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10 June 2025

Dear Edward,

2023 Scottish Greenhouse Gas Statistics

A report has been laid in Parliament today in regard to the 2023 Scottish Greenhouse Gas (GHG) Statistics and emissions reduction, under section 34A of the Climate Change (Scotland) Act 2009.

The official statistics show that Scottish emissions in 2023 have reduced by 51.3 per cent since the 1990 baseline. This is a reduction of 1.9 per cent on our position in 2022. This confirms we are over halfway on our journey to net zero.

There was a very large reduction in emissions in the electricity generation sector, with a large reduction in gas-fired electricity generation being principally responsible for this drop. More modest but still important reductions were seen in Fuel Supply, Buildings & Product Uses, Domestic Transport, Industry and Waste.

The statement to Parliament on this report, due to be made on 12 June, will recognise the progress made in Scotland during 2023 and the continued positive action we continue to commit to, in order to achieve net zero by 2045. The upcoming Climate Change Plan will outline policies and proposals for the plan period of 2026 to 2040; engagement with Parliament on delivering the next climate change plan, will continue.

I hope this update is helpful.

Yours sincerely,

GILLIAN MARTIN

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An Official Statistics publication for Scotland

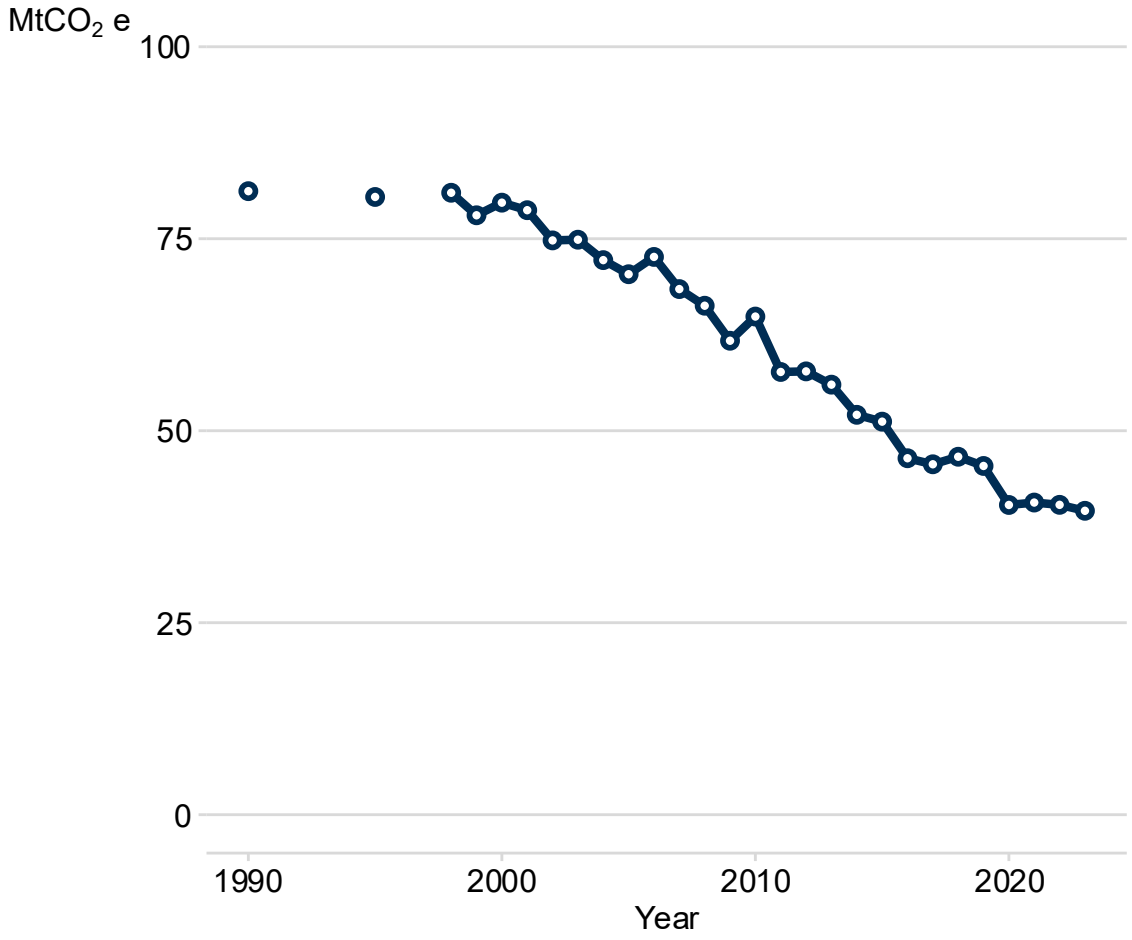
Agriculture, Environment and Marine

Scottish Greenhouse Gas Statistics 2023

In 2023, Scottish net emissions of the basket of seven greenhouse gases were estimated to be 39.6 million tonnes carbon dioxide equivalent ($MtCO_2e$). Emissions reduced by 0.8 MtCO2e compared to 2022; a 1.9 per cent reduction.

- **39.6 MtCO2e in 2023**
- **Down 51.3% from 1990**
- **Down 1.9% from 2022**

Chart 1: Scottish Greenhouse Gas Emissions, 1990 to 2023.



There was a very large reduction in emissions in the electricity generation sector of 0.8 MtCO2e in 2023, with a large reduction in gas-fired electricity generation being principally responsible for this drop. More modest reductions were seen in Fuel Supply (-0.4 $MtCO_2e$); and Buildings & Product Uses, Domestic Transport, Industry and waste; which all reduced emissions by 0.1 $MtCO_2e$ when compared to 2022.

Agriculture emissions were essentially unchanged between 2022 and 2023, falling very slightly by 0.1 per cent.

However, the above reductions were offset partially by increased emissions in international aviation and shipping (+0.3 $MtCO_2e$) effectively returning to their pre-COVID levels; and 'Land Use, Land Use Change And Forestry' (LULUCF) increasing by 0.6 $MtCO_2e$ in the latest year due to a reduction in the forestry sink as a result of historical planting reaching maturity.

Between 1990 and 2023, there was a 51.3 per cent reduction in estimated net emissions, a 41.6 $MtCO_2e$ 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) (-13.8 $MtCO_2e$; 93.4 per cent reduction)
- Industrial emissions fell 7.5 $MtCO_2e$ (59.5 per cent reduction)
- 'Land Use, Land Use Change And Forestry' (LULUCF) reducing its net emissions over the period, reducing by 5.5 $MtCO_2e$ since 1990.
- Reduction in Waste Management emissions (such as Landfill) (-4.6 $MtCO_2e$; a 73.1 per cent reduction)
- Reduction in Fuel supply emissions (-3.7 $MtCO_2e$; a 55.9 per cent reduction). Reduction in Buildings and product use emissions (-3.4 $MtCO_2e$; a 31.0 per cent reduction)
- Domestic transport fell by 2.4 $MtCO_2e$ (a 17.3 per cent reduction)
- Agricultural emissions fell by 1.1 $MtCO_2e$ (an 13.0 per cent reduction)

International aviation and shipping emissions increased by 0.4 $MtCO_2e$

More details can be found in Section B.

$MtCO_2e$ 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.

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 2022 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.

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Section A. Introduction to Greenhouse Gases

Purpose of this Publication

The “Scottish Greenhouse Gas Emissions 2023” Official Statistics publication contains the results of the Scottish Greenhouse Gas Inventory for 1990-2023. 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).

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- SF_6 and nitrogen trifluoride- NF_3). 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, 2023

Name of Greenhouse Gas		Global Warming Potential (GWP) (Conversion factor to carbon dioxide equivalent)	Contribution to Scotland's Net Greenhouse Gas Emissions, 2023 (in $MtCO_2e$)	Percentage of Scotland's Net Greenhouse Gas Emissions, 2023 (in $MtCO_2e$)
Carbon dioxide	CO_2	1	25.7	65.0%
Methane	CH_4	28	10.3	26.0%
Nitrous oxide	N_2O	265	2.9	7.4%
F-gases [2], of which….			0.6	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			39.6	100.0%

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

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 has traditionally been 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.

[1] Fifth Assessment Report — IPCC

The Baseline Period for reporting against Climate Change Targets is:

- 1990 for carbon dioxide carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O)
- 1995 for Fluorinated gases (F gases)[2]: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), nitrogen trifluoride (NF_3)

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 2023.

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 1990-2023. It uses the 'Territorial Emissions Statistics' sectors, which are the same categories now used for the UK report. For the purposes of reporting, greenhouse gas emissions are allocated into categories as follows:

- **Electricity Supply** – Includes emissions from power stations.
- **Fuel Supply** – Includes emissions from fuel production and fuel supply activities such as mining, refining, manufacturing, and distributing fuels.
- **Domestic Transport** – Includes all emissions from domestic vehicles, including domestic air and marine travel.
- **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.
- **Waste** – Includes all emissions in the Waste Management sector. Additionally; Includes emissions from accidental fires and includes emissions from household composting, and small-scale waste burning.

