CLIMATE CHANGE AUTHORITY

2023 ANNUAL PROGRESS REPORT

October 2023

3 Reducing emissions

Key information about Chapter 3

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

Australia needs to reduce its emissions on average by 17 Mt CO_2-e per year to reach its 2030 emissions reduction target. Over 2022–23, Australia's emissions increased by 4 Mt CO_2-e.

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

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

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

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

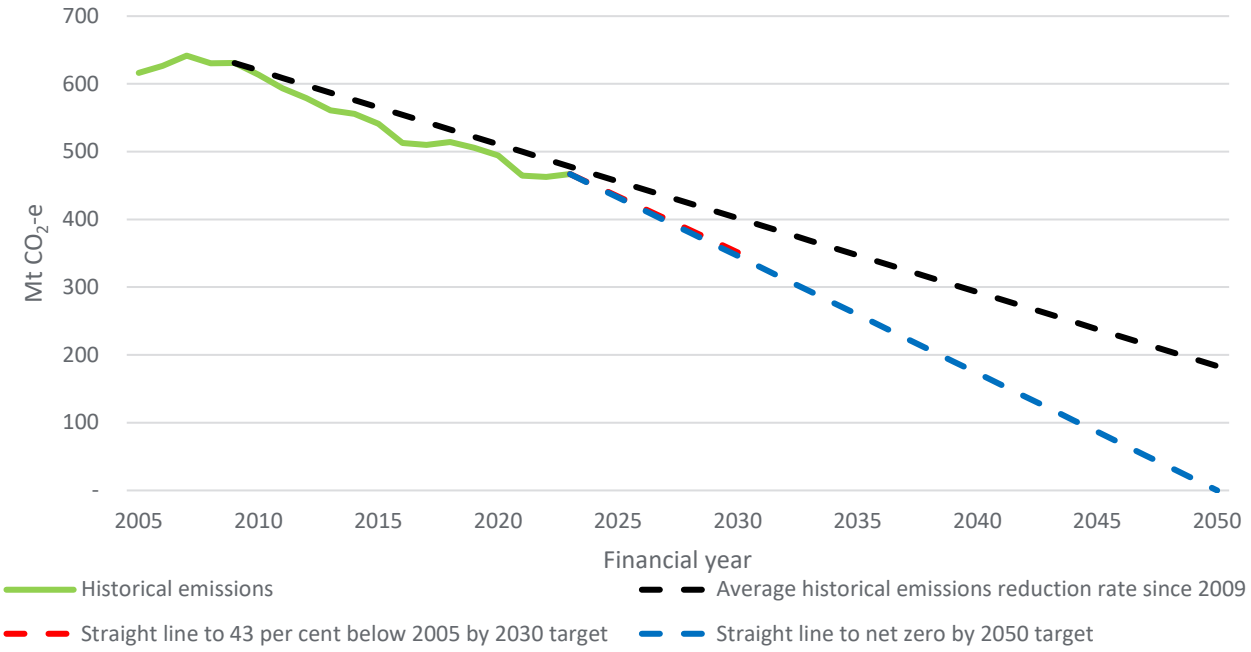
Capacity building to support on-farm emissions reductions should yield big dividends.

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

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

Australia is not reducing emissions at the rate needed to reach the 2030 target. Over 2022–23 Australia's emissions did not decline, they increased by 4 Mt CO_2-e. Australia needs to decarbonise at an average annual rate of 17 Mt CO_2-e to reach its 2030 emissions reduction target. As stated in our 2022 Annual Progress Report, this required rate of decarbonisation is 40% faster than the average annual rate of decarbonisation over the period 2009–2023 (CCA, 2022a).

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

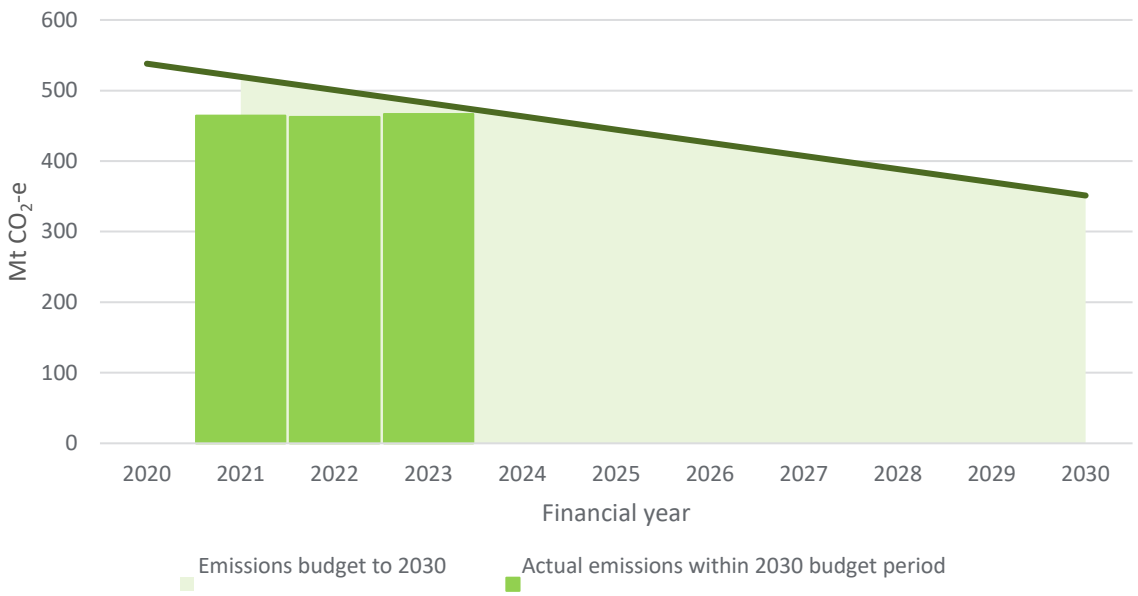


Notes: Includes preliminary estimates of emissions from April to June 2023.

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

When viewed on an emission budget basis, Australia is tracking ahead of its target trajectory (Figure 3.2). Australia's target trajectory starts at our 2020 target, which was overachieved due to a range of factors including the effects of the global COVID-19 pandemic. However, unless emissions reductions accelerate quicky towards the authority's benchmark of 17 Mt CO_2-e on average per year, emissions are likely to breach the target trajectory in 2024 or 2025.

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



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

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

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

Sector	Emissions in year to June 2022	Emissions in year to June 2023	Annual change in emissions
	Mt CO_2-e	Mt CO_2-e	Per cent
Electricity	158	152	-4
Industry and resources	184	185	0
Transport	92	99	8
Agriculture	79	82	3
Waste	14	14	0
Land	-64	-64	0
Total	463	467	1

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

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

3.2 Electricity

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

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

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

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

Table 3.2: State and territory 2030 renewable electricity targets

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

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

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

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

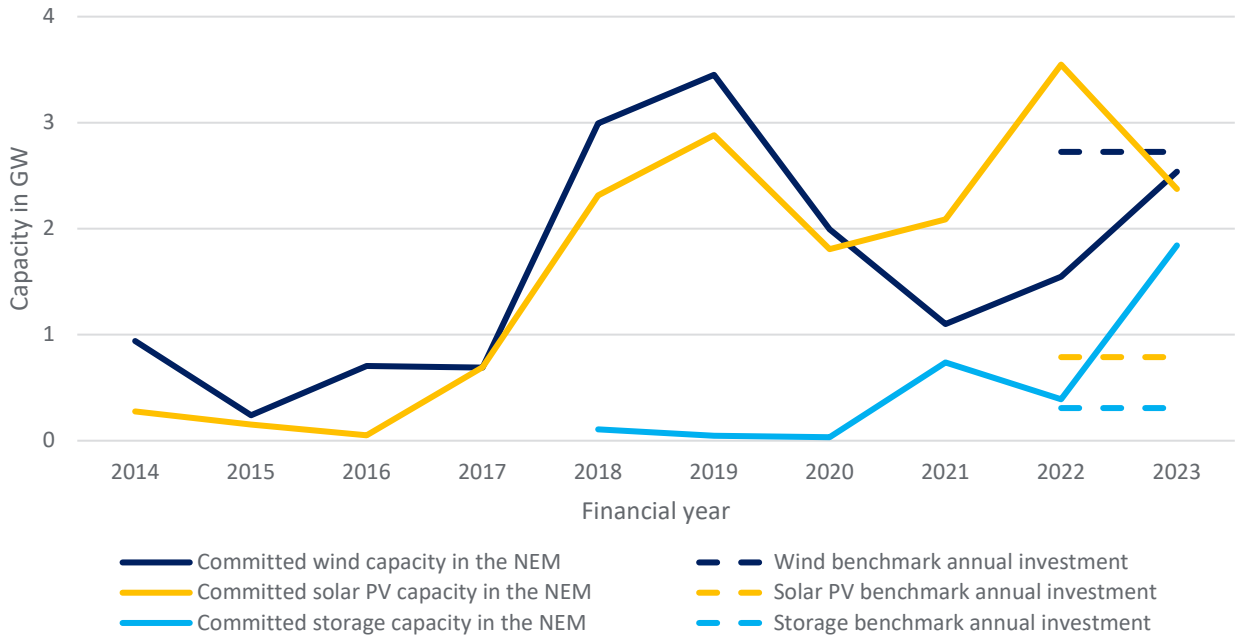
3.2.1 Leading indicators of change

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

Utility-scale solar photovoltaic (PV) needs to roughly double and wind capacity triple in the National Electricity Market (NEM) between July 2022 and June 2030 for an 82% renewable share to be achieved (AEMO, 2023a); (AEMO, 2022c). The authority is tracking the capacity of committed[5] wind, solar and shallow and medium storage projects to gauge if there are sufficient projects in the pipeline to meet the 82% target by 2030.

