Australian Government
Department of Industry, Science, Energy and Resources

Australia's emissions projections 2020

December 2020

Executive summary

Australia is on track to meet and beat its 2030 target of 26 to 28 per cent below 2005 levels.

Australia's 2030 target (26–28 per cent below 2005 levels)

Emissions in 2030 are projected to be 478 Mt CO_2-e, 33 Mt CO_2-e lower than the 2019 estimate for 2030 of 511 Mt CO_2-e. Under a scenario aligned with the Technology Investment Roadmap, Australia's emission are projected to be 29 per cent below 2005 levels by 2030.

To achieve Australia's 2030 target of 26 to 28 per cent below 2005 levels, emissions reductions of 56 to 123 Mt CO_2-e between 2021 and 2030 are required. When past overachievement is included, Australia is on track to beat its 2030 target by 403 Mt CO_2-e. Under a scenario aligned with the Technology Investment Roadmap, Australia is projected to beat its 2030 target by 145 Mt CO_2-e without relying on past overachievement.

Australia's position against the 2030 target has improved by more than 300 Mt CO_2-e since the previous projections were published in 2019. The downward revision in the 2020 projections reflects:

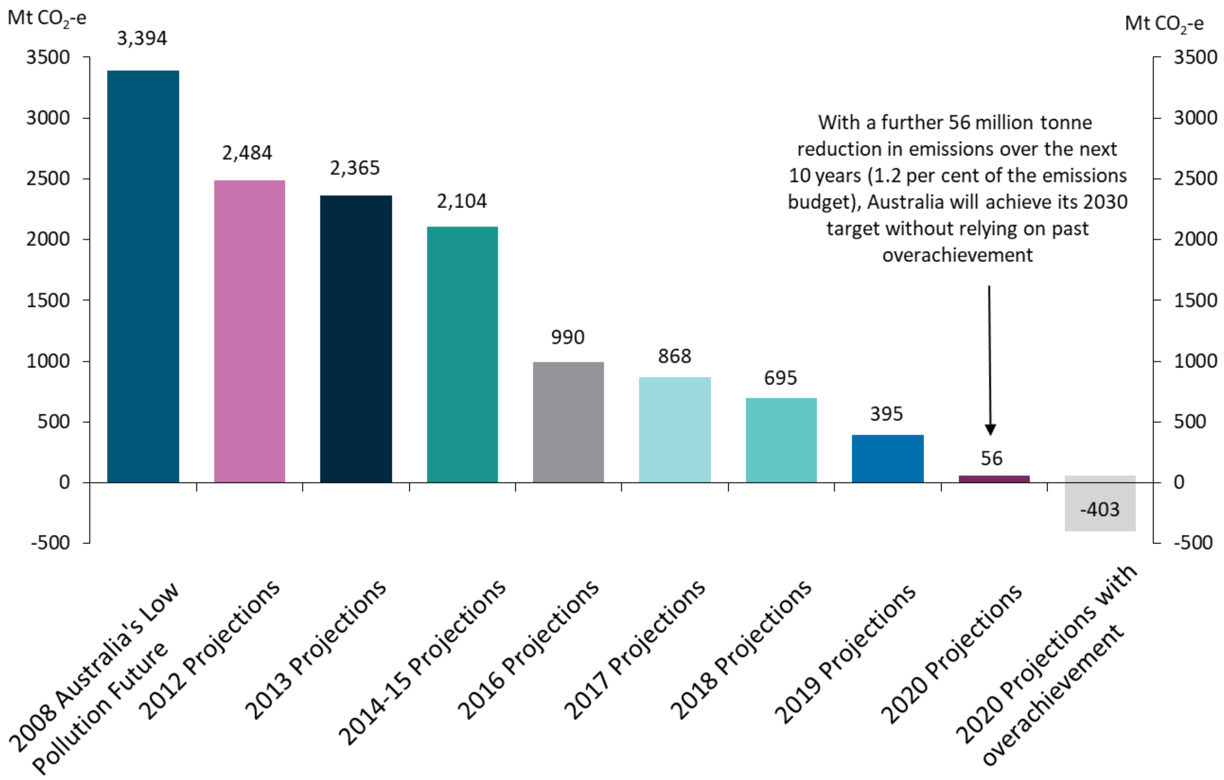
- the inclusion new measures to accelerate the development and deployment of low emissions technologies in the Australian Government's 2020-21 Budget;
- a further reduction in projected emissions from the electricity sector due to continued strong renewables uptake (particularly small and mid-scale solar) by households and businesses
- the temporary effect of COVID-related restrictions on the Australian economy, with the projected impact of the pandemic on future emissions largely limited to an acceleration of pre-existing trends.

The assumptions applied to the baseline projections are conservative. Historically, Australia has outperformed the emissions projections, with the emissions reduction task to achieve our 2020 and 2030 target revised downwards with each new iteration. The 2020 projections include a scenario aligned with the Technology Investment Roadmap (the high technology uptake sensitivity), built around the priority technologies identified in the Government's Technology Investment Roadmap and first Low Emissions Technology Statement. Under this scenario, Australia is expected to overachieve on its 2030 target by 145 Mt CO_2-e and emissions are forecast to be 436 Mt CO_2-e in 2030, 29 per cent below 2005 levels.

Table 1: Cumulative emissions reduction task 2021 to 2030

Calculation of 2030 emissions reduction task	26 per cent below 2005 level in 2030 (Mt CO_2-e)	28 per cent below 2005 level in 2030 (Mt CO_2-e)
Cumulative emissions 2021-2030	4,880	4,880
Emissions budget 2021-2030	4,832	4,764
Overachievement of previous targets	*-128 (target period 2008-2012)* *-303 (target period 2013-2020)* *-28 (waste protocol units)* ***Total: -459***	
Emissions reduction task[1]	**56** **(1.2 per cent of the emissions budget)** **-403 with past overachievement**	**123** **(2.6 per cent of the emissions budget)** **-336 with past overachievement**
Emissions reduction task (high technology uptake scenario)	**-145**	**-77**

Figure 1: Change in the cumulative emissions reduction task over time, 2030 target[2]



[1] The emissions reduction task is adjusted by 7 Mt CO_2-e to account for projected voluntary action using Australian Carbon Credit Units over the period 2021-30.

[2] For a target of 26 per cent below 2005 levels

Progress against Australia's 2030 emissions reduction target is assessed against an emissions budget covering the period 2021-2030. By assessing progress against the 2030 target through an emissions budget:

- Australia is committed to being accountable for emissions in every single year;
- The impact of changes in annual emissions in the target period is substantially lessened, better reflecting the long-run trends in Australia's emissions trajectory; and
- Continuity with Australia's commitments under the Kyoto Protocol (2008-2012 and 2013-2020) is maintained.

An emissions budget approach is central to how many other countries acquit progress against their targets, including the European Union and the United Kingdom.

Figure 2: Australia's cumulative emissions reduction task to 2030, Mt CO_2-e

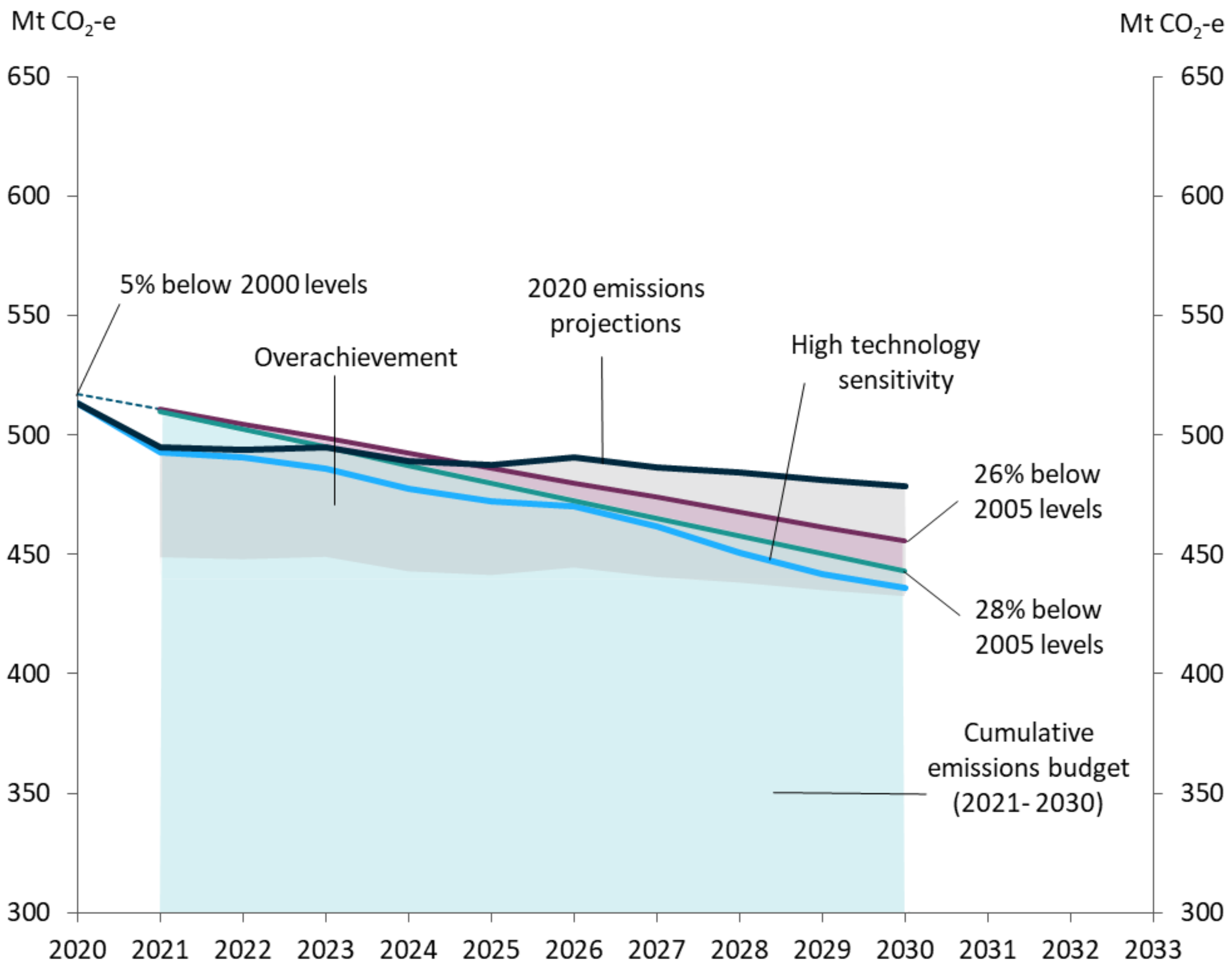
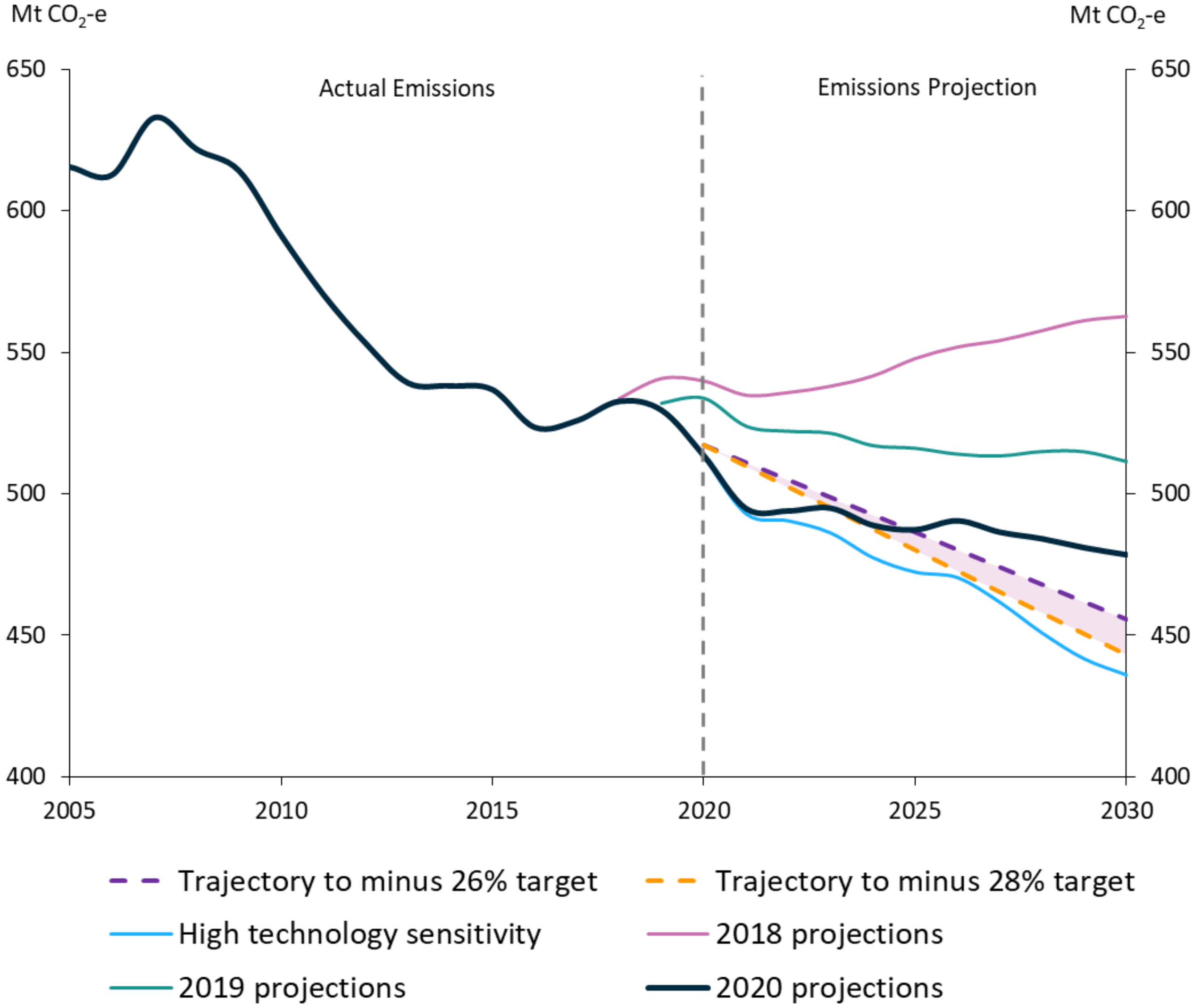
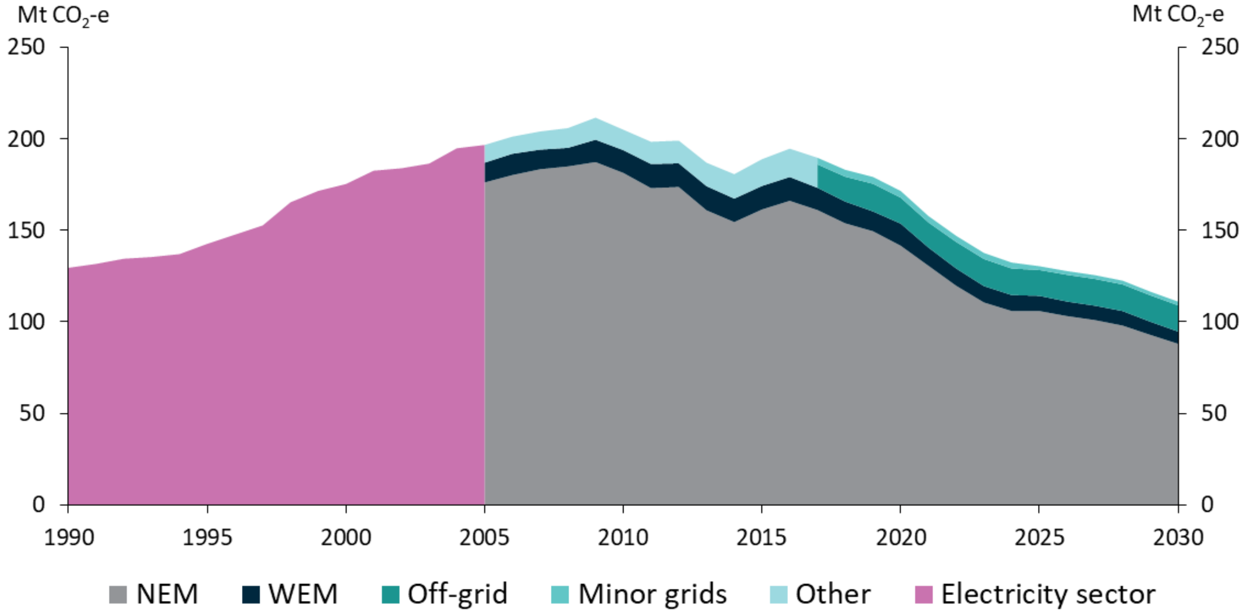


Figure 3: Australia's emissions projections, 2005 to 2030 and the 2030 emissions reduction task, Mt CO_2-e



Technology is a key driver for projected reductions in emissions, with the inclusion of new measures projected to accelerate the development and deployment of low emissions technologies. This is particularly true in the electricity sector, where growth in renewables has outstripped previous forecasts. New modelling has led to an upwards revision of projected small scale rooftop solar PV deployment from 15 GW over the decade in the 2019 projections, to 24 GW from 2020 to 2030. Supporting this growth in rooftop PV is an assumed increased deployment of household scale storage systems, with further grid stability supported by new gas capacity, including to support the replacement of the Liddell Power Station, and the operation of the Snowy 2.0 project from 2025.

Figure 4: Electricity emissions, 1990 to 2030, Mt CO_2-e

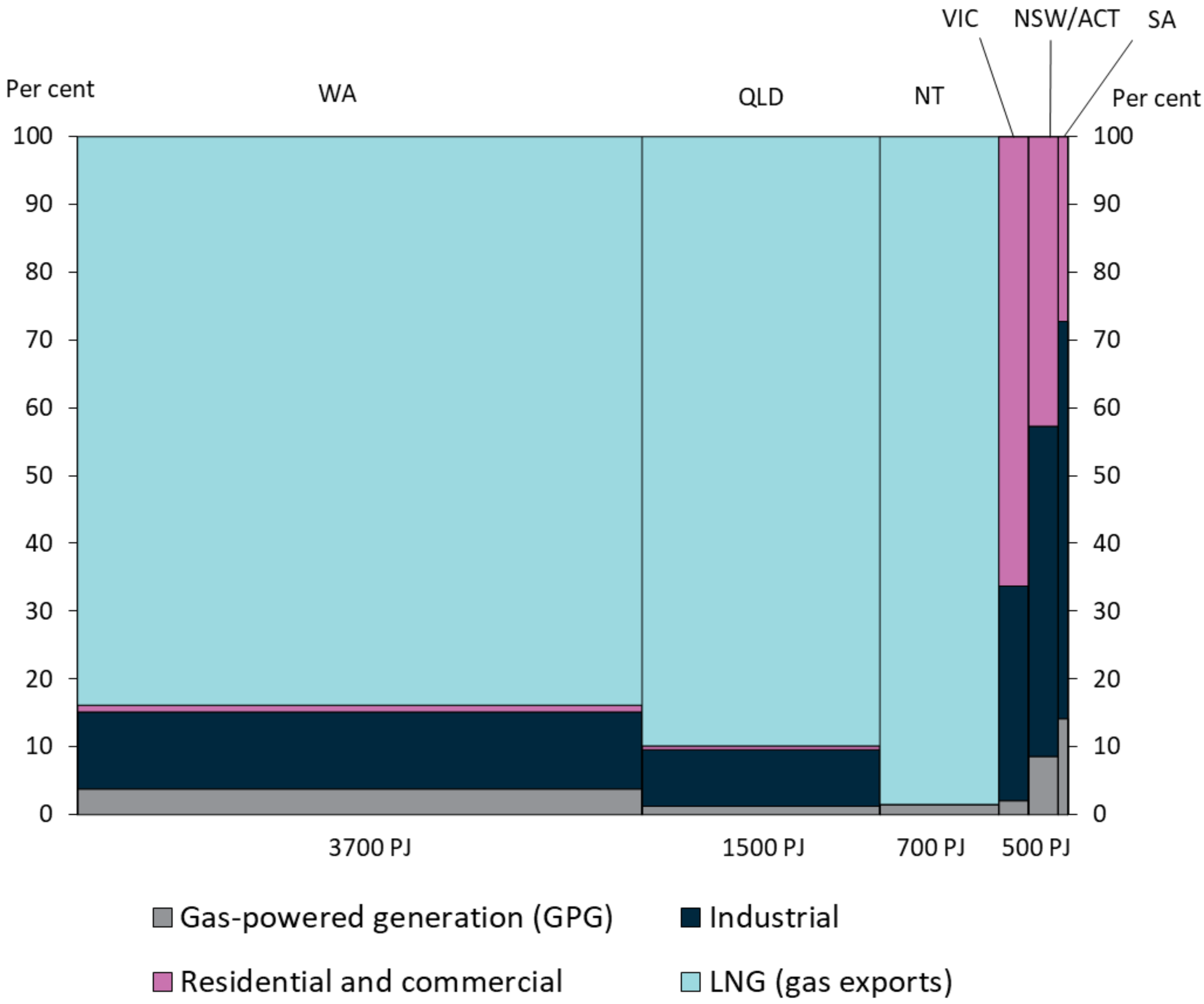


While Australia will continue to export the majority of its gas production, gas will continue to play an important role for households and the domestic economy (Figure 4). In the National Electricity Market (NEM) renewables are projected to supply over 30 per cent of electricity in 2021 and 55 per cent in 2030. Emissions in the NEM decline by more than 26 per cent below 2005 levels by 2022. Baseload gas generators are increasingly replaced by gas peaking generation over the decade and gas will continue to play a crucial role in meeting peak demand, which occurs in the evening as generation from solar PV declines.

In addition to supporting the deployment of renewables, gas is also used in the residential and commercial sectors for heating homes, buildings and water. Gas is also an important feedstock used in the industrial sector. Emissions associated with gas production are projected to increase as supplies are boosted to meet east coast demand and to support growing exports of Liquefied Natural Gas (LNG). Gas production in Australia is projected to grow by 3 per cent over 2020 to 2030. New gas production is projected to be from the Narrabri development and the Bowen and Galilee basins in the middle of the decade, and from the Beetaloo basin in 2030.

Emissions from LNG and coal production are projected to increase to 2030 as Australia's energy exports are projected to increase, based on IEA forecasts. The announcement of long term emissions targets by China, Japan and the Republic of Korea have not yet resulted in additional short term policies and are not projected to have any additional impact on the export outlook before 2030 beyond that already anticipated by the International Energy Agency.

Figure 5: Projected gas production and use by state and territory in 2030, per cent[3][4]



In the transport sector the projected uptake of electric vehicles has been revised up from 19 per cent of new vehicles sales in 2030 in the 2019 projections, to 26 per cent in 2030 in the 2020 projections. The COVID-19 pandemic has accentuated these pre-existing technology-led trends, like teleworking, with a short, temporary impact on emissions in Australia largely due to a reduction in passenger transport activity. These reductions primarily occurred in the domestic aviation and light passenger vehicle (car) fleets, where quarterly emissions were lower by 75 and 26 per cent (1.5 and 2.9 Mt CO_2-e), respectively. Transport activity is projected to rebound in 2021-22 and 2022-23, although to remain at a lower level than in the 2019 projections reflecting technology trends and slower population growth.

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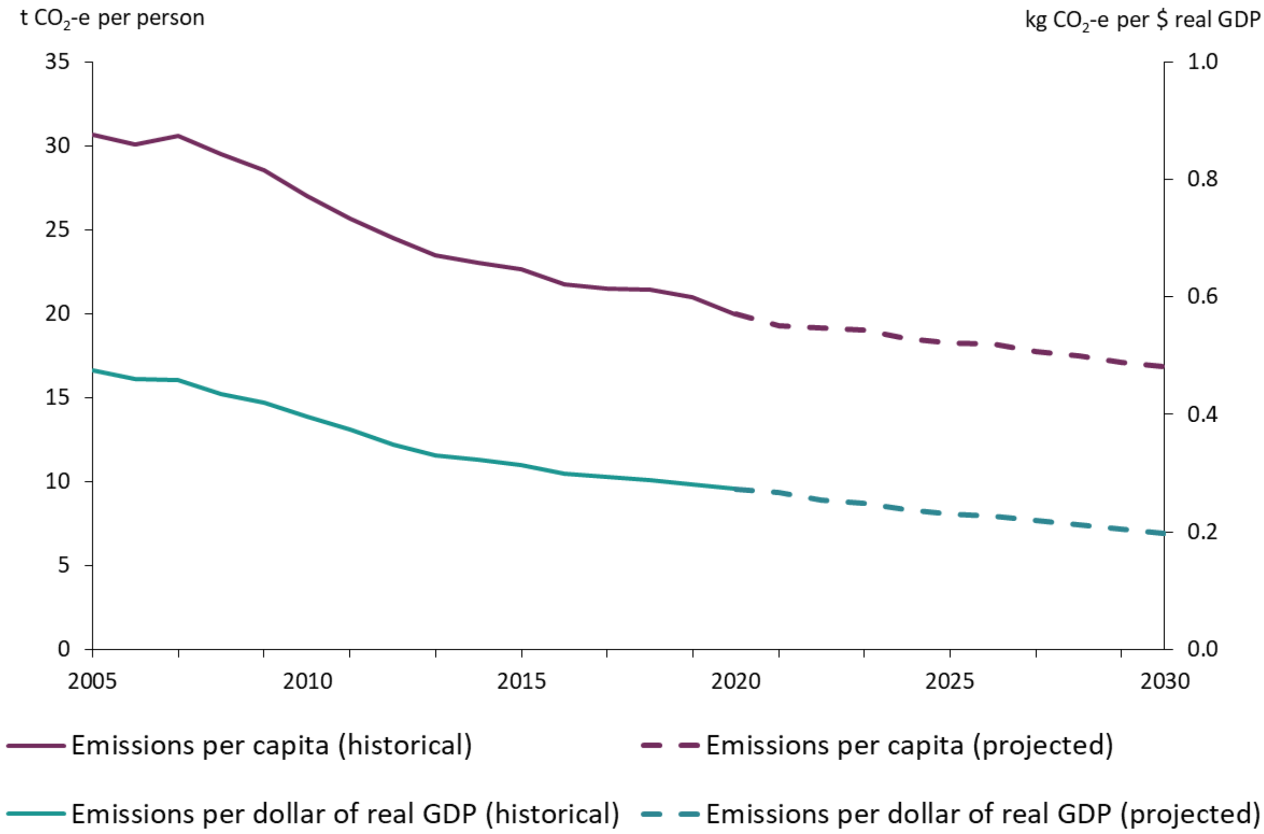
3 Estimates of gas production and consumption (PJ) are rounded to the nearest 100 PJ
4 Gas consumption and production in Tasmanian not visible on chart

The emissions intensity of the economy (Gross Domestic Product (GDP)) has continued to decline and is projected to fall by 58 per cent from 2005 to 2030. Emissions per person are also expected to fall by 45 per cent from 2005 to 2030.

