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ACT Greenhouse Gas Inventory for 2020-21

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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1. ACT GREENHOUSE GAS EMISSIONS INVENTORY SUMMARY

The ACT's total net greenhouse gas emissions in 2020-21 were 1,685 kilotonnes of carbon dioxide equivalent (kt CO_2-e).

1.1 ACT emissions summary

The Australian Capital Territory (ACT) Government has adopted greenhouse gas reduction targets established under the *Climate Change and Greenhouse Gas Reduction Act 2010* (the Act). This report provides estimates of the ACT's greenhouse gas emissions attributable to sectors within the Territory for the 2020-21 financial year. The estimates are based on the method established under the *Act* and agreed methodologies with the ACT Government which satisfy the legislative requirements of the Act.

The ACT Greenhouse Gas Emissions Inventory Report 2020-21 is the annual report required by the Act.

It contains:

- an overview of the ACT's greenhouse gas emissions from 1989-90 to 2020-21
- an explanation of sources of emissions and changes compared to 2019-20 and previous years
- an analysis of the ACT's progress in meeting legislated greenhouse gas targets and the renewable energy targets

In summary, the ACT's total net greenhouse gas emissions in 2020-21 were 1,685 kilotonnes of carbon dioxide equivalent (kt CO_2-e). These consist of emissions from transport (64%), natural gas combustion (22%), waste decomposition (10%), industrial processes and product use (9%), fugitive emissions from fuels (3%) and agriculture (1%). Total emissions are partly offset by land use, land-use change and forestry (LULUCF) that provide net sequestration (removal) of 144 kt CO_2-e (-9% of total emissions) – that is, the sector absorbed more emissions than it generated. Figure 1 shows the results for 2020-21.

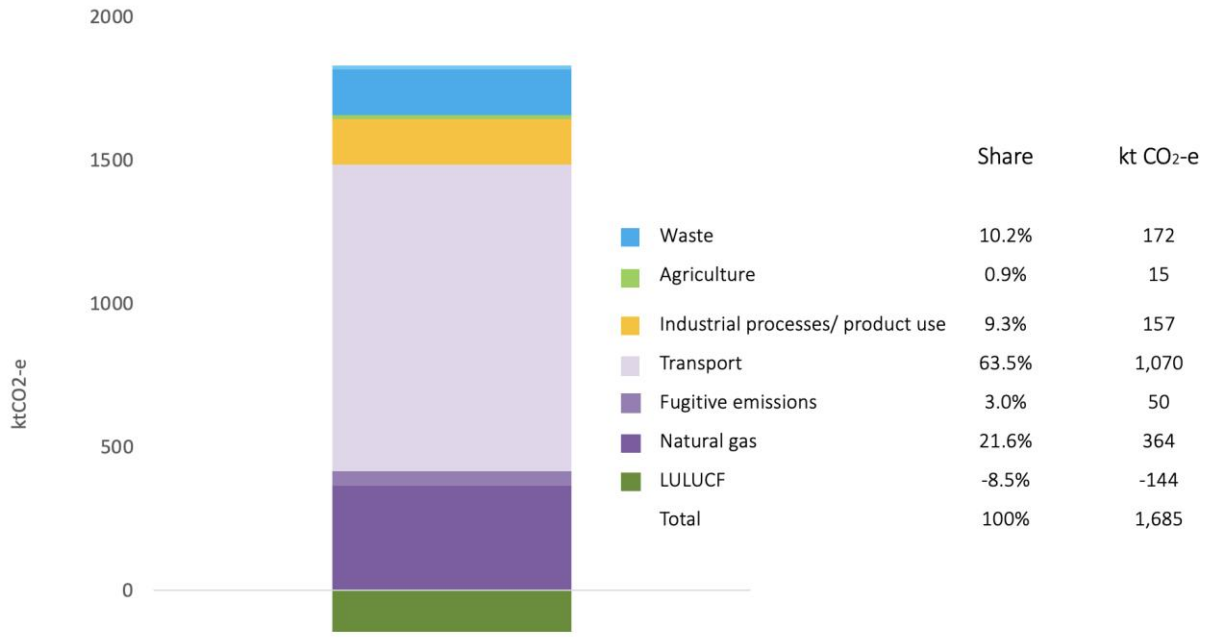

Figure 1. ACT emissions by sector and energy sub-sector, 2020-21

Note: Numbers may not sum due to rounding.