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

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



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

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

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

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

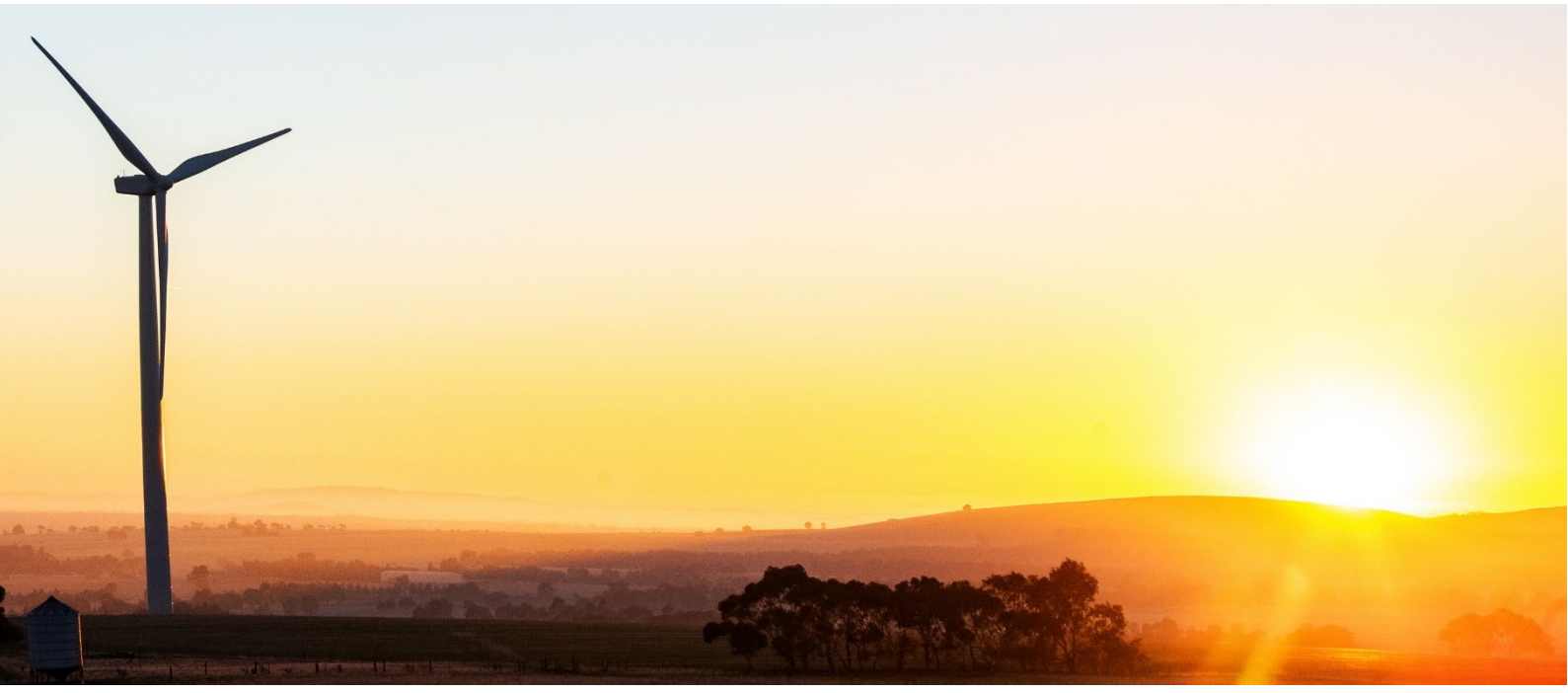
3.2.1.2 Suggested leading indicators

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

Stakeholders also proposed leading indicators relating to:

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

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

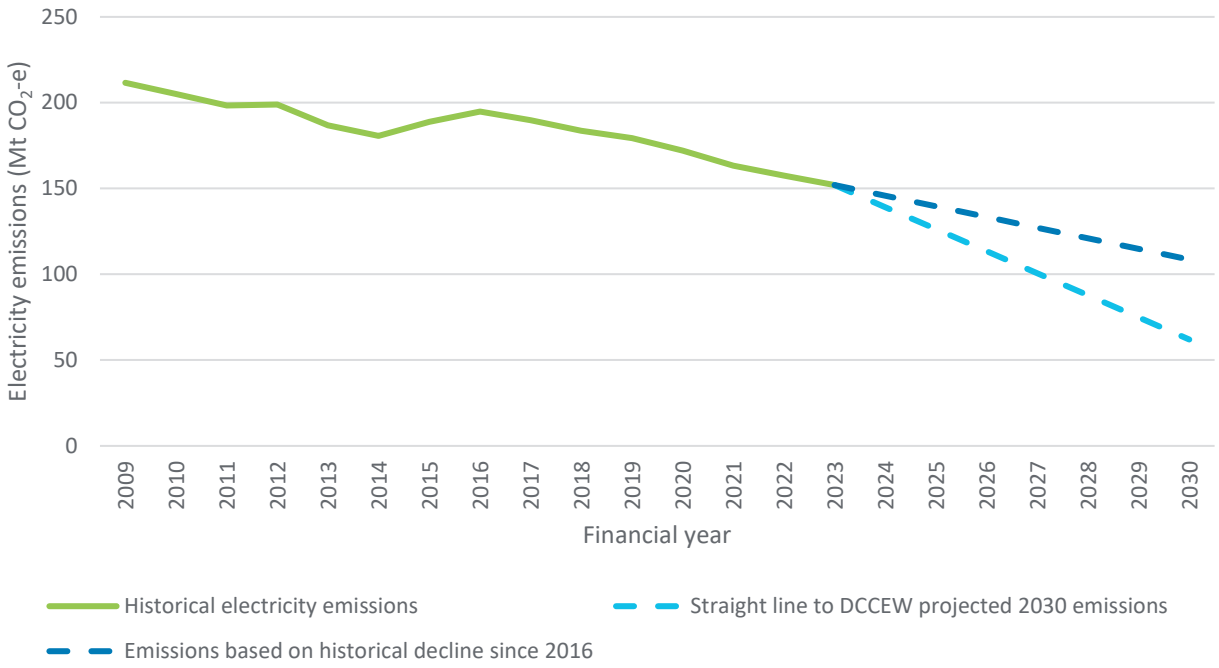


3.2.2 Sectoral issues, context and trends

Electricity emissions decreased by 5.6 Mt CO_2-e over the year to June 2023, reaching 152 Mt CO_2-e (DCCEEW, 2023m)[6]. This 3.6% reduction is consistent with annual declines in the electricity sector since 2016 (Figure 3.4). Renewables reached 32% of Australia's electricity generation in 2022, while coal accounted for 47% and gas for 19% (DCCEEW, 2023a).

Under a scenario which assumes a national renewable electricity target of 82% by 2030, electricity emissions are projected to decline to 62 Mt CO_2-e in 2030 (DCCEEW, 2022a). The implied straight-line trajectory is shown in Figure 3.4 and requires electricity emissions to decline on average by 13 Mt CO_2-e per year. Although emissions have been declining steadily since 2016, this has been at less than half the rate (6 Mt CO_2-e per year) than that required to achieve the renewable energy target in 2030.

Figure 3.4: Historical electricity emissions and projected decline



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

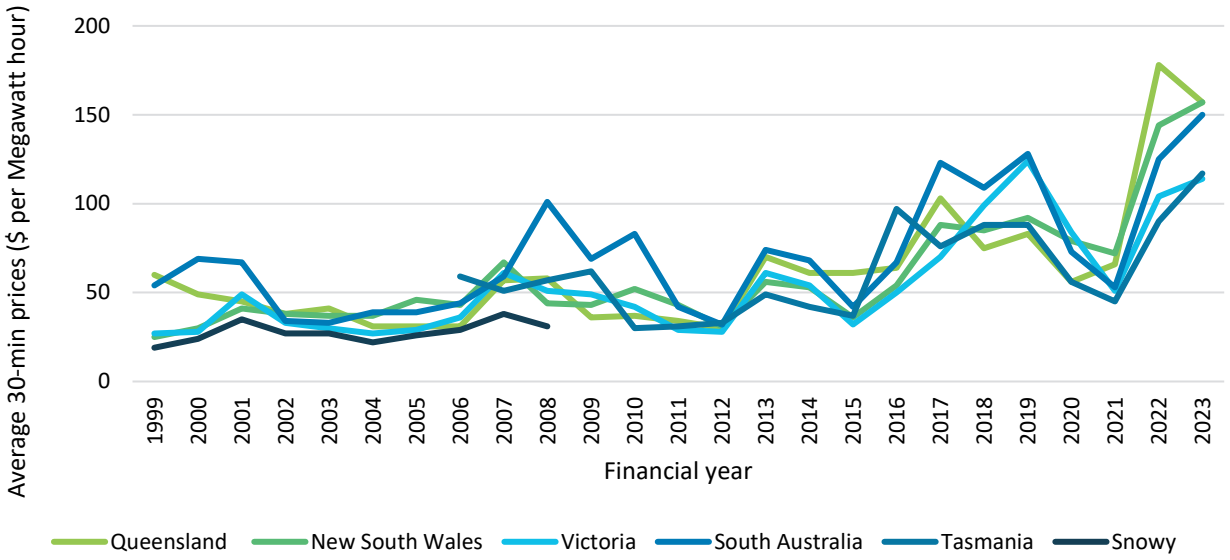
6 This includes preliminary estimates for April to June 2023.

3.2.3 Innovations and developments

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

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

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



Source: (AER, 2023c)

3.2.3.1 Utility-scale renewable generation and storage

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

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

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

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

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

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

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

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

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

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

Source: (Aurecon, 2022)

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

3.2.3.2 Planning and approvals processes

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

3.2.3.2.1 State and territory level - development approval

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

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

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

Table 3.6: Development approval timelines, New South Wales

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

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

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

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

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

3.2.3.2.2 Federal level – EPBC Approval

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

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

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

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

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

9. RECOMMENDATION

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

10. RECOMMENDATION

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

3.2.3.3 Grid connection process

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

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

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

BOX 3.2: Case study: Renewable Energy Zones

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

Table 3.7: New South Wales REZ progress to 2030

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

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

3.2.3.4 Network infrastructure

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

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

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

11. RECOMMENDATION

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

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

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

Table 3.8: Progress of nationally strategic projects to 2030

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

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

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

12. RECOMMENDATION

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

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

BOX 3.3: Regulatory Investment Test for Transmission process

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

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

3.2.3.5 Shallow, medium and deep storage

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

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

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

Notes: Shallow storage includes durations with less than 4 hours, medium storage includes durations between 4 and 12 hours (inclusive), and deep storage includes storage with durations greater than 12 hours (AEMO, 2022a).
Source: (AEMO, 2023a); (AEMO, 2022c).

