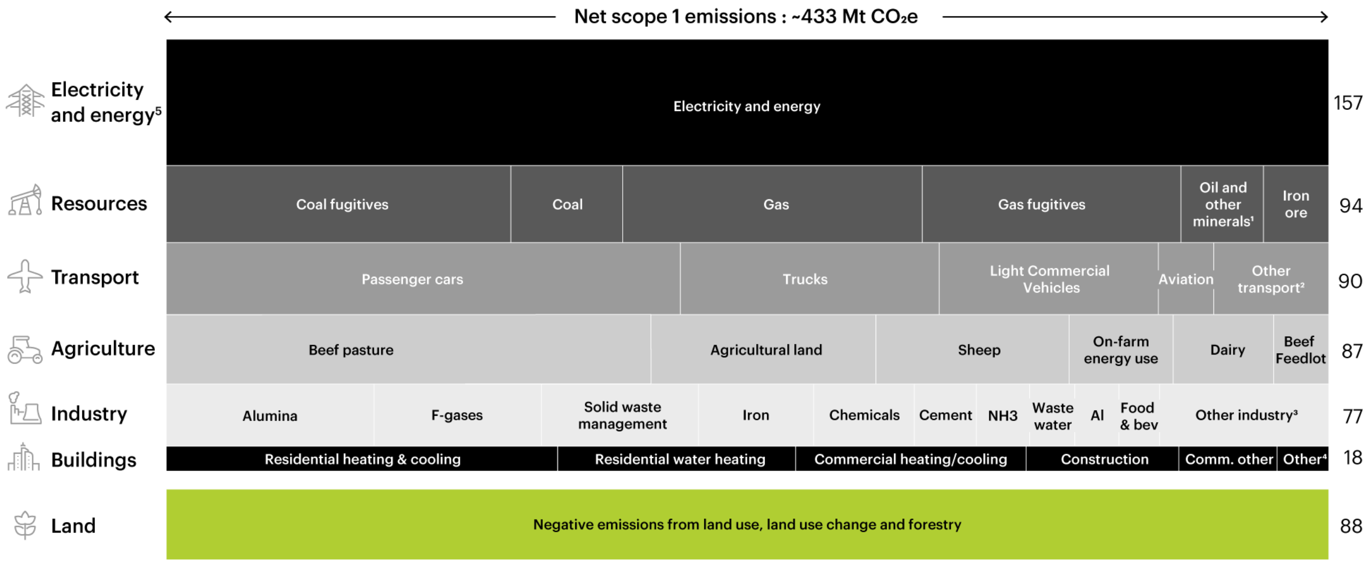
Figure 7: Summary of emission reduction scenarios (based on current technologies & cost projections)

Scenario	Target	Implications
One Australia's emission reduction efforts are maintained from a 29 per cent reduction in 2022 and passing through a 43 per cent reduction in 2030.	~50 per cent emission reduction by 2035 on 2005 *From 2022 to 2035* ▪ Electricity and energy emissions fall by 121 Mt (78 per cent) ▪ Resources emissions fall by 16 Mt (17 per cent) ▪ Transport emissions fall by 4 Mt 4 per cent) ▪ Industry emissions fall by 15 Mt (20 per cent) ▪ Buildings emissions fall by 2 Mt (12 per cent) ▪ Agriculture emissions are flat 0 Mt (0 per cent) ▪ Land sink emissions rise by 22 Mt (25 per cent)	Requires existing policy measures and commitments to be fully implemented as announced. The net transition investment cost for this scenario is $210 to $300 billion. Does not require explicit behavioural changes and does not impact export activity. Minimal investment in the foundations for a competitive green exports sector in the future.
Two Australia's emission reduction efforts are accelerated.	~60 per cent emission reduction by 2035 on 2005. *From 2022 to 2035* ▪ Electricity and energy emissions fall by 132 Mt (85 per cent) ▪ Resources emissions fall by 29 Mt (31 per cent) ▪ Transport emissions fall by 10 Mt (11 per cent) ▪ Industry emissions fall by 32 Mt (41 per cent) ▪ Buildings emissions fall by 7 Mt (41 per cent) ▪ Agriculture emissions fall by 6 Mt (8 per cent) ▪ Land sink emissions rise by 17 Mt (19 per cent)	Requires new or augmented policy measures to be implemented. The net transition investment cost for this scenario is $395 to $480 billion. Does not require explicit behavioural changes and does not impact on export activity. Significant investment in the foundations for a competitive green exports sector in the future.

Three Australia's emission reduction efforts are pushed further.	~70+ per cent emission reduction by 2035 on 2005 *From 2022 to 2035* ▪ Electricity and energy emissions fall by 143 Mt (91 per cent) ▪ Resources emissions fall by 50 Mt (53 per cent) ▪ Transport emissions fall by 14 Mt (18 per cent) ▪ Industry emissions fall by 42 Mt (54 per cent) ▪ Buildings emissions fall by 10 Mt (56 per cent) ▪ Agriculture emissions fall by 13 Mt (16 per cent) ▪ Land sink emissions are flat 0 Mt (0 per cent)	Requires new or augmented policy measures to be implemented. The net transition investment cost for this scenario is $435 to $530 billion. Potential loss of export value of $100 to $150b per year and carbon leakage risk as a result of economic activity reductions, depending on global demand for emissions intensive goods, and the effectiveness of carbon leakage policies. May require explicit consumer behaviour changes and increased green product imports to further decarbonise the domestic economy.

In the 2022 base year for this analysis Australia's net emissions were 433 Mt CO_2e.

Figure 8: Australia's 2022 emissions by sector



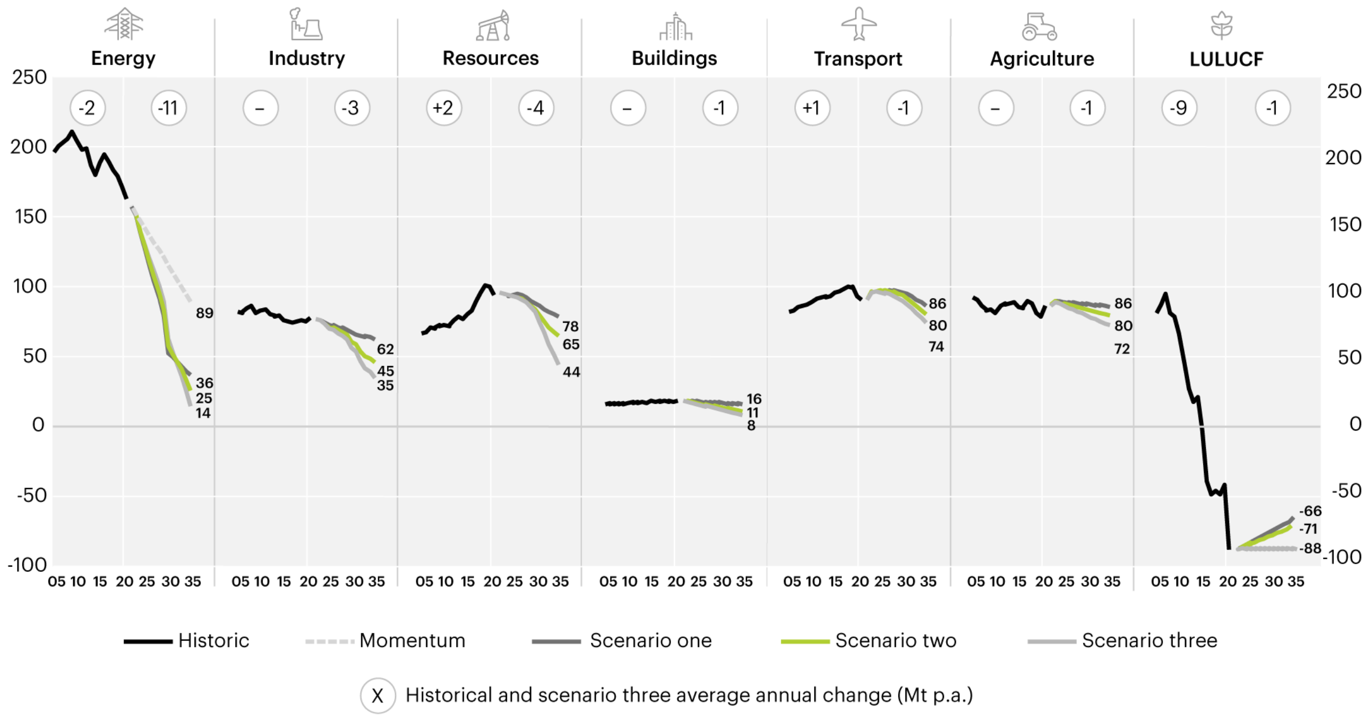
1. Includes: oil refining, oil refining fugitives, gold, Other minerals, Copper, Nickel, Lithium
2. Includes the segments: Maritime, Buses and Rail
3. Includes hydrogen, food and beverage, aluminium, pulp and paper, glass and ceramics, wastewater management, ethylene, steel, lime and process use of carbonates
4. Residential other, including the segments: Residential appliances, – lighting and – cooking
5. Includes direct emissions from electricity generation, while emissions from gas, oil, and other primary energy sources are at tributed to the sectors where they are consumed

Note: Land and Agriculture are treated as a single sector as part of the government's NDC 2035 consultation – for analytical purposes and as aligned with other reports they have been modelled as separate sectors in this work ('Agriculture' and 'Land')

Source: National Inventory Report 2022, DCCEEW, April 2024

Emissions in each sector are projected forward from the 2022 base year to 2035 in this analysis.

Figure 9: Pace of historic and future emission reductions by sector and scenario, $MtCO_2e$



Source: National Inventory Report 2022, DCCEEW, April 2022; and McKinsey Decarbonisation Scenario Explorer

Finding 5: The bulk of the emission reduction task to 2035 will fall to electricity and energy, resources and industry with smaller contributions expected from transport, agriculture and buildings, and no additional reductions expected from the land sector — where maintaining the historical peak size of Australia's carbon sink requires additional effort.

Finding 6: New capital investment to deliver emission reductions to 2035 is substantial, ranging from $210 to $530 billion for all sectors.

2.2.1 Scenario one (~50 per cent cut)

Scenario one is defined by the following assumptions.

- Full implementation of existing policies and measures, including the 82 per cent renewable target, the capacity investment scheme, the safeguard mechanism and the national vehicle efficiency standard.
- Full achievement of specific corporate emission reduction targets announced and backed by specific plans of leading industry players (and excluding corporate targets not yet supported by specific plans).
- Trend rates of delivery of some infrastructure and technology (solar) and increases to historical peak rates and above in some cases (wind).
- All low emission technologies adopted and deployed are readily available and demand for these technologies is not constrained by their supply.

The ~50 per cent emission reduction by 2035 on 2005 levels in this scenario is broadly consistent with recent Australian Government projections.[24]

[24] Department of Climate Change, Energy, the Environment and Water, Australia's emissions projections 2024.

In scenario one the largest emission reductions come from the following sectors.

- Electricity and energy — emissions from electricity generation fall by 122 Mt or 78 per cent from 2022 to 2035 as renewable electricity sources reach about 85 per cent of national electricity supply, assuming build rates for wind, solar and storage capacity in line with the AEMO integrated system plan.
- Resources — emissions fall by 16 Mt or 17 per cent from 2022 to 2035 driven by increased levels of electrification and the use of biofuels in mining.
- Industry — emissions fall by 15 Mt or 20 per cent from 2022 to 2035 driven by existing government policies including the import ban on refrigerants with high global warming potential and the safeguard mechanism.

In scenario one emission reductions from the transport, buildings and agriculture sector are more limited.

- Transport — increases in vehicle demand due to population growth and slow rates of replacement of petrol and diesel vehicles with low emission technologies.
- Buildings — natural asset replacement rates of gas heating and cooling appliances with electric technology alternatives (coupled with a low emissions baseline).
- Agriculture — nascent technologies to reduce enteric fermentation from livestock (particularly pasture fed livestock) remain challenging to scale.

Finding 7: Achieving around a 50 per cent 2035 emission reduction target requires ongoing effort and progress — Australia's current electricity and energy infrastructure build rate remains a significant challenge.

Figure 10: Summary of emission reductions by sector — scenario one (~50 per cent cut)

Sector	Emission reduction
Electricity and energy	Electricity and energy emissions fall 78 per cent from 157 to 36 Mt CO_2e from 2022 to 2035 and the renewables penetration of the national electricity market increases from 32 to 85 per cent over the period.
Resources	Resources emissions fall 17 per cent from 94 to 78 Mt CO_2e from 2022 to 2035.
Transport	Transport emissions fall 4 per cent from 90 to 86 Mt CO_2e from 2022 to 2035.
Industry	Industry emissions fall 20 per cent from 77 to 62 Mt CO_2e from 2022 to 2035.
Buildings	Building emissions fall 12 per cent from 18 to 16 Mt CO_2e from 2022 to 2035.
Agriculture	Agriculture emissions are more or less unchanged at 86 Mt CO_2e from 2022 to 2035.
Land	Land emissions increase from -88 to -66 Mt CO_2e from 2022 to 2035 — a 25 per cent reduction in emissions stored in the nation's carbon sink.

2.2.2 Scenario two (~60 per cent cut)

Scenario two is defined by the following assumptions.

- All industry players adopt and deploy low emission technologies (which are readily available) in line with leading industry players' announcements and plans.
- The funding gap facing commercial deployment and adoption of these technologies is bridged by new or augmented policy measures.
- Permitting and social licence bottlenecks are addressed to enable the delivery of infrastructure and technology above trend rates (and double historical peak rates in some cases).

- Challenges to scaling a skilled workforce, such as our sluggish migration system, are progressed to enable the delivery of infrastructure and technology above trend rates (and double historical peak rates in some cases).
- Australia is successful at securing the supply of low emission technologies by 'moving to the front of the queue' for scarce global supplies where needed.
- Capital excellence is improved by raising the productivity of large scale project delivery, avoiding cost and time overruns.
- Improved coordination and collaboration for better integration of demand and supply of low emission products, policies and measures at all levels of government to provide regulatory stability, and supply chain transparency through digital solutions.

Between scenarios one and two the largest incremental emission reductions come from the following sectors.

- Industry — emissions fall by 32 Mt or 41 per cent from 2022 to 2035, enabled through a mix of electrifying low and high temperature heating, and technologies addressing process emissions.
- Resources — emissions fall by 29 Mt or 31 per cent from 2022 to 2035, enabled by electrifying fixed mining equipment and LNG liquefaction, and reducing fugitive emissions from the production of coal and gas.
- Electricity and energy — emissions from electricity generation fall by 132 Mt or 84 per cent from 2022 to 2035 as renewable electricity sources reach about 90 per cent of national electricity supply, assuming a significant acceleration in the build rates for wind and transmission capacity (2 times historical peak rates), increases in new gas capacity to address system firming and peak day shortfalls, and accelerated uptake of consumer energy resources.

In scenario two emission reductions from the transport, building and agriculture sectors are significant.

- Agriculture — emissions fall by 7 Mt or 8 per cent from 2022 to 2035, enabled through a combination of scaling methane reducing feed additives (for feedlot livestock), reducing fertiliser use and greater adoption of urease and nitrogen inhibitors, and electrification and fuel switching for agriculture equipment.
- Transport — emissions fall by 10 Mt or 11 per cent from 2022 to 2035, enabled primarily by accelerated adoption of electric vehicles across passenger and commercial vehicles.
- Building — emissions fall by 7 Mt or 41 per cent from 2022 to 2035, enabled primarily by accelerated adoption of heat pumps in residential space heating and cooling, water heating, and commercial space heating and cooling.

Finding 8: Achieving around a 60 per cent 2035 emission reduction target would require a significant policy push from governments, and sustained investment actions from the private sector to encourage widespread deployment and adoption of low emission technologies, and to breakthrough bottlenecks in attaining project approvals and social licence and skilled workforce scaling.

Figure 11: Summary of emission reductions by sector — scenario two (~60 per cent cut)

Sector	Emission reduction
Electricity and energy	Electricity and energy emissions fall 85 per cent from 157 to 25 Mt CO_2e from 2022 to 2035 and the renewables penetration of the national electricity market increases from 32 to 90 per cent over the period.
Resources	Resources emissions fall 31 per cent from 94 to 65 Mt CO_2e from 2022 to 2035.
Transport	Transport emissions fall 11 per cent from 91 to 80 Mt CO_2e from 2022 to 2035.
Industry	Industry emissions fall 41 per cent from 77 to 45 Mt CO_2e from 2022 to 2035.
Buildings	Building emissions fall 41 per cent from 18 to 11 Mt CO_2e from 2022 to 2035.
Agriculture	Agriculture emissions fall 8 per cent from 86 to 80 Mt CO_2e from 2022 to 2035.
Land	Land emissions increase from -88 to -71 Mt CO_2e from 2022 to 2035 — 19 per cent reduction in emissions stored in the nation's carbon sink.

2.2.3 Scenario three (~70+ per cent cut)

Scenario three is defined by the following assumptions.

