ATTACHMENT C
FOI 65339
Document 1

DEPARTMENT OF THE ENVIRONMENT AND ENERGY

MS19-000818

To: Minister for Energy and Emissions Reduction (For Decision)

RELEASE OF THE JUNE 2019 QUARTERLY UPDATE OF THE NATIONAL GREENHOUSE GAS INVENTORY

Timing: 29 November 2019 - to meet the deadline for tabling in the Senate by 30 November 2019.

Recommendations:

1. That you note that the June *2019 Quarterly Update of the National Greenhouse Gas Inventory* is ready for release (**Attachment A**).

Noted / Please discuss

2. That you approve the *June 2019 Quarterly Update of the National Greenhouse Gas Inventory* (**Attachment A**) for tabling in the Senate before 30 November 2019 as per the Senate procedural order of continuing effect (17 October 2018 J.3974).

Approved / Not approved

Minister: Date:

Comments:

Clearing Officer: Sent: 22/11/2019	s22	A/g Assistant Secretary, NISIR / ICCEID	Ph: 6159 7430 Mob: s22
Contact Officer:	s22	Director, NIS ICCEI Division	Ph: s22 Mob: s22

Key Points:

1. The *Quarterly Update* provides comprehensive national emission estimates for all sectors up to June 2019 and for the National Electricity Market (NEM) up to the September quarter 2019.

2. The estimates include the latest National Greenhouse and Energy Reporting Scheme (NGERS) data, which was available as of 31 October 2019.

3. Tabling of this Quarterly Update is required by 30 November 2019 to meet the Senate procedural order of continuing effect (17 October 2018 J.3974).

Results

4. National emission levels for the June 2019 quarter were unchanged relative to the previous quarter, on a seasonally adjusted and weather normalised basis, but increased by 0.3 per cent in trend terms (Table 1 **Attachment A**).

5. Emissions for the year to June 2019 are estimated to be 532.0 Mt CO_2-e, down 0.1 per cent (0.4 Mt CO_2-e) on the previous year.

    a. Emissions had been increasing since 2016 with this the first decline since then.

6. The decrease in the year to June 2019 reflects annual decreases in emissions from the *electricity* (down 1.2 per cent), *transport* (down 0.5 per cent) and *agriculture* (down 5.9 per cent) sectors (Table 3 **Attachment A**).

7. Australia's emissions for the year to June 2019 were 0.8 per cent below emissions in 2000, and 12.9 per cent below emissions in 2005.

8. Emissions per capita, and the emissions intensity of the economy, have declined further and are at their lowest levels in 29 years.

9. The table in **Attachment B** compares the estimates for the new publication (June 2019) and previous publication (March 2019 *Quarterly Update)*. Key points, the proposed web landing page and draft text of the tabling letter are at **Attachments C, D** and **E**.

Special Topic

10. The *June 2019 Quarterly Update* also includes a special topic on how international trade affects Australia's national greenhouse gas inventory.

    a. The preliminary consumption-based inventory, provides complementary information and context to the standard production-based national greenhouse gas inventory.

    b. The approach adjusts our production-based inventory by adding overseas emissions associated with imports and subtracting Australian export-related emissions.

11. Australia's consumption-based emissions are lower than our production-based emissions, in contrast to most other OECD countries.

    a. In the year to June 2019, Australia's consumption-based inventory is estimated to be 450 Mt CO_2-e; this is 82 Mt CO_2-e or 15 per cent below our production-based inventory.

    b. These emissions are 102 Mt CO_2-e or 18 per cent lower compared to 2004-05.

12. Australian emissions released in producing our exports for 2018-19 were estimated at 199 Mt CO_2-e. This is 67 Mt CO_2-e or 50 per cent more than for 2004-05.

Consultation

13. The Department of the Treasury and the Australian Bureau of Statistics have been consulted on technical aspects of the consumption-based inventory modelling and on the content of the special topic.

ATTACHMENTS

A: *Quarterly Update of the National Greenhouse Gas Inventory: June 2019*
B: Comparison of the estimates for the new publication and previous publication
C: Key Points
D: Web landing page
E: Draft text of the tabling letter

Australian Government
Department of the Environment and Energy

Quarterly Update of Australia's National Greenhouse Gas Inventory: June 2019

Incorporating emissions from the NEM up to September 2019

Australia's National Greenhouse Accounts

Preface

The *Quarterly Update* provides estimates of Australia's national inventory of greenhouse gas emissions up to the June quarter of 2019, and emissions from the National Electricity Market (NEM)[1] up to the September quarter 2019.

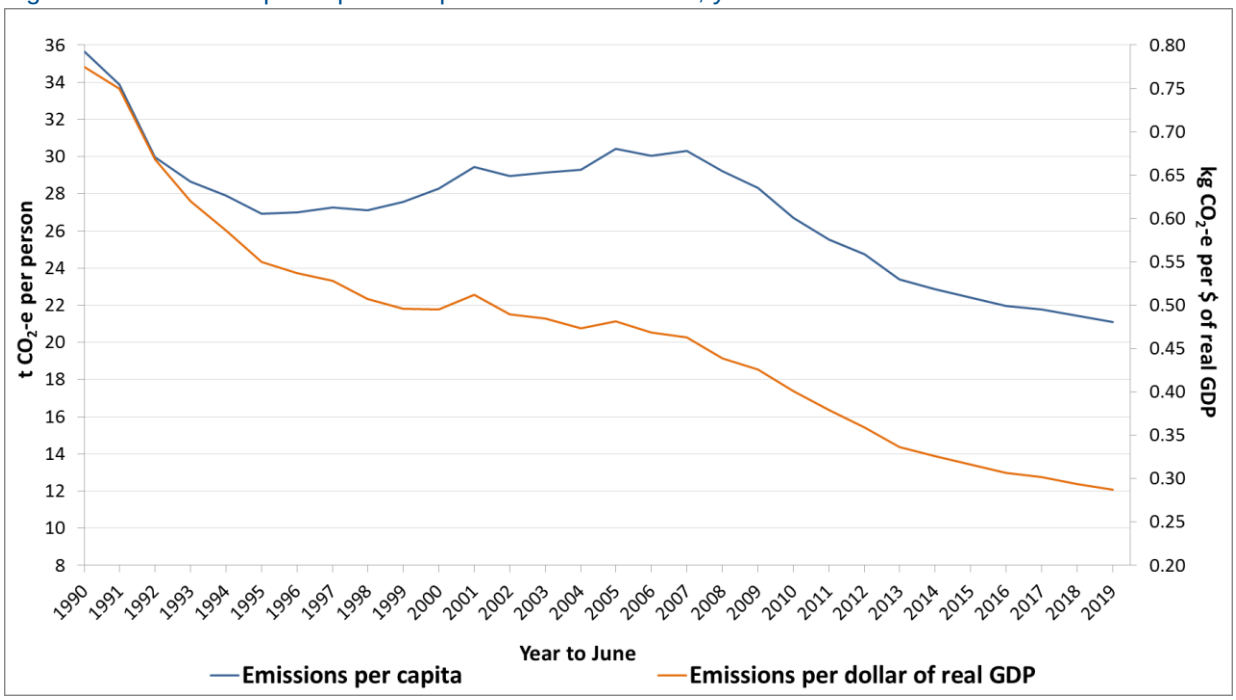
National emission levels[2] for the June quarter 2019 were unchanged relative to the previous quarter, on a seasonally adjusted and weather normalised basis, but increased by 0.3 per cent in trend terms.

Emissions for the year to June 2019 are estimated to be 532.0 Mt CO_2-e, down 0.1 per cent or 0.4 Mt CO_2-e on the previous year. Strong growth in emissions from *stationary energy* (3.6 per cent or 3.5 Mt CO_2-e) and *fugitive emissions* (4.4 per cent or 2.4 Mt CO_2-e), were offset by the combination of the ongoing reduction in emissions from *electricity* (1.2 per cent or 2.1 Mt CO_2-e) and the effects of the drought on *agriculture* (5.9 per cent or 4.2 Mt CO_2-e).

Australia's emissions for the year to June 2019 have declined 15.2 per cent since the peak in the year to June 2007 and were 0.8 per cent below emissions in 2000 and 12.9 per cent below emissions in 2005.

In the year to June 2019 emissions per capita, and the emissions intensity of the economy were at their lowest levels in 29 years. Emissions per capita in the year to June 2019 were lower than 1990 by 40.9 per cent, while the emissions intensity of the economy was 62.9 per cent lower than in 1990 (Figure P1).

Figure P1: Emissions per capita and per dollar of real GDP, year to June 1990 to 2019



Source: Department of the Environment and Energy

Emissions from the *electricity* sector are experiencing a long term decline, down 15.0 per cent from the peak recorded in the year to June 2009. Emissions in the NEM for the September quarter 2019 decreased by 1.5 per cent on a seasonally adjusted and weather normalised basis compared with the previous quarter.[3] For the September 2019 quarter, generation from renewables increased

[1] The NEM includes grid electricity in the Eastern and South Eastern states and accounts for approximately 83 per cent of total electricity estimates in the year to June 2019.

[2] National emissions levels are inclusive of all sectors of the economy, including Land Use, Land use Change and Forestry (LULUCF).

[3] 'Unadjusted', 'seasonally adjusted, weather normalised' and 'trend' are defined in Section 4 - Technical notes

20.3 per cent primarily due to increases in wind generation (21.4 per cent) and solar generation (33.5 per cent).

Recalculations

In this *Quarterly Update,* the time-series of emissions has been recalculated using critical new datasets released since the publication of the March *Quarterly Update* and in preparation for the submission of the Australian Government's National Inventory Report under the UN Framework Convention on Climate Change next year. These datasets include:

- Newly released National Greenhouse and Energy Reporting Scheme (NGERS) data, including final data for 2017-18 and preliminary data for 2018-19, which became available as of 31 October 2019;
- The 2019 Energy Update revised energy consumption estimates down for the entire period 2014-2018; and
- New data from the Australian Bureau of Agricultural and Resource Economics and Sciences showing the drought intensifying its impacts beyond previous expectations.

Detail is provided in Section 5 - Technical Notes.

Special Topic

The special topic (Section 4) highlights that the growing importance of international trade in conjunction with the specialisation in Australia of the production of goods that are relatively emissions-intensive to produce have placed upward pressure on Australia's greenhouse gas inventory in recent years.

A consumption-based national greenhouse gas inventory has been generated by the Department for the first time. It is presented as a preliminary inventory for ongoing work.

This new account estimates the impacts on emissions in Australia and in other countries due to Australian consumption. According to this indicator, Australia's consumption-based inventory decreased by 4 per cent or 20 Mt CO_2-e to 450 Mt CO_2-e in the year to June 2019. Emissions generated by Australian consumption are 102 Mt CO_2-e or 18 per cent lower compared to 2004-05.

On an annual basis, the preliminary consumption-based inventory shows that the emissions generated to support Australia's consumption are less than those reported as the (production-based) national greenhouse gas inventory by 82 Mt CO_2-e or 15 per cent.

Consumption-based emissions are approximately 17.7 tonnes per person, which is around 3.4 tonnes per person less than the per capita emission calculation using the national greenhouse gas inventory.

The consumption-based inventory estimates that emissions released in Australia in producing our exports for 2018-19 were 199 Mt CO_2-e. This is 67 Mt CO_2-e or 50 per cent more than for 2004-05.

The preliminary analysis indicates that the net effect of Australia's trade with North East Asia, has been to exert strong upward pressure on Australia's national greenhouse gas inventory.

Contents

1. Overview

Table 1: National Greenhouse Gas Inventory[4], June quarter 2019, emissions growth rates

	June quarter 2019	Year to June 2019
Quarterly change – seasonally adjusted and weather normalised[5]	0.0%	
Quarterly change – seasonally adjusted and weather normalised – trend[5]	0.3%	
Annual Change		-0.1%

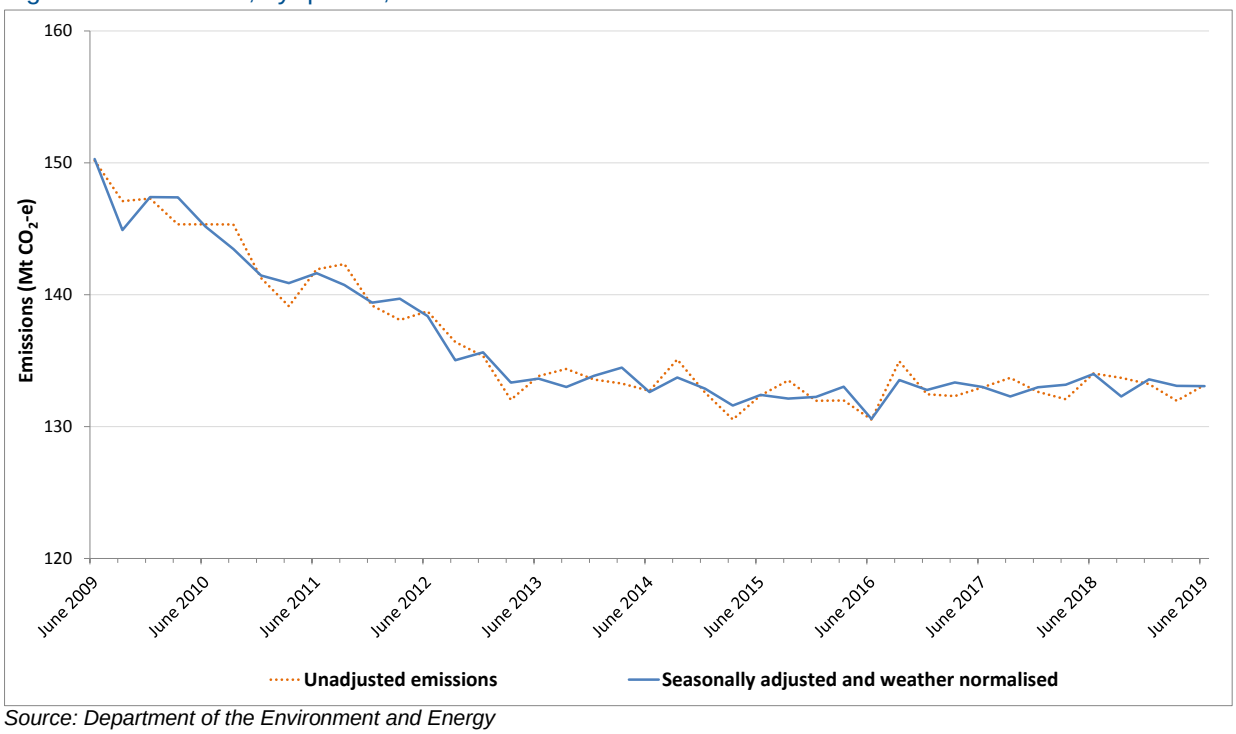
Table 2: National Electricity Market (NEM)[6], September quarter 2019, emissions growth rates

	September quarter 2019	Year to September 2019
Quarterly change – seasonally adjusted and weather normalised[5]	-1.5%	
Quarterly change – seasonally adjusted and weather normalised – trend[5]	-2.6%	
Annual Change		-2.9%

Summary of emissions in the June quarter 2019

National emissions for the June quarter 2019 were unchanged relative to the previous quarter, on a seasonally adjusted and weather normalised basis, but increased by 0.3 per cent in trend terms (Figure 1 and Figure 2).

Figure 1: Emissions[2], by quarter, June 2009 to June 2019



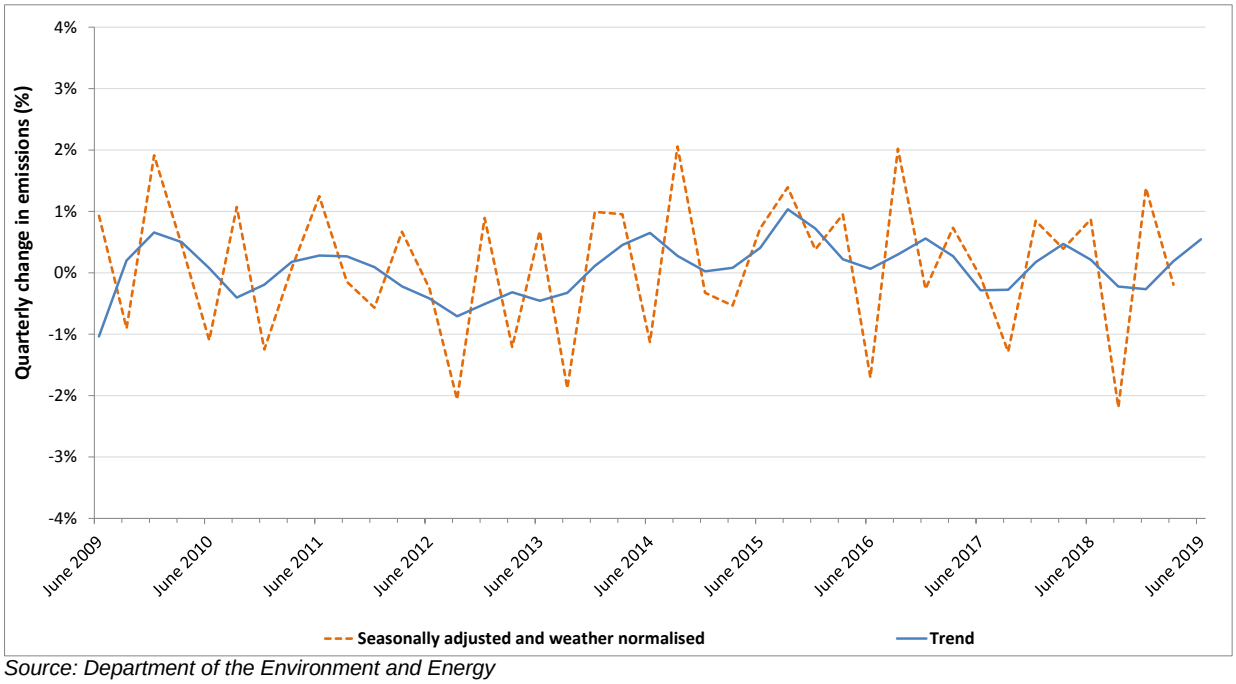
Source: Department of the Environment and Energy

[4] National emissions levels are inclusive of all sectors of the economy, including *Land Use, Land Use Change and Forestry* (LULUCF).

[5] 'Unadjusted', '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 83 per cent of total *electricity* estimates in the year to September 2019.

Figure 2: Emissions growth rates, by quarter, June 2009 to June 2019

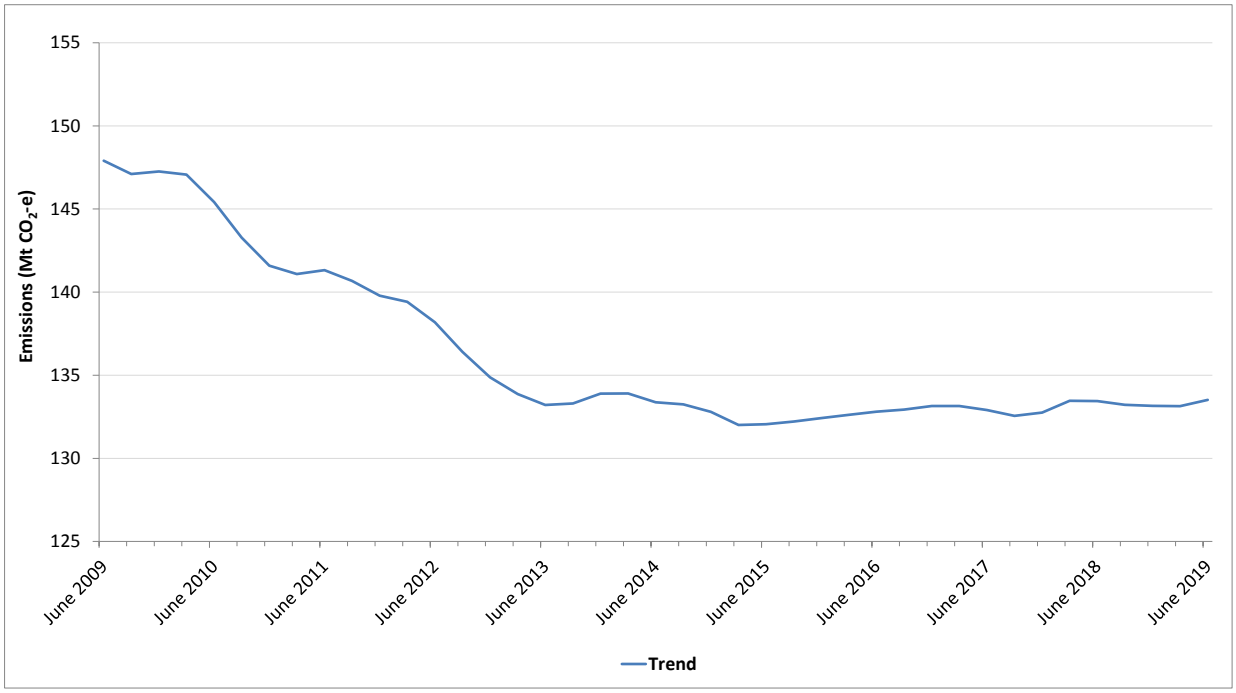


Source: Department of the Environment and Energy

On a seasonally adjusted basis, strong growth in emissions from Australia's export industries, principally LNG (0.6 Mt CO_2-e), were offset by the combination of the ongoing reduction in *electricity* emissions (1.8 per cent or 0.8 Mt CO_2-e) and the effects of the drought on *agriculture* (0.8 per cent or 0.1 Mt CO_2-e).

Trend emissions (Figure 3) increased by 0.3 per cent, due to increases in emissions the *stationary energy* and *fugitive emissions* sectors. This mainly reflects increases in LNG exports (up 6.1 per cent).

