



Australian Government
Department of the Environment and Energy

Committee: SENATE ENVIRONMENT
AND COMMUNICATIONS

Tabled Document

Inquiry: SUPPLEMENTARY ESTIMATES

Date: 23 OCTOBER 2017

Witness: MR. ROB STURGISS

Organisation: DEPT. ENVIRONMENT AND
ENERGY

Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2017

Incorporating NEM electricity emissions up to June 2017

Australia's National Greenhouse Accounts



August 2017

© Commonwealth of Australia, 2017.



Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2017 is licensed by the Commonwealth of Australia for use under a Creative Commons By Attribution 3.0 Australia licence with the exception of the Coat of Arms of the Commonwealth of Australia, the logo of the agency responsible for publishing the report, content supplied by third parties, and any images depicting people. For licence conditions see: <http://creativecommons.org/licenses/by/3.0/au/>

This report should be attributed as 'Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2017, Commonwealth of Australia 2017.

The Commonwealth of Australia has made all reasonable efforts to identify content supplied by third parties using the following format '© Copyright, [name of third party]'.

Disclaimer

The views and opinions expressed in this publication are those of the authors and do not necessarily reflect those of the Australian Government or the Minister for the Environment and Energy.

Preface

This report provides estimates of Australia's national inventory of greenhouse gas emissions up to the March quarter of 2017, and electricity emissions from the National Electricity Market (NEM)^a up to the June quarter 2017.

Australia's National Greenhouse Accounts are made up of a series of comprehensive reports and databases that estimate Australia's greenhouse gas emissions and are designed to fulfil Australia's international and domestic reporting requirements. The *Quarterly Update* is a publication series that reports on the latest estimates of Australia's national greenhouse gas inventory.

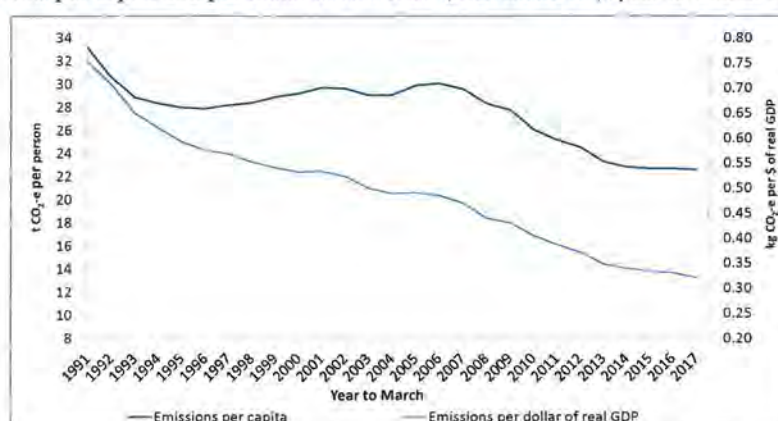
For the June quarter 2017, emissions from the NEM^a decreased by 2.8 per cent on a seasonally adjusted and weather normalised basis, and decreased 2.3 per cent in the year to June 2017 when compared to the previous year.

Australia's annual emissions for the year to March 2017 are estimated to be 550.1 Mt CO₂-e. This figure is 0.8 per cent below emissions in 2000 (554.4 Mt CO₂-e) and 9.1 per cent below emissions in 2005 (605.0 Mt CO₂-e).

For the March quarter 2017, national emissions levels, excluding the Land Use, Land Use Change and Forestry (LULUCF) sector, have increased 1.6 per cent relative to the previous quarter on a seasonally adjusted and weather normalised basis^b. For the year to March 2017, emissions increased 1.0 per cent on the previous year. The expansion in LNG exports, which saw a production increase of 39.7 per cent over the previous year, was the major contributor to this increase in emissions.

Emissions (including LULUCF) per capita, and the emissions intensity of the economy, were at their lowest levels in 27 years in 2017. Emissions per capita in the year to March 2017 have fallen 34.2 per cent since 1990, while the emissions intensity of the economy has fallen 58.4 per cent since 1990 (Figure P1).

Figure P1: Emissions per capita and per dollar of real GDP (incl. LULUCF), year to March 1991 to 2017



Source: Department of the Environment and Energy.

- a The NEM includes grid electricity in the Eastern and South Eastern states and accounts for approximately 86 per cent of total electricity estimates in the year to March 2017.
- b 'Unadjusted', 'seasonally adjusted, weather normalised' and 'trend' are defined in Section 5: *Technical notes*.

Contents

1. Overview	5
2. Sectoral analysis	10
2.1 Energy – Electricity	10
2.2 Energy – Stationary energy excluding electricity	12
2.3 Energy – Transport	13
2.4 Energy – Fugitive emissions	14
2.5 Industrial processes and product use	14
2.6 Agriculture	15
2.7 Waste	16
2.8 Land Use, Land Use Change and Forestry	16
3. Emissions per capita and per dollar of GDP	18
4. Special topic: Regional biocarbon stock accounts in the Great Barrier Reef catchment area	19
5. Technical notes	24
6. Data tables	31
7. Related publications and resources	41

1. Overview

Table 1: National Greenhouse Gas Inventory¹, March quarter 2017, emissions growth rates

	March quarter	Year to March 2017
Quarterly change – seasonally adjusted and weather normalised ²	1.6%	
Quarterly change – seasonally adjusted and weather normalised – trend ²	0.5%	
Annual change		1.0%

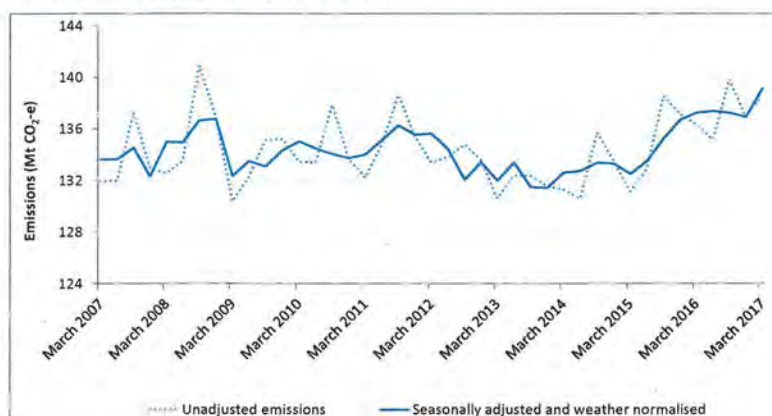
Table 2: National Energy Market (NEM) *electricity*³, June quarter 2017, emissions growth rates

	June quarter	Year to June 2017
Quarterly change – seasonally adjusted and weather normalised ²	-2.8%	
Quarterly change – seasonally adjusted and weather normalised – trend ²	-0.4%	
Annual change		-2.3%

Summary of quarterly emissions

Seasonally adjusted emissions increased 1.6% in the March quarter 2017 (Figures 1-3). Trend emissions increased 0.5% when compared to the December quarter 2016. Increases in trend emissions from the *stationary energy (excluding electricity), transport, fugitive emissions, industrial processes and product use, and agriculture* sectors were partially offset by decreases in trend emissions from the *electricity and waste* sectors.

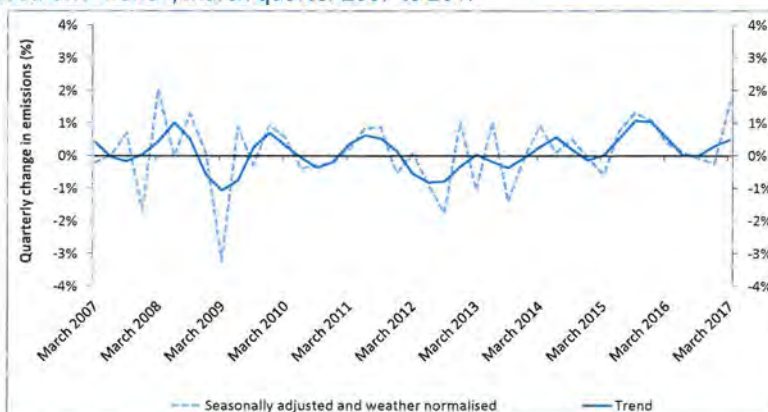
Figure 1: National Greenhouse Gas Inventory¹, 'seasonally adjusted and weather normalised' and 'unadjusted' emissions², March quarter 2007 to 2017



Source: Department of the Environment and Energy

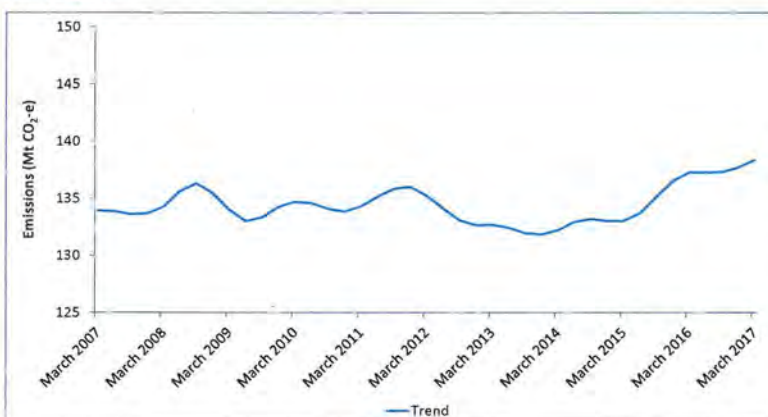
- 1 For quarterly estimates, LULUCF is excluded from the national total due to relatively high levels of uncertainty - see Section 5.11.
- 2 'Unadjusted', 'seasonally adjusted, weather normalised' and 'trend' are defined in Section 5: *Technical notes*.
- 3 The NEM includes grid electricity in the Eastern and South Eastern states and accounts for approximately 86% of total *electricity* estimates in the year to March 2017.

Figure 2: National Greenhouse Gas Inventory¹, quarterly emissions growth rates, 'seasonally adjusted and weather normalised' and 'trend'², March quarter 2007 to 2017



Source: Department of the Environment and Energy

Figure 3: National Greenhouse Gas Inventory (excluding LULUCF), quarterly, 'trend' emissions, March quarter 2007 to 2017



Source: Department of the Environment and Energy

Summary of annual emissions

Annual emissions for the year to March 2017 (excluding LULUCF) are estimated to be 550.4 Mt CO₂-e. This represents a 1.0% increase in emissions when compared with the previous year.

Over the year to March 2017, there were increases in emissions from the *stationary energy (excluding electricity), transport, fugitive emissions, industrial processes and product use, and agriculture* sectors. These increases were partially offset by a decline in emissions from the *electricity and waste* sectors. The annual increases in *stationary energy (excluding electricity)* and *fugitive emissions* were largely driven by an increase in LNG exports.

Sectoral summary

The National Greenhouse Gas Inventory data, disaggregated by sector for the years to March 2016 and 2017, are presented in Table 3.