- Several low emission technologies are deployed and adopted at their 'theoretical limit' with commercial and consumer take up rates of 90 to 100 per cent and accelerated rates of capital replacement, in some cases.
- Record breaking build rates for wind, transmission and gas capacity would enable the electricity sector to operate at a renewables penetration level above 90 per cent in 2035.[25]
- The funding gap facing commercial deployment and adoption of some of these technologies at their 'theoretical limit' is bridged by new or augmented policy measures.
- Partial reductions in emissions intensive economic activity, for example, reduced exports of thermal coal and LNG ahead of global demand signals, are possible ways to reduce emissions — the loss of Australia's export value in this scenario is estimated at $100 to $150 billion per year, while having no (or increasing) impact on global emissions due to carbon leakage.
    - We note that this assumption based on central forecasts of global demand for Australia's emissions intensive exports, around which there is significant uncertainty.
    - If global demand falls faster than expected then Australia's exports of thermal coal and LNG (and scope one emissions associated with these activities) would reduce in line with global demand without any carbon leakage to other nations.
    - The degree of carbon leakage risk (if any) would also depend on the effectiveness of carbon leakage policies domestically and globally.
- The size of Australia's existing carbon sink is maintained (at its highest historical level) while avoiding any material trade offs with other sectors' emission reduction capacity, in terms of sufficient land availability for renewable energy sites, biofuel feedstock production and low emission agricultural crop and livestock production.

[25] In scenario 3 renewable electricity sources reach 90+ per cent of national electricity supply.

Finding 9: Achieving around a 70+ per cent 2035 emission reduction target would necessitate deeper rates of deployment and adoption for some low emission technologies prematurely, and could risk trade offs in Australia's export activity and associated carbon leakage, depending on global demand for emissions intensive goods and the effectiveness of carbon leakage policies.

Figure 12: Summary of emission reductions by sector — scenario three (~70+ per cent cut)

Sector	Emission reduction
Electricity and energy	Electricity and energy emissions fall 91 per cent from 157 to 14 Mt CO_2e from 2022 to 2035 and the renewables penetration of the national electricity market increases from 32 to 90+ per cent over the period.
Resources	Resources emissions fall 53 per cent from 94 to 44 Mt CO_2e from 2022 to 2035.
Transport	Transport emissions fall 18 per cent from 91 to 74 Mt CO_2e from 2022 to 2035.
Industry	Industry emissions fall 54 per cent from 77 to 35 Mt CO_2e from 2022 to 2035.
Buildings	Building emissions fall 56 per cent from 18 to 8 Mt CO_2e from 2022 to 2035.
Agriculture	Agriculture emissions fall 16 per cent from 87 to 72 Mt CO_2e from 2022 to 2035.
Land	Land emissions remain stable -88 Mt CO_2e from 2022 to 2035 — which is Australia's current historical peak rate.

3. Maximising our potential

This section considers what it will take to maximise the ambition and achievability of Australia's 2035 target.

Figure 13: Emission reduction potential across sectors

Sector	Coverage	Baseline (2005)	Current (2022)	Key decarbonisation levers to 2035
Electricity and energy	Fuel combusted for electricity generation in the National Electricity Market, Western Australia's Wholesale Electricity Market and all off-grid systems.	197 Mt CO_2e 32 per cent of Australia	157 Mt CO_2e 36 per cent of Australia	The replacement of coal generation with wind and solar generation, supported by storage and gas for firming and peaking and upgrades to transmission hosting capacity are the main drivers of emission reductions in the electricity sector.
Resources	Fuel combustion, fugitive and production emissions in mining, oil, coal and gas sectors, including downstream infrastructure (concentration and refining). On site ore and minerals processing.	66 Mt CO_2e 11 per cent of Australia total	94 Mt CO_2e 22 per cent of Australia total	Electrification, carbon capture and storage, fugitive emissions reducing processes and fuel switching are the main drivers of emission reductions in the resources sector.
Transport	Combustion of liquid fuels for all modes of transportation (vehicles, aviation, rail, maritime). Off farm gate transportation of livestock.	82 Mt CO_2e 13 per cent of Australia total	90 Mt CO_2e 21 per cent of Australia total	Electrification of road transport and the use of renewable fuels to replace liquid fossil fuel use in aviation are the main drivers of emission reductions in the transport sector.
Industry	Fuel combustion and process emissions from metals and minerals (high temperature heat), food and paper (low temperature heat), waste, chemicals and fluorinated gases.	83 Mt CO_2e 14 per cent of Australia total	77 Mt CO_2e 18 per cent of Australia total	Electrification of high temperature heating, electrification of low temperature heating and technologies which address or reduce process emissions are the main drivers of emission reductions in the industry sector.
Buildings	(Non-electricity) energy usage within buildings including space heating and cooling, water heating, construction, appliances, and cooking.	21 Mt CO_2e 3 per cent of Australia total	18 Mt CO_2e 4 per cent of Australia total	The replacement of gas appliances with reverse cycle air conditioners for space heating and cooling, electric water heaters and induction and electric cooktops are the main drivers of emission reductions in the buildings sector.
Agriculture	Livestock farming (manure management and enteric fermentation). Crop farming and production. On farm transportation of livestock.	86 Mt CO_2e 14 per cent of Australia total	86 Mt CO_2e 20 per cent of Australia total	Reduced fertiliser use and adoption of urease and nitrogen inhibitors, electrification and fuel switching for agricultural equipment, and methane reducing feed additives for pasture fed livestock, are the main drivers of emission reductions in the agriculture sector.
Land	Reforestation, afforestation, native forest logging land clearing / deforestation, forests, grassland, cropland, harvested wood products and other land types.	75 Mt CO_2e 12 per cent of Australia total	-88 Mt CO_2e 20 per cent of Australia total	Maintaining the size of Australia's existing carbon sink over the next decade with the main drivers being afforestation (more tree planting) and reducing deforestation (less tree clearing).

3.1 Core enablers

The evidence base identified a range of challenges along Australia's decarbonisation pathway and correspondingly, six critical key enablers to address these challenges. We note there are numerous interactions between these enablers that have not been explicitly called out here, but which are crucial to maximising the ambition and achievability of Australia's emission reduction efforts.

Figure 14: Summary of key enablers to address challenges across the economy

Enabler	Description	Significance	Example
Closing the funding gap	Net transition cost could be significantly higher than typical Capex spend, and technology may require abatement cost in-line with global trends. Approximately half of incremental abatement potential in scenario two (~60 per cent cut) is dependent on solving the enabler.	High	Funding gap for EV trucking infrastructure and grid upgrades in locations along key freight routes, e.g. Sydney to Melbourne.
Permitting and social licence	Permitting required for renewable energy and storage, or community support required for reforestation efforts. Approximately one quarter of incremental abatement potential in scenario two (~60 per cent cut) is dependent on solving the enabler.	High	30 GW of hosting capacity to be built by 2035 across 17 REZs.
Scaling a skilled workforce	Additional skilled workers required to deliver infrastructure and technology required. Approximately one third of incremental abatement potential in scenario two (~60 per cent cut) is dependent on solving the enabler.	Medium	~40k+ operations and maintenance jobs deploying in wind and solar by 2035.
Securing supply of technology	Need to ensure Australia is in front of the queue for scarce global supply of low emission technology or pursues domestic innovation & production. Approximately half of incremental abatement potential in scenario two (~60 per cent cut) is dependent on solving the enabler.	Medium	Supply gap of a wide variety of light commercial vehicle (LCV) EVs that meet customer and business requirements.
Coordination and collaboration	Alignment required across value chains, such as data transparency, demand signals, and consumer engagement is required to support the transition. Approximately one quarter of incremental abatement potential in scenario two (~60 per cent cut) is dependent on solving the enabler.	Medium	CCUS common user infrastructure for carbon transport and sequestration to achieve economic scale and distribute costs.
Improving capital excellence	Need to boost productivity of project delivery to avoid timeline and cost overruns. Approximately one third of incremental abatement potential in scenario two (~60 per cent cut) is dependent on solving the enabler.	Medium	Learning from 'hyperscalers' in terms of automation and economies of scale in the workforce and supply chains through standardisation.

Source: McKinsey Analysis (2024)

3.1.1 Closing the funding gap

The transition investment cost associated with reducing Australia's emissions are substantial and increasing from scenario one (~50 per cent cut) to scenario two (~60 per cent cut) to scenario three (~70+ per cent cut).

- The bulk of transition investment costs estimated in this analysis relate to large scale, front loaded capital expenditure investments in infrastructure in the electricity and energy and resources sectors.
- 'Net' refers to the transition investment cost necessary to shift the technology mix in each sector over the next 10 years (according to the three emission reduction scenarios) minus the expected investment cost if each sector were to continue to use current technology over the next 10 years.

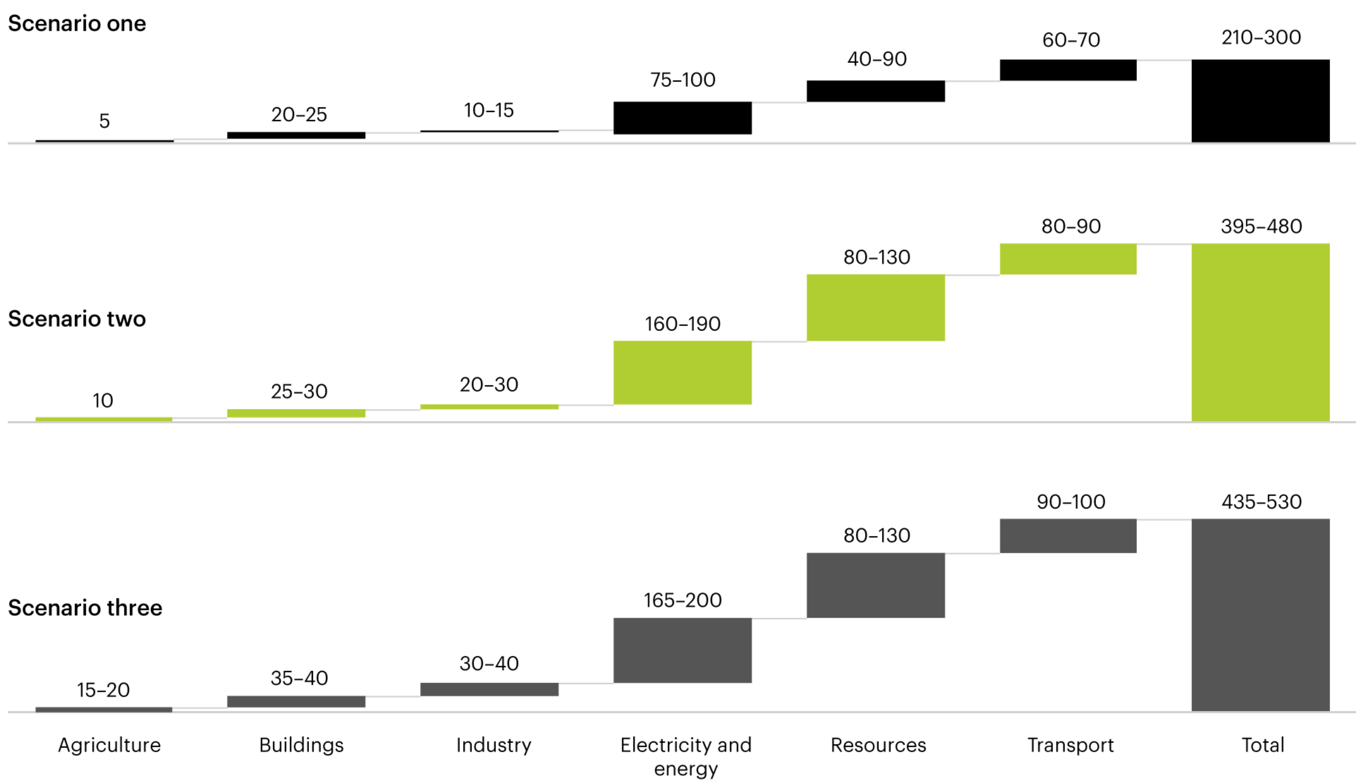
Australia's Governments have already made considerable funding commitments toward Australia's transition to net zero, including but not limited to the Australian Government's Powering Australian Plan and FMIA Agenda, and various jurisdictional government renewable energy funding initiatives.

However, mobilising increasing amounts of private sector investment capital means addressing at least three core challenges.

- Green premium — low and zero emission technologies and products are typically more expensive than conventional alternatives and consumers' willingness to pay this premium remains limited, for example, for lower emission dairy and beef products and lower emission metal products like green iron.
- High risks — front loaded capital investments are often subject to volatile cash flows due to higher than average technology, regulatory and market risks (particularly first of a kind investment in Australia), for example electrifying LNG facilities and common user CCUS infrastructure.
- Long term incentives — transition investments typically face long term uncertainty and instability associated with government policy frameworks, for example, a current lack of post 2030 electricity market design incentives to drive investment in gas firming capacity.

We note the Government's recent NEM Wholesale Market Review and Gas Market Review. It is critical that responses to these are designed to provide longer term certainty in Australia's energy market policy frameworks.

Figure 15: Net transition capital expenditure by sector from this analysis (A$ billion 2025 to 2035)



1. Gross capex calculated as capital expenditure relating to the maintenance and upgrade of current emitting and future low/no-emissions technologies. Net capex is gross capex less the equivalent capex in a baseline scenario where all technology penetrations remain constant.

Source: Decarbonisation Scenario Explorer, ABS (2023) 'Private New Capital Expenditure and Expected Expenditure, Australia', ABC, ACCR

Half of the incremental emission reductions in scenario two (~60 per cent cut) are dependent on addressing this enabler — by new and augmented policies from governments, sustained investment actions from the private sector and an increased willingness of consumers to pay the associated green premium in the market.[26]

[26] Incremental emission reductions (levers) in each scenario can be dependent on multiple enablers.

We note there is a range of policy mechanisms and measures that could be designed to deliver this funding.

Finding 10: The business case for many low emission technologies needs significant additional funding support before these technologies can be deployed and adopted at a commercial scale, notwithstanding the possibility of new technologies emerging and cost reductions in existing technologies over the next ten years.

3.1.2 Approvals and social licence

Timely permitting and approval processes — backed by community support and benefits sharing — is mission critical to maximising ambition and achievability of Australia's emission reduction targets. Australian planning processes are often complex, requiring the involvement of multiple government agencies and multiple levels of government to progressively approve elements of a project.

Large scale infrastructure projects in the electricity and energy, resources, industry and transport sectors are particularly vulnerable in this regard. For example, in the electricity and energy sector a more rapid acceleration in the build rate of wind and transmission projects is currently limited by planning permits, approvals and lengthy environmental impact assessments and frequently subject to delays and community opposition. These challenges drive up project costs and increase the risk premium that investors require to reach financial investment decision, ultimately resulting in fewer projects going ahead.

A recent study assessing 170 onshore wind and solar projects in Australia between 2000 and 2023 found the average lead time for permitting and approval was 12 to 18 months, with commissioning and grid connection taking an additional 6 to 12 months on average.[27]

We note that the Australian Government's 2024 Budget provides $134.2 million to strengthen and streamline environmental approval decisions for priority projects, including renewables and critical minerals projects. The commitment includes $24.5 million for improving planning and working with jurisdictional governments in seven priority regions to clarify where developments can and cannot occur.

We also note the Government's commitment to accelerate delivery of reforms to the Environment Protection and Biodiversity Conservation Act 1999, designed to streamline environmental approvals and remove barriers to the transition more generally.

A quarter of the incremental emission reductions in scenario two (~60 per cent) are dependent on addressing this enabler — based on more streamlined and adaptive regulatory frameworks, purposeful stakeholder engagement and distributed benefits for local communities. [28]

Finding 11: The efficiency and effectiveness of Australia's regulatory approvals system needs to improve significantly to enable a rapid acceleration in build rates of electricity and energy and other low emission technology and infrastructure.

3.1.3 Scaling a skilled workforce

Australia urgently needs to address existing and projected skilled workforce shortages to maximise the ambition and achievability of Australia's emission reduction targets. The energy sector will be the largest source of new jobs to 2030, with major growth in construction and maintenance roles through to 2050.

A shift from scenario one (~50 per cent cut) to scenario two (~60 per cent cut) requires an additional 59,000 workers by 2030 and 82,000 by 2050 — a three to four fold increase on 2022 levels.

[27] Energy Economics, Waiting to generate: An analysis of onshore wind and solar PV project development lead-times in Australia, 2024.
[28] Incremental emission reductions (levers) in each scenario can be dependent on multiple enablers.

This surge in demand will coincide with competing pressures: a housing and infrastructure crisis, and significant expansion in defence manufacturing and digital capability — all drawing on the same skilled workforce.