Figure 3: Trend emissions, by quarter, June 2009 to June 2019



Source: Department of the Environment and Energy

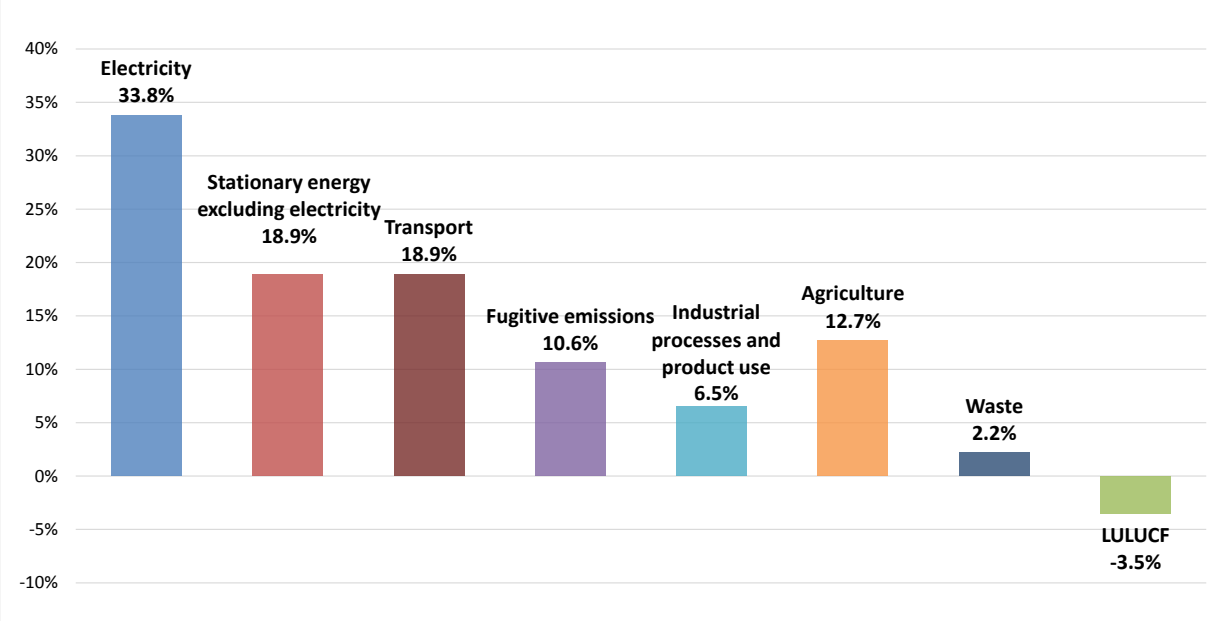
Summary of annual emissions

Emissions for the year to June 2019 are estimated to be 532.0 Mt CO_2-e. The 0.1 per cent or 0.4 Mt CO_2-e decrease in emissions over the year to June reflects annual decreases in emissions from the *electricity, transport* and *agriculture* sectors (Table 3). These decreases in emissions were partially offset by increases in emissions from *stationary energy* and *fugitive* sectors.

Table 3: 'Unadjusted' annual emissions, by sector, for the year to June 2018 and 2019

Sector	Annual emissions (Mt CO_2-e)		Change (%)
	Year to June 2018	Year to June 2019	
Energy – Electricity	182.0	179.9	-1.2
Energy – Stationary energy excluding electricity	97.3	100.8	3.6
Energy – Transport	100.9	100.4	-0.5
Energy – Fugitive emissions	54.0	56.4	4.4
Industrial processes and product use	34.5	34.7	0.6
Agriculture	71.6	67.4	-5.9
Waste	11.8	11.8	0.0
Land Use, Land Use Change and Forestry	-19.7	-19.3	2.0
National Inventory Total	**532.4**	**532.0**	**-0.1**

Figure 4: Share of total emissions, by sector, for the year to June 2019



Source: Department of the Environment and Energy

Emissions from total export industries increased by 6 per cent, mainly reflecting the increases in LNG exports (up 21.3 per cent). The increases in LNG exports contributed 1.4 Mt CO_2-e to the 3.5 Mt CO_2-e increase in *stationary energy* emissions and 4.8 Mt CO_2-e to *fugitive* emissions due to flaring and the venting and leakage of methane and carbon dioxide.

Transport emissions decreased 0.5 per cent over the year to June reflecting a 4.3 per cent decrease in petrol consumption.

Over the year to June 2019 there were decreases in emissions from the *electricity* and *agriculture* sectors. The 1.2 per cent decrease in emissions from the *electricity* sector is mainly due to a 1.6 per cent reduction in coal consumption, a 17.4 per cent reduction in gas consumption, and a corresponding 20.1 per cent increase in supply from renewable sources in the NEM. The 5.9 per cent decline in emissions from the *agriculture* sector reflects the effects of drought which has led to a decline in livestock populations as well as fertiliser use.[7]

Sectoral trends since 1990

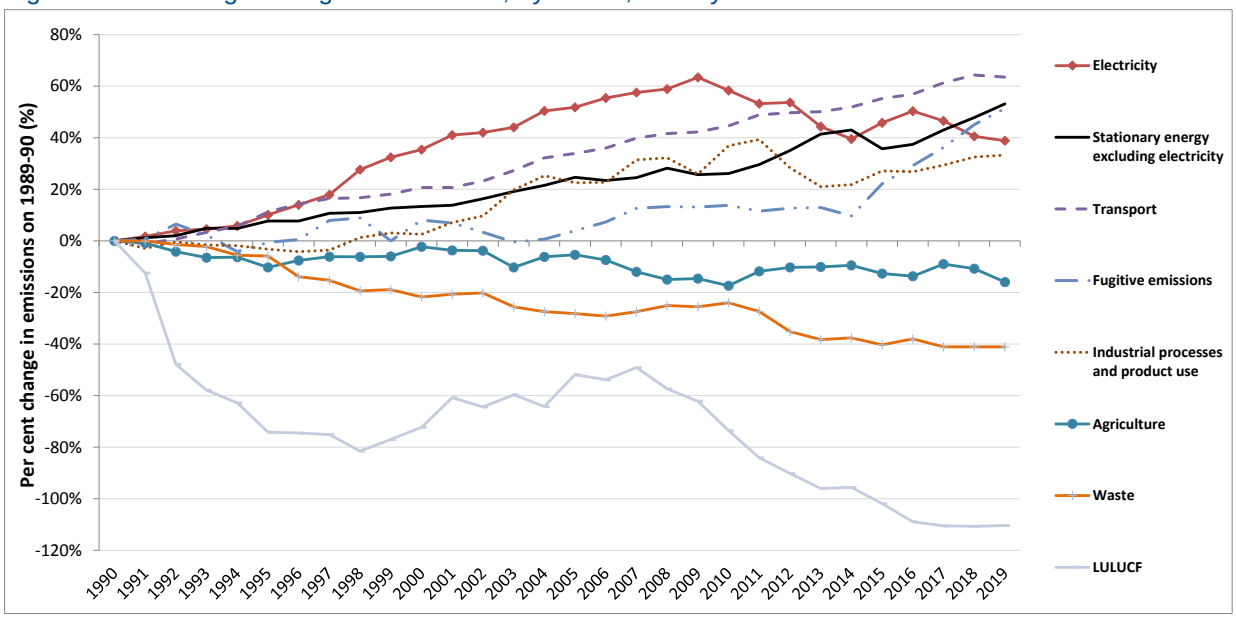
Australia's emissions in the year to June 2019 were 532.0 Mt CO_2-e, which is 12.0 per cent (72.9 Mt CO_2-e) lower than in 1990.

In percentage terms, the *transport* sector has experienced the largest increase, increasing 63.5 per cent (39.0 Mt CO_2-e) between 1990 and the year to June 2019. Other sectors which have increased in emissions since 1990 include *fugitive emissions* (51.4 per cent or 19.1 Mt CO_2-e), *stationary energy excluding electricity* (53.1 per cent or 35.0 Mt CO_2-e), *electricity* (38.8 per cent or 50.3 Mt CO_2-e) and *industrial processes and product use* (33.3 per cent or 8.7 Mt CO_2-e).

In contrast, the *waste* and *agriculture* sectors have each decreased in emissions since 1990. *Land Use, Land Use Change and Forestry (LULUCF)* emissions have decreased by the largest margin of any sector since 1990 (110.4 per cent or 203.8 Mt CO_2-e).

The change in emissions from each sector from the year to June 1990 to 2019 in percentage terms is presented in Figure 5.

Figure 5: Percentage change in emissions, by sector, since year to June 1990



Source: Department of the Environment and Energy

[7] Australian Bureau of Agricultural and Resource Economics and Sciences (2019). *Agricultural Commodities, September Quarter 2019*.

2. Sectoral Analysis

2.1 Energy – Electricity

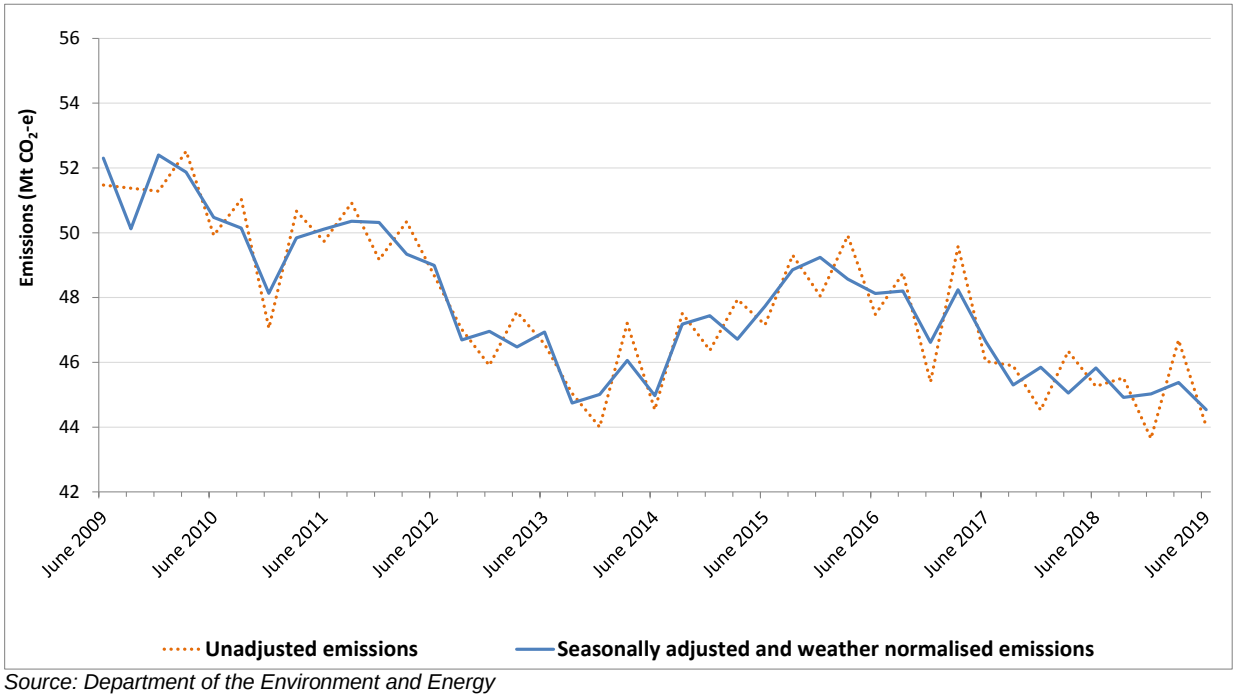
Electricity generation is the largest source of emissions in the national inventory, accounting for 33.8 per cent of emissions in the year to June 2019 (Figure 4).

Electricity sector emissions in the year to June 2019 were 15.0 per cent (31.8 Mt CO_2-e) lower than the peak recorded in the year to June 2009 (Data Table 1A).

Electricity sector emissions decreased 1.8 per cent in the June quarter of 2019 on a 'seasonally adjusted and weather normalised'[8] basis (Figure 6). This reflected strong increases in hydro and wind generation (42.0 and 14.8 per cent) and decreases in coal and natural gas generation (5.7 and 21.3 per cent) in the National Electricity Market (NEM).

Over the year to June 2019, emissions from *electricity* decreased by 1.2 per cent compared with the year to June 2018.

Figure 6: *Electricity* sector emissions, by quarter, June 2009 to June 2019



Source: Department of the Environment and Energy

National Electricity Market (NEM) emissions

Emissions in the NEM for the September quarter 2019 decreased by 1.5 per cent on a seasonally adjusted and weather normalised basis compared with the previous quarter (Figure 7). Emissions from the NEM account for around 83 per cent of national electricity emissions.

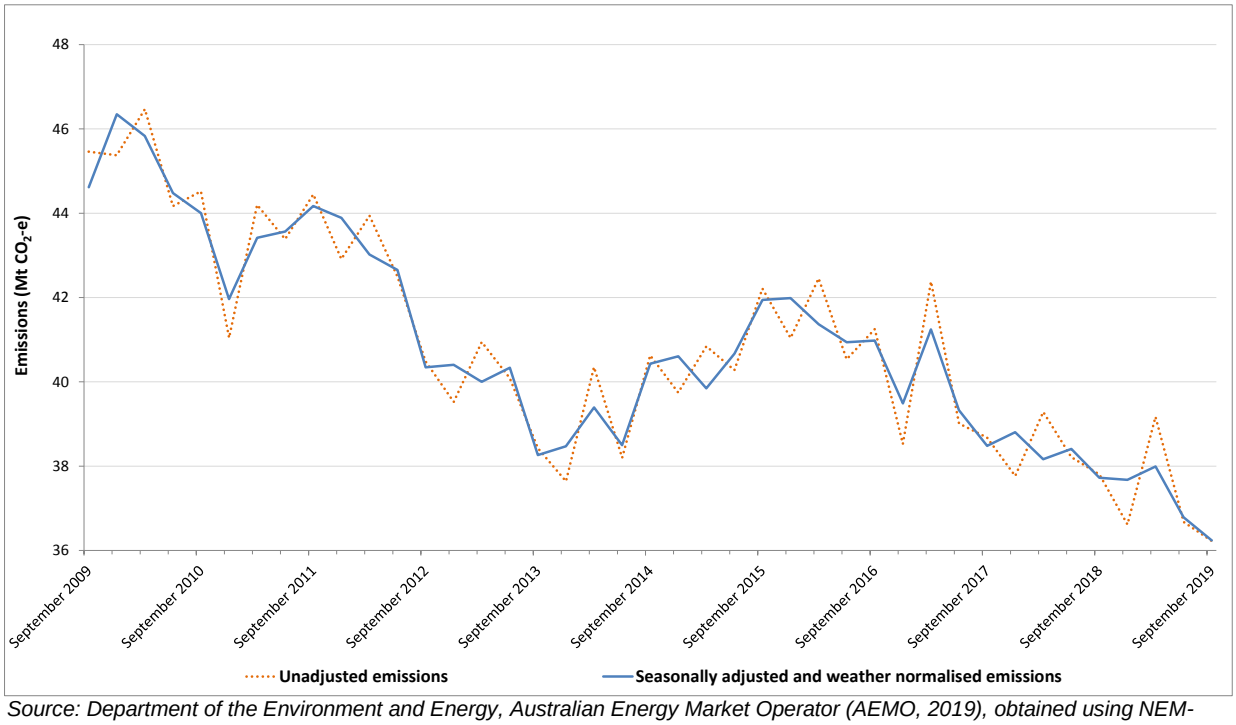
[8] Two adjustments are made:

a) Seasonal adjustment is a first-order adjustment using Eurostat software that systematically corrects emissions data for average fluctuations in seasonal conditions 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

b) Weather normalisation is a second-order adjustment that systematically corrects emissions data for atypical temperature effects on electricity demand within the year 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 7: Special Topic' of the December 2011 *Quarterly Update*

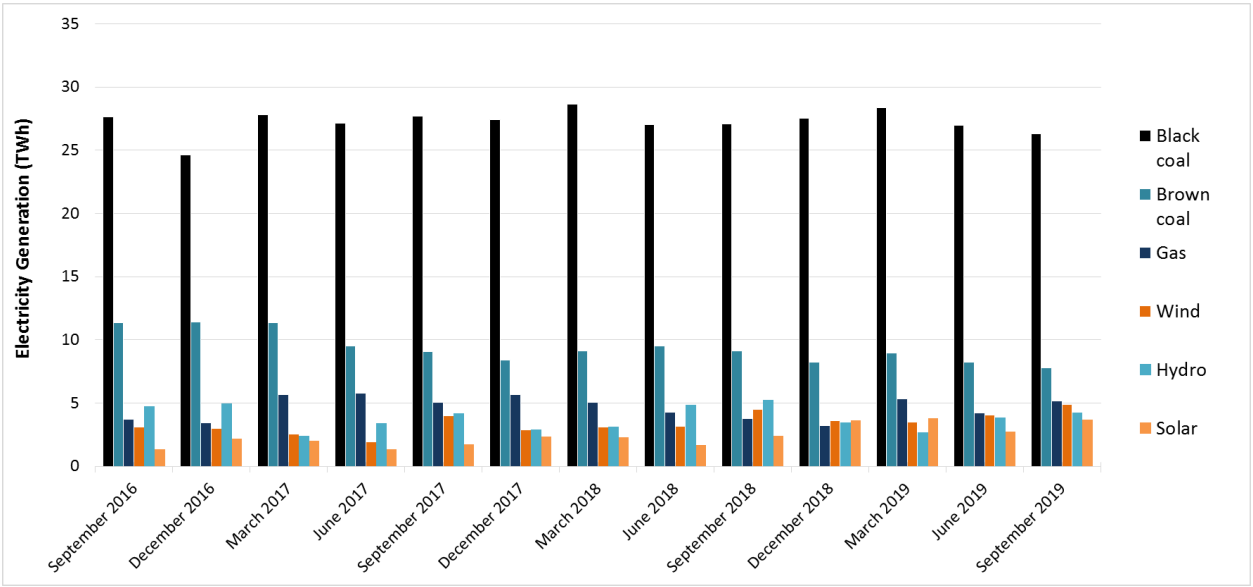
Figure 7: NEM *electricity* emissions, by quarter, September 2009 to September 2019



Source: Department of the Environment and Energy, Australian Energy Market Operator (AEMO, 2019), obtained using NEM-Review software

For the September 2019 quarter, generation from renewables increased 20.3 per cent, significantly higher than the 6.0 per cent increase for the June 2019 quarter (Figure 8). This was primarily due to increases in wind generation (21.4 per cent) and solar generation (33.5 per cent).

Figure 8: Electricity generation in the NEM, by fuel, by quarter, September 2016 to September 2019



Source: Australian Energy Market Operator (AEMO, 2019), obtained using NEM-Review software

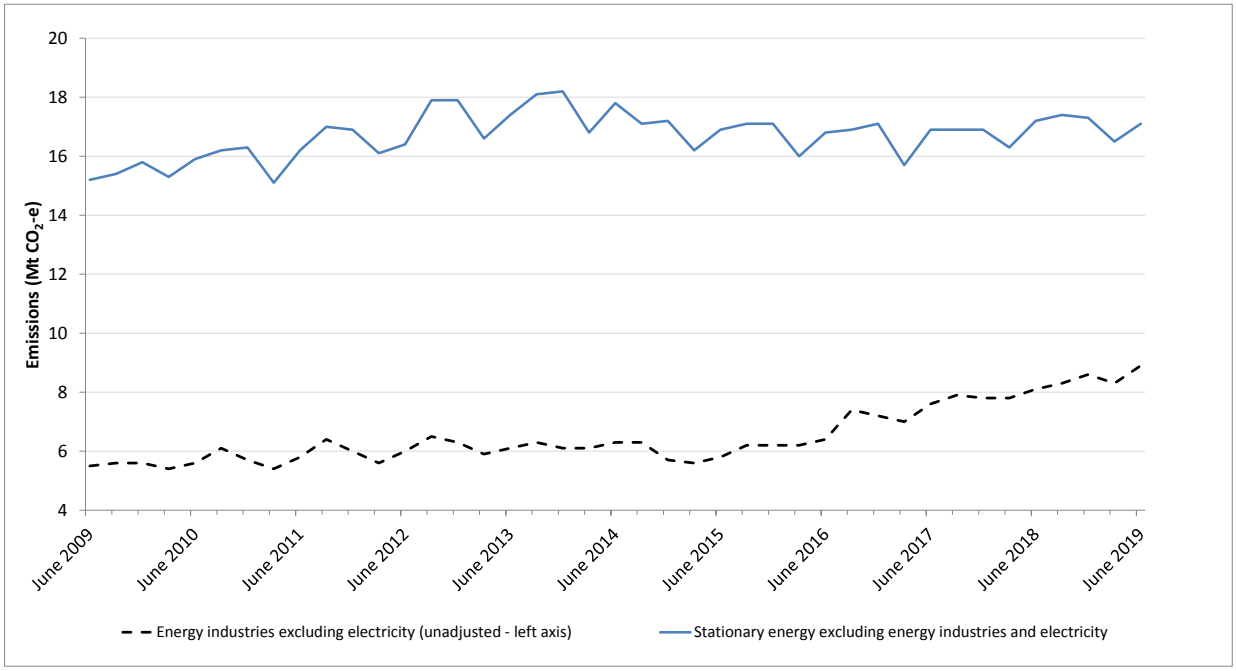
2.2 Energy – Stationary energy excluding electricity

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

In the year to June 2019, *stationary energy excluding electricity* accounted for 18.9 per cent of Australia's national inventory (Figure 4).

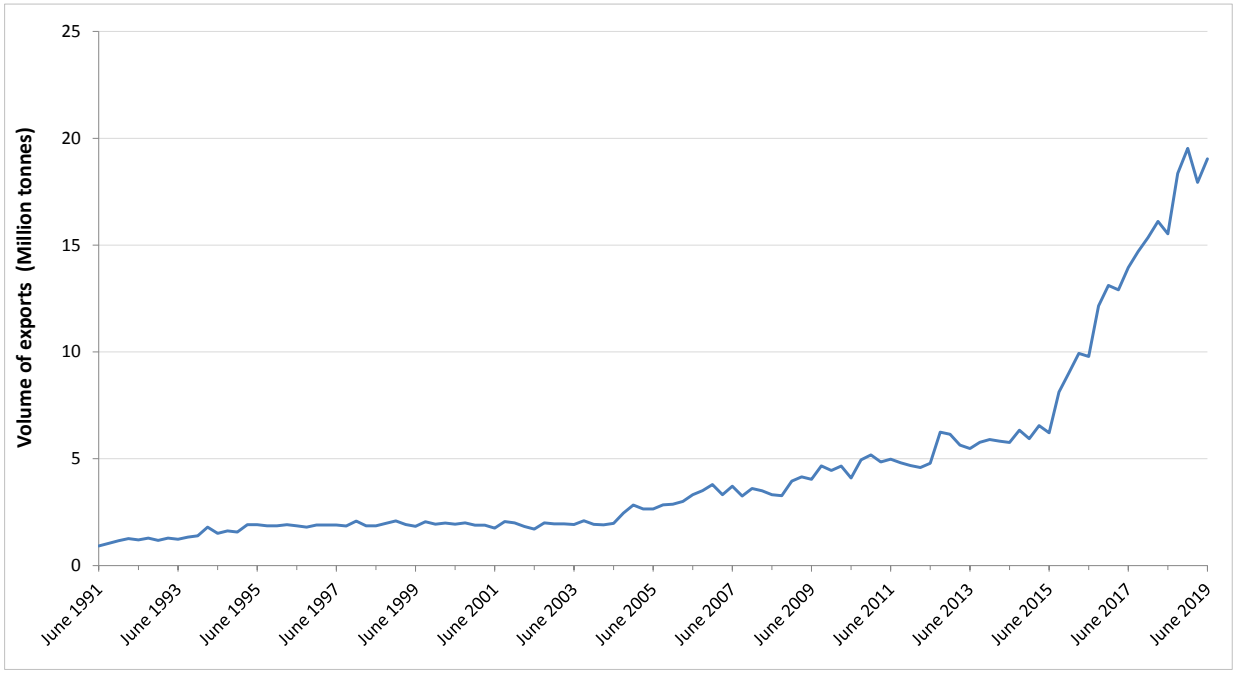
Emissions from *stationary energy excluding electricity* in the June quarter of 2019 increased 0.3 per cent in trend terms compared with the March quarter of 2019. Emissions over the year to June 2019, increased by 3.6 per cent when compared with the previous year (Figure 9).