[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.

- **Agriculture** – Covers all agricultural practices, excluding the land on which agriculture is conducted.
- **Land Use, Land Use Change and Forestry (LULUCF)** – Includes emissions and removals of CO2 from changes in the carbon stock in forestland, cropland, grassland, wetlands, settlements and harvested wood products, and emissions of other greenhouse gases from drainage (excl. croplands and intensive grasslands) and rewetting of soils, nitrogen mineralisation associated with loss and gain of soil organic matter, and fires. As impacts of carbon stock changes are included in this sector, CO2 emissions of biogenic origin (e.g. burning biomass for energy) are excluded from other sectors to avoid double counting.
- **International Aviation and Shipping (IA&S)** – includes emissions associated with out-bound journeys to avoid double counting.

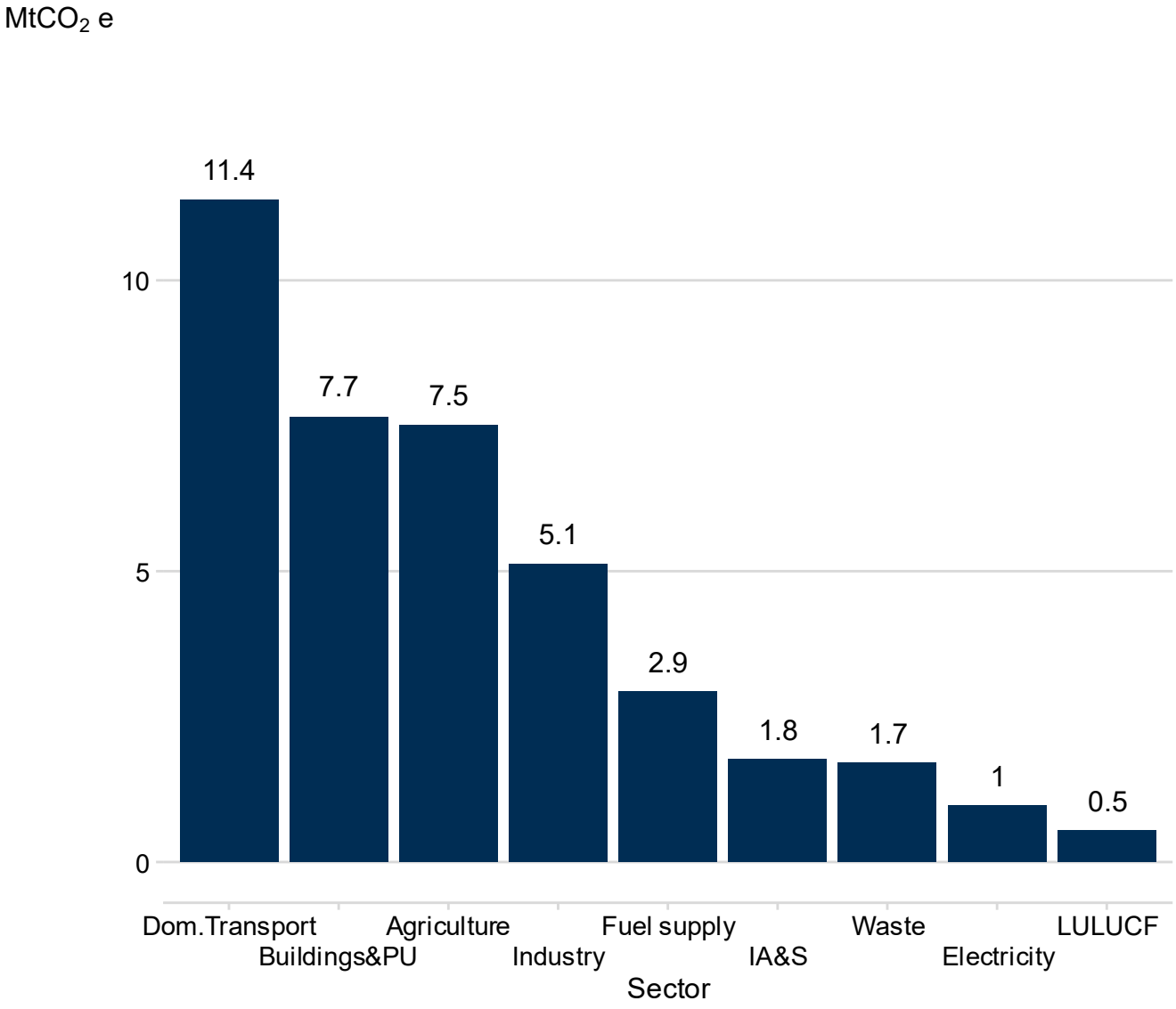
When emissions are reported by source, emissions are attributed to the sector that emits them directly. These high-level sectors are made up of a number of more detailed sectors, which follow the definitions set out by the Intergovernmental Panel on Climate Change (IPCC), and which are used in international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

2023 results

Chart 2 presents the net sources and sinks of Scottish Greenhouse Gas Emissions in 2023, grouped by sector.

Chart 2. Scottish Greenhouse Gas Emissions by Territorial Emissions Statistics Sector, 2023.



Main points

- In 2023, Domestic transport (excluding International Aviation and Shipping) (11.4 $MtCO_2e$) was the largest source of net emissions, followed by Buildings and product use (7.7 $MtCO_2e$), Agriculture (7.5 $MtCO_2e$), Industry (5.1 $MtCO_2e$) and Fuel supply (2.9 $MtCO_2e$).

- Less significant emitters in 2023 were: International aviation and shipping (IA&S) (1.8 $MtCO_2e$), Waste (1.7 $MtCO_2e$), and Electricity supply (1.0 $MtCO_2e$.
- Whilst only contributing 0.5 $MtCO_2e$ to total net emissions in 2023, the Land Use, Land Use Change and Forestry (LULUCF) sector is important in that this sector emitted 15.3 $MtCO_2e$ of gross greenhouse gases in 2023, whilst removing 14.8 $MtCO_2e$ of greenhouse gases from the atmosphere, mainly in forestry.

Table 2. Scottish Greenhouse Gas Emissions by Gas and by Territorial Emissions Statistics Sector 2023. Values in $MtCO_2e$

TES sector	Carbon Dioxide	Methane	Nitrous Oxide	Fluorinated gases	Total
Agriculture	1.2	4.5	1.9		7.5
Buildings and product uses	7.1	0.1	0.1	0.4	7.7
Domestic transport	11.1	0.0	0.1	0.1	11.4
Electricity supply	0.9	0.0	0.0		1.0
Fuel supply	2.6	0.3	0.0		2.9
Industry	5.0	0.0	0.0	0.1	5.1
International aviation and shipping	1.7	0.0	0.0		1.8
LULUCF	-3.9	3.7	0.7		0.5
Waste	0.0	1.6	0.1		1.7
Net emissions	**25.7**	**10.3**	**2.9**	**0.6**	**39.6**