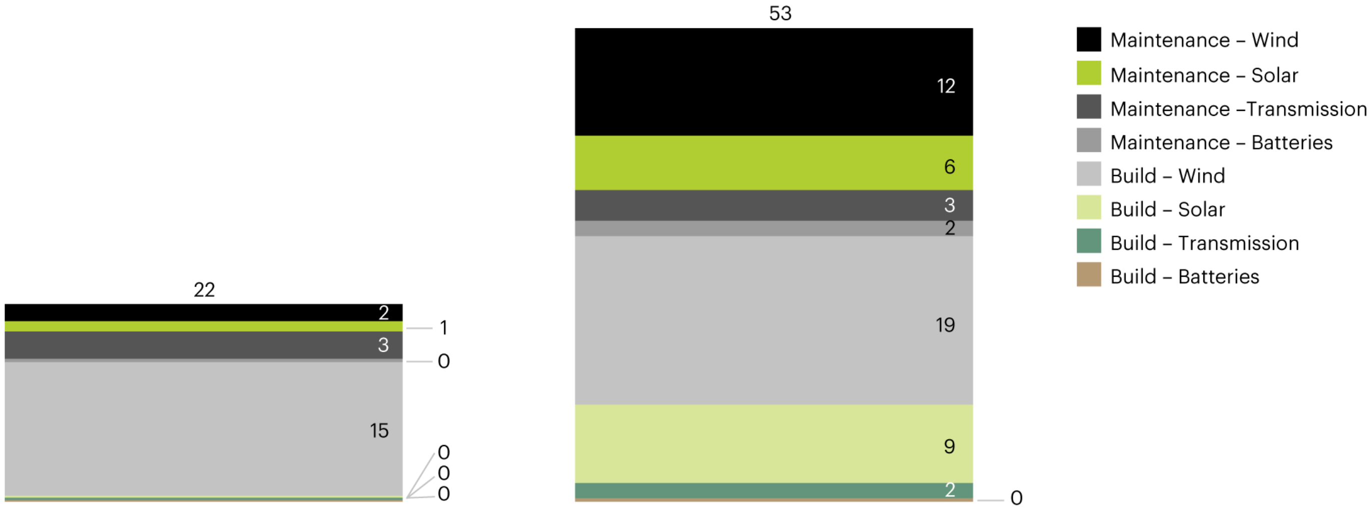
Looking across all sectors, electrical trades shortages — such as electricians, electrical engineers, air-conditioning and refrigeration mechanics, and electronics or telecoms trade workers — will be most acute due to the rapid electrification needed across the economy to reduce emissions.

We note that Australia already faces a significant shortage in electrical skills, with a vacancy rate of over 40 per cent in some regions. At the same time, workers employed in emissions intensive industries will require reskilling before potentially being able to alleviate this shortage.

A third of the incremental emission reductions in scenario two (~60 per cent cut) are dependent on addressing this enabler — by increasing the supply of skilled workers in critical areas, and reducing the overall workforce needed through more efficient approaches to infrastructure and technology construction and maintenance. [29]

Figure 16: Projected jobs to build wind, solar & transmission projects needed to achieve scenario two

FTE 000's, 2022 to 2035

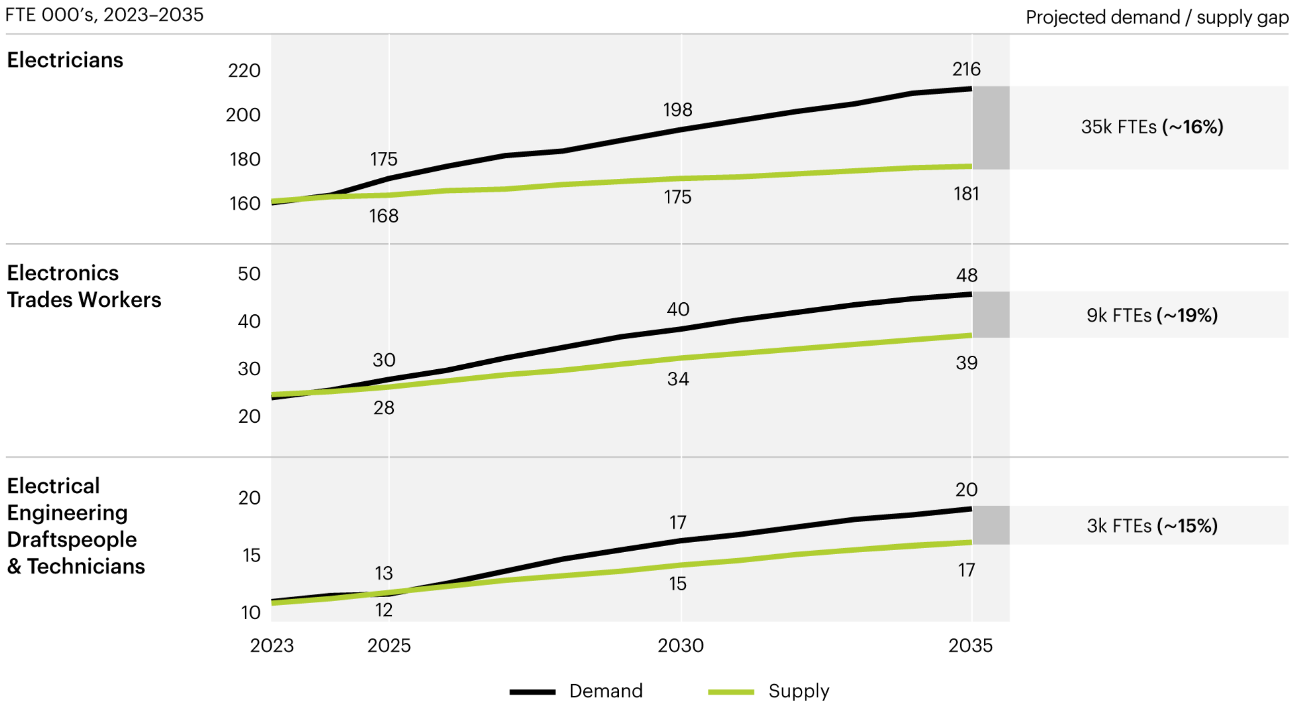


1. Baseline chosen as capex jobs calculated based on incremental change from previous year
2. Average per year

Source: ARENA Skilling Australian Industry for the Energy Transition 2021 (jobs multiplier and construction year assumptions); US Environmental protection agency, NSW Government Electricity Transmission reliability standards, SolarWise, Solar.com (average asset lifespan assumptions); team analysis

[29] Incremental emission reductions (levers) in each scenario can be dependent on multiple enablers.

Figure 17: Projected demand and supply of critical transition skills



Note: Based on historical 30% of construction workforce being electricians. Hydrogen superpower scenario of AEMO.

Source: The Australian Electricity Workforce for the 2022 ISP, AEMO June 2022; and Empowering Everyone, Diversity in the Energy Sector, Clean Energy Council, October 2021

Finding 12: A comprehensive approach to scaling skilled labour capacity through cross industry reskilling, international migration, vocational education and training and university programs, is a critical enabler to the transition.

3.1.4 Securing supply of technology

The achievement of scenario one (~50 per cent cut) and scenario two (~60 per cent cut) rely on key low emission technologies being deployed and adopted at scale. However, the risk in securing supply of these technologies and related inputs, such as large scale synchronous condensers to stabilise renewable electricity grids, poses another level of challenge to maximising the ambition and achievability of Australia's emission reduction targets.

The supply of low emission technologies across sectors can be secured either through domestic development ('build it'), import ('buy it'), or a combination of both. Australia's abundance of natural resources, its skilled workforce and its access to capital, position it well to source some technology and related inputs domestically, as well as play a lead role in exporting in some cases (for example lithium for overseas battery production).

There are two critical sectors where Australia will need to be 'at the front of the global queue' for supply.

- Electricity and energy — acquiring key high voltage cables and transformers to connect regionally based renewables and storage with metropolitan energy consumers (with current wait times of 4 to 5 years in some cases) and acquiring synchronous condensers to improve grid performance and efficiency with increasing renewables penetration.
- Transport — acquiring low emission vehicle technology imports, particularly of battery electric vehicles (for passenger and light commercial travel) and fuel cell electric vehicles (for long haul and heavy freight).

Half of the incremental emission reductions in scenario two (~60 per cent cut) are dependent on addressing this enabler — especially critical technologies related to energy and electrification. [30]

Finding 13: It is critical to identify key low emission technologies that are available without significant supply constraints, those with moderate supply constraints and those facing high risk of supply shortages.

3.1.5 Coordination and collaboration

Coordination and collaboration of Australia's decarbonisation effort on a truly 'nation building' scale is crucial to maximising the ambition and achievability of Australia's emission reduction targets. This level of coordination and collaboration cannot be left to markets (alone) to facilitate, given the sheer complexity of the decarbonisation challenge. Three distinct approaches are required.

- Accelerating green technology development through cross sector coordination — for example, coordinated capacity building of sustainable aviation fuel refineries and feedstock supplies, and development of cross industry common infrastructure for carbon capture, utilisation and storage.
- Providing a consistent and stable regulatory environment across all levels of government — to minimise the impact of regulatory risk on hurdle rates of return for decarbonisation projects and sharpen demand signals for low carbon products, via guarantee of origin schemes and mandated emission standards (for example).
- Improved supply chain transparency through digital solutions — strengthen demand signals along supply chains in the economy (inter and intra industry) via the development of digital solutions to collect and generate high quality and easily accessible sustainability data.

We note that while the newly established Net Zero Economy Authority is a good start to address the need for higher levels of coordination and collaboration with respect to regional changes in employment, the challenges referred to above are broader than its current remit.

A quarter of the incremental emission reductions in scenario two (~60 per cent cut) are dependent on addressing this enabler. [31]

Finding 14: The risk of supply chain bottle necks and inefficient use of scarce resources is minimised by adopting a 'nation building' approach to the coordination and collaboration of the transition.

3.1.6 Improving capital excellence

The productivity of decarbonisation project delivery in terms of time and cost can be a key limiting factor to maximising the ambition and achievability of Australia's emission reduction targets. For example, the average schedule and budget overrun of electricity and energy sector projects globally is 50 per cent on both metrics. This is likely to continue as many countries are simultaneously demanding the same skilled trades and equipment inputs to rebuild their energy systems.

Two key factors can be leveraged to ameliorate this challenge across all sectors.

- Learning from hyper scaler data centre providers[32] — standardisation of infrastructure builds enables full application of automation in economies of scale in the workforce and supply chain, compared to highly customised infrastructure projects.

[30] Incremental emission reductions (levers) in each scenario can be dependent on multiple enablers.
[31] Incremental emission reductions (levers) in each scenario can be dependent on multiple enablers.
[32] Known hyper scaler providers include Google, Amazon, and Microsoft.

- The potential application of generative artificial intelligence — for example to improve energy efficiency through advanced predictive analytics and real time monitoring of energy systems, and facilitating the design of more efficient transportation systems based on shared autonomous electric vehicles.

A third of the incremental emission reductions in scenario two (~60 per cent cut) are dependent on addressing this enabler.[33]

Finding 15: Improving the efficiency of decarbonisation project delivery goes directly to the affordability and timeliness of Australia's emission reduction efforts.

4. Sector deep dives

4.1 Critical unlocks in electricity and energy

Electricity and energy sector emissions are currently the largest single source of emissions in Australia, accounting for 36 per cent of Australia's total emissions at 157 Mt per year. Emissions are the result of fuel combustion to produce electricity in the National Electricity Market, Western Australia's Wholesale Electricity and all major off grid electricity systems. Fossil fuel based generation accounts for about 60 per cent of total electricity production each year (around 280 TWh) with renewable generation accounting for about 40 per cent.

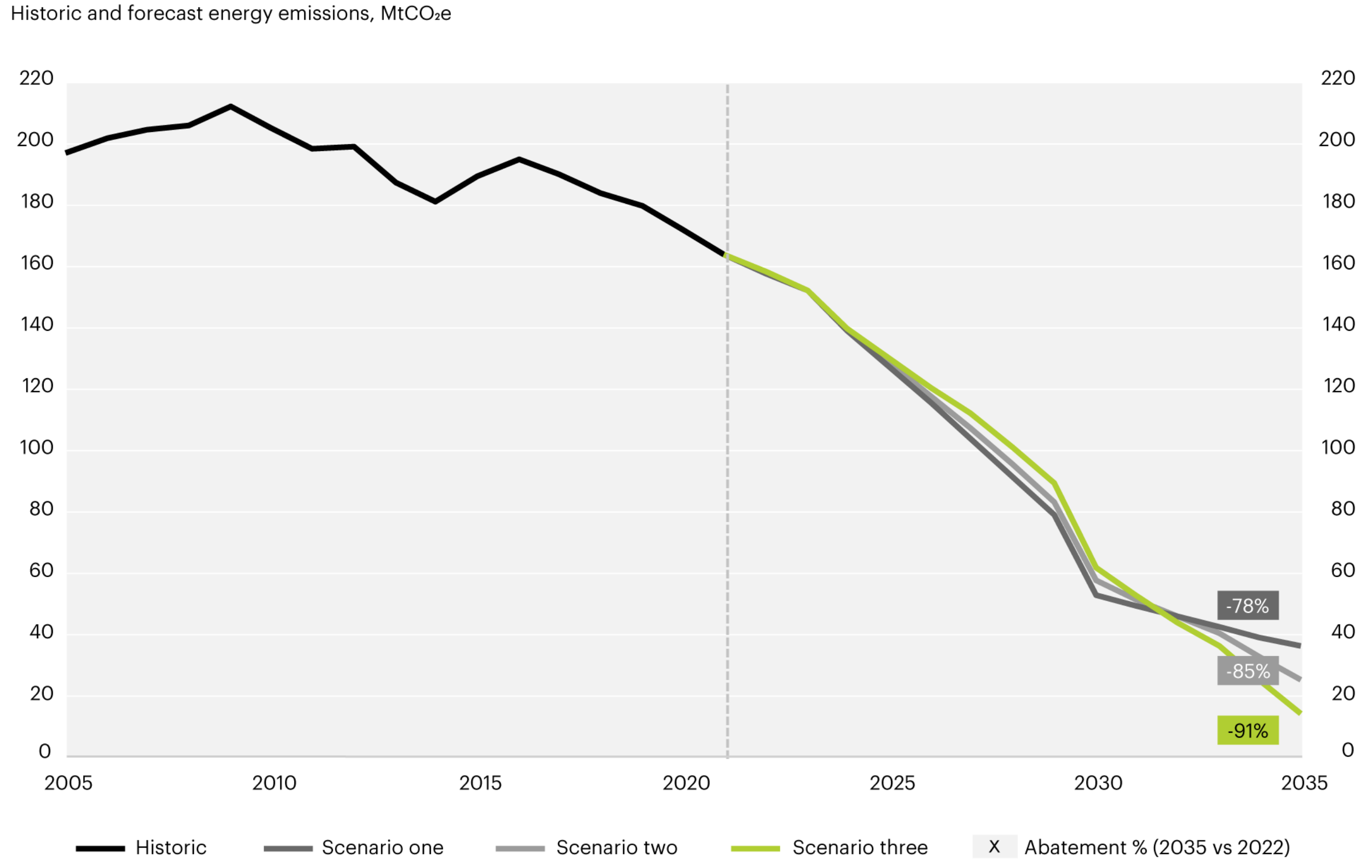
Australia has the potential to reduce electricity and energy sector emissions by 78 to 91 per cent by 2035 — scenario two achieves an emission saving of 132 Mt per year when comparing 2022 and 2035. The replacement of coal generation with wind and solar generation, supported by storage and gas for firming and peaking and upgrades to transmission hosting capacity is the main driver of emission reductions in the electricity sector. Transition investment costs for this sector have been estimated at $75 to 200 billion to 2035.

Electrification will be the key driver of emission reductions across other sectors, resulting in projected electricity demand increases of 50+ per cent by 2035.

- Buildings — demand is projected to increase by 1.4 times as homes shift from gas space and water heating to reverse cycle air conditioners and heat pump water heaters.
- Industry — demand is projected to double driven by electrification of both low and high grade process heat, which includes the electrification of alumina digestion and calcination, and the adoption of heat pumps or electric boilers with thermal storage in sectors such as food and beverage manufacturing.
- Resources — demand is projected to increase by 1.5 to 2 times driven by the electrification of LNG liquefaction plants and the transition to electric mobile and fixed plant machinery across mining operations, as conventional diesel use is phased out.
- Transport — demand is projected to increase more than tenfold driven by the growing adoption of electric passenger vehicles and light commercial vehicles, with hydrogen and renewable diesel anticipated to play a more significant role in heavy duty trucks.

Finding 16: Over the next decade, the potential for emission reductions from electricity and energy is the largest of all sectors in percentage and absolute terms. Transition investment costs for this sector have been estimated at $75 to $200 billion to 2035.