Figure 9: *Stationary energy excluding electricity* emissions and energy industries excluding electricity by quarter, June 2009 to June 2019



Source: Department of the Environment and Energy

Figure 10: LNG exports, by quarter, June 1991 to June 2019



Source: Department of Industry Innovation and Science

Unadjusted emissions from *stationary energy excluding electricity* are estimated to have increased by 3.5 Mt CO_2-e in the year to June 2019 compared with the year to June 2018. This was driven primarily by a 1.4 Mt CO_2-e increase due to the 21.3 per cent in LNG exports in the year to June 2019 (Figure 10).

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.

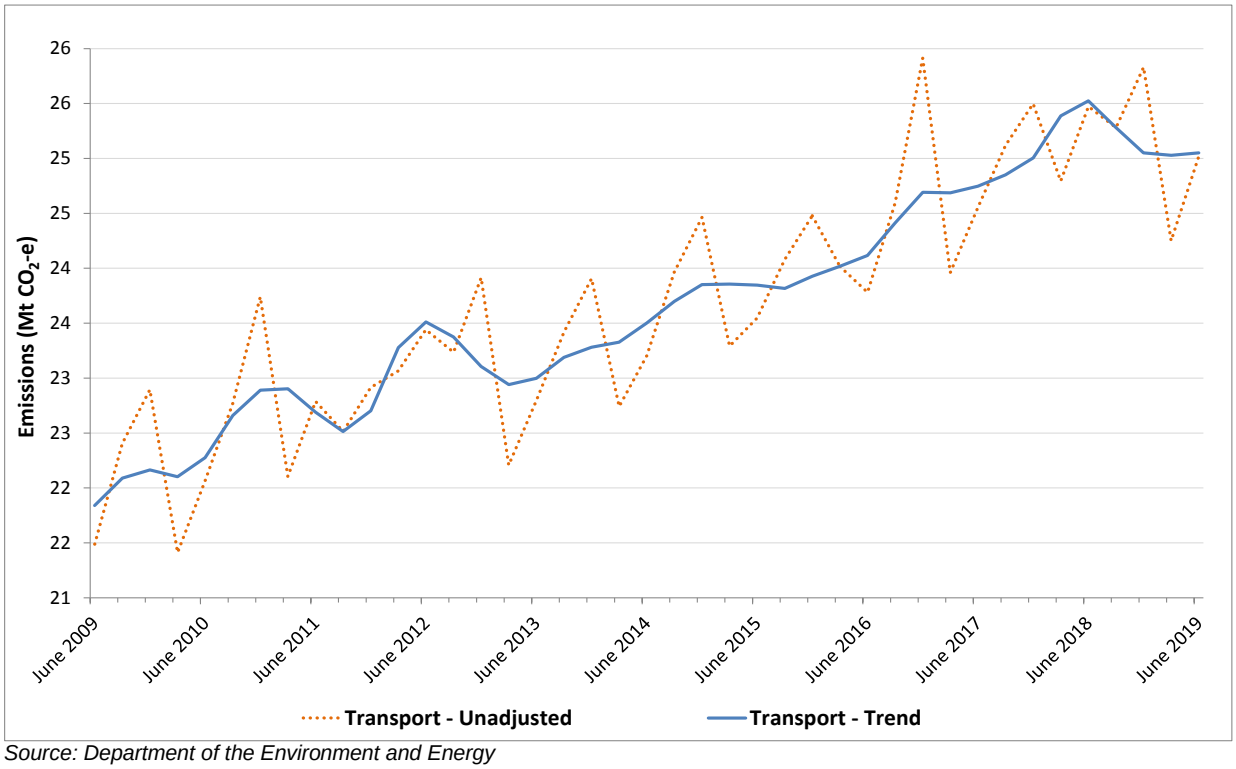
In the year to June 2019, transport accounted for 18.9 per cent of Australia's national inventory (Figure 4).

The domestic transport sector accounts for over 70 per cent[9] of liquid fuels consumed in Australia. The past six years have seen a decrease in the consumption of petrol (including ethanol-blended) of 5.0 per cent and a strong increase in diesel consumption of 18.9 per cent.

Emissions in the June 2019 quarter increased 0.1 per cent in trend terms, while 'unadjusted' emissions increased 3.2 per cent (Figure 11). This is attributed to increased diesel sales for the June 2019 quarter after unusually low diesel sales in the March 2019 quarter.

Emissions from *transport* over the year to June 2019 decreased by 0.5 per cent when compared with the previous year. This decline in transport emissions reflected a 4.3 per cent annual decline in petrol consumption.

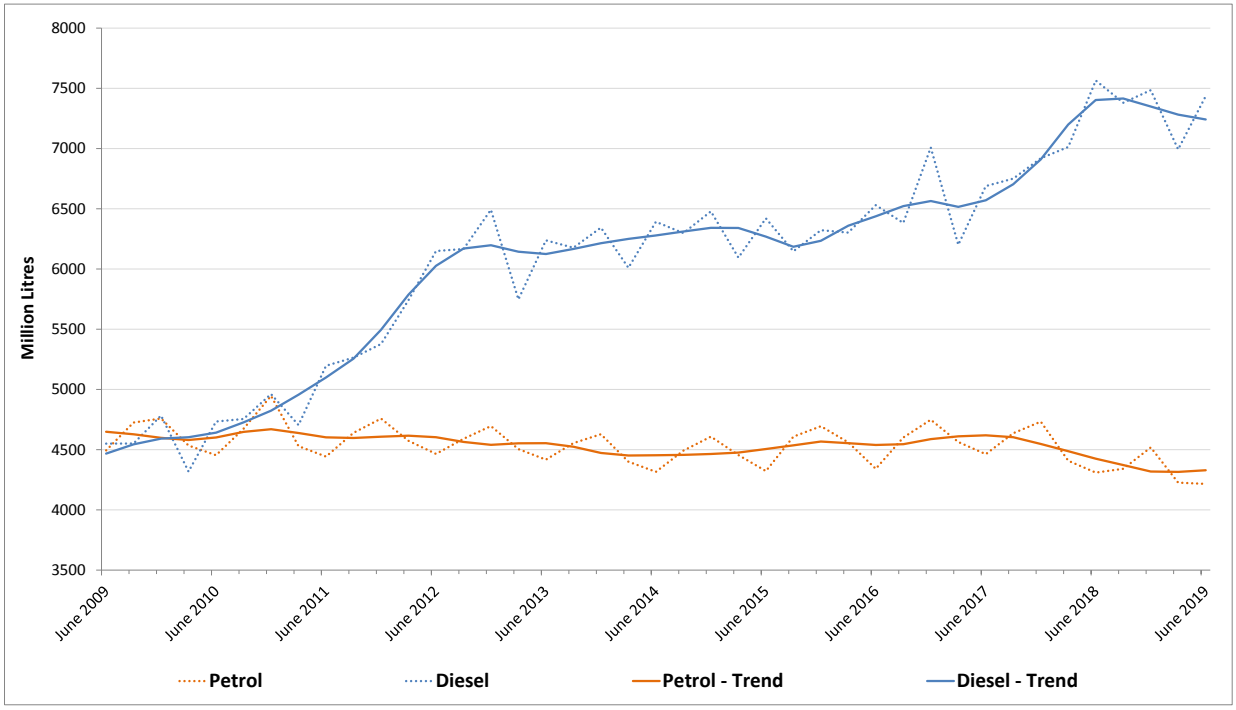
Figure 11: *Transport* emissions, unadjusted and trend, by quarter, June 2009 to June 2019



Source: Department of the Environment and Energy

[9] Department of the Environment and Energy (2019). Australian Energy Statistics: Table F. https://www.energy.gov.au/publications/australian-energy-update-2019

Figure 12: Consumption of primary liquid fuels, unadjusted and trend, by quarter, June 2009 to June 2019



Source: Department of the Environment and Energy

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.

Figure 13: *Fugitive emissions*, unadjusted and trend, by sub-sector, by quarter June 2009 to June 2019

Source: Department of the Environment and Energy

Fugitive emissions in the June quarter increased 4.0 per cent on a seasonally adjusted basis. Emissions increased in trend terms by 1.6 per cent.

The increase in emissions was driven by total gas production increasing 10.1 per cent in the June 2019 quarter. Underlying this rise was a 6.1 per cent increase in LNG exports. A 2.9 per cent increase in underground coal production also contributed to the increase in *fugitive* emissions.

Annual unadjusted emissions in this sector increased by 4.4 per cent over the year to June 2019 (Figure 13). This increase in *fugitive* emissions was driven by an increase of 20.7 per cent[10] in natural gas production, and partially offset by a decrease of 6.8 per cent in underground coal production.

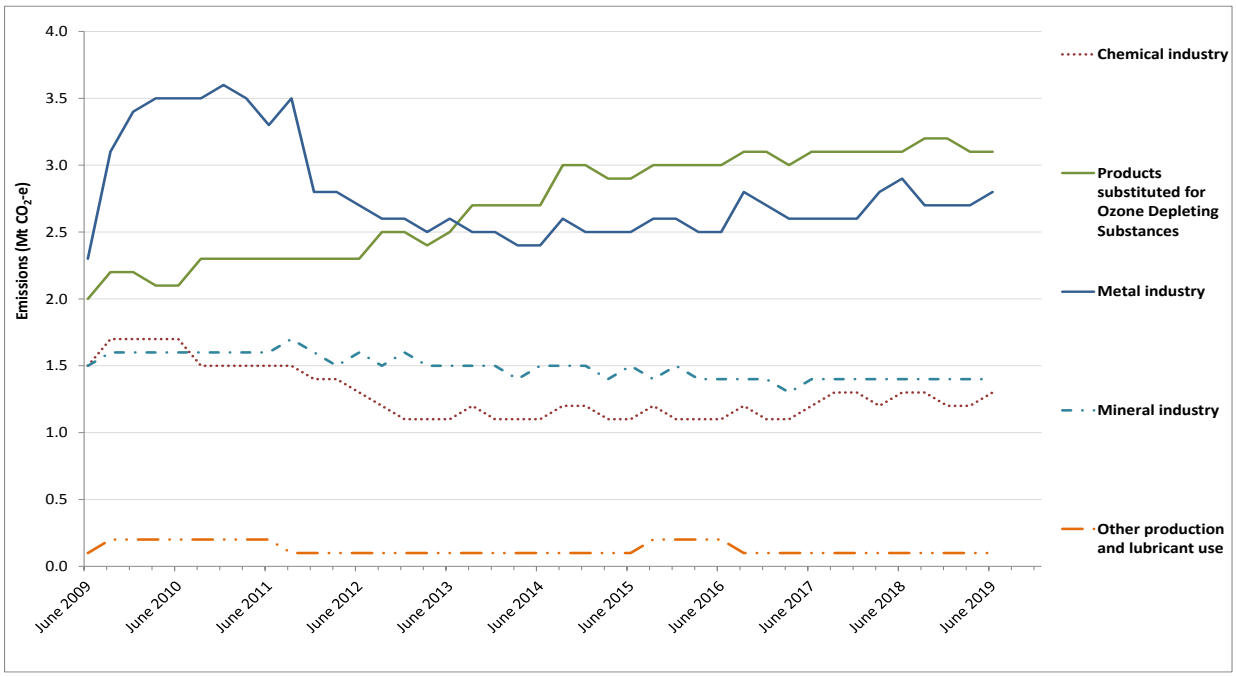
2.5 Industrial processes and product use

Emissions from *industrial processes and product use* occur as the result of by-products of materials and reactions used in production processes. This sector includes emissions from processes used to produce chemical, metal, and mineral products. It also includes emissions from the consumption of synthetic gases.

In the year to June 2019, *industrial processes and product use* accounted for 6.5 per cent of Australia's national inventory (Figure 4).

Trend emissions for industrial processes and product use increased by 0.3 per cent in the June quarter on the previous quarter. Over the year to June 2019, the increase of 0.8 per cent was largely due to increasing emissions from chemicals production and a 1.6 per cent increase in emissions from products used as substitutes for ozone depleting substances (Figure 14).

Figure 14: Industrial processes and product use emissions, unadjusted, by sub-sector, by quarter, June 2009 to June 2019



Source: Department of the Environment and Energy

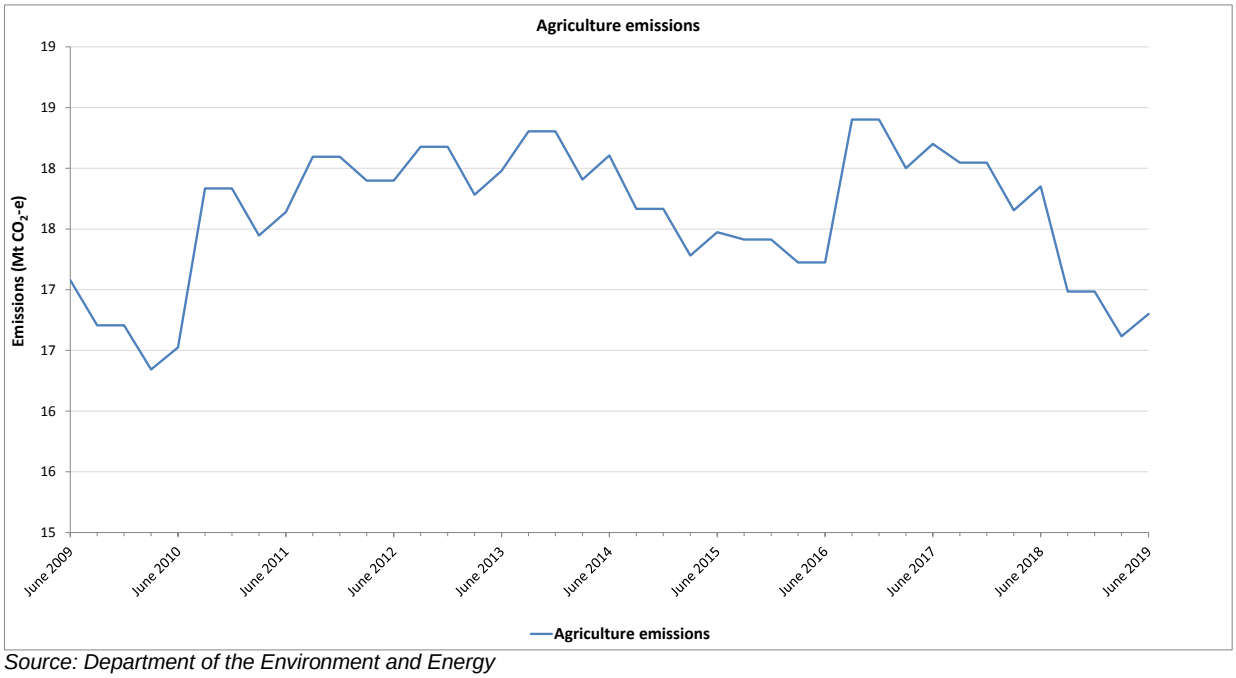
[10] Department of Industry, Innovation and Science (2019). *Resources and Energy Quarterly, September 2019*

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 (Figure 15).

In the year to June 2019, *agriculture* accounted for 12.7 per cent of Australia's national inventory (Figure 4). Emissions from Agriculture have decreased by 5.9 per cent over the year to June 2019.

Figure 15: *Agriculture* emissions, unadjusted, by quarter, June 2009 to June 2019[11]



Source: Department of the Environment and Energy

Drought conditions have impacted the cattle and sheep industries due to poor grazing conditions and the high cost and availability of grain. The lack of feed available has led to elevated levels of turn-off of both sheep and cattle resulting in a contraction in the Australian national herd and flock. Floods in Queensland in early 2019 also led to a significant loss of cattle (approximately 600,000).[12]

During 2018-19, drought conditions impacted crop yields throughout Australia as planting decisions are primarily driven by water availability and market demand. Drier than average seasonal conditions during the planting window and reduced supplies of irrigation water have reduced the cotton harvest by almost 50 per cent. In New South Wales the area of rice planted declined by close to 90 per cent in 2018–19 and production is estimated to have declined to 59,000 tonnes.[13]

The forecast volume of farm production for 2019–20 is similar to levels last recorded during the Millennium Drought.

[11] The nature of the data underpinning the agriculture estimates creates an anomaly in the unadjusted quarterly data which is managed through seasonal adjustment and weather normalisation (Data Tables 1B and 1C).

[12] Australian Bureau of Agricultural and Resource Economics and Sciences (2019). *Agricultural Commodities, September Quarter 2019*

[13] Australian Bureau of Agricultural and Resource Economics and Sciences (2019). Australian Crop Report: September Edition. http://www.agriculture.gov.au/abares/research-topics/agricultural-commodities/australian-crop-report/overview

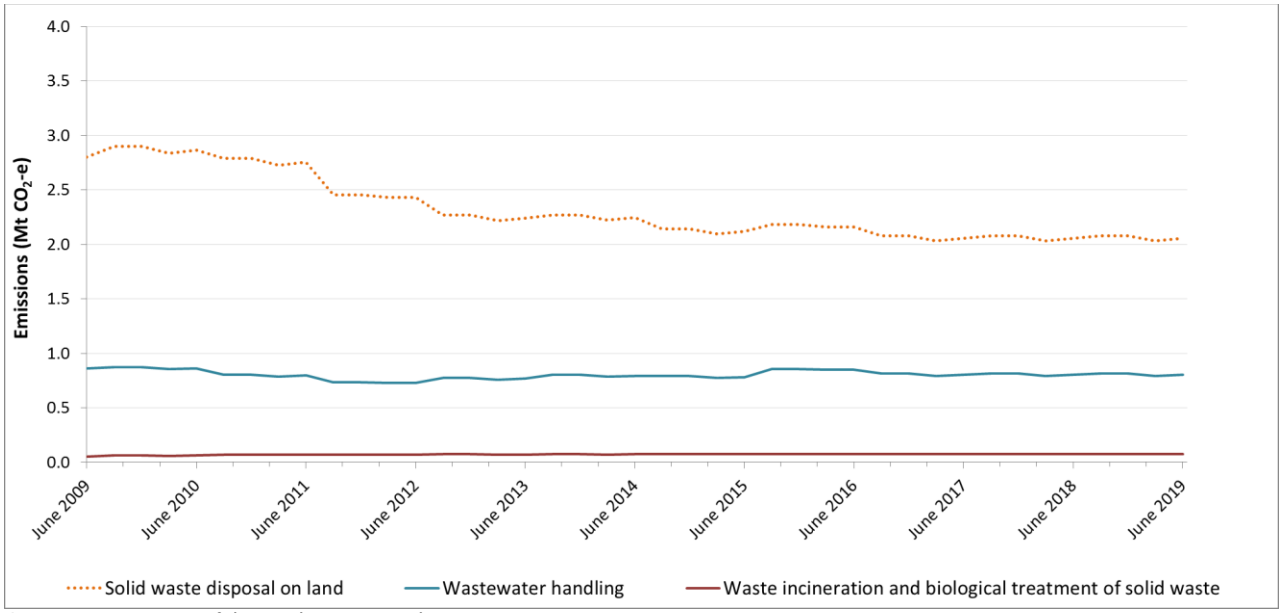
2.7 Waste

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 June 2019, *waste* accounted for 2.2 per cent of Australia's national inventory (Figure 4).

Emissions from *waste* remained steady over the year to June 2019 (Figure 16).

Figure 16: *Waste* emissions, unadjusted, by sub-sector, by quarter, June 2009 to June 2019



Source: Department of the Environment and Energy

2.8 Land Use, Land Use Change and Forestry

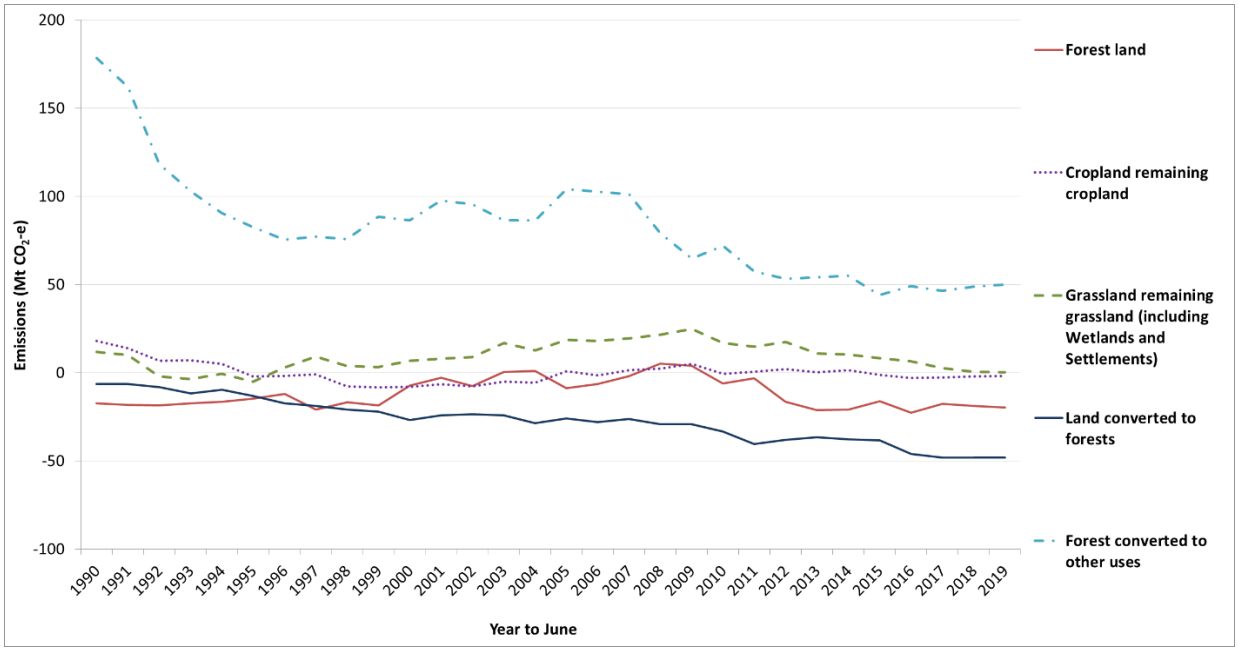
The *Land Use, Land Use Change and Forestry (LULUCF)* sector of the national inventory includes estimates of net anthropogenic emissions for forests and agricultural lands and changes in land use.

