Quarterly Update of Australia’s National Greenhouse Gas Inventory: December 2021

Incorporating emissions from the NEM up to March 2022

Australia’s National Greenhouse Accounts
Preface

The Quarterly Update provides estimates of Australia’s national inventory of greenhouse gas emissions up to the December quarter of 2021, and preliminary estimates of emissions for the year-to-March quarter 2022.

Emissions for the year to December 2021 are estimated to be 488.0 Mt CO$_2$-e, up 0.8% or 4.1 Mt CO$_2$-e on the previous year. This increase in emissions reflects the balance of:

- Ongoing reductions in emissions from electricity (down 4.2%; 7.0 Mt CO$_2$-e);
- Increased transport emissions (up 4.0%; 3.5 Mt CO$_2$-e) reflecting the continuing recovery from the impacts of COVID restrictions on movement;
- Increased emissions from stationary energy (excluding electricity) (up 3.3%; 3.3 Mt CO$_2$-e); driven primarily by increased fuel combustion in the manufacturing sector;
- Increased fugitive emissions (up 1.8%; 0.9 Mt CO$_2$-e), reflecting increased venting and flaring in oil and gas; and
- Increased emissions from agriculture (up 4.2%; 3.1 Mt CO$_2$-e) due to the continuing recovery from drought.

Emissions in the year to December 2021 were 21.4% below emissions for the year to June 2005 (the baseline year for Australia’s Paris target).

Figure P1: Emissions$^{2,3}$, by quarter, December 2000 to December 2021 (including preliminary March 2022)

Source: Department of Industry, Science, Energy and Resources

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1 Carbon dioxide equivalent (CO$_2$-e) emissions values are calculated using Global Warming Potential (GWP) values for a 100 year time horizon from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5). See Section 5 - Technical Notes for further detail.

2 ‘Actual’, ‘seasonally adjusted, ‘weather normalised’ and ‘trend’ are defined in Section 5 - Technical notes.

3 National emissions levels are inclusive of all sectors of the economy, including Land Use, Land use Change and Forestry (LULUCF) and includes the application of the IPCC’s natural disturbance provision.
On a quarterly basis, national emission levels for the December quarter 2021 increased 0.1% or 0.1 Mt CO$_2$-e on the previous quarter in trend terms (Figure P1). The trend result for the December quarter 2021 reflects increases across the *stationary energy*, *fugitive emissions*, *industrial processes*, *agriculture and waste* sectors. These increases were partially offset by decreases across the *electricity*, *transport* and *land use, land use change and forestry* sectors.

In the year to December 2021, the emissions intensity of the economy was at its lowest level in 32 years, 68.5% below 1990 levels. Emissions per capita were lower than 1990 by 48.9%, but increased slightly in the year to December 2021, reflecting lower than usual population growth as a result of COVID restrictions on movement throughout 2021.

On an annual basis, the consumption-based inventory increased 1.2% or 4.8 Mt CO$_2$-e to 403.9 Mt CO$_2$-e in the year to December 2021. Emissions associated with production of exports increased by 4.2% or 9.3 Mt CO$_2$-e to 231.4 Mt CO$_2$-e and emissions associated with consumption of imports increased by 7.3% or 10.1 Mt CO$_2$-e to 147.3 Mt CO$_2$-e.

National emissions are preliminarily estimated to be 489 Mt CO$_2$-e in the year to March 2022, an increase of 2.0% on the previous year. On a quarterly basis, national emissions are preliminarily estimated to be 122 Mt CO$_2$-e in trend terms, a decrease of 0.4% on the previous quarter.
1. Overview

Table 1: National Greenhouse Gas Inventory\(^4\), December quarter 2021, rates of change

<table>
<thead>
<tr>
<th></th>
<th>December quarter 2021</th>
<th>Year to December 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarterly change – seasonally adjusted and weather normalised(^5)</td>
<td>0.3%</td>
<td></td>
</tr>
<tr>
<td>Quarterly change – seasonally adjusted and weather normalised – trend(^5)</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>Annual Change</td>
<td></td>
<td>0.8%</td>
</tr>
</tbody>
</table>

Table 2: National Electricity Market (NEM)\(^6\), March quarter 2022, rates of change

<table>
<thead>
<tr>
<th></th>
<th>March quarter 2022</th>
<th>Year to March 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarterly change – seasonally adjusted and weather normalised(^5)</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>Quarterly change – seasonally adjusted and weather normalised – trend(^5)</td>
<td>-1.7%</td>
<td></td>
</tr>
<tr>
<td>Annual Change</td>
<td></td>
<td>-4.0%</td>
</tr>
</tbody>
</table>

Summary of emissions in the December quarter 2021

National emissions for the December quarter 2021 increased 0.1% or 0.1 Mt CO\(_2\)-e on the previous quarter in trend terms. Emissions were higher than the September 2021 quarter in the stationary energy, fugitive emissions, industrial processes, agriculture and waste sectors in trend terms. These increases were partially offset by decreases in the electricity, Transport and LULUCF sectors across the same period.

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\(^4\) National emissions levels are inclusive of all sectors of the economy, including Land Use, Land Use Change and Forestry (LULUCF).
\(^5\) ‘Actual’, ‘seasonally adjusted’, ‘weather normalised’ and ‘trend’ are defined in Section 5: Technical notes.
\(^6\) The NEM includes grid electricity in the Eastern and South Eastern states and accounts for approximately 81% of total electricity estimates in the year to December 2021.
Figure 1: Emissions\(^7\), by quarter, December 2010 to December 2021

Source: Department of Industry, Science, Energy and Resources

Figure 2: Change in emissions, by quarter, December 2010 to December 2021

Source: Department of Industry, Science, Energy and Resources

\(^7\) ‘Seasonally adjusted’, ‘weather normalised’, and ‘trend’ are defined in Section 5: Technical notes
Emissions of individual gases

Carbon dioxide (CO$_2$) emissions contribute the largest share of aggregate emissions in Australia at approximately 70% of total emissions. In trend terms, since the peak in September 2008, there has been a 27.5% or 32.2 Mt decline in quarterly emissions of carbon dioxide to 84.8 Mt in December 2021 (Figure 3). The most important factors causing this long term decline in CO$_2$ emissions include the continuing shift in the generation of electricity towards renewable fuel sources, and away from coal, and decreasing emissions in the Land sector. Against these downward forces, the long term growth of emissions from transport activity and the expansion of LNG exports have placed upward pressure on this time series.

Methane (CH$_4$) emissions contribute approximately 26% of aggregate emissions in Australia. Overall CH$_4$ emissions have declined by 21.9% in trend terms since the peak in September 1990. Trends in CH$_4$ emissions are dominated by events in Agriculture such as drought, Fugitives related to coal, oil and gas production levels, and the Land and Waste sectors.