1.2 Changes in emissions

The ACT's total emissions have reduced by 1,392 kt CO_2-e (-45%) since 1989-90.

Since the ACT's baseline year (1989-90) the territory's population has grown 54% from 279,000 to 432,000 whilst total emissions have fallen 45% from 3,077 kt CO_2-e to 1,685 kt CO_2-e. The key driver of this outcome has been the emission reductions associated with electricity generation. Emissions from electricity began gradually declining in 2015-16 and then fell to zero 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, representing an overall reduction of -251 kt CO_2-e
- A reduction in emissions from natural gas combustion resulting in a reduction of -16 kt CO_2-e
- A reduction in emissions associated with agriculture of -13 kt CO_2-e

The overall impact of these emission reductions has been slightly muted by increased emissions from:

- Waste decomposition (69 kt CO_2-e)
- Transport (30 kt CO_2-e)
- Industrial processes and product use (22 kt CO_2-e)
- Fugitive emissions from fuels (13 kt CO_2-e)

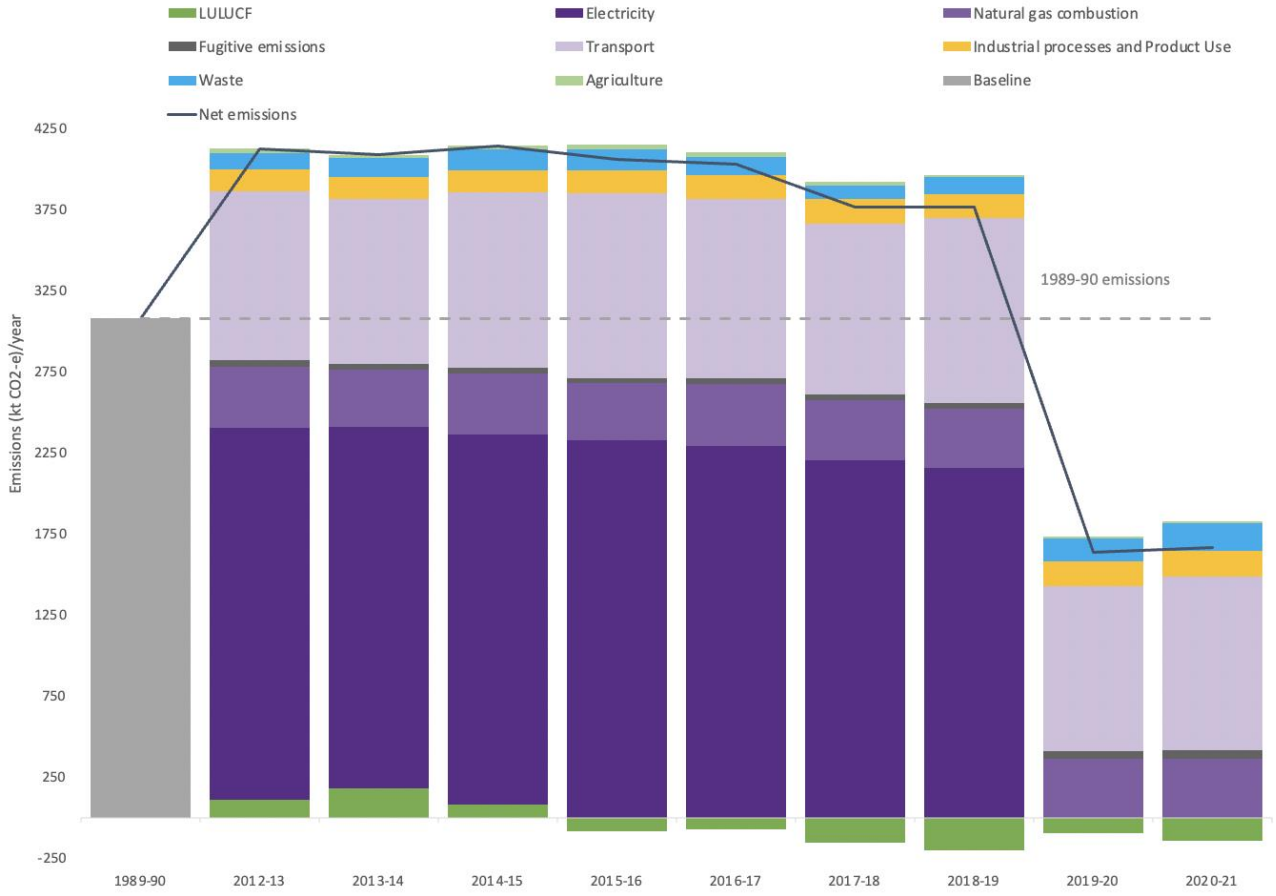

Figure 2. Net emissions and emissions by sector – ACT, 2012-13 to 2020-21

1.3 Per capita emissions

At 3.9 tonnes tCO_2-e in 2020-21, the ACT's per capita emissions are just 18% of the national average of 21.5 tCO_2-e (for the year 2018-19) and lower than all the other states and the Northern Territory, but higher than Tasmania[1].

Per capita emissions decreased by 65% between 1989-90 and 2020-21. The majority of this decline took place from 2016-17 to 2019-20 as the ACT delivered on its renewable energy targets and per capita emissions fell from 9.8 to 3.9 tCO_2-e (61%).