Figure 18: Electricity and energy sector decarbonisation pathways to 2035



Source: McKinsey Analysis (2024)

4.1.1 Key levers

Accelerating the wind build rate

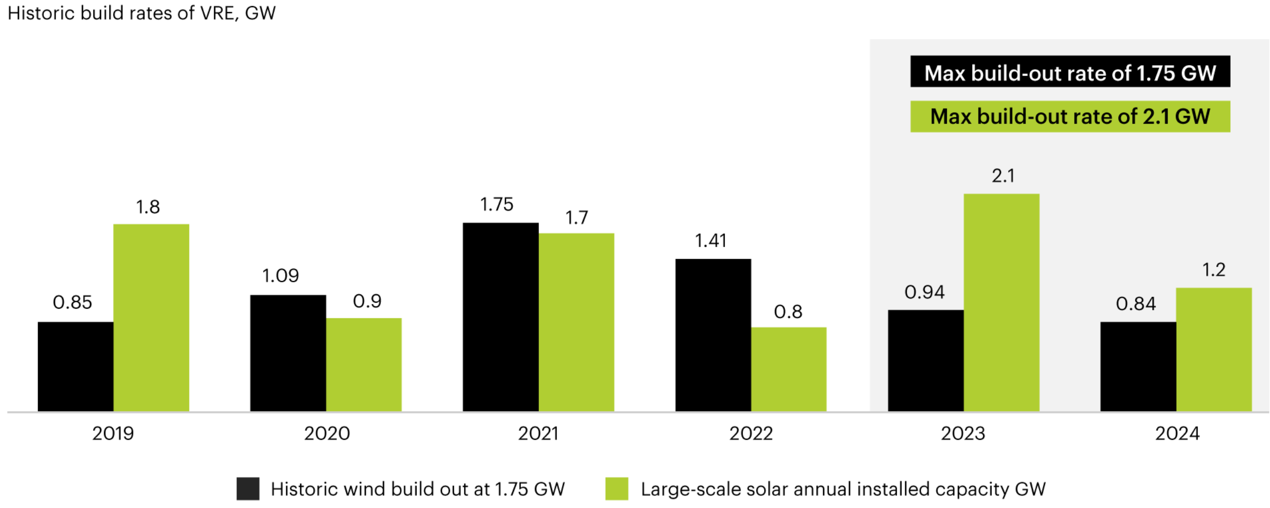
Australia's peak build rate for utility scale wind generation was 1.75 GW in 2021 and the peak build rate for large scale solar generation was 2.1 GW in 2023 — the stark difference reflects the greater complexity associated with developing wind projects.

In 2023 and 2024, renewables contributed about 40 per cent of Australia's total electricity supply, against a target penetration of 82 per cent in 2030 and possibly higher levels by 2035 — around 90 per cent in the 2035 scenarios referred to in this report.

A least cost high penetration renewable electricity mix requires that more wind generation be built to 2035 versus the more costly alternative of 'overbuilding' of solar and storage to compensate for less wind generation — which is what current build rates of wind and solar are driving toward.

Achieving wind generation capacity levels consistent with the least cost renewable electricity mix requires a substantial acceleration in annual build rates from 1 GW in 2023 and 2024 to 4 GW per year by 2030, reaching 6 GW per year by 2035.

Figure 19: Historical renewables build rates



Note: The demand for skilled people directly employed to build new energy infrastructure is forecast to increase from approximately 48,000 in 2025 to over 60,000 in 2035; workforce needs for utility renewables constitute ~50% of full-time equivalent jobs in 2035 as per AEMO 2024 Draft ISP

Source: AEMO 2024 ISP, Clean Energy Council 2022, NEM Generation Information 2024, Clear Energy Report 2025

Unlocking transmission build bottlenecks

The task of expanding transmission capacity to host new utility scale renewable generation remains a daunting but critical one. The AEMO integrated system plan has identified a need for an additional 3,800 km of transmission lines to be built by 2030 under its central scenario(s). By mid 2024 approximately 850 km of the new transmission required had been delivered, due to delays in obtaining regulatory approvals and building social licence.

Delivery of the majority of transmission projects specified and scheduled in the AEMO integrated system plan is crucial to support renewables penetration levels of 80 to 90 per cent by 2035. This represents a significant step up in the roll out of transmission line capacity, effectively doubling from 1.6 GW per year of additional hosting capacity (achieved over the last 15 years) to 3 GW per year to 2035.

Adequate investment in dispatchable capacity

Utility scale storage (batteries and pumped hydro) and gas generation capacity (and gas storage) are dispatchable sources of energy needed to back up or 'firm' intermittent renewables when sun and wind levels are low. Gas peaking generation is also needed to meet demand during peak periods of consumption.

A high penetration renewable electricity system will require adequate storage capacity and gas capacity to maintain electricity system security and reliability for household and business consumers.

The AEMO integrated system plan specifies a reduction of about 1.5 GW of coal generation capacity per year as the electricity system progresses from 40 per cent renewables penetration in 2023 and 2024, to 80 or 90 per cent from 2030. As this dispatchable coal generation capacity declines, the need for storage capacity and gas capacity increases considerably, at least until much longer duration utility scale batteries are developed.

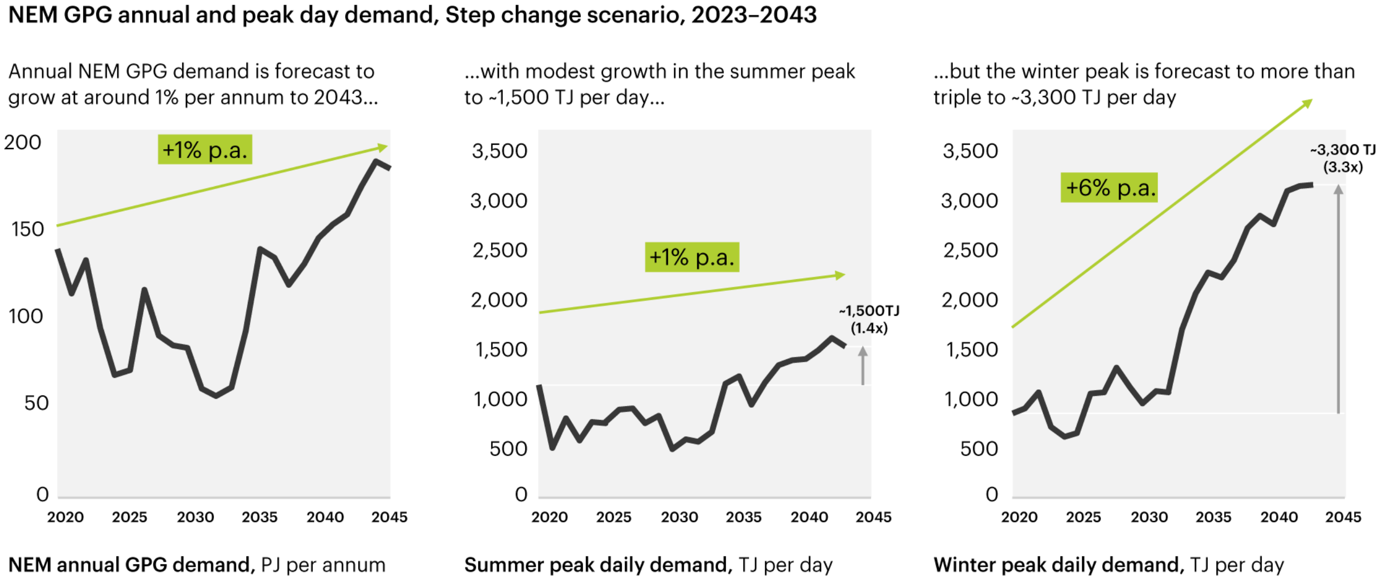
Since 2020 storage capacity has increased from 1 GW to 2.5 GW, alongside improvements in average duration of storage technologies. At the current build rate, there is a risk of falling short of the 14 GW target by 2030 and 18 GW target by 2035 specified in the AEMO integrated system plan.

Even if these storage capacity targets were achieved, gas capacity would still be required to meet peak demand and to provide back up in the event of multi day periods of low sun and wind levels — given that long duration battery and pumped hydro storage is currently limited to 8 and 24 hours.

This challenge is compounded by declines in the availability of east coast domestic gas supply and the emerging peak day gas supply shortfalls, highlighted in the AEMO gas statement of opportunities. By 2035, factoring in expected residential, industrial, and generation requirements, the gap between peak demand (per day) of 2,500 TJ and supply of 1,500 TJ could exceed 1,000 TJ of gas.

Finding 17: Timely investment in adequate gas and storage capacity are crucial to support renewables penetration levels of 85 to 90 per cent by 2035.

Figure 20: Forecast demand for gas powered generation in the national electricity market



Source: Australian Energy Market Operator

4.1.2 Key enablers

Figure 21: Summary of key enablers for electricity and energy decarbonisation

Improve capacity excellence in project delivery

Developers can improve the cost and time to deliver large scale energy projects.

Shift away from relying solely on fixed-price contracts with Engineering, Procurement, and Construction firms — which often leave developers distanced from on-the-ground delivery — toward an integrated and proactive approach where they can enhance their internal capabilities to directly manage the complexities of projects.	Learn from the principles of standardisation and mass production — exemplified by hyper scaler data centre providers — and capture the benefits of automation and economies of scale in workforce and supply chains in contrast to overly customised infrastructure projects which miss out on these efficiency gains and learning curves.

Expedite approvals and build social licence

Governments worldwide are grappling with energy transition project approvals process that are too slow, and although Australia's context is unique, there are examples of radical approaches overseas.

Fixed Timelines and Centralised Permitting — New York's Accelerated Renewable Energy Growth and Community Benefit Act imposes statutory limits of 12 months for issuing permits and consolidates all state permits and environmental reviews	Expanding Community Benefits — Denmark's 2008 Promotion of Renewable Energy Act specifies that renewable projects offer more than 20 per cent ownership to local residents and similarly, New York's new permitting framework includes	Pre-Development Site Readiness Activities —The EU's RED III designates renewable acceleration zones where permitting timelines are capped at one year, facilitating faster project initiation.	Recognition of National Objectives in Regulation — RED III also establishes an overriding public interest in the planning, construction, and operation of renewable energy sources, storage, and grid connections, while maintaining high

<table>
<tr><td colspan="3">under the Office of Renewable Energy Siting.</td><td colspan="3">requirements for projects to deliver tangible benefits to host communities.</td><td colspan="3"></td><td colspan="3">standards of environmental protection.</td></tr>
<tr><td colspan="12">Drive innovation and retain optionality
Greater innovation in optimising the transmission network is crucial to enhancing the flexibility and capacity of Australia's electricity grid and significant opportunities exist for innovation in network hosting that should be scaled and proven.</td></tr>
<tr><td colspan="3">Virtual Transmission through Storage — solutions like the System Integrity Protection Scheme are allowing transmission lines to operate at higher capacities by integrating battery backups, such as Victoria's 'Big Battery' or New South Wales's Waratah Super Battery, and similarly, the increased use of storage within renewable energy zones to prevent curtailment during peak generation effectively boosts transmission capacity.</td><td colspan="3">Advanced Grid Components — innovations in grid technology have the potential to enhance existing transmission corridors, for instance, restringing with new conductors like Aluminium Conductor Composite Cores has increased capacity by up to 50 per cent in some cases overseas.</td><td colspan="3">Optimising Generation Hosting and Demand Growth on Distribution Networks — concepts like Distributed Renewable Energy Zones which, involve widespread storage deployment across networks, can enable additional solar integration with minimal transmission upgrades, and advanced stochastic grid modelling and analytics, as seen in Europe, are helping pinpoint the most cost effective enhancement opportunities.</td><td colspan="3">Maximising Consumer Energy Resource Integration — effective integration of distributed energy resources relies on robust platforms for distributed energy resources management, supported by appropriate hardware and software to control loads, where the key challenge lies in refining and clearly communicating the customer value proposition to encourage widespread adoption.</td></tr>
<tr><td colspan="12">Boost investor confidence
If we are to have any real chance of meeting the enormous decarbonisation investment requirement, Australia's governments need to align on three things urgently in order to raise investment certainty.</td></tr>
<tr><td colspan="4">A comprehensive and durable national energy transition plan — substantial, timely and efficient flows of capital into energy assets and infrastructure require clear and stable long term investment signals from the energy policy framework.</td><td colspan="4">The private sector continues to be the primary driver of energy sector investment — notwithstanding the critical role of energy policy, private capital and markets are best placed to deliver an energy mix that is reliable, affordable and low emissions.</td><td colspan="4">A technology agnostic portfolio of energy mix options — the complexity associated with balancing energy reliability, affordability and low emissions necessitates that all demand and supply side technologies be 'on the table' for consideration by the market and the community over time.</td></tr>
</table>

4.2 Critical unlocks in resources

The resources sector contributes 22 per cent of Australia's total emissions at 96 Mt per year, primarily through fugitive emissions from the production of coal and natural gas and the use of diesel in mining operations. Mining extraction activities and oil and gas extraction activities account for about half of total emissions each. Total emissions are also evenly split between fugitive sources and energy sources.

Australia has the potential to reduce resources sector emissions by 17 to 53 per cent by 2035 — scenario two achieves an emission saving of 29 Mt per year when comparing 2022 and 2035. Electrification, carbon capture and storage, fugitive reducing processes and fuel switching are the main drivers of emission reductions in the resources sector. Transition investment costs for this sector have been estimated at $40 to 130 billion to 2035.

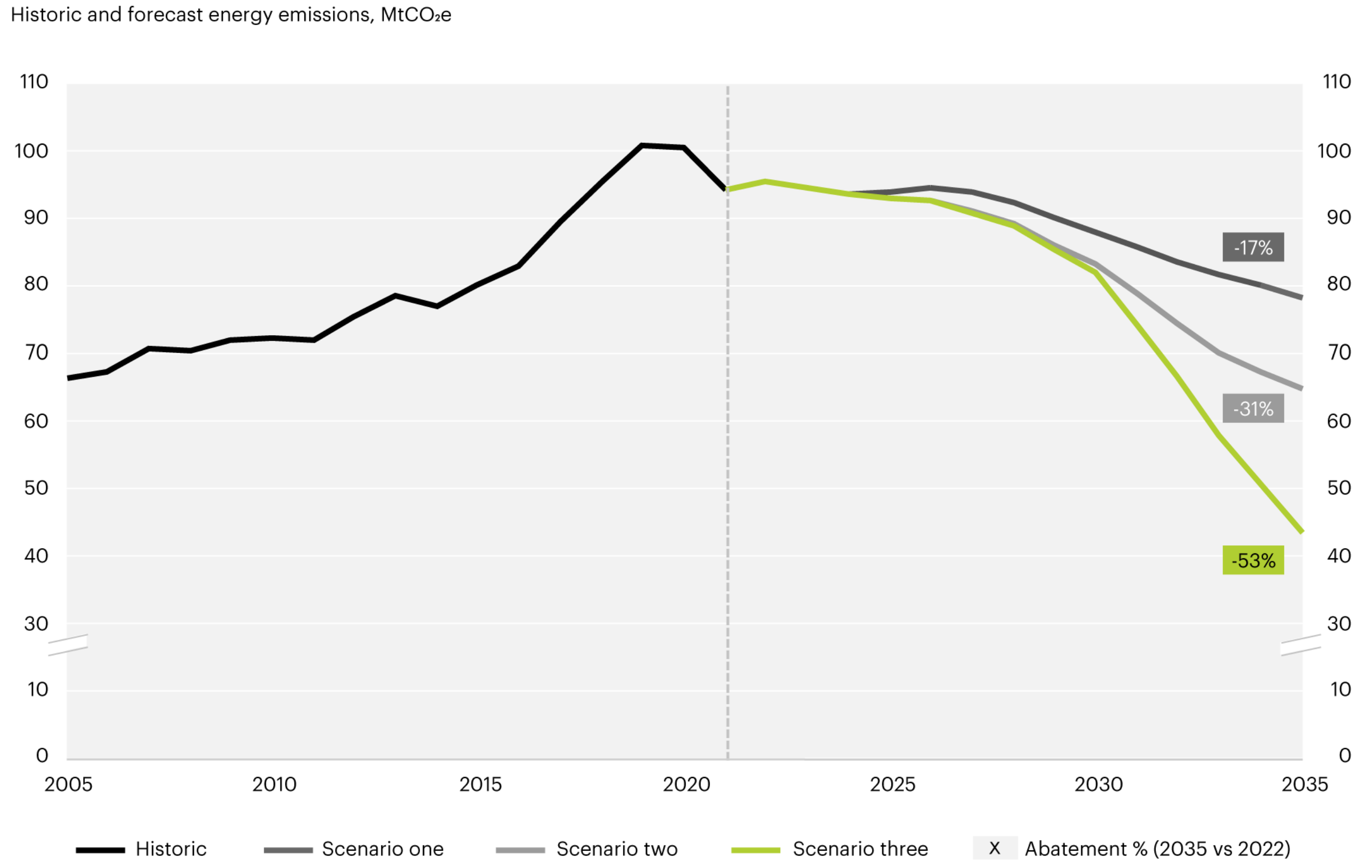
Resources activity levels impacting emission reductions have been projected as follows.

- Natural gas — activity is projected to grow until 2035 before declining due to challenges in securing enough raw feed gas for LNG liquification facilities and an assumption that fields will not be extended or replaced past their current end of life.
- Coal — activity is projected to steadily decrease by 30 per cent globally between 2030 and 2050 in line with International Energy Agency scenarios.