Nitrous oxide (N$_2$O) emissions contribute around 4% of aggregate emissions in Australia. Overall N$_2$O emissions have declined by 15.8% since the peak in September 2011. Trends in N$_2$O emissions are sensitive to events in the Agriculture sector such as synthetic fertilizer use and biomass burning in the Land sector.

Other gases comprising hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF$_6$) contribute the balance of total aggregate emissions (around 2%). Growth in emissions of other gases is primarily driven by consumption of refrigerants in refrigeration and airconditioning equipment.

Figure 3: Emissions, by quarter, by gas, trend, December 2000 to December 2021

Source: Department of Industry, Science, Energy and Resources
Summary of annual GHG emissions

Emissions for the year to December 2021 are estimated to be 488.0 Mt CO$_2$-e. The 0.8% or 4.1 Mt CO$_2$-e increase in emissions over the year to December reflects annual increases in emissions from the transport, stationary energy, fugitives, industrial processes and agriculture sectors. These increases in emissions were partially offset by decreases in emissions from the electricity, land use, land use change and forestry and waste sectors (Table 3).

Table 3: Actual annual emissions, by sector, for the year to December 2020 and 2021

<table>
<thead>
<tr>
<th>Sector</th>
<th>Annual emissions (Mt CO$_2$-e) year to December 2020</th>
<th>Annual emissions (Mt CO$_2$-e) year to December 2021</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy – Electricity</td>
<td>167.5</td>
<td>160.4</td>
<td>-4.2%</td>
</tr>
<tr>
<td>Energy – Stationary energy excluding electricity</td>
<td>99.3</td>
<td>102.6</td>
<td>3.3%</td>
</tr>
<tr>
<td>Energy – Transport</td>
<td>87.4</td>
<td>90.9</td>
<td>4.0%</td>
</tr>
<tr>
<td>Energy – Fugitive emissions</td>
<td>49.9</td>
<td>50.8</td>
<td>1.8%</td>
</tr>
<tr>
<td>Industrial processes and product use</td>
<td>32.0</td>
<td>32.5</td>
<td>1.4%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>74.1</td>
<td>77.2</td>
<td>4.2%</td>
</tr>
<tr>
<td>Waste</td>
<td>13.0</td>
<td>13.0</td>
<td>-0.1%</td>
</tr>
<tr>
<td>Land Use, Land Use Change and Forestry</td>
<td>-39.3</td>
<td>-39.5</td>
<td>-0.4%</td>
</tr>
<tr>
<td>National Inventory Total</td>
<td>483.9</td>
<td>488.0</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

Figure 4: Share of total emissions, by sector, for the year to December 2021

Source: Department of Industry, Science, Energy and Resources
Over the year to December 2021 the 4.2% decrease in emissions from the electricity sector reflected a decrease of 4.4% in coal generation, a decrease of 23.0% in gas generation and an increase of 18.1% in supply from renewable sources in the NEM. The Australian Electricity Market Operator noted that gas generation has declined to record lows due to pricing fluctuations rendering gas generation ‘subeconomic’ in most regions throughout most of 2021.

Transport emissions increased 4.0% over the year to December 2021. Petrol consumption increased 2.4% while consumption of domestic jet fuel was higher by 23.6% on the year to December 2020 as COVID restrictions on movement were lifted.

Emissions from the agriculture sector increased 4.2% to 77.2 Mt CO\(_2\)-e, reflecting a continuation of the recent changes in rainfall, cropping and livestock numbers.

In the year to March 2022, the preliminary estimate for total emissions is 489 Mt CO\(_2\)-e. This would be an increase of 2.0 % or 9.5 Mt CO\(_2\)-e on the year to March 2021. This estimate will be finalised with the publication of the March 2022 Quarterly Update in August 2022.

Long term sectoral trends

The most important sectoral drivers of Australia’s long-term emissions trend have been:

- **Electricity** – where after decades of strong growth, emissions peaked in 2009 and have since fallen 24.2%. This reflects accelerating renewables deployment and gradual displacement of coal as a fuel source. Still, emissions remained 22.8% above 1990 levels in the year to December 2021.

- **Stationary energy (excluding electricity)** – which has shown the largest growth of any sector in percentage terms since 1990. Emissions have increased 53.6% or 35.8 Mt CO\(_2\)-e driven, in particular, by recent growth in the export of LNG;

- **Transport** – where emissions have increased 48.1% or 29.6 Mt CO\(_2\)-e since 1990, despite recent volatility due to the impacts of the COVID pandemic;

- **Fugitives** – where emissions have increased 27.0% or 10.8 Mt CO\(_2\)-e since 1990. Emissions were relatively stable until 2012 but have increased strongly as a result of the growth of the LNG industry;

- **Agriculture** – where emissions have declined by 15.8% or 14.4 Mt CO\(_2\)-e since 1990, in line with declining cattle and sheep populations; and,

- **Land Use, Land Use Change and Forestry (LULUCF)** – where emissions have decreased by the largest margin of any sector since 1990 (120.3% or 234.1 Mt CO\(_2\)-e) due to reductions in land clearing and native forest harvesting, increases in plantations and native vegetation, and improvements in soil carbon.

The changes in emissions from each sector from the year to December 1990 to 2021 in percentage terms are presented in Figure 5.

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2. Sectoral Analysis

2.1. Energy – Electricity

*Electricity* generation is the largest source of emissions in the national inventory, accounting for 32.9% of emissions in the year to December 2021 (Figure 4).

*Electricity* sector emissions are experiencing a long term decline, down 24.2% (51.2 Mt CO\(_2\)-e) from the peak recorded in the year to June 2009 (Data Table 1A).

Electricity sector emissions decreased 1.4% in the December quarter of 2021 on a trend basis (Figure 6). This reflected a 5.2% increase in renewable generation in the NEM. The December quarter 2021 saw metered demand in the NEM lower by 8.8% than in the previous quarter.

Over the course of the year to December 2021, emissions from *electricity* decreased 4.2% compared with the year to December 2020, due to the ongoing substitution of renewable energy for fossil fuel power sources.
National Electricity Market (NEM) emissions

Emissions in the NEM for the March quarter 2021 decreased 1.7% on a trend basis compared with the previous quarter (Figure 7).

For the March 2022 quarter, generation from renewables increased 4.6% in trend terms (Figure 8).
2.2. Energy – Stationary energy excluding electricity

Stationary energy excluding electricity includes emissions from direct combustion of fuels, predominantly from the manufacturing, mining, residential and commercial sub-sectors.

In the year to December 2021, stationary energy excluding electricity accounted for 21.0% of Australia’s national inventory (Figure 4).

