ACT GREENHOUSE GAS INVENTORY FOR 2023-24

ACT Government

PREPARED FOR:

ENVIRONMENT, PLANNING AND SUSTAINABLE DEVELOPMENT DIRECTORATE

ACT GOVERNMENT

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The findings in this report have been formed on the above basis.

VERSION CONTROL

Version	Date	Authors	Project Director
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ACKNOWLEDGEMENT OF COUNTRY

We recognise the First Peoples of this nation and their ongoing connection to culture and country. We acknowledge Aboriginal and Torres Strait Islander Peoples as the Traditional Owners, Custodians and Lore Keepers of the world's oldest living culture and pay respects to their Elders past, and present.

EXECUTIVE SUMMARY

This report presents the results of ACT greenhouse gas (GHG) inventory 2023-24 and discusses their implications for ACT's greenhouse gas emissions reduction and renewable energy targets.

The main results of the inventory are as follows:

1. The ACT's total net GHG emissions in 2023-24 were 1,489 ktCO_2-e, down by 50% from the 1990 baseline and 4% from the previous year.
2. The major sources of emissions were ground transport (65.5%) and stationary energy (21.7%) consisting of fossil fuel gas combustion (19.2%), fugitive gas emissions (1.8%) and other stationary fuels (0.7%). Waste including wastewater, industrial processes and product use (IPPU), aviation, and agriculture shared 6.5%, 2.5%, 2%, and 1.8% of emissions, respectively. The net carbon sequestration by the land use, land use change and forestry (LULUCF) sector offset nearly 10% of these emissions.
3. Emissions associated with ground transport decreased by 3% and that with stationary fossil fuel gas (including fugitive emissions) decreased by 14% compared to the previous year; however, waste emissions increased by 27%.
4. The ACT's per person emissions in 2023-24 were 3.1 tCO_2-e, a decrease by 71% from 2012-13 and 6% from the previous year.
5. The ACT continued to maintain 100% renewable electricity supply in 2023-24.

The inventory results show:

1. The ACT achieved and has maintained the 2020 emissions reduction target (40% reduction on 1990 levels) and is currently on track to meet the 2025 target of emissions reduction by 50-60%.
2. The ACT continued to meet the annual per person emissions reduction target, i.e., per person emissions peaked in 2012-13 and there has been a pronounced downward trend since.
3. The ACT reached the target of 100% renewable electricity supply in 2019-20 and continued to maintain it in 2023-24.

1. Introduction

1.1 Inventory context

The *Climate Change and Greenhouse Gas Reduction Act 2010* (the Act) sets a Territory wide greenhouse gas (GHG) emissions reduction target of zero net emissions by 30 June 2045. The Act also sets a target for annual per person emissions to peak by 30 June 2013 and an interim target of 40% emissions reduction (on 1990 levels) by 30 June 2020. The *Climate Change and Greenhouse Gas Reduction (Interim Targets) Determination 2018* sets interim emissions reduction targets of 50-60% by 30 June 2025, 65-75% by 30 June 2030, and 90-95% by 30 June 2040.

The Act sets a renewable energy target, i.e., the use of renewable electricity in the ACT is 100% on and from 1 January 2020.

This ACT Greenhouse Gas Inventory Report 2023-24 has been prepared to satisfy Part 2, Section 12 of the Act. It contains the following:

- the amount of GHG emissions in the ACT for 2023-24;
- an analysis of the ACT's progress in meeting GHG emissions targets, including a comparison of the annual emissions with emissions reduction targets, identification of the main sources of emissions, and identification of possible reasons for changes in amounts of emissions from previous years; and
- an analysis of the ACT's progress in meeting the renewable energy target, including compliance with the target, and identification of the main sources of renewable energy generated for the ACT.

1.2 Overview of ACT

The Australian Capital Territory (ACT) encompasses approximately 2,358 square kilometres in southeastern Australia. It features a mix of rugged plains and hills and has a temperate climate with warm summers and cool winters. Around 75% of ACT's land is reserved for natural ecosystems and greenspace (Figure 1)[1], however, urban expansion due to population growth continues to be an environmental challenge. The ACT's economy is primarily driven by the service industries, particularly those related to public administration. In contrast to other Australian states and territories, primary sectors such as agriculture, mining, and forestry, represent a small proportion of the economy.[2]

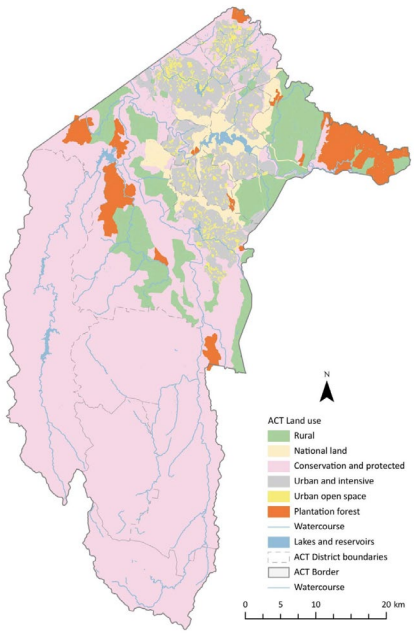

Figure 1. Main land use types in the ACT.

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[1] Source: Environment, Planning and Sustainable Development Directorate - Environment; Source: Australian Capital Territory; Sources: State and Territory Greenhouse Gas Inventories 2022 (AGEIS, 20224). National, state and territory population 2022 (ABS, 2024).

[2] Source: Australian Capital Territory; Sources: State and Territory Greenhouse Gas Inventories 2022 (AGEIS, 20224). National, state and territory population 2022 (ABS, 2024).

1.3 Overview of inventory methodology

The estimates are based on the method established under the Act, the *Climate Change and Greenhouse Gas Reduction (Greenhouse Gas Emissions Measurement Method) Determination 2024* (the Determination).

Specifically, the amount of GHG emissions in the ACT for the inventory year include the following sectors:

- **Energy**: GHG emissions from 'fuel combustion' for 'stationary energy', 'ground transport', and 'domestic aviation' and 'fugitive gas emissions' from the distribution of fossil fuel gas.
- **Industrial processes and product use (IPPU)**: emissions of synthetic greenhouse gases from refrigeration and air-conditioning systems in the industrial, residential and mobile sectors.
- **Agricultural**: GHG emissions from livestock and the non-CO_2 emissions from agricultural soils.
- **Land use, land use change and forestry (LULUCF)**: GHG emissions from 'Forest land', 'Cropland', 'Grassland', 'Wetland', 'Settlements', and 'Harvested Wood products'.
- **Waste**: GHG emissions from 'Solid waste disposal' and 'Wastewater handling'.

The methodologies used to estimate GHG emissions in the ACT for the inventory year 2023-24, including emission factors, activity data, data quality and data sources, are summarised in Appendix 1. Limitations in methodologies and activity data are discussed in the relevant sectors in Section 3.

2. ACT emissions summary

2.1 ACT emissions in 2023-24

The ACT's net GHG emissions in 2023-24 were 1,489 kilotonnes of carbon dioxide equivalent (kt CO_2-e), with 1,649 kt CO_2-e of emissions from various sources and a net removal of 160 kt CO_2-e (9.7% of total emissions) by land use, land use change and forestry (LULUCF) sector. The major sources of emissions were ground transport (65.5%) and stationary energy (21.7%) consisting of fossil fuel gas combustion (19.2%), fugitive gas emissions (1.8%) and other stationary fuels (0.7%). Further emissions were generated from waste processing and decomposition including wastewater (6.5%), industrial processes and product use (2.5%), aviation (2%) and agriculture (1.8%). Table 1 shows the results for 2023-24.