Main points

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

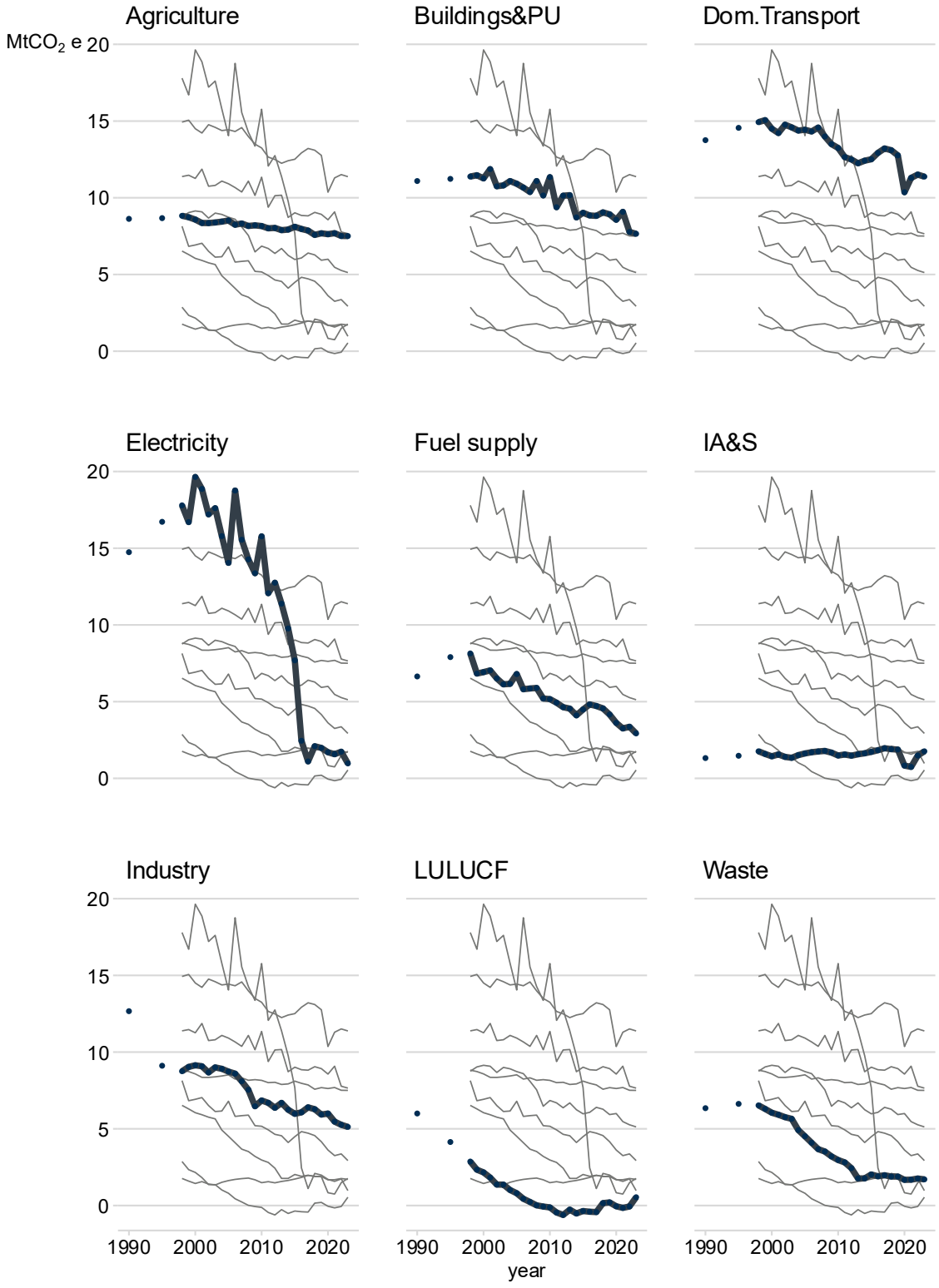
- Methane was the main net gas emitted in the Agriculture (4.5 $MtCO_2e$), followed by nitrous oxide (1.9 $MtCO_2e$) and carbon dioxide (1.2 $MtCO_2e$).
- Almost all emissions in the Waste Management sector were emitted in the form of methane (1.6 $MtCO_2e$).
- LULUCF was a net sink of Carbon Dioxide (-3.9 MtCO2e) but a net emitter of Methane (+3.7 MtCO2e) and Nitrous Oxide (+0.7 MtCO2e).

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 2023, broken down by Territorial Emissions Statistics Sector.

Chart 3: Greenhouse Gas Emissions in Scotland, by Territorial Emissions Statistics Sector 1990 to 2023.



Long term (1990 to 2023) and short term (2022 to 2023) trends by category

Chart 4 shows how emissions have changed between 1990 and 2023 in all source categories. Chart 5 shows how emissions have changed between 2022 and 2023.

Chart 4. Change in net emissions by Territorial Emissions Statistics Sector between 1990 and 2023

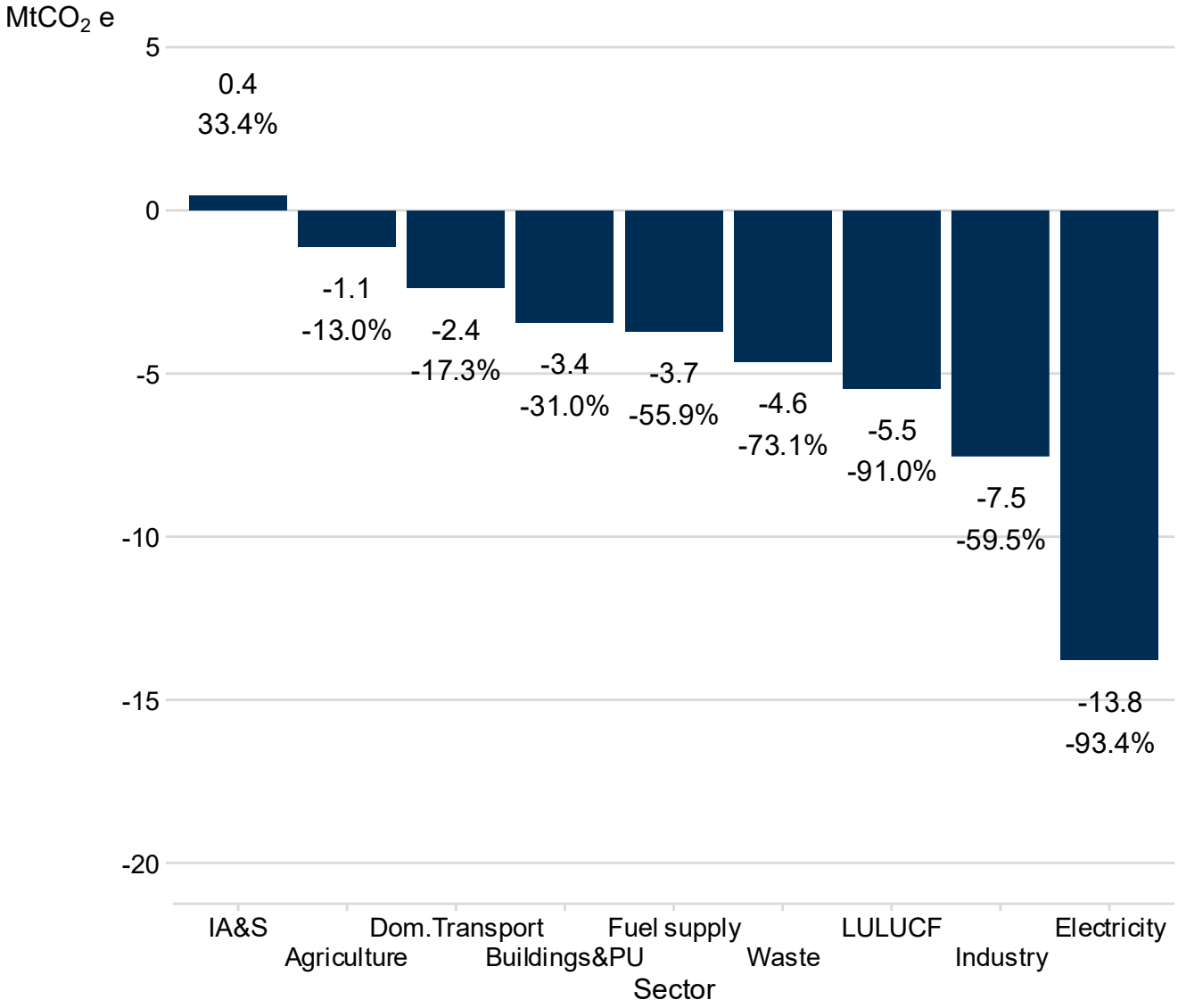
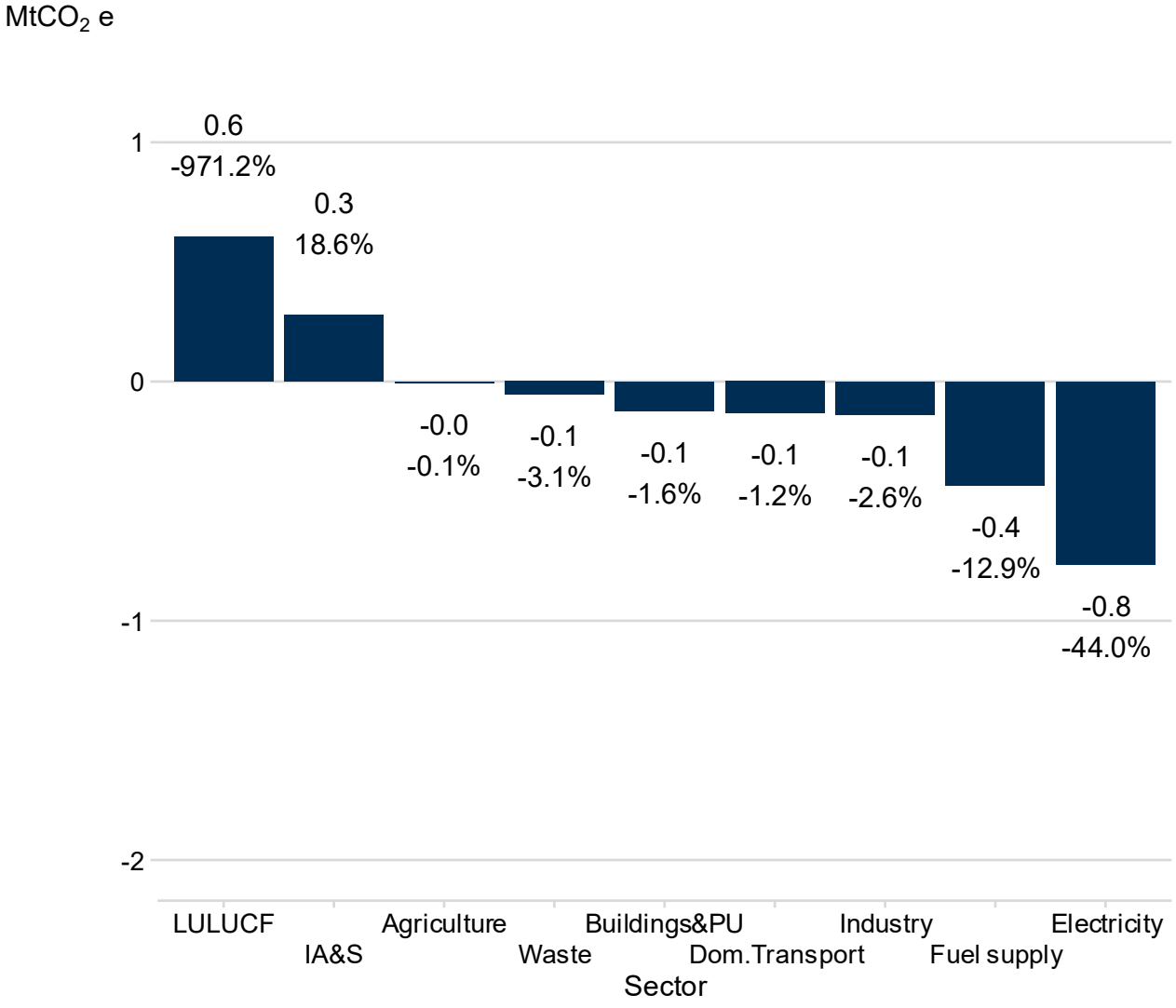