Emissions from stationary energy excluding electricity in the December quarter of 2021 increased 0.8% (0.2 Mt CO$_2$-e) in trend terms compared with the previous quarter. Emissions over the year to December 2021 increased 3.3% when compared with the previous year (Figure 9).

An important driver of emissions trends in stationary combustion over the last 5 years has been the production of LNG for export. Figure 10 shows that LNG production has increased by 172% compared to the year to December 2015, before the start of the rapid ramp up.
2.3. Energy – Transport

The transport sector includes emissions from the direct combustion of fuels in transportation by road, rail, domestic aviation and domestic shipping. The main fuels used for transport are automotive gasoline (petrol), diesel oil, liquefied petroleum gas (LPG) and aviation turbine fuel.
In the year to December 2021, transport accounted for 18.6% of Australia’s national inventory (Figure 4).

Emissions in the December 2021 quarter decreased 0.6% in trend terms on the previous quarter, reflecting a 0.8% decrease in petrol consumption (Figure 12).

Emissions from transport over the year to December 2021 increased 4.0% compared with the previous year (Figure 11), reflecting a return towards normal levels of transport activity following the removal of COVID related restrictions on movement. This increase was partly the result of a 2.4% increase in petrol consumption and a 5.4% increase in diesel consumption (Figure 12).

Figure 11: Transport emissions, actual and trend, by quarter, December 2010 to December 2021

Source: Department of Industry, Science, Energy and Resources
2.4. Energy – Fugitive emissions

Fugitive emissions occur during the production, processing, transport, storage, transmission and distribution of fossil fuels. These include coal, crude oil and natural gas. Emissions from decommissioned underground coal mines are also included in this sector.

Fugitive emissions in the December quarter increased 1.7% in trend terms.

LNG production was higher by 1.0% in the December 2021 quarter. Carbon dioxide injection at the Gorgon project remained below maximum capacity but increased to 0.5 Mt CO$_2$ over the quarter (around 2.0 Mt CO$_2$ for the year to December 2021)$^9$. Coal production was lower by 0.4% in the December 2021 quarter.

Annual emissions in this sector increased 1.8% over the year to December 2021 (Figure 13). This was driven by growth in venting and flaring emissions caused by an overall increase in LNG production of 4.1% over the year.

2.5. Industrial processes and product use

Emissions in *industrial processes and product use* include greenhouse gases emitted as by-products of the production of chemicals, metals and minerals, as well as emissions of synthetic greenhouse gases used in products such as refrigerators and air conditioners.

In the year to December 2021, *industrial processes and product use* accounted for 6.7% of Australia’s national inventory (Figure 4). Emissions increased 1.4% (0.4 Mt CO$_2$-e) in actual terms over the year to December 2021 (major subcategories are shown in Figure 14).

Emissions from *industrial processes and product use* increased by 0.3% in the December quarter in trend terms.
2.6. Agriculture

Emissions from agriculture include methane, nitrous oxide and carbon dioxide. Methane and nitrous oxide emissions are estimated for enteric fermentation and manure management in livestock. They are also estimated for rice cultivation, agricultural soils and field burning of agricultural residues. Carbon dioxide emissions are reported from the application of urea and lime.

In the year to December 2021, agriculture accounted for 15.8% of Australia’s national inventory (Figure 4). Emissions from agriculture increased 4.2% (3.1 Mt CO$_2$-e) in actual terms over the year to December 2021 (Figure 15).
Drought conditions have continued to ease in the December quarter 2021. This has led to herd and flock rebuilding, however livestock population numbers are yet to fully recover to previous levels. There has been some rebound in crop production, particularly rice, in the December quarter 2021 due to the increase in water availability. Emissions from production of many crops is likely to stabilise in future quarters, but rice and cotton production are forecast to increase further.

2.7. Waste

The waste sector includes emissions from landfills, wastewater treatment, waste incineration and the biological treatment of solid waste. Emissions largely consist of methane, which is generated when organic matter decays under anaerobic conditions.

In the year to December 2021, waste accounted for 2.7% of Australia’s national inventory (Figure 4). Emissions from waste decreased 0.1% (0.01 Mt CO\textsubscript{2}-e) over the year to December 2021 in trend terms (Figure 16).

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2.8. Land Use, Land Use Change and Forestry

The Land Use, Land Use Change and Forestry (LULUCF) sector of the national inventory includes estimates of net anthropogenic emissions for forests and agricultural lands and changes in land use.

In the year to December 2021, the LULUCF sector accounted for -8.1% of Australia’s national inventory – a net sink (Figure 4).

Net emissions for the LULUCF sector in the year to December 2021 are estimated to be -39.5 Mt CO$_2$-e (Figure 17). The magnitude of this net sink has increased by 0.4% (0.2 Mt CO$_2$-e) on the previous twelve months due to a continuing decline in land clearing emissions (Figure 17).

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12 LULUCF includes Forest converted to other uses, Forest land remaining forest land, Land converted to forest land, Grassland remaining grassland (including Wetlands and Settlements) and Cropland remaining cropland.
3. Emissions per capita and per dollar of GDP

In the year to December 2021, the emissions intensity of the economy is at its lowest level in 32 years. National inventory emissions per dollar of real GDP fell from 0.8 kg CO$_2$-e per dollar in the year to December 1990 to 0.2 kg CO$_2$-e per dollar in the year to December 2021 (Figure 18). This represents a decline of 68.5% from the year to December 1990.

National inventory emissions per capita were 18.9 t CO$_2$-e per person in the year to December 2021. This represents a 48.9% decline from 37.1 t CO$_2$-e per person in the year to December 1990. Emissions per capita increased slightly in the year to December 2021, reflecting lower than usual population growth as a result of COVID restrictions on movement throughout 2021.

Over the period from December 1990 to December 2021, Australia’s population grew strongly from 17.2 million to around 25.8 million, an increase of 50.3%.

Australia’s real GDP (chain volume measures) also experienced significant growth over this period, expanding from $0.8 trillion in the year to December 1990 to around $2.1 trillion in the year to December 2021, an increase of 144.3%.

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13 Emissions per capita and per dollar of real GDP levels are inclusive of all sectors of the economy, including Land Use, Land Use Change and Forestry (LULUCF)


Figure 18: Emissions per capita and per dollar of real GDP, actual year to December 1990 to 2021

Source: Department of Industry, Science, Energy and Resources
4. Consumption-based national greenhouse gas inventory

Table 4: Consumption-based national greenhouse gas inventory\textsuperscript{17}, December quarter and year to December 2021, emissions growth rates

<table>
<thead>
<tr>
<th></th>
<th>December quarter 2021</th>
<th>Year to December 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarterly change – seasonally adjusted\textsuperscript{18}</td>
<td>3.3%</td>
<td></td>
</tr>
<tr>
<td>Quarterly change – seasonally adjusted– trend</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>Annual Change</td>
<td></td>
<td>1.2%</td>
</tr>
</tbody>
</table>

A consumption-based emissions inventory 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.