In the year to June 2019, the *LULUCF* sector[14] accounted for a net sink equivalent to 3.5 per cent of Australia's national inventory (Figure 4).

Net emissions for the *LULUCF* sector in the year to June 2019 are estimated to be a sink of 19.3 Mt CO_2-e (Figure 17). The sink of emissions remains generally flat, with a small decrease of 2.0 per cent (0.4 Mt CO_2-e) on the previous twelve months (Table 3).

[14] *LULUCF* includes Forest conversion, Forest land remaining forest land, Land converted to forest land, Grasslands (including Wetlands and Settlements) and Croplands

Figure 17: *LULUCF* net anthropogenic emissions, by sub-sector, year to June, 1990 to 2019



Source: Department of the Environment and Energy

3. Emissions per capita and per dollar of GDP

In the year to June 2019 emissions per capita, and the emissions intensity of the economy are at their lowest levels in 29 years.[15]

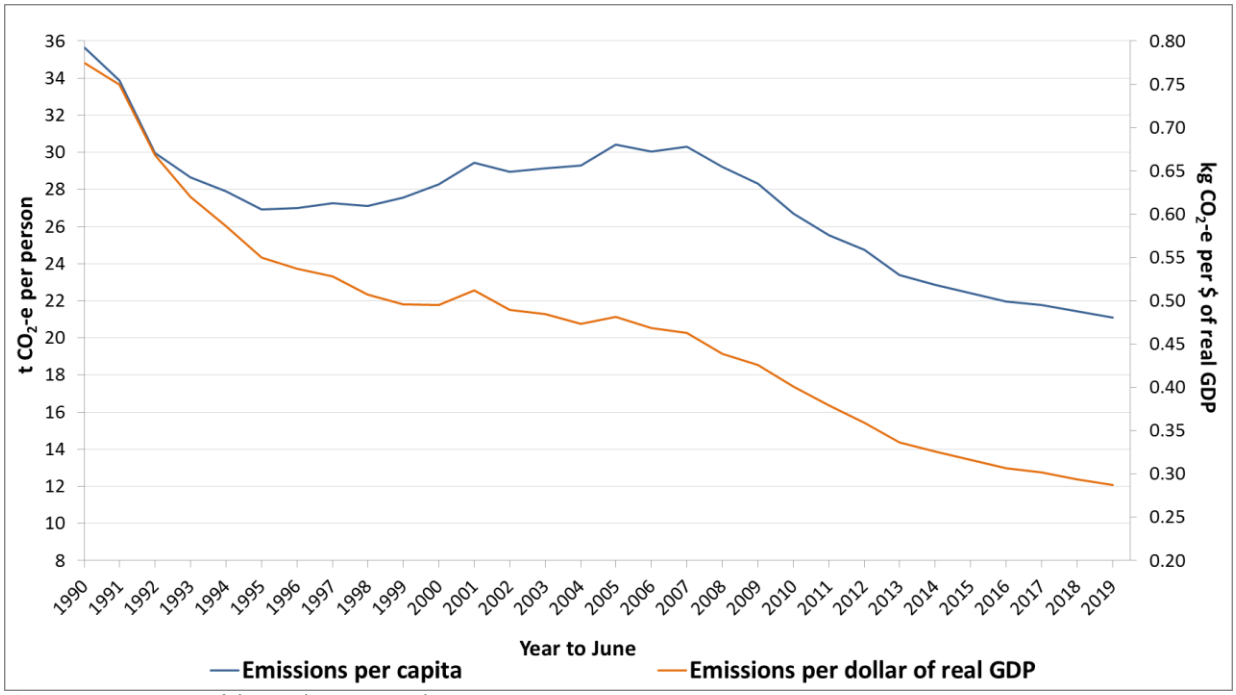
National inventory emissions per capita were 21.1 t CO_2-e per person in the year to June 2019. This represents a 40.9 per cent decline in national inventory emissions per capita from 35.6 t CO_2-e in the year to June 1990.

Over the period from 1989-90 to June 2019, Australia's population grew strongly from 17.0 million to around 25.4 million.[16,17] This reflects growth of 48.8 per cent.

Australia's real GDP (chain volume measures) also experienced significant growth over this period, expanding from $0.8 trillion in 1989-90 to around $1.9 trillion in the year to June 2019.[18] This represents a growth of 136.8 per cent.

National inventory emissions per dollar of real GDP fell from 0.77 kg CO_2-e per dollar in the year to June 1990 to 0.29 kg CO_2-e per dollar in the year to June 2019 (Figure 18). This represents a decline of 62.9 per cent from the year to June 1990.

Figure 18: Emissions per capita and per dollar of real GDP, unadjusted, year to June 1990 to 2019



Source: Department of the Environment and Energy

[15] 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)

[16] Australian Bureau of Statistics (2019), *Australian Demographic Statistics*, pub. no. 3101 http://www.abs.gov.au/ausstats/abs@.nsf/mf/3101.0

[17] Australian Bureau of Statistics (2019), *Population Clock*. http://www.abs.gov.au/AUSSTATS/abs@.nsf/Web+Pages/Population+Clock

[18] Australian Bureau of Statistics (2019), *National Accounts: National Income, Expenditure and Product*, Cat. No. 5206.0 http://www.abs.gov.au/ausstats/abs@.nsf/mf/5206.0

4. Special Topic – Australia's carbon footprint – a consumption-based national greenhouse gas inventory

Both Australia's economy and national greenhouse gas inventory are affected by international trade and capital flows. As a relatively small, open economy, Australia's income levels and emission outcomes will be strongly influenced by the forces of globalisation and by changing global demand patterns and technologies. The growing importance of international trade on the Australian economy in conjunction with the specialisation in Australia of the production of goods that are relatively emissions-intensive to produce, such as LNG, have placed upward pressure on Australia's inventory outcomes in recent years.

International trade generates improvements in living standards, and exports have increasingly contributed to Australia's GDP, rising as a share of GDP from 14 to 19 per cent since 2004-05. Preliminary estimates indicate that emissions released in Australia in producing our exports for 2018-19 were 199 Mt CO_2-e, which is 67 Mt CO_2-e or 50 per cent more than for our exports in 2004-05 (which reflects the base year of Australia's Paris Agreement target).

Globalisation is also tending to lead to increasing interdependence between national greenhouse gas inventories. For example, some of the emissions recorded in Australia's national inventory have been released in Australia to support, through trade, the consumption of goods by another country. Correspondingly, the emissions released in the production of goods that are subsequently imported and consumed in Australia are recorded in the inventories of other countries.

The level of emissions released in the production of goods for export, and for all goods consumed in Australia, can be estimated through some adjustments to the national greenhouse gas inventory (a 'consumption-based inventory') using data from the Department's National Greenhouse Accounts and input-output tables prepared by the ABS (see Box 1 and Section 4.5 for details).

Box 1: Production- vs consumption-based emissions inventories

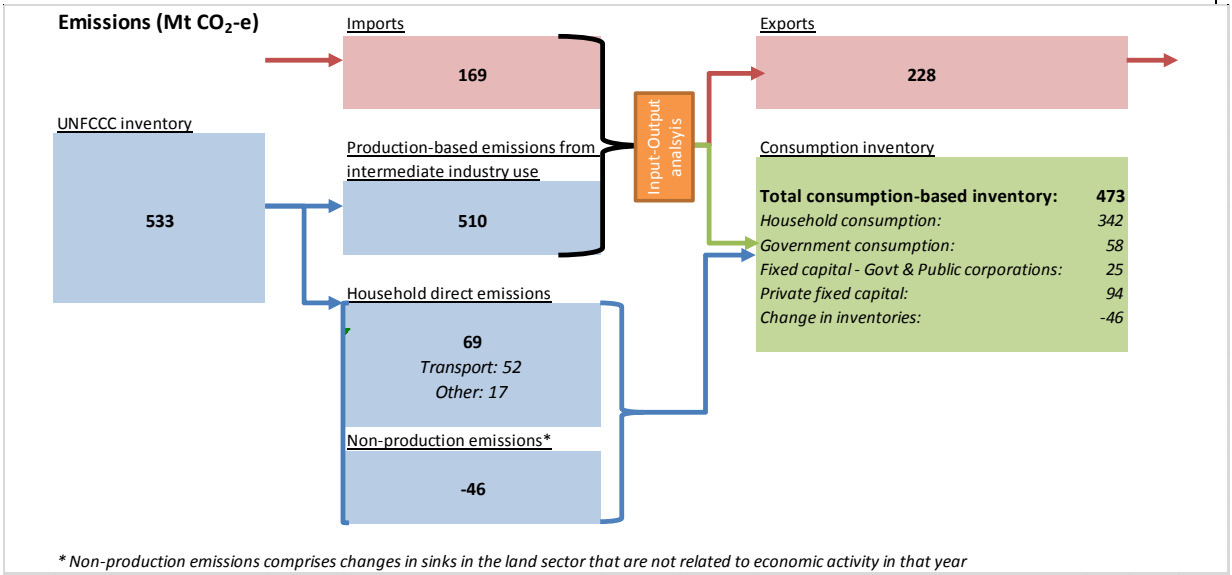
Each year, the Australian Government submits a national greenhouse gas inventory under reporting commitments to the UN Framework Convention on Climate Change (UNFCCC). These emissions occur inside the territorial boundaries of Australia and this inventory is known as a 'production-based' emissions inventory.

A 'consumption-based' inventory is the estimate of emissions generated both in Australia and overseas to support the consumption of goods and services by Australians.

To make a preliminary estimate of a 'consumption-based' emissions inventory, the Department has calculated the greenhouse gas emissions associated with production and imports by Australian industries in 2016-17, using the latest annual submission to the UNFCCC for all gases and sources and the most recent ABS publication of input-output tables (see Section 4.5 for more details). This "greenhouse gas emissions-extended" input-output analysis also allows disaggregation of emissions by final use, including exports, household and other private and government consumption and capital formation.

The relationship between the 'production-based' national inventory and a 'consumption-based' inventory is set out below.

Figure ST1: Emissions supply and use reconciliation flow chart year 2016 - 17



Emissions for the production-based inventory for the June quarter were 533 Mt CO_2-e in 2016-17. The Department's analysis estimates that emissions generated during the production of Australia's imports were 169 Mt CO_2-e. Emissions generated for Australia's exports totalled 228 Mt CO_2-e. Overall emissions associated with Australian consumption totalled 473 Mt CO_2-e. Household consumption was the most significant contributor at 342 Mt CO_2-e (or 72 per cent), followed by fixed capital formation (by government and private industry) and changes in inventories (mostly related to the land sector), which were together responsible for emissions of 74 Mt CO_2-e (or 16 per cent).

Government final consumption was responsible for emissions of 58 Mt CO_2-e (or 12 per cent). When combined with gross fixed capital formation from government and public corporations, the Government sector was responsible for emissions of 83 Mt CO_2-e (or 18 per cent of consumption-based emissions across the economy).

Changes in land-sector sinks (e.g. growth in forests and plantations) are reported separately in this analysis because they are not related to economic activity in the reporting year. This sink, equivalent to 46 Mt CO_2-e, is part of Australia's UNFCCC inventory sector of "land-use, land-use change and forestry". In the consumption-based inventory, the changes in the carbon stored in these forests and wood products are treated as "changes in inventory" based on the nearest analogue under the ABS System of National Accounts of growing stock in plantations.

The implied emissions factors applied to the ABS merchandise trade statistics in this article were calculated from this analysis.

Further details of the methods and data used for this analysis are described in section 4.5. Limiting assumptions, the results of sensitivity analyses undertaken and plans for further work to refine the preliminary estimates presented here are also described.

Preliminary estimates for this 'consumption-based inventory' show emissions from Australian consumption to be 450 Mt CO_2-e in 2018-19.

Using this indicator, emissions caused by Australia's consumption are lower relative to 2004-05 than is indicated by the change in the national inventory over the same period. Preliminary estimates indicate that the consumption-based inventory is lower now by 102 Mt CO_2-e, or 18 per cent compared to 2004-05, while the national inventory is lower now by 78 Mt CO_2-e, or 13 per cent compared to 2004-05.

Emissions caused by the combustion of fuels in importing countries are reported in those importing countries where the emissions occur and are not considered further in this article as they do not directly affect the amount of emissions released to service the consumption of goods in Australia. This is a common approach for these kinds of analyses.[19]

4.1 Effects of trade on Australia's national greenhouse gas inventory

Globalisation is the process of integration of national economies. Declines in international transactions costs, transport costs and more rapid diffusion of new technologies mean that economies – and, in some cases, national greenhouse gas inventories – are increasingly interdependent.

Growth in global demand, together with the changes from globalisation, is making Australia's exports an increasingly important driver of Australia's emissions profile. The composition of Australia's exports is quite different to the composition of goods that Australia imports, however. International trade leads to specialisation in production and Australia has tended to specialise in the production of goods that are also relatively emissions-intensive to produce.

Every exported product will cause direct emissions at the producing facility; and indirect or induced emissions from the process of producing all of the inputs required by the producing facility to make the exported product. For every exported product, an implied emission factor can be developed that relates the direct and induced emissions for every real dollar of value of the exported product (Section 5.5 for details of the method).

Important Australian export goods that also have relatively high implied emission factors for production include aluminium, LNG and agricultural goods (see Box 2 for discussion of the resulting emissions intensity and Figure ST3).[20]

The total emissions released from the production of individual export products can be estimated and tracked and show the rapid rise in the importance of LNG exports, in particular, to Australia's emissions profile.

In 2018-19, LNG caused an estimated 49 Mt CO_2-e emissions in Australia (Figure ST4).

In total, preliminary estimates of emissions released in Australia to support the production of goods for export were 51 Mt CO_2-e in the June Quarter 2019 (Figure ST5).[21] In the 2018-19 financial year, these emissions were estimated to be 199 Mt CO_2-e and to have increased by 67 Mt CO_2-e or by 50 per cent since 2004-05 due to changes in the makeup of export goods as well as increasing export volumes.

The rise in importance of emissions released by export industries in the production of goods for export is illustrated in Figure ST6. The share of emissions generated by Australia's industries for export has increased from 22 to 37 per cent since 2004-05. This reflects the rise in the value of merchandise exports as a proportion of GDP from 14 to 19 per cent since 2004-05, as well as increasing emissions intensity of the total exports (Figure ST7).

[19]For example, see UK Committee on Climate Change, 2019. Reducing UK emissions – 2019 Progress Report to Parliament, Chapter 1 Part 4, (page 27) for an example of a consumption-based greenhouse gas inventory. Available at https://www.theccc.org.uk/publication/reducing-uk-emissions-2019-progress-report-to-parliament/, Accessed on 5 November 2019.

[20] An important exception relates to Australia's significant exports of relatively low emissions-intensive iron ore.

[21] Total emissions generated by exports (occurring in Australia and overseas) are higher—as some proportion of the total induced emissions in exports are generated from imports (e.g. emissions occurring overseas for refining of diesel fuel, which is then used by the Australian agriculture sector). See Figure ST7 below for more details.

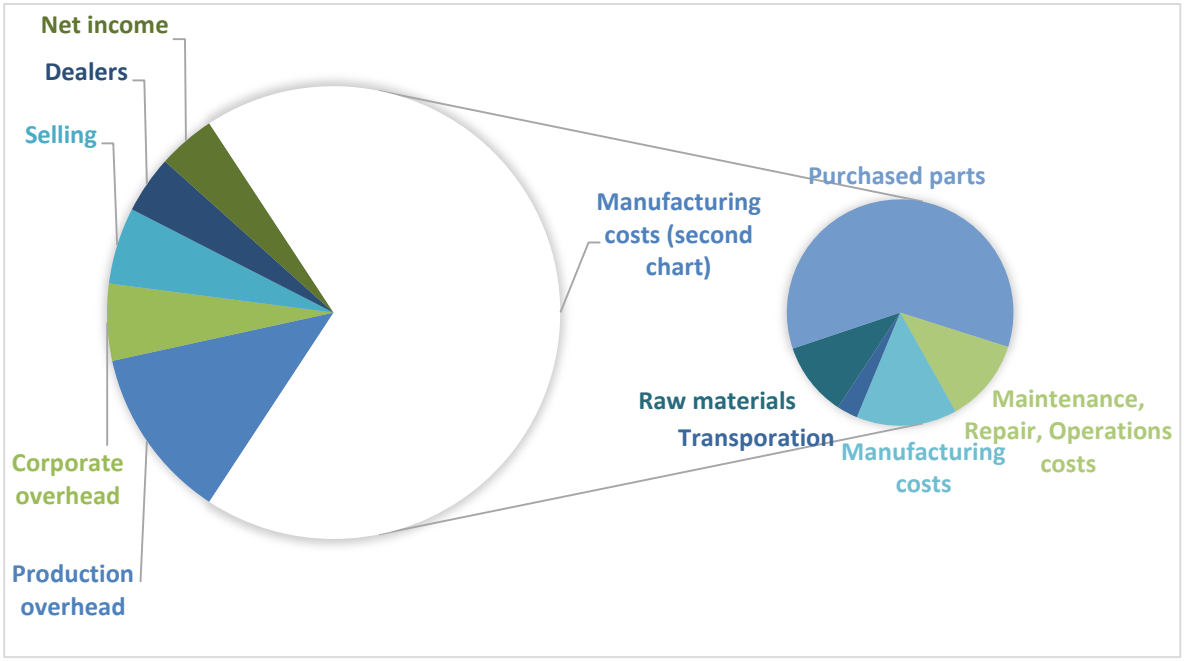
Box 2: Emissions intensity of primary production compared to elaborately transformed manufactured goods

Using trade and price deflator statistics reported by the ABS, emissions are calculated on the basis of the *long-run value*[22] of exports and the *long-run value* of imports.

Manufactured goods include complex supply chains and, as the complexity of the manufacturing process increases, the cost of raw materials and energy (or land) as a fraction of the total cost of production decreases, while the share of low-emissions inputs including labour and research and development expenses in the cost of production tends to increase.

For example, approximately one third of the cost of a car relates to corporate and production overheads (including R&D), sales costs and profit (see Figure ST2). Most of the manufacturing cost relates to purchase of parts from upstream suppliers, manufacturing, operational and maintenance costs, with 7 per-cent of the final price reflecting raw material costs.

Figure ST2: Cost breakdown of a standard US mid-sized passenger vehicle

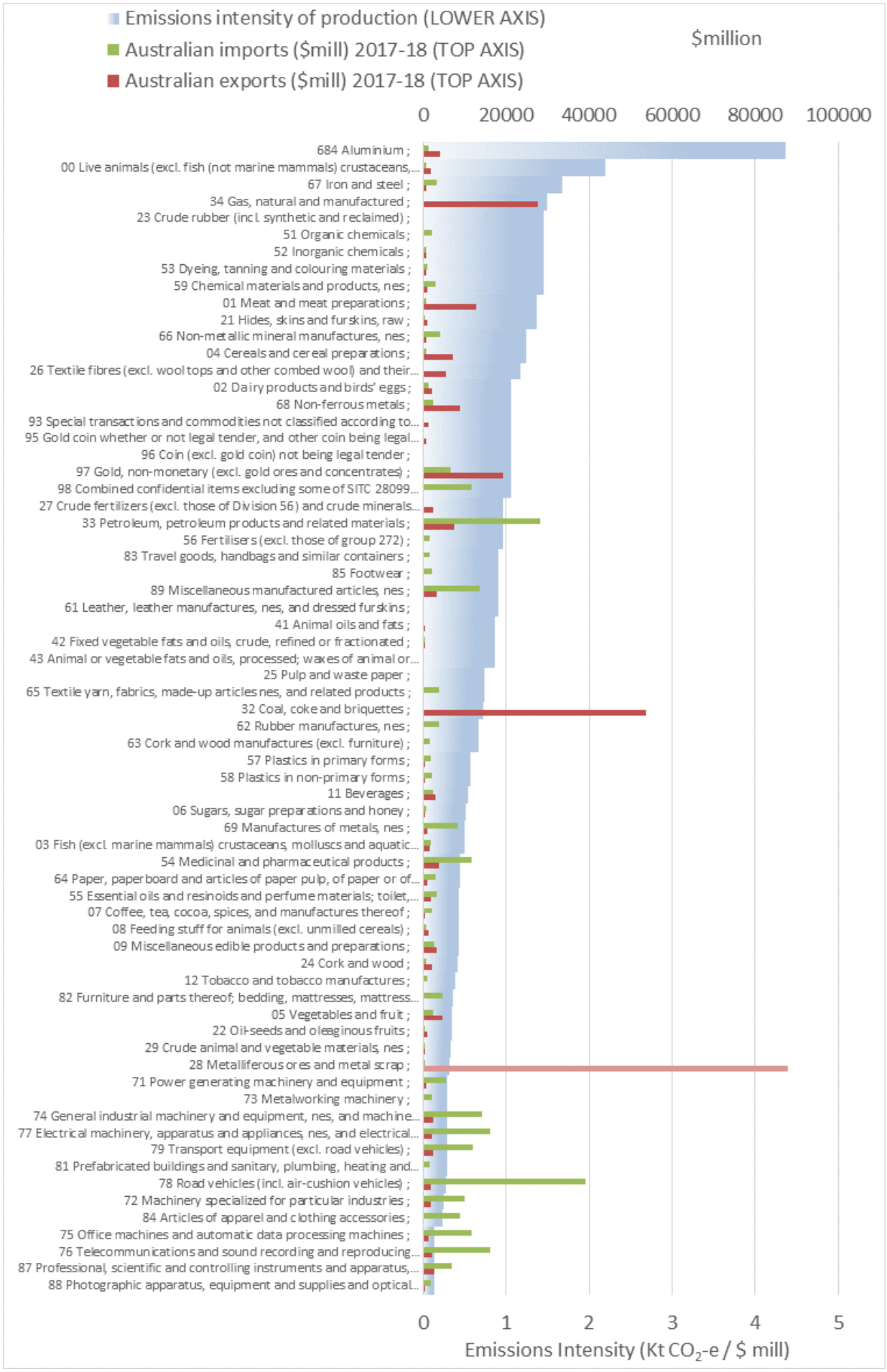


Source: Derived from US EPA (Report prepared for the U.S. Environmental Protection Agency. Automobile industry retail price equivalent and indirect cost multipliers, 2009. Available at https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100AGJ1.TXT, accessed on 4th November 2019).