Chart 5. Change in net emissions by Territorial Emissions Statistics Sector between 2022 and 2023.



Total Emissions

Overall, there has been a 41.6 $MtCO_2e$ (51.3 per cent) decrease in net emissions between 1990 and 2023. In the latest year, 2023, total net emissions fell by 0.8 MtCO2e (1.9%).

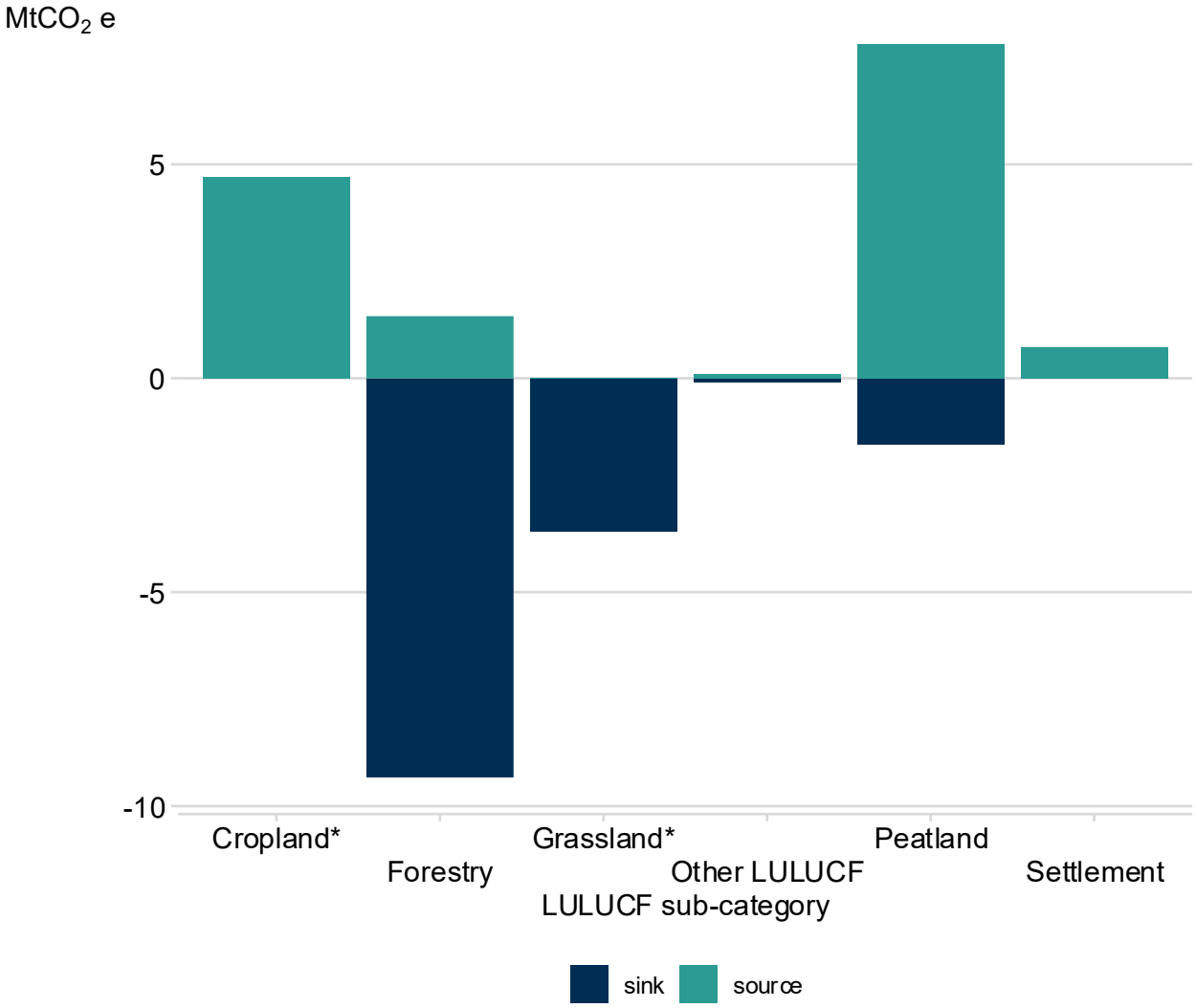
Land Use, Land Use Change And Forestry (LULUCF)

LULUCF is a net source of GHG emissions in Scotland in 2023, emitting 0.6 $MtCO_2e$ of net emissions. In 1990 net emissions were 6.0 $MtCO_2e$. In the period 2009-2017, and 2021-2022, LULUCF exhibited net removals of greenhouse gases in Scotland.

Chart 6 below shows, for each sub-sector of the land use sector in 2023, 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 2023, removing a net amount of GHG emissions of 7.6 $MtCO_2e$ and 3.6 $MtCO_2e$ 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, 2023



* 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 (-2.4 $MtCO_2e$) but rebounded in 2021 by 0.9 $MtCO_2e$, and increased again in 2022 by 0.3 $MtCO_2e$. In the latest year, domestic transport emissions fell slightly by 0.1 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 1.0 $MtCO_2e$ in 2023 (93.4 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.