On an annual basis, the consumption-based inventory increased 1.2% or 4.8 Mt CO\textsubscript{2}-e to 403.9 Mt CO\textsubscript{2}-e in the year to December 2021. Emissions in Australia associated with production of exports increased by 9.3 Mt CO\textsubscript{2}-e (up 4.2%) and emissions associated with consumption of imports increased by 10.1 Mt CO\textsubscript{2}-e (up 7.3%), reflecting the return towards normal levels of trade after COVID-related supply chain constraints.

Emissions generated by Australian consumption were 154.9 Mt CO\textsubscript{2}-e (27.7%) lower compared to the year 2005, and were less than the (production-based) national greenhouse gas inventory by 84.1 Mt CO\textsubscript{2}-e or 17.2% in the year to December 2021 (Figure 19).

On a trend basis, Australia’s consumption-based inventory was higher relative to the previous quarter (0.1 Mt CO\textsubscript{2}-e or 0.1%).

Consumption-based emissions are approximately 15.7 tonnes per person per year, which is 3.3 tonnes per person less than the per capita emission level using the production-based national greenhouse gas inventory.

\textsuperscript{17} National emissions levels are inclusive of all sectors of the economy, including Land Use, Land Use Change and Forestry (LULUCF).

\textsuperscript{18} ‘Actual’, ‘seasonally adjusted and ‘trend’ are defined in Section 5 Technical notes.
Figure 19: National Greenhouse Gas Production and Consumption-based inventories, Australia, by quarter, December 2005 to December 2021

![Graph showing national greenhouse gas inventory and consumption-based inventory](image)

Source: Department of Industry, Science, Energy and Resources

Figure 20: Global emissions generated during production of Australia’s imports and exports, by quarter, December 1990 to December 2021

![Graph showing emissions](image)

Source: Department of Industry, Science, Energy and Resources
Special Topic – Improvements to Land Sector Reporting

Updating inventory estimates is a requirement of the international reporting system to ensure emissions reflect the latest information and science.

For the 2022 national inventory report submission covering the years 1990-2020, the Department has made a number of significant data-driven improvements to the LULUCF estimates—building on years of research and model development.

These improvements have been reflected in the December Quarterly 2021 report and reflect Australia’s commitment to the continuous improvement of the national inventory as new information emerges. When improvements are made to the data and models used to generate Australia’s emissions estimates, these estimates are recalculated all the way back to 1990, consistent with international reporting rules.

The key improvements to land sector emissions and removals estimation methods for the 2022 submission of the National Inventory Report and the December Quarterly 2021 report are described below. Detailed descriptions of the methodology and revisions is reported in Australia’s annual National Inventory Report submission to the UNFCCC published in May 2022.

Savanna fire management model

The Department has made enhancements to the tier 3 spatial model used to estimate emissions from fires in savanna regions in northern Australia, drawing on new research from CSIRO that incorporated fire impacts on mortality and carbon dynamics of living tree biomass and standing dead wood in FullCAM for the first time. FullCAM or the Full Carbon Accounting Model is the calculation tool for modelling Australia’s greenhouse gas emissions from the land sector. This work brought together years of field data collected by the Darwin Centre for Bushfire Research (Charles Darwin University) and the CSIRO that allowed new insights into the role of fire in live tree mortality and generating larger size debris.

Improving representation of the impacts of fire on savanna ecosystems has shown that high-severity, late dry season fires during the 1990s and 2000s lead to a run-down in carbon stocks that is being reversed through the return of indigenous fire management principles, increasing the proportion of areas burnt in the early dry season (Figure ST 1). While annual burning rates are highly variable, in trend terms early dry season burning has increased from 24 per cent of the total area burned in savanna regions in 2005 to 52 per cent in 2020.
Calibration of plantation yields

CSIRO has undertaken major improvements to the carbon-stock calculation model used for plantation species in commercial plantings and farm forestry. The key improvement has been recalibration of the above-ground biomass (AGB) accumulation rates derived from over 16,000 site-based observations of stand-level biomass (Figure ST 2).

As well as improving accuracy, the new data has supported a generalised Australia-wide calibration that expands the spatial domain of application of the FullCAM model beyond existing National Plantation Inventory (NPI) regions and to new species and species groups (Figure ST 3).
ST 2 Relationship between observed and predicted AGB by plantation species on the: (a) fourth-root transformation scale, and (b) natural scale
Continuing progressive implementation of spatial native forest harvesting model

Building on the implementation of a new spatial model for native forest harvesting in NSW and Victoria introduced in the previous National Inventory Report, the inventory moved from a tier 2 estate model driven by reported harvest volumes (Figure ST 4), to a tier 3 spatial model for Tasmanian public multiple-use forests. The spatial model improves accuracy by using locations, dates and types of harvesting as provided by state agencies. The new spatial model also incorporates the latest FullCAM national-scale datasets such as a spatial model of maximum potential biomass, and year-to-year variation in forest productivity and soil carbon dynamics.

The existing non-spatial model for private native forest harvesting was retained. However, new time series data from the Tasmanian government on the proportion of total log production sourced from public and private land was incorporated to improve accuracy.

Harvesting of native forests causes emissions as trees are removed, and leaves and branches left on site decay or are burned to assist regeneration. Logs used for timber or pulp production appear as an emission from the forest, but contribute to the net sink from the harvested wood products reporting category. The area of harvesting in each year is far smaller than the area of regrowing forests that
have previously been harvested. As a result the harvested native forest category contributes a net sink in the national inventory.

**ST 4 Volume of logs produced from native forests by state 2005-2020**

![Graph showing volume of logs produced from native forests by state 2005-2020](image)

*Source: ABARES 2021*

**Tier 3 spatially explicit model for coastal wetlands**

A new spatial model has been developed for coastal wetlands to more accurately model establishment and clearing of mangroves. This model is built on a recent national collation of carbon accumulation field data for Australian coastal wetlands, mangroves and tidal marshes.

The new model has also included an improved spatial identification of mangrove ecosystems resulting in expanding the area reported under both clearing of mangroves (reported under *lands converted to settlements*) and mangrove regeneration (reported under *Land converted to forest land*) (Figure ST 5ST ). Within these mapped coastal wetlands zones the Department’s remote sensing time-series is used to identify conversion between woody and non-woody vegetation cover in FullCAM.

