



An Official Statistics publication for Scotland

Agriculture, Environment and Marine

Scottish Greenhouse Gas Statistics 2022

There are two measures of greenhouse gases presented in this release:

Source Emissions

A net measure of the actual emissions and removals of greenhouse gases in Scotland. Includes international aviation and shipping.

This measure can be used for UK and international comparisons.

- **40.6 MtCO₂e in 2022**
- **Down 50.1% from 1990**
- **Down 0.1% from 2021**

Emissions For Reporting Against Targets

The Committee for Climate Change (CCC) recommended a new method of reporting emissions for the purposes of monitoring performance against targets for the June 2020, and future, publications. This is known as the GHG Account and the calculation is detailed in section C.

- **Down 50.0% from baseline period**

On this adjusted basis, the GHG account reduced by 50.0 per cent between the baseline period and 2022. The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 specifies a target reduction of 53.8 per cent reduction over the same period.

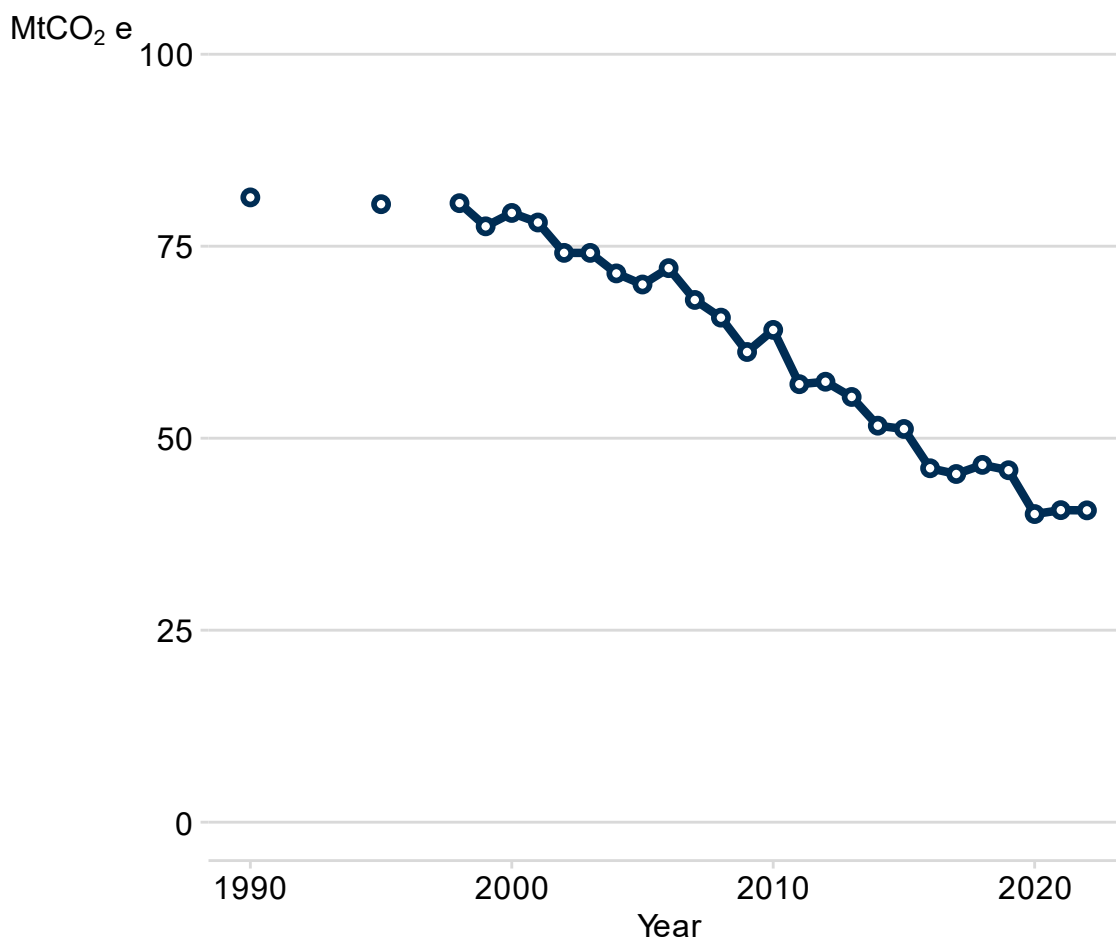
Therefore the interim target for 2022 has not been met.

Figures have been revised since last year's release to incorporate methodological improvements and new data

MtCO₂e refers to million tonnes of carbon dioxide equivalent. This is a consistent measure of assessing the contribution of greenhouse gases to global warming.

The Baseline Period uses 1990 for carbon dioxide, methane and nitrous oxide and 1995 for hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride.

Chart 1: Scottish Greenhouse Gas Emissions, 1990 to 2022.



In 2022, Scottish source emissions of the basket of seven greenhouse gases were estimated to be 40.6 million tonnes carbon dioxide equivalent (MtCO₂e). This level of emissions is essentially unchanged from the position in 2021; with a very slight reduction of 0.1 per cent in the latest year.

However, the stable level of net emissions between 2021 and 2022 belies a substantial amount of volatility at the sectoral level.

There was a very large reduction in emissions in the Buildings and product use sector of 1.2 MtCO₂e in 2022, with a combination of elevated fuel prices and relatively mild temperatures at the start of 2022 being principally responsible for this drop. More modest reductions were seen in Agriculture (-0.3 MtCO₂e) and Industry (-0.1 MtCO₂e).

However, these reductions were almost entirely offset by increases in emissions in all other sectors. International Aviation and shipping showed an increase in emissions of 0.7

MtCO_{2e} and Domestic transport increased by 0.3 MtCO_{2e}. Both of these increases principally relate to recovery from the impact of the COVID restrictions on transport. Increases of 0.2 MtCO_{2e} were also seen in Land Use, Land Use Change and Forestry (LULUCF) and Electricity supply. Fuel supply emissions increased marginally by 0.1 MtCO_{2e}, and a very minor increase was observed in waste emissions.

Between 1990 and 2022, there was a 50.1 per cent reduction in estimated net emissions, a 40.8 MtCO_{2e} decrease, with all sectors except International Aviation and shipping falling over the period. The contributions to this overall reduction, in descending order of significance, were:

- Reduction in Electricity Supply emissions (i.e. power stations) (-13.0 MtCO_{2e}; 88.1 per cent reduction)
- Industrial emissions fell 7.2 MtCO_{2e} (56.8 per cent reduction)
- 'Land Use, Land Use Change And Forestry' (LULUCF) reducing its net emissions over the period, reducing by 5.8 MtCO_{2e} since 1990.
- Reduction in Waste Management emissions (such as Landfill) (-4.9 MtCO_{2e}; a 75.4 per cent reduction)
- Reduction in Buildings and product use emissions (-3.6 MtCO_{2e}; a 32.7 per cent reduction)
- Reduction in Fuel supply emissions (-3.3 MtCO_{2e}; a 49.9 per cent reduction).
- Domestic transport fell by 2.0 MtCO_{2e} (a 15 per cent reduction)
- Agricultural emissions fell by 1.0 MtCO_{2e} (an 11.9 per cent reduction)

International aviation and shipping emissions increased slightly by 0.2 MtCO_{2e}

More details can be found in [Section B](#).

Revisions To Greenhouse Gas Emissions Statistics

Note that as part of this release all of the figures have been revised since the previous publication, to incorporate methodological improvements and new data. Comparing these 2022 figures with the 2021 figures published a year ago will therefore give a different year-on-year percentage change; one which is incorrect and should not be used. The correct percentage changes are given in this publication and associated tables. Details of these revisions can be found later in this statistical release in [Section D](#).

Contents

Contents	4
Section A. Introduction to Greenhouse Gases	6
Purpose of this Publication	6
Using the Statistics. Which measure to use and when?	6
Which greenhouse gases are reported on and how do they contribute to global warming?	7
Reporting of the Baseline Period and 1990	9
What are net emissions and carbon sinks?	9
Emissions sectors.....	9
Section B. Results – Net emissions of Scottish Greenhouse Gas Emissions	12
2022 results	12
Key Trends By Territorial Emissions Statistics Sector	13
Long term (1990 to 2022) and short term (2021 to 2022) trends by category.....	15
Emissions by type of gas	21
Carbon Dioxide (CO ₂).....	23
Methane (CH ₄).....	24
Nitrous Oxide (N ₂ O).....	25
Fluorinated gases (F-gases).....	26
Section C. Scotland’s GHG Account for assessing progress against statutory targets.....	29
Introduction.....	29
2022 GHG Account Calculation.....	30
Section D. Revisions to the Inventory and Methodology	31
Compilation of the Greenhouse Gas Inventory	31
Impact of Revisions	32
Revisions between the 1990-2021 and 1990-2022 inventories	32
Details of Main Revisions and Interpretation of Revisions to the Inventory	34
Interpretation of uncertainties in the inventory	36
Section E. Exclusions, Glossary and Acknowledgements	37
Why are some greenhouse gas emissions not considered in this statistics release?	37
Glossary	38
Acknowledgements	41
Annex A: Information required for reporting under sections 33 and 34 of the Climate Change (Scotland) Act 2009.	42
Introduction.....	42

Under section 3342

Under section 3444

**Annex B: Scottish greenhouse gas emissions using categories presented in
Scotland’s climate change plan.50**

**Annex C: Scottish greenhouse gas emissions using older “national
communications” categories.....51**

Section A. Introduction to Greenhouse Gases

Purpose of this Publication

The “Scottish Greenhouse Gas Emissions 2022” Official Statistics publication contains the results of the Scottish Greenhouse Gas Inventory for 1990-2022. The Scottish Greenhouse Gas Inventory is the key data source for understanding the origins and magnitudes of the emissions. The inventory is compiled in line with international guidance from the Intergovernmental Panel on Climate Change (IPCC). Data are reported by source sector (such as energy supply) and by greenhouse gas (such as carbon dioxide). The inventory is also used to report data against targets as required under the Climate Change (Scotland) Act 2009.

Using the Statistics. Which measure to use and when?

The official statistics publication “Scottish Greenhouse Gas Emissions 2022” includes data on two categorisations of greenhouse gas emissions.

- **Estimated net source emissions.** These are sometimes referred to as “territorial” emissions, as they are produced within a country’s territory or economic sphere. Section B contains results using this categorisation.
- **GHG account.** These are net source emissions which have been adjusted to remove the effect of successive revisions to the data over time. Section C contains results using this approach.

The publication does not contain information on consumption-based emission estimates. Consumption-based emissions refer to greenhouse gas emissions associated with the spending of Scottish residents on goods and services, wherever in the world these emissions arise together with emissions directly generated by Scottish households, through private heating and motoring. This information was most recently published in May 2024 for the years 1998 to 2020 as part of the Official Statistics publication: “Scotland’s Carbon Footprint 1998-2020”. Section E contains information on what territorial emissions are excluded from the greenhouse gas inventory.

The table below shows how to use the different categorisations of statistics on greenhouse gas emissions.

	Estimated Source Emissions (Section B)	GHG Account (Section C)
Used for reporting progress against Scotland's Climate Change Targets ¹	No	Yes
Can be compared with EU countries ²	Yes	No
Can be compared with UK ³	Yes	No
Includes International Aviation and Shipping	Yes	Yes
Includes North Sea Oil & Gas	No	No
Data on individual greenhouse gases	Yes	No
Data on sectoral emissions	Yes	No
Base Year	1990	Baseline Period (Variable)

¹ Further information on Scotland's Climate Change Targets can be found in Section C.

² Following the inclusion of drainage and rewetting of organic soils into the Scottish inventory, EU comparisons including land use are technically invalid.

³ Direct comparisons between Scotland and the UK can be made by adding up the results for the four Devolved Administrations separately. The UK figure in this case would exclude offshore emissions.

Which greenhouse gases are reported on and how do they contribute to global warming?

The basket of greenhouse gases consists of carbon dioxide, methane, nitrous oxide, and the four F-gases (hydrofluorocarbons- HFCs, perfluorocarbons – PFCs, sulphur hexafluoride- SF₆ and nitrogen trifluoride- NF₃). These gases are weighted by Global Warming Potential (GWP), so that total greenhouse gas emissions can be reported on a consistent basis. The GWP for each gas is defined as its warming influence relative to that of carbon dioxide over a 100 year period. Greenhouse gas emissions are then presented in *carbon dioxide equivalent* (CO_{2e}) units. In the case of some of the F-gases, the global warming potential is listed as being within a range of values, due to the gases existing as a variety of isotopes with differing GWPs.

Table 1. List of Greenhouse Gases and their contribution to Scotland's net greenhouse gas emissions, 2022

Name of Greenhouse Gas		Global Warming Potential (GWP) (Conversion factor to carbon dioxide equivalent)	Contribution to Scotland's Net Greenhouse Gas Emissions, 2022 (in MtCO ₂ e)	Percentage of Scotland's Net Greenhouse Gas Emissions, 2022 (in MtCO ₂ e)
Carbon dioxide	CO ₂	1	26.9	66.2%
Methane	CH ₄	28	10.2	25.0%
Nitrous oxide	N ₂ O	265	2.9	7.2%
F-gases ² , of which....			0.7	1.6%
• Hydrofluorocarbons	HFC	4 – 12,400	0.6	1.4%
• Perfluorocarbons	PFC	6,630 – 11,100	0.0	0.1%
• Sulphur hexafluoride	SF ₆	23,500	0.0	0.1%
• Nitrogen trifluoride	NF ₃	16,100	0.0	0.0%
Total Net Greenhouse Gases			40.6	100.0%

The Global Warming Potentials (GWPs) are based on international reporting standards, as set by the Intergovernmental Panel on Climate Change (IPCC)¹.

Section B contains further data on the individual greenhouse gases. Section D contains a more detailed discussion of the causes and impacts of revisions between the 1990-2021 and 1990-2022 inventories.

¹ Fifth Assessment Report — IPCC

Reporting of the Baseline Period and 1990

In this publication, a single 1990 Base Year is used for all estimated source emissions (Section B). This year is referred to as “1990” in charts, tables and text.

A different baseline is used for the reporting progress against Scotland’s Climate Change Targets, using the GHG account. This is referred to as “Baseline Period” when referring to changes over time in the charts, tables and text.

The Baseline Period for reporting against Climate Change Targets is:

- 1990 for carbon dioxide carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O)
- 1995 for Fluorinated gases (F gases)²: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF₆), nitrogen trifluoride (NF₃)

The difference between these definitions of baseline year tend to be small as F gases are a minority contribution to the total emissions in terms of carbon dioxide equivalent.

Within this publication, data are estimated for the Baseline Period; and the years 1990, 1995 and 1998 to 2022.

What are net emissions and carbon sinks?

The emissions reported are the combination of emissions minus removals from the atmosphere by *carbon sinks*. Carbon sinks are present in the ‘Land Use, Land Use Change and Forestry’ (LULUCF) category, they are mostly associated with the effects of grasslands and forestry to sequester carbon, as well as the carbon stored in wood products. These are known as “removals” as they offset emissions.