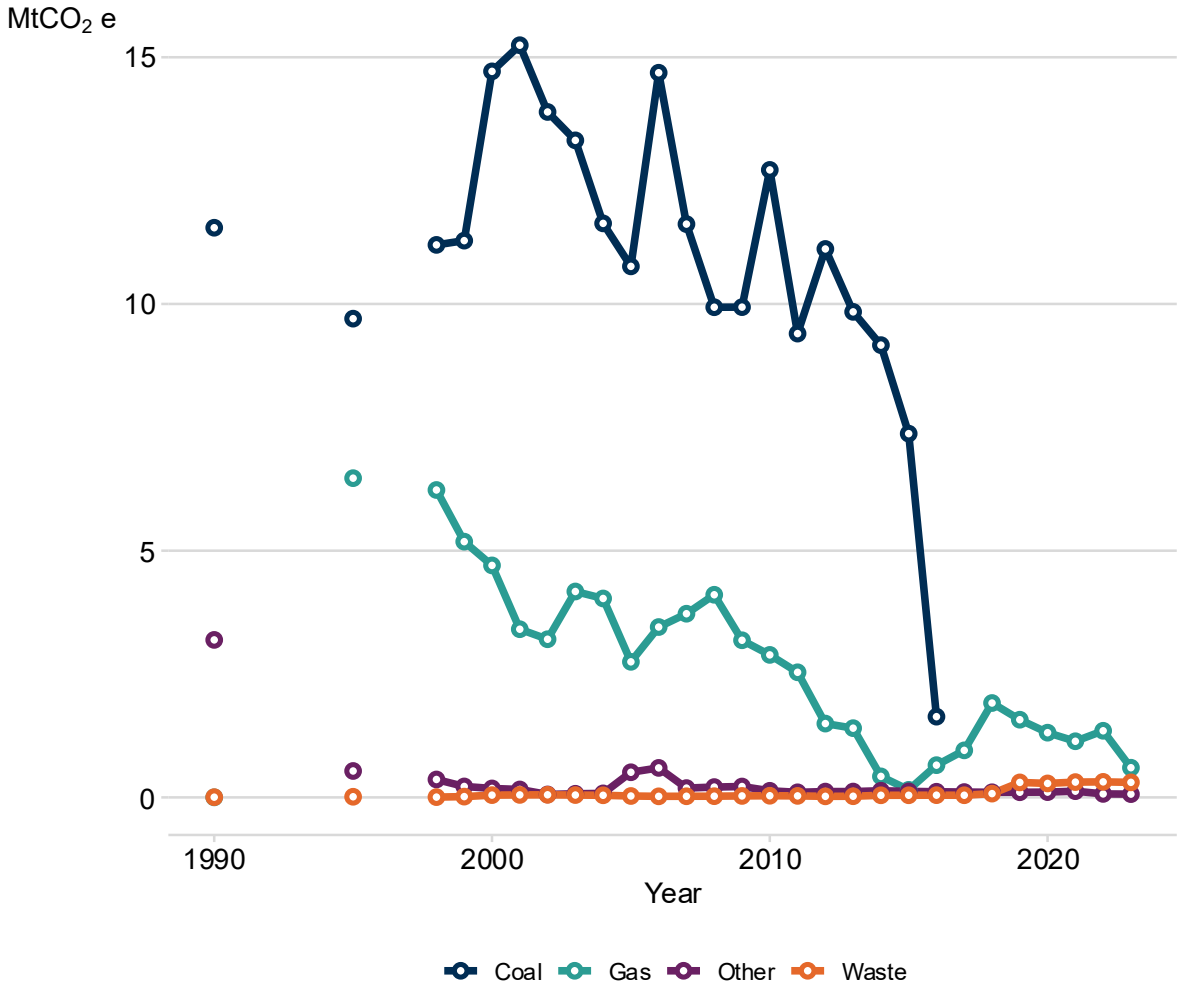
Between 2022 and 2023 Electricity Supply emissions decreased by 0.8 $MtCO_2e$ (44.0 per cent increase). This decrease was largely due to decreased gas generation during 2023.

Chart 7 below shows 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.

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 2023, EfW plants contributed 31.3 per cent of total emissions from electricity generation, largely due to the reduced contribution of gas generation to the energy mix.

Chart 7. Electricity generation emissions by fuel source, Scotland, 1990-2023.



Industry

This sector has seen a 7.5 $MtCO_2e$ (59.5 per cent) fall in emissions between 1990 and 2023. 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 2022 and 2023 there was a reduction of 0.1 $MtCO_2e$ in total emissions from industry.

Agriculture

This sector has seen a 1.1 $MtCO_2e$ (13.0 per cent) fall in emissions between 1990 and 2023. Between 2022 and 2023 agricultural emissions essentially remained constant at a level of 7.5 MtCO2e, falling marginally by 0.1%.

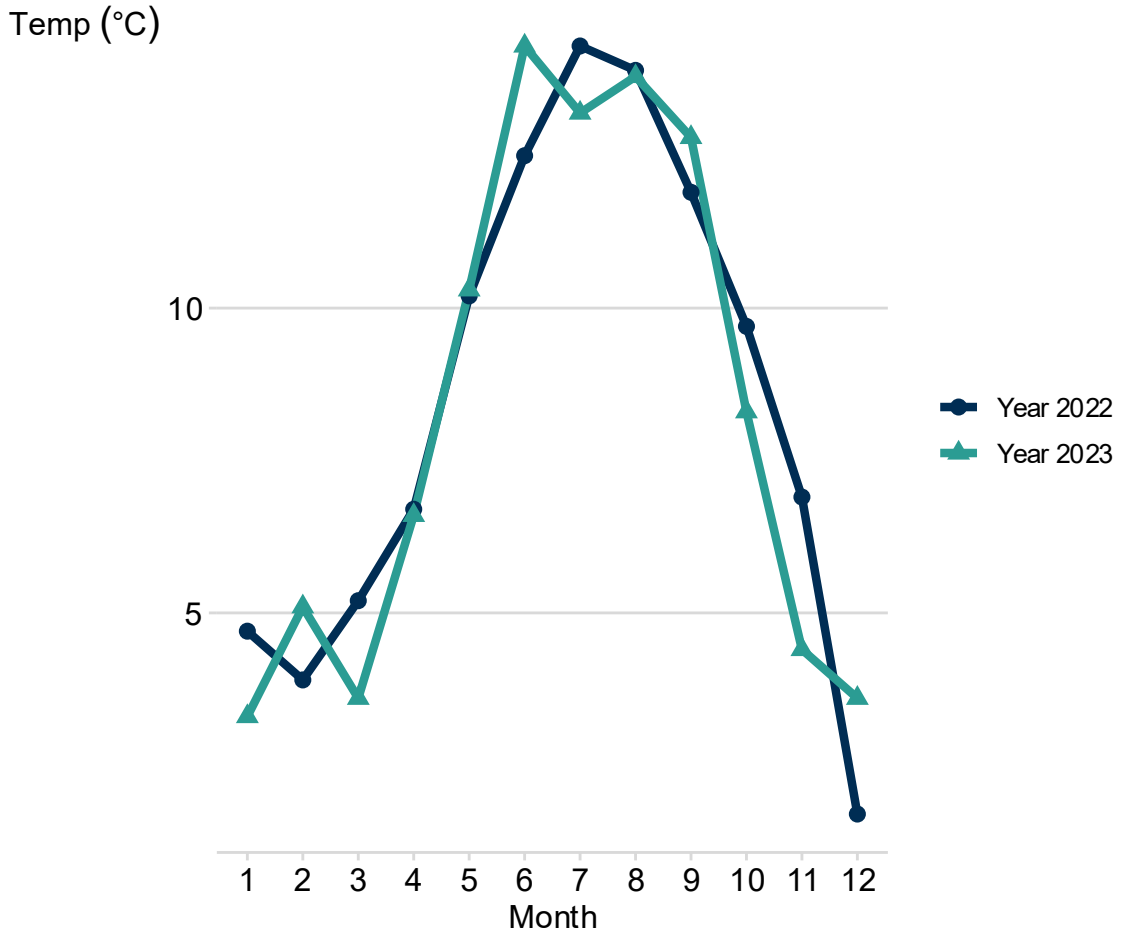
Buildings and product uses

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 31.0 per cent between 1990 and 2023. 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 marginally between 2022 and 2023 from 7.8 $MtCO_2e$ to 7.7 $MtCO_2e$ (-1.6 per cent). As ambient temperatures were relatively stable on average between the 2 years, albeit with much more moderate temperatures in December 2023. This change in emissions was likely caused by elevated fuel prices, leading to a reduction in demand (Chart 8).

Chart 8. Mean air temperature by month, Scotland. 2022 and 2023.



Data obtained from Met Office[3]

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 2023, international aviation and shipping increased by 0.4 $MtCO_2e$. Between 2022 and 2023 international aviation and shipping emissions increased by 0.3 $MtCO_2e$ (18.6 per cent increase) and have now essentially returned to their pre-COVID levels.

[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 1.7 $MtCO_2e$ in 2023. However, between 1990 and 2023 emissions reduced by 4.6 $MtCO_2e$ (73.1 per cent). This decrease is largely due to the progressive introduction of methane capture and oxidation systems within landfill management.