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Innovative use of remote sensing to model methane and carbon dioxide emissions from reservoirs

Emissions from water reservoirs are modelled to reflect the surface area of inundated sediments and biomass, which decay in the absence of oxygen and produce methane. This modelling approach is consistent with the IPCC 2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories. Methane and carbon dioxide emissions from 201 Australian reservoirs, representing 95% of national reservoir area, are now more accurately estimated with a new approach developed by the Department, informed by remote sensing and depth gauge data, to reflect changes in surface area as reservoir levels vary through time.

The annual average surface area is estimated based on a regression model linking reported gauge depth at the dam (BOM data) to an accurate estimate of the reservoir’s surface area (Digital Earth Australia data) at matching dates (Figure ST 6) drawing on multiple satellite passes with monthly observations over 30 years. The result is a lookup table of surface area to gauge depth for individual reservoirs that closely matches the dam’s storage curves.

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ST 6 Satellite imagery of surface area at different reservoir depths, and validation against the dam storage curve
5. Technical notes

5.1. Quarterly Coverage

The Quarterly Update uses emissions estimates based on Australia’s United Nations Framework Convention on Climate Change (UNFCCC) inventory time series to better support implementation of Australia’s 2030 and 2050 targets. This UNFCCC inventory will be used to track progress towards Australia’s commitments under the Paris Agreement and to achieve net zero emissions by 2050. On 24 May 2022, the Australian Prime Minister stated Australia would set a new target to reduce emissions by 43 per cent (on 2005 levels) by 2030.

The inventory used by Australia to acquit its Paris Agreement targets includes anthropogenic sources and sinks across Australia’s economy. This comprehensive approach is consistent with the one adopted by all parties to the UNFCCC and ensures Australia’s accounting is complete and comparable with other reporting party inventories.

5.2. International guidelines

The Quarterly Update has been prepared in accordance with the international guidelines agreed for use for the Paris Agreement including the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines for the Preparation of National Greenhouse Gas Inventories and, where applicable, the 2019 IPCC Refinement to the 2006 IPCC Guidelines.

The Quarterly Update reports on the national inventory with the application of the IPCC’s natural disturbances provision, consistent with the Government’s Nationally Determined Contribution (NDC) submission that indicated it would meet its emission reduction commitments using this provision.

The national inventory prepared without the application of the natural disturbances provision is reported in the Australian Government’s National Inventory Report submitted to the UNFCCC Secretariat each year in April or May. That submission provides full details of estimates of annual emissions from bushfires and sequestration from subsequent biomass recovery.

5.3. Greenhouse gases

Emissions are expressed on a carbon dioxide equivalent (CO$_2$-e) basis using the Global Warming Potential (GWP) weighting factors indicated in Table 5. As greenhouse gases vary in their radiative activity and in their atmospheric residence time, converting emissions into CO$_2$-e allows the integrated effect of emissions of the various gases to be compared.

Commencing with the Quarterly Update of December 2020, the Department has applied the 100-year time GWP values from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) to estimate emissions, consistent with rules adopted under the UN Framework Convention on Climate Change (UNFCCC) Paris Agreement (Decision 18/CMA.1 Annex 2.D Paragraph 37). This approach will also be used to track Australia’s progress towards its Paris Agreement Nationally Determined Contribution, on an emissions budget basis.

Paris Agreement update to Global Warming Potential for emission estimation

According to Paris Agreement Decision 18/CMA.1 Annex 2.D Paragraph 37 - “Each Party shall use the 100-year time-horizon global warming potential (GWP) values from the IPCC Fifth Assessment
Report, or 100-year time-horizon GWP values from a subsequent IPCC assessment report as agreed upon by the CMA, to report aggregate emissions and removals of GHGs, expressed in CO$_2$ eq.”

Prior to the December 2020 Quarterly Update, the GWPs used were the 100-year time-horizon GWPs contained in the 2007 IPCC Fourth Assessment Report of Climate Science (AR4), in accordance with previous UNFCCC decisions.

Table 5 compares the IPCC Fifth and Fourth Assessment Reports’ 100-year GWPs.

### Table 5: Comparison of the IPCC Fifth and Fourth Assessment Reports’ 100-year GWPs

<table>
<thead>
<tr>
<th>Major greenhouse gases</th>
<th>4$^{th}$ Assessment Report GWP (Table 2.14)</th>
<th>5$^{th}$ Assessment Report GWP (Table 8.A.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide (CO$_2$)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Methane (CH$_4$)</td>
<td>25</td>
<td>28</td>
</tr>
<tr>
<td>Nitrous oxide (N$_2$O)</td>
<td>298</td>
<td>265</td>
</tr>
<tr>
<td>Perfluorocarbon - CF4</td>
<td>7,390</td>
<td>6,630</td>
</tr>
<tr>
<td>Perfluorocarbon – C2F6</td>
<td>12,200</td>
<td>11,100</td>
</tr>
<tr>
<td>HFC-23</td>
<td>14,800</td>
<td>12,400</td>
</tr>
<tr>
<td>HFC-32</td>
<td>675</td>
<td>677</td>
</tr>
<tr>
<td>HFC-41</td>
<td>92</td>
<td>116</td>
</tr>
<tr>
<td>HFC-43-10mee</td>
<td>1,640</td>
<td>1,650</td>
</tr>
<tr>
<td>HFC-125</td>
<td>3,500</td>
<td>3,170</td>
</tr>
<tr>
<td>HFC-134</td>
<td>1,100</td>
<td>1,120</td>
</tr>
<tr>
<td>HFC-134a</td>
<td>1,430</td>
<td>1,300</td>
</tr>
<tr>
<td>HFC-143</td>
<td>353</td>
<td>328</td>
</tr>
<tr>
<td>HFC-143a</td>
<td>4,470</td>
<td>4,800</td>
</tr>
<tr>
<td>HFC-152</td>
<td>53</td>
<td>16</td>
</tr>
<tr>
<td>HFC-152a</td>
<td>124</td>
<td>138</td>
</tr>
<tr>
<td>HFC-161</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>HFC-227ea</td>
<td>3,220</td>
<td>3,350</td>
</tr>
<tr>
<td>HFC-236cb</td>
<td>1,340</td>
<td>1,210</td>
</tr>
<tr>
<td>HFC-236ea</td>
<td>1,370</td>
<td>1,330</td>
</tr>
<tr>
<td>HFC-236fa</td>
<td>9,810</td>
<td>8,060</td>
</tr>
<tr>
<td>HFC-245ca</td>
<td>693</td>
<td>716</td>
</tr>
<tr>
<td>HFC-245fa</td>
<td>1,030</td>
<td>858</td>
</tr>
<tr>
<td>HFC-365mfc</td>
<td>794</td>
<td>804</td>
</tr>
<tr>
<td>Sulphur hexafluoride (SF$_6$)</td>
<td>22,800</td>
<td>23,500</td>
</tr>
</tbody>
</table>

Australia’s emissions of the greenhouse gas nitrogen trifluoride (NF$_3$) are considered negligible and are not estimated.
5.4. Quarterly methodology and growth rates

Emission estimates have been compiled by the Department using the estimation methodologies incorporated in the Australian Greenhouse Emissions Information System (AGEIS) and documented in the National Inventory Report.