Table 1. ACT 2023-24 greenhouse gas emissions by source

Emission Source	Emissions 2023-24 (kt CO2-e)	Share of total emissions (inc. LULUCF)	Share of total emissions (exc. LULUCF)
Ground transport	1,079.7	72.5%	65.5%
Fossil fuel gas combustion	316.6	21.3%	19.2%
Waste including wastewater	107.9	7.2%	6.5%
Industrial processes/product use	41.3	2.8%	2.5%
Aviation	32.9	2.2%	2.0%
Agriculture	30.1	2.0%	1.8%
Fugitive emissions – fossil fuel	29.6	2.0%	1.8%
Other stationary energy	11.0	0.7%	0.7%
Subtotal (excl. LULUCF)	1,649.1	110.8%	100%
LULUCF	-160.5	-10.8%	NA
Total (inc. LULUCF)	1,488.7	100%	NA

2.2 Changes in emissions

The ACT's total emissions have reduced by 1,513 kt CO2-e (-50%) since 1989-90.

Since the ACT's baseline year (1989-90) the Territory's population has grown 67% from 279,000 to 472,803 whilst total emissions have fallen 50% from 3,002 kt CO_2-e to 1,489 kt CO_2-e. The key driver of this outcome continues to be the emission reductions associated with electricity generation. Emissions from electricity began gradually declining in

2015-16 and then fell to zero in 2019-20 in line with the Territory's 100% renewable electricity supply target. Further contributors to emission reductions since 2012-13 were:

- carbon sequestration by the LULUCF sector, which changed from a net carbon emitter to a net carbon sink in 2015-16 and continued to be so, representing an overall reduction of 300 kt CO_2-e in 2023-24 compared to 2012-13,
- a reduction in emissions from fossil fuel gas combustion (-62 kt CO_2-e),
- a reduction in fugitive emissions associated with fossil fuel gas combustion (-8 kt CO_2-e) (see section 3.1 Fossil fuel Gas for discussion of accounting changes for fugitive emissions), and
- a reduction in aviation emissions (-26 kt CO_2-e).

The overall impact of these emission reductions has been partially offset by increased emissions from:

- ground transport (39 kt CO_2-e)
- waste decomposition including wastewater (7 kt CO_2-e) (see section 3.5.2 Wastewater for discussion of accounting changes in wastewater)

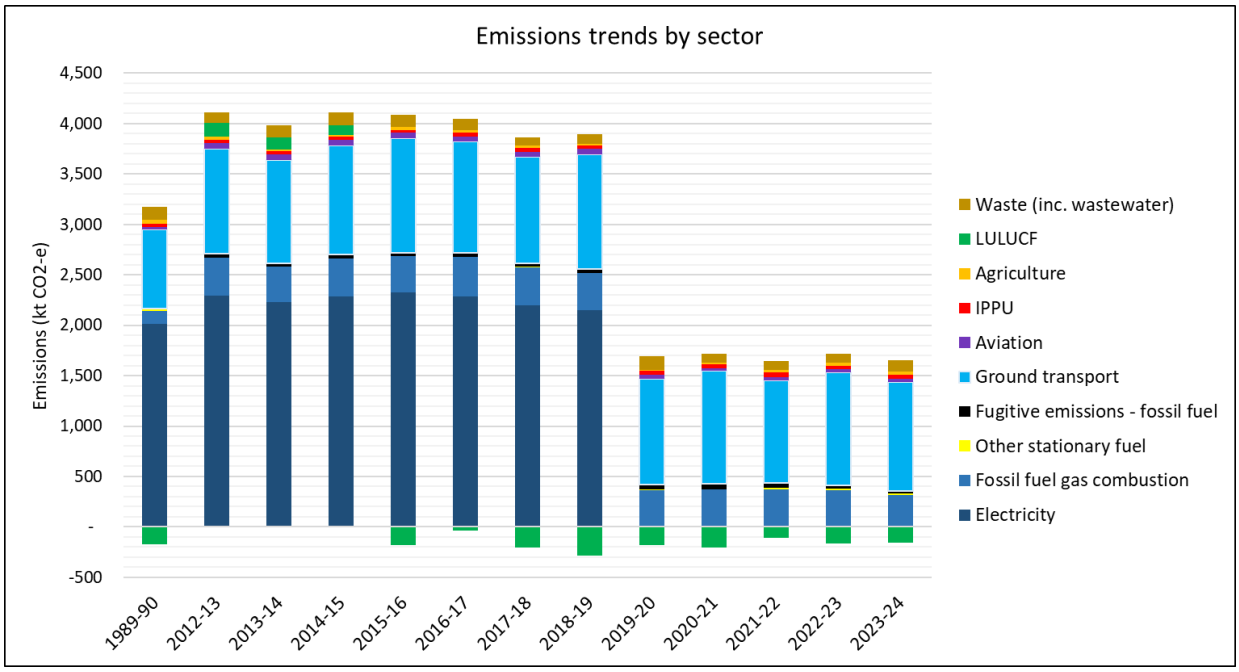

Figure 2. Emissions trends by sector

2.3 Per capita emissions

At 3.1 tCO_2-e in 2023-24, the ACT's per capita emissions are just 19% of the national average of 15.9 tCO_2-e (for the year 2021-22) and lower than all the other states and the Northern Territory, but higher than Tasmania[3].

Part two, section 8 of the Act states that the per person target, which is the average amount of GHG emissions produced per person in the ACT each year, is to peak by 30 June 2013. The ACT is in compliance with the target with per capita emissions falling since 2012-13. Per capita emissions decreased by 71% between 1989-90 and 2023-24. The majority of this decline took place from 2018-19 to 2019-20 as the ACT delivered on its renewable energy targets and per capita emissions fell from 8.3 to 3.4 tCO_2-e (59% decrease).

[3]Sources: State and Territory Greenhouse Gas Inventories 2022 (AGEIS, 2024). National, state and territory population 2022 (ABS, 2024).