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

3.2.3.5.1 Shallow and medium storage

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

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

13. RECOMMENDATION

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

3.2.3.5.2 Deep storage

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

The 1,998 MW Borumba Pumped Hydro project (Queensland) is an anticipated[8] pumped hydro project with the potential to provide deep storage (AEMO, 2023a). Detailed project studies are underway, and the project is targeting operations by the end of the decade (Queensland Hydro, 2023). This will be challenging given the significant development and construction timeframes for pumped hydro energy storage projects, with Snowy 2.0 being the prime example.

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

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

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

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

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

14. RECOMMENDATION

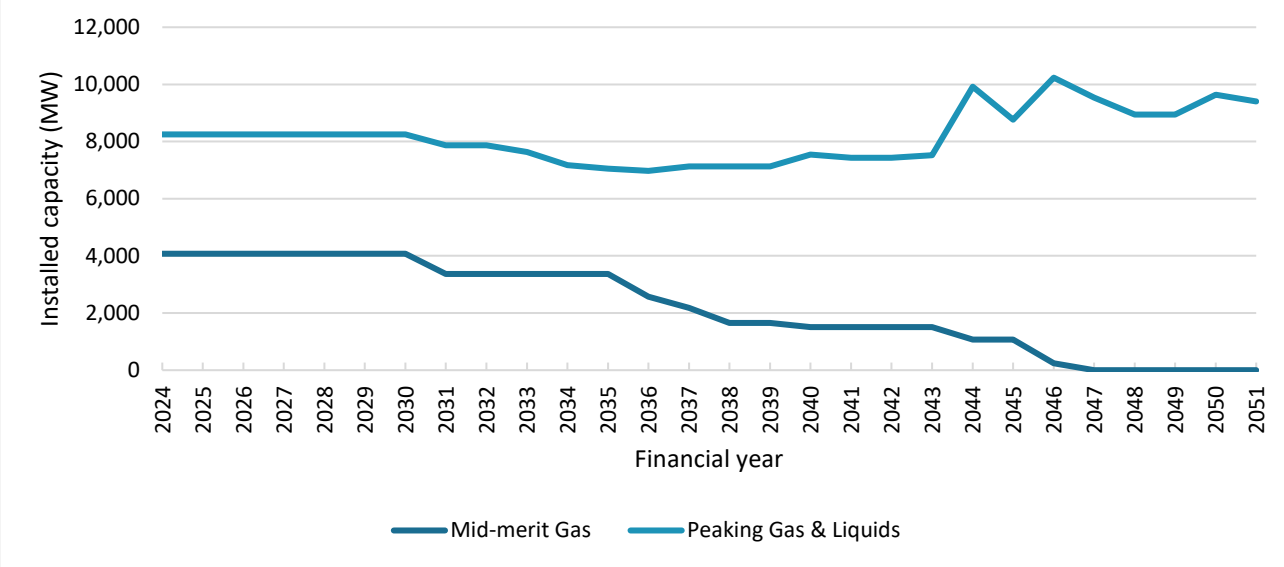
Provide funding via ARENA and the CEFC to accelerate the commercialisation and deployment of deep storage options.

3.2.3.6 The role of gas

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

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

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



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

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

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

15. RECOMMENDATION

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

3.2.3.7 Coal plant closures

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

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

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

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

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

[9] AEMO's Step Change Scenario.

Table 3.10: State targets for coal closures

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

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

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

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

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

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

3.2.3.8 Social licence for renewable energy deployment

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

3.2.3.9 Supply chain and workforce constraints

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

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

3.2.3.10 Artificial intelligence

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

3.2.4 Policy opportunities and recommendations

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

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

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

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

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

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

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

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

Table 3.11: Policy effectiveness in the electricity sector[a]

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

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

3.3 Industry and Resources (excluding electricity generation)

Less than 1% increase in industry and resource sector emissions from 2021–22 to 2022–23[10]

Australia's industry and resources sectors include LNG production, oil and gas extraction, mining and manufacturing industries. Reported domestic emissions from the industry and resources sector were 185 Mt CO_2-e in 2022–23[11].

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

3.3.1 The Safeguard Mechanism

The Safeguard Mechanism is the Australian Government's policy for reducing emissions at Australia's largest industrial facilities. Facilities which emit more than 100,000 t CO_2-e per year of Scope 1 emissions are covered under the policy (DCCEEW, 2023dd). The reformed Safeguard Mechanism came into effect on 1 July 2023.

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

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

Facility	Reporting entity	Emissions in 2021–22 (Mt CO_2-e)
Gorgon LNG	Chevron	8.3
Ichthys LNG	INPEX	6.7
North West Shelf Project LNG	Woodside Energy	6.4
Port Kembla Steelworks	Blue Scope Steel	6.2
Wheatstone Operations LNG	Chevron	3.9
Worsley Alumina	South 32	3.6
Queensland Alumina refinery	Queensland Alumina	3.1
Qantas Airways	Qantas	3.1
Moomba Gas Plant	Santos	2.2
Whyalla Steelworks	Onesteel Manufacturing	2.2

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

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

3.3.2 Leading indicators

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

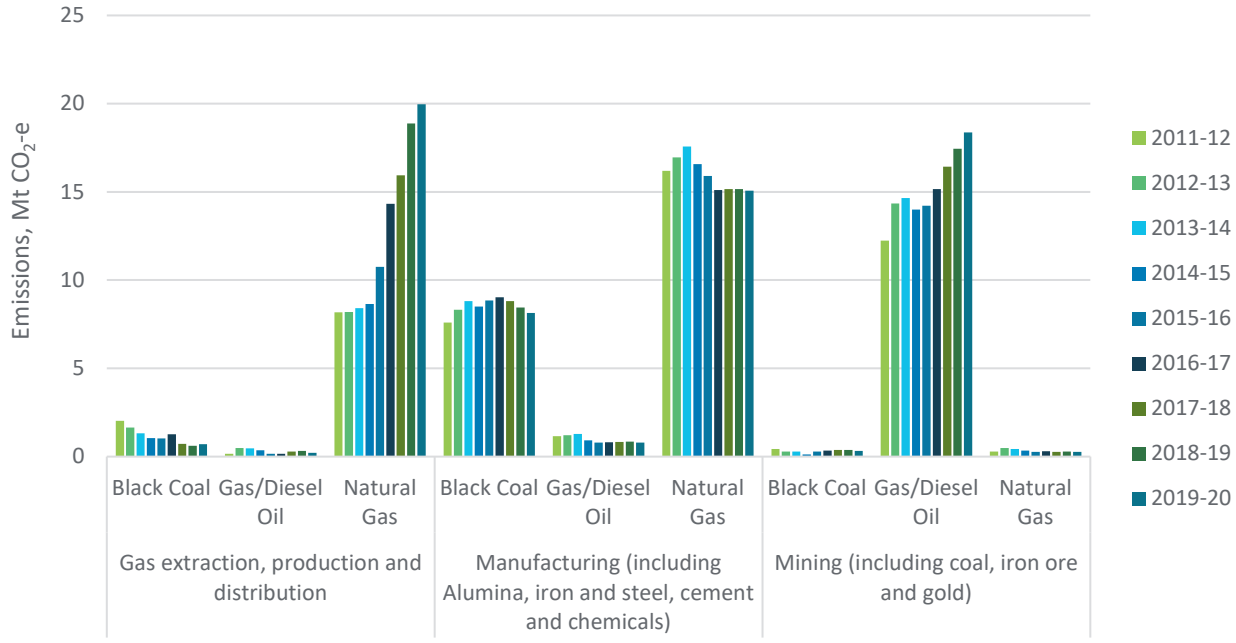
3.3.2.1 Stationary energy

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

The main sources of stationary energy emissions in 2022–23[12] were manufacturing[13] (32 Mt CO_2-e), coal and metal ore mining (22 Mt CO_2-e) and LNG and gas extraction and distribution[14] (24 Mt CO_2-e).

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

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



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

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

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

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

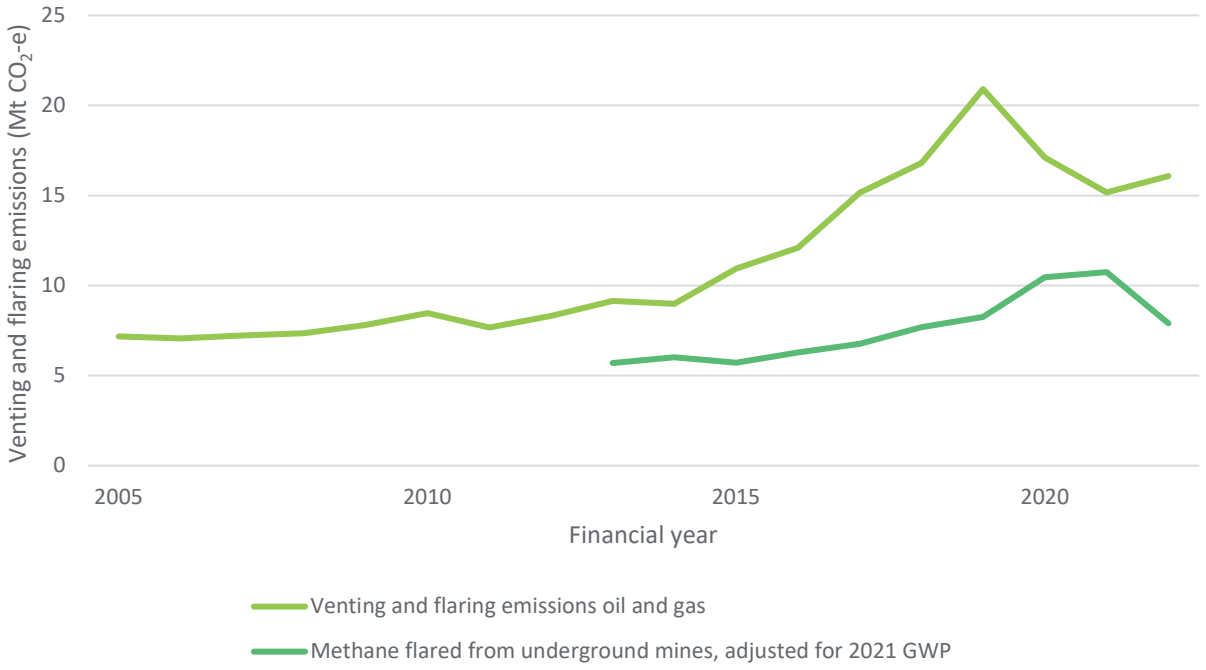
14 Includes oil and gas extraction and gas production and distribution.