Figure 6: Emissions per person and emissions intensity of GDP, 2005 to 2030



Contents

Projection results

Introduction

Emissions projections are estimates of Australia's future greenhouse gas emissions. They provide an indicative assessment of how Australia is tracking against its emissions reduction targets. They also provide an understanding of the expected drivers of future emissions.

Australia's 2030 target is converted into an emissions budget which enables Australia to annually track its progress to the target. The cumulative emissions reduction task represents the total emissions that must be avoided or offset for Australia to achieve its targets. If the emissions reduction task is a negative value, this indicates Australia is on track to overachieve on its targets.

The 2020 projections include:

- A projection of emissions from 2021 to 2030, which provides an estimate of Australia's emissions reduction task to meet its 2030 emissions reduction target.
- Sensitivity analyses (including a scenario aligned with the Technology Investment Roadmap) to illustrate how emissions may differ under changes in economic growth and technology uptake.

These projections update *Australia's emissions projections 2019*.

This report contains a high-level description of projections methods. A detailed description of the methodologies applied and key data inputs to the projections can be found in the *Methodology for the 2020 Projections* on the Department's website.

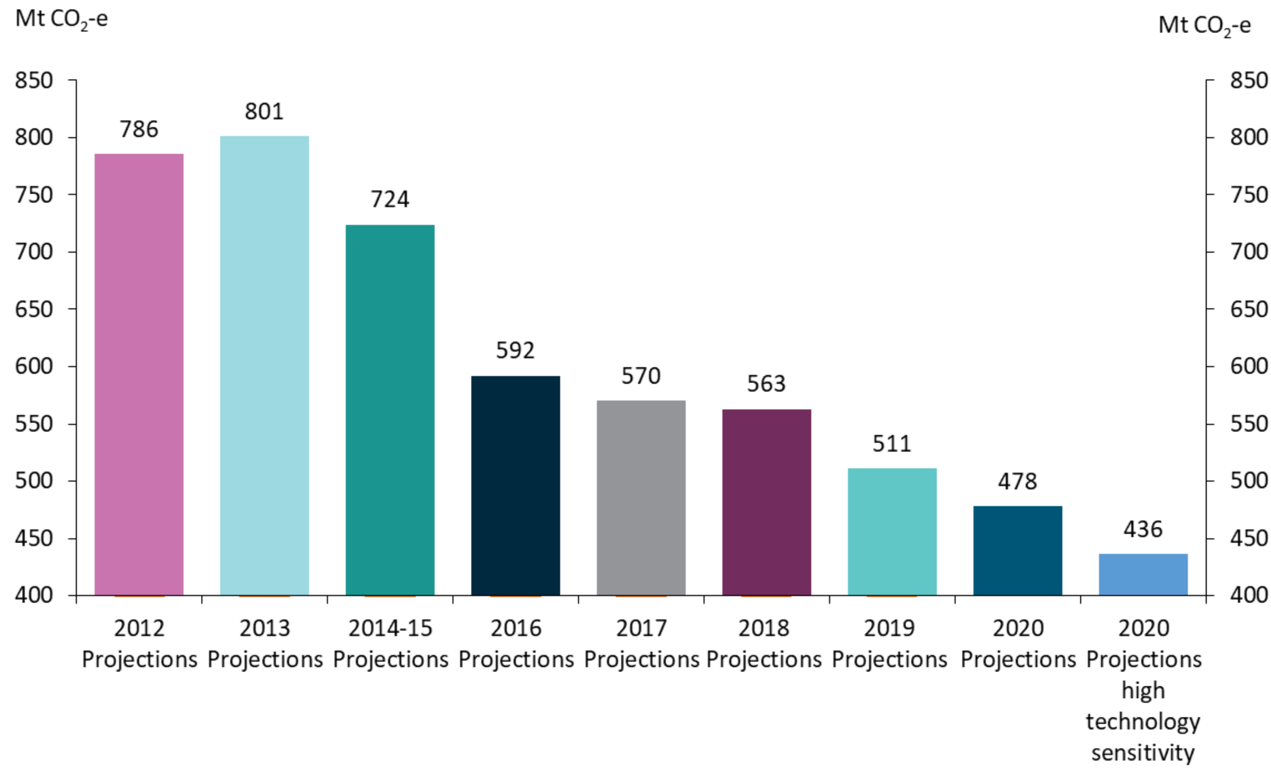
Emissions to 2030

Australia's abatement task to meet the 2030 target is projected to be between 56 Mt CO_2-e (26 per cent reduction) and 123 Mt CO_2-e (28 per cent reduction) over the period 2021 to 2030. This is equivalent to between 1.2 per cent of the emissions budget (26 per cent target) and 2.6 per cent of the emissions budget (28 per cent target). When past overachievement is included, Australia overachieves on the 2030 target by between 403 million tonnes (26 per cent target) and 336 million tonnes (28 per cent target). Under a scenario aligned with the Technology Investment Roadmap, Australia is expected to overachieve on its 2030 target by 145 Mt CO_2-e.

Emissions are projected to decline to 478 Mt CO_2-e in 2030 which is 22 per cent below 2005 levels. Under a scenario aligned with the Technology Investment Roadmap, emissions are forecast to be 436 Mt CO_2-e in 2030, 29 per cent below 2005 levels. Emissions are projected to decline early in the decade due to the impact of new measures to accelerate the development and deployment of low emissions technologies, reductions from the electricity sector due to continued strong renewables uptake by households and businesses' and the largely temporary effects of the COVID-19 pandemic on transport activity. Emissions are projected to stabilise in the latter half of the decade with agriculture emissions expected to increase as average seasonal conditions are assumed to return.

This projection does not yet include the impacts of measures which have not yet been implemented, for example, crediting of abatement below Safeguard facilities' baselines under the King Review's Safeguard Crediting Mechanism.

Figure 7: Projected emissions in 2030 over time, Mt CO_2-e



Changes since the 2019 projections

The 2020 projections include new measures announced in the Australian Government's 2020-21 Budget. The Budget provides funding to the Australian Renewable Energy Agency (ARENA), expands the investment mandate of the Clean Energy Finance Corporation and supports the development and deployment of low emissions technologies by businesses and communities. Further information on the measures are available at www.budget.gov.au/2020-21.

Australian households and businesses' continue to adopt renewables at record rates. The 2020 projections include a significant increase in the deployment of small-scale solar photovoltaics (PV, <100 kW) which has led to a declining trend in electricity emissions. Over the period to 2030 this projection includes just over 24 GW[5] of small-scale PV is installed in Australia. This is based on input data from the Clean Energy Regulator (CER).

The 2020 projections includes the impact of the pandemic which has accelerated pre-existing technology-led trends such as teleworking. Transport activity, in particular aviation and passenger road transport, have also temporarily declined in the 2020 and 2021 financial years due to restrictions on travel.

[5] Rooftop PV capacity presented in this report is effective cumulative capacity, which considers replacement of systems and the effect of degradation on systems over time.

Figure 8: Australia's emissions, 1990 to 2030, Mt CO_2-e

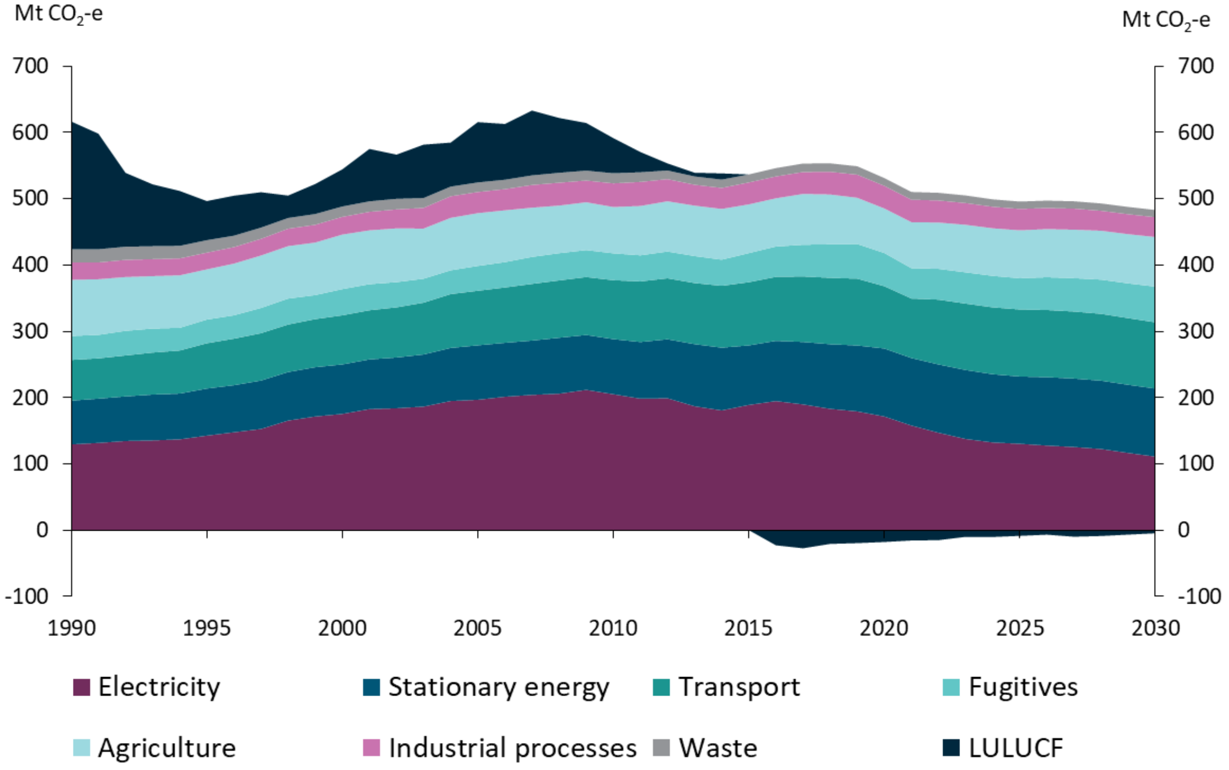


Table 2: Sectoral breakdown of 2020 projections results to 2030, Mt CO_2-e

Emissions by sector (Mt CO_2-e)	National Greenhouse Gas Inventory		Projection
	2005	2020	2030
Electricity	197	172	111
Stationary energy	82	103	103
Transport	82	94	100
Fugitives	37	50	54
Industrial processes and product use	32	34	30
Agriculture	80	67	75
Waste	14	12	11
Land use, land use change and forestry	91	-18	-5
Total	**615**	**513**	**478**

Note: totals do not sum due to rounding.

Sectoral trends

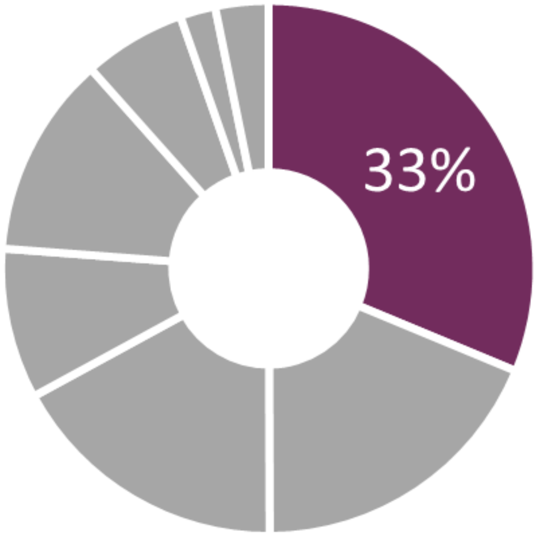
This chapter sets out the emissions projections associated with each sector. The sector breakdown is consistent with the international guidelines for reporting under the United Nations Framework Convention on Climate Change (UNFCCC). These sectors are described in Table 3 below:

Table 3: Projections sector coverage

Sector	Coverage
Electricity	Emissions from the combustion of fuels to generate electricity
Stationary energy	Emissions from the combustion of fuels to generate steam, heat or pressure, other than for electricity generation and transport
Transport	Emissions from the combustion of fuels for transportation within Australia
Fugitives	Emissions released during the extraction, processing and delivery of fossil fuels
Industrial processes and product use	Emissions from non-energy related industrial production and processes. Includes emissions from hydrofluorocarbons (HFCs) (used in refrigerants and air conditioning)
Agriculture	Emissions from livestock, manure management and crop residue Emissions from rice cultivation, application of nitrogen to soils, and burning of agricultural residues
Waste	Emissions from the disposal of solid waste and wastewater
Land use, land use change and forestry	Emissions and sequestration from activities occurring on forest lands, forests converted to other land uses, grasslands, croplands, wetlands and settlements

Electricity

33% of Australia's emissions in 2020
↓ 60 Mt CO_2-e 2020 to 2030



Emissions from electricity generation are the result of fuel combusted for the production of electricity in the National Electricity Market (NEM), Western Australia's Wholesale Electricity Market (WEM), other small grids and off-grid.

The NEM is the electricity market covering the east coast of Australia. It comprises five regions – Queensland, New South Wales (including the ACT), Victoria, Tasmania, and South Australia – and represents approximately 85 per cent of electricity generation in Australia. The WEM operates in the South West of Australia. The other grids comprise the small grids (the Darwin Katherine Interconnected System (DKIS), the North West Interconnected System (NWIS), and Mt Isa) and off-grid electricity generation.

Full market modelling is completed for the NEM, WEM, NWIS, DKIS and Mt Isa grids as part of the projections.

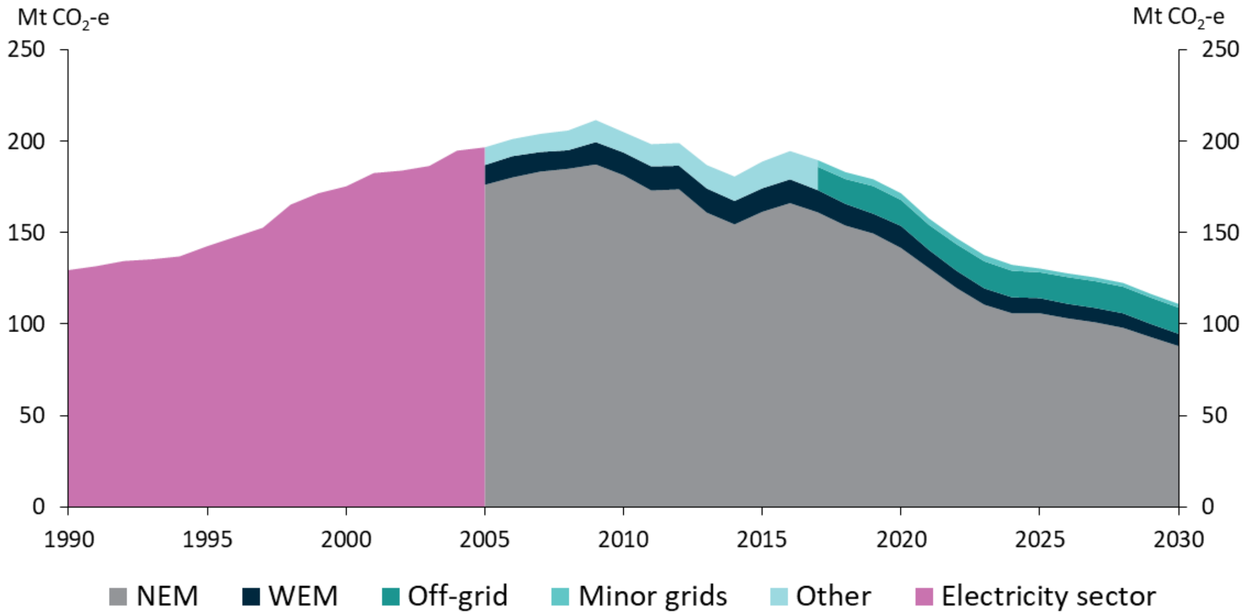
Emissions trends

Since 2016, emissions in electricity have been falling, driven by large amounts of renewable generation entering the market. Over the projections period, emissions are projected to decline from 2020 by 60 Mt CO_2-e, reaching 111 Mt CO_2-e in 2030.

These declines are driven by the projected continued decarbonisation of electricity generation across the country, including the country's largest market, the NEM. Large deployment of renewables, in particular rooftop solar, form a growing share of generation in the NEM. By 2030, decentralised rooftop solar forms the largest capacity type in Australia, making up around a third of all grid connected capacity in the country.

This sees the emissions intensity of electricity decline over the decade to 2030, please see Appendix C – Indirect (Scope 2) emissions factors for electricity grids, for more details.

Figure 9: Electricity emissions, 1990 to 2030, Mt CO_2-e



National Electricity Market (NEM)

Emissions in the NEM are projected to decrease by 54 Mt CO_2-e from 2020 to 2030, as this grid is projected to see a growing share of renewable generation. Emissions in the NEM decline by more than 26 per cent below 2005 levels by 2022.

Renewables in the NEM

The NEM is projected to see large additions of renewable capacity over the decade to 2030. Total gas, pumped hydro and battery storage capacity are also forecast to increase.

Rooftop solar is the biggest contributor to renewables growth. The Clean Energy Regulator's projections for rooftop solar, adopted in this modelling, show strong uptake to 2025 as cumulative effective capacity reaches 22 GW. Expectations are that strong growth continues to 2030, with rooftop capacity tripling over the decade to over 32 GW in the NEM. The installation of small-scale battery storage is assumed to rise with the installation of rooftop systems, however the number of systems without storage also increased to 2030.

Large-scale renewables also enter the market early in the 2020s, under the Clean Energy Regulator's pipeline of large-scale projects adopted in the projections. However, the continued growth of rooftop solar slows the uptake of utility scale solar over the longer term in the projections, as large quantities of solar competes during the middle of the day. The result that in the longer-term, small-scale solar crowds out new large-scale solar in the NEM.

The high penetration of intermittent renewable generation requires more firming capacity. The commissioning of the Snowy 2.0 project in March 2025 provides 2 GW of pumped hydro capacity which supports the balancing of high levels of renewable operating during the day, but significantly more firming capacity will be required to support system strength.

Additional large-scale battery capacity is also projected to be built over the decade to 2030, but this is not as strong as the growth in small-scale batteries behind the meter (4.1 GW in 2030). The Government's Underwriting New Generation Initiative (UNGI) and target to ensure the exit of the Liddell coal station in

NSW is replaced by 1,000 MW of dispatchable capacity ensures additional reliable capacity is available over the decade.

The first stage of the Battery of the Nation project, in the form of the first stage of Marinus link interconnector between Victoria and Tasmania provides 750 MW of additional capacity to trade electricity between Tasmania and the mainland by the end of the projections period. This additional capacity also allows wind generation in Tasmania to be exported to the mainland. Other major interconnector projects such as the interconnection between New South Wales and South Australia in Project EnergyConnect, and New South Wales and Victoria in VNI West also support the ability to trade electricity across the NEM, allowing balancing of intermittent renewables across the eastern states.

Modelling for the projections shows gas generation continues to support a grid with high renewable penetration. Gas generation plays an increasingly important role in managing peak demand in the morning and evenings where renewables are not available. Nationally, new gas capacity is projected to outpace retirements by 1 GW over the decade, supporting peaking loads rather than baseload generation. The Government continues to support the reliability of the grid by ensuring adequate dispatchable capacity is deployed in the NEM under the UNGI and Liddell replacement target.

Due to timing, the projections does not take account of the NSW Electricity Infrastructure Roadmap announced in November 2020.

Demand in the NEM

The overall effect of the COVID-19 pandemic on electricity demand has been relatively small with Australia not seeing the large declines observed in some countries. Lower business consumption has been offset by increased residential consumption as more people began working from home in the short-term.

The projections use AEMO's forecasts of underlying electricity demand that is met by the grid and from onsite rooftop solar systems. The NEM is projected to see little growth in electricity demand as energy efficiency offsets increases in demand associated with population growth. The projections further include savings from energy efficiency measures announced under the Climate Solutions Package and measures announced in the 2020-21 Budget.

Growing electricity consumption from electric vehicles does drive additional consumption by 2030, however a low starting share of the fleet and increasing efficiency of the electricity use in electric vehicles results in consumption only accounting for one per cent of total demand on the NEM in 2030.

Rooftop PV is projected to meet a growing share of this underlying demand, leading to lowering demand met through the grid. This trend continues as installations of rooftop solar continue to be strong throughout the projections period, and the NEM reaches low levels of operational demand, particularly in the middle of the day, across all NEM regions in the projections. To limit the emergence of negative demand events in the projections modelling, a level of curtailment was assumed to apply to some solar generation. In 2030 this curtailment was assumed to reduce the output of rooftop PV systems by approximately 6,000 GWh.

Western Australia Wholesale Electricity Market (WEM) and the Darwin Katherine Interconnected System (DKIS)

Emissions in the WEM are projected to decrease by 5 Mt CO_2-e from 2020 to 2030, as this grid is projected to see a growing share of renewable generation.

Emissions decrease over the first half of the decade as increased renewable capacity, particularly wind and rooftop solar, comes online and thermal generation declines. The projections modelling shows a build of battery storage to balance this renewable generation, including the large-scale battery in the WEM supported by the Government's investment in energy security in WA.

Gas generation continues to support the balancing of the system in the WEM. Both gas in peaking plants and baseload generation increases at the end of the projections period as coal capacity declines and intermittent renewables increases, with gas remaining a significant share of the generation mix in 2030.

The Darwin Katherine Interconnected System (DKIS), which is the largest electricity grid in the NT, but less than one per cent the size of the NEM, sees emissions decline by less than 1 Mt to 2030. However, this represents a 40 per cent decline in this grid as solar (both large-scale and rooftop) come online to meet the NT government's 50 per cent renewable energy target, displacing gas generation. The size of the grid means these declines are small relative to overall electricity sector emissions. To meet this target in the DKIS, a relatively large amount of storage is needed to support the 50 per cent penetration of solar generation, which is the only renewable resource available for this grid. The result is approximately 450 MW of combined large and small scale battery capacity in 2030, which represents over a third of the capacity in the DKIS in this year.

Off-grid electricity, and the North West Interconnected System

Emissions from off-grid electricity use are projected to remain flat to 2030, as declining emissions from remote industry sites and communities are offset by increased electricity use to support the production of LNG.

Mining and remote communities

Emissions in mining and remote communities are projected to decline by 1 Mt CO_2-e by 2030. Electricity demand is projected to grow at an average of one per cent per year over the projections period.

Additional demand is more than met by increasing solar generation. Mining operations and remote communities are incentivised to switch to more hybrid systems to reduce the high fuel costs of liquid fuels, which currently supply almost 50 per cent of generation for this subsector.

The projections show strong growth in renewable generation which reaches over 2,000 GWh by 2030, adding around 800 MW of new capacity, in particular large-scale solar, by 2030.

The North West Interconnected System (NWIS) is a relatively small grid serving the resource industry in the north-west of Western Australia. Emissions are projected to remain relatively flat as a growing share of solar generation is offset by demand growth from 2025.

Electricity to support the production of LNG

Emissions associated with electricity production at LNG facilities occur when natural gas is combusted in onsite generators. Emissions from this source are projected to increase by 1 Mt CO_2-e over the decade to 2030 following rising LNG production. Electricity use in LNG facilities follows the trend of total LNG production, which is projected to grow by 2030. Please see the fugitive oil and gas section of the projections for further details.

The projections includes the announced battery project at the Darwin LNG facility. Electricity generation emissions at the Darwin LNG facility are projected to reduce by 20 per cent[6], in line with Conoco Phillips' announcement.

