CLIMATE ANALYTICS

A fossil-free Australia

An ambitious Paris-aligned phase-out of coal, gas and oil from the national energy system

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About Climate Analytics

Climate Analytics is a global climate science and policy institute. Our mission is to deliver cutting-edge science, analysis and support to accelerate climate action and keep warming below 1.5°C.

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Foreword

In 2015, in the Paris Agreement, the world's governments collectively committed to limit global warming to 1.5°C and reach global net zero emissions in the second half of the century. As one of its signatories, the Australian government is morally and legally bound to align its national actions and policies with the Paris Agreement, and contribute its fair share to limiting warming to 1.5°C.

Today, it is clear that we are likely to overshoot 1.5°C due to the lack of sufficient action by most governments, including Australia's, since the Paris Summit. This will inevitably increase impacts and damages from climate change; so the focus now has to be on limiting the magnitude and duration of overshoot. The imminence of overshoot only increases the obligation on all countries to act with the highest possible ambition, pursuing stringent mitigation to bring CO_2 emissions to net zero by mid-century and greenhouse gas emissions to net zero by the 2070s - at the latest.

This can only be achieved with a rapid phase-out of the primary source of greenhouse gas emissions, fossil fuels – a fact Australia recognised and publicly supported at COP28 in 2023 during the Paris Agreement's first Global Stocktake. There is now an international focus on developing fossil fuel phase-out roadmaps, which Australia has publicly supported.

In the years since Paris, global warming has accelerated markedly, and has now reached about 1.4°C above pre-industrial levels.

Impacts are already far more visible and catastrophic, including in Australia. We have seen the devastating wildfires of 2019/20 that burned seven million hectares of forests, repeated record flooding, increasingly intense cyclones, and extraordinary marine heatwaves. Our coral reefs - the Great Barrier Reef, Ningaloo, the remote Scott Reef (targeted for gas drilling by Woodside) - and other places have all suffered repeated and catastrophic bleaching events.

The disastrous flooding in Nepal was clearly triggered by climate warming related to rock-glacier collapse, as warming destabilises landscapes across the Himalaya region. Unfortunately it is just a taste of what is to come unless we get fossil fuel emissions reduced rapidly.

As we brace for the additional impacts of a super El Niño in 2026/2027 and the likelihood of extreme heat, drought and fires ahead we have to ask ourselves: is the Australian government doing enough on climate change?

This report finds it is not – but more importantly, it shows the way forward. The government is far from getting Australia's emissions onto anything like a Paris-aligned 1.5°C pathway. The government appears to prefer that industrial polluters - especially the fossil fuel extraction industry - buy offsets instead of cutting emissions.

Our report introduces the Australian Fossil Fuel Phaseout (FFPO) scenario, a new Paris-aligned 1.5°C national pathway that shows what a transition out of coal, fossil gas and oil looks like for Australia - and shows that it's achievable. It will require major policy changes and improvement, but all of these are well within the capabilities of this country. What's missing is the political will.

The Australian government's fossil fuel habit not only hastens global climate chaos, it also risks leaving the country behind as most of the world upgrades to clean energy. The costs of renewable energy, battery storage and electric vehicles are plummeting. A series of global energy crises have exposed high vulnerability to global commodity prices.

Phasing out fossil fuels will future-proof Australia's economy. It will reduce energy costs and accordingly the cost of living, and improve energy security. Our next report will set out the benefits of such action, undertaken in a fair and just manner to protect jobs and the economy. And it would be in Australia's direct national interest to limit and reduce the oncoming catastrophic climate changes that will come our way if we continue on our present fossil fuel intensive pathway.

As important as this is within Australia, an Australian move towards a fossil fuel free economy would be a massively important global signal, especially to our Pacific neighbours who are increasingly being courted by regional superpowers. They face multiple climate risks including accelerated sea level rise, and look to Australia for leadership and support.

An Australian fossil fuel phase-out commitment will provide a signal to other major emitters that a turning point has been reached. Such an essential change of direction would constitute active global leadership.

The question now is whether the Australian government is willing to take those steps – for its people, its nature and its future.

Bill Hare
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List of Abbreviations

ABS – Australia Bureau of Statistics
ACT – Australian Capital Territory
ACCU – Australia Carbon Credit Unit
AEMO – Australian Energy Market Operator
ARENA – Australian Renewable Energy Agency
BECCS – Bioenergy with Carbon Capture and Storage
CCA – Climate Change Authority
CCS – Carbon Capture and Storage
CCU – Carbon Capture and Utilisation
CCUS – Carbon Capture, Utilisation, and Storage
CDR – Carbon Dioxide Removal

CIS – Capacity Investment Scheme
CPP scenario – Current Policy Scenario
CSIRO – Commonwealth Scientific and Industrial Research Organisation
DACCS – Direct Air Carbon Capture and Storage
DCCEEW – Department of Climate Change, Energy, the Environment and Water
DKIS – Darwin-Katherine Interconnected System
EAF – Electric Arc Furnace
EJ – Exajoule
EP – Emissions Projections
EV – Electric Vehicle
FMIA – Future Made in Australia
FFPO scenario – Fossil Fuel Phase-Out Scenario
FY – Financial Year
GDP – Gross Domestic Product
GHG – Greenhouse Gas
GPP – Green Public Procurement
$GtCO_2$ – Gigatonnes of Carbon Dioxide
GW – Gigawatt
GWh – Gigawatt-hour
HFO – Heavy Fuel Oil
HPA – Highest Possible Ambition
H2A – Hard-to-Abate
IAM – Integrated Assessment Model
ICE – Internal Combustion Engine
IEA – International Energy Agency
ICJ – International Court of Justice
IPCC – Intergovernmental Panel on Climate Change
IPPU – Industrial Processes and Product Use
ISP – Integrated System Plan
LULUCF – Land Use, Land-Use Change and Forestry
LCV – Light Commercial Vehicle
LNG – Liquefied Natural Gas
MDO – Marine Diesel Oil
MPIP – Major Public Infrastructure Pipeline
$MtCO_2$ – Metric Tonnes of Carbon Dioxide
$MtCO_2e$ – Metric Tonnes of Carbon Dioxide Equivalent
Mtpa – Million Tonnes per Annum
NRAP – National Rail Action Plan
NDC – Nationally Determined Contribution
NEM – National Electricity Market
NGGI – National Greenhouse Gas Inventory
NT – Northern Territory
NSW – New South Wales
NVES – New Vehicle Efficiency Standard
NWIS – North-West Interconnected System
NZP – Net Zero Plan
PIK – Potsdam Institute for Climate Impact Research
PJ – Petajoule

PPA – Power Purchase Agreement
PV – Photovoltaic
R&D – Research and Development
RBA – Reserve Bank of Australia
SAF – Sustainable aviation fuel
Scope 1 emissions – Direct emissions from assets controlled by a company
Scope 2 emissions – Indirect emissions from purchased energy, such as electricity
SGM – Safeguard Mechanism
SWIS – South West Interconnected System
TWh – Terawatt-hour
V2G – Vehicle-to-Grid
(V)LSFO – (Very) Low Sulfur Fuel Oil
WA – Western Australia

Key messages

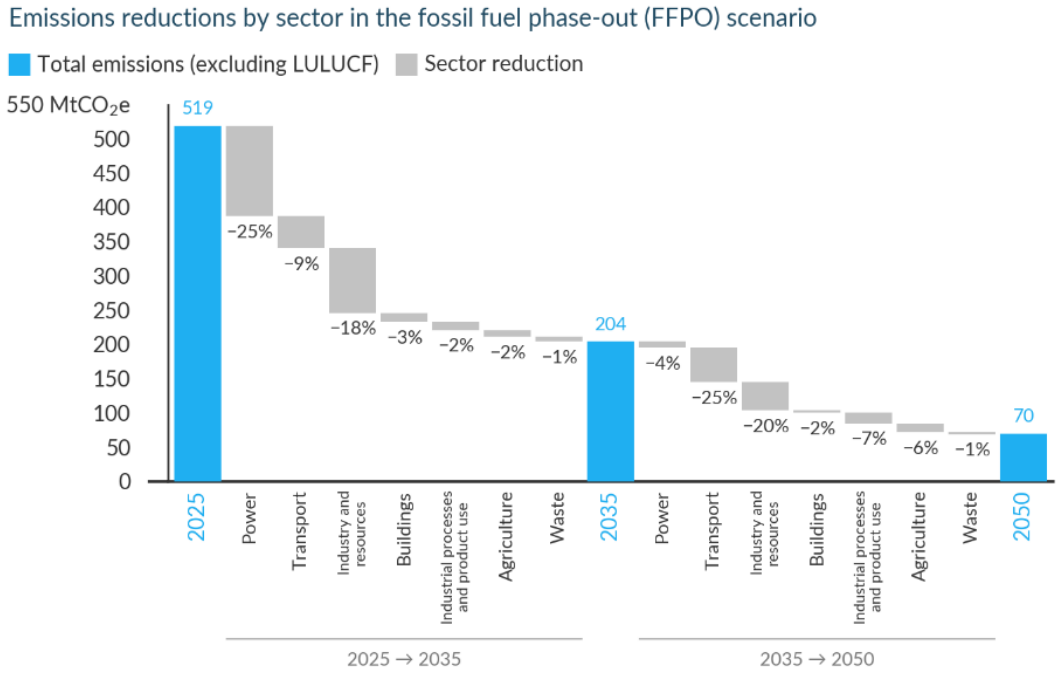
A fossil fuel phase-out would deliver Australia's climate commitments and send a signal to the world that the country is serious about Paris-aligned climate action.

Paris, 2015: Australia and the world's governments committed to limit global warming to 1.5°C and reach global net zero emissions in the second half of the century. As a signatory to the Paris Agreement, the Australian government is morally and legally bound to contribute its fair share to the goal of transforming and decarbonising its energy systems.

Australia's current policies barely meet its 2030 Paris Agreement target, nor do they align with its 2035 target. If the government is to meet its own stated goal of reaching net zero greenhouse emissions by mid-century, and strictly limit the magnitude and duration of 1.5°C overshoot, its current policies will leave it with a huge burden of emissions to deal with.

This report shows that Australia can meet its climate goals and reach net zero emissions by phasing out fossil fuels. Climate Analytics modelled it in a new Fossil Fuel Phase-out (FFPO) scenario, a Paris-aligned pathway for Australia informed by the latest global evidence. We set out its results and compare them with the government's current policies - the Current Policy Projections (CPP) scenario.

A fossil fuel phase-out for Australia to meet its climate commitments and to play its role in global efforts to limit warming to 1.5°C is urgent. We show this is possible in all sectors, we set out the policies the government needs to adopt, and we highlight what it is not doing - or needs to be doing more of. The government needs to start this phase-out now.



To achieve a fossil fuel phase-out fast enough to meet the Paris Agreement goals, the Australian government needs to immediately begin implementing ambitious policies for a clean energy transformation. That involves a coordinated shift away from coal, fossil gas and oil across the economy. To align with the FFPO scenario:

- **Coal:** coal-fired generation needs to be phased out by 2034, a critical step in the transition to clean electricity. Clean alternatives need to replace coal use in industry by 2040. In the Current Policy Projections, coal only exits the electricity system by 2050.
- **Fossil gas:** the government needs to cut domestic fossil gas demand by 90% between 2025 and 2040, and 98% by 2050 by eliminating its use in the electricity system, in Australian buildings and across industry. This trajectory is at odds with the government's fossil gas framing as a transition fuel. Current policies see fossil gas demand only decrease by 38% between 2025 and 2050, leaving gas emissions of 45 MtCO2e per year to be compensated by carbon dioxide removal (CDR) in 2050.
- **Oil:** Australia needs to halve oil and oil product demand below 2025 levels by 2035, fall 80% below 2025 levels by 2040, and reach zero by 2050, through a step change in the electrification of passenger and freight transport, a switch to sustainable fuels in aviation and shipping, and the replacement of oil, diesel and other products in industry. Under the CPP scenario, by mid-century, a third of Australia's final energy demand still comes from oil and oil products.

A decarbonised power sector

- Decarbonising Australia's electricity supply requires clear, binding fossil fuel phase-out dates to ensure an orderly transition. To align with the FFPO scenario,

the government must target 87% of renewable generation nation-wide by 2030, 96% by 2035, and 100% by 2050.

- The government's current policies allow coal, gas and oil to remain in the system until at least 2050, which is incompatible with the Paris Agreement's 1.5°C warming limit. Our model shows their elimination needs to be achieved much earlier.
- It needs to back this with adequate incentives: removing bottlenecks like lengthy permitting times, particularly for wind projects and grid infrastructure, or a lack of resources for regulatory bodies, can ensure that the transition advances at an orderly pace.

Exiting oil in transport

- Transport is currently set to become the highest-emitting sector of the Australian economy. Momentum around passenger electric vehicles is growing, but freight transport remains a blind spot in the government's policy framework.
- This report shows Australia can get to zero transport emissions by 2045, with in-depth electrification of road transport, including heavy road freight and rail.
- The government needs to set targets for sales of electric vehicles across vehicle types by 2035 at the latest, commit investment to expanding the charging network, and incentivise modal shift towards electrified rail.
- It also needs to make a switch to alternative fuels - like sustainable aviation fuel and ammonia - in aviation and shipping, which is currently not covered by any federal policies.
- The government needs to set a strategy for both transport sectors targeting the elimination of oil, and include their international components in its climate framework.

Transitioning the industry

- The government needs to urgently prioritise tightening the Safeguard Mechanism (SGM), its main instrument for industrial emissions, to avoid the current situation where industry can simply buy its way out of cutting emissions - with offsets. Under a fossil fuel phase-out, direct Safeguard emissions decline by nearly two-thirds by 2035.
- Converting the SGM into a proper compliance-based emissions trading system with a declining baseline and constraining the use of offsets would provide the signals needed for the industrial sectors to decarbonise.

Alongside strengthening the Safeguard Mechanism, the government needs to adopt an approach tailored to each industry:

- Foster a domestic green hydrogen industry to benefit all industries through programs such as the Future Made in Australia policy, while ensuring widespread access to cheap renewable electricity can improve green hydrogen's cost competitiveness.
- Develop a whole-of-economy green industrial strategy that builds on Future Made in Australia, with further commitment to de-risking capital and operational expenditure for clean industries.

Eliminating fossil fuel exports

As one of the world's biggest fossil fuel exporters, Australia has no framework in place to phase out these exports.

- The IEA makes it clear that, under a net zero pathway, there is no room for new fossil gas, oil and coal projects. Meanwhile, the International Court of Justice Advisory Opinion has reaffirmed that failure to protect the climate system, including through curbing fossil fuel production can be an internationally wrongful act attributable to the state.
- The government needs to devise a time-bound strategy for both the decline and elimination of exports, with a halt to project approvals and a plan for the retirement of existing export projects before they become stranded. Under the FFPO scenario, coal and LNG production fall immediately, dropping by nearly 80% and 25% by 2035, respectively. Coal exports are residual by 2040, when LNG exports are a third of their current levels.

Cutting methane emissions

- Reducing emissions from this potent, short-lived greenhouse gas is one of the most readily accessible levers to limit warming in the short term. In the FFPO scenario, government action to tackle energy-related methane emissions, often at negative net cost, and the decrease in fossil fuel production lead to their elimination by 2040.
- To align with the FFPO scenario, by mid-century, anthropogenic methane emissions need to be at almost half their 2020 level.
- The government needs to implement measures to eradicate energy-related methane emissions that would go hand in hand with the plan on fossil fuel production, and ramp up R&D efforts to scale methane abatement technologies in waste and agriculture.

Planning for net zero

- Under the government's policies, 245 million tonnes of residual emissions remain in the system by 2050. Reaching net zero from there would require Australia to scale removals to more than half of the country's present net emissions, with sequestration the government assumes would come from the land sector.
- But more than half (151Mt) of the residual emissions under current policies in 2050 are from the energy sector; they are emissions that can be totally eliminated, so carbon dioxide removal would be entirely inappropriate to deal with these.
- Under the FFPO scenario, gross mid-century residual emissions fall to 70 Mt. With a conservative assumption on land-based sequestration, under this pathway, direct air capture (DAC) would need to store around 17 $MtCO_2e$ per year by 2050.

To balance residual emissions from agriculture and hard-to-abate industrial sectors, carbon dioxide removal (CDR) will be necessary to achieve global net negative emissions and bring warming below 1.5°C. However, the more stringent emission reductions are, the smaller the burden of deployment.

CDR carries risks and uncertainties, has land, water and energy footprints that can compromise other sustainability goals. The government must account for these side effects and reserve CDR for counterbalancing unavoidable emissions, rather than using it to offset continued fossil fuel use. It must be a complement to a fossil fuel phase-out.

Executive summary

Australia and the Paris Agreement in the overshoot era

Inadequate climate action to date means the world will likely exceed 1.5°C of warming in the early 2030s and, under current global policy settings, will reach 2.6°C of warming by 2100. The magnitude and duration of the overshoot of 1.5°C will determine the commitment to irreversible physical, ecological, and economic loss and damage. Without a rapid cut in emissions, overshoot will become permanent.

Global national action now has to focus on emissions reductions that limit both the magnitude and duration of this exceedance to the lowest possible levels, and bring warming back well below 1.5°C as fast as possible. To halt warming, we need to reach net zero CO_2, and to reverse it, to reach and sustain net negative CO_2 emissions.

Fossil fuel phase-out, in line with the first Global Stocktake call for "transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner", is essential for stringent emissions reductions: in 2023, fossil fuels were responsible for 70% of global GHG emissions.

This report sets out the results of our fossil fuel phase-out (FFPO) scenario, a new modelled pathway showing how Australia can phase out fossil fuels in alignment with the Paris Agreement, informed by the latest global and national evidence. It is a roadmap to transition away from fossil fuels, as the International Conference on Transitioning away from Fossil Fuels, held in Santa Marta in April 2026 and in which Australia participated, called for.

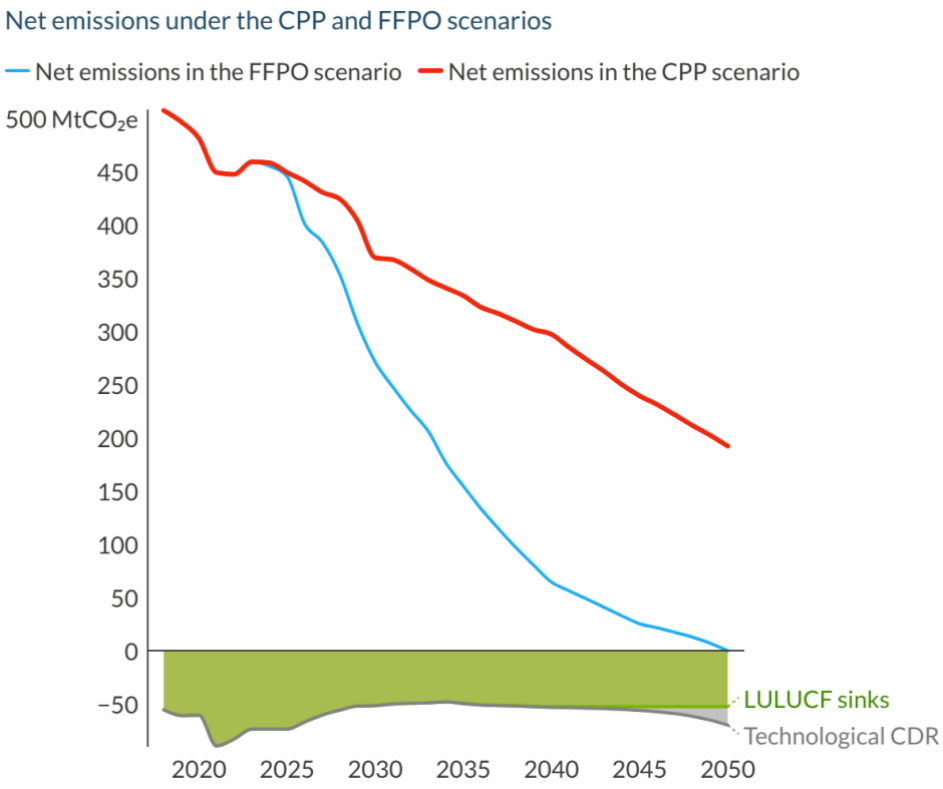
In addition to the FFPO scenario, we present the current policy projections (CPP) pathway, built to represent the energy and emissions implications of Australia's current climate and energy policy framework. The report investigates the gap between Australia's projected energy system transformation to 2050 under current policy settings and what Paris alignment requires, by comparing it with the FFPO scenario.

To align with the FFPO scenario, Australia needs to reduce its net emissions by 55% below 2005 levels by 2030, 75% by 2035, and reach net zero emissions by 2050 at the latest. But right now, both targets and implementation are insufficient: Australia's current policies barely meet its 2030 Nationally Determined Contribution target of reducing net emissions by 43% below 2005 levels by the end of this decade, nor do they align with its 2035 targets of 62-70%.

The government has a policy of getting to net zero greenhouse gas emissions by 2050. Under the CPP scenario, 2050 residual emissions (emissions that need to be compensated to get to net zero) are 245 $MtCO_2e$, or more than half of current net emissions. 151 Mt

of these residual emissions would be from the energy sector – fossil emissions that need to be eliminated. Our modelling work shows that much more needs to and can be done.

To get to net zero greenhouse gases by 2050, residual emissions need to be compensated by an equally large amount of negative CO_2 emissions. Planning for such a large quantum of residual emissions creates multiple risks. The government's Net Zero Plan anticipates nearly all the 2050 negative emissions to come from the land sector. Relying on a massive increase in Australia's carbon sink over this timeframe carries with it sustainability and geophysical risks, including from climate change itself. A clear policy focus has to be to minimise residual emissions. Under the FFPO scenario, deep emissions cuts reduce 2050 residual emissions to 70 $MtCO_2e$ (see discussions below).



Two diverging trajectories

The climate imperative to get to net zero emissions means that energy systems – including Australia's – need to transition away quickly from fossil fuels, thanks to renewable power rollout, electrification, fuel switching and energy efficiency across the economy.

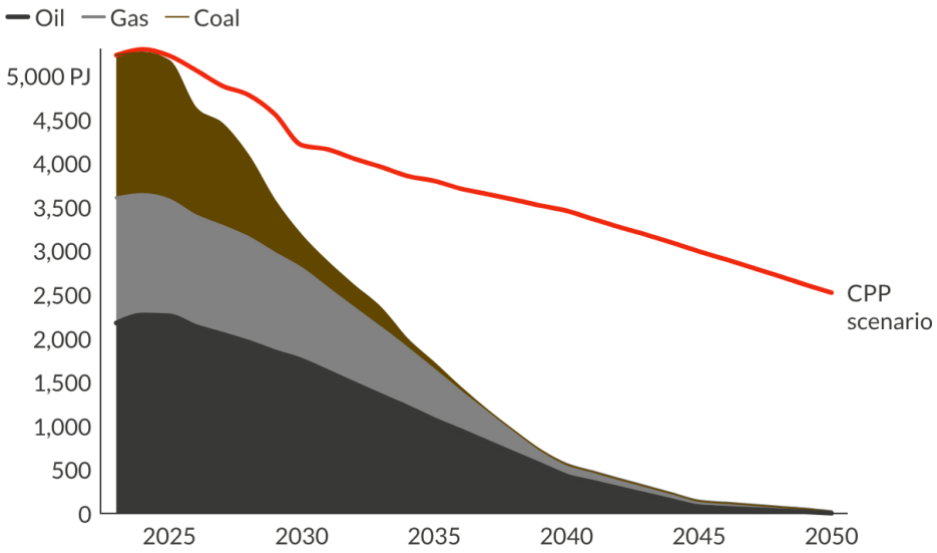
To achieve the FFPO scenario, the Australian government needs to implement ambitious policy action for the clean energy transformation that leads to a coordinated shift away from coal, gas and oil. In order to enable this Paris-aligned transformation:

- **Coal:** Coal-fired generation needs to be phased out by 2034 as a critical step to generating clean electricity to power the transformation. Coal use in industry needs

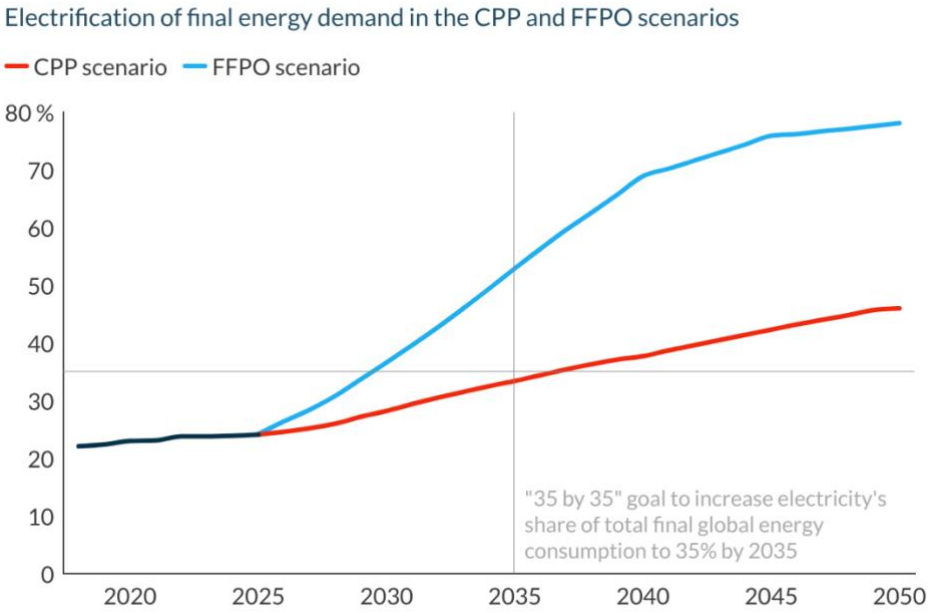
to be replaced by clean alternatives by 2040. In the CPP scenario, it only exits the electricity system by 2050.

- **Fossil gas:** Domestic fossil gas demand needs to drop by 90% between 2025 and 2040, and 98% by 2050 thanks to its elimination in the electricity system, in Australian buildings and across the manufacturing sectors. This trajectory is at odds with the government's fossil gas framing as a transition fuel: in the CPP scenario, fossil gas demand only decreases by 38% between 2025 and 2050, leaving gas emissions of 45 $MtCO_2e$ per year to be compensated by CDR in 2050.
- **Oil:** Australia needs to halve demand for oil and oil products below 2025 levels by 2035, cut it to 80% below 2025 levels by 2040 and reach zero by 2050, through a step change in the electrification of passenger and freight transport, a switch to sustainable fuels in aviation and shipping, and the replacement of oil, diesel and other products in industry. Under the CPP scenario, by mid-century, a third of Australia's final energy demand still comes from oil and oil products, leaving 106 $MtCO_2e$ of residual emissions.

Total primary energy demand from fossil fuels in the FPPO scenario by fuel, compared to the CPP scenario



Deep electrification powered by renewables is what makes the fossil fuel phase-out in the FFPO scenario possible. Under this pathway, electricity's share of final energy demand rises from a quarter in 2025 to 36% by 2030, half by 2035 and over 75% by 2050, as every energy sector transitions. By comparison, it reaches only 28% by 2030, 33% by 2035 and 46% by 2050 in the CPP scenario. While electricity does the heavy lifting, hydrogen, ammonia and biomass make more limited contributions to Australia's decarbonisation.

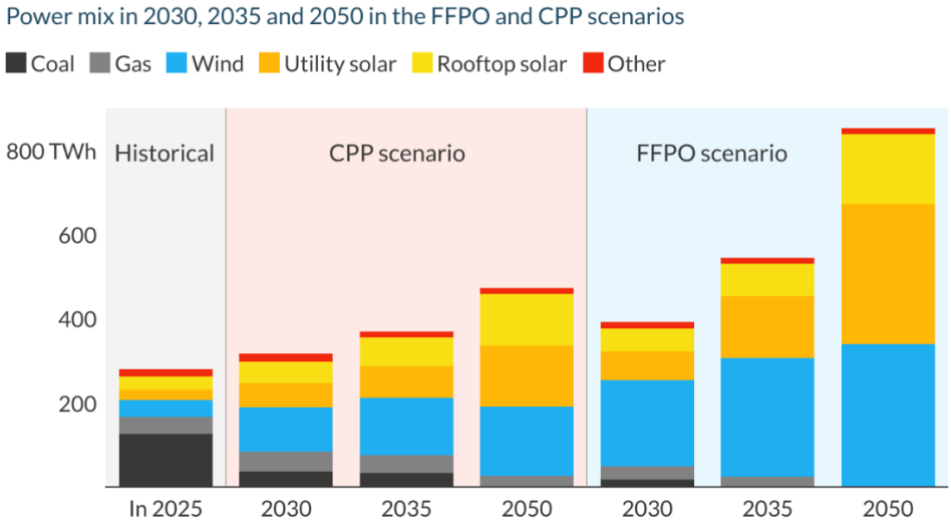


Power

Power sector decarbonisation will be the backbone of Australia's transition away from fossil fuels. In the FFPO scenario, coal is effectively phased out by 2034 and fossil gas a few years later.

The massive deployment of solar, wind and storage capacity is the driver of Australia's electricity sector transformation. Australia needs to increase wind and solar capacity to 135 GW by 2030, 212 GW by 2035 and 390 GW by 2050, from 54 GW in 2025. It also needs to deploy 41 GW of additional storage capacity by the end of the decade, rising to 97 GW by 2035 and 191 GW by mid-century. In comparison, the CPP scenario requires 5 GW of additional storage by 2030, 13 GW by 2035 and 47 GW by 2050.

Decarbonising Australia's electricity supply requires clear, binding fossil fuel phase-out dates to ensure an orderly transition. Current policies would allow fossil fuels to remain in the system until at least 2050, which is incompatible with the Paris Agreement's warming limit.

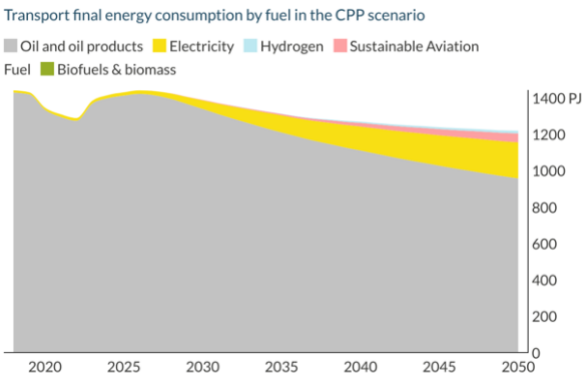


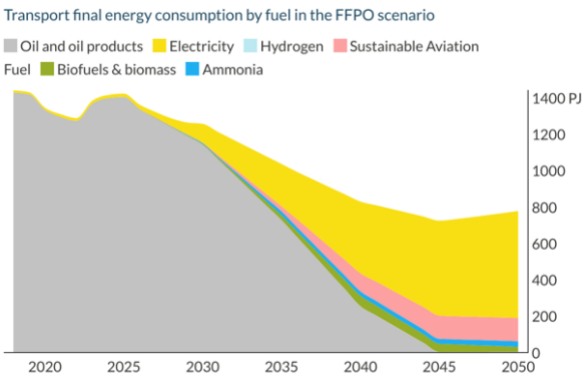
Policy implications

To align with the phase-out of coal in the power sector by 2034 and fossil gas by the late 2030s, the Australian government needs to:

- Establish retirement timelines for the coal and fossil gas power fleet, and implement them in a just and fair manner.
- Remove the bottlenecks to clean capacity deployment and de-risk investment settings for renewable energy.
- Plan for the necessary infrastructure upgrades and renewable buildout in line with ambitious renewables targets. The government's 82% on-grid renewables 2030 target translates into 77% of total generation once off-grid systems are included. To align with the FFPO scenario, the government needs to pursue a clean electricity share of 87% by 2030, 96% by 2035 and 100% by 2050, covering all power systems.

Transport





Australia's domestic transport sector has the highest dependency on fossil fuels in the economy: oil met 99% of demand in 2024 and was responsible for 100 $MtCO_2e$. Road transport alone emitted 43 $MtCO_2e$ from passenger road transport and 40 $MtCO_2e$ from road freight and light commercial vehicles.

The pace of electrification is slow, and for now limited to passenger vehicles. Under current policies, the government appears to be accepting transport becoming the most emissive sector of the Australian economy, maintaining high levels of oil demand into the future with the cost and energy security implications this entails. Under the CPP scenario, total transport emissions decline by a third below 2025 levels by 2050, leaving the sector as the largest emitter throughout the trajectory.

The government has an opportunity to decarbonise this sector: to align with the FFPO scenario, Australia needs to get to zero transport emissions by 2045 thanks to deep electrification of all transport segments. That also includes a transition of the heavy road freight sector – a blind spot of current policies – and of rail transport, as well as a switch to alternative fuels in aviation and shipping. To align with the FFPO scenario, emissions need to decline by 19% below 2025 levels by 2030, and nearly halve by 2035. Under the CPP scenario, they decline by 5% by 2030, 14% by 2035, and are only one third below 2025 levels in 2050.

International transport

International aviation and shipping emissions fall outside Australia's domestic UNFCCC inventories, but they are part of the national energy balance and add to national fossil fuel use. Whether the emissions from this sector are counted domestically or not, there is still a requirement to get emissions and fossil fuel use from the sector as close as possible to zero by 2050.

In 2024, international aviation emitted 15 $MtCO_2e$, compared to 10 $MtCO_2e$ from domestic aviation; international shipping, 2.2 $MtCO_2e$ against 1.6 $MtCO_2e$ for its domestic counterpart.

With transition frameworks and policy support limited both domestically and globally, both sectors remain on an oil-dependent trajectory to 2050 under the CPP scenario, by when they would account for the equivalent of 14% of Australia's domestic net emissions. In the FFPO scenario, by 2045, aviation energy demand is met by clean fuels like biomass or electricity-derived SAF, while international shipping has effectively transitioned to ammonia.

Policy implications

Given the role road transport plays, the government needs to put its focus on this subsector. To align with the FFPO scenario, it needs to:

- Set targets for the phase-out of new internal combustion engine vehicle sales, achieved by 2035 at the latest in the FFPO scenario.
- Strengthen the New Vehicle Efficiency Standard, supported by purchase incentives, charging infrastructure and fleet targets.
- Address the current policy blind spot around heavy transport, which is not covered by the NVES, the National EV Strategy or the Safeguard Mechanism, with a sectoral plan.

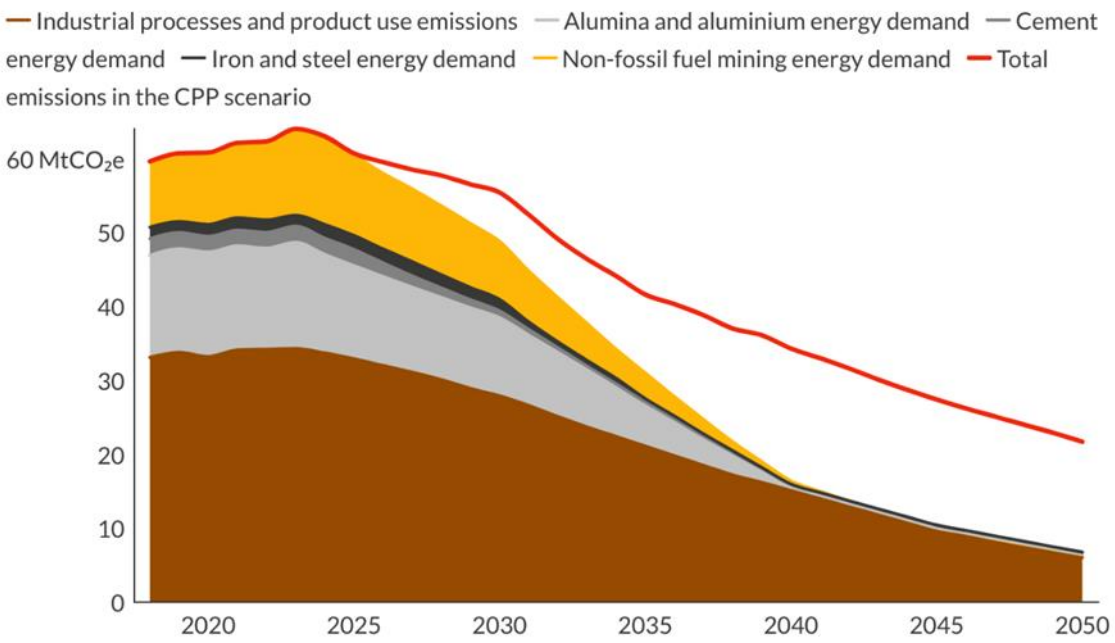
Beyond road, the government needs to:

- Encourage modal shifts away from road through investments in new electrified rail networks for both passenger and freight transport, and electrification of the existing stock. In the FFPO scenario, Australia's rail sector is fully electrified by 2045.
- Prepare and implement an action roadmap for aviation and shipping that combines targets and policies for the deployment of low- and zero-emission fuels. In the FFPO scenario, they meet 20% of domestic aviation demand by 2035, and 75% by 2040. By 2045, both domestic and international aviation and shipping have switched to sustainable aviation fuel and ammonia.
- Monitor international transport emissions and prepare a strategy for the sector's transition to clean fuels by 2050.

Industry

In the FFPO scenario, Australia's industrial energy demand is fully decarbonised by 2045. Electricity and green hydrogen displace fossil fuels across all subsectors, with limited support from biomass and biofuels. By contrast, the government's current policies see a slower decline in emissions, based on its optimistic assumptions about the effectiveness of the Safeguard Mechanism.

Emissions from industrial energy demand and industrial processes and product use in the FFPO scenario



Note: This graph excludes the "Other manufacturing" stationary emissions category.

Iron and steel

The national iron and steel sector is small in output but carbon intensive, relying on coal for both energy and the reduction of iron ore. To align with the FFPO scenario, the sector needs to transition existing facilities to electricity, phase out coal in the 2030s and fossil gas by 2040. Policy-backed scale-up of green hydrogen and renewable electricity contributes towards energy-related sectoral emissions reaching zero by 2040, while the sector still emits 1 $MtCO_2e$ in 2050 under current policies.

Likewise, the adoption of clean technologies in the FFPO scenario brings process emissions down from 8 $MtCO_2e$ today to 2 $MtCO_2e$ by 2050.

Alumina and aluminium

Alumina refining emissions were 12 $MtCO_2e$ in 2025. To align with the FFPO scenario, electricity's share in alumina refining needs to rise from 5% today to 40% by 2035 and two-thirds by 2050, by when hydrogen meets the rest of the subsectoral energy demand, through a switch to electrified mechanical vapour recompression and green hydrogen-based calcination. Emissions from the sector need to fall to 19% below 2025 levels by 2030, 61% by 2035 and zero by 2040. Under current policies, they halve by 2035 and are 87% lower than current levels by 2050.

More than 90% of the energy demand for aluminium production is electrified, and the remainder is met by fossil gas to generate high-temperature heat for smelting. The subsector generated energy emissions of 0.5 $MtCO_2e$ in 2025. To align with the FFPO scenario, it needs to be fully electrified by 2030, compared to 2050 under current policies.

Mining

Mining is one of the few parts of the economy where emissions have grown significantly in recent years. Even as the sector expands production, electricity replaces diesel in vehicles, equipment and infrastructure. Thanks to fuel switching and a limited rollout of hydrogen, the sector reaches real zero by 2045. Under current policies, the share of electricity in mining's energy mix only reaches three quarters by 2050, despite the savings electrification offers.

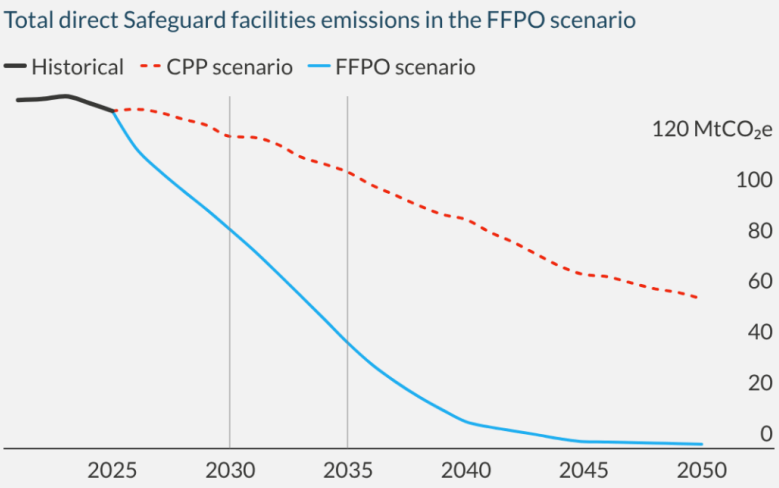
Ammonia

Ammonia is a key input for fertiliser and explosives production. The domestic sector, reliant on fossil gas, emitted 4 $MtCO_2e$ in 2025. To align with the FFPO scenario, the sector needs to transition to green ammonia rapidly, eliminating gas use as both a feedstock and a heat source by 2040.

Policy implications

Aligning with the FFPO scenario for industry requires both a step change in the policy framework to achieve emissions reductions in industry, and political leadership to enable the emergence of green industries.

Because of its cross-cutting coverage, the government must prioritise tightening the Safeguard Mechanism to avoid the current situation where industry can buy its way out of emissions reductions with offsets. It needs to constrain ACCU use in the Safeguard Mechanism to provide the signals needed for industry to decarbonise. To align with the FFPO scenario, direct Safeguard emissions must decline by 32% below 2025 levels by 2030, and 63% by 2035, an average decline of 7% per year to 2030, and 12% from 2030 to 2035.



Note: in both scenarios, SGM emissions are projected by applying each covered subsector's emissions growth rate to the share of its emissions currently covered by the scheme.

Source: 2024 - 2025 Safeguard Mechanism data insights

Alongside strengthening the Safeguard Mechanism, the government must:

- Foster a domestic green hydrogen industry to benefit all industries through programs such as the Future Made in Australia policy, while ensuring widespread access to cheap renewable electricity can improve green hydrogen's cost competitiveness.
- Develop a whole-of-economy green industrial strategy that builds on Future Made in Australia, with further commitment to de-risking capital and operational expenditure for clean industries.

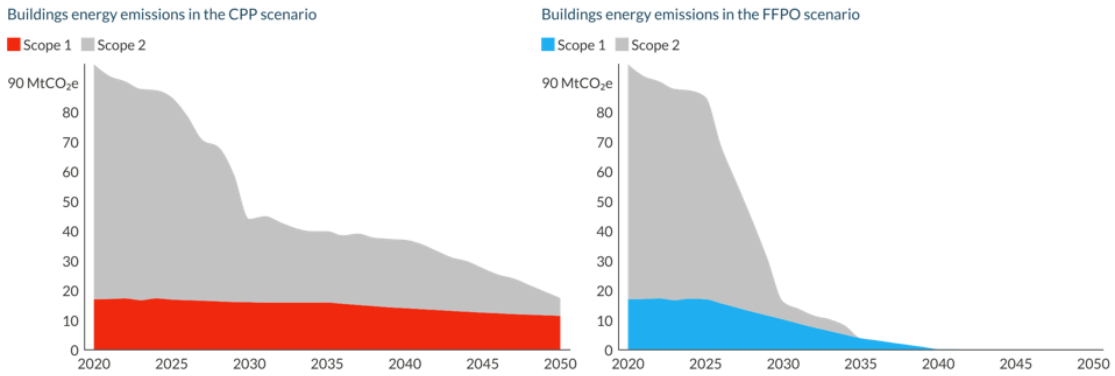
Each subsector has different dynamics and challenges, so each needs its own approach:

- Iron and steel: direct federal and state support at Whyalla and Port Kembla towards low-emission production rather than reinvestment in blast furnaces, and secure the scrap supply electric arc furnaces need.
- Alumina and aluminium: tie continued assistance under Future Made in Australia and the Australian Renewable Energy Agency to decarbonisation outcomes.
- Mining: reform the Fuel Tax Credits system, which favours diesel over electrification, and support the switch to renewables outside the main grids.
- Ammonia: mandate a growing share of green ammonia among users.

Buildings

The buildings sector accounts for around 20% of Australia's final energy use, with the residential subsector responsible for about 12%. In the FFPO scenario, full electrification and the phase-out of fossil gas from buildings, combined with improvements in energy

efficiency through retrofitting and higher efficiency standards, reduce emissions, lower buildings' energy bills, and improve health outcomes and indoor comfort. In the CPP scenario, Scope 1 emissions from buildings decrease by one third to 2050, and the sector retains Scope 2 emissions because of slower electricity decarbonisation.



Policy implications

To align with the FFPO scenario for the buildings sector, the government needs to:

- Consolidate a national building electrification strategy based on all-electric, high-efficiency standards for new buildings and a staged phase-out of fossil gas appliances. In the FFPO scenario, residential properties' energy intensity per square metre halves between 2025 and 2050.
- Further support households and businesses for energy efficiency improvements and electrification.

Fossil fuel exports

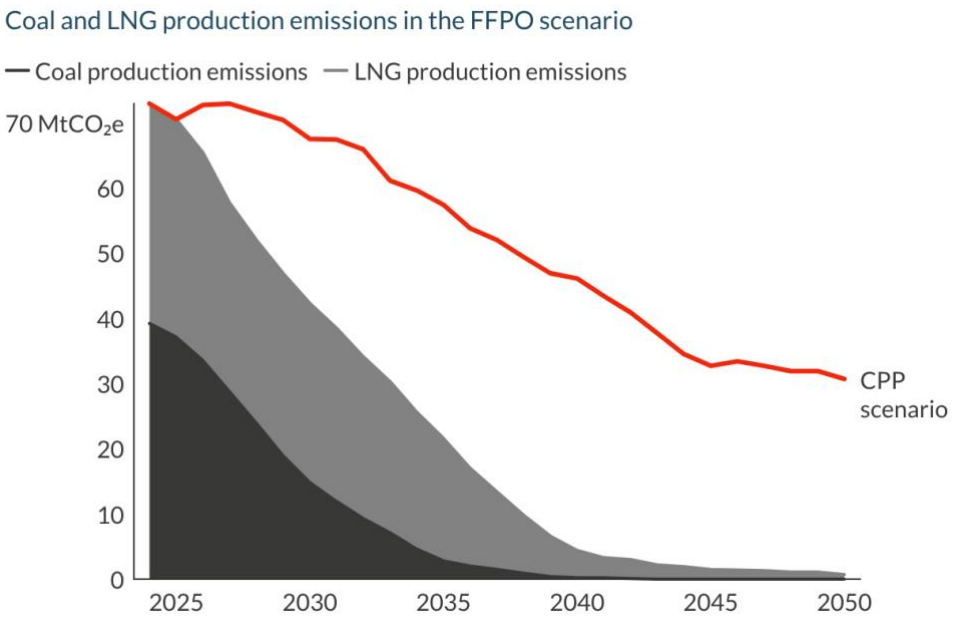
As one of the world's biggest fossil fuel exporters, Australia has no framework in place to phase them out. That is despite the IEA finding that, to align with the Paris Agreement, no new fossil gas fields and coal mines are needed, and the International Court of Justice's Advisory Opinion on Climate Change, which found that the failure to protect the climate system, including through fossil fuel production, the granting of exploration licences or the provision of subsidies, may constitute an internationally wrongful act attributable to the government.

To align with the FFPO scenario, coal and LNG production must fall immediately, dropping by nearly 80% and 25% by 2035, respectively. Coal exports decrease by 95% between 2025 and 2040, when LNG exports are a third of their current levels, leading in parallel to a drop in domestic emissions associated with the production of these fuels.

By 2050, Australia only exports 7 Mtpa of LNG and has effectively stopped exporting coal. These trajectories leave no room for new project developments, consistent with the

IEA findings that existing global production is already more than sufficient to meet demand on a Paris-aligned pathway.

By contrast, under current policies, coal production is still at half of current levels by 2050. By mid-century, the government still projects exports of more than 50 million tonnes of LNG a year.



Policy implications

A transition away from fossil fuel production needs to take a two-stage approach. The first is to immediately stop approving new fossil fuel projects and the expansion of existing ones. The second is to coordinate the retirement of existing assets on a planned, asset-by-asset basis, through an overarching fossil fuel phase-out strategy with set timelines.

On-site abatement offers small gains alongside reduction in production. Better management of fugitive methane at active and abandoned coal mines and LNG facilities, reductions in flaring and venting, and on-site electrification of production are all available today.

To align its actions with its stated commitment to a global fossil fuel phase-out, the Australian government needs to:

- Include a climate trigger that assesses both domestic and offshore emissions from proposed fossil fuel projects in the federal environmental assessment framework;

- Establish managed decline schedules for coal and fossil gas production;
- Coordinate with trade partners to move away from fossil dependency.

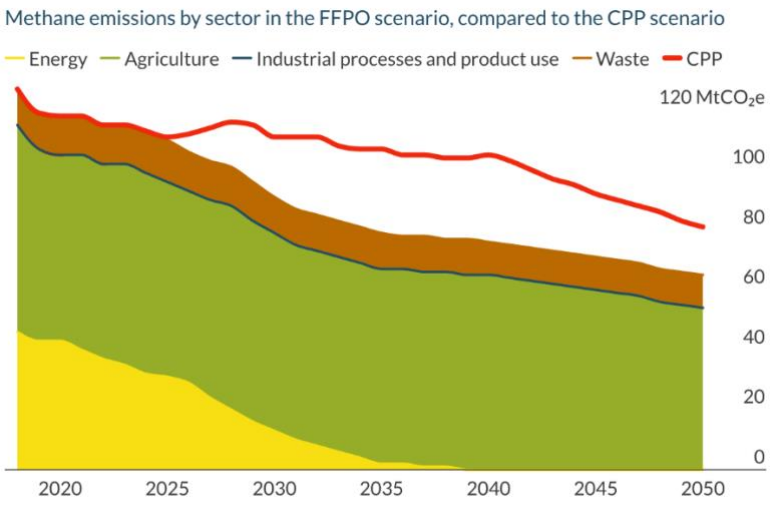
Cutting methane emissions

Despite having signed on to the Global Methane Pledge, the government has failed to address methane emissions. Under the CPP scenario, anthropogenic methane emissions would decrease by 3% below 2020 levels by 2030 – compared with the 30% pledged – and by 28% by 2050.

Reducing emissions from this potent, short-lived greenhouse gas is one of the most readily accessible levers to limit warming in the short term. To align with the FFPO scenario, energy-related methane emissions must decline by half below 2020 levels by 2030 and be eliminated by 2040, driven by cuts in fossil fuel production and specific abatement measures, many of them available at net-negative cost.

Waste and agriculture methane emissions are harder to abate, and make up most of the residual emissions in 2050 under the FFPO scenario. The government can support the deployment of multiple sector-specific solutions to mitigate them, like feed supplements in agriculture or diversion of organic waste in the waste sector.

Because global governments, including that of Australia, have done little in the years after the Global Methane Pledge was launched at COP26 in 2021, its target is now more challenging to reach. To align with the FFPO scenario, methane emissions need to be at least 21% below 2020 levels by 2030, and 44% lower by mid-century.



Note: excluding methane emissions from the land use, land-use change and forestry sector.

Policy implications

To align the methane emissions trajectory with the FFPO scenario, the government must:

- Set separate 2030, 2035 and 2050 targets for methane emissions with policies to achieve these, with the most rapid emissions reductions possible from the energy sector,
- Improve the monitoring and reporting of coal and gas-related methane emissions,
- Integrate methane emissions into the planning for the fossil fuel production phase-out,
- Support R&D for the scale-up and learning cost decline of methane mitigation technologies across sectors, with pilot projects and implementation roadmaps.

Net zero, residual emissions and carbon dioxide removal

Mid-century residual emissions

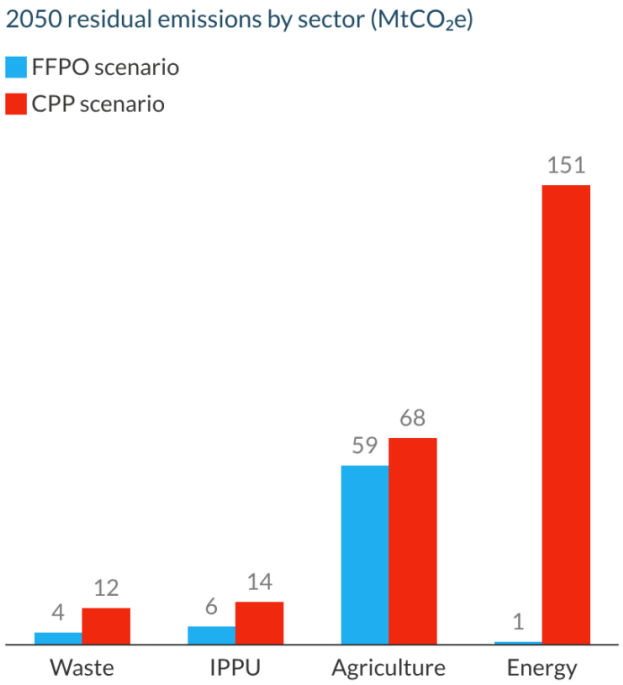
Aligning with the Paris Agreement's temperature limit requires reducing emissions as close to zero as possible, and scaling up negative emissions globally to counterbalance residual emissions once all feasible abatement options have been deployed.

To balance residual emissions from agriculture and specific industrial sectors, carbon dioxide removal will be necessary to achieve global net negative emissions and bring warming below 1.5°C. CDR needs to be strictly limited to balancing residual emissions and is not a substitute for a fossil fuel phase-out.

The scale of the removal task therefore depends on how much abatement comes before it. Under the CPP scenario, 245 $MtCO_2e$ of emissions per year would remain in 2050, 151 Mt of which would come from the energy sector, where clean technologies such as electric vehicles and renewables are cost-competitive today.

That level of outstanding emissions is not compatible with the government's own commitment. Reaching net zero from there would require it to scale removals to more than half of Australia's present net emissions.

The FFPO scenario cuts emissions much further. Gross mid-century residual emissions fall to 70 Mt, coming mostly from agriculture, with waste and Industrial Processes and Product Use contributing the rest.