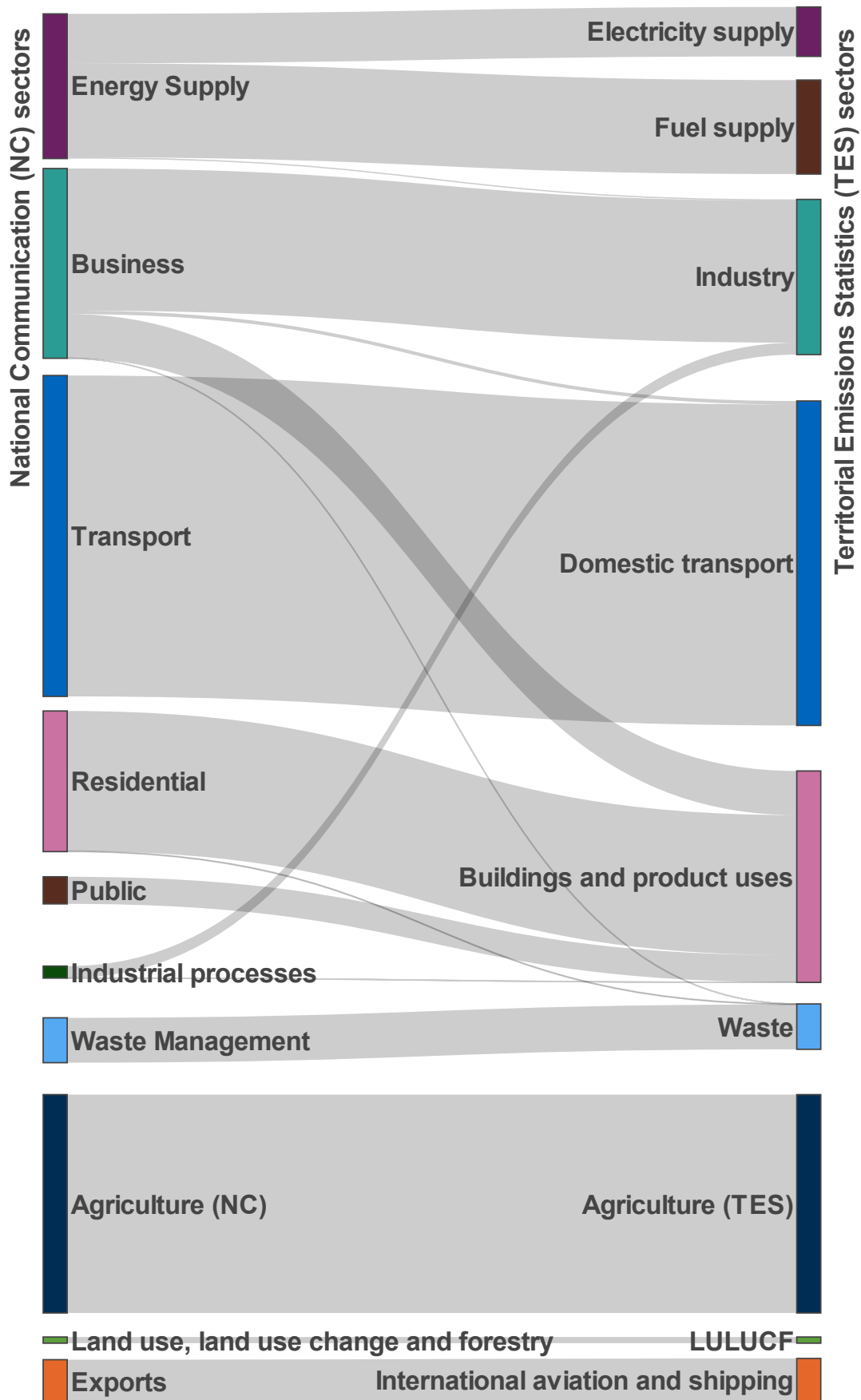
Emissions sectors

This publication provides the latest estimates of Scotland’s greenhouse gas emissions by source from 1990-2022. It uses the ‘Territorial Emissions Statistics’ sectors, which are the same categories now used for the UK report. Previously these statistics were categorised by ‘National Communication Categories’ but following a consultation exercise by the Department for Energy Security and Net Zero, it was determined that the national communication categories were not meeting users’ needs. Annex C presents emissions using the previous categories.

Figure 1 below shows the relationship between the old categories and the new categories.

² The Kyoto Protocol allows Parties flexibility to choose either 1990 or 1995 as the base year for the industrial gases. Using a 1995 base year is in line with the approach adopted by the UK Government and many EU Member States.

Figure 1: Relationship between National Communications categories and Territorial Emissions Statistics Sectors, Scotland 2022.



For the purposes of reporting, greenhouse gas emissions are allocated into categories as follows:

- **Electricity Supply** – Includes emissions from power stations previously allocated to the Energy Supply sector.
- **Fuel Supply** – Includes emissions from fuel production and fuel supply activities such as mining, refining, manufacturing, and distributing fuels previously allocated to the Energy Supply sector.
- **Domestic Transport** – Includes all emissions previously allocated to the Transport sector and now includes air conditioning and refrigeration on vehicles.
- **Buildings and Product Uses** – Includes emissions from combustion on residential, public sector and commercial sites. Also includes emissions from product uses such as nitrous oxide (N₂O) use as an anaesthetic; and F-gas emissions from aerosols, and metered dose inhalers or residential refrigeration and air conditioning.
- **Industry** – These comprise of emissions from manufacturing, industrial processes and construction, as well as industrial refrigeration and air conditioning. Emissions from coke production previously categorised as part of the Energy Supply sector are now included in the Industry sector as energy from coke production is primarily used in the iron and steel industry.
- **Waste** – Includes all emissions previously allocated to the Waste Management sector. Additionally; Includes emissions from accidental fires previously allocated to the Business sector and includes emissions from household composting, small-scale waste burning, and accidental fires previously allocated to the Residential sector.
- **Agriculture** – The coverage of the Agriculture sector is unchanged. However, there have been some changes to the categories within the Agriculture sector.
- **Land Use, Land Use Change and Forestry (LULUCF)** – The coverage of the LULUCF sector is unchanged. However, there have been some substantial changes to the categories within the LULUCF sector to align better with land use policy. Key changes include the separation of forestry and peatlands related emissions into their own sub-sectors, as well as the creation of new categories within forestry and peatlands that better describe the emissions and removals.
- **International Aviation and Shipping (IA&S)** – unchanged from previous categorisation.

When emissions are reported by source, emissions are attributed to the sector that emits them directly. These high-level sectors are made up of a number of more detailed sectors, which follow the definitions set out by the Intergovernmental Panel on Climate Change (IPCC), and which are used in international reporting tables which are submitted to the United Nations Framework Convention on Climate Change (UNFCCC) every year.

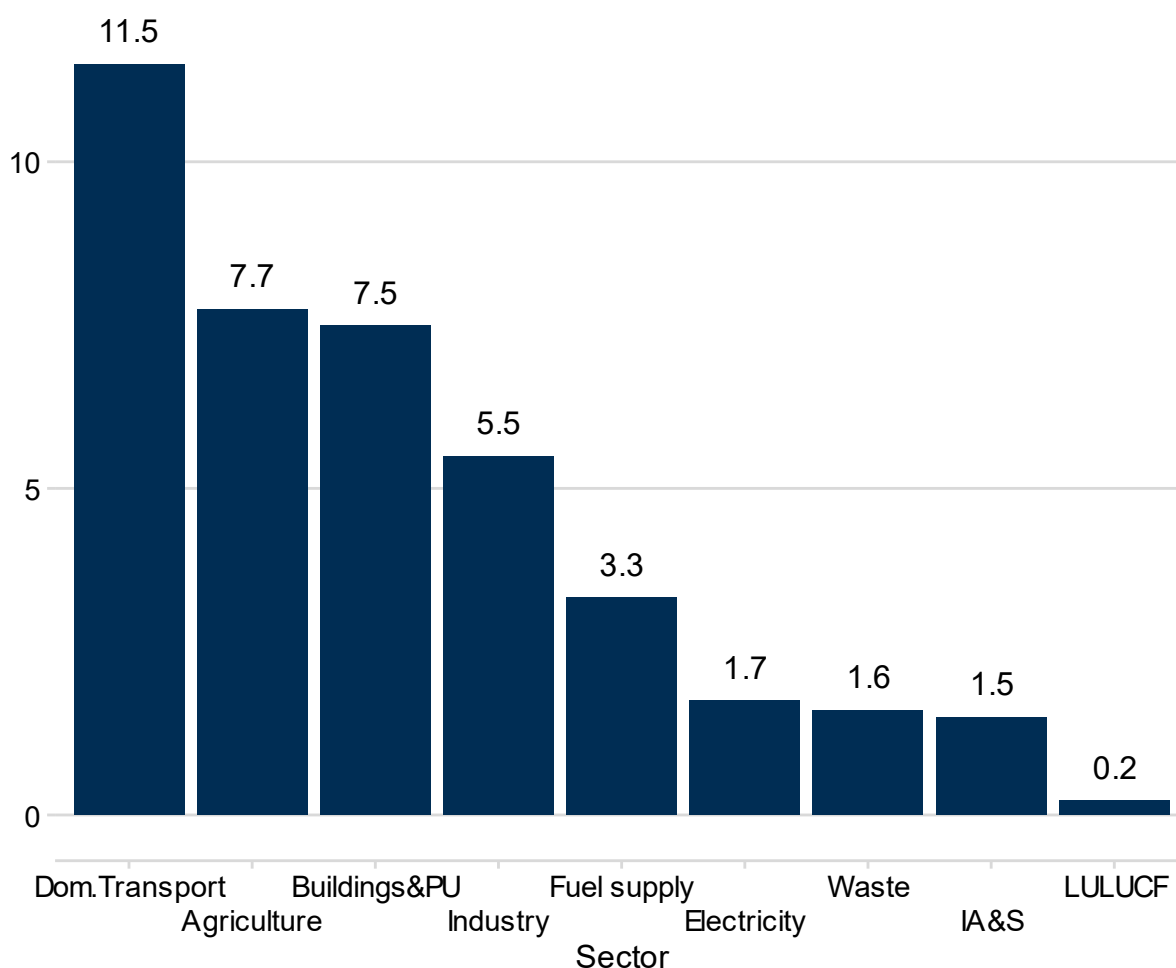
Section B. Results – Net emissions of Scottish Greenhouse Gas Emissions

2022 results

Chart 2 presents the net sources and sinks of Scottish Greenhouse Gas Emissions in 2022, grouped by sector.

Chart 2. Scottish Greenhouse Gas Emissions by Territorial Emissions Statistics Sector, 2022.

MtCO₂ e



Main points

- In 2022, Domestic transport (excluding International Aviation and Shipping) (11.5 MtCO₂e) was the largest source of net emissions, followed by Agriculture (7.7 MtCO₂e), Buildings and product use (7.5 MtCO₂e), Industry (5.5 MtCO₂e) and Fuel supply (3.3 MtCO₂e).

- Less significant emitters in 2022 were: Electricity supply (1.7 MtCO_{2e}), Waste (1.6 MtCO_{2e}) and International aviation and shipping (IA&S) (1.5 MtCO_{2e}).
- Whilst only contributing 0.2 MtCO_{2e} to total net emissions in 2022, the Land Use, Land Use Change and Forestry (LULUCF) sector is important in that this sector emitted 14.6 MtCO_{2e} of gross greenhouse gases in 2022, whilst removing 14.4 MtCO_{2e} of greenhouse gases from the atmosphere, mainly in forestry.

Table 2. Scottish Greenhouse Gas Emissions by Gas and by Territorial Emissions Statistics Sector 2022. Values in MtCO_{2e}

TES sector	Carbon Dioxide	Methane	Nitrous Oxide	Fluorinated gases	Total
Agriculture	1.3	4.6	1.9		7.7
Buildings and product uses	7.0	0.0	0.1	0.4	7.5
Domestic transport	11.3	0.0	0.1	0.1	11.5
Electricity supply	1.7	0.0	0.0		1.7
Fuel supply	3.0	0.3	0.0		3.3
Industry	5.3	0.0	0.0	0.1	5.5
International aviation and shipping	1.5	0.0	0.0		1.5
LULUCF	-4.2	3.7	0.7		0.2
Waste	0.0	1.5	0.1		1.6
Grand Total	26.9	10.2	2.9	0.7	40.6

Main points

Carbon dioxide was the main greenhouse gas emitted or removed in most sectors, with the exceptions of the Agriculture and Waste Management sectors.

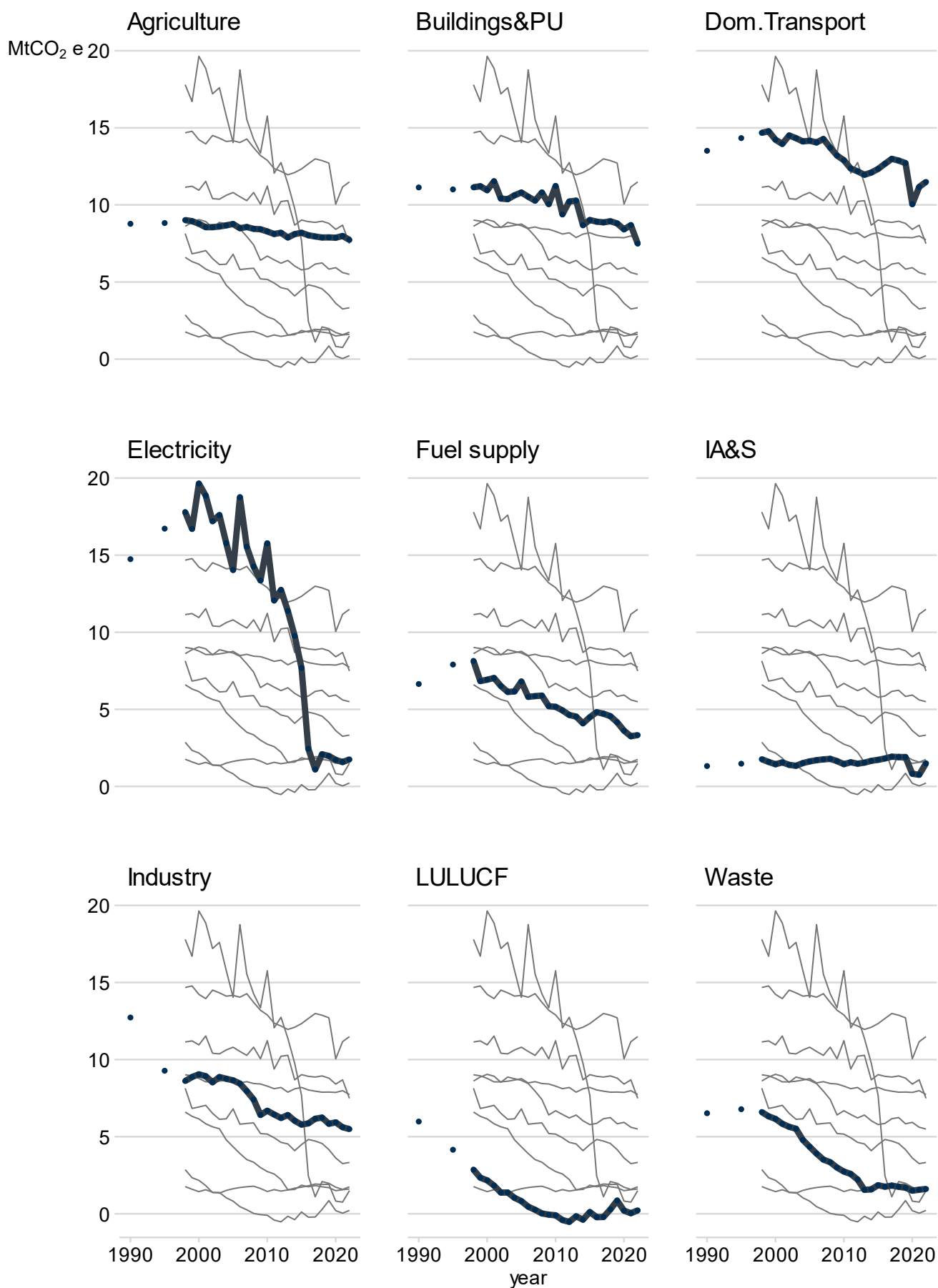
- Methane was the main net gas emitted in the Agriculture (4.6 MtCO_{2e}), followed by nitrous oxide (1.9 MtCO_{2e}) and carbon dioxide (1.3 MtCO_{2e}).
- Almost all emissions in the Waste Management sector were emitted in the form of methane (1.5 MtCO_{2e}).