The estimates are calculated using the latest national inventory data and indicators from external data sources (listed in Section 5.6). These data are used to determine growth rates, which are applied to estimate quarterly emissions growth.

Quarterly growth rates are calculated as the percentage change between the estimates for the previous quarter and the current quarter. Annual growth rates are calculated as the percentage change between the estimates for the twelve months to the end of the equivalent quarter in the previous year, and the twelve months to the end of the current quarter.

5.5. Recalculations

Periodic recalculations of the quarterly emission estimates are undertaken as more complete and accurate information becomes available, and in response to changes in estimation methods and international reporting requirements.

Recalculations are undertaken consistently with international guidelines, are estimated on a time series consistent basis and are subject to annual international expert review.

Recalculations since the September Quarter 2021

The recalculations since the September 2021 edition of the Quarterly Update for the financial years 2005 and 2019 to 2021, by sector in Mt CO$_2$-e, are shown in Table 6 and are a result of the incorporation of updated emission factors and methodologies used to calculate annual inventory estimates.

Recalculations in this Quarterly Update also include updates to indicators used to derive emissions estimates in the quarters beyond the latest official inventory year reported in the Australian Government’s annual National Inventory Report submitted under the UNFCCC.
### Table 6: Recalculations (Mt CO₂-e) since the September 2021 Quarterly Update, by sector, 2005 and 2019 to 2021

<table>
<thead>
<tr>
<th>Sector</th>
<th>Financial Years and Quarters</th>
<th>FY 2005</th>
<th>FY 2019</th>
<th>FY 2020</th>
<th>FY 2021</th>
<th>FY 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sep</td>
<td>Dec</td>
<td>Mar</td>
<td>Jun</td>
<td>Sep</td>
<td>Dec</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Electricity</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Stationary energy (excluding electricity)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.2</td>
<td>-0.1</td>
</tr>
<tr>
<td>Transport</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fugitive emissions</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Industrial processes and product use</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Waste</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>LULUCF</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-3.5</td>
<td>-3.5</td>
</tr>
<tr>
<td>Total</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-3.3</td>
<td>-3.8</td>
</tr>
</tbody>
</table>

### 5.6. Source Data

Preliminary activity data are obtained under the National Greenhouse and Energy Reporting System (NGERS) and from a range of publicly available sources, principally:

5.7. Actual time series

The ABS defines an original time series as showing ‘the actual movements in the data over time’. The actual time series in this report are equivalent to an original time series.

5.8. Seasonal adjustment analysis

The ABS defines seasonal adjustment as follows: ‘A seasonally adjusted time-series is a time-series with seasonal component removed. This component shows a pattern over one year or less and is systemic or calendar related.’

The actual quarterly data have been adjusted using Demetra to remove the effects of seasonal factors. Demetra is a standard seasonal adjustment tool, consistent with methods applied by the ABS.

5.9. Weather normalisation

The seasonally adjusted estimates are further adjusted to correct for the effects of variations around average seasonal temperatures. This process is termed ‘weather normalisation’ and is designed to provide a clearer indication of the underlying trends in the emissions data.

Seasonal temperatures are an important predictor of emissions in Australia due to their influence on demand for electricity for heating and cooling (air conditioning).

The weather normalisation methodology is based on the Bureau of Meteorology concept of ‘heating and cooling degree days,’ and is applied to total emissions (excluding LULUCF) and the electricity sector. The methodology is described in detail in ‘Section 7: Special Topic’ of the December 2011 edition of the Quarterly Update.

5.10. Trend analysis

The trend series provides the best indication of underlying movements in the inventory by smoothing short term fluctuations in the seasonally adjusted and weather normalised series, caused for example, by extreme weather events such as floods or fires. The trend time series is estimated

5.11. Quarterly uncertainty

For all sectors the Department’s assessment is that the 90% confidence interval for the national inventory is ± 5.3% (i.e. there is a 90% probability that future revisions will be limited to ± 5.3% of the current estimate).

5.12. Sectoral emissions sources and sinks

Energy

Electricity

- Emissions from the combustion of fuel used to generate electricity for public use.

Stationary energy excluding electricity

- Energy industries: petroleum refining, gas processing and solid fuel manufacturing (including coal mining and oil/gas extraction and processing).
- Manufacturing industries and construction: direct emissions from the combustion of fuel to provide energy used in manufacturing such as steel, non-ferrous metals, chemicals, food processing, non-energy mining and pulp and paper.
- Other sectors: energy used by the commercial, institutional, residential sectors as well as fuel used by the agricultural, fishery and forestry equipment. This also includes all remaining fuel combustion emissions associated with military fuel use.

Transport

- Road transport: passenger vehicles, light commercial vehicles, trucks, buses and motorcycles.
- Domestic air transport: commercial passenger and light aircraft on domestic routes using either aviation gasoline or jet kerosene. International air transport is reported but not included in Australia’s total emissions (in line with international guidelines).
- Coastal shipping: domestic shipping and small craft. International shipping is reported but not included in Australia’s total emissions (in line with international guidelines).
- Rail transport: railways, but not electric rail, where fuel combustion is covered under the electricity sector.
- Transmission of natural gas.

Fugitive emissions

Emissions, other than those attributable to energy use, from:

- Solid fuels: CO$_2$ and CH$_4$ from coal mining activities, post-mining and decommissioned mines and CO$_2$, CH$_4$ and N$_2$O from flaring associated with coal mining.
- Oil and natural gas: exploration, extraction, production, processing and transportation of natural gas and oil. Includes leakage, evaporation and storage losses, flaring and venting of CO$_2$, CH$_4$ and N$_2$O.
Industrial processes and product use

- **Mineral industry:** CO$_2$ from cement clinker and lime production; the use of limestone and dolomite and other carbonates in industrial smelting and other processes; soda ash production and use; and magnesia production.
- **Metal industry:** CO$_2$ and PFCs from aluminium smelting; CO$_2$, CH$_4$ and N$_2$O from iron and steel production; and CO$_2$ from the production of ferroalloys and other metals.
- **Chemical Industry:** includes N$_2$O from the production of nitric acid; CO$_2$ from ammonia production, acetylene use and the production of synthetic rutile and titanium dioxide; and CH$_4$ from polymers and other chemicals.
- **Other product manufacture and use:** CO$_2$ from the consumption of CO$_2$ in the food and drink industry and the use of sodium bicarbonate, SF$_6$ from electrical equipment.
- **Product uses as substitutes for Ozone Depleting Substances:** HFCs from refrigeration and air conditioning equipment, foam blowing, metered dose inhalers, fire extinguishers, solvent use.
- **Non-energy products from fuel and solvent use:** CO$_2$ produced by oxidation of lubricating oils and greases.