Role of carbon dioxide removal

In its modelling for the Net Zero Plan, the Treasury projects that land-based sequestration will compensate for all of Australia's residual emissions in 2050. Land use, land-use change and forestry (LULUCF) sequestration is hard to monitor, its resilience in a warming world is uncertain, and it can compete with other land uses.

The FFPO scenario takes a more conservative pathway for LULUCF, assuming about 53 $MtCO_2$ of sequestration by mid-century. Under the FFPO scenario, direct air capture delivers the remaining 17 $MtCO_2$ needed to reach net zero.

Like land-based removals, direct air capture carries risks and uncertainties, and these technologies have land, water and energy footprints that can compromise other sustainability goals. The government must account for these side effects and reserve CDR for counterbalancing unavoidable emissions, rather than using it to offset continued fossil fuel use.

To scale up technological CDR, it can provide near-term R&D support and de-risking instruments such as tax credits, procurement and carbon markets, and integrate CDR into grid and planning frameworks through CDR hubs that run on surplus renewable energy.

Introduction

As a signatory to the Paris Agreement, Australia has committed to limiting global warming to 1.5°C and reaching net zero emissions globally in the second half of the century. Its new 2035 target and revised 2050 net zero strategy do not align with the ambition the Agreement requires, and current domestic policies fall short of even those weaker targets.

Beyond the need to align domestic emissions with 1.5°C, Australia is also one of the world's largest fossil fuel exporters, and its emissions footprint from these exports far exceeds its domestic emissions. Given how critical a global transition away from fossil fuels will be to limiting warming to 1.5°C, Australia has a pivotal role to play in this process.[1]

Only a rapid, comprehensive global phase-out of coal, gas and oil can keep the world aligned with 1.5°C. Australia has made increasingly strong rhetorical commitments to this transition: at COP30 in November 2025 it joined over 80 countries in signing the Belém Declaration, calling for a "just, orderly and equitable transition away from fossil fuels," building on its earlier support for the First Global Stocktake's commitment to "transitioning away from fossil fuels in energy systems." [2,3]

This commitment is reinforced by international law: the ICJ's July 2025 Advisory Opinion found that country's failure to act on fossil fuel consumption and production "may constitute an internationally wrongful act," potentially raising legal risks for continued fossil fuel development in Australia in the absence of a phase-out strategy.[4]

Phasing out fossil fuels will future-proof Australia's economy. It will reduce fossil fuel bills and the cost of living, improve energy security and allow investment to be channelled into new green industrial opportunities. Continued reliance on fossil fuel exports presents a strategic risk if Australia's consumers transition away from fossil fuels, as South Korea's commitment to end coal-fired power demonstrates.[5] The heatwaves and bushfires of summer 2025–26, made more likely by climate change, illustrate the stakes of inaction.[6]

This report presents a newly developed model of the Australian economy, with a focus on its energy system. We use it to analyse two scenarios: "current policies" (CPP), aligned

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[1] UNFCCC, "Outcome of the First Global Stocktake."
[2] DCCEEW, "Australia's Participation at COP30."
[3] UNFCCC, "Outcome of the First Global Stocktake."
[4] ICJ, *Summary of the Advisory Opinion of 23 July 2025*.
[5] Mercer, "Rude Shock for Australia as South Korea Unshackles from Coal Reliance."
[6] World Weather Attribution, "Climate Change Eclipses La Niña Cooling in Australia to Drive Extreme Heatwave and Heightened Fire Risk."

with the government's plans, and "fossil fuel phase-out" (FFPO), an alternative 1.5°C pathway for Australia.

The FFPO scenario accounts for the fact that emissions have not fallen in line with the IPCC AR6 Paris-aligned pathways,[7] and that global emission reductions have yet to start.[8] Insufficient action in recent years means the world will very likely reach 1.5°C of warming by the early 2030s.[9]

This is no excuse to abandon the commitments agreed to in Paris. The temperature limit remains a legally-binding, scientifically grounded anchor of the Agreement, and all parties are legally required to pursue their highest possible ambition towards it. With rapid action, it remains possible to limit overshoot and bring warming back below 1.5°C before 2100.

This modelling work shows what it takes to turn Australia's political and legal commitments into reality. It is framed by global pathways that limit peak warming as close to 1.5°C as possible and reach net zero as quickly as possible in the second half of the century, as the Paris Agreement requires. The 1.5°C limit is scientifically recognised as a planetary boundary beyond which climate risks, including tipping points, accelerate sharply. [10] [11]

By combining top-down results and bottom-up analyses,[12] we identify the gap between likely trajectories under current policies and the transformation actually needed to align with 1.5°C. We complement these findings with practical policy implications designed to support policymakers in increasing ambition in a sustainable and cost-efficient way.

[7] Tom Prater, "Interactive."
[8] Forster et al., "Indicators of Global Climate Change 2024."
[9] Foster and Rahmstorf, "Global Warming Has Accelerated Significantly."
[10] Ritchie et al., "The Implications of Overshooting 1.5 °C on Earth System Tipping Elements—a Review."
[11] Climate Analytics and PIK, *Rescuing 1.5°C: New Evidence on the Highest Possible Ambition to Deliver the Paris Agreement*.
[12] The underlying assumptions are detailed further in the technical annex.

Developing a 1.5°C pathway for Australia

Implications of global climate goals

Due to insufficient action in recent years, the world will very likely reach 1.5°C of warming by the early 2030s, meaning that it is heading towards a period of overshoot of the Paris Agreement's 1.5°C limit. The risk of overshooting 1.5°C increases the obligation on all Parties to act with the highest possible ambition to bring CO_2 emissions to net zero by mid-century and greenhouse gas (GHG) emissions to net zero by the 2070s at the latest, in line with Articles 2.1 and 4.1 of the Paris Agreement.

A Paris-aligned pathway for an individual country begins with a top-down view of what the global energy system must look like to limit warming to 1.5°C and how individual countries fit into this global pathway. That top-down perspective is then tested against what is possible at the national level. For Australia, we use a bottom-up model of the Australian energy system.

The approach draws on a wide range of information on Paris-aligned energy and economic transitions. The primary top-down resource underpinning this approach is the Highest Possible Ambition (HPA) scenario,[13] developed by Climate Analytics and the Potsdam Institute for Climate Impact Research (PIK) using the REMIND Integrated Assessment Model (IAM). The HPA scenario, published in November 2025, updates IPCC AR6 scenarios to reflect both the fact that emissions have not decreased in line with the Paris Agreement, and that the costs of clean energy technologies have plummeted. The next section details the global results from the HPA scenario and their implications.

IAMs such as REMIND provide data at macro-regional levels. The HPA results for the Canada-Australia-New Zealand region were translated into the Australian context, informed by domestic data points from existing higher-ambition Australian studies, and adjusted to reflect national specificities. The resulting FFPO scenario shows the transformations Australia must undertake by 2050 to meet the Paris Agreement's 1.5°C temperature limit.

By design, the FFPO scenario prioritises domestic decarbonisation and decarbonising Australia's existing export portfolio of minerals, processed metals, agriculture, fertiliser and other commodities. By the late 2040s, this would make Australia a source of zero-

[13] Climate Analytics, "Rescuing 1.5°C: New Evidence on the Highest Possible Ambition to Deliver the Paris Agreement."

carbon mining, processing and fertiliser production, substantially cutting both export-related and domestic emissions. Public debate on clean export opportunities tends to focus on new commodities and markets, but Australia's existing production needs cleaning up, too. The country supplies close to 40% of the world's iron ore production, 30% of bauxite, 10% of the world's alumina, and is one of the world's top-10 aluminium producers.[14]

Decarbonising these industries alone would make Australia a titan of zero-carbon industry. This position could later be extended by replacing coal and gas export markets with clean technologies, with various pathways for achieving this identified in the literature.

Limiting overshoot with highest possible ambition

The HPA scenario models the highest possible ambition that countries could undertake from 2025 to limit overshoot of 1.5°C to the lowest possible level and return warming to well below 1.5°C by 2100.

Under the HPA, temperatures exceed 1.5°C for 40 years and peak at around 1.7°C before declining to ~1.2°C by 2100. Overshoot of 1.5°C is at least a decade longer and 0.1°C higher than in net zero, 1.5°C-aligned IPCC AR6 scenarios, due to insufficient emissions reductions over the last five years.

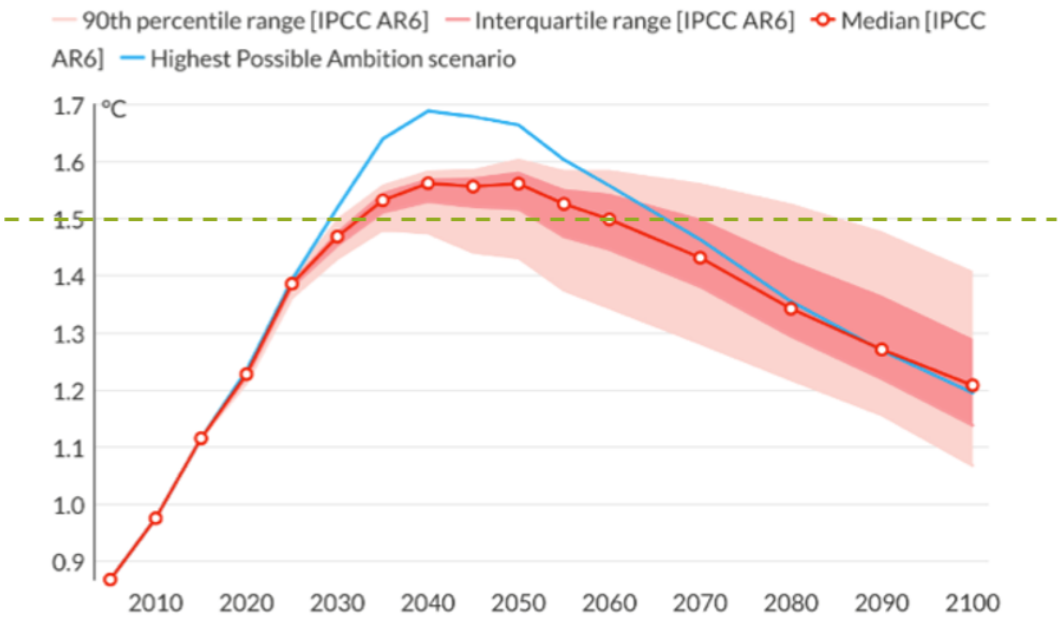

Figure 1: Limiting overshoot with highest possible ambition.

As the HPA scenario starts from 2025, the resulting emissions pathway differs from what IPCC AR6 had envisaged. Global GHG emissions in 2025 were around 25% higher than

[14] Geoscience Australia, "Australian Mineral Facts."

those assumed in IPCC AR6 scenarios. As a result, global emissions remain higher than those modelled in the IPCC AR6 scenarios until the late 2030s.

However, the pathway catches up rapidly. In the HPA scenario, emissions fall by around 4% per year to 2030, then fall by 11% per year over the 2030s, declining by two-thirds in a single decade. This steeper descent is made possible by the dramatic cost reductions and scale-up of renewable technologies since the AR6 scenarios were developed. Achieving this pathway requires immediate action. Every year of delay narrows the window to limit the scale and duration of overshoot.

Table 1: Global warming outcomes. AR6 versus Highest Possible Ambition and IEA Net Zero Emissions scenario.

	Source	Peak warming	Warming by 2100	Time for net zero CO_2	Time for net zero GHG	Overshoot duration
C1a[15]	IPCC, AR6	<1.6°C. [1.4-1.6]	1.2°C	~2050	~2070	~30 years
Highest Possible Ambition (HPA)[16]	Climate Analytics/Potsdam Institute for Climate Impact Research	1.7°C	1.2°C	2045	2060	~40 years
Net Zero Emissions by 2050[17]	International Energy Agency	1.65°C	1.45°C	2050	~2100	~Several decades

Table 2: Emissions reductions in the HPA pathway compared with IPCC AR6 C1a, 2020 to 2050.

	HPA		AR6 C1a (5th percentile)		AR6 C1a (Median)		AR6 C1a (95th percentile)		HPA vs. median C1a pathway
	$GtCO_2e$	*Relative to 2019*	*$GtCO_2e$*	*Relative to 2019*	*$GtCO_2e$*	*Relative to 2019*	*$GtCO_2e$*	*Relative to 2019*	*Gap ($GtCO_2e$)*
2019	56.6	—	52.3	—	55.0	—	57.6	—	—
2025	56.7	+0.2%	34.4	-34.3%	42.4	-22.9%	50.8	-11.9%	+14.4
2030	46.8	-17.3%	22.5	-57.0%	32.7	-40.4%	37.4	-35.1%	+14.1
2035	29.0	-48.7%	13.3	-74.6%	24.6	-55.2%	29.1	-49.5%	+4.4T

[15] Guivarch et al., "Annex III."
[16] Climate Analytics, "Rescuing 1.5°C: New Evidence on the Highest Possible Ambition to Deliver the Paris Agreement."
[17] IEA, "Net Zero Emissions by 2050 Scenario (NZE)."

The timing of net zero

The timing of net zero CO_2 and net zero GHG milestones is central to the logic of this pathway. Warming will continue until the world reaches net zero CO_2 emissions. Reaching net zero CO_2 as soon as possible is therefore critical to limiting the extent of temperature overshoot. Meanwhile, reaching net zero GHG emissions is key to achieving long-term temperature decline.

In the HPA scenario, the world achieves net zero CO_2 in 2045, five to ten years before the median 1.5°C scenario in the IPCC AR6. Net zero GHG emissions are achieved in the early 2060s, around a decade ahead of the median IPCC AR6 scenario, to compensate for higher cumulative CO_2 emissions. Net-negative CO_2 emissions, driven by carbon dioxide removal, then bring temperatures back below 1.5°C.

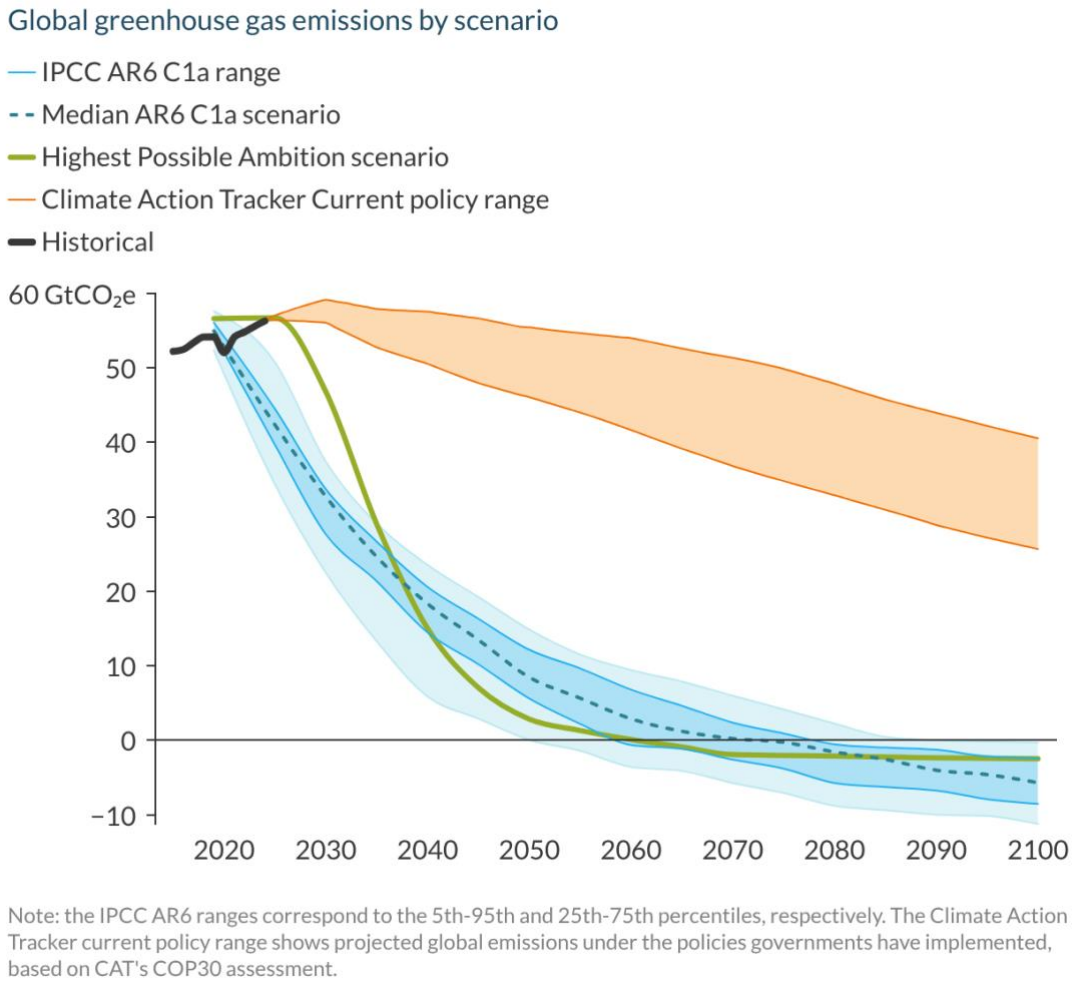

Figure 2: Global highest possible ambition pathway, compared with AR6 and current policy pathways.

A rapid, global phase-out of fossil fuels is needed

In the HPA, clean electricity pushes fossil fuels out of the global energy system at pace and scale. Production and consumption of all fossil fuels peak immediately and fall rapidly,

with coal effectively phased out by the 2040s, gas in the 2050s and oil in the 2060s. Complete elimination of fossil fuels from the global economy follows in the second half of the century, with advanced economies achieving fully fossil-free economies by 2050 and the global economy becoming fossil-free by 2070.

The relationship between fossil fuels and carbon dioxide removal is critical. Without a fossil fuel phase-out, CDR will not bring temperatures down. CDR is a complement to the fossil fuel phase-out, not a substitute for it.

To achieve this phase-out, the energy system must be fundamentally transformed. Electricity demand more than triples by 2050 and electricity provides more than two-thirds of final energy demand directly. Underpinning this is an extraordinary build-out of renewables: global renewable capacity grows 3.5-fold by 2030 relative to 2022 levels, doubling again by 2035 to reach around seven times 2022 levels and rising to almost 20 times 2022 levels by 2050. Wind and solar supply over 90% of electricity demand by 2050.

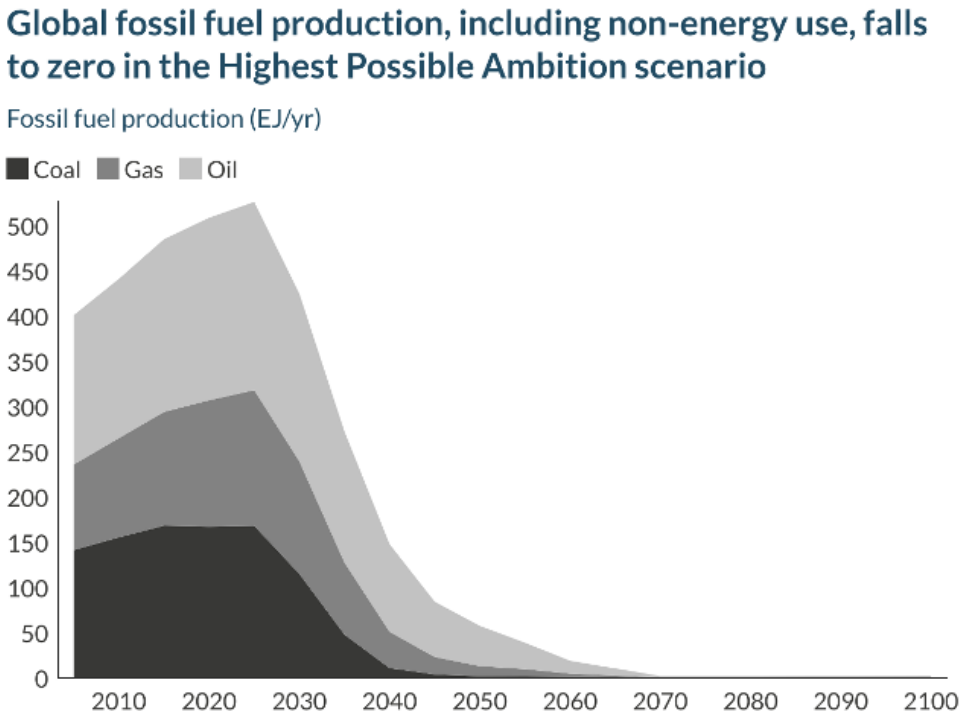

Figure 3: Global fossil fuel production phase-out under the highest possible ambition pathway.

Methane needs to be reduced

Methane emissions fall rapidly in the HPA scenario to help limit peak warming and drive long-term temperature decline. Reductions are fastest in the energy sector, driven by the rapid phase-out of fossil fuel extraction. Methane emissions from fossil fuel extraction are approximately halved over the 2020s, cut by 90% by 2040 and essentially eliminated by mid-century. In percentage terms, this represents reductions of around 40% by 2030

and 70% by 2035 in energy sector methane emissions. There are more modest reductions in methane emissions from waste and agriculture.

At the global level, methane emissions fall by around 20% by 2030 across all sectors, broadly matching the level implied by the Global Methane Pledge. However, this is not the ceiling of ambition. Reductions accelerate strongly through the 2030s and beyond, as fossil fuel extraction collapses and further abatement measures take hold, with global methane emissions falling by 31% by 2035 and 48% by 2050 relative to 2020 levels.

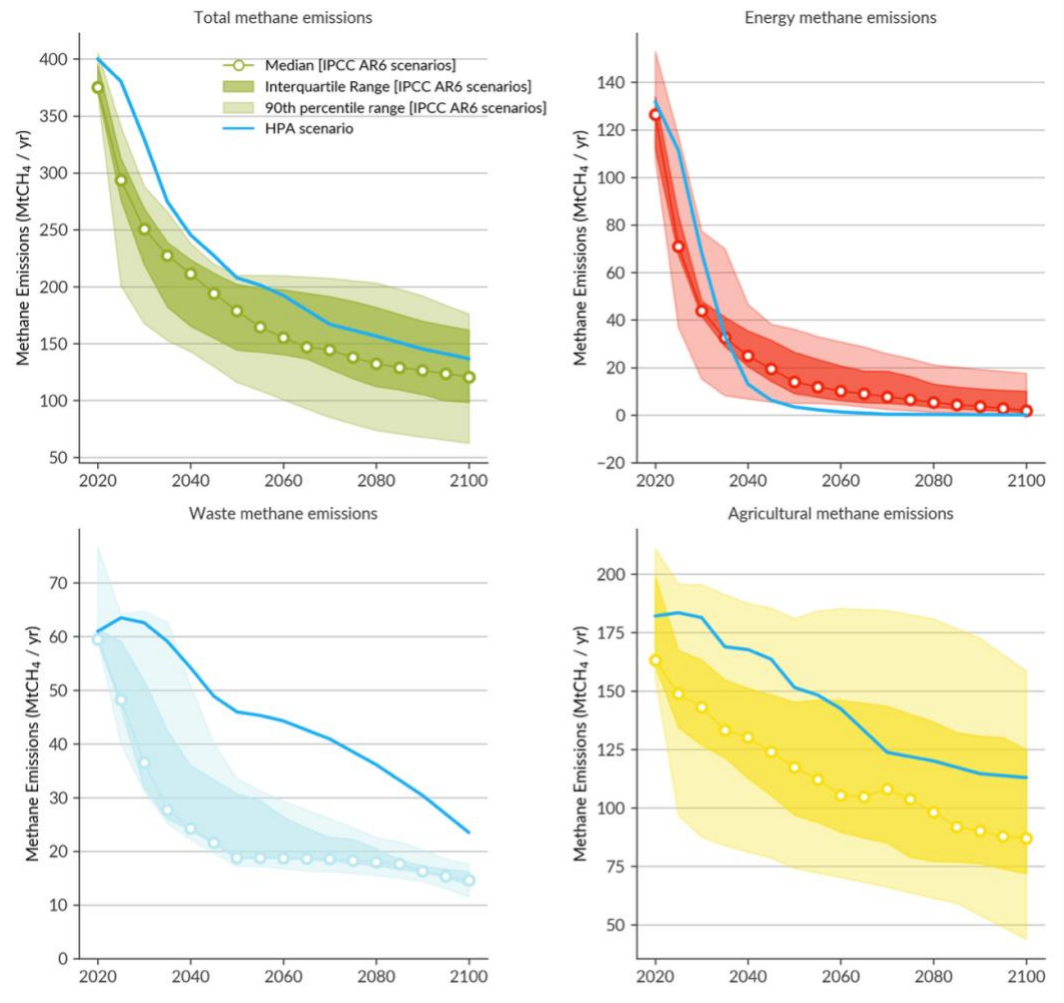

Figure 4: Global methane reductions to limit overshoot.

Role of carbon dioxide removal

Carbon dioxide removal is limited to unavoidable applications, while energy and emissions impact are constrained

What is CDR?

The IPCC Sixth Assessment Report (2022, p. 1796)[18] defines CDR as removing CO_2 from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products, for decades to millennia. CDR falls into two categories:

- Conventional CDR, such as forest sinks and other land-based reservoirs.
- Engineered, technological or novel CDR, which involves technological interventions such as direct air carbon capture and storage (DACCS), biomass energy carbon capture and storage (BECCS), as well as early-stage land-or sea-based methods such as biochar and ocean alkalinisation.

As carbon capture and storage (CCS) and carbon capture and utilisation (CCU) do not capture CO_2 from the atmosphere, they are emissions reduction technologies, not CDR.

All CDR types face uncertainty around permanence, sustainability and availability, raising questions about government net zero plans that rely on the pace, scale and cost of future CDR deployment:

- Conventional CDR faces challenges regarding permanence (forest fires can release stored carbon and negate its climate benefit entirely) and scarcity (government climate pledges collectively require around one billion hectares of land for conventional CDR, exceeding what is realistically feasible).[19,20]
- Engineered, novel and other technological CDR approaches are constrained by financial costs, biomass availability limits, scalability and access to adequate geological storage. Novel early-stage CDR approaches face environmental hazards, unresolved side effects, financial/technological immaturity and legal uncertainty.[21]

Carbon dioxide removal is a key lever to limit overshoot

Historical failures to curb global emissions mean that carbon dioxide removal (CDR) — the active extraction of CO_2 from the atmosphere — is now an essential component of any strategy to meet the Paris Agreement's 1.5°C temperature limit.

Stopping global warming requires bringing CO_2 emissions to net zero. The earlier this is achieved, the lower the peak temperature will be. To bring temperatures back down from their peak, however, requires achieving net-negative emissions. Only CDR can achieve this at scale.

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[18] van Diemen et al., "Annex I."
[19] United Nations Environment Programme, *Emissions Gap Report 2023*.
[20] Climate Resource, "Land Gap Report Briefing Note: 2023 Update."
[21] Lamb et al., *State of Carbon Dioxide Removal - 1st Edition*.

Large-scale CDR is difficult, uncertain and costly. It also carries the risk of being framed as an alternative to a steep fossil fuel phase-out, with reliance on future technologies providing an excuse for continued inaction today. As the CSIRO puts it, "CDR is needed as a complement, rather than a substitute, for emissions reductions."[22]

There are limits to available CDR capacity. Shindell and Rogelj (2025)[23] find that in 78 of 81 least-cost 1.5°C overshoot pathways, all available CDR would be needed to compensate for hard-to-abate (H2A) emissions and overshoot. Using CDR to offset emissions from easier-to-decarbonise sectors — such as electricity generation — reduces what remains available for H2A sectors, increasing system-wide costs or rendering net zero targets impossible.

CDR must therefore be treated as a last resort, reserved for those emissions that genuinely cannot be eliminated. This means that climate policy must be designed to minimise CDR reliance through two complementary lines of action: an early and rapid fossil fuel phase-out and a determined effort to reduce residual emissions from H2A sectors.[24]

The HPA pathway reflects this. Compared with AR6 pathways, HPA requires smaller, but still very substantial, levels of net-negative emissions in the long term, because its deeper and earlier emissions reductions reduce reliance on CDR. Australia has an important role to play in ensuring the successful and sustainable roll-out of CDR as part of a globally consistent response.

[22] Grant et al., *Australian Carbon Dioxide Removal Roadmap*.
[23] Shindell and Rogelj, "Preserving Carbon Dioxide Removal to Serve Critical Needs."
[24] Edelenbosch et al., "Reducing Sectoral Hard-to-Abate Emissions to Limit Reliance on Carbon Dioxide Removal."

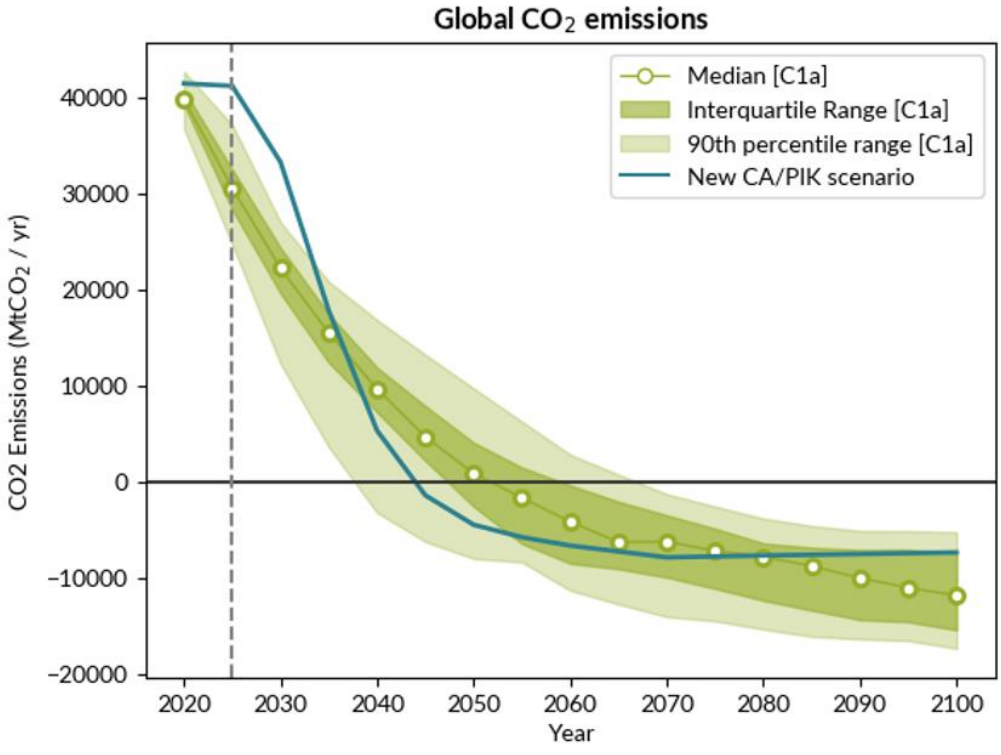

Figure 5: Substantial negative CO_2 emissions will be needed within 20 years.

The environmental risks associated with CDR depend heavily on the type deployed. Land-based CDR, including afforestation, reforestation and BECCS, requires extensive land and water, competing directly with food production, biodiversity and other ecosystem needs.[25] Land-based carbon storage is also inherently impermanent: forests can be lost to fire, drought or disease and the reliability of these sinks is expected to diminish under future warming conditions. Emerging blue carbon techniques are excluded from this scenario entirely, as they remain at early stages of development, carry poorly understood ecological risks and lack the evidence base needed to be relied upon at the required scale within the relevant timeframe.

CDR deployment in this scenario is designed to broadly meet constraints on sustainability and feasibility identified in the literature. Bioenergy with carbon capture and storage (BECCS) is limited to 3 $GtCO_2$/yr, reflecting feasibility and land-use concerns. Direct air carbon capture and storage (DACCS) reaches 2.5 $GtCO_2$/yr by 2050 and 3.5 $GtCO_2$/yr by 2100 as the technology scales. Land-use measures contribute approximately 2 $GtCO_2$/yr, deliberately held at the lower end of the range given the environmental risks of large-scale land-based carbon storage and its unreliability under future warming conditions.

[25] Braun et al., "Multiple Planetary Boundaries Preclude Biomass Crops for Carbon Capture and Storage Outside of Agricultural Areas."

Together, these CDR levers are essential to reduce temperatures from their post-overshoot peak, achieve net zero GHG emissions, and ultimately reach net-negative GHG emissions. The feasible and sustainable deployment of CDR depends on the pace of the fossil fuel phase-out, the level of residual emissions remaining from hard-to-abate sectors and how ambitiously demand-side measures reduce energy use across the economy.

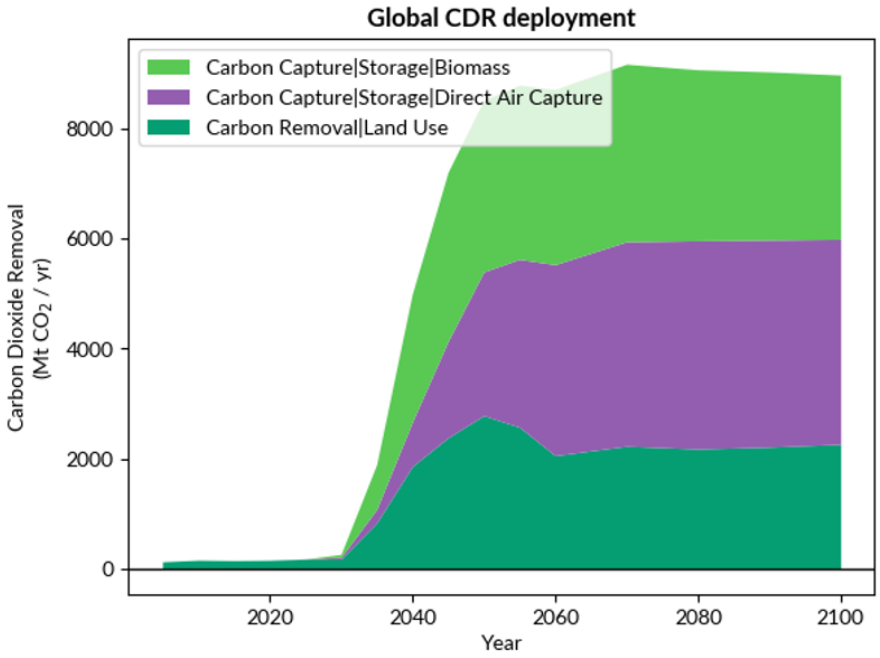

Figure 6: Three CDR options deployed in the HPA scenario.

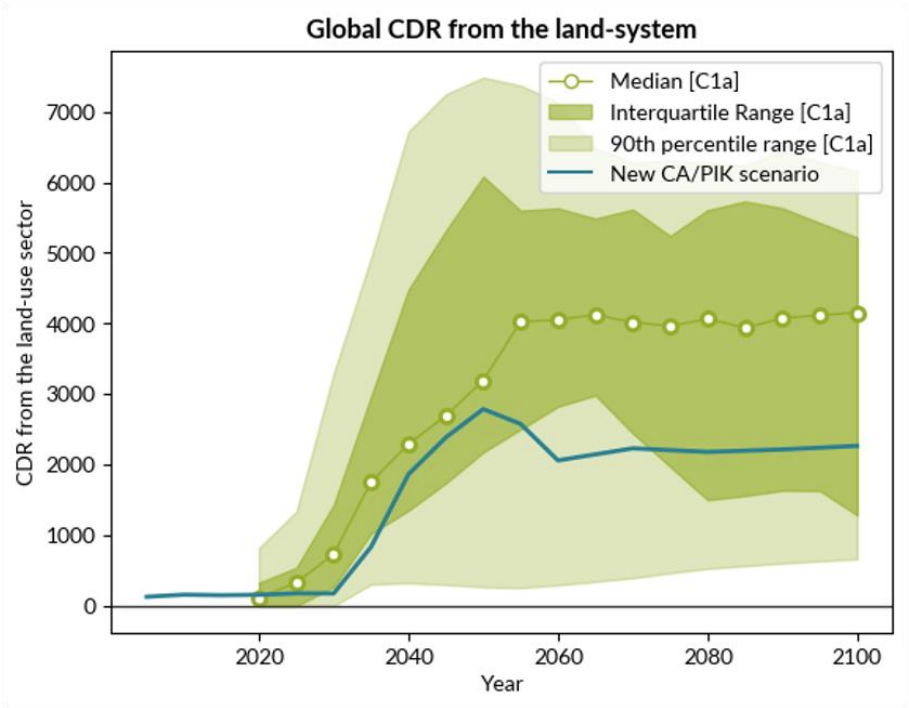

Figure 7: Land-based CDR in the Highest Possible Ambition scenario (afforestation and reforestation).

How does our scenario address the risks associated with CDR?

The HPA scenario on which the Australian FFPO pathway is based has lower overall CDR deployment than the median 1.5°C-aligned scenario across the IPCC AR6 C1a scenarios. It also excludes CDR options beyond afforestation and reforestation, BECCS and DACCS. More importantly, it imposes sustainability and feasibility constraints on biomass, CCS and CDR deployment.

Land-based CDR is deliberately constrained because of its demands on land and water, potential competition with food production and biodiversity and vulnerability to fire, drought and other threats to permanence. BECCS is limited to 3 $GtCO_2$ per year, while land-use measures contribute approximately 2 $GtCO_2$ per year, globally. Emerging blue carbon approaches are excluded because of their early stage of development and uncertain ecological impacts. DACCS reaches 2.5 $GtCO_2$ per year by 2050 and 3.5 $GtCO_2$ per year by 2100 as the technology scales.

Under these constraints, total CDR deployment reaches around 8 $GtCO_2$ per year in 2050 and then broadly plateaus. By limiting reliance on CDR while prioritising rapid fossil fuel phase-out and reductions in hard-to-abate residual emissions, the pathway seeks to minimise the environmental and feasibility risks associated with large-scale removal. By 2100, cumulative CDR deployment contributes approximately 0.23°C of cooling. As discussed in the Reaching net zero emissions section, our FFPO scenario for Australia retains the HPA global conceptual approach of minimising reliance on both land-based and technological CDR.

Australia’s climate policy context and outlook

Framework and targets

Australia's current climate policy framework is the basis of the CPP scenario, which models the national trajectory as projected by the government as of 2026. Australia's climate policies have strengthened considerably since 2022, but their effectiveness in reducing gross emissions remains uneven and, in several sectors, structurally limited. The Climate Change Act 2022, the 2035 Nationally Determined Contribution (NDC) and the 2050 net zero commitment and plan have improved national climate governance, generated a policy signal and moved towards a more coordinated system of legislated targets from a weak starting point. However, these targets are framed around net greenhouse gas emissions, where progress can be achieved through a combination of source-level emissions reductions, land-sector sequestration and the use of offsets.

Australia's latest Nationally Determined Contribution sets emissions reduction targets on a 'net' accounting basis — incorporating the land use, land-use change, and forestry (LULUCF) sector — of 43% by 2030 and 62–70% by 2035 below 2005 levels. Australia has also committed to reaching net zero emissions by 2050.[26]

The Climate Action Tracker has rated Australia's 2030 NDC as "Insufficient".[27] Downscaled IPCC AR6 pathways show that Australia should reduce net emissions by 72% by 2030 and 81% by 2035.[28] For 1.5°C alignment, the June 2025 Climate Action Tracker Australia profile assessed that the government should also set targets on a gross basis — excluding LULUCF — of at least 50% by 2030 and 61% by 2035 below 2005 levels, which translate to net reductions of 60% by 2030, and 76% by 2035.[29]

Table 3: Emissions reductions from Australia's NDC, compared with downscaled and global 1.5°C aligned pathways.

	NDC targets	Downscaled AR6 1.5°C aligned targets	Climate Action Tracker
2030	43% below 2005 levels	72% below 2005 levels	60% below 2005 levels
2035	62-70% below 2005 levels	81% below 2005 levels	76% below 2005 levels

Emissions and policies state-of-play

In 2024, Australia's net emissions were 23% lower than in 2005.[30,31] As shown in Figure 8, the majority of the reductions in net emissions came from the LULUCF sector's switch from a net emitter to a net sink. Excluding this sector, emissions from the rest of the economy — or gross emissions — were only 2% below their 2005 levels.[32]

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[26] Australian Government, "Australia's 2035 Nationally Determined Contribution."
[27] Climate Action Tracker, "Australia. June 2025."
[28] Climate Analytics, "A Blueprint for Climate Leadership."
[29] Climate Action Tracker, "Australia. June 2025."
[30] Different inventories can show different values because of revisions to historical data. We use the National Greenhouse Accounts data from the December 2025 Quarterly Update of Australia's National Greenhouse Gas Inventory, published in May 2026. These values may differ from earlier and later quarterly updates, and from the National Inventory Report and the Emissions Projections.
[31] Department of Climate Change, Energy, the Environment and Water, "National Greenhouse Gas Inventory Quarterly Update: June 2025."
[32] Department of Climate Change, Energy, the Environment and Water, "National Greenhouse Gas Inventory Quarterly Update: June 2025."

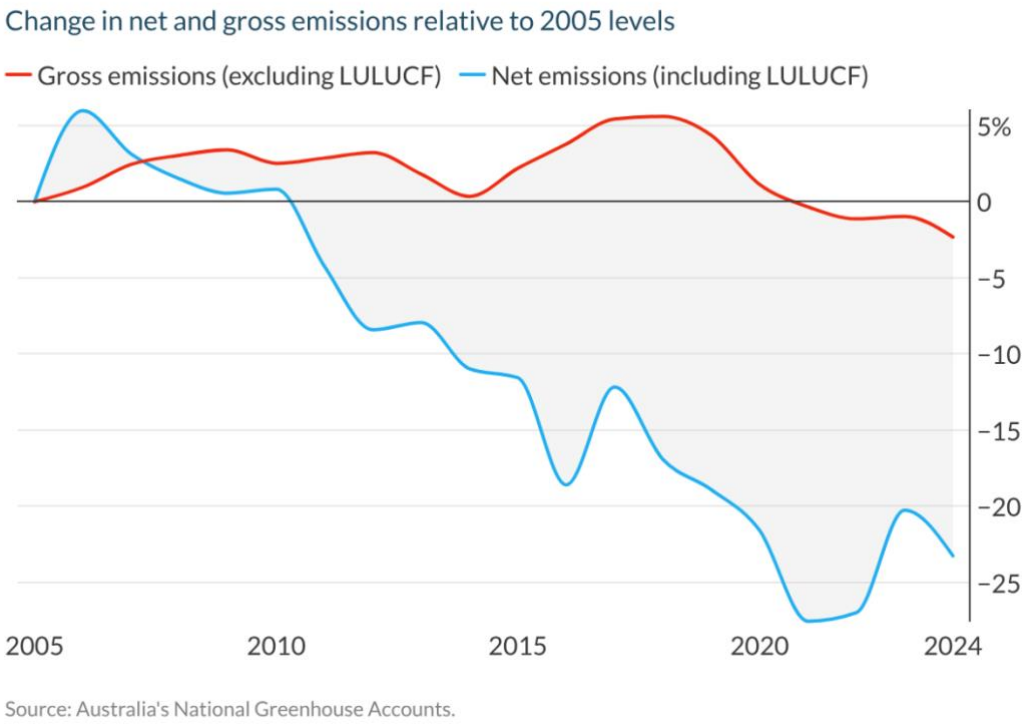

Figure 8: Net emissions reduction between 2005 and 2024.

Gross emissions reductions have been uneven across sectors. The scale-up of renewables has been the major driver of emissions reductions: while electricity remains the largest source of national greenhouse gas emissions, accounting for 29% in 2024, sectoral emissions have fallen 25% since 2005. The power sector provides the strongest evidence that a comprehensive climate policy package — including federal and state renewable electricity targets, the expanded Capacity Investment Scheme, Rewiring the Nation and Renewable Energy Transformation Agreements — can reduce gross emissions.

At present, the renewable energy scale-up is supported by a non-binding target of 82% renewable electricity generation in the main grids by 2030, equivalent to 77% once minor grids and off-grid generation are included. With 36% of total electricity generation sourced from renewables in 2024, the current slow pace of transmission build-out, storage deployment, planning approvals, connection reform and coal-exit management threatens the achievement of the target.[33] AEMO's 2026 ISP report has flagged that, if renewable generation, storage and transmission are delayed, renewables would reach only 75% of NEM supply by 2030.[34]

[33] Australian Government Department of Climate Change, Energy, the Environment, and Water, *Australian Energy Statistics - Update Report 2025*.
[34] AEMO, *Appendix A2. ISP Development Opportunities*.

Outside electricity, progress has been lacklustre. Gross emissions excluding electricity have risen 10% since 2005, with increases in transport and stationary energy emissions.

The Safeguard Mechanism (SGM) is the main policy for industrial emissions. It legislates decreasing net emissions ceilings for over 200 of Australia's largest industrial facilities. The SGM applies to plants emitting over 100,000 tCO_2e and covers 87% of emissions in the resources sector, 56% in industry, 11% in transport and 3% in electricity. Safeguard facilities represent 30% of national emissions.[35]

Under the SGM, covered facilities face a baseline that requires a 4.9% reduction in emissions each year until 2030. Aggregate Safeguard net emissions are intended to fall from 120 $MtCO_2e$ in 2025 to no more than 100 $MtCO_2e$ in 2030. According to DCCEEW, the SGM will deliver cumulative emissions reductions of around 200 $MtCO_2e$ by 2030 relative to the department's pre-2023 reform business-as-usual projections.[36]

The Safeguard Mechanism's effectiveness depends on baseline design and the extent to which facilities achieve real on-site emissions reductions rather than relying on offsets. The SGM remains a limited policy intervention for reducing emissions at source, as it focuses on net emissions. This allows facilities to remain compliant even when their direct emissions increase, as long as excess emissions are offset with Australian carbon credit units (ACCUs) or Safeguard Mechanism credits.[37] This effectively allows Safeguard facilities to meet their obligation through credits, delaying on-site abatement. Because around half of Safeguard facilities are involved in extracting and processing fossil fuels, the scheme allows coal, fossil gas and oil production to continue.

Transport policy remains slow-acting. The New Vehicle Efficiency Standard (NVES) is important because Australia entered the 2020s with comparatively weak vehicle efficiency regulation and rising transport emissions. However, the NVES affects new light vehicles rather than the existing vehicle stock. The transition away from fossil fuels is also highly uneven across transport modes: passenger vehicles are beginning to shift to electricity, but little policy is in place to support fuel switching in heavy road freight, aviation, shipping and parts of regional transport. In gross-emissions terms, this means transport is unlikely to provide rapid near-term reductions without stronger complementary policies, such as heavy vehicle standards, freight electrification, public transport investment, active transport infrastructure, aviation fuel mandates and demand-side measures.

Figure 9 shows that no sector other than electricity has a trajectory consistent with deep decarbonisation, with transport, stationary energy and fugitive emissions higher than they were in 2005.

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[35] Department of Climate Change, Energy, the Environment and Water, *Australia's Net Zero Plan*.
[36] Department of Climate Change, Energy, the Environment and Water, *Australia's Net Zero Plan*.
[37] Clean Energy Regulator, "Quarterly Carbon Market Reports."

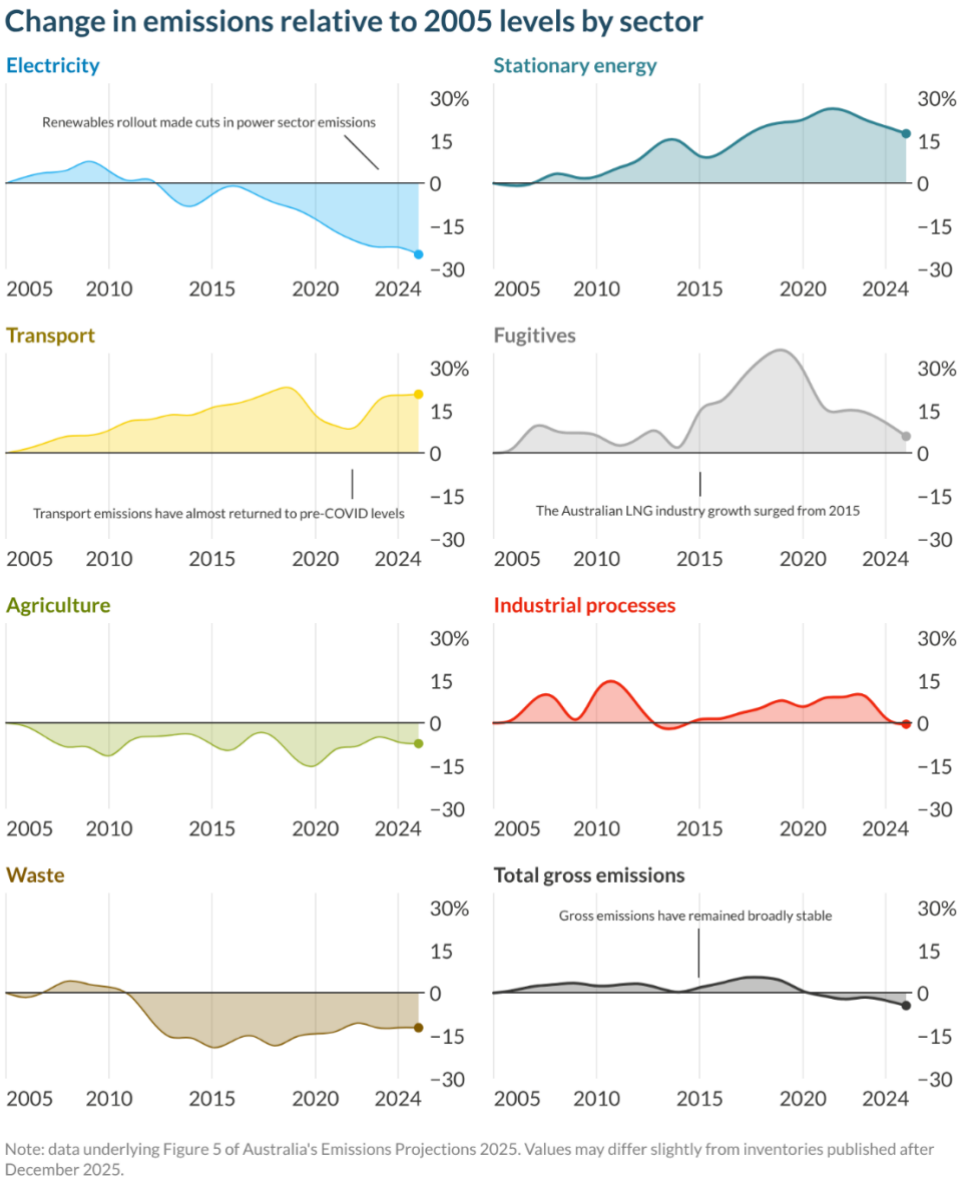


Figure 9: Change in emissions relative to 2005 levels, by sector (%).

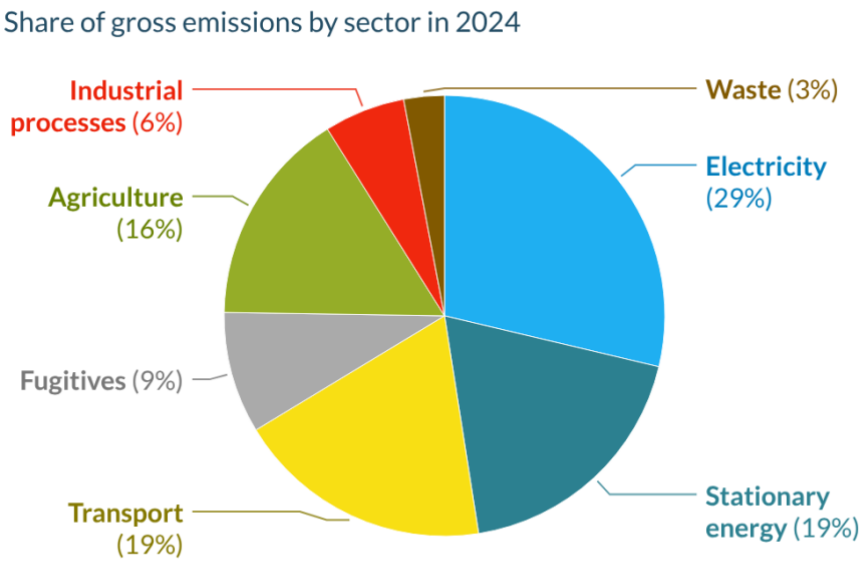


Figure 10: Share of gross emissions by sector in 2024.

Emissions projections

Every year, the Department of Climate Change, Energy, the Environment and Water publishes its emissions projections, showing where emissions are headed and whether Australia is on track to meet its climate targets. The latest projections, from December 2025, do not show any material change in trajectory (see Figure 11). They anticipate that Australia will come very close to its 2030 NDC target, reaching 42% below 2005 levels by 2030, but highlight that policies are not yet in place to reach the 2035 target: emissions in 2035 are projected to be 48% below 2005 levels, short of the 62–70% NDC target.

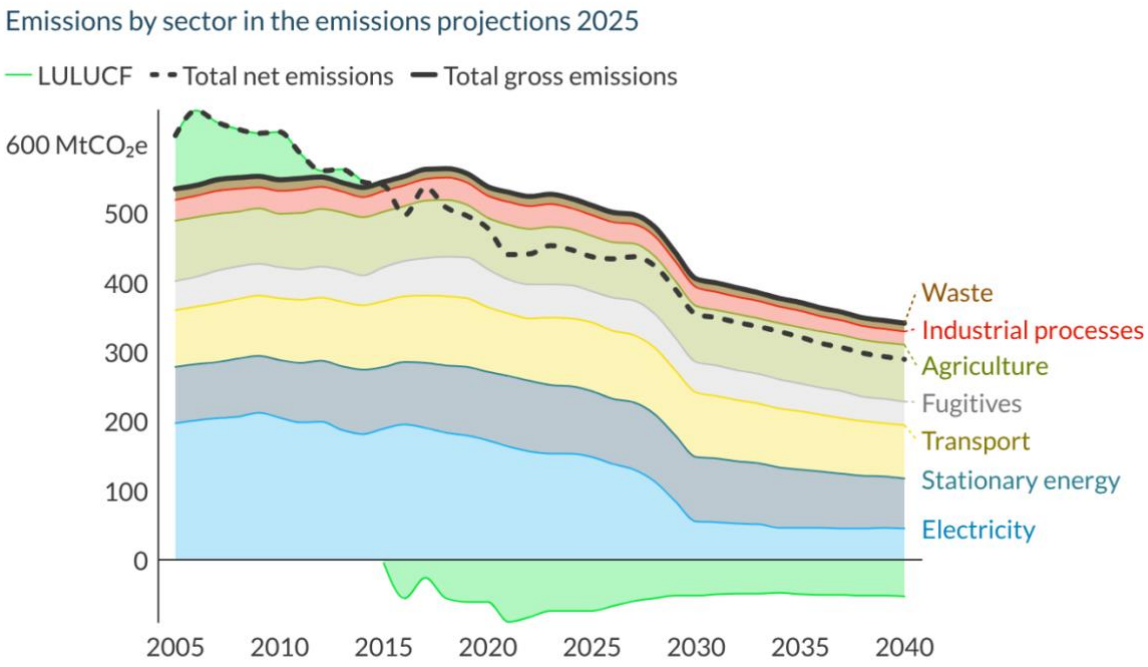


Figure 11: Sectoral emissions in the 2025 emissions projections.[38]

If current trends continue, the projections show that the power sector will account for the overwhelming majority of emissions reductions to 2035, with the largest share of abatement occurring by 2030 as coal power generation is phased down. Emissions reductions from other sectors are far more modest (see Table 4).