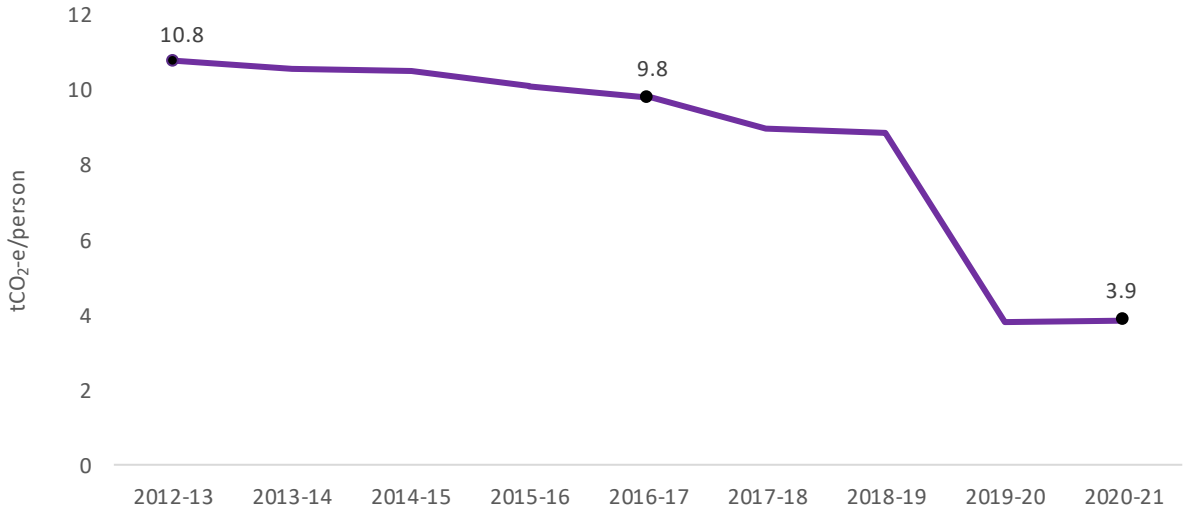

Figure 3. Trend in per capita emissions (tCO_2-e) – ACT, 2012-13 to 2020-21

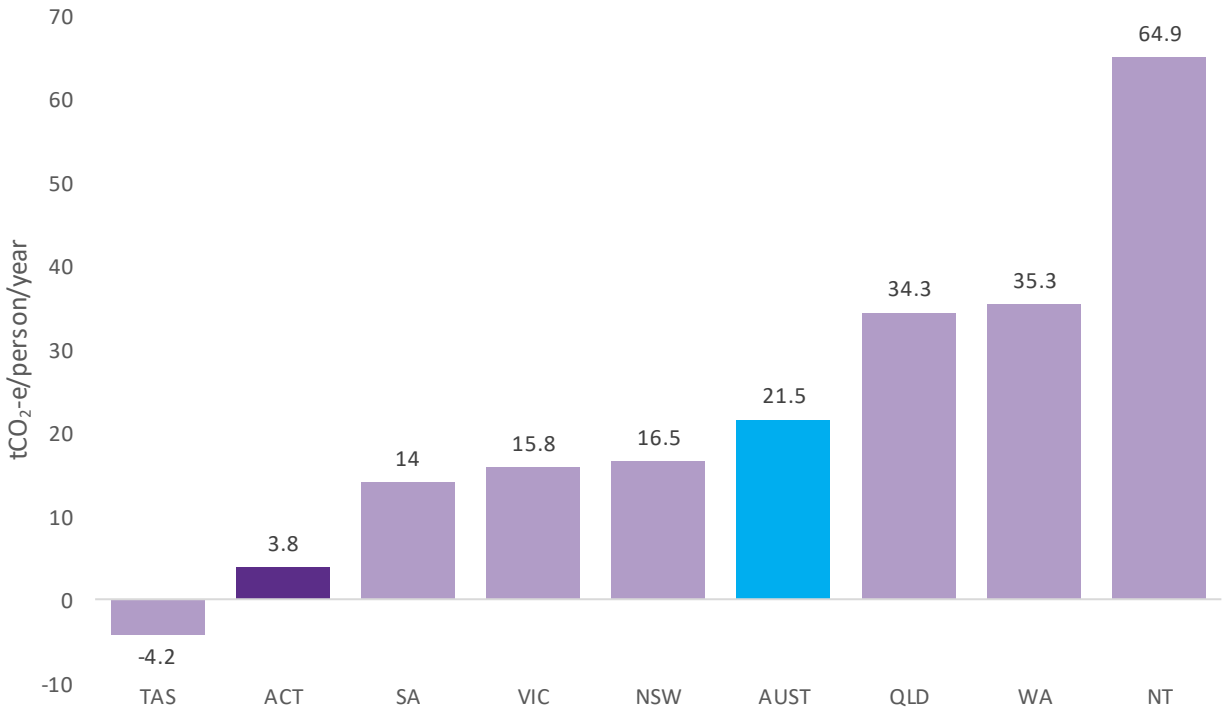

Figure 4. Per capita emissions (tCO_2-e) by State, Territory and Nation[1]

1 Sources: State and Territory Greenhouse Gas Inventories 2019 (DISER, 2021). National, state and territory population: September 2020 (ABS, 2021). Australian National Accounts: State Accounts, 2019-20 financial year (ABS, 2020).

2. EMISSIONS BY SECTOR

2.1 Overview of emissions by sector

This section presents the ACT's greenhouse gas emissions by sector and describes the activities that drive these emissions and the reasons for changes over the past years.