Where F gases are emitted, they have been in relatively small amounts via the Buildings and product use, Domestic transport and Industry sectors.

Key Trends By Territorial Emissions Statistics Sector

Chart 3 presents the main sources of Scottish Greenhouse Gas Emissions from 1990 to 2022, broken down by Territorial Emissions Statistics Sector.

**Chart 3: Greenhouse Gas Emissions in Scotland, by Territorial Emissions
Statistics Sector 1990 to 2022.**



Long term (1990 to 2022) and short term (2021 to 2022) trends by category

Chart 4 shows how emissions have changed between 1990 and 2022 in all source categories. Chart 5 shows how emissions have changed between 2021 and 2022.

Chart 4. Change in net emissions by Territorial Emissions Statistics Sector between 1990 and 2022

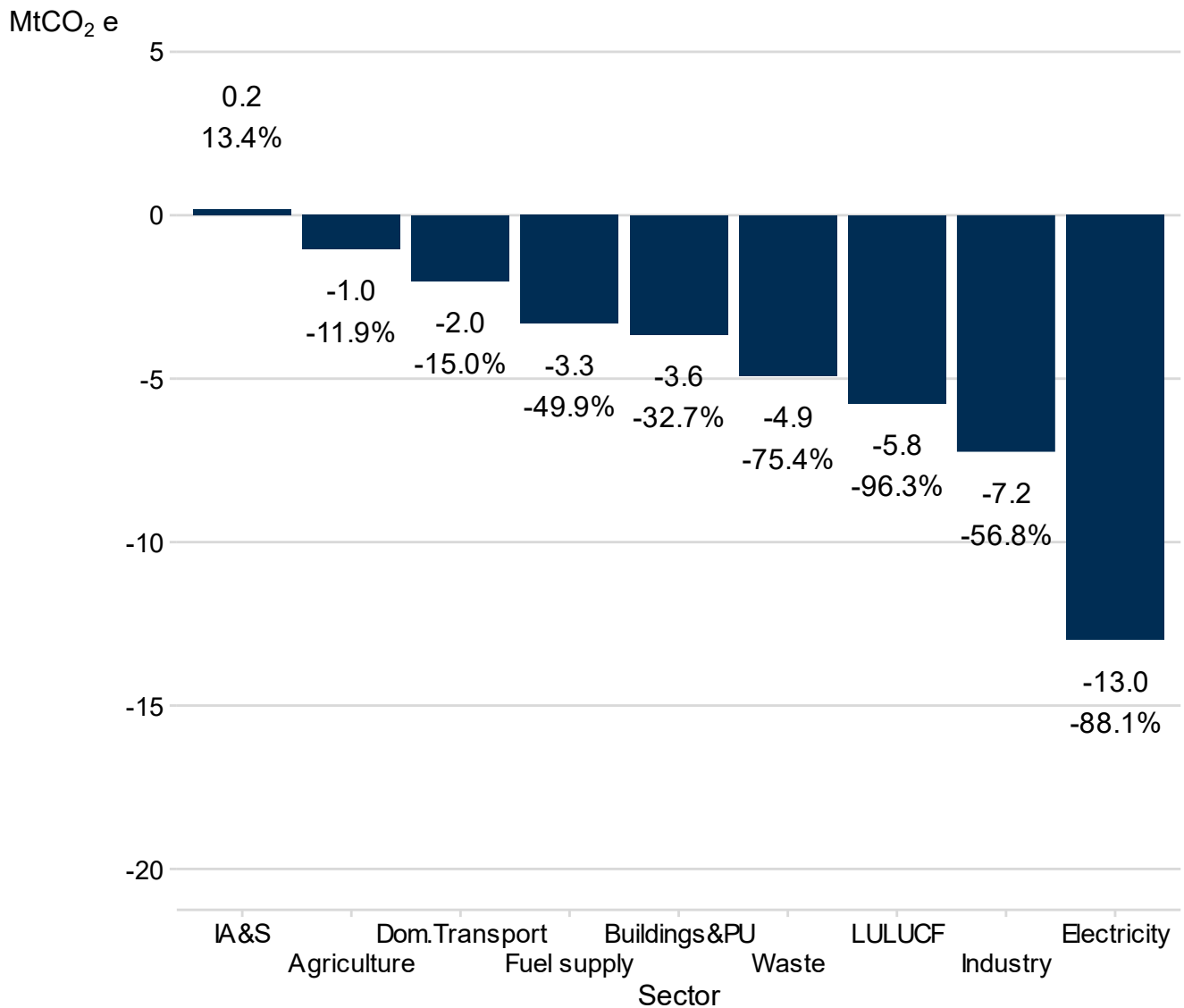
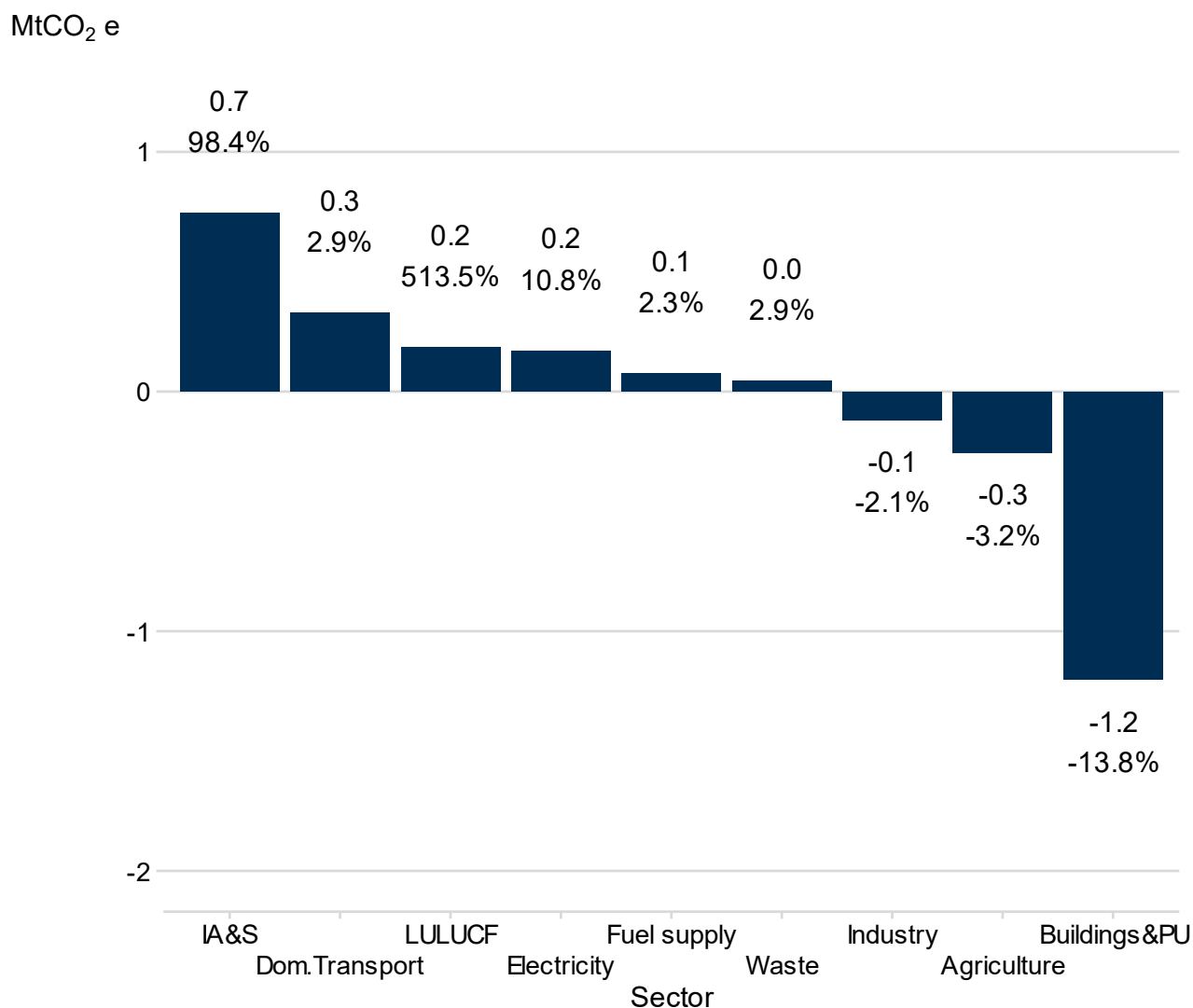


Chart 5. Change in net emissions by Territorial Emissions Statistics Sector between 2021 and 2022.



Total Emissions

Overall, there has been a 40.8 MtCO₂e (50.1 per cent) decrease in net emissions between 1990 and 2022. Total emissions were essentially unchanged between 2021 and 2022; remaining at the level of 40.6 MtCO₂e although, in percentage terms the data indicate a marginal reduction of 0.1 per cent.

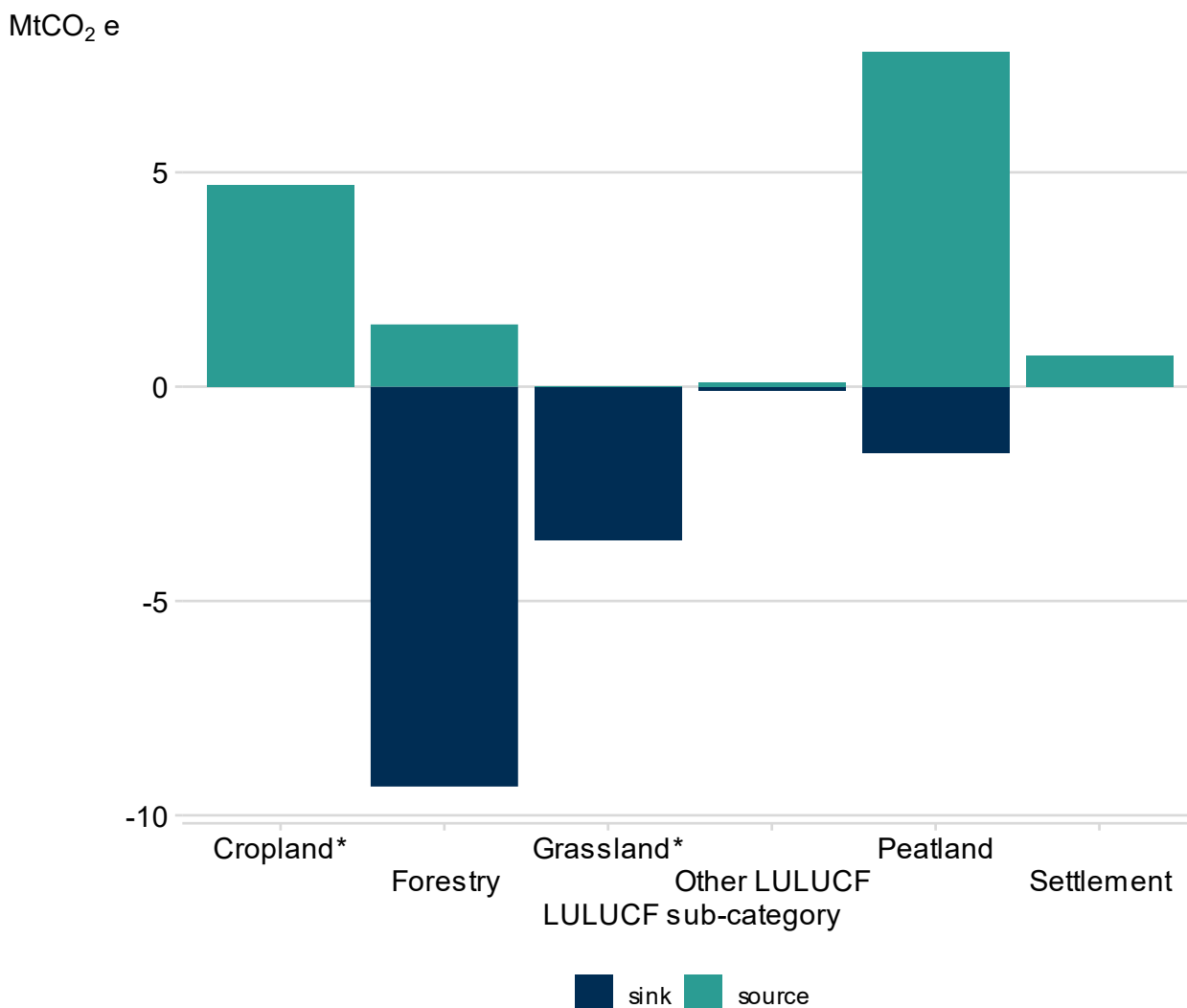
Land Use, Land Use Change And Forestry (LULUCF)

LULUCF is a net source of GHG emissions in Scotland in 2022, emitting 0.2 MtCO₂e of net emissions. In 1990 net emissions were 6.0 MtCO₂e. In the period 2009-2017, LULUCF exhibited net removals of greenhouse gases in Scotland.

Chart 6 below shows, for each sub-sector of the land use sector in 2022, that the net total includes some significant emissions sources, and equally significant ‘sinks’

which remove carbon dioxide from the atmosphere. Forestry and grassland on mineral soils categories are net sinks of GHG emissions in 2022, removing a net amount of GHG emissions of 7.9 MtCO₂e and 3.6 MtCO₂e respectively. All other land use types are net sources of greenhouse gas emissions, with peatlands and mineral croplands showing substantial net emissions to the atmosphere.

Chart 6. Sources and sinks of GHG emissions in Land Use, Land Use Change and Forestry, Scotland, 2022



* Cropland and Grassland relate to mineral soils only; emissions from these categories on organic soils are included in the Peatland category.

Domestic Transport

Domestic Transport has consistently been a large part of Scotland's emissions. This sector showed dramatic reduction in emissions associated with the COVID-19 lockdown in 2020 (-2.7 MtCO₂e) but rebounded in 2021 by 1.1 MtCO₂e, and increased again in 2022 by 0.3 MtCO₂e.