- Iron ore — activity is projected to increase until 2030 driven by foreign demand, before declining and plateauing by 2035, driven by gradually declining demand and enhanced competition from latent capacity overseas.
- Oil — activity is projected to decline slowly to 2025, driven by plant closures and the absence of new plant openings, and then remain stable from 2025 to 2040.
- Copper, nickel and lithium — activity is projected to increase as critical minerals are increasingly utilised in technologies replacing fossil fuels, compared to the supply of other minerals which is projected to remain constant.

Finding 18: Over the next decade, the potential for emission reductions from resources is substantial in both percentage and absolute terms. Transition investment costs for this sector have been estimated at $40 to 130 billion to 2035.

Figure 22: Resources sector decarbonisation pathways to 2035



Source: McKinsey Analysis (2024)

Electrification of LNG liquefaction and mining machinery

Electrification, supported by low cost, firmed renewable energy, offers the greatest potential for emission reductions in the resources sector — particularly in LNG production processes and mobile and fixed plant machinery across mining operations.

Power generation and mechanical drive turbines in LNG liquefaction can be electrified with 20 to 100 per cent effectiveness in terms of emission reductions — by replacing gas turbines and steam turbines with electric motors and drives. Electrification can also enhance energy efficiency and improve operational flexibility for the

LNG sector. Several major gas projects in Australia have committed to electrifying their sites and they face significant capital investment in new infrastructure and modifications to existing facilities.

Mobile and fixed plant machinery used in mining operations can be electrified with 100 per cent effectiveness in terms of emission reductions — by replacing diesel vehicles and equipment with electric vehicles and equipment based on renewable power and charging infrastructure. Several major mining operations have committed to electrifying their sites and face significant capital investment in new infrastructure and modifications to existing facilities.

Carbon capture and storage for gas

Carbon, capture and storage can be applied to all stages of the stationary gas sector value chain where emissions occur — including stationary energy and gas processing — with 60 to 80 per cent effectiveness in terms of emission reductions. Abatement costs can vary depending in the application and proximity to carbon basins.

Access to carbon basins with CCS infrastructure is a crucial determinant of the applicability of this decarbonisation lever to stationary gas sector participants. The development of common user CCS hubs in close proximity to LNG projects in Western Australia and the Northern Territory will minimise cost and maximise the effectiveness of this decarbonisation lever.

Processes to reduce fugitive and vented emissions

Processes to reduce fugitive and vented emissions include pipe replacement and leak detection and repair (LDAR) in natural gas distribution and ventilation air methane (VAM) technology in underground coal mining.

Due to the diffuse nature of fugitive and vented emissions, these reduction processes are only 30 to 60 per cent effective in terms of emission reductions. Nevertheless, these processes can deliver additional efficiency improvements, and don't generally require major modifications to existing facilities, nor do they significantly impact plant availability, downtime, or production volumes.

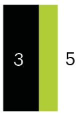
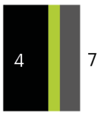
Fuel switching

Biofuels, such as ethanol, biodiesel, biomethane and renewable diesel, offer additional potential for emission reductions in the resources sector over the next 10 years. Their key advantage is their interchangeability with conventional fuels with minimal modifications to existing equipment and vehicles and their 100 per cent effectiveness in terms of emission reductions.

Australia's capacity to produce biofuel feedstocks, from a range of renewable biomass sources, is anticipated to increase towards the end of the current decade. This makes biofuels an option for remote resources facilities, particularly where electrification can be challenging due to infrastructure limitations, heavy machinery and high energy requirements. This potential will also depend on biofuel production capacity limitations, exporting of feedstocks and competition from other domestic users like aviation and agriculture.

4.2.1 Key levers

Figure 23: Resources sector decarbonisation pathway assumptions

Segment	Activity adj. abatement, 2022-35, Mt CO_2(e)	Pathway assumptions, 2035		
		Scenario one	Scenario two	Scenario three
Gas stationary energy		**~40%** electrification of liquefaction and **~25%** electrification of extraction, transportation and distribution based on asset announcements	**57%** CCS on liquefaction power gen. based on existing infrastructure and proximity to sequestration; **~70%** electrification of extraction power gen.	**~20%** activity reduction; **~10%** increased electrification of liquefaction
Gas fugitives		**100%** operational venting controls; **16%** (operational) and **~60%** (transport) reinjection based on access to sequestration basins and commitments	**~60%** (operational) reinjection with the based on sites that have made CCS announcements but have not progressed to commitments or permits	**~20%** activity reduction
Coal		13% to **18%** leak management; 7% to **9%** leak re-use based on major underground players with existing tech; **12%** electrification based on announced fleet plans	**~70%** fixed plant electrification benchmarked from iron ore fixed plant	Accelerated phase-out of thermal coal exports; ~40% to **~80%** VAM in underground coal mines; 12% to **30%** electrified mobile plant
Iron ore		**~30%** mobile plant electrification and **~70%** fixed plant electrification in line with major players' commitments	No change from Current course	No change from Accelerated action
Oil and other minerals		**10-30%** electrification in other mining and **10%** emissions intensity reduction in oil refining based on major players' commitments	**~70%** other minerals electrification benchmarked from iron ore fixed plant; **~30%** reduction in oil refining emissions intensity due to increased electrification	No change from Accelerated action

- Unabated emissions
- Scenario one abatement
- Scenario two abatement
- Scenario three abatement

Source: McKinsey Analysis (2024)

4.2.2 Key enablers

Figure 24: Summary of key enablers for resources sector decarbonisation

Low cost, firmed renewable electricity supply

Increased electrification will require significant investment in expanding on grid and off grid renewable energy capacity on the east coast and west coast of Australia.

Transitioning to an affordable, reliable energy system requires substantial, timely and efficient flows of capital into new energy assets and infrastructure, which in turn requires robust long term investment signals from a comprehensive and durable national energy policy framework.	For off grid resources facilities to electrify, they will need to invest in renewable generation and firming technologies such as gas or batteries, to back up their operations day and night.

Streamlined permitting and common user CCS hubs in proximity to gas facilities

We need to improve the economic viability of the technology and accelerate its deployment.

Approval timelines of 8 to 10 years (currently) for CCS projects in Australia are too long, especially for existing gas facilities with limited asset lives remaining, which drives them to alternative technologies like purchasing carbon offsets, which have shorter payback periods.	Global examples of countries implementing processes to streamline CCS project approval processes include Denmark, where the Danish Energy Agency (DEA) is the single agency responsible licensing exploration and storage of carbon dioxide.	Common user CCS infrastructure or 'hubs' serve as centralised points for capturing, transporting, and storing emissions from multiple sources, significantly reducing the per unit cost for multiple users by sharing infrastructure like pipelines and storage facilities.	Establishing CCS hubs in close proximity to major gas facilities, and where possible, integrating CCS hubs into existing industrial precincts to leverage existing expertise and workforce, further helps improve the economic viability of the technology and accelerate its deployment.

Deployment of Ventilation Air Methane technologies at scale in Australian coal mines

The majority of Australia's underground coal mining operations have the potential to apply VAM technology if the barriers can be addressed.

VAM technologies involves capturing and either destroying or utilising methane from underground coal mine ventilation systems through methods such as thermal or catalytic oxidation, or concentration.	VAM technologies have been implemented commercially and successfully in countries such as China and the United States, but these designs do not meet Australia's stringent mining safety standards	To date Australia has conducted small scale demonstrations, such as Regenerative Thermal Oxidiser (RTO) trials, but high temperatures pose explosion risks when used in underground coal mines.	Barriers related to maturity of the technology, failure to meet Australian safety standards and challenges with integration need to be addressed before VAM technology can be deployed at scale in Australia.

Policy support and incentives to bridge the green premium and be deployed and adopted at scale.

Emerging decarbonisation technologies often face a cost disadvantage compared to 'at scale' conventional technologies and need support and incentives before they can be commercialised at scale.

The Safeguard Mechanism is a key policy incentive that helps improve the relative economics of decarbonisation technologies for large resources facilities, but this does not cover midsized operations.	Future Made in Australia Innovation Fund provides support to renewable diesel and other low carbon liquid fuels, but not other resources sector technologies like CCS, which is heavily supported in China for example.	An additional challenge that may warrant support is the resources sector's reliance on finite project lifetimes, and the mismatch that can occur between investment payback periods for new decarbonisation technology retrofits and remaining project life of incumbent LNG facilities.

4.3 Critical unlocks in transport

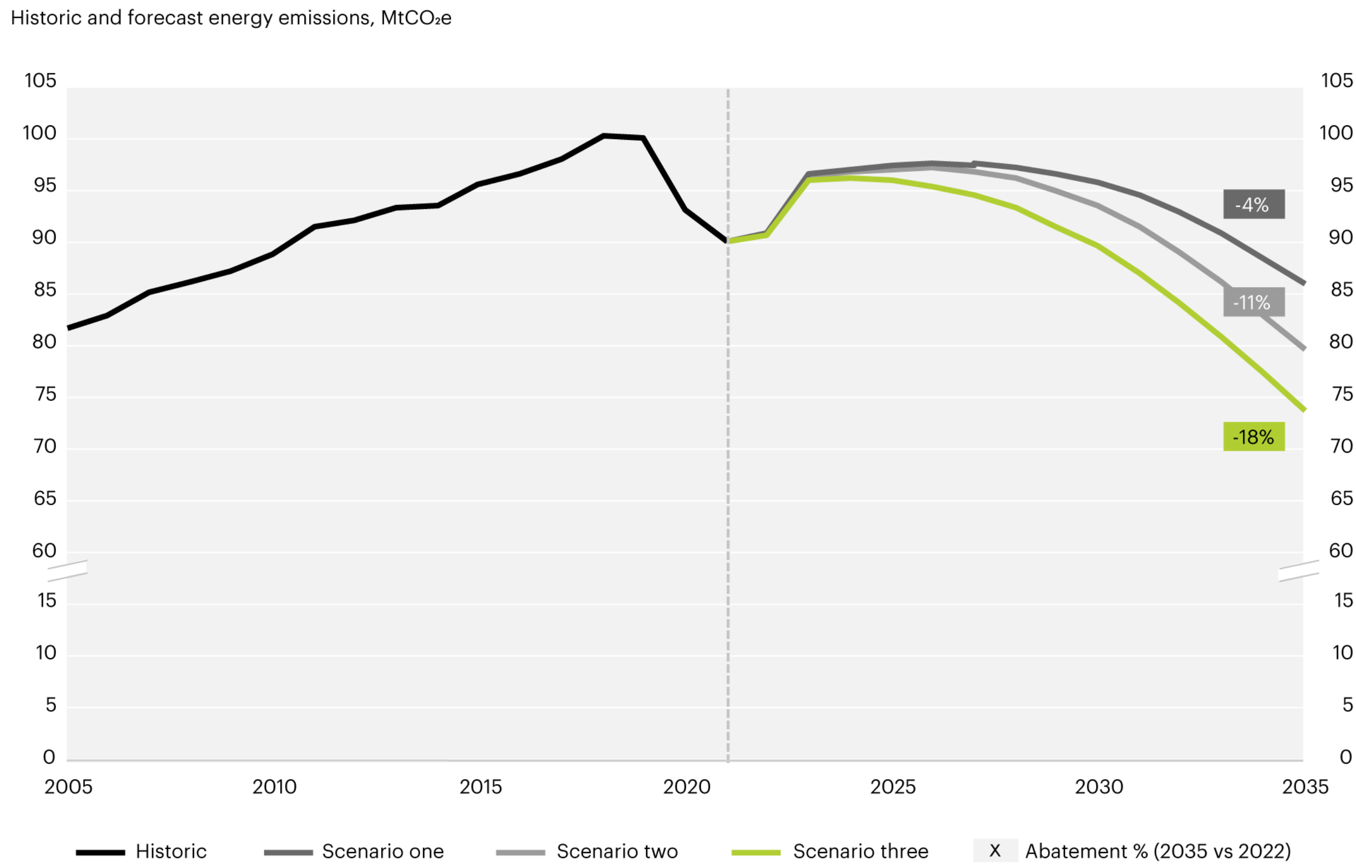
The transport sector contributes 20 per cent of Australia's total emissions at 91 Mt per year, primarily through road transport and aviation, with about half this being attributed to passenger vehicles. Across all transport segments, emissions arise almost exclusively from the combustion of imported liquid fossil fuels — petrol, diesel, and kerosene.

Australia has the potential to reduce transport sector emissions by 4 to 18 per cent by 2035 — scenario two achieves an emission saving of 10 Mt per year when comparing 2022 and 2035. Electrification of road transport and the use of renewable fuels to in place of liquid fossil fuels in aviation are the main drivers of emission reductions in the transport sector. Transition investment costs for this sector have been estimated at $60 to $100 billion to 2035.

The growing population, and correspondingly, the growing demand for road transport, aviation and other transport (such as maritime transport) is projected to net out some of the gains from early decarbonisation activities in this sector. We note that population growth alone would increase emissions by 28 per cent between 2022 and 2035, holding the existing emissions intensity of the transport fleet constant.

Finding 19: Over the next decade, the potential for emission reductions from transport is moderate in both percentage and absolute terms. Transition investment costs for this sector have been estimated at $60 to $100 billion to 2035.

Figure 25: Transport sector decarbonisation pathways to 2035



Source: McKinsey Analysis (2024)

Electrification of road transport

Electrification of passenger and light commercial vehicles is the most impactful lever to reduce transport emissions to 2035, given that electric vehicle technology is largely mature. In the passenger vehicle segment, battery electric vehicles are assumed to dominate plug-in hybrid electric vehicles, 90 to 10 per cent, due to the lower total cost of ownership of fully electric vehicles and the continued extension of their driving range. While the purchase price of battery EVs is comparable with hybrid EVs, the running costs of hybrid EVs are nearly 2.5 times that of battery EVs in some cases.

Compared to combustion engine passenger vehicles, the purchase price of passenger EVs remains significantly higher. However, in total cost of ownership terms — factoring in lifetime operational costs and upfront costs — passenger EVs are fast approaching parity with passenger ICEs. However, for the commercial vehicle segment, the total cost of owning EVs remains more than 2 times that of ICEs.

The rate at which the existing fleet of ICE vehicles can be replaced by EVs is also constrained by asset depreciation and the on road lifespan of the existing fleet. The average passenger vehicle in Australia is on the road for more than 15 years, which serves as a limiting factor to the rate of vehicle stock replacement each year, even with very high rates of new sales going to EVs.

Green hydrogen is gaining traction as a future fuel source, for heavy duty trucks and linehaul freight vehicles because of its advantages over battery EVs in terms of refuelling times, maximum weight and travel range. However, the total cost of ownership for hydrogen trucks is only projected reach parity with diesel trucks after 2030 and hence hydrogen truck do not play a substantial role in this 2035 analysis.

Use of renewable fuels in aviation

The use of 'drop in' sustainable aviation fuel in aviation has the potential to contribute significantly to emission reductions in the transport sector. These fuels can be used in the existing commercial jet fleet without modification, in place of kerosene based jet fuels and they can be blended up to 50 per cent with kerosene.

The most promising development pathway for sustainable aviation fuel in Australia is known as HEFA (hydro processed esters and fatty acids) and HVO (hydrotreated vegetable oil) refining. This involves converting feedstocks like vegetable oils, waste oils, or animal fats into renewable diesel and sustainable aviation fuel.

Australia currently has no SAF refining capacity, and while several projects have been announced, none of them have yet reached final investment decision. Securing and scaling enough feedstock for this refining capacity will be challenging and may require diverting feedstock exports to domestic use. Importing sustainable aviation fuels is another option that is being pursued by Australia's aviation industry.

We note that there are policy initiatives supporting SAF development pathways, such as the Australian Renewable Energy Agency's SAF Funding Initiative.

Additional levers for deeper reductions

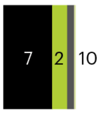
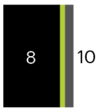
Several other decarbonisation levers have been identified as having a positive but limited potential to contribute to transport sector emissions by 2035.

- A modal shift from road to rail to reduce emissions in the commercial vehicles segment.
- Expanding the use of renewable diesel to reduce emissions in the heavy commercial vehicles segment.
- Commercialising emerging forms of air transport technologies designed for shorter distances, including electric and hydrogen planes, to reduce emissions in the aviation segment.

These technologies may have a more substantial role to play beyond 2035.