Agriculture

CH$_4$ and N$_2$O emissions from the consumption, decay or combustion of living and dead biomass, including:

- **Enteric fermentation in livestock:** emissions associated with microbial fermentation during digestion of feed by ruminant (mostly cattle and sheep) and some non-ruminant domestic livestock.
- **Manure management:** emissions associated with the decomposition of animal wastes while held in manure management systems.
- **Rice cultivation:** CH$_4$ emissions from anaerobic decay of organic material when rice fields are flooded.
- **Agricultural soils:** emissions associated with the application of fertilisers, crop residues and animal wastes to agricultural lands and the use of biological nitrogen fixing crops and pastures.
- **Field burning of agricultural residues:** emissions from field burning of cereal and other crop stubble, and the emissions from burning sugar cane prior to harvest.
- **Carbon dioxide emissions from the application of urea and lime.**

Waste

Emissions are predominantly CH$_4$. Small amounts of CO$_2$ and N$_2$O are generated through incineration and the decomposition of human wastes respectively. The main sources are:

- **Solid waste:** emissions resulting from anaerobic decomposition of organic matter in landfills.
- **Wastewater:** emissions resulting from anaerobic decomposition of organic matter in sewerage facilities (including on-site systems such as septic tanks) during treatment and disposal of wastewater.
- **Incineration:** emissions resulting from the incineration of solvents and clinical waste.
- **Biological treatment of solid waste:** emissions resulting from the anaerobic decomposition of organic material in composting and anaerobic digester facilities.
Land Use, Land Use Change and Forestry

The LULUCF sector includes:

- **Forest converted to other land uses**: emissions and removals resulting from the direct human-induced removal of forest and replacement with pasture, crops or other uses since 1972. Emissions arise from the burning and decay of cleared vegetation, and changes in soil carbon from current and past events.

- **Land converted to forest**: emissions and removals (i.e. sinks) from forests established on agricultural land. Growth of the forests and regrowth on cleared lands provides a carbon sink, while emissions can arise from soil disturbance on the cleared lands (N₂O). Both new plantings and the regeneration of forest from natural seed sources contribute to this classification as well as sequestration projects under the Emissions Reduction Fund.

- **Forest land remaining forest land**: emissions and removals in forests managed under a system of practices designed to support commercial timber production such as harvest or silvicultural practices or practices that are designed to implement specific sink enhancement activities. Forest harvesting causes emissions due to the decay of harvest slash and any subsequent prescribed burning. The regrowth of forests following harvesting provides a carbon sink and the harvested wood product pool can be a carbon sink or source depending on the rate of input and the rate of decay.

- **Wildfire emissions on forest land**: are reported using IPCC guidance on natural disturbances. Further information on fire emissions occurring over the 2019-20 bushfire season is reported in the Australian Government’s National Inventory Report.

- **Cropland**: Anthropogenic emissions and removals on croplands occur as a result of changes in management practices on cropping lands, from changes in crop type (particularly woody crops) and from changes in land use.

- **Grazing land**: Anthropogenic emissions and removals on grasslands result from changes in management practices on grass lands, particularly from changes in pasture, grazing and fire management; changes in woody biomass elements and from changes in land use.

- **Wetlands**: Net emissions from the coastal lands including dredging of seagrass, aquaculture, and loss of tidal marsh areas. Changes in mangroves are reported under forest classifications.

5.13. Measurements

The units used in this quarterly update inventory are:

- grams (g)
- tonnes (t)
- metres (m)
- litres (L)

Standard metric prefixes used in this inventory are:

- kilo (k) = 10³ (thousand)
- mega (M) = 10⁶ (million)
- giga (G) = 10⁹
- tera (T) = 10¹²
- peta (P) = 10¹⁵
In this report, emissions are expressed in Mt CO\textsubscript{2}-e, which represents millions of tonnes of carbon dioxide equivalent gas.

### 5.14. Science and innovation in the national greenhouse gas inventory

The Australian national greenhouse gas inventory meets international standards and has been reviewed by the UNFCCC on fifteen occasions and by the Australian National Audit Office twice. The most recent ANAO audit, conducted in 2017, found the inventory emissions calculations to be accurate to within 99.9%.

The inventory is prepared by a team of officials in the Department of Industry, Science, Energy and Resources with extensive international experience. Several members of the team have participated in UN reviews of other countries’ data and five contributed to the most recent update of the IPCC Guidelines for the preparation of national greenhouse gas inventories. Inventory methods and data are reviewed before publication by the National Greenhouse Gas Inventory Committee, comprising representatives of the States and Territories under an agreement reached by the Council of Australian Governments in 1991.

The inventory estimates are based on the best available science. The inventory methods are supported by research and analysis through long term partnerships with the CSIRO Data61, CSIRO Land and Water, CSIRO Oceans and Atmosphere and the ANU and shorter term contributions from many academic institutions around Australia including UNSW, University of Sydney, Monash University, University of Queensland.

Timely emissions data has been released through the Quarterly Update of the National Inventory since 2010. Very few other governments provide such timely information (known updates are published by countries including the Netherlands, Sweden and New Zealand) with these updates usually being partial in coverage and focussed on the electricity or energy system only. In November 2021, Eurostat published a quarterly emissions account for the European Union for the first time. It is understood that these updates will be published regularly.

The Australian inventory systems have been built upon important innovations and early adoptions of emerging international techniques to measure, estimate and verify greenhouse gas emissions.

1. With the **National Greenhouse and Energy Reporting Act 2007**, the Australian parliament was among the first to legislate an integrated greenhouse gas emissions company reporting system, after the European Union in 2004, and the NGER system remains one of the most comprehensive integrated company reporting systems for greenhouse gas emissions anywhere.

2. Australian governments have invested in **customised emissions data modelling software** (AGEIS), which supports efficient production of high-quality data. Promotion of enhanced data monitoring and transparency internationally has been a long-standing objective of Australian Governments and the Australian approach to emissions data modelling and management has been used to assist the Thai Government to develop its own software (TGEIS) while information on software development has been shared with both the US Environment Protection Agency and the China Ministry of Ecology under a bilateral program managed by DFAT.

3. The Australian Government was the first to introduce the use of **remote sensing techniques** to detect forest loss and land clearing in national greenhouse gas inventories. Estimates of forest loss and land clearing for Australia, for each State and Territory and for some regions are updated and
published every single year through this system. Australian Governments have championed the use of remote sensing techniques around the world and, in particular, have strongly supported the introduction of similar systems in Indonesia through bilateral partnerships managed by DFAT.