Electricity supply

Energy Supply was historically the biggest contributor to emissions, but has seen very large changes over the period covered by these statistics, reducing from 14.7 MtCO_{2e} in 1990 to 1.7 MtCO_{2e} in 2022 (88.1 per cent reduction). Overall emissions reductions in this sector are mainly due to reductions in emissions as a result of the complete cessation of coal use for electricity generation in Scotland, and a reduction in fossil fuel generation more generally.

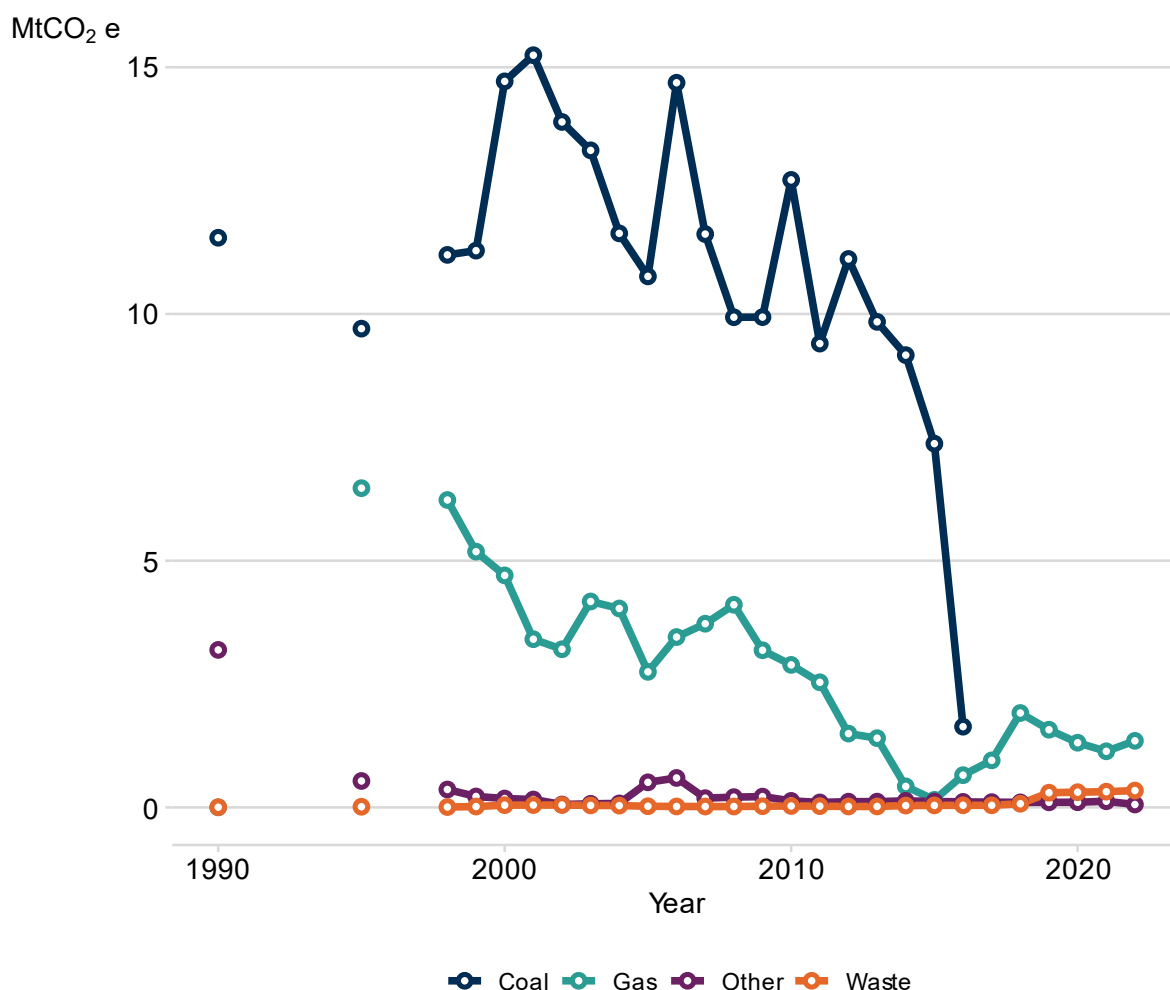
Between 2021 and 2022 Electricity Supply emissions increased by 0.2 MtCO_{2e} (10.8 per cent increase). This increase was largely due to increased gas generation during 2022.

Chart 7 below shows, for the first time, a breakdown of electricity generation emissions in Scotland, by fuel. It shows that coal fired power stations emitted a very large amount of emissions historically (peaking at a level of 15.2 MtCO_{2e} in 2001 but showed a dramatic decrease in emissions starting from 2013, before ceasing entirely from 2017.

Gas generation has shown a generally decreasing trend over the time-series but has increased slightly in the latest year.

Energy from waste (EfW) emissions have historically been very low and only reached a notable level from 2019 when these emissions equalled 0.3 MtCO_{2e}. Emissions have stayed at this level since, but we expect future increases in these emissions as more plants, currently under construction, begin operation. In 2022, EfW plants contributed 19.5 per cent of total emissions from electricity generation.

Chart 7. Electricity generation emissions by fuel source, Scotland, 1990-2022.



Industry

This sector has seen a 7.2 MtCO₂e (56.8 per cent) fall in emissions between 1990 and 2022. As shown in Chart 3, much of this decrease occurred between 1990 and 1995 – linked to a decline in emissions from manufacturing and the iron and steel industry over this time period. There was a further smaller reduction between 2008 and 2009 coinciding with the recession. Between 2021 and 2022 there was a reduction of 0.1 MtCO₂e in total emissions from industry.

Agriculture

This sector has seen a 1.0 MtCO₂e (11.9 per cent) fall in emissions between 1990 and 2022. Between 2020 and 2021 agricultural emissions fell 0.3 MtCO₂e.

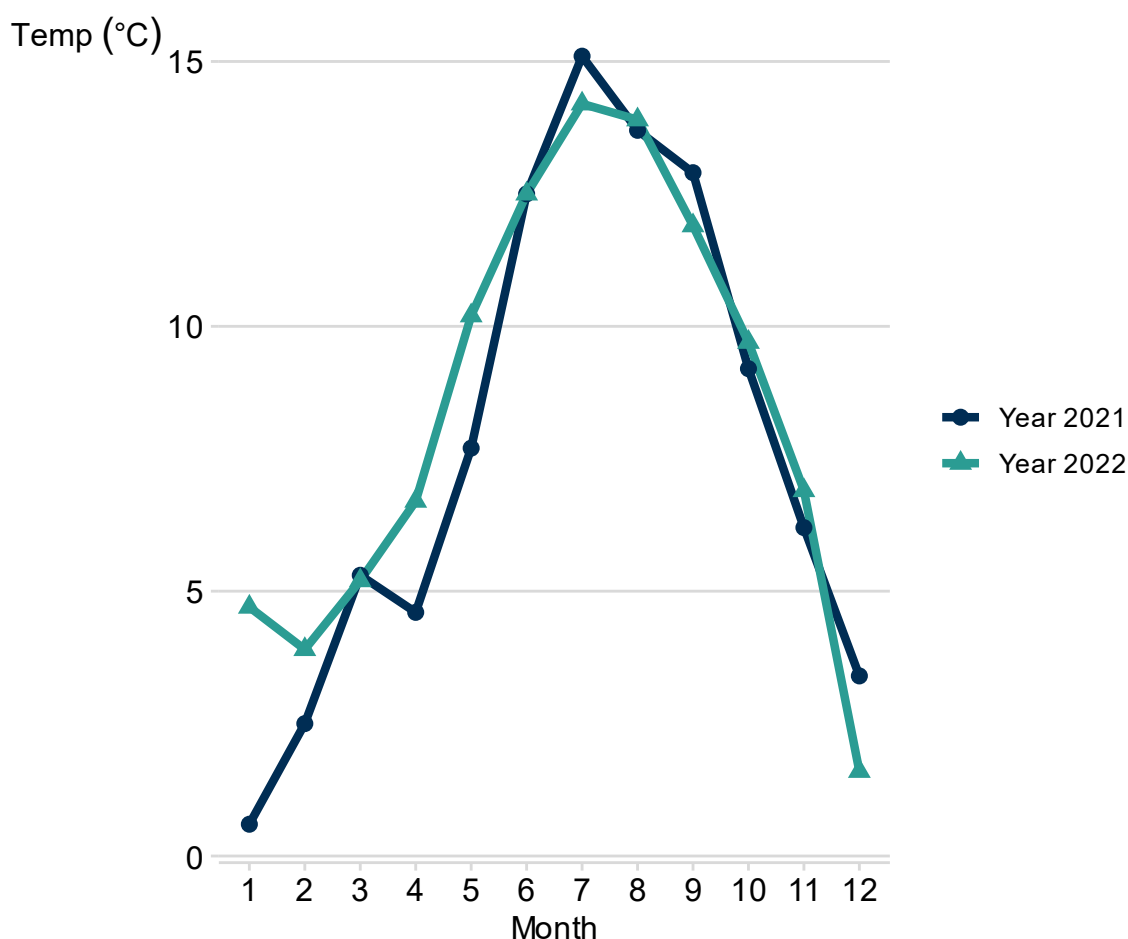
Buildings and product uses

The Buildings and product uses sector is dominated by direct fuel combustion for home heating in households, and other buildings. There has been a reduction of 32.7 per cent between 1990 and 2022. This long-term decrease is mainly due to a

switch from less efficient solid and liquid fuels to natural gas for heating, and improvements in energy efficiency.

Buildings and product uses decreased between 2021 and 2022 from 8.7 MtCO_{2e} to 7.5 MtCO_{2e} (-13.8 per cent). This change in emissions was in part caused by elevated fuel prices and relatively warmer temperatures in January, February and April 2022, resulting in less fuel being used for domestic heating (Chart 8).

Chart 8. Mean air temperature by month, Scotland. 2021 and 2022.



Data obtained from Met Office³

International Aviation and shipping (IA&S)

International aviation was affected dramatically during the early part of the COVID-19 restrictions with International shipping affected to a lesser degree. Between 1990 and 2022, international aviation and shipping increased by 0.2 MtCO_{2e}. Between 2021 and 2022 international aviation and shipping emissions increased by 0.7 MtCO_{2e} (98.4 per cent increase).

³ Source Met Office: Met Office data download

Waste Management

Waste management emissions are dominated by methane emissions. Emissions from Waste Management have been relatively static over recent years, with a value of 1.6 MtCO₂e for 2021, mirroring the level seen in 2013. However, between 1990 and 2021 emissions reduced by 4.9 MtCO₂e (75.4 per cent). This decrease is largely due to the progressive introduction of methane capture and oxidation systems within landfill management.

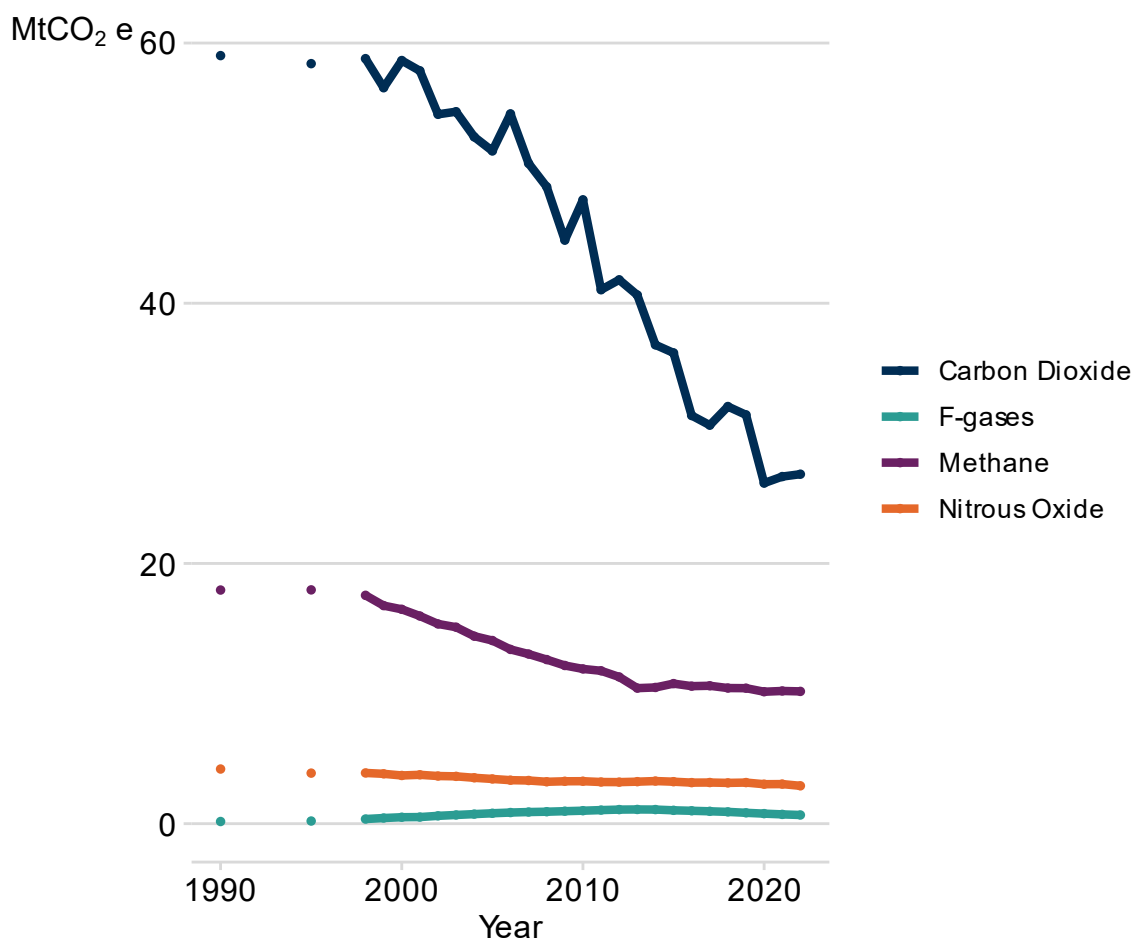
Fuel supply

Fuel supply emissions relate to the production and supply of fossil fuels and other energy sources. These emissions have essentially halved since 1990, reducing by 3.3 MtCO₂e over that period.

Emissions by type of gas

Chart 9 shows the trends in emissions, broken down by gas from 1990 to 2022.

Chart 9. Scottish Greenhouse Gas Emissions, by Gas, 1990-2022.