3.3.2.2 Fugitive emissions

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

Venting and flaring emissions in 2022 from oil and gas activities have increased by 124% since 2005[15]. Similarly, emissions from flaring of methane from underground coal mining activities have increased by 89% between 2012–13 to 2020–21[16], noting reduced fugitive emissions from coal production in 2021 and 2022 due to events such as flooding (DCCEEW, 2022a).

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



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

3.3.2.3 Industrial Processes and Product use (IPPU)

Reducing the 10 Mt CO_2-e[17] of emissions associated with leakage of hydrofluorocarbons from refrigeration and air-conditioning through the adoption of alternative and lower global warming potential refrigerants should be a focus of government and industry.

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

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

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

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

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

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

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

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

3.3.3 Sectoral issues, context and trends

Emissions from the industry and resources sectors increased by 0.04% (0.1 Mt CO_2-e) to 185 Mt CO_2-e in the year to June 2023. Over the longer term, emissions in these sectors have increased 10% (17 Mt CO_2-e) between 2014–15 to 2022–23.

3.3.4 Innovation and developments

3.3.4.1 2023 reforms to the Safeguard Mechanism

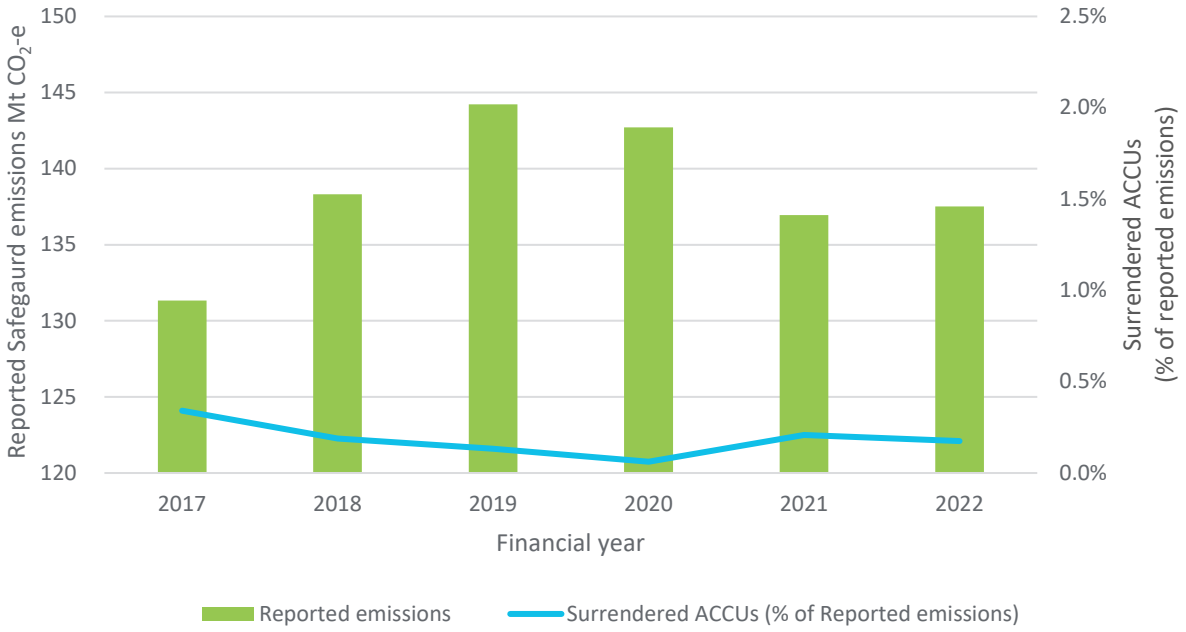
Reforms to the Safeguard Mechanism, under the *Safeguard Mechanism (Crediting) Amendment Act 2023*, were passed by the federal parliament on 30 March 2023 and new arrangements took effect from 1 July 2023. The reforms included changes to associated subordinate legislation to implement the package.

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

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

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

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



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

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

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

These Safeguard outcomes include requirements for:

- net emissions from Safeguard facilities over 1 July 2020 to 30 June 2030 to not exceed 1,233 Mt of CO_2-e.
- two point-in-time targets for emissions from Safeguard facilities, net emissions in 2029–2030 to not exceed 100 Mt of CO_2-e, and net zero from 2049–2050.
- gross emissions from Safeguard facilities, measured as a five-year rolling average, to reduce over time.

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

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

Following the reforms, the range of compliance options includes:

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

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

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

3.3.4.1.1 Funding support for industry and resource sector decarbonisation

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

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

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

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

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

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

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

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

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

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

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

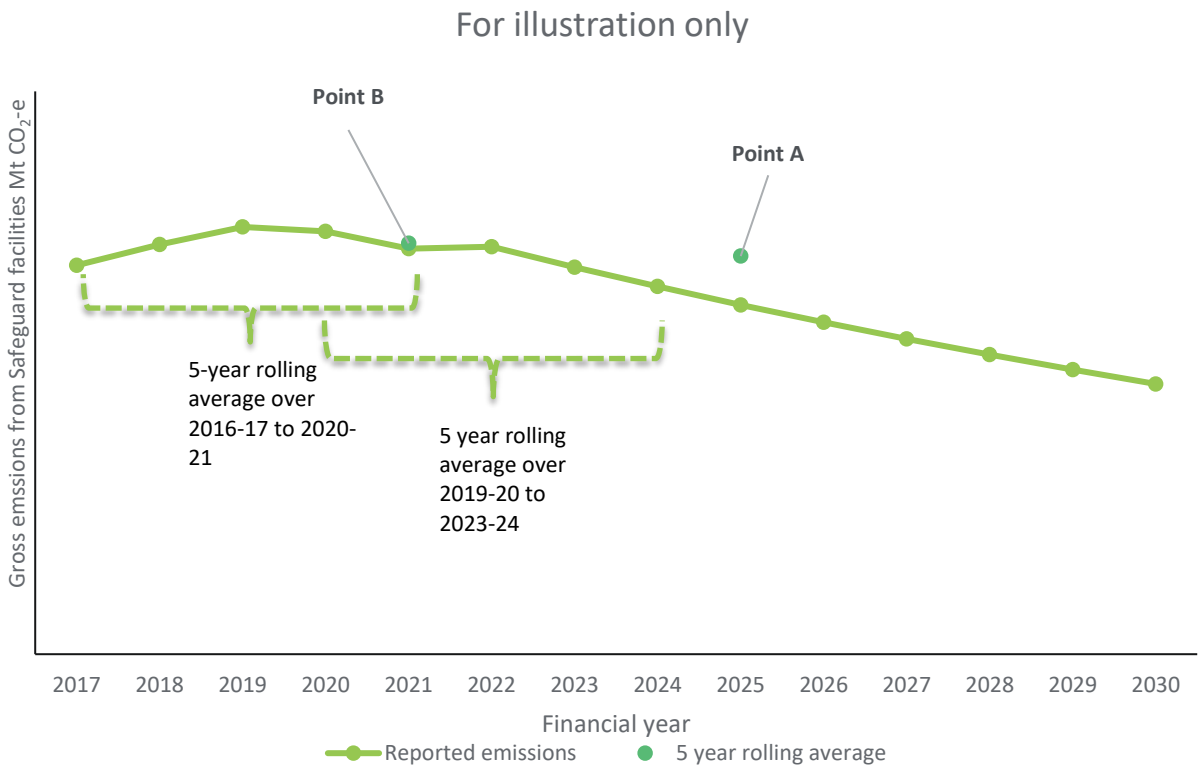
The authority is also expected to have a role in the Government's 2026-2027 review of the Safeguard Mechanism, including advising on the extent to which on-site abatement is being driven by the Safeguard reforms, and whether any additional incentives are required.

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

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

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

Figure 3.10: Illustrative example of 5-year rolling average



3.3.5 Policy opportunities and recommendations

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

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

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

3.3.5.1 Accelerate progress on mitigation emissions associated with refrigerant gases

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

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

Measures for improved containment and effective recovery of refrigerants will also be key for limiting the environmental impacts of Australia's existing refrigerant bank, estimated to have a total global warming potential of around 100 Mt CO_2-e in 2021 (DAWE, 2021).

17. RECOMMENDATION

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

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

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

18. RECOMMENDATION

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

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

Under the reformed Safeguard Mechanism, baselines for new facilities and existing facilities that begin producing new products will be set at international best practice, adapted for the Australian context (DCCEEW, 2023aa). Importantly, for new gas fields supplying LNG projects, the Safeguard reforms set the international best practice as net zero reservoir CO_2 emissions (*National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015,* s 35A), reflecting opportunities for CCS. Similarly, for shale gas extraction developments, such as from the Beetaloo Basin, a zero baseline will be applicable (*National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015*, ss 10, 54).