Table 4: Electricity emissions, Mt CO_2-e

Emissions by grid	2005	2020	2025	2030
National Electricity Market	176	142	106	88
Queensland	46	47	39	35
New South Wales/ACT	58	49	34	27
Victoria	64	42	32	25
South Australia	8	4	<1	<1
Tasmania	<1	<1	<1	<1
Western Australia Wholesale Electricity Market	11	12	8	7
Other grids, including off-grid	10	18	16	16
Total electricity sector	**197**	**172**	**130**	**111**

Note: totals may not sum due to rounding

6 http://www.conocophillips.com.au/newsroom/news-releases/story/innovative-darwin-lng-battery-project-to-reduce-carbon-emissions/

Figure 10: Fuel generation mix, 2020 to 2030, GWh

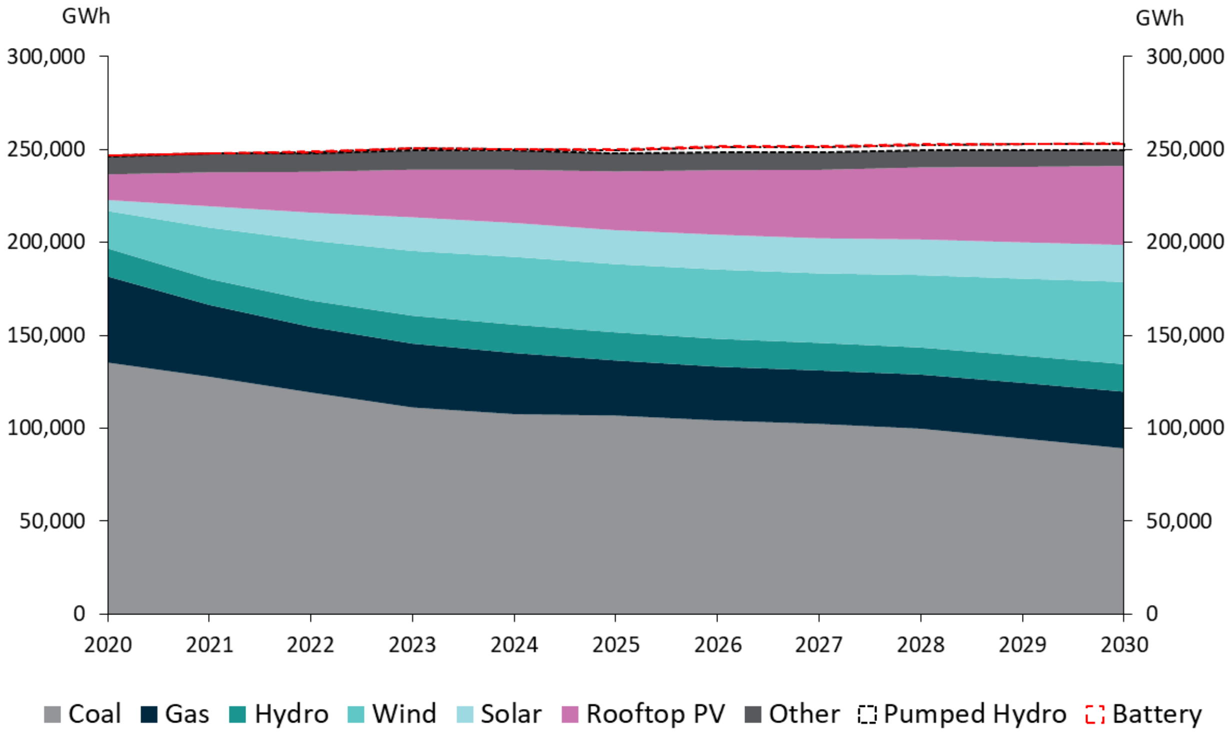


Table 5: Renewable share of generation, per cent

Percentage of renewables[7]	2005	2020	2025	2030
National Electricity Market		27	47	55
Queensland		15	35	40[8]
New South Wales/ACT		19	40	51
Victoria		25	48	56
South Australia		57	95	94
Tasmania		99	100	100[9]
Western Australia Wholesale Electricity Market		18	35	40
Other grids, including off-grid		2	7	13
Total electricity sector	**9[10]**	**23**	**42**	**50**

[7] This high share of renewable generation requires additional firming, shown in the model as pumped hydro capacity and to a lesser extent, battery storage. These are not shown in this table.

[8] Renewable share is defined in this table as renewable generation sent out over total generation (excluding storage in pumped hydro and batteries). Queensland's energy target has been considered under this projections as a consumption target in line with assumptions under AEMO's 2020 Integrated System Plan. A consumption target takes account of factors such as exports that this number does not.

[9] Renewable share is defined as noted above. Tasmania's interim renewable energy target accounts for factors such as exports that this number does not.

[10] Calculated on an as generated basis.

Table 6: Installed capacity by technology, GW

Installed capacity	2020	2025	2030
Coal	25	23	19
Gas	19	19	20
Hydro	7	7	7
Wind	8	13	15
Large-scale solar	3	8	8
Mid-scale solar (100kW to 5MW)	<1	1	2
Small-scale solar (≤100kW)	12	25	36
Other	4	4	4
Pumped Hydro	1	1	3
Battery storage	<1	3	6
Total	**79**	**104**	**119**

Comparison to previous projections

Compared to the 2019 projections, electricity emissions are projected to be 19 Mt CO_2-e lower in 2030 and 173 Mt CO_2-e lower cumulatively over the period 2021 to 2030.

Lower demand forecast in the NEM, with higher penetration of renewable generation, driven by uptake of rooftop solar and renewable policies, has delivered the majority of the revision by 2030. Emissions from the NEM are projected to be 16 Mt CO_2-e lower in 2030 compared to the 2019 projections.

Rooftop PV projections

In recent years Australia has seen growth in decentralised power generation in the form of solar PV panels installed on the rooftops of residential and commercial buildings. These systems allow users to reduce retail bills by using power generated on-site, as well as export electricity to the grid.

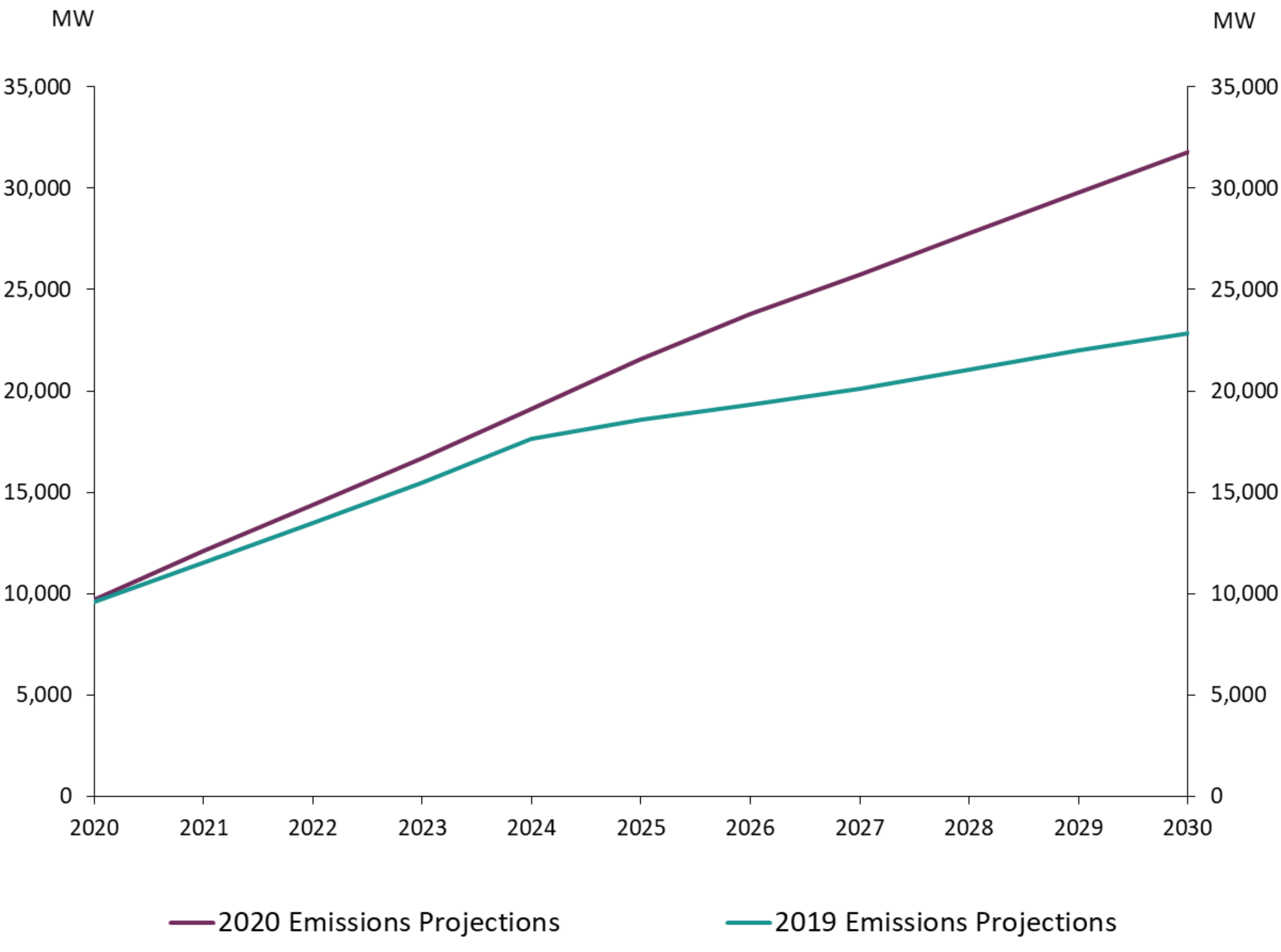
The largest segment in these distributed generators is small-scale systems, under 100kW in size. These systems have the ability to generate small-scale technology certificates (STCs) under the Small-scale Renewable Energy Scheme (SRES). Recent years have seen record levels of small-scale generation installations. The COVID-19 pandemic has not slowed the installation rate of systems with an estimated 667 MW of capacity installed in Quarter 2 2020, an 11 per cent increase on Quarter 1 2020, and 41 per cent higher than Quarter 2 2019[11].

[11] Clean Energy Regulator, Quarterly Carbon Market Report: June Quarter 2020, 28.

The projections, which account for the Clean Energy Regulator small-scale projections to 2025, see strong growth to continue to 2030 based on advice from the Regulator. National annual installations rates are close to or over 3GW over the period to 2025, and over 2GW across the entire decade. Some of these systems are replacements for older, small systems and the cumulative capacity is further reduced as systems degrade over time. However, with the majority of systems being installed in recent years or over the projections period, replacements and degradation have limited impact on total capacity by 2030.

The result is rapid growth in capacity of small-scale installed systems across the projections, with rooftop systems the largest single technology type by a large margin in 2030. The largest capacity is in the NEM, which accounts for over 80 per cent of Australia's small-scale rooftop capacity.

Figure 11: Effective cumulative capacity in the NEM for small-scale rooftop systems, MW



This growing capacity of decentralised generation presents new challenges in managing an operable grid, which has been designed for electricity to flow from central power stations to end-users. AEMO has recognised that 'declining minimum demand could lead to issues with managing voltage, system strength, and inertia…creating near-term operational and planning challenges…'[12] Some of these challenges in system security have seen action from the South Australian government with requirements that future systems are able to be centrally managed.

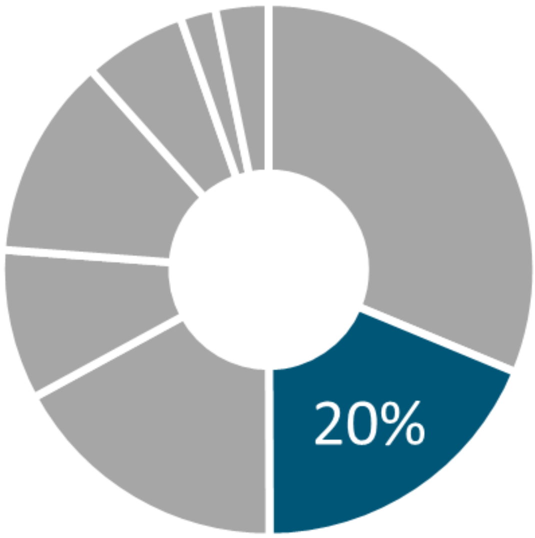
[12] AEMO, 2020 Electricity Statement of Opportunities, 4.

To ensure an operable and secure system, and taking precedent from actions in South Australia, the projections include curtailment of rooftop generation during periods of low minimum demand in the system. This has resulted in approximately 6,000 GWh of curtailment in 2030 in the NEM, approximately 3 per cent of NEM demand. Longer-term trends in storage, demand response and other balancing or system managing technologies may result in a different and potentially lower outcome for rooftop generation curtailment outside the projections period. The Energy Security Board (ESB) is undertaking a Post 2025 Project to take a holistic look at what needs to change to ensure the NEM can meet the needs of consumers in a future of diverse energy sources including distributed energy participation.

Stationary energy

20% of Australia's emissions in 2020

↑ <1 Mt CO_2-e 2020 to 2030

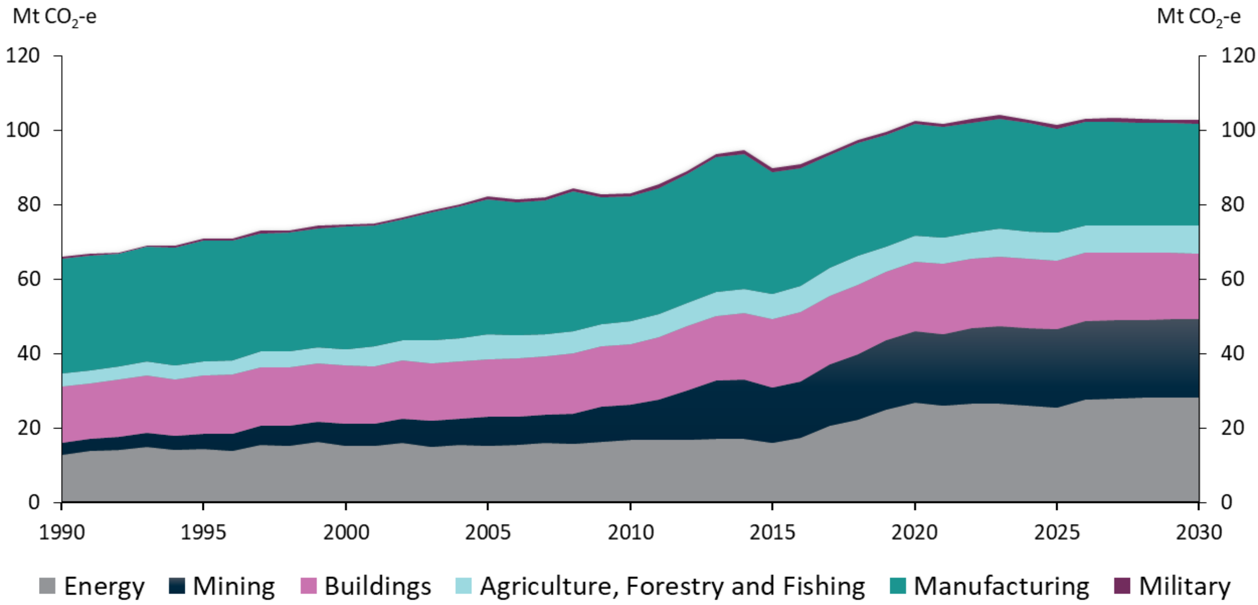


Emissions from stationary energy are from the burning of fuels for energy used directly, in the form of heat, steam or pressure (excluding for electricity generation and transport). The stationary energy emissions are produced from almost all sectors of the economy. The stationary energy sector consists of six subsectors: energy, mining, manufacturing, buildings, agriculture, forestry and fishing, and military.

Emissions trends

Stationary energy emissions have increased from 1990-2020 at an average rate of 1.5 per cent per year. Emissions are projected to grow more slowly at an average rate of less than 0.1 per cent per year from 2020. Emissions are projected to be 103 Mt CO_2-e in 2030 (Figure 12). Fuel switching, energy efficiency measures and assumed technological improvements are the major factors contributing to the slower rate of emissions growth.

Figure 12: Stationary energy emissions, 1990 to 2030, Mt CO_2-e



Manufacturing

Manufacturing of goods and commodities is the largest subsector within the stationary energy sector. Most manufacturing emissions (40 per cent) come from the manufacture of basic non-ferrous metals such as alumina and aluminium. Emissions from alumina refineries accounts for about 90 per cent of emissions from the non-ferrous metals classification. Other significant emission sources in manufacturing are the manufacture of chemicals (26 per cent) and non-metallic minerals (15 per cent).

Table 7: Manufacturing emissions, Mt CO_2-e

Emissions by subsector	2020	2025	2030
Non-ferrous metals	12	11	10
Alumina	11	10	9
Other	1	1	<1
Non-metallic minerals	5	4	4
Iron and steel	1	1	2
Pulp, paper and print	1	1	1
Chemicals	8	7	7
Food processing, beverages and tobacco	3	3	3
Other manufacturing	1	<1	<1
Total	**30**	**28**	**27**

Note: totals may not sum due to rounding

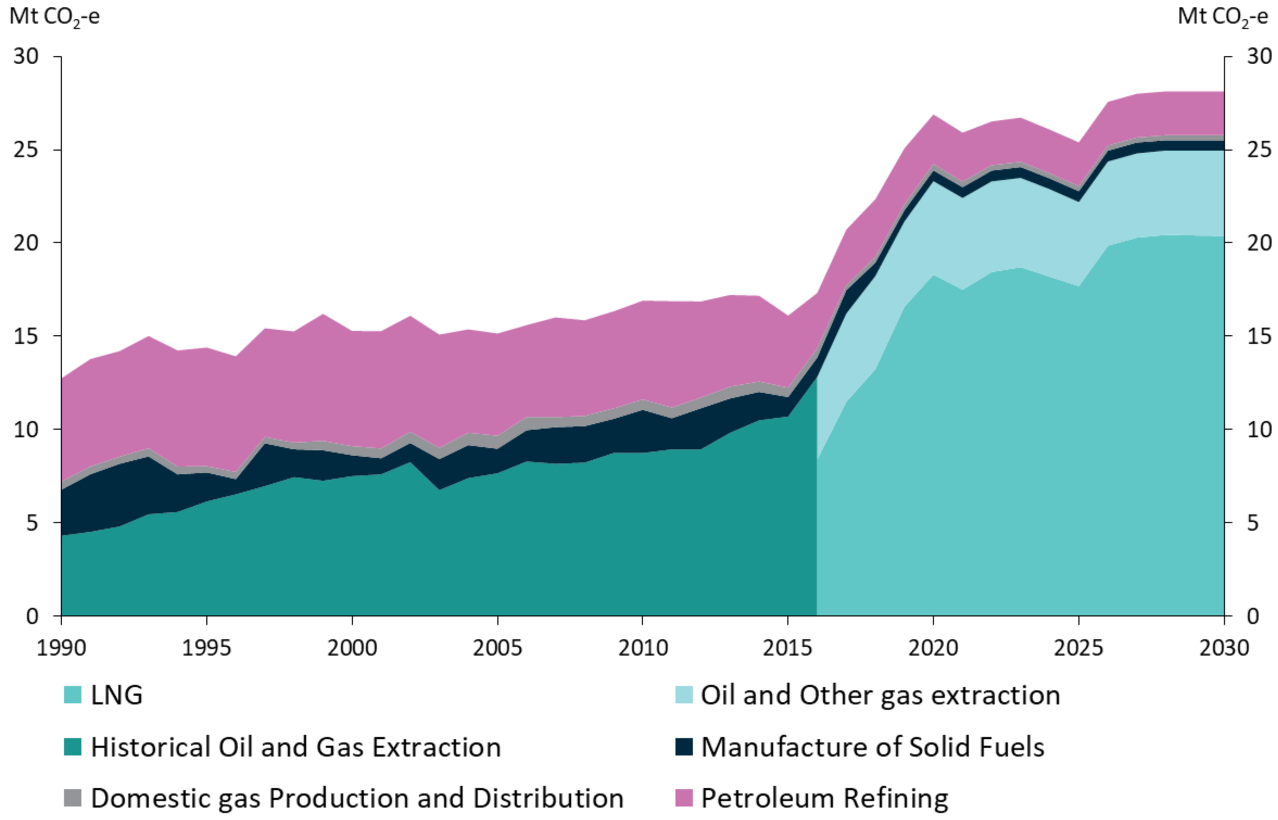
Despite a relatively stable projection of commodity production, emissions from the manufacturing subsector are projected to decline from 30 Mt CO_2-e in 2020 to 27 Mt CO_2-e in 2030 (Table 7). This decline in emissions is mainly due to the take up of emission reduction opportunities in the non-ferrous metals, iron and steel, non-metallic mineral and chemical subsectors. Some examples of these opportunities include digestion technology upgrades in the alumina industry, the uptake of natural gas direct reduction (DR) and electric arc furnace (EAF) processes in iron and steel industry, and improved burner design and efficiency improvements to incumbent technology in the ammonia industry. The assumed adoption of these technologies, where economic, reduces fuel use and emissions. Emission reductions from industrial energy efficiency measures announced in the 2020–21 Budget are also included.

Energy

Emissions trends in the energy subsector are mainly driven by LNG production which accounts for about 70 per cent of emissions in the energy subsector. Emissions from the energy subsector are projected to increase over 2020-2030 period from 27 Mt CO_2-e in 2020 to 28 Mt CO_2-e in 2030 (Table 8, Figure 13).

Emissions from all other industries within the energy subsector are expected to remain relatively stable over the projections period, with the exception of petroleum refining. The announced closure of the Kwinana petroleum refinery in Western Australia is included in this projection and is assumed to take effect by mid-2021.

Figure 13: Energy subsector emissions, 1990 to 2030, Mt CO_2-e



Buildings

The building subsector includes all the emissions from fuel combustion in residential and commercial buildings. Emissions in this subsector are projected to decrease by 5 per cent over the 2020 to 2030 period (Table 8). Emissions in the buildings subsector are primarily driven by gas use in residential and commercial buildings. Emissions from the residential and commercial buildings subsector is projected to fall as energy efficiency measures put downward pressure on growth in energy consumption. This reduction is partially offset by an increase in emissions from construction activity from 2024.

Mining

The mining subsector consists of coal mining and other mining. Other mining includes all mining other than coal and is primarily made up of emissions from iron ore (50 per cent), and gold (26 per cent) mining. Stationary energy emissions from coal production are expected to increase from 9 Mt CO_2-e in 2020 to 10 Mt CO_2-e in 2022 and remain stable until 2030Emissions from other mining are projected to increase from 10 Mt CO_2-e in 2020 to 11 Mt CO_2-e from 2022 to the rest of projections period, driven by the growth in iron ore and gold production.

The emissions from the mining subsector as a whole are projected to increase from 19 Mt CO_2-e in 2020 to 21 Mt CO_2-e in 2030 (Table 8). This increase is slowed due to technological improvements such as advanced engine technologies, increasing automation, and electrification of mining equipment. These technological improvements deliver a range of productivity benefits in addition to emissions reduction, including fuel consumption savings and efficiency improvements.

Agriculture, Forestry and Fishing (Energy use)

Emissions from energy use in agriculture, forestry and fishing activities, including fuel used for on-farm vehicles and machinery, is projected to grow steadily over the projections period. This is modelled based on projections from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), of the gross value of farm production which is projected to increase over the early 2020s. The increase in emissions is projected to be partially offset by fuel switching from diesel and energy efficiency improvements.

Military

The military subsector covers fuel use by military vehicles (e.g. trucks, planes) and fuel used for training within Australia. This is one of the smallest subsectors in the stationary energy projections. Emissions from the military subsector remain flat over the projections period (Table 8).

Table 8: Stationary energy emissions, Mt CO_2-e

Emissions by subsector	2005	2020	2025	2030
Manufacturing	36	30	28	27
Energy	15	27	25	28
Buildings	15	19	18	18
Mining	8	19	21	21
Agriculture, Forestry and Fishing	7	7	7	7
Military	1	1	1	1
Total	**82**	**103**	**101**	**103**

Note: totals may not sum due to rounding

Alumina production emissions in the emissions projections

The emissions intensity of alumina production in Australia is projected to decrease through the decade to 2030.

Alumina is aluminium oxide and is mainly used in the production of primary aluminium. There are currently six alumina refineries operating in Australia; two in Queensland and four in Western Australia. These refineries produce around 20 million tonnes of alumina per year of which approximately 88 per cent is exported.

World alumina demand is forecast to rise driven by higher demand for primary aluminium. Australia is the second largest producer and the world's largest exporter of alumina. These projections assume Australia's alumina refineries will continue operating around current levels to 2030.

The total stationary energy (excluding electricity) emissions for alumina refineries in Australia is around 11 Mt CO_2-e per year. The refining process involves four steps: digestion; clarification; precipitation; and calcination. Process heat for the alumina dissolution process, currently through steam from coal or gas fired boilers, is the biggest consumer of energy in the alumina refining process. This is followed by gas consumption for the calcination process.

The total stationary energy (excluding electricity) emissions of alumina refineries are projected to decline from 11 Mt CO_2-e in 2020 to 9 Mt CO_2-e in 2030. This decline in emissions is mainly due to the projected uptake of emissions reduction opportunities across the industry. This includes opportunities to improve efficiency, reduce energy consumption as well as fuel switching. One example, is improvement of the digestion process with proven and emerging technologies such as single stream or double digestion technologies. The projected uptake of the mechanical vapour recompression (MVR) technology also reduces energy consumption.

Another source of emissions from alumina production are indirect emissions associated with electricity generation. Electricity consumption in alumina refineries is projected to increase as a result of electrification from the uptake of emissions reduction opportunities such as MVR. However, emissions from this source are projected to fall from around 1.3 Mt CO_2-e in 2020 to 1.1 Mt CO_2-e in 2030, as the emissions intensity of Australia's electricity grids declines over the decade.

Emissions from alumina production is projected to be 12Mt CO_2-e in 2020 and 10Mt CO_2-e in 2030.

Table 9: Projected alumina production, Alumina Production emissions and emissions intensity in the projections

Sector	2020	2025	2030
Alumina Production (Mt Alumina)	20	20	20
Electricity (indirect emissions) (Mt CO_2-e)	1	1	1
Stationary energy emissions (Mt CO_2-e)	11	10	9
Natural gas use (Mt CO_2-e)	6	5	5
Coal use (Mt CO_2-e)	5	5	4
Other fuel (Mt CO_2-e)	<1	<1	<1
Total emissions (Mt CO_2-e)	**12**	**11**	**10**
Emissions intensity (Mt CO_2-e/ Mt Alumina)	**0.60**	**0.55**	**0.50**

Note: totals may not sum due to rounding

Comparison to previous projections

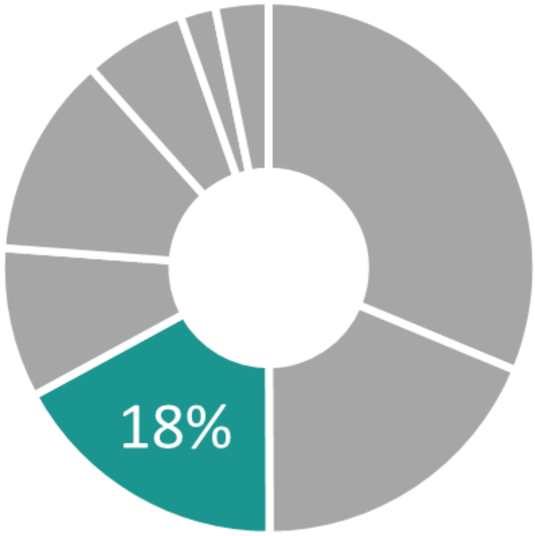
Compared to the 2019 projections, stationary energy emissions are 3 Mt CO_2-e lower in 2030 and 19 Mt CO_2-e lower cumulatively over the period 2021 to 2030. The reduction in stationary energy emissions is due to:

- energy savings from energy efficiency measures, including those announced in the 2020-2021 Budget;
- the inclusion of fuel switching and energy efficiency opportunities identified in the manufacturing subsector;
- lower than projected emissions in 2020 reported in the National Greenhouse Gas Inventory;
- the announced closure of the Kwinana petroleum refinery in Western Australia.