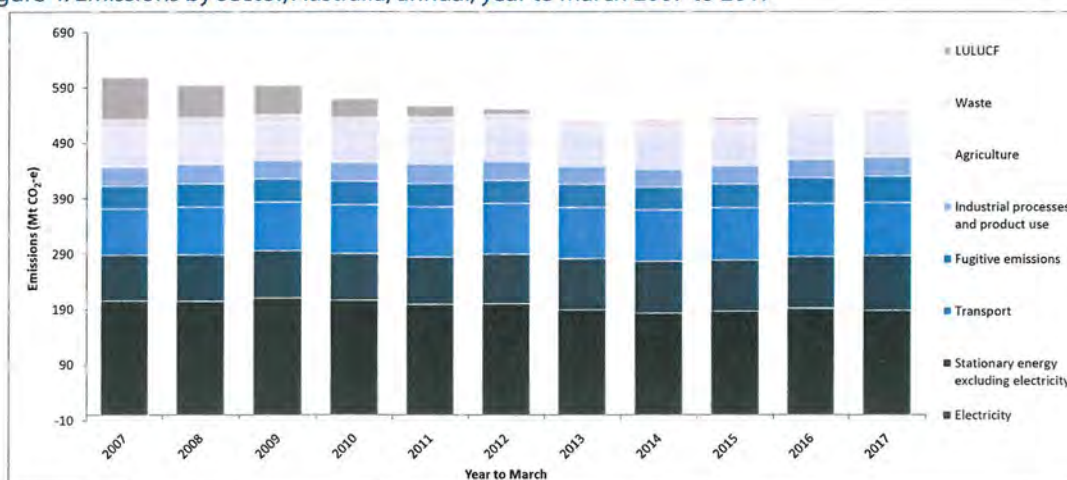
Table 3: National Greenhouse Gas Inventory, 'unadjusted' emissions by sector, Years to March 2016 and 2017

Sector	Annual emissions (Mt CO ₂ -e)		Change (%)
	Year to March 2016	Year to March 2017	
Energy – Electricity	191.7	188.0	-1.9%
Energy – Stationary energy excluding electricity	93.1	98.5	5.8%
Energy – Transport	95.6	96.0	0.4%
Energy – Fugitive emissions	47.0	47.6	1.3%
Industrial processes and product use	32.9	33.9	2.8%
Agriculture	73.2	75.0	2.5%
Waste	11.4	11.4	-0.3%
National Inventory Total (excluding Land Use, Land Use Change and Forestry)	544.9	550.4	1.0%
Land Use, Land Use Change and Forestry ^a	-1.1	-0.2	-77.6%
National Inventory Total (including Land Use, Land Use Change and Forestry)	543.8	550.1	1.2%

^a includes deforestation, afforestation/reforestation, forest management, crop and grazing land management

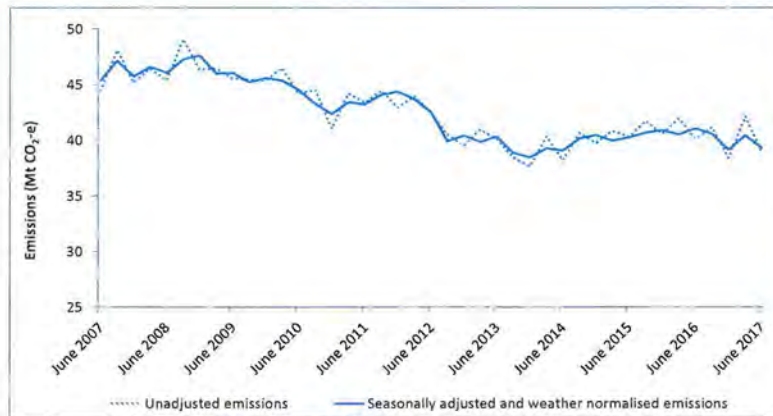
The annual emissions by sector are presented in Figure 4. This figure illustrates the relative contribution to emissions of each of the sectors in Table 3. The quarterly and annual changes in emissions for each of these sectors are presented in Section 2: *Sectoral Analysis*.

Figure 4: Emissions by sector, Australia, annual, year to March 2007 to 2017



Source: Department of the Environment and Energy

Figure 5: NEM electricity emissions, quarterly, 'unadjusted' and 'seasonally adjusted and weather normalised' emissions, June quarter 2007 to 2017



Source: Department of the Environment and Energy

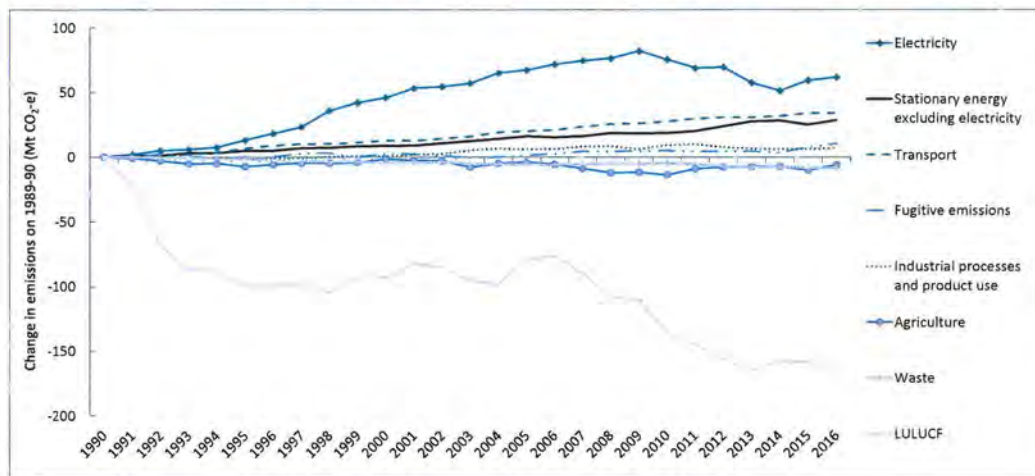
Sectoral trends since 1990

Since 1990, the National Greenhouse Gas Inventory (excluding *Land Use, Land Use Change and Forestry - LULUCF*) has increased by 31.1%, reaching 550.4 Mt CO₂-e in the year to March 2017.

The *electricity* sector has experienced the largest growth, increasing by 58.5 Mt CO₂-e between 1990 and the year to March 2017. In percentage terms, *electricity* increased 45.1% and *stationary energy excluding electricity* grew 49.7%. Emissions from *transport* grew 56.3%, *fugitive emissions* increased by 28.1%, and *industrial processes and product use* increased 29.9%. In contrast, emissions from the *waste* and *agriculture* sectors have decreased by 42.2% and 6.5% respectively since 1990.

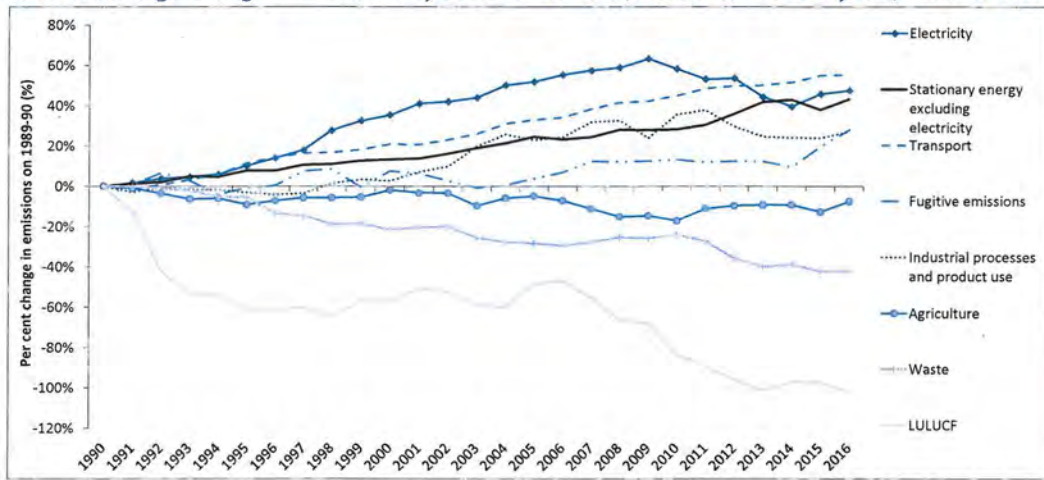
Figures 6 and 7 present the change in emissions from each sector from 1990 to 2016 in Mt CO₂-e and percentage terms.

Figure 6: Change in emissions by sector since 1990, Australia, financial years, 1990 to 2016



Source: Department of the Environment and Energy

Figure 7: Percentage change in emissions by sector since 1990, Australia, financial years, 1990 to 2016



Source: Department of the Environment and Energy

2. Sectoral analysis

2.1 Energy – Electricity

Electricity generation is the largest source of emissions in the national inventory, accounting for 34% of emissions in the year to March 2017.

Electricity sector emissions have declined 23.7 Mt CO₂-e (11.2%) in the year to March 2017 from peaks recorded in the year to June 2009.

This time series of emissions data is adjusted to isolate the effects of underlying economic factors on emissions from seasonal and climatic impacts.

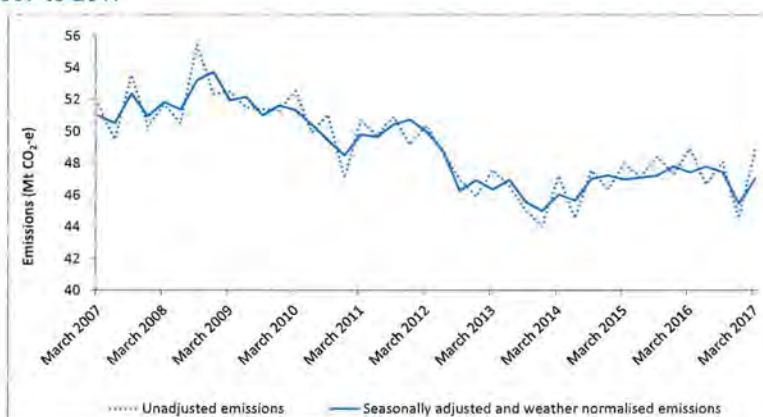
Unadjusted emissions and seasonally adjusted and weather normalised estimates⁴ of quarterly emissions from *electricity* are presented in Figure 8.

Unadjusted emissions from *electricity* generation increased by 9.6% in the March quarter 2017 compared to the December quarter 2016. An increase in original emissions is typical for the March quarter as generally hotter temperatures increase demand for electricity.

On a seasonally adjusted and weather normalised basis, emissions increased by 3.5% with trend emissions decreasing 0.6% in the March 2017 quarter compared to the December quarter 2016.

More information on 'seasonal adjustment', 'trend', 'unadjusted' and 'weather normalisation' analysis is in Section 5: *Technical notes*.

Figure 8: Electricity, quarterly, 'unadjusted' and 'seasonally adjusted and weather normalised' emissions, March quarter 2007 to 2017



Source: Department of the Environment and Energy

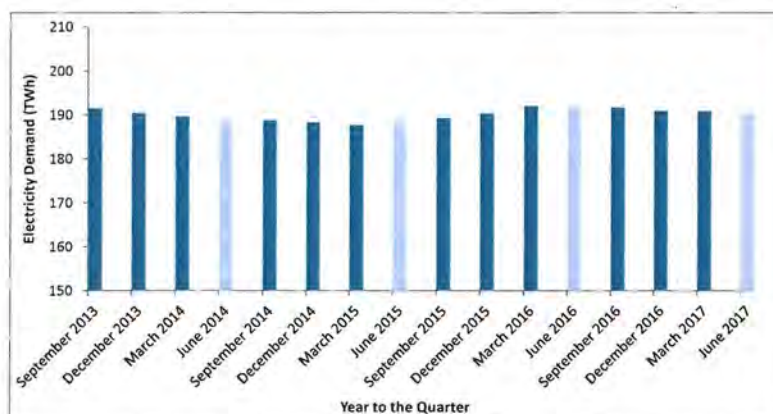
Over the year to March 2017, annual emissions from *electricity* decreased by 1.9%. This decrease was partially driven by weakening demand in the National Electricity Market (NEM) (Figure 9).