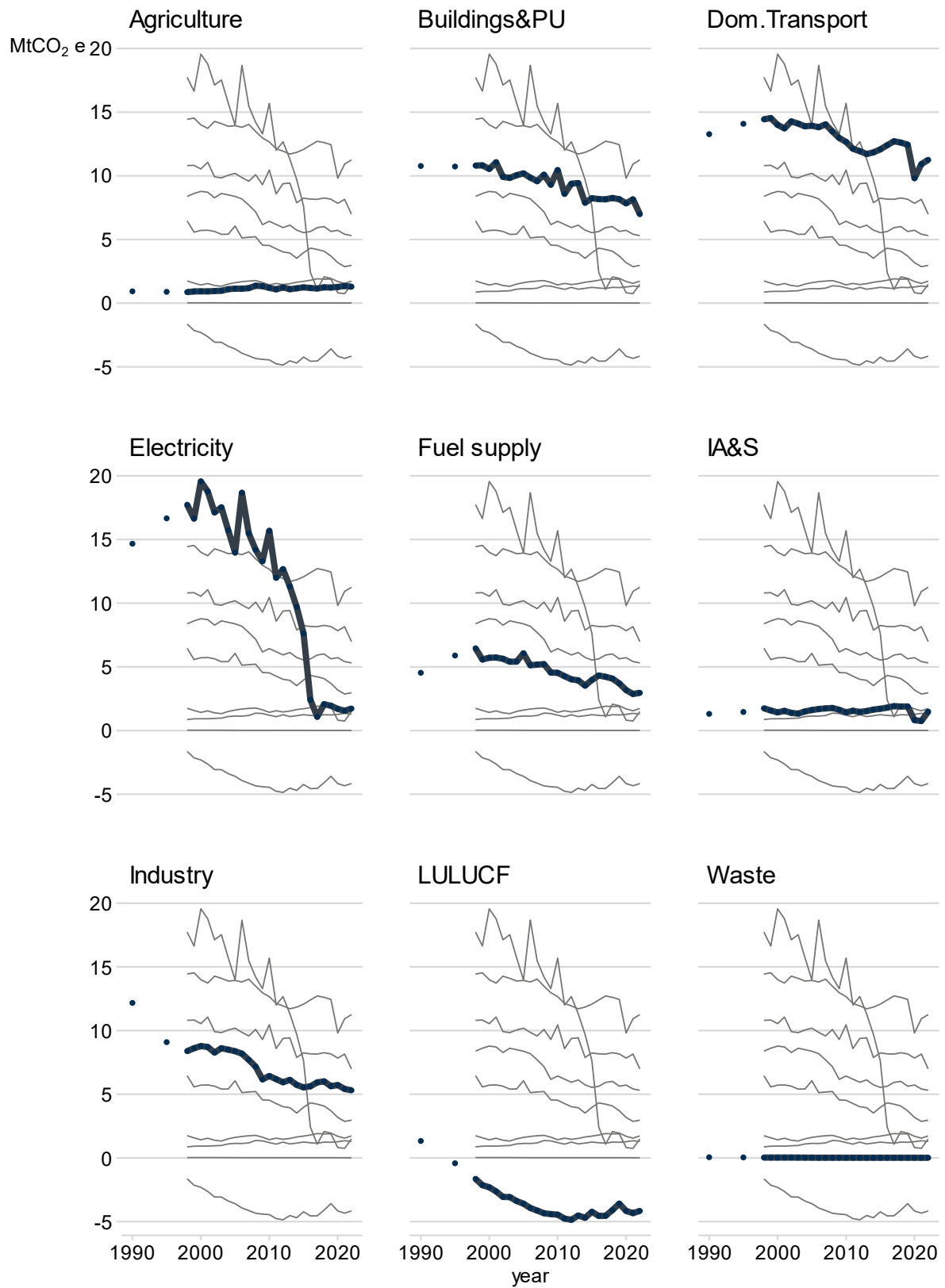
Main Points

- Carbon dioxide is by far the largest contributor to Scottish greenhouse gas emissions in all years (66.2 per cent of all emissions in 2022) and is the most volatile series of all gases – largely driven by changes in energy supply emissions and to a lesser extent, emissions from the buildings.
- Methane is the second most common greenhouse gas in 2021 (25.0 per cent of all net emissions) followed by nitrous oxide (7.2 per cent) and F-gases making up the remainder (1.6 per cent).
- Carbon dioxide has seen the largest reduction from 1990 to 2022 (32.2 MtCO_{2e} reduction). There have also been reductions in both methane (7.8 MtCO_{2e} reduction) and nitrous oxide (1.3 MtCO_{2e} reduction). Emissions from fluorinated gases showed a large increase from 1990 to 2013 but have been declining since that time. Although they still remain small in absolute terms, some of these gases have particularly large global warming potentials. These HFCs replace chlorofluorocarbons (CFCs) which were banned by the Montreal Protocol due to their impact on the ozone layer.

Charts 10 to 13 present results on individual gases broken down by main sectors over time. Chart 10 shows how carbon dioxide emissions have changed from 1990 to 2022.

Carbon Dioxide (CO₂)

Chart 10. Carbon Dioxide (CO₂) Emissions by Territorial Emissions Statistics Sector, 1990 to 2022.

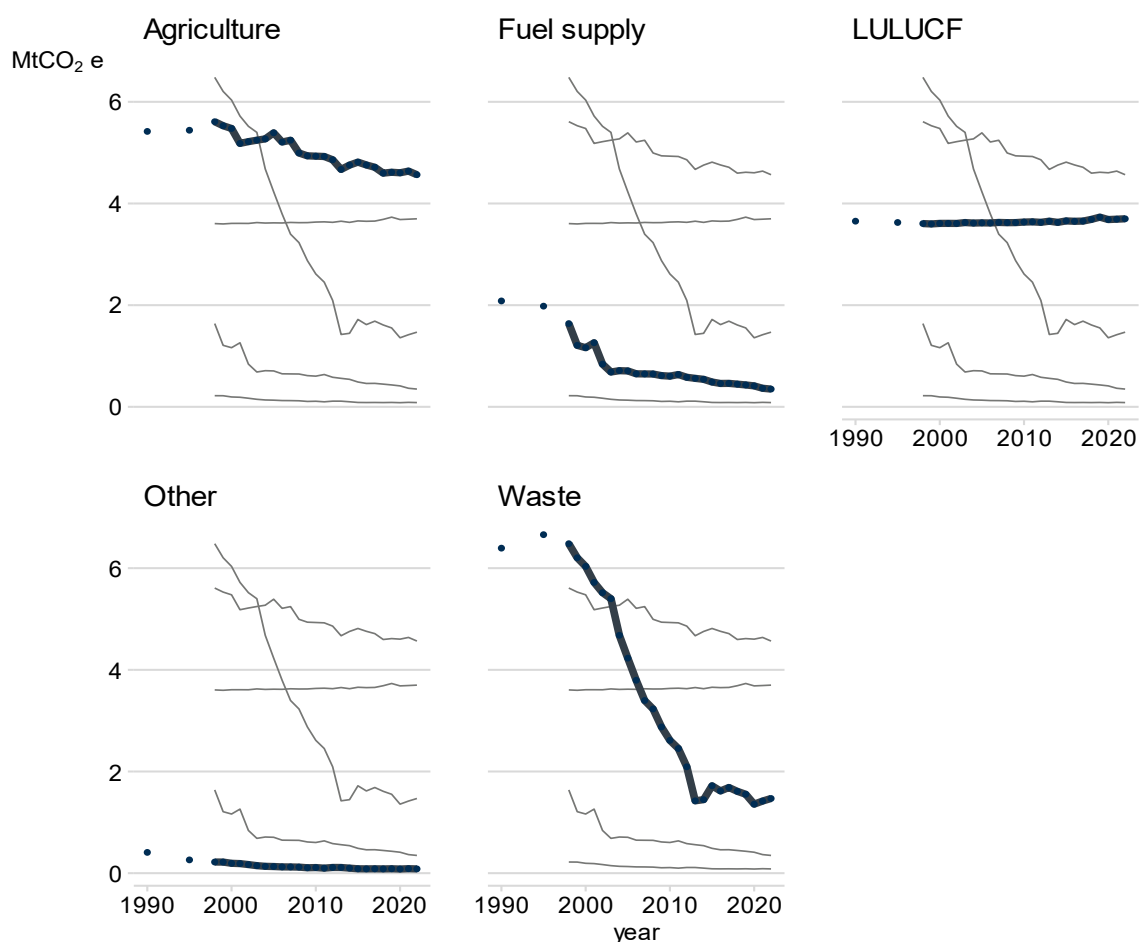


Main Points

- Chart 10 shows that Electricity Supply was a key source of carbon dioxide emissions in the earlier part of the time-series, after which the change in fuels used in electricity generation substantially reduces CO₂ emissions from this source. Change in electricity supply emissions is the main driver of changes in total carbon dioxide emissions.
- Transport (excluding international) is the next most common source of carbon dioxide emissions across the entire time-series.
- The LULUCF sector, has become a much greater net CO₂ sink for Scotland over the time-series. In 1990 it emitted 1.3 MtCO₂ of net CO₂ emissions. From 1995, this sector became a net-CO₂ sink, reaching a maximum in 2012 when it acted to sequestrate 4.9 MtCO₂. Since that time, this net CO₂ sink has been generally reducing to its current (2022) level where it reached net CO₂ emissions of -4.2 MtCO₂. These trends reflect forestry planting activities in the early 1990s reaching maturity and gradually reducing its potential to remove CO₂.

Methane (CH₄)

Chart 11. Methane (CH₄) Emissions by Territorial Emissions Statistics Sector 1990 to 2022.

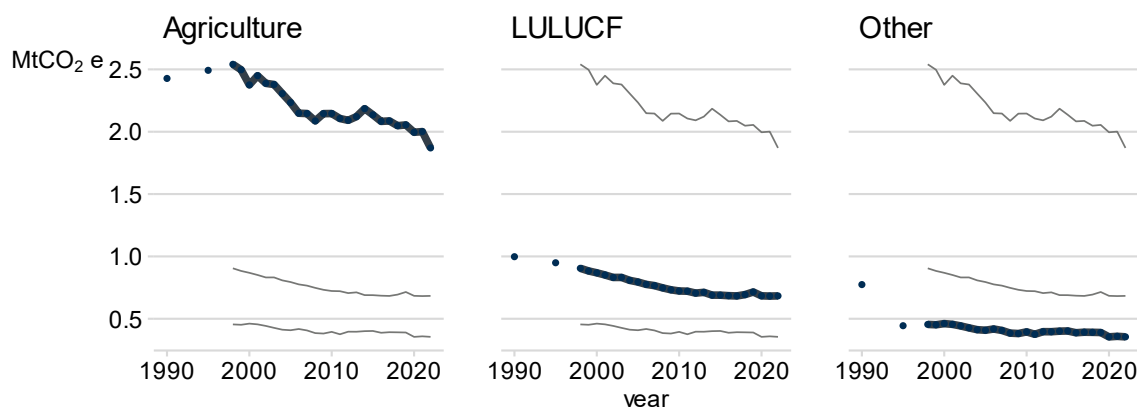


Main Points

- Methane emissions from Waste Management have fallen by 4.9 MtCO₂e between 1990 and 2022 (a 77.0 per cent reduction). This is largely due to the progressive introduction of methane capture and oxidation systems within landfill management.
- In the Fuel Supply sector, methane emissions have fallen by 1.7 MtCO₂e between 1990 and 2022 (an 83.2 per cent reduction), partly due to reductions in emissions from sources such as coal mining.
- Methane emissions in the Agriculture sector have fallen by 0.9 MtCO₂e between 1990 and 2022 (a 15.7 per cent reduction). This is mainly due to a decrease in livestock numbers (particularly cattle and sheep).
- Land Use emissions of methane have risen very slightly over the entire time-series.

Nitrous Oxide (N₂O)

Chart 12. Nitrous Oxide (N₂O) Emissions by Territorial Emissions Statistics Sector, 1990 to 2022.

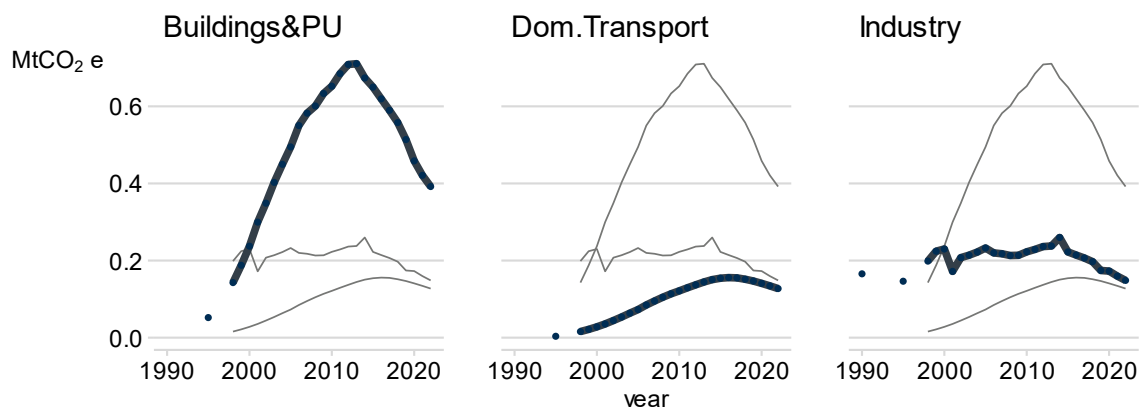


Main Points

- Agriculture is by far the main contributor to emissions of nitrous oxide. These are largely produced by agricultural practices on soils, and to a lesser extent by animal manures. Emissions of nitrous oxide in this sector have fallen by 0.6 MtCO₂e between 1990 and 2022 – a 23.0 per cent reduction.
- ‘Land Use, Land Use Change And Forestry’ fell by 0.3 MtCO₂e (31.5 per cent reduction) between 1990 and 2022.

Fluorinated gases (F-gases)

Chart 13. F-gas Emissions by Territorial Emissions Statistics Sector, 1990 to 2022



Main Points

- F gases are the most potent greenhouse gases with high global warming potentials but they are emitted in very small quantities in a limited number of sectors. As a result, they contribute less to global warming than the other greenhouse gases in Scotland. (For targets, these gases use 1995 as a baseline year rather than 1990)
- There is a sharp increase in HFC gases of 0.9 MtCO₂e between 1990 and 2013 (from 0.2 MtCO₂e in 1995 to 1.1 MtCO₂e in 2013), but have since decreased every year from that peak. This change was largely in the buildings and product use sector. This increase is because F gases were introduced to replace chlorofluorocarbons (CFCs), which were used in appliances such as industrial air conditioning units. CFCs were banned under the Montreal Protocol, as they were contributing to the depletion of the ozone layer.

**Table 3. Greenhouse Gas Emissions in Scotland by Territorial Emissions
Statistics Sector: 1990 to 2022. Values in MtCO₂e**

Sector	1990	2021	2022	2021-2022		1990-2022	
				% Change	Change	% Change	Change
Agriculture	8.8	8.0	7.7	-3.2%	-0.3	-11.9%	-1.0
Buildings and product uses	11.1	8.7	7.5	-13.8%	-1.2	-32.7%	-3.6
Domestic transport	13.5	11.2	11.5	2.9%	0.3	-15.0%	-2.0
Electricity supply	14.7	1.6	1.7	10.8%	0.2	-88.1%	-13.0
Fuel supply	6.6	3.3	3.3	2.3%	0.1	-49.9%	-3.3
Industry	12.7	5.6	5.5	-2.1%	-0.1	-56.8%	-7.2
International aviation and shipping	1.3	0.8	1.5	98.4%	0.7	13.4%	0.2
LULUCF	6.0	0.0	0.2	513.5%	0.2	-96.3%	-5.8
Waste	6.5	1.6	1.6	2.9%	0.0	-75.4%	-4.9
Net emissions	81.4	40.6	40.6	-0.1%	-0.0	-50.1%	-40.8

(some early years omitted to fit table on page, full table available in the accompanying excel tables file)

Table 4. Scottish Greenhouse Gases, by gas, 1990 to 2022. Values in MtCO_{2e}

Gas	1990	2021	2022	2021-2022		1990-2022	
				% Change	Change	% Change	Change
CO ₂	59.0	26.7	26.9	0.7%	0.2	-54.5%	-32.2
CH ₄	18.0	10.2	10.2	-0.3%	-0.0	-43.4%	-7.8
N ₂ O	4.2	3.0	2.9	-4.4%	-0.1	-30.7%	-1.3
F-gases	0.2	0.7	0.7	-6.6%	-0.0	303.3%	0.5
HFC	0.0	0.6	0.6	-6.4%	-0.0	23005.2%	0.6
PFC	0.1	0.1	0.0	-9.9%	-0.0	-61.2%	-0.1
SF ₆	0.0	0.1	0.0	-4.9%	-0.0	20.3%	0.0
NF ₃	0.0	0.0	0.0	0.0%	-	-17.5%	-0.0
Net emissions	81.4	40.6	40.6	-0.1%	-0.0	-50.1%	-40.8

(some early years omitted to fit table on page, full table available in the accompanying excel tables file)

Section C. Scotland's GHG Account for assessing progress against statutory targets

Introduction

A full reporting of the figures, required by the statutory requirements of Climate Change (Scotland) Act 2009, is available in Annex A which accompanies this publication.