Table 4: Sources of emissions reductions in 2030 and 2035 in government projections

	2030 ($MtCO_2e$)	Reduction from 2025 (%)	2035 ($MtCO_2e$)	Reduction from 2025 (%)
Electricity	-92	63%	-101	69%
Stationary energy	-2	2%	-11	12%
Transport	-6	6%	-15	15%
Fugitives	-1	2%	-5	10%
Agriculture	0.2	0%	0.5	0%
Industrial processes	-3	11%	-7	22%
Waste	-1	8%	-2	11%
Gross emissions	-106	19%	-140	27%

[38] DCCEEW, "Australia's Emissions Projections 2025."

The slow pace of decarbonisation outlined under current policies is not consistent with the step change required to align with the Paris Agreement. The emissions projections form the basis of the current policies (CPP) scenario outlined later in this report; its divergence from the fossil fuel phase-out (FFPO) pathway shows the gap that needs to be overcome to align with the Paris Agreement's 1.5°C warming limit.

Australia's fossil fuel problem

The main source of the lack of progress so far, and of the projected continuation of current trends, is Australia's continued support for fossil fuel production alongside domestic decarbonisation targets. While the Australian government reiterated its support for a fossil fuel phase-out at COP30, national policies do not reflect this commitment, and instead continue to back coal, gas and oil use. State and federal governments have actively expanded fossil fuel licensing.

The federal government's 2024 Future Gas Strategy explicitly positions gas as part of Australia's transition to net zero and seeks to preserve Australia's role as a reliable trade and investment partner.[39] New South Wales, for instance, issued its first new gas exploration permits in a decade. Victoria and South Australia released new petroleum exploration acreage in the Otway and Gippsland basins, Queensland awarded new exploration permits in the Taroom Trough, and both the federal and Western Australian governments approved the North West Shelf expansion, allowing the LNG plant to operate until 2070.[40,41,42]

Fossil fuels provide around 90% of Australia's primary energy supply (before transformation or conversion into useable forms). The government's projections project a further decline in fossil fuel dependency, but this is, as noted above, driven substantially by electricity sector decarbonisation with limited decarbonisation in other economic sectors (see Figure 12).

[39] Department of Industry, Science and Resources, "Future Gas Strategy."
[40] Wright, "Australia's New South Wales to Open New Gas Exploration Sites for First Time in a Decade."
[41] Australian Energy Producers, "Media Release New Gas Exploration Acreage a Welcome Boost to Australia's Energy Security."
[42] ABC News, "Oil and Gas Exploration Site the 'size of Singapore' Approved in Queensland."

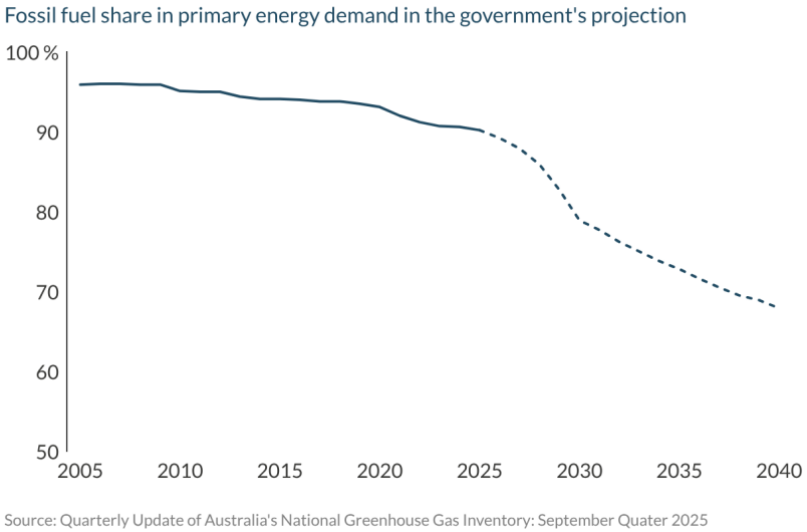
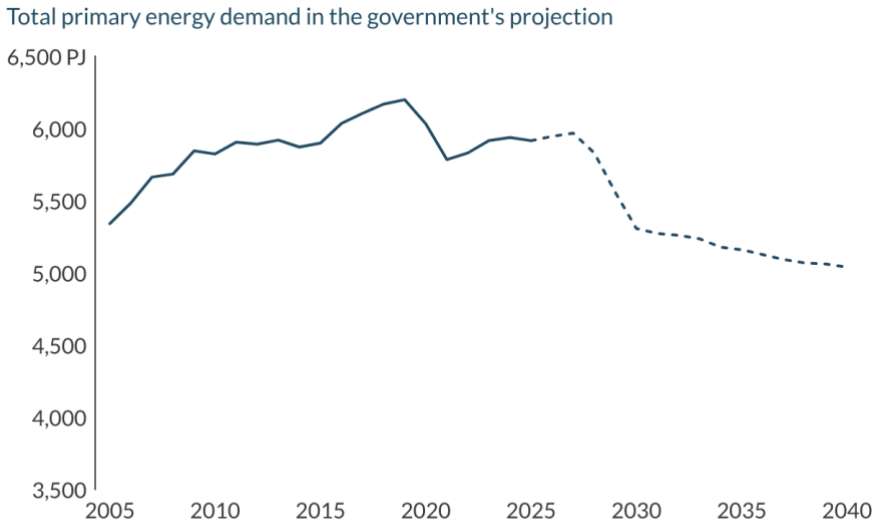


Figure 12: Historical and projected share of fossil fuels in Australia's primary energy consumption (to 2040 under current policies).

In absolute terms, Australia's total primary energy demand has increased by one-fifth since 2000, though it dropped during the COVID-19 pandemic.[43] DCCEEW's emissions projections show primary energy demand declining as the share of fossil fuels in the power sector falls, because electricity is a far more efficient energy carrier than fossil fuels.[44]

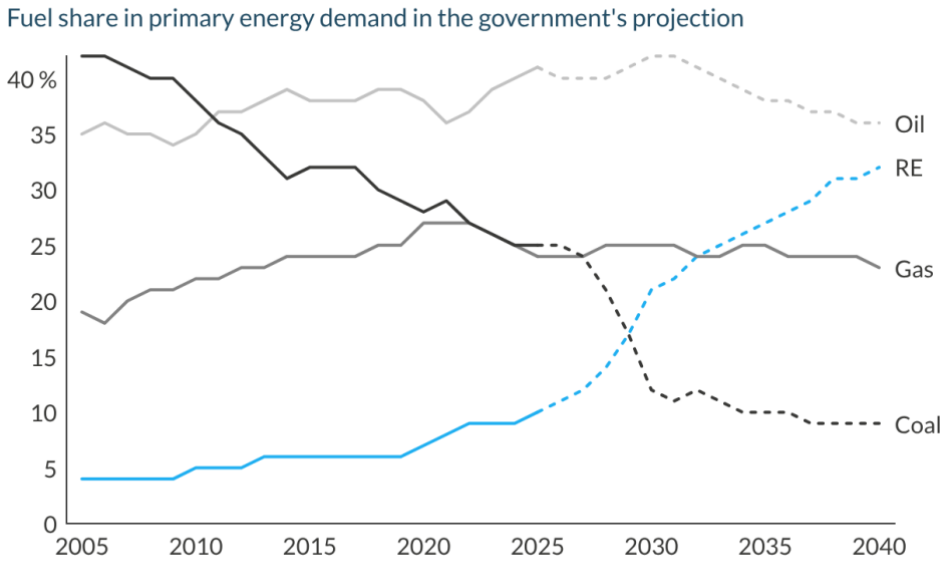


[43] All historical figures are to 2024, the most recent complete year in the Australian Government Department of Climate Change, Energy, the Environment, and Water, *Australian Energy Statistics - Update Report 2025*.
[44] DCCEEW, "Australia's Emissions Projections 2025."

Figure 13: Historical and projected primary energy consumption under current policies.

At present, oil provides 40% of primary energy, coal and gas 25% each, and renewables, biomass and waste 10%.[45] Under current policies, oil's share remains above 40% through to 2040 due to continued use in the transport sector and mining operations. Renewables are expected to replace coal demand in electricity, with coal's share consequently falling to 10% in 2040.

Under the DCCEEW's emissions projections, renewables' share of primary energy demand rises to about 32% by 2040, up from 10% in 2024, driven largely by the displacement of coal in the power system. However, oil and gas are projected to retain high shares of primary energy demand through the 2040s, when they should be declining rapidly.



Source: Quarterly Update of Australia's National Greenhouse Gas Inventory: September Quarter 2025

The FFPO scenario presented later in this report, and its contrast with the CPP scenario, illustrates one potential pathway for Australia to phase out its reliance on fossil fuels.

Australia's net zero strategy

Until September 2025, the absence of a strategy to reach net zero by 2050 was a gap in Australia's policy framework. The net zero plan published by the previous Coalition government in 2021 was considered obsolete and disavowed by the government. In September 2025, alongside the release of the 2035 NDC, the Australian Government

[45] Australian Government Department of Climate Change, Energy, the Environment, and Water, *Australian Energy Statistics - Update Report 2025*.

released its Net Zero Plan (NZP), setting out a more detailed pathway towards net zero emissions by 2050.

Underpinned by Treasury modelling, the NZP uses a different modelling approach from the emissions projections and serves a more aspirational purpose, extending to 2050 rather than 2040.

While finally outlining how the government sees the achievement of its mid-century climate goal, the new NZP lacks sector-specific emissions targets, such as a post-2030 renewables target. It projects that Australia's gross emissions will fall to 296 $MtCO_2e$ by 2035, and to 167 $MtCO_2e$ by 2050.[46] By 2050, emissions are concentrated in agriculture (62 $MtCO_2e$), transport (36 $MtCO_2e$), industry (32 $MtCO_2e$) and extractive resources, mining, oil and gas (19 $MtCO_2e$), with smaller contributions from electricity and energy and the built environment (9 $MtCO_2e$ each). Meeting the net zero target relies on offsetting roughly one-third of 2025 gross emissions.[47]

To counterbalance these emissions and achieve net zero by 2050, the plan projects 167 $MtCO_2e$ of carbon dioxide removals, mostly from afforestation and reforestation.[48] The CSIRO cautioned that such a large-scale expansion of land-based carbon dioxide removal could compete with agriculture for land, increase land prices, and create broader social and economic pressures.[49] These risks are compounded by concerns about permanence, measurement, and additionality.

Beyond the issues raised by this heavy reliance on the LULUCF sector, such residual emissions in 2050, particularly in sectors with existing cost-efficient decarbonisation technologies such as transport and electricity, reflect delayed action and a lack of ambition in tackling fossil fuel production and consumption.

[46] Department of Climate Change, Energy, the Environment and Water, *Australia's Net Zero Plan*.
[47] Australian Government, Australia's Net Zero Transformation: Treasury Modelling and Analysis: Technical Appendices.
[48] Department of Climate Change, Energy, the Environment and Water, *Australia's Net Zero Plan*.
[49] CSIRO, "Australian Carbon Dioxide Removal Roadmap."

Figure 14: Projected sources of land-based sequestration under the baseline scenario of Australia's Net Zero Plan (based on Chart 3.14 of the document).

Results

Modelling a fossil-free energy system

The policy context assessed above establishes the basis for the two scenarios used in this report. The current policies (CPP) scenario reflects the trajectory implied by Australia's existing targets, sector plans, emissions projections and key policy instruments, including the Safeguard Mechanism. It therefore captures the direction of travel under present policy settings, while also exposing the limits of an approach that relies heavily on net accounting, offsets, land-sector removals and uneven sectoral coverage rather than comprehensive reductions in fossil fuel use at source.

Released every December, the emissions projections forecast Australia's emissions under policies currently in place or at an advanced design stage. The government's published projections only extend until 2040, so our own CPP scenario relies on additional assumptions to extend the underlying technological and economic framework and quantify its impact on the energy system and emissions. The government's 2025 emissions projections, on which the scenario draws, consolidate information from numerous disparate sources, some of which are not publicly available. Inputs to our CPP

scenario have thus been cross-checked and extended to 2050 using other data sources, many of them produced by government. While our CPP findings can be considered consistent across their constituent parameters, the scenario remains a reflection of government expectations, based on imperfect information.

The fossil fuel phase-out (FFPO) scenario is developed against this baseline. It explores what a credible 1.5°C–aligned pathway would require if Australia were to move beyond incremental policy adjustment and instead prioritise rapid gross emissions reductions, accelerated renewable energy deployment, electrification, energy and material efficiency, and targeted use of low-carbon fuels and feedstocks where direct electrification is not yet feasible.

This scenario framing makes the sectoral analysis that follows essential. Economy-wide targets and headline policy instruments indicate the broad direction, but the practical feasibility of decarbonisation is determined within each sector. In the following chapters, we discuss the current situation in each sector and its relevant sub-sectors, providing the basis for our modelling assumptions. We then present the findings under the FFPO and the CPP scenarios and highlight the main drivers of the two decarbonisation pathways. Based on our findings, we provide policy implications for each sector to enable decarbonisation in line with a more ambitious pathway.

Zero-emission power sector

Current context

Past failures to decarbonise, combined with the looming 2030 renewables target, are pushing Australia towards a power sector crunch. Australia currently generates about 270 TWh of electricity per year. Coal remains the leading source of power, at 45%, but has been in decline since 2000, when it generated more than 80%. Gas currently generates 17% of electricity, down from 22% in 2014.[50]

Rapid growth in solar and wind generation has been the countervailing trend to declining coal use. Solar generation has grown from just 50 GWh in 2000 to 48.6 TWh in 2024, when it accounted for 18% of total national generation. Wind has grown to nearly 31

[50] Australian Government Department of Climate Change, Energy, the Environment, and Water, *Australian Energy Statistics - Update Report 2025*.

TWh over the same period (12%). Including hydropower, renewables generated 35% of Australia's total electricity in 2024.[51]

The renewables revolution in electricity has been the main driver of Australia's gross emissions reductions in recent years and remains central to national climate action. Australia has a relatively straightforward path to replacing fossil fuels by tapping its abundant solar and wind potential. Coupled with electrification, decarbonised power can in turn provide the backbone for economy-wide climate action.

Australia's decentralised power system comprises the National Electricity Market (NEM), by far the largest grid, serving the east coast states; the South-West Interconnected System (SWIS) in the south-west of Western Australia, which is considerably smaller; and a range of smaller systems across Australia serving mostly individual remote facilities. Renewables deployment has varied by system. The NEM has seen considerable progress relative to the rest of the world; the SWIS has been slower; and areas beyond these two main grids lag further behind, with reliance on coal and diesel remaining high, particularly at mining sites.

Supported by the Powering Australia framework, Australia has targeted an 82% renewables share of on-grid electricity by 2030, equivalent to 77% of total generation when factoring in off-grid power, according to the federal government.[52] The Capacity Investment Scheme (CIS) provides notable support for this target by underwriting investment in new generation and "dispatchable" technologies, such as battery storage.[53] While areas away from the two main grids are not covered by the target, the government expects the SGM to reduce fossil fuel-based power generation. Policy priorities for renewable energy roll-out therefore differ by grid and geographical area.

Structure of the Australian power sector

The power sector is a core component of the model. It follows least-cost optimisation dynamics under a set of numerous constraints: in the CPP scenario, these constraints are set so that the results align with the government's own projections, providing an emulation of the government's assumptions; in the FFPO scenario, they represent a more ambitious pathway informed by both the HPA global scenario and national high-ambition trajectories. Under these constraints and according to techno-economic parameters, the model isolates both the capacity deployment and generation dispatch that minimise system costs.

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[51] Australian Government Department of Climate Change, Energy, the Environment, and Water, *Australian Energy Statistics - Update Report 2025*.
[52] Department of Climate Change, Energy, the Environment and Water, "Powering Australia."
[53] DCCEEW, "Capacity Investment Scheme."

To capture the heterogeneous nature of Australia's electricity system, our model represents power generation across four distinct grids: the NEM, the SWIS, the Darwin-Katherine Interconnected System (DKIS), and off-grid systems. The off-grid category includes the North-West Interconnected System and remote power consumers. Although the DKIS is represented explicitly in the model, its results in this report are aggregated under the off-grid category given its relatively small role in the national power sector. The model also includes separate representations of LNG electricity and Worsley's plant in Western Australia, discussed in their respective sections.

Historical capacity and generation data are sourced from national datasets, including AEMO data for the NEM and the SWIS, the WA Whole-of-System Plan, the Northern Territory Energy Outlook, the Australian Energy Statistics, the Platts datasets and Ember data. Generator costs by type and scenario are drawn from the CSIRO GenCost study, which also underpins the AEMO modelling and CSIRO Net Zero studies. Resource availability shapes for intermittent renewable sources are generated using the methodology from the *Wind and Solar Benchmarks for a 1.5°C World*.[54]

Each grid is constrained by different targets for the share of renewable energy generation. For the CPP scenario, these are drawn from the Emissions Projections and Net Zero Plan, with assumptions extending to 2050. For the FFPO scenario, targets are informed by the HPA scenario, as shown below:

Table 5: Renewable generation share constraints by grid and year in the CPP and FFPO scenarios.

	Renewable generation share constraints in the CPP scenario (%)			Renewable generation share constraints in the FFPO scenario (%)
Grid	**NEM**	**SWIS**	**Off-grid**	**Across grids**
2030	84%	82%	31%	87%
2040	87%	84%	68%	95%
2050	95%	95%	82%	100%

These renewable constraints act as floors that the model must meet. In addition to renewable energy share targets, we impose technology-specific constraints to reflect

[54] Climate Analytics and New Climate Institute, *Technical Annex: Wind and Solar Benchmarks for a 1.5°C World*.

real-world limitations. One important constraint across scenarios is coal power, for which we adopt the exogenous capacity trajectories discussed in the dedicated subsection.

Rooftop PV capacity and generation are set exogenously in both the NEM and the SWIS. In the CPP scenario, these follow the AEMO Step Change scenario for the NEM and the AEMO Expected Case for the SWIS. In the FFPO scenario, they follow the AEMO Accelerated Transition scenario and the AEMO High Case, respectively. As rooftop PV deployment depends on individual household and business decisions, more granular representation of its rollout is outside the scope of this work.

As discussed in the storage subsection, we assume, consistent with AEMO, that Snowy 2.0 and Borumba will commence operation in 2028 and 2032, respectively, as assumed in the 2024 ISP, in both scenarios. The CPP scenario is generally constrained to evolve within the range of the projections. The full methodology is provided in the technical annex.

How to align Australia's power sector with 1.5°C: current policies vs fossil fuel phase-out scenario

Future power demand

The projected electricity demand in each grid emerges from the aggregation of electricity demand across end-use sectors (such as transport) and intermediate energy supply and transformation sectors (such as coal mining), which are discussed in their dedicated sectoral sections below. Because they reflect fundamentally different futures, the two scenarios show vastly different trajectories for electricity demand, which in turn influence the scale of the power system.

Under the CPP scenario, national power demand is aligned with the government's Emissions Projections, themselves based to an extent on inputs from the 2025 IASR and the frameworks of the 2024 ISP. Power demand increases by nearly 55% between 2025 and 2040, and nearly doubles between 2025 and 2050 to reach 480 TWh, in part because of population and economic growth, moderate electrification and fuel switching in industry, transport and buildings.

In the FFPO scenario, a deeper and faster transition to electricity across all sectors, as detailed in the sectoral section later in this report, results in substantially higher electricity demand than under current policies. Electricity demand doubles from current levels by 2035 and is three times as high as 2025 levels in 2050.

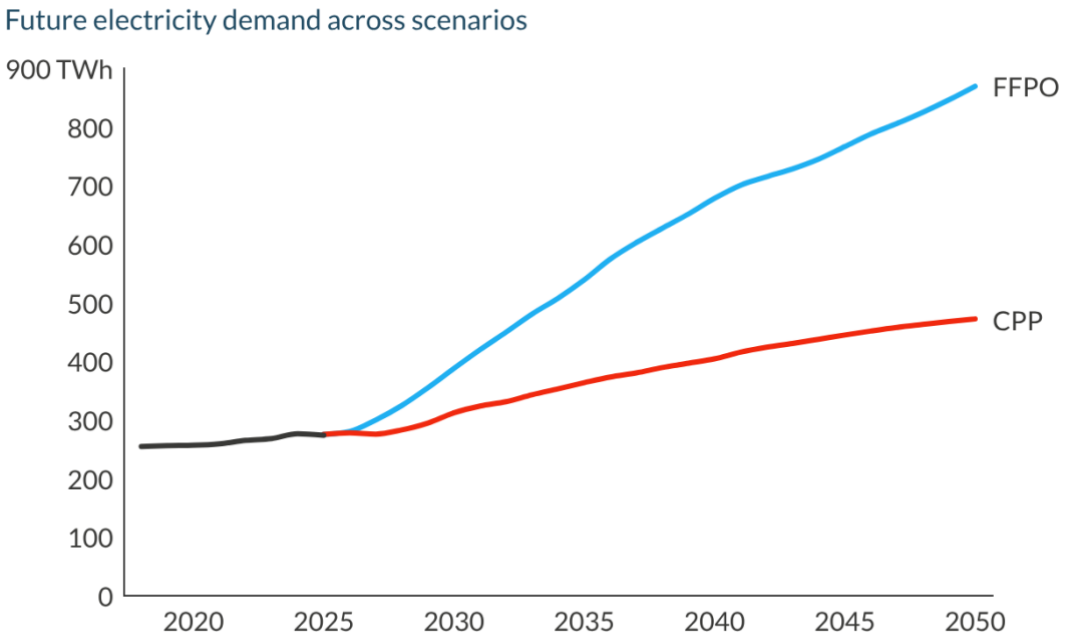

Figure 15: Future electricity demand across scenarios.

Accelerated electricity decarbonisation dramatically reduces emissions

The two distinct renewable trajectories across scenarios, and their differences in the role of fossil fuel power generation, produce divergent emissions pathways. The accelerated fossil fuel phase-out and build-out of renewables and other clean generation under the FFPO scenario, presented below, lead to an immediate and sustained reduction in electricity emissions. In this pathway, power sector emissions drop 78% below 2025 levels by 2030 and 94% by 2035, and fall below 5 $MtCO_2$ by the late 2030s (see Figure 16).

By comparison, under the CPP scenario, power sector emissions drop 58% below 2025 levels by 2030, as Australia reaches its announced target of 82% renewable generation by 2030, but stall thereafter, decreasing from 62 $MtCO_2$ in 2030 to 48 $MtCO_2$ in 2040. By mid-century, when the government has pledged to reach net zero, they fall to 13 $MtCO_2$ (see Figure 16).

As noted, this trajectory assumes that the 82% on-grid target is reached, although the country is not currently on track to do so. Assessing the current trajectory is outside the scope of this work, but failure to reach the target would lead to higher emissions at the end of the decade and delay abatement towards mid-century.

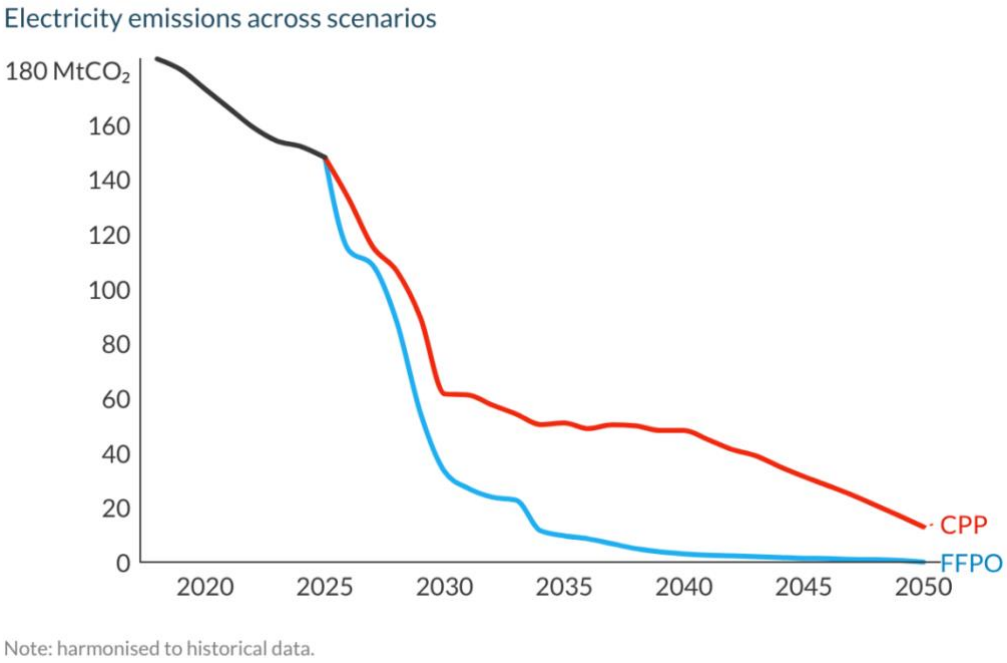

Figure 16: Electricity emissions across scenarios.

Power mixes across scenarios

Under the CPP scenario, the power mix reaches the government's 82% renewables target by 2030 and continues to increase in the following decades. Both coal and fossil gas remain in the system until 2050, consistent with the capacity envelope of the government's Emissions Projections and Queensland's latest energy plan. The mix decarbonises steadily but retains a fossil fuel tail until mid-century, when the last coal-fired power unit is retired. The role of gas diminishes from around 40 TWh in 2025 to 23 TWh by mid-century.[55]

[55] The following sections exclude electricity for LNG production and for Worsley's plant, covered in the relevant sections.

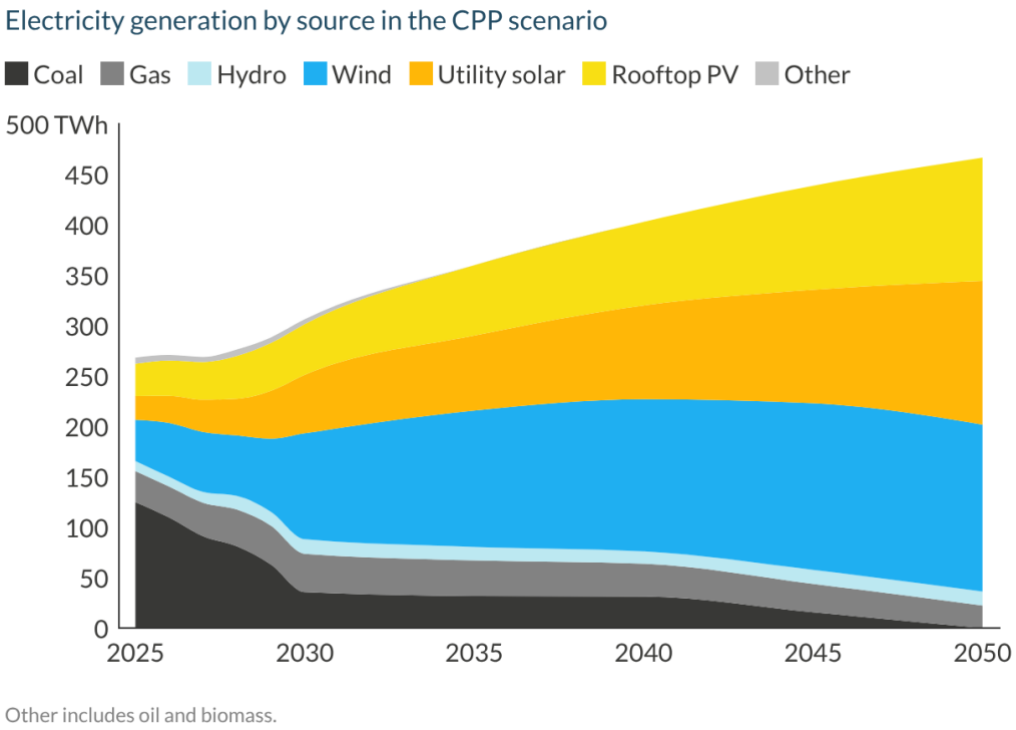

Figure 17: Electricity generation by source in the CPP scenario.

The FFPO scenario sees a rapid phase-out of coal capacity followed by fossil gas, coupled with deep penetration of renewables in the system. In this scenario, Australia's electricity system relies predominantly on wind and solar as non-fossil power sources, rather than a single renewable technology. Rooftop and utility-scale PV provide large volumes of generation during daylight hours, while wind expands alongside them and helps diversify renewable output across regions and time periods.

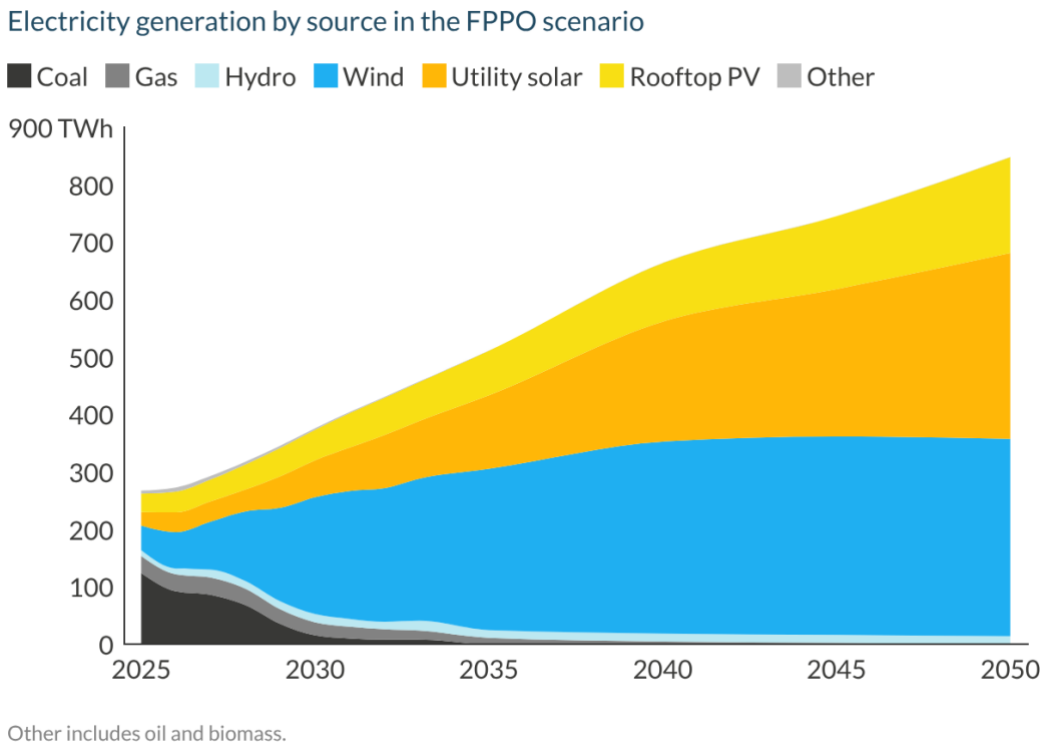

Figure 18: Electricity generation by source in the FFPO scenario.

Coal phase-out

Given its historical and current predominance in Australia's power system, the pace of the coal phase-out is a key component of the sector's transition, and more broadly of the national emissions trajectory.

As mentioned above, coal capacity is set exogenously in the model in both scenarios. As further coal capacity deployment in Australia is considered unlikely, the maximum capacity addition for both brown and black coal is set to zero across all grids. In the CPP scenario, designed to align with the Emissions Projections, coal retirement follows facility-level schedules from the AEMO ESOO for WA and the AEMO 2026 ISP for the NEM Step Change scenario, reflecting the Queensland government's 2025 announcements.

The 2024 Projections, published by the government in December 2024 and before the release of this plan, projected national coal capacity to decrease to 1 GW by 2040, from 22 GW in 2025. The 2025 projections, published one year later and factoring in this new state-level strategy, now project coal capacity at 5 GW in 2040, resulting in 45 $MtCO_2e$ of electricity emissions that year, up from 29 $MtCO_2e$ in the previous iteration of the projections.

In both scenarios, SWIS coal capacity is assumed to be phased out by 2031, in line with the AEMO assumption. Such a literal interpretation of the state governments' and market operator's current plans and assumptions may appear optimistic given that the coal

phase-out in Western Australia faces headwinds, WA's renewable pipeline remaining limited, and Bluewaters' role in the SWIS is set to continue longer than expected.[56]

As a result, in the CPP scenario coal output decreases to 36 TWh in the NEM by 2030 — compared to 119 TWh in 2025 — but stagnates at 31 TWh by 2040 before declining to zero by 2050. This long tail of coal generation leaves high power sector emissions until mid-century.

There is no role for coal in a 1.5°C-aligned power system. In the FFPO scenario, the NEM coal capacity is fully phased out by 2034. Aligning with such an ambitious trajectory would require a major step up in renewable deployment (detailed in the following subsection) to make up both for the capacity to be retired in the very near-term, but also for the additional power demand, in light of the 42-month's notice for closure required in the NEM.[57] All in all, given its outsized contribution to Australia's emissions and the cost-competitiveness of renewables, accelerating the coal phase-out remains the most accessible emissions reduction measure in the country.

The tight timelines for coal exit under a Paris-aligned scenario highlight the lag in coal phase-out retirement, for which the pace must accelerate. Paris-aligned benchmarks based on IPCC AR6 previously show that coal-fired generation must be essentially phased out in developed countries by 2030 in 1.5°C-aligned scenarios.[58]

Table 6: Coal capacity and output by grid, scenario and year.

	CPP				FFPO			
	Capacity (GW)		Electricity generation (TWh)		Capacity (GW)		Electricity generation (TWh)	
Grid	NEM	SWIS	NEM	SWIS	NEM	SWIS	NEM	SWIS
2025	21	1	119	6	21	1	119	6
2030	13	< 0.5	36	< 1	5	<0.5	14	< 1
2040	5	0	31	0	0	0	0	0
2050	0	0	0	0	0	0	0	0

[56] Daniel Mercer, "WA Coal Phase-out Uncertainty amid Bluewaters Power Station Closure Backflip."
[57] CCA, *2025 Annual Progress Report*.
[58] Climate Action Tracker, "Paris-Aligned Benchmarks for the Power Sector"; Climate Analytics and PIK, *Rescuing 1.5°C: New Evidence on the Highest Possible Ambition to Deliver the Paris Agreement*.

Renewable deployment

Aside from rooftop PV, hydro and biomass, whose exogenous capacity and generation are constrained, the model can build and dispatch generation sources like wind and utility-scale solar, but also storage technologies such as batteries to satisfy demand while minimising system costs. As detailed in the technical appendix, the renewable share constraint, defined at the grid level and by scenario, acts as a generation floor. In the CPP scenario, each grid must meet at least the renewable share of generation it has in the projections, while in the FFPO scenario, they must match at least the regional renewable share from the HPA (87% in 2030, 95% in 2040, and 100% in 2050). Where cost-effective, these floors can be exceeded, and are in most years in both the CPP and FFPO scenarios. Table 7 shows the share of generation of renewables by grid under both scenarios.

Table 7: Renewable share of generation by scenario and grid.

	Renewable share of generation (%)			
Scenario	**CPP**	**CPP**	**FFPO**	**FFPO**
Grids	**NEM, SWIS**	**Off-grid**	**NEM, SWIS**	**Off-grid**
2030	84%	38%	91%	87%
2040	87%	68%	99%	98%
2050	97%	82%	100%	100%

In our CPP scenario, as per the government plan, they become the dominant source of generation nationwide, but both fossil gas and coal remain in the system. Australia meets its 2030 electricity target of 82% of on-grid renewable power generation, before a slowdown in pace beyond 2030. By contrast, off-grid renewable deployment lags behind, with only 38% of renewable energy generation in 2030. The capacity mix in this scenario is shown with capacity by renewable source in Figure 19.

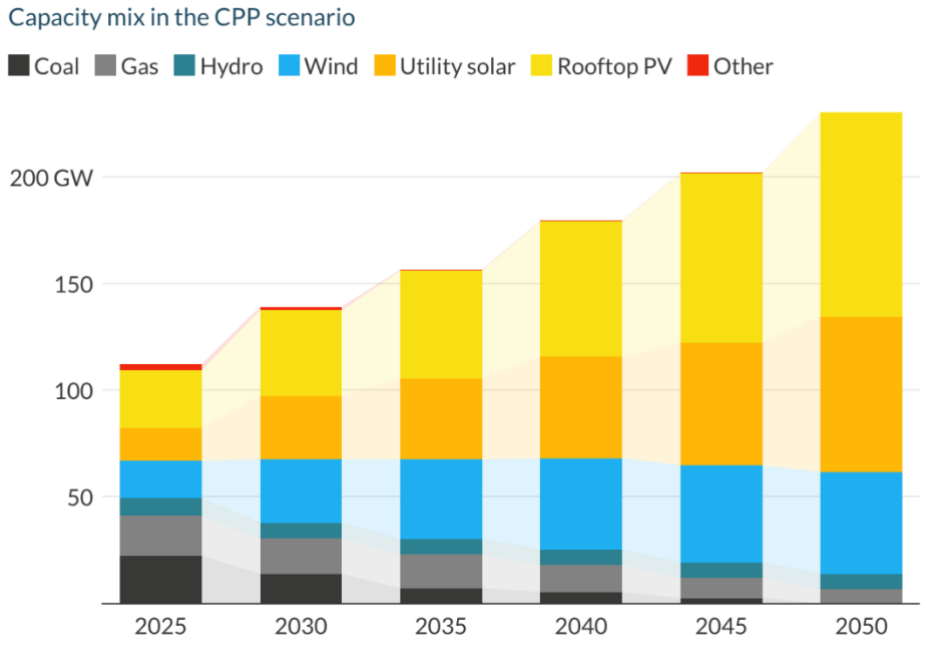

Figure 19: Capacity mix in the CPP scenario.

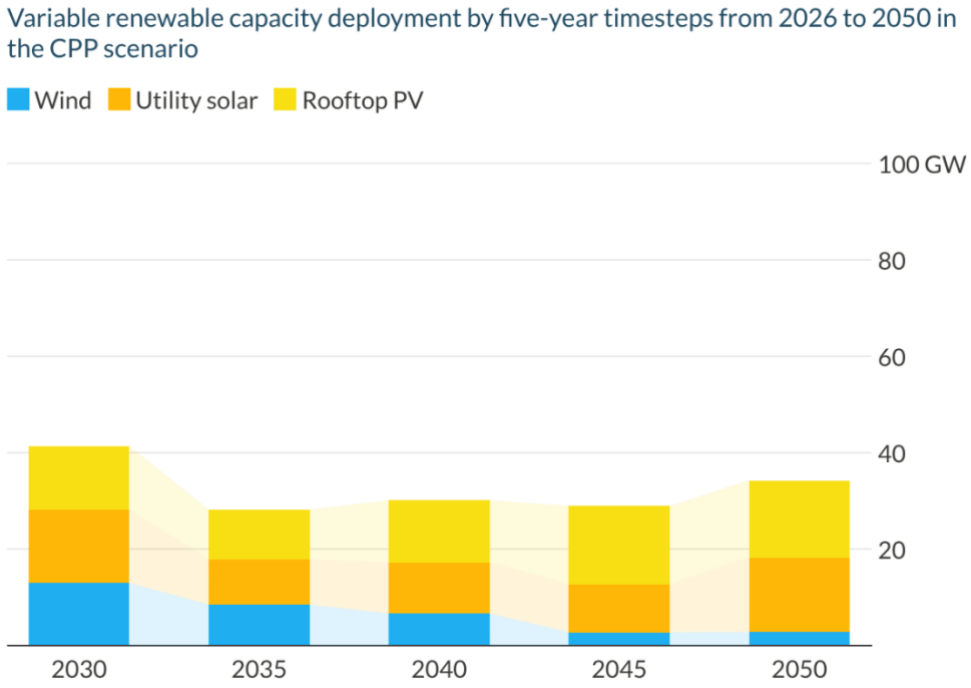

Figure 20: Variable renewable capacity deployment by five-year timesteps in the CPP scenario.

Table 8: Renewable capacity by source in the CPP scenario.

	CPP scenario		
Capacity (GW)	Wind	Utility PV	Rooftop PV
2030	30	30	40
2040	43	48	64
2050	48	73	96

Our FFPO scenario is considerably more ambitious than the government's current goal, with a significantly accelerated fossil fuel phase-out and a rapid expansion of renewables. In this pathway, solar and wind provide most of the additional generation over the model's timeframe. By 2030, they supply 85% of the national electricity, rising to 95% by 2035 and approaching 98% by 2050.

Due to its abundant potential, its complementarity with solar power and its relatively low cost, onshore wind provides the bulk of generation in the short term. This share is in line with that of other studies, including government projections. It accounts for half of the generation mix by 2030 and 40% by 2050.

In the FFPO scenario, the NEM continues to lead in renewable deployment, reaching a 91% renewable share by 2030 and increasing to 99% by 2035. By 2050, the largest national grid comprises 71 GW of wind capacity, including 12 GW of offshore wind, along with 81 GW of utility-scale PV and 109 GW of rooftop PV capacity.

Rooftop solar becomes an important component in the NEM, contributing to its transition from a concentrated, centralised supply grid to a decentralised one. Rooftop PV generation rises from 28 TWh in 2025 to 152 TWh by 2050, the equivalent of two-thirds of NEM power generation in 2025. Utility-scale PV grows more slowly in the short term, from 24 TWh in 2025 to 38 TWh in 2030, before scaling to over 155 TWh by 2050.

While hydropower retains its supporting role in the NEM, the storage roll-out and the start of operation of Borumba and Snowy 2.0 provide important backing for variable renewable energy sources (see the dedicated section on storage).

The SWIS sees similar dynamics, with cumulative additions of 12 GW, 14 GW and 8 GW of wind, utility-scale solar and rooftop solar capacity, respectively, to 2050. Away from the two main grids, the combination of wind and utility-scale PV displaces diesel and fossil gas use in minor industrial areas like the Pilbara and in remote industrial sites. 15 GW of wind and 74 GW of utility-scale PV are deployed in these more remote areas out to 2050, where power demand increases fivefold over the same timeframe.

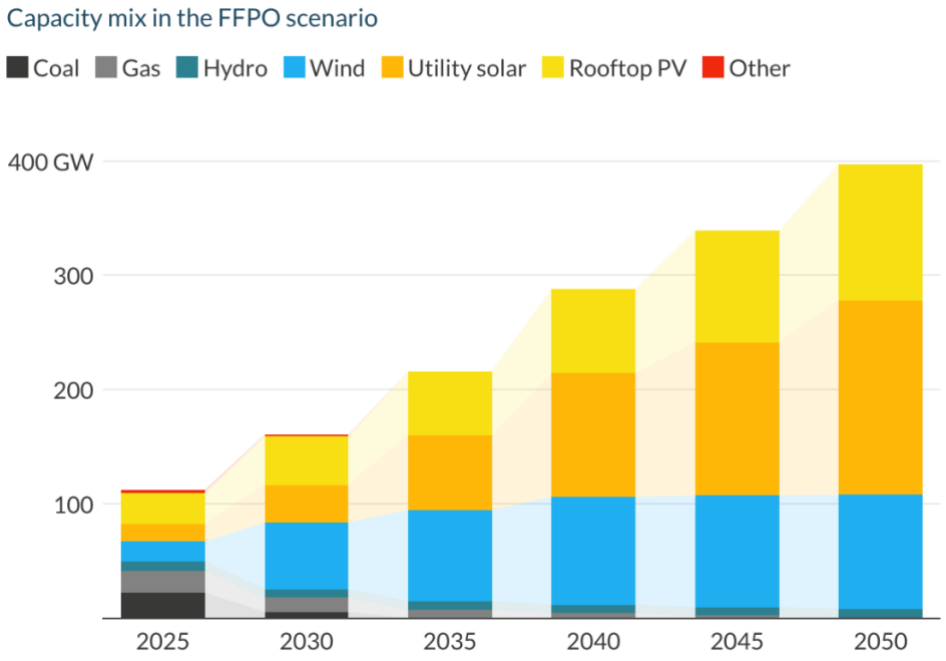

Figure 21: Electricity sector capacity mix in the FFPO scenario.

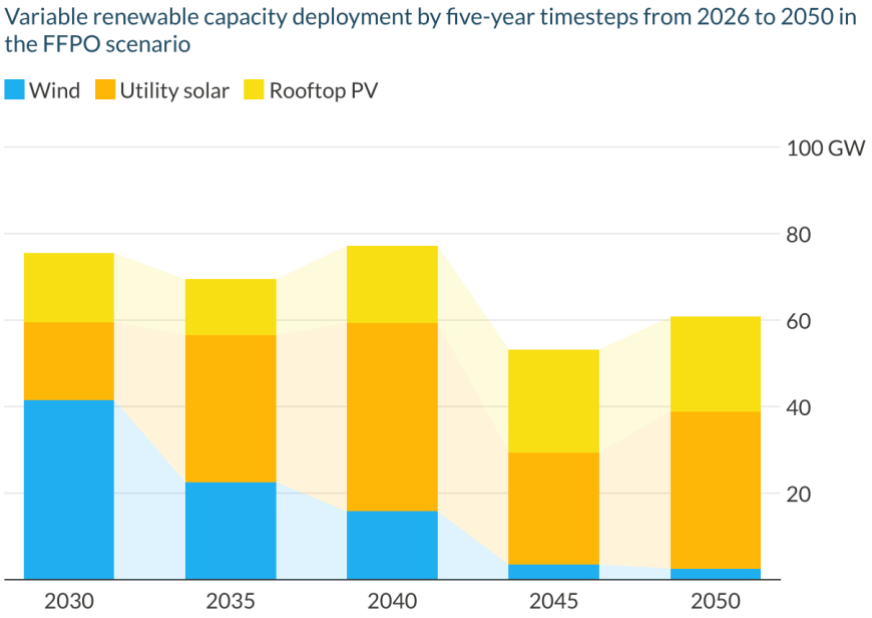

Figure 22: Variable renewable capacity deployment by five-year timesteps in the FFPO scenario.

The massive phase-in of renewables leads to a decrease in fossil gas consumption under the FFPO scenario. Fossil gas generation declines to 6% of generation by 2030 and is essentially phased out by the late 2030s.[59] Growth of gas in a firming role, as promoted

[59] As in the National Pathways Explorer's methodology, a fuel is considered phased out when its share in the generation mix reaches below 1%.

by fossil fuel industry advocates whose talking points are sometimes reused by policymakers, does not materialise.

Table 9: Renewable capacity by source in the FFPO scenario.

	FFPO scenario		
Capacity (GW)	Wind	Utility PV	Rooftop PV
2030	59	33	43
2040	95	108	74
2050	100	170	120

Large role for storage

As the system decarbonises and variable energy sources like solar and wind generate more electricity, the role of batteries and storage in the power system grows both for firming renewable output and providing grid stability during periods of low generation. For instance, large-scale battery storage systems are already installed in Kwinana and Collie, WA, to support the upcoming coal power plants closure.

In the NEM, two major pumped hydro projects will also contribute to storage capacity, delivering long duration flexibility to the system. Snowy 2.0 is expected to provide 350 GWh of storage upon full operation from 2028, with Borumba starting its full operation by 2032.

Under the FFPO scenario, national storage capacity increases dramatically from residual levels today to 586 GWh by 2030, with a large share of this capacity sitting in the NEM as coal is displaced from the system. By 2040, total national storage capacity grows further to 1,136 GWh, to nearly 1,450 GWh by 2050. In the NEM, storage energy capacity reaches 994 GWh by 2050, with 107 GW of dispatchable storage power capacity available.

By contrast, total capacity in the CPP scenario remains relatively low throughout the projection, increasing to 512 GWh by 2040 and 638 GWh by 2050.

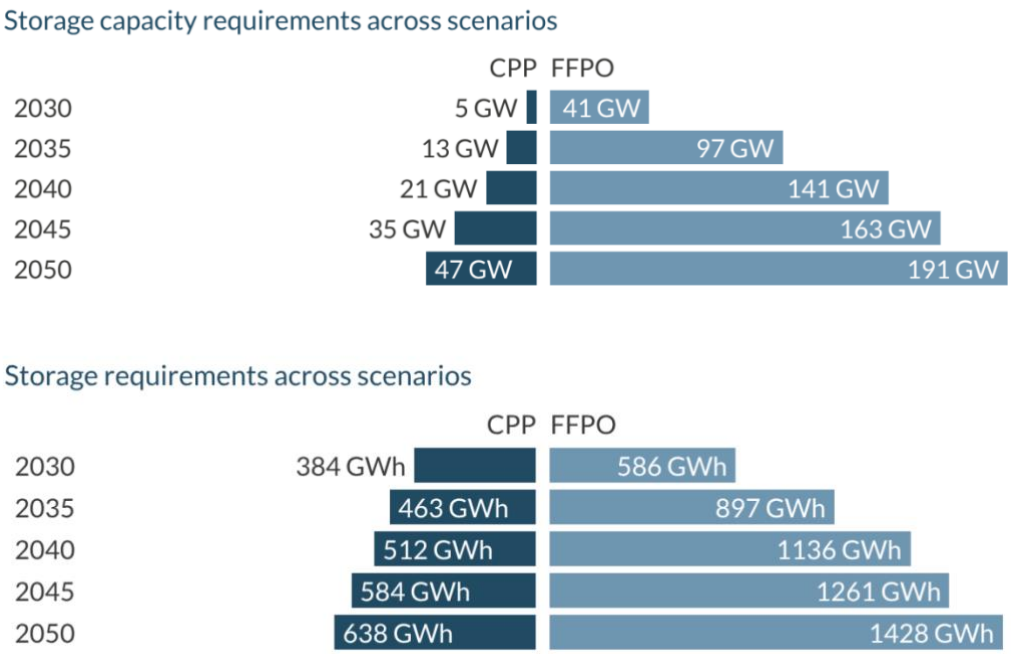

Figure 23 Storage requirements by power capacity (GW) and energy capacity (GWh).

There is a wide range of projections of storage needs. Our results are much higher than those in the 2025 CSIRO Net Zero scenarios, which find storage power capacity of 48-57 GW in 2050, depending on the scenario.[60] In the Net Zero Australia E+RE+ scenario, 605 GWh of battery storage is deployed by 2050, but with significant fossil gas and pumped hydro storage capacity build-out.[61] The 2026 ISP Accelerated Transition sees the deployment of 661 GWh of storage by 2035 in the NEM, increasing to 818 GWh in 2050, results close to but lower than the NEM figures from the FFPO scenario, less reliant on fossil gas.[62]

While well in line with the literature, we estimate that our storage requirements only approximate what they would be in the real world. First, our model only simulates sector coupling by integrating an evolving power load shape into the model, rather than representing the interaction between end-use and supply explicitly. Second, our coarse temporal resolution does not capture storage requirements as well as a high-resolution model would, as is widely documented in the literature.[63]

[60] CSIRO, "Modelling Sectoral Technology and Emissions Pathways to 2035 and Net Zero Emissions."
[61] Net Zero Australia, "Downscaling – Firm Generation and Pumped Hydro Energy Storage"; Net Zero Australia, "Methods, Assumptions, Scenarios & Sensitivities."
[62] AEMO, "2026 Integrated System Plan."
[63] Bistline, "The Importance of Temporal Resolution in Modelling Deep Decarbonization of the Electric Power Sector."

System costs

As Australia's electricity system transitions away from fossil fuels, its cost structure will change. To evaluate this shift, we calculated the average cost of supplying electricity under the CPP and FFPO scenarios. The costs shown in Figure 24 exclude transmission and distribution, which fall outside the scope of this work. They also do not include the capital costs of the existing generators.[64]

In the FFPO scenario, fuel costs fall over time, while capital costs for clean energy account for a growing share of the total. Storage supports a much higher share of variable renewables. By contrast, under CPP, continued reliance on fossil fuels keeps fuel costs elevated to mid-century, offsetting its lower expenditure on storage. Overall, the average cost of supplying electricity is slightly lower to 2050 in the FFPO scenario than under CPP, noting the limitations of these figures set out above.

[64] The techno-economic parametrisation of the model, used to realise least-cost dispatch and capacity expansion, is set out in the technical annex. The costs per technology follow those of GenCost 2025/26, using Current Policies for CPP and Net Zero by 2050 for FFPO. The latter shows a steeper learning rate for renewable technologies. For technologies not included in GenCost, we normalised cost data from the IASR. In accordance with the literature, the FFPO scenario uses the GenCost low fuel prices, while CPP uses high prices (ACIL Allen, 2024; IEA, 2025).