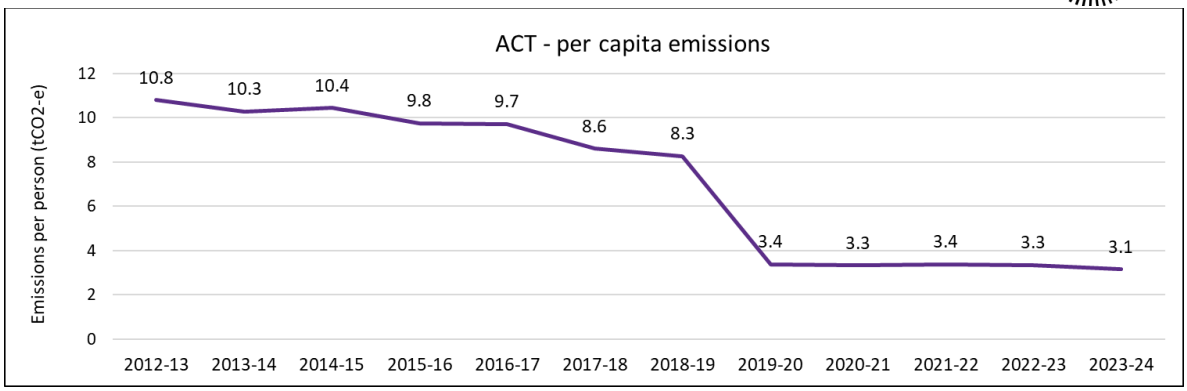

Figure 3. Trend in per capita emissions (tCO_2-e) – ACT, 2012-13 to 2023-24

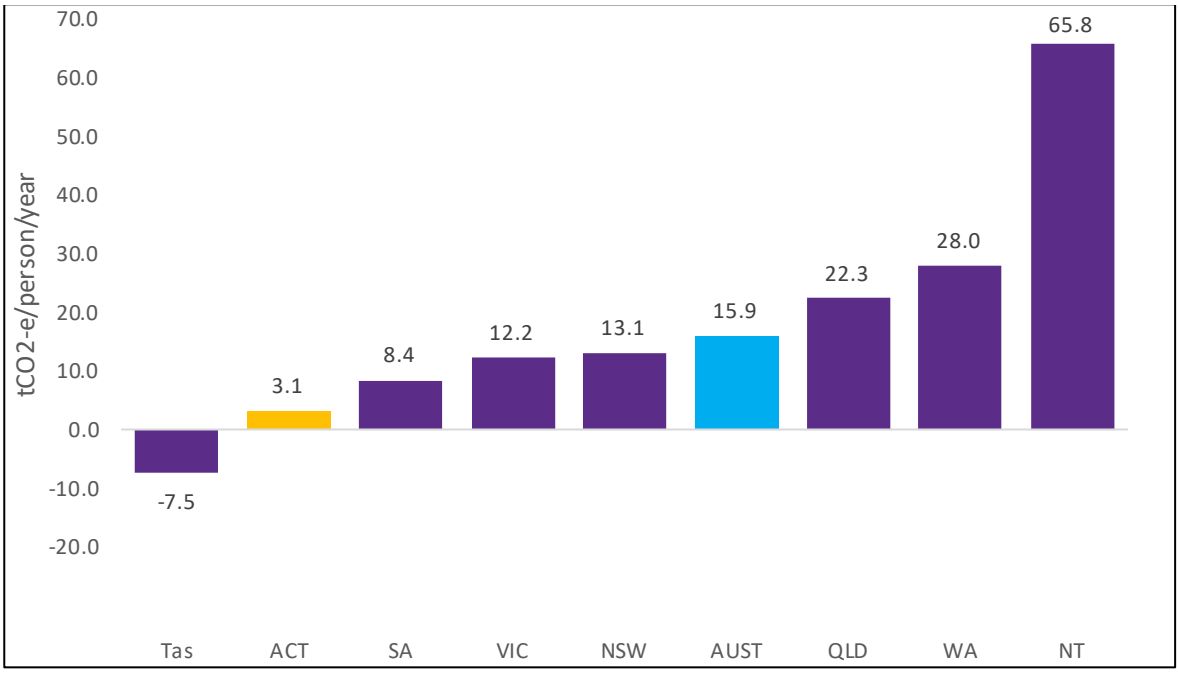

Figure 4. 2023-24 Per capita emissions (tCO_2-e) by State, Territory and Nation

3. Emissions by sector

This section presents the ACT's GHG emissions by sector and key sub-sectors within each sector, describes the activities that drive these emissions and discusses possible reasons for changes in emissions over the past years (see Appendix 3 for a summary of data restatements for the previous years).

Sector definitions are drawn from the following five Intergovernmental Panel on Climate Change (IPCC) source categories:

- Energy
- Industrial processes and product use
- Agriculture
- Land use, land-use change and forestry
- Waste

3.1 Energy

Energy sector is the main source of emissions in the ACT, comprising a total of 1,470 $ktCO_2$-e (89% of total emissions, excluding LULUCF) in 2023-24. Electricity emissions being zero since 2019-20, ground transport is the main source of emissions in this sector.

3.1.1 Electricity

Electricity-related emissions remained at zero in 2023-24 due to the ACT maintaining its 100% renewable electricity supply.

The ACT differs from all other Australian states and territories in having no thermal fossil fuel electricity generators located within its borders. Most of the electricity consumed in the ACT is imported from the National Electricity Market grid, and most of the imported electricity is generated at power stations located either within NSW, or, by way of flows through inter-connectors between state grids, Queensland, or Victoria. Consequently, a conventional jurisdictional GHG inventory following IPCC Guidelines (i.e., reporting only emissions from sources located within the jurisdictional boundary) would greatly under-estimate historic emissions arising from consumption of electricity in the ACT. For this reason, the ACT emissions inventory has always reported Scope 2 emissions for electricity consumption.

Since 1 January 2020, the ACT has offset 100% of residual electricity emissions through renewable generation and retiring Large Generation Certificates (LGCs). The financial year 2023-24 was the fifth year in which the ACT achieved zero electricity-related emissions. Total electricity flow in the ACT was flat at 3,070 GWh, compared to 3,071 GWh in 2022-23, however the portion supplied by renewable sources within the ACT grew by 25% to 439 GWh with the remaining 2,630 GWh imported from the NSW grid. The renewable power percentage (RPP) associated with the federal Large-scale Renewable Energy Target (LRET) was 18.7% for the financial year 2023-24, therefore, it was calculated that 492 GWh of the ACT's electricity consumption was from LGC producing renewable sources. A further 334 GWh of renewable electricity were generated from small-scale solar PV (<200 kW) within the ACT (up 33%) and 100 GWh of below baseline hydroelectricity from Snowy Hydro. These renewable sources do not generate LGCs and are therefore not captured in the RPP. The total quantity of renewable electricity supplied to the ACT in 2023-24 was 928 GWh up 8.1% on the previous year.

The ACT surrendered 2,218,905 LGCs in 2023-24 to maintain its 100% renewable electricity supply.

Table 2. 2023-24 pathway to zero emissions electricity

	2023-24 contribution to target (GWh)	YoY change (%)
Total electricity supplied to customers	3,070	-0%
LRET generation	492	-3.7%
Small-scale solar PV (<200 kW)	334	+33%
ACT share of Snowy Hydro output[4]	100	+6.4
Required surrender of LGCs	2,143	-3.2%
Residual electricity	0	0

3.1.2 Stationary energy

Emissions from stationary energy sources in 2023-24 were 357 kt CO_2-e (21.7% of total emissions), 97% of which is associated with fossil fuel gas (combustion and network leakage).

Since the accomplishment of 100% renewable electricity supply, fossil fuel gas has become the second largest emission source in the ACT with fossil fuel gas combustion and fugitive emissions comprising 21% of the emissions in 2023-24. Remaining stationary energy emissions arise from LPG (0.7%) and firewood (<0.1%). No heating oil was consumed in 2023-24 (Table 3).

Table 3. Emissions from stationary energy sources (in kt CO_2-e)

Emissions sources	1989-90*	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Fossil fuel gas combustion	127.7	378.4	352.3	381.3	362.8	391.8	376.7	367.8	365.6	368.1	369.9	366.6	316.6
LPG	-	-	-	-	-	-	-	-	6.3	6.3	14.8	11.8	10.8
Heating oil	-	-	-	-	-	-	-	-	0.1	0.1	0.1	0.1	-
Wood fuel	16.8	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.5	0.3	0.2
Fugitive emissions	3.5	37.6	32.8	32.8	29.8	35.2	33.7	33.2	46.5	51.0	53.6	33.9	29.6

[4] Below baseline (pre-RET) generation

from fossil fuel													
Total	**148.0**	**416.3**	**385.4**	**414.4**	**392.9**	**427.3**	**410.7**	**401.3**	**418.8**	**425.8**	**438.9**	**412.8**	**357.3**

Note: 1989-90 fossil fuel gas consumption emissions include CNG used by TCCS bus fleet.

Emissions associated with fossil fuel gas (combustion and fugitive) in 2023-24 decreased by about 14% from the previous year. Per capita fossil fuel gas use continued its long-term decline, falling from 15.3 GJ in 2022-23 to 13 GJ in 2023-24. The long-term decline is shown in Table 4, as more gas heating, hot water, and cooking is converted to electricity, gas appliances become more efficient and gas connections are further limited in new dwellings.