In contrast, the *long-run value* or cost of primary production of bulk commodities (such as metals, LNG, coal) in large part reflects the energy cost of extraction and energy-intensive or land-intensive processing so that the emissions intensity of these production processes tends to be higher per dollar of production than it is for elaborately transformed manufactured goods.

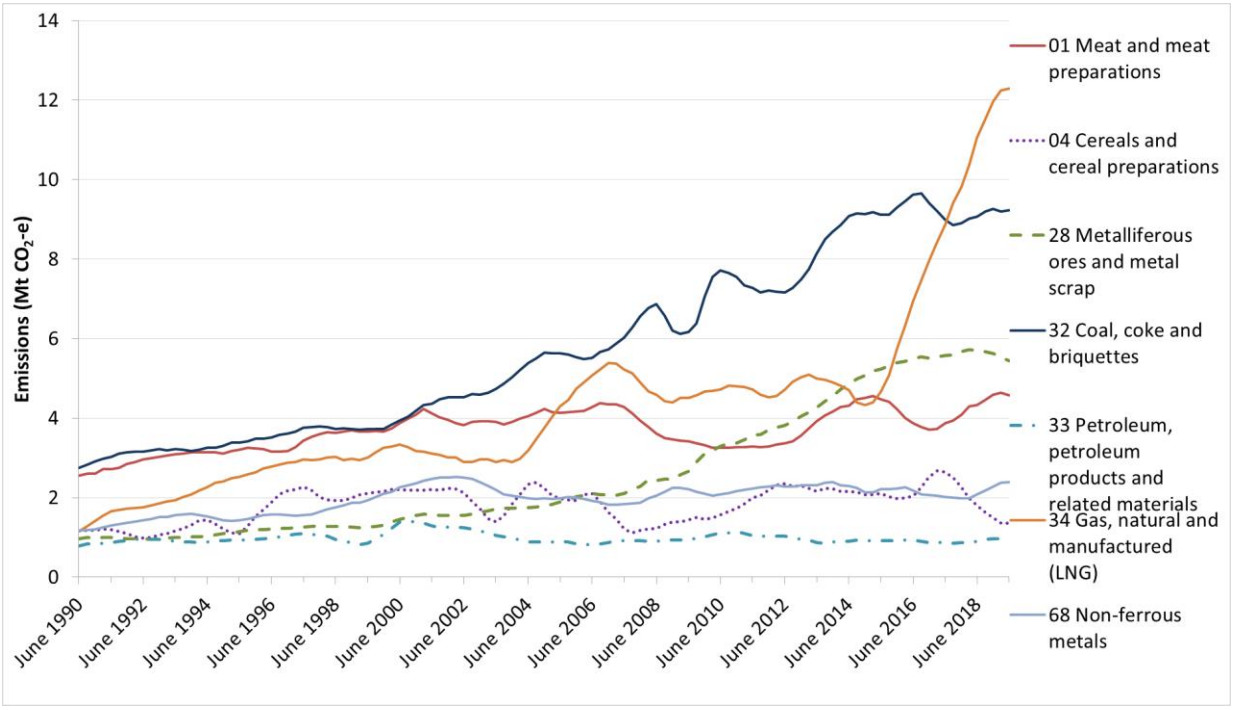
[22] The long run value after adjusting for price effects and inflation is referred to as a 'chain volume measure'.

Figure ST3: Implied Emission Factors by export product and export values, Australia



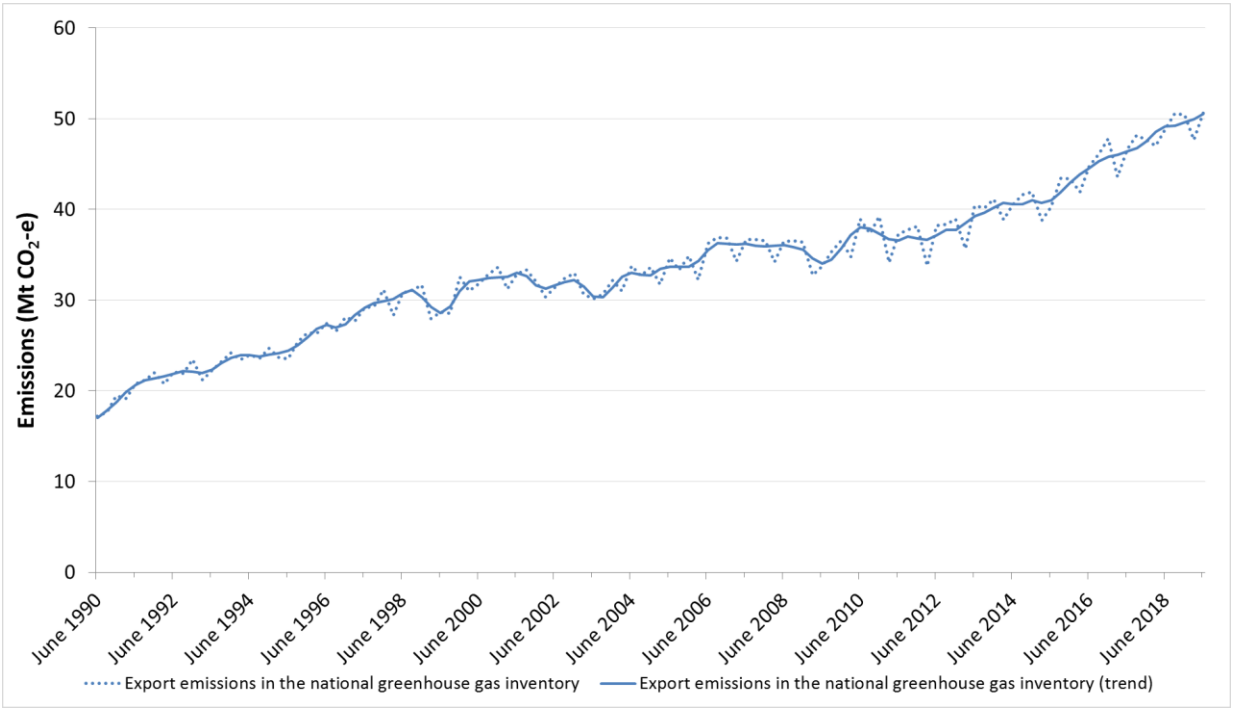
Source: Department of Environment and Energy. Derived from ABS trade statistics.

Figure ST4: Emissions associated with major Australian merchandise export products, seasonally adjusted, by quarter, June 1990 to June 2019



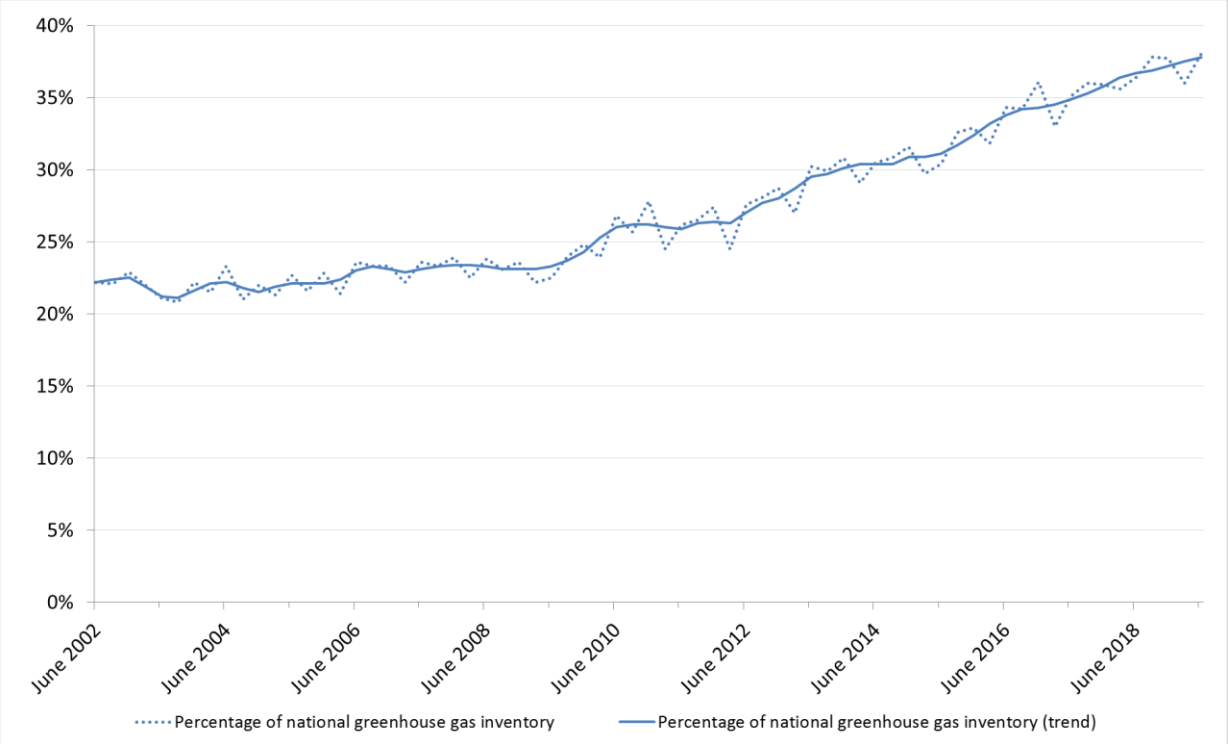
Source: Department of Environment and Energy. Derived from ABS trade statistics.

Figure ST5: Emissions in the Australian national greenhouse gas inventory associated with Australia's total merchandise exports, by quarter, June 1990 to June 2019



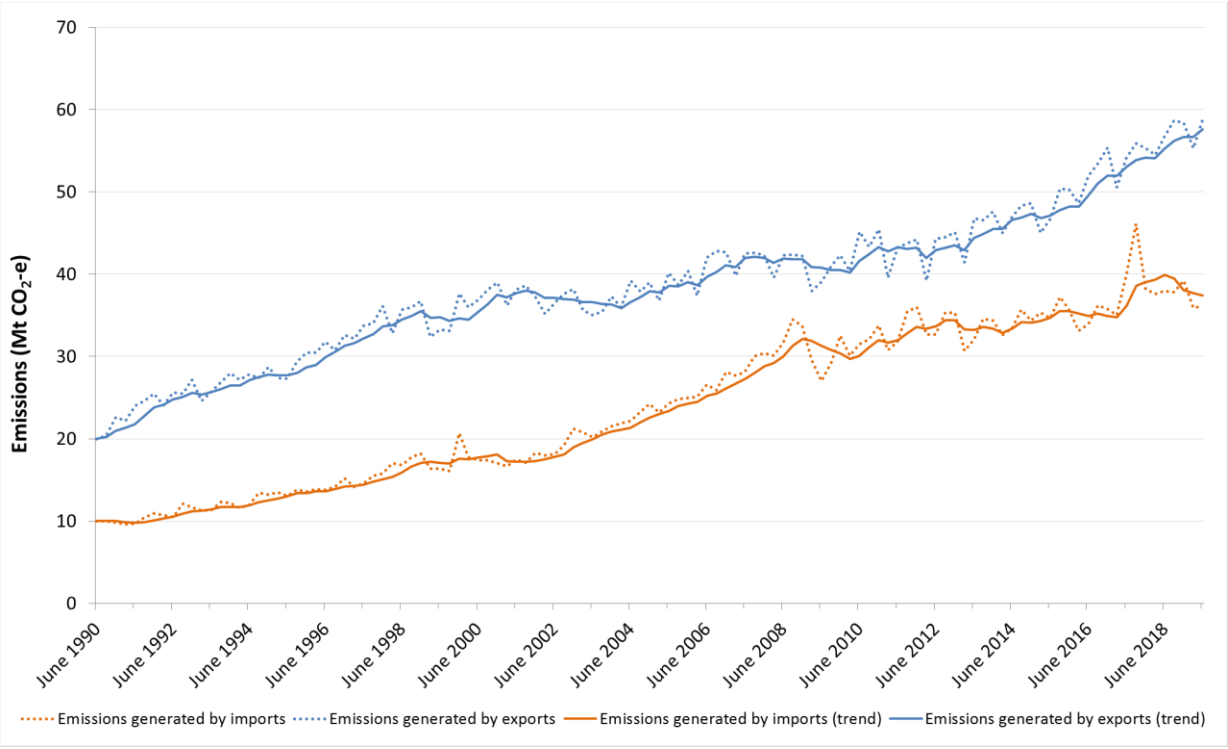
Source: Department of Environment and Energy. Derived from ABS trade statistics.

Figure ST6: Emissions in Australia associated with Australia's total merchandise exports, as a share of the national greenhouse gas inventory, by quarter, June 2002 to June 2019



Source: Department of Environment and Energy. Derived from ABS trade statistics.

Figure ST7: Global emissions generated during production of Australia's imports and exports, by quarter, June 1990 to June 2019



Source: Department of Environment and Energy. Derived from ABS trade statistics.

4.2 Effects on the 'Consumption-based inventory'

While globalisation means that Australia is importing more, the process of specialisation in production has also meant that Australia has tended to import goods that are relatively less emissions-intensive. For example, Australia tends to import elaborately transformed manufactured goods such as machinery or road transport vehicles with large components of costs in engineering design, labour and distribution which tend to be less emissions-intensive than inputs like fuel or land (see Box 2, and Figure ST2).[23]

In total, emissions released in the rest of the world to support the production of goods for import into Australia were about 36 Mt CO_2-e in the June Quarter 2019 (Figure ST7). The estimate for the 2018-19 financial year was 149 Mt CO_2-e. These annual emissions have increased by 54 Mt CO_2-e or by 57 per cent since 2004-05.

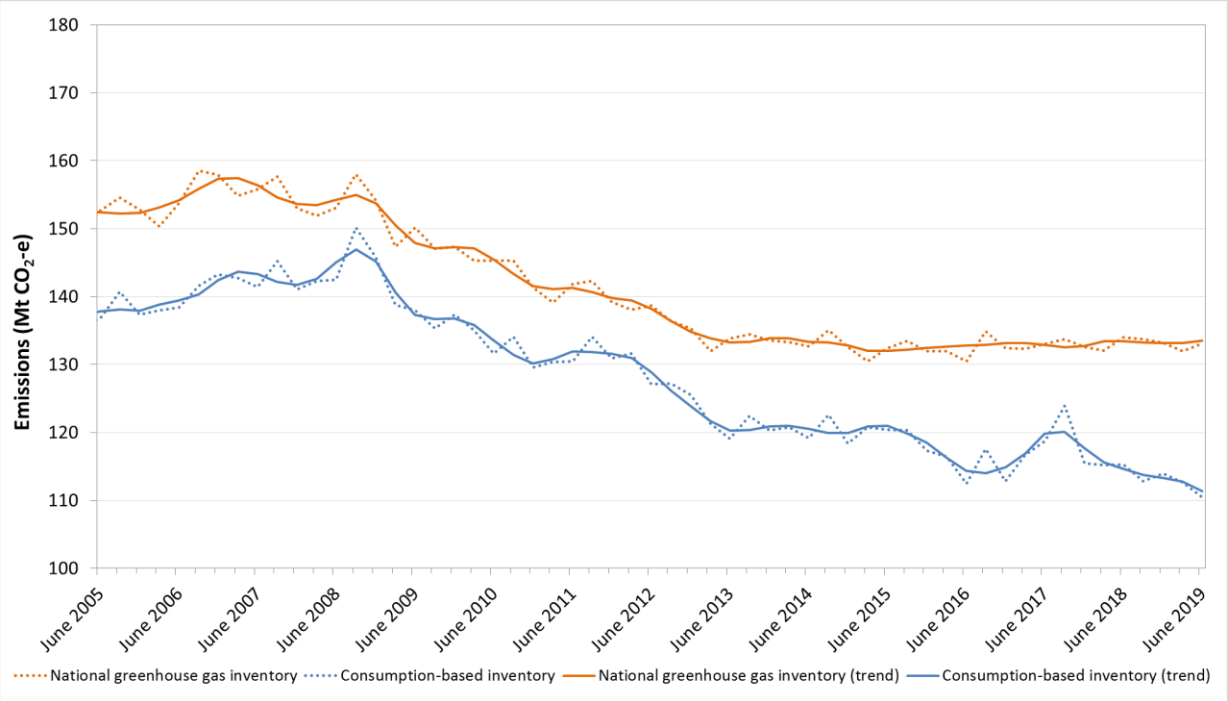
Adjusting the national greenhouse gas inventory for emissions caused by exports, and imports, provides a better indication of the emissions released globally during the production of goods that Australia consumes.

The consumption-based inventory was lower than the national greenhouse gas inventory by 23 Mt CO_2-e in the June Quarter 2019. Overall, the gap between the inventories has become wider over the period since 2010 (Figure ST8).

On an annual basis, the preliminary consumption-based inventory shows that the emissions generated to support Australia's consumption are less than those reported as the (production-based) national greenhouse gas inventory by 82 Mt CO_2-e or 15 per cent.

Consumption-based emissions are approximately 17.7 tonnes per person, which is around 3.4 tonnes per person less than the per capita emission calculation using the national greenhouse gas inventory.

Figure ST8: National Greenhouse Gas and Consumption-based inventories, Australia, by quarter, June 2005 to June 2019



[23] An important exception is petroleum products, for which there are extensive fuel inputs used in the refining process.

In large part, this differential between the emissions in the national greenhouse gas inventory and the consumption-based inventory derives from the effects of globalisation and changing global demand patterns on Australia's trade.

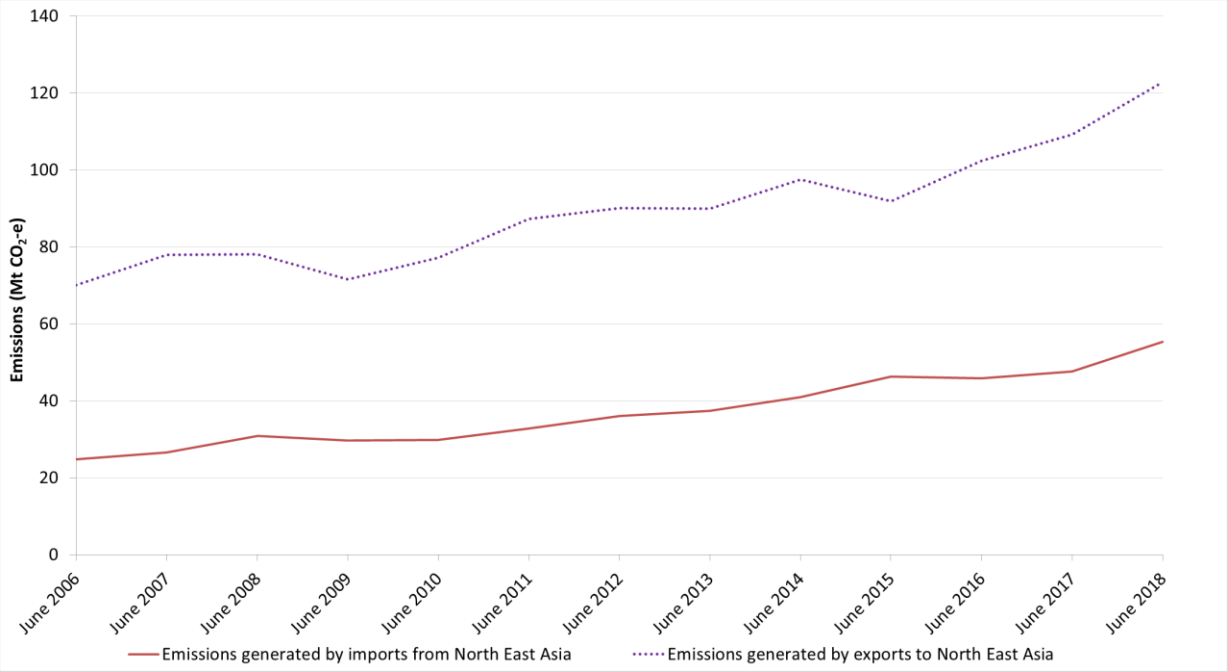
4.3 Implications for emissions associated with regional trade flows

The consumption-based inventory is determined by overall trade flows. However, trade is often undertaken between complementary economies that specialise in ways that support each other's consumption patterns. This is the case with Australia's trade with North East Asia (in this analysis, taken to be China, Japan and the Republic of Korea).

Emissions from Australia's export activities to North-East Asia were around 123 Mt CO_2-e in 2017-18 or about 23 per cent of total national emissions. This is a strong increase from 70 Mt CO_2-e in 2005-06 and represents a significant proportion of the increase in emissions generated by Australia's total exports since 2005-06 (Figure ST9).

On the import side, emissions associated with the production of Australia's imports from North-East Asia are much smaller than the emissions associated with Australia's exports (Figure ST9).

Figure ST9: Emission released in the Australian production of goods for export to North-East Asia and in the production of imports from North East Asia, year to June 2006 to 2018



The net effect is that the Chinese, Japanese and the Republic of Korean economies are exerting a strong pull on Australia's national greenhouse gas inventory through trade. Increased exports to North-East Asia have caused an estimated increase in Australia's national greenhouse gas inventory of around 50 Mt CO_2-e or around 9 per cent since 2005-06.[24] North-East Asia is also having a strong impact on Australia's consumption-based inventory.

[24] This represents the emissions occurring within Australian territory, which are lower than total emissions associated with exports to North – East Asia.