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

For example, the Gorgon LNG facility, operational since 2019, sequesters CO_2 emissions from the facility's industrial processes and stores it permanently in geological formations. Similarly, the Moomba CCS project, under development and scheduled to start injection in 2024, plans to sequester 1.7 million tonnes of CO_2-e from the Moomba gas processing facility (Santos, 2023). Another example is the proposed Bayu Undan CCS project – located in Timor-Leste – expected to commence operations in 2027 (Fitzgerald, 2023), noting the project also requires development of a regulatory framework to facilitate cross-border carbon capture and storage. Earlier this year, the authority published a comprehensive assessment of opportunities for carbon sequestration in Australia – *Reduce, remove and store – The role of carbon sequestration in accelerating Australia's decarbonisation* (CCA, 2023).

19. RECOMMENDATION

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

- implementation of international best practice measures for reducing methane emissions from flaring activities that do not perversely encourage venting emissions.
- development of standards in line with international best practice to support methane leak. detection and repair across equipment, technologies and operational practices.
- introduction of requirements for existing oil and gas facilities to sequester all CO_2 emissions produced.

Table 3.13: Policy effectiveness table - Safeguard Mechanism

Aspect	Analysis
Scope	The Safeguard Mechanism is a legislated framework that is designed to limit the emissions from facilities that produce more than 100,000 tonnes of CO_2-e each year (scope 1). In 2020–2021, Safeguard facilities were responsible for 28% of national emissions.
Impact	The Safeguard Mechanism was established in 2016 to regulate emissions of Australia's large industries. Since its commencement in 2016, the Safeguard Mechanism has been ineffective in reducing emissions from Australia's large industrial facilities. In 2023, the Australian Government reformed the scheme and new arrangements commenced on 1 July 2023.
Efficiency	The Clean Energy Regulator is responsible for the monitoring, compliance and enforcement of the Safeguard Mechanism. The baseline decline rates apply to all existing and new facilities, except for emissions intensive trade exposed businesses based on comparative impact on competitiveness. Monitoring arrangements have been put in place as part of the reforms to ensure the new legislative emissions objectives are achieved. The Safeguard Mechanism includes a range of enforcement measures, including enforceable undertakings, infringement notices, a court injunction or a civil penalty. Through the 2023 Safeguard reforms, the Government updated the civil penalty to base it on both the quantity of excess emissions and the number of days of non-compliance. The 2023 reforms also included anti-avoidance measures to ensure businesses would not be able to define or redefine a facility with the intention to avoid coverage To address competitive distortions for emissions intensive trade-exposed facilities, the Mechanism allows for targeted funding support and discounted decline rate based on a comparative scheme impact metric. There are several public financing vehicles aimed at accelerating the development, demonstration and commercialisation of low emissions technologies for the industry and resources sectors.
Relevance	The intervention creates a financial incentive for facilities to invest in onsite emissions mitigation activities to reduce emissions. Safeguard facilities have access to domestic offsets (ACCUs) to offset their emissions.
Coherence	The intervention is scalable as it allows for a recalibration of policy settings based on a planned review in 2026 - 2027. As part of this review, the Authority will advise the Government on the extent to which on-site abatement is being driven by the reforms, and whether any additional incentives are required. The reforms allow for flexible compliance options, including offsets, banking and borrowing provisions and multi-year monitoring periods. The reforms require the Minister for Climate Change to act if emissions are expected to breach the scheme's emissions targets, such as by amending the scheme rules or taking other policy actions.
Sustainability	The reformed scheme is in its first few months of operation. The authority will review progress of the scheme on an annual basis and will form a view on the sustainability of this mechanism over time.

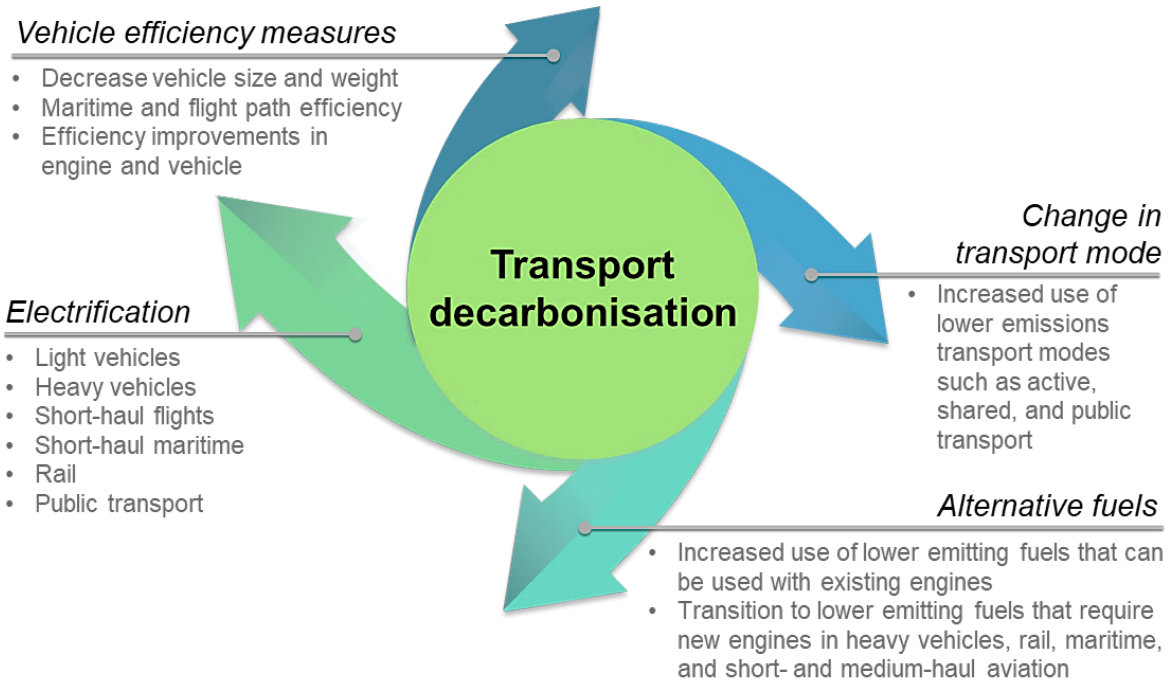
3.4 Transport

6% increase in transport emissions during 2022–23

3.4.1 Sectoral issues, context and trends

Transport emissions were 98 Mt CO_2-e emissions in 2022–23 (DCCEEW, 2023m). Light vehicles were the source of 59% of Australia's transport emissions (unpublished data provided by DCCEEW), and there is a mature technology to address these emissions, in the form of electric vehicles. This makes accelerating the take-up of electric vehicles a high priority for meeting Australia's 2030 target.

Figure 3.11: Measures to decarbonise the transport sector



Source: Climate Change Authority

3.4.2 Leading indicators of change

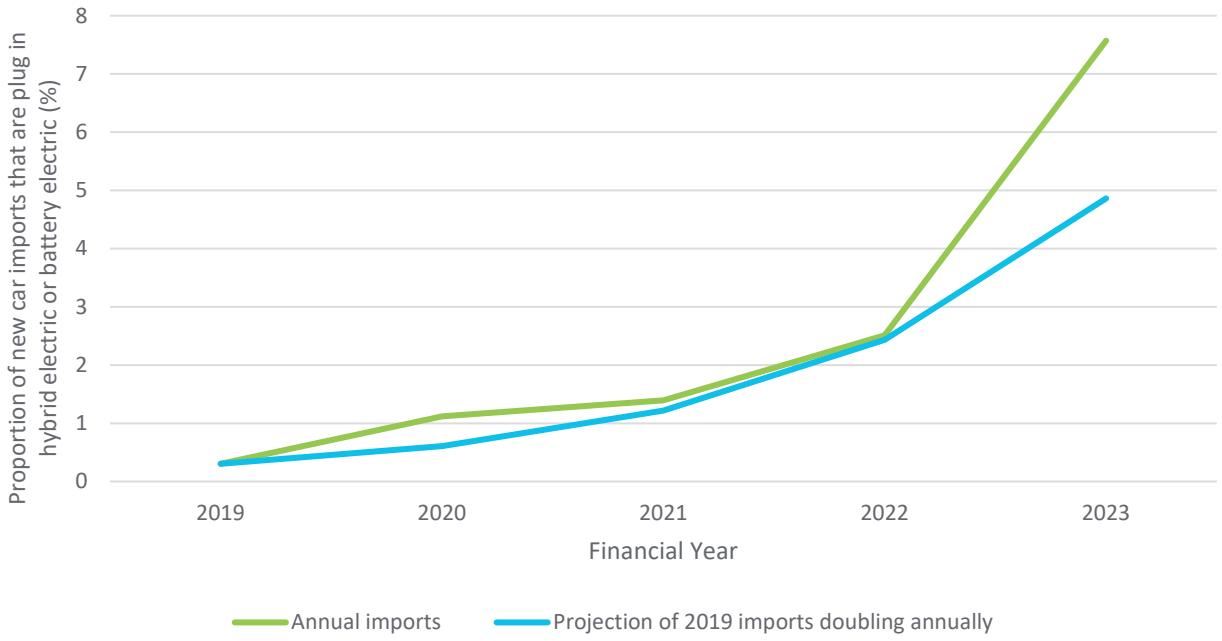
Growth in electric vehicle imports and the successful roll out of charging infrastructure are early indicators of the take-up of, and potential barriers to, electric vehicle growth.