Table 4. Total and per capita fossil fuel gas consumption in the ACT (excluding transport)

Fossil fuel gas	Units	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Consumption	TJ	7,343	6,837	7,399	7,040	7,603	7,311	7,137	7,096	7,144	7,179	7,115	6,145
Per capita use	GJ/ capita	19.3	17.7	18.8	17.6	18.5	17.2	16.3	15.9	15.8	15.8	15.3	13.0

Note: historic values have been restated for the entire time series due to changes in calculation methodology and improved data quality for ACT share of network from 2019-20.

3.1.3 Ground transport

Ground transport emissions were calculated to be 1,080 kt CO2-e in 2023-24, a 3% decrease from 2022-23.

Sales of major transport fuels decreased in all categories with petrol decreasing 4%, diesel decreasing 3% and CNG and LPG each decreasing 6%. Per capita transport energy use decreased about 3% to 34.4 GJ per capita, which is lower than pre pandemic levels (Table 6). This may be due to the increasing adoption of electric vehicles.

Table 5. Ground transport fuel consumption

Transport fuels	Units	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Petrol (unleaded, E10, E85)	kl	330,838	317,559	315,243	320,310	321,073	321,300	312,014	282,816	295,277	263,304	293,443	282,655
Diesel	kl	85,096	91,401	117,193	128,265	137,070	146,269	151,247	144,012	161,827	149,885	161,833	157,504
LPG	Kl	21,760	15,275	11,404	11,528	9,348	7,211	5,986	4,508	3,647	2,913	2,503	2,363
CNG (ACTION)	GJ	-	109,791	108,614	100,089	87,283	85,297	80,585	74,480	90,583	82,058	67,480	63,712
GJ/capita*	GJ							**37.9**	**34.3**	**36.4**	**32.9**	**35.3**	**34.4**

**Not calculated prior to 2018-19 because disaggregated fuel data not available. Note historic values have been restated due to correction of an understatement of the GJ content in ethanol in prior years.*

Table 6. Ground transport emissions in the ACT (in kt CO_2-e)

Transport fuels	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Total emissions	790.0	1,040.5	1,018.6	1,083.2	1,138.5	1,104.8	1,055.6	1,140.1	1,046.8	1,123.8	1,015.9	1,116.2	1,079.7

Notes: 1) Ground transport emissions include all emissions from transport fuel use such as off-road vehicles and other machinery and domestic marine. 2) 1989-90 emissions exclude CNG used by TCCS bus fleet (which is included in stationary fossil fuel gas combustion).

3.1.4 Aviation

Aviation emissions were 33 kt CO_2-e in 2023-24, a 4% increase from 2022-23.

Aviation emissions have been calculated in accordance with the GHG Protocol guidance for cities and account for emissions that occur within the jurisdiction. All emissions associated with the landing and take-off (LTO) cycle (including taxi-out, take-off, climb, descent, land and taxi-in) are taken as a proxy for aviation emissions that occur within the ACT boundary. It is assumed that all cruising altitude emissions occur outside of the ACT. AVGAS fuel sales data are used to estimate emissions from local crafts.

Prior to 2022-23, fleet composition and LTO emissions have been estimated based on the top two aircraft used in Australia (Boeing 737-800 and Airbus A-320). Starting from 2022-23, activity data was sourced from Canberra Airport and provides the flight movements by aircraft type at Canberra Airport (departures and arrivals combined; see Table 7).LTO cycle emissions have been calculated using the Airport Carbon and Emissions Reporting Tool (ACERT): ACERT_7.2338_ACI_Public developed by ACI World for the purpose of calculating airport carbon emission inventories. LTO emissions are calculated based on number of LTO cycles per aircraft type. The commercial aviation emissions increased slightly from 32 to 33 kt CO_2-e in 2023-24 compared to 2022-23 due to the slight increase of flight movements. Commercial aviation emissions were lower than pre-covid levels, due to previous method utilised the Boeing 737-800 and Airbus A-320 as representative fleet to assess LTO cycle emissions, using the 1.A.3.a Aviation 2 LTO emissions calculator 2019 developed by the European Environment Agency. However, a significant number of small propeller planes also operate at the Canberra Airport.

Table 7. Regular public transport air service movements (departures and arrivals) in Canberra Airport (Source: Canberra Airport)

Aviation	Units	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23*	2023-24
Arrivals	#	7,569	20,858	20,197	19,354	19,219	19,008	19,303	19,267	14,333	8,236	11,110		
Departures	#	7,523	20,958	20,294	19,435	19,280	19,083	19,370	19,321	14,367	8,250	11,127		
Total	#	15,092	41,816	40,491	38,789	38,499	38,091	38,673	38,588	28,700	16,486	22,237	39,088	39,402

**Restated to reflect the accurate fleet composition and flight movements at Canberra Airport.*

Table 8. Aviation emissions (kt CO_2-e)

Aviation	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23*	2023-24*
Total emissions	21.4	59.1	57.2	54.8	54.4	53.8	54.6	54.9	40.9	23.7	31.7	31.7	32.9

**Data and method change from 2022-23 due to availability of higher quality data*

3.2 Industrial Processes and Product Use (IPPU)

Emissions from the IPPU sector were calculated to be 41 kt CO_2-e in 2023-24, a 4% increase from 2022-23.

This category includes synthetic greenhouse gas emissions from refrigeration and air-conditioning (RAC) systems in the residential and commercial/industrial sectors and mobile air-conditioning (MAC). Estimation of emissions from medical gases has been discontinued since 2022-23 as these emissions are negligible. Emissions from residential RAC are calculated using household data from the Australian Bureau of Statistics (ABS) along with other inputs and assumptions to estimate residential hydrofluorocarbon (HFC) leakage. Commercial RAC-related emissions data are obtained from the Australian Government NGER scheme and relate to large emitters. It is noted that there is currently a gap in the inventory relating to small to medium businesses that may have refrigeration and air conditioning equipment but are below the NGER reporting threshold. There are currently no suitable data sources to estimate this emission source. Activity data related to MAC were also obtained from the Australian Government.

IPPU emissions represented 2.5% of the 2023-24 emissions (see Table 9).

Table 9. Industrial processes and product use emissions summary (kt CO_2-e)

IPUU	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Total emissions	30.4	31.3	31.3	31.6	29.7	36.2	37.7	35.0	39.7	40.2	43.7	39.5	41.3

Note: historic data values have been restated for entire time series due to changes in calculation methodology and updates to data sources for vehicles from 2022-23.

3.3 Agriculture

Agricultural emissions were estimated to be 30 kt CO_2-e in 2023-24.

Enteric fermentation accounts for the majority (~85%) of agricultural emissions, followed by agricultural soils and manure management. Enteric fermentation is positively correlated with numbers of meat cattle and sheep and lambs in the ACT. Agricultural emissions have been in decline from 2015-16 to 2019-20 in line with a reduction in livestock

numbers, with drought and market conditions listed as two reasons why herd sizes decreased over this time. Livestock numbers were updated retrospectively based on Agriculture Livestock Population Activity Tables 2022 in the Australia's National Greenhouse Accounts (ANGA) survey released in April 2024. A significant change in sheep livestock numbers from 40,902 to 91,760, along with relatively small growth in other livestock during 2021-22, led to a 43% rise in enteric fermentation emissions. Consequently, emissions data for 2021-22 has been updated from 17.5 to 25.5 kt CO_2-e. Furthermore, historical restatements have been made to agriculture soils for entire time series due to changes in crop residue emission factors in the National Inventory Report 2022[5].