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

- Energy
- Industrial processes and Product Use
- Agriculture
- Land use, land-use change and forestry (LULUCF)
- Waste

2.2 Sector changes compared to previous years

2.2.1 Energy

Electricity

Electricity-related emissions were zero in 2020-21 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 NSW 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 greenhouse gas 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 2019-20 the ACT has offset 100% of residual electricity emissions through renewable generation and retiring Large Generation Certificates (LGCs). The financial year 2020-21 was the second year in which the ACT achieved zero electricity-related emissions. The target was achieved in a similar manner to last year with the majority of the reduction achieved through the retirement of LGCs. The ACT generates LGCs through its contracts with windfarms around Australia (Coonooer Bridge and Ararat in Victoria, Hornsdale 1, 2 and 3 in SA, and Sapphire 1 and Crookwell 2 in NSW) and from large-scale solar farms within the ACT. The ACT government maintains a 'stockpile' of LGCs and retires a quantity yearly on a first-in first-out (FIFO) basis. The 2,109 thousand LGCs surrendered to meet the target this year (Table 1) were accrued in earlier years and the LGC 'stockpile' was replenished with the 1,797 thousand new LGCs (generated this year). Over time as the ACT pursues further renewable projects this shortfall will be eliminated such that the annual creation of LGCs matches or exceeds the annual surrender requirements.

In addition to the surrender of LGCs (equivalent to 2,109 GWh of electricity), generation associated with the Large Renewable Energy Target (LRET) was the second largest contributor to maintaining the target, contributing 540 GWh. The contribution from rooftop solar PV (systems under 200 kW) increased 12% year-on-year to 228 GWh while the ACT's share of Snowy Hydro output[2] fell slightly to 90 GWh.

Table 1. 2020-21 pathway to zero emissions electricity

	2020-21 contribution to target (GWh)	YoY change (%)
Total electricity supplied to customers	2,967	-0.7%
LRET generation	540	-0.3%
Rooftop solar PV (<200 kW)	228	12.4%
ACT share of Snowy Hydro output[2]	90	-3.0%
Required surrender of LGCs	2,109	-1.9%
Residual electricity	0	

Natural gas combustion (including fugitive emissions)

Natural gas emissions represented 22% of total ACT emissions in 2020-21, with fugitive emissions from the natural gas network (e.g., leakage) accounting for a further 3% of emissions.

Total natural gas emissions (excluding transport) were flat compared to last year (slight 0.4% increase) at 364 kt CO2-e and per capita gas use was 18.2 GJ (slight 0.5% increase).

Overall, the trend in per capita gas use shows a long-term decline as shown in Table 2, as more gas heating, hot water, and cooking is converted to electricity, and gas connections are further limited in new dwellings.

Since the accomplishment of 100% renewable electricity supply, natural gas has become the second largest emission source in the ACT with natural gas combustion and fugitive emissions comprising 25% of the inventory in 2020-21.

Table 2. Natural gas use in the ACT (excluding transport)

Natural gas	Units	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Per capita use	GJ/capita	21.3	19.5	20.8	19.4	20.5	19.3	18.6	18.1	18.2
Total emissions	kt CO_2-e	378	352	376	358	387	372	368	362	364

2.2.2 Transport

Transport emissions were calculated to be 1,070 kt CO_2-e in 2020-21, a small (5%) increase from 2019-20 most likely due to a rebound in transportation following the COVID-19 pandemic.

The increase is predominantly due to increased petrol and diesel fuel sales (up 5% and 7% respectively) and a 22% increase in compressed natural gas (CNG) supplied to the ACT bus network.

Per capita transport energy use rebounded in 2020-21, in-line with increases in CNG, petrol and diesel use to almost reach levels from before the pandemic, as shown in Table 3.

Note that transport-related emissions calculations are based on fuel sales surveys obtained by the ACT Government. Fuel sales data also includes sales of LPG and heating oil, of which both are likely to be used almost entirely for stationary energy purposes. However, the impact of this on overall numbers is minimal.

Table 3. Transport energy use in the ACT

Transport fuels	Units	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Per capita use	GJ/capita	40.2	38.4	39.9	40.7	40.6	40.4	36.0	31.8	33.8
Total emissions	kt CO_2-e	1,040	1,019	1,083	1,139	1,105	1,056	1,140	1,019	1,070

[2] Below baseline (pre-RET) generation

2.2.3 Industrial Processes and Product Use

Emissions from industrial processes and product use (IPPU) rose slightly from 155 kt CO_2-e to 157 kt CO_2-e in-line with the long-term trend.