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

3.4.2.1 Electric vehicle imports

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

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

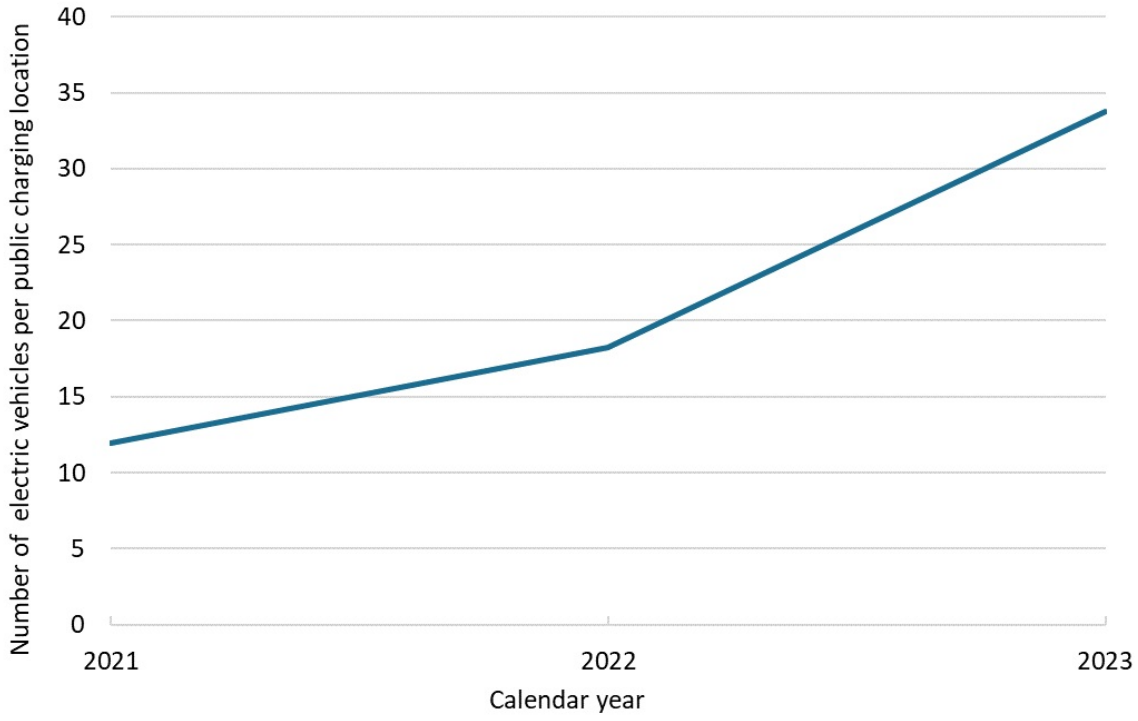


Source: *Based on unpublished Australian Bureau of Statistics data supplied to the authority.*

3.4.2.2 Vehicle charging infrastructure

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

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



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

3.4.3 Road Transport

Tailpipe emissions from road transport contribute 83% (82 Mt CO_2-e) of Australia's transport emissions (unpublished data provided by DCCEEW).

Road transport emissions can be reduced by:

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

While electric vehicles run on electricity supplied by the grid, the emissions intensity of electricity on a tonnes of CO_2 per kilometre travelled basis is lower than emissions from equivalent ICE vehicles (DCCEEW, 2023e). The emissions intensity of electric vehicles will reduce further as the proportion of renewable energy generation in the grid increases.

3.4.3.1 Passenger vehicles

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

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

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

The authority made a submission on the design of the Fuel Efficiency Standard which emphasised the need for Australia to decrease the tailpipe emissions intensity of new vehicles to zero by 2040 or earlier, as soon as the market is capable of doing so, given CSIRO modelling projected 99% of all vehicle sales are electric by 2038 and 2042 in two scenarios with strong climate action (CSIRO, 2022a). Based on the projected emissions intensity of the grid in 2030, the authority found that for every 5% greater share of electric vehicles, there is an additional 2.5–2.6 Mt CO_2-e in emissions reduction[19].

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

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

20. RECOMMENDATION

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

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

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

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

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

21. RECOMMENDATION

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

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

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

22. RECOMMENDATION

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

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

23. RECOMMENDATION

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

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

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

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

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

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

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

24. RECOMMENDATION

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

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

3.4.3.2 On-road trucks

On-road trucks were the source of 22% of transport emissions (20 Mt CO_2-e) in 2021 while only representing 3.2% of road vehicles in Australia (DCCEEW, 2023o; Bureau of Infrastructure and Transport Research Economics, 2022). Trucks have larger engines that consume more fuel, and drive a greater average distance than cars. Trucks had an average age of 11–16 years in Australia in 2021 (Bureau of Infrastructure and Transport Research Economics, 2022), resulting in higher emissions due to older more inefficient vehicles being used for longer (Electric Vehicle Council & Australian Trucking Association, 2022).

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

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

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

25. RECOMMENDATION

Encourage uptake of lower emissions heavy vehicles by:

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

3.4.3.2.1 Supporting infrastructure

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

BOX 3.5: Electrification of trucks case study – Janus Electric

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

3.4.4 Shipping and aviation

Domestic shipping was a source of 2 Mt CO_2-e and aviation 8 Mt CO_2-e, or together 11% of total transport emissions in 2022–23 (unpublished data provided by DCCEEW). Pre-COVID-19, Australia's international aviation and shipping emissions were 18 Mt CO_2-e (DCCEEW, 2023cc).

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

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

3.4.5 Adaptation and wellbeing

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

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

3.4.6 Policy opportunities and recommendations

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

Table 3.14: Policy effectiveness in the Transport sector

Aspect	Analysis
Scope	Light road vehicles (59% of transport emissions (unpublished data provided by DCCEEW) are covered under the National Electric Vehicle Strategy (DCCEEW, 2023e) including a commitment to develop a Fuel Efficiency Standard. The government established the Australian Jet Zero Council which brings together a cross-section of senior stakeholders from across the aviation sector and its supply chains to lead efforts to deliver net zero aviation in Australia. The council will also coordinate across the sector to provide advice to government on issues related to the aviation industry's transition to net zero emissions (DITRDCA, 2023b). Rail and heavy vehicles do not have sector specific announced plans for decarbonisation beyond their inclusion in the Transport and Infrastructure Net Zero Roadmap and Action Plan.
Impact	Current policies are not having the required impact, as transport emissions are projected to increase by 2030 (DCCEEW, 2022a). An effective Fuel Efficiency Standard can provide policy certainty for the light vehicle sub-sector with a relevant long-term target. The authority will watch with interest in the finalisation of the Fuel Efficiency Standard design and planned implementation.
Efficiency	There are no transport sector emissions reductions targets. Notably: • the National Electric Vehicle Strategy does not have a clear timebound objective for electric vehicles reaching a set percentage of sales, the percentage of Australia's car fleet that are electric or for the rollout of infrastructure targets. • the Australian Government has committed $7.8 million over 4 years from 2022–23 to develop the Transport and Infrastructure Net Zero Roadmap and Action Plan and $0.6 million in 2023–24 for the Maritime Emissions Reduction National Action Plan, but has not committed funding for other subsectors (DITRDCA, 2023a; Treasury, 2023a).
Relevance	The National Electric Vehicle Strategy aims to drive supply and demand of passenger electric vehicles, and build the charging infrastructure to enable the uptake of electric vehicles (DCCEEW, 2023e). The success of electric vehicle uptake depends on many enablers which the strategy considers. However, the strategy does not address the issue of accessibility, reliability and interoperability of different chargers for users.

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

3.5 Agriculture

4% emissions increase in agriculture emissions in 2022–23

Agricultural emissions increased to 82 Mt CO_2-e in 2022–23, up from 79 Mt CO_2-e in the previous year (unpublished data provided by DCCEEW). This was primarily due to increased livestock numbers and crop production (DCCEEW, 2023m). Of the total, 57 Mt CO_2-e is methane produced by enteric fermentation primarily from pasture cattle and sheep. Dairy cattle and feedlot cattle are also a source of enteric fermentation emissions but are collectively a 4 times smaller source of emissions than pasture cattle.

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

3.5.1 Emissions trends

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

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

Table 3.15: Sources of enteric fermentation in 2022–23

Emissions from enteric fermentation in 2022–23 by source (Mt CO_2-e)				
Cattle	Sheep	Pork	Other livestock	Total
43	14	Less than 1	Less than 1	57

Source: (DCCEEW, 2023m)

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

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

5-year average emissions intensity by source (t CO_2-e/t product)		
Beef	Pork	Chicken
18	4	Less than 1

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

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

3.5.2 Leading indicators of change

3.5.2.1 Enteric fermentation

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

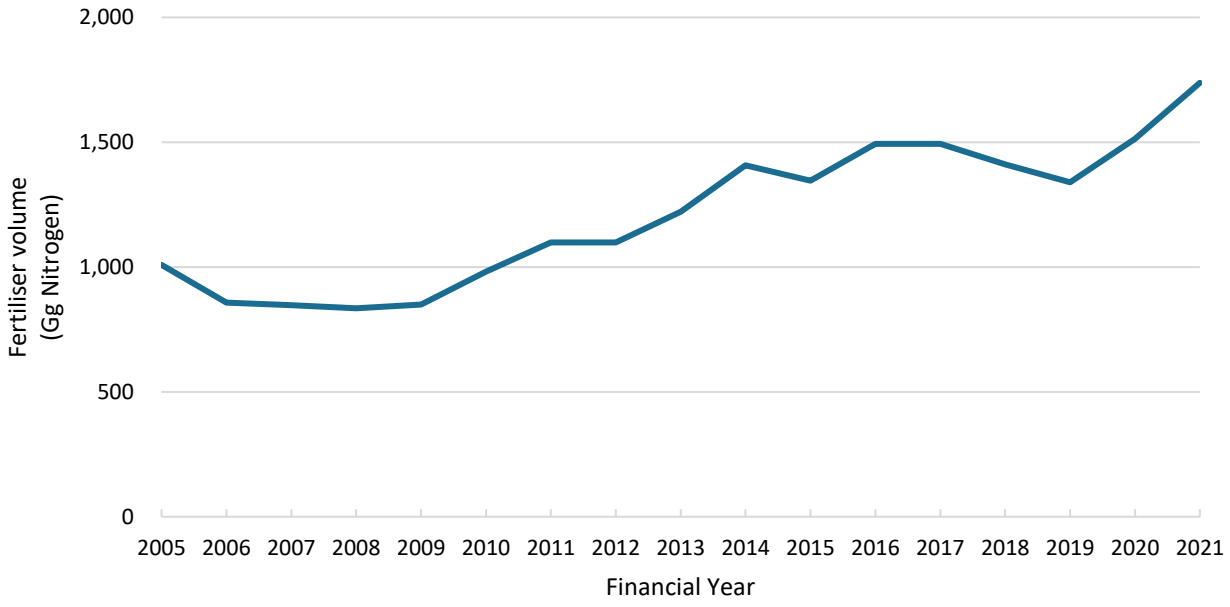
In future years, the authority aims to include a leading indicator on the volume of use of *Asparagopsis* and other feed supplements to estimate emissions reductions from enteric fermentation from their uptake. The authority is working with the industry to facilitate access to these data. To date, FutureFeed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

3.5.2.2 Fertiliser use

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

Fertiliser use for crops and pasture has increased in recent years as drought has been followed by improved growing conditions (DCCEEW, 2023c). Total nitrogen fertiliser emissions were 6 Mt CO_2-e in 2022–23 (unpublished data provided by DCCEEW) compared to 5 Mt CO_2-e in 2021–22 (DCCEEW, 2023m).