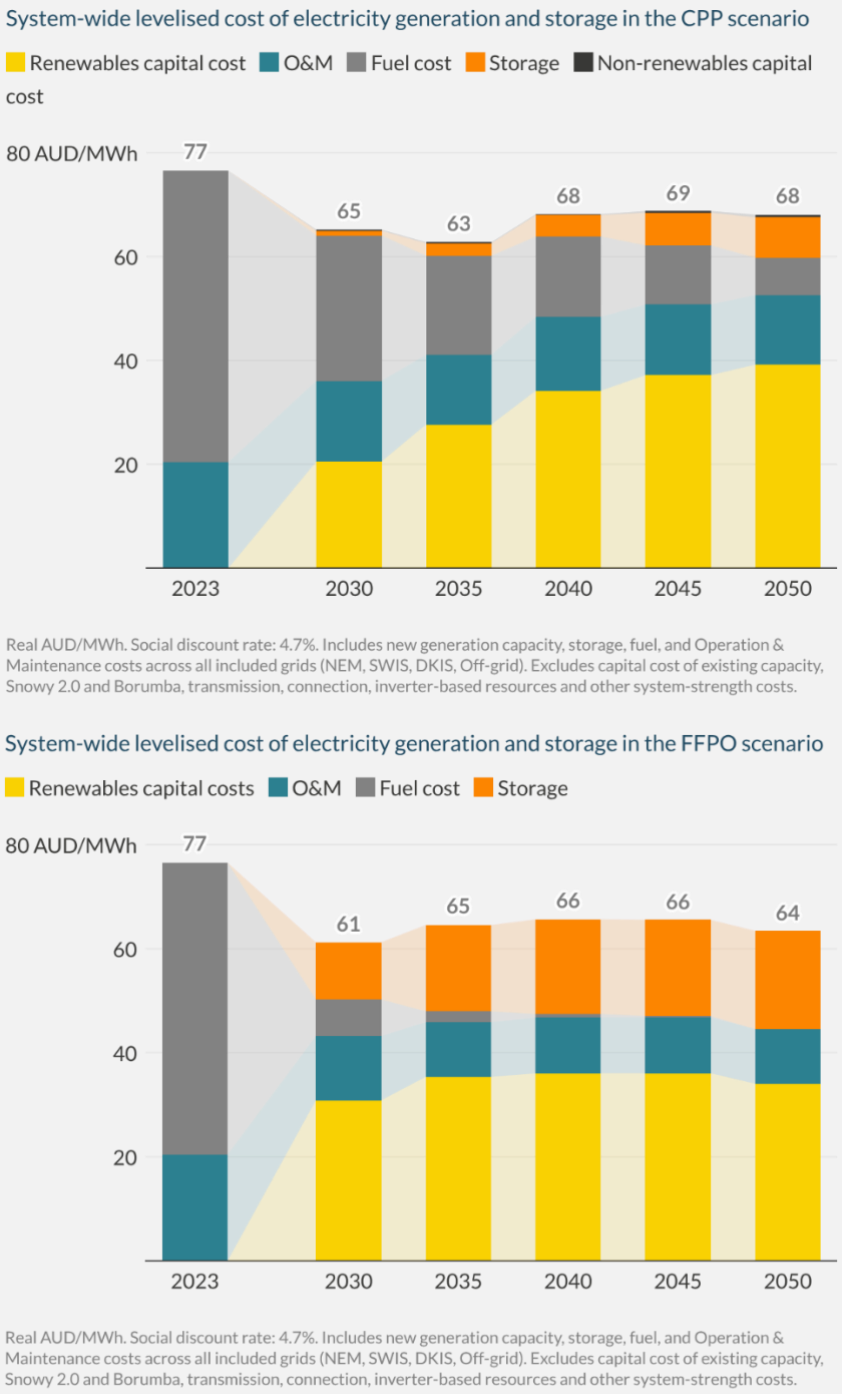

Figure 24: System-wide levelised cost of electricity generation and storage in the CPP and FFPO scenarios.

Textbox 1: System costs

Policy implications

Renewable deployment in Australia has built momentum, but the pace needs to accelerate substantially. Reaching the 82% target will require on-grid renewable generation to grow at 8% per year, as the CCA has noted. Beyond that, deployment must continue to scale up to align with the FFPO scenario.

Grid infrastructure is one of the main bottlenecks Australia faces in the transition to renewables. Many projects face delays of multiple years. Lags in infrastructure roll-out slow the connection of wind and solar projects, impose additional costs on the system through the prolonged operation of fossil fuel assets, and increase curtailment of renewables.[65]

The same delivery challenge applies to storage. Under the FFPO scenario, storage capacity rises far above the CPP pathway, twice higher than CPP levels by mid-century, making storage scale-up a central policy priority to support renewables deployment. The CIS provides a starting point by underwriting clean dispatchable capacity, including battery storage, alongside new renewable generation. To reach the storage capacity requirements under the FFPO scenario, the latter scheme should be extended and strengthened as needed to bring forward the mix of short- and long-duration batteries, pumped hydro, demand response and system services required to replace coal and minimise renewable curtailment.

Approval timelines present a further obstacle, both for grid infrastructure and for renewable energy projects. In its Annual Progress Report 2025, the CCA estimated that, at current rates of environmental approval, Australia would reach only 76% of renewable energy on grid by 2030. Wind approvals are proceeding the most slowly, despite wind accounting for a large share of the new capacity needed in the near term under the FFPO scenario. These lengthy processes affect the project pipeline and delay deployment. They also have a chilling effect on upstream investment, creating uncertainty for developers and investors. Responsibility is shared between federal and state-level processes: a survey in NSW found that two-thirds of respondents identified state planning as a greater source of delay than federal processes under the EPBC Act.[66]

The Productivity Commission's inquiry report has recommended the creation of a "well-resourced" team dedicated to energy projects that would work proactively across different levels of government, ensuring approvals proceed at the necessary pace while meeting environmental and regulatory requirements.

The administrative and environmental approval systems are not equipped to support the necessary pace of the energy transition, yet continue to allow projects with significant climate and environmental impacts, such as the NWS expansion and potentially the

[65] Clean Energy Investor Group, “Transmission Bottleneck Analysis.”
[66] Lexology, “The Latest on EPBC Clean Energy Project Approvals.”

Browse project in WA. The Browse project is of particular concern: beyond its significant climate impact and the fossil gas lock-in it would cause, it also poses serious risks to Scott Reef.

Community and political opposition to renewables has played a part, even as this has often been based on unfounded power reliability and competing land use claims. In the case of the Victoria to New South Wales Interconnector West, delays and contested engagement have added risks to the timely delivery of the transition and reduced the scope for lower-cost renewable generation to enter the system sooner. The CCA notes that benefit-sharing approaches differed across states, with some lagging behind. Improved communications, application of best practices in consultative processes, and ensuring the transition benefits affected households and communities, can enhance acceptability and the successful development of projects.

Where fossil fuels are concerned, Australia still lacks a definitive timeline to phase out coal-fired power. The Queensland government's Energy Roadmap 2025 indicates continuous investments in, and operation of, state-owned coal power generation as long as needed, which also dramatically slows down national-level coal phase-out plans.[67] Existing retirement dates are not binding and remain vulnerable to ad hoc, plant-by-plant extensions, with no federal mechanism to hold the overall trajectory in place. The absence of a binding retirement timeline, or of adequate consequences for the continued operation of carbon-intensive power sources, has been noted as a source of confusion for renewable power developers and for the public, which remains unclear about the end goal of the transition and its pace.

Resolving this through clearer policy signals, including a clear, timebound strategy for the retirement of the coal and fossil gas fleet paired with the enhancement of existing instruments such as the Capacity Investment Scheme, would improve certainty for all stakeholders involved and support the roadmap needed to deliver the strategy.

[67] Queensland Government, *Energy Roadmap - Improving Our Energy Assets While Building What We Need for the Future*.

Decarbonising transport

The transport sector's energy use: current situation

Transport has the highest dependence on fossil fuels of any Australian sector. The sector's energy demand has grown in recent decades, with little diversification away from oil products. They met 99% of the sectoral energy demand in 2024.[68]

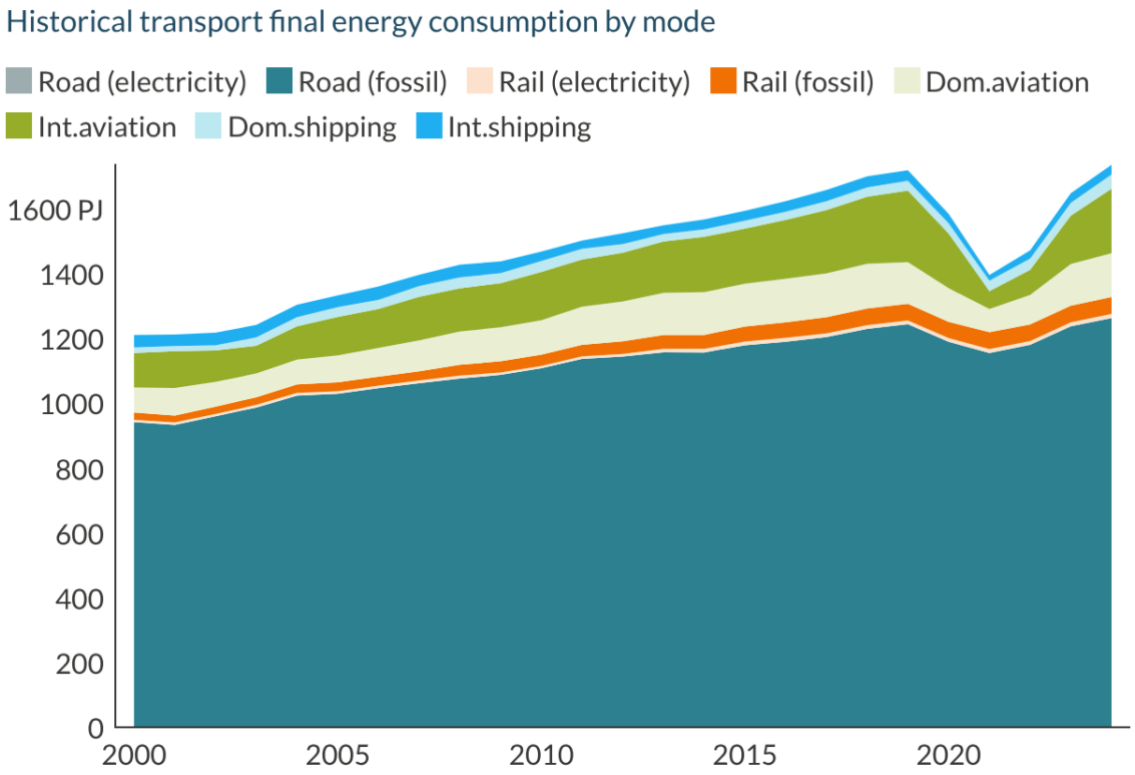

Figure 25: Historical transport final energy consumption by mode.

Structure of the Australian transport sector

To model the transport sector, we use the *Australian Energy Statistics 2025* as the primary source for historical energy demand in each transport mode, with future energy demand projected using different activity-level forecasts. The transport sector is divided into nested modes. At the higher level, there are two modes, passenger and freight, with international transport covered as a separate memo item (see dedicated section). Both total passenger and freight activity growth across modes is based on population and GDP

[68] Climate Change Authority, "Sector Pathways Review."

growth, respectively. Each mode, for instance rail or road, takes a share of the total activity, and each submode, for instance, motorcycles or buses for passenger road transport, accounts for a share of activity within that mode. Finally, each fuel used within a mode is assigned a final energy intensity.

For road transport, in the CPP scenario, we derive activity levels based on several factors: average distance travelled, occupancy for passenger vehicles, weight for freight vehicles and fleet numbers per vehicle type, sourced from the Step Change scenario in the 2025 Inputs, Assumptions and Scenarios Report Electric Vehicle Workbook.[69,70,71] The fuel-switching pathway is influenced by the latest 2025–2040 emissions by mode type trajectory.

For other transport modes, rail and coastal shipping activities forecasts are taken directly from the Bureau of Infrastructure and Transport Research Economics (BITRE) Australian Aggregate Freight Forecasts — 2022 Update. Energy demand is shaped by activity levels and energy savings through electrification, reflecting the estimated emissions reduction trend.

The domestic aviation activity level is sourced from the BITRE's Australian Aviation Forecasts.[72] Future energy and emissions intensities, with the phase-in of sustainable aviation fuel from 2028, are back-calculated from the latest emissions projections.

The FFPO scenario uses different activity levels for each mode and sub mode, based on its own macroeconomic assumptions. Fuel mixes at the sub mode level converge with those of the HPA scenario by 2030. Efficiency improvements are aligned with the growth rate in the HPA scenario for the macro-region, except for electric vehicles, for which efficiency improvements are sourced from the AEMO IASR 2025 EV Green Energy Export scenario to align with an ambitious domestic scenario.[73] Special measures are taken for domestic aviation to reflect real-world constraints and assumptions (see the technical appendix).

The following subsections discuss scenario results across the transport sector and its various modes.

How to align Australia's transport sector with 1.5°C: current policies vs. fossil fuel phase-out scenario

Pace of road transport electrification is the key difference between scenarios

[69] CSIRO, "Electric Vehicle Projections 2024."
[70] BITRE, *Australian Infrastructure and Transport Statistics Yearbook 2024*.
[71] Australian Breau of Statistics, "Survey of Motor Vehicle."
[72] BITRE, "Australian Aviation Forecasts – 2024 to 2050."
[73] AEMO, "2025 Inputs, Assumptions and Scenarios."

Emissions pathway for zero transport emissions by 2045

Oil products such as gasoline and diesel supply 99% of energy demand in Australian transport, with electricity meeting the remaining 1%. In the FFPO scenario, Australia sees a steep and sustained decline in fossil fuel use. Total oil consumption falls sharply after 2030 and is effectively phased out by the late 2040s.

Electricity drives the transition, scaling rapidly to become the dominant transport fuel by 2040, reflecting the high penetration of EVs in passenger and freight road transport, as well as for rail. By 2050, electricity alone represents 77% of final energy consumption. Sustainable aviation fuel (SAF) begins to replace kerosene in the domestic aviation sector from 2028, accelerating rapidly in the 2040s to fully replace kerosene by 2050. Biofuels support the transition in freight transport, with modest growth in the medium term.

Overall energy consumption falls to substantially lower levels by 2045, driven by electrification and energy efficiency improvements across transport modes. In the FFPO scenario, energy consumption drops from around 1400 PJ at present to 830 PJ by 2040 and 780 PJ by 2050.

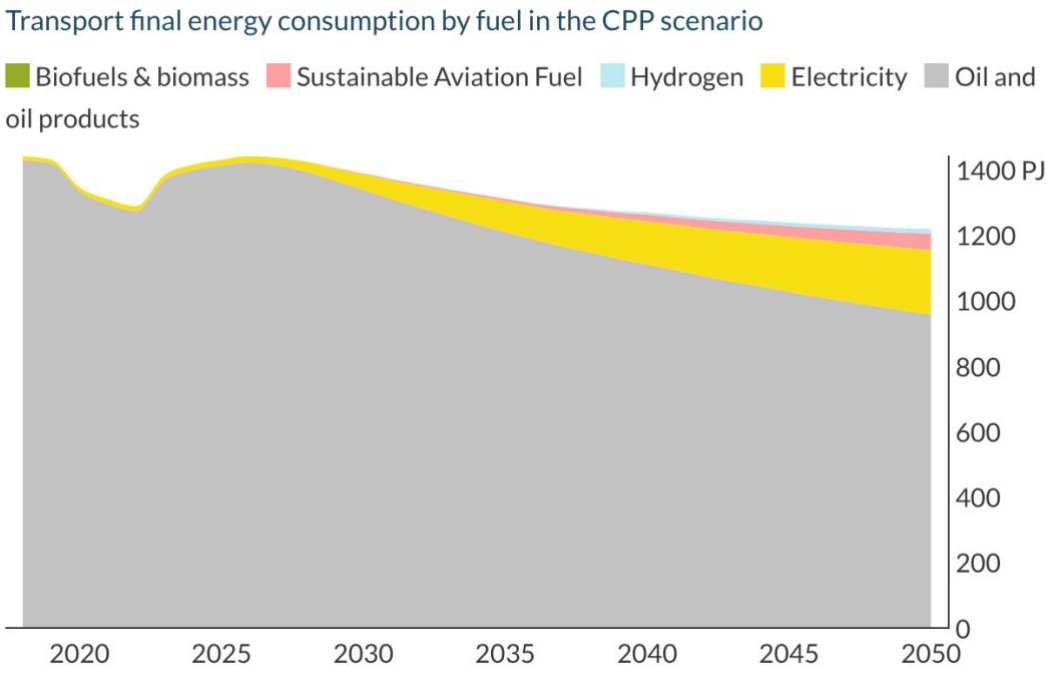

Figure 26: Transport final energy consumption by fuel in the CPP scenario.

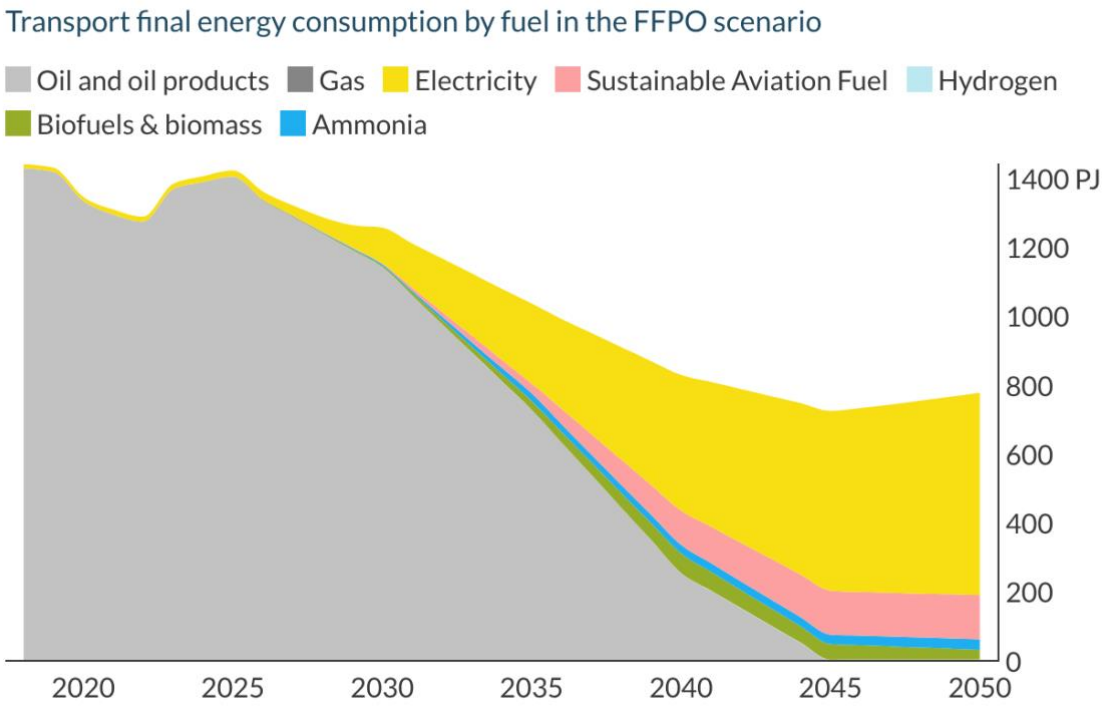

Figure 27: Transport final energy consumption by fuel in the FFPO scenario.

In the FFPO scenario, Australian transport emissions are halved between 2025 and 2035 and continue to decline to zero by 2045. In the CPP scenario, limited fuel switching and electrification barely deliver a one-third reduction in emissions between now and 2050. By then, transport would be by far the highest-emitting sector in the Australian economy, at nearly 70 $MtCO_2e$, creating a major emissions burden for the government's net zero target.

While outside the scope of this report, the transport sector's transition carries myriad co-benefits for Australian citizens. A swift transition to a zero-emissions transport system would reduce air pollution, make Australia more resilient to global energy shocks by cutting expensive imported fuel, and lower household and business costs.

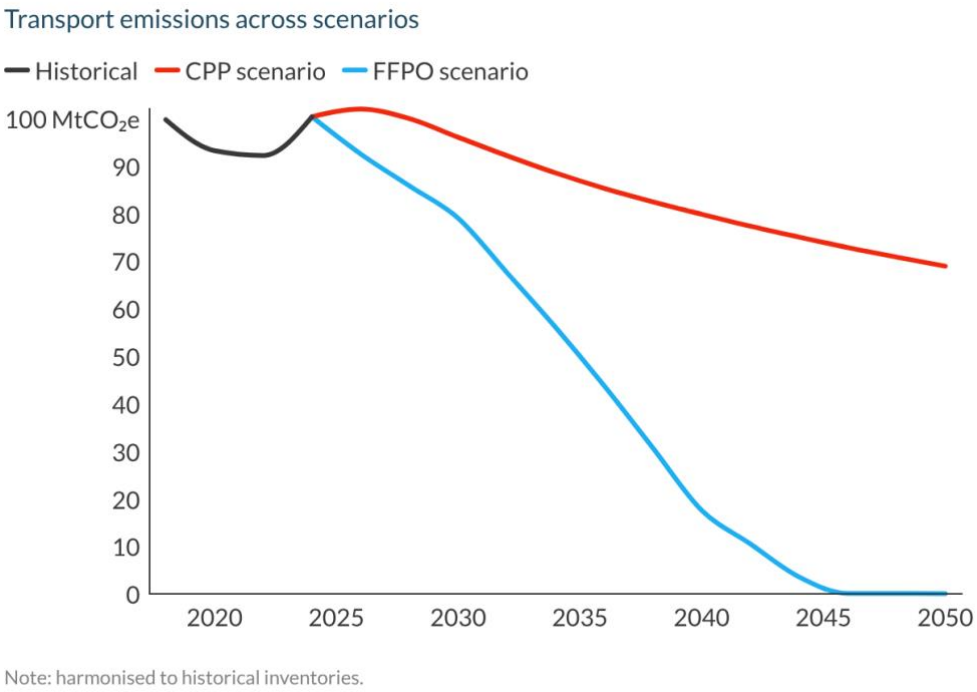

Figure 28: Domestic transport emissions across scenarios.

Road transport

Road transport was responsible for 84% of Australia's transport emissions and 18% of national net emissions in 2024.[74] Consequently, reducing these emissions will be central to any effort to align with 1.5°C. Emission reductions in the FFPO scenario take advantage of the dramatic decline in the cost of battery electric vehicles. Adequate and ambitious policies can accelerate uptake and realise both the climate and financial benefits these vehicles offer.

As discussed in the policy implications below, this would require a structural change in the government's current approach. The sectoral transformations in different road transport segments (passenger cars and light commercial vehicles, trucks) are covered separately in the following sections.

[74] DCCEEW, *Australia's National Greenhouse Accounts*.

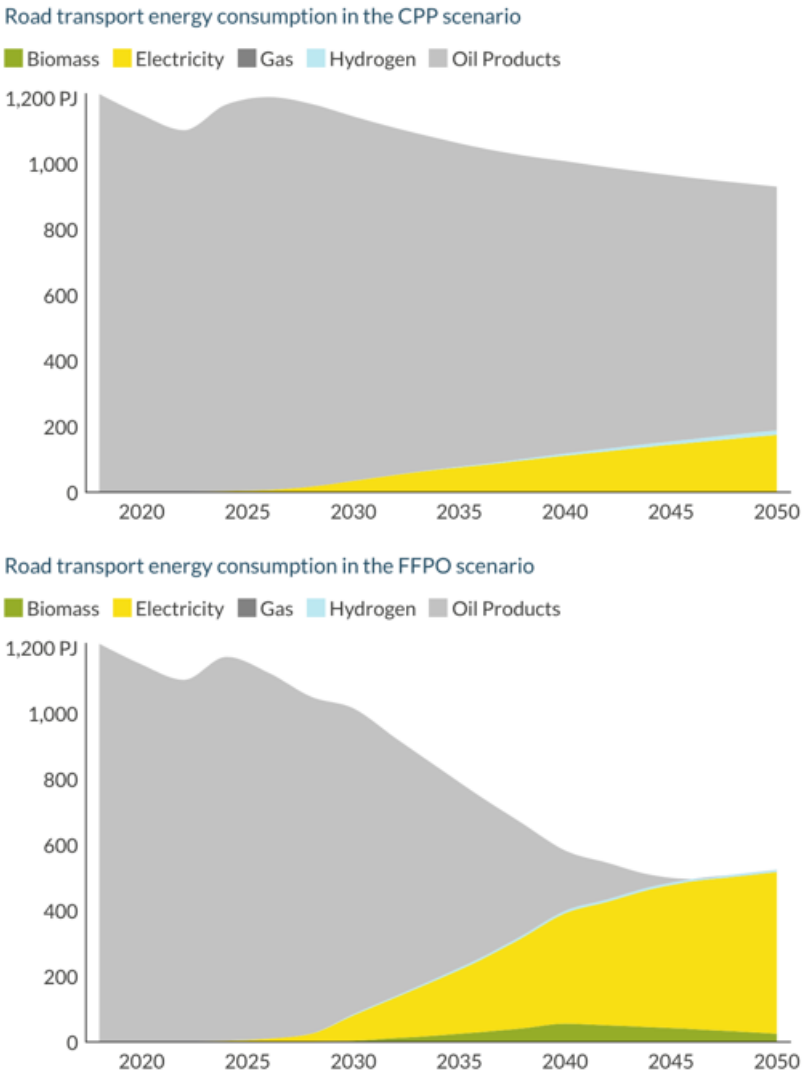

Figure 29: Road transport energy consumption in the CPP and FFPO scenarios.

In the CPP scenario, road transport remains the most energy- and emissions-intensive mode to 2050. Its emissions decrease from 81 $MtCO_2e$ in 2024 to 77 $MtCO_2e$ in 2030, 62 $MtCO_2e$ in 2040 and 51 $MtCO_2e$ in 2050, driven by a limited switch to battery vehicles and the impact of the New Vehicle Efficiency Standard (NVES).

In contrast, the FFPO scenario and its rapid switch away from fossil fuels see emissions drop to 64 $MtCO_2e$ by 2030 and 12 $MtCO_2e$ by 2040, before reaching zero by 2045, when fossil fuels are phased out of Australia's energy system.

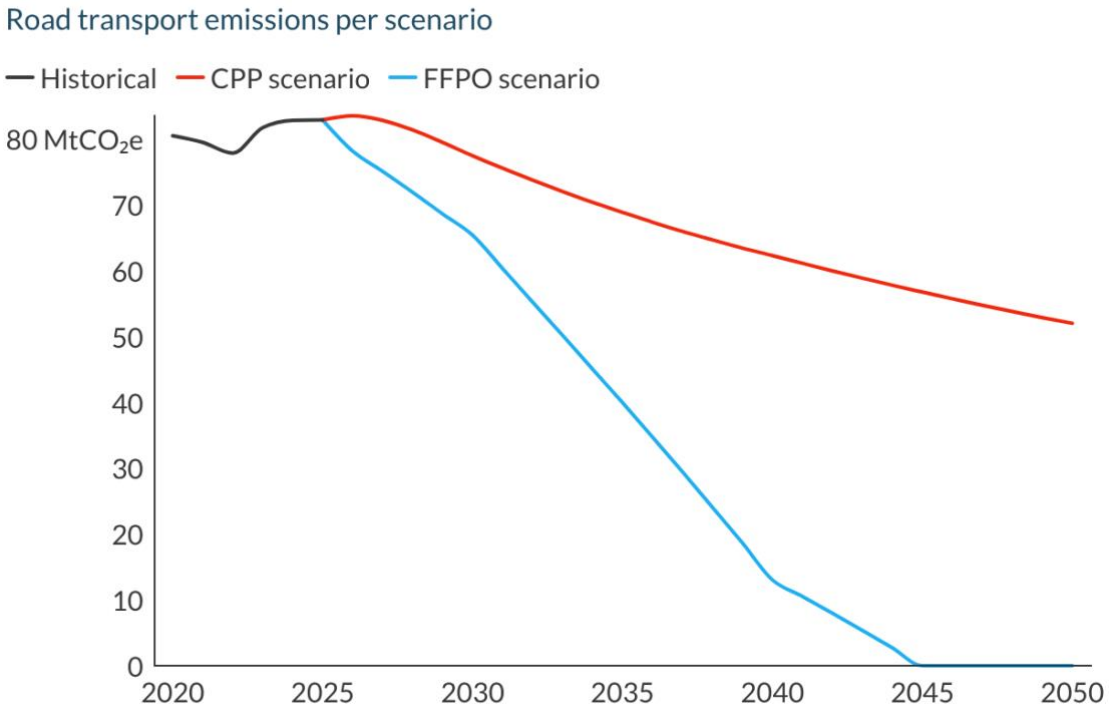

Figure 30: Road transport emissions by scenario.

Cars and light commercial vehicles

Cars and light commercial vehicles had the highest emissions within the road transport segment in 2024, at 42 $MtCO_2e$ and 18 $MtCO_2e$, respectively. Together, they accounted for 72% of road transport emissions in 2024.

Australia remains a relative laggard in the EV roll-out. While combined battery electric and plug-in hybrid sales now represent more than 10% of new passenger vehicle sales, this remains well below the global average of 25% in 2025 and the much higher shares in China and Norway, at 53% and 97%, respectively.[75] The electrification of light commercial vehicles is even further behind, with battery vehicles representing only 1.5% of new sales in Australia.

Australia introduced several policies in 2025 to decarbonise transport, including the NVES, tax credits for EV purchases and investment in charging infrastructure.[76] However, these initiatives focus primarily on the lightest passenger vehicles. As of 2025, there were 32 EVs per public charging point in Australia, compared with 11 and 13 in China and the EU, respectively.[77]

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[75] IEA, *Global EV Outlook 2026*.
[76] Australian Government, *Transport and Infrastructure Net Zero Roadmap and Action Plan*.
[77] IEA, *Global EV Outlook 2026*.

The broader taxation and subsidy regime favours sustained oil consumption. Meanwhile, Australia has no commitment to phase out ICE vehicles and no systematic strategy to encourage modal shifts from road to rail or other forms of low carbon transport.

CPP scenario

In the CPP scenario, the combined effect of the NVES and limited electrification uptake leads to a small shift in transport's fuel mix and emissions. By 2030, electricity accounts for 4% and 2% of the car and LCV fuel mix, respectively, rising to 17% and 9% by 2040. By mid-century, electricity meets 30% and 18% of these modes' energy demand, with fossil fuels supplying the rest.

Continued reliance on diesel and petrol for cars and LCVs locks in the energy security risks Australia faces in an increasingly volatile world, along with risks to household and business energy costs. The government projections, published in 2025, do not reflect the energy crisis that followed the US-Iran war, which pushed many Australian consumers and businesses to invest in EVs. June 2026 was the best-selling month for EVs in Australia, with total sales in the first six months of the year already 50% above 2025.[78] An updated CPP pathway accounting for this recent interest would likely show a faster pace of electrification.

In the CPP pathway, cars and LCV emissions decrease from 60 $MtCO_2e$ in 2024 to 27 $MtCO_2e$ by 2050 because of the fleet turnover and improvements in energy efficiency rather than by a major shift away from fossil fuels. Other smaller passenger sub-sectors, such as motorcycles and buses, also see their emissions decline at a similar overall pace, from 2 $MtCO_2e$ to 1 $MtCO_2e$ by 2050.

FFPO scenario

By comparison, under the FFPO scenario, these emissions reach zero by 2045. Deep transport electrification, enabled by adequate policies, is the main driver of change for passenger vehicles. The electrified share of the car energy mix reaches 50% by 2040 and climbs to 100% by the late 2040s.

For LCVs, biofuels play a moderate role in the transition, reaching nearly one-third of the sub-sector's energy demand in 2040 before stabilising at 25% in 2050. This limited role for biofuels can help decarbonise older parts of the existing fleet during the turnover period, but biofuels are not a long-term alternative to electrification given their sustainability and environmental footprint. As EVs and LCVs are far more energy efficient than their ICE counterparts, electrifying the fleet leads to significant reductions in the sector's energy consumption. By 2050, energy demand from these two segments is 59% below 2024 levels.

[78] EVDB Australia, "EV Market Stats 2026."

Policy implications

Aligning road transport emissions with 1.5°C will require strong and immediate measures to enable electrification, which is the sub-sector's main decarbonisation lever. Doing so would require a target to limit sales of ICE vehicles, similar to the EU's, defined for both cars and LCVs. Such a target would provide certainty for the domestic car service industry, importers and buyers. Clear targets provide a desired outcome for policymakers to work towards, allowing the regulatory environment to be adjusted accordingly, rather than leaving uptake to develop passively. This contributes to what the Productivity Commission calls a "network effect", where confidence in future uptake makes investments in charging infrastructure safer and a better charging network, in turn, contributes to further uptake.[79]

Incentives can then be deployed to align with that target. Some are already in place, but they can be better calibrated to maximise abatement. They also need to avoid exacerbating inequality; the fringe benefit tax exemption for electric vehicles, for example, disproportionately benefits high-income earners.[80]

Generating an adequate second-hand market is an important component of building a critical mass in the fleet and enabling broad adoption. Incentives for companies to adopt EV fleet targets can help generate this market. Similarly, as fuel tax schemes are reviewed, the pricing of ICE vehicles could be further integrated into transport climate policy to support electrification.

The availability of chargers is a major constraint on the current EV roll-out. Building code mandates for EV-ready parking can be combined with charging requirements in new developments, drawing, for example, on experience in Kenya and India. France and the UK have set quantified charger roll-out targets that can in turn inform policies to meet them.[81]

While not within the scope of this modelling exercise, vehicle-to-grid (V2G) charging can create a bidirectional connection between an EV and the grid. This effectively turns the EV into a mobile battery and by extension a source of income for households when energy is sold back to the grid. V2G can further incentivise EV uptake for households and businesses while giving grid operators a flexible source of stored power to help balance the electricity system. Pilot-scale projects are already underway.[82]

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[79] Productivity Commission, "Statutory Review of the Electric Car Discount."
[80] AFR, "30pc of EV Tax Breaks Go to the Wealthy."
[81] IEA, *Global EV Outlook 2026*.
[82] CSIRO, "New Study Brings Vehicle-to-Grid Technology a Step Closer in Australia."

Road freight transport

The government has no target for articulated and rigid trucks, whose emissions are projected to be 20 $MtCO_2e$ in 2025. The 2023 National EV Strategy explicitly identifies passenger vehicles as "a first priority".[83] Heavy transport has remained a policy blind spot.

The sector has some globally unique characteristics. Australia has high freight volumes relative to its population, carried over long distances.[84] Electric truck sales were just 1% of new sales in 2025. Globally, electric truck sales stood at 9% of new sales in 2025 and 26% in China.[85] [86] [87]

CPP scenario

Under the CPP scenario, emissions from road freight climb to 22 $MtCO_2e$ in 2030 and reach 23 $MtCO_2e$ by 2050 as freight activity grows faster than the fleet decarbonises. Electrification is much more modest than in passenger cars, with only 11% of rigid trucks' and 6% of articulated trucks' energy demand met by electricity by 2050. For articulated trucks, green hydrogen accounts for 5% of energy demand by mid-century, as this fuel offers advantages for long-distance travel that are well suited to Australia's geography.

FFPO scenario

Under the FFPO scenario, electricity replaces most fossil fuel use in heavy-duty vehicles, with biofuels meeting the remainder. The electricity share rises from 2.4% to 10% for articulated trucks and from below 1% to 8% for rigid trucks by 2030 before fossil fuels are entirely phased out by 2045. Biofuel shares peak in 2040 at just under 20% of energy consumption for both truck types, before declining to around 5% by 2050. Total emissions fall rapidly between 2030 and 2040, from 17 MtCO2e to 2.5 MtCO2e. Green hydrogen, which is considered in the CPP scenario, is excluded from the FFPO scenario given the relative competitivity and cost decline of batteries.

Policy implications

The decarbonisation of road freight will require the same electrification levers as passenger vehicles. As with light-duty vehicles, targets would support policy roll-out and align policies with the required outcomes. These would need to be differentiated by freight type and operator. More than 90% of truck operators are small businesses, and 70% have only one truck.[88] For these operators, concessional finance and incentives that lower the effective ownership costs of electric and hydrogen trucks can enable the transition, delivering the long-term benefits these vehicles offer while lowering the high upfront capital costs that remain an obstacle.[89] Differentiated taxes, targeted purchase

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[83] DCCEEW, *National Electric Vehicle Strategy*.
[84] AECOM, *Electrifying Road Freight Report: Pathway to Transition* (2024).
[85] Electric Vehicle Council, *State of Electric Vehicles 2025*.
[86] IEA, "Global EV Data Explore."
[87] BITRE, *Road Vehicles Australia January 2025*.
[88] AECOM, *Electrifying Road Freight Report: Pathway to Transition* (2024).
[89] Climate Change Authority, "Sector Pathways Review."

incentives and scrappage schemes have been identified as potential policies to support uptake.[90]

Building dedicated clean freight corridors, with charging infrastructure along the main roadways used to transport goods across Australia, will be paramount in enabling the sector's transition.

A report commissioned by ARENA from AECOM identified the need for at least 165 freight charging hubs across the country.[91] Delivering these, and going beyond them, will require mapping the sector's needs, factoring in intramodality to complement more efficient rail and marine freight and harmonising policies and regulations across states and network providers.

Developing both the charging infrastructure and underlying energy infrastructure will be critical to support uptake and reduce range anxiety. AECOM found that the transmission and distribution of electricity represent a greater challenge than absolute generation, particularly in a scenario aligned with the FFPO scenario, where renewable energy deployment progresses rapidly.[92]

Cost optimisation will require different technologies depending on where and how freight is transported. Hydrogen road freight is more suited to long distances, where the marginal cost of stopping is higher, and can form part of regional highway charging infrastructure, while the urban freight segment can build on the broad charging-network efforts that would already be needed to decarbonise light-duty vehicles.

Heavy road transport decarbonisation is already underway

New-energy heavy-duty trucks stood at 1% of new sales in Australia in 2025, equivalent to about 900 vehicles. Over the same period, China's sales share rose to more than 25%, the highest in the world. The Chinese government has supported both demand for and supply of these vehicles. Recent updates to the scrappage scheme, which included purchase incentives, drove strong momentum in new energy heavy truck sales, with the sales share exceeding 50% in December 2025.[93]

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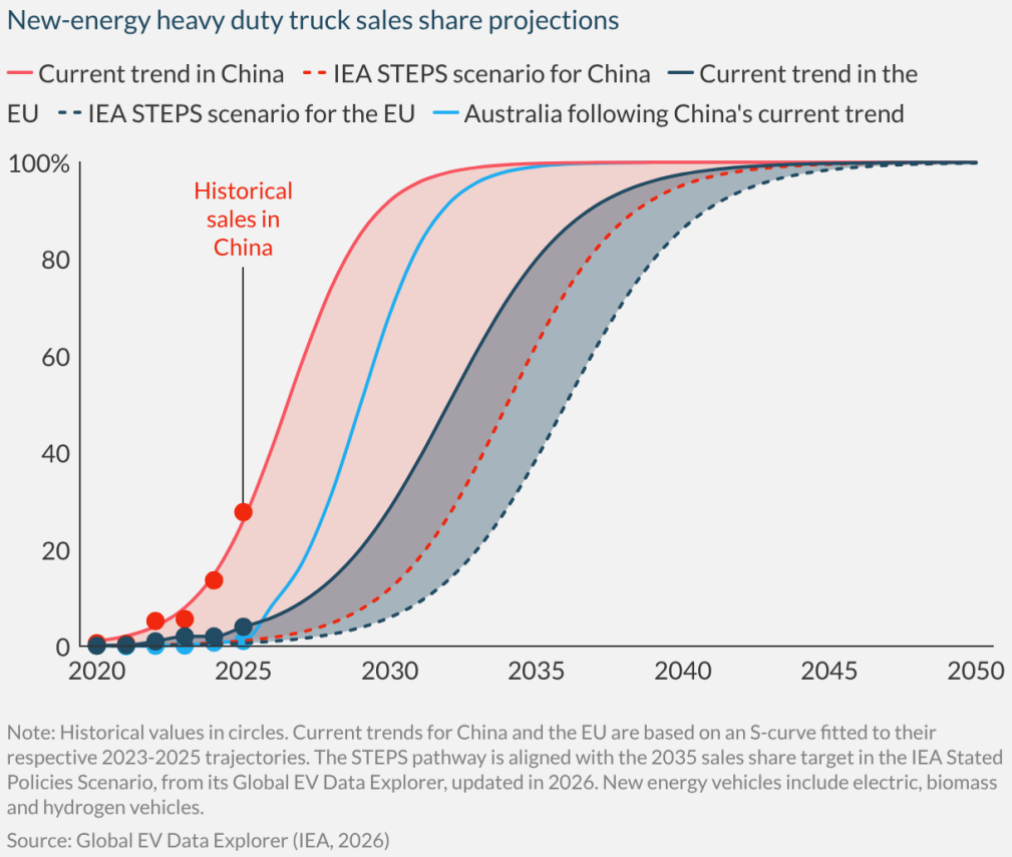
[90] ClimateWorks, "Delivering Freight Decarbonisation: Strategies for Reducing Australia's Transport Emissions."
[91] AECOM, *Electrifying Road Freight Report: Pathway to Transition* (2024).
[92] AECOM, *Electrifying Road Freight Report: Pathway to Transition* (2024).
[93] CVWORLD, *New Energy Commercial Vehicles Units in December*; IEA, "Trends in Heavy-Duty Electric Vehicles."

Unlike in China, substantial incentives for zero-emission commercial vehicles are not yet widespread across the EU, and the sales share was only 4% in 2025. Yet, in Europe, battery electric trucks can already reach total cost of ownership parity with diesel trucks for urban operations and regional deliveries.[94] In its Stated Policies scenario, the IEA anticipates that sales of non-fossil fuel heavy-duty trucks will reach close to 100% between 2040 and 2050, and current trends suggest that this milestone might be reached sooner.[95]



Note: Historical values in circles. Current trends for China and the EU are based on an S-curve fitted to their respective 2023-2025 trajectories. The STEPS pathway is aligned with the 2035 sales share target in the IEA Stated Policies Scenario, from its Global EV Data Explorer, updated in 2026. New energy vehicles include electric, biomass and hydrogen vehicles.

Source: Global EV Data Explorer (IEA, 2026)

Figure 31: New-energy heavy-duty truck sales share projection.

Textbox 2: Heavy road transport decarbonisation is already underway

Rail

Rail is a diverse sector in Australia, and freight and passenger rail follow very different dynamics. Rail accounts for 57% of the freight transport demand, the most of any mode,

[94] Petroni and Getachew, *Road to Real Zero Freight Trucking in Europe*.
[95] European Comission, "German €1.6 Billion E-Truck Charging Hub Funding Approved by EU — A Milestone for Heavy-Duty Zero-Emission Corridors."

while only accounting for 4% of passenger travel demand.[96] Passenger rail is concentrated in urban areas. The major metropolitan networks in Sydney, Melbourne, Brisbane and Perth are largely electric, but passenger transport on regional networks is comparatively more reliant on fossil fuels.[97] Freight rail, which moves bulk commodities such as iron ore, coal and grain over long distances, benefits from the economies of scale the mode offers, but most freight services operate on non-electrified track.

Total rail emissions were 4 $MtCO_2e$ in 2024. Freight rail was responsible for 95% of these and drew 95% of its energy from diesel. Passenger rail is mostly, but not fully, electrified, with diesel making up 21% of its energy use.

CPP scenario

Beyond road transport, electrification also deepens for both freight and passenger rail. Under current policies, combined freight and passenger emissions fall from 4 $MtCO_2e$ in 2024 to 3 $MtCO_2e$ in 2030 and 2 $MtCO_2e$ in 2040, after which the decline flattens to 1.3 $MtCO_2e$ in 2050. As per the government's projections, this moderate decline in emissions is enabled by the Safeguard Mechanism, which covers 82% of national rail emissions and is anticipated to incentivise fuel switching and efficiency improvements. Passenger rail continues its incremental electrification, reaching a 93% electricity share by 2050 through the extension of the already largely electric network, while freight rail remains largely dependent on diesel, with electricity representing only 40% of its energy demand by 2050.

[96] Department of Infrastructure, Transport, Regional Development, Communications and the Arts, *Transport and Infrastructure Net Zero Roadmap and Action Plan*.
[97] Australasian Railway Association, "Rollingstock Decarbonisation Critical Path - Summary Report."

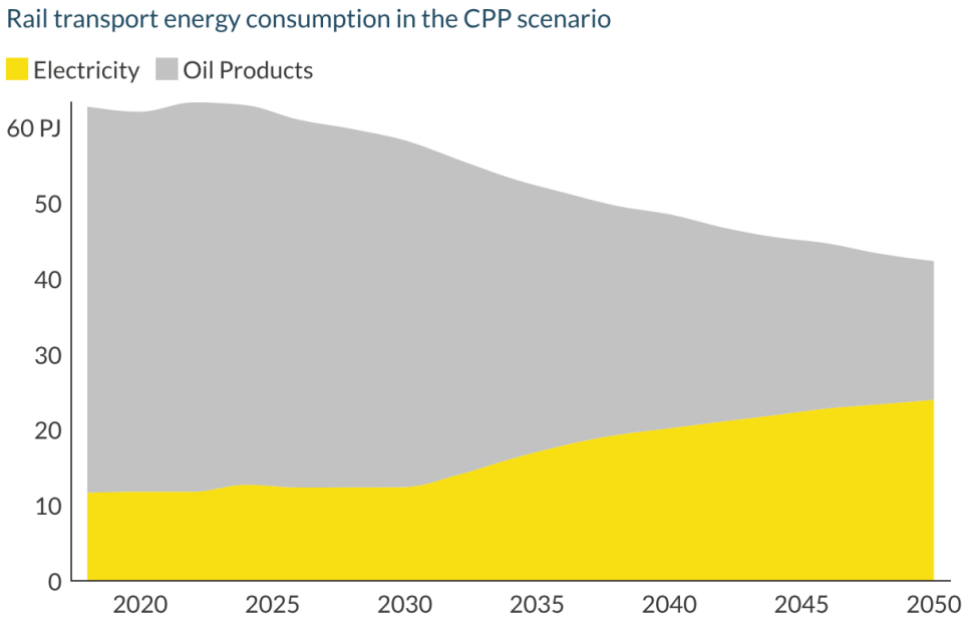


Figure 32: Rail transport energy consumption in the CPP scenario.

FFPO scenario

Under the FFPO scenario, rail reaches zero scope 1 emissions by 2045 through full electrification, despite higher activity levels for both passengers and freight. In passenger rail, the pace of electrification is much faster than in the CPP scenario. By 2040, 93% of passenger rail energy demand comes from electricity, a level not reached until 2050 under the CPP scenario.

The main source of divergence between the FFPO and CPP scenarios comes from freight rail. In the FFPO scenario, freight rail reaches full electrification by 2045, enabled by the concentration and intensity of rail activity in specific regions such as WA's Pilbara, where high-volume, vertically integrated heavy-haul lines provide opportunities for electrification. About half of the diesel fleet is due for replacement over the coming decade, making the 2030s an inflection point for the sector's decarbonisation.[98]

[98] Australasian Railway Association, "Rollingstock Decarbonisation Critical Path - Summary Report."

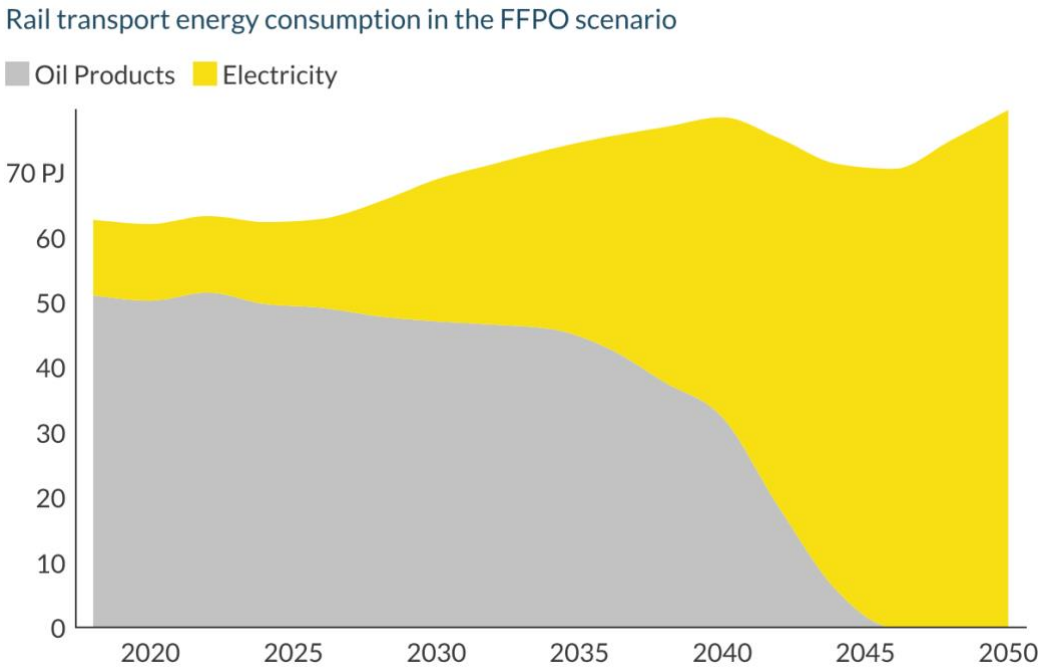


Figure 33: Rail transport energy consumption in the FFPO scenario.

Policy implications

Despite its relatively low share of transport emissions, enabling an orderly transition of the rail network is integral to the decarbonisation of specific regions and industries like the Pilbara, and can provide the foundation for more ambitious modal shift policies. The Net Zero Plan for transport identifies regulatory fragmentation and a lack of harmonisation as obstacles to the sector's transition and to greater modal shift.[99] The second stage of the National Rail Action Plan is therefore an opportunity to address these barriers.

A comprehensive federal-state strategy crossing jurisdictional boundaries would allow for better planning across the sector, while harmonising approaches and technical standards across regions with very different economic profiles but a shared need for a common transition framework. Such overarching rail strategy should also be aligned with action on heavy road freight, considering the policy blind spot this sector still represents, to incentivise economies of scale and the sustainability benefits offered by rail.[100]

This strategy would need to be complemented by state and nationally led investment in infrastructure that has, in some areas, been left largely to the private sector. It should actively promote rail as a mode of transport for both commodities and people, as called for by the Australasian Railway Association, including by demand-side measures.[101] Rail

[99] Australian Government, *Transport and Infrastructure Net Zero Roadmap and Action Plan*.
[100] Productivity Commission, "Investing in Cheaper, Cleaner Energy and the Net Zero Transformation: Interim Report."
[101] Australasian Railway Association, "The Future of Freight."

investments fit within broader diversification and industrial policy agendas: first, by supporting the decarbonisation of existing industries, and then by enabling the broader expansion of the economy, especially through the shift towards green exports that could build on these logistics developments.

Some pitfalls must be avoided. Reliance on biofuels or renewable diesel in the short term may support the immediate transition but also risks locking in technology displacement rather than directing investment towards more durable electrified pathways. The 2032–2037 procurement window is an opportunity to accelerate the transition: decisions made during the replacement of a large share of the fleet could either support ambitious climate targets or, on the contrary, lock in emissions for decades.[102]

The role of modal shift

Increased energy demand in the model reflects changes in activity levels, driven by population and GDP growth rather than modal shift from road – which accounts for the overwhelming share of transport emissions – to rail.

Rail is an efficient, low-emissions mode compared with other forms of transport. Encouraging a shift from road to rail can cut both sectoral emissions and road congestion. Rail freight is dominated by bulk freight such as minerals. For non-bulk freight, rail carries only 16%, while road transport accounts for 80%.

The government identifies the expansion of high-capacity public transport network as a national priority, including high-speed rail on the east coast of Australia. New, large-scale investment in public transport can improve mobility efficiency and provide an alternative more affordable than private vehicles. In the latest updates on the five-year Major Public Infrastructure Pipeline (MPIP), transport accounts for 53% of the total investment, equivalent to AUD 129 billion.[103]

These changes can create new jobs and upskilling opportunities to operate and maintain new technologies. The 2025 Transport and Infrastructure Net Zero Roadmap and Action Plan and the MPIP both identify workforce investment as

[102] Australasian Railway Association, "Rollingstock Decarbonisation Critical Path - Summary Report."
[103] Infrastructure Australia, *Infrastructure Market Capacity 2025 Report*.

essential to achieving net zero in the transport sector, with infrastructure workforce shortages estimated to peak around 2027.[104]

Textbox 3: Role of modal shift

Domestic aviation

A mix of solutions needs to be scaled

In 2024, the domestic aviation sector consumed 137 PJ, all of it from oil-based fuels. It represented 10% of the domestic transport energy demand. Aviation is harder to electrify than ground transport due to energy density constraints. SAF produced through biomass-based pathways and power-to-liquids can replace kerosene and is the main decarbonisation vector in the FFPO scenario for the nearly 10 $MtCO_2e$ emitted by domestic aviation at present. Energy efficiency gains, combined with shifting aviation demand to lower-emitting transport modes such as rail where feasible, also contribute.

CPP scenario

In the CPP scenario, SAF deployment remains modest, meeting roughly 25% of aviation energy demand by 2050 while oil products remain predominant. Under current policies, domestic aviation emissions increase at a compound annual growth rate of 0.5% over the modelling horizon, reaching over 11 $MtCO_2e$ by mid-century.

Although passenger travel is expected to grow even faster, the government's projections assume that this upward pressure on emissions will be partly offset by operational and technological improvements of about 1% annually, incentivised by the Safeguard Mechanism and the progressive roll-out of SAF from 2028.

[104] Department of Infrastructure, Transport, Regional Development, Communications and the Arts, *Transport and Infrastructure Net Zero Roadmap and Action Plan*; Infrastructure Australia, *2025 Infrastructure Market Capacity Report*.