These emissions represented 9% of the 2020-21 inventory. IPPU emissions in the ACT arise primarily from hydrofluorocarbon (HFC) gases used in refrigeration and air-conditioning equipment. This category is termed 'product used as substitutes for ozone depleting substances' in the IPCC category system.

The ACT's HFC emissions were previously estimated using a linear regression based on the values reported in the National Greenhouse Gas Inventory (NGGI). This method, however, does not allow for recent changes from the past two years to be captured accurately. Consequently, a new methodology was developed this year that draws on household data from the Australian Bureau of Statistics (ABS) along with other inputs and assumptions to estimate residential HFC leakage. Commercial data was obtained from the Australian Government.

Although the approach resulted in lower IPPU emissions than previously reported, it also resulted in closer alignment with the emissions reported under the NGGI. Changes are summarised in Table 4.

Table 4: Recalculated industrial processes and product use emissions summary

Industrial processes and Product Use (kt CO_2-e)	2016-17	2017-18	2018-19	2019-20	2020-21
Total emissions (current)	147	150	149	155	157
Previously reported	207	212	212	214	-
NGGI	155	157	176	-	-

2.2.4 Agriculture

Agricultural emissions were estimated to be 15 kt CO_2-e in 2020-21, equal to actual emissions reported in 2019-20.

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, sheep and lambs in the ACT. Agricultural emissions declined from 2016-17 in line with a reduction in livestock numbers, with drought and market conditions listed as two reasons why herd sizes have decreased over this time.

The method used to calculate agricultural emissions was updated for this period to consider livestock numbers most recently reported by the ABS (2019-20). Agricultural emissions were previously reported based on the most recent published national inventory, thus resulting in a two-year lag (instead of one year). Emissions for this sector are updated retrospectively when livestock numbers are published.

Agriculture (kt CO_2-e)	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Total emissions	28	21	23	28	28	24	16	15	15

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

The estimate of total emissions from the LULUCF sector in 2020-21 is -144 kt CO_2-e, compared to -97 kt CO_2-e in 2019-20. It is important to note these estimates are based on different approaches to LULUCF reporting, with the ACT Government adopting an updated approach in 2020-21. Accounting methods (and hence emission figures) for this sector could again change in future years.

Table 5. Recalculated LULUCF emissions

LULUCF (kt CO_2-e)	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20*	2020-21
Forest land	34	115	36	-95	-73	-147	-188	-106	-136
Cropland	0	0	0	0	0	0	0	0	0
Grassland	45	33	9	-15	-24	-23	-22	-12	-23
Wetland	3	3	3	3	3	3	2	8	3
Settlements	7	8	7	1	5	2	-3	1	1
Harvested wood	19	20	23	19	14	10	10	12	11
Total emissions	**108**	**179**	**78**	**-87**	**-76**	**-156**	**-200**	**-97**	**-144**
Previous emissions*	122	196	109	-9	2	-97	-97	-97	

*As reported by SPR in the ACT GGI 2019-20

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 2021 and it presents data for the year ending 30 June 2019. This means there is currently a time lag in reporting on annual LULUCF emissions estimates, of up to two years. Nonetheless, the trends in the LULUCF emissions profile over time (e.g., over the past decade) are important for monitoring changes in the ACT's greenhouse gas inventory on an annual basis.

In recent years, 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. Further changes are expected over the coming years, as the Australian Government continues to introduce and implement method changes to incorporate the use of new science and technologies and updated datasets – for example, further work in underway on new systems and datasets for soil carbon assessments that will be incorporated in future LULUCF reporting.

While the method changes are all focused on continually improving the estimates of LULUCF emission sources and removals, the material changes year-to-year have been problematic for the ACT Government, which is tracking its performance with emissions reduction initiatives against legislative commitments and other 'point in time' targets, e.g., emissions reduction targets relating to years including 2013, 2020 and 2045.