4.4 Conclusion

The estimates presented here reflect the Department's initial assessment of a 'consumption-based' inventory. This preliminary analysis highlights the interdependence of national greenhouse gas inventories through trade.

Export demand, mainly from North East Asia, has been exerting strong upward pressure on Australia's national greenhouse gas inventory. Emissions released in Australia in producing our exports for 2018-19 were estimated to be 199 Mt CO_2-e which is 67 Mt CO_2-e or 50 per cent more than those released in producing our exports for 2004-05.

This is the first time a consumption-based national greenhouse gas inventory has been produced by the Department generated from its data. It provides useful insights into the impacts of Australian consumption on global emissions. According to this indicator, global emissions caused by Australian consumption have fallen by 102 Mt CO_2-e or 18 per cent since 2004-05.

Technical notes to the Special Topic

The trend in the consumption-based inventory over time, discussed above, is estimated using ABS trade data and emissions factors calculated from an input-output analysis for the year 2016-17.

This section firstly describes the methodology for the 2016-17 input-output analysis, and secondly the calculation of the consumption-based inventory time-series.

The estimates presented in this article represent the Department's initial assessment of the impacts of trade on national emissions. Assumptions and limitations with this preliminary work and their impact on the estimates have been tested through a sensitivity analysis, and priorities for future work have been identified.

As input-output tables are subject to some imprecision, the Department considers that the uncertainty around the consumption-based inventory estimates, calculated as they are using input-output tables, will be larger than for the uncertainty for the national greenhouse gas inventory estimates.

Methodology of the 2016-17 input-output analysis

To estimate the consumption-based inventory, the Department has used common environmentally-extended input-output analysis techniques; applying an emissions-intensity vector to the ABS input-output tables (Cat No 5209.0.55.001), for the most recent available year, 2016-17.

The basic equation for the input-output analysis is provided below:

$$x = (I - A)^{-1} f = Lf \qquad \text{(Equation 1)}$$

Where x is the $n \times 1$ vector of total output by IOIG

I is the identity matrix ($n \times n$)

A is the input coefficient matrix

f is the final demand of the economy

$L = (I - A)^{-1}$ is known as the Leontief Inverse matrix or total requirement matrix (ABS Table 10)

Environmentally-extended input-output analysis adapts this method by calculating the emissions associated with production by each industry (Equation 2).

All emissions reported in the United Nations Framework Convention on Climate Change (UNFCCC) inventory were allocated to Input-Output Industry Groups (IOIG).[25] The emissions mapping methodology was developed in collaboration with the Department of the Treasury with technical advice from the Bureau of Infrastructure, Transport and Regional Economics and the Australian Bureau of Statistics, and the result was used to estimate the direct emissions-intensity vector for 2016-17 (e). For key industries, detailed facility-level data reported under the National Greenhouse and Energy Reporting (NGER) framework were also investigated. NGER data has been used to refine the allocation of emissions to industry grouping, and for quality control of the results, by identifying key subsectors within the broader industry groups with different emissions profiles or different end-uses (e.g. domestic gas compared to LNG).

$$Consumption\ emissions = e\ (I - A)^{-1} f = e\ L\ f \quad \text{(Equation 2)}$$

Where e is the vector of $1 \times n$ of direct emissions intensity for each IOIG (or total emissions for each industry group divided by their total economic output, for the year 2016-17)

To ensure completeness of the resulting consumption emissions using available ABS input-output table products, this calculation was performed with 'indirect allocation of imports'. That, is the requirements coefficients (*L*) and final demand (*f*) matrices treat imported goods and services as products of the equivalent Australian industry. The effect of this simplifying assumption on the emissions calculations is to treat the production function and the emissions intensity of production in overseas countries as equivalent to that which applies for Australia's domestic production. In general, this is likely to be a conservative assumption (towards the upper-bound of emissions generated by imports) — for example, compared to the OECD average, the Australian electricity sector is relatively emissions-intensive.

The assumption of equivalent greenhouse gas emissions intensity of merchandise imports and domestic production can be revisited in future work considering multi-regional input-output tables and international trade databases (e.g. the Global Trade Analysis Project). However, use of these types of datasets brings other accuracy trade-offs e.g. reduced industry and commodity detail, and poor quality or incomplete coverage of emissions data.

Time-series of trade-adjusted emissions.

In order to estimate a time-series of trade-adjusted emissions for Australia up to the June 2019 quarter, ABS international trade data (Cat No. 6457 & 5368) was used along with the total emissions intensity for each industry group from the input-output analysis.

The total emissions intensity vector for each industry group, was calculated by multiplying the direct emissions intensity vector with the total requirements of each industry (including upstream imports): $e\ \times\ (I - A)^{-1}$. These emission factors were applied to the ABS merchandise trade data (in real, 2016-17 dollar terms), according to the key industry group producing each product category.

The resulting time-series of emissions embodied in imports (E_M) and exports (E_X), was combined with the national inventory emissions (E_{NGGI}) from the *Quarterly Update of Australia's National Greenhouse Gas Inventory: June 2019* to calculate a consumption-based inventory.

$$Trade\ adjusted\ inventory = E_{NGGI} + E_M - E_X \quad \text{(Equation3)}$$

[25] In contrast, other consumption based inventory estimates tend to only allocate emissions from energy use (E.g. Wiebe, K. S. and N. Yamano (2016), "Estimating CO2 Emissions Embodied in Final Demand and Trade Using the OECD ICIO 2015: Methodology and Results". OECD Science, Technology and Industry Working Papers, No. 2016/5, OECD Publishing, Paris.).

Sensitivity analysis

This study was in part prompted by analysis undertaken by the OECD as part of a global study[26]. In relation to Australia, the Department's work improves on that study, which was partial in scope (dealing with energy emissions), used older and much coarser datasets.

A sensitivity analysis was performed to test the impact of areas which have greater uncertainty. Three scenarios have been run as outlined below.

Overall these scenarios have limited impact on consumption emissions (+1 / -1 per cent), while emissions induced by exports and imports are more sensitive to these assumptions (+0 / -8 per cent, and +1 / -13 per cent, respectively). Increasing the emissions intensity of motor vehicle imports results in the greatest increase in imports and consumption emissions, while allocating land-sector sinks to the forestry industry reduces all three emissions variables.

1. Aggregate emissions factor for LNG, domestic gas production and crude oil production.

Within the ABS input-output tables, the LNG, domestic gas and oil production industries are aggregated as a single industrial sector. For this analysis, this aggregation was not appropriate, as the emissions profiles of the LNG industry, domestic gas and crude oil production are very different. The final use of the products of each industry are also very different, with LNG produced for export, natural gas used by a number of industries and in final consumption, and crude both exported and domestically refined with minor industrial uses. In the baseline modelling, the Department disaggregated the emissions intensity factors and final uses of these industries.

This analysis showed that around 95 per cent of the emissions from the LNG industry relate to direct emissions or emissions associated with grid-based electricity use. These emissions are well understood, and are based on detailed facility level reporting under the NGER framework. Non-electricity induced emissions from LNG are approximately 2 per cent of total LNG emissions, which is consistent with recent detailed CSIRO study for the Queensland Coal Seam Gas to LNG industry which found that the fraction of non-electricity induced emissions accounted for approximately 3 per cent of total lifecycle emissions.[27]

The sensitivity analysis compares the results of the modelling based on the detailed industry sub-sectors with the results based on the ABS aggregated input-output industry group for the oil and gas sector as a whole.

The analysis shows that the emissions induced by Australian consumption, imports and exports are relatively insensitive to the disaggregation of LNG from other oil and gas extraction industries (this scenario resulted in variation relative to the baseline of 0, -2 and -2 per cent to emissions from total consumption, total imports and total exports, respectively.)

2. International emissions intensity benchmark for motor vehicle imports

Since Australia ceased domestic manufacturing of motor vehicles, the emission factor for production of the industrial sector 'motor vehicles and parts' only reflects the ongoing production of parts within Australia.

[26] "Estimating CO2 Emissions Embodied in Final Demand and Trade Using the OECD ICIO 2015: Methodology and Results". OECD Science, Technology and Industry Working Papers, No. 2016/5, OECD Publishing, Paris.

[27] Heinz Schandl, Tim Baynes, Nawshad Haque, Damian Barrett and Arne Geschke (2019). Final Report for Final Report for GISERA Project G2 - Whole of Life Greenhouse Gas Emissions Assessment of a Coal Seam Gas to Liquefied Natural Gas Project in the Surat Basin, Queensland, Australia. CSIRO, Australia.

The sensitivity analysis has applied the average emission intensity of production from the UK motor vehicle manufacturing industry to the emissions associated with motor vehicle imports, based on UK Government official statistics.[28]

Under this scenario, consumption emissions increased by 0.2 per cent while emissions associated with imports increased by 1 per cent, with minimal impact on export emissions (0.0 per cent increase).

3. Allocation of forest sink to industry

In the land sector, it would be incorrect to assume that the current sink in forests relates to the annual economic output by the forestry sector in calculating the emissions intensity of production (in contrast to the combustion of fuel to produce products).

For the baseline model the production of wood products from forests is assumed to be managed sustainably and to be carbon neutral (over the long term), with the remaining industrial emissions corresponding to fuel use etc.

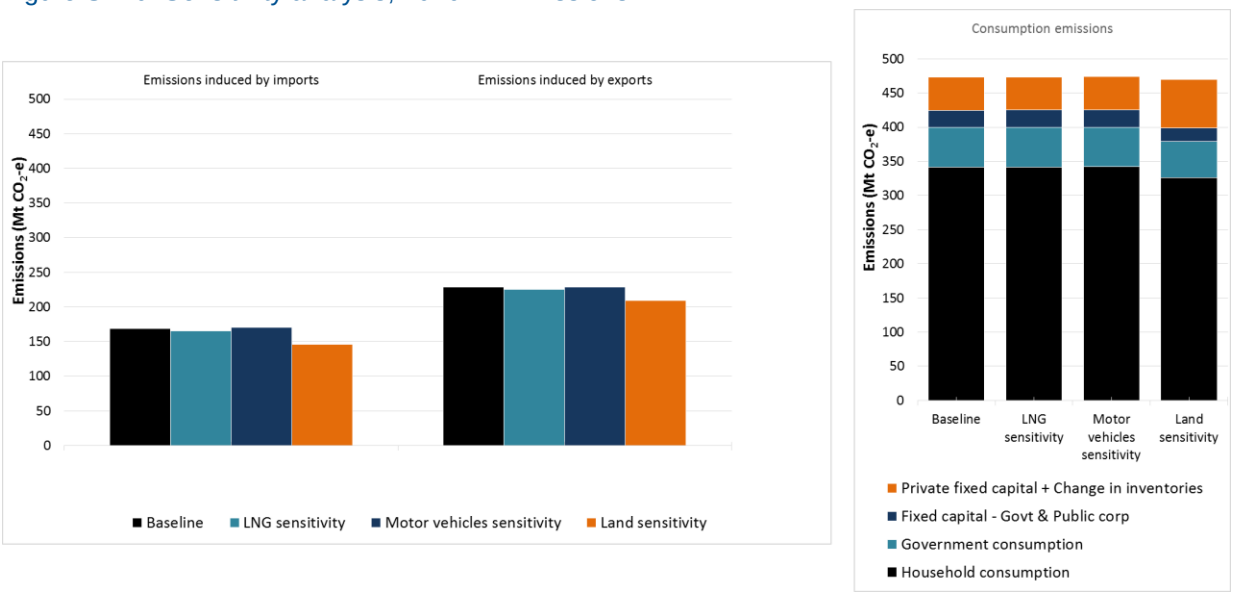
For the sensitivity analysis, these forest sinks are allocated in their entirety to the forestry industry sector.

Most of the forestry sink relates to long timescale changes in management. For example the overall net sink calculated for harvested native forests in 2017 reflects the decline in historical harvest levels over the period 2008 – 2013. In reality, wood production in 2017 would be responsible for a small net emission of carbon from the areas affected by harvesting. Likewise the sink in plantation forests reflects the age class of Australia's total plantation area (currently in a growth phase, as plantations mature for harvesting). In the final consumption emissions under the baseline model scenario, the changes in the carbon stored in these forests are treated as "changes in inventory" based on the nearest analogue under the Australian System of National Accounts for growing stock in plantations. Future improvements will investigate the attribution of this sink between industry use and other accounting sectors.

Under this scenario, emissions declined for emissions induced by consumption, exports and imports (reducing by 1, 8 and 13 per cent, respectively).

Figure ST10 and Table ST1 summarise the results of the sensitivity analysis.

Figure ST10: Sensitivity analysis, 2016-17 Emissions



[28] Derived from Department for Environment, Food & Rural Affairs. UK's carbon footprint: Annual carbon dioxide emissions relating to UK consumption. Table 13 – Indirect emissions from the supply chain. Available from https://www.gov.uk/government/statistics/uks-carbon-footprint Accessed on 6 November 2019.

Table ST1: Sensitivity analysis, annual emissions 2016-17 Emissions,

Sensitivity analysis:	Baseline ($kt CO_2$-e)	Low		High	
		Change ($kt CO_2$-e)	Change (Per cent)	Change ($kt CO_2$-e)	Change (Per cent)
Consumption emissions	473,040	-3,464	-1%	2,576	1%
Emissions induced by imports	168,776	-22,534	-13%	1,216	1%
Emissions induced by exports	228,398	-19,070	-8%	69	0%

Future improvements

The estimates presented here reflect the Department's initial assessment of a 'consumption-based' inventory. Future work will review and, if necessary, refine existing calibrations and consider approaches that will move the analysis to a more complete 'consumption-based' inventory time-series.

In particular, future work on these indicators will examine the following:

(i) Relaxing the assumption of constant production functions;

(ii) Relaxing the assumption of equivalent production functions in Australia and overseas;

(iii) Extensions to include analysis of trade in services into the time-series analysis, which have been assumed in this article to have a relatively negligible impact; and

(iv) Conversion of emissions estimates to a residency basis under the System of National Accounts.

It is anticipated that the implementation of point (i) will increase the estimate of emissions for the consumption-based inventory in the past and, therefore, increase the estimate of reductions in emissions of the consumption-based inventory over time. Implementation of point (ii) is expected to reduce the estimated level of emissions in the consumption-based inventory relative to the national greenhouse gas inventory for 2016-17. Implementation of point (iii) will factor in trade in services – education is an important export sector – although the emissions intensity of services tends to be low therefore its impact on emissions is likely to be relatively neutral. Trade in services also includes freight costs which are important in understanding the impacts of trade on global emissions. These are treated in the national greenhouse gas inventory as a memo item in accordance with the territory basis of UNFCCC reporting systems. Implementation of point (iv) will make relevant adjustments to international freight and also adjust for non-resident use of private motor vehicles to improve consistency with input-output modelling.

Overall, the Department considers that the current analysis tends to be robust in relation to a gap between Australia's territorial and trade-adjusted emissions in recent years and a decline in consumption-based emissions over time.

5. Technical notes

5.1 Quarterly coverage

The *Quarterly Update* uses emissions estimates based on our United Nations Framework Convention on Climate Change (UNFCCC) inventory time series to better support implementation of Australia's 2030 target. The UNFCCC inventory will be used to track progress towards Australia's commitment to reduce emissions levels by 2030 under the Paris Agreement.

5.2 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 UNFCCC in Warsaw 2013 including the *Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories* (2006).

5.3 Greenhouse gases

This report covers sources of greenhouse gas emissions and removals by sinks resulting from human (anthropogenic) activities for the major greenhouse gases listed in Table 4 below.

Table 4: Major greenhouse gases covered by the Quarterly Update

Major greenhouse gases
Carbon dioxide (CO_2)
Methane (CH_4)
Nitrous oxide (N_2O)
Perfluorocarbons (PFCs)
Hydrofluorocarbons (HFCs)
Sulphur hexafluoride (SF_6)

Australia's emissions of the greenhouse gas nitrogen trifluoride (NF_3) are considered negligible and are not estimated.

Global warming potentials (GWPs) have been used for each of the major greenhouse gases to convert them to carbon dioxide equivalents (CO_2-e). 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. The GWPs used in this Report were the 100-year GWPs contained in the 2007 IPCC Fourth Assessment Report (IPCC 2007), by international agreement.

5.4 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 7.6). 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 international reporting requirements.

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

Recalculations since the March Quarter 2019

The recalculations since the March 2019 edition of the *Quarterly Update* for the financial years 2005 and 2016 to 2018), by sector in Mt CO_2-e, are shown in Table 5.

Incorporation of recently reported activity data from the National Greenhouse and Energy Reporting System for 2017-18 and 2018-19 resulted in recalculations to *stationary energy (excluding electricity)*, *fugitive emissions*, and *industrial processes and product use*. The NGERs data for 2018-19 will be published by the Clean Energy Regulator in February 2020.

The newly released Australian Energy Update 2019 included new energy consumption data for 2017-18, and recalculations for earlier years. Emissions derived from actual fuel consumption data from the Australian Energy Update 2019 replaced earlier projected data 2017-18 emissions data for *Stationary Energy (excluding Electricity)*.This resulted in a downwards revision for *Stationary Energy (excluding Electricity)*.

Table 5: Recalculations (Mt CO_2-e) since the March 2019 *Quarterly Update*, by sector, 2005 and 2017 to 2019

Sector	Financial Years and Quarters															
	2005				2017				2018				2019			
	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun
Agriculture[29]	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
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.8	0.8	0.9	0.0
Stationary energy (excluding electricity)	0.0	0.0	0.0	0.0	-0.3	-0.3	-0.3	-0.3	-0.7	-0.7	-0.6	-0.7	-1.0	-1.0	-1.0	0.0
Transport	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0
Fugitive emissions	0.0	0.0	0.0	0.0	-0.3	-0.3	-0.3	-0.3	-0.8	-0.7	-0.6	-0.7	-0.9	-1.4	-1.4	0.0
Industrial processes and product use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	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	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**	**-0.5**	**-0.5**	**-0.5**	**-1.4**	**-1.3**	**-1.3**	**-1.4**	**-1.1**	**-1.8**	**-1.7**	**0.0**

[29] Recalculations to 2 or more decimal places are not shown in this table

Revisions to Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) livestock population, crop production and rice cultivation data resulted in recalculations to *agriculture*. A revision to the enteric fermentation emission factor for emus and ostriches has also resulted in a recalculation to *agriculture* for the entire time series.[30]

5.6 Source data

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

- Australian Bureau of Statistics (2019), Australian Demographic Statistics, pub. no. 3101 http://www.abs.gov.au/ausstats/abs@.nsf/mf/3101.0
- Australian Bureau of Statistics (2019), Population Clock. http://www.abs.gov.au/AUSSTATS/abs@.nsf/Web+Pages/Population+Clock
- Australian Bureau of Agricultural and Resource Economics and Sciences (2019*). Agricultural Commodities, September Quarter 2019.*
- Australian Bureau of Agricultural and Resource Economics and Sciences (2019). *Australian Crop Report, September Quarter 2019.*
- Australian Bureau of Statistics (2019), *National Accounts: National Income, Expenditure and Product*, Cat. No. 5206.0 http://www.abs.gov.au/ausstats/abs@.nsf/mf/5206.0
- Australian Energy Market Operator (2019), Market data extracted using NEM-Review software: http://www.aemo.com.au/Electricity/Data
- Bureau of Infrastructure, Transport and Regional Economics (2019), Domestic Totals & Top Routes: http://www.bitre.gov.au/publications/ongoing/domestic_airline_activity-time_series.aspx
- Bureau of Meteorology (2019), Monthly climate summaries: http://www.bom.gov.au/
- Department of Industry, Innovation and Science (2019). *Resources and Energy Quarterly, September 2019*
- Department of the Environment and Energy (2019). Australian Energy Statistics: Table F. https://www.energy.gov.au/publications/australian-energy-update-2018
- Department of the Environment and Energy (2019), Australian Greenhouse Emissions Information System: http://ageis.climatechange.gov.au/

5.7 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.

5.8 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 unadjusted 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.

[30] IPCC, 2019 Refinement to the 2006 IPCC Guidelines for the National Greenhouse Gas Inventories

5.9 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 Demetra tool. More information on trend analysis is available on the ABS website http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Time+Series+Analysis:+The+Basics.

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 *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*.

5.11 Quarterly uncertainty

For all sectors the Department's assessment is that the 90 per cent confidence interval for the national inventory is ± 6.5 per cent (i.e. there is a 90 per cent probability that future revisions will be limited to ± 6.5 per cent 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_2O 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_2O.

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_2O from iron and steel production; and CO_2 from the production of ferroalloys and other metals.
- Chemical Industry: includes N_2O 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: HFC and 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_2O 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_2O 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 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 (N_2O). 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 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 management land are reported using the natural disturbances provision.
- 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) = 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 CO_2-e, which represents millions of tonnes of carbon dioxide equivalent gas.

5.14 Future publications

The September 2019 Quarterly Update of Australia's National Greenhouse Gas Inventory will be published by 29 February 2020.