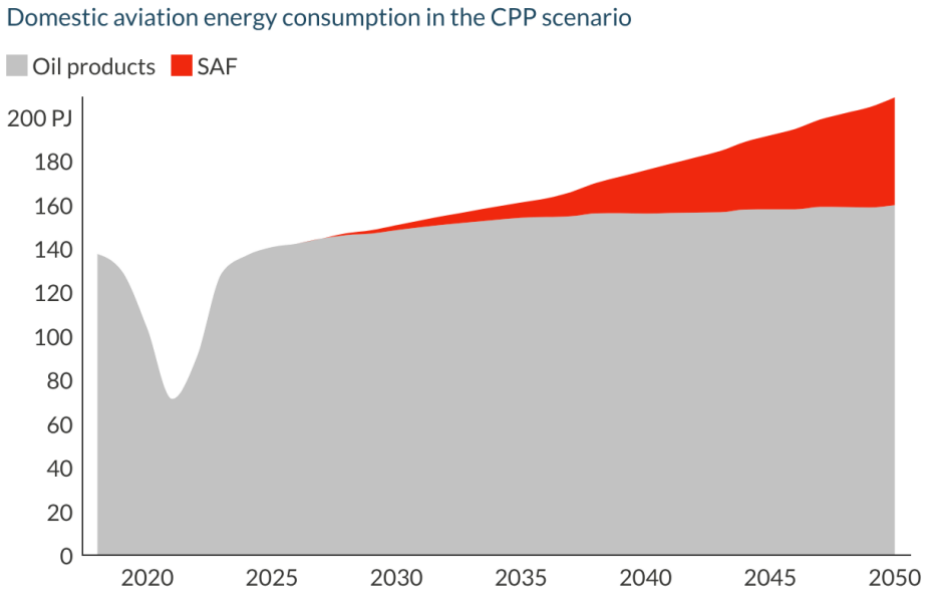


Figure 34: Aviation transport energy consumption in the CPP scenario.

FFPO scenario

Under the FFPO scenario, both energy intensity and activity levels are reduced roughly twice as fast as under the CPP scenario, with behavioural measures accounting for up to 20% of avoided demand by 2050. These include modal shifts from short-haul flights to high-speed rail, reductions in business flights through online meetings and imposition of levies for frequent flyers. These improvements, combined with an earlier SAF scale-up, which meets one-fifth of the sector's energy demand by 2035, reduce scope 1 emissions by more than 99% a decade later.

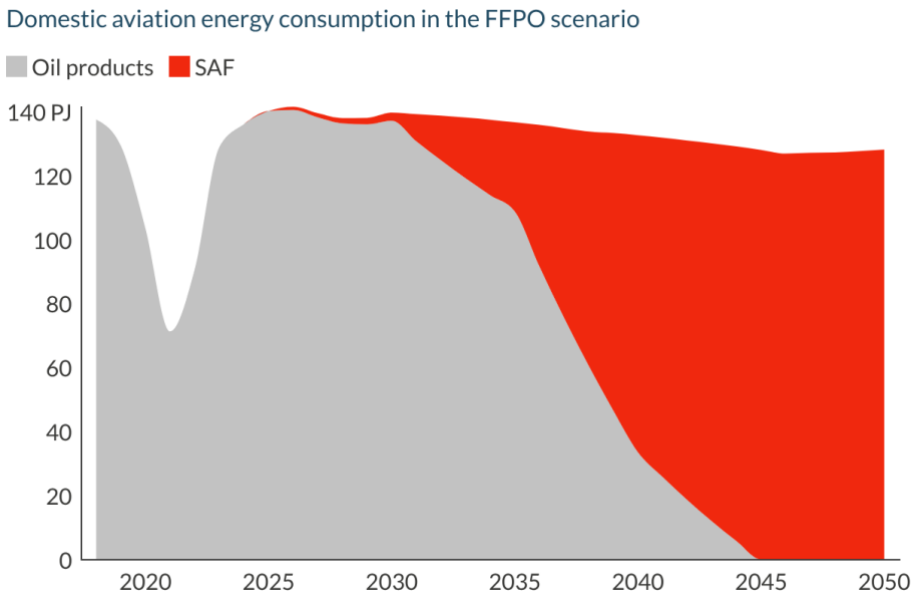


Figure 35: Aviation sector energy consumption in the FFPO scenario.

Policy implications

Decarbonisation efforts must both support SAF and other low-carbon liquid fuel scale-up and cover the broader transformation of aviation demand and technology. The government currently subsidises fuel switching, including AUD 250 million allocation through the FMIA Innovation Fund and AUD 1.1 billion through the Cleaner Fuels Program.[105,106,107]

First, demand-side measures should give practical effect to the avoided demand assumptions in the FFPO scenario. These could include stronger incentives to substitute short-haul flights with rail where viable, public- and private-sector travel rules that reduce avoidable business flights and frequent flyer levies designed to focus demand restraint on high-frequency discretionary travel rather than occasional or essential regional travel. These measures would help deliver the up to 20% avoided demand assumed under the FFPO scenario while improving equity and reducing reliance on scarce future fuel supplies.

Second, fuel policy should support the scale-up of zero-emissions aviation fuels. Support under the FMIA, SAF Funding Initiative and Cleaner Fuels Program should be paired with stronger sustainability criteria, blending milestones and revenue-certainty mechanisms that lower investment risks. This would more closely align fuel support with the speed of fuel switching required under the FFPO scenario.

Limiting the SGM's reliance on offsets can support earlier uptake of SAF and operational efficiency improvements. Complementary market-based measures, such as a passenger and freight levy, could cover smaller aviation operators currently outside the Safeguard Mechanism threshold and ensure that decarbonisation costs are internalised by the sector to generate revenue to support rail alternatives, airport and aircraft efficiency and real zero fuel supply chains.

Domestic shipping

Unlike road transport, which serves a broad range of household, commercial and urban freight needs, coastal shipping is concentrated in a small number of bulk supply chains moving raw and semi-processed materials between extraction, refining and manufacturing locations. Dry bulk commodities account for more than four-fifths of the

[105] Department of Infrastructure, "Consultation on Future Made in Australia."
[106] DCCEEW (2025). Joint media release: Low carbon liquid fuels of the Future Made in Australia. https://minister.dcceew.gov.au/bowen/media-releases/joint-media-release-low-carbon-liquid-fuels-future-made-australia
[107] DCCEEW (2025). New production incentive for low carbon liquid fuels. dcceew.gov.au/about/news/new-prod-incentive-low-carbon-liquid-fuels

domestic freight task, with bauxite, alumina and iron ore alone making up over half of total transport work.[108]

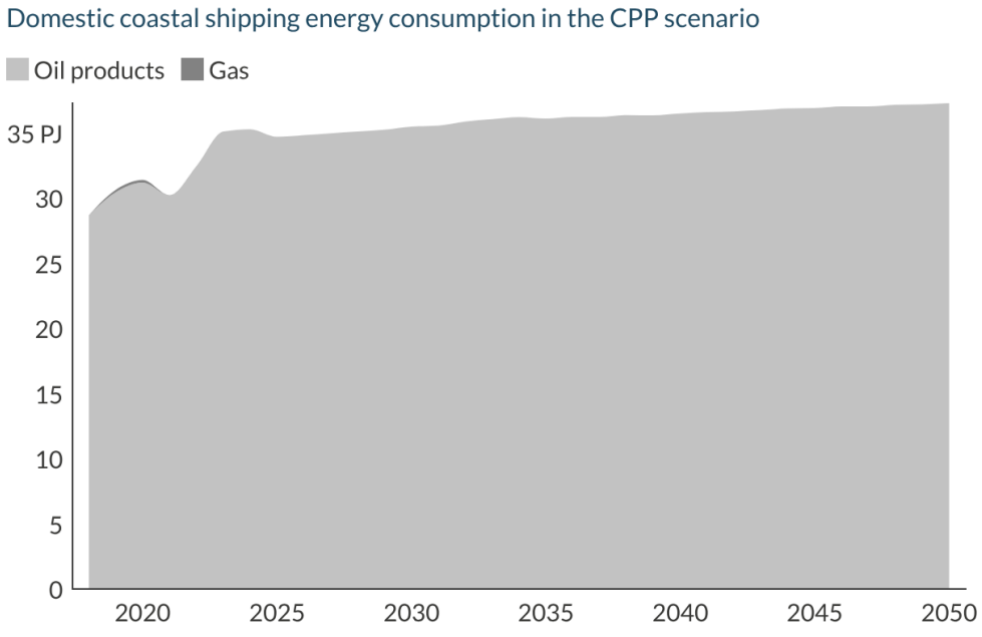
Although integral to the supply chains of major bulk export commodities such as bauxite, alumina and iron ore, the sector remains dependent on fuels that combine high energy density with operational flexibility over long distances.

In 2024, coastal shipping emissions amounted to 2 $MtCO_2e$, or about 2% of the total transport emissions. Total energy demand was 35 PJ in 2024. Marine fuel oils accounted for around two-thirds of the sector energy demand, with the remainder met by gasoline to power petrol-powered outboards and other light duty.

CPP scenario

Under the CPP scenario, domestic coastal shipping remains essentially unchanged rather than undergoing a transition. Indeed, fossil-based marine fuels continue to make up virtually the entire fuel mix to mid-century (see Figure 36), broadly in line with historical patterns, with no penetration of drop-in biofuels or scalable zero-emission fuels (SZEFs) like green ammonia.

Both energy efficiency and freight task remain stable throughout the model horizon, leading domestic shipping emissions in 2050 to remain close to historical levels, just under 3 $MtCO_2e$.



[108] Bureau of Infrastructure and Transport Research Economics (2022). Australian aggregate freight forecasts — 2022 update.
https://www.bitre.gov.au/sites/default/files/documents/bitre_rr154.pdf

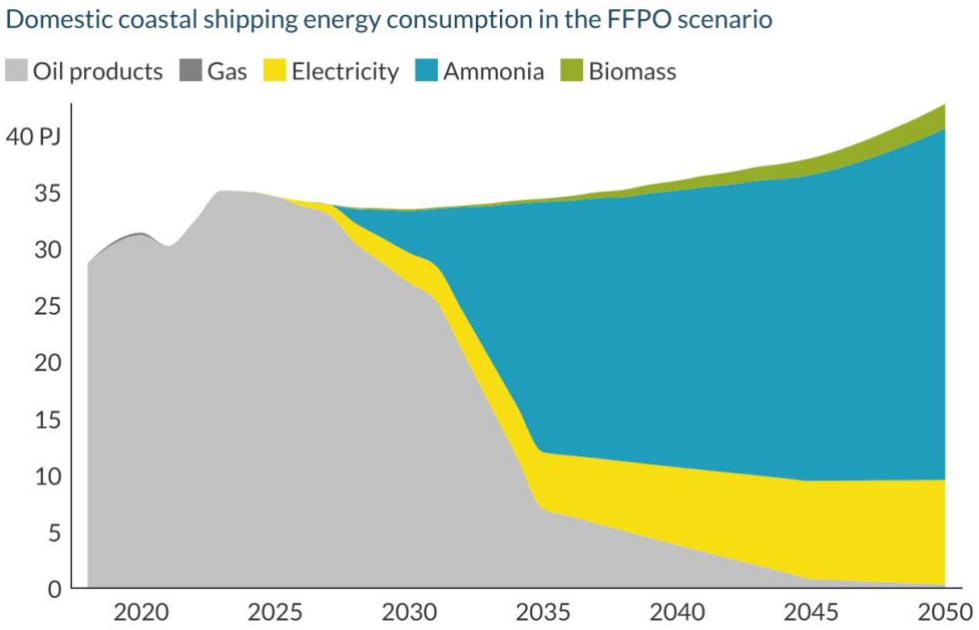
Figure 36: Domestic coastal shipping transport energy consumption in the CPP scenario.

FFPO scenario

In the FFPO scenario, fossil-based marine fuels, including MDO, heavy fuel oil (HFO), (very) low sulphur fuel oil ((V)LSFO) and gasoline are almost entirely eliminated from the energy mix by 2050, with only residual MDO use remaining below 1% of demand.

Green ammonia becomes the dominant fuel in long-distance shipping, meeting roughly 73% of total sectoral energy demand by mid-century. Electricity plays the second-largest role, driven primarily by shore power and the electrification of smaller recreational boats and domestic marine uses that would otherwise continue to rely on gasoline. Biofuels such as Bio-LSFO, Bio-MDO, and Bio-methanol make limited inroads, together accounting for over 5% of demand by 2050. Combined with stronger efficiency improvements than under the CPP scenario, this fuel switch effectively decarbonises domestic coastal shipping in the 2040s (see Figure 37).

This rapid green ammonia roll-out should be read as a high-ambition, favourable-cost pathway. It is aligned with an ambitious scenario under low SZEF price assumptions, in which lower SZEF costs and higher fossil-fuel costs accelerate substitution away from incumbent marine fuels.[109] The projections under the FFPO scenario are therefore contingent on a policy and market environment that narrows the green fuel premium and enables early investment in fuel supply and bunkering infrastructure.



[109] Smith, T. et al (2025). International Maritime Decarbonisation Transitions – The costs and impacts of different pathways for international shipping to achieve alignment to the 1.5°C temperature goal – Main Report. https://www.u-mas.co.uk/wp-content/uploads/2025/04/Main-report-Apr2025.pdf

Figure 37: Domestic coastal shipping transport energy consumption in the FFPO scenario.

Policy implications

Current policy remains far from this trajectory. The 2025 Transport and Infrastructure Net Zero Roadmap and Action Plan,[110] the ongoing Maritime Emissions Reduction National Action Plan[111] and the Singapore-Australia Green and Digital Shipping Corridor show that the Commonwealth has recognised maritime decarbonisation as a policy issue.[112] Despite that, Australia still has no clear phase-out pathway for oil-based marine fuels, no strong domestic regulatory driver for the uptake of maritime SZEFs and no coordinated plan to build the bunkering, port and supply infrastructure at the speed required.

In line with the present modelling, Climate Analytics has previously found that international shipping can reach real zero emissions by 2050 and identified ammonia as one of the most promising zero-carbon fuel options.[113] A Paris-aligned maritime strategy would therefore need to move well beyond roadmap language, and require firm phaseout signals for marine oil, targeted support for ammonia and electrification infrastructure and an adequate policy package.

The international policy context may strengthen this signal, but it remains uncertain. The IMO Net Zero Framework (NZF) was approved at MEPC 83 in April 2025 as draft amendments to MARPOL Annex VI. Its formal adoption, however, was adjourned in October 2025 for one year, and MEPC 84 in 2026 continued discussions and guideline work without settling the final design or timing.[114] If adopted with sufficient stringency, the framework could provide an important demand signal for zero- and near-zero-emission fuels, including green ammonia. However, it should be treated as a complement to domestic action, not a substitute for it. Given the fuel-price and supply-chain uncertainties surrounding SZEF deployment, Australian policy should use IMO momentum to de-risk domestic infrastructure and green fuel supply — leveraging Australia's abundant renewable resources for renewable hydrogen as well as its existing

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[110] Commonwealth of Australia (2025). Transport and Infrastructure Net Zero Roadmap and Action Plan. https://www.infrastructure.gov.au/sites/default/files/documents/transport-and-infrastructure-net zero-roadmap-and-action-plan.pdf

[111] Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts (2023). Australia's Maritime Context and Emission Reduction Initiatives. https://www.infrastructure.gov.au/sites/default/files/documents/mernap-background-presentation.pdf

[112] Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts (2024). Singapore and Australia Green and Digital Shipping Corridor. https://www.dfat.gov.au/sites/default/files/singapore-australia-green-digital-shipping-corridor.pdf

[113] Climate Analytics (2025). Real zero: delivering a fossil free future. https://ca1-clm.edcdn.com/publications/Real-zero-delivering-a-fossil-free-future.pdf

[114] DNV (2026). IMO MEPC 84: Revisiting the Net zero Framework. https://www.dnv.com/news/2026/imo-mepc-84-revisiting-the-net zero-framework/

ammonia production knowledge base, rather than assuming that international regulation alone will deliver the rapid ammonia uptake seen in the FFPO scenario.

International aviation and shipping

Domestic aviation and shipping tell only part of the story, however. International flights and bunkers, while excluded from national inventories under UNFCCC reporting conventions, are part of Australia's wider energy balance and materially shape the transport sector's overall fossil fuel dependence.

In aviation, international flights account for roughly 60% of both Australia's total aviation final energy demand and emissions in 2024, equivalent to 14 $MtCO_2e$. In shipping, international bunkers are slightly larger than domestic coastal shipping but of a similar order of magnitude, with absolute emissions of 2 $MtCO_2e$. Figure 38 below shows how the international segments compare with their domestic counterparts under both the FFPO and CPP scenarios.

International aviation

Under the CPP scenario, international aviation remains overwhelmingly dependent on oil products, with SAF playing a smaller role than in domestic aviation, accounting for around 10% of the fuel mix by 2050. Passenger traffic volumes grow faster than in domestic aviation, at a compound annual growth rate of 3% between 2025 and 2050. Energy efficiency improvements are also around half those in domestic aviation. This leaves the larger aviation segment exposed to the same structural constraint as domestic aviation, but at greater scale: efficiency gains and limited SAF uptake slow emissions growth, but do not deliver a phaseout of fossil jet fuel. As a result, emissions reach 24 $MtCO_2e$ by mid-century.

Under the FFPO scenario, international aviation shifts progressively towards SAF through the 2040s, with oil use falling markedly and SAF meeting roughly 90% of final energy demand by 2050, with the rest met by electricity and hydrogen. As in the CPP scenario, reductions in passenger demand and energy intensity occur more slowly than in domestic aviation. This pathway would therefore not only depend on domestic SAF policy but also on tighter international accountability, stronger demand management and fuel-supply cooperation across the routes served by Australian carriers and airports.

International shipping

Under the CPP scenario, international shipping follows a diversification pathway rather than a phaseout. Oil-based marine fuels remain dominant, but LNG and biofuels together reach around a quarter of international shipping energy demand by 2050. Ammonia remains marginal, at roughly 5% of the mix by mid-century.

International freight activity, aligned with IMO projections, is also expected to grow faster than domestic activity, at a compound annual growth rate of 1.8% between 2025 and 2050. As in domestic shipping, this leaves the sector dependent on incumbent marine fuels and exposed to continued emissions rather than undergoing a structural transition.

Under the FFPO scenario, the international shipping pathway is much closer to the domestic coastal shipping transition, with oil-based marine fuels displaced rapidly and ammonia becoming the central fuel for long-distance maritime activity. The main difference is the underlying freight task: international shipping activity grows much more slowly, at around 0.3% a year CAGR between 2025 and 2050, compared with around 2.5% for the domestic coastal component.

This means that the international transition is driven less by activity growth than by the speed at which zero-emission fuels, compatible vessels, bunkering infrastructure and port-side systems can be deployed. The fast ammonia roll-out in the FFPO scenario should therefore be read as a high-ambition pathway contingent on favourable zero-emission fuel prices and early infrastructure investment, rather than as an automatic outcome of current policy settings.

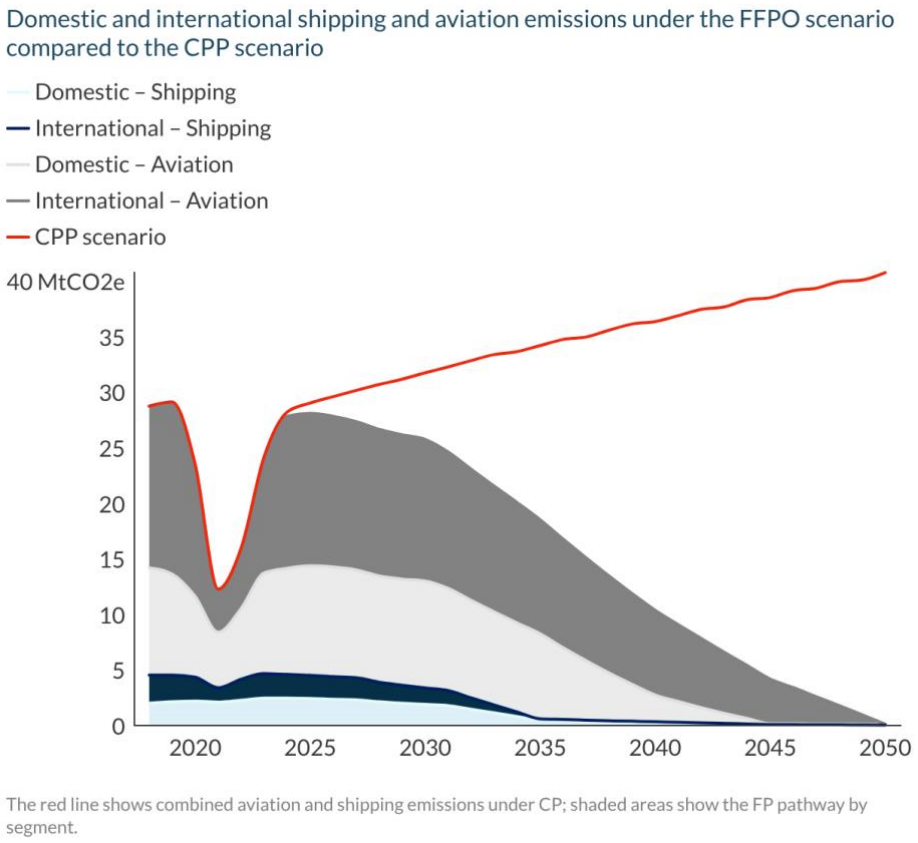

Figure 38: International and domestic shipping and aviation emissions in the FFPO scenario compared with the CPP scenario.

Policy implications

Current policy settings for international aviation remain too narrow. The Climate Action Tracker rated the sector's action as critically insufficient, meaning that if all other sectors were to align with its level of climate action, the world would be on track for warming of

greater than 4°C.[115] A Paris-aligned approach would combine support for alternative fuel, stricter sustainability and lifecycle emissions criteria for SAF, and stronger demand-side measures for avoidable international travel, potentially supported by a market-based framework that internalises aviation decarbonisation costs while raising revenue for alternative fuels.

International shipping is more directly affected by emerging global regulation. As mentioned above, IMO NZF's formal adoption was adjourned during the latest MEPC, leaving important design details unresolved. If adopted with sufficient stringency, the framework could still provide a material demand signal for SZEFs such as green ammonia in the international shipping sector, particularly because it applies to ships above 5000 GT engaged in international trade, while ships trading solely domestically are outside its scope.[116]

Four elements are especially relevant to the transition modelled in the FFPO scenario. First, the framework uses a well-to-wake GHG fuel-intensity standard, which would make lifecycle emissions central to compliance and improve the relative position of renewable ammonia compared with oil-based marine fuels and LNG. Second, its two-tier compliance structure and surplus-unit system would create a financial penalty for high-intensity fuels and a tradable compliance value for ships that overperform, improving the business case for vessels able to operate on very low-GHG fuels such as green ammonia.

Third, the IMO Net zero Fund is intended to reward zero- and near-zero-emission fuels and technologies, which could help narrow the initial cost gap between green ammonia and conventional marine fuels.[117] Fourth, by signalling future demand for low-GHG fuels across large oceangoing vessels, the framework could support earlier investment in ammonia-ready newbuilds, retrofits, certification systems, port safety protocols and bunkering infrastructure. [118]

The NZF is not yet formally adopted, its final stringency remains uncertain and its coverage does not remove the need for Australian policy to prepare domestic ports and fuel supply chains. As with its domestic component, Australia should therefore use IMO momentum to de-risk international bunkering and green fuel supply while avoiding the

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[115] Climate Action Tracker, "International Aviation. October 2025."
[116] DNV (2025). IMO MEPC 83: GHG requirements approved, taking effect from 2028. https://www.dnv.com/news/2025/imo-mepc-83-ghg-requirements-approved-taking-effect-from-2028/
[117] International Maritime Organization (2025). The IMO Net zero Framework - FAQs. https://www.imo.org/en/mediacentre/hottopics/pages/faqs-the-imo-net zero-framework.aspx
[118] Smith, T. et al (2025). International Maritime Decarbonisation Transitions – The costs and impacts of different pathways for international shipping to achieve alignment to the 1.5°C temperature goal – Main Report. https://www.u-mas.co.uk/wp-content/uploads/2025/04/Main-report-Apr2025.pdf

assumption that international regulation alone will deliver the rapid ammonia uptake required to align with a 1.5°C-aligned pathway.

Decarbonising mining, minerals processing and other industry

The industry sector's energy use: current situation

Australia's industry sector is energy- and carbon-intensive. Oil, fossil gas and coal each provide about a fifth of its energy demand, and electricity provides a quarter, with biomass and hydrogen making up the rest.[119]

Industry emissions are recorded across two inventory categories: energy, primarily covering emissions from fossil fuel combustion, and Industrial Processes and Product Use (IPPU), which includes non-energy emissions from chemical and physical transformations. Together, industrial energy demand emissions (38 $MtCO_2e$, see graph below) and IPPU emissions (31 $MtCO_2e$) accounted for 15% of Australia's net emissions in 2024.[120]

[119] Department of Climate Change, Energy, the Environment and Water, "Australian Energy Update 2025."
[120] DCCEEW, *Australia's National Greenhouse Accounts*.

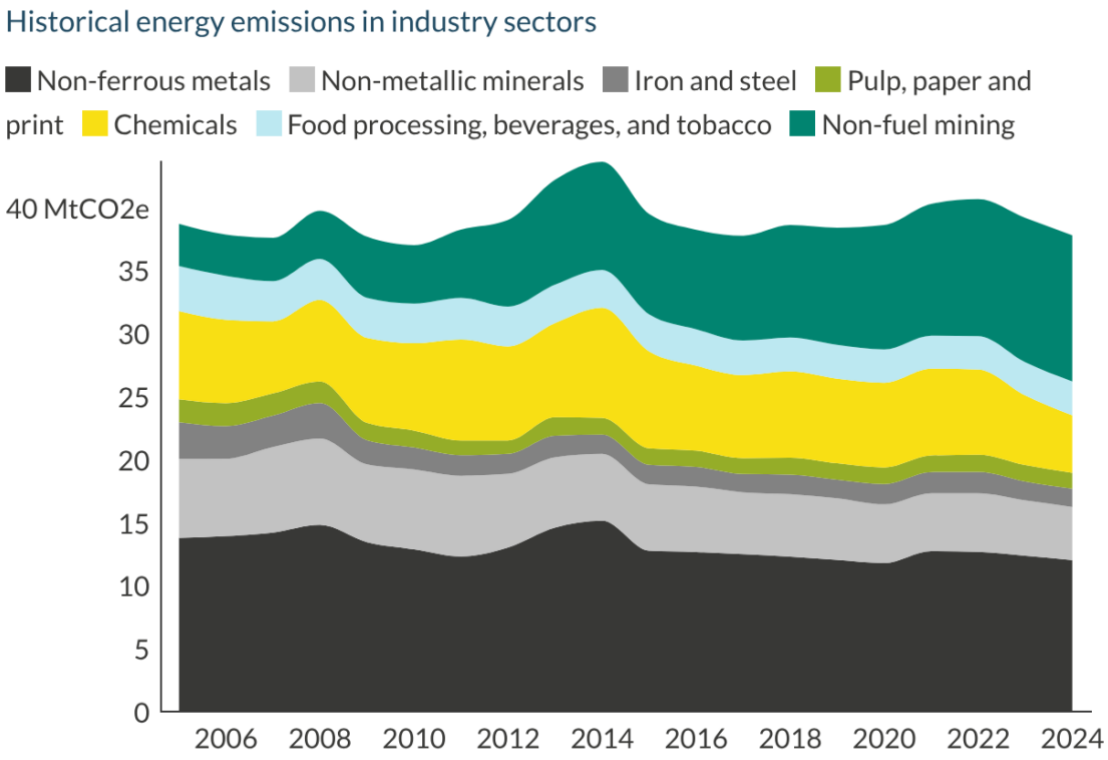

Figure 39: Historical energy emissions in industry sectors.

Non-ferrous metals accounted for one-third of industry energy emissions, in part because of fossil gas and coal use in alumina refining. Non-fuel mining accounted for a further third, with iron ore extraction responsible for 90% of the sub-sector's emissions. Emissions from mining have grown in recent years as production has risen faster than energy efficiency has improved, with the sub-sector still relying almost entirely on fossil fuels.

The Safeguard Mechanism is the main policy for tackling these emissions. The government expects manufacturing and mining stationary energy emissions to fall by 35% between 2025 and 2040.[121] These projections are optimistic, both in terms of the pace of on-site abatement relative to offsetting (see Safeguard Mechanism textbox) and compared with current trends, at least for mining.[122]

[121] DCCEEW, "Australia's Emissions Projections 2025."
[122] IEEFA, "Cutting Australian Mining's Diesel Emissions."

Structure of the Australian industry sector

The high energy intensity of these sub-sectors and their distinct characteristics require specific approaches to replacing existing fossil fuel use. Given this heterogeneous landscape, each sub-sector is modelled separately, with a focus on alumina and aluminium production, steelmaking, cement production, ammonia production and mining. All are key inputs to the economy, key exports, or both, as with iron ore, other critical minerals, and bauxite, alumina and aluminium. Energy demand in each industry sub-sector is calculated based on future production pathways, technology switching, energy efficiency improvements and, in the CPP scenario, emissions trends.

Across sub-sectors, ACIL Allen's Gas, Liquid Fuel, Coal and Renewable Gas Projections report commissioned by AEMO, was used as a key input for commodity production assumptions.[123] As the FFPO scenario focuses on domestic decarbonisation, it adopts relatively conservative commodity production profiles and does not assume a major scale-up of export-oriented heavy industries.

Production of alumina, aluminium and steel remains relatively stable to 2050 under both scenarios. Production trajectories for iron ore and cement are scaled in line with crude steel production forecasts in the IEA's World Energy Outlook 2024 and the CSIRO Stated Policies (CSP) scenario.[124] Both increase slightly above current levels. Iron ore production increases by 11% and 4% by 2050 in the CPP and FFPO scenarios, respectively, while cement production increases by 20% in both scenarios.

CSIRO's net zero modelling provided sector-specific inputs for modelling industrial transformation, particularly in the alumina and aluminium sub-sectors.[125] As with other sectors of the economy, results from the HPA scenario were also used to benchmark the pace and nature of technology switching and energy efficiency improvements.[126] Finally, industry-specific publications were used for each sub-sector, as detailed in the Technical Appendix. The Other Manufacturing sub-sector was used as a residual category to balance the overall system energy and emissions.

Current policy outlook

Our CPP scenario shows current industrial decarbonisation approaches falling well short of alignment with the Paris Agreement's 1.5°C temperature limit. In contrast to the

[123] ACIL Allen, *Gas, Liquid Fuel, Coal and Renewable Gas Projections*.
[124] CSIRO, "Modelling Sectoral Technology and Emissions Pathways to 2035 and Net Zero Emissions"; IEA, *World Energy Outlook 2024*.
[125] CSIRO, "Modelling Sectoral Technology and Emissions Pathways to 2035 and Net Zero Emissions."
[126] Climate Analytics and PIK, *Rescuing 1.5°C: New Evidence on the Highest Possible Ambition to Deliver the Paris Agreement*.

broader economy, overall energy use remains stable at current levels (around 1.1 EJ) between 2025 and 2050. However, this trend has multiple drivers. While energy efficiency contributes to savings, increased output creates upward pressure on electricity demand. Electrification progresses without fundamentally displacing fossil fuels from the mix, with fossil fuels still supplying about 30% of demand in 2050.

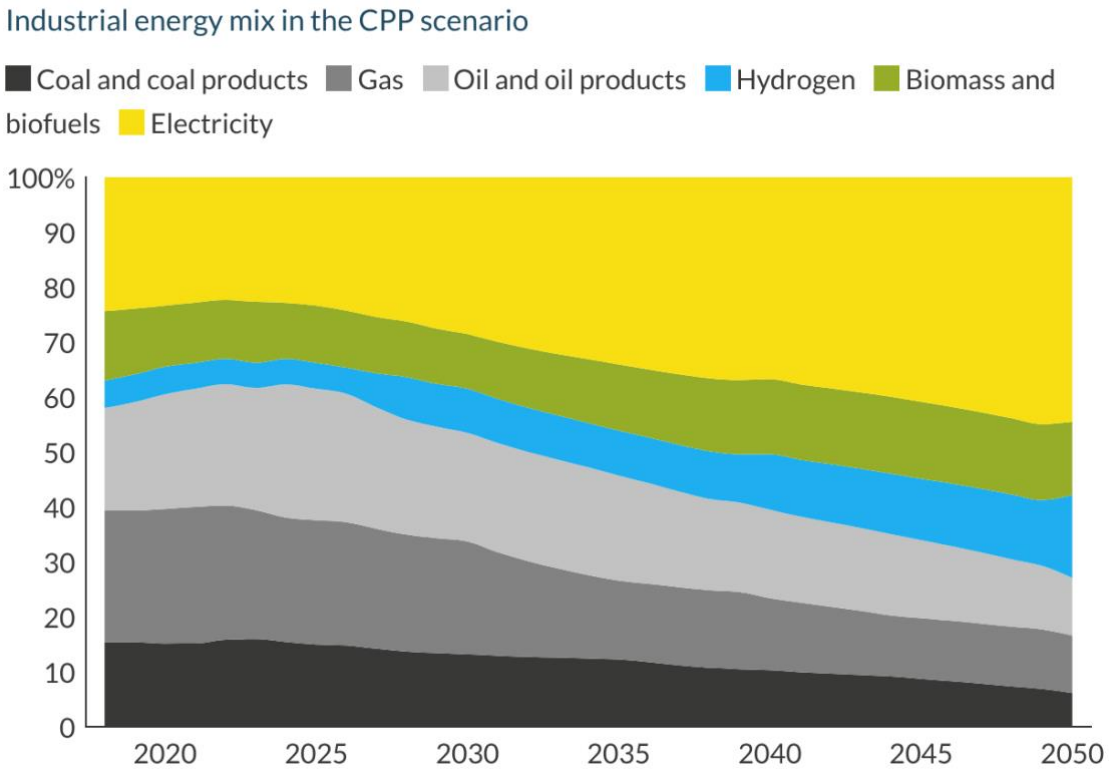

Figure 40: Industrial energy mix in the CPP scenario.

Moderate electrification and energy efficiency reduce energy emissions throughout the projection period. Emissions reductions tend to be concentrated in specific sub-sectors. Those from iron and steel, non-fossil mining, alumina and aluminium, ammonia and cement fall from 28 $MtCO_2e$ in 2025 to 7 MtCO2e by 2050. The continued use of fossil fuels in conventional production technologies is expected to hamper the overall sectoral transition, and emissions from other manufacturing and industrial processes remain high by mid-century.

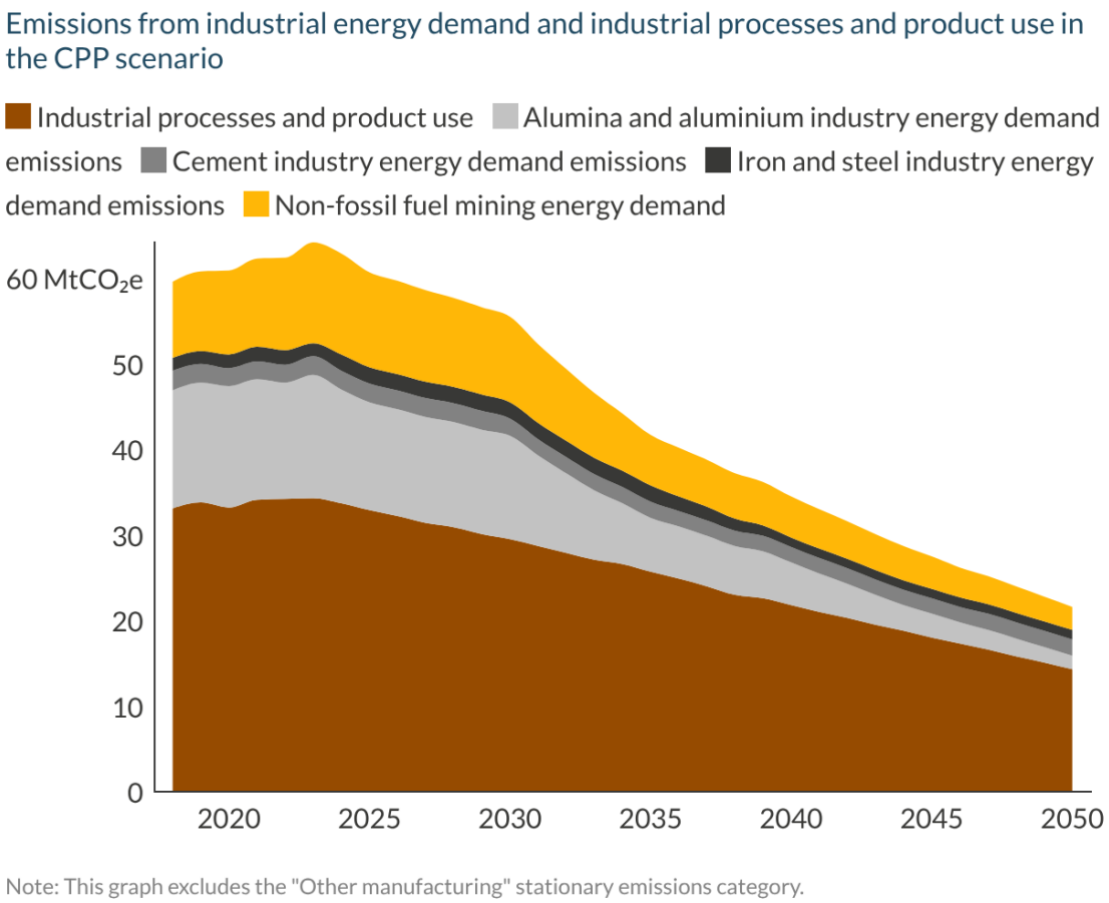

Figure 41: Emissions from industrial energy demand and industrial processes in the CPP scenario.

How to align Australia's industry sector with 1.5°C

Industry activity grows in tandem with decarbonisation

In the alternative FFPO scenario, accelerated renewable-based electrification drives the transformation of industrial emissions and energy demand. Low-carbon fuels and feedstocks, including green hydrogen, provide an important complement, particularly in eliminating process/IPPU emissions. Reduced energy use, including through materials efficiency and recycling, also helps to mitigate emissions from rising production in green industries.

Changes manifest differently across different sub-sectors, depending on technological development and the integration of low-carbon energy. Across industry as a whole, the combined effect is to dramatically accelerate the phase-out of fossil fuel use and, consequently, industrial emissions.

Under the FFPO scenario, fossil fuel use declines by about 70% by 2035. Both coal and gas are eliminated by 2040, while oil is phased out by 2045. As early as 2035, electricity

accounts for 55% of Australia's industry energy mix. Energy demand emissions from key sub-sectors - iron and steel, non-fossil mining, alumina and aluminium, ammonia and cement – fall to 21 $MtCO_2e$ in 2030 and below 1 $MtCO_2e$ by 2041. Achieving these emission reductions involves different approaches specific to each sub-sector, as outlined below.

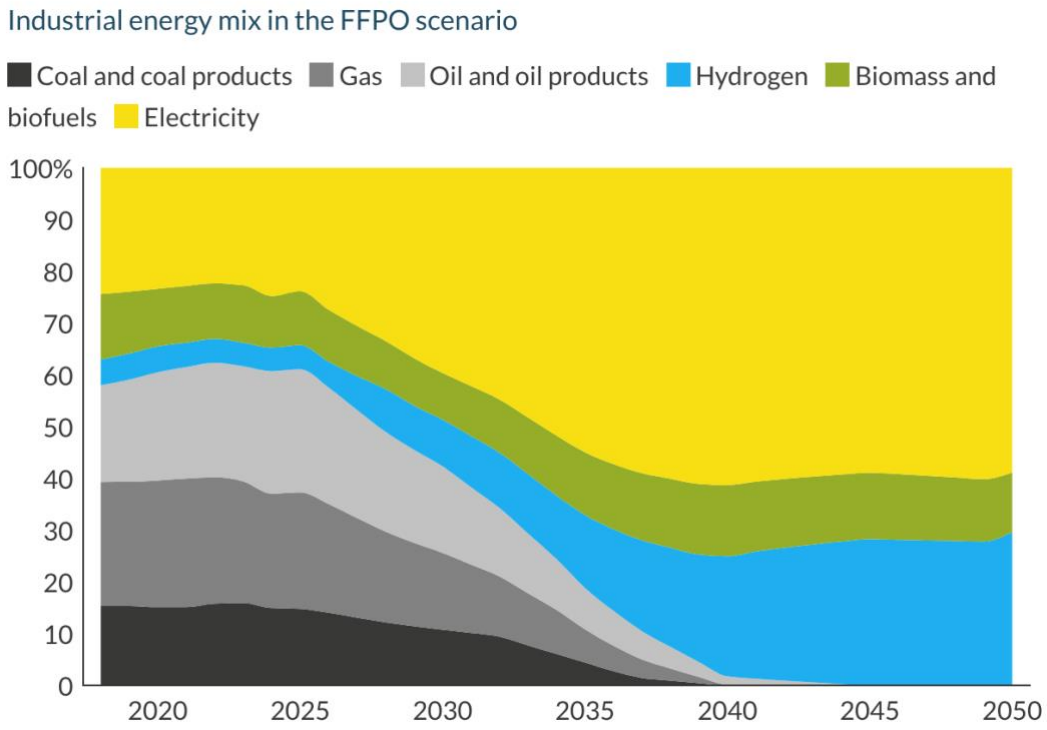

Figure 42: Industrial energy mix in the FFPO scenario.

Cross-industry action drives emissions reductions

As various sub-sector transformations take hold, the FFPO scenario delivers a materially faster decline in industrial emissions than the CPP scenario. The difference is most pronounced for emissions from energy use, which account for more than half of total industry emissions. By 2040, fossil fuels are mostly absent from industry in the FFPO scenario.

IPPU emissions are more difficult to abate. Even so, they fall steadily as technologies improve and the sector's capital stock changes. Between 2025 and 2050, IPPU emissions decline by 80% in the FFPO scenario, compared with 57% under the CPP scenario.

Total industry emissions under the two scenarios diverge quickly. By 2030, emissions are 25% below 2025 levels in the FFPO scenario, compared with 12% under the CPP scenario. By 2050, industry emissions fall by over 90% in the FFPO scenario, but just 58% in the CPP scenario.

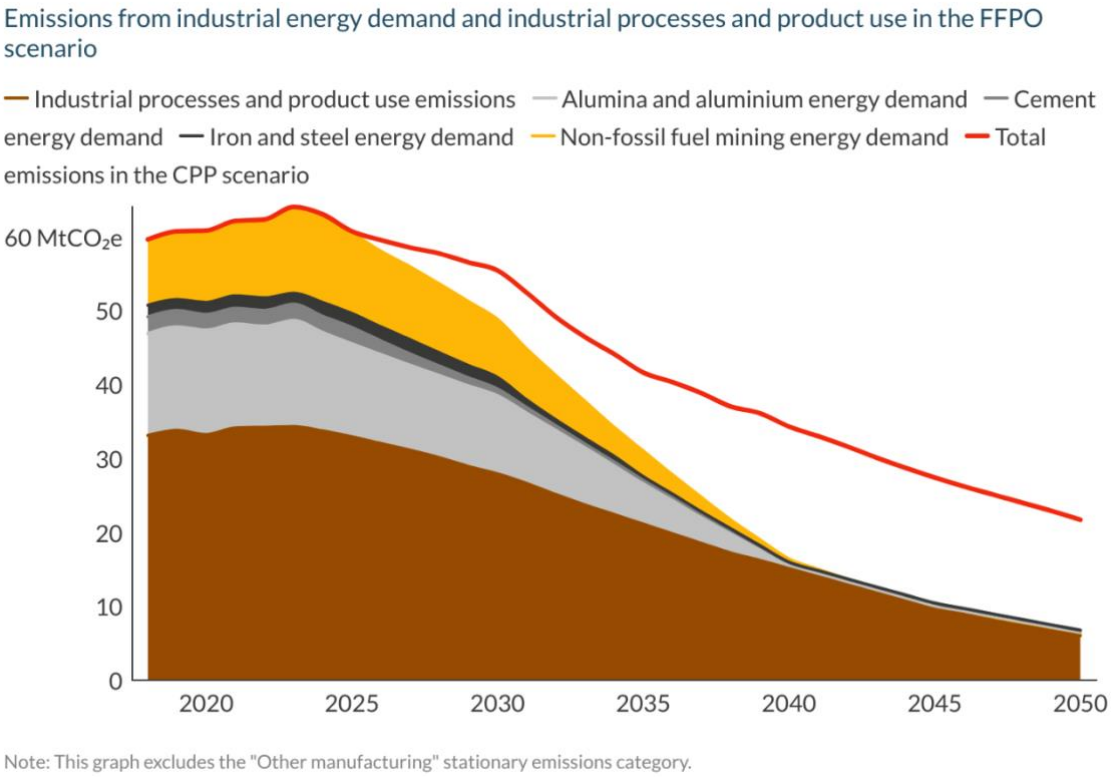

Figure 43: Industrial energy demand and industrial process emissions in the FFPO and CPP scenarios.

Safeguard Mechanism

The Safeguard Mechanism (SGM) is the government's flagship emissions policy for industry and the resources sector. As described in Australia's climate policy context and outlook, it requires facilities emitting more than 100 $ktCO_2e$ per year to keep their net emissions below a baseline that declines by 4.9% per year to 2030. In 2024–25 it covered 208 facilities, with gross emissions of 133 $MtCO_2e$.[127]

Because the SGM regulates net emissions, facilities can meet their individual baselines through virtually uncapped offsets in place of on-site abatement, allowing emitters to buy their way out of cutting their direct emissions. In 2024–25 alone, 11 million ACCUs were surrendered to meet compliance, more than 50% more than in the previous year.[128] Most of these ACCUs come from methods

[127] Climate Integrity, *Latest Safeguard Mechanism Data Shows Australia's Centrepiece Climate Policy Is Primarily a Clearinghouse for Low-Integrity Offsets*.
[128] DCCEEW, "Safeguard Mechanism Review Consultation Paper."

criticised for their lack of integrity, so the credits surrendered may not represent equivalent emissions removals.[129]

These structural flaws risk taking Australia off track for the government's own climate targets and a 1.5°C-aligned pathway — especially given that half of Safeguard emissions come from fossil fuel-producing facilities. The upcoming Safeguard Review, which will determine how the scheme operates to 2035, is an opportunity the government must seize to correct course.

In the FFPO scenario, covered facilities reduce their direct emissions to 87 $MtCO_2e$ by 2030, 42 $MtCO_2e$ by 2035 and 11 $MtCO_2e$ by 2040. By contrast, direct Safeguard emissions fall to 122 $MtCO_2e$, 108 $MtCO_2e$ and 90 $MtCO_2e$ by 2030, 2035 and 2040, respectively in the CPP scenario.

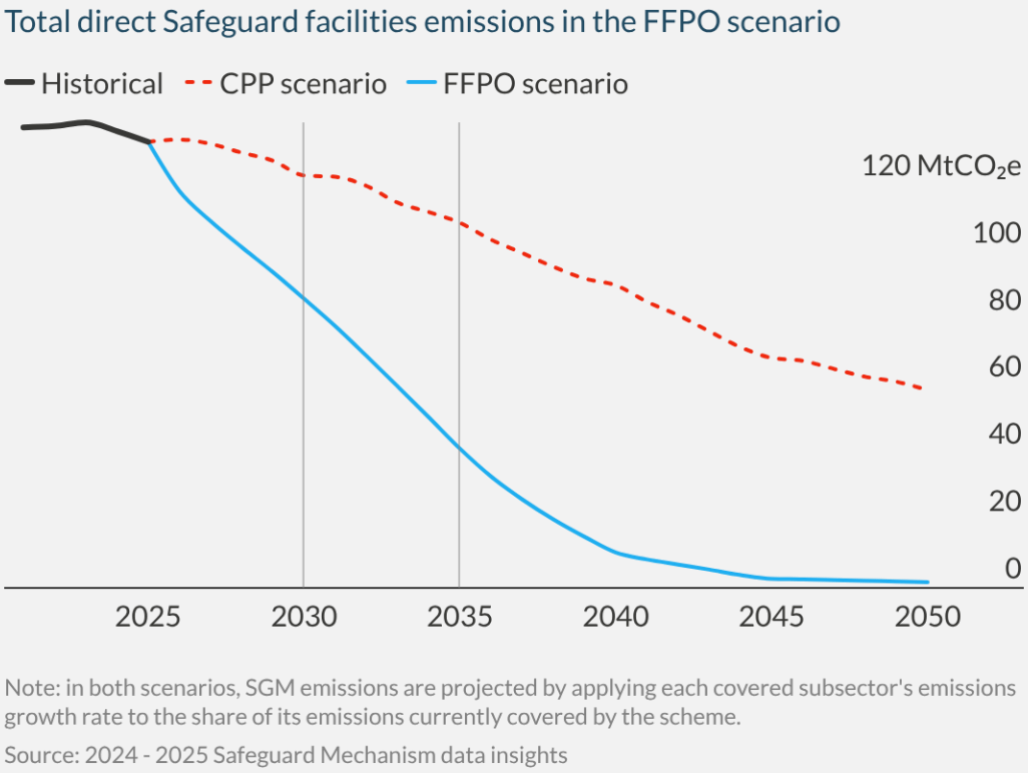

Figure 44: Total emissions from Safeguard Mechanism facilities in the CPP and FFPO scenarios.

Textbox 4: Safeguard Mechanism

[129] Climate Integrity, *Latest Safeguard Mechanism Data Shows Australia's Centrepiece Climate Policy Is Primarily a Clearinghouse for Low-Integrity Offsets*; Climate Action Tracker, "Australia. June 2025."

Iron and steel

Structure of the sector

Final energy consumption and total production volume are taken from government sources: the 2025 Australian Energy Statistics and the Department of Industry, Science and Resources' Resources and Energy Quarterly, respectively.[130,131]

In the CPP scenario, the deployment of low-carbon production technologies drives emissions reductions and changes in the fuel mix. Production volumes are also held stable in the FFPO scenario, while the fuel mix follows results from the HPA scenario for the macro-region of Canada, Australia and New Zealand.

Scale up hydrogen-based production and recycling

Alignment with the 1.5°C temperature limit requires the iron and steel sector shift away from fossil gas, coal and related products towards 'green' hydrogen (produced through electrolysis of water using renewable electricity) and electricity. Greater materials and energy efficiency further drives carbon intensity downwards.

The rapid scale-up of hydrogen-based steel production facilities has a major impact. Coal is phased out of the sector by the early 2030s, and gas by 2040. By the 2040s, the entire Australian iron and steel sector operates solely on green hydrogen and electricity.

Electric arc furnaces (EAFs) powered by renewable-generated electricity and utilising recycled steel scrap provide a more straightforward decarbonisation pathway than 'primary' steel made from newly produced iron. Current steel production relies heavily on fossil fuels, mainly coal, for both energy and the 'reduction' of iron ore into iron. At the global level, the International Energy Agency's 1.5°C-aligned Net Zero Emissions scenario shows recycled steel accounting for about half of production by 2050.[132] A lack of suitable scrap and the unsuitability of secondary steel for some applications limit further growth.

These changes result in iron and steel's energy-related emissions, already low given the sector's limited output, falling to zero by 2040 under the FFPO scenario, compared with 1 $MtCO_2e$ in 2050 under the CPP scenario. Iron and steel's IPPU emissions, which mainly come from the iron reduction process and are considerably higher than its energy emissions, also decline from nearly 8 $MtCO_2e$ to less than 2 $MtCO_2e$ by 2050.

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[130] Department of Climate Change, Energy, the Environment and Water, "Australian Energy Update 2025."
[131] Department of Industry, Science and Resources, "Resources and Energy Quarterly: March 2025."
[132] IEA, *Net Zero by 2050 - A Roadmap for the Global Energy Sector*.

Policy implications

Ensuring that Australia's existing steelmaking facilities transition to cleaner production relies on reform of the Safeguard Mechanism or, ideally its replacement with a genuine emissions trading system and stringent carbon pricing regime. It also means removing current subsidies and other support for fossil fuel-based production.

The existing policy regime provided the certainty that BlueScope needed to reinvest in blast furnace-based production at its Port Kembla facility, and the Australian government provided grant-based assistance for the project in 2024.[133] Australia's other primary steelmaking facility, at Whyalla, South Australia, is in deep financial trouble. The federal and state governments must direct financial support towards low-emission technologies, rather than subsidising emission-intensive steel, to support facilities in transitioning to green hydrogen over gas as coal phases down.

Australia's current and prospective new EAF-based secondary steelmaking facilities are on track for production based on 100% renewable electricity. Government policies, including the Capacity Investment Scheme (CIS), must ensure that industry can access affordable decarbonised energy through the existing grid or dedicated power purchase agreements (PPAs).

The build-out of affordable renewable electricity is, in turn, critical to the production of affordable green hydrogen at scale. This will require additional support through mechanisms such as the Hydrogen Headstart production credits and the broader Future Made in Australia (FMIA) program, which saw reduced support in the 2026–27 budget.[134]

Sufficient quantities of steel scrap are needed to ensure the viability of EAF steelmaking. This could include developing a recycling ecosystem that uses steel from decommissioned oil and gas infrastructure. Modified 'extended producer responsibility' principles could be applied to fossil fuel infrastructure owners and operators to incentivise investment in recycling business models. Bans on scrap exports may also be needed.[135]

Financial reform is critical to the development of new, capital-intensive green iron and steel facilities. Improved project 'bankability' requires significantly lower cost of capital for industry proponents. Government entities such as the Clean Energy Finance Corporation (CEFC) can help de-risk projects. Provision of common user infrastructure and an appropriately skilled workforce are other government priorities.

Improved demand-side policies, including green public procurement (GPP) mandates and embodied carbon limits, can stimulate innovation and give low-carbon companies a

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[133] Ministers for the Department of Industry, Science and Resources, "$200 Million to Help Future-Proof Regional Steel Manufacturing."
[134] Joshua S Hill, *"Future Made Somewhere Else:" Budget Slashes Funding for Green Hydrogen, Home-Made Solar and Batteries*.
[135] UN Environment Programme, "Extended Producer Responsibility."

competitive advantage. Stimulating export demand through mechanisms such as a 'clean commodities trading company', created in concert with trading partners, could have a particularly transformative impact, particularly by increasing domestic value-adding.[136]

Greater Australian investment in R&D can support breakthroughs in areas such as green iron production technologies suitable for Australia's iron ore resources, and help expand the market penetration of recycled steel products. Formal targets for green iron and steel production and consumption, can provide overarching guidance for sector decarbonisation.