Emissions for this sector are calculated using the most recent data available from the ANGA survey and ACT GHG inventory published by the Australian Government and are subject to two years lag.

Table 10. Agriculture emissions summary (kt CO_2-e)

(kt CO_2-e)	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Enteric fermentation								13.3	11.6	14.5	25.5[&]	25.5[&]	25.5[&]
Manure management								0.9	0.8	1.0	1.7	1.7	1.7
Agricultural soils								1.6*	1.4*	1.7*	2.9*	2.9*	2.9*
Total emissions	**42.0**	**28.0**	**21.0**	**22.9**	**27.7**	**27.6**	**23.7**	**15.8**	**13.8**	**17.2**	**30.1**	**30.1**	**30.1**
Previously Stated		**28.0**	**21.0**	**22.9**	**27.6**	**27.5**	**23.6**	**16.0**	**13.9**	**17.5**	**17.5**	**17.5**	**NA**

**Restated in line with historic recalculations in Agricultural soils described in section 5 of the National Inventory Report 2022.*

[&]Restated after 2021-22 changes mentioned above

3.4 Land Use, Land-Use Change and Forestry (LULUCF)

Emissions from the LULUCF sector in 2023-24 were -160 kt CO_2-e, compared to -165 kt CO_2-e in 2022-23 indicating the LULUCF sector is continuing to act as a net sink for carbon emissions in the ACT.

The ACT Government's reporting on LULUCF emissions is based on estimates prepared and published by the Australian Government in annual State and Territory Greenhouse Gas Inventories (STGGI) reports. STGGI reports are usually published approximately 18-24 months after the end of each reporting year. The latest STGGI report, used to estimate the LULUCF emissions this year, was released in April 2024 and it presents data for the year ending 30 June 2022. This means there is currently a time lag in reporting on annual LULUCF emissions estimates, of up to two years.

As noted in previous inventories, the LULUCF emissions source category has been subject to regular method changes at the national level, resulting in material fluctuations in the LULUCF emissions data year-to-year for each state and territory. Furthermore, these method changes have resulted in retrospective changes that extend back to the ACT's baseline year of 1989-90, which has had implications for the entire time series of emissions data. In 2023-24 further changes were introduced, resulting in material restatements back to the baseline year (see Table 11). Major historical restatements have been made due to broad changes in methodology and data revisions, by incorporating new science and technologies in the National Inventory Report 2022, to continually improving the estimates of LULUCF emission sources.

To reduce these year-to-year fluctuations that have impacted the ACT emissions inventory reporting, the ACT Government has adopted a rolling average based on the previous three years of national inventory data for the current year's inventory. This approach smooths the interannual variations to some extent and reduces the extent to which the following year may see a significant increase or decrease and unsettle current considerations about legislated commitments and targets. It also enables the Territory to report on its updated inventory without needing to wait the full 18-24 months for previous financial year reporting. The ACT Government intends to continue using the Australian Government's authoritative datasets, and material changes in the LULUCF emissions source category will continue to be incorporated over time, although the impact will be expressed through changes that are averaged over several years.

The 2023-24 estimates for the LULUCF sector indicate that it has continued to act as a net sink for the ACT although removals were lower in 2023-24 compared to the previous year.

[5] Source: National Inventory Report 2022, Volume 1, Page 264-265, Table 5.30

Table 11. Historic LULUCF emissions (kt CO_2-e)

LULUCF (kt CO_2-e)	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Forest land		93.67	94.57	49.66	-163.71	-72.38	-212.86	-269.74	-171.72	-184.80	-116.28	-157.60	-152.89
Cropland		0.05	0.02	0.03	0.41	-0.02	-0.05	0.04	-0.06	-0.03	-0.01	-0.03	-0.02
Grassland		25.66	26.86	22.34	-10.68	15.94	-1.99	-9.90	-5.15	-10.66	6.44	-3.13	-2.45
Wetland		2.02	2.10	2.49	2.56	2.75	2.37	2.16	1.82	2.60	2.86	2.43	2.63
Settlements		26.57	4.41	14.59	-5.85	18.99	9.88	-0.13	2.95	-9.72	1.76	-1.67	-3.21
Harvested wood		-8.90	-7.21	4.04	-2.12	-2.69	-2.63	-8.97	-6.24	-4.51	-4.10	-4.95	-4.52
Total emissions	**-173.8**	**139.1**	**120.8**	**93.2**	**-179.4**	**-37.4**	**-205.3**	**-286.6**	**-178.4**	**-207.1**	**-109.3**	**-165.0**	**-160.5**
Previously stated (total)		**251**	**192**	**75**	**246**	**-207**	**-323**	**-244**	**-197**	**-124**	**-254**	**-192**	**NA**

**Restated in line with historic recalculations described in section 6 of the National Inventory Report 2022 for the entire time series*

3.5 Waste

In 2023-24, emissions from landfill were 102 kt CO_2-e, having increased by 29% compared to last year. Emissions from wastewater have increased by 5%, rising to 5.8 kt CO2-e in 2023-24, compared to 5.5 kt CO_2-e in 2022-23.

Waste-related emissions fall into two separate sub-categories – methane emissions from the breakdown of organic materials in solid waste sent to landfill, and emissions of methane and/or nitrous oxide from the treatment of wastewater.

3.5.1 Emissions from landfill

In the ACT, solid waste emissions arise from the active Mugga Lane landfill site and the closed West Belconnen site. Because the breakdown of organic solid wastes in landfill sites is very slow, most of the methane emissions arise from legacy waste, sent to landfill as long as thirty or forty years ago. ACT waste emissions are estimated using the Solid Waste Calculator workbook, built by the Clean Energy Regulator (CER) for use as a reporting tool by organisations required to report under the National Greenhouse and Energy Reporting Scheme. Emissions from landfill increased to 102 kt CO_2-e in 2023-24 despite the waste to landfill volume dropping from 219,999 tonnes in 2022-23 to 187,949 tonnes in 2023-24 and methane capture and combustion increasing from ~14 million m^3 in 2022-23 to ~18 million m^3 in 2023-24. This reflects the time lag in emissions reductions being realised due to reduced waste volumes and is impacted by the design of the CER Solid Waste Calculator. Given the uncertainties related to calculating waste emissions, the CER calculator applies a hierarchical approach to data quality whereby methane flared data, being measured activity data, is higher in the hierarchy than the calculator outputs, being modelled data. As such, whenever measured flare data exceeds 75% of the theoretical waste emissions (as calculated by the calculator), the formula stops using the waste emissions model and simply calculates waste emissions as CO_2-e flared divided by 0.75. This has the impact of increasing emissions as flared gas continues to increase above the 75% threshold.

Several years ago, the model was populated with annual disposal data provided by ACT NoWaste, extending back to 1975. Estimates for each successive year are made by adding, at the appropriate place in the model, the reported volume of waste sent to landfill during the year, and the volume of landfill gas captured and either used in engines to generate electricity or flared. Data on gas captured and burnt prior to 2019-20 has been supplied by LGI (Landfill Gas Industries) and previously by Energy Developments Ltd (EDL).

For a given waste stream composition, landfill gas emissions, the net amount of capture and flaring, are a complex function of several factors, which include the quantity of waste to landfill during the inventory year, the year-on-year profile of quantities sent in past years (extending back as much as two or more decades), the volume of gas captured and flared during the inventory year, and the year-on-year profile of capture and flaring in past years. Emissions from landfill have varied by as much as 72% over the inventory years 2012-13 to 2023-24 driven primarily by methane flaring volumes.