In December 2017 the Climate Change Committee (CCC) provided advice on the future measurement and accounting of emissions against Scotland's climate change targets⁴.

The CCC used the term "GHG Account" to refer to their recommended manner of accounting for emissions, which is intended to better separate the impacts on targets of scientific and methodological improvements to the GHG inventory, from those of 'on-the-ground' policy actions. The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 requires that Scottish Ministers follow the CCC's most recent advice on the method to be used for reporting on target outcomes, which currently means the GHG Account method set out here.

At the heart of this method is the freezing of inventory methods (the scientific methods used for the measurement and estimation of emissions levels) between the time that target levels are set (or reviewed through independent advice from the CCC) and the time when target outcomes come to be reported. To ensure that the inventory methods used for the purpose of reporting target outcomes do not become too far separated from the best science and evidence, the base inventory will be re-aligned to the most up to date inventory methods at least every 5 years.

The base inventory used in this publication uses the 1990-2020 data, published in June 2022.

⁴ Letter from Lord Deben to Roseanna Cunningham MSP advising on Scottish climate target framework - Climate Change Committee (theccc.org.uk)

2022 GHG Account Calculation

In accordance with advice from the Climate Change Committee, the calendar year 2020 (for which emissions data was first published in June 2022) has been selected as the base inventory for reporting progress to the 2022 interim target.

Table 5: Calculation of the Scottish GHG Account for 2022

Year	Baseline Period (1)	2020	2021	2022
Inventory data				
A. Base Inventory source emissions data (June 2022 data (1990-2020)) (3)	83.0	40.6	N/A	N/A
B. June 2023 source emissions data (1990-2021 inventory)	82.0	40.6	41.6	N/A
C. June 2024 source emissions data (1990-2022 inventory)	81.4	40.1	40.6	40.6
Revisions between inventories (2)				
between A and B	-1.0	0.1	0.1	0.1
between B and C	-0.6	-0.5	-1.0	-1.0
Combined revision	-1.6	-0.4	-0.9	-0.9
GHG Account (latest inventory, less combined revision)	83.0	40.6	41.5	41.5
GHG Account figures, expressed as a percentage reduction from the baseline period.	0.0%		-49.9%	-50.0%

1. The Baseline period uses a 1995 base-year for F-Gas emissions, and 1990 for all other greenhouse gases.
2. Where data do not exist for a particular year, revisions are carried over from the previous complete year
3. Values for the base inventory use updated global warming potentials as shown in chart D4 in the June 2022 publication. In line with international carbon reporting practice, the GWPs used in the 2024 inventory are consistent with the IPCC 5th Assessment Report (AR5 without climate feedback effects. This change has resulted in methane moving from a GWP multiplier of 25 to 28, and nitrous oxide reducing from 298 to 265. Other changes to individual isotopes of fluorinated gases have also been made.

4. Totals may not exactly equal the sum of components due to rounding.
5. The GHG Account for 2020 is shown in Scottish Greenhouse Gas Statistics 2020 published in June 2022

Under the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019, targets are set for the years from 2018 onwards. A full list of these target levels is available on the Scottish Government [website](#), with the 2022 interim target being a 53.8 per cent reduction from baseline levels.

Table 8 shows a 50.0 per cent reduction from baseline levels in 2022. As a result, **the statutory emissions reduction target for 2022 has not been met.**

Section D. Revisions to the Inventory and Methodology

This section examines key revisions in estimated source emissions between the latest inventory (1990-2022) and the previous inventory (1990-2021).

Compilation of the Greenhouse Gas Inventory

The greenhouse gas inventory covers a wide variety of anthropogenic sources of greenhouse gas emissions. There is therefore a wide variety of emissions sources which require different approaches to their estimation. There are a large number of data sources used in its compilation, obtained from Government statistics, regulatory agencies, trade associations, individual companies, surveys and censuses. The methods used to compile the greenhouse gas inventory are consistent with international guidance on national inventory reporting from the Intergovernmental Panel on Climate Change.

Most emission estimates are compiled by combining activity data (such as fuel use) with a suitable emission factor (such as amount of CO₂ emitted per unit of fuel used). Estimates of emissions from the industrial sector are often compiled based on plant-specific emissions data. Emissions from some sectors are based on more complicated models - such as the model used to estimate emissions from landfill, and the model used to estimate the carbon dynamics in soils when trees are planted. Much of the data on net emissions from 'agriculture' and 'land use, land use change and forestry emissions' are based on modelled data for Scotland, which are consistent with, but not constrained to, the UK totals and thus are known as "bottom up" estimates.

Many of the remaining emissions sources within the inventory have been collated on a "top down" approach where estimates of emissions have been apportioned to Scotland using proportions of energy use in the Department of Business, Energy and Industrial Strategy (BEIS) Publication "Digest of UK Energy Statistics (DUKES)". This approach is prompted by data availability on emissions being more limited at the sub-UK level.

Impact of Revisions

Revisions between the 1990-2021 and 1990-2022 inventories

Charts 14 to 16 illustrate the impacts of revisions between the 1990-2021 and 1990-2022 inventories. This is followed by a discussion of the reasons for the key revisions.

Chart 14. Scottish Greenhouse Gas Emissions. Comparison of the net greenhouse gas emissions for the 1990-2021 and 1990-2022 Inventories.

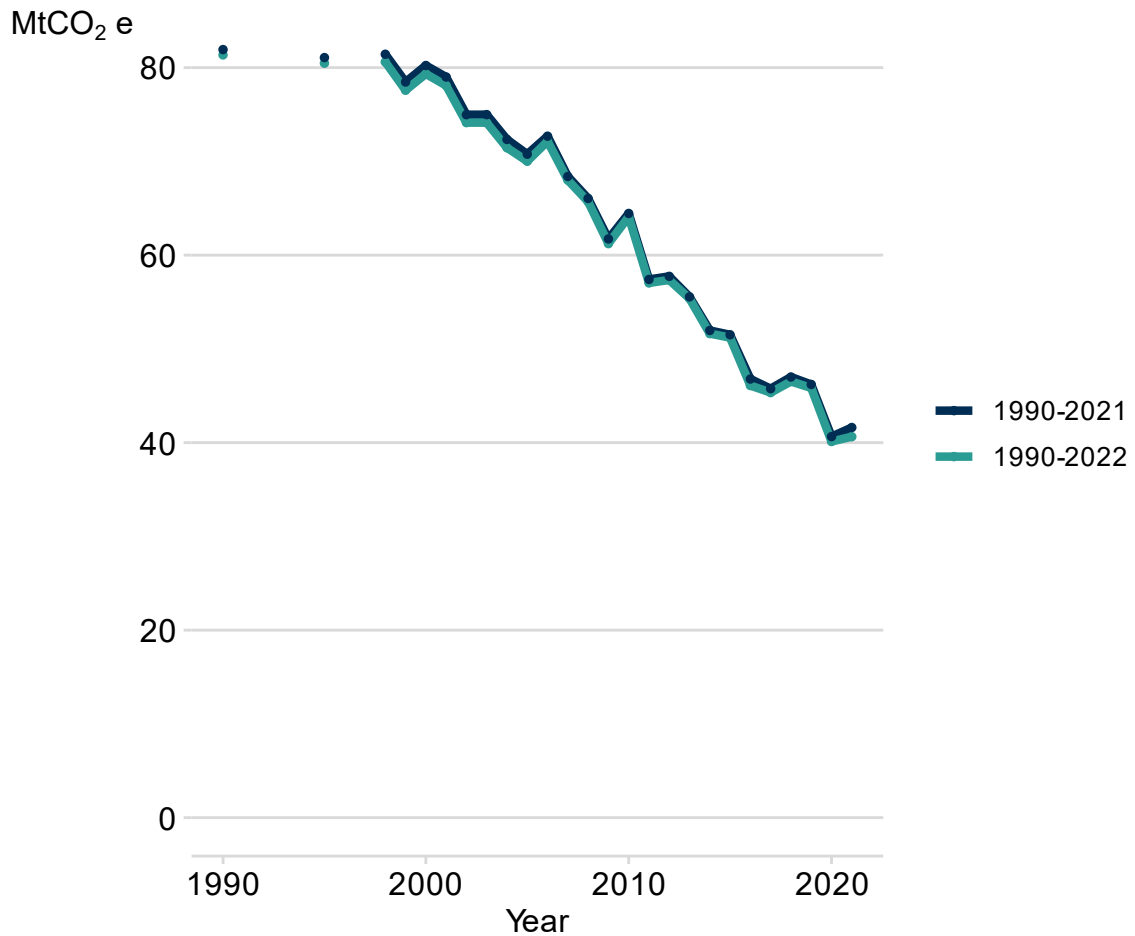


Chart 15 shows revisions to the baseline period, between the two most recent inventories.

Chart 15. Revisions to emissions in 1990, from the 1990-2021 inventory to the 1990-2022 inventory, by Territorial Emissions Statistics Sector.

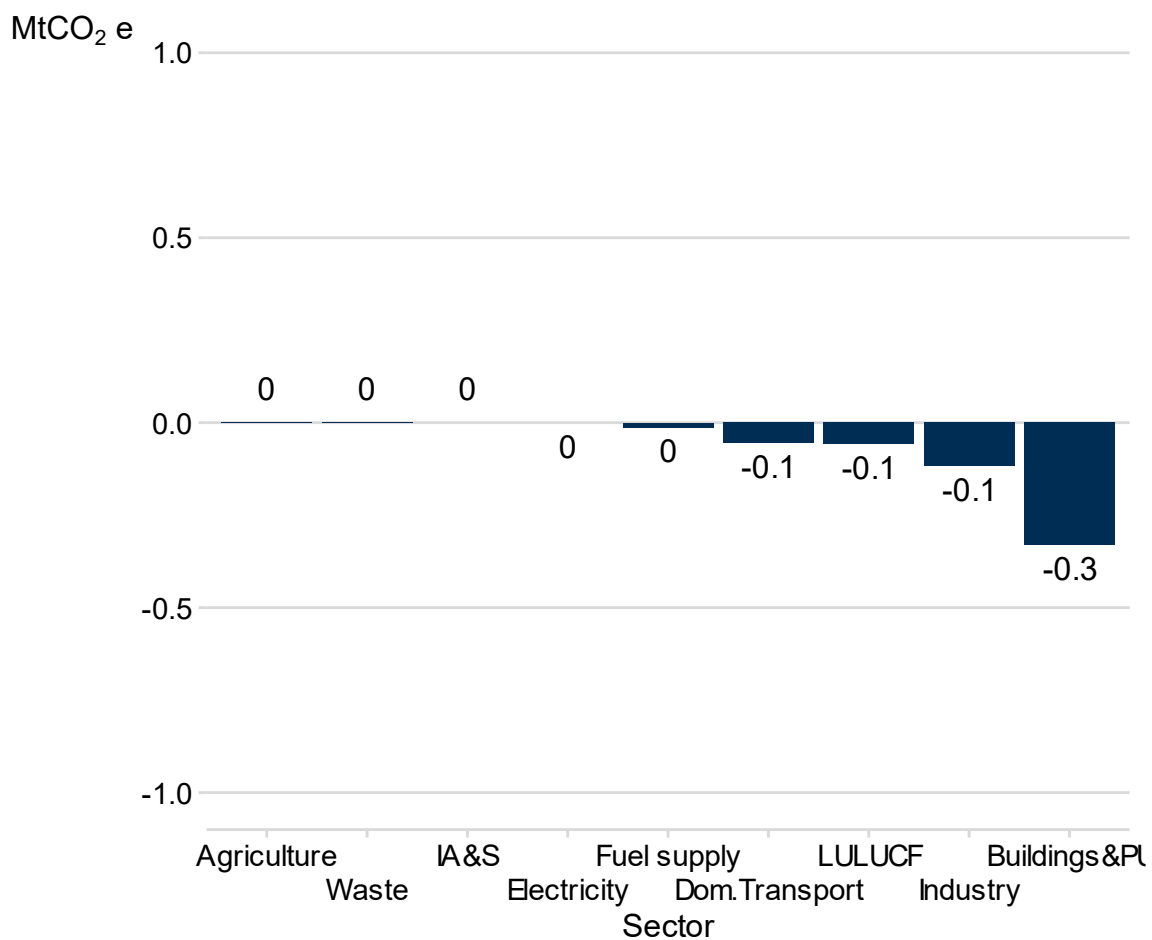
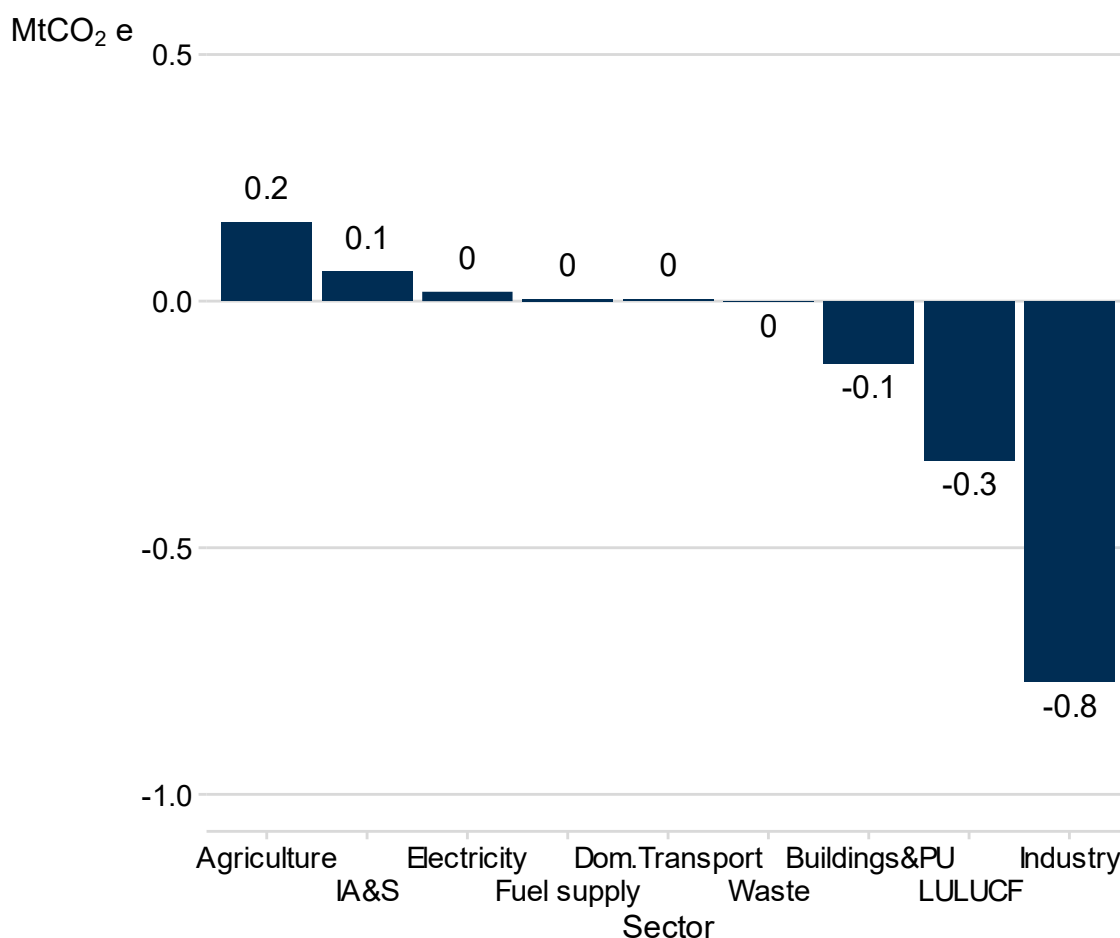


Chart 16 shows revisions to the data for the year 2021, between the two most recent inventories.