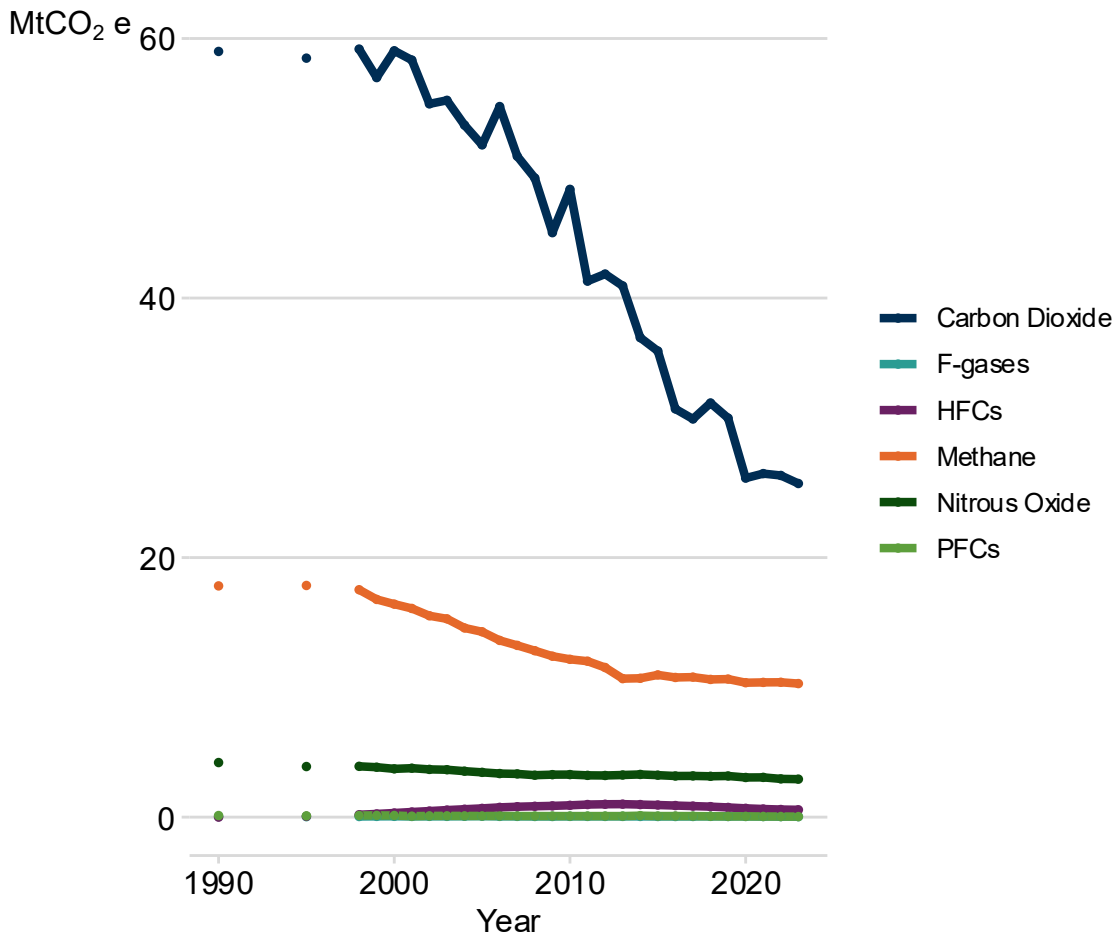
Fuel supply

Fuel supply emissions relate to the production and supply of fossil fuels and other energy sources. These emissions have more than halved since 1990, reducing by 3.7 $MtCO_2e$ over that period.

Emissions by type of gas

Chart 9 shows the trends in emissions, broken down by gas from 1990 to 2023

Chart 9. Scottish Greenhouse Gas Emissions, by Gas, 1990-2023.



Main Points

- Carbon dioxide is by far the largest contributor to Scottish greenhouse gas emissions in all years (65.0 per cent of all emissions in 2023) 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.

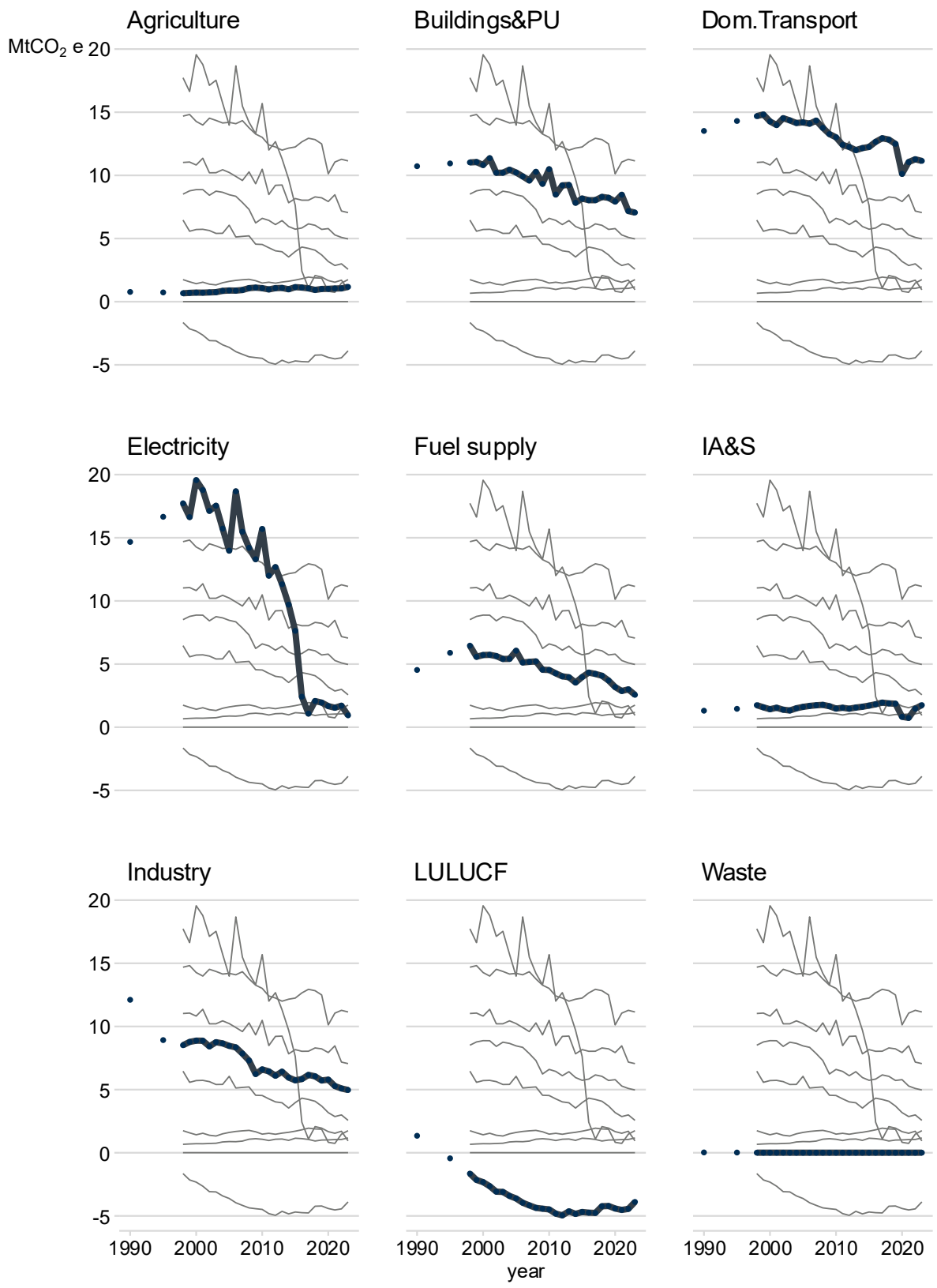
- Methane is the second most common greenhouse gas in 2023 (26.0 per cent of all net emissions) followed by nitrous oxide (7.4 per cent) and F-gases making up the remainder (1.6 per cent).

- Carbon dioxide has seen the largest reduction from 1990 to 2023 (33.3 $MtCO_2e$ reduction). There have also been reductions in both methane (7.5 $MtCO_2e$ 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 2023.

Carbon Dioxide (CO_2)

Chart 10. Carbon Dioxide (CO_2) Emissions by Territorial Emissions Statistics Sector, 1990 to 2023.