4 Two adjustments are made:

(1) Seasonal adjustment – is a first-order adjustment using ABS software that systematically corrects emissions data for average fluctuations in seasonal conditions and which, for example, controls for the effects of two seasonal peaks in electricity demand - one in winter (associated with demand for heating) and one in summer (associated with demand for cooling); and
(2) Weather normalisation - is a second-order adjustment that systematically corrects emissions data for atypical temperature effects on electricity demand within the year, and which, for example, controls for the effects of unusually cold winters or unusually hot summers.

The weather normalisation methodology is described in detail in 'Section 6: Special Topic' of the December 2011 edition of the *Quarterly Update*.

Figure 9: Annual metered electricity demand in the National Electricity Market, year to the quarter,⁵ 2013-2017

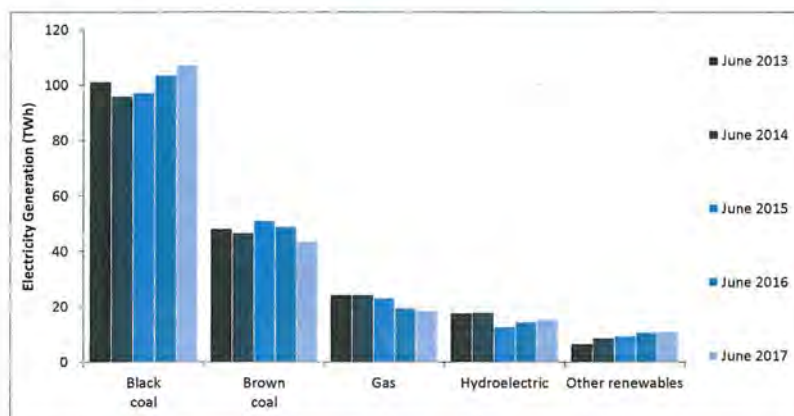


Source: Australian Energy Market Operator (AEMO, 2017), obtained using NEM-Review software

NEM electricity emissions decreased 2.3% in the year to June 2017 compared with the year to June 2016. This is the result of reduced demand, and a reduction in electricity generated from brown coal and an increase in electricity generated from renewable sources.

Changes in the fuel mix used to generate electricity in the NEM (Figure 10) in the year to June 2017 included generation from black coal increasing 3.7 terrawatt hours (TWh, 3.6%), hydroelectric generation increasing 1.0 TWh (7.2%), and generation from wind and other renewables (excluding small-scale solar) growing 0.4 TWh (3.9%) when compared with the previous twelve months. Conversely, generation from brown coal decreased 5.3 TWh (10.8%) and gas generation decreased 1.0 TWh (5.0%).

Figure 10: Annual electricity generation by fuel in the National Electricity Market, year to June 2013 to 2017



Source: Australian Energy Market Operator (AEMO, 2017), obtained using NEM-Review software

5 The data presented in Figure 9 represents demand for the year to the quarter in the x-axis. For example, December 2015 correlates to demand from 1 January 2015 to 31 December 2015 and September 2015 correlates to demand from 1 October 2014 to 30 September 2015

2.2 Energy – Stationary energy excluding electricity

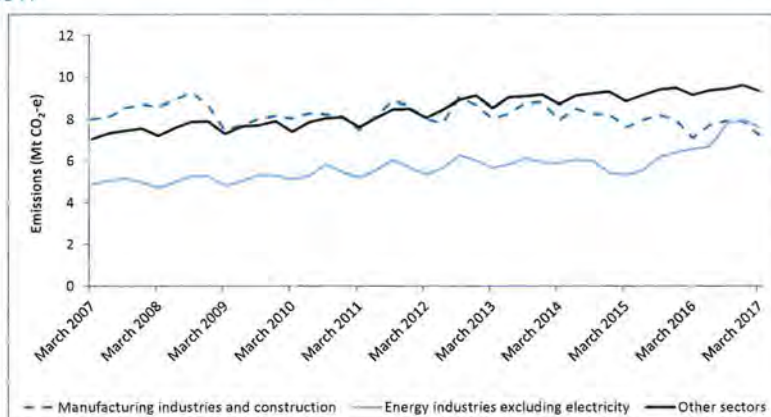
Stationary energy excluding electricity includes emissions from direct combustion of fuels, predominantly in the manufacturing, mining, residential and commercial sectors. In the year to March 2017, *stationary energy excluding electricity* accounted for 18% of Australia's national inventory.

The emissions per quarter for *stationary energy excluding electricity* (Figure 11) incorporate the following categories:

- **Energy industries** – includes fuel combustion in the petroleum refining, oil and gas extraction and processing, coal mining and solid fuel manufacturing sectors. Emissions from electricity generation are analysed separately (Section 2.1);
- **Manufacturing industries and construction** – includes fuel combusted in the manufacturing, non-energy mining and construction sectors; and
- **Other sectors** – includes fuel combustion by the commercial, institutional, residential, agriculture, fishery and forestry and military sectors.

Quarterly emissions from *stationary energy excluding electricity* in March 2017 increased 1.5% in trend terms compared with the December quarter 2016, with annual emissions over the year to March 2017 increasing 5.8% when compared with the previous year.

Figure 11: Stationary energy excluding electricity by sub-sector, quarterly, 'unadjusted' emissions, March 2007 to 2017

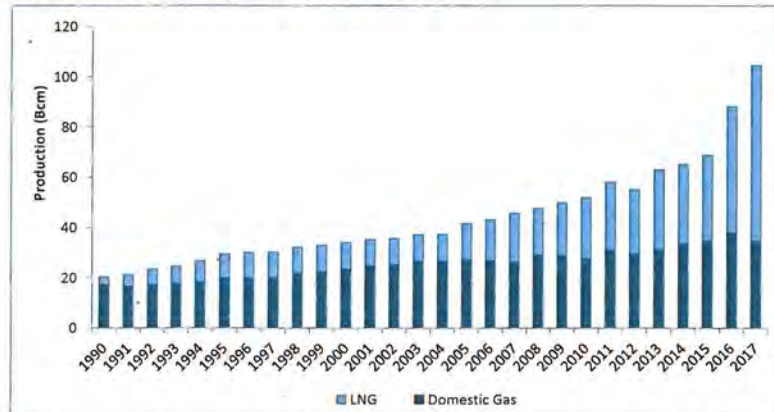


Source: Department of the Environment and Energy

Energy industries excluding electricity increased 5.3 Mt CO₂-e in the year to March 2017 compared with the previous year, and this was primarily driven by a 39.7% increase in LNG production⁶ (Figure 12).

6 Department of Industry, Innovation and Science (2016). *Resources and Energy Quarterly, March 2017*.

Figure 12: Natural gas production, financial years, 1990 to 2017



Sources: Department of Industry and Science (2017), *Resources and Energy Quarterly*

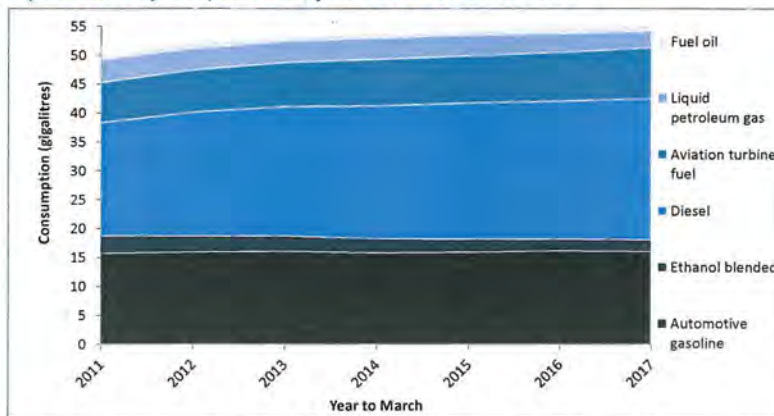
2.3 Energy – Transport

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 March 2017, *transport* accounted for 17% of Australia’s national inventory.

Emissions from the *transport* sector increased 2.5% in trend terms in the March 2017 quarter. Annual emissions from *transport* over the year to March 2017 increased by 0.4% when compared with the previous year.

Annual consumption of the major liquid fuels is presented in Figure 13 and is a broad indicator of emissions from the domestic transport sector, which accounts for over 70%⁷ of liquid fuels consumed in Australia. The past six years have seen a decrease in the consumption of automotive gasoline (including ethanol-blended) of 3.6%, and strong increases in diesel and aviation turbine fuel consumption of 24.6% and 26.5% respectively.

Figure 13: Consumption of major liquid fuels, year to March 2011 to 2017



Source: Department of the Environment and Energy (2017), *Australian Petroleum Statistics*

⁷ Department of Industry and Science (2015). *Australian Energy Statistics*: Table F. <http://www.industry.gov.au/industry/Office-of-the-Chief-Economist/Publications/Pages/Australian-energy-statistics.aspx>

2.4 Energy – Fugitive emissions

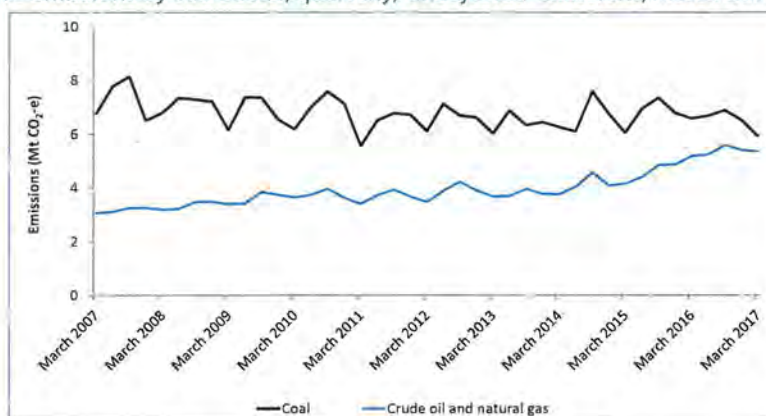
Fugitive emissions occur during the production, processing, transport, storage, transmission and distribution of fossil fuels such as coal, crude oil and natural gas. Emissions from decommissioned underground coal mines are also included in this sector. In the year to March 2017, *fugitive emissions* accounted for 9% of Australia's national inventory.

Fugitive emissions increased 0.5% in trend terms in the March quarter 2017 and annual emissions in this sector increased by 1.3% over the year to March 2017. This increase was driven by an increase of 18.7% in natural gas production⁸, which was partially offset by a 7.7% annual decrease in coal production⁸.

As depicted in Figure 12, LNG expansion for export is the primary driver in gas growth, having increased 39.7% in 2017⁸. Domestic gas sales partially offset LNG growth, decreasing 9.0% in the same period⁸.

The time series of unadjusted quarterly emissions from fugitive emissions from March 2007 to 2017 are presented in Figure 14.