In 2023-24 the ACT obtained more detailed data relating to the waste composition of the various waste streams which has been used to refine the emissions estimate from this year forward.

In addition to the waste disposed of within the ACT, an additional 213,209 tonnes of waste (94% of which was construction and demolition waste) were disposed of in interstate landfills. This is excluded from the inventory on the basis that it would represent double counting with other state inventories.

Table 12. Historic emissions from waste to landfill (kt CO2-e)

Emissions from waste to landfill	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
(kt CO2-e)	101.0	90.3	104.3	114.0	113.7	95.0	65.2	84.8	118.1	69.0	81.1	79.4	102.1

Note: historic values have been restated for entire time series due to changes in methodology and error correction.

3.5.2 Emissions from wastewater

Wastewater emissions were about 6 kt CO_2-e or 0.4% of the total emissions in 2023-2024. Wastewater emissions consist of methane and nitrous oxide released during the digestion treatment process used at Lower Molonglo Wastewater Quality Control Centre. Emissions from wastewater treatment have shown a gradual increase over time until a step change occurred in 2020-21 due to changes in the NGER Determination legislation in 2020.

Table 13. Historic emissions from wastewater (kt CO2-e)

Emissions from wastewater	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
(kt CO2-e)	27.0	10.7	10.8	10.9	11.0	10.9	11.6	12.1	12.0	13.1	6.0	5.5	5.8

4. Progress towards meeting the ACT targets

4.1 The ACT greenhouse gas emissions targets

Compared to 1989-90 levels, the ACT's total emissions have fallen by 50% in 2023-24. The annual per person emissions have constantly decreased from 10.8 tCO_2-e in 2012-13 to 3.1 tCO_2-e in 2023-24.

The ACT's emission reduction targets are legislated under the *Climate Change and Greenhouse Gas Reduction Act 2010.* Its principal target is to reduce GHG emissions to achieve zero net emissions in the ACT by 30 June 2045.

The ACT's interim targets are to reduce GHG emissions from 1989-90 levels by:

- 40% by 2020
- 50 to 60% by 2025
- 65 to 75% by 2030
- 90 to 95% by 2040

As shown in Table 14, since 1989-90, emissions have decreased by 50% in 2023-24. This has been largely due to the ACT achieving its renewable energy target in 2019-20, a decline in fossil fuel gas and transport fuel consumption and carbon sequestration in the land use sector from 2015-16. The ACT has achieved and maintained the 2020 target (40% emissions reduction) and is currently on track to meet its interim emissions reduction target of 50 to 60% by 2025 however methodology changes and refinements at the national inventory level are ongoing and may result in further variations for key sectors such as LULUCF. This can impact the ACT's ability to meet its targets through impacting 2024-25 emissions or through historic changes that reduce the baseline.

Another target relates to per capita emissions. The average amount of GHG emissions produced per person in the ACT each year was required to peak by 30 June 2013. Based on the table below, we note that per capita emissions peaked in 2012-13 and there has been a pronounced downward trend since.

Table 14. Progress towards emissions reduction targets

Year	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Total emissions (kt CO_2-e)	3001.8	4,110.3	3,980.8	4,108.8	3,911.9	4,006.6	3,654.7	3,610.2	1,511.5	1,505.8	1,538.0	1,550.3	1,488.7
Change relative to 1989-90 (%)	NA-	36.9	32.6	36.9	30.3	33.5	21.8	20.3	-49.6	-49.8	-48.8	-48.4	-50.4
Per capita emissions (tCO_2-e)	11.0	10.8	10.3	10.4	9.8	9.7	8.6	8.3	3.4	3.3	3.4	3.3	3.1

Note: historic values have been restated after changes mentioned above.

4.2 The ACT renewable energy target

The ACT reached the target of 100% renewable electricity use in 2019-20 and continued to maintain the target in 2023-24.

The renewable energy target is legislated under the *Climate Change and Greenhouse Gas Reduction Act 2010.* The ACT has a target of a 100% renewable electricity supply on and from 1 January 2020. This target was achieved and has been maintained. Refer to section 3.1.1 for further details.

Appendix 1 Summary of emissions calculation methodology for 2023-24 reporting

The GHG emissions inventory for the year 2023-24 includes all gases covered under the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3) and are reported in carbon dioxide equivalent (CO_2-e). The methodologies used to estimate GHG emissions across Energy, IPPU, Argriculture, LULUCF, and Waste sectors are summarised below.

Table 15: Emission calculation methodology for the Energy sector

Subsectors	Methods	Emission factors	Activity data used	Data source	Data accuracy
Stationary: Electricity	The methodology follows section 5.1 of the *Climate Change and Greenhouse Gas Reduction (Greenhouse Gas Emissions Measurement Method) Determination 2023.*		Electricity consumption (kWh)	EvoEnergy	High accuracy – actual consumption data is recorded using direct measurement
Stationary fuels: Fossil fuel gas combustion	Emissions associated with stationary fossil fuel gas combustion is calculated by multiplying ACT net gas consumption with NGA emission factor for Natural gas distributed in a pipeline.	51.5 kg CO_2-e/GJ	Fossil fuel gas consumption (GJ)	EvoEnergy	High accuracy – actual consumption data is recorded using direct measurement
Stationary fuels: Liquefied petroleum gas (LPG) combustion	LPG activity data is converted to emissions using the NGA emission factor for LPG stationary	1,557 kg CO_2-e/kL	LPG sales (tonnes) (converted to kL)	Elgas, Origin Energy and Supagas and relates to deliveries of LPG cylinders.	High accuracy – actual consumption data is recorded using direct measurement

Subsectors	Methods	Emission factors	Activity data used	Data source	Data accuracy
Stationary fuels: Heating oil	Heating oil activity data is converted to emissions using the NGA emission factor for heating oil	2,601 kg CO_2-e/kL	Heating oil (kL)	Private companies	High accuracy – actual consumption data is recorded using direct measurement
Stationary fuels: Wood fuel	Firewood activity data is converted to emissions data using the NGA emission factor for dry wood.	1.2 kg CO_2-e/GJ	Wool fuel (tonnes) (converted to GJ)	ACT Government	High accuracy – actual consumption data is recorded using direct measurement
Fugitive emissions	Unaccounted for gas (UAG) is calculated as the difference between Total Gas Receipts and Total Network Gas. 37.3% of UAG is assumed to be leakage (fugitive emission) as per the NGA factors. Fugitive emissions are converted to tCO_2-e using the NGA emission factors for UAG.	Natural gas composition factor: CO_2: 0.8 kg CO_2-e/TJ CH_4: 437 kg CO_2-e/TJ	Unaccounted for gas (GJ)	EvoEnergy	High accuracy – actual consumption data and ACT share of gas network is recorded using direct measurement
Ground transport	Fuel sale emission data is converted to emissions (tCO_2-e) using NGA emission factors. CNG bus fuel use is reported here, and is subtracted from Stationary Fuels to avoid double-counting	Petrol: 2312.6 kg CO_2-e/kL Diesel: 2717.8 kg CO_2-e/kL LPG: 1598.2 kg CO_2-e/kL Ethanol (as part of E10 fuel): 9.4 kg CO_2-e/kL CNG: 54.5 kg CO_2-e/GJ	Fuel sales for unleaded petrol, E10, E85, Diesel, LPG in kL and CNG from Canberra bus fleet use (GJ)	Private companies	High accuracy - actual fuel sales data is used.
Aviation	Emissions from domestic aviation are calculated in accordance with the GHG Protocol guidance for cities and account for emissions that occur within the jurisdiction using the	AVGAS (Gasoline for use as fuel in an aircraft): 2,240 kg CO_2-e/kL	1. Landing and take-off cycles (LTO; #) 2. Time in mode (taxi-out, take-off, climb, decent, land, taxi-in; seconds)	1. Canberra Airport 2. ACERT 3. Canberra Airport	Medium accuracy – actual landing and take-off data (number of movements) and aircraft composition is used but time in mode is modelled.