Main Points

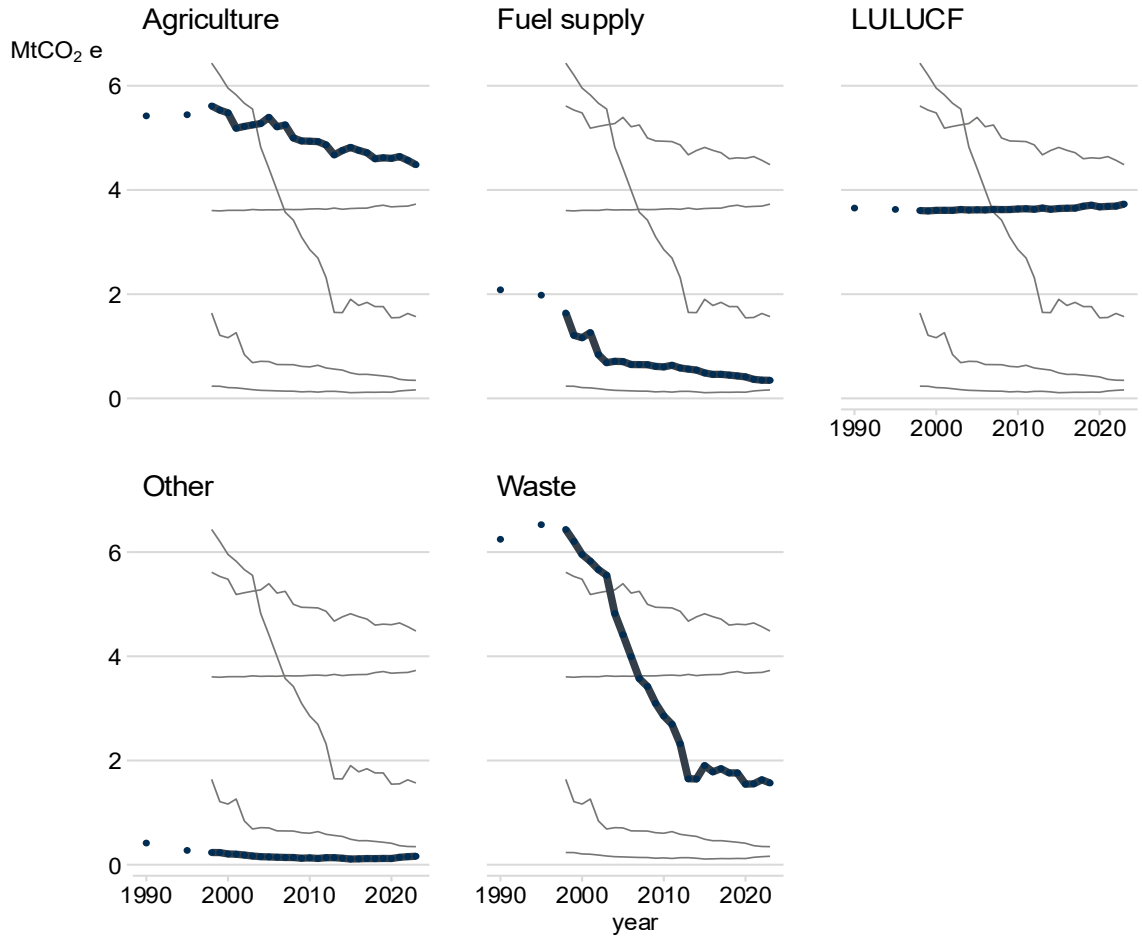
- Chart 10 shows that Electricity Supply was a key source of carbon dioxide emissions in the earlier part of the time-series, after which the change in fuels used in electricity generation substantially reduces CO_2 emissions from this source. Change in electricity supply emissions is the main driver 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 $MtCO_2$ of net CO2 emissions. From 1995, this sector became a net-CO2 sink, reaching a maximum in 2012 when it acted to sequestrate 5.0 $MtCO_2$. Since that time, this net CO2 sink has been generally reducing to its current (2023) level where it reached net CO2 emissions of -3.9 $MtCO_2$ These trends reflect forestry planting activities in the early 1990s reaching maturity and gradually reducing its potential to remove CO2.

Methane (CH_4)

Chart 11. Methane (CH_4) Emissions by Territorial Emissions Statistics Sector 1990 to 2023.



Main Points

- Methane emissions from Waste Management have fallen by 4.7 $MtCO_2e$ between 1990 and 2023 (a 74.9 per cent reduction). This is largely due to the progressive introduction of methane capture and oxidation systems within landfill management.

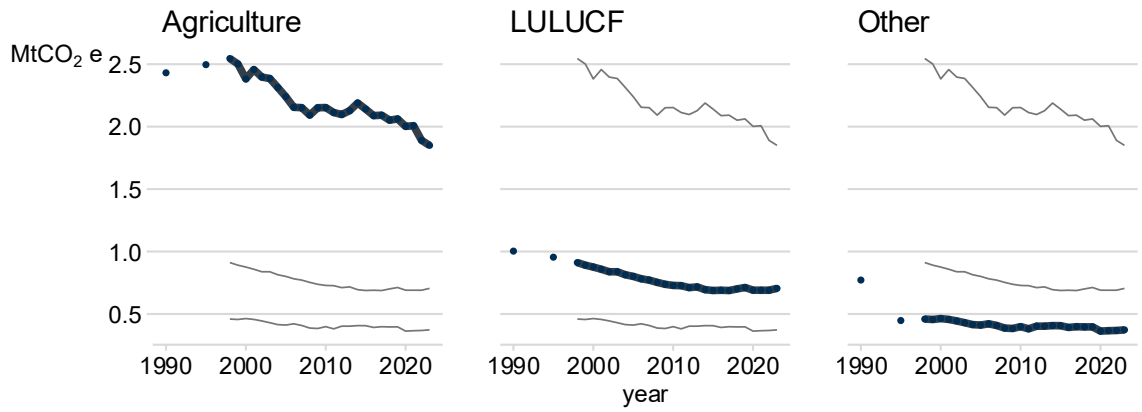
- In the Fuel Supply sector, methane emissions have fallen by 1.7 $MtCO_2e$ between 1990 and 2023 (an 83.4 per cent reduction), partly due to reductions in emissions from sources such as coal mining.

- Methane emissions in the Agriculture sector have fallen by 0.9 $MtCO_2e$ between 1990 and 2023 (a 17.3 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 (N_2O)

Chart 12. Nitrous Oxide (N_2O) Emissions by Territorial Emissions Statistics Sector, 1990 to 2023.



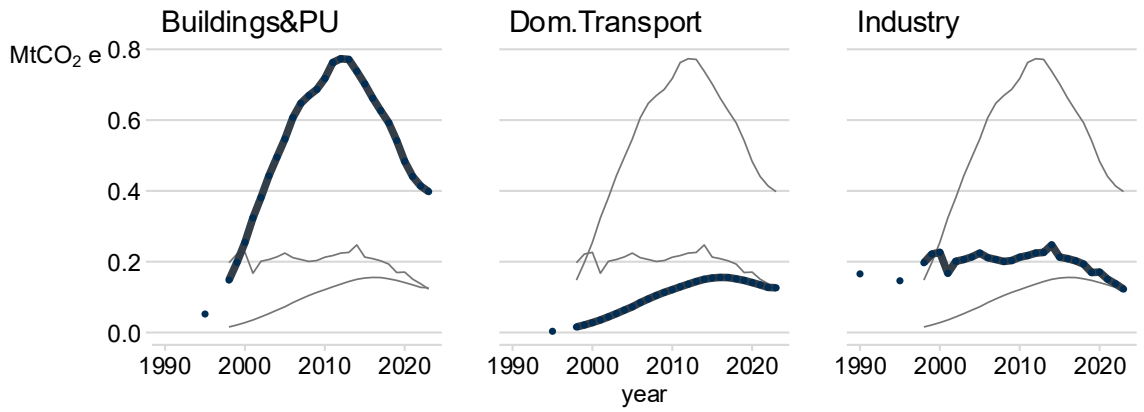
Main Points

- 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 $MtCO_2e$ between 1990 and 2023 – a 23.9 per cent reduction.

- 'Land Use, Land Use Change And Forestry' fell by 0.3 $MtCO_2e$ (29.8 per cent reduction) between 1990 and 2023.

Fluorinated gases (F-gases)

Chart 13. F-gas Emissions by Territorial Emissions Statistics Sector, 1990 to 2023



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 historical targets, these gases use 1995 as a baseline year rather than 1990)

- There is a sharp increase in HFC gases of 0.9 $MtCO_2e$ between 1990 and 2013 (from 0.2 $MtCO_2e$ in 1995 to 1.1 $MtCO_2e$ 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 2023. Values in $MtCO_2e$

Sector	1990	2022	2023	1990-2023		2022-2023	
				Change	% Change	Change	% Change
Agriculture	8.6	7.5	7.5	-1.1	-13.0%	0.0	-0.1%
Buildings and product uses	11.1	7.8	7.7	-3.4	-31.0%	-0.1	-1.6%
Domestic transport	13.8	11.5	11.4	-2.4	-17.3%	-0.1	-1.2%
Electricity supply	14.7	1.7	1.0	-13.8	-93.4%	-0.8	-44.0%
Fuel supply	6.6	3.4	2.9	-3.7	-55.9%	-0.4	-12.9%
Industry	12.7	5.3	5.1	-7.5	-59.5%	-0.1	-2.6%
International aviation and shipping	1.3	1.5	1.8	0.4	33.4%	0.3	18.6%
LULUCF	6.0	-0.1	0.5	-5.5	-91.0%	0.6	-971.2%
Waste	6.3	1.8	1.7	-4.6	-73.1%	-0.1	-3.1%
Net emissions	**81.2**	**40.3**	**39.6**	**-41.6**	**-51.3%**	**-0.8**	**-1.9%**