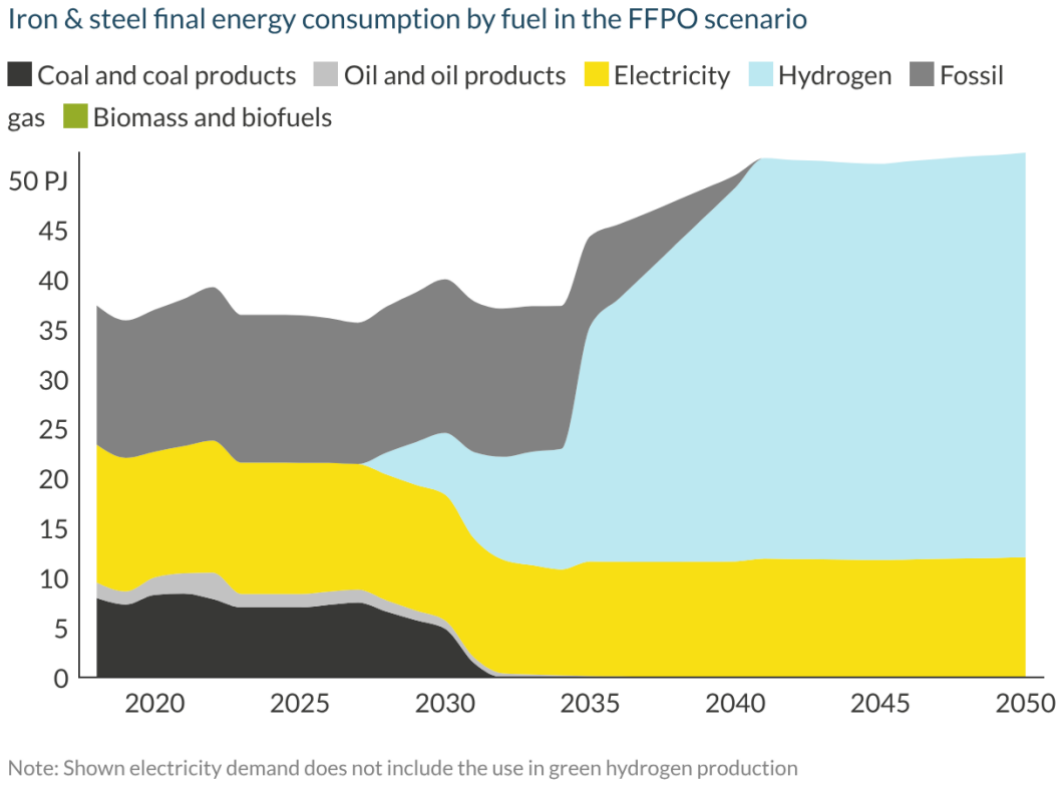

Figure 45: Iron and steel final energy consumption by fuel in the FFPO scenario.

Cement

Structure of the sector

The cement production pathways used in both CPP and FFPO scenarios follows the trend from the CSIRO Stated Policies (CSP) scenario.[137] In the CPP scenario, the fuel share aligns with the government's projections, which assume reduced fossil fuel use through

[136] Asia-Pacific Development, Diplomacy & Defence Dialogue, *The Case for an Australian Clean Commodities Trading Initiative*.
[137] CSIRO, "Modelling Sectoral Technology and Emissions Pathways to 2035 and Net Zero Emissions."

thermal energy efficiency improvements. In the FFPO scenario, the pace of clean energy integration aligns with the HPA scenario while keeping the production pathway the same as the CPP scenario.

Emissions fall as biomass use grows

In the FFPO scenario, cement energy use falls below 14 PJ by 2050, while it remains broadly stable under the CPP scenario, thanks to efficiency gains in production and switch to alternative production pathways.

Biomass and waste with high bioenergy content supplant coal and gas-based heat generation, while alternative raw materials reduce the sector's reliance on clinker, the main and most emissions-intensive component of traditional cement. Biomass demand grows by approximately 100% by 2035 from present levels, then dips to around 75% above 2020 levels by 2050. Green hydrogen also plays a major role in cement production once it becomes cost-competitive for kiln heating, accounting for nearly one-third of energy demand in 2050.

While cement energy emissions in the CPP scenario remain over 4 $MtCO_2e$ in 2050, they fall to less than 1 by 2037 under the FFPO scenario. Nearly 65% of on-site emissions result from chemical reactions during calcination, with the remainder coming from energy combustion, and clinker production is equivalent to 53% of IPPU emissions across all of Australia's mineral industries. Cement IPPU emissions are 1 $MtCO_2e$ by 2050 under the FFPO scenario, compared to 3 $MtCO_2e$ in CPP. Overall, the emissions intensity of Australian cement reaches 121 kg CO_2e per tonne of produced cement by 2050 in the FFPO pathway, within the recommended range of 40–125 kg CO2e per tonne of cement under the near-zero pathway of the Global Cement and Concrete Association.[138]

These chemical reactions are unavoidable in conventional clinker production, highlighting the need to reduce clinker's share in the final product while using CCS to abate remaining emissions.

[138] Global Cement and Concrete Association, *Numerical Definitions for Low Carbon and Near Zero Cement*.

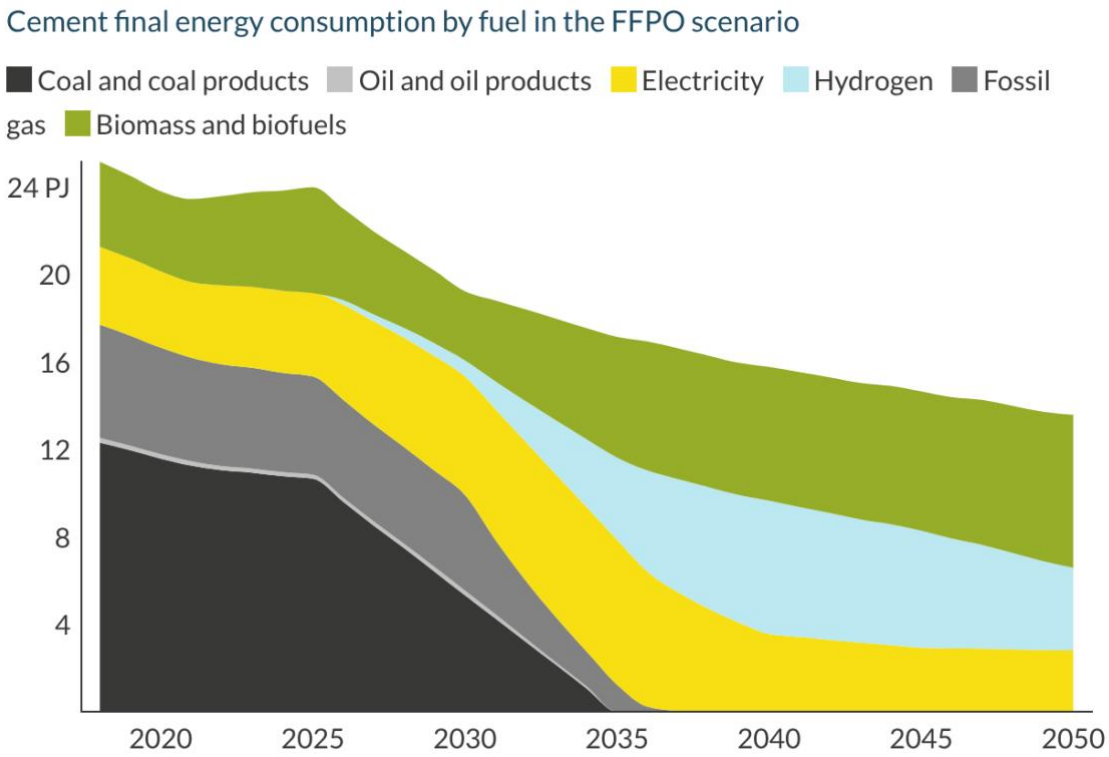

Figure 46: Cement final energy consumption by fuel in the FFPO scenario.

Biomass sustainability boundaries

The use of biomass in energy systems creates sustainability risks. If left unchecked, biomass deployment can compete with other land uses and harm local livelihoods, biodiversity and the environment.[139] To account for these risks, the HPA scenario places sustainability limits on global biomass use. In this scenario, biomass supply is capped at 80 EJ per year (around 60% higher than current levels), confining its use to hard-to-electrify sectors while allowing the rest of the economy to benefit from declining clean energy costs.[140]

Australia has not relied heavily on biomass so far. It accounted for 3% of domestic energy consumption in 2024.[141] Few studies have examined Australia's biomass potential, partly because it has not been a major policy priority as it has in

[139] IPCC, "Climate Change 2022 - Mitigation of Climate Change."
[140] Climate Analytics, "Rescuing 1.5°C: New Evidence on the Highest Possible Ambition to Deliver the Paris Agreement."
[141] Australian Government Department of Climate Change, Energy, the Environment, and Water, *Australian Energy Statistics - Update Report 2025*.

countries such as Brazil, Canada or the United States. To reflect country-specific dynamics and limit reliance on biomass in a way that is consistent with the global HPA scenario and Australia's context, the FFPO scenario includes sustainability bounds on biomass deployment.

Drawing on Crawford et al. (2016), still a landmark paper used in publications such as the 2025 CSIRO CDR Roadmap, we excluded short-rotation tree crops and native grasses on environmental grounds, and applied a conservative collection rate to crop stubble to account for soil resilience, collection inefficiencies and other practical constraints.[142]

The 2021 Bioenergy Roadmap identifies additional feedstock potential beyond that considered by Crawford et al.[143] We included only non-overlapping feedstocks from the Roadmap and applied a conservative 33% multiplier to derive the share of this potential that would be usable, a ratio lower than the average 45% factor cited in the Roadmap under a business-as-usual (BAU) scenario, to account for economic and policy constraints.

The full details are available in the technical annex. The result is a total upper bound of 887 PJ of biomass feedstock, substantially lower than the theoretical resource potential identified in the Roadmap (2600 PJ), and below the estimated availability used in the Net Zero Australia study (1200 PJ), which also considered similar constraints.[144] This estimate remains approximate due to the limited availability of literature and the simplicity of the coefficients applied. Better mapping of Australia's biomass resources would support more robust climate and energy system planning, supporting better-informed policy for their integration. In the meantime, the FFPO scenario's limited reliance on biomass reduces these risks.

Policy implications

Increasing the supply of biomass to substitute for fossil fuel combustion and raw materials is a necessary enabler of cement's decarbonisation pathway. This can be achieved through support from programs such as FMIA and any financial support for fossil fuels should be diverted towards cleaner alternatives. Alternative fuels derived from waste, including biomass, have high potential to replace fossil fuels, but development of waste management and supply chains must consider broader sustainability outcomes.

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[142] Crawford et al., "A Spatial Assessment of Potential Biomass for Bioenergy in Australia in 2010, and Possible Expansion by 2030 and 2050."
[143] ENEA et al., "Australia's Bioenergy Roadmap."
[144] McCall et al., *Methods, Assumptions, Scenarios and Sensitivities*.

As in steel, developing a domestic green hydrogen ecosystem will be critical to decarbonising cement. This can be facilitated by programs such as FMIA, while broader support under commitments such as the Capacity Investment Scheme (CIS) can increase the availability of cheap renewable electricity, helping to improve the economics of green hydrogen.

Reforms to, or possible replacement, of the SGM are needed to ensure that industry invests in decarbonised production. Demand for low-carbon cement can be stimulated by GPP and embodied carbon limits. Regulatory reform can also seek enhanced materials efficiency in the built environment. Transitioning from product to performance-based standards for building and construction is critical to enable greater uptake of cements and concretes with lower clinker content.[145]

Enhanced R&D can also support further breakthroughs in low-to-no clinker cements and concretes. This represents a potentially significant market, and innovation in the US has shown the financial viability of start-ups when public funds support their early-stage development. Given that traditional cement production will continue to some extent, Australia will need to ensure robust CCS regulation to avoid wasteful investment in transport and storage capacity for avoidable fossil energy emissions. CCS should be limited to abating unavoidable IPPU emissions in cement and other industries.

Alumina and aluminium

Structure of the sector

The alumina and aluminium sectors use the same primary data sources in the CPP scenario. The dataset draws from the Australian Aluminium Council for historical values and the Step Change scenario in gas, liquid fuel, coal and renewable gas projections by ACIL Allen's *Gas, Liquid Fuel, Coal and Renewable Gas Projections* for future production pathways.[146]

Energy demand in alumina is aligned with the 2023–2035 emissions trajectory in Australia's Emissions Projections, and annual energy efficiency gains are applied to demand after 2035. In aluminium, where 90% of energy demand is met by electricity, the remaining 10%, currently met by fossil gas, is assumed to be fully electrified by 2050. Based on the CSIRO A40/G1.5 scenario and the Australian industry-focused report from the Australian Industry Energy Transition Initiative, energy demand and emissions in the

[145] Environmental Coalition on Standards, *A Performance-Based Standard for Common Cements*.
[146] Australian Aluminium Council LTD, "Sustainability Data Tables 2024"; ACIL Allen, *Gas, Liquid Fuel, Coal and Renewable Gas Projections*.

FFPO scenario are driven by shifts in production routes rather than decreases in production.[147]

The transition occurs through energy efficiency, enhanced electrification and green hydrogen

Production of aluminium, and particularly its precursor alumina, is highly energy-intensive. Currently, Australian alumina refining is almost entirely reliant on fossil fuels, while aluminium already has an existing electricity-dominated energy profile.

In the FFPO scenario, electrification and green hydrogen are key to driving down fossil fuel demand with the phase-in of electrified mechanical vapour recompression and green hydrogen-based calcination. This leads to electricity providing close to 40% of sectoral energy demand in 2035 and 67% in 2050, up from 5% at present.

Green hydrogen, used to generate high-temperature heat, provides 18% of energy demand in 2035 and 33% in 2050, replacing current fossil gas. The share of fossil fuels, most of which is fossil gas, falls from 97% in 2025 to 42% by 2035 before reaching zero in 2040.

More than 90% of energy demand in Australian aluminium production is already met by electricity, with the remainder coming from fossil gas to generate high temperature heat in cast house operations and carbon anodes production.[148] The current small share of fossil gas in the smelting process is phased out so that the sub-sector fully electrifies by 2030 in the FFPO scenario.

Low CO_2 concentrations in aluminium production, derived from the Hall-Heroult electrolysis process make CCS deployment more challenging than elsewhere. Sector-specific approaches will be required to remove process emissions, such as zero emissions electrodes.[149] Recycling more aluminium would also cut emissions.[150] Aluminium is highly recyclable, and avoiding virgin production can reduce energy demand by 95%.

Alumina refining sees emissions reductions of 19% below current levels by 2030 and 61% by 2035 in the FFPO scenario. Together with aluminium smelters, which phase out fossil gas by 2030, energy-related emissions from the sector are zero by 2040, with less than 1 $MtCO_2e$ of industrial processes and product use emissions remaining by 2040.

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[147] CSIRO, "Modelling Sectoral Technology and Emissions Pathways to 2035 and Net Zero"; Australian Industry Energy Transitions Initiative, *Pathway to Industrial Decarbonisation*.
[148] Hydro, "Our Roadmap to Net-Zero Emissions in Aluminium Production."
[149] Hydro, "HalZero - Pioneering Zero-Emission Electrolysis."
[150] Australian Aluminium Council LTD, "Recycling Aluminium."

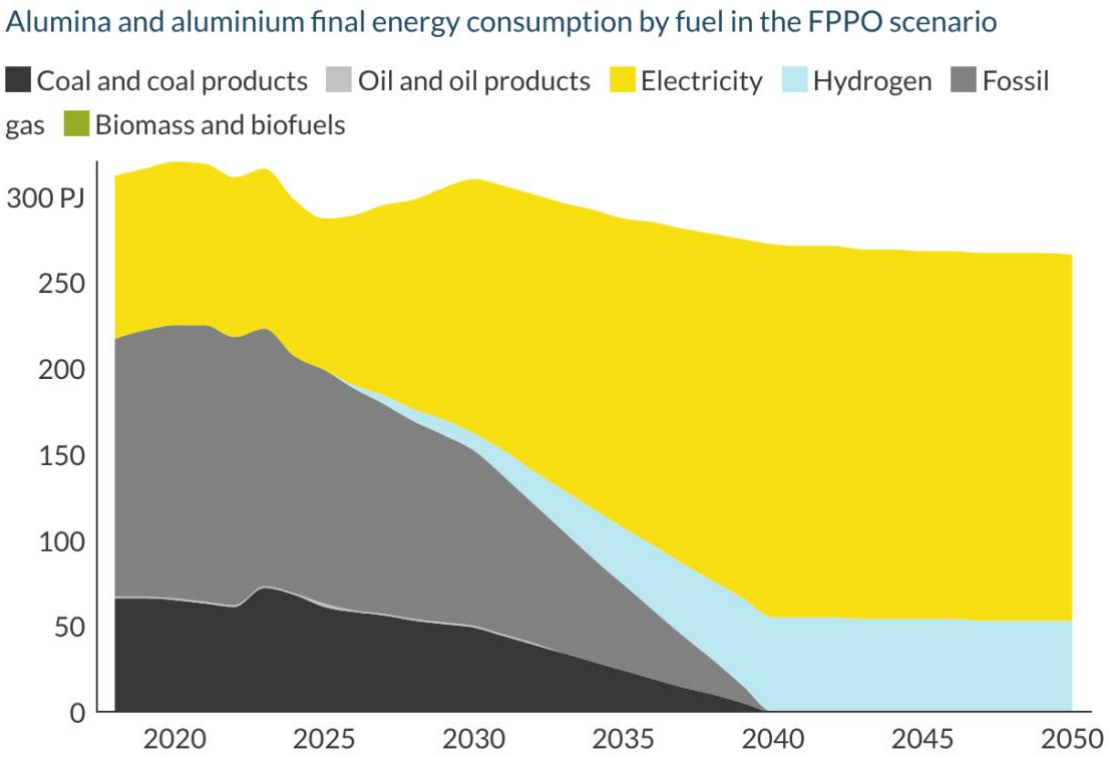

Figure 47: Alumina and aluminium final energy consumption in the FFPO scenario.

Policy implications

Australia should tie existing support to alumina and aluminium producers to emissions reduction outcomes. Governments have intervened to support sectoral jobs and production levels threatened by growing competitiveness challenges in recent decades.[151] This has included seeking to directly secure affordable clean power for aluminium producers — either from government-owned entity Snowy Hydro or by signing renewable PPAs and on-selling electricity to smelters — as the most important production input.[152]

Future policy should eliminate taxpayer support for uncompetitive, carbon-intensive production by contractually tying support to progressive decarbonisation.

Government must also continue to de-risk industry investment in cleaner production and foster development of the required technologies and recycled aluminium supply chain. Reform of the SGM is again essential to shifting private investment flows. Continued assistance to alumina and aluminium under FMIA and its supporting agencies is also vital. Green alumina is already a priority target of FMIA production credits and innovation funding, but the program has faced budgetary challenges that threaten future progress. The Australian Renewable Energy Agency (ARENA) has taken a particular interest in clean

[151] Australian Aluminium Council LTD, *Securing a Level Playing Field*.
[152] Jane Norman, *Government Considers Dramatic Intervention to Save Tomago Smelter*.

alumina and will need to revive its commitment to early-stage technology partnerships with Rio Tinto, Alcoa and South32.[153]

Green hydrogen supply must again be developed in ways identified in the iron and steel and cement subsections. Scrap-based production must be accelerated through financial and regulatory support to develop re-smelting technologies and facilities and divert currently exported raw materials to domestic use.[154] GPP and other demand stimulation policies (e.g. embodied carbon limits, performance-based standards) can help incentivise industry investment in recycled aluminium and low emissions primary production. Enhanced R&D and early-stage technology support could help overcome CCS-specific barriers for managing unavoidable IPPU emissions, while enabling regulation should again be mindful of avoiding unproductive outcomes.

Zero-carbon mining

Structure of the sector

Iron ore accounts for 90% of Australia's non-fossil mining output and is the sector's largest energy consumer. The CPP scenario assumes that the technological developments and electrification projected for iron ore are also rolled out across other mineral mining.

Under the FFPO scenario, fuel switching and electrification pathways are aligned with projection in the HPA scenario. Iron ore mining activity levels are aligned with IEAs' 2024 World Energy Outlook Net Zero Scenario, while other non-fossil fuel mining and on-site electricity follows the CSIRO A40/G1.5 in the CSIRO' net zero modelling.[155]

Mining electrification plays an important role in upstream decarbonisation

Mining plays two roles in the FFPO transition: it decarbonises its own operations while simultaneously expanding the supply of iron ore and minerals needed for clean energy technologies. The scenario meets both objectives through the scale-up of renewable off-grid power and the near-elimination of diesel from mine haulage and machinery and mineral processing due to electrification. It would also contribute substantially to Australia's energy security: mining represents a quarter of national diesel consumption, three times more than agriculture.[156]

Iron ore

In the FFPO, iron ore production expands by 5% from 2024 levels by 2050, compared to 13% in the CPP scenario, because of lower global primary steel demand. Total final energy

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[153] Government of Australia, *A Roadmap for Decarbonising Australian Alumina Refining - Australian Renewable Energy Agency (ARENA)*.
[154] LEK Consulting and Australian Aluminium Council LTD, *Enabling Development of Aluminium Recycling Capability in Australia*.
[155] CSIRO (2025). Modelling sectoral pathways to net zero emissions. https://www.csiro.au/-/media/Environment/25-00150_CSIRO-Modelling-and-Additional-Scenario-Summary-Report_FINAL_250903.pdf
[156] Australia Institute, "Diesel Use in Australian Mining."

demand falls by around 23% between 2024 and 2050 in the FFPO scenario, whereas it remains broadly stable in the CPP scenario, because electric drivetrains are much more energy efficient than diesel equipment. From around 10 $MtCO_2e$ in 2025, emissions fall by 27% by 2030 and nearly 95% by 2040, reaching real zero in 2045.

Other non-fossil fuel mining

Beyond iron ore, the FFPO scenario requires rapid deployment in Australia of clean energy technologies, including batteries, electric vehicles, wind turbines and solar panels. Australia is largely a technology taker in clean energy, as in other areas. Yet, it is a major producer and emerging processor of the critical minerals used to produce them, including bauxite, lithium, nickel and copper, which see growing global demand out to 2050.

Still, upstream decarbonisation of international metals supply chains, increased demand for mineral exports in international markets and some growth in domestic minerals processing, creates ongoing energy complications.

In the FFPO scenario, non-fossil fuel mining's energy demand increases at an average of 6.4% per annum through to 2050, driven by higher international demand for the transition. In this scenario, diesel and other oil product consumption in the sector is minimal by 2040, and emissions fall to zero by 2045.

Deep electrification of both iron ore and other non-fossil fuel mining, powered by renewables, resolves the emissions challenges currently associated with production growth. Electricity grows to 95% of the energy mix in both sub-sectors by 2050 under the FFPO scenario, driving a collapse in diesel use across mine equipment and vehicles, as well as mineral processing. This compares with 74% electrification in the CPP scenario. Mining, which is heavily concentrated in remote and regional areas, contributes to a sharp rise in Australia's off-grid power demand over several decades. Electrification proves more scalable than green hydrogen, which remains marginal in the sub-sector by mid-century.

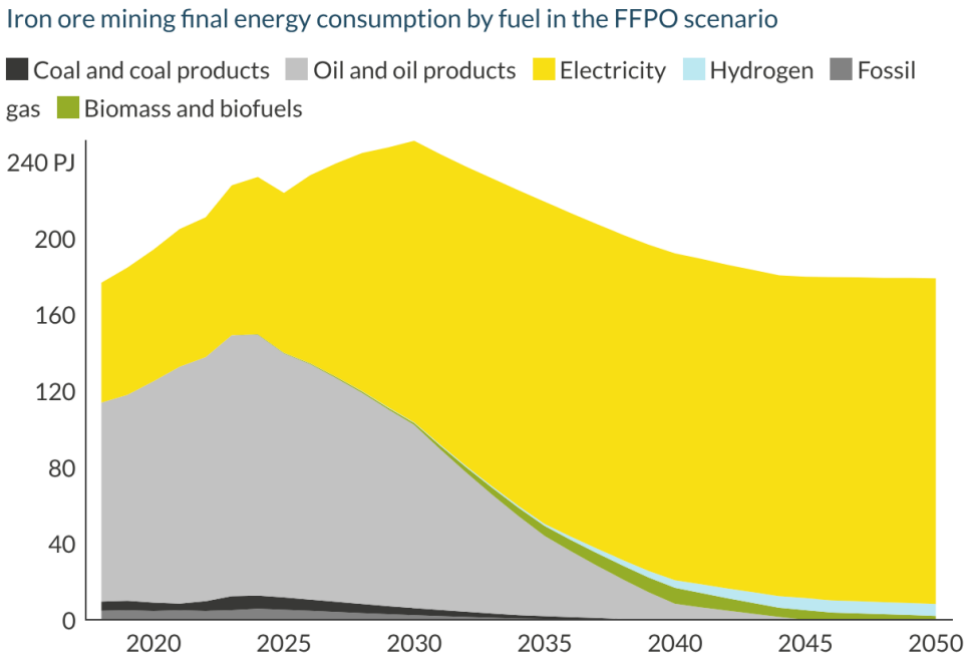

Figure 48: Iron ore mining final energy consumption by fuel in the FFPO scenario.

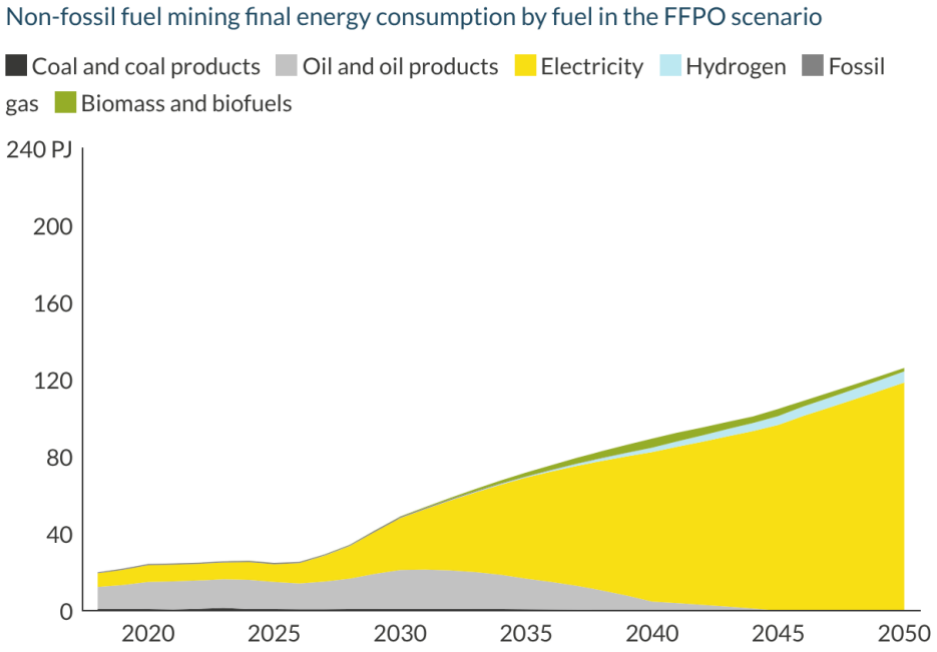

Figure 49: Non-fossil fuel mining final energy consumption by fuel in the FFPO scenario, excluding iron ore mining.

The industrial race towards real zero mining

The scale of deployment now underway by mining companies shows that the pathway is achievable, though corporate ambition remains uneven without policy constraints and support.

Fortescue's Real Zero target aims to eliminate scope 1 and 2 emissions from its Australian terrestrial iron ore operations by 2030 without voluntary offsets. Its procurement strategy anticipates the deployment of 300–400 zero-emission haul trucks with phased deliveries from 2028 to 2030, alongside the establishment of clean energy infrastructure.[157, 158] The company plans on having its first battery electric haul truck operational by the end of 2026, and has begun the construction of a 680 MW solar farm, complemented by a giga-battery.[159]

BHP has advanced battery-electric truck and locomotive trials and previously aimed to replace its Western Australian iron ore haul-truck fleet by the mid-2030s. Its latest disclosures, however, state that technology delays have pushed back fleet electrification at scale beyond FY2030. Leaked internal documents have separately shown that BHP delayed several decarbonisation projects in its Western Australian operations, when it has achieved major emissions reductions at its Chilean copper operations.[160,161] BHP's formal group-wide target remains at least a 30% reduction in operational emissions below 2020 levels by 2030 and net zero operational emissions by 2050.[162] While these measures do not address the scope 3 emissions embodied in exported iron ore, they contribute to domestic decarbonisation given the massive scale of Pilbara production.

Australia will also play an important role in the upstream decarbonisation of non-fossil mining supply chains. The remote Bellevue gold mine has achieved isolated periods of 100% and averages of 80–90% renewables generation through off-grid

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[157] Fortescue (2025). Climate Transition Plan. https://content.fortescue.com/fortescue17114-fortescueeb60-productionbbdb-8be5/media/project/fortescueportal/shared/documents/publications/reports/fy25-climate-transition-plan.pdf
[158] Fortescue (2025). Fortescue unites world's best technology and manufacturing to accelerate decarbonisation globally. https://www.fortescue.com/en/articles/fortescue-unites-worlds-best-technology-and-manufacturing-to-accelerate-decarbonisation-globally
[159] "Fortescue fits out first 240 tonne electric haul truck, and rolls out first 6 MW fast charger."
[160] Australia Institute, "Diesel Use in Australian Mining."
[161] IEEFA, "After 'The BHP Files': What We Learned about Policy's Role in Decarbonising Mining."
[162] BHP (2025). BHP GHG Emissions Calculation Methodology 2025. https://www.bhp.com/-/media/documents/investors/annual-reports/2025/250819_bhpghgemissionscalculationmethodology2025.pdf

solar, wind and batteries.[163] The Kathleen Valley lithium mine, operated by Liontown Resources in which billionaire Gina Rinehart's Hancock Prospecting is a shareholder, also runs on 80% renewable electricity through an off-grid hybrid of solar, wind and battery storage.[164]

Policy implications

Adequate mining policy must support businesses through the transition while setting a baseline of ambition and certainty about its direction and speed. The priority reforms for decarbonised mining are reforming or replacing of the SGM and the Fuel Tax Credits (FTC) system for diesel. The current design of these policies disincentivises investment in overcoming the high upfront capital expenditure barrier to new clean technology investment and favours retention of the status quo. Improving these policies would encourage industry investment that is typically already cost-effective over investment lifetimes, even without adequately priced carbon.

As discussed in the dedicated sections of this report, the SGM must incentivise investments in cleaner production instead of offsets. More generous treatment of trade-exposed industries such as mining should also be wound back in favour of a carbon-border adjustment mechanism.

Government should continue to develop markets for cleaner production in sectors such as critical minerals in other ways. This includes sustained engagement with international institutions and customers to establish green premiums, creating public and private buyers' clubs and greater mineral traceability and certification regimes for end products. However, Australia must go well beyond current efforts, which mostly seek recognition of status quo advantages over rival producers, to stimulate demand for minerals with credible zero emissions production pathways.[165]

Regional and remote mining regions are also underserved by renewable energy and affordable electricity more generally, a situation that requires rapid action. Western Australia's Pilbara is served by the North-West Interconnected System (NWIS), in which renewables generate just 2% of electricity.[166] Overhauling this disjointed mix of loosely interconnected public-private infrastructure through a common user infrastructure approach is estimated to be capable of avoiding $30 billion in additional transition costs.

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[163] Renew Economy, *Giant Off-Grid Gold Mine Achieves Average 91 per Cent Renewables over Month with Wind, Solar and Batteries*.
[164] Renew Economy, "'Doing What We Built It to Do:' Rinehart-Backed Lithium Mine Runs on 80 Pct Renewables for Second Year in Row."
[165] Brad Thompson, *Canberra Backs Green Premium for Failing Australian Nickel Miners*.
[166] Infrastructure Australia, "North West Interconnected System Connectivity."

[167] It could further improve the competitiveness of renewables-powered electrified mining.

Additional support may be required to help industry members invest in new technologies and processes, including through R&D, early-stage commercialisation or ensuring the bankability of mature but capital-intensive projects. Larger and highly profitable mining companies should be particularly compelled to invest in renewable power and fleet electrification. As well as SGM and FTC improvements, this should include further corporate governance and financial reforms to ensure long-term managerial and investor commitment to decarbonisation in the face of commodity market volatility.

Green ammonia production

Structure of the sector

Ammonia production capacity by plant follows the assumptions from the ACIL Allen Gas, liquid fuel, coal and renewable gas projections report.[168] The feedstock fuel mix follows the ACIL Allen assumptions under the Step Change scenario under CPP, and the FFPO follows the fossil gas demand forecasts in chemical industry in the HPA scenario as a proxy.[169]

Phasing out fossil gas in hydrogen production drives sectoral decarbonisation

Australian ammonia production is fully gas-based, generating emissions of 4 $MtCO_2e$ in 2024, including 0.5 $MtCO_2e$ of energy emissions and the rest categorised as IPPU. Australian production increases to 2050 in the FFPO scenario, while global demand for green ammonia remains uncertain. Capacity expansion in Kwinana and the new Perdaman plant coming online from 2028 will lift total output by 63% above current levels by 2029.

In the FFPO scenario, energy emissions from ammonia production reach zero by 2040, as do the steam methane reforming process emissions. Electricity replaces gas for heat and steam by 2040, while green hydrogen from electrolysis progressively replaces the grey hydrogen used as feedstock. The grey hydrogen share falls from close to 100% in 2025 to 26% in 2035 and to zero by 2040, at which point all output is green ammonia. Total energy demand rises over the same period, from 49 PJ in 2025 to 87 PJ in 2035. After 2040, the subsector is responsible for only 1 $MtCO_2e$ of residual nitrous oxide from ammonium nitrate production.

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[167] Clean Energy Finance Corporation, *United Action on Pilbara Infrastructure Could Save Australia $30 Billion: Report*.
[168] ACIL Allen, *Gas, Liquid Fuel, Coal and Renewable Gas Projections*.
[169] ACIL Allen, *Gas, Liquid Fuel, Coal and Renewable Gas Projections*.

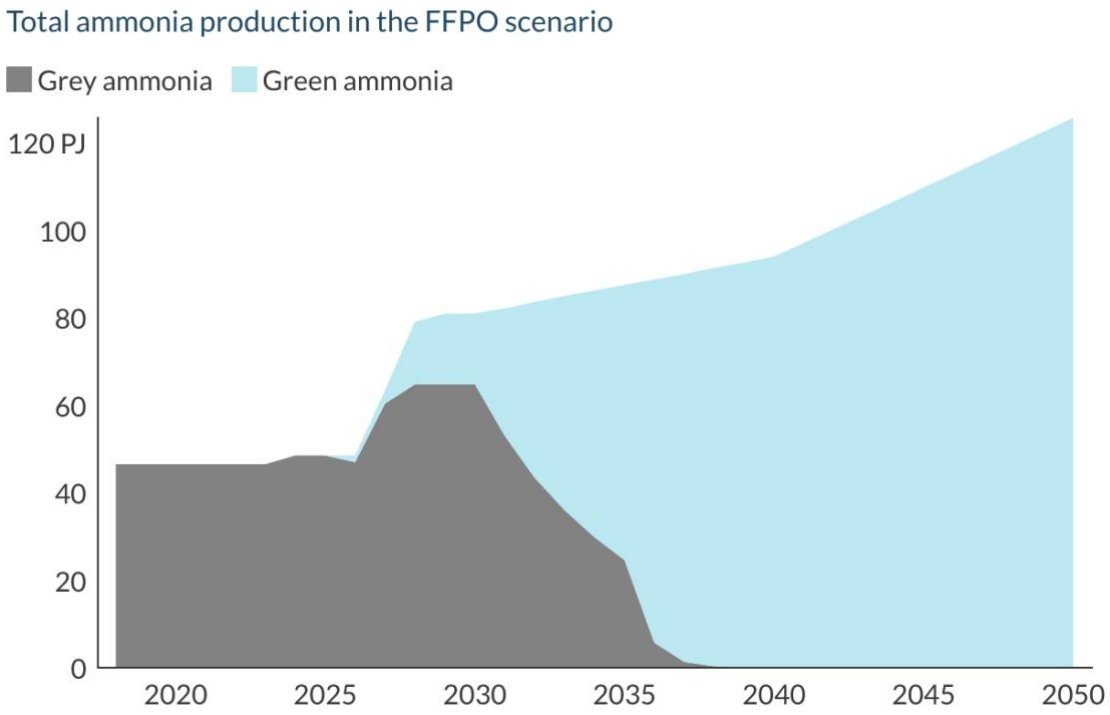


Figure 50: Total ammonia production in the FFPO scenario.

Policy implications

Growing green hydrogen production and dramatically lowering costs are critical to green ammonia development. Policy priorities include the accelerated build-out of renewable electricity, including through financial support for generators and the provision of common user transmission and related infrastructure.

More direct support to green hydrogen and eventual green ammonia production should also continue through FMIA and other industry policy instruments. The post-Iran war energy market provides added national security-informed incentives for government support, due to likely long-term international fertiliser supply chain insecurity.

More demand-focused policies are necessary to accelerate market development, including improving the bankability of new capital-intensive projects. The initial focus is mostly domestic, though with downstream export implications. Government could mandate a growing percentage share of green ammonia use — a modification of the 'renewable portfolio standard' approach deployed under Australia's successful Renewable Energy Target — among major existing grey hydrogen consumers.

Cooperation with international institutions and customers would also help ensure that ammonia demand growth — and management of ongoing safety concerns — is met by green supply in sectors such as shipping fuels. The Australia-to-Asia bulk shipping route for resources is well-positioned to serve as a green shipping corridor. This would require enhanced R&D and de-risking of new shipping investments. Governments could also

leverage existing trading networks and port infrastructure, as well as the International Maritime Organisation's atypically strong cross-border regulatory capacity.

A significantly tighter or replaced SGM is particularly important in the context of managing growing ammonia demand. Reforms must remove the significant 'grey discount' for gas-based production and reduce the green premium for renewables-based production. This would help in avoiding expansion of carbon-intensive production.

Hydrofluorocarbons emissions

Hydrofluorocarbons (HFCs) are synthetic greenhouse gases, often used in refrigeration and air conditioning. HFC-134a, the most common HFC in Australia, has a global warming potential of 1,300, meaning one tonne has the warming effect of 1,300 tonnes of carbon dioxide.

In 2016, Australia agreed to the Kigali Amendment, an international agreement to phase down global HFC production and use. Australia and other developed countries are to reduce imports by 85% by 2036 below the 2011–2013 average. As Australia depends entirely on imports, they will be capped at 1.6 $MtCO_2e$ from 2036 onwards.[170]

The CPP scenario projects a fall from 11 $MtCO_2e$ today to 6 $MtCO_2e$ by 2035. In the FFPO scenario, emissions are aligned with government projections to 2040, then follow the growth rate in the HPA scenario for the macroeconomic region, falling from 11 $MtCO_2e$ today to around 1 $MtCO_2e$ by 2050.

[170] Department of Climate Change, Energy, the Environment and Water, "Hydrofluorocarbon (HFC) Phase-Down."

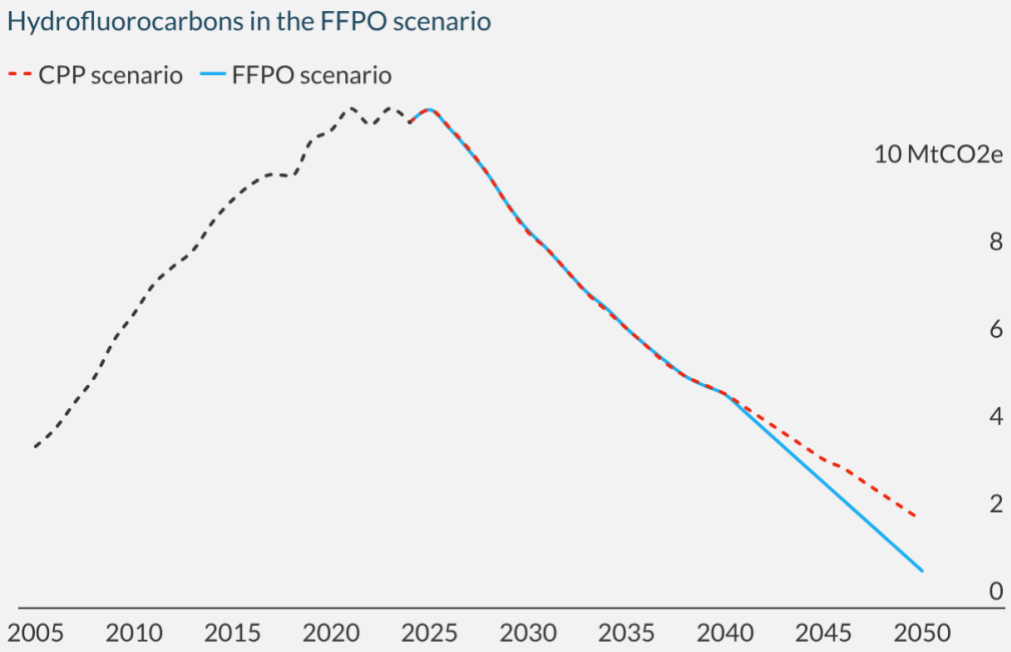


Figure 51: Reduction in hydrofluorocarbons in the FFPO scenario to 2050

Decarbonising buildings

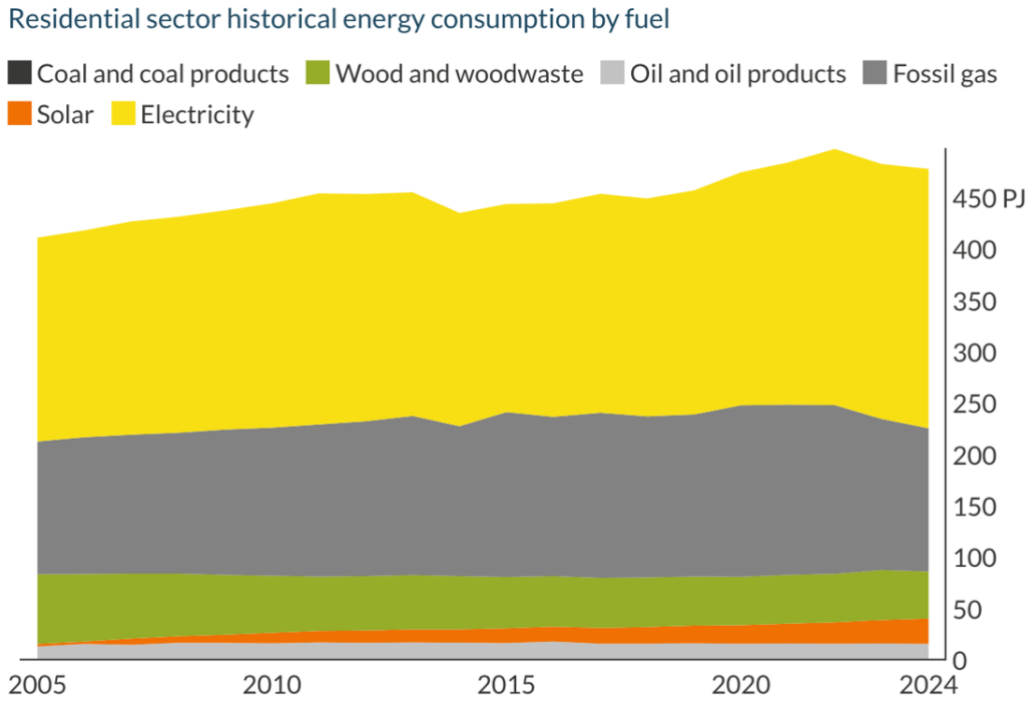
The building sector's energy use: current situation

The buildings sector accounts for around 20% of Australia's final energy use, with the residential sub-sector responsible for about 12%. Both shares have remained roughly constant over the past two decades.[171]

Direct energy demand is relatively electrified: electricity provides more than half of the sector's energy, followed by gas at a quarter, oil at 10%, and small contributions from wood (mostly residential) and direct solar. Fossil fuels supply 30–32% of the sector's direct final energy demand. The shares of fossil gas and wood biomass have stayed largely unchanged over the past 20 years (Figure 52), despite the need to decarbonise.

When the fossil fuels used to generate electricity are also taken into account, the sector's dependence on fossil fuels rises to 65–70%, as more than 60% of generation in Australia's major electricity grids came from fossil fuels in 2024. Scope 1 and scope 2 emissions from the built environment, including those from its energy supply, were estimated by the government at 22% of Australia's emissions.[172] One of the strongest dynamics in Australia's buildings sector has been the growth of rooftop and small-scale solar photovoltaic (PV) generation, which supplied 11% of national generation in 2024.

[171] Australian Government Department of Climate Change, Energy, the Environment, and Water, *Australian Energy Statistics - Update Report 2025*.
[172] Australian Government, *Built Environment Sector Plan*.



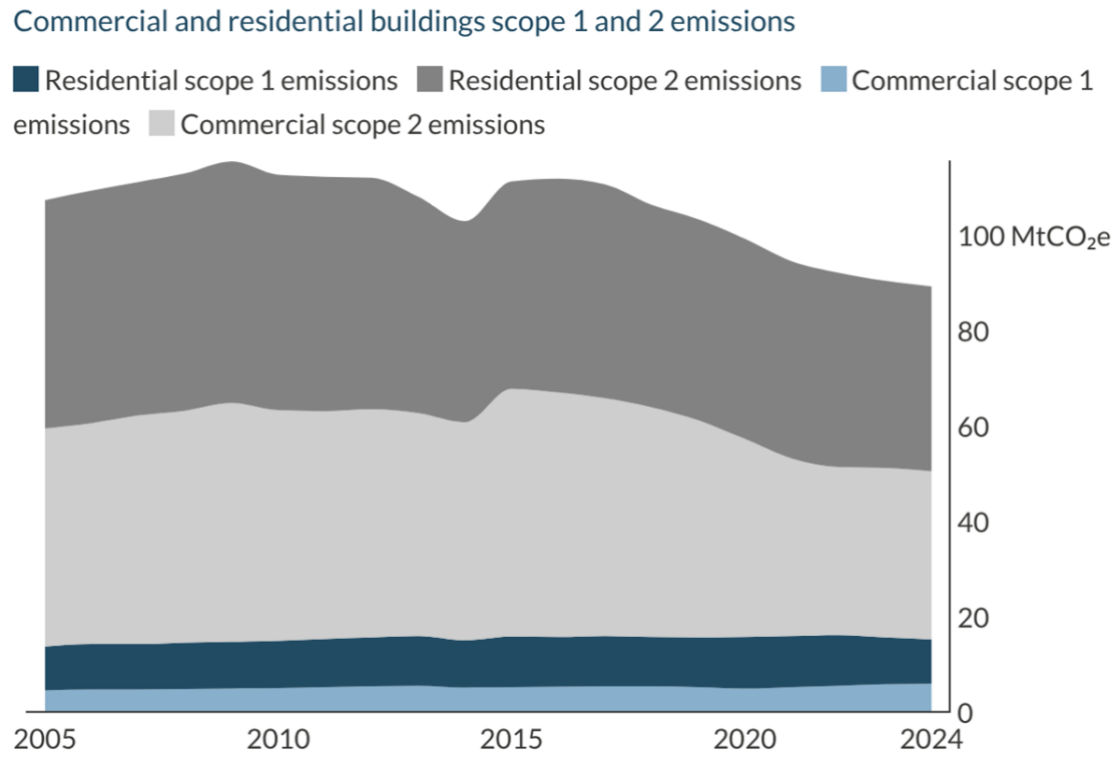


Figure 52: Final energy demand for buildings and residential from 2000 to 2024 and historical scope 1 and 2 emissions for residential and commercial buildings, based on the National Greenhouse Accounts.

Structure of the Australian buildings sector

Buildings are represented as an end-use sector, defined by activity levels, fuel shares, and a final energy intensity, across different sub-sectors that represent different building types: residential, commercial, industrial buildings, construction and others. Sectoral energy consumption, and therefore building-sector emissions, captures changes in activity levels, fuel shares and final energy intensity.

We take historical energy demand in the residential sector directly from the Australian Energy Statistics, with CPP projections based on the 2025 Emissions Projections, the 2021 Residential Baseline Study for Australia and New Zealand for 2000 to 2040 for residential buildings, and the Commercial Building Baseline Study 2022 for the non-residential segment.[173]

In the FFPO scenario, each sub-sector's fuel share converges towards the corresponding share of the HPA scenario for the Canada, Australia and New Zealand macro-region over the 2030–2035 period. Alongside this convergence, we assume that residual biomass uses in the residential sector, where wood is burned for heating, is phased out by 2030.

Current policy outlook

Australia has fairly limited policy commitments to encourage rapid electrification and efficiency improvements. The Household Energy Upgrades and Cheaper Homes Batteries Program, and the Small-Scale Renewable Energy Scheme (for businesses as well as homes), subsidise investment in new electrical appliances, rooftop solar, energy storage, and efficiency upgrades.[174] But their funding pools are relatively small, at less than AUD 1 billion each. Building standards remain much weaker than in leading jurisdictions such as Europe.[175]

The federal government also rejected a CCA recommendation to phase out new gas connections in new and existing residential buildings in 2024.[176] Some Australian states have, however, taken up this challenge. Victoria, which has the highest demand for gas in

[173] Energy Consult, *2021 Residential Baseline Study for Australia and New Zealand for 2000 to 2040*; Department of Climate Change, Energy, the Environment and Water, *Commercial Building Baseline Study 2022*.
[174] Australian Government, *Built Environment Sector Plan*.
[175] Daniel et al., "A National Roadmap for Improving the Building Quality of Australian Housing Stock."
[176] "Energy Minister Rejects Call for Home Gas Ban and Zero Emissions for Cars by 2040."

buildings, has developed a roadmap to phase out its use, accompanied by concrete requirements, such as a requirement for all new housing to be fully electric from 2027.[177]

Under current policies, buildings' emissions decline at a modest pace, in line with limited government action in the sector. Our current policies pathway continues the trend towards energy efficiency gains and electrification in the government's current projection and buildings baseline studies, showing that sectoral electrification reaches only 70% in 2050, up from the current 57%.[178] Gas use halves over the same period, while oil consumption remains stable. Overall, fossil fuels' share of the buildings' energy mix is still 33% in 2030, 24% in 2040 and 19% in 2050.

Under the CPP scenario, buildings' scope 1 emissions are still 16 $MtCO_2e$ in 2030 and 11 $MtCO_2e$ in 2050, with the gains from direct electrification and energy efficiency partly offset by growing population and economic activity. Overall, total energy demand in buildings increases to 1,030 PJ by 2050, from 850 PJ in 2025. The deployment of wind and solar in the power sector reduces the sector's scope 2 emissions, which fall from 68 $MtCO_2e$ in 2025 to 28 $MtCO_2e$ by 2030, 23 $MtCO_2e$ by 2040 and 6 $MtCO_2e$ by 2050.

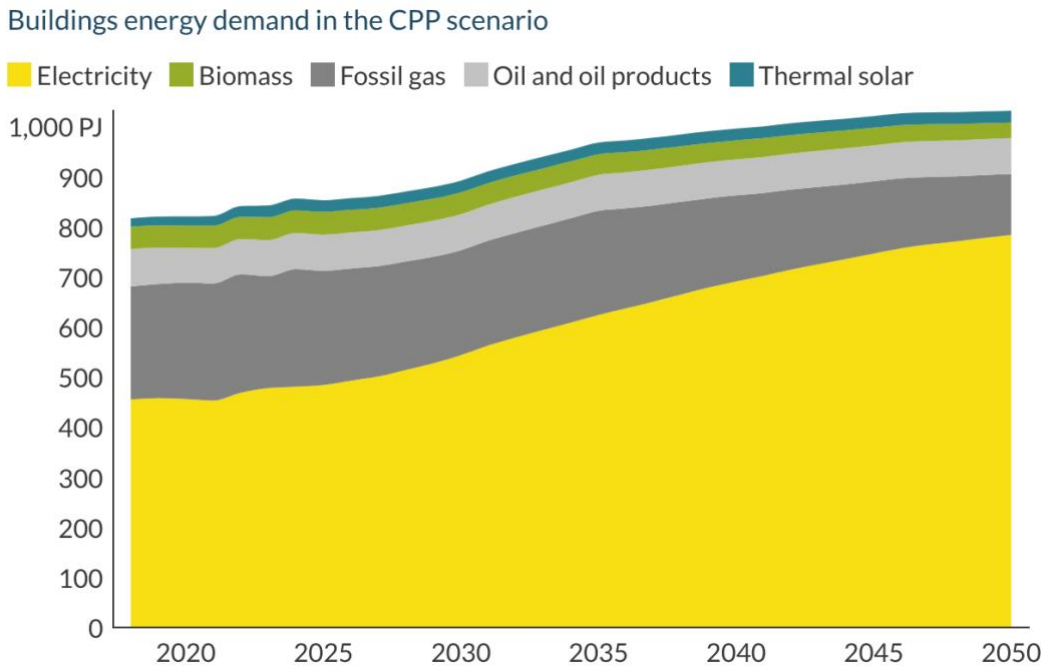


Figure 53: Building energy demand in CPP scenario.

[177] Daniel et al., "A National Roadmap for Improving the Building Quality of Australian Housing Stock."
[178] Including construction, unlike the above figures.