Figure 3.14: Nitrogen fertiliser sales in Australia



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

3.5.2.3 Other technologies and policies

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

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

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

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

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

Emissions from red meat and wool arising from enteric fermentation and manure management in 2022–23 were 55 Mt CO_2-e (unpublished data provided by DCCEEW).

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

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

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

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

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

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

Currently, feed supplements could be included in feedlot and dairy cattle production systems, where the supplement can be delivered with feed on a regular basis (Ridout, 2022). Feedlot cattle account for approximately 4% of the Australian beef herd, and based on feedlot numbers, potential emissions reductions from use of *Asparagopsis* have been estimated to be 0.6–2.0 Mt CO_2-e (Ridout, 2022). Further research, including an effective dose rate, is required before feed supplements can become an effective emissions reduction solution for the livestock industry (Ridout, 2022). *Asparagopsis* supplements have only been commercially available since June 2022 (MLA, 2022a), and the cost of growing the industry (and flow on costs to farmers) is relatively uncertain (AgriFutures Australia and CBA, 2022).

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

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

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

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

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

The company operates 28 pastoral and cropping farms over more than 4.5 million hectares across Australia and has capacity to run more than 220,000 cattle and 250,000 sheep, as well as a mixture of dryland and irrigated cropping. Using emissions factors derived from national greenhouse accounts data, the authority estimates these capacity figures could result in potential emissions of 0.4 Mt CO_2-e and 0.05 Mt CO_2-e respectively for cattle and sheep. These estimates do not consider the effects on emissions from factors such as feed type, climate and herd management practices.

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

3.5.3 Physical climate impacts

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

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

3.5.4 Innovations and developments

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

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

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

3.5.5 Policy opportunities and recommendations

3.5.5.1 Establish clear expectations for the agriculture sector

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

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

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

3.5.5.2 Enhanced funding to support net zero agriculture solutions

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

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

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

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

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

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

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

26. RECOMMENDATION

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

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

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

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

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

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

BOX 3.8: Consumer labelling

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

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

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

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

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

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

The program should include:

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

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

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

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

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

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

27. RECOMMENDATION

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

3.5.5.4 Reducing nitrous oxide emissions from fertiliser use

Nitrogen fertilisers contributed 6 Mt CO_2-e of emissions to Australia's 2022–23 national inventory (unpublished data provided by DCCEEW). One method to reduce emissions from use of nitrogen fertilisers is through nitrification inhibitors, which are often coatings applied during manufacture that slow the release of nitrogen from fertiliser to the atmosphere or waterways (Agriculture Victoria, 2023b). Application of nitrification inhibitors can more than halve emissions from nitrogen fertilisers (Meng, et al, 2021). Nitrification inhibiting fertilisers are more expensive than untreated fertiliser, which can discourage broad uptake by farmers (Folina, 2021). This issue was also raised with the authority during consultation.

28. RECOMMENDATION

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

3.5.6. Policy effectiveness

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

Table 3.17: Policy effectiveness in the agriculture sector

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

3.6 Land Use, Land-Use Change and Forestry

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

Australia's land sector will be critical to Australia achieving its emissions reduction targets. The land sector removed more carbon dioxide from the atmosphere than it released in 2022–23 – resulting in net emissions of -64 Mt CO_2-e[21] equivalent to removing 14% of Australia's national total (unpublished data provided by DCCEEW). The size of the net sink reflects the long-term decline in the rate of land clearing and the influence of La Niña conditions (unpublished data provided by DCCEEW).

3.6.1 Emissions sectoral trends

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

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

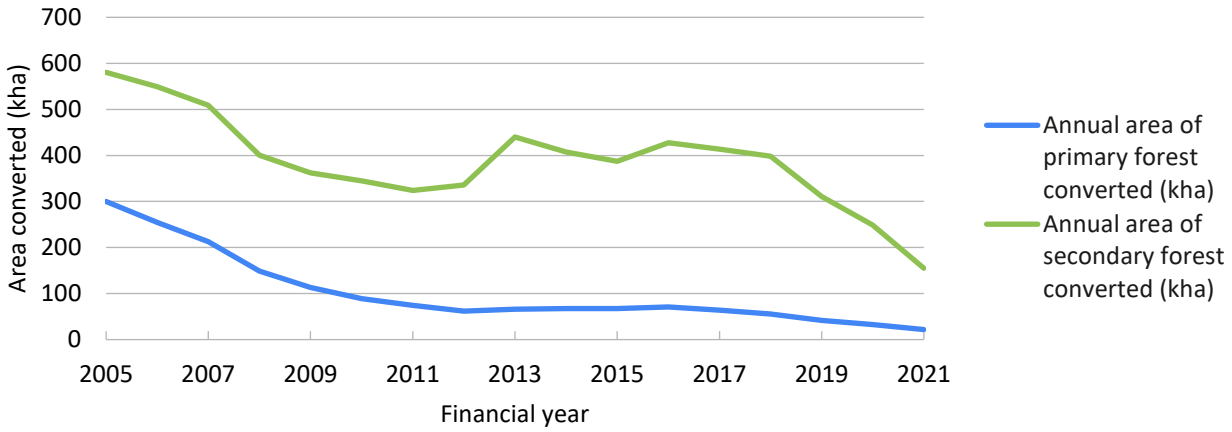
21 The latest estimate of Australia's net emissions in the land sector is -64 Mt CO2-e . Over the past year the Department of Climate Change, Energy, the Environment and Water (DCCEEW) has recalculated the sink to be around 20 Mt CO2-e larger (a higher negative number) than previously estimated due to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

3.6.2 Leading indicators of change

3.6.2.1 Area of land cleared

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

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



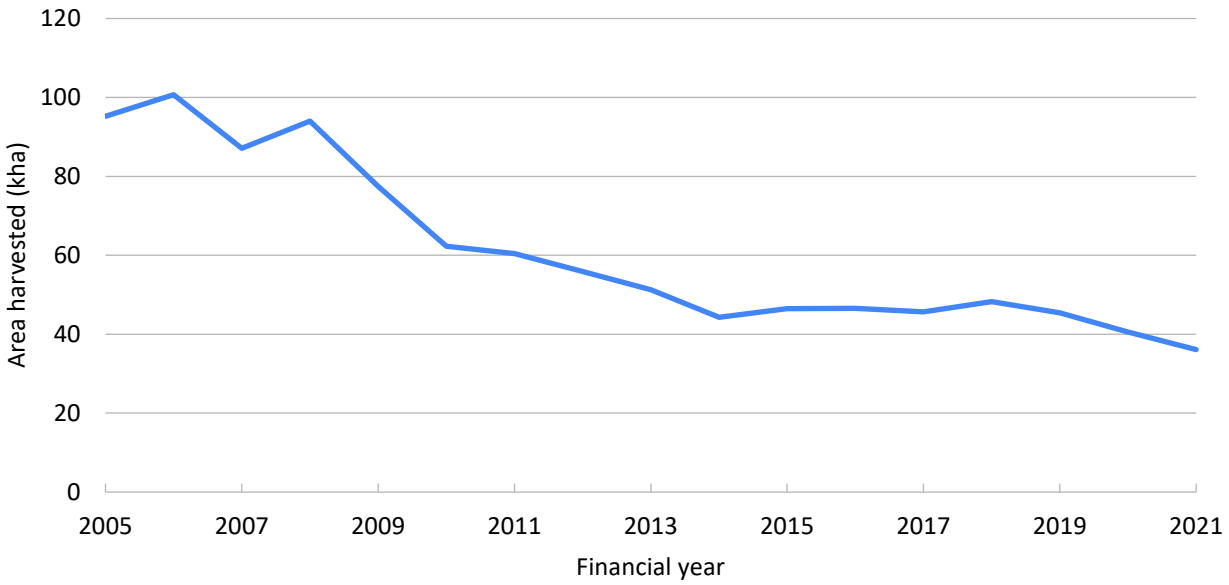
Source: (DCCEEW, 2023d, Table A5.6.12.6)

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

3.6.2.2 Area of native forest harvested

A decline in the area of native forest harvested for timber since 2004–05 has resulted in significantly lower direct emissions from timber harvest and has enabled greater emissions removals from the atmosphere from native forests (Figure 3.16). In 2004–05, harvested native forests provided -18 Mt CO_2-e. By 2020–21, emissions removals had increased to -36 Mt CO_2-e, a twofold increase in emissions removals (DCCEEW, 2023c).