Chart 16. Revisions to emissions in 2021, from the 1990-2021 inventory to the 1990-2022 inventory, by Territorial Emissions Statistics Sector.



Details of Main Revisions and Interpretation of Revisions to the Inventory

Revisions to emission inventory estimates reflect the continuous development of scientific understanding of emissive processes, and the improvement to underlying data and methods to generate accurate emission estimates; few revisions to the Greenhouse Gas Inventories arise as a result of 'errors' in the popular sense of the word. The compilation of the inventory is governed by a rigorous quality assurance process and is subject to a great deal of third party scrutiny, such as annual reviews by the UNFCCC of the UK inventory.

The latest published Scotland greenhouse gas inventory (currently 1990-2022) represents the best available data at the time and these supersede any previous data, which should be disregarded.

A complete list of the revisions between the previous and latest inventories can be found in the National Atmospheric Emissions Inventory report Greenhouse Gas

Inventories for England, Scotland, Wales and Northern Ireland: 1990 - 2022. Details of the most notable revisions are listed below:

- **Agriculture**
 - The most significant recalculations for stationary combustion in agriculture are from burning oil combustion which are due to revisions in the UK inventory. This relates to an improvement in the resolution of oil combustion data which now differentiate the sector using these fuels.
- **Buildings and product uses**
 - Revisions to natural gas combustion due to:
 - Revisions due to the incorporation of the new data which relate to actual gas consumption rather than weather corrected data.
 - Revisions to the Digest of UK Energy Statistics (DUKES) for the later portion of the timeseries and to incorporate point source data into methodology.
 - The most significant recalculations are from the combustion of burning oil, gas oil and coal, with the latter two only impacting the later portion of the timeseries and mainly affect commercial combustion.
- **Domestic Transport**
 - Recalculations to road transport from revisions to the activity data and a more appropriate fuel consumption split between hot and cold-start emissions. In addition there have been revisions to the Non-Road Mobile Machinery data which now differentiate between vehicle types.
- **Electricity supply**
 - Recalculations are primarily due to revisions to DUKES data in 2020 and 2021.
- **Fuel supply**
 - Recalculations are primarily due to revisions to DUKES data in later years and also small recalculations across the timeseries due to a revision to the model used to split emissions from abandoned coal mines to UK Nations.
- **Industry**
 - Revisions to Non-Road Mobile Machinery which now differentiate between vehicle types.
 - Most significant recalculations from gas combustion in industry.
 - Recalculations between 2016-2021 from a revision to DUKES.
 - Revisions due to the incorporation of the new data which relate to actual gas consumption rather than weather corrected data.

- The most significant recalculations are from the combustion of burning oil, gas oil and coal, with the latter two only impacting the later portion of the timeseries.
- **LULUCF**
 - The largest recalculations for forest land were the inclusion of new data to the forest land carbon stock change soil model and inclusion of urban trees across the whole timeseries.
 - For grassland, there were minor changes to peatland restoration areas in Scotland from Peatland Action including the addition of restoration areas for domestic peat extraction.
- **Waste**
 - Recalculation to landfill emissions in 2021 in Scotland due to adjustment in landfill gas data regional statistics.
 - For composting there was a revision to the composting data timeline provided by UK Centre for Ecology & Hydrology affecting the national inventory.

Interpretation of uncertainties in the inventory

All estimates, by definition, are subject to a degree of statistical 'error' but in this context it relates to the uncertainty inherent in any process or calculation that uses sampling, estimation or modelling.

Estimates of greenhouse gases are compiled by a consortium of contractors. The source emissions are based upon a range of data sources, ranging from model based estimates to point source emission data. As a result, the estimates are subject to a degree of uncertainty. Full analyses of these uncertainties are provided on the National Atmospheric Emissions Inventory website⁵.

The Scottish Government previously commissioned research to overhaul and update the uncertainties model used for the Scottish greenhouse gas inventory. A detailed study was carried out in parallel with the compilation with the 1990-2014 Scottish greenhouse gas inventory to review and improve the uncertainty calculations. A link to this project and to the full report can be found in the [Scottish Greenhouse Gas Inventory Uncertainties Project](#).

⁵ Report: UK Greenhouse Gas Inventory, 1990 to 2021: Annual Report for submission under the Framework Convention on Climate Change - NAEI, UK (beis.gov.uk)

Section E. Exclusions, Glossary and Acknowledgements

Why are some greenhouse gas emissions not considered in this statistics release?

The methods used to compile the Scottish Greenhouse Gas Inventory are consistent with international reporting and are therefore comparable to the greenhouse gas emission estimates reported by all other EU Member States and other Annex 1 parties⁶ to the UNFCCC. All countries estimate and submit their greenhouse gas inventory estimates to be consistent with methods set out in international guidance for national inventory methods from the Intergovernmental Panel on Climate Change (IPCC), known as the IPCC (2006) guidelines. The IPCC (2006) guidelines state that national inventories should report on all anthropogenic (human) emissions and removals of greenhouse gas emissions, as a result of human activities within a country's territorial sphere.

However, there are some emissions and removals of carbon dioxide that occur as a result of short-cycle biogenic processes. This biocarbon has only recently been abstracted from the atmosphere before it is then re-released as carbon dioxide. In accordance with the IPCC (2006) guidelines, these emissions and sinks are therefore excluded from the greenhouse gas inventory, as they could lead to double counting. If countries do choose to estimate these biocarbon emissions, they are reported *outside of the national inventory total*, as a memo item to that country's submission to the UNFCCC. This means that some sources and sinks of greenhouse gases are not included in the Scottish and UK inventory totals.

Examples of reasons for why some sources and sinks of greenhouse gases are not included in the greenhouse gas inventory

1. Due to short-cycle biocarbon (carbon only been recently abstracted from the atmosphere)

- **Carbon dioxide (CO₂) emissions from biomass combustion.** For example, this includes CO₂ emissions from biomass power stations
- **Process emissions in food and drink production.** These include CO₂ emissions from brewing, fermenting and malting and in the production of food.
- **CO₂ emissions from biodegradable waste to landfill.** Emissions are not estimated where they arise from biogenic sources of waste such as food. Fossil-derived organic matter (such as plastic) is assumed to be non-biodegradable and there are no emissions associated with its decomposition.

⁶ Annex 1 countries are required to submit information on their national greenhouse gas inventories annually to the UNFCCC.

However, methane (CH₄) emissions from biodegradable waste sent to landfill are considered in these greenhouse gas statistics as they are formed by the anaerobic (oxygen-free) decay of organic matter in solid waste disposal sites.

2. Where there has been no anthropogenic influence

- **Natural accumulation and storage of carbon in peatland.** For emissions or removals of peatland to be considered for IPCC reporting, they require humans to alter the peatland – either through wetland drainage, rewetting, peatland extraction or through another land use change. The UK and Scotland has elected to include the IPCC (2006) Wetlands Supplement as part of their inventory reporting from the 1990-2019 vintage of the inventory: <http://www.ipcc-nggip.iges.or.jp/home/wetlands.html>

3. Beyond the territorial definitions as prescribed by the IPCC (2006) reporting requirements

- **“Blue carbon”.** Blue carbon refers to the carbon captured by the world's oceans and coastal ecosystems. The carbon captured by living organisms in oceans is stored in the form of biomass and sediments from mangroves, salt marshes and seagrasses. However, it should be noted that research is underway to being to develop estimates of the environmental changes resulting from changes to coastal wetlands environments.

Glossary

Adjusted emissions

See GHG Account

Afforestation

The act or process of establishing a forest on land that has not been forested in recent history.

Baseline Period

Emissions reduction is based on a Baseline Period. For the greenhouse gases CO₂, CH₄ and N₂O, 1990 was specified as the baseline. 1995 is the baseline for emissions of the F-gases.

Carbon dioxide (CO₂)

Carbon dioxide is one of the main gases responsible for climate change. It is mostly emitted through the oxidation of carbon in fossil fuels, e.g. burning coal.

Carbon sink

A carbon sink is a natural or artificial reservoir that accumulates and stores CO₂ for an indefinite period.

Climate change

Climate change is a long-term change in the earth's climate. This can be accelerated by human activity, e.g. by releasing CO₂ into the atmosphere.

Deforestation

The removal of forest stands by cutting and burning to provide land for agricultural purposes, residential or industrial building sites, roads, etc., or the harvesting of trees for building materials or fuel.

Fluorinated gases (F-gases)

F-gases are the generic name given to HFCs, PFCs, SF₆ and NF₃. These have been used as replacements for CFCs, which are ozone depleting substances that have been banned under the Montreal Protocol. They have very high global warming potentials.

Greenhouse effect

The greenhouse effect is the process by which heat from the sun is trapped within the Earth's atmosphere by greenhouse gases. This process is also known as radiative forcing.

GHG Account

The Climate Change Committee (CCC) recommended a new method of adjusting emissions for the purposes of reporting against targets in this, and future, publications. This adjustment acts to remove the impact of revisions to the historical time-series. This is known as the GHG Account and the calculation is detailed in section C.

Greenhouse gas

A greenhouse gas is a gas which absorbs infrared radiation emitted from the surface of the Earth, helping to retain a portion of that energy in the atmosphere as heat.

Global warming potential (GWP)

GWP is a measure of how much a greenhouse gas is estimated to contribute to global warming. It is a relative scale which compares the potency of each gas to CO₂.

Hydrofluorocarbons (HFCs)

HFCs are produced commercially as a substitute for chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). HFCs are largely used in refrigeration and insulating foam. Their Global Warming Potentials range from 4 to 12,400 times that of CO₂, depending on the gas type.

Inventory

The inventory contains greenhouse gas emissions estimates for Scotland and the UK. The Inventory is a disaggregation of the UK Inventory, which is based on five major sectors: energy, industrial processes, agriculture, land-use, land-use change and forestry, and waste.

IPCC

The Intergovernmental Panel on Climate Change (IPCC) assesses the scientific, technical and socio-economic information relevant for the understanding of the risk

of human-induced climate change. They provide advice to the UNFCCC on the scientific evidence and developments which are used to inform National Inventories.

LULUCF

Estimates of emissions and removals from land use, land use change and forestry (LULUCF) depend critically on assumptions made on the rate of loss or gain of carbon in Scotland's carbon rich soils. In Scotland, LULUCF activities, taken as a whole, acts as a slight source in recent years although acted as a net sink between 2009-2017, absorbing more greenhouse gas emissions than it releases.

Methane (CH₄)

Methane is a greenhouse gas that is around 28 times more potent in the atmosphere than CO₂ over a 100-year time horizon. Main sources include agriculture and landfill.

National Communication (NC) Sectors

The UK NC sectors are agreed groupings of the more detailed sectors reported to the United Nations Framework Convention on Climate Change by the UK. This report no longer uses NC sectors.

Nitrogen trifluoride (NF₃)

Nitrogen trifluoride is a greenhouse gas that is around 16,100 times more potent in the atmosphere than CO₂ over a 100-year time horizon. The main source of nitrogen trifluoride is in the making of semiconductors.

Nitrous oxide (N₂O)

Nitrous oxide is a greenhouse gas that is around 265 times more potent in the atmosphere than CO₂ over a 100-year time horizon. The main source is agricultural soil.

Other Petroleum Gas (OPG)

This consists mainly of ethane plus some other hydrocarbons, excluding butane and propane.

Perfluorocarbons (PFCs)

PFCs are a by-product of aluminium smelting. They are also the replacement for CFCs in manufacturing semiconductors. The Global Warming Potentials of PFCs ranges from 6,630 – 11,100 times that of CO₂ over a 100-year time horizon.

Radiative forcing

An externally imposed perturbation in the radiative energy budget of the Earth's atmosphere. Such a perturbation can be brought about by changes in the concentrations of radiatively active species (e.g. greenhouse gases), changes in the solar irradiance incident upon the planet, or other changes that affect the radiative energy absorbed by the surface (e.g. changes in surface reflection properties).

Sequestration

The process by which carbon sinks remove carbon dioxide (CO₂) from the atmosphere.

Source (UNFCCC definition)

Any process or activity which releases a greenhouse gas or a precursor greenhouse gas to the atmosphere.

Sulphur hexafluoride (SF₆)

It is largely used in heavy industry to insulate high-voltage equipment and to assist in the manufacturing of cable-cooling systems. Its global warming potential is 23,500 times that of CO₂ over a 100-year time horizon.

UNFCCC

In 1992, the UNFCCC was adopted as the basis for a global response to climate change. The ultimate objective of the Convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system.

Acknowledgements

We would like to thank our contractors, Ricardo, in consortium with Aether, Rothamsted Research and the Centre for Ecology & Hydrology for their invaluable support in compiling and improving the Scottish greenhouse gas inventory every year. Links to the Devolved Administrations inventories for each year can be found here: [Devolved Administrations - Greenhouse Gas Reports - NAEI, UK \(beis.gov.uk\)](#)

Annex A: Information required for reporting under sections 33 and 34 of the Climate Change (Scotland) Act 2009.

Introduction

The following sections summarise, using data from the main sections of this statistics bulletin and other sources, the information required under the requirements of sections 33 and 34 of the Climate Change (Scotland) Act 2009. For ease, the information is interspersed with the wording of the requirements themselves.

Under section 33

Subsection 2 requires the report must state—

(a) the emissions reduction target for the target year

The emissions reduction target for 2022 is a 53.8% reduction from the baseline.

(b) whether the emissions reduction target for the target year has been met

The target has not been met.