Figure 14: Fugitive emissions by sub-sector, quarterly, 'unadjusted' emissions, March 2007 to 2017



Source: Department of the Environment and Energy

2.5 Industrial processes and product use

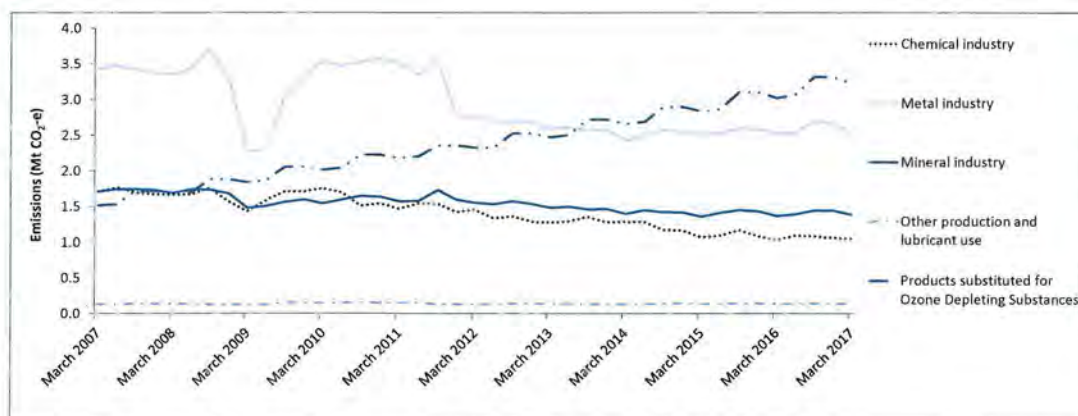
Emissions from *industrial processes and product use* occur as the result of by-products of materials and reactions used in production processes. In the national inventory, this sector includes emissions from processes used to produce chemical, metal, and mineral products, as well as emissions from the consumption of synthetic gases. In the year to March 2017, *industrial processes and product use* accounted for 6% of Australia's national inventory.

Trend emissions for *industrial processes and product use* increased by 1.2% in the March quarter 2017, with annual emissions increasing 2.8% over the year to March 2017. The annual increase was driven by increasing iron and steel production of 5.9%⁸, and a 7.0% increase in emissions from products used as substitutes for ozone depleting substances.

Figure 15 presents the unadjusted emissions per quarter for the sub-sectors of *industrial processes and product use* from March 2007 to 2017.

⁸ Department of Industry, Innovation and Science (2017). *Resources and Energy Quarterly, March 2017*.

Figure 15: Industrial processes and product use by sub-sector, quarterly, 'unadjusted' emissions, March 2007 to 2017



Source: Department of the Environment and Energy

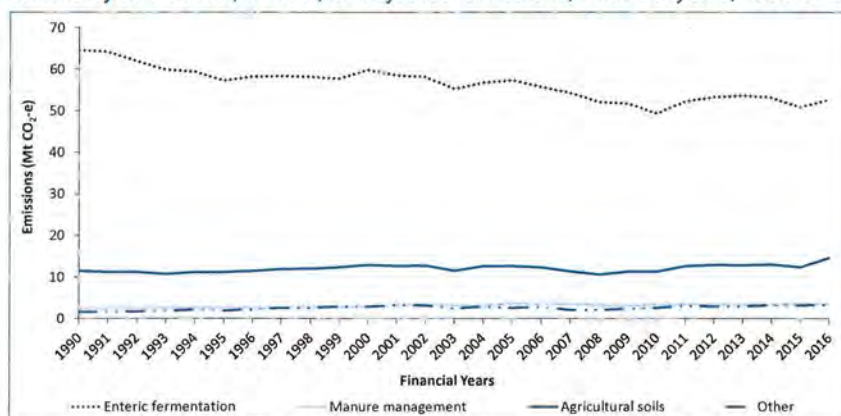
2.6 Agriculture

Emissions from *agriculture* include methane and nitrous oxide from enteric fermentation in livestock, manure management, rice cultivation, agricultural soils, and field burning of agricultural residues (Figure 16). In the year to March 2017, *agriculture* accounted for 14% of Australia's national inventory.

The *agriculture* sector is the dominant source for both methane and nitrous oxide emissions. This sector also includes carbon dioxide emissions from the application of urea and lime.

Agriculture emissions have increased by 2.5% over the year to March 2017 compared with the previous twelve months, following increases in emissions from enteric fermentation and agricultural soils - both driven by an increasing beef cattle population⁹.

Figure 16: Agriculture by sub-sector, annual, 'unadjusted' emissions, financial years, 1990 to 2016



Source: Department of the Environment and Energy estimates

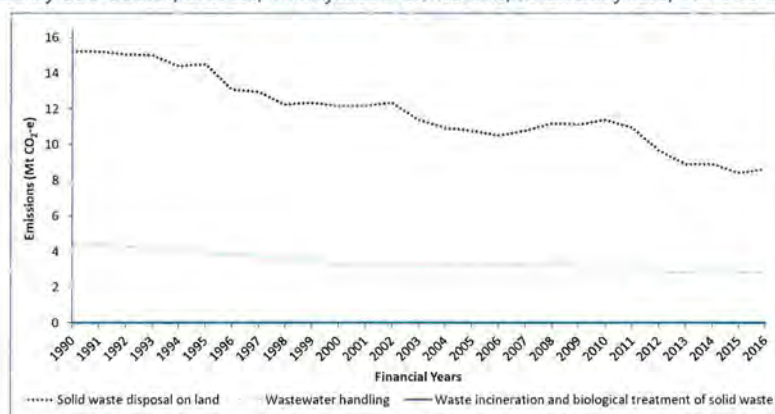
9 Australian Bureau of Agricultural and Resource Economics and Sciences (2017). *Agricultural Commodities, March Quarter 2017*.

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 (Figure 17). In the year to March 2017, *waste* accounted for 2% of Australia's national inventory.

Annual emissions from *waste* were estimated to have remained largely unchanged over the year to March 2017.

Figure 17: Waste by sub-sector, annual, 'unadjusted' emissions, financial years, 1990 to 2016



Source: Department of the Environment and Energy estimates

2.8 Land Use, Land Use Change and Forestry

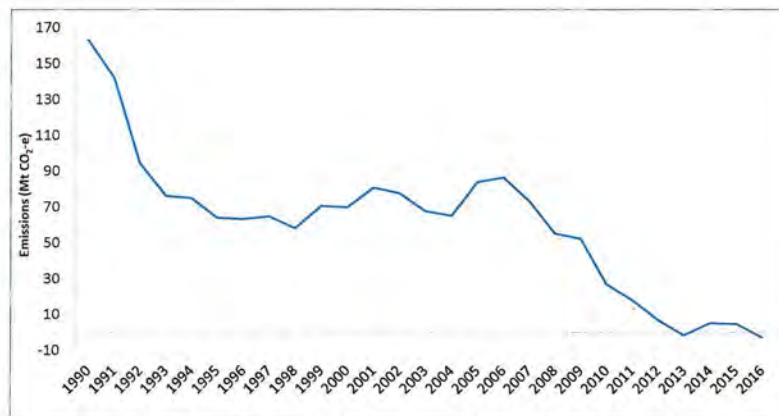
The *Land Use, Land Use Change and Forestry* (LULUCF) sector of the national inventory includes estimates of net anthropogenic emissions for forests and agricultural lands and changes in land use. In the year to March 2017, the LULUCF sector accounted for a net sink of -0.1% of Australia's national inventory.

The principal sub-classifications of the LULUCF sector under the Kyoto Protocol classification system include *Deforestation, Forest Management, Afforestation/Reforestation, Grazing land management, Crop land management* and *Revegetation* (Figure 18).

Net emissions for the LULUCF sector in the year to March 2017 are estimated to be a sink of 0.2 Mt CO₂-e using the Kyoto Protocol classification system (Section 1, Table 3), increasing 0.9 Mt CO₂-e (77.6%) on the previous twelve months.

As processed satellite images are not yet available to support the calculation of emissions estimates for 2016, these preliminary estimates are subject to change and have a greater level of uncertainty than the other sectors in the national inventory (see Section 5: *Quarterly Uncertainty*).

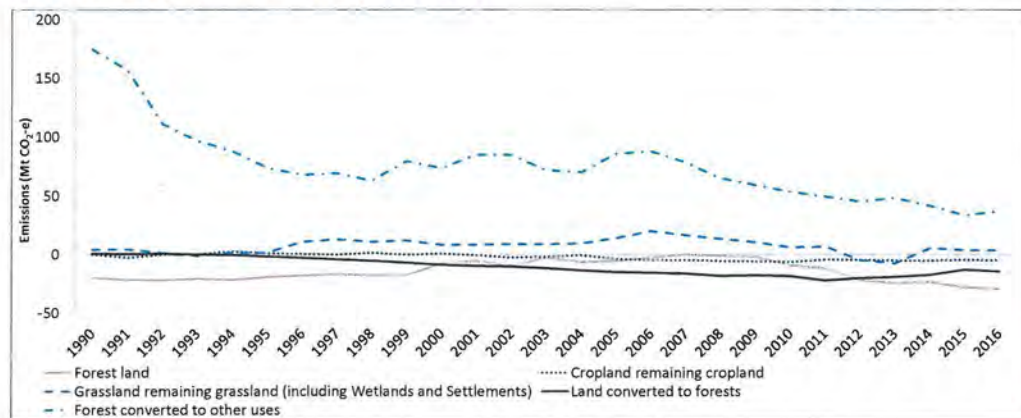
Figure 18: Net anthropogenic emissions from the Land Use, Land Use Change and Forestry sector, Kyoto Protocol classifications, financial years, 1990-2016



Source: Department of the Environment and Energy

The major sub-classifications under the United Nations Framework Convention on Climate Change include *Forest conversion*, *Forest land remaining forest land*, *Land converted to forest land*, *Grasslands (including Wetlands and Settlements)* and *Croplands* (Figure 19).

Figure 19: Net anthropogenic emissions from the Land Use, Land Use Change and Forestry sector, UNFCCC classifications, financial years, 1990-2016



Source: Department of the Environment and Energy

3. Emissions per capita and per dollar of GDP

Australia's emissions per capita have declined over the past decade, and emissions per dollar of gross domestic product (GDP) have declined over the last 27 years. In the year to March 2017, national inventory emissions per capita (excluding LULUCF) were 22.6 t CO₂-e per person, compared to 24.7 t CO₂-e in 1990, representing an 8.6% decline. When LULUCF activities are included¹⁰, the year to March 2017 estimate is 22.6 t CO₂-e per person, compared to 34.3 t CO₂-e in 1990, representing a 34.2% decline.

Australia's population grew strongly over this period, from 17.1 million in 1989-90 to around 24.5 million in December 2016 (growth of 43.4%).^{11,12}

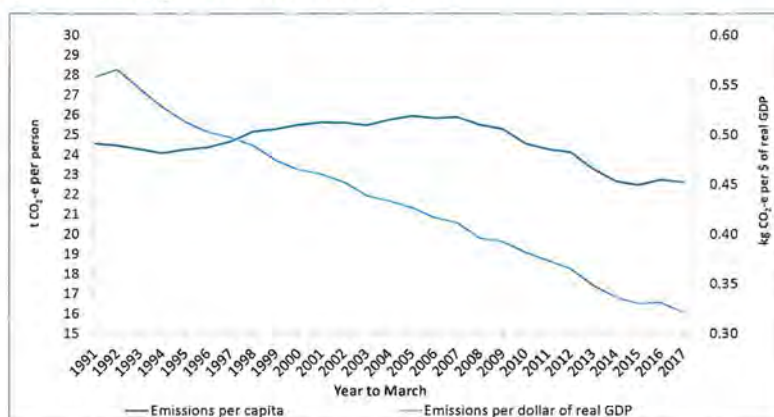
National inventory emissions per dollar of real GDP (excluding LULUCF) fell from 0.56 kg CO₂-e per dollar in 1990 to 0.32 kg CO₂-e per dollar in the year to March 2017, which is a decline of 42.2%.¹³ When LULUCF is included¹⁰, the 1990 estimate is 0.77 kg CO₂-e per dollar, compared to 0.32 kg CO₂-e per dollar in the year to March 2017, which is a decline of 58.4%.¹³

Australia's GDP grew significantly over this period, from \$0.8 trillion in 1989-90 to around \$1.7 trillion in the year to March 2017 (growth of 126.7%)¹³.