	Airport Carbon and Emissions Reporting Tool (ACERT).		3. Aircraft type		

Table 16: Emission calculation methodology for the IPPU sector

Subsectors	Methods	Emission factors	Activity data used	Data source	Data accuracy
Commercial refrigerant leakage	Sum of commercial and industrial (C & I) emissions reported through NGERs.	N.A.	NGER data for C&I sector	CER confidential data	Medium accuracy - C & I emissions are based on NGER reporting; however, data may be incomplete as C & I emissions from businesses that do not trigger the NGER threshold are not covered.
Residential refrigerant leakage	Residential emissions modelled based on data and assumptions for number of households, number of refrigerators and air-conditioning units per household, charge size, leakage and refrigerant used	Blended GWP of refrigerators: 1494 Blended GWP of air conditioning: 1,491	1. ABS Household statistics for residential sector 2. Modelled phase down of high GWP refrigerants.	1. ABS 2. ACT_Pathways model v4.8	Low accuracy – emissions estimated from assumptions for appliance, charge size, leakage rates and refrigerant type.
Mobile air conditioning refrigerant leakage	Mobile refrigerant emissions per vehicle was modelled based on total number of vehicles and total vehicle refrigerant stock at the national level (light and heavy vehicles). It was then applied to number of vehicles in the ACT.	Refrigerant emissions per light vehicle: 0.04 tCO_2-e Refrigerant emissions per heavy vehicle: 0.28 tCO_2-e	Number of light and heavy vehicles registered in the ACT	ACT Government	Low accuracy- – model used for estimating emissions per vehicle

Table 17: Emission calculation methodology for the Agriculture sector.

Subsectors	Methods	Emission factors	Activity data used	Data source	Data accuracy
Enteric fermentation	Enteric fermentation emissions are calculated based on the livestock categories in accordance with Australia's National Inventory and the implied emission factors per head of livestock.	Beef cattle-pasture: 50.3 kg CH_4/ head/yr Sheep and lambs: 6.69 kg CH_4/ head/yr Goat: 5 kg CH_4/ head/yr Horse: 18 kg CH_4/ head/yr	Agriculture Livestock Population Activity Tables 2022	Australia's National Greenhouse Accounts survey	Medium accuracy –changes in headcount or livestock composition will be reflected in the inventory, which are usually published approximately 18-24 months after the end of each reporting year.
Manure management	Methane manure management emissions are calculated based on the livestock categories in accordance with Australia's National Inventory and the implied emission factors per head of livestock. The direct and indirect emissions from nitrous oxide have been removed because they are negligible for all activities across the entire time series.	Beef cattle-pasture: 4.71 kg CH_4/ head/yr Sheep: 0.34 kg CH_4/ head/yr Poultry: 0.04 kg CH_4/ head/yr	Agriculture Livestock Population Activity Tables 2022	Australia's National Greenhouse Accounts survey	Medium accuracy – only reduction in headcount or livestock composition will be reflected in the inventory, which are usually published approximately 18-24 months after the end of each reporting year.
Agricultural soils	Agricultural soils emissions are taken directly the official ACT GHG inventory published by the Australian Government	N.A.	Agricultural soils emissions	Australia's National Greenhouse Accounts – STGGI	Medium accuracy - Agriculture emissions are based on estimates prepared and published by the Australian Government in annual STGGI which are usually published approximately 18-24 months after the end of each reporting year.

Table 18: Emission calculation methodology for LULUCF sector

Subsectors	Methods	Emission factors	Activity data used	Data source	Data accuracy
Forest land Cropland Grassland Wetland Settlements Harvested Wood Products	LULUCF emissions are taken directly the official ACT GHG inventory published by the Australian Government and are rolling averaged for the last three years.	N.A.	Land use, land use change and forestry emissions	Australia's National Greenhouse Accounts – STGGI	Medium accuracy - LULUCF emissions are based on estimates prepared and published by the Australian Government in annual STGGI which are usually published approximately 18-24 months after the end of each reporting year.

Table 19: Emission calculation methodology for Waste sector

Subsector	Methods	Emission factors	Activity data used	Data source	Data accuracy
Solid Waste disposal	GHG emissions are calculated using the NGER Solid Waste Calculator using waste weight and composition, historic data and methane flared as inputs	N.A	Waste to landfill (tonnes) Waste composition (%) Historic waste data for NGER Solid Waste Calculator (tonnes)	ACT Government for waste to landfill, waste composition, historic waste data after 2007/08. Gas captured and burnt prior to 2019-20: Landfill Gas Industries, after 2019-20: Energy Developments Ltd (EDL). Climate Change and Greenhouse Gas Reduction (Greenhouse Gas Emissions Measurement Method) Determination 2024 for historic waste data from 1974/75 to 2007/08	Medium accuracy – actual waste volume by type and flare data is recorded using direct measurement. The landfill methane emissions are modelled based on these inputs, however, there is 75% cap in the modelled emissions.

Subsector	Methods	Emission factors	Activity data used	Data source	Data accuracy
Wastewater handling	Nitrous oxide and methane (fugitive) emissions from wastewater handling is as reported by Icon Water. Emissions arising from the use of diesel, fossil fuel gas and heating oil in wastewater handling is counted elsewhere.	N.A	Nitrous oxide emissions and methane emissions from wastewater	Icon Water	High accuracy – nitrous oxide and methane fugitive emissions from wastewater handling is reported by Icon Water.

Appendix 2 Detailed ACT emissions sources 2023-24

Emission source (IPCC Categories)	Subcategories		2023-24 emissions (kt CO_2-e)
1 Energy			**1,470**
1.A Fuel Combustion	Stationary energy		***328***
		Electricity	*0*
		Fossil fuel gas	*317*
		Stationary LPG	*11*
		Heating oil	*0*
		Wood fuel	*<1*
	Ground transport		***1,080***
		Petrol (unleaded, E10, and E85)	*644*
		Diesel	*428*
		LPG	*4*
		CNG	*3*
	Domestic aviation		***33***
1.B. Fugitive Emissions from Fuels	Fossil fuel gas distribution		***30***
2. Industrial processes			**41**
2.F Product uses as substitutes for Ozone Depleting Substances	Refrigeration and air conditioning		*41*
3. Agriculture			**30**
3.A Enteric fermentation			*26*
3.B Manure management			*2*
3.D Agricultural soils			*3*
4. LULUCF			**-160**
4.A Forest land			*-153*
4.B Cropland			*-0.02*
4.C Grassland			*-2*
4.D Wetlands			*3*
4.E Settlements			*-3*
4.G Harvested wood products			*-5*
5. Waste			**108**
5.A Solid waste disposal	Landfill		*102*
5.D Wastewater treatment and discharge			*6*
Total			**1,489**

Note: Numbers may not sum due to rounding.