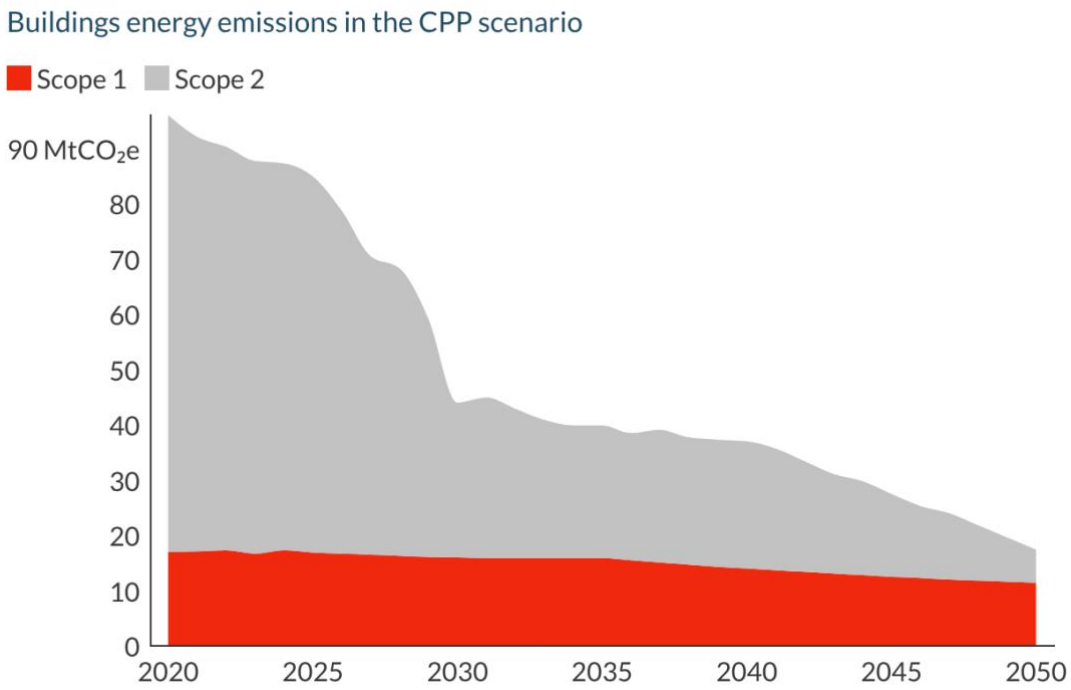


Figure 54: Scope 1 and 2 emissions from buildings in the CPP scenario.

The role of data centres in Australia's energy system

The AI boom and resulting infrastructure investments are affecting energy systems. Global data centre power consumption reached 485 TWh in 2025, twice the electricity generated in the National Electricity Market, and rose by 15% that year. It is forecast to reach 950 TWh by 2030, representing 3% of total electricity demand. The magnitude of this future demand is highly uncertain: it depends on how AI and other technologies affect the economy and how they are used, as well as on efficiency gains. Its geographical distribution is less uncertain: the IEA expects the US, China and other advanced economies to account for most of it.[179]

Data centres have rapidly entered the debate in Australia. In its advice report on the 2035 NDC target, the CCA stated that "the rapid growth of artificial intelligence and data centres is driving significant increases in electricity demand, which in turn is contributing to higher emissions than anticipated, making a more ambitious target harder to meet." [180] OpenAI's CEO noted Australia's potential to attract data centre investment; the Department of Industry found that planned

[179] IEA, "Key Questions on Energy and AI."
[180] CCA, *2035 Target Advice*.

investments in Australian data centres could "scale up to more than $100 billion."[181]

Data centres' potential impacts on Australia's energy system remain underexplored. In its 2026 ISP, AEMO included a sensitivity analysis testing alternative NEM pathways with higher data centre demand, informed by a report it commissioned from Oxford Economics.[182] This report provides the basis for modelling data centres separately in our model.

Data centres were projected to consume 2% of NEM electricity in 2025. Under the trajectory used for our FFPO scenario (based on Oxford Economics' projections for the more ambitious Green Hydrogen Exports pathway), additional data centre electricity demand reaches 41 TWh in 2050, compared with 35 TWh under the CPP scenario (based on Step Change). The NEM absorbs the overwhelming share of that demand, with little deployment in the SWIS or off-grid systems.

In the FFPO scenario, this additional demand is met by renewables. There is a risk that these large, concentrated new loads could drive up fossil fuel generation to meet the extra demand. In the US, data centre developers are increasingly turning to on-site fossil gas where grid capacity is lacking. Policies and safeguards are needed to prevent this: proactively managing the connection pipeline so that new loads are matched with new renewable capacity, using data centre flexibility to support the grid, and pairing new facilities with co-located storage, can help avoid fossil fuel lock-in.

How to align the Australian buildings sector with 1.5°C

Fossil fuel phase-out largely rests on improved efficiency and electrification

In the FFPO scenario, ambitious policies transform the buildings sector and deliver major emissions reductions despite economic and population growth. Two dynamics drive the sector to 2050: rapid electrification and deep energy efficiency improvements.

Electricity's share of the sector's energy demand rises to 72% by 2030 and 97% by 2050. Policies to incentivise electrification across both the existing stock and new builds phase out fossil gas and oil from the sector by 2040, while the assumed phase-out of wood from

[181] DISR, "National AI Plan"; AFR, "OpenAI's Sam Altman Says Australia Can Be a Data Centre World Leader."
[182] AEMO, "2026 Integrated System Plan"; Oxford Economics, "Data Centre Energy Demand."

residential consumption by 2030 removes another combustion source. Absolute electricity demand for buildings rises by 18% by 2030 and 49% by 2050.

Efficiency gains primarily come from mass retrofitting and the replacement of existing stock with more efficient residential and commercial premises, alongside the substitution of gas- and other combustion-based appliances with electric equivalents. After 2040, efficiency improvements compensate for increased demand from economic and population growth, in line with the conclusions of the Australian Energy Market Operator's draft 2026 Integrated System Plan.[183] Together, these changes halve residential energy intensity per square metre between 2025 and 2050. Total energy demand in buildings decreases by 13% between 2025 and 2050, to 750 PJ.

The turnover and renovation of the building stock bring substantial co-benefits for indoor comfort, health and air quality. More than 70% of Australian houses have an energy rating of three stars or lower, and most were built before efficiency standards were introduced.[184] The poor performance of this stock drives up heating and cooling needs, energy use and emissions, while posing health risks to low-income households, the elderly and other vulnerable communities. A Victorian study found that even a relatively minor upgrade to a house's thermal envelope pays for itself within three years through combined energy and healthcare savings.[185]

Phasing out combustion-based appliances brings further benefits: as Asthma Australia noted in a submission to a Senate inquiry, fossil gas stoves account for 12% of the childhood asthma burden, and wood heaters are the largest contributor to poor air quality in the ACT. Because there is no minimum healthy level of air pollution, cutting the use of both makes indoor and outdoor air safer.[186]

As a result of these combined buildings sector changes, direct emissions shrink from 17 $MtCO_2e$ in 2024 to 10 $MtCO_2e$ in 2030 and zero by 2040. This compares with 16 $MtCO_2e$ in 2030 and 11 $MtCO_2e$ in 2050 under the CPP scenario. With power sector decarbonisation, scope 2 emissions fall from 68 $MtCO_2e$ in 2025 to 6 $MtCO_2e$ in 2030 and zero by 2035.

[183] AEMO, *Draft 2026 Integrated System Plan for the National Electricity Market*.
[184] Daniel et al., "A National Roadmap for Improving the Building Quality of Australian Housing Stock."
[185] Sustainability Victoria, "The Victorian Healthy Homes Program."
[186] Asthma Australia, "Submission to the Inquiry Into Residential Electrification."

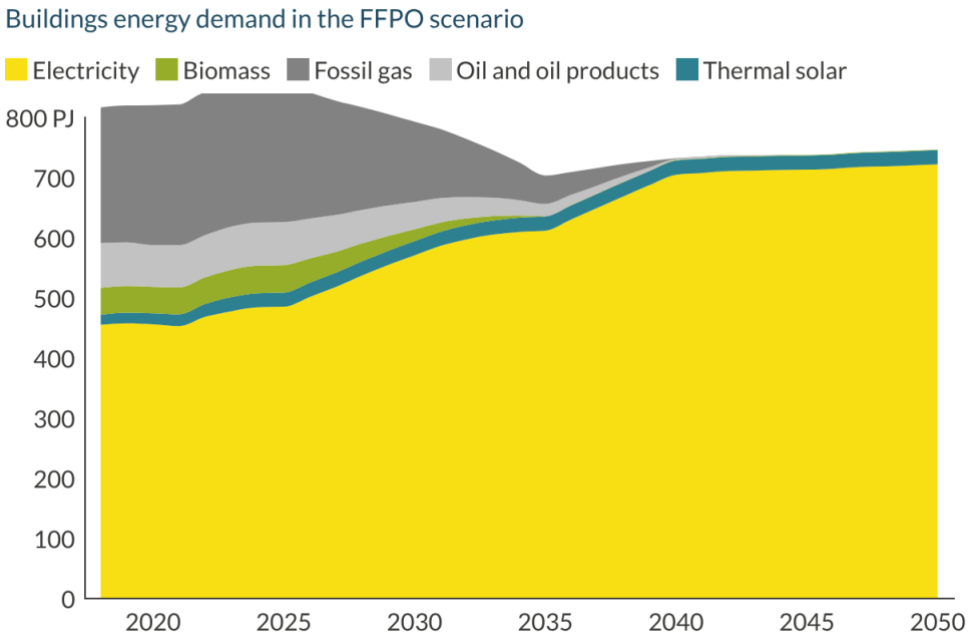


Figure 55: Building energy demand in the FFPO scenario.

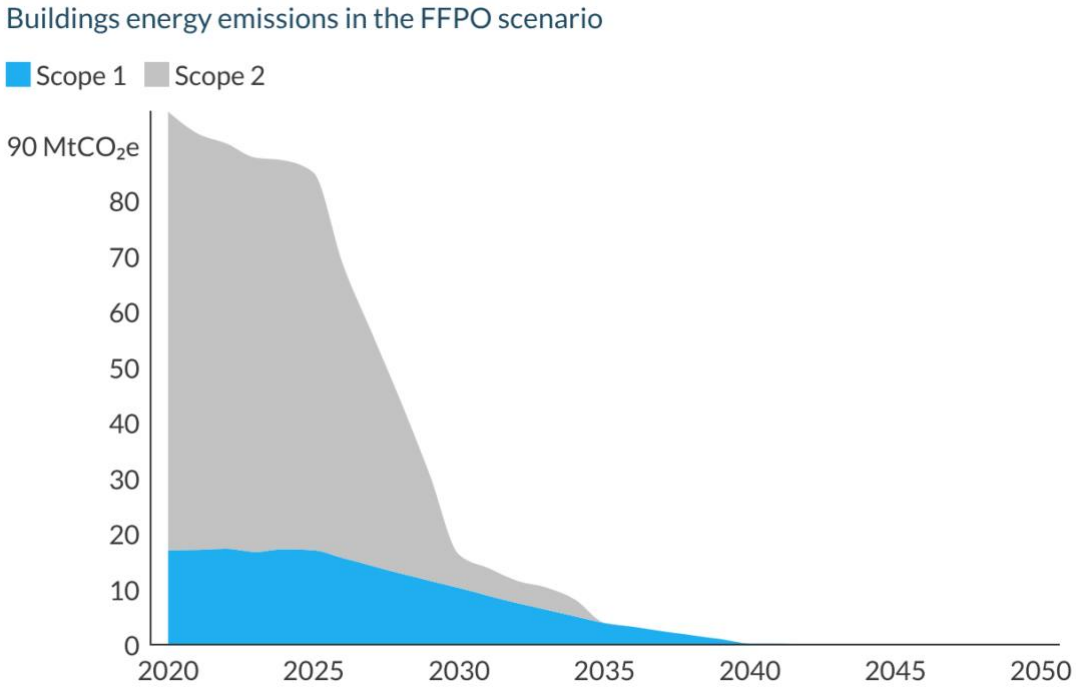


Figure 56: Building scope 1 and 2 emissions in the FFPO scenario.

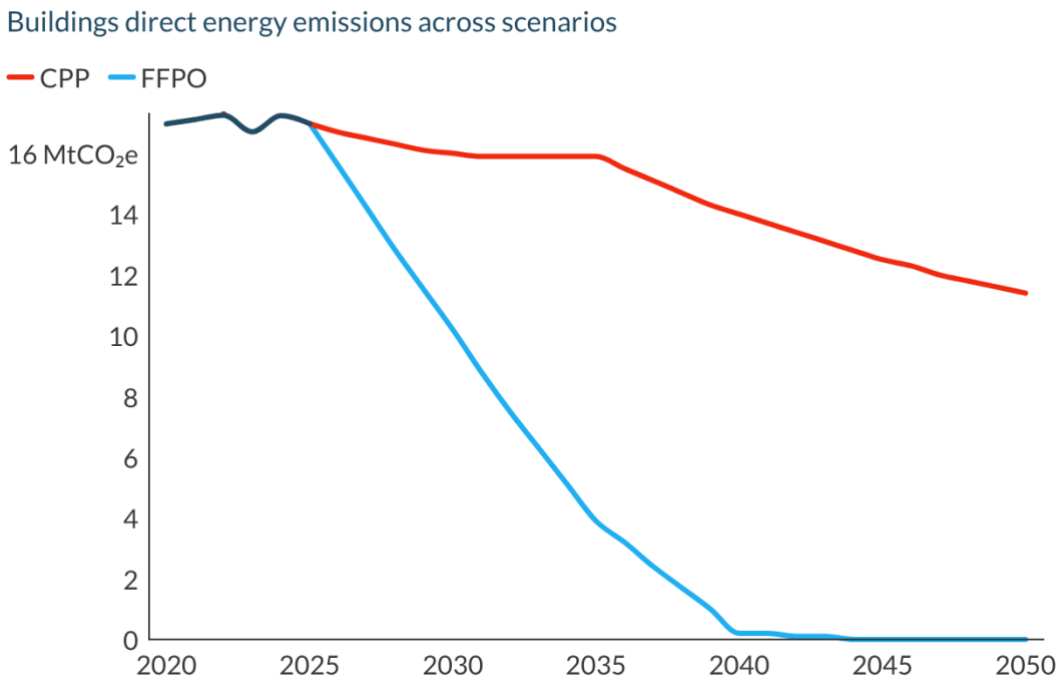


Figure 57: Direct building emissions in the FFPO and CPP scenarios, and comparison of scope 1 (direct) and 2 emissions per scenario.

Policy implications

Aligning with the FFPO scenario for buildings would require reaching zero direct building emissions by 2040. This would be in line with the scope of the EU's own target, which it aims to meet by 2050.[187] It would require accelerating electrification of the sector, phasing out the remaining fossil fuel use in heating and improving energy efficiency, all of which would deliver co-benefits for indoor comfort, energy bills and air quality.

Federal and state governments need to set clear mandates and targets for electrifying both existing and new buildings. The EU, for example, requires all new buildings to be zero-emission from 2030, and the Australian government could follow this example, folding such a requirement into a broader housing policy package.[188] Financial packages for renovation and retrofitting would then help meet targets across the existing stock, not only new buildings, with particular support for vulnerable households.

Coordination between federal and state governments on electrification must be complemented by adequate measures to phase out fossil fuels in buildings, including a ban on new gas connections, as reiterated in the Climate Change Authority's 2025 Annual Progress Report, in which it stated that the federal government could work "with state

[187] European Commission, "Nearly-Zero Energy and Zero-Emission Buildings."
[188] European Commission, "Nearly-Zero Energy and Zero-Emission Buildings."

and territory governments to coordinate a national phase-out of new and existing gas connections".[189]

Both must be paired with energy efficiency improvements. The government needs to improve the energy and thermal performance of buildings, including through a strengthened National Construction Code (NCC). This would require overturning the pause on further residential NCC changes until mid-2029, adopted in October 2025, while ensuring that stronger standards do not impede the development of new housing.[190]

Phasing out fossil fuel production

Current situation

Australia is a major net exporter of energy, while simultaneously reliant on oil imports. In 2024, it exported the equivalent of almost four times its domestic energy demand, and more than 6.5 times the energy it imported.[191]

Coal and coal products accounted for two-thirds of Australia's energy exports, liquefied natural gas a further 30%, and oil the small remainder. By contrast, the overwhelming majority of energy imports were oil and oil products.[192]

Australia's role as a major player in regional and global energy and carbon-intensive goods trade shapes the energy and climate futures of its mainly Asian trading partners. China, Japan, Korea, Taiwan and India all import fossil fuels from Australia, while Australia's fossil fuel producers target Southeast Asia as the next demand hotspot for gas.[193] Diplomatic and political pressure, exerted in both directions, contributes to fossil fuel lock-in both nationally by prolonging exports and in trading partners by cementing the role of fossil fuels in their energy systems.

The government does not report emissions generated offshore from the use of its exports; as per IPCC guidelines, these are reported in importing countries' national

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[189] CCA, *2025 Annual Progress Report*.
[190] Treasury, "Meeting Communiqué: Building Ministers' Meeting, October 2025."
[191] Australian Government Department of Climate Change, Energy, the Environment, and Water, *Australian Energy Statistics - Update Report 2025*.
[192] Australian Government Department of Climate Change, Energy, the Environment, and Water, *Australian Energy Statistics - Update Report 2025*.
[193] Department of Industry Science and Resources, "Resources and Energy Quarterly."

inventories. However, they contribute disproportionately to Australia's climate footprint. CO_2 emissions embedded in Australia's fossil fuel exports were 40% higher than in 2010, and 234% higher than its domestic emissions in 2022.[194] Cumulatively between 1961 and 2023, Australia's fossil fuel exports were responsible for 30 $GtCO_2$. This figure does not account for related methane emissions, or goods that serve as inputs for carbon-intensive processes abroad, such as iron ore for steelmaking.[195]

The government has made no move to phase out fossil fuel exports, nor has it set any target date for the phase-out of domestic fossil fuel consumption. It again rejected the inclusion of a "climate trigger" that would assess domestic or international emissions from local projects during the 2025 reforms of the Environment Protection and Biodiversity Conservation Act 1999.[196] It also approved the extension of the North West Shelf project in WA, the country's largest LNG facility, to 2070, 20 years beyond the date by which Australia has committed to reach net zero.

Sectoral structure

The two scenarios modelled show vastly different trajectories for Australia's fossil fuel production and exports. The CPP scenario, reflecting current policies, sees the status quo continue on a moderate downward trend, with ongoing coal and gas exports justified on the basis that demand will persist elsewhere. The FFPO scenario, in contrast, sees production and exports decline steeply as the world adopts more ambitious climate policies and turns away from fossil fuels.

Both the coal and LNG production sectors are modelled as energy conversions. Coal mines are modelled in aggregate, broken down into three types of product: thermal black coal, brown coal and metallurgical coal. LNG plants are represented at the plant level, with LNG electricity supply represented as a separate, independent electricity production grid. Emissions from gas production are calculated based on production intensities.

In the CPP scenario, we calibrate the emissions intensity of each product using Safeguard Mechanism data, the Emissions Projections and the Net Zero Plan, split between stationary and fugitive emissions. In the FFPO scenario, stationary and fugitive emissions from coal mining follow the HPA trajectories set out in the technical annex. Across sectors, fugitive methane declines in line with the CH_4 extraction emissions in the HPA. For LNG, we account for the roll-out of electric drives and waste heat recovery, following the assumptions of the Australian Industry Energy Transition Initiative.[197]

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[194] Climate Action Tracker, "Highlighting the Hypocrisy: Fossil Fuel Export Emissions."
[195] Grant and Hare, "Australia's Global Fossil Fuel Carbon Footprint."
[196] Evans, "'Climate Trigger' Formally Ruled out of Environment Laws."
[197] Australian Industry Energy Transitions Initiative, *Pathway to Industrial Decarbonisation*.

While domestic demand is determined by aggregating demand across sectors (for example, the brown coal required for Victoria's lignite plants in the power sector), the export trajectories, which represent the bulk of demand for both coal and LNG, are input exogenously. Under the CPP scenario, the production pathways for coal and LNG are determined in the short term by the Resources and Energy Quarterly to 2030, and by the Emissions Projections to 2040, complemented by the Net Zero Plan for the period to 2050.[198]

In the FFPO scenario, we replicate the approach taken by the Reserve Bank of Australia, holding Australia's share of each partner's fossil fuel consumption constant. Exports then track each partner's projected demand, taken here from the HPA results.[199] See the technical appendix for more details.

How to align Australia's fossil fuel industry with 1.5°C

Coal mining

The combined saleable production of thermal and metallurgical coal, serving both domestic and export markets, was 468 Mtpa in 2024. Coal mining emissions, from fugitive and stationary sources, were 38 $MtCO_2e$ in that year.

Under the CPP scenario, coal production volumes remain high to sustain exports while domestic demand declines alongside declining coal use in Australia's power system. Total saleable coal production declines by 5% between 2025 and 2030, by 24% by 2035, and by 56% by 2050. This broadly follows the government's own projections, which see run-of-mine production (i.e., before it is processed to be saleable) drop from 582 Mt in 2025 to 558 Mt in 2030 and 454 Mt by 2035.[200,201]

[198] DCCEEW, "Australia's Emissions Projections 2025"; Australian Government, *Australia's Net Zero Transformation*; Department of Industry Science and Resources, "Resources and Energy Quarterly."
[199] Reserve Bank of Australia, *Towards Net Zero: Implications for Australia of Energy Policies in East Asia*.
[200] Department of Industry, Science and Resources, "Resources and Energy Quarterly: March 2025."
[201] DCCEEW, "Australia's Emissions Projections 2025."

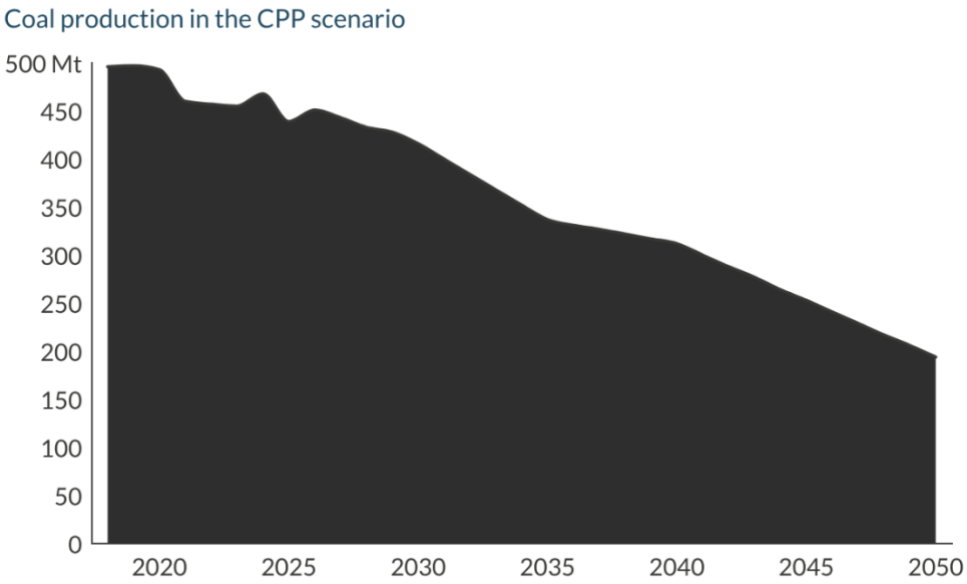

Figure 58: Coal production in the CPP scenario.

The government anticipates a moderate decline in coal mining emissions after they peak in 2028, based on optimistic assumptions about the SGM and a high rate of on-site abatement that may not materialise so long as Australian Carbon Credit Units remain cheap, rather than on a demand-driven decline. Under current policies, coal mining emissions remain broadly stable to 2030, before decreasing to 27 $MtCO_2e$ by 2040 and 16 $MtCO_2e$ by 2050.

By contrast, under the FFPO pathway, production falls by 47% by 2030 and declines to residual levels by the late 2030s. This trajectory leaves no room for new coal mine developments, consistent with IPCC and IEA findings that existing global production is already more than sufficient to meet demand under a Paris-aligned pathway.

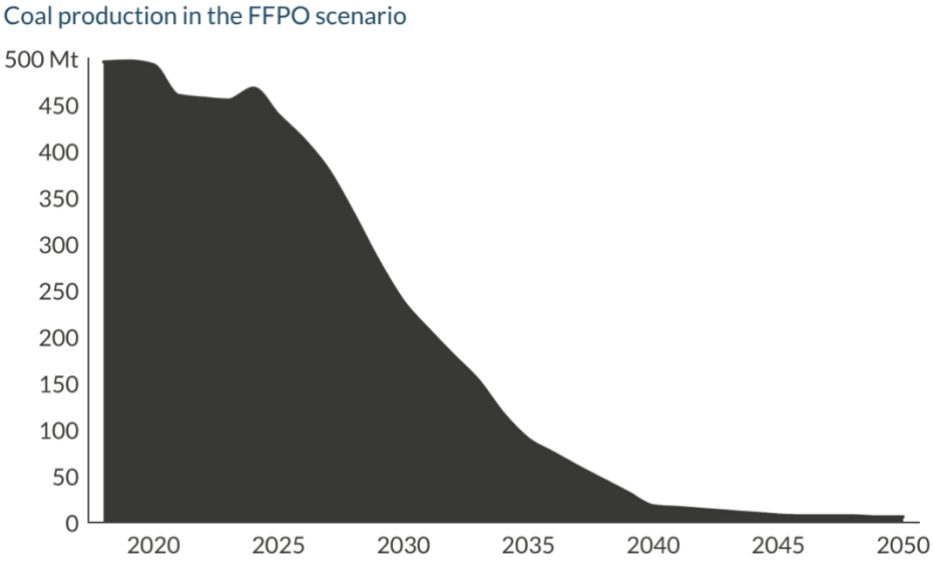

Figure 59: Coal production in the FFPO scenario.

The electrification of coal mines, including a switch to electric machinery and haulage and a phase-out of on-site gas use, reduces emissions intensity in the near term. Improvements in fugitive methane management at active and abandoned mines, through monitoring and leak management technologies, contribute to further reductions of this potent greenhouse gas. As the IEA notes, methane emissions from the energy system are low-hanging fruit, with significant abatement achievable at no net cost. Combined, these factors mean that coal mining emissions halve by 2030 and are at residual levels by 2040.

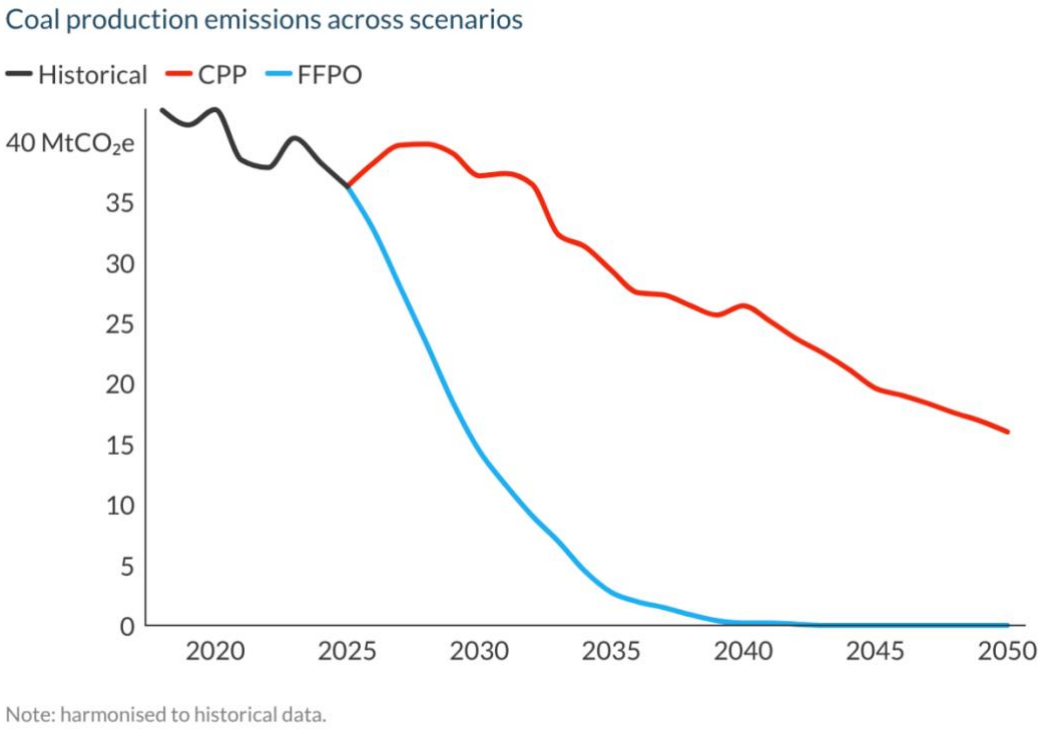

Figure 60: Coal production-related emissions across the CPP and FFPO scenarios out to 2050.

LNG production

The fossil fuel export industry is a major domestic energy user. In 2024, 30% of the gas consumed in Australia was supporting LNG production, either self-consumed at LNG plants or at on-site electricity generators. The remainder supplies domestic consumers such as manufacturers, gas power generators and buildings.[202] Support for the gas industry is enshrined in national strategy, as evidenced by the government's 2024 Future Gas Strategy, despite its incompatibility with the Paris Agreement's 1.5°C temperature limit.

[202] Australian Government Department of Climate Change, Energy, the Environment, and Water, *Australian Energy Statistics - Update Report 2025*.

The government does not anticipate the steep decline in fossil fuels seen in 1.5°C-aligned scenarios. Under current policy projections, LNG production decreases only marginally from 79 Mt in 2025 to 75 Mt by 2035. The pace of decline slows after 2040, and by mid-century, Australia still exports more than 50 Mt of LNG annually.

The government anticipates a decline in emissions from LNG production, based on optimistic assumptions about the SGM and a high rate of on-site abatement that may not materialise so long as Australian Carbon Credit Units remain cheap, but at a slower pace than emissions reductions across the rest of the economy.

LNG-related emissions (including electricity) accounted for 7% of Australia's gross emissions in 2025. The government anticipates that this share will rise to 8% by 2030. LNG-related emissions, encompassing on-site gas combustion, electricity generation, and methane and CO_2 fugitive emissions from venting and flaring, decrease by 11% by 2030 and 56% by 2050 under the CPP scenario, from a current level of 35 $MtCO_2e$. The CPP scenario, which relies on modest decarbonisation of production processes but imposes no policy constraints on demand, still sees around 16 $MtCO_2e$ of LNG-related GHG emissions in 2050.

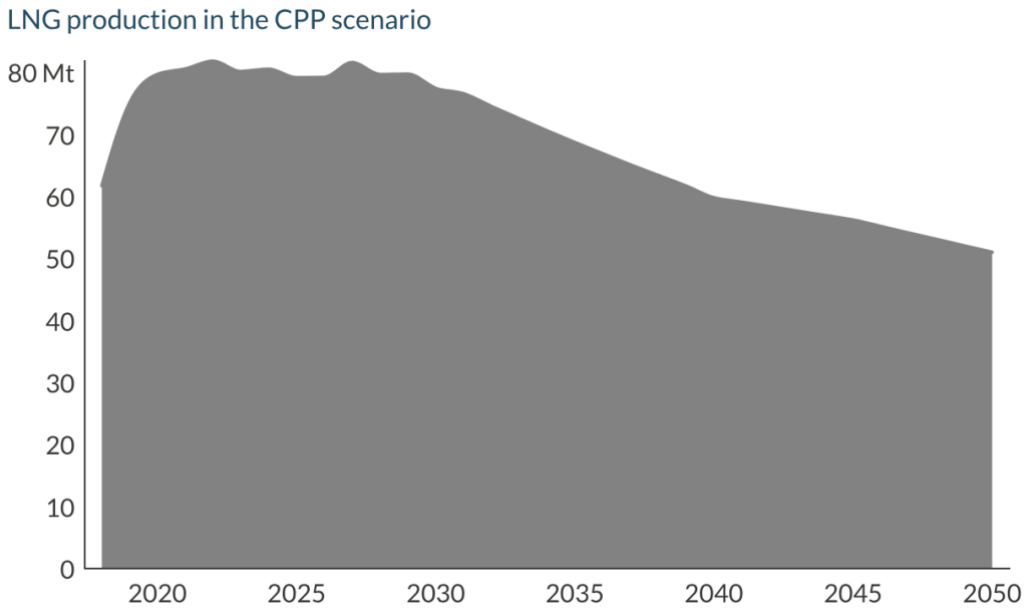

Figure 61: LNG production in the CPP scenario.

LNG exports follow a different trajectory under the more ambitious FFPO scenario. From about 80 Mtpa in 2024, annual LNG production falls to 63 Mtpa by 2035, 30 Mtpa by 2040 and 7 Mtpa by 2050.

This production profile does not allow for further expansion of the LNG industry in Australia, consistent with IPCC and IEA findings that there is no room for new long-lead fossil fuel developments in a pathway aligned with the Paris Agreement's 1.5°C

temperature limit.[203] As covered in the following section, this would also apply to oil and gas exploration and development for domestic purposes, given the relatively small volumes of production compared with exports. Globally, under the highest ambition pathway on which our fossil fuel phase-out scenario for Australia is based, existing production is more than sufficient to meet demand to 2050.[204]

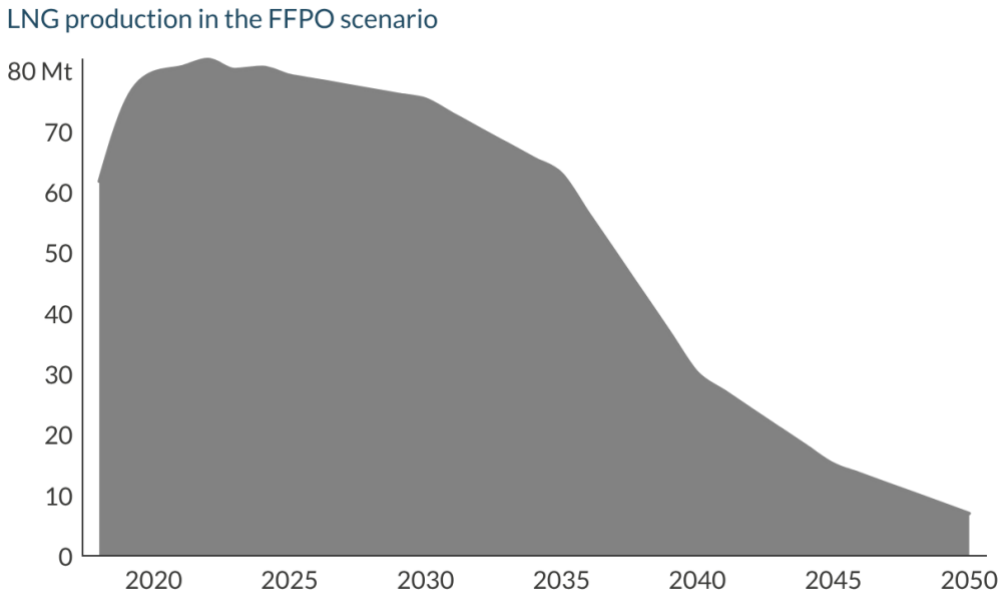

Figure 62: LNG production in the FFPO scenario.

At LNG plants, the FFPO scenario sees the systematic roll-out of renewables for on-site generation and waste heat recovery systems, followed within a few years by electric drives. This reduces the amount of fossil fuel combusted for LNG production, from 440 PJ in 2024, according to the national energy statistics, to 90 PJ by 2040.

Substantial improvements in methane emissions management, through technologies to monitor and manage leakage as well as measures to cut flaring and venting, further reduce emissions of this potent greenhouse gas. The methane intensity of Australia's LNG production in the FFPO scenario, aligned with the HPA scenario, is consistent with the reductions from the latest IEA Net Zero Emissions scenario, falling by 85% between 2025 and 2035.

Combined, these factors dramatically cut emissions intensity. Reductions in demand and cuts to both stationary and fugitive emissions under the FFPO scenario push total emissions from LNG production down from 35 $MtCO_2e$ in 2025 to 17 $MtCO_2e$ by 2035, 5 $MtCO_2e$ by 2040 and less than 1 $MtCO_2e$ by 2050: these reductions, though drastic,

[203] IPCC, "Climate Change 2022 - Mitigation of Climate Change."
[204] Climate Analytics and PIK, *Rescuing 1.5°C: New Evidence on the Highest Possible Ambition to Deliver the Paris Agreement*.

are broadly consistent with those envisioned by Equinor for its plants in Norway. Relative to the CPP scenario, in which the share of LNG in national emissions remains stable, this share drops in the FFPO scenario to 4% of domestic gross emissions by 2040, and 1% by 2050.

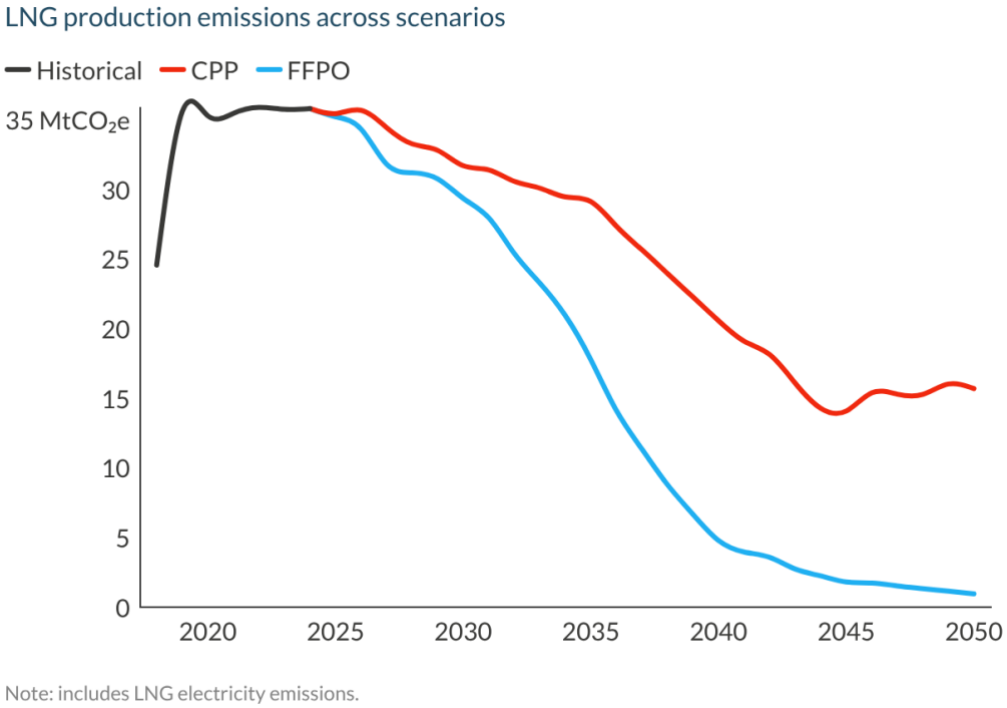

Figure 63: LNG production-related emissions across the CPP and FFPO scenarios out to 2050.

Switching to green exports is a unique opportunity for Australia

Australia could replace export-linked economic and employment returns from fossil fuels with growth in alternative green industries. This includes domestically decarbonised commodities such as metals, fertilisers, and fuels, which can act as energy carriers for Australia's comparatively low-cost and abundant renewable energy. It also includes mineral and technology inputs to the generation, transmission, storage, and utilisation of renewables or other clean forms of energy.

Our FFPO scenario assumes modest growth in these sectors, reflecting the considerable ongoing uncertainty about which industries might dominate in future. New assumptions could be easily overlaid onto the scenario as clearer pathways emerge. Regardless, emissions from Australia's largely status quo

commodity export mix still crater under the FFPO scenario, producing newly decarbonised output, as already captured in the industry sector above.

Policy implications

With fossil fuel production and export emissions accounting for a significant share of both Australia's domestic and global contribution to climate change, the government must prioritise a managed phase-out of the sector to align with the Paris Agreement's 1.5°C temperature limit. Doing so would help redirect investment flows towards Paris-aligned diversification opportunities instead of prolonging an industry that is ultimately incompatible with a world moving to reduce greenhouse gas emissions. It would also allow the government to regain political credibility as public sentiment increasingly turns against fossil fuel companies.

A coherent government strategy must therefore focus on carefully planning the phase-out of fossil fuel production and exports, while ensuring adequate economic diversification and support for affected communities. Australia has long discussed the need to diversify its economy, but this transition now requires concrete implementation to ensure industries are resilient in a rapidly changing global context. Localised transition support will also be essential for workers and regions that depend heavily on fossil fuel industries.

A first step would be to stop approving new fossil fuel projects and expansions, in line with findings from both the IEA and the IPCC, as well as the ICJ's advisory opinion that state support for new fossil fuel developments may constitute a breach of international law. In 2026, such projects are increasingly out of step with global climate objectives and risk locking in emissions from assets that may ultimately become stranded.

The second step is to coordinate the retirement of existing assets on a planned, asset-by-asset basis, through an overarching fossil fuel phase-out strategy with clear timelines. Transition planning involving governments, private stakeholders, and civil society can support an orderly and just transition.

A fossil-free Australian energy system

The sectoral transformations outlined above all contribute to a restructuring of the way Australia supplies and consumes energy. The following section details the high level, aggregated trajectories of the FFPO scenario, compared to the CPP pathway.

Final energy demand

A structural, system-level difference between the FFPO and CPP scenarios is the trajectory of final energy demand, or demand from end-use sectors such as transport, buildings and industry, out to 2050. In the FFPO scenario, final energy demand falls 6% below 2025 levels by 2030 and 17% by 2035, and by mid-century is still 19% below 2025 levels. Under CPP, demand remains broadly stable to 2040 and is only 5% below 2025 levels by 2050.

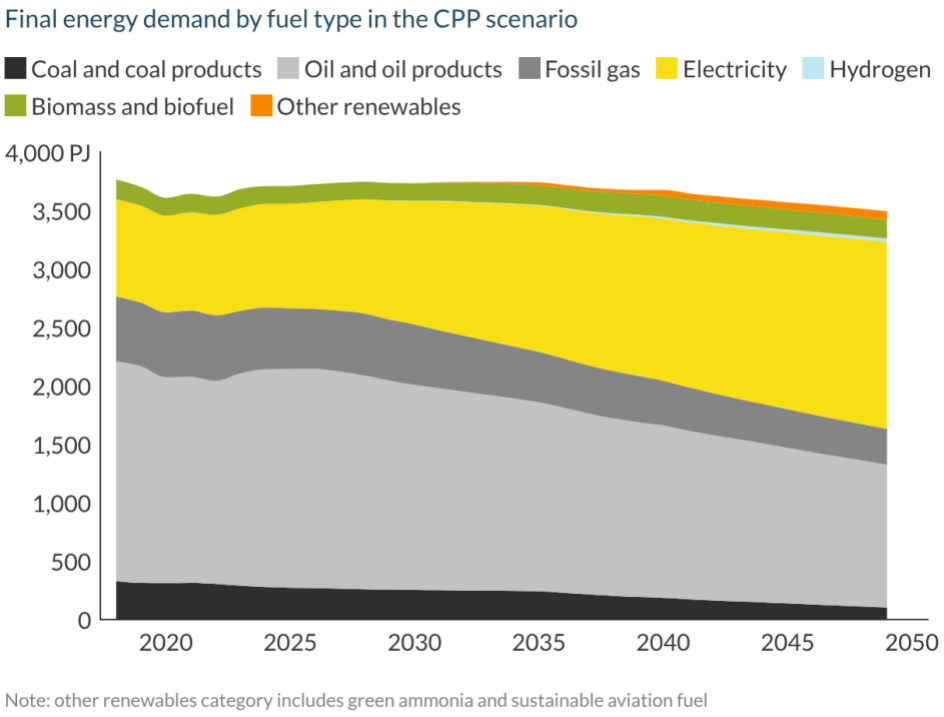

Figure 64: Final energy demand by fuel type between 2018-2050 in the CPP scenario

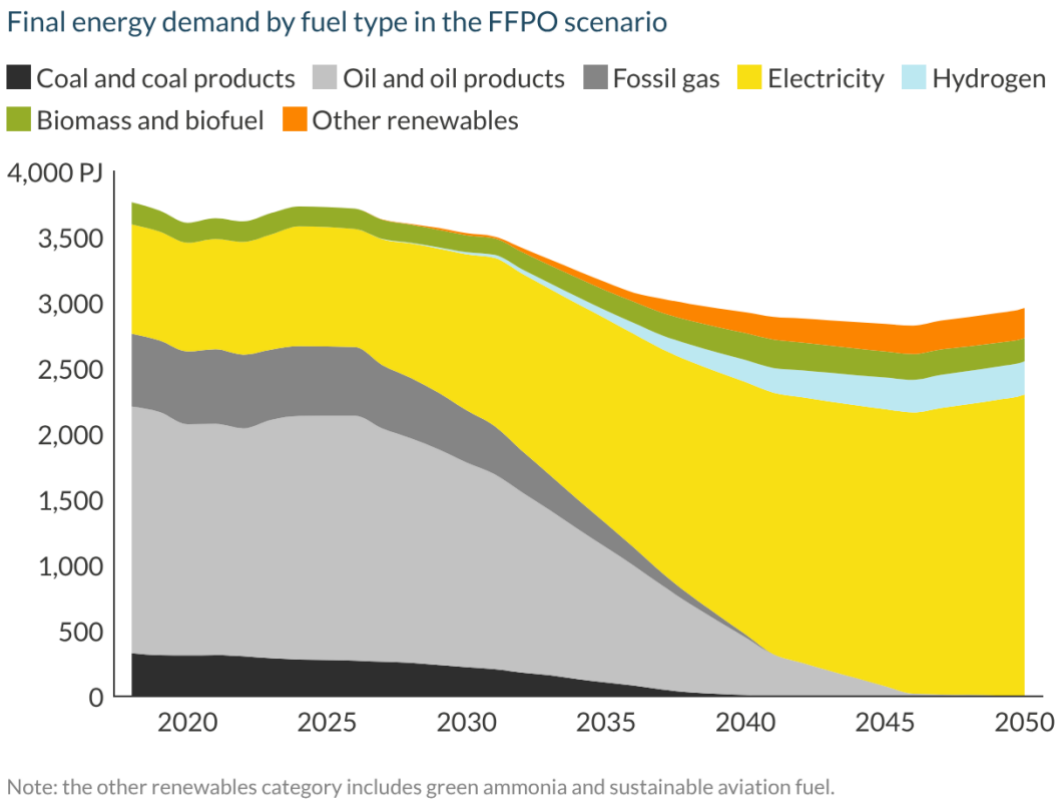

Figure 65: Final energy demand by fuel type between 2018-2050 in the FFPO scenario

This near-term fall occurs despite real GDP and population growing faster than under the CPP pathway (see macroeconomic drivers textbox). Higher growth usually pushes energy demand up. In the FFPO scenario, however, widespread electrification and structural efficiency gain more than compensate it. Electricity and electric technologies deliver more useful energy per unit of input than the fossil-based technologies they replace, so electrification lowers economy-wide energy intensity down even as output rises. Demand from direct air carbon capture and storage, emerging in the 2040s, stays small, at only 100 PJ in 2050 (see section on carbon dioxide removal).

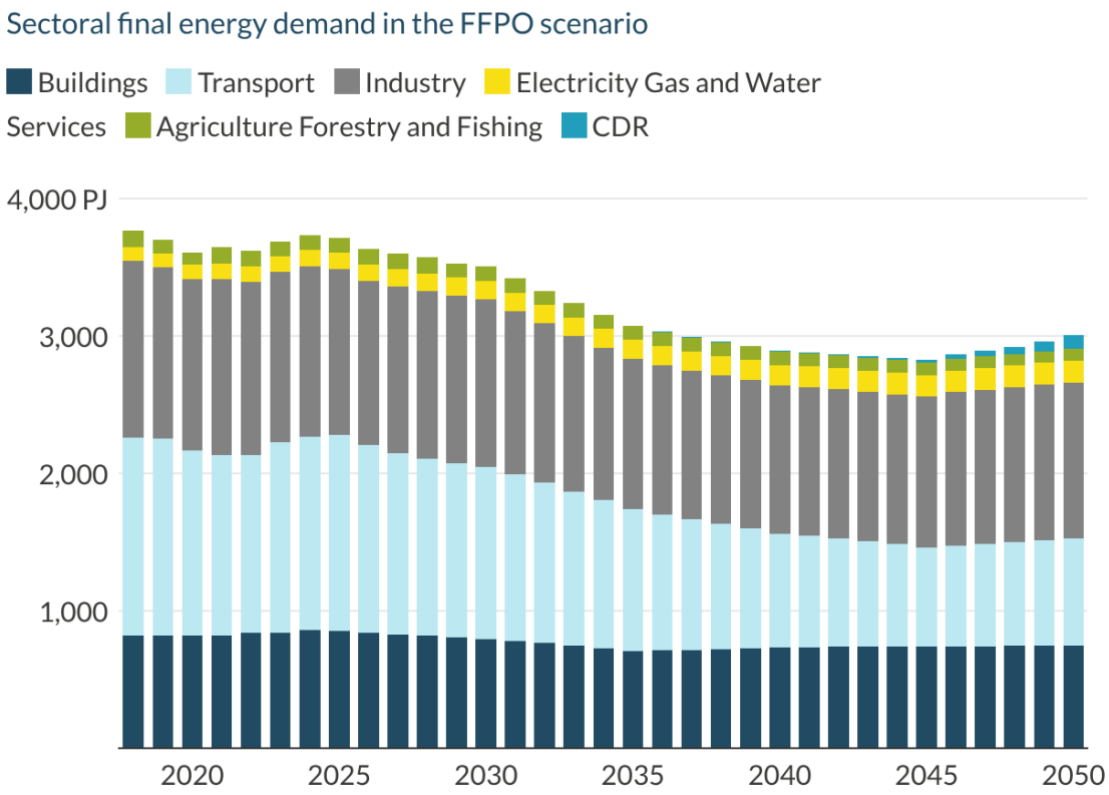

Figure 66: Sectoral final energy demand in the FFPO scenario.

Macroeconomic drivers

Population and GDP growth are the two main macroeconomic inputs. They drive activity — how much people travel, how much demand there is for office space etc — which in turn drives demand across the model's energy demand sectors.

The choice of these drivers therefore has a large impact on the energy system. We aligned them with standard Australian sources: AEMO and the RBA for GDP, and government forecasts from the ABS for population (see technical annex for details).[205] GDP grows by an average of 1.9% per year from 2025 to 2050 under the CPP scenario, compared with 2.6% under the FFPO scenario. Australia's population increases to 35 million under the CPP scenario, and 38 million under the FFPO. These timeseries are in line with those used or determined in other

[205] ABS, "Australian System of National Accounts (2024-25 Financial Year)"; RBA, "Statement of Monetary Policy"; ABS, "Population Projections, Australia (2022 (Base) - 2071)"; ABS, "Household and Family Projections, Australia (2021 - 2046)"; AEMO, "2025 Inputs, Assumptions and Scenarios."

publications, such as the Treasury's Net Zero Transformation modelling and the Deloitte 2024-25 Economic forecasts.[206]

Following AEMO's scenarios, futures with stronger climate action also assume higher economic and population growth, both of which are higher under FFPO than under CPP. Typically, a larger economy with a higher population would produce higher emissions if energy and emissions intensity remained constant. This is not the case in either AEMO's scenarios or FFPO, as coordinated renewable deployment, electrification and energy efficiency improvements reduce emissions while delivering the co-benefits already discussed in this report.

Textbox 5: Macroeconomic drivers

Electrification

Electricity is the backbone of Australia's transformation under the FFPO scenario. Electricity demand and share of energy consumption increases massively through to 2050. In this scenario, final electricity demand (which excludes electricity demand from transformation processes, like from electrolysers) reaches 350 TWh in 2030 and 650 TWh in 2050, up from 240 TWh at present. In contrast, it only rises to 450 TWh by 2050 in the CPP scenario.

Under the FFPO scenario, electricity demand represents 36% of Australia's final energy demand in 2030, 51% in 2035 and over 75% in 2050, up from 24% currently. In the CPP scenario, Australia would almost meet the global goal of 35% electrification by 2035, rising to 46% by mid-century. Fossil fuels would therefore continue to play a major role in the national energy system, contributing to the country's emissions burden in 2050 (see next section for more details).

[206] Deloitte, "Economic Forecasts 2024-25"; Australian Government, *Australia's Net Zero Transformation*.

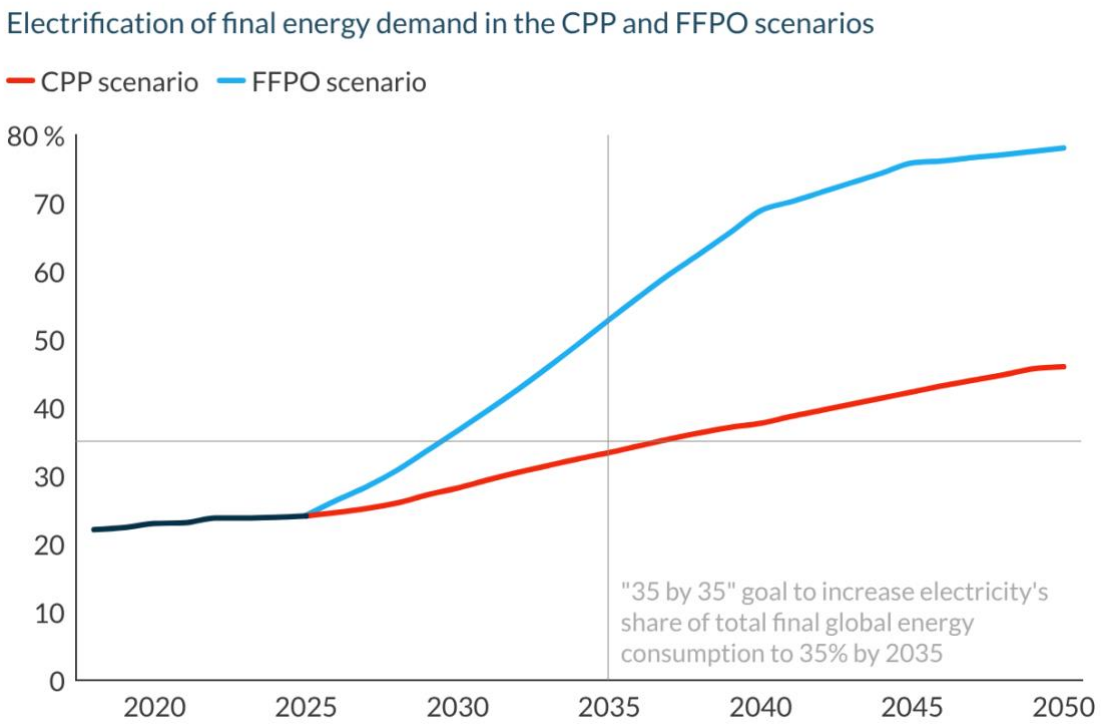

Figure 67: Electrification of final energy demand in the CPP and FFPO scenarios.