4.3.1 Key levers

Figure 26: Transport sector decarbonisation pathway assumptions

Segment	Activity adj. abatement, 2022-35, Mt CO_2(e)	Pathway assumptions, 2035		
		Scenario one	Scenario two	Scenario three
Passenger vehicles		**22% BEV** stock and **79% BEV share of new car sales** in 2035, based on NVES draft legislation	**8 p.p. increase in BEV** stock to 30% of vehicles and **100% BEV share of new car sales** based on stricter efficiency standards	**7 p.p. increase in BEV stock** to 37% in 2035 based on 95% government and corporate BEV share of new vehicle sales by 2030
Commercial vehicles (LCV)		**36% BEV stock** and **81% BEV share of new vehicles sales** in 2035 based on total cost of ownership analysis and NVES draft legislation	No change from Current course	**57% BEV stock** by 2035 in-line with EU forecast
Commercial vehicles (HDT, MDT, LDT)		**13% BEV stock** and **53% BEV share of new vehicles sales** in 2035 (HDT, MDT and LDT), based on analysis of total cost of ownership	**3 p.p. increase in BEV stock** to 16% and **73% BEV share** of new vehicle sales based on $100USD/t carbon price	**10% modal shift** of road freight between capital cities to rail assuming **10% renewable diesel** for ICE vehicles in 2035
Domestic aviation		**1.2% p.a. efficiency** improvement in line with fleet renewal and flight optimisation; **5% SAF blending** by 2035 in-line with industry aspirations	**15%** SAF blending for domestic aviation by 2035, in line with lower-bound of proposed EU regulations	**20% SAF blending** for domestic aviation by 2035, in line with upper-bound of proposed EU regulations
Other transport		**5–15% electrification** of other transport (rail, buses, maritime)	**50%** BEV bus stock based on state government targets, 20% methanol fuel in domestic shipping	No change from Accelerated action

■ Unabated emissions ■ Scenario one abatement ■ Scenario two abatement ■ Scenario three abatement

Source: McKinsey Analysis (2024)

4.3.2 Key enablers

Figure 27: Summary of key enablers for transport sector decarbonisation

Consumer driven demand for electric vehicles

Improving consumer attitudes and preferences towards purchasing electric vehicles.

Consumer surveys reveal that nearly a third of Australians claimed they would never switch to an EV due to concerns related to high upfront costs, a lack of public EV charging infrastructure and range anxiety'	Even though the total cost of ownership between EVs and ICEs is converging, closing the gap between upfront costs is needed to drive higher rates of EV uptake, and this will require sustained policy support.

Competitive supply of in demand electric vehicles

Removing regulatory and other barriers to the supply of electric vehicles in Australia will further support the objectives of the National New Vehicle Efficiency Standard.

Australia is generally considered an attractive market for OEM suppliers due to its high levels of car ownership, high margins on cars sold, and the market opportunities for Asian suppliers with competitive product offerings catering to local preferences in the passenger vehicles segment, such as Utes and 4WD SUV models.	While there's an ongoing effort to harmonise Australian vehicle standards with global standards, Australian vehicle width and weight limits are not fully harmonised with overseas OEM suppliers. Australian standards, including Australian Design Rules, often differ from international regulations, especially for weight requirements of heavier vehicles, leading to modifications and potential cost increases for manufacturers.

Faster development of charging infrastructure and electric vehicle maintenance capacity

Both private and public charging infrastructure need to be implemented ahead of deeper electric vehicle penetration.

For passenger electric vehicles, both private (household) and public charging stations are required, and consumer behaviour and the built environment will need to be factored in to how and where these assets are installed.	The skilled workforce pipeline will need to be sufficient to install and maintain Australia's network of charging stations and make necessary electricity grid capacity and reliability upgrades to enable fleet hubs, charging hotspots, and commercial 'mega chargers' on road freight arteries.	Targeted government support will need to address 'charging deserts' or regions with a lack of accessible and reliable charging infrastructure due to Australia's low population density (which will help with range anxiety).	Building up Australia's electric vehicle maintenance capacity in terms of skilled technicians and service stations catering to all light and heavy vehicle segments of the market.

Greater coordination across a currently fragmented electric vehicle supply chain

This is needed to lower risk premiums for private sector investments in electric vehicles and charging infrastructure.

Facilitating green logistics ecosystems involves truck operators, infrastructure developers, and freight buyers collaborating to build green corridors or hubs, to promote more sustainable investments, such as electric vehicles, renewable energy, and optimized routes.	New financing methods, such as aggregators offering bus and truck depot electrification at scale, or OEMs providing new types of financing agreements for heavy vehicles, can attract capital from large institutional investors and infrastructure funds.

Scaling sustainable aviation fuel supply and addressing the green premium on renewable fuels

This is essential to enable medium term emission reductions in the aviation and heavy vehicle segments.

Acceleration of SAF refinery production projects to FID and targeted growth of key feedstock supply, such as oilseed, for domestic SAF production.	Domestic SAF has a significantly higher cost structure, compared to kerosene based jet fuel, needs to be bridged before SAF will be used at scale.

4.4 Critical unlocks in industry

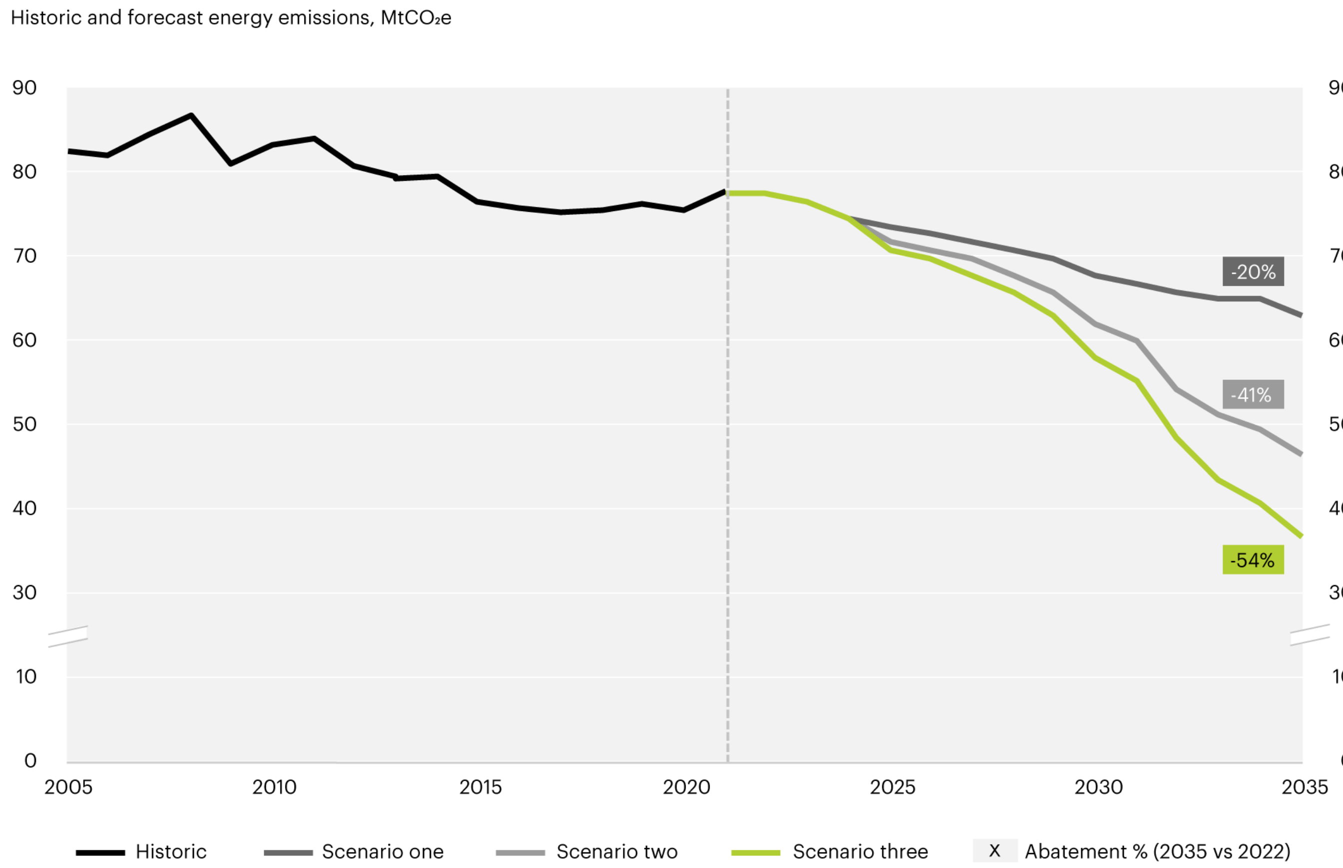
The industry sector contributes 18 per cent of Australia's total emissions at 77 Mt per year, primarily from minerals and metals refining, waste management, chemicals manufacturing, fluorinated gas use and industries using low temperature process heat.[33] About half of industry emissions are concentrated in a small number of major facilities in metals, minerals, and chemical segments, and the other half arises from smaller emitters in segments such waste, food and beverages, and paper and pulp.

Australia has the potential to reduce industry sector emissions by 20 to 54 per cent by 2035 — scenario two achieves an emission saving of 32 Mt per year when comparing 2022 and 2035. Electrification of high temperature process heat, electrification of low temperature process heat, and technologies which address or reduce other process emissions are the main drivers of emission reductions in the industry sector. Transition investment costs in this sector have been estimated at $10 to $40 billion to 2035.

Industry sector emissions have been more or less stable over the past decade due to consistent activity levels and consistent emissions intensity of production. The one exception to this is the waste segment, for which the activity level has grown in line with population growth.

Finding 20: Over the next decade, the potential for emission reductions from industry is substantial in percentage and absolute terms. Transition investment costs for this sector have been estimated at $10 to $40 billion to 2035.

Figure 28: Industry sector decarbonisation pathways to 2035



Source: McKinsey Analysis (2024)

[33] Fluorinated gases, also known as F-gases, are a group of man-made gases containing fluorine and used in various industrial applications, including refrigeration, air conditioning, and fire suppression.

Process emissions reduction through low-GWP refrigerants and low clinker cement

Low global warming potential refrigerants in the fluorinated gases segment and low clinker cement offer the largest potential for process related emission reductions from the industry sector.

Low GWP refrigerants, such as propane, carbon dioxide and ammonia, can reduce the emissions intensity of refrigeration and air conditioning by 2 to 3 times. Import quotas introduced in 2018 are already reducing the use of high GWP refrigerant gases in Australia. However, switching to low emissions alternatives often requires substantial capital investment new air conditioning and refrigeration equipment with standard capital replacement cycles of 10 to 30 years. Low emission alternatives also come with additional challenges, such as higher flammability risk, higher toxicity and immature supply chains.

About 70 per cent of emissions from cement manufacturing occur during the clinker production process. Low clinker cement reduces this primary driver of emissions while minimising the impact on cement performance requirements such as strength and durability. For example, limestone calcined clay cement is a low clinker cement capable of reducing emissions by 40 per cent compared to general purpose cement.

Electrification of low and high temperature process heat goods manufacturing

Electrification of low and high temperature process heat offers significant potential for emission reductions.

Technologies for electrifying low temperature process heat (<200C°) such as electrified heaters and boilers, thermal storage solutions and heat pumps, are commercially available, with the potential to replace the use of fossil fuels in the production of pulp and paper and food and beverages (for example).

Technologies for electrifying high temperature process heat (>200 C° and often higher than 1,000 C°) such as heat pumps, electric boilers, induction heaters, roto dynamic heaters, and plasma arc furnaces, are commercially available, with the potential to replace the use of fossil fuels in the production of alumina, steel, cement, glass, ceramics, and semiconductors (for example).

Different technologies have different challenges but generally, the economics of switching to high temperature heat electrification are less favourable than switching to low temperature heat electrification, when compared to their respective fossil fuel alternatives.

Carbon, capture, usage and storage to address hard-to-abate emissions

Carbon, capture, usage and storage (CCUS) is an effective but high cost technology for reducing emissions in hard to abate industries. CCUS can be applied to both energy emissions and process emissions but generally, the economics of switching from fossil fuel alternatives is more favourable in the case of process emissions, from industries like ammonia production and solid waste management (for example).

In conventional ammonia production, about two thirds of emissions are process emissions from steam methane reforming based on natural gas, which could be captured using CCUS to produce very low emission blue ammonia. This would require access to low cost natural gas, and access to common user CCUS infrastructure.

In conventional solid waste management, nearly 100 per cent of emissions are process emissions from the degradation of organic waste into methane. About 42 per cent of landfill methane in Australia is captured and three quarters of this captured gas is used for its energy value. It is typically the larger landfill sites near population centres that invest in this methane capture due to economies of scale.

Fuel switching

Switching from coal to natural gas or biofuels in an industrial production process offers significant potential for emission reductions, particularly where the economics or practicalities of electrification are prohibitive.

Fuel switching is most practical and feasible for industries currently reliant on coal for their energy inputs.

Coal provides about 90 per cent of the thermal energy required for cement production, to heat the kilns that transform raw materials into clinker and as a source of ash in the kiln feed. By switching from coal to natural gas, or biofuels, the emissions intensity of cement production could be reduced significantly.

Coal provides roughly 75 per cent of the energy and feedstock needs of the iron and steel production, as a source of energy in blast furnaces and as coking coal to act as a reductant in the process. By switching from coal to natural gas, or biofuels, the emissions intensity of iron production could be reduced significantly.

The higher cost of biofuels and natural gas compared to coal means a significant green premium will exist for this source of abatement. Gaining access to biofuels and natural gas may also pose a barrier. For the next few years at least, the agriculture, resources and transport sectors will also be competing for limited domestic supplies of biofuels due to constraints in refining and feedstock capacity. Importing biofuels is another option, but global demand for biofuels is also increasing.

4.4.1 Key levers

Figure 29: Industry sector decarbonisation pathway assumptions – Part A

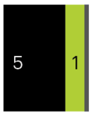
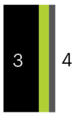
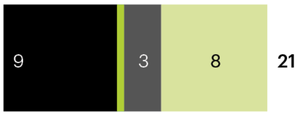
Segment	Activity adj. abatement, 2022-35, Mt CO_2(e)	Pathway assumptions, 2035		
		Scenario one	Scenario two	Scenario three
F-Gases	1 7 3 2 13	**46%** uptake of low-GWP refrigerants in line with DCCEEW projections and legislated bulk import quotas on Hydrofluorocarbons	**78%** uptake of low-GWP refrigerants based on no new sales of high-GWP refrigerants post-2025 and improved maintenance and leakage mgmt.	**91%** uptake of low-GWP refrigerants targeting 10% residual emissions (2022 baseline) accounting for long tail consumers
Alumina	2 5 5 12	**100%** shift from fossil-fuelled digestion to **78%** Partial MVR/ Double digestion and 22% full digester electrification in line with major players' plan	**100%** electrified digestions and **11%** electrified calcination in line with ARENA's 'Innovator' pathway	No change from Accelerated action
Solid waste management	8 1 2 11	Methane capture increased from **78%** to **89%** application (60% effective); **50%** reduction in annual food & organic waste per NWPAP1 2019	**100%** application methane capture due to low abatement cost; **75%** reduction in annual inflow of food & organic more aggressive than NWPA[1]	**100%** application methane capture due to low abatement cost; **90%** reduction in food & organic waste more aggressive than NWPAP
Steel	4 2 3 9	Whyalla transitions to natural gas DRI in line with announcements and increases production capacity from **~1.2 Mtpa** to **~1.8 Mtpa**	Port Kembla (**3.1 Mtpa**) replaced with natural gas DRI in line with most ambitious transition pathway	No change from Accelerated action

1. National Waste Policy Action Plan

■ Unabated emissions ■ Scenario one abatement ■ Scenario two abatement ■ Scenario three abatement

Source: McKinsey Analysis (2024)

Figure 29: Industry sector decarbonisation pathway assumptions – Part B

Segment	Activity adj. abatement, 2022-35, Mt CO_2(e)	Pathway assumptions, 2035		
		Scenario one	**Scenario two**	**Scenario three**
Chemicals		**100%** application of N2O tertiary catalyst abatement technology on nitric acid plants	**100%** substitution of coal (~5% of 2022 energy mix) for natural gas	No change from Accelerated action
Ammonia		Perdaman urea production begins in 2027 in line with expected commissioning date	**100%** CCUS for West Coast ammonia plants due to lower cost natural gas and more suitable carbon sequestration sites	No change from Accelerated action
Cement		Low clinker cement increased from nil to **21%** and alt. fuel usage increase from **16%** to **35%** in line with Cement Industry Federation (CIF)	Accelerated uptake of low clinker cement to **29%**; Accelerated uptake of alternative fuels to **52%**	No change from Accelerated action
Other industry		Partial electrification of low temperature heat segments and substitution from high carbon intensity fossil fuels to natural gas	Further electrification of low temperature heat segments	Further electrification of low temperature heat segments; **90%** decarbonised wastewater treatment plants

■ Unabated emissions ■ Scenario one abatement ■ Scenario two abatement ■ Scenario three abatement

Source: McKinsey Analysis (2024)

4.4.2 Key enablers

Figure 30: Summary of key enablers for industry sector decarbonisation

Supply of low-cost, firmed, renewable electricity The economics of electrification are directly impacted by supply of low cost, firmed, renewable electricity.	
Transitioning to an affordable, reliable energy system requires substantial, timely and efficient flows of capital into new energy assets and infrastructure, which in turn requires robust long term investment signals from a comprehensive and durable national energy policy framework.	This is particularly critical for the small to medium sized energy users, not able to capitalise on economies of scale, and who may also require streamlined and coordinated grid connections and distribution network upgrades.
Supply of low cost natural gas The economics of fuel switching from oil and coal to natural gas are directly impacted by supply of low cost natural gas.	
For industrial processes heavily fuelled by coal, such as cement and iron production, the availability and cost of gas will be a key barrier to overcome, before investing substantial capital in new infrastructure and equipment that enables fuel switching to gas.	Successful implementation of the Future Gas Strategy and the removal of policy and regulatory impediments to investment in domestic gas resources and infrastructure is critical to the supply of low cost gas to Australia's industries.