Transport

18% of Australia's emissions in 2020

↑ 6 Mt CO_2-e 2020 to 2030



Emissions in the transport sector are the result of the combustion of fuels for transportation. This includes road, domestic aviation, rail, domestic shipping, off-road recreational vehicle activity and gas pipeline transport. Road transport includes cars, light commercial vehicles, motorcycles, rigid trucks, articulated trucks and buses.

Emissions from the generation of electricity used in electric vehicles and rail are accounted for in the electricity sector.

Emissions trends

In 2020, the impacts of COVID-19 led to large reductions in transport activity, which resulted in transport emissions declining by 7 Mt CO_2-e to be 94 Mt CO_2-e in the year to June 2020. Emissions are projected to decline by an additional 4 Mt CO_2-e in the year to June 2021 before rebounding in 2022 and 2023, and peaking at 101 Mt CO_2-e in 2026. In 2030, at the end of the projection period, emissions are projected to be 100 Mt CO_2-e.

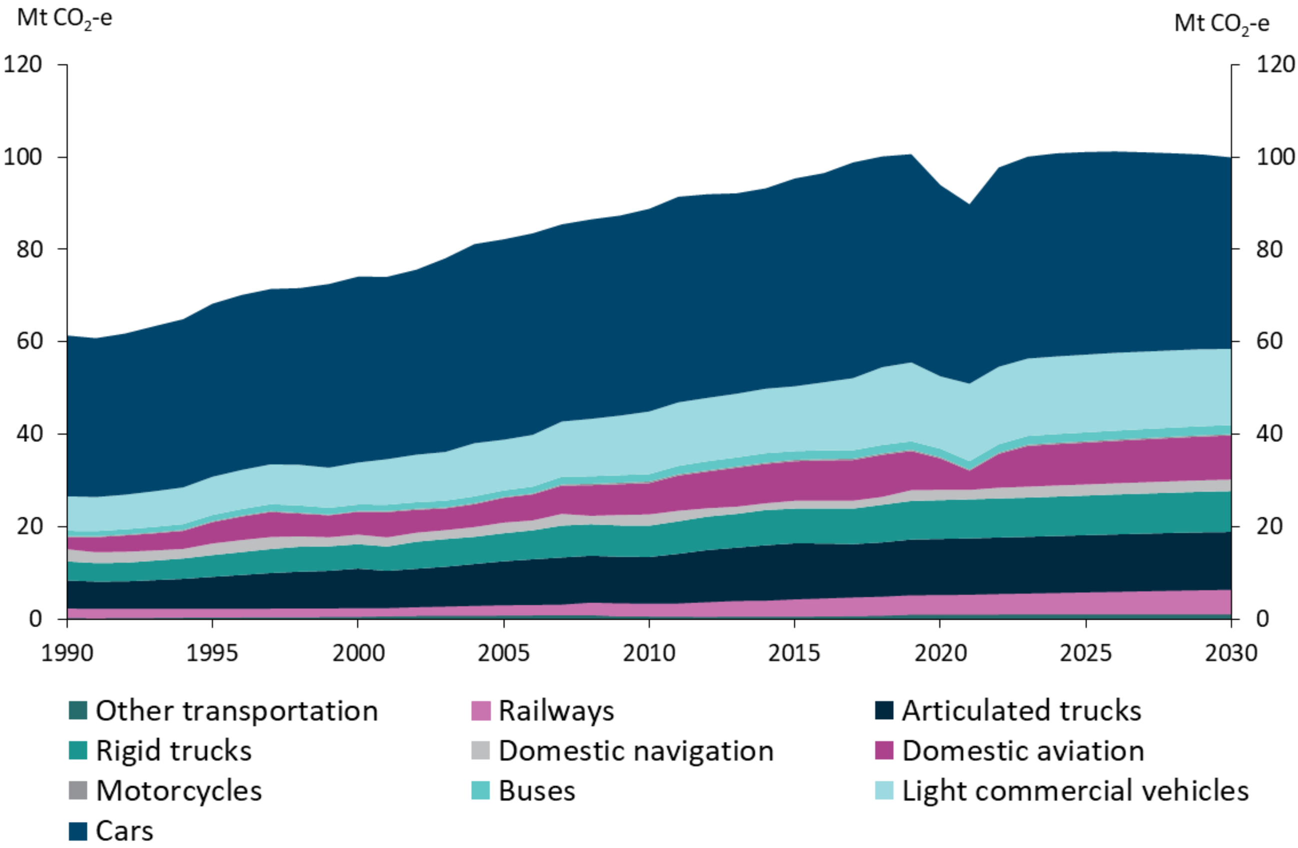
Emissions from light duty vehicles (cars and light commercial vehicles) were 62 Mt CO_2-e (62 per cent of total transport emissions) in 2019. Emissions from light duty vehicles are projected to fall to 56 Mt CO_2-e in 2021 before rebounding by 2024. After 2024, emissions decline as fuel switching and efficiency improvements more than offset increased demand from a higher population reaching 58 Mt CO_2-e in 2030.

The domestic aviation subsector has been most heavily impacted by COVID-19. Emissions are projected to halve between 2019 and 2021, reaching 4 Mt CO_2-e. The decline in aviation emissions from 2019 to 2021 is 40 per cent of the projected decline in total transport emissions over the same period. Emissions are projected to rebound to pre-COVID-19 levels by 2023 and then continue to increase as passenger activity is assumed to grow in-proportion with population growth.

The transport subsectors primarily supporting freight - heavy-duty trucks (articulated and rigid trucks) and rail - emitted 20 and 4 Mt CO_2-e in 2019, respectively. Unlike emissions in the light duty vehicle and domestic aviation subsectors, and in spite of the economic recession caused by COVID-19, heavy-duty truck and rail emissions did not materially decline during 2020. Heavy-duty truck and rail emissions are both projected to

consistently grow over the decade to be 1 Mt CO_2-e higher in 2030 compared to 2020. The Emissions Reduction Fund, Climate Solutions Fund, and other 2020-21 Budget measures including the Future Fuels Strategy are expected to incentivise technology uptake and efficiency improvements in these sub-sectors.

Figure 14: Historic and projected transport emissions, 1990 to 2030, Mt CO_2-e



Modelling impacts of COVID-19 on the transport sector

The COVID-19 pandemic could result in enduring changes in passenger preferences, however, the timing and scale of these changes are uncertain. The pandemic has increased the number of people working from home and reduced business travel. It is expected that some of these work preferences will endure after the health risks associated with the pandemic have reduced. These reductions in activity could be offset by an increased preference for domestic holidays and a reduced preference for public transport.

The modelling completed for the Department includes assumptions on the short and long term effect of the global pandemic on transport activity[13]. The methodology includes two mechanisms through which transport activity is impacted; a 'preference mechanism', which affects passenger activity; and an 'economic mechanism', that affects both freight and passenger activity.

The preference mechanism attempts to account for pandemic-related changes in the tendency of individuals to use transport. It was calibrated through an analysis of activity data for various modes of passenger transport in Australia during the period in which the effects of COVID-19 became apparent. The impact reduces over time as individuals' tendency to use transport was assumed to reach a new normal.

[13] The Department commissioned Energeia Pty Ltd to undertake transport sector modelling for the 2020 projections.

The economic mechanism estimates the expected impact on demand as a result of the pandemic's uneven impact across the economy. It was based on an analysis of reported revenue impacts on the various economic sectors in Australia and the input-output distribution of supply of transport services to these sectors. The economic mechanism had a much smaller impact on the results compared with the preference mechanism. The combined impact of these mechanisms on demand for transport is shown in Table 10.

Table 10. Annual COVID-19 activity impact relative to a no change scenario, per cent

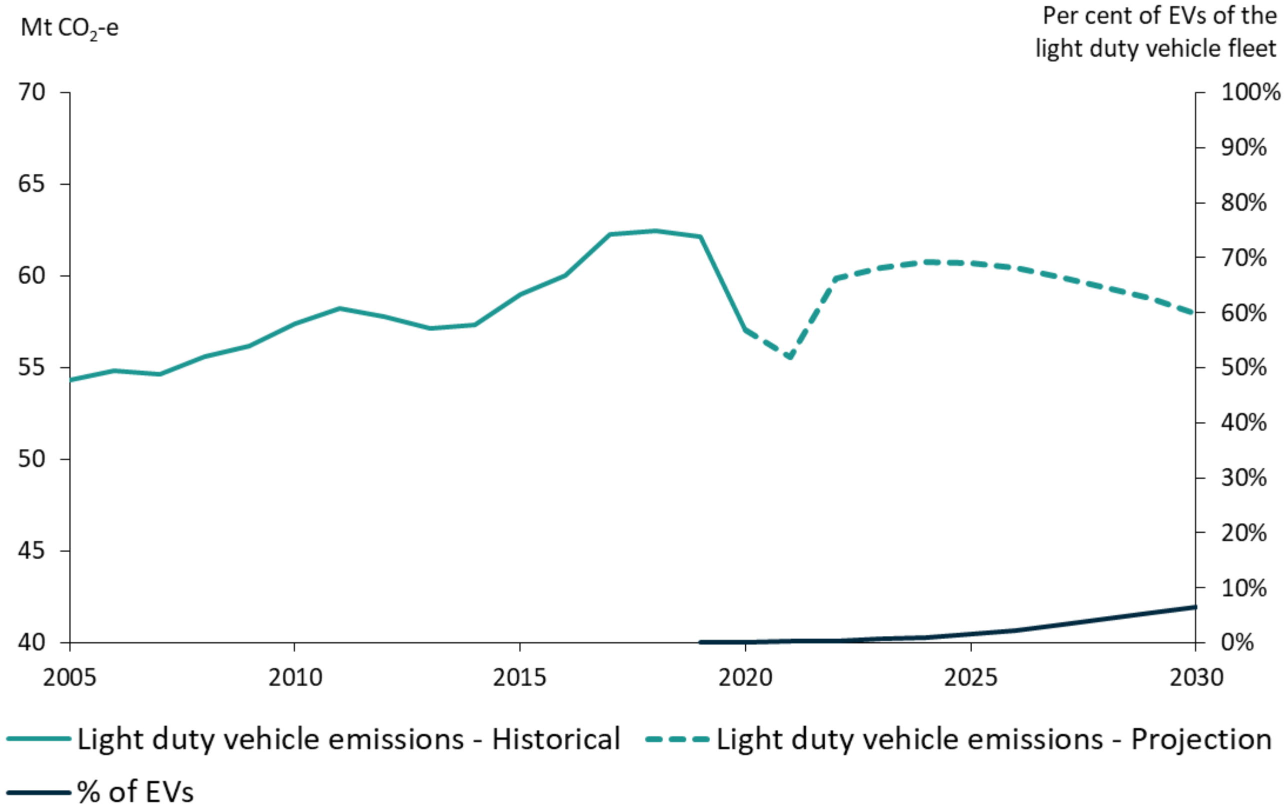
	Passenger					Freight			
	Road (Private)	Road (Public)	Aviation	Marine	Rail (diesel)	Road	Aviation	Marine	Rail (diesel)
2020	-10	-16	-24	-16	-16	-1	-1	-1	-1
2021	-14	-34	-56	-34	-34	-1	-1	-2	-1
2022	-5	-12	-19	-12	-12	0	0	-1	0
2023 onwards	-1	-1	-2	-1	-1	0	0	0	0

Table 11: Transport emissions, Mt CO_2-e

Subsector	Subsector-Type	2020	2025	2030
Cars	Road	41	44	41
Light commercial vehicles	Road	16	17	16
Articulated Trucks	Road	12	12	13
Rigid Trucks	Road	8	9	9
Buses	Road	2	2	2
Motorcycles	Road	<1	<1	<1
Domestic aviation	Non-Road	7	9	10
Rail	Non-Road	4	5	5
Domestic navigation	Non-Road	2	2	2
Pipeline transport	Non-Road	1	1	1
Other transport (recreational vehicles)	Non-Road	<1	<1	<1
Total	**n/a**	**94**	**101**	**100**

Note: totals may not sum due to rounding.

Figure 15: Light-duty vehicle emissions and the proportion of electric vehicles in the light-duty vehicle fleet



Light duty vehicle emissions intensity

Out of all the transport subsectors, the light duty vehicle fleet is projected to experience the greatest reductions in emissions intensity (g CO_2-e/km) over the period to 2030.

Changes in the emissions intensity of internal combustion engine (ICE) vehicles and uptake of, hybrid, electric and fuel-cell vehicles are the main drivers of reductions in the emissions intensity of the fleet. In the modelling, the Department assumed that ICE vehicle emissions intensity would decline by 1.2 per cent per annum, reflecting expected improvements in engine technology Uptake of electric and fuel cell vehicles was projected as a function of expected model availability and return on investment. By 2030 this uptake function projected that electric and fuel cell vehicles would represent 7 per cent of the light duty vehicle fleet.

Table 12: Projected light duty vehicle activity and electric vehicle stock and sales

	2020	2025	2030
Activity (billion km travelled)	218	250	267
Number of EVs (including plug-in hybrids) in the light duty vehicle stock ('000)[14]	26	292	1,320
Per cent of EVs (including plug-in hybrids) in the light duty vehicle stock	0.1	2	7
Number of EVs (including plug-in hybrids) in new light duty vehicle sales ('000 per year)	10	99	289
Per cent of EVs (including plug-in hybrids) in new light duty vehicle sales	1	9	26

Although electric vehicles have no direct combustion emissions, emissions do result from the generation of the electricity they consume, which is accounted for in the electricity sector. The emissions intensity of electric vehicles has been estimated by multiplying the demand for electricity by the projected average emissions factor for grid generation in Australia. Over the projections period to 2030, new electric vehicles are assumed to have increased energy efficiency. With the average emissions intensity of grid electricity projected to decline, the emissions associated with the use of new electric vehicles per kilometre travelled is projected to improve by 33 per cent over period 2020 to 2030 (Table 13).

Table 13: Projected emissions intensity of new light duty vehicles, g CO_2-e per km

	2020	2025	2030
Internal combustion engines (g CO_2-e per km)	222	208	196
Battery electric, excl. plug-in hybrids (g CO_2-e per km)	111	83	68

Comparison to previous projections

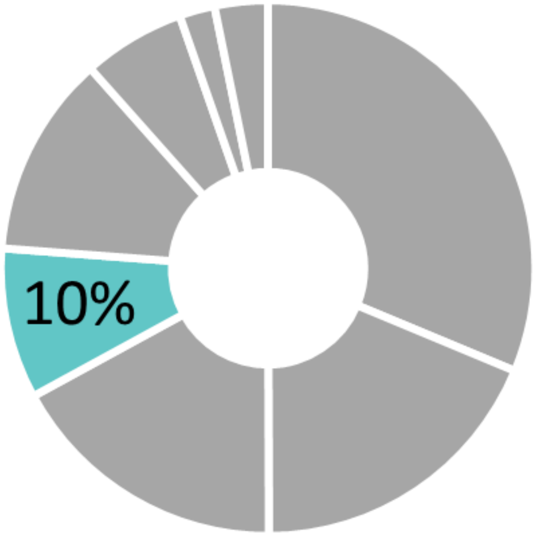
Compared to the 2019 projections, transport sector emissions are projected to be 8 Mt CO_2-e lower in 2030. As a result of COVID-19, transport emissions have been revised down 13 Mt CO_2-e in 2021. From 2021 to 2030 cumulative emissions are 68 Mt CO_2-e lower compared to the 2019 projection. Downwards revisions in the latest projection is a result of the impact of COVID-19, downwards revisions in assumed population and GDP trends, mode switching, and a faster pace of emission intensity reduction in the vehicle fleet.

[14] The projections also assume 191,000 hydrogen fuel cell vehicles in 2030 representing almost 1 per cent of the light duty vehicle stock.

Fugitives

10% of Australia's emissions in 2020

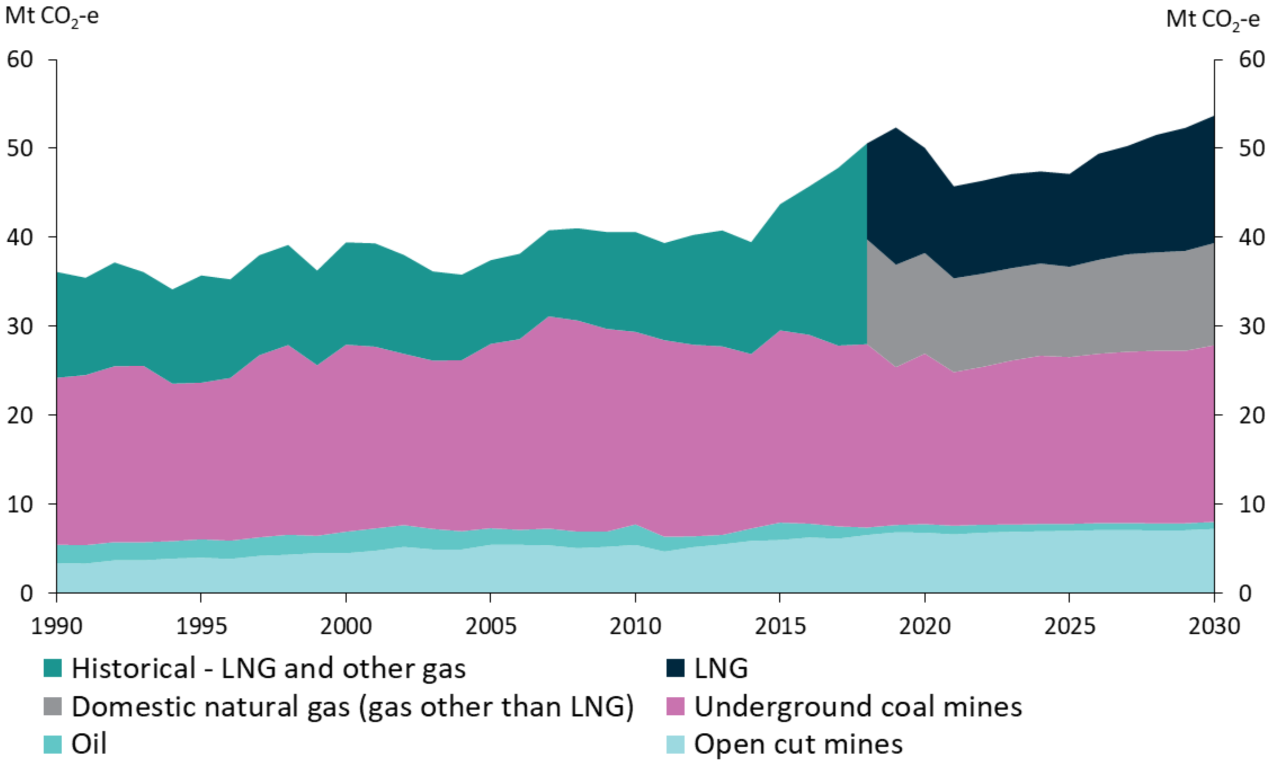
↑ 4 Mt CO_2-e 2020 to 2030



Fugitive emissions are released during the extraction, processing and transport of fossil fuels. Fugitive emissions do not include emissions from fuel combusted to generate electricity, operate mining plant and equipment or transport fossil fuels by road, rail or sea.

Overall fugitive emissions are estimated to be 50 Mt CO_2-e in 2020. Fugitive emissions are projected to increase to 54 Mt CO_2-e in 2030.

Figure 16: Fugitive emissions, 1990 to 2030, Mt CO_2-e



Coal fugitive emission trends

Fugitive emissions from coal were 26 Mt CO_2-e in 2020, 52 per cent of all fugitive emissions. Emissions are projected to temporarily decline in 2021 and then increase as a number of mines return to normal production levels. After 2025 emissions are projected to remain relatively flat reaching 27 Mt CO_2-e in 2030 mainly due to increased production of metallurgical coal at underground mines.

Fugitive emissions of carbon dioxide and methane are released at coal mines during the extraction of coal. There is wide variation in the gas content across Australian coal basins and across coal fields within the basins due to distinct geological and biogenic processes, including the way the coal was formed, tectonic history, and groundwater flows. This variability results in a small number of underground mines in the Southern, Hunter and Newcastle basins in New South Wales and the Bowen basin in Queensland having a large impact on total emissions. There are over 100 operating coal mines in Australia. The ten largest emitting mines account for 54 per cent of coal fugitive emissions.

The primary drivers of emissions are the amount of coal produced, the emissions intensity of the mine and the amount of methane captured. Around 40 per cent of the methane generated from underground coal mines is currently captured for flaring or for electricity generation.[15]

Australia's coal production is projected to increase to 2030 based on projections from the Office of the Chief Economist and the International Energy Agency (Table 14). Metallurgical coal production is projected to increase to meet demand for global steel production. Thermal coal production is also projected to increase although at a slower rate. Brown coal, which is consumed domestically for electricity generation in Victoria, is projected to decline.

In 2020 Japan, China and South Korea took receipt of 66 per cent of Australia's coal exports. In October 2020 these countries announced long term emission reduction targets. These targets are not expected to impact Australia's coal production to 2030 in the absence of new short term policies.

Table 14: Run-of-mine coal production in Australia, million tonnes[16]

	2020	2025	2030
Black Coal	564	600	619
Brown Coal	43	34	27
Total	**606**	**635**	**646**

Note: totals may not sum due to rounding.

Metallurgical coal is extracted from a higher proportion of underground mines compared with thermal coal. The increase in metallurgical coal production is projected to be met from new mines, mostly in the Bowen basin in Queensland. The projections also include emissions from abandoned coal mines that continue to emit, at a declining rate, after they cease production.

[15] DISER, National Inventory Report 2018 Volume 3, 169.

[16] Run of mine coal production relates to the amount of raw material extracted from the mine. In their Resource and Energy Quarterly the Office of the Chief Economist publishes forecasts of saleable coal which is less than run-of-mine coal production. Saleable coal tends to average 80 per cent of run-of-mine production, but it differs from mine to mine.

Eighty-three per cent of Australia's coal is extracted from open cut coal mines which have a lower emissions intensity than underground mines. Emissions from open cut coal mines are projected to maintain their share of coal production and increase broadly in line with production. Brown coal production is projected to decline with only a small impact on fugitive emissions. Although brown coal currently accounts for around 7 per cent of Australia's coal production it accounts for less than 0.1 per cent of fugitive emissions.

Oil and gas fugitive emission trends

Fugitive emissions from oil and gas are estimated to be 24 Mt CO_2-e in 2020, representing 48 per cent of fugitive emissions. Emissions are projected to decline to the middle of the decade and then grow to 27 Mt CO_2-e in 2030, representing 50 per cent of fugitive emissions.

Liquefied Natural Gas (LNG)

In 2020 fugitive emissions from LNG are estimated to be 12 Mt CO_2-e. Emissions are projected to fall and be 10 Mt CO_2-e in 2021 before growing to 14 Mt CO_2-e in 2030.

Australia's LNG industry has experienced rapid growth since 2015, going from three LNG facilities to ten LNG facilities in the space of five years. Similarly LNG fugitive emissions have grown rapidly since 2015, reflecting increases in LNG production as well as high gas flaring activity that often occurs in the initial years of an LNG project (Figure 18). It is not expected that flaring emissions from LNG facilities will reach these high levels again as emissions from the newest of Australia's 10 LNG facilities move to a more steady state of operations.

Australia's LNG is exported to Asia where energy demand is projected to grow over the coming decades. China, India and south-east Asia are forecast to be the largest growth markets of LNG in Asia. Australia's LNG has the potential to lower emissions in these LNG importing countries by around 170 Mt CO_2-e by providing an alternative to higher emissions fuels.

LNG production in Australia is projected to grow to 2030 (Table 15), after a short term decline in production due to the impact of COVID-19 on demand, as well as technical issues at the Gorgon and Prelude LNG facilities. Over 2023 and 2024 the Darwin LNG facility is assumed to be taken offline for maintenance, before returning in 2025 with new feed gas from the Barossa field. The Barossa field is a relatively high CO_2 field and as such, venting emissions are projected to increase. These emissions could be lower if technologies like carbon capture and storage are implemented. Santos and Mitsubishi announced in December 2020 that they would be exploring options for 'carbon neutral LNG'.

During the middle of the decade production at the North West Shelf facility is projected decline as the current gas source is assumed to deplete and other smaller sources provide some backfill gas. LNG emissions are projected to continue to grow as a second train at the Pluto facility is assumed to come online (2026) and gas from the Browse basin provides a large source of backfill for the North West Shelf facility (2028). The Browse basin is another relatively high CO_2 basin, contributing to the increase in venting emissions to 2030.