These declines have resulted from specific emissions management actions across sectors, the large decline in land use change emissions over the period, and structural changes in the economy.

Figure 20 provides an overview of emissions per capita and per dollar of real GDP from the year to March 1991 to 2017, illustrating these declining trends.

Figure 20: Emissions (excluding LULUCF) per capita and per dollar of real GDP (2015-16 prices), 'unadjusted' annual emissions, year to March 1991 to 2017



Source: Department of the Environment and Energy estimates

10 LULUCF includes afforestation/reforestation, deforestation, cropland management, grazing land management, forest management, and revegetation.

11 Australian Bureau of Statistics (2017), *Australian Demographic Statistics*, pub. no. 3101 <http://www.abs.gov.au/ausstats/abs@.nsf/mf/3101.0>

12 Australian Bureau of Statistics (2017), Population Clock. <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Web+Pages/Population+Clock>

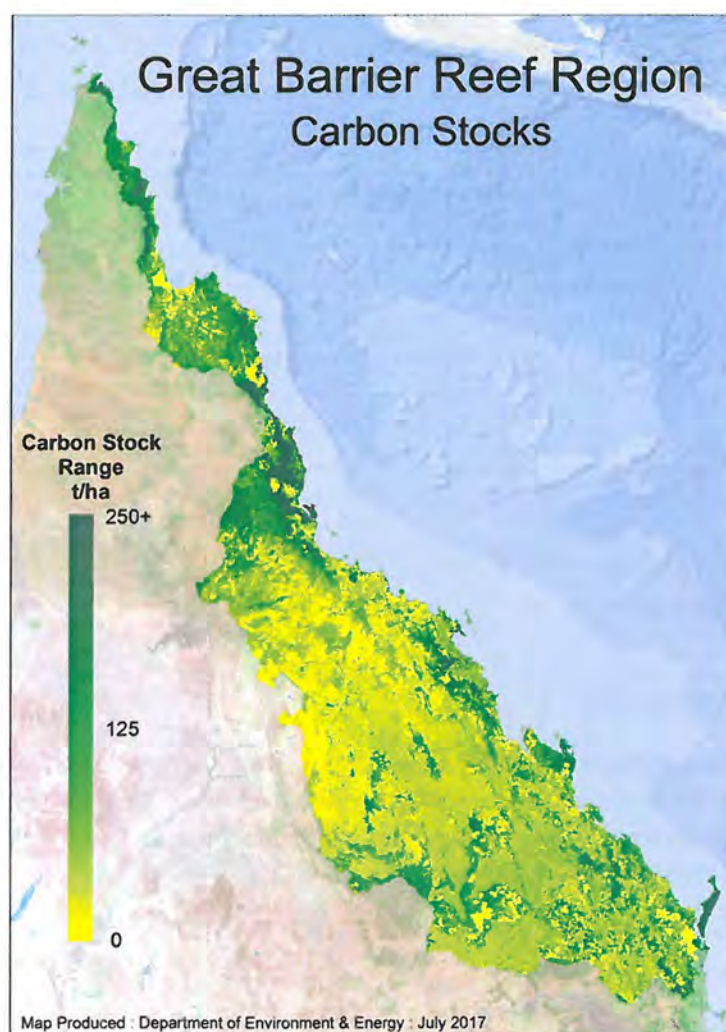
13 2015-16 prices., Australian Bureau of Statistics (2017), *National Accounts: National Income, Expenditure and Product*, pub. no. 5206 <http://www.abs.gov.au/ausstats/abs@.nsf/mf/5206.0>

4. Special topic: Regional biocarbon stock accounts in the Great Barrier Reef catchment area

The Department has commenced production of a set of regional biocarbon stock accounts to both support the National and State Greenhouse Accounts, and to support national efforts to compile comprehensive Environmental-Economic Accounts. Biocarbon represents carbon associated with vegetation, including in living biomass, dead organic matter and soils.

This first set of biocarbon accounts have been prepared for the Great Barrier Reef region, and will form part of the ABS' experimental ecosystem account for this area (ABS, 4680.0.55.001). The Department is taking advantage of innovative mapping functions developed inside the FullCAM architecture to produce a map of the results.

Figure 21: Map of biocarbon density (tonnes of carbon per hectare)



Source: Department of the Environment and Energy

4.1 Spatial results and carbon reservoirs

Biocarbon stocks are most dense in mangrove forests and the forests of the wet tropics. Figure 21 shows where these reservoirs of carbon are concentrated within the ecosystem. A deep green area highlights where these stocks reach at least 250 tC/ha.

The carbon density of any individual location can vary significantly by square kilometre and can potentially exceed 1,500 tC/ha, especially in mangroves. These mangrove forests are estimated to achieve, on average, 686 tC/ha, while other forests average 111 tC/ha.

Mangroves make up over 5% of carbon stocks in the ecosystem despite representing only 0.5% of the land by area in this study. This is about six times more carbon-dense than the other forests of the region. Tidal marshes are also shown to be as carbon-dense as conventional forests, despite a lack of significant tree cover.

Table 4: Carbon density of land types (t / ha)

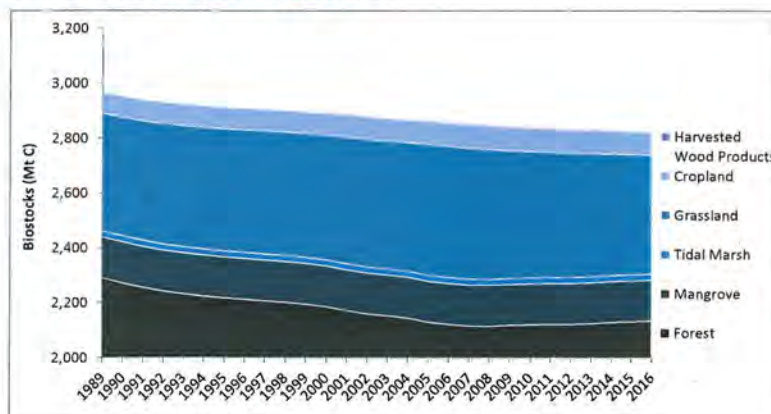
Financial Year	Forest ^a	Mangrove	Tidal Marsh	Grassland	Cropland	Total
1989	109.91	685.15	118.20	21.41	48.94	69.29
1995	110.71	685.28	118.17	21.48	47.52	68.05
2000	111.78	685.43	118.16	21.52	47.08	67.57
2005	113.58	685.69	118.14	21.79	47.15	66.88
2006	113.66	685.76	118.14	21.78	47.27	66.74
2007	113.52	685.84	118.14	21.74	47.24	66.60
2008	113.04	685.92	118.13	21.60	47.21	66.48
2009	112.21	685.99	118.13	21.41	47.25	66.37
2010	111.84	686.11	118.13	21.28	47.17	66.31
2011	111.53	686.21	118.13	21.16	47.13	66.24
2012	110.90	686.35	118.12	21.01	47.46	66.12
2013	110.72	686.48	118.12	20.90	47.25	66.08
2014	110.14	686.65	118.12	20.78	47.36	66.06
2015	109.61	686.82	118.12	20.66	47.45	65.99
2016	109.03	687.04	118.11	20.59	47.58	65.96
Average	111.37	685.73	118.15	21.39	47.45	67.27

a) includes Harvested Wood Products

4.2 Aggregate results

The Department estimates that the whole Great Barrier Reef (GBR) catchment area held approximately 2.8Gt of biocarbon in the landscape in the year ending June 2016. This is an estimated decrease of 0.14 Gt (-4.9%) relative to the estimated opening stocks of 1990 (Figure 22). This is mostly driven by transitions between forest and grassland, and vice-versa.

Figure 22: Total biocarbon stocks by land type (Mt C)



Source: Department of the Environment and Energy

4.3 Analysis of changes in biocarbon stocks

The rate of loss of biocarbon has slowed significantly since the late 1990s. There has been a changing balance between the long-term losses of past land clearing activities and the sequestration of carbon into new forests.

In 2008, the annual net change in forest area in the GBR region moved from a net loss to a net gain, placing forest carbon stocks into accumulation. However, the ecosystem as a whole continues to exhibit losses of carbon overall (Figure 23).

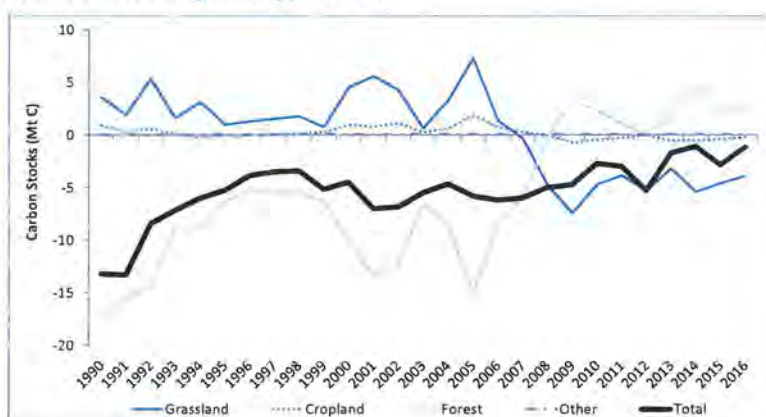
Losses in carbon is consistent with information in the National Greenhouse Accounts, where Queensland land sector emissions have been reducing over time but remain positive.

When a forest is cleared, some of the carbon is lost instantaneously, such as from harvesting slash or from conversion burning practices, leading to an initial flush of emissions from a disturbance event. The remainder is moved to a grassland classification where it will be gradually lost over a period of decades.

Regrowing a forest or establishing a new forest sequesters carbon and increases carbon stocks.

It follows that from around 2008, carbon sequestration from new forests has begun to dominate losses associated with current and past land clearing events. If this trend continues, those longer-term net losses from historic land clearing could be expected to peter out, which would place the overall carbon stock change into accumulation in the future.

Figure 23: Total biocarbon stocks by land type (Mt C)



Source: Department of the Environment and Energy

4.4 Explanatory notes

The Great Barrier Reef ecosystem area is defined as the North-East Coast Australian Drainage Division (Bureau of Meteorology), but excluding the *South East Queensland Catchments* Natural Resource Management (NRM) region encompassing Brisbane and surrounds.

Carbon stocks are estimated using the same systems and methods as those in the National Greenhouse Gas Inventory produced by the Department of the Environment and Energy (DoEE) using methods consistent with the guidelines of the Intergovernmental Panel on Climate Change (IPCC). This is underpinned by the Full Carbon Accounting Model (FullCAM) maintained by DoEE and utilised in conjunction with satellite imagery and other spatial inputs to determine the carbon content of varying types of land coverage. These systems have been subject to the review of Australia's peers in the carbon-accounting community as part of compliance activities under the United Nations Framework Convention on Climate Change (UNFCCC), and are continuously improved by scientific studies.

Land types are presented as per their cover at the end of the year ending June 30th. For example, this means that an area of *forest* that is converted to *grassland* during year X will be presented as a *grassland* in year X, but as a *forest* in year X-1. All remnant carbon from the conversion event, notably the soil carbon, will be moved from the *forest* classification to the *grassland* classification accordingly. Carbon impacted by a transition event will decay or accumulate over time until it reaches the equilibrium of its new classification within the climatic parameters and spatial inputs of FullCAM.