To reduce these year-to-year fluctuations that have impacted the ACT emissions inventory reporting, the Territory Government has changed its methodology for LULUCF reporting by adopting a rolling average based on the previous three years of national inventory data for this year's inventory. This approach should tend to smooth the interannual variations to some extent and reduce 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. However, it is important to note the ACT intends to continue using the Australian Government's authoritative datasets, and material changes in the LULUCF emissions source category would continue to be incorporated over time, although now their impact would be expressed through changes that are averaged over several years.

In this context, the 2020-21 estimates for the LULUCF sector indicate that it has increased its contribution as a net sink for the ACT, based on increased carbon stocks in growth and regeneration of forests and grasslands, which is attributable in part to bushfire management including hazard reduction burning operations. This is reflected in the increase in net removals through the LULUCF sector since 2015-16 and the most recent data published by the Australian Government for 2018-19.

2.2.6 Waste

In 2020-21 emissions from landfill were 159 kt CO_2-e having risen ~25-35% year-on-year over the past three years. Emissions from wastewater have risen slightly, from 12 kt CO_2-e in 2019-20 to 13 kt CO_2-e in 2020-21.

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.

Emissions from landfill

Revisions to historic waste to landfill data are the primary cause of increased emissions observed in this year's inventory.

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 for use as a reporting tool by organisations required to report under the National Greenhouse and Energy Reporting Scheme.

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. Due to the impact of historic data on present and future emissions, the inventory has been revised from 2012-13 to reflect updated waste collection data and global warming potential (GWP) of methane from 25 (AR4) to 28 (AR5). Revisions to waste-to-landfill data are summarised in Table 6. These represent improvements in the data for 2014-15 to 2017-18. The result of the revisions is an increase in emissions from landfill in the effected years as well as an increase in subsequent years due to the multi-year nature of waste to landfill emissions.

Table 6. Historic waste data revisions

Waste to landfill (t)	2014-15	2015-16	2016-17	2017-18
Current data	244	319	511	341
Previously reported	222	244	231	236

Emissions from wastewater

The increase in wastewater is in line with the long-term gradual increase in population growth.

Wastewater emissions consist of methane and nitrous oxide released during the digestion treatment process used at Lower Molonglo Wastewater Quality Control Centre. Data on fugitive emissions are provided by Icon Water. Emissions from wastewater treatment are largely proportional to population and have shown a gradual increase over time.

3. PROGRESS TOWARDS MEETING THE ACT TARGETS

3.1 The ACT greenhouse gas emissions targets

Compared to 1989-90 levels, the ACT's total emissions have fallen by 45%. The ACT has an interim emissions reduction target in 2025 of a 50 to 60% reduction from 1989-90 levels.

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

In the interim, the ACT's targets are to reduce greenhouse gas emissions from 1989-90 levels by:

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

The ACT has made progress towards its next interim target in 2025. As shown by the table below, since 1989-90, emissions have decreased by 45%. This has been largely due to the ACT achieving its Renewable Energy Target in recent years. However, the remaining 5% reduction required to meet the 2025 interim target could present challenges. Changes to point-of-consumption technologies may be needed (e.g. zero emissions vehicles and/or a transition away from natural gas) and achieving this can take time. Further, it is uncertain how the economic recovery following the COVID pandemic will impact emissions. This assessment is made while noting that methodology changes and refinements at the national inventory level are ongoing and may result in further variations for key sectors such as LULUCF.

Another target relates to per capita emissions. The average amount of greenhouse gas 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 again in 2014-15. However, there has been a pronounced downward trend since.

Table 7. 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
Total emissions (kt CO_2-e)	3,077	4,123	4,087	4,144	4,060	4,027	3,765	3,763	1,638	1,685
Change relative to 1989-90	0%	34%	33%	35%	32%	31%	22%	22%	-47%	-45%
Per capita emissions (tCO_2-e)	11.0	10.8	10.5	10.5	10.1	9.8	9.0	8.8	3.8	3.9

3.2 The ACT renewable energy target

The ACT achieved this target in 2019-20 and continues to maintain this achievement in 2020-21.