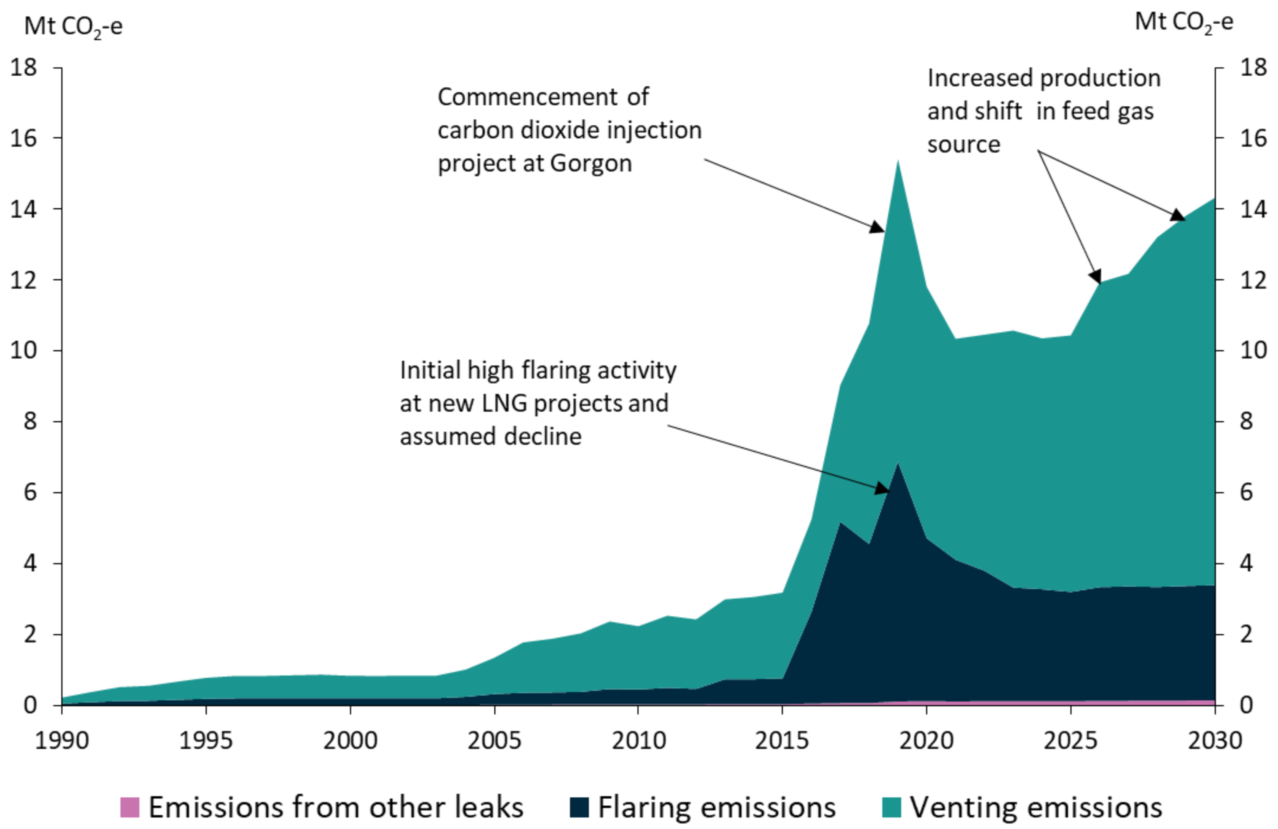
Emission increases over the decade are somewhat offset by the carbon dioxide injection project at the Gorgon LNG facility. The project, which is one of the largest in the world and commenced in August 2019, is assumed to abate around 3.4 Mt CO_2-e a year once operating at capacity.

Figure 17: LNG projects in Australia

Table 15: LNG production in Australia, million tonnes

LNG production	2020	2025	2030
Total	**79**	**77**	**88**

Figure 18: LNG fugitive emissions, 1990 to 2030, Mt CO_2-e



Domestic natural gas

Fugitive emissions from domestic natural gas are estimated to be 11 Mt CO_2-e in 2020 and remain broadly at that level until falling to 10 Mt CO_2-e the middle of the decade before growing to 11 Mt CO_2-e in 2030 (Table 16). The major users of domestic natural gas are the electricity, industrial, commercial and residential sectors.

While domestic gas demand is fairly flat over the period 2021 to 2030, fugitive emissions in this sector are projected to grow. This is due to new unconventional gas developments in New South Wales (Narrabri), Queensland (Bowen and Galilee basins) and the Northern Territory (Beetaloo).

The Australian Energy Market Operator (AEMO) forecasts a shortfall in gas supply to meet gas demand in the east coast market around the mid-2020s. The projections assume that this shortfall is met through the Narrabri gas development, the opening of two LNG import terminals and some gas from the Beetaloo basin in 2030.

Oil

Fugitive emissions from oil extraction are projected to be 1 Mt CO_2-e in 2020 and remain around that level to 2030 (Table 16). Crude oil and condensate production is projected to increase in the short term by 2 per cent and remain flat over the projections period. Refinery output is also projected to decline over the projections period as the Kwinana petroleum refinery closes in the middle of the 2021 calendar year.

Table 16: Fugitive emissions, Mt CO_2-e

Emissions by subsector	2005	2020	2025	2030
LNG	1	12	10	14
Domestic natural gas	8	11	10	11
Oil	2	<1	<1	<1
Open cut mines	5	7	7	7
Underground coal mines	21	19	19	20
Total	**37**	**50**	**47**	**54**

Note: totals may not sum due to rounding.

Comparison to previous projections

Compared to the 2019 projections, fugitive emissions from coal are 2 Mt CO_2-e lower in 2030 and 10 Mt CO_2-e lower cumulatively over the period 2021 to 2030. The decrease reflects lower projected coal production to 2030 and an updated production outlook for certain gassy mines.

Compared to the 2019 projections, fugitive emissions from oil and gas are projected to be 3 Mt CO_2-e lower in 2030 and 47 Mt CO_2-e lower cumulatively over the period 2021 to 2030. The decrease is due to improvements in methods for estimating fugitive onshore gathering and boosting emissions from natural gas production. The method draws on the latest research from the US and adopted by the US Environmental Protection Agency. The inclusion of new subsectors in fugitive oil and gas emissions of post meter emissions, abandoned gas wells and abandoned oil wells marginally offsets the decrease in emissions from the improved onshore gathering and boosting estimation method.

LNG related emissions in the emissions projections

Emissions related to LNG are accounted for in three sectors of the emissions projections:

- the electricity sector
- the stationary energy sector, and
- the fugitives sector

Around 80 per cent of emissions related to LNG are from the fugitive and stationary energy sectors (see Figure 19).

Figure 19: LNG related emissions in the projections, 2020 and 2030, per cent

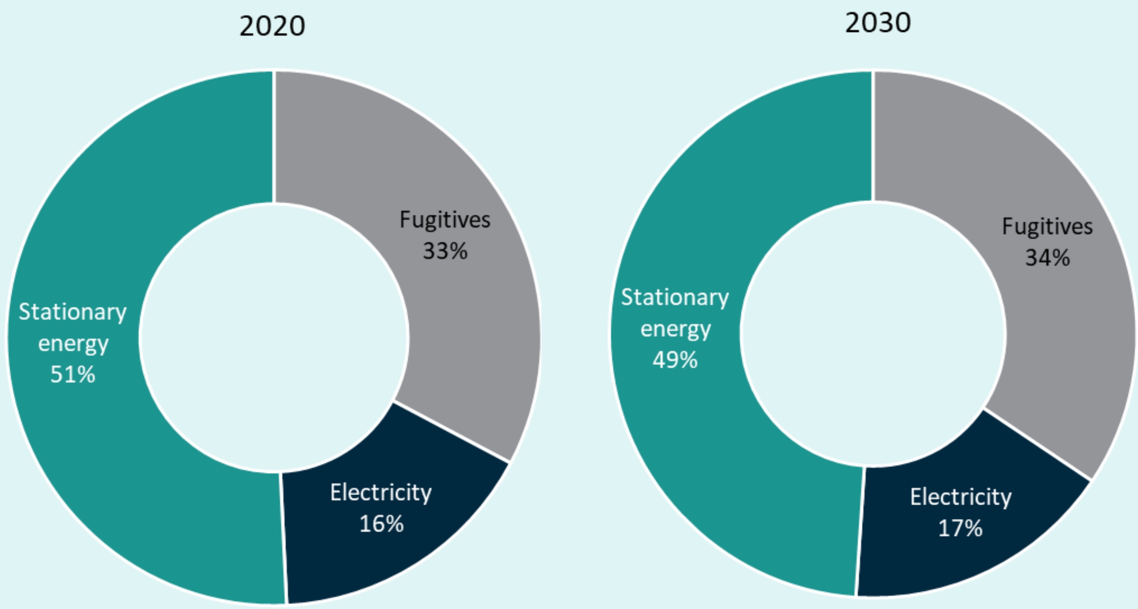


Table 17: LNG emissions in the projections, Mt CO_2-e

Sector	2020	2025	2030
Electricity	6	6	7
Stationary energy	18	18	20
Fugitives	12	10	14
LNG total	36	34	42
Emissions projections total	**513**	**487**	**478**
Emissions projections without LNG	**477**	**453**	**437**

Note: totals may not sum and calculated percentages may not match figure 19 due to rounding.

LNG related emissions in the stationary energy (excluding electricity) and electricity sectors are from the combustion of raw natural gas for driving compressors or generating electricity on-site.

Fugitive emissions from LNG are emissions released intentionally or unintentionally in the exploration, extraction, production, processing, storage and delivery of LNG. The biggest sources of LNG fugitive emissions is from gas venting and gas flaring.

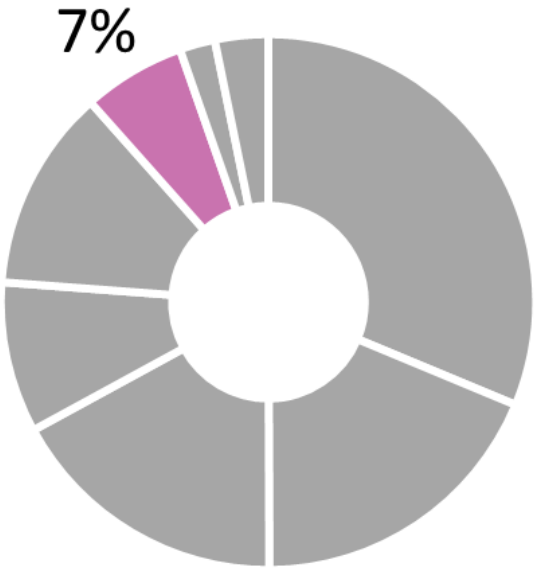
Venting is the intentional release of gas (including carbon dioxide and methane) usually from routine operations. Flaring is the burning of excess gasses that cannot be recovered or reused during plant operations and is important in managing the pressure, flow and composition of the gas in production and processing.

Fugitive emissions are dependent on the carbon dioxide content of the raw gas which varies between gas fields. The carbon dioxide content of coal seam gas fields that supply the Queensland LNG facilities is generally much lower than the conventional off-shore gas fields of Western Australia and the Northern Territory that supply gas to the remaining LNG plants in Australia.

LNG emissions are projected to be 36 Mt CO_2-e in 2020, to 42 Mt CO_2-e 2030. Over the period 2021 to 2030, related LNG emissions are projected to be 375 Mt CO_2-e.

Industrial processes and product use

7% of Australia's emissions in 2020
↓ 4 Mt CO_2-e 2020 to 2030



The industrial processes and product use (IPPU) sector includes emissions from non-energy related production processes. Emissions from this sector include by-product gases from chemical reactions in production processes, the release of synthetic greenhouse gases from commercial and household equipment, combustion of lubricant oils not used for fuels, and carbon dioxide used in food and beverage production. Energy-related emissions are accounted for in the stationary energy sector.

Table 18 below lists the subsectors that comprise the IPPU sector and the main production processes which drive emissions from these subsectors.

Table 18: Production processes in industrial processes and product use

Subsector	Main production processes
Metal industry	Iron and steel, and aluminium production
Chemical industry	Ammonia, nitric acid and titanium dioxide production
Mineral industry	Cement clinker and lime production
Product uses as substitutes for ozone depleting substances	Hydrofluorocarbons used in refrigeration and air conditioning equipment, foam, fire protection and aerosols
Non-energy products from fuel and solvent use	Emissions from lubricant oils not used for fuel
Other production	Carbon dioxide used in food production
Other product manufacture and use	Sulphur hexafluoride used in electrical switchgear

Emissions trends

Industrial processes and product use emissions are projected to decline from 34 Mt CO_2-e in 2020 to 30 Mt CO_2-e in 2030, 6 per cent below 2005 levels.

Figure 20: Industrial processes and product use emissions, 1990 to 2030, Mt CO_2-e

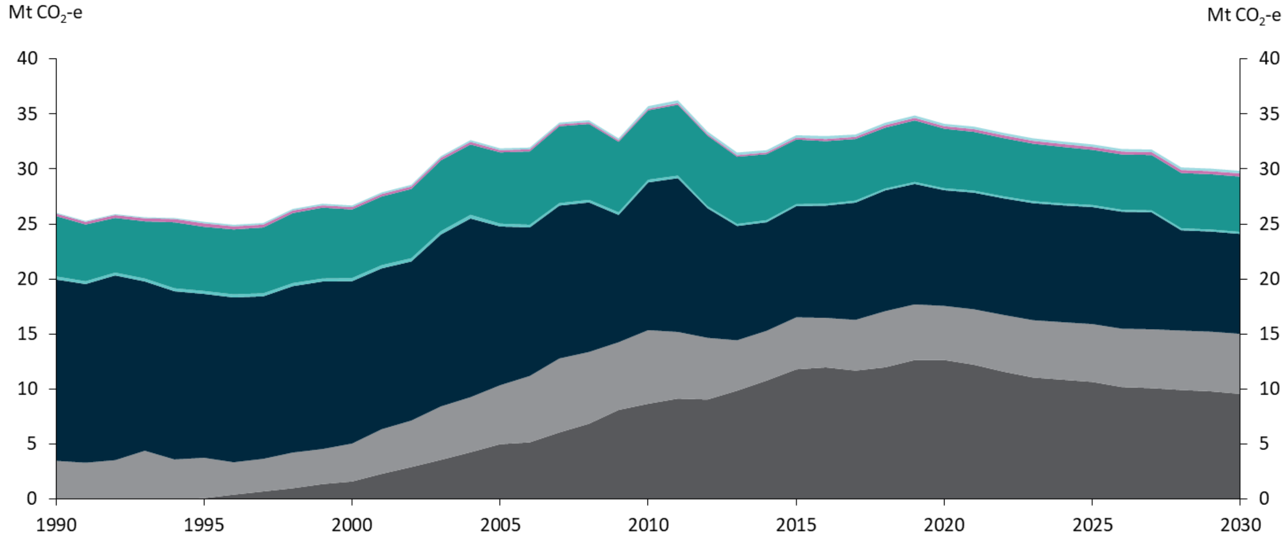


Table 19: Industrial processes and product use emissions, Mt CO_2-e

Emissions by subsector	2005	2020	2025	2030
Product uses as substitutes for ozone depleting substances	5	13	11	10
Metal industry	14	11	11	9
Chemical industry	5	5	5	5
Mineral industry	6	5	5	5
Non-energy products from fuel and solvent use	<1	<1	<1	<1
Other production	<1	<1	<1	<1
Other product manufacture and use	<1	<1	<1	<1
Total	**32**	**34**	**32**	**30**

Note: totals may not sum due to rounding.

Hydrofluorocarbon emissions

Product uses as substitutes for ozone depleting substances, or hydrofluorocarbons (HFCs), is the largest source of emissions in the IPPU sector in 2020, contributing 13 Mt CO_2-e or 37 per cent of total emissions. Emissions from HFCs peaked in 2020 (13 Mt CO_2-e), after which emissions are projected to decrease to 10 Mt CO_2-e in 2030. Changes in emissions in the HFC subsector are the main driver for changes in the IPPU sector as a whole.

The decrease in HFC emissions results from the HFC phase-down implemented through the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* and associated Regulations. The HFC-phase down legislates an annual import quota on bulk imports of HFCs that will reduce until 2036.

This projection includes the impact of proposed measures to inform owners of refrigeration and air conditioning equipment of the benefits of regular maintenance. These measures will reduce refrigerant leaks, improve the energy performance of refrigeration and air conditioning equipment and reduce emissions from HFCs. The remaining abatement from this measure relates to lower electricity use which is reflected in reduced electricity demand in the electricity sector.

Other industry emissions

The metal industry is the second largest contributing subsector to IPPU emissions (31 per cent of total emissions in 2020) after HFCs. Emissions from the metal industry subsector are projected to remain steady to 2027, contributing around 11 Mt CO_2-e each year. In the late 2020s, the emissions are projected to decline to 9 Mt CO_2-e in line with projected technological improvements in steelworks facilities, such as the uptake of natural gas direct reduction (DR) and electric arc furnace (EAF) processes.

Chemical industry emissions make up 14 per cent of emissions in the IPPU sector in 2020, and are projected to remain relatively stable around 5 Mt CO_2-e over projections period. The main drivers for projected emissions growth is the increased production forecasts for facilities producing nitric acid and ammonia. These forecasts have increased in line with the growth in the iron ore and coal mining industries, which influences demand for explosives, as well as increasing demand from the fertiliser industry.

Emissions from the mineral industry subsector are projected to remain relatively stable. A slight decrease from the projected declines in domestic production of clinker is offset by increased emissions in other subsectors of mineral industry.

Aluminium smelter emissions in the emissions projections

There are currently four aluminium smelters operating in Australia: Bell Bay (Tasmania), Boyne Island (Queensland), Portland (Victoria) and Tomago (New South Wales). These smelters produce around 1.6 million tonnes of primary aluminium per year of which approximately 90 per cent is exported.

The largest source of emissions for an aluminium smelter is indirect emissions associated with electricity generation (known as Scope 2 emissions). These emissions occur at the power stations and not at the aluminium smelter. Emissions from this source (estimated using electricity grid average emission factors) are projected to fall as the emissions intensity of the grid declines to 2030.

The stationary energy (excluding electricity) emissions are a relatively small source and is mostly associated with the combustion of natural gas to bake carbon anodes in the smelting process and control temperature

of molten aluminium in the casting process. IPPU emissions are primarily the carbon dioxide emitted from the oxidation of the carbon anodes. This source also includes perfluorocarbon emissions.

IPPU emissions from aluminium production have been trending down since 1990 as a result of improvements in process controls. IPPU emissions have declined by 63 per cent from 1990 to 2018 which includes a 95 per cent decline in perfluorocarbon emissions.

Global primary aluminium demand is forecast to rise as the world's economy recovers from the COVID-19 pandemic. This is driven by increased demand in the transport, construction and durables goods sectors. However, the export value of Australia's aluminium will decline from $3.7 billion in 2020 to an estimated $3.2 billion in 2021, as additional aluminium output from new and existing aluminium smelters in China adds to global aluminium inventories[17].These projections assume Australia's four aluminium smelters will continue operating around current levels to 2030 (Table 20).

The energy intensity of Australia's smelters is lower than international counterparts in North and South America, and Europe though it is higher than China[18]. Emissions from aluminium smelters are projected to decline from 19 Mt CO_2-e in 2020 to 13 Mt CO_2-e in 2030. Indirect emissions from electricity generation are projected to fall as the emission intensity of the grid falls, while stationary energy (excluding electricity) and industrial process emissions are projected to remain relatively steady. The emissions intensity of the aluminium smelters will decrease through the projection period (Table 21).

Table 20: Aluminium Production, million tonnes

Sector	2020	2025	2030
Aluminium Production	1.6	1.6	1.6

Table 21: Aluminium Production emissions (Mt CO_2-e) and emissions intensity (Mt CO_2-e/Mt Al) in the projections

Sector	2020	2025	2030
Electricity (indirect emissions)	16	12	10
Industrial processes and Stationary energy	3	3	3
Total emissions	**19**	**15**	**13**
Emissions intensity	**12.2**	**9.7**	**8.4**

[17] Office of the Chief Economist (OCE) 2020, Resources and Energy Quarterly September 2020, 15, Commonwealth of Australia, Canberra.

[18] International Aluminium Institute, http://www.world-aluminium.org/statistics

Iron and steel production

The emissions intensity of iron and steel production in Australia is projected to decline over the decade to 2030.

Australia is the world's largest exporter of iron ore and metallurgical coal Australia and is a key supplier of the raw materials used in global steel production. The iron and steel sector is a large contributor to global emissions accounting for 7 per cent of global energy emissions.

Low carbon materials such as steel and aluminium were identified as a priority low emissions technology in the Technology Investment Roadmap: First Low Emissions Technology Statement 2020. The statement included a stretch goal of producing low emissions steel for under $900 per tonne that would contribute to reducing Australian and global emissions.

The majority of Australia's steel is produced from two large integrated steelworks: Whyalla (South Australia) and Port Kembla (New South Wales). Australia produced 6 million tonnes of steel in 2020.

The largest source of emissions are from the industrial process of using coke and pulverised black coal as a reductant in the blast furnace. Emissions from the consumption of electricity and from the stationary energy fuel combustion at the coke ovens and blast furnace are also large sources of emissions.

The emissions intensity of Australia's steel production is assumed to reduce to 2030 as opportunities for natural gas direct reduction (DR) and electric arc furnace (EAF) processes are adopted in the second half of the decade.

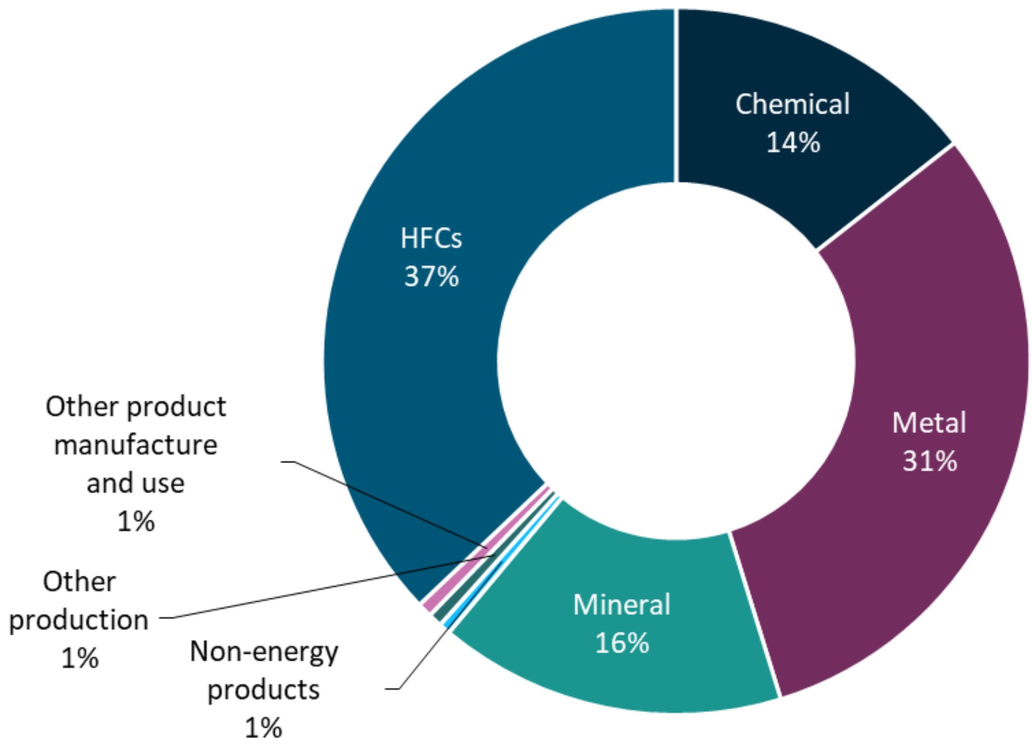
Table 22: Steel Production, million tonnes

Sector	2020	2025	2030
Steel Production	6	6	6

Table 23: Steel Production emissions (Mt CO_2-e) and emissions intensity (Mt CO_2-e/Mt Steel) in the projections

Sector	2020	2025	2030
Industrial processes	7	7	6
Stationary energy	2	2	2
Electricity (indirect emissions)	1	1	1
Total emissions	11	10	9
Emissions intensity	**1.8**	**1.8**	**1.6**

Figure 21: Emissions by subsector in 2020, per cent



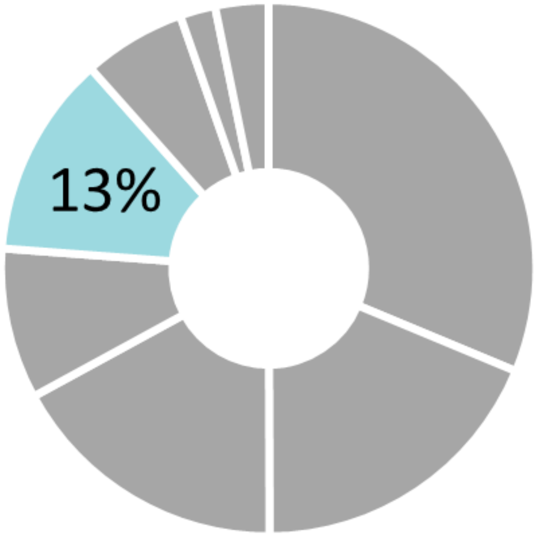
Comparison to previous projections

Compared to the 2019 projections, emissions are projected to be 3 Mt CO_2-e lower in 2030 and 16 Mt CO_2-e lower cumulatively over the period 2021 to 2030. This is mainly due to downward revisions in the metal industry subsector due to fuel switching and the uptake of technological opportunities.

Agriculture

13% of Australia's emissions in 2020

↑ 8 Mt CO_2-e 2020 to 2030



The agriculture sector includes emissions from biological processes associated with agricultural commodity production. This includes emissions from enteric fermentation (the digestive process of ruminant animals such as sheep and cattle), agricultural soils, manure management, liming and urea application, rice cultivation and field burning of agricultural residues. It does not include emissions from energy used in farm machinery or electricity use, which are included in the electricity and stationary energy sectors.

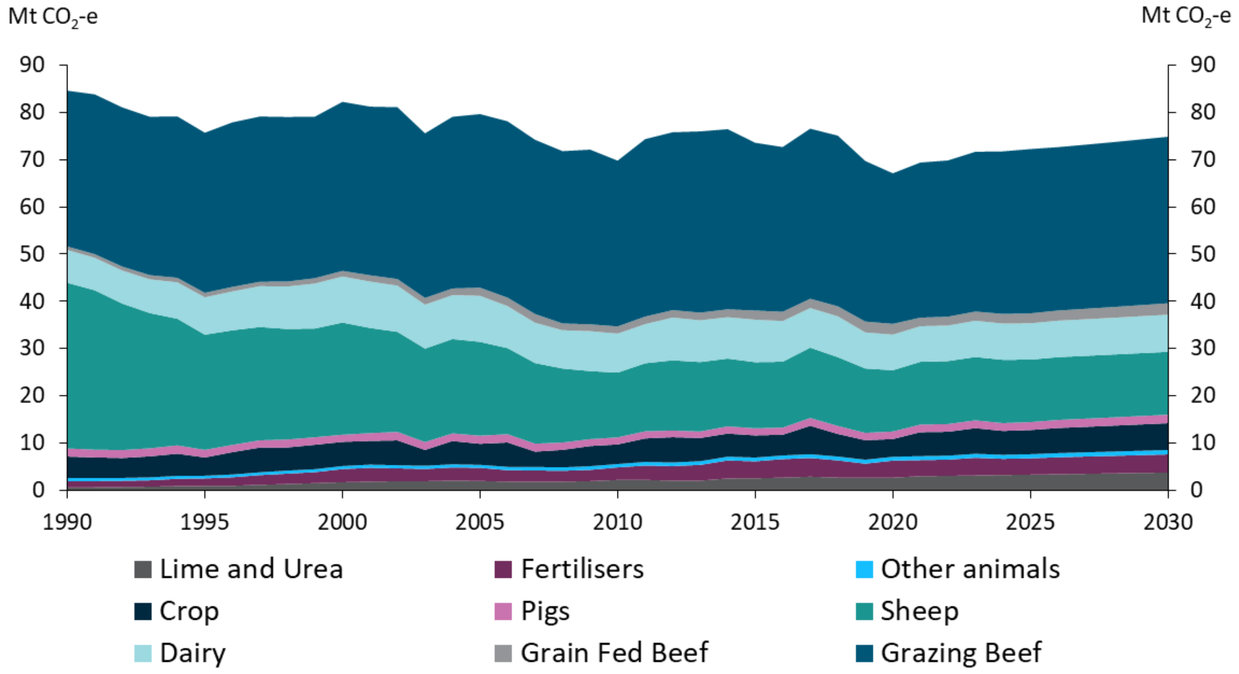
Agriculture emissions are predominantly methane and nitrous oxide, with a small amount of carbon dioxide emissions from the application of lime and urea. The emissions projections presented below are expressed as carbon dioxide equivalent.