4. Net emissions from the land use, land use change and forestry sector are modelled through an **integrated carbon stock model** (FullCAM) which was originally supported through the commissioning of around 40 scientific reports and remains a leading example of integrated vegetation and soil carbon stock models around the world.

5. The use of ‘**top-down’ inverse modelling** techniques to test and raise the quality and robustness of emissions data, with a focus on methane and HFCs, has been introduced in the Australian inventory and this remains a rare example (Switzerland and the United Kingdom are examples of others) of the use of these techniques in national greenhouse gas inventory systems.

6. The national inventory is produced as part of a set of **National Greenhouse Accounts**, which includes emissions data published at national, state and territory, and industry levels as well as on a consumption-basis (see section 4.)

**5.15. Future publications**

The March 2022 Quarterly Update of Australia’s National Greenhouse Gas Inventory will be published by 31 August 2022.
Tracking Australia’s emissions

The data presented in Table 7 and Figure 21 include Australia’s annual emissions for 2000 to 2021.

Australia’s annual emissions for the year to December 2021 are estimated to be 488.0 Mt CO$_2$-e. This figure is 14.3% below emissions in the year to December 2000 (569.3 Mt CO$_2$-e) and 21.4% below emissions in the year to December 2005 (621.1 Mt CO$_2$-e).

Table 7: National inventory total from 2000 to 2021 by financial year, and year to December 2021

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Emissions (Mt CO$_2$-e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>569.3</td>
</tr>
<tr>
<td>2001</td>
<td>586.9</td>
</tr>
<tr>
<td>2002</td>
<td>586.4</td>
</tr>
<tr>
<td>2003</td>
<td>598.5</td>
</tr>
<tr>
<td>2004</td>
<td>592.0</td>
</tr>
<tr>
<td>2005</td>
<td>621.1</td>
</tr>
<tr>
<td>2006</td>
<td>634.7</td>
</tr>
<tr>
<td>2007</td>
<td>646.3</td>
</tr>
<tr>
<td>2008</td>
<td>634.9</td>
</tr>
<tr>
<td>2009</td>
<td>636.7</td>
</tr>
<tr>
<td>2010</td>
<td>615.0</td>
</tr>
<tr>
<td>2011</td>
<td>593.8</td>
</tr>
<tr>
<td>2012</td>
<td>578.0</td>
</tr>
<tr>
<td>2013</td>
<td>561.7</td>
</tr>
<tr>
<td>2014</td>
<td>560.5</td>
</tr>
<tr>
<td>2015</td>
<td>549.5</td>
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<tr>
<td>2016</td>
<td>525.2</td>
</tr>
<tr>
<td>2017</td>
<td>524.2</td>
</tr>
<tr>
<td>2018</td>
<td>529.8</td>
</tr>
<tr>
<td>2019</td>
<td>516.4</td>
</tr>
<tr>
<td>2020</td>
<td>497.3</td>
</tr>
<tr>
<td>2021</td>
<td>484.6</td>
</tr>
<tr>
<td>Year to December 2021</td>
<td>488.0</td>
</tr>
</tbody>
</table>
Figure 21: National inventory total from 2000 to 2021 by financial year

Source: Department of Industry, Science, Energy and Resources
6. Related publications and resources

Australia’s national Greenhouse Accounts


National Greenhouse Gas Inventory: Quarterly Updates

Quarterly Updates of Australia’s National Greenhouse Gas Inventory are the most up to date source of information on Australia’s national emissions. They provide a summary of Australia’s national emissions, updated on a quarterly basis. They give timely information to policy makers, markets and the public to demonstrate how Australia is tracking against its targets.


National Inventory Report 2020

The three volumes comprising Australia’s National Inventory Report 2020 were submitted under the UNFCCC and the Kyoto Protocol in May 2022. This report contains national greenhouse gas emission estimates for the period 1990-2020 and preliminary estimates for 2021 compiled under the rules for reporting applicable to the UNFCCC.

- Volume 1: Includes Australia’s data for energy (stationary energy, transport and fugitive emissions), industrial processes and product use, and agriculture.
- Volume 2: Australia’s data for the Land Use, Land Use Change and Forestry (LULUCF) and waste sectors, recalculations and improvements.
- Volume 3: Australia’s data for Kyoto Protocol LULUCF, Kyoto Protocol accounting requirements, annexes, glossary and references.


State and Territory Greenhouse Gas Inventories 2020 (due for publication June 2022)

This document provides an overview of the latest available estimates of annual greenhouse gas emissions for Australia’s States and Territories. It complements Australia’s National Inventory Report 2020 and the National Inventory by Economic Sector 2020 (due for publication in June 2022).

National Inventory by Economic Sector 2020 (due for publication June 2022)


Australian Greenhouse Emissions Information System (AGEIS)

The AGEIS centralises the Department’s emissions estimation, emissions data management and reporting systems. AGEIS is being used to compile national and State and Territory inventories. The interactive web interface provides enhanced accessibility and transparency to Australia’s greenhouse emissions data: https://ageis.climatechange.gov.au/

Australia’s Emissions Projections 2021

The report provides detail on emissions trends, including sector specific analysis of factors driving emissions. The report estimates the emissions reduction effort required to meet Australia’s emissions reduction targets. The projections include sensitivity analyses to illustrate how emissions may differ under changes in economic growth. https://www.industry.gov.au/data-and-publications/australias-emissions-projections-2021

Full Carbon Accounting Model

The Full Carbon Accounting Model (FullCAM) is the calculation engine which supports the estimation of carbon stock change on forest and agricultural systems. FullCAM can be downloaded from the Department’s webpage: https://www.industry.gov.au/data-and-publications/full-carbon-accounting-model-fullcam

Australia’s Seventh National Communication/Fourth Biennial Report

Australia’s Seventh National Communication (2017) summarises information on Australia’s implementation of its UNFCCC and Kyoto Protocol obligations including: emissions and removals of greenhouse gases; national circumstances; policies and measures; vulnerability assessment; financial, technology and capacity building cooperation; education, training, and public awareness. Countries such as Australia are required to submit these reports to the UNFCCC every four years.
In accordance with international reporting requirements, the 2017 National Communication also incorporates Australia’s Third Biennial Report. Australia last submitted its Fourth Biennial Report (2019). These must be submitted every two years and outline Australia’s progress in achieving emission reductions and the provision of financial, technology, and capacity-building support. More information is available at:
http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/10138.php

What the rest of the world is doing

Other developed countries are also required to produce annual greenhouse gas inventories. More information regarding the reporting requirements and various international reports (including reports by Australia) are located online. https://unfccc.int/ghg-inventories-annex-i-parties/2021