Development of common-user infrastructure We need to improve the economic viability of the technology and accelerate its deployment.		
This is a key unlock for WA ammonia industry in Western Australia, where the economics of blue are most promising, and potentially other hard-to-abate industries such as lime and cement production.	Common user CCS infrastructure or 'hubs' serve as centralised points for capturing, transporting, and storing emissions from multiple sources, significantly reducing the per unit cost for multiple users by sharing infrastructure like pipelines and storage facilities.	Establishing CCS hubs in close proximity to major gas facilities, and where possible, integrating them into existing industrial precincts to leverage existing expertise and workforce, further helps improve the economic viability of the technology and accelerate its deployment.

Efficient regulation to facilitate the uptake of new technologies The existing regulatory framework for industry needs modification in some cases.	
This is critical where existing regulation is a blocker to the deployment and adoption of new technologies, for example, low clinker cement would benefit from inclusion into building codes and standards that acknowledge the materials altered physical properties while ensuring it meets all relevant performance standards and existing formulations. Regulations also play an important role in the more fragmented segments with damaging externalities.	This is also critical where existing regulation fails to address the negative externalities associated with incumbent technologies, for example in refrigeration and air conditioning to support the accelerated phase out of high GWP refrigerants.

Raising awareness to drive behavioural changes Behavioural change on the supply side and demand side are important.
This is critical where decarbonisation involves the participation of thousands or millions of individual actors, for example, raising awareness about the benefits and strategies for solid waste prevention and reduction in households, and raising awareness in the construction industry value chain (developers, engineers, designers, and builders) of the benefits and applicability of low carbon cement and other inputs.

4.5 Critical unlocks in buildings

The buildings sector contributes 4 per cent of Australia's total emissions at 18 Mt per year, primarily resulting from gas heating and cooling, and gas water heating, within residential and commercial dwellings and also from construction, commercial appliances and residential appliances.

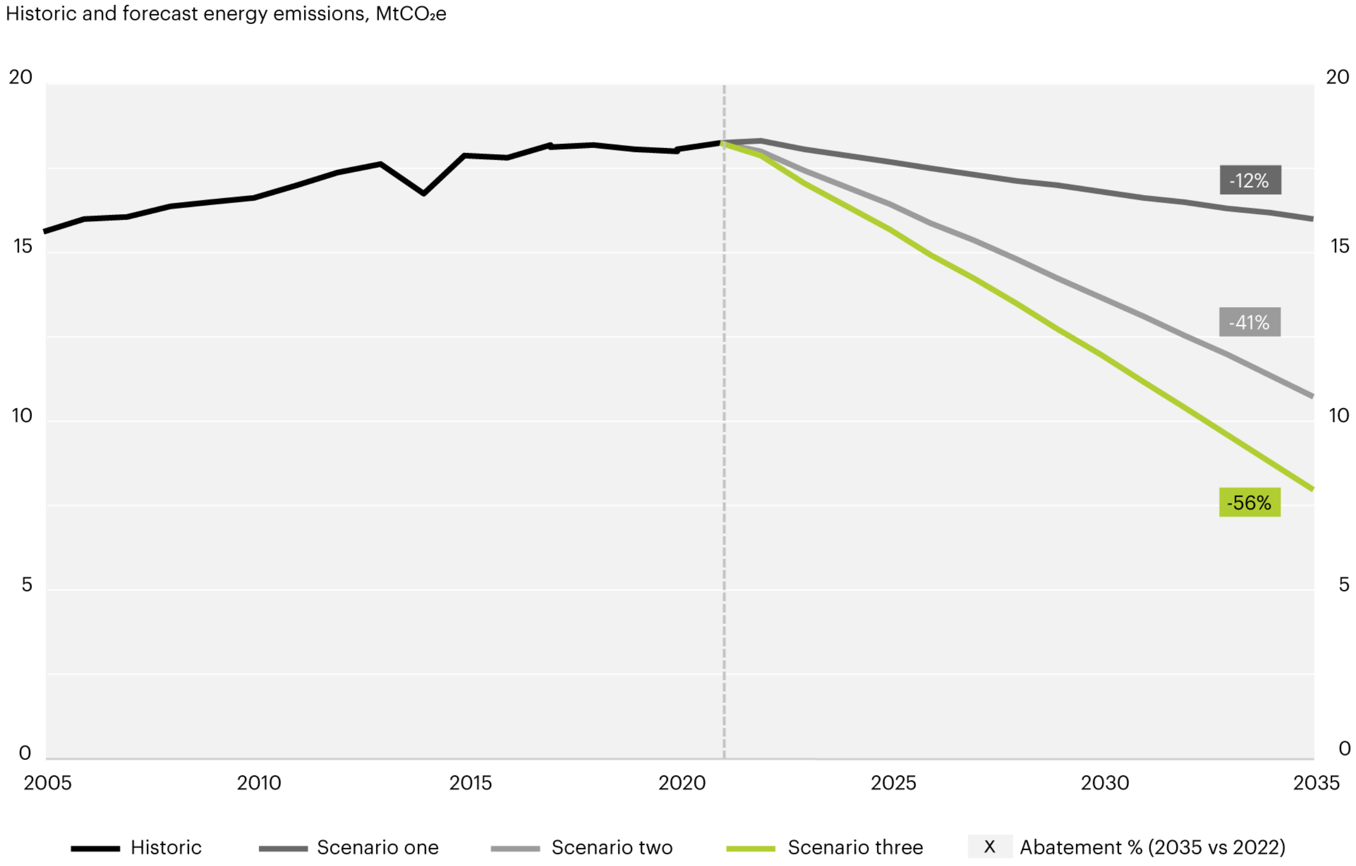
Australia has the potential to reduce buildings sector emissions by 12 to 56 per cent by 2035 — scenario two achieves an emission saving of 7 Mt per year when comparing 2022 and 2035. The replacement of gas appliances with reverse cycle air conditioners for space heating and cooling, electric water heaters and induction and electric cooktops are the main drivers of emission reductions in the buildings sector. Transition investment costs in this sector have been estimated at $20 to $40 billion to 2035.

The buildings sector emissions have increased by 16 per cent since 2005 driven by population growth and insufficient growth in the use of electric appliances compared to gas appliances in dwellings. There are nearly 11 million residential and 1 million non-residential buildings in Australia. Over the next decade residential and commercial floor space is expected to grow by 1.2 per cent and 1.5 per cent per year (respectively) and construction activity is expected to grow by 1.5 per cent per year.

Although beyond its direct emissions foot print, the buildings sector also consumes more than half of Australia's electricity production each year (or about 55 per cent of Australia's total scope 2 emissions). While scope 2 emission reduction in the buildings sector, and all other sectors of the economy, is primarily dependent on the transition of the electricity sector to renewables based power, investment in energy efficiency has an important role to play in reducing scope 2 emissions (at least until levels above 90 per cent renewables are achieved).

Finding 21: Over the next decade, the potential for emission reductions from buildings is limited in absolute terms but substantial as a percentage of total building emissions. Transition investment costs for this sector have been estimated at $20 to $40 billion to 2035.

Figure 31: Building sector decarbonisation pathways to 2035



Source: McKinsey Analysis (2024)

Electrification of space heating and cooling, water heating and cook tops

In the built environment context, heat pump and magnetic induction technologies are generally significantly more energy efficient than gas appliance alternatives.

- The use of reverse cycle air conditioners for space heating and cooling is up to 300 per cent more energy efficient than gas appliance alternatives.
- The use of heat pump water heating is up to 400 per cent more energy efficient than gas appliance alternatives.
- The use of induction cooktops is up to 200 per cent more energy efficient than gas appliance alternatives.

However, reaching higher rates of electrification penetration in residential and non-residential dwellings can be challenging.

- Electric appliances can require more space and may require an electricity supply upgrade.
- Electric appliances may require three phase power, increasing the cost of electricity per unit.
- Replacement of gas appliances with electric appliances before end of asset life is an additional cost.

4.5.1 Key levers

Figure 32: Buildings sector decarbonisation pathway assumptions

Segment	Scope 1 emissions change, Mt CO_2(e) p.a. 2022-35,	Pathway assumptions, 2035		
		Scenario one	Scenario two	Scenario three
Residential – heating/ cooling	2 2 2 1 7	Heat pumps increase to **~45%** of space heating by 2035, primarily in owner-occupied stand-alone dwellings uptake in Victoria at end of gas boiler life of 15 years	Heat pumps to increase to **~60%** of space heating technology mix by 2035, driven by elimination of sale of gas appliances in 2028	**95% uptake** in multi-unit dwellings; accelerated capital replacement of gas boilers of 10 years
Residential – water heating	2 1 1 5	**~25%** penetration of water heat pumps, driven primarily from owner-occupied stand-alone dwellings in Victoria transitioning from gas at end-of-life of 15 years	**~35%** penetration of water heat pumps, driven by elimination of sale of gas appliances in 2028	**95% uptake** in multi-unit dwellings; accelerated capital replacement of gas boilers of 10 years
Commercial – heating/ cooling	2 1 1 4	Heat pumps increase to **~30%** of space heating mix, driven primarily through transition from gas in retail, office and hotel facilities	Heat pumps to increase to **~35%** of space heating mix, driven primarily through transition from gas in retail, office and hotel facilities	More than **~10%** of heat pumps in large warehouses and factories; capital replacement of gas boilers of 10 years
Construction	1 2	**~35%** of construction machinery and equipment to be electric by 2035	**~50%** of construction machinery and equipment to be electric by 2035	**10% biofuel blending** in construction equipment
Commercial – appliances	1	Electric appliances are **~70%** of appliance technology mix	As per Current course	As per Current course
Residential – appliances	<1	More than **99%** of appliances expected to be electric, and **~70%** of cooktops to be electric/induction technology	**~75%** of cooktops to be electric/induction technology	As per Accelerated action
2035 emissions	8 6 5 3 22			

1. Decrease in emissions intensity

■ Unabated emissions ■ Scenario one abatement ■ Scenario two abatement ■ Scenario three abatement

Source: McKinsey Analysis (2024)

4.5.2 Key enablers

Figure 33: Summary of key enablers for building sector decarbonisation

Trusted government standards, guidelines and programmes

Build on the establishment of standards, programs, and innovative measures, to better impact the total building emission foot print (scope1, scope 2 and scope 3).

Drive greater transparency of commercial buildings' sustainable performance through the National Australian Built Environment Rating System.	Revise emissions standards for energy used in the buildings such as in the National Australian Built Environment Rating System to reflect the cost of fully firmed green power, ensuring accurate representation of sustainable energy sources.	Further develop standards for lifecycle emissions measurement in the National Construction Code. This will emphasise its importance in design and planning guidelines, promoting the emission saving of electrification, promoting the benefits of repurposing and renovating existing dwellings, as well as reusing and recycling materials and end of life structure.

Generating market confidence through demand signals

How buildings are made and used impacts their total emission foot print (scope1, scope 2 and scope 3).

The 'chicken and egg' problem needs to be addressed whereby suppliers of building materials are reluctant to invest in low emission materials production (at scale) because developer (and building consumer) demand is uncertain, due to a reluctance to commit using low emission materials without assurance of their availability and reliability (at scale).	Governments as the largest group of building consumers should lead the way towards purchasing low emission materials, by consistently prioritising emission standards in government commissioned and owned buildings.	Educate consumers and businesses more generally on the importance of prioritising sustainability metrics in their choice of dwelling, as buyers often focus on upfront costs and traditional performance metrics, while overlooking the total lifecycle emissions of materials and structures.

Financial incentives to address capital cost constraint

Overcoming financial barriers to higher rates of electrification of Australia's dwelling stock.

Support low income households to electrify their household appliances using incentive mechanisms such as targeted subsidies, low interest financing options, and direct government assistance programs.	Address split incentives between owners and tenants of dwellings by for example, extending the financial support via the Clean Energy Finance Corporation for owners to manage the upgrade to electric appliances.	Introduce environmental upgrade agreements, as a financing mechanism to allows building owners to fund environmental upgrades by repaying a loan through a local council charge, known as an environmental upgrade charge, as a way to access capital for upgrades that improve a building's energy, water, or overall environmental efficiency.

Innovation to overcome practical barriers, such as space limitations

Overcoming non-financial barriers to higher rates of electrification of Australia's dwelling stock.

Address practical constraints particularly in commercial dwellings (such as in large warehouses, data centres and factories) to support implementation of reverse cycle air conditioners, as well as adequate battery storage, this may include modular units, rooftop installations, decentralised or integrated systems (such as systems that combine air ventilation with heating and cooling) as well as leveraging vertical space.	For energy storage specifically, innovative solutions such as high capacity batteries and advanced grid management can play a dual role by optimising both the use of limited space where this can't practically be changed, while enhancing overall energy reliability and efficiency.

Develop adequately sized and skilled workforce.

This will be necessary to accelerate higher rates of dwelling electrification.

Develop and recruit appropriate workforce and skills, from training salespeople in appliance stores to training electricians to rewire homes in metropolitan and rural areas.

4.6 Critical unlocks in agriculture

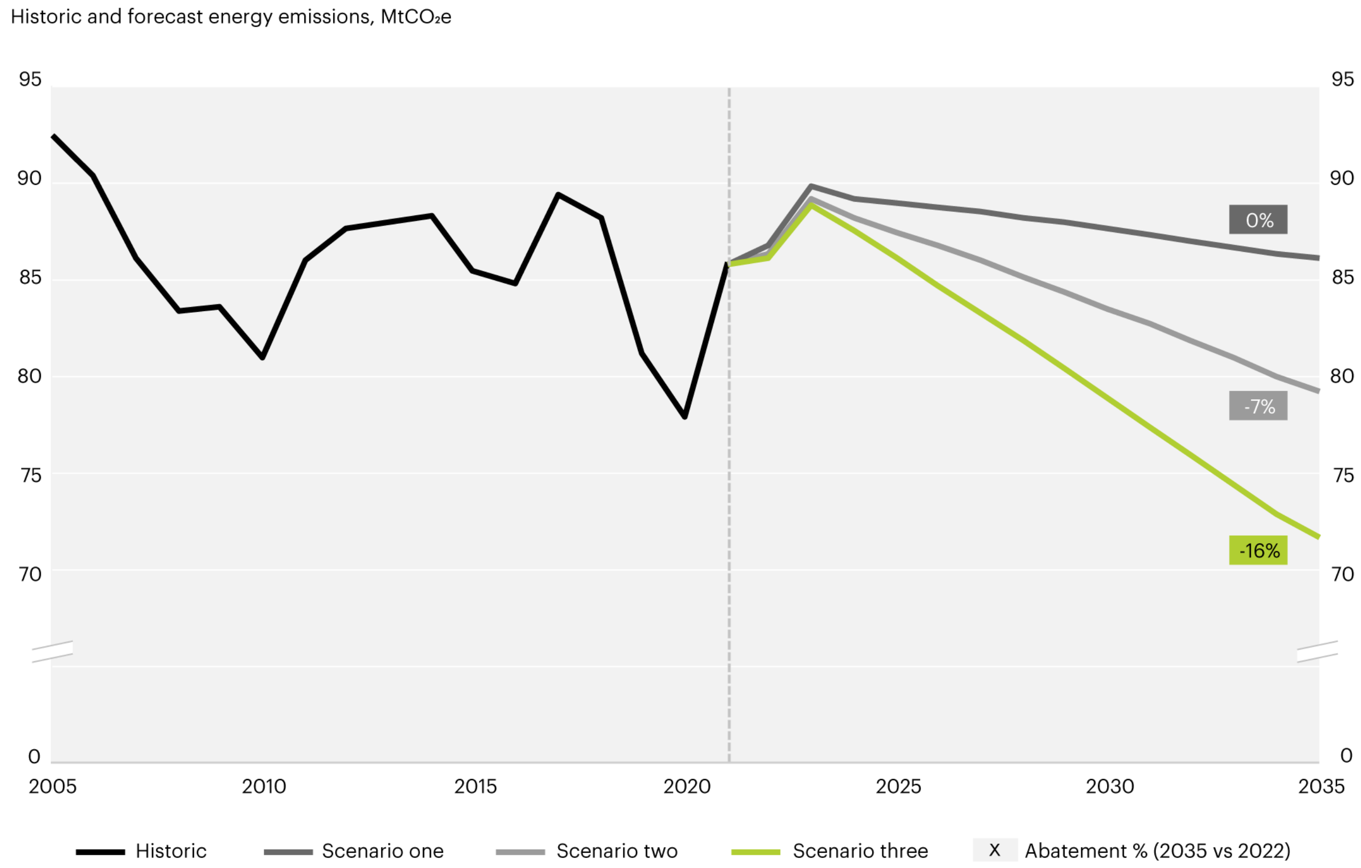
The agriculture sector contributes 19 per cent of Australia's total emissions at 86 Mt per year, primarily resulting from high levels of methane produced through livestock digestion and the decomposition of manure, the majority of which arises from pasture grazing animals in Australia. The sector provides agricultural produce for 90 per cent of food and beverages consumed domestically and is a major exporter to the world.