Emissions trends

Agriculture emissions are projected to be 69 Mt CO_2-e in 2021, 2 Mt CO_2-e higher than current levels, due to the easing of the drought and conditions becoming more favourable for growth in agricultural activities. Agriculture emissions are projected to gradually rise to 75 Mt CO_2-e in 2030, 12 per cent above 2020 levels, as agricultural activities return to expected average seasonal conditions[19].

[19] Expected average seasonal conditions reflect agricultural growth rates for commodities taken from ABARES. Growth rates reflect historical averages, as climate-adjusted productivity estimates are not currently available. More information is available in The Methodology report, *Methodology for the 2020 Projections*, on the Department's website.

Figure 22: Agriculture emissions, 1990 to 2030, Mt CO_2-e



Grain fed beef and grazing beef trends

Beef cattle is projected to remain the largest contributor to agricultural emissions, followed by sheep and dairy cattle. Agricultural outputs have a strong dependence on short-term climate variations, as shown in Figure 22, with recent drought leading to less feed and higher levels of cattle sold which has reduced the livestock population in the short term. Although Australia is emerging out of two years of drought, the COVID-19 pandemic has increased market uncertainty which may result in some farmers postponing rebuilding herds.

Table 24 shows that grazing beef emissions are projected to increase by approximately 3 Mt CO_2-e from 2020 to 2030, an increase of 11 per cent. Although grazing beef are anticipated to return to expected average seasonal conditions, the impact of drought and floods in recent years result in a lower percentage increase from 2020 to 2030 when compared to grain-fed beef. This is due to grain fed beef in feedlots historically being more drought resistant than grazing beef. Grain fed cattle are also more emissions intensive than grazing beef due to higher energy uptake and an increased concentration of manure in feedlots.

Fertiliser trends

Emissions from inorganic or synthetic fertiliser are projected to increase by 7 per cent (<1 Mt CO_2-e) between 2020 and 2030. The trend of increasing fertiliser emissions is driven by a projected increase in crop production. This is in line with the historical relationship between fertiliser and crops, as agricultural production increases so does the demand for nutrients in the form of fertiliser.

Table 24: Agriculture emissions, Mt CO_2-e

Emissions by subsector	2005	2020	2025	2030
Grazing beef	37	32	35	35
Grain fed beef	2	2	2	2
Dairy	10	8	8	8
Sheep	20	13	13	13
Pigs	2	2	2	2
Crop	4	4	5	6
Other animals	1	1	1	1
Fertilisers	3	4	3	4
Lime and urea	2	3	3	4
Total	**80**	**67**	**72**	**75**

Note: totals may not sum due to rounding.

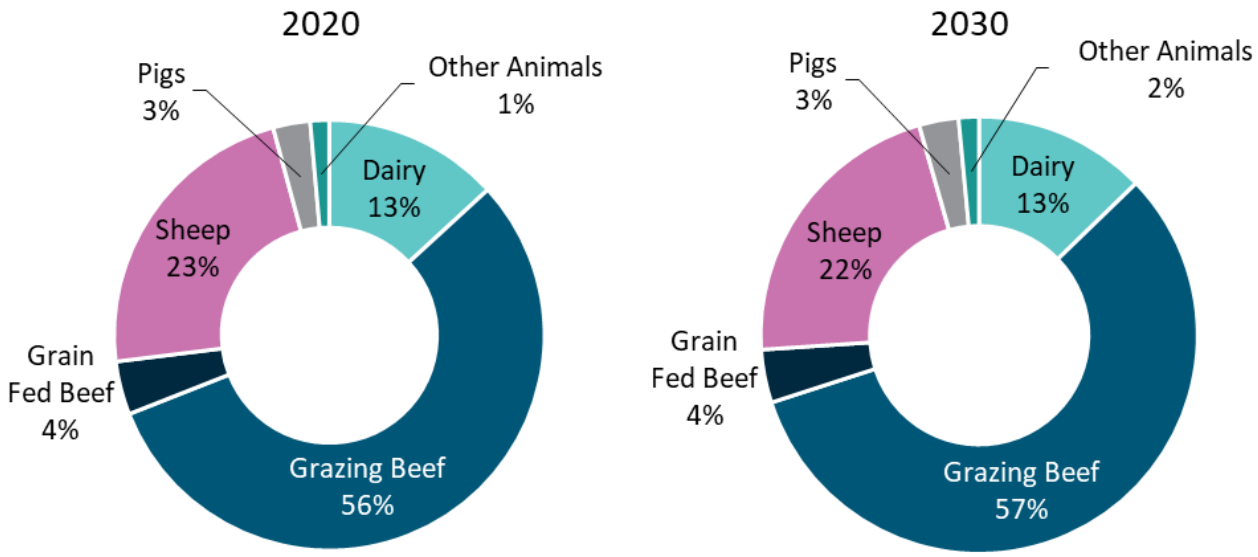
Other Livestock

Enteric fermentation emissions from livestock accounted for 68 per cent of total agriculture emissions in 2020, with livestock numbers being a key driver of emissions in this sector. Emissions from enteric fermentation are projected to be 46 Mt CO_2-e in 2020 and 49 Mt CO_2-e in 2030, an increase of 8 per cent. Grazing beef cattle is the largest contributing commodity to enteric fermentation emissions at 59 per cent in the year 2020, followed by sheep at 24 per cent.

Figure 23 shows the proportion of livestock emissions by commodity projected for 2020 and 2030. Although international prices are rising in the short term for pig meat due to the spread of African swine fever, the proportion of emissions from pigs is unchanged over 2020 to 2030 when compared to other livestock. The majority of beef will continue to be fed by grazing on pasture.

The subsector ‘Other animals’ includes emissions from commodities such as goats, horses, deer, buffalo, donkeys, emus and camels. Other animals are projected to slowly increase in emissions from 2020 to 2030 but will continue to be the smallest subsector.

Figure 23: 2020 and 2030 livestock emissions, commodity categories, per cent



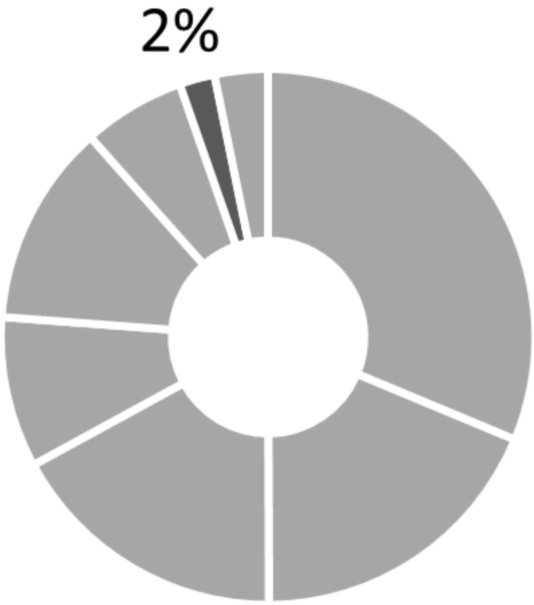
Note: totals may not sum due to rounding.

Comparison to previous projections

Compared to the 2019 projections, emissions are lower in 2020 by less than 1 Mt CO_2-e and higher in 2030 by less than 1 Mt CO_2-e. Cattle numbers are projected to be higher in 2030 than in the 2019 projections due to stronger than expected herd and flock building. Projected emissions associated with cattle, sheep and pig manure management has been revised up compared to the 2019 projections due to the implementation of an improved method for calculating manure management emissions in the National Greenhouse Gas Inventory.

Waste

2% of Australia's emissions in 2020
↓ 1 Mt CO_2-e 2020 to 2030



The waste sector includes emissions from the disposal of organic materials to landfill and wastewater emissions from domestic, commercial and industrial sources. Emissions are predominantly methane, generated from anaerobic decomposition of organic matter. Small amounts of carbon dioxide and nitrous oxide are generated through incineration and the decomposition of human waste.

Emissions trends

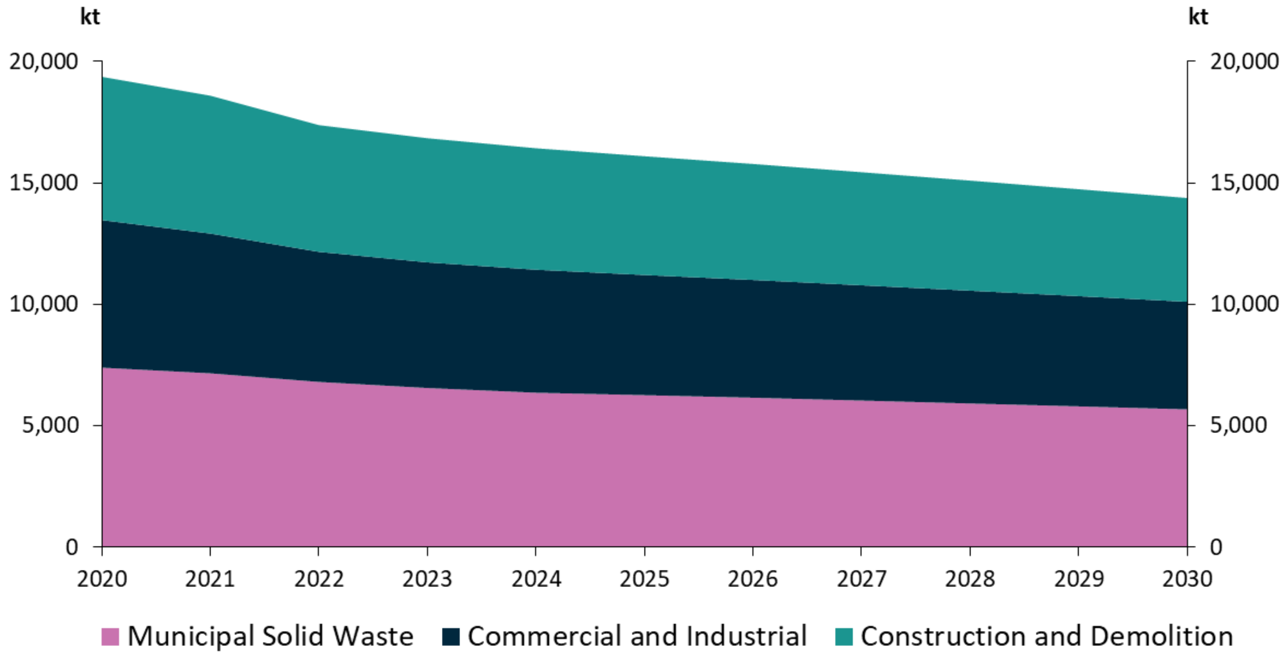
Waste emissions are projected to be 12 Mt CO_2-e in 2020. Emissions are projected to have a small decline of 1 Mt CO_2-e from 2020 to 2030. This gradually declining trend is a result of lower emissions from landfills driven by a reduction in the amount of waste deposited and an increase in methane capture.

Solid Waste

Emissions are released from waste deposited at landfills over more than 50 years, depending on the type of waste and the conditions at the landfill. Therefore changes in the type and amount of waste deposited impact the generation of emissions over a number of decades.

Current policies and measures contribute to a reduction in the amount of waste and the composition of waste deposited at landfills. The projections take account of measures such as the National Food Waste Strategy target to reduce food waste landfilled by 50 per cent per capita by 2030 and the Recycling Modernisation Fund to divert waste from landfill to recycling. The projections also include state and territory resource recovery targets, with rates of recycling projected to increase over the time series.

Figure 24: Waste deposited at landfills, 2020 to 2030, kt



Waste deposited at landfills can be classified according to three waste streams: municipal solid waste, commercial and industrial waste, and construction and demolition waste; as shown in Figure 24. Emissions from landfill are projected to gradually decline across all three waste streams due to a reduction in waste deposited at landfills, a declining proportion of food waste and a projected gradual increase in methane capture rates.

Emissions from the biogenic treatment of solid waste are projected to increase to 2030 as an increasing proportion of food waste is assumed to be diverted from landfills to composting. Figure 25 shows the gradual increase in emissions as a greater proportion of food organics decompose in anaerobic digester facilities and composting facilities. Despite the increase in this subsector, the overall downward trend in solid waste influences a very gradual reduction in total waste emissions.

Domestic and commercial wastewater emissions are projected to increase slowly from 2024 as facilities support a growing population while emissions from industrial food production are projected to remain relatively unchanged to 2030. Carbon dioxide emissions from the incineration of solvents and clinical waste are also projected to remain unchanged and stay below 1 Mt CO_2-e every year out to 2030.

Figure 25: Waste emissions, 1990 to 2030, Mt CO_2-e

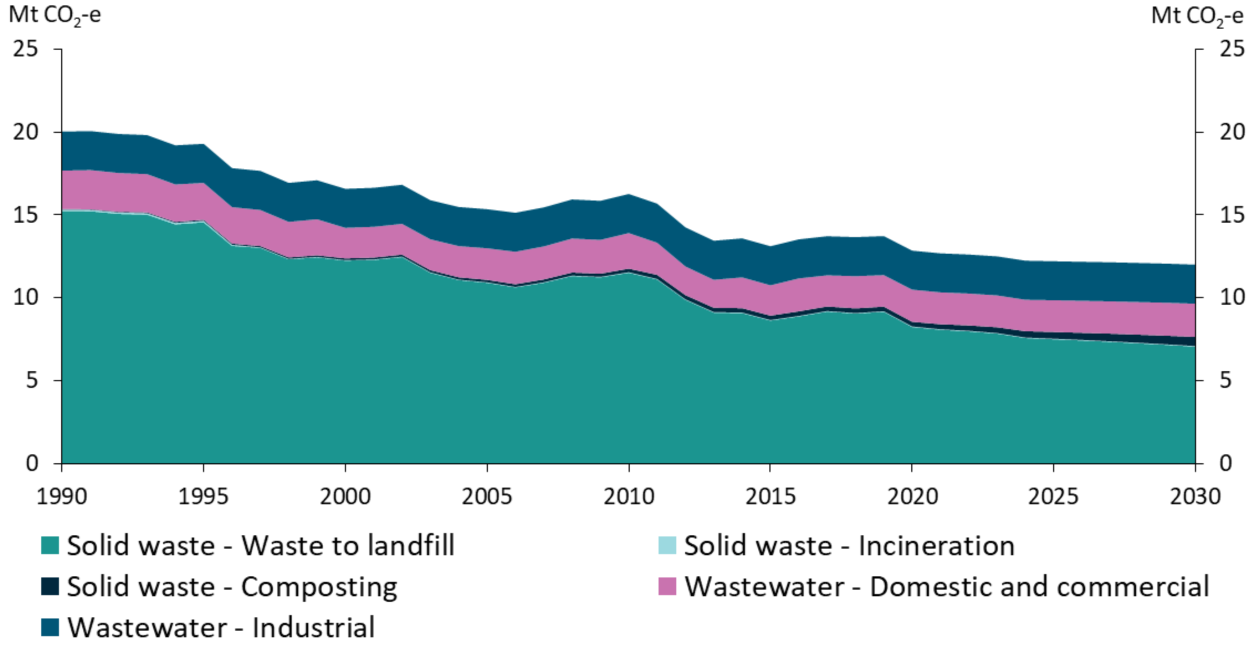


Table 25: Waste emissions, Mt CO_2-e

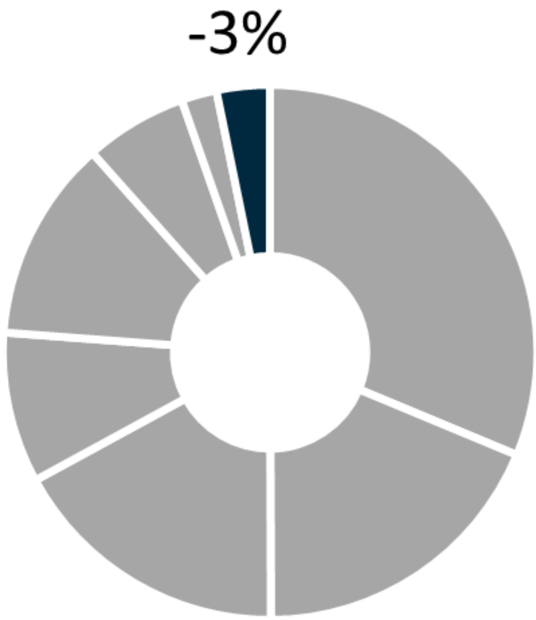
Emissions by subsector	2005	2020	2025	2030
Solid waste - waste to landfill	11	8	7	7
Solid waste - composting	<1	<1	<1	1
Solid waste - incineration	<1	<1	<1	<1
Wastewater – domestic and commercial	2	2	2	2
Wastewater – industrial	1	1	1	1
Total	**14**	**12**	**11**	**11**

Note: totals may not sum due to rounding.

Comparison to previous projections

Compared to the 2019 projections, emissions are projected to be less than 0.2 Mt CO_2-e higher in 2020 and in 2030. Cumulatively from 2020 to 2030, waste sector emissions are 2 Mt CO_2-e higher than the 2019 projection. The increase in emissions reflects the impact of revisions in solid waste disposal reported in the National Greenhouse and Energy Reporting Scheme and in the National Waste Database. Despite the increase in emissions compared to the 2019 projections, there remains a gradual decline in the emissions trend across the projections time series.

Land use, land use change and forestry



3% (net sink equivalent)
of Australia's emissions in 2020
↑ 13 Mt CO_2-e 2020 to 2030

The land use, land use change and forestry (LULUCF) sector includes both sources of greenhouse gas emissions and sinks that remove carbon dioxide from the atmosphere and sequester it as carbon in living biomass, debris and soils. Changes to land management practices have had significant impacts on Australia's vegetation since 1990. Over the decade 2008-2018, the area of land under forest in Australia has increased by around 3 million hectares or around 2 per cent of total forest area[20]. Reductions in vegetation clearing, especially primary forest clearing (that is, clearing of forest that has not been previously cleared), the fostering of vegetation growth and the use of shelter belts have all contributed to improved carbon stock outcomes in Australia's forests and on Australia's grazing lands. This positive trend has been supported by the Australian Government and, for example, around 80 per cent of funds distributed under the Emission Reduction Fund has been allocated to improve the carbon stocks on Australia's grazing lands, mainly through increasing or maintaining vegetation cover.

Soil carbon is also an important potential sink and is one of five priority sectors identified in the Low Emission Technology Statement to develop low-cost methods for estimating carbon sequestration in Australia's crop and grazing lands. The Australian Government is investing to improve the accuracy of the existing models to estimate soil carbon more accurately at project scales and, by improving land management practices through ERF projects, there is significant opportunity to support reduction in agricultural emissions in future.

The LULUCF sector projections are based on the UNFCCC inventory structure as described in Australia's *National Inventory Report 2018*. The major categories used include:

- **forest land**, including *forest land remaining forest* and *land converted to forest* (e.g. harvest and re-generation of native forests, establishment and harvest of plantations, wildfires and prescribed

[20] The IPCC also records that in southern Australia there has been a marked greening of the landscape over recent decades - reflecting a range of influences but including the effects of better land management. This greening trend observed by the IPCC has not been universal. Australia's outcomes have been exceptional and ranked Australia highest amongst OECD countries with the largest net gain in forest area over the period 2010-2020, ahead of Chile, USA, France and Italy - according to the Food and Agriculture Organization of the United Nations' (FAO) Global Forest Resource Assessment 2020.

burning) and includes sinks from regrowing forest on previously cleared land, and carbon stored in harvested wood products and their disposal in landfill

- **forest clearing**, emissions from the UNFCCC land use classification of *forest converted to other land uses,* includes direct clearing-related emissions and delayed emissions from previous clearing, mainly through the gradual loss of soil carbon over a number of years but excluding sinks from regrowing forests on previously cleared lands
- **cropland**, i.e. woody horticulture and changes in soil carbon under herbaceous crops
- **grasslands**, i.e. changes in soil carbon through pastoral activities, fire management in savanna range-lands and changes in shrubby vegetation extent on grasslands and
- **wetlands and settlements**, gains and losses of woody vegetation that is not already classified as *for-est land* (e.g. sparsely planted trees or shrubs) on wetlands and within settlement boundaries (from ABARES' catchment-scale land-use mapping), as well as aquaculture activities, dredging of seagrasses and mangrove and tidal marsh conversions not already reported in *forest land* or *forest conversions.*

Emissions trends

LULUCF emissions have decreased since 1990 reaching -18 Mt CO_2-e in 2020. Over the period to 2030 the emission sink declines to -5 Mt CO_2-e in 2030. The sector is projected to remain a net sink over the whole decade.

Figure 26: Emissions and removals from land use, land use change and forestry (LULUCF), 1990 to 2030, Mt CO_2-e

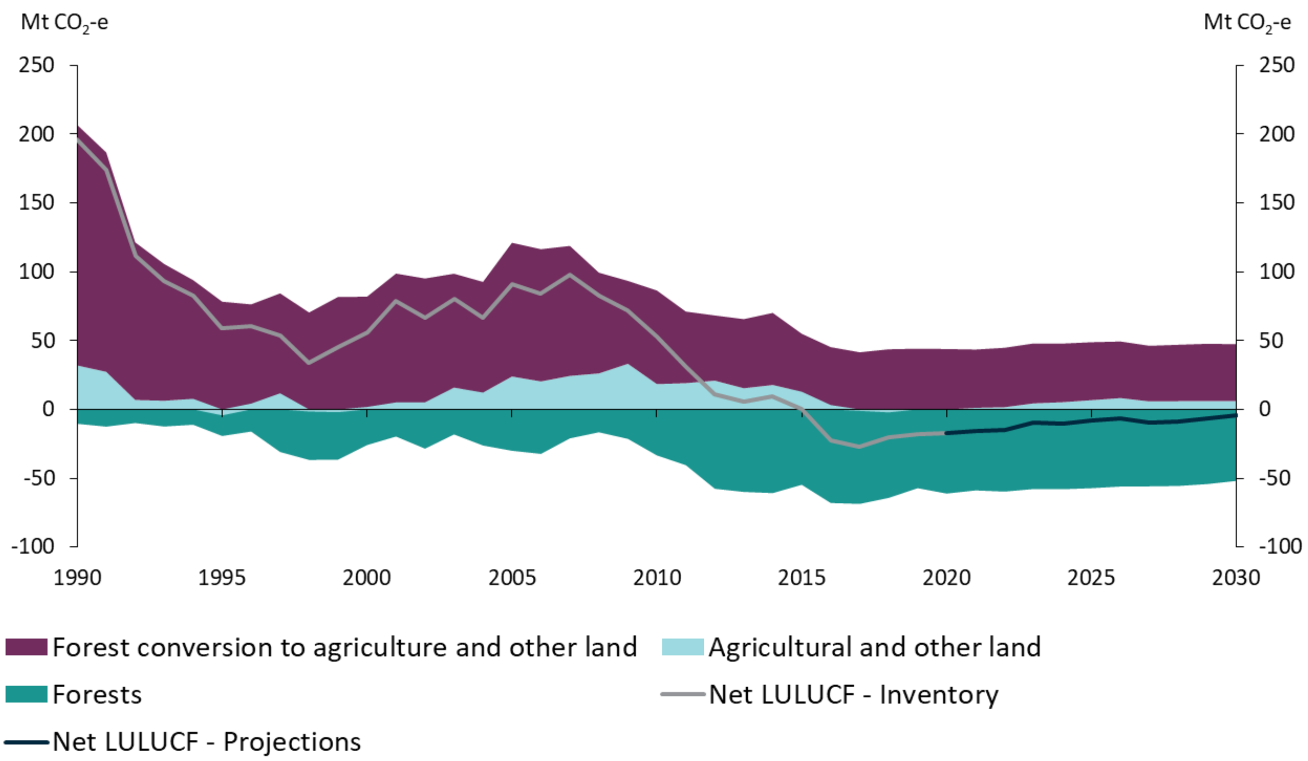


Table 26: Emissions and removals from land use, land use change and forestry (LULUCF), Mt CO_2-e

Emissions by subsector	2005	2020	2025	2030
Forests	-30	-62	-57	-52
Agricultural and other land	24	0	7	6
Forest conversion to agriculture and other land	97	44	42	41
Net LULUCF emissions	**91**	**-18**	**-8**	**-5**

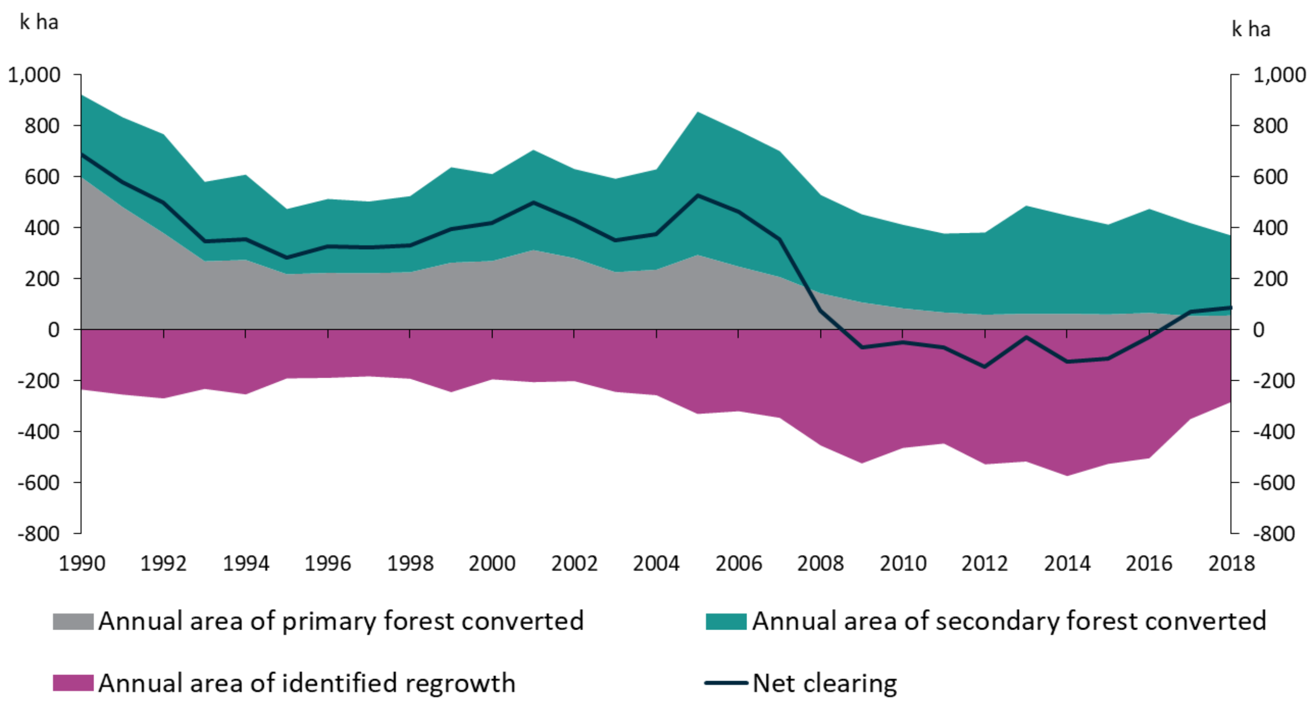
Land clearing

The largest source of emissions in the LULUCF sector is land clearing. Land clearing includes emissions associated with the conversion of forests to agricultural and other land uses. The main source of emissions in this subsector is the combustion of cleared forest vegetation on site and the decay of soil carbon onsite following the clearing event.