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 from 2019-20. Refer to section 2.2.1 for further details.

APPENDIX 1 DETAILED ACT EMISSIONS SOURCES 2020-21

Emission source (IPCC Categories)	Subcategories		2020-21 emissions (kt CO_2-e)
1 Energy			**1,485**
1.A Fuel Combustion			
	Electricity		0
	Natural gas combustion		364
	Transport		1,070
		Petrol	*571*
		Diesel	*402*
		LPG	*13*
		All other fuels	*85*
1.B. Fugitive Emissions from Fuels	Natural gas		50
2. Industrial processes			**157**
2.F Product uses as substitutes for Ozone Depleting Substances	Refrigeration and air conditioning		157
3. Agriculture			**15**
	Enteric fermentation		13
	Manure management		1
	Agricultural soils		1
4. Land Use, Land-Use Change and Forestry UNFCCC			**-144**
	Forest land		-136
	Cropland		0
	Grassland		-23
	Wetland		3
	Settlements		1
	Harvested Wood Products		11
5. Waste			**172**
	Landfill emissions		159
	Wastewater		13
Total			**1,685**

Note: Numbers may not sum due to rounding.

APPENDIX 2 CHANGES IN LULUCF EMISSIONS ESTIMATES BETWEEN THE 2019-20 AND 2020-21 ACT GREENHOUSE GAS INVENTORIES

This figure illustrates the differences in ACT's LULUCF emissions data between the ACT Greenhouse Gas Inventory (GGI) for 2019-20 and the current report for 2020-21. Section 2.2.5 describes the methodological changes that have given rise to these differences.

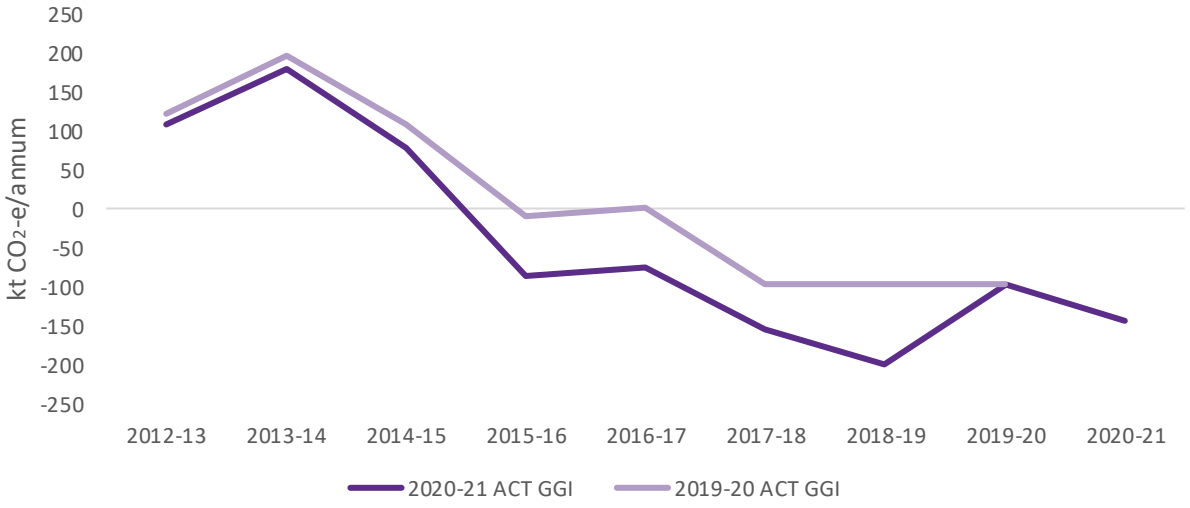

Figure 5. ACT's total net LULUCF emissions – comparison of 2019-20 and 2020-21 ACT GGIs