(c) the percentage by which the net Scottish emissions account for the target year is lower than the baseline,

For the purpose of assessing progress to the 2022 target (on the basis of the 1990-2022 inventory), the net Scottish emissions account was 50.0% lower in 2022 than the baseline.

(d) the amount by which the net Scottish emissions account for the target year is lower or higher than the emissions reduction target for that year

The net Scottish emissions account for 2022 was 3.2 million tonnes of carbon dioxide equivalent (MtCO_{2e}) higher than the target for that year.

(e) the cumulative amount by which the net Scottish emissions accounts are lower or higher than the corresponding emissions reduction targets, calculated by adding each amount by which an account is lower or higher than the corresponding target for each year in the period beginning with 2018 and ending with the target year.

The cumulative amount by which the net Scottish emissions accounts over the period from 2018 to the current target year (2022) was 7.8 MtCO_{2e} higher than the targets for those years.

Subsection 3 requires the report must specify the methods used to determine each figure and amount in subsection 2 in accordance with the most up-to-date advice provided by the relevant body (the UK Climate Change Committee) on the methods to be used for that purpose:

The figure in subsection 2(c) above has been derived using an identical calculation to that recommended by the Climate Change Committee (CCC) in their advice on the future measurement and accounting of emissions against Scotland’s climate change targets⁷. This calculation is shown below, using the 1990-2020 inventory as the reference inventory, and adjusting for cumulative revisions subsequently introduced in the 1990-2021 and 1990-2022 inventories:

Year	Baseline Period (1)	2020	2021	2022
Inventory data				
A. Base Inventory source emissions data (June 2022 data (1990-2020)) (3)	83.0	40.6	N/A	N/A
B. June 2023 source emissions data (1990-2021 inventory)	82.0	40.6	41.6	N/A
C. June 2024 source emissions data (1990-2022 inventory)	81.4	40.1	40.6	40.6
Revisions between inventories (2)				
between A and B	-1.0	0.1	0.1	0.1
between B and C	-0.6	-0.5	-1.0	-1.0
Combined revision	-1.6	-0.4	-0.9	-0.9
GHG Account (latest inventory, less combined revision)	83.0	40.6	41.5	41.5
GHG Account figures, expressed as a percentage reduction from the baseline period.	0.0%		-49.9%	-50.0%

1. The Baseline period uses a 1995 base-year for F-Gas emissions, and 1990 for all other greenhouse gases.

⁷ [Letter from Lord Deben to Roseanna Cunningham MSP advising on Scottish climate target framework - Climate Change Committee \(theccc.org.uk\)](https://theccc.org.uk)

2. Where data do not exist for a particular year, revisions are carried over from the previous complete year (see shaded cells)
3. Values for the base inventory use updated global warming potentials as shown in chart D4 in the June 2022 publication. In line with international carbon reporting practice, the GWPs used in the 2024 inventory are consistent with the IPCC 5th Assessment Report (AR5 without climate feedback effects). This change has resulted in methane moving from a GWP multiplier of 25 to 28, and nitrous oxide reducing from 298 to 265. Other changes to individual isotopes of fluorinated gases have also been made.
4. Totals may not exactly equal the sum of components due to rounding.
5. The GHG Account for 2020 is shown in Scottish Greenhouse Gas Statistics 2020 published in June 2022

Under section 34

All of the information under this section is reported on the basis of the most up to date available greenhouse gas inventory methods, i.e. the 1990 – 2022 inventory.

Subsection 1 requires the report must state — (a) in relation to net Scottish emissions of greenhouse gases—

(i) the baseline,

The Baseline period uses a 1995 base-year for F-Gas emissions, and 1990 for all other greenhouse gases. In the 1990-2022 inventory the baseline amount of emissions was 81.4 MtCO_{2e}.

(ii) the aggregate amount of net Scottish emissions of greenhouse gases for the year covered by the report,

On the basis of the 1990-2021 inventory, net Scottish emissions in 2022 were 40.6 MtCO_{2e}.

(iii) the percentage by which the aggregate amount of net Scottish emissions of greenhouse gases for the year covered by the report is lower than the baseline,

On the basis of the 1990-2022 inventory, net Scottish emissions in 2022 were 50.1 % lower than the baseline.

(iv) the percentage by which the aggregate amount of net Scottish emissions of greenhouse gases for the year covered by the report is lower or higher than the equivalent amount for the immediately preceding year, and

On the basis of the 1990-2022 inventory, net Scottish emissions in 2022 were 0.1% lower than in 2021.

(v) the methods used to determine the aggregate amount of net Scottish emissions of greenhouse gases, together with details of any changes to those methods,

The aggregate amount of net Scottish emissions set out above has been determined from regional disaggregation of the UK Greenhouse Gas Inventory. Full details of the methodology used in the UK Inventory, together with further breakdowns, are provided in the National Inventory Report⁸ submitted annually by the UK Government to the United Nations Framework Convention on Climate Change (UNFCCC). This latest release includes the following revisions to previous calculations:

Agriculture

The most significant recalculations for stationary combustion in agriculture are from burning oil combustion which are due to revisions in the UK inventory. This relates to an improvement in the resolution of oil combustion data which now differentiate the sector using these fuels.

Buildings and product uses

Revisions to natural gas combustion due to:

incorporation of the new data which relate to actual gas consumption rather than weather corrected data.

Revisions to the Digest of UK Energy Statistics (DUKES) for the later portion of the timeseries and to incorporate point source data into methodology.

The most significant recalculations are from the combustion of burning oil, gas oil and coal, with the latter two only impacting the later portion of the timeseries and mainly affect commercial combustion.

Domestic Transport

Recalculations to road transport from revisions to the activity data and a more appropriate fuel consumption split between hot and cold-start emissions. In addition there have been revisions to the Non-Road Mobile Machinery data which now differentiate between vehicle types.

Electricity supply

⁸ https://uk-air.defra.gov.uk/reports/cat09/2304171441_ukghqi-90-21_Main_Issue1.pdf

Recalculations are primarily due to revisions to DUKES data in 2020 and 2021.

Fuel supply

Recalculations are primarily due to revisions to DUKES data in later years and also small recalculations across the timeseries due to a revision to the model used to split emissions from abandoned coal mines to UK Nations.

Industry

Revisions to Non-Road Mobile Machinery which now differentiate between vehicle types.

Most significant recalculations from gas combustion in industry.

Recalculations between 2016-2021 from a revision to DUKES.

Revisions due to the incorporation of the new data which relate to actual gas consumption rather than weather corrected data.

The most significant recalculations are from the combustion of burning oil, gas oil and coal, with the latter two only impacting the later portion of the timeseries.

LULUCF

The largest recalculations for forest land were the inclusion of new data to the forest land carbon stock change soil model and inclusion of urban trees across the whole timeseries.

For grassland, there were minor changes to peatland restoration areas in Scotland from Peatland Action including the addition of restoration areas for domestic peat extraction.

Waste

Recalculation to landfill emissions in 2021 in Scotland due to adjustment in landfill gas data regional statistics.

For composting there was a revision to the compositing data timeline provided by UK Centre for Ecology & Hydrology affecting the national inventory

(b) in relation to the net Scottish emissions account—

(i) its amount for the year covered by the report,

In 2022, the net Scottish emissions account was 40.6 MtCO₂e.

(ii) the percentage by which the account for the year covered by the report is lower than the baseline,

On the basis of the 1990-2022 inventory, the net Scottish emissions account in 2022 was 50.1 % lower than the baseline.

(iii) the percentage by which the account for the year covered by the report is lower or higher than the equivalent account for the immediately preceding year.

On the basis of the 1990-2022 inventory, the net Scottish emissions account in 2022 was 0.1 % lower than in 2021.

(iv) the percentage of any reduction in the account for the year covered by the report, relative to the equivalent account for the immediately preceding year, which is accounted for by reductions in net Scottish emissions of greenhouse gases,

All (100%) of the reduction in the net Scottish emissions account between 2021 and 2022 was accounted for by changes in net Scottish emissions of greenhouse gases.

(c) the total amount of carbon units that were—

(i) credited to or debited from the net Scottish emissions account for the year covered by the report,

No carbon units were credited or debited to the net Scottish emissions account for 2022.

(ii) purchased by the Scottish Ministers in the year covered by the report, and

No carbon units were purchased by Scottish Ministers in 2022.

(iii) held by the Scottish Ministers immediately after the end of the year covered by the report and which remained available to offset greenhouse gas emissions for other target years,

No carbon units were held by Scottish Ministers immediately after the end of 2022.

(d) for each target year preceding the year covered by the report—

(i) the aggregate amount of net Scottish emissions of greenhouse gases.

Year	2010	2011	2012	2013	2014	2015
Net GHG emissions (MtCO ₂ e)	64.1	57.0	57.4	55.4	51.6	51.2
Year	2016	2017	2018	2019	2020	2021
Net GHG emissions (MtCO ₂ e)	46.1	45.3	46.5	45.8	40.1	40.6

(ii) the amount of the net Scottish emissions account *

Year	2010	2011	2012	2013	2014	2015
Net Scottish Emissions Account (MtCO ₂ e)	64.4*	61.6*	61.8*	54.1*	48.8*	50.6*
Year	2016	2017	2018	2019	2020	2021
Net Scottish Emissions Account (MtCO ₂ e)	51.4*	53.3*	46.5	45.8	40.1	40.6

* The figures set out here for the net Scottish emissions account for the years 2010 to 2017 are consistent with the approach used in previous statutory annual target reports and are on the basis of Scottish emissions adjusted for the operation of the EU Emissions Trading System (EU ETS). The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 has subsequently altered the emissions accounting basis for assessing progress to targets from 2018 onwards, to remove that adjustment. As such, these earlier figures are not directly comparable to those in other columns of the table or other sections of the report.

(e) the fair and safe Scottish emissions budget, and the aggregate amount of net Scottish emissions of greenhouse gases for the period from 2010 to the end of the year covered by the report.

The fair and safe Scottish emissions budget for emissions over the period 2010 to 2050⁹ is 1,028 MtCO₂e. The total amount of net Scottish emissions of greenhouse gases over the period from 2010 to 2022 is 641.8 MtCO₂e.

⁹ The level of fair and safe Scottish emissions budget is determined directly from the advice of the UK Committee on Climate Change. The Committee's most recent advice on this matter was provided in December 2022: [Scottish Emission Targets & Progress in reducing emissions in Scotland – 2022 Report to Parliament - Climate Change Committee \(theccc.org.uk\)](https://www.theccc.org.uk/reports/2022/scottish-emission-targets-and-progress-in-reducing-emissions-in-scotland-2022-report-to-parliament-climate-change-committee/)

Subsection 3 requires that, if the methods used to determine net Scottish emissions of greenhouse gases change and that change is such as to require adjustment of an amount for an earlier target year, the report must —

(3)

(a) specify the adjustment required and state the adjusted amount, and (b) explain why the adjustment is required.

The latest greenhouse gas inventory (1990-2022) contains some relatively minor revisions to previous estimates of emissions, these mainly relate to revisions to energy data and availability of more detailed data on the use of fuel oil. These revisions are listed in more detail in section 34 (v).

The combined impact of these changes has resulted in the previously published value for emissions in 2021 being decreased by 1.0 MtCO_{2e} to the revised level of 40.6 MtCO_{2e}.

Annex B: Scottish greenhouse gas emissions using categories presented in Scotland's climate change plan.

The Scottish Government's Climate Change Plan was published in February 2018 presenting a strategy to reduce emissions over the period to 2032. The modelling activity supporting this plan used a modified version of the sectoral categories used in the Scottish Greenhouse Gas Emissions publication. The following table presents the latest Scottish emissions data using these alternative categories.

Annex B: Table 1. Scottish GHG emissions using Climate Change Plan emissions categories, All values shown in MtCO_{2e}.

CCP Sector	BaseYear	2021	2022	2021-2022		BaseYear-2022	
				% Change	Change	% Change	Change
Agriculture	8.8	8.0	7.7	-3.2%	-0.3	-11.9%	-1.0
Electricity Generation	14.7	1.6	1.7	10.8%	0.2	-88.1%	-13.0
Industry	19.3	8.8	8.8	-0.6%	-0.1	-54.5%	-10.5
LULUCF	6.0	0.0	0.2	513.5%	0.2	-96.3%	-5.8
Buildings	11.3	8.9	7.7	-13.5%	-1.2	-31.9%	-3.6
Transport	14.8	11.8	12.9	9.1%	1.1	-13.3%	-2.0
Waste Management	6.5	1.5	1.6	2.9%	0.0	-75.6%	-4.9
Net emissions	81.4	40.6	40.6	-0.1%	0.0	-50.1%	-40.8

Annex C: Scottish greenhouse gas emissions using older “national communications” categories.

Annex C: Table 1. Scottish GHG emissions using National Communications categories, All values shown in MtCO_{2e}.

NC Category	1990	2021	2022	2021-2022		1990-2022	
				% Change	Change	% Change	Change
Agriculture	8.8	8.0	7.7	-3.2%	-0.3	-11.9%	-1.0
Business	11.7	7.0	6.7	-3.5%	-0.2	-42.5%	-5.0
Energy Supply	21.7	4.9	5.1	5.0%	0.2	-76.4%	-16.5
International Aviation and shipping (exports)	1.3	0.8	1.5	98.4%	0.7	13.4%	0.2
Industrial processes	1.9	0.4	0.4	-3.3%	0.0	-77.2%	-1.4
Land use, land use change and forestry	6.0	0.0	0.2	513.5%	0.2	-96.3%	-5.8
Public	2.1	1.1	1.0	-8.8%	-0.1	-54.0%	-1.1
Residential	8.0	6.0	5.0	-16.3%	-1.0	-37.5%	-3.0
Transport	13.5	11.0	11.4	3.0%	0.3	-15.9%	-2.1
Waste Management	6.5	1.5	1.6	2.9%	0.0	-75.6%	-4.9
Net emissions	81.4	40.6	40.6	-0.1%	0.0	-50.1%	-40.8

An Official Statistics publication for Scotland

Official and National Statistics are produced to high professional standards set out in the Code of Practice for Official Statistics. Both undergo regular quality assurance reviews to ensure that they meet customer needs and are produced free from any political interference.

Correspondence and enquiries

For enquiries about this publication please contact:

Andrew Mortimer
Climate Change Statistics
Energy and Climate Change Analytical Unit
Office of the Chief Economic Adviser
Scottish Government
e-mail: ccstatsmodelling@gov.scot

For general enquiries about Scottish Government statistics please contact:

Office of the Chief Statistician,
e-mail: statistics.enquiries@gov.scot

How to access background or source data

Background data are available from National Atmospheric Emissions Inventory website and from a separate Excel workbook accompanying this publication

Complaints and suggestions

If you are not satisfied with our service or have any comments or suggestions, please write to the Chief Statistician, 3WR, St Andrews House, Edinburgh, EH1 3DG, e-mail statistics.enquiries@gov.scot.

If you would like to be consulted about statistical collections or receive notification of publications, please register your interest at www.gov.scot/scotstat

Details of forthcoming publications can be found at:

<https://www.gov.scot/publications/official-statistics-forthcoming-publications/>

Crown Copyright

You may use or re-use this information (not including logos) free of charge in any format or medium, under the terms of the Open Government Licence. See:

www.nationalarchives.gov.uk/doc/open-government-licence/