Most forest conversion activity in Australia is for the purpose of maintaining pastures for grazing activities. Some forest conversion does occur to support cropping as well as smaller quantities for settlements, infrastructure and reservoirs.

The 2020 land clearing emissions projection was developed based on recent trends in land clearing activity. Most clearing activity in Australia is associated the re-clearing of regrown forest vegetation. Land clearing restrictions have seen primary forest conversion stabilise at record low levels over the past decade (Figure 27).

Figure 27: Historical land clearing activity, 1990 to 2018, k ha



For the 2020 projection it was assumed that primary forest conversion would remain at historic low levels and that regrowth and re-clearing activity responds to changes in the number of livestock included in the projection for the agriculture sector. The projection also includes the assumption that a 10 year cycle of regrowth and re-clearing applies which involves land managers re-clearing regrowth vegetation to maintain production.

The land clearing projection results show re-clearing emissions sustained around current levels for the first half of the decade. In the second half of the decade re-clearing emissions are assumed to decline in response to the reduction in secondary forest regrowth observed over the 2016-2018 period (Figure 27).

Treatment of bush fires in the projections

Bushfires release significant amounts of carbon dioxide, but generally recover over time, generating a significant carbon sink in the years following the fire. This means, for example that the 2019-20 bushfires will have negligible impact on Australia's progress towards its 2020 or 2030 target.

Australia's national greenhouse gas inventory includes all anthropogenic fires. Approaches have been developed to identify non-anthropogenic natural disturbances, and carbon stock loss and subsequent recovery from non-anthropogenic natural disturbances are modelled to average out over time, leaving greenhouse gas emissions and removals from anthropogenic fires as the dominant result. Consistent with this method, the emissions projections include emissions from prescribed burning. The Department actively monitors the forest recovery from the bushfires to ensure that any future human disturbances, such as salvage logging, future fire disturbance and the impacts of changes in climate are taken into account.

Comparison to previous projections

The projections have been revised to reflect updates and improvements in the most recent National Inventory Report, submitted in May 2020. LULUCF emissions are projected to be -5 Mt CO_2-e in 2030, an upwards revision of 5 Mt CO_2-e compared to the 2019 projections.

There are two main factors driving the LULUCF projections.

First, updated estimates for Emissions Reduction Fund (ERF) and the Climate Solutions Fund (CSF) have shifted some abatement in the time-series so that it occurs beyond 2030. The major changes in assumptions for the ERF were the research based updates to estimates for regrowing forests provided by the Department's FullCAM model.

Second, the National Inventory submitted to the UNFCCC in May 2020 included updated estimates for Flooded Land Remaining Flooded Land. This source is assumed to add 4 Mt CO_2-e of emissions to each year of the projection period.

Sensitivity Analyses

Emissions projections are inherently uncertain, involving expert judgement and assumptions about global and domestic economies, policies and technologies. Sensitivity analyses have been prepared alongside the baseline emissions projections to assess how emissions are impacted by different economic and technology assumptions. The sensitivities do not assume any policy changes.

Three sensitivities have been prepared:

- high technology uptake,
- weaker recovery, and
- stronger recovery.

When considered with the baseline projections, they present a possible range of emissions trajectories to 2030.

High technology uptake sensitivity

The high technology sensitivity scenario is aligned with the Government's Technology Investment Roadmap and the priority technologies identified in the Government's first Low Emissions Technology Statement.[21] The 2020 Statement identified five priority low emissions technologies:

- clean hydrogen
- energy storage
- low carbon materials (steel and aluminium)
- carbon capture and storage
- soil carbon

The Statement outlines a stretch goal for each priority technology to become economically competitive with and replace high emission incumbent. The projections high technology uptake scenario focuses on energy storage, carbon capture and storage and soil carbon, noting clean hydrogen and low carbon materials are not assumed to deliver significant emissions reductions until after 2030.

In addition to the Statement assumptions, the high technology scenario assumes the costs of technologies, particularly renewables and battery storage decline faster than in the baseline. Improvements in these technologies are complementary to the priority technologies identified in the Statement. Households see more uptake of battery storage, and coupled with more effective management of distributed energy sees a greater share of renewable generation in the grid. Globally, energy demand is assumed to be lower due to higher take-up of energy efficient or renewable technologies internationally.

Emissions in the high technology uptake sensitivity are projected to be 436 Mt CO_2-e in 2030, 9 per cent below baseline emissions and 29 per cent below 2005 levels.

Weaker recovery sensitivity

The weaker recovery sensitivity assumes a slower recovery from the global pandemic and a more delayed return to pre-pandemic levels of activity in Australia and globally than assumed in the baseline. Compared to

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[21] https://www.industry.gov.au/sites/default/files/September%202020/document/first-low-emissions-technology-statement-2020.pdf

the baseline, these economic conditions are assumed to decrease demand for Australia's products both domestically and internationally. This reduces energy demand from industry and households. Weaker recovery scenario assumes closure of the large manufacturing facilities, towards the end of the decade. This will lead to lower demand and consequent early closure of coal power generation.

Emissions in 2030 are projected to be 387 Mt CO_2-e, 19 per cent lower than baseline emissions in 2030.

Stronger recovery sensitivity

The stronger recovery sensitivity assumes a faster recovery from the global pandemic and faster return to pre-COVID-19 levels of activity in Australia and globally than assumed in the baseline. Compared to the baseline, strong economic growth is assumed to increase demand for Australia's products both domestically and internationally. This sees increased energy demand from industry and households.

Emissions in 2030 are projected to be 495 Mt CO_2-e, 3 per cent above baseline emissions in 2030.

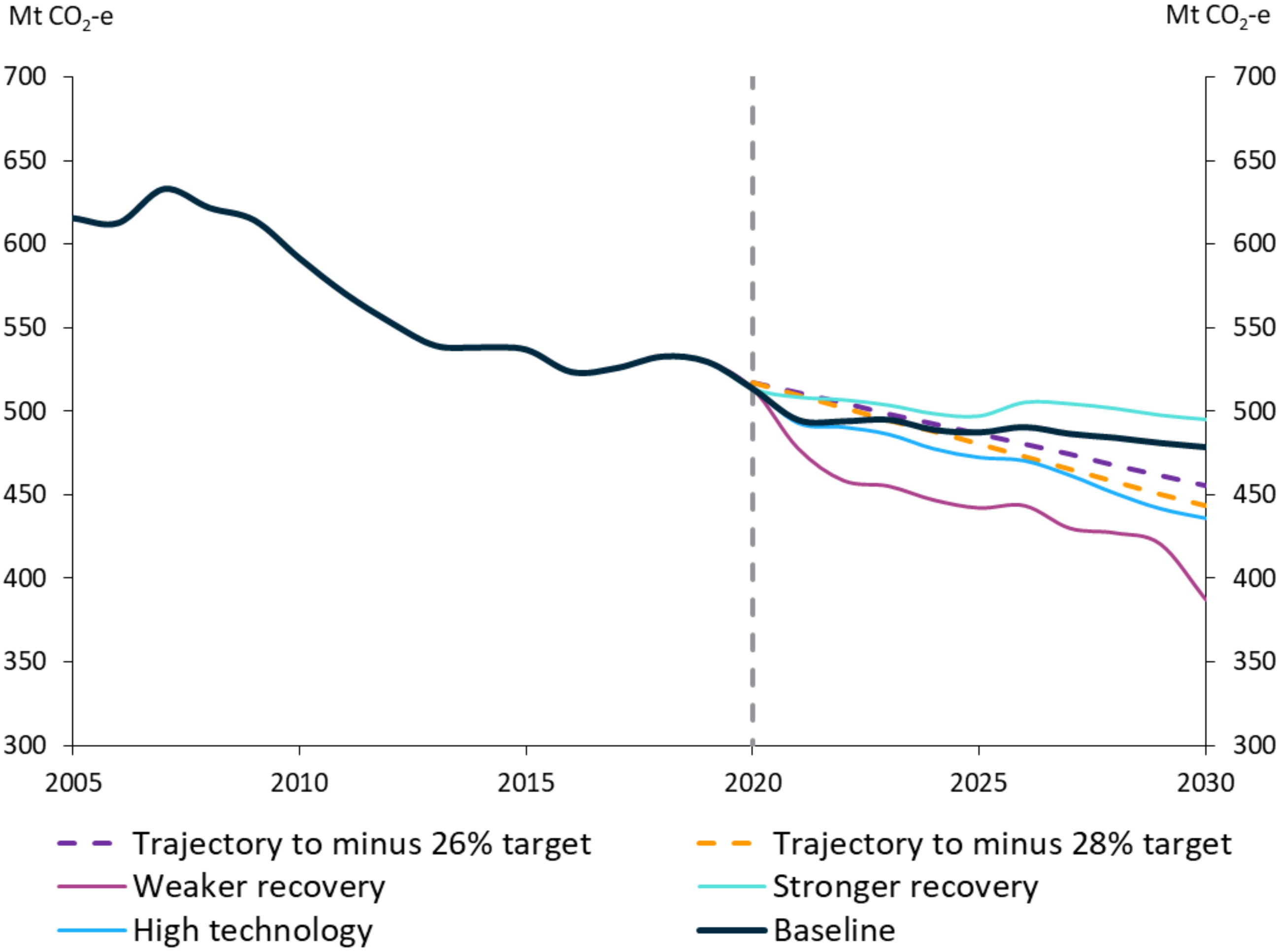
Table 27: Sensitivity results compared to baseline, Mt CO_2-e

	2005	2020	2025	2030
Baseline	615	513	487	478
High technology uptake	615	513	472	436
Weaker recovery	615	513	442	387
Stronger recovery	615	513	497	495

Table 28: Cumulative emissions reduction task to 2030 under baseline and sensitivity analyses, Mt CO_2-e

	Cumulative emissions reduction task (26 per cent below 2005)	Cumulative emissions reduction task (28 per cent below 2005)
Baseline	56	123
High technology uptake	-145	-77
Weaker recovery	-436	-368
Stronger recovery	194	262

Figure 28: Australia's emissions projections, baseline, weaker recovery, stronger recovery and high technology scenarios, 2005 to 2030, Mt CO_2-e



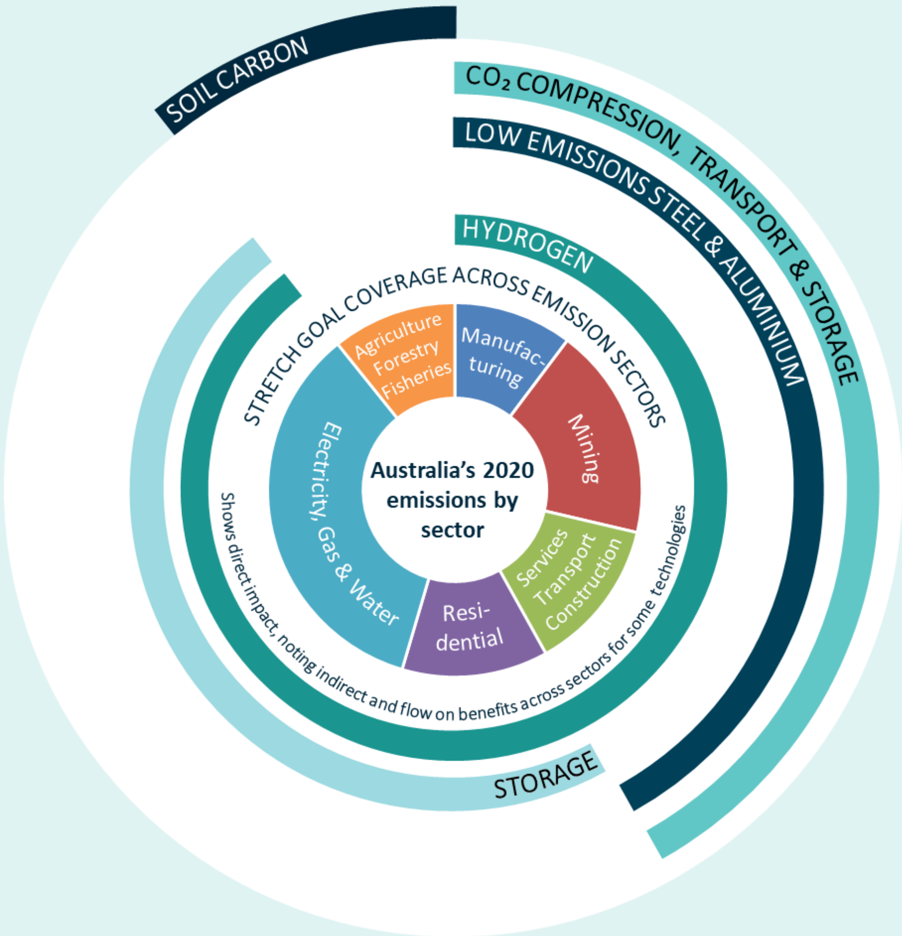
First Low Emissions Technology Statement

Annual Low Emissions Technology Statements will support the Technology Investment Roadmap's technology-based approach to reducing emissions while capturing the economic and employment opportunities that will arise with growing global demand for low emissions technologies. The Government will use annual Statements to guide, track and measure the impact of our investment in new and emerging low emissions technologies.

The first Low Emissions Technology Statement was published in 2020. The Statement sets ambitious stretch goals to reduce the cost of priority low emissions technologies in Australia and globally, including hydrogen, energy storage, carbon capture and storage, low emissions steel and aluminium, and soil carbon measurements. It also supports partnerships with the private sector, the states and territories, and international partners to ensure Australia stays at the cutting edge of low emissions technology investment. The Technology Investment Roadmap and first Statement will be the cornerstone of the Long Term Emissions Reduction Strategy, which will be presented at the UNFCCC COP26 in Glasgow.

The Statement is available from the Department of Industry, Science, Energy and Resources website: https://www.industry.gov.au/data-and-publications/technology-investment-roadmap-first-low-emissions-technology-statement-2020

Figure 29: Emissions scope of the first Low Emissions Technology Statement



Emissions projections by economic sector

Introduction

The emissions projections are prepared under the rules for reporting applicable to the United Nations Framework Convention on Climate Change (UNFCCC). The categories used in UNFCCC reporting are the Intergovernmental Panel on Climate Change (IPCC) categories, which relate to the direct processes that produce emissions, such as methane produced within the digestion process of animals in the agriculture sector. The IPCC categories are used to present the results in the main body of this report.

Emissions projections by economic sector provides an alternative approach to presenting the projections by disaggregating emissions by Australia-New Zealand Standard Industry Classifications (ANZSIC). These classifications relate to recognisable industries and business activities, such as mining.

To make the projections more accessible, work has been done to prepare the projections by economic sector. This has been done to show emissions under industries more people recognise.

Method

The emissions projections results have been mapped from emissions reporting sectors to economic sectors utilising the same methodology as is applied for the preparation of the *National Inventory by Economic Sector 2018*[22].

Results

Direct Emissions (Scope 1 emissions)

Table 29 shows that, on an ANZSIC basis, electricity, gas and water, and primary industries are the largest sources of emissions. Emissions from the electricity, gas and water sector are mostly due to the combustion of fossil fuels at power stations to produce electricity for a number of purposes, including heavy industrial users in manufacturing and businesses (see Indirect (Scope 2) emission projections by economic sector for more details).

Emissions from the electricity, gas and water economic sector are projected to fall by 59 Mt CO_2-e from 2020 to 2030 as the emissions intensity of electricity generation declines. Although this sector continues to contribute a relatively large proportion of total emissions by 2030, its share of total emissions declines from 35 per cent in 2020 to 25 per cent in 2030, as emissions in the electricity sector declines (see the electricity chapter for more details).

Emissions from agriculture, forestry and fishing are currently at their lowest level since 1990 due to the drought and a net sink from forests. Emissions are projected to increase by 21 Mt CO_2-e from 2020 to 2030 as livestock numbers increase over the projections period and the emissions sink from forests declines (see the Agriculture and LULUCF chapters for more details).

Emissions from mining decline into 2021 from 2020 as production at coal and in the LNG sector see short term declines, but emissions grow by 2 Mt CO_2-e from 2021 to 2025, and a further 8 Mt CO_2-e to 2030 as coal returns to a normal production levels in the short-term, followed by an increase in LNG emissions by

[22] https://www.industry.gov.au/data-and-publications/national-greenhouse-gas-inventory-by-economic-sector-2018

2030 (see the Fugitives chapter for more details). Combined with the growth in the agriculture, forestry and fishing sector, Primary Industries' emissions grow from 29 per cent of total emissions in 2020 to 37 per cent in 2030.

Services, Construction and Transport sees a decline in emissions as transport activity, particularly aviation, continues to be restricted during the COVID-19 pandemic, but emissions rise after activity resumes at higher levels in 2022, and the sector remains relatively flat over the rest of the projections. The remaining sectors of Manufacturing and residential see more limited declines over the period to 2030. These sectors, along with Primary Industries, have a growing share of emissions by 2030 as the emissions from electricity, gas and water declines.

Table 29: Emission projections by economic sector, Mt CO_2-e

Emissions by economic sector	2020	2025	2030
Primary Industries[23]	149	160	175
Agriculture, Forestry and Fishing	52	67	74
Mining	97	93	101
Manufacturing	58	56	54
Electricity, Gas and Water	178	138	119
Services, Construction and Transport	63	68	68
Residential	66	65	62
Total	**513**	**487**	**478**

Note: totals may not sum due to rounding.

[23] Primary Industries includes the subsectors of Agriculture, Forestry and Fishing, and Mining.

Figure 30: Emission projections by economic sector, Mt CO_2-e[24]

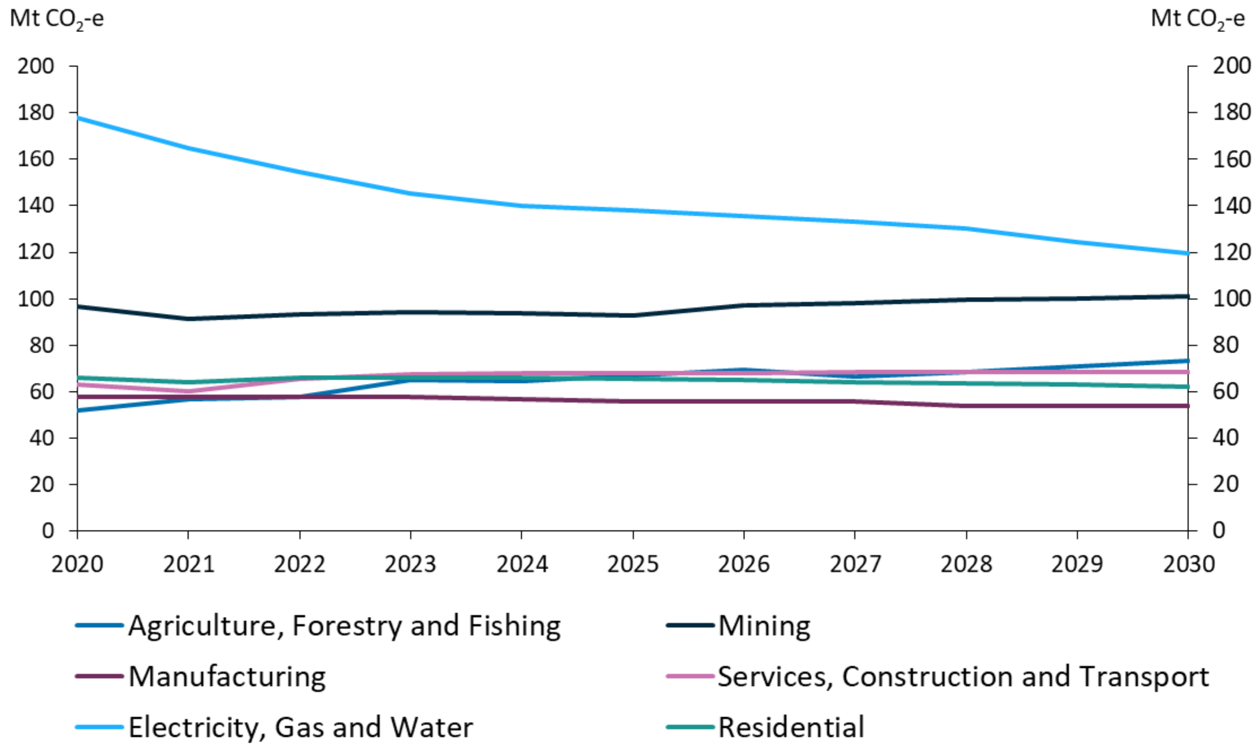
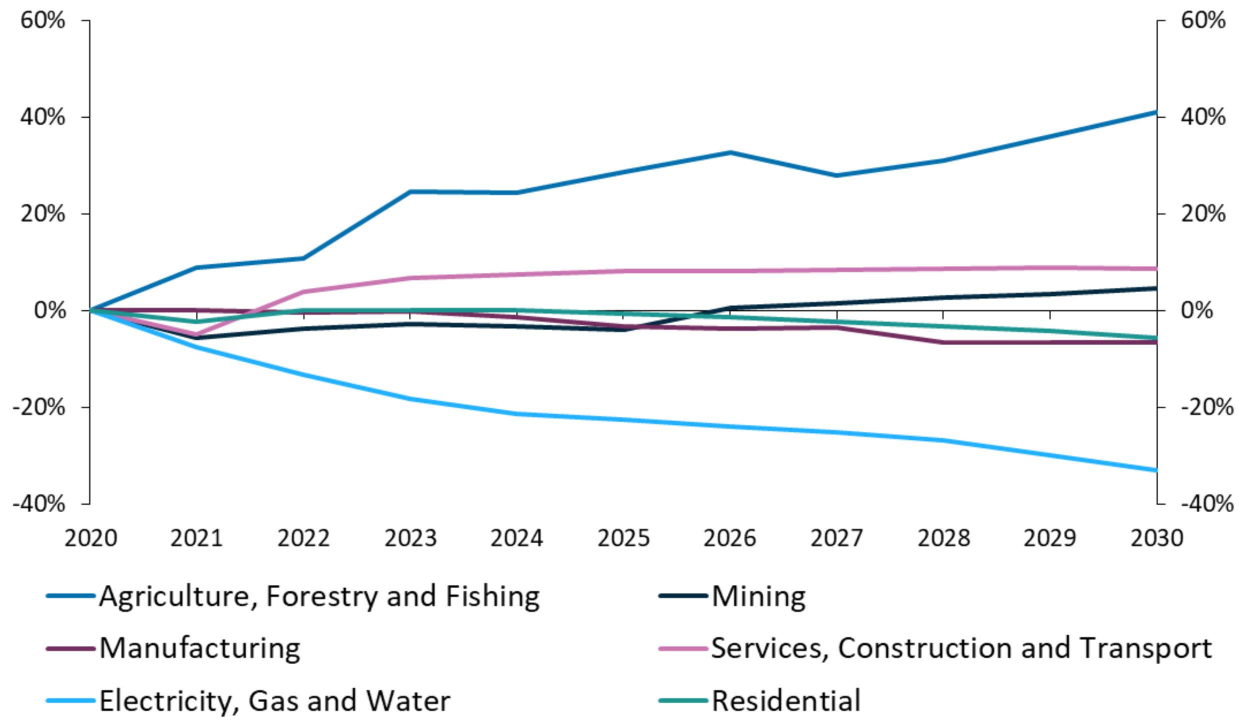


Figure 31: Percentage change in projections by economic sector[25]



[24] Primary industries is shown in its separate subsectors of Agriculture, Forestry and Fishing, and Mining, on this chart.
[25] Ibid.

Indirect (Scope 2) emission projections by economic sector

Emissions projections by economic sector attribute a relatively large amount of emissions to the 'Electricity, Gas and Water' sector. The electricity supply activities in this category includes generation that is transmitted and distributed to a variety of electricity end-users, such as businesses and households.