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

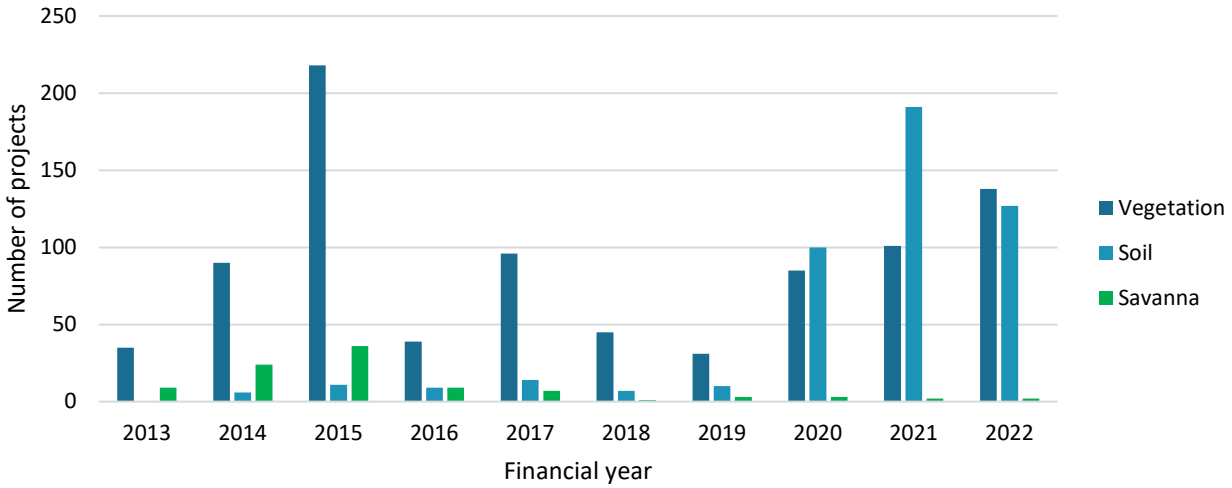


Source: (DCCEEW, 2023c, Table 6.4.16)

3.6.2.3 Number of new land-based ACCU scheme projects

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

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



Source: (CER, 2023b)

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

3.6.3 Impacts of climate change

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

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

3.6.4 Innovations and developments

3.6.4.1 Increasing demand for carbon offsets

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

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

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

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

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

3.6.4.2 Net zero agricultural supply-chain commitments

3.6.4.2.1 Mandatory commitments

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

3.6.4.2.2 Voluntary commitments

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

3.6.4.2.3 Nature-related commitments

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

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

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

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

3.6.5 Policy opportunities and recommendations

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

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

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

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

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

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

3.6.5.2 Farm-level capacity building

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

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

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

29. RECOMMENDATION

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

3.6.5.3 Supporting a sustainable forest industry

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

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

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

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

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

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

3.6.5.4 Continuing to refine the ACCU scheme

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

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

3.6.5.4.1 Supporting effective vegetation management regulations

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

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

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

3.6.6 Policy effectiveness

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

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

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

3.7 Waste

0% change in waste emissions in 2022–23

Greenhouse gas emissions from landfill have been relatively stable over the past decade and were 14 Mt CO_2-e in 2022–23 (DCCEEW, 2023m). This is consistent with the stable trend in the amount of organic waste going to landfill over this time. The dumping of organic waste, such as food and garden waste in landfills, is the key driver for greenhouse gas emissions from landfills.

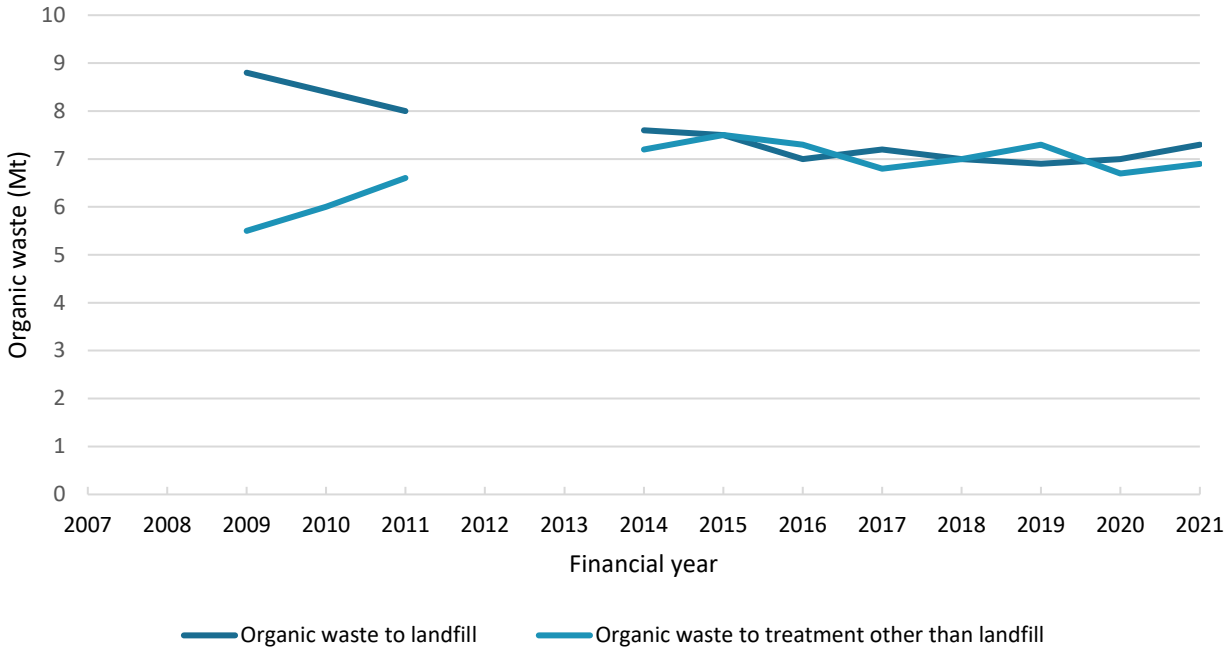
3.7.1 Emissions trends

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

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

Emissions in the waste sector are projected to decline from 13 Mt CO_2-e (2.6% of total emissions) in 2020 to 11 Mt CO_2-e (2.6%) in 2030, and 10 Mt CO_2-e (2.6%) in 2035 (DCCEEW, 2022a). The projected decline in emissions from the waste sector is based on assumptions of increased landfill gas capture and federal, state and territory policies to reduce the amount of organic waste going to landfill (DCCEEW, 2022a).

Figure 3.18: Treatment of organic waste



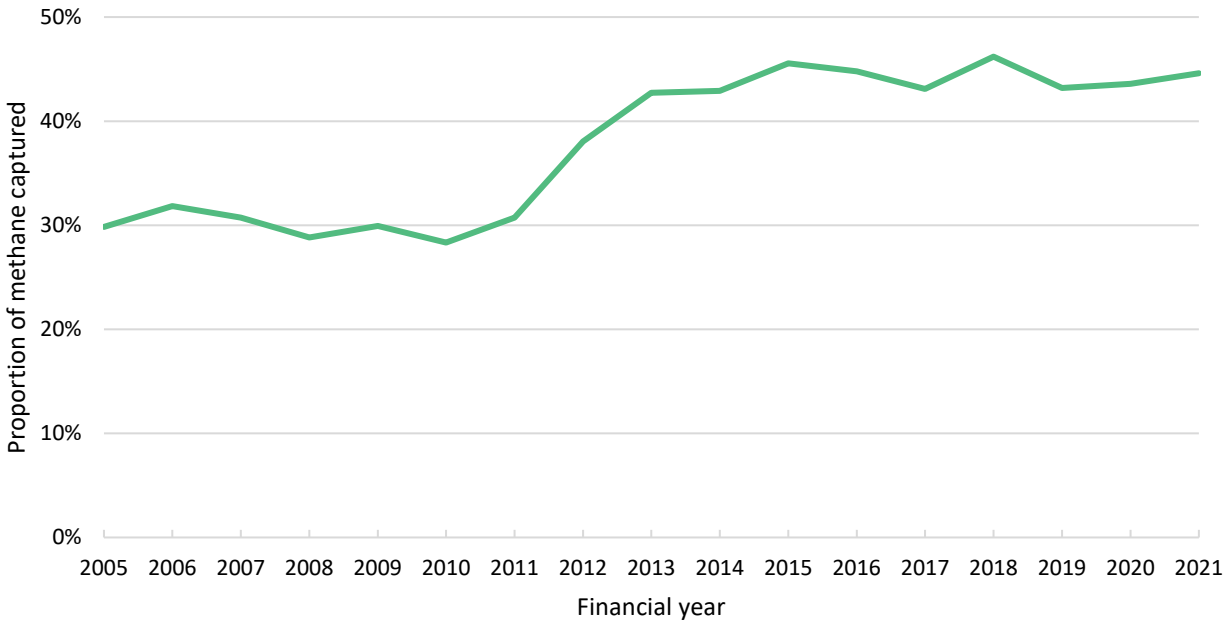
Source: (Blue Environment, 2022)[22]

[22] No data available for years 2007, 2012 and 2013

3.7.2 Leading indicators of change

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

Figure 3.19: Methane capture at landfill



Source: (DCCEEW, 2023c, Table 7.2)

3.7.3 Innovations and developments

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

3.7.3.1 Biological methane oxidation treatments

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

3.7.3.2 Source Separated Organics

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

3.7.3.3 Government support for recycling infrastructure

The Australian government's recycling modernization fund has co-funded five paper and cardboard recycling facilities that will be commissioned in the 2023–24 financial year, increasing Australia's paper and cardboard processing capacity (DCCEEW, 2023x). The recycling of paper and cardboard diverts this waste stream from landfill, avoiding emissions from being produced in landfill. This would avoid approximately 0.8 Mt CO_2-e of emissions per year if capacity is fully utilised.

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

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

3.7.4 Policy opportunities and recommendations

3.7.4.1 Reducing organic waste going to landfill

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

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

BOX 3.9: Circular economy

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

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

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

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

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

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

30. RECOMMENDATION

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

3.7.4.2 Incentivising greater methane capture from landfill

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

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

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

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

31. RECOMMENDATION

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

3.7.5 Policy effectiveness

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

Table 3.19: Policy effectiveness in the Waste sector

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

For more information about the work of the Climate Change Authority, visit our website at https://www.climatechangeauthority.gov.au/.

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