The scope of carbon stocks in this account aligns with the areas of emission-producing activities under the UNFCCC rules, then adds stocks associated with those lands deemed to be in a state of equilibrium and not exchanging carbon with the atmosphere and oceans at a calculable level. Among forests, 16.2 Mha is identified as stable, containing 733 Mt of above-ground biocarbon and 1,115 Mt of below-ground biocarbon.

The only activity-based exclusions from the account are:

- Seasonal, weather-related and cropping-related fluctuations in carbon stocks that have been deemed through the greenhouse accounting process to not have a long-term impact on carbon stocks and would otherwise make the identification of trends in the account difficult,
- The impacts of severe bushfire events on losses and subsequent gains in carbon, and
- Seagrasses, for which estimates are in the process of being developed.

A forest is defined as being $\geq 2\text{m}$ in height and $\geq 20\%$ canopy cover. Where a settlement or wetland is forested on these criteria, it is classified as *forest*, unless it is a *mangrove*. *Mangroves* are identified using the same height and canopy criteria within the mangroves Major Vegetation Group. *Tidal marshes* are principally those areas within the mangroves Major Vegetation Group that do not meet the definition of a forest. Areas of human settlement and inland wetlands that are not a forest are treated as *grasslands* for the purposes of this account, and may include sparse woody vegetation below the threshold for a *forest*.

Harvested Wood Products includes wood and paper products brought into use or disposed to solid waste disposal sites since 1940. When assessing carbon density, *harvested wood products* are included with *forest* carbon stocks.

This is an experimental account and subject to further improvement. The systems underpinning this account, while operating on a carbon stock-change basis, were originally designed and calibrated to produce accurate estimates of greenhouse gas emissions in accordance with the scope of the UNFCCC and Kyoto Protocol accounting systems. Estimates for *mangroves* and *tidal marsh* are based on emerging national methods for UNFCCC greenhouse gas accounting and are particularly subject to further refinement. DoEE welcomes feedback on the nature of the accounts.

5. Technical notes

5.01 Quarterly coverage

This report provides estimates of Australia's national inventory up to the March quarter of 2017 and includes the emission sources *energy, industrial processes and product use, agriculture and waste sectors*, and the land sector activities *deforestation, afforestation and reforestation, grazing land management, cropland management, and forest management*.

5.02 International guidelines

The Quarterly Update has been prepared in accordance with the international guidelines agreed for use at the Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) in Warsaw 2013. These include the *Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories* (2006), and the *Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol* (2013).

5.03 Greenhouse gases

Consistent with the requirements of the Kyoto Protocol, this report covers sources of greenhouse gas emissions and removals by sinks resulting from human (anthropogenic) activities for the major greenhouse gases – carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF₆). In accordance with IPCC guidelines, Australia's emissions of the greenhouse gas nitrogen trifluoride (NF₃) are considered negligible and are not estimated.

GWPs have been used for each of the major greenhouse gases to convert them to carbon dioxide equivalents (CO₂-e). As greenhouse gases vary in their radiative activity and in their atmospheric residence time, converting emissions into CO₂-e allows the integrated effect of emissions of the various gases to be compared. The GWPs used in this Report were the 100-year GWPs contained in the 2007 IPCC Fourth Assessment Report (IPCC 2007), by international agreement.

5.04 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 5.06). These data are used to determine growth rates, which are applied to infer 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.

5.05 Recalculations

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

The recalculations must comply with international guidelines, are estimated on a time series consistent basis and are subject to annual international expert review.

The recalculations since the December 2016 edition of the *Quarterly Update* for the years 2000 and 2014 to 2016, by sector, in million tonnes of carbon dioxide equivalent (Mt CO₂-e), are shown in Table 5.

Recalculations since the December Quarter 2016

Revisions to ABARES livestock and crop data resulted in recalculations to *agriculture* for 2016 and 2017.

Revisions to DIS commodities production data resulted in recalculations to *fugitive emissions*, and *industrial processes and product use*.

Table 5: Absolute emissions recalculations (Mt CO₂-e) of the National Greenhouse Gas Inventory since the June 2016 Quarterly Update by sector, 2000 and 2014-2016

Sector	Financial Years and Quarters															
	2000				2014				2015				2016			
	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0
Electricity	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	0.1	-0.4	0.1	-0.1	-0.7
Stationary Energy (excluding electricity)	-0.2	0.1	0.1	-0.1	-0.1	-0.1	-0.1	0.1	-0.1	-0.1	-0.1	0.1	-0.3	-0.1	0.0	-0.1
Transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fugitive Emissions	-0.3	0.2	0.2	-0.1	-0.1	-0.1	-0.1	0.1	-0.1	-0.1	-0.1	0.2	0.5	0.8	0.6	1.1
Industrial Processes and Product Use	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	-0.5	0.3	0.4	-0.2	-0.1	-0.2	-0.1	0.2	0.0	-0.1	-0.4	0.4	0.8	1.8	1.7	1.3

Forthcoming recalculations

The national inventory is subject to continuous improvement. All methods and data sources are kept under review to ensure that the inventory is consistent with international guidelines, is able to use the best data available, and takes account of the latest empirical science. Ongoing emissions estimation method development is scheduled for parts of the *fugitive emissions*, *agriculture*, *forestry* and other *land use sectors*, in accordance with the national inventory improvement plan.

The incorporation of new NGERs data will be progressively implemented in future releases.

5.06 Source data

Preliminary activity data are obtained under the NGERs and from a range of publicly available sources, principally:

ABARES – *Agricultural Commodities*

<http://www.daff.gov.au/abares/>

ABS – *Australian National Accounts: National Income, Expenditure and Product*

<http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5206.0Dec%202013?OpenDocument>

AEMO – Market data extracted using NEM-Review software

<http://www.aemo.com.au/Electricity/Data>

BITRE – *Domestic Totals & Top Routes*

http://www.bitre.gov.au/publications/ongoing/domestic_airline_activity-time_series.aspx

BoM - Monthly climate summaries

<http://www.bom.gov.au/>

DIIS – Resources and Energy Quarterly

<http://www.industry.gov.au/industry/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-quarterly.aspx> (formerly available under *Resources and Energy Quarterly* from BREE and *Australian Mineral Statistics* from ABARES)

– *Australian Petroleum Statistics*

<http://www.industry.gov.au/industry/Office-of-the-Chief-Economist/Publications/Pages/Australian-petroleum-statistics.aspx> (formerly published by BREE)

Department of the Environment and Energy – Australian Greenhouse Emissions Information System

<http://ageis.climatechange.gov.au/>

5.07 Unadjusted time series

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

5.08 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'. SEASABS is the main seasonal adjustment tool used by the ABS.

The unadjusted quarterly data have been adjusted using SEASABS to remove the effects of seasonal factors. SEASABS analysis for the Quarterly Update uses a 5 term Henderson moving average.

5.09 Trend analysis

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

The trend time series is estimated using the ABS SEASABS tool. More information on trend analysis is available on the ABS website.

5.10 Weather normalisation

The seasonally adjusted and trend 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 seasonally adjusted series corrects for the regular effects of differences in average temperatures between seasons. The weather normalised series further corrects for fluctuations in average seasonal conditions.

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 Land Use, Land Use Change and Forestry) and the electricity sector. The methodology is described in detail in 'Section 7: Special Topic' of the December 2011 edition of the *Quarterly Update*.

5.11 Quarterly uncertainty

For all sectors except Land Use, Land Use Change and Forestry, the Department's assessment is that the 90% confidence interval for the national inventory is $\pm 1\%$ (i.e. there is a 90% probability that future revisions will be limited to $\pm 1\%$ of the current estimate). The estimates for Land Use, Land Use Change and Forestry are subject to a greater level of uncertainty than the other sectors. This is due to the combined uncertainties from lags in the detection of deforestation and forest harvesting events; the measurement and estimation of carbon stocks and sequestration rates in living biomass and soils; and the influence of weather and climate conditions.

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 refinery, 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; and
- 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; and
- Transmission of natural gas.

Fugitive emissions:

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

- Solid fuels: CO₂ and CH₄ from coal mining activities, post-mining and decommissioned mines. CO₂, CH₄ and N₂O from flaring associated with coal mining; and
- 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 CO₂, CH₄ and N₂O.

Industrial processes and product use:

- Mineral Industry: CO₂ 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: CO₂ and PFCs from aluminium smelting; CO₂, CH₄ and N₂O from iron and steel production; and CO₂ from the production of ferroalloys and other metals;
- Chemical Industry: includes N₂O from the production of nitric acid; CO₂ from ammonia production, acetylene use and the production of synthetic rutile and titanium dioxide; and CH₄ from polymers and other chemicals;
- Other product manufacture and use: CO₂ from the consumption of CO₂ in the food and drink industry and the use of sodium bicarbonate, SF₆ from electrical equipment;
- Product uses as substitutes for Ozone Depleting Substances: HFC and refrigeration and air conditioning equipment; foam blowing; metered dose inhalers; fire extinguishers; solvent use; and
- Non-energy products from fuel and solvent use: CO₂ produced by oxidation of lubricating oils and greases.

Agriculture:

CH₄ and N₂O emissions from the consumption, decay or combustion of living and dead biomass:

- 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: CH₄ 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; and
- Carbon dioxide emissions from the application of urea and lime.

Waste:

Emissions are predominantly CH₄. Small amounts of CO₂ and N₂O 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; and
- 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 Land Use, Land Use Change and Forestry sector includes:

- Deforestation: emissions and removals from the direct human-induced removal of forest and replacement with pasture, crops or other uses since 1990. Emissions arise from the burning and decay of cleared vegetation, and changes in soil carbon from current and past events; and
- Afforestation and reforestation: emissions and removals (i.e. sinks) from forests established on agricultural land since 1990. 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 Emission Reduction Fund.
- Forest management: 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 management land are reported using the natural disturbances provision;
- Cropland management: 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; and
- Grazing land management: 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.

5.15 Acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
AEMO	Australian Energy Market Operator
AGEIS	Australian Greenhouse Emissions Information System
BoM	Bureau of Meteorology
BREE	Bureau of Resources and Energy Quarterly
DIIS	Department of Industry, Innovation and Science
DIRD	Department of Infrastructure and Regional Development
DIS	Department of Industry and Science
GDP	Gross Domestic Product
GWP	Global Warming Potential
LULUCF	Land Use, Land Use Change and Forestry
NEM	National Electricity Market
UNFCCC	United Nations Framework Convention on Climate Change

5.16 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) = 10^3 (thousand)
- mega (M) = 10^6 (million)
- giga (G) = 10^9
- tera (T) = 10^{12}
- peta (P) = 10^{15}

In this report, emissions are expressed in Mt CO₂-e, which represents millions of tonnes of carbon dioxide equivalent gas.