Electricity is not the only energy carrier able to displace fossil fuels. Green hydrogen deployment remains limited under the CPP pathway, but rises to 250 PJ by 2050 under the FFPO scenario, with demand from the industry sectors and the growth of green ammonia. Biomass consumption in final energy demand sectors increases moderately under the FFPO scenario, from around 150 PJ in 2025 to 170 PJ in 2050, peaking at 210 PJ in 2040 (compared to 180 PJ in 2040 and 160 PJ in 2050 in CPP). This comparatively small growth limits competition with other land use.

Meanwhile, the share of fossil fuels in final energy demand falls from 70% today to 58% in 2030. They are phased out from end-use sectors in the second half of the 2040s under the FFPO scenario. In the CPP pathway, they still represent over two-thirds of the final energy mix in 2030 and 45% by 2050.

The following section examines primary energy demand from coal, fossil gas and oil. Unlike final energy demand, primary energy demand counts fuel consumption “at source”, and so includes the fuels used as inputs to processes that convert energy from one form to another, such as coal used for electricity production.

Coal phase-out

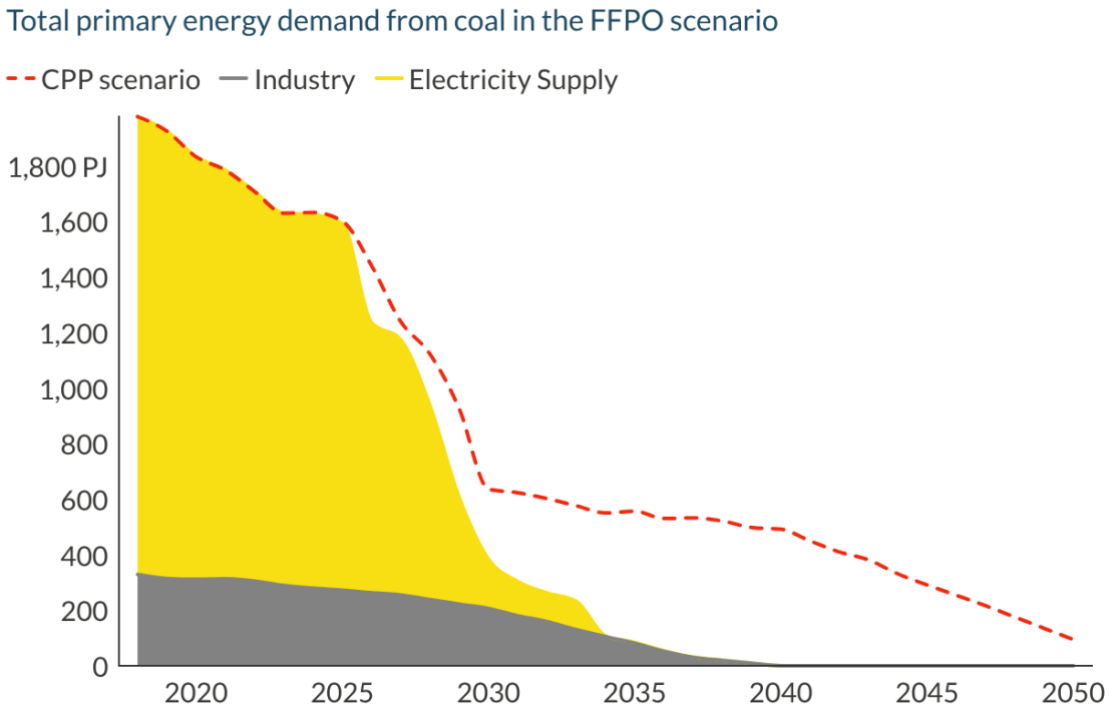

Figure 68: Total primary energy demand from coal in the FFPO scenario compared to CPP.

Australia's domestic coal consumption is concentrated in the power and industry sectors. It accounted for one-fourth of the national energy consumption in 2024.[207] Under the FFPO pathway, renewables deployment in the electricity system and the switch to hydrogen in industry end coal-fired generation by 2034 and phase out coal use in industry by 2040.

The CPP scenario follows the same trend to 2030, as both the SWIS and the NEM move towards the 82% on-grid renewables target, but the trajectories diverge post-2030: coal use in electricity continues until mid-century and there is no phase-out in industry. In this scenario, primary coal demand falls to 69% below 2025 levels by 2040 and 94% below by 2050.

This trajectory is not aligned with the Paris Agreement's temperature limit. Paris-aligned benchmarks for the power sector have shown that developed countries should phase out coal from their electricity systems by 2030.[208] The HPA scenario, which accounts for the

[207] Department of Climate Change, Energy, the Environment and Water, "Australian Energy Update 2025."
[208] Climate Action Tracker, "Paris-Aligned Benchmarks for the Power Sector."

emissions reductions missed since the AR6 cycle, finds that coal must be phased out globally in the 2040s.[209]

Gas phase-out

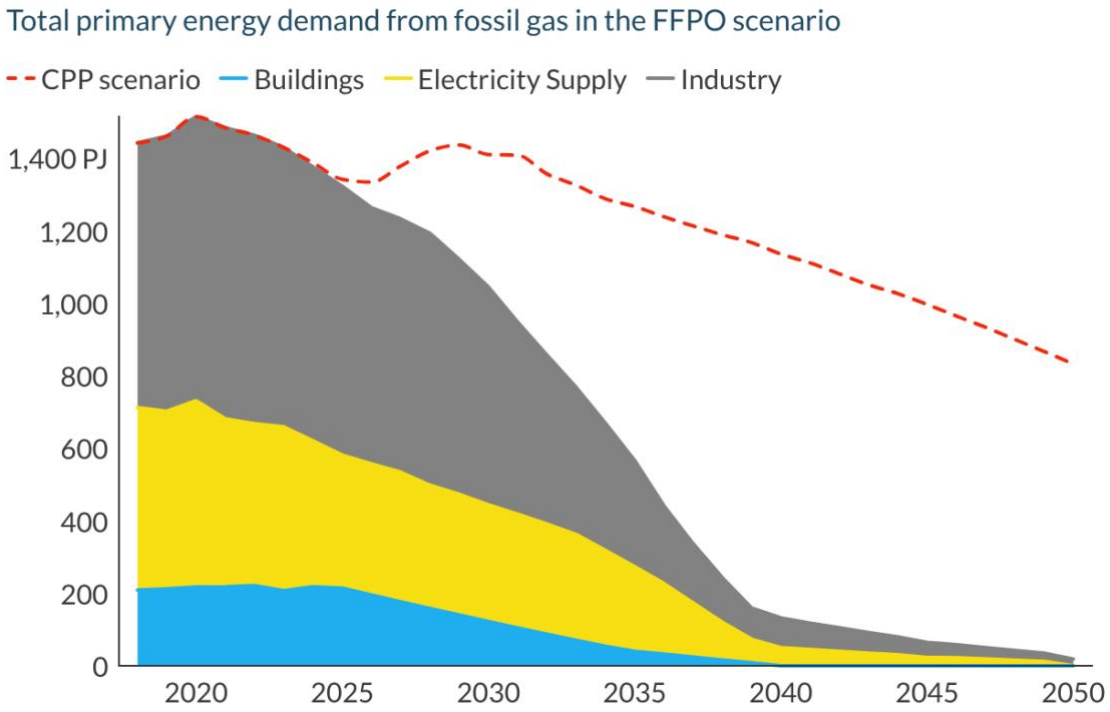

Figure 69: Total primary energy demand from fossil gas in the FFPO scenario compared to CPP.

Fossil gas use is more diverse than that of coal. As with the latter, most of Australia's production is exported as LNG, but fossil gas is also used across buildings, industry and power generation. It accounted for 25% of national energy consumption in 2024.[210]

The FFPO and CPP scenarios have vastly different consumption trajectories for this fuel. In the FFPO scenario, the shift to renewables, electrification of buildings and industry, and fuel switching across industry subsectors lead to a substantial decline in fossil gas consumption. Demand falls by 90% between 2025 and 2040, and by 98% by 2050.

Fossil gas keeps playing an important role in the CPP scenario. Its consumption falls by only 15% by 2040 and 38% by 2050. This lower reduction is a consequence of the government's framing of fossil gas as a transition fuel. The Future Gas Strategy points to continued reliance on gas in the domestic market and calls for new gas exploration to

[209] Climate Analytics, "Rescuing 1.5°C: New Evidence on the Highest Possible Ambition to Deliver the Paris Agreement."
[210] Department of Climate Change, Energy, the Environment and Water, "Australian Energy Update 2025."

secure supply at affordable prices.[211] The document promotes Australia as a "reliable trading partner" for fossil gas. In the CPP pathway, LNG production is by far the largest gas end-user domestically, accounting for 30% of domestic primary gas demand: more than for any other fuel, domestic and international energy policy are interlinked for fossil gas.

The IEA finds that no new field development is needed in a 1.5°C-aligned scenario.[212] Echoing these findings, in the HPA scenario, existing capacity is more than sufficient to meet global demand.[213] New exploration and production run counter to a reasonable interpretation of the Paris Agreement and of Australia's role as an Annex II country, and risk contravening international law as set out by the ICJ in its 2025 advisory opinion.

Oil phase-out

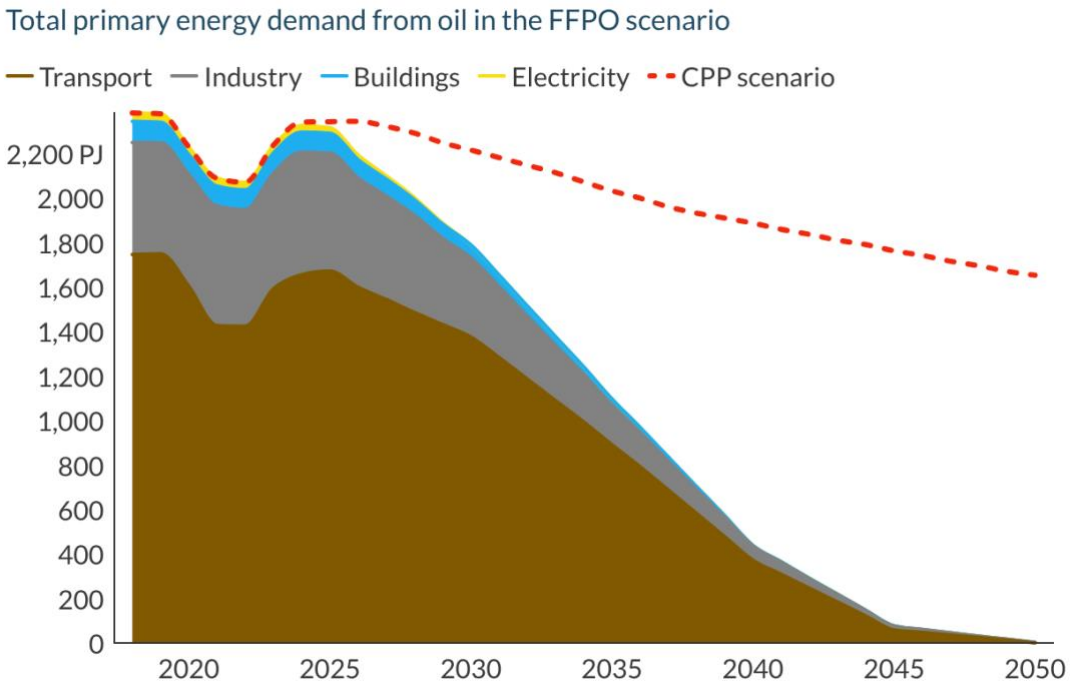

Figure 70: Total primary energy demand from oil in the FFPO scenario compared to CPP

Oil accounts for the largest share of energy demand in Australia, at 40%.[214] Half of this demand sits in the transport sector, where oil and oil products met 99% of the total

[211] Department of Industry, Science and Resources, "Future Gas Strategy."
[212] IEA, *Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach - 2023 Update*.
[213] Climate Analytics, "Highest Possible Ambition: Science-Aligned Fossil Fuel Phase-out Pathways."
[214] Department of Climate Change, Energy, the Environment and Water, "Australian Energy Update 2025."

sectoral demand in 2025. Oil phase-out in the FFPO scenario is mainly driven by the electrification of the transport sector with the switch to electric vehicles in passenger and freight transport, and to sustainable aviation fuels in aviation. Under this scenario, oil demand halves between 2025 and 2035, falls 80% below 2025 levels by 2040 and is phased out by 2050.

Conversely, oil sees the slowest decline of all fossil fuels in the CPP scenario, falling by only 30% between 2025 and 2050. This is largely a consequence of sluggish transport sector electrification: while oil consumption in industry falls by two-thirds over this timeframe, transport oil use falls by only 20%. This would lock Australia into its current fossil fuel insecurity, as 80% of Australia's refined products were imported in 2024.[215]

This phase-out trajectory is nowhere near a Paris-aligned timeframe. The combined lag in eliminating coal, fossil gas and oil from its energy system would leave Australia with a major emissions burden by mid-century — discussed in more detail in the following sections — in addition to missing out on the employment, energy security and other co-benefits of the transition.

Reaching net zero emissions

Minimising residual emissions

The structural changes under the FFPO scenario place Australia on a Paris-aligned emissions trajectory where gross emissions fall to 320 $MtCO_2e$ in 2030 and 202 by 2035, equivalent to 39% and 62% below 2005 levels. By 2050, gross residual emissions, mostly coming from agriculture with marginal contributions from waste and industrial processes and product use, are at 70 $MtCO_2e$ (see Figure 71: Gross emissions by sector in the FFPO scenario (excl. technological CDR), compared with gross emissions from the CPP scenario.

In comparison, in the CPP scenario gross emissions are 21% below 2005 levels in 2030, 28% by 2035. Outstanding gross emissions would be 245 $MtCO_2e$ in 2050.[216]

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[215] Department of Climate Change, Energy, the Environment and Water, “Australian Energy Update 2025.”

[216] This is higher than what is modelled under the government’s Net Zero Plan (in which residual emissions are 167 $MtCO_2e$ by mid-century), as the CPP pathway is aligned to the government projections in the period to 2040. By design, the two government documents are not internally consistent since they are based on self-contained independent modelling exercises. The baseline scenario from the Net Zero Plan, for example, achieves Australia’s 2035 NDC goal of reducing emissions by 65% below 2005 levels by 2035; under the projections, net emissions are only 48% lower than 2005 levels by then.

Emissions at this level do not fit the usual definition of residual, used to refer to outstanding emissions once all technically and economically feasible abatement has been deployed. Of the 245 $MtCO_2e$ still emitted in 2050, 151 $MtCO_2e$ comes from the energy sector, where many readily available technologies are cost-competitive for decarbonisation.

As covered in more detail in the following section, the more emissions a pathway leaves, the heavier the removals burden it passes on. Reaching the government's net zero goal from 245 $MtCO_2e$ would require scaling removals to more than half of Australia's current net emissions. Carbon dioxide removal cannot be a substitute for actual emissions cuts. Carbon dioxide removal, either land-based or technological, has its own risks and uncertainties; land sinks are reversible, and deployment of either land-based or technological CDR has land, water and energy footprints that compromise other sustainability goals. Any removals should be reserved to counterbalance "truly" unavoidable emissions instead of being used as offsets for continued fossil fuel use.

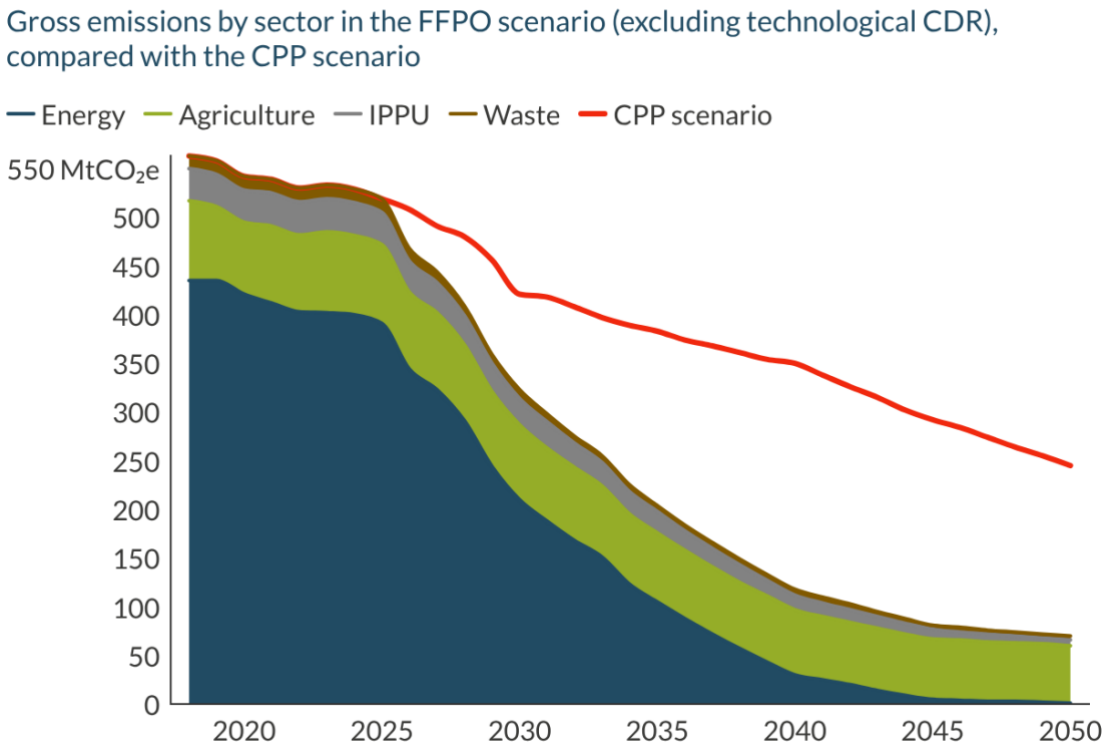


Figure 71: Gross emissions by sector in the FFPO scenario (excl. technological CDR), compared with gross emissions from the CPP scenario

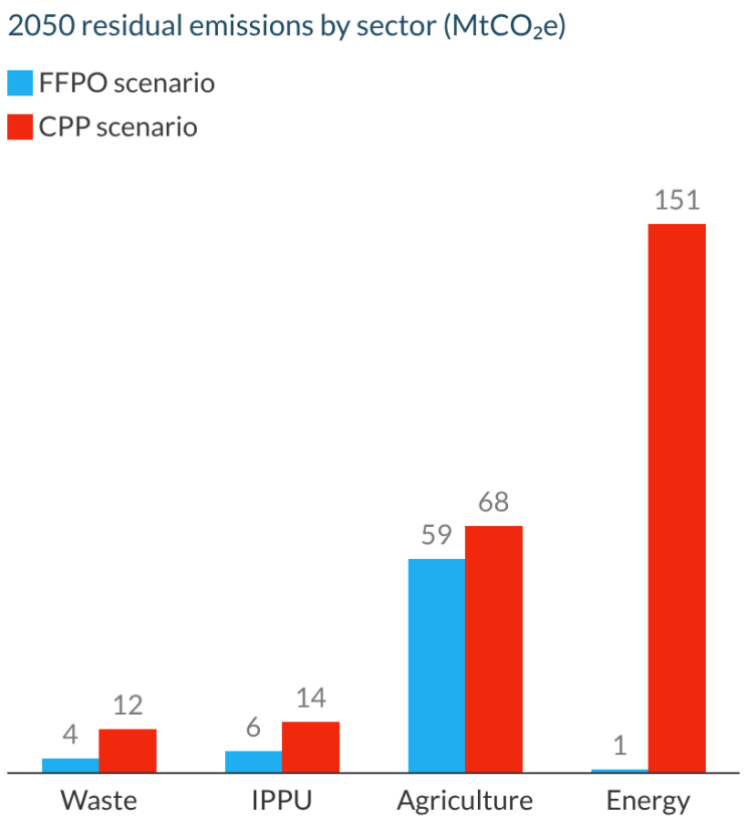


Figure 72: Residual emissions by sector across scenarios

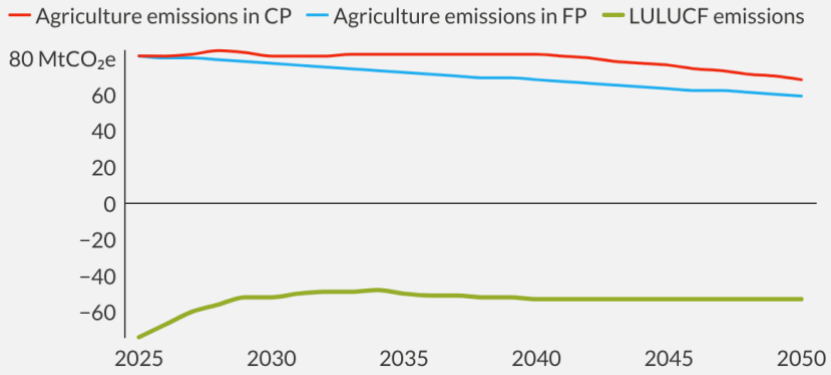
The land sector's key role in the transition

Our model focuses primarily on Australia's energy system, which can deliver the bulk of the national emissions reductions needed to align with the Paris Agreement temperature limit. But because of Australia's landmass, its diverse biomes and its agricultural output, the land sector also plays an important role in the transition.

Agriculture in particular accounts for the majority of 2050 residual emissions in the government's net zero plan, which notes the lack of commercially viable abatement options in the sector. The sector's emissions fall by only 30% between 2025 and 2050. For agriculture sectors (like for waste and IPPU, as discussed separately), we have applied the per-gas emissions growth rate from the HPA CAZ region to the historical CO_2, N_2O and other GHGs time series.

For methane emissions, the HPA scenario which uses a default SSP2 socio-economic set-up may be underestimating the total CH4 reductions which can be achieved, including via demand-shifts to reduce consumption of particular

methane-intensive agricultural products. To capture the broader potential for methane mitigation in agriculture, we use the range from the C1a pathways.



Textbox 6: Land sector's role in the transition

Urgent action is needed to cut methane emissions

In 2022, Australia signed the Global Methane Pledge, a call to reduce global methane emissions by at least 30% below 2020 levels by 2030. According to the latest available inventory, agriculture accounted for around half of Australia's methane emissions, with energy, LULUCF and waste contributing 26%, 15% and 11%, respectively. Methane emissions made up 27% of Australia's total greenhouse gas emissions.[217]

Methane abatement potential differs by sector. Most energy-related methane emissions come from coal mining and oil and gas fugitive emissions. A large share of these can be abated at net-negative to low cost, and in an ambitious climate scenario declining production would drive them down further: in the FFPO scenario, energy-related methane emissions are eliminated by 2040. Under this pathway, total methane emissions are 21% below 2020 levels by 2030 and 44% by 2050, falling short of the Global Methane Pledge because of lack of progress in the first half of the decade. In comparison, they decline by 3% by 2030 and 8% by 2040 below 2020 levels in the CPP scenario.

Waste, agriculture and LULUCF methane emissions are harder to tackle and make up a significant share of residual emissions in 2050, as shown below. Shifting away from meat-based protein in diets, scaling up agricultural methane technologies

[217] DCCEEW, *Australia's National Greenhouse Accounts*.

that are not yet commercially viable, and improving waste management practices could drive these emissions down further.[218]

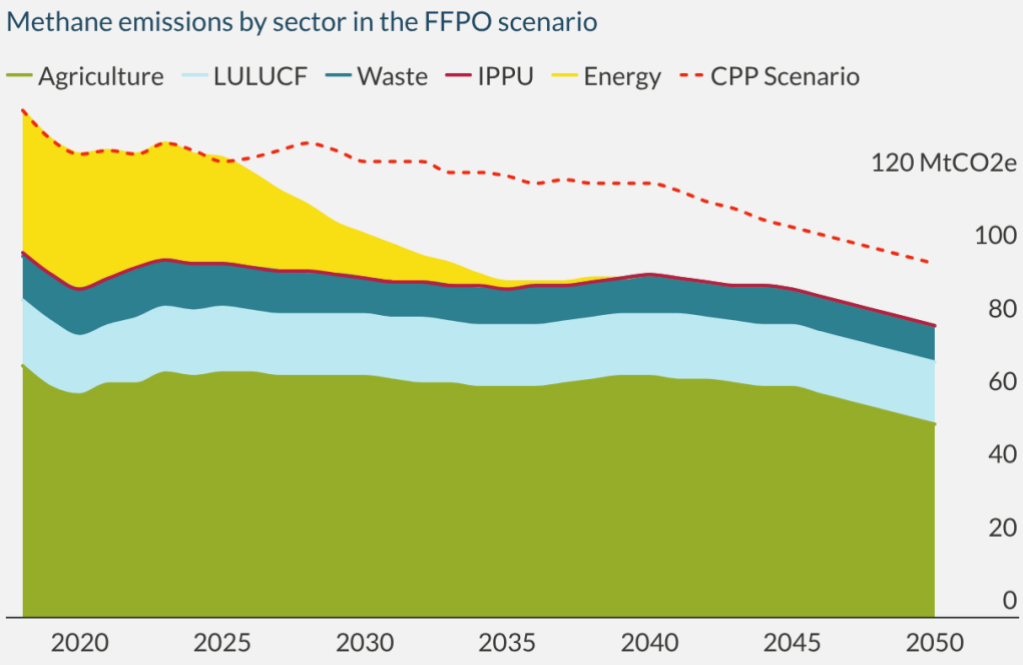


Figure 73: Methane emissions by sector in the FFPO scenario

Textbox 7: Urgent action is needed to cut methane emissions

Range of carbon dioxide removal requirements

To reach net zero greenhouse gas emissions by 2050 in the FFPO scenario, 70 $MtCO_2$ must be sequestered mid-century to match the residual emissions that cannot be eliminated by other means (see their breakdown in Figure 72). In the following sections, we distinguish CDR between two types: so-called conventional CDR refers to land sequestration, while novel or technological CDR refers to human-made technologies able to remove carbon from the atmosphere.

LULUCF is a substantial source of negative emissions

Because of Australia's landmass and its diverse biomes, the LULUCF sector will be among the first contributors to negative emissions and the main CDR source to get to net zero

[218] Climate Change Authority, "Sector Pathways Review."

in 2050. It is for now the only source of negative emissions in Australia, with an estimated net sink of 74 $MtCO_2e$ in 2025.

For these reasons, the future trajectory of the LULUCF sector is an important component of the FFPO scenario's path towards net zero. We have included conservative assumptions about the evolution of this sector, especially relative to other published modelling. We assume that LULUCF sink levels will follow the government's projections to 2040, then stay constant afterwards.

This methodological choice may underestimate what ambitious, sustainable land-use policies can achieve. Nevertheless, it avoids underestimating the need for technological CDR, as higher LULUCF sinks would lower the technological CDR required for the same net emissions outcome. It also avoids the pitfall of over relying on LULUCF to meet climate targets. LULUCF emissions accounting is uncertain, especially as global temperature increases erode the potential for land to sequester carbon.[219]

In this sense, our approach treats stronger LULUCF performance as an upside rather than a starting point. If effective land-use policies deliver larger sinks than projected – which would be welcome if sustainable – the path to net zero becomes easier. That outcome cannot be assumed, and the FFPO scenario prioritises reducing gross emissions as far as possible and scaling up technological CDR, over which there is greater control, to limit the risk of falling short of the 2050 net zero greenhouse gas target.

This choice makes our net emissions structure and trajectory differ from those of other modelling (see Figure 74). Like discussed in the section on Australia's net zero strategy, the government's net zero plan anticipates that land sequestration will compensate all 167 $MtCO_2e$ of outstanding mid-century emissions. Our CPP scenario has even more gross emissions in 2050 (245 $MtCO_2e$). Achieving land sinks of this scale relies on many assumptions. It would require the roll-out of the incentives needed to drive such high levels of abatement, which would have to more than double relative to current levels in less than 25 years. It relies on sequestration prospects remaining favourable in a warming world. It might also generate trade-offs with other land uses. The Treasury did not include what it calls novel CDR technologies because of their high projected cost.[220]

The CSIRO 2025 net zero scenarios, which informed the design of the government's 2035 NDC target, show a wide range of trajectories for LULUCF emissions, with higher sequestration the sooner Australia reaches net zero. CSIRO notes that "sequestration from trees will peak and then decline, and there is a limit to the land that can be used to

[219] Global Carbon Budget, "GCB 2025."
[220] Australian Government, *Australia's Net Zero Transformation*.

store carbon", and emphasises the need for both steeper emissions cuts and technological CDR.[221]

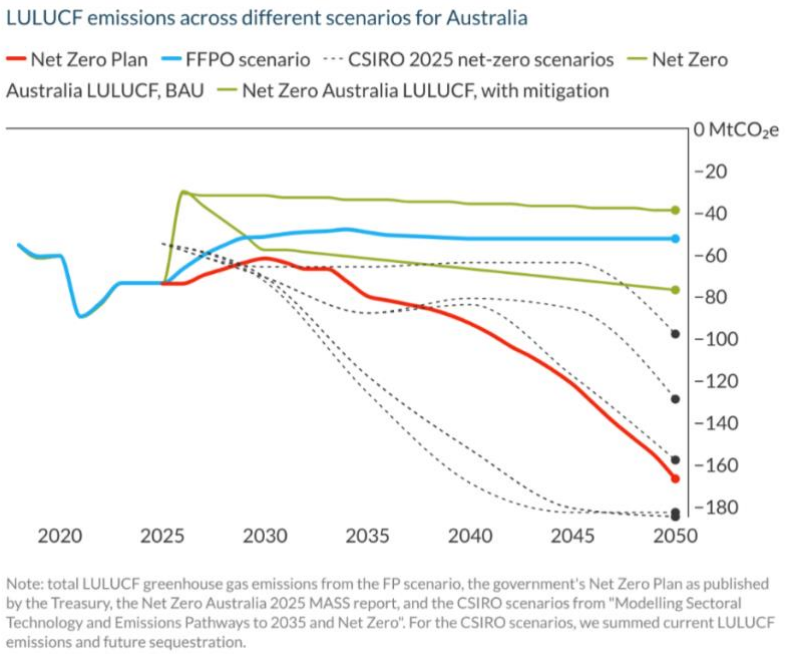


Figure 74: LULUCF emissions across different scenarios for Australia

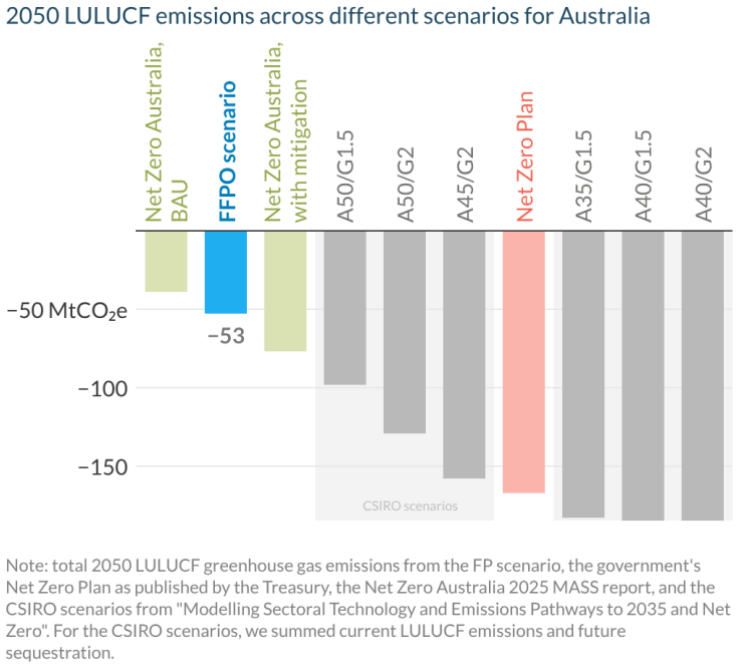


Figure 75: LULUCF emissions in 2050 across different scenarios for Australia

[221] CSIRO, "Modelling Sectoral Technology and Emissions Pathways to 2035 and Net Zero Emissions."

Novel CDR can close the gap to reach net zero

Based on this LULUCF trajectory, FFPO net emissions are 55% below 2005 levels by 2030, and 75% by 2035. After accounting for the 53 $MtCO_2e$ of LULUCF sequestration mid-century, 17 $MtCO_2e$ of net emissions remain to be closed to reach net zero GHGs in 2050. This residual will need to be addressed through novel CDR technologies.

In the FFPO scenario, we focus on the implementation of DACCS. Direct air capture is well suited to Australia's comparative advantage in CDR: the country has abundant renewable potential, and the fossil fuel phase-out at the core of this scenario builds the renewable deployment momentum DACCS can draw on. The most mature DAC capture options (solid-sorbent systems and mineral looping) have a high level of technological readiness and are commercially deployed.[222]

To represent DACCS in our model, we relied on the technical parameters from the 2025 CSIRO CDR Roadmap, the first large-scale, comprehensive study of CDR potential in Australia.[223] CSIRO finds the country has a DACCS potential of 216 $MtCO_2e$ per year of capacity under conservative assumptions, nearly half of Australia's current GHG emissions in CO_2 equivalent.

Like other emerging technologies, DACCS deployment will follow a scaling trajectory as the technology matures and experience accumulates. We modelled its scale-up as a logistic ramp-up, aligned with how other technologies, across sectors, grew. The ramp rises at the pace of the middle of the novel CDR range in the highest ambition scenarios of the third State of CDR report (Figure 76), adjusted to start in 2035.[224] The CSIRO finds that "the maturity of solid adsorbent and liquid absorbent DAC capture and geological CO_2 storage processes make FOAK-scale facilities possible in Australia within the next decade".[225]

[222] Edwards et al., *The State of Carbon Dioxide Removal - 3rd Edition (2026).*
[223] CSIRO, “Australian Carbon Dioxide Removal Roadmap.”
[224] Edwards et al., *The State of Carbon Dioxide Removal - 3rd Edition (2026).*
[225] CSIRO, “Australian Carbon Dioxide Removal Roadmap.”

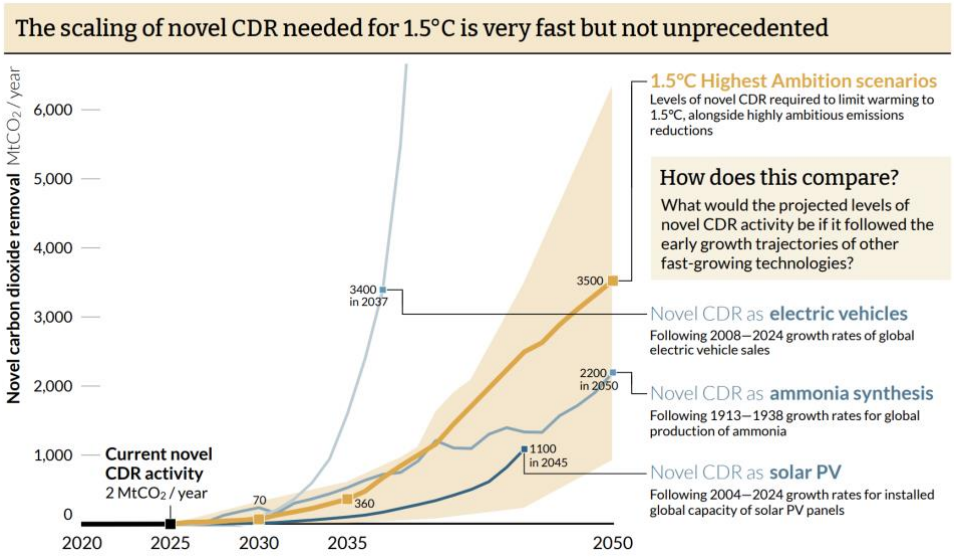


Figure 76: Scaling pace of novel CDR under Highest Ambition 1.5°C aligned scenarios, relative to other technologies[226]

The resulting net emissions trajectory is shown below in Figure 77. By mid-century, 53 $MtCO_2$ of LULUCF sequestration and 17 $MtCO_2$ of DACCS match the residual emissions, allowing Australia to fully reach net zero emissions.

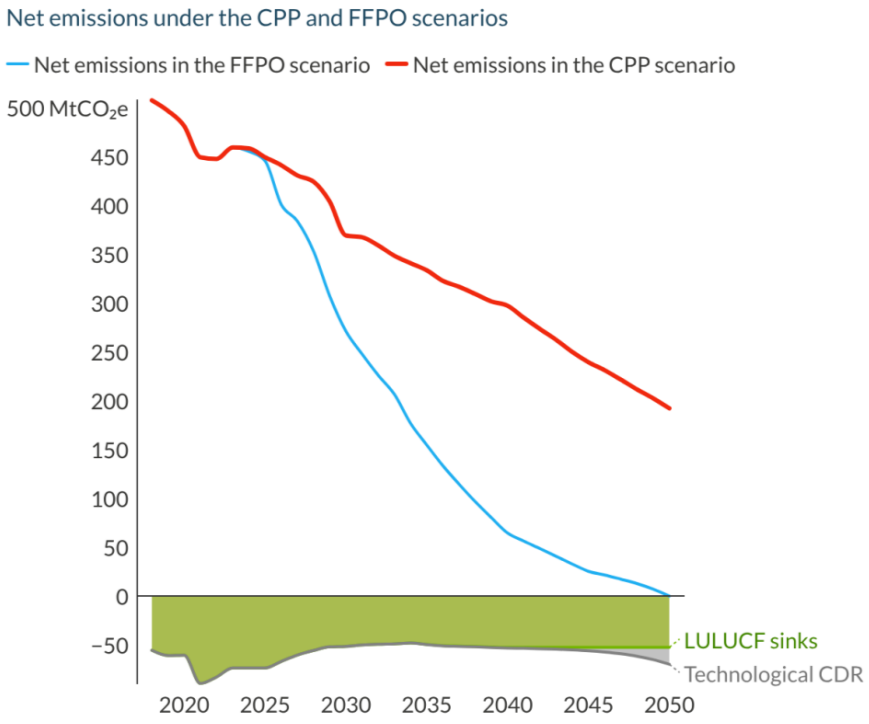


Figure 77: Net emissions under the CPP and FFPO scenarios.

[226] Edwards et al., *The State of Carbon Dioxide Removal - 3rd Edition (2026).*

Carbon dioxide removal as an inevitable part of the pathway to bring temperatures back below 1.5°C

In the FFPO scenario, net GHG emissions including LULUCF reach zero in 2050. This aligns with the Australian government's current long-term strategy and net zero targets. However, to limit the magnitude and duration of overshoot and get temperatures significantly below 1.5°C by 2100, the world needs to reach net zero GHGs in the 2nd half of the century and go on to achieve net-negative GHGs.[227] As not all countries will be able to reach net zero GHGs at the same time, some countries will need to reach net-negative GHG emissions before the date of global net zero GHGs.[228]

There are multiple reasons why Australia, along with a range of other countries, could be well-placed to catalyse this shift from net zero to net-negative emissions. This includes Australia's high degree of regulatory and fiscal capacity (which will be essential in managing a carbon removal industry), and the non-negligible potential for geological CO_2 storage in Australia which will be central to achieving net-negative emissions via technological CDR.[229]

The Highest Possible Ambition (HPA) pathway produced by Climate Analytics and PIK provides one example of a global pathway that shifts from net zero to net-negative emissions.[230] The HPA scenario reaches net zero GHGs around 2060, which means that at least some countries need to be net-negative GHGs before 2060. We downscaled this pathway to the national level to provide a perspective on the level of net-negative emissions required at the country-level to limit the magnitude and duration of overshoot, bring temperatures back down significantly below 1.5°C by 2100.

In this country-level version of the HPA, Australia's emissions (excluding LULUCF) reach net zero by the early 2040s. Including Australia's LULUCF sink would pull forwards the date of net zero further, so that in the HPA scenario the date of net zero is accelerated by over a decade compared to the FFPO scenario. In this scenario, Australia's emissions would then saturate at a level of around -200 $MtCO_2$/yr in the second half of the century.

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[227] Climate Analytics, "Rescuing 1.5°C: New Evidence on the Highest Possible Ambition to Deliver the Paris Agreement."
[228] Oliver Geden and Restinger Andy, *Overshoot: Returning to 1.5°C Requires Net-Negative Emissions Targets*.
[229] Matthew J. Gidden et al., "A Prudent Planetary Limit for Geologic Carbon Storage."
[230] Climate Analytics, "Rescuing 1.5°C: New Evidence on the Highest Possible Ambition to Deliver the Paris Agreement."

This is the result of a single scenario, and further work is ongoing to better understand the differentiated potential at the national level to achieve net-negative emissions, which will inform future modelling. However, it is very likely that, if the world is to reach net zero and net-negative GHG emissions soon after 2050, Australia will need to reach net zero and then catalyse the shift to net-negative GHG emissions before 2050.

To do so would require either further action to cut residual emissions or further scaling up carbon dioxide removal approaches. As residual emissions in the FFPO scenario are already at a very low level, shifting to an earlier date of net zero predominantly would rely on accelerated CDR roll-out. This could include deploying bioenergy with carbon capture and storage (BECCS) – which is not considered in the FFPO scenario, further accelerating DACCS roll-out, and potentially considering other CDR methods such as enhanced weathering.

Any scale-up of CDR needs to be cognisant of the potential negative side-effects of CDR deployment, including on biodiversity, water scarcity, competition with food production and the traditional land-uses. Identifying CDR deployment pathways that align with highest possible ambition but also are within feasibility and sustainability constraints remains an avenue for future research.

Textbox 8: Carbon dioxide removal as an inevitable part of the pathway to bring temperatures back below 1.5°C

Policy implications

The above stylised approach aims to capture a progressive ramp-up in deployed DACCS capacity. Pilot plants would need to scale up through the 2030s to put R&D improvements into practice, then scale further in line with the policies and government targets needed to avoid backloading emissions reductions. Near-term scale-up and early policy support will be critical to enabling this technology to contribute to global climate goals.[231]

In its roadmap, the CSIRO made DACCS-specific policy recommendations: contribute to R&D that lowers both capital and operational costs and undertake further work to evaluate impacts across multiple dimensions, including climate conditions, local environments, and energy supply. As DACCS is an energy-intensive technology,[232] the level of DACCS deployment described above for 2050 would require 28 TWh of

[231] Zurbriggen et al., "Short-Term Action Is Key for Gigaton-Scale Direct Air Capture by 2050."
[232] Edwards et al., *The State of Carbon Dioxide Removal - 3rd Edition (2026).*

electricity, around 10% of Australia's electricity demand today and 4% of 2050 demand in the FFPO scenario.[233]

The CSIRO also recommends mapping CDR potential at a more granular level, establishing a monitoring framework and improving social acceptance of CDR, all of which would build a clearer understanding of how alignment with ambitious climate goals can be achieved. These recommendations apply more broadly to other CDR solutions like BECCS or emerging technologies like biochar; a portfolio approach is better suited to take advantage of the diverse benefits of different technologies, and all-fronts CDR development could contribute to Australia's R&D sector and wider economy.[234]

De-risking will be necessary for CDR to scale up. Although we are still at an early stage of CDR policy design, a set of policy instruments can be expected to increase investor confidence across the whole scaling process: on the supply side, through permitting support, tax credits and public investment; and on the demand side, through public procurement and integration in carbon credit markets.[235]

Comprehensive planning will be central. While outside the scope of this modelling, an emerging body of research is examining the benefits of DACCS integration into power grids. When operated flexibly and powered by low-carbon surplus electricity, DACCS can consume renewable generation that would otherwise be curtailed.[236] Clustering CDR activities in hubs, where done sustainably, is also an example of the potential benefits of planning, and can deliver economies of scale and better integration with the local grid and existing economic activity.[237] The synergies achievable by embedding CDR in national and state-level planning can lower the overall implementation costs of achieving ambitious pathways.

Target-setting is an integral component of planning. The CDR Roadmap calls for a national target for technological CDR, which could complement the NDC and Net Zero Plan, would reduce the risks of over-reliance on conventional LULUCF, and send a clear investment signal. It would also position Australia as a global leader: no G20 government has a binding quantitative technological CDR target yet.[238]

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[233] DCCEEW, "Australia's Emissions Projections 2025."
[234] CSIRO, "Australian Carbon Dioxide Removal Roadmap."
[235] Edwards et al., *The State of Carbon Dioxide Removal - 3rd Edition (2026).*
[236] Liu et al., "Addressing Solar Power Curtailment by Integrating Flexible Direct Air Capture."
[237] Arwa and Schell, "Impact of Direct Air Capture Process Flexibility and Response to Ambient Conditions in Net-Zero Transition of the Power Grid."
[238] Edwards et al., *The State of Carbon Dioxide Removal - 3rd Edition (2026).*

Policy priorities for a rapid fossil fuel phase-out

The FFPO scenario represents one among many pathways for Australia to align with 1.5°C while reflecting its unique national circumstances. It requires high ambition and cohesive policy planning, but with immediate action, it is within Australia's economic and technical reach. Aligning with the 1.5°C temperature limit is a legal imperative in addition to being a political and moral one. The ICJ's July 2025 advisory opinion adds to a growing body of international law indicating that continued state support for fossil fuels breaches the Paris Agreement, and by extension, the legal standards its signatories are bound by.

In addition to its climate benefits and the international leadership it would demonstrate, the FFPO scenario would deliver co-benefits across the economy. The renewable power build-out would reduce national energy costs. Its energy and materials efficiency improvements can reduce natural resource stress, lower energy bills for businesses and households and improve quality of life. Eliminating oil dependence in transport would diminish international trade dependencies, helping to insulate Australia from volatile fossil fuel markets. Green export growth could replace and potentially exceed fossil fuel revenues and employment, bolstering diplomatic relations and strengthening the resilience of the Australian economy as the world shifts away from fossil fuels.

The government now needs to focus on how to decarbonise at the speed and scale required. To do so, increased ambition will need to be matched by comprehensive and concrete policy commitments, both at economy-wide and sector-specific levels, giving real substance to the fossil fuel phase-out it has already endorsed rhetorically.

Stronger targets, roadmaps and framework conditions

The first priority in achieving a fossil fuel phase-out is setting stronger, 1.5°C-aligned emissions reduction targets, in line with those outlined above at both net and gross levels. Additional sector-specific emissions reduction targets can be integrated into a broader policy reform process. Sectoral targets would act as roadmaps for phasing out fossil fuels and phasing in low-to-zero-emissions alternatives, and should include milestones for coal, gas and oil to exit the energy system, reflecting sectoral and sub-national priority actions.

Targets are one thing. To realise more ambitious targets, Australia would need more stringent framework conditions to support the rapid economy-wide elimination of fossil fuels and their replacement by renewables, electrification, energy efficiency and, where necessary, alternative low-to-zero-emissions fuels and feedstocks.

Future-dated restrictions on fossil fuel technologies — such as ICE vehicles or gas-connected buildings — could form part of the policy mix used to accelerate energy system transformation.

Subsidies that sustain fossil fuel use should be eliminated across all sectors. Fiscal and regulatory support should concurrently be extended to 1.5°C-aligned energy technologies where there is a recognised need under current or future market settings, benefitting both producers and consumers. Social licence challenges, such as ensuring a just transition for affected fossil fuel communities and vulnerable households during the rollout of new infrastructure and technology, should be integrated into policy design to ensure that the transition's benefits are extended to all Australians.

Sector-specific reforms

Power sector priorities

Renewable targets, further de-risking renewables investment accelerating infrastructure build-out

Electricity is the backbone of the fossil fuel phase-out because it enables emissions reductions in end-use sectors. In addition to an ambitious phase-in of renewables, the FFPO scenario shows that coal-fired power generation should be phased out by 2034, followed by fossil gas generation by 2040. To align with such a trajectory, the government needs to:

- Establish timelines for the retirement of the coal and fossil gas power fleet to provide certainty about the evolution of the grid in the short and medium term, plan for the necessary infrastructure upgrades and renewable build-out, and resolve the current ambiguity around the role of fossil gas in the power system.
- Establish adequate incentives and de-risking measures for renewable projects, for example through the continuation and upgrading of the Capacity Investment Scheme beyond its current end date in 2027.
- Streamline administrative processes to enable the necessary build-out and investor confidence, while ensuring social licence and environmental sustainability.

Industry sector priorities

Stronger green industry policy, mandating genuine emission reductions and ending fossil fuel subsidies

Aligning with the FFPO pathway for the industry will require both a step change in the policy framework to achieve emissions reductions in industry and political leadership to enable the emergence of green industries. To do both, the government needs to:

- Tighten the Safeguard Mechanism framework during the 2026–27 review cycle, to constrain reliance on offsets and ensure that the scheme operates in a manner consistent with a fossil fuel phase-out and ambitious reductions in direct, rather than net, emissions.
- Remove fossil fuel subsidies in a just and fair manner. Australia's diesel rebate, for example, disincentivises fuel switching, emissions-saving technologies and energy efficiency improvements.
- Develop a whole-of-economy green industrial strategy that builds on Future Made in Australia, with further commitment to de-risking capital and operational expenditure for 1.5°C-aligned industry. Such an approach would need to be individualised for each sub-sector:
    - In mining, reforming the Fuel Tax Credits system for diesel would remove the disincentive to invest in low-carbon technologies that have high upfront capital costs but pay back over the long run. Remote and regional mining regions such as the Pilbara remain underserved by renewables, which can be rectified through a common-user infrastructure approach that could help avoid AUD 30 billion in additional transition costs.[239]
    - For iron and steel, access to affordable renewable electricity can ensure that Australia's EAF-based steelmaking facilities remain competitive. This can be supplied through the grid or dedicated PPAs.
    - For cement, demand-side policies can stimulate uptake of low-carbon cement. Alongside government procurement and embodied carbon limits, transitioning from product- to performance-based standards for building and construction can reduce the share of clinker in cement. For alumina and aluminium, government support for producers should be contractually tied to progressive decarbonisation outcomes.
    - Accelerate the green hydrogen build-out and pair it with demand-side mandates modelled on the Renewable Energy Target and international cooperation to ensure that growing ammonia demand growth is met by green supply.
    - More generally, plan for the provision of assets such as common-user infrastructure and promote green markets through government procurement and international trade negotiations, potentially supported by a carbon border adjustment mechanism.

Transport sector priorities

Zero-emission vehicles, truck standards, modal shift and low-carbon fuels

[239] Clean Energy Finance Corporation, *United Action on Pilbara Infrastructure Could Save Australia $30 Billion: Report*.

In the FFPO scenario, transport emissions reach zero by 2045, largely through deep electrification. To achieve this, the government can:

- Strengthen the New Vehicle Efficiency Standard to establish a pathway to near-total zero-emission sales for new passenger vehicles and light commercial vehicles in the 2030s, supported by purchase incentives, charging infrastructure, fleet targets and a second-hand EV market.
- Expand support for consumer EV purchases and investment in charging infrastructure in line with sales targets, helping to build a critical mass for the growing second-hand EV market.
- Address the policy blind spot for heavy transport, currently not covered by the NVES, the National EV Strategy and the Safeguard Mechanism. The transition could be supported by concessional finance and scrappage support for small operators and dedicated freight charging corridors.
- Encourage modal shifts away from road and air transport through investment in new electrified rail networks for both passenger and freight transport. The second stage of the National Rail Action Plan provides a window to address the regulatory fragmentation and underinvestment that impede modal shift, while avoiding reliance on biofuels that risks locking in fossil-dependent technology rather than durable electrification.
- Prepare an action roadmap for aviation and shipping that combines targets for the deployment of low and zero-emission fuels. This includes stronger SAF sustainability standards, production and blending targets and incentives for modal shift to rail.

Buildings sector priorities

Supporting consumer and business investment in electrification and efficiency and mandating fossil fuel phase-out

In the FFPO scenario, the share of electricity in the buildings mix rises from 57% at present to 97% by 2050, while fossil gas and oil are phased out by 2040. Policies aligned with the 1.5°C temperature limit for the buildings sector would include:

- Consolidating a national building electrification strategy based on all-electric, high-efficiency standards for new buildings and a staged phase-out of new fossil gas appliances.
- Providing fiscal support to consumers under programs such as the Household Energy Upgrades Program and Cheaper Homes Batteries Program and the Small-Scale Renewable Energy Scheme.
- Reforming building regulations, codes and standards to include requirements for electricity consumption and restrictions on fossil fuel use in both new and existing buildings.

Though emissions embodied in building materials are not captured in our model, Australia should adopt mandatory requirements for their assessment, reporting and incorporation within building regulations, codes and standards, as well as government procurement commitments. This can both reduce total materials demand and accelerate the shift towards green steel and cement. Beyond just the buildings sector, this would incentivise the phase-out of fossil fuels and feedstocks in the broader economy.

Priorities to phase out fossil fuel exports

Assessing climate impacts and reforming trade

There is no place for continued fossil fuel exports in a global transformation aligned with the Paris Agreement's temperature limits. Australia's economy would therefore need to shift away from carbon-intensive coal and fossil gas exports. Current policies instead continue to support these exports, despite international government rhetoric calling for a transition away from fossil fuels. To align actions with words, the government should therefore:

- Include a climate trigger that assesses both domestic and offshore emissions from proposed fossil fuel projects in the federal environmental assessment framework, for example through the introduction of a climate trigger in the federal *Environment Protection and Biodiversity Conservation Act 1999*.
- Establish managed decline schedules for coal and fossil gas production, including clear timelines for production to end, alongside methane controls, electrification and efficiency measures to minimise emissions during their phase-out.
- Coordinate with trade partners to move away from fossil fuel dependency and towards the *electrostate* economic model, for example through novel trade and investment agreements that jointly sequence shifts in cross-border production and consumption of energy and energy-carrying goods, with binding fiscal and regulatory obligations on participating governments to achieve shared pathways.

Residual emissions and carbon dioxide removal

Bringing warming down from peak overshoot will need the deployment of carbon dioxide removal. This can only be effective if fossil CO_2 emissions are reduced to the lowest possible level. The FFPO scenario leaves around 70 $MtCO_2e$ of gross residual emissions in 2050, mainly non-CO_2 from non-energy sectors. To align with the FFPO scenario, the government needs to focus first on reducing gross emissions as far as possible, then setting separate residual emissions and removals targets so that CDR does not weaken incentives for direct abatement, by:

- Establishing interim sectoral emissions milestones across all sectors to anticipate the likely scale of residual emissions, complemented by a quantified roadmap for scaling up of land-based and technological CDR.
- Supporting innovation and R&D in technological CDR.

- Establishing institutional support to improve understanding of the potential environmental and social impacts of CDR and to support social acceptance, with the goal of establishing a high-integrity CDR framework.

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