6. Data tables

Data Table 1A: Unadjusted emissions (Mt), by sector, by quarter, since 2001-02[31]

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2001-2002	September	47.5	19.4	18.9	10.2	7.3	19.5	4.0	126.8	16.6	143.4
	December	44.3	19.4	19.6	9.6	7.1	19.5	4.0	123.4	16.6	139.9
	March	45.4	18.6	18.5	8.9	6.9	19.0	3.9	121.2	16.2	137.4
	June	46.8	19.2	18.7	9.8	7.3	19.2	4.0	125.0	16.4	141.3
2002-2003	September	48.6	19.9	19.6	9.9	7.8	18.1	3.8	127.6	18.7	146.4
	December	46.2	19.9	20.2	9.1	7.8	18.1	3.8	125.1	18.7	143.8
	March	45.4	19.1	19.1	8.5	7.8	17.7	3.7	121.3	18.3	139.7
	June	46.4	19.5	19.3	9.5	7.7	17.9	3.7	124.1	18.5	142.6
2003-2004	September	49.0	20.3	20.3	10.0	8.3	18.9	3.6	130.5	16.6	147.1
	December	46.8	20.3	21.0	9.2	8.3	18.9	3.6	128.2	16.6	144.8
	March	50.0	19.4	19.8	8.6	8.1	18.7	3.6	128.2	16.4	144.7
	June	49.1	19.9	20.0	9.7	7.9	18.7	3.6	129.0	16.4	145.4
2004-2005	September	50.9	20.8	20.8	10.2	8.0	19.1	3.6	133.5	22.4	155.9
	December	48.2	20.9	21.1	9.6	8.0	19.1	3.6	130.5	22.4	152.9
	March	48.8	19.8	19.7	8.9	7.9	18.7	3.5	127.4	21.9	149.3
	June	48.9	20.4	20.6	10.0	8.0	18.9	3.6	130.4	22.1	152.6
2005-2006	September	50.9	20.7	20.6	10.5	8.2	18.7	3.6	133.1	21.4	154.6
	December	48.9	20.5	21.9	9.8	8.0	18.7	3.6	131.4	21.4	152.8
	March	50.6	19.4	20.5	9.2	7.8	18.3	3.5	129.3	21.0	150.3
	June	50.9	20.6	20.5	10.5	8.0	18.5	3.5	132.6	21.2	153.8

[31] 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	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2006-2007	September	52.2	20.5	21.2	10.9	8.5	17.8	3.7	134.9	23.7	158.5
	December	50.8	21.0	22.0	10.3	8.6	17.8	3.7	134.2	23.7	157.9
	March	51.6	19.8	21.2	9.7	8.4	17.4	3.6	131.7	23.2	154.8
	June	49.5	20.6	21.4	11.0	8.6	17.6	3.6	132.4	23.4	155.8
2007-2008	September	53.5	21.4	21.7	11.8	8.7	17.1	3.8	138.0	19.8	157.7
	December	50.3	21.3	22.3	9.9	8.6	17.1	3.8	133.2	19.8	153.0
	March	51.7	20.3	21.3	9.9	8.5	16.9	3.7	132.3	19.6	151.9
	June	50.5	21.4	21.7	10.6	8.6	16.9	3.7	133.5	19.6	153.1
2008-2009	September	55.4	21.9	22.1	10.7	9.3	17.3	3.8	140.5	17.6	158.0
	December	52.3	21.4	22.6	10.7	8.7	17.3	3.8	136.7	17.6	154.2
	March	52.5	19.2	21.2	9.5	7.3	16.9	3.7	130.1	17.2	147.3
	June	51.5	20.3	21.5	11.2	7.5	17.1	3.7	132.8	17.4	150.2
2009-2010	September	51.4	20.6	22.4	11.3	8.6	16.7	3.8	134.8	12.3	147.1
	December	51.3	21.0	22.9	10.3	9.0	16.7	3.8	135.0	12.3	147.3
	March	52.5	20.3	21.4	9.9	9.1	16.3	3.8	133.3	12.0	145.3
	June	49.9	21.1	22.1	10.8	9.0	16.5	3.8	133.2	12.1	145.3
2010-2011	September	51.0	21.9	22.8	11.6	9.1	17.8	3.7	137.9	7.4	145.3
	December	47.1	21.6	23.7	10.8	9.2	17.8	3.7	133.9	7.4	141.3
	March	50.7	20.1	22.1	9.0	9.0	17.4	3.6	131.9	7.2	139.1
	June	49.7	21.6	22.8	10.2	8.9	17.6	3.6	134.6	7.3	141.9
2011-2012	September	50.9	23.0	22.5	10.8	9.2	18.1	3.3	137.8	4.6	142.3
	December	49.2	22.5	22.9	10.5	8.2	18.1	3.3	134.6	4.6	139.2
	March	50.3	21.3	23.1	9.6	8.1	17.9	3.2	133.6	4.5	138.1
	June	48.7	22.0	23.4	11.1	7.9	17.9	3.2	134.2	4.5	138.7

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2012-2013	September	47.0	24.0	23.2	11.0	8.0	18.2	3.1	134.6	1.8	136.4
	December	45.9	23.8	23.9	10.6	8.0	18.2	3.1	133.5	1.8	135.3
	March	47.6	22.1	22.2	9.8	7.7	17.8	3.0	130.2	1.8	132.0
	June	46.6	23.1	22.8	10.6	7.8	18.0	3.1	132.0	1.8	133.8
2013-2014	September	45.0	24.0	23.4	10.3	8.1	18.3	3.1	132.3	2.0	134.4
	December	44.0	23.9	23.9	10.2	8.0	18.3	3.1	131.5	2.0	133.6
	March	47.2	22.5	22.7	10.1	7.7	17.9	3.1	131.3	2.0	133.3
	June	44.5	23.7	23.2	10.2	7.9	18.1	3.1	130.7	2.0	132.7
2014-2015	September	47.5	23.0	24.0	12.4	8.4	17.7	3.0	136.0	-0.9	135.1
	December	46.4	22.5	24.5	11.0	8.4	17.7	3.0	133.5	-0.9	132.6
	March	47.9	21.4	23.3	10.4	8.1	17.3	2.9	131.4	-0.9	130.5
	June	47.2	22.3	23.5	11.6	8.2	17.5	3.0	133.2	-0.9	132.4
2015-2016	September	49.3	22.9	24.1	12.3	8.4	17.4	3.1	137.6	-4.1	133.5
	December	48.0	22.9	24.5	11.8	8.4	17.4	3.1	136.1	-4.1	132.0
	March	49.9	21.8	24.0	11.9	8.1	17.2	3.1	136.0	-4.1	132.0
	June	47.5	22.8	23.8	12.1	8.2	17.2	3.1	134.6	-4.1	130.5
2016-2017	September	48.8	23.9	24.6	12.6	8.6	18.4	3.0	139.8	-4.9	134.9
	December	45.4	23.9	25.9	12.3	8.5	18.4	3.0	137.3	-4.9	132.4
	March	49.6	22.3	24.0	12.1	8.2	18.0	2.9	137.1	-4.8	132.3
	June	46.0	24.1	24.6	13.6	8.4	18.2	2.9	137.8	-4.8	133.0
2017-2018	September	45.9	24.4	25.1	13.7	8.5	18.0	3.0	138.6	-5.0	133.7
	December	44.5	24.3	25.5	13.6	8.6	18.0	3.0	137.6	-5.0	132.6
	March	46.3	23.7	24.8	12.9	8.6	17.7	2.9	136.9	-4.8	132.1
	June	45.3	24.9	25.5	13.8	8.7	17.9	2.9	138.9	-4.9	134.0

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2018-2019	September	45.5	25.3	25.3	13.8	8.8	17.0	3.0	138.5	-4.9	133.7
	December	43.7	25.5	25.8	14.4	8.7	17.0	3.0	138.1	-4.9	133.2
	March	46.7	24.4	24.3	13.3	8.5	16.6	2.9	136.7	-4.7	132.0
	June	44.0	25.6	25.0	14.9	8.7	16.8	2.9	138.0	-4.8	133.1

Data Table 1B: Seasonally adjusted emissions (Mt), by sector, by quarter, since 2001-02[32]

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2001-2002	September	46.3	18.9	18.7	9.6	7.1	19.3	4.0	124.1	16.2	140.0
	December	45.2	19.1	18.9	9.7	7.1	19.3	4.0	123.4	16.3	139.7
	March	45.8	19.2	19.0	9.6	7.1	19.2	4.0	123.8	16.6	140.4
	June	46.7	19.3	19.1	9.5	7.4	19.3	4.0	125.0	16.5	141.7
2002-2003	September	47.2	19.4	19.3	9.4	7.6	18.0	3.7	124.9	18.5	143.2
	December	47.2	19.5	19.5	9.2	7.8	18.0	3.7	125.1	18.5	143.6
	March	45.7	19.7	19.6	9.2	8.0	17.9	3.7	123.9	18.7	142.7
	June	46.4	19.7	19.7	9.2	7.8	18.0	3.7	124.3	18.7	142.9
2003-2004	September	47.6	19.9	20.1	9.4	8.1	18.8	3.6	127.7	16.4	144.1
	December	47.8	19.9	20.3	9.3	8.3	18.8	3.6	128.2	16.4	144.5
	March	50.2	20.1	20.4	9.3	8.3	18.9	3.6	130.8	16.8	147.7
	June	49.4	20.0	20.5	9.4	8.0	18.7	3.6	129.4	16.4	145.7
2004-2005	September	49.4	20.4	20.6	9.5	7.8	19.0	3.6	130.6	22.3	152.9
	December	49.1	20.5	20.4	9.7	7.9	19.0	3.6	130.4	22.2	152.6
	March	48.9	20.6	20.2	9.7	8.0	18.9	3.6	129.9	22.2	152.1
	June	49.4	20.6	21.0	9.7	8.1	18.9	3.6	131.1	22.0	152.9
2005-2006	September	49.4	20.2	20.4	9.8	8.0	18.7	3.5	130.2	21.5	151.7
	December	49.9	20.1	21.2	9.9	7.9	18.6	3.5	131.2	21.3	152.6
	March	50.6	20.1	21.1	10.0	7.9	18.5	3.5	131.8	21.2	153.0
	June	51.6	20.7	20.9	10.2	8.1	18.5	3.6	133.4	20.8	154.2

[32] 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.

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2006-2007	September	50.6	20.0	21.0	10.3	8.3	17.8	3.6	131.9	24.0	155.7
	December	51.8	20.6	21.3	10.3	8.5	17.7	3.6	134.0	23.7	157.7
	March	51.5	20.6	21.7	10.6	8.6	17.6	3.6	134.0	23.3	157.4
	June	50.3	20.7	21.8	10.7	8.8	17.6	3.6	133.2	22.8	156.2
2007-2008	September	51.9	20.8	21.5	11.1	8.5	17.1	3.7	135.0	20.3	155.0
	December	51.2	20.9	21.5	10.0	8.5	17.0	3.7	133.1	19.9	152.8
	March	51.4	21.2	21.9	10.8	8.7	17.1	3.8	134.6	19.6	154.3
	June	51.4	21.5	22.0	10.3	8.8	16.9	3.7	134.2	18.7	153.3
2008-2009	September	53.9	21.3	22.0	10.1	9.1	17.2	3.7	137.6	18.3	155.5
	December	53.4	21.0	21.8	10.8	8.6	17.1	3.7	136.5	17.8	154.2
	March	52.0	20.0	21.8	10.4	7.4	17.1	3.7	132.2	17.1	149.5
	June	52.3	20.4	21.7	10.9	7.7	17.1	3.7	133.5	16.3	150.3
2009-2010	September	50.1	20.0	22.3	10.7	8.4	16.6	3.8	132.3	13.2	144.9
	December	52.4	20.6	22.2	10.3	8.8	16.6	3.8	134.8	12.6	147.4
	March	51.9	21.3	22.1	10.8	9.3	16.5	3.8	135.4	11.8	147.4
	June	50.5	21.2	22.3	10.5	9.2	16.6	3.8	133.9	11.0	145.2
2010-2011	September	50.1	21.2	22.6	11.0	8.9	17.7	3.7	135.4	8.4	143.5
	December	48.1	21.2	23.0	10.7	9.1	17.7	3.7	133.7	7.8	141.5
	March	49.8	21.1	22.8	9.8	9.1	17.7	3.6	133.8	7.0	140.9
	June	50.1	21.8	23.0	10.0	9.1	17.7	3.6	135.4	6.2	141.6
2011-2012	September	50.4	22.3	22.4	10.3	9.0	18.0	3.3	135.2	5.5	140.7
	December	50.3	22.1	22.2	10.4	8.1	17.9	3.3	134.5	4.9	139.4
	March	49.3	22.4	23.8	10.5	8.3	18.1	3.3	135.4	4.2	139.7
	June	49.0	22.1	23.6	10.8	8.1	17.9	3.2	135.0	3.5	138.4

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2012-2013	September	46.7	23.2	23.1	10.5	7.8	18.1	3.1	132.2	2.8	135.0
	December	47.0	23.4	23.2	10.6	7.9	18.0	3.1	133.4	2.1	135.6
	March	46.5	23.2	22.9	10.5	7.9	18.0	3.1	131.8	1.5	133.3
	June	46.9	23.2	23.0	10.4	7.9	18.0	3.1	132.7	0.9	133.6
2013-2014	September	44.7	23.2	23.3	9.9	7.9	18.2	3.2	130.2	2.9	133.0
	December	45.0	23.5	23.2	10.3	7.9	18.2	3.1	131.5	2.3	133.8
	March	46.1	23.6	23.4	10.7	7.9	18.1	3.1	132.8	1.7	134.5
	June	45.0	23.7	23.4	10.0	8.0	18.1	3.1	131.3	1.2	132.6
2014-2015	September	47.2	22.4	23.8	11.9	8.2	17.6	3.0	133.9	-0.1	133.7
	December	47.4	22.2	23.8	11.1	8.3	17.5	3.0	133.5	-0.7	132.9
	March	46.7	22.4	23.9	11.0	8.3	17.5	3.0	132.8	-1.1	131.6
	June	47.7	22.2	23.8	11.4	8.3	17.4	3.0	133.8	-1.5	132.4
2015-2016	September	48.9	22.4	23.9	11.9	8.3	17.4	3.1	135.6	-3.5	132.1
	December	49.2	22.6	23.8	11.8	8.3	17.3	3.1	136.1	-3.9	132.2
	March	48.6	22.7	24.6	12.5	8.2	17.4	3.1	137.4	-4.3	133.0
	June	48.1	22.7	24.0	11.8	8.2	17.1	3.1	135.1	-4.5	130.6
2016-2017	September	48.2	23.3	24.4	12.3	8.4	18.4	3.0	137.8	-4.4	133.5
	December	46.6	23.6	25.3	12.3	8.4	18.3	3.0	137.5	-4.8	132.8
	March	48.2	23.2	24.6	12.7	8.4	18.2	2.9	138.5	-5.0	133.3
	June	46.7	23.9	24.7	13.4	8.4	18.1	2.9	138.4	-5.2	133.0
2017-2018	September	45.3	23.8	25.0	13.3	8.4	18.1	3.0	136.6	-4.6	132.3
	December	45.8	24.0	24.8	13.6	8.5	17.9	3.0	137.8	-4.8	133.0
	March	45.1	24.7	25.5	13.6	8.8	17.9	2.9	138.3	-5.0	133.2
	June	45.8	24.8	25.6	13.5	8.8	17.7	2.9	139.5	-5.1	134.0

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2018-2019	September	44.9	24.7	25.1	13.4	8.6	17.0	3.0	136.4	-4.6	132.3
	December	45.0	25.2	25.2	14.3	8.7	16.9	3.0	138.3	-4.8	133.6
	March	45.4	25.4	24.9	14.0	8.7	16.8	2.9	138.1	-4.9	133.1
	June	44.5	25.4	25.1	14.6	8.7	16.7	2.9	138.5	-5.0	133.1

Data Table 1C: Trend emissions (Mt), by sector, by quarter, since 2001-02[33]

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2001-2002	September	46.1	18.9	18.7	9.8	7.1	19.4	4.0	124.0	16.7	140.4
	December	45.5	19.1	18.8	9.7	7.0	19.3	4.0	123.8	16.2	139.7
	March	45.8	19.2	19.0	9.6	7.1	19.2	4.0	124.0	16.4	140.4
	June	46.7	19.3	19.1	9.5	7.3	18.9	3.9	124.7	17.0	141.8
2002-2003	September	47.3	19.4	19.3	9.4	7.6	18.4	3.8	125.0	18.0	143.1
	December	47.0	19.6	19.5	9.3	7.8	18.0	3.7	124.6	18.7	143.4
	March	46.3	19.7	19.6	9.2	7.9	17.9	3.7	124.3	18.7	142.9
	June	46.4	19.8	19.8	9.3	7.9	18.1	3.7	124.9	18.1	143.0
2003-2004	September	47.4	19.8	20.0	9.3	8.1	18.5	3.6	126.6	16.9	143.9
	December	48.6	20.0	20.3	9.3	8.3	18.8	3.6	128.6	16.3	145.0
	March	49.4	20.0	20.4	9.3	8.2	18.8	3.6	129.8	16.8	145.9
	June	49.6	20.1	20.5	9.4	8.0	18.9	3.6	130.2	18.3	146.1
2004-2005	September	49.4	20.3	20.5	9.6	7.9	19.0	3.6	130.3	20.5	152.9
	December	49.1	20.5	20.4	9.7	7.9	19.0	3.6	130.3	22.0	152.5
	March	49.0	20.6	20.4	9.7	8.0	18.9	3.6	130.4	22.3	152.5
	June	49.2	20.5	20.6	9.7	8.1	18.9	3.6	130.4	21.9	152.4
2005-2006	September	49.5	20.3	20.8	9.8	8.0	18.7	3.6	130.6	21.6	152.2
	December	49.8	20.1	21.1	9.9	7.9	18.6	3.5	131.2	21.3	152.3
	March	50.8	20.2	21.0	10.0	7.9	18.5	3.5	131.9	21.1	153.1
	June	51.1	20.3	20.9	10.2	8.1	18.3	3.6	132.5	21.9	154.1

[33] 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.

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2006-2007	September	51.2	20.5	21.0	10.3	8.3	17.9	3.6	133.0	23.1	155.9
	December	51.4	20.6	21.3	10.4	8.5	17.7	3.6	133.4	23.7	157.4
	March	51.3	20.6	21.7	10.5	8.7	17.6	3.6	133.8	23.4	157.4
	June	51.0	20.7	21.8	10.8	8.7	17.5	3.6	134.0	22.4	156.4
2007-2008	September	51.3	20.8	21.6	10.8	8.5	17.2	3.7	133.9	20.8	154.6
	December	51.5	20.9	21.6	10.8	8.5	17.1	3.7	133.8	19.9	153.6
	March	51.1	21.2	21.8	10.6	8.7	17.0	3.8	134.2	19.4	153.5
	June	52.0	21.4	22.0	10.3	8.9	17.0	3.7	135.4	18.8	154.2
2008-2009	September	53.3	21.3	22.0	10.2	8.9	17.1	3.7	136.4	18.3	155.0
	December	53.3	20.9	21.8	10.4	8.5	17.2	3.7	136.0	17.8	153.7
	March	52.4	20.4	21.7	10.6	7.8	17.1	3.7	134.4	17.1	150.4
	June	51.8	20.0	21.8	10.8	7.8	17.0	3.7	133.0	15.8	147.9
2009-2010	September	51.8	20.1	22.1	10.7	8.3	16.7	3.8	133.3	14.2	147.1
	December	52.0	20.6	22.2	10.5	8.9	16.5	3.8	134.2	12.7	147.3
	March	51.8	21.1	22.1	10.6	9.2	16.6	3.8	134.8	11.7	147.1
	June	50.8	21.3	22.3	10.8	9.2	16.9	3.8	134.9	10.5	145.4
2010-2011	September	49.7	21.2	22.7	10.9	9.0	17.4	3.7	134.4	9.0	143.3
	December	49.1	21.1	22.9	10.6	9.1	17.6	3.7	134.1	7.8	141.6
	March	49.5	21.2	22.9	10.1	9.2	17.7	3.6	134.4	7.0	141.1
	June	50.2	21.7	22.7	10.0	9.1	17.7	3.5	134.7	6.2	141.3
2011-2012	September	50.4	22.2	22.5	10.2	8.8	17.9	3.4	135.1	5.5	140.7
	December	50.2	22.2	22.7	10.4	8.5	18.0	3.3	135.2	4.9	139.8
	March	49.6	22.3	23.3	10.5	8.2	18.0	3.2	134.9	4.2	139.4
	June	48.5	22.7	23.5	10.6	8.0	18.0	3.2	134.4	3.5	138.2

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2012-2013	September	47.3	23.2	23.4	10.6	7.9	18.0	3.1	133.4	2.8	136.4
	December	46.6	23.4	23.1	10.6	7.8	18.0	3.1	132.7	2.1	134.9
	March	46.7	23.2	22.9	10.5	7.9	18.0	3.1	132.3	1.6	133.9
	June	46.0	23.2	23.0	10.3	7.9	18.0	3.1	131.7	1.7	133.2
2013-2014	September	45.1	23.3	23.2	10.1	7.9	18.2	3.1	131.3	2.2	133.3
	December	45.1	23.5	23.3	10.3	7.9	18.2	3.1	131.4	2.2	133.9
	March	45.6	23.6	23.3	10.6	7.9	18.2	3.1	132.0	1.9	133.9
	June	46.0	23.3	23.5	10.9	8.0	18.0	3.1	132.9	1.1	133.4
2014-2015	September	46.8	22.7	23.7	11.1	8.2	17.7	3.0	133.2	0.1	133.2
	December	47.3	22.3	23.9	11.1	8.3	17.5	3.0	133.3	-0.7	132.8
	March	47.0	22.3	23.9	11.1	8.3	17.5	3.0	133.4	-1.1	132.0
	June	47.7	22.3	23.8	11.4	8.3	17.4	3.0	133.9	-2.0	132.1
2015-2016	September	48.8	22.4	23.8	11.8	8.3	17.4	3.1	135.3	-3.1	132.2
	December	49.1	22.6	23.9	12.1	8.3	17.3	3.1	136.3	-3.9	132.4
	March	48.6	22.7	24.0	12.1	8.2	17.4	3.1	136.6	-4.3	132.6
	June	48.3	22.9	24.1	12.1	8.3	17.7	3.1	136.7	-4.4	132.8
2016-2017	September	47.8	23.3	24.4	12.1	8.4	18.0	3.0	137.1	-4.5	132.9
	December	47.5	23.5	24.7	12.4	8.4	18.3	2.9	137.8	-4.7	133.1
	March	47.4	23.6	24.7	12.8	8.4	18.2	2.9	138.2	-5.0	133.2
	June	46.6	23.8	24.7	13.2	8.4	18.1	2.9	137.8	-5.0	132.9
2017-2018	September	45.7	23.9	24.9	13.5	8.4	18.0	3.0	137.4	-4.8	132.6
	December	45.4	24.1	25.0	13.5	8.6	18.0	3.0	137.7	-4.8	132.8
	March	45.5	24.6	25.4	13.6	8.7	17.9	2.9	138.3	-5.0	133.5
	June	45.4	24.7	25.5	13.4	8.8	17.6	2.9	138.6	-5.0	133.4

Year	Quarter	Energy				Industrial processes and product use	Agriculture	Waste	Total excluding LULUCF	LULUCF	National Inventory Total
		Electricity	Stationary energy excl. electricity	Transport	Fugitive emissions						
2018-2019	September	45.2	24.9	25.3	13.6	8.7	17.2	3.0	138.3	-4.8	133.2
	December	45.1	25.1	25.1	13.9	8.7	16.9	3.0	137.9	-4.7	133.2
	March	45.0	25.4	25.0	14.2	8.7	16.8	2.9	138.2	-4.8	133.1
	June	45.1	25.4	25.1	14.4	8.7	16.7	2.9	139.0	-5.0	133.5

Tracking Australia's emissions

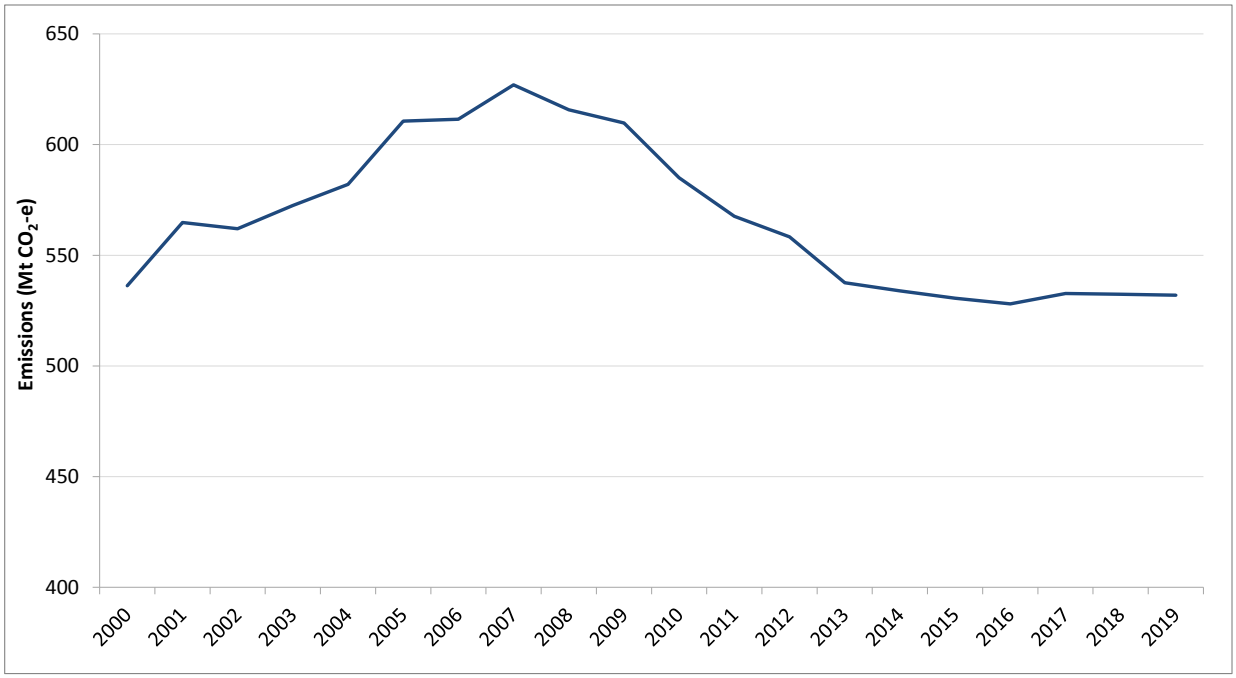
The date presented in Table 6 and Figure 19 include Australia's annual emissions for 2000 to 2019.