Australia has the potential to reduce agriculture sector emissions by 0 to 16 per cent by 2035 — scenario two achieves an emission saving of 6 Mt per year when comparing 2022 and 2035. Reduced fertiliser use and adoption of urease and nitrogen inhibitors, and electrification and fuel switching for agricultural equipment are the main drivers of emission reductions in the agriculture sector, given that methane inhibiting feed additives remain challenging to scale for pasture fed animals. Transition investment costs for this sector have been estimated at $5 to $20 billion to 2035.

Agricultural emissions have declined by 6 per cent since 2005, driven by gradually declining livestock numbers — a 33 per cent fall in the sheep herd from 101 to 68 million, a 12 per cent fall in the beef cattle herd from 25 to 22 million, and a 33 per cent fall in the dairy cattle herd 3 to 2 million. Looking forward, sheep herd sizes and beef cattle herd sizes are projected to remain constant, and dairy cattle herd sizes are projected to fall slightly.

Finding 22: Over the next decade, the potential for emission reductions from agriculture is limited in percentage and absolute terms. Transition investment costs for this sector have been estimated at $5 to $20 billion to 2035.

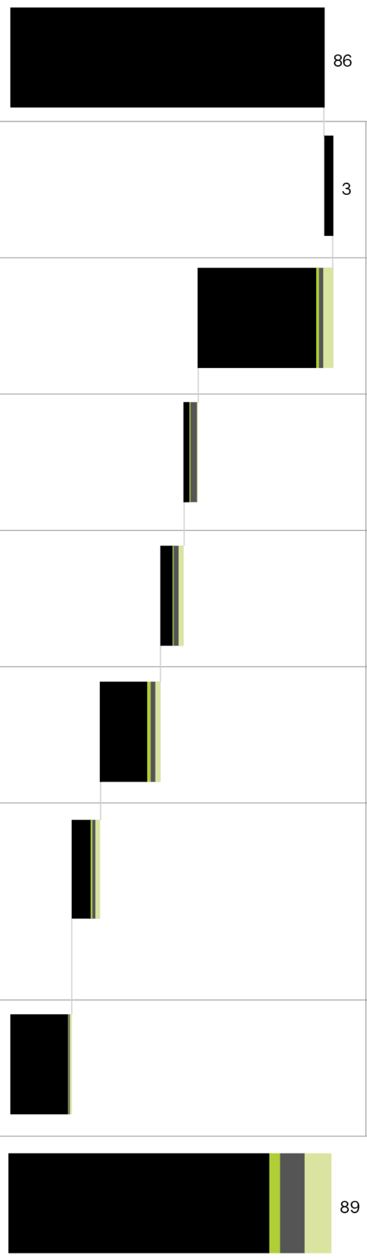
Figure 34: Agriculture sector decarbonisation pathways to 2035



Source: McKinsey Analysis (2024)

4.6.1 Key levers

Figure 35: Agriculture sector decarbonisation pathway assumptions



Segment	Activity adj. abatement, 2022-35, Mt CO_2(e)	Pathway assumptions, 2035		
		Scenario one	**Scenario two**	**Scenario three**
2022 Baseline	86			
2022-35 activity impact	3	Beef herd increased 9% from FY21 to FY23[2]. Thereafter, constant total cattle herd with switch from dairy (-1%/yr) and pasture (-0.1%/yr) to feedlot; constant sheep herd; constant size of crop- and pastureland		
Beef pasture		**2%** uptake of methane-reducing feed additives (-0.8Mt)	**4%** uptake of methane-reducing feed additives (-1.2Mt)	**20%** uptake of methane-reducing feed additives (-2.7Mt)
Beef feedlot		**6%** uptake of methane-reducing feed additives (-0.26Mt)	**90%** uptake of methane-reducing feed additives (-1.8Mt)	**100%** uptake of methane-reducing feed additives (-0.2Mt)
Dairy		**9%** uptake of methane-reducing feed additives (-0.3Mt)	**45%** uptake of methane-reducing feed additives (-1.3Mt)	**90%** uptake of methane-reducing feed additives (-1.3Mt)
Crop and pasture-land		**34%** of cropland has measures to reduce fertilizer use[3] (-0.9Mt)	**45%** of cropland has measures to reduce fertilizer use[3] (-1.3Mt)	**56%** of cropland has measures to reduce fertilizer use[3] (-1.4Mt)
On farm energy use		**6%** of farming equipment is electrified (-0.5Mt)	**16%** of farming equipment is electrified (-0.8Mt)	**24%** of farming equipment is electrified, and **10% biofuels** blending in conventional equipment (-1.2Mt)
Other livestock		**2%** uptake of methane-reducing feed additives for sheep (-0.2Mt)	**4%** uptake of methane-reducing feed additives for sheep (-0.3Mt)	**20%** uptake of methane-reducing feed additives for sheep (-0.4Mt)
2035 Emissions	89			

1. Based on a weighted average of the abatement in each segments below the segment and their respective contribution to business as usual
2. Based on actual ABARES data
3. Levers include reduced fertilizer application, enhanced efficiency fertilizers, variablle rate fertilizers, nitrification and urease inhibitors etc.

Unabated emissions | Scenario one abatement | Scenario two abatement | Scenario three abatement

Source: McKinsey analysis based on DCCEEW Australia's Emissions Projections (2023) and National Inventory Report (2024)

Adoption of methane inhibiting feed additives

Methane reduction in livestock through feed additives is an evolving science with good prospects — for example, under the right circumstances, feed additives derived from seaweed have demonstrated effectiveness in reducing enteric methane by up to 80 per cent in beef cattle and up to 67 per cent in dairy cattle.

However, factors related to diet and consistent administration of methane inhibitors make the current effectiveness of this technology high for feedlot cattle but low for pasture fed cattle — which represents about 95 per cent of cattle in Australia. The technology needs further development to accommodate the greater mobility and more variable diet of grasses and forages associated with pasture fed cattle.

The economics of the technology are also challenging because the productivity improvements associated with adopting methane inhibitors, in terms of cattle weight gain, have not been demonstrated consistently across diverse geographic areas and conditions in the trials conducted to date. As adoption rates and demand grow, scaling of the production and supply of methane inhibitors is expected to reduce the cost of abatement by lowering the unit cost of the feed additives.

Electrification and adoption of renewable fuels in agricultural equipment

The electrification and the use of 'drop in' renewable fuels, such as biofuel, for agricultural equipment has the potential to contribute to emission reductions in the agriculture sector.

The vast majority of agricultural vehicles and equipment used on Australian farms is currently fuelled by conventional diesel. Biofuels can replace diesel fuel with minimal or no modifications to existing equipment and vehicles, but at a cost of 1.5 to 3 times higher. For the next few years at least, the agriculture, resources and transport sectors will be competing for limited domestic supplies of biofuels due to constraints in refining and feedstock capacity. Importing renewable fuels is another option but global demand is also increasing.

Electrification of some equipment and vehicles, such as tractors, preharvest processes, utility vehicles and grain augers is commercially available, while full scale electric combine harvesters are still being developed and commercialised. A key barrier to adoption of electrification generally is the long lifespan of agricultural equipment and vehicles of 20 years or more and the cost associated with premature capital replacement.

Reduction in fertiliser use and the adoption of urease and nitrogen inhibitors

The reduction in fertiliser use through more efficient and integrated farming practices, as well as adoption of low emissions fertilisers, such as urease and nitrogen inhibitors, have the potential to contribute to emission reductions in the agriculture sector. A reduction in fertiliser use is also a reduction in its negative externalities such as polluted waterways, lower soil biodiversity and harm to wildlife.

At least one fifth of Australia's fertiliser consumption by the agricultural sector could be reduced in the next ten years via more efficient and integrated farming practices.

- Precision agriculture — adopting best practices and technologies such as variable rate technology to help align nutrient supply and crop demand more accurately.
- Regenerative agriculture — holistic farming approaches focused on improving soil health, enhancing biodiversity, and increasing crop resilience by leveraging natural processes, applied to both crop and livestock agriculture.
- Circular solutions — a closed loop system where nutrients, organic matter and other waste products are reused or recycled, such as enhanced composting and cover crops, further decreasing dependency on synthetic fertilisers.

Emission reductions can also be achieved through adoption of low emission fertilisers.

- Enhanced efficiency fertilisers — including slow release or urease and nitrification inhibitors, which under the appropriate conditions can help reduce nitrogen volatilisation and leaching, thereby increasing crop nitrogen use efficiency.
- Biological fertiliser alternatives and bio stimulants — increasingly being used in sustainable farming to help reduce nitrogen loss and enhancing nutrient availability in soils with naturally low organic matter.

4.6.2 Key enablers

Figure 36: Summary of key enablers for agriculture sector decarbonisation

Value chain collaboration and improved transparency

Full supply chain emissions must be measurable and transparent to the market.

Robust emissions tracking and traceability at all point in Australia's food supply chain (from farm to supermarket) is necessary to provide confidence to individual participants to invest in emission reduction technologies and to shift to a more sustainable product strategy, and more confidence to customers willing to pay a green premium.

Financial incentives to support landowners and farmers

Medium and small farms need financial support to deploy and adopt emission reduction technologies as they scale up.

The 'chicken and egg' problem needs to be addressed, as insufficient scale of adoption makes the unit costs of technologies too high, which means that farm productivity benefit can't be fully demonstrated or realised, which in turn means technology providers can't achieve scale economies of production because demand is too low.

Lowering the cost curve through sustainable research and development

More affordable and more effective technology will be adopted more quickly.

Private and public investment in emerging sustainable agriculture technologies (for example) satellite imaging for precision farming, improving the effectiveness of methane inhibiting feed additive technologies for feedlot and pasture fed animals, automated systems, drones, sensors, and data analytics for tasks like crop monitoring, irrigation, and livestock management.

Raising awareness to drive behavioural changes

Behavioural change on the supply side and demand side are important.

Continued awareness building among farmers of new sustainable practices and tools, including small adjustments to common practices, such as using chicken or pig manure more efficiently as an organic replacement to traditional fertilisers, can have a positive impact on emissions, productivity and cost.

Continued awareness building among consumers about the environmental impact of food choices can help drive increased demand for low emission, sustainable produce, and educational campaigns and incentives for reducing food waste can further support emission reductions.

4.7 Critical unlocks in land

Land use, land-use change, and forestry (the land sector) is a net carbon sink that sequesters 20 per cent of Australia's total emissions at -88 Mt per year, which is Australia's current historical peak rate. The size of this carbon sink is the result of changes in land use.

- Reforestation — restoring trees and vegetation in areas that used to be forested.
- Afforestation — establishing trees and vegetation in areas that were not previously forested.
- Land clearing / deforestation — removal of trees and vegetation from an area.
- Native forest logging — harvesting trees from forests that occur naturally in an area.
- Savanna fire management — the reintroduction of controlled fire burning during the early dry season to reduce the frequency and severity of fires in the late dry season.

Australia's total emission reductions since 2005 have been predominantly driven by land sector changes — in 2005 land sector emissions were 163 Mt higher than in 2022 (+75 Mt compared to -88 Mt). The Government's baseline 2035 emission reduction scenario for land sector emissions is -61 Mt, reflecting a return to average climate conditions from an above average net sink in the 3 years to 2024.[34]

In this analysis potential changes to land sector emissions range from +25 to 0 per cent when comparing 2022 and 2035, which means emissions from the land sector are increasing or constant.

- Scenario one is more or less consistent with the Government's baseline scenario, projecting an increase in emissions of 22 Mt per year when comparing 2022 and 2035 (a reduction in the size of Australia's carbon sink from -88 Mt to -66 Mt).[35]
- Scenario two projects an increase in emissions of 17 Mt per year when comparing 2022 and 2035 (a reduction in the size of Australia's carbon sink from -88 Mt to -71 Mt).
- Scenario three projects no change in the size of Australia's carbon sink when comparing 2022 and 2035 (that is, remaining constant at the historical peak rate of -88 Mt per year) — which represents a 27 Mt increase compared to the Government's baseline projection of -61 Mt in 2035.

Maintaining the current historical peak of rate of -88 Mt per year — which requires policies and investments to offset slowing sequestration rates from maturing forests and grasslands — has been assumed as the upper bound in this analysis in the absence of any strong evidence currently available, to indicate that new policies and investments can with confidence sustainably exceed this rate by 2035.

We acknowledge that this is a rapidly evolving field and that new methods for land based sequestration are being developed and enhanced, which are expected to increase Australia's land sink potential further over time.

Finding 23: Over the next decade, simply maintaining the historical peak size of Australia's existing carbon sink will require additional effort. This means emissions from the land sector are likely to remain constant (with additional effort) or increase.

Afforestation and reforestation

It is encouraging to note that from 2005 to 2022, land converted to forest in Australia has increased by an average of 400,000 hectares per year, including grassland, cropland, settlements and wetlands. The key method for this conversion in Australia has been human induced regeneration, which involves changing land management practices to allow natural regeneration of native vegetation to occur, rather than planting new trees.

Australia has 170 mega hectares of suitable land for forestation based on existing land cover and protection status, which theoretically could sequester 600 Mt per year over 30 years (or 3.5 tCO_2e per hectare). However, the abatement cost, factoring in the associated agriculture GDP opportunity loss, varies depending on the sequestration intensity potential of the parcels of land. Moreover, the sequestration rates are highly uncertain currently, especially on the short to medium term.

Avoided land clearing

While the rate of deforestation in Australia has declined in recent years, it remains somewhat elevated compared to other developed nations. In 2022 land clearing released 14.5 $MtCO_2e$, of which 40 per cent represented primary (old growth) forest clearing and 60 per cent represented secondary (new growth) forest clearing. The typical cost of avoided land clearing in Australia ranges between $35 and $40 per tCO_2e, reflecting the value of agriculture, urban and other land use potential.

[34] Department of Climate Change, Energy, the Environment and Water, Australia's emissions projections 2024 November 2024.
[35] The -66 Mt in 2035 represents the historical average based on the Government's projections.

Reducing native forest logging

Logging, particularly native forest logging, does not always receive the same level of attention as deforestation and land clearing. The National Inventory Report reveals a strong (positive) correlation between land sector emissions and native forest logging.

Over the past 30 years, there has been a steady decline in native forest logging due to bans in some jurisdictions, shifting consumer preferences and a rise in alternative timber sources, such as bamboo, recycled plastics, steel, wood composites etc. However, despite this trend, 28,000 hectares of harvested native forests were reported in 2022.

4.7.1 Key levers

Figure 37: Land sector decarbonisation pathway assumptions

	Sequestration per year in 2035, Mt CO_2e	**Description**	**Abatement cost,** $ / tCO_2e
Scenario one	66	A return to an historical average by 2035	
Scenario two	5	Human induced regeneration on land with average sequestration rates ■ Historical rate of land converted to forest (0.4 Mha per year), achieving an average sequestration per year across 30 year period (3.5 tCO_2e per year) ■ Sequestration is discounted to account for lower sequestration for juvenile forests	50[1]
	71		
Scenario three	11	Human induced regeneration on land with high sequestration rates ■ Incremental abatement from human induced regeneration, using higher sequestration	40[3]
	6	Avoided land clearing ■ From 2010-2020, average annual secondary land clearing was 0.4 Mha per year ■ 7.7 Mt COZe sequestration achieved by avoiding land clearing in 1.2 hectares[2]	35–40[2]
	88		

1. Estimate based on sequestering 600 Mt CO_2e using land with 30 billion per year agricultural GDP; McKinsey TRAILS model
2. Estimate of economic sequestration from avoided land clearing of native forest regrowth, section 7.3.2 in Australia's Carbon Sequestration Potential November 2022, CSIRO
3. Estimate based on sequestering 50 Mt CO_2e using land with 2 billion per year agricultural GDP; McKinsey TRAILS model

Scenario one   Scenario two   Scenario three

Source: McKinsey Analysis (2024)

4.7.2 Key enablers

Figure 38: Summary of key enablers for land sector decarbonisation

Community engagement Effective engagement and collaboration with communities is key for long term success.
Regional communities play a critical role in terms of direct land ownership, knowledge and skills, labour, as well as being the long term custodians of the land and forest and so benefit sharing mechanisms will need to be developed to ensure communities gain their fair share of the value created from land sector abatement and restoration projects.
Lowering the cost curve through sustainable research and development More effective technology will raise precision and confidence in land sector abatement.
Private and public investment in emerging land sector abatement technologies (for example) satellite imaging and agroforestry biochar or the application of biochar, in agroforestry systems.
Encouraging rigorous debate and sound decision making The community and landowners need to be well informed.
Continued awareness building among communities about the benefits and trade off associated with land sector abatement and restoration projects.

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