6. Data tables

Data table 1A: Quarterly emissions by sector since 2001-02, 'unadjusted'^a

Year	Quarter	Energy			Fugitive Emissions	Industrial processes and product use	Agriculture	Waste	National Inventory		
		Electricity	Stationary energy excl. electricity	Transport					Total (excl. LULUCF)	LULUCF	Total incl. LULUCF
2001-02	September	47.5	19.1	18.9	9.9	7.3	19.5	4.0	126.2	19.5	145.7
	December	44.3	19.4	19.6	9.5	7.1	19.5	4.0	123.2	19.5	142.8
	March	45.4	18.8	18.5	9.0	7.0	19.1	3.9	121.6	19.1	140.7
	June	46.8	19.3	18.7	9.8	7.3	19.3	3.9	125.1	19.3	144.4
2002-03	September	48.6	19.7	19.4	9.5	7.8	18.3	3.7	127.0	17.0	143.9
	December	46.2	20.0	20.0	9.1	7.9	18.3	3.7	125.2	17.0	142.2
	March	45.4	19.2	18.9	8.7	7.8	17.9	3.6	121.5	16.6	138.1
	June	46.4	19.5	19.1	9.4	7.7	18.1	3.6	123.8	16.8	140.7
2003-04	September	48.9	20.2	20.1	9.6	8.3	18.9	3.6	129.7	16.3	146.0
	December	46.8	20.3	20.8	9.2	8.4	18.9	3.6	128.0	16.3	144.3
	March	49.9	19.5	19.6	8.9	8.1	18.7	3.5	128.4	16.1	144.5
	June	49.0	19.9	19.8	9.6	8.0	18.7	3.5	128.6	16.1	144.7
2004-05	September	50.9	20.7	20.7	10.0	8.0	19.2	3.6	133.0	21.1	154.1
	December	48.2	20.8	21.0	9.5	8.0	19.2	3.6	130.2	21.1	151.3
	March	48.8	20.0	19.6	9.1	7.9	18.8	3.5	127.6	20.6	148.3
	June	48.9	20.5	20.4	9.9	8.1	19.0	3.5	130.4	20.9	151.3
2005-06	September	50.9	20.6	20.3	10.3	8.3	18.8	3.5	132.5	21.8	154.3
	December	48.9	20.5	21.5	9.8	8.1	18.8	3.5	131.2	21.8	152.9
	March	50.6	19.6	20.3	9.4	7.9	18.4	3.4	129.5	21.3	150.8
	June	50.9	20.5	20.2	10.2	8.1	18.6	3.5	132.0	21.5	153.5

^a This table presents estimates of quarterly emissions by sector since 2001-02, in unadjusted terms. As numbers are rounded, the sum of the sectors may not exactly equal the totals.

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	National Inventory		
		Electricity	Stationary energy excl. electricity	Transport	Fugitive Emissions				Total (excl. LULUCF)	LULUCF	Total incl. LULUCF
2006-07	September	52.2	20.5	21.0	10.8	8.6	18.0	3.6	134.6	18.4	153.0
	December	50.8	21.0	21.8	10.2	8.7	18.0	3.6	134.1	18.4	152.5
	March	51.6	19.9	20.9	9.8	8.5	17.6	3.5	131.9	18.0	149.9
	June	49.5	20.5	21.2	10.9	8.6	17.8	3.5	132.0	18.2	150.2
2007-08	September	53.5	21.1	21.7	11.4	8.7	17.1	3.7	137.2	13.8	151.1
	December	50.3	21.2	22.2	9.8	8.6	17.1	3.7	133.0	13.8	146.8
	March	51.7	20.5	21.3	10.0	8.5	16.9	3.6	132.5	13.7	146.2
	June	50.5	21.5	21.7	10.6	8.7	16.9	3.6	133.5	13.7	147.1
2008-09	September	55.4	22.4	22.1	10.8	9.2	17.3	3.7	140.9	13.1	154.0
	December	52.3	21.8	22.6	10.7	8.6	17.3	3.7	136.9	13.1	150.0
	March	52.5	19.6	21.1	9.5	7.2	16.9	3.6	130.4	12.8	143.2
	June	51.5	20.4	21.5	10.8	7.4	17.1	3.6	132.3	13.0	145.2
2009-10	September	51.4	21.0	22.4	11.2	8.5	16.7	3.8	135.1	6.7	141.8
	December	51.3	21.4	22.9	10.3	8.9	16.7	3.8	135.2	6.7	141.9
	March	52.5	20.6	21.4	9.8	9.0	16.4	3.7	133.4	6.6	140.0
	June	49.9	21.4	22.1	10.7	9.0	16.6	3.7	133.4	6.6	140.0
2010-11	September	51.0	22.1	22.5	11.6	9.1	18.0	3.6	137.9	4.5	142.3
	December	47.1	21.7	23.5	10.8	9.1	18.0	3.6	133.7	4.5	138.1
	March	50.7	20.3	22.3	9.0	8.9	17.6	3.5	132.2	4.4	136.6
	June	49.7	21.7	22.9	10.2	8.8	17.8	3.6	134.8	4.4	139.2
2011-12	September	50.9	23.4	22.9	10.7	9.3	18.2	3.2	138.6	1.6	140.2
	December	49.2	22.8	23.4	10.4	8.3	18.2	3.2	135.4	1.6	137.0
	March	50.3	21.4	22.7	9.6	8.2	18.0	3.1	133.4	1.6	135.0
	June	48.7	21.9	23.0	11.0	8.0	18.0	3.1	133.8	1.6	135.4

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	National Inventory		
		Electricity	Stationary energy excl. electricity	Transport	Fugitive Emissions				Total (excl. LULUCF)	LULUCF	Total incl. LULUCF
2012-13	September	47.0	24.2	23.0	10.9	8.3	18.3	3.0	134.8	-0.5	134.3
	December	45.9	23.8	23.8	10.5	8.2	18.3	3.0	133.6	-0.5	133.1
	March	47.6	22.2	22.3	9.7	8.0	17.9	2.9	130.6	-0.5	130.1
	June	46.6	23.1	23.0	10.6	8.0	18.1	3.0	132.4	-0.5	131.9
2013-14	September	45.0	24.0	23.4	10.3	8.3	18.4	3.0	132.4	1.2	133.6
	December	44.0	23.9	23.9	10.2	8.2	18.4	3.0	131.5	1.2	132.8
	March	47.2	22.6	22.7	10.0	7.9	18.0	3.0	131.3	1.2	132.5
	June	44.5	23.7	23.1	10.1	8.0	18.2	3.0	130.6	1.2	131.8
2014-15	September	47.5	23.5	23.9	12.2	8.2	17.6	2.9	135.7	1.2	136.9
	December	46.4	23.0	24.6	10.8	8.2	17.6	2.9	133.5	1.2	134.6
	March	47.9	21.8	23.2	10.2	7.9	17.3	2.8	131.1	1.1	132.3
	June	47.1	22.6	23.5	11.4	8.0	17.5	2.8	132.9	1.1	134.1
2015-16	September	48.4	23.8	24.1	12.2	8.5	18.6	2.9	138.5	-0.8	137.8
	December	47.3	23.8	24.5	11.7	8.4	18.6	2.9	137.1	-0.8	136.4
	March	48.9	22.8	23.5	11.8	8.1	18.4	2.8	136.3	-0.7	135.6
	June	46.6	23.8	23.3	11.9	8.2	18.4	2.8	135.1	-0.7	134.4
2016-17	September	48.1	25.1	23.6	12.5	8.7	19.0	2.9	139.8	0.2	140.0
	December	44.5	25.5	24.5	11.9	8.6	19.0	2.9	136.9	0.2	137.1
	March	48.8	24.2	24.6	11.3	8.3	18.6	2.8	138.5	0.2	138.7
	June										

Data table 1B: Quarterly emissions by sector since 2001-02, 'seasonally adjusted'^a

Year	Quarter	Energy							National Inventory Total (excl. LULUCF) ^a
		Electricity ^a	Stationary energy excl. electricity	Transport	Fugitive Emissions	Industrial processes and product use	Agriculture	Waste	
2001-02	September	46.4	18.8	18.7	9.5	7.1	19.4	3.9	124.0
	December	45.6	19.0	18.9	9.6	7.1	19.4	3.9	123.3
	March	46.5	19.2	19.0	9.5	7.1	19.3	3.9	124.4
	June	46.8	19.4	19.1	9.5	7.4	19.4	3.9	125.4
2002-03	September	47.3	19.4	19.2	9.2	7.6	18.1	3.7	124.6
	December	47.0	19.6	19.3	9.2	7.8	18.1	3.7	124.8
	March	46.0	19.7	19.4	9.2	8.0	18.0	3.6	124.0
	June	46.8	19.6	19.5	9.2	7.8	18.1	3.7	124.6
2003-04	September	47.3	19.9	19.9	9.3	8.1	18.8	3.6	126.8
	December	48.0	20.0	20.1	9.3	8.3	18.8	3.6	127.9
	March	50.1	20.1	20.1	9.4	8.3	18.9	3.6	130.6
	June	49.3	20.0	20.3	9.4	8.1	18.8	3.5	129.2
2004-05	September	49.4	20.4	20.4	9.5	7.9	19.1	3.5	130.2
	December	49.3	20.4	20.3	9.6	7.9	19.1	3.5	130.0
	March	49.5	20.6	20.1	9.7	8.1	19.0	3.5	130.3
	June	50.1	20.7	20.8	9.8	8.2	19.0	3.5	132.2
2005-06	September	49.6	20.2	20.0	9.8	8.1	18.7	3.5	130.0
	December	49.4	20.2	20.8	9.9	8.0	18.7	3.5	130.4
	March	50.1	20.2	20.8	10.0	8.1	18.6	3.5	131.2
	June	50.3	20.6	20.6	10.0	8.2	18.5	3.5	131.6

^a This table presents estimates of quarterly emissions by sector since 2001-02, in seasonally adjusted terms. Estimates for the national inventory total and the *electricity* sector include weather normalisation, as described in Section 5: *Technical Notes*. Seasonally adjusted estimates for all other sectors are presented without weather normalisation. As a result, the national inventory total may differ from the sum of the rows.

Energy									
Year	Quarter	Electricity ^a	Stationary energy excl. electricity	Transport	Fugitive Emissions	Industrial processes and product use	Agriculture	Waste	National Inventory Total (excl. LULUCF) ^a
2006-07	September	51.3	20.1	20.8	10.2	8.4	17.9	3.6	132.4
	December	52.1	20.6	21.1	10.3	8.6	17.9	3.6	133.9
	March	51.0	20.6	21.5	10.6	8.7	17.8	3.5	133.6
	June	50.5	20.6	21.6	10.7	8.8	17.7	3.6	133.6
2007-08	September	52.4	20.7	21.5	10.8	8.5	17.1	3.7	134.5
	December	50.9	20.8	21.6	9.8	8.6	17.0	3.7	132.3
	March	51.8	21.3	21.8	10.8	8.7	17.1	3.7	135.0
	June	51.4	21.6	22.0	10.4	8.8	16.9	3.7	134.9
2008-09	September	53.2	21.8	21.9	10.2	9.0	17.2	3.7	136.6
	December	53.7	21.4	21.9	10.7	8.5	17.1	3.7	136.8
	March	51.9	20.4	21.7	10.4	7.3	17.1	3.6	132.3
	June	52.1	20.6	21.7	10.6	7.5	17.1	3.6	133.5
2009-10	September	51.0	20.4	22.3	10.6	8.3	16.7	3.7	133.1
	December	51.6	20.9	22.2	10.2	8.8	16.6	3.7	134.3
	March	51.3	21.5	22.1	10.7	9.2	16.6	3.7	135.0
	June	50.4	21.6	22.3	10.5	9.1	16.6	3.7	134.5
2010-11	September	49.4	21.4	22.4	11.0	8.8	17.8	3.6	134.1
	December	48.5	21.3	22.7	10.7	9.0	17.8	3.6	133.7
	March	49.8	21.3	22.9	9.8	9.1	17.8	3.6	134.0
	June	49.6	21.9	23.1	10.0	9.0	17.8	3.5	135.1
2011-12	September	50.4	22.6	22.8	10.2	9.1	18.1	3.2	136.3
	December	50.7	22.4	22.6	10.4	8.2	18.0	3.2	135.5
	March	50.0	22.4	23.3	10.4	8.4	18.2	3.2	135.6
	June	48.8	22.0	23.2	10.7	8.2	18.1	3.1	134.4