Australia's annual emissions for the year to June 2019 are estimated to be 532.0 Mt CO_2-e. This figure is 0.8 per cent below emissions in 2000 (536.2 Mt CO_2-e) and 12.9 per cent below emissions in 2005 (610.6 Mt CO_2-e).

Table 6: National inventory total from 2000 to 2019, by financial year

Financial Year	Emissions (Mt CO_2-e)
2000	536.2
2001	564.8
2002	562.0
2003	572.5
2004	582.0
2005	610.6
2006	611.5
2007	627.0
2008	615.7
2009	609.8
2010	585.0
2011	567.6
2012	558.3
2013	537.6
2014	533.9
2015	530.6
2016	528.0
2017	532.7
2018	532.4
2019	532.0

Figure 19: National inventory total, year to June 2000 to 2019



Source: Department of the Environment and Energy

7. Related publications and resources

Australia's National Greenhouse Accounts

The following Department of the Environment and Energy (DoEE) publications are all available on the departmental website:

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

National Inventory Report 2017

The three volumes comprising Australia's forthcoming National Inventory Report 2017 were submitted under the UNFCCC and the Kyoto Protocol in May 2019. These reports contains national greenhouse gas emission estimates for the period 1990-2017 and preliminary estimates for 2018 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 2017

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 2017* and the *National Inventory by Economic Sector 2017*.

National Inventory by Economic Sector 2017

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 Australia's *National Inventory Report 2017* and the *State and Territory Greenhouse Gas Inventories 2017*.

Australian Greenhouse Emissions Information System (AGEIS)

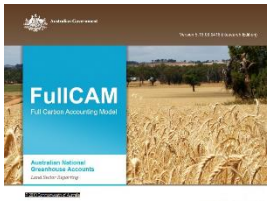
The AGEIS centralises the Department's emissions estimation, emissions data management and reporting systems. AGEIS is being used to compile national and State and Territory inventories. The interactive web interface provides enhanced accessibility and transparency to Australia's greenhouse emissions data: http://www.environment.gov.au/climate-change/climate-science-data/greenhouse-gas-measurement/ageis

Australia's Emissions Projections: 2018

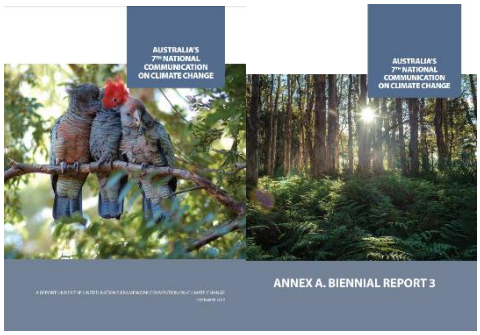
The report provides detail on emissions trends, including sector specific analysis of factors driving emissions. The report estimates the emissions reduction effort required to meet Australia's emissions reduction targets. The projections include sensitivity analyses to illustrate how emissions may differ under changes in economic growth.
http://www.environment.gov.au/climate-change/publications/emissions-projections-2018

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/climate-science-data/greenhouse-gas-measurement/land-sector



Australia's Seventh National Communication/Third 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. Biennial Reports 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/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/national-inventory-submissions-2019

environment.gov.au

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ATTACHMENT B

COMPARISON OF THE ESTIMATES FOR THE NEW PUBLICATION AND PREVIOUS PUBLICATION

	New publication	Previous publication
National Inventory	**June quarter**	**March quarter**
Quarterly change (seasonally adjusted)	0.0%	-0.4%
Quarterly change – trend	0.3%	-0.1%
Annual change	-0.1%	0.6%
NEM	**September quarter**	**June quarter**
Quarterly change (seasonally adjusted)	-1.5%	-2.8%
Quarterly change – trend	-2.6%	-0.9%
Annual change	-2.9%	-2.6 %

ATTACHMENT C

KEY POINTS

June 2019 *Quarterly Update* of Australia's national greenhouse gas inventory

- In the year to June 2019 emissions were 532.0 Mt CO_2-e, down 0.1 per cent or 0.4 Mt CO_2 -e on the previous year.
  - Emissions had been increasing since 2016 with this the first decline since then.
- The decrease in the year to June 2019 reflects:
  - the ongoing reduction in *electricity* emissions (down 1.2 per cent or 2.1 Mt CO_2-e);
    - : mainly due to a 1.6 per cent reduction in coal consumption;
    - : a 17.4 per cent reduction in gas consumption; and
    - : a corresponding 18.0 per cent increase in supply from renewable sources.
  - a 0.5 per cent decrease in *transport* emissions reflecting a 4.3 per cent decrease in petrol consumption; and
  - a 5.9 per cent or 4.2 Mt CO_2-e decrease in *agriculture* emissions reflects a decline in livestock populations as well as fertiliser use due to drought conditions.
- Offsetting this decrease was a 6 per cent increase in emissions from total export industries mainly reflecting the strong growth LNG exports (up 21.3 per cent or 7.8 Mt CO_2-e).
- In the year to June 2019, Australia's emissions related to LNG production were 42.7 Mt CO_2 –e.
  - When these emissions are excluded from Australia's inventory, total emissions are estimated at 489.3 Mt CO_2 –e
- The latest official *Quarterly Update* of Australia's national greenhouse gas inventory shows that, in the year to June 2019, emissions per capita and the emissions intensity of the economy have declined further and are at their lowest levels in 29 years.
  - Emissions per capita in the year to June 2019 were lower than 1990 by 40.9 per cent,
  - Emissions intensity of the economy was 62.9 per cent lower than in 1990.
- Australia's emissions for the year to June 2019 are estimated to be 532.0 Mt CO_2-e.
  - This is 15.2 per cent below the peak in the year to June 2007; and
  - 0.8 per cent below emissions in 2000 and 12.9 per cent below emissions in 2005.

What's happening in the last quarter?

- Emissions in the June quarter of 2019 were unchanged relative to the previous quarter, on a seasonally adjusted and weather normalised basis, but increased by 0.3 per cent in trend terms.

- Strong growth in emissions from Australia's export industries, principally LNG, were offset by the combination of:

    - the ongoing reduction in *electricity* emissions (down 1.8 per cent or 0.8 Mt CO_2-e);

    - the effects of the drought on agriculture emissions (down 0.8 per cent or 0.1 Mt CO_2-e).

What's happening in the electricity sector?

- National Electricity Market (NEM) emissions in the September quarter 2019 decreased by 1.5 per cent on a seasonally adjusted and weather normalised basis and by 2.6 per cent in trend terms.

    - Electricity generation from renewables increased 20.3 per cent which reflects the longer term trend.

        : Wind generation increased 21.4 per cent and solar generation increased 33.5 per cent.

- *Electricity* sector emissions decreased by 1.2 per cent in the year to June 2019 and 15.0 per cent from the peak recorded in the year to June 2009. This decline mainly reflects changes in the NEM:

    - a 1.6 per cent reduction in coal consumption,

    - a 17.4 per cent reduction in gas consumption, and

    - a corresponding 20.1 per cent increase in supply from renewable sources.

Why are you reporting a consumption-based greenhouse gas inventory? How does it relate to Australia's international emissions targets?

- The preliminary consumption-based inventory complements Australia's production-based national greenhouse gas inventory that is used to track progress towards our emissions reduction commitments.

- It provides additional context.

    - The consumption-based inventory estimates that Australian emissions released in producing our exports for 2018-19 were 199 Mt CO_2-e. This is 67 Mt CO_2-e or 50 per cent more than for 2004-05.

- Australia will continue to produce and report on our production-based national greenhouse gas inventory in accordance with our international obligations under the United Nations Framework Convention on Climate Change.

What is a consumption-based inventory?

- The new preliminary consumption-based national greenhouse gas inventory tracks the 'carbon footprint' of Australian consumption.
    - It includes all the emissions associated with the production and use of goods consumed in Australia, whether these emissions occur in Australia or overseas.
    - This inventory does not include emissions generated in producing goods that Australia exports.
- Comparing the consumption-based inventory with our production-based national greenhouse gas inventory shows how international trade influences our emissions profile.

What are Australia's consumption-based emissions?

- For the year to June 2019, preliminary estimates for the 'consumption-based' inventory are 450 Mt CO_2-e. This represents a decrease of 4 per cent or 20 Mt CO_2-e on the previous year.
    - Consumption-based emissions are 102 Mt CO_2-e or 18 per cent lower compared to 2004-05.
- In the year to June 2019, the consumption-based inventory is estimated to be 82 Mt CO_2-e or 15 per cent lower than Australia's national greenhouse gas inventory.
    - This equates to 17.1 tonnes per person or around 4 tonnes per person lower than the national greenhouse gas inventory.
- Australia's consumption-based emissions are lower than our production-based emissions, in contrast to most other OECD countries.

How reliable are the estimates?

- While they are preliminary estimates, the Department of the Environment and Energy has developed them in consultation with the Treasury and the ABS, and is confident that the conclusions presented from the consumption-based inventory are robust.
    - As with all aspects of the National Greenhouse Accounts, work will continue to improve and refine the estimates over time.

Does this analysis include emissions from combustion of fossil fuels that Australia exports?

- No. The consumption-based inventory estimates the emissions generated to service the consumption of goods in Australia, not overseas consumption of Australian exports.
- This is a common approach for these kinds of analyses, for example the UK's Carbon Footprint published by the UK Department for Environment Food and Rural Affairs.

<u>IF ASKED</u>: Who else estimates 'consumption-based' or 'trade-adjusted' emissions? How do their results compare?

- The UK Climate Change Committee tracks the UK's consumption-based emissions, using statistics from the Department of Environment, Food and Rural Affairs.
    - UK's consumption-based emissions were estimated at 784 Mt CO_2-e in 2016, around 56 per cent higher than its production-based emissions of 503 Mt CO_2-e.
    - The UK statistics are classified as "experimental" due to inherent uncertainties.
- The OECD also publishes estimates of consumption-based emissions, including for Australia.
    - These estimates are not directly comparable as they only include partial coverage of emissions (only carbon dioxide emissions from energy) and are based on coarser OECD trade data.
    - The OECD results differ from the Department's consumption-based inventory. The OECD results indicate that Australia's consumption-based emissions are higher than production-based emissions in 2015, and that they remain above 2005 levels.

<u>IF ASKED</u>: Why was it assumed that the Australia's emissions intensity is the same as those of our trading partners?

- The Department has made this simplified assumption for the preliminary inventory and plans to analyse and account for the emissions intensities of our trade partners as part of future improvements to the consumption-based inventory.

We have strong emission reduction targets and the right policy mix to achieve them

- Australia has a proud record of meeting our emissions reduction targets, and we are committed to the Paris Agreement.
- We are on track to beat our 2020 target by 367 million tonnes.
- Our 2030 target to reduce emissions by 26 to 28 per cent is strong and responsible.
- The newly announced $3.5 billion Climate Solutions Package and existing measures will deliver around 235 million additional tonnes of emissions reductions without adversely impacting the economy.
- Technological change and other sources of abatement could deliver at least another 100 million tonnes.
- We are taking achievable and responsible action on climate change over the longer term.

Why do the historical emissions estimates keep changing?

- Australia's National Greenhouse Gas Accounts take into account the latest scientific evidence.
- The accounts are reviewed annually by an UNFCCC expert review team for transparency, accuracy, completeness, comparability and consistency.
- Emissions estimation techniques and data sources continue to be refined, updated and improved.
- To ensure the accuracy of the estimates, and consistency of the series through time, recalculations of past emission estimates are undertaken for all previous years.
- Time series is a central component of Australia's national inventory of greenhouse gas emissions because it provides information on historical emissions trends and tracks the effects of policies and programs to reduce emissions at the national level.

ATTACHMENT D

WEBSITE LANDING PAGE MATERIAL

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

The *Quarterly Update* provides estimates of Australia's national inventory of greenhouse gas emissions up to the June quarter of 2019, and emissions from the National Electricity Market (NEM)[1] up to the September quarter 2019.

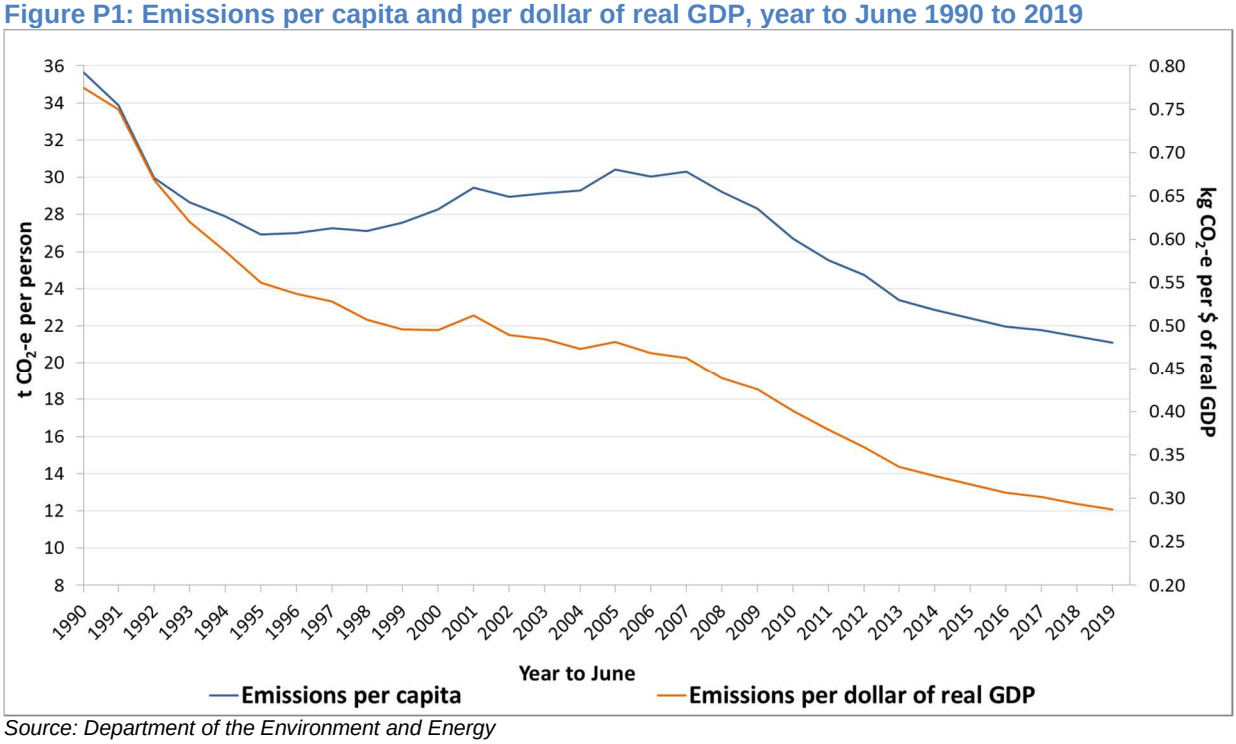
National emission level[2] for the June quarter 2019 were unchanged relative to the previous quarter, on a seasonally adjusted and weather normalised basis, but increased by 0.3 per cent in trend terms.

Emissions for the year to June 2019 are estimated to be 532.0 Mt CO_2-e, down 0.1 per cent or 0.4 Mt CO_2-e on the previous year. Strong growth in emissions from *stationary energy* (3.6 per cent or 3.5 Mt CO_2-e) and *fugitive emissions* (4.4 per cent or 2.4 Mt CO_2-e), were offset by the combination of the ongoing reduction in emissions from *electricity* (1.2 per cent or 2.1 Mt CO_2-e) and the effects of the drought on *agriculture* (5.9 per cent or 4.2 Mt CO_2-e).

Australia's emissions for the year to June 2019 have declined 15.2 per cent since the peak in the year to June 2007 and were 0.8 per cent below emissions in 2000 and 12.9 per cent below emissions in 2005.

In the year to June 2019 emissions per capita, and the emissions intensity of the economy were at their lowest levels in 29 years. Emissions per capita in the year to June 2019 were lower than 1990 by 40.9 per cent, while the emissions intensity of the economy was 62.9 per cent lower than in 1990 (Figure P1).

Figure P1: Emissions per capita and per dollar of real GDP, year to June 1990 to 2019



Source: Department of the Environment and Energy

Emissions from the *electricity* sector are experiencing a long term decline, down 15.0 per cent from the peak recorded in the year to June 2009. Emissions in the NEM for the September quarter 2019

[1] The NEM includes grid electricity in the Eastern and South Eastern states and accounts for approximately 83 per cent of total electricity estimates in the year to June 2019.

[2] National emissions level are inclusive of all sectors of the economy, including Land Use, Land use Change and Forestry (LULUCF).

decreased by 1.5 per cent on a seasonally adjusted and weather normalised basis compared with the previous quarter.[3] For the September 2019 quarter, generation from renewables increased 20.3 per cent primarily due to increases in wind generation (21.4 per cent) and solar generation (33.5 per cent).

Recalculations

In this *Quarterly Update,* the time-series of emissions has been recalculated using critical new datasets released since the publication of the March *Quarterly Update* and in preparation for the submission of the Australian Government's National Inventory Report under the UN Framework Convention on Climate Change next year. These datasets include:

- Newly released National Greenhouse and Energy Reporting Scheme (NGERS) data, including final data for 2017-18 and preliminary data for 2018-19, which became available as of 31 October 2019, which led to reassessments of enhanced rates of energy efficiency improvements in key industries in 2018-19;
- The 2019 Energy Update revised energy consumption estimates down for the entire period 2014-2018; and
- New data from the Australian Bureau of Agricultural and Resource Economics and Sciences showing the drought intensifying its impacts beyond previous expectations.

Detail is provided in Section 5 - Technical Notes.

Special Topic

The special topic (Section 4) highlights that the growing importance of international trade in conjunction with the specialisation in Australia of the production of goods that are relatively emissions-intensive to produce have placed upward pressure on Australia's greenhouse gas inventory in recent years.

A consumption-based national greenhouse gas inventory has been generated by the Department for the first time. It is presented as a preliminary inventory for ongoing work.

This new account estimates the impacts on emissions in Australia and in other countries due to Australian consumption. According to this indicator, Australia's consumption-based inventory decreased by 4 per cent or 20 Mt CO_2-e to 450 Mt CO_2-e in the year to June 2019. Emissions generated by Australian consumption are 102 Mt CO_2-e or 18 per cent lower compared to 2004-05.

On an annual basis, the preliminary consumption-based inventory shows that the emissions generated to support Australia's consumption are less than those reported as the (production-based) national greenhouse gas inventory by 82 Mt CO_2-e or 15 per cent. This is approximately 17.1 tonnes per person, which is around four tonnes per person less than the per capita emission calculation using the national greenhouse gas inventory.

The consumption-based inventory estimates that Australian emissions released in producing our exports for 2018-19 were 199 Mt CO_2-e. This is 67 Mt CO_2-e or 50 per cent more than for 2004-05.

The preliminary analysis indicates that the net effect of Australia's trade with North East Asia, has been to exert strong upward pressure on Australia's national greenhouse gas inventory.

[3] 'Unadjusted', 'seasonally adjusted, weather normalised' and 'trend' are defined in Section 4 - Technical Notes

Senator the Hon Scott Ryan

President of the Senate

Parliament House

CANBERRA ACT 2600

Dear Mr President

I present to you the *Quarterly Update of Australia's National Greenhouse Gas Inventory: June 2019 (Incorporating emissions from the NEM up to September 2019).*

Yours sincerely

Simon Birmingham

November 2019