(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 2023. Values in $MtCO_2e$

Gas	1990	2022	2023	1990-2023		2022-2023	
				Change	% Change	Change	% Change
CO2	59.0	26.3	25.7	-33.3	-56.4%	-0.6	-2.4%
CH4	17.8	10.4	10.3	-7.5	-42.2%	-0.1	-1.0%
N2O	4.2	2.9	2.9	-1.3	-30.4%	0.0	-0.7%
F-Gases	0.2	0.7	0.6	0.5	290.5%	0.0	-4.7%
HFCs	0.0	0.6	0.6	0.6	22812.6%	0.0	-3.5%
PFCs	0.1	0.0	0.0	-0.1	-64.6%	0.0	-8.7%
SF6	0.0	0.0	0.0	0.0	-9.8%	0.0	-16.6%
NF3	0.0	0.0	0.0	0.0	-17.5%	0.0	0.0%
Net emissions	81.2	40.3	39.6	-41.6	-51.3%	-0.8	-1.9%

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

Table 5: Emissions from electricity generation by fuel source, 1990 to 2023. Values in $MtCO_2e$

Fuel source	1990	2022	2023	1990-2023 Change	2022-2023 Change
Power stations - coal	11.5	0.0	0.0	-11.5	0.0
Power stations - gas	0.0	1.4	0.6	0.6	-0.7
Power stations - municipal solid waste	0.0	0.3	0.3	0.3	0.0
Power stations - other fuel	0.0	0.0	0.0	0.0	0.0
Power stations - petroleum	3.2	0.1	0.0	-3.1	0.0
Net emissions	**14.7**	**1.7**	**1.0**	**-13.8**	**-0.8**

Section C. Revisions to the Inventory and Methodology

This section examines key revisions in estimated source emissions between the latest inventory (1990-2023) and the previous inventory (1990-2022).

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 CO_2 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 1990-2022 and 1990-2023 inventories

Charts 14 to 16 illustrate the impacts of revisions between the 1990-2022 and 1990-2023 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 1990-2022 and 1990-2023 Inventories.

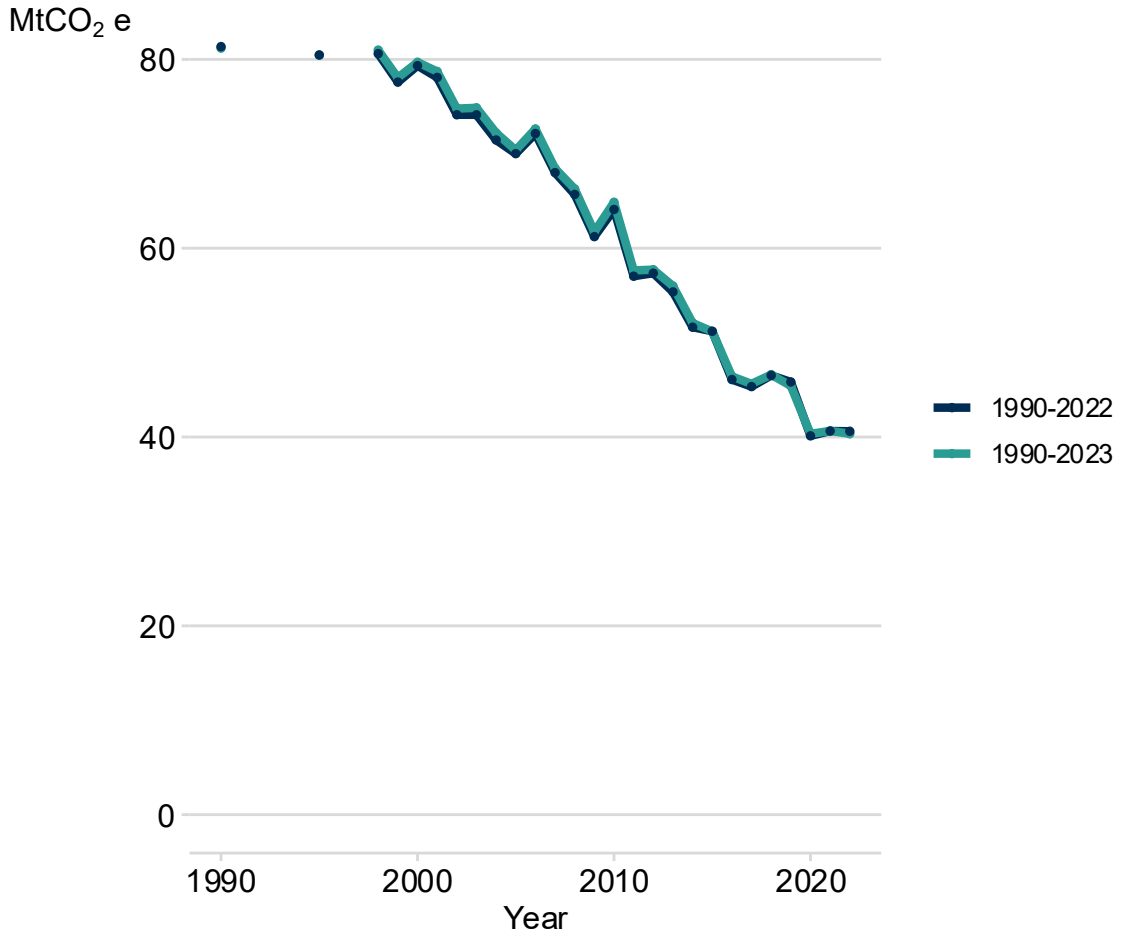


Chart 15 shows revisions to the baseline period, between the two most recent inventories.

Chart 15. Revisions to emissions in 1990, from the 1990-2022 inventory to the 1990-2023 inventory, by Territorial Emissions Statistics Sector.

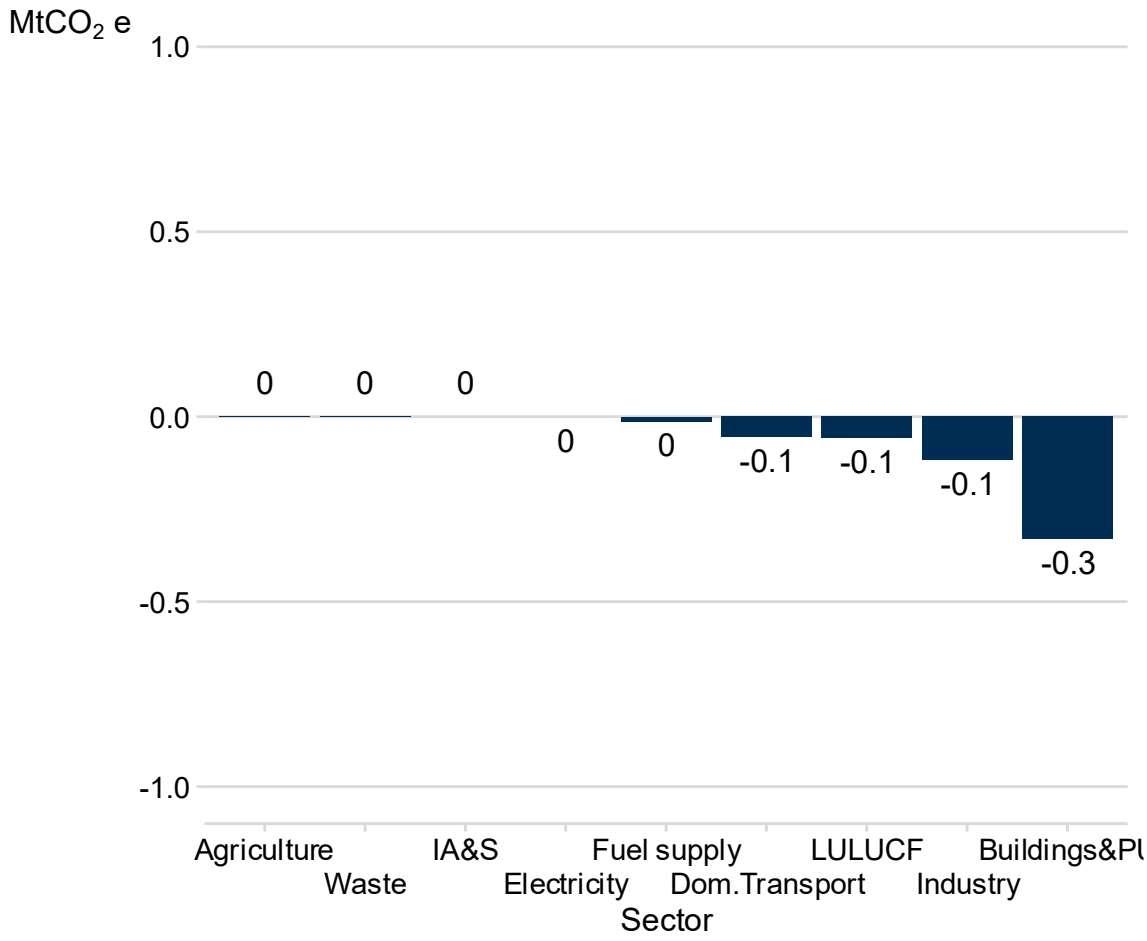