To better understand how emissions from electricity generation relates to the end-users of that electricity, emissions in this section have been further allocated to electricity consumers according to the share of electricity consumption of each economic sector. These estimates are known as 'indirect' emissions from the generation of electricity, or scope 2 emissions.

The emissions projections results have been mapped to indirect economic sectors utilising the same methodology as is applied for the preparation of the *National Inventory by Economic Sector 2018*.

The biggest contributor to indirect electricity emissions is the services, construction and transport sector with 48 Mt CO_2-e in 2020, and continues to be the biggest contributor over the projections period, with 34 Mt CO_2-e in 2030. However, this sector, along with all economic subsectors, see declines in emissions across the projections period, as total electricity emissions decline.

This is a change to the longer term historical trends that have seen growing emissions across all indirect sectors over the long-term since 1990[26]. However it continues more recent trends of declines in indirect emissions, driven by a decarbonisation of the electricity sector coupled by slowing growth in consumption as energy efficiency lowers demand. This decline of emissions in the electricity sector is projected to continue to 2030 (see the electricity chapter for more details), and drives lower indirect emissions across all economic sectors.

Although all sectors see declines in emissions, the share of subsectors' contribution to total indirect emissions changes over the projections period, as some subsectors seeing stronger declines than others. The largest decline is in the residential sector, as homes install large amounts of rooftop PV, reducing their reliance on electricity purchased from the grid, and reducing their share of indirect emissions from 22 per cent in 2020 to 16 per cent in 2030.

Emissions from the mining sector also decline, from 27 Mt in 2020 to 19 Mt in 2030, as the share of renewable generation grows, but the declines are smaller, as demand increases and renewable penetration does not reach the same level of penetration in off-grid electricity, which powers a large proportion of the mining sector (see electricity chapter for more details). The Agriculture, Forestry and Fishing subsector also remains flat as agricultural production, and so electricity demand, grows over the projections period, offsetting lower emissions intensity. The result are slower declines in the Primary Industries subsector, which includes Agriculture, Forestry and Fishing, and the Mining subsectors.

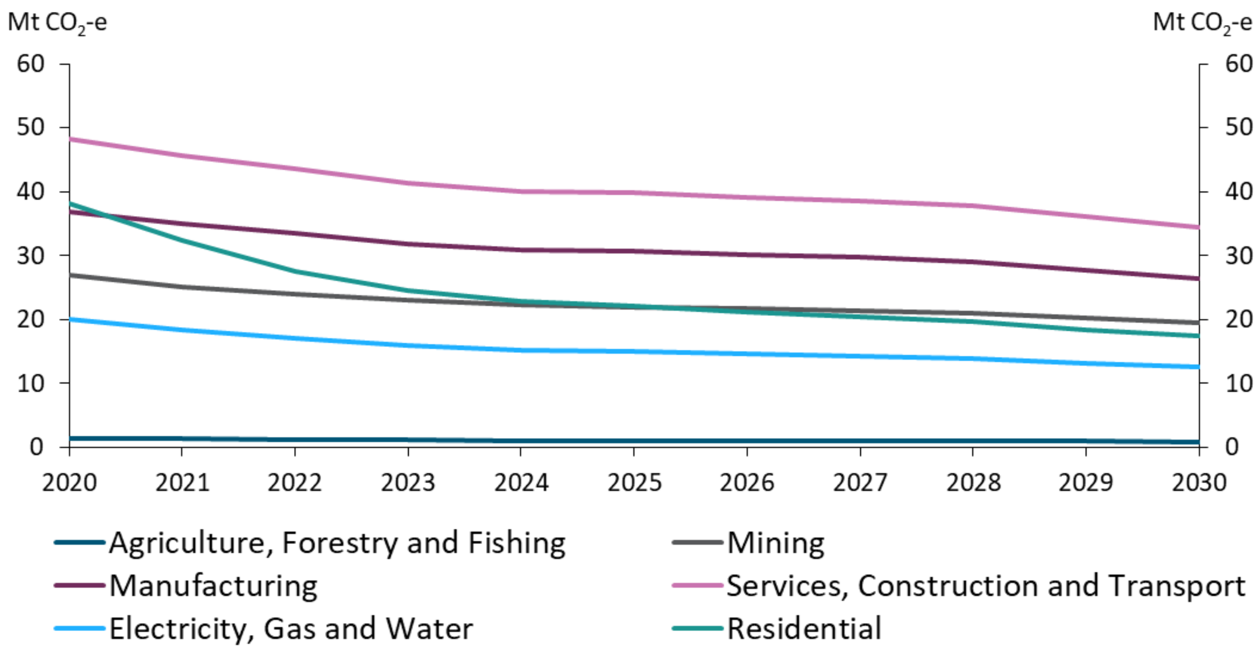
Electric vehicles form a growing share of indirect electricity emissions in the Residential and Services, Construction and Transport sectors. However a low starting point of fleet share and growing efficiency in vehicle batteries means this is more than offset by the declines in this subsector from the growing share of renewables in the electricity sector.

[26] Department of Industry, Science, Energy and Resources, National Inventory by Economic Sector 2018: Australia's National Greenhouse Accounts, 13.

Table 30: Indirect emissions projections from the generation of electricity, Mt CO_2-e

Emissions by economic sector	2020	2025	2030
Primary Industries[27]	28	23	20
Agriculture, Forestry and Fishing	1	1	1
Mining	27	22	19
Manufacturing	37	31	26
Electricity, Gas and Water	20	15	13
Services, Construction and Transport[28]	48	40	34
Residential	38	22	17
Total electricity generation	**172**	**130**	**111**

Figure 32: Emissions projections from the generation of electricity trends, Mt CO_2-e[29]



[27] Primary Industries includes the subsectors of Agriculture, Forestry and Fishing, and Mining.
[28] In 2020 and 2021 the COVID-19 pandemic has resulted in a temporary increase in electricity demand from the residential sector and a decrease in electricity demand from the services, construction and transport sector. This impact has not been included in the scope 2 estimates due to a lack of data.
[29] Primary industries is shown in its separate subsectors of Agriculture, Forestry and Fishing, and Mining, on this chart.

Consumption based emissions projections

Australia has an open trading economy and economic and emission outcomes are strongly influenced by trade in goods and services. Australia is an exporter of goods that are relatively emissions-intensive to produce, for example LNG. Exports of these emissions intensive goods have increased and these goods comprise an increasing proportion of Australia's emissions.

A consumption based emissions projection accounts only for emissions generated, either domestically or overseas, in support of production of goods and services that are finally consumed in Australia. This accounting approach excludes emissions generated during the production of exports, but also includes overseas emissions generated during production of the products that are imported for domestic consumption.

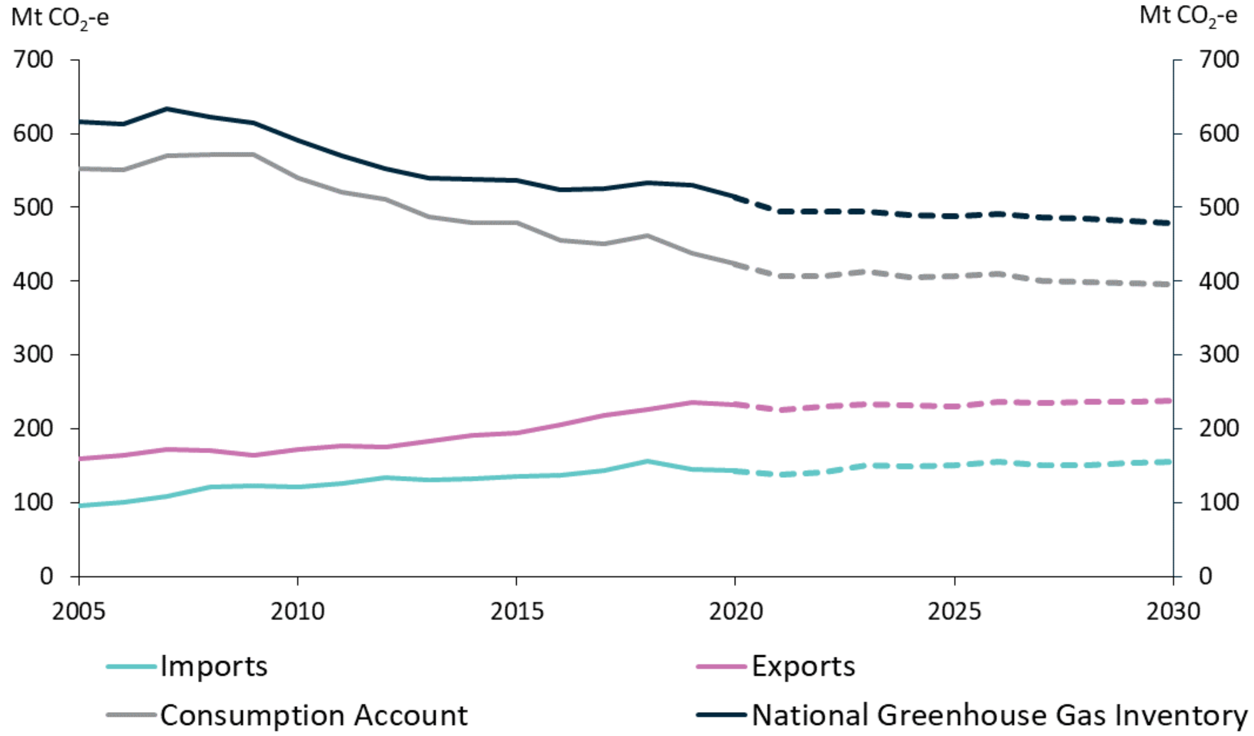
Table 31: Consumption based emissions projections, Mt CO_2-e

Consumption based emissions projections	2020	2025	2030
Australia's emissions projections	513	487	478
Emissions generated by exports	233	231	238
Emissions generated by imports	143	151	155
Consumption based emissions projections	423	407	396

Emissions generated in Australia to produce goods that are exported is projected to increase by 2 per cent from 2020 to 2030. Increases in the production of certain emissions intensive commodities are largely offset by the reduced emissions intensity of the Australian economy which, for example, reduces the emissions associated with Australia's aluminium exports due to a lower emissions intensity of electricity. Australia's consumption-based inventory is projected to decrease from 423 Mt CO_2-e in 2020 to 396 Mt CO_2-e in 2030 which is 28 per cent lower than emissions in the year 2005.

Emissions per person on a consumption basis are projected to fall to approximately 14 tonnes per person in 2030, which is around 3 tonnes per person less than per capita emissions from the emissions projections.

Figure 33: Australia's emissions projections and consumption-based projections, Mt CO_2-e



Method

This is the first time a consumption-based national greenhouse gas projection has been produced by the Department.

The consumption based projection utilises the methods applied in the Quarterly Updates of the National Greenhouse Gas Inventory. The underlying methodology and data inputs were described in the Special Topic to the *June 2019 Quarterly Update of the National Greenhous Gas Inventory*.

The consumption based projection uses the Australia's emissions projections and ABS Input Output tables for 2017-18. The proportion of Australia's emissions associated with the production of exports has been increasing since 1990. In this analysis it is assumed that the inter-relationships between Australian industries remains constant to 2030 except for key export industries such as LNG and coal where the proportion of emissions exported were adjusted to take account of production and emissions data in the emissions projections. If emissions associated with exports continue to increase at the historical rate this would result in an overestimate of consumption based emissions to 2030.

As input-output tables are subject to some imprecision, the Department considers that the uncertainty around the consumption-based inventory estimates, calculated as they are using input-output tables, will be larger than the uncertainty for the national greenhouse gas inventory estimates. The current method will be reviewed and refined to improve the accuracy of the consumption-based projections. In particular to project the changes in economic flows across a wider range of economic sectors and utilise international data to better project the emissions intensity of Australia's imports.

Appendix A – Methodology

An extensive methodology for Australia's emissions projections is provided as a separate document alongside the report. The methodology report, *Methodology for the 2020 Projections*, can be found on the Department's website.

Accounting approach

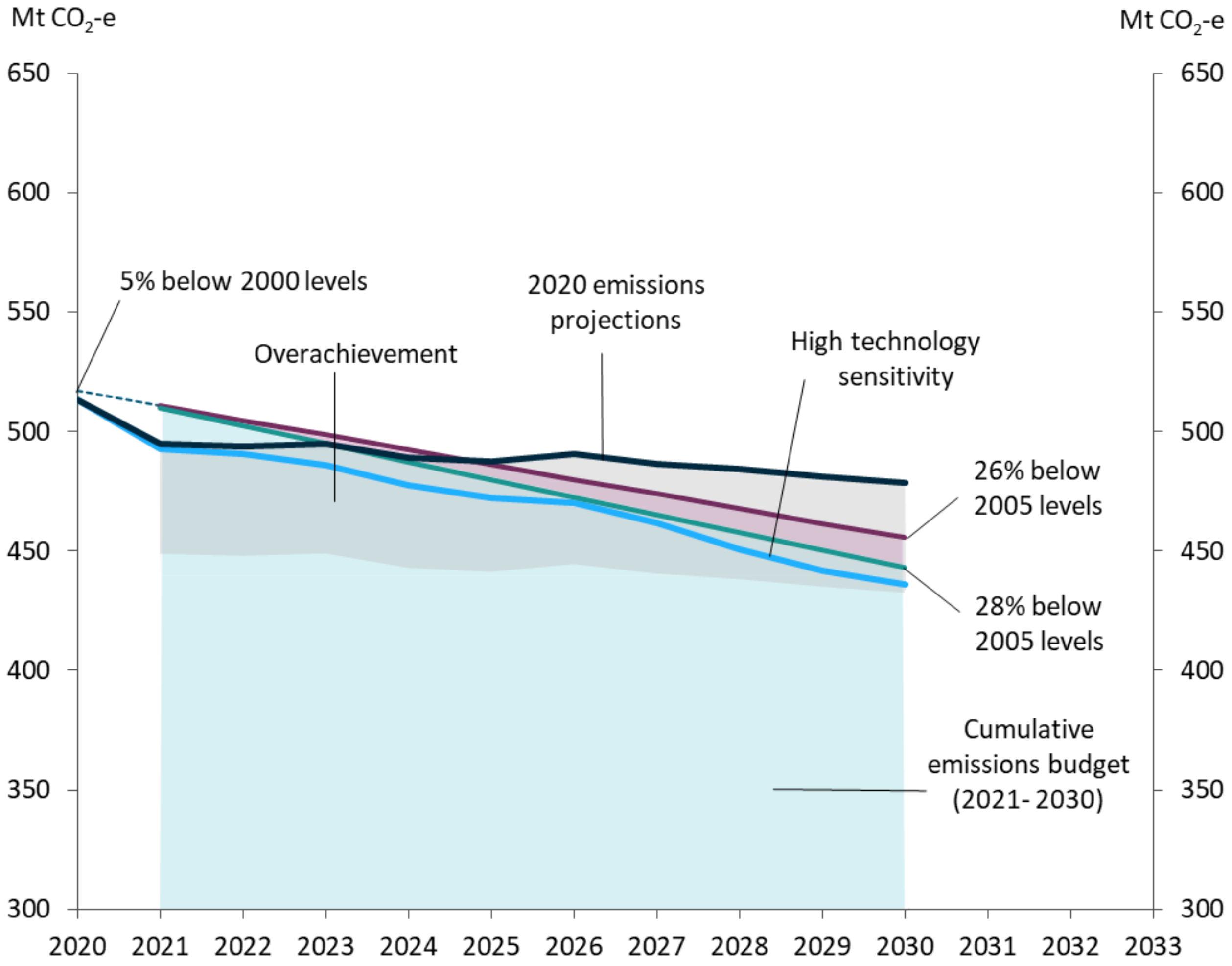
The emissions projections are estimated on a United Nations Framework Convention on Climate Change (UNFCCC) accounting basis consistent with Australia's accounting for the 2030 targets. Reporting years for all sectors are reported for financial years as key data sources are published on this basis. For instance, '2030' refers to financial year 2029–30.

Methodology for calculating Australia's cumulative emissions reduction task to 2030

Australia assesses progress against its 2030 target, of 26 to 28 per cent below 2005 levels, using an emissions budget approach. Australia considers its 2030 emissions budget as a ten year commitment from 2021 to 2030. A trajectory to achieve the emissions budget is calculated by taking a linear decline from 2020 to 2030, beginning from the 2020 target of 5 per cent below 2000 levels and finishing at 26 per cent and 28 per cent below 2005 levels in 2030. Australia's progress is assessed as the difference in cumulative emissions between projected emissions and the target trajectory from 2021–2030.

Australia's 2030 target is inclusive of all emissions and removals of greenhouse gases reported in its annual national inventory under the UNFCCC. This includes the gases CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3 and the energy, industrial processes and product use, agriculture and waste sectors and UNFCCC LULUCF sub-classifications (cropland, forest land, grassland, harvested wood products, settlements and wetlands).

Figure 34: Australia's cumulative emissions reduction task to 2030, Mt CO_2-e



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2021–2030
Budget trajectory (26 per cent target) Mt CO_2-e	511	505	499	492	486	480	474	468	462	455	**4832**
Budget trajectory (28 per cent target) Mt CO_2-e	510	502	495	487	480	473	465	458	451	443	**4764**
2020 projections	495	494	495	489	487	490	486	484	481	478	**4880**

Emission Projections by Economic Sector

This report uses the ANZSIC hierarchy from the Australian and New Zealand Standard Industrial Classification 2006 (ABS cat no. 1292.0). The mappings applied are based on the allocations used for the *National Inventory by Economic Sector 2018*.

The emission projections by economic sector allocates Australia's total emissions on a UNFCCC reporting basis consistent with Australia's 2030 target. The *National Inventory by Economic Sector 2018* allocates Australia's total emissions on a Kyoto reporting base, consistent with Australia's 2020 target.

Data sources

The key data sources include:

- historical emissions data from the *National Inventory Report 2018*, released in May 2020, and the *Quarterly Update of Australia's National Greenhouse Gas Inventory*[30]*,*
- macroeconomic assumptions of gross domestic product and population consistent with the Australian Government's 2020–21 Budget; and
- commodity forecasts and activity levels informed by a number of publications and data from government agencies and other bodies, including:
  - the Department of Industry, Innovation and Science, Energy and Resources
  - the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)
  - the Australian Energy Market Operator (AEMO).

The Department applies consistent assumptions across all sectors of these projections.

Institutional arrangements and quality assurance

The projections are prepared by the Department of Industry, Science, Energy and Resources using the best available data and independent expertise to analyse Australia's future emissions reduction task. The Department engages with a technical working group comprising of representatives from Commonwealth agencies to test the methodologies, assumptions and projections results. Australia makes formal submissions on its emissions projections to the United Nations and these are subject to UN expert review. The last review was completed in 2020.

The preparation of the emissions projections underwent a performance audit by the Australian National Audit Office (ANAO) in 2016 and 2017. The audit found the arrangements for preparing, calculating and reporting on Australia's greenhouse gas emission projections were largely effective. The audit report, *Accounting and Reporting of Australia's Greenhouse Gas Emissions Estimates and Projections* is published on the ANAO website.

Difference between projections and forecasts

The Department prepares emissions projections using the latest data including production and activity levels, commodity prices and macroeconomic assumptions. The Department makes reasonable assumptions about this data into the future based on the advice of other government agencies and external consultants. These include macroeconomic forecasts by the Australian Treasury; activity forecasts by other government

[30] June Quarter 2020.

agencies such as the Australian Bureau of Agricultural and Resource Economics; forecasts by other public bodies such as the Australian Energy Market Operator; and announced investment intentions by businesses.

The projections are modelled taking this data into account and indicate what Australia's future emissions could be if the assumptions that underpin the projections continue to occur. For example, the projections presume that assumptions around the current rates of economic and population growth, the take up of certain technologies and the impacts of current government policies will remain valid. The projections do not attempt to account for the inevitable, but as yet unknown, changes that will occur in technology, energy demand and supply and the international and domestic economy.

In contrast, emissions forecasts speculate on the expectations or predictions of what will happen in the future and thus what future emissions will be. In a forecast the assumptions represent expectations of actual future events or changes. For example, this could mean forecasting emissions based on alternative predictions of how technology may evolve, how consumers and businesses will react to these technological changes and subsequently what impacts this would have on emissions. Alternatively this could mean forecasting emissions based on expectations about restructures in the Australian economy. Often a number of different scenarios that reflect different forecast assumptions are undertaken at the same time.

Both projections and forecasts are inherently uncertain, involving judgements about the future growth path of global and domestic economies, policies and measures, technological innovation and human behaviour. This uncertainty increases the further into the future emissions are projected (or forecast).

The distinction between forecasts and projections can also be seen in the Treasury's economic estimates underlying Australian Government fiscal projections. The estimates divide the forecast horizon into two distinct periods: the near-term forecast period which covers the first two years beyond the current financial year; and the longer-term projection period which includes the last two years of the forward estimates, and up to 36 more years for intergenerational analysis. The economic estimates over the forecast period are based on a range of short-run forecasting methodologies, while those over the projection period are based on medium-to long-run rules.

Feedback

The Department of Industry, Science, Energy and Resources welcomes feedback regarding Australia's emissions projections at Emissions.Projections@industry.gov.au.

Appendix B – Consideration of policies

The emissions projections are developed on the basis of adopted policies and measures including:

- The Technology Investment Roadmap and first Low Emissions Technology Statement
- The Emissions Reductions Fund and the Climate Solutions Fund
- Large-scale Renewable Energy Target and the Small-scale Renewable Energy Scheme
- Energy efficiency measures at the state and federal level
- Implemented initiatives under the National Energy Productivity Plan, the ARENA and the CEFC
- State renewable energy targets in Queensland, Victoria, Tasmania and the Northern Territory
- State-based waste policy frameworks and the National Food Waste Strategy, and
- The legislated phase-down of hydrofluorocarbons (HFCs)
- Energy Performance, refrigeration and air conditioning measures.

The emissions projections do not take account of estimates of abatement from potential future policies and measures.

Measures from the 2020–21 Budget

In October 2020, the Australian Government announced continued funding for the ARENA, the expansion of the investment mandate of the CEFC and a number of other measures that would invest in low emissions technologies, reduce emissions and increase productivity, including the Technology Co-investment fund. Further information on the measures are available at www.budget.gov.au/2020-21.

Updates to the Emissions Reduction Fund and Climate Solutions Fund abatement estimates

The Emissions Reduction Fund (ERF) is a voluntary scheme that provides incentives for emission reduction projects. Eligible project types include energy efficiency, vegetation, savanna burning, agriculture, industrial fugitives, transport and waste. The ERF is estimated to contribute 60 Mt CO_2-e of abatement to 2020[31], and 210 Mt CO_2-e over the period 2021 to 2030. This abatement is inclusive of past and future auctions.

The Climate Solutions Fund (CSF) was announced in February 2019 to provide additional funding to continue purchasing low-cost abatement and build on the momentum of the ERF. The CSF is projected to contribute 67 Mt CO_2-e over the period 2021 to 2030.

The projected abatement from the ERF/CSF has been updated to take account of the latest contract delivery schedule (including outcomes from the tenth and eleventh auctions), with more abatement assumed to be delivered after 2030, and to take account of updates to the Full Carbon Accounting Model (FullCAM). FullCAM is the model used by ERF project participants to estimate abatement for a number of forest-based methods. An update to FullCAM was released for public use in September 2020 and reflects the latest available science and research.

[31] Clean Energy Regulator, Quarterly Carbon Market Report - September Quarter 2020, page 12. The volume of Australian Carbon Credit Units (ACCUs) contracted under the ERF has reached 200 million with 60 million ACCUs already delivered under contract.

Appendix C – Indirect emissions factors for Australia's electricity grids

Indirect Scope 2 emissions factors, tonnes CO_2-e per MWh.

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Australia, all grid connected	0.72	0.66	0.61	0.56	0.54	0.54	0.52	0.51	0.50	0.47	0.45
NEM	0.72	0.66	0.61	0.56	0.54	0.53	0.52	0.51	0.50	0.47	0.45
NSW/ACT	0.77	0.72	0.66	0.61	0.58	0.55	0.52	0.51	0.51	0.49	0.47
QLD	0.78	0.74	0.71	0.65	0.62	0.62	0.61	0.60	0.59	0.57	0.56
SA	0.30	0.27	0.21	0.19	0.17	0.22	0.22	0.22	0.18	0.16	0.15
VIC	0.87	0.78	0.68	0.62	0.61	0.64	0.64	0.62	0.58	0.52	0.48
TAS	0.12	0.16	0.13	0.10	0.10	0.11	0.11	0.09	0.07	0.06	0.05
SWIS	0.66	0.57	0.54	0.52	0.52	0.50	0.48	0.48	0.48	0.44	0.42
NWIS	0.58	0.57	0.56	0.53	0.51	0.50	0.49	0.49	0.49	0.49	0.49
DKIS	0.64	0.57	0.52	0.51	0.49	0.48	0.46	0.44	0.41	0.37	0.33

Indirect Scope 2 and 3 combined emissions factors, tonnes CO_2-e per MWh.

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Australia, all grid connected	0.81	0.74	0.68	0.63	0.61	0.60	0.59	0.58	0.56	0.53	0.50
NEM	0.82	0.75	0.69	0.63	0.61	0.61	0.59	0.58	0.56	0.53	0.51
NSW/ACT	0.86	0.80	0.74	0.69	0.66	0.62	0.58	0.57	0.57	0.55	0.53
QLD	0.91	0.85	0.82	0.75	0.72	0.71	0.71	0.70	0.69	0.67	0.65
SA	0.36	0.32	0.25	0.22	0.21	0.27	0.27	0.26	0.21	0.19	0.18
VIC	0.96	0.85	0.75	0.68	0.66	0.69	0.69	0.68	0.64	0.57	0.52
TAS	0.14	0.19	0.15	0.12	0.12	0.13	0.13	0.11	0.08	0.07	0.06
SWIS	0.70	0.60	0.57	0.56	0.55	0.53	0.51	0.51	0.51	0.47	0.44
NWIS	0.61	0.61	0.60	0.56	0.54	0.54	0.52	0.52	0.52	0.52	0.52
DKIS	0.72	0.64	0.59	0.57	0.56	0.54	0.52	0.50	0.46	0.41	0.37