Data table 1C: Quarterly emissions by sector since 2001-02, trend ^a

Year	Quarter	Energy							National Inventory Total (excl. LULUCF) ^a
		Electricity ^a	Stationary energy excl. electricity	Transport	Fugitive Emissions	Industrial processes and product use	Agriculture	Waste	
2001-02	September	46.2	18.9	18.8	9.6	7.1	19.4	3.9	123.8
	December	46.1	19.1	18.9	9.6	7.1	19.4	4.0	124.0
	March	46.3	19.2	19.0	9.5	7.2	19.3	3.9	124.4
	June	46.9	19.4	19.1	9.4	7.4	19.0	3.8	124.9
2002-03	September	47.1	19.5	19.2	9.3	7.6	18.5	3.7	124.9
	December	46.8	19.6	19.3	9.2	7.8	18.1	3.7	124.4
	March	46.5	19.7	19.4	9.2	7.9	18.0	3.6	124.3
	June	46.5	19.7	19.6	9.2	8.0	18.3	3.6	124.9
2003-04	September	47.3	19.8	19.8	9.3	8.1	18.6	3.6	126.5
	December	48.5	19.9	20.0	9.3	8.3	18.8	3.6	128.4
	March	49.3	20.0	20.2	9.4	8.2	18.9	3.6	129.6
	June	49.6	20.1	20.3	9.4	8.1	18.9	3.5	130.0
2004-05	September	49.4	20.3	20.3	9.5	7.9	19.0	3.5	129.9
	December	49.4	20.5	20.3	9.6	7.9	19.1	3.5	130.2
	March	49.6	20.6	20.3	9.7	8.1	19.0	3.5	130.8
	June	49.7	20.5	20.4	9.7	8.1	18.9	3.5	130.9
2005-06	September	49.7	20.3	20.5	9.8	8.1	18.8	3.5	130.8
	December	49.7	20.2	20.6	9.9	8.1	18.7	3.5	130.6
	March	49.9	20.3	20.7	10.0	8.1	18.6	3.5	130.9
	June	50.6	20.4	20.7	10.1	8.2	18.4	3.5	131.8

^a This table presents estimates of quarterly emissions by sector since 2001-02, in trend terms. Estimates for the national inventory total and the *electricity* sector include weather normalisation, as described in Section 5: *Technical Notes*. Trend estimates for all other sectors are presented without weather normalisation. As a result, the national inventory total may differ from the sum of the rows.

Energy									
Year	Quarter	Electricity ^a	Stationary energy excl. electricity	Transport	Fugitive Emissions	Industrial processes and product use	Agriculture	Waste	National Inventory Total (excl. LULUCF) ^a
2006-07	September	51.3	20.4	20.8	10.2	8.4	18.1	3.5	132.6
	December	51.4	20.5	21.1	10.3	8.6	17.9	3.5	133.3
	March	51.3	20.6	21.4	10.6	8.7	17.7	3.6	133.9
	June	51.2	20.6	21.5	10.6	8.7	17.5	3.6	133.8
2007-08	September	51.4	20.7	21.5	10.5	8.6	17.3	3.6	133.6
	December	51.5	20.9	21.6	10.4	8.6	17.0	3.7	133.6
	March	51.5	21.3	21.8	10.3	8.7	17.0	3.7	134.2
	June	52.1	21.7	21.9	10.4	8.9	17.0	3.7	135.6
2008-09	September	52.8	21.6	22.0	10.4	8.8	17.1	3.7	136.3
	December	53.1	21.2	21.8	10.4	8.2	17.1	3.6	135.4
	March	52.6	20.7	21.8	10.5	7.7	17.1	3.6	134.0
	June	51.8	20.4	21.9	10.5	7.6	17.0	3.7	133.0
2009-10	September	51.5	20.6	22.1	10.5	8.1	16.8	3.7	133.3
	December	51.4	21.0	22.2	10.5	8.8	16.5	3.7	134.2
	March	51.1	21.4	22.2	10.5	9.1	16.6	3.7	134.7
	June	50.4	21.5	22.2	10.7	9.1	17.0	3.7	134.6
2010-11	September	49.4	21.4	22.4	10.8	9.0	17.5	3.6	134.1
	December	49.0	21.3	22.7	10.5	9.0	17.8	3.6	133.8
	March	49.3	21.5	22.9	10.1	9.1	17.9	3.6	134.3
	June	49.9	21.9	23.0	10.0	9.0	17.9	3.4	135.1
2011-12	September	50.4	22.4	22.9	10.1	8.8	18.0	3.3	135.8
	December	50.6	22.4	22.9	10.4	8.5	18.1	3.2	136.0
	March	49.9	22.3	23.1	10.5	8.3	18.2	3.1	135.2
	June	48.4	22.6	23.2	10.6	8.2	18.2	3.1	134.1

Year	Quarter	Energy							National Inventory Total (excl. LULUCF) ^a
		Electricity ^a	Stationary energy excl. electricity	Transport	Fugitive Emissions	Industrial processes and product use	Agriculture	Waste	
2012-13	September	47.1	23.0	23.1	10.6	8.1	18.2	3.0	133.1
	December	46.6	23.3	23.0	10.5	8.1	18.2	3.0	132.6
	March	46.6	23.4	23.0	10.4	8.1	18.2	2.9	132.7
	June	46.3	23.2	23.1	10.2	8.1	18.2	3.0	132.4
2013-14	September	45.8	23.3	23.2	10.1	8.1	18.2	3.0	131.9
	December	45.4	23.5	23.2	10.2	8.1	18.2	3.0	131.8
	March	45.5	23.6	23.2	10.4	8.1	18.2	3.0	132.2
	June	46.1	23.4	23.4	10.7	8.1	18.0	2.9	132.9
2014-15	September	46.7	23.0	23.7	10.9	8.1	17.7	2.9	133.2
	December	47.1	22.7	23.8	11.0	8.1	17.4	2.8	133.0
	March	47.1	22.6	23.9	11.0	8.1	17.5	2.8	133.0
	June	47.1	22.8	23.9	11.1	8.2	17.8	2.8	133.7
2015-16	September	47.3	23.1	23.9	11.6	8.2	18.2	2.8	135.1
	December	47.5	23.4	23.9	11.9	8.3	18.5	2.9	136.5
	March	47.8	23.7	23.8	12.1	8.3	18.6	2.9	137.2
	June	47.5	24.0	23.6	12.0	8.4	18.7	2.8	137.3
2016-17	September	47.0	24.5	23.7	11.9	8.5	18.7	2.8	137.3
	December	46.5	24.9	24.1	11.9	8.5	18.8	2.8	137.7
	March	46.3	25.3	24.7	12.0	8.6	18.8	2.8	138.3
	June								

Data table 2: Tracking Australia's emissions

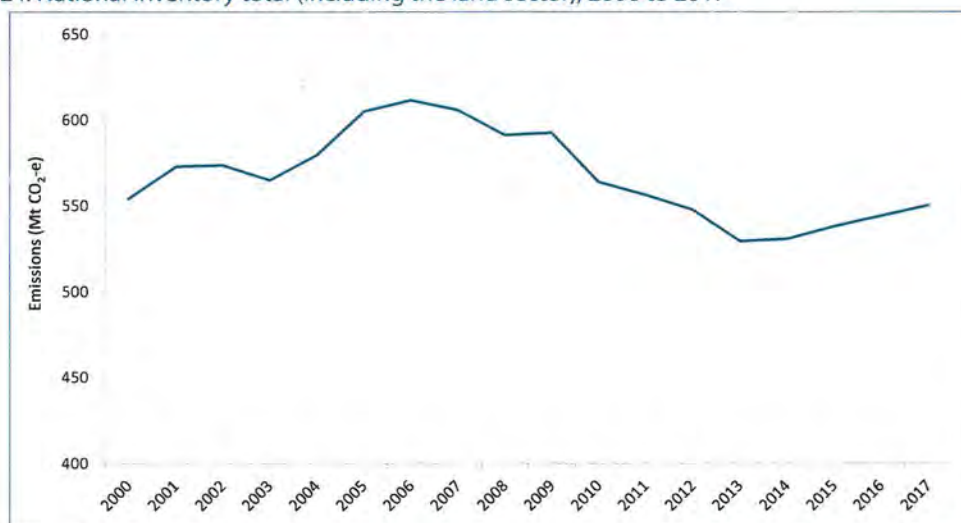
The data presented in Table 6 and Figure 24 include Australia's annual emissions (including the land sector) for 2000 to 2017.

Australia's annual emissions for the year to March 2017 are estimated to be 550.1 Mt CO₂-e. This figure is 0.8 per cent below emissions in 2000 (554.4 Mt CO₂-e) and 9.1 per cent below emissions in 2005 (605.0 Mt CO₂-e).

Table 6: National inventory total (including the land sector), 2000 to 2016

Year ^a	Emissions (Mt CO ₂ -e)
2000	554.4
2001	572.9
2002	573.6
2003	564.9
2004	579.6
2005	605.0
2006	611.5
2007	605.7
2008	591.2
2009	592.4
2010	563.8
2011	556.3
2012	547.7
2013	529.5
2014	530.7
2015	537.9
2016	544.1
2017	550.1

Figure 24: National inventory total (including the land sector), 2000 to 2017



Source: Department of the Environment and Energy

a 2000-2015 *National Inventory Report 2015* (DEE, 2017) <http://www.environment.gov.au/climate-change/greenhouse-gas-measurement/progress-inventory>; 2016 and 2017 *Quarterly Update: March 2017*.

7. Related publications and resources

Australia's National Greenhouse Accounts

The following Department of the Environment and Energy publications are all available on the departmental website.

National Inventory Report 2015

The three volumes comprising Australia's *National Inventory Report 2015* were submitted under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol in May 2017. These reports contains national greenhouse gas emission estimates for the period 1990-2015 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.



<http://www.environment.gov.au/climate-change/greenhouse-gas-measurement/progress-inventory>

State and Territory Greenhouse Gas Inventories 2015

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 2015* and the *National Inventory by Economic Sector 2015*.

National Inventory by Economic Sector 2015

This document provides an overview of the latest available estimates of annual greenhouse gas emissions, disaggregated by Australia-New Zealand Standard Industrial Classifications (ANZSIC). It complements the Australia's *National Inventory Report 2015* and the *State and Territory Greenhouse Gas Inventories 2015*.

Australia's Emissions Projections: December 2016

Australia's Emissions Projections: December 2016 is an update of Australia's domestic emissions projections, including:

- A projection of emissions from 2016 to 2020, which provides an estimate of the abatement task Australia must achieve to meet its 2020 emissions reduction target, and
- A projection of emissions from 2021 to 2030, which provides an estimate of the abatement task Australia must achieve to meet its 2030 emissions reduction target.



<http://www.environment.gov.au/climate-change/publications/tracking-to-2020>

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.

<http://ageis.climatechange.gov.au>

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: <http://www.environment.gov.au/climate-change/greenhouse-gas-measurement/land-sector>.

Australia's Second Biennial Report

Australia's second Biennial Report is a comprehensive summary of Australia's progress towards meeting its commitments under the United National Framework Convention on Climate Change (UNFCCC). Countries such as Australia are required to submit these reports to the UNFCCC every two years.

<http://www.environment.gov.au/climate-change/publications/australias-second-biennial-report>



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: http://unfccc.int/national_reports/items/1408.php8.



environment.gov.au