Appendix 3 Summary of 2022-23 restatements

Inventory aspect	Reason for change
Electricity	
Fossil fuel gas combustion	Minor historic restatement due to change in calculation methodology and increased data quality relating to ACT share of network from 2019-22 (actual data replacing modelled data).
LPG	
Heating oil	
Wood fuel	
Fossil fuel gas - fugitive emissions	Minor historic restatement due to increased data quality relating to ACT share of network from 2019-22 (actual data replacing modelled data).
Ground transport	
Aviation	Historical restatement due to increased data quality and changes in LTO calculator. Modelled fleet composition replaced with actual data
IPPU	Historic restatement due to changes in methodology and updates to the data source for vehicles. See section: 3.2
Agriculture	Historic restatement due to methodology change (see table 5.30) in National Inventory Report 2022, Volume 1 (dcceew.gov.au) and data revisions in the Agriculture Livestock Population Activity Tables in Australia's National Greenhouse Accounts 2022 survey (dcceew.gov.au).
LULUCF	Major historic restatement due to broad changes to methodology and data revisions in the National Inventory Report. See tables 5.30, 6.4.18, 6.4.23,6.5.4, 6.5.7, 6.6.2, 6.6.11, 6.7.5, 6.7.7, 6.8.2, 6.8.5 and 6.10.7, in National Inventory Report 2022, Volume 1 (dcceew.gov.au)
Waste	Historical restatement due to availability of higher quality data which impacted the inputs into the NGER Solid Waste Calculator. Error correction that understated methane capture and combustion
Wastewater	

2023-24 GHG Inventory results - emissions in kt CO2-e

Emission sources	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Electricity	2,015.8	2,295.1	2,231.4	2,283.8	2,323.4	2,288.4	2,200.9	2,152.8	-	-	-	-	-
Fossil fuel gas combustion	127.7	378.4	352.3	381.3	362.8	391.8	376.7	367.8	365.6	368.1	369.9	366.6	316.6
LPG	-	-	-	-	-	-	-	-	6.3	6.3	14.8	11.8	10.8
Heating oil	-	-	-	-	-	-	-	-	0.1	0.1	0.1	0.1	-
Wood fuel	16.8	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.5	0.3	0.2
Fugitive emissions - fossil fuel	3.5	37.6	32.8	32.8	29.8	35.2	33.7	33.2	46.5	51.0	53.6	33.9	29.6
Grounnd transport	790.0	1,040.5	1,018.6	1,083.2	1,138.5	1,104.8	1,055.6	1,140.1	1,046.8	1,123.8	1,015.9	1,116.2	1,079.7
Aviation	21.4	59.1	57.2	54.8	54.4	53.8	54.6	54.9	40.9	23.7	31.7	31.7	32.9
IPPU	30.4	31.3	31.3	31.6	29.7	36.2	37.7	35.0	39.7	40.2	43.7	39.5	41.3
Agriculture	42.0	28.0	21.0	23.0	27.7	27.6	23.7	15.8	13.8	17.2	30.1	30.1	30.1
LULUCF	- 173.8	139.1	120.8	93.2	- 179.4	- 37.4	- 205.3	- 286.6	- 178.4	- 207.1	- 109.3	- 165.0	- 160.5
Waste	101.0	90.3	104.3	114.0	113.7	95.0	65.2	84.8	118.1	69.0	81.1	79.4	102.1
Wastewater	27.0	10.7	10.8	10.9	11.0	10.9	11.6	12.1	12.0	13.1	6.0	5.5	5.8
Total (inc. LULUCF)	3,001.8	4,110.3	3,980.8	4,108.8	3,911.9	4,006.6	3,654.7	3,610.2	1,511.5	1,505.8	1,538.0	1,550.3	1,488.7
Total (exc. LULUCF)	3,175.6	3,971.2	3,860.0	4,015.7	4,091.2	4,044.0	3,860.0	3,896.8	1,689.9	1,713.0	1,647.3	1,715.2	1,649.1

2022-23 GHG Inventory results - emissions in kt CO2-e

Emission sources	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021/22	2022/23
Electricity	2,015.8	2,295.1	2,231.4	2,283.8	2,323.4	2,288.4	2,200.9	2,152.8	-	-	-	-
Fossil fuel gas combustion	127.7	378.4	352.3	376.0	357.9	387.3	372.4	367.8	362.7	364.5	367.2	361.8
LPG	-	-	-	-	-	-	-	-	6.3	6.3	14.8	11.8
Heating oil	-	-	-	-	-	-	-	-	0.1	0.1	0.1	0.1
Wood fuel	16.8	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.5	0.3
Fugitive emissions - fossil fuel	3.5	37.6	32.8	32.8	29.8	35.2	33.7	33.2	46.0	50.4	53.1	33.4
Grounnd transport	790.0	1,040.5	1,018.6	1,083.2	1,138.5	1,104.8	1,055.6	1,140.1	1,046.8	1,123.8	1,015.9	1,116.2
Aviation	21.4	59.1	57.2	54.8	54.4	53.8	54.6	55.0	40.9	23.7	31.7	54.2
IPPU	30.4	30.4	30.5	31.1	29.2	35.7	37.2	34.7	39.1	39.6	43.0	38.8
Agriculture	51.8	28.0	21.0	23.0	27.7	27.6	23.7	16.0	13.9	17.5	17.5	17.5
LULUCF	- 184.8	251.0	192.1	75.2	245.8	- 207.4	- 323.5	- 243.9	- 196.8	- 124.3	- 253.9	- 192.4
Waste	169.0	90.0	103.5	116.5	119.0	101.8	72.6	92.8	126.5	158.9	140.3	174.7
Wastewater	-	10.7	10.8	10.9	11.0	10.9	11.6	12.1	12.0	13.1	6.0	5.5
Total (inc. LULUCF)	3,041.6	4,221.0	4,050.5	4,087.5	4,337.0	3,838.4	3,539.2	3,660.7	1,497.8	1,674.0	1,436.1	1,622.0
Total (exc. LULUCF)	3,226.4	3,970.0	3,858.4	4,012.3	4,091.2	4,045.8	3,862.6	3,904.7	1,694.6	1,798.2	1,690.0	1,814.3

Differences in emissions between 2023-24 and 2022-23 GHG inventories due to historical restatements (kt CO2-e)

Emission sources	1989-90	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021/22	2022/23
Electricity	-	-	-	-	-	-	-	-	-	-	-	-
Fossil fuel gas combustion	-	-	-	5.3	4.9	4.5	4.4	0.0	2.9	3.6	2.7	4.8
LPG	-	-	-	-	-	-	-	-	-	-	-	-
Heating oil	-	-	-	-	-	-	-	-	-	-	-	-
Wood fuel	-	-	-	-	-	-	-	-	-	-	-	-
Fugitive emissions - fossil fuel	-	-	-	-	-	-	-	-	0.4	0.6	0.5	0.5
Grounnd transport	-	-	-	-	-	-	-	-	-	-	-	-
Aviation	-	-	-	-	-	-	-	- 0.0	-	-	-	- 22.4
IPPU	-	0.9	0.9	0.5	0.5	0.5	0.4	0.3	0.6	0.7	0.7	0.7
Agriculture	- 9.8	-	-	-	-	-	-	- 0.2	- 0.2	- 0.2	12.7	12.7
LULUCF	11.0	- 111.9	- 71.4	18.0	- 425.2	170.0	118.2	- 42.6	18.4	- 82.8	144.6	27.4
Waste	- 68.0	0.2	0.8	- 2.4	- 5.3	- 6.7	- 7.4	- 8.0	- 8.4	- 89.8	- 59.2	- 95.4
Wastewater	27.0	-	-	-	-	-	-	-	-	-	-	-
Total (inc. LULUCF)	- 39.8	- 110.7	- 69.7	21.4	- 425.1	168.2	115.6	- 50.5	13.7	- 168.1	101.9	- 71.7
Total (exc. LULUCF)	- 50.8	1.2	1.7	3.4	0.1	- 1.7	- 2.6	- 7.9	- 4.7	- 85.3	- 42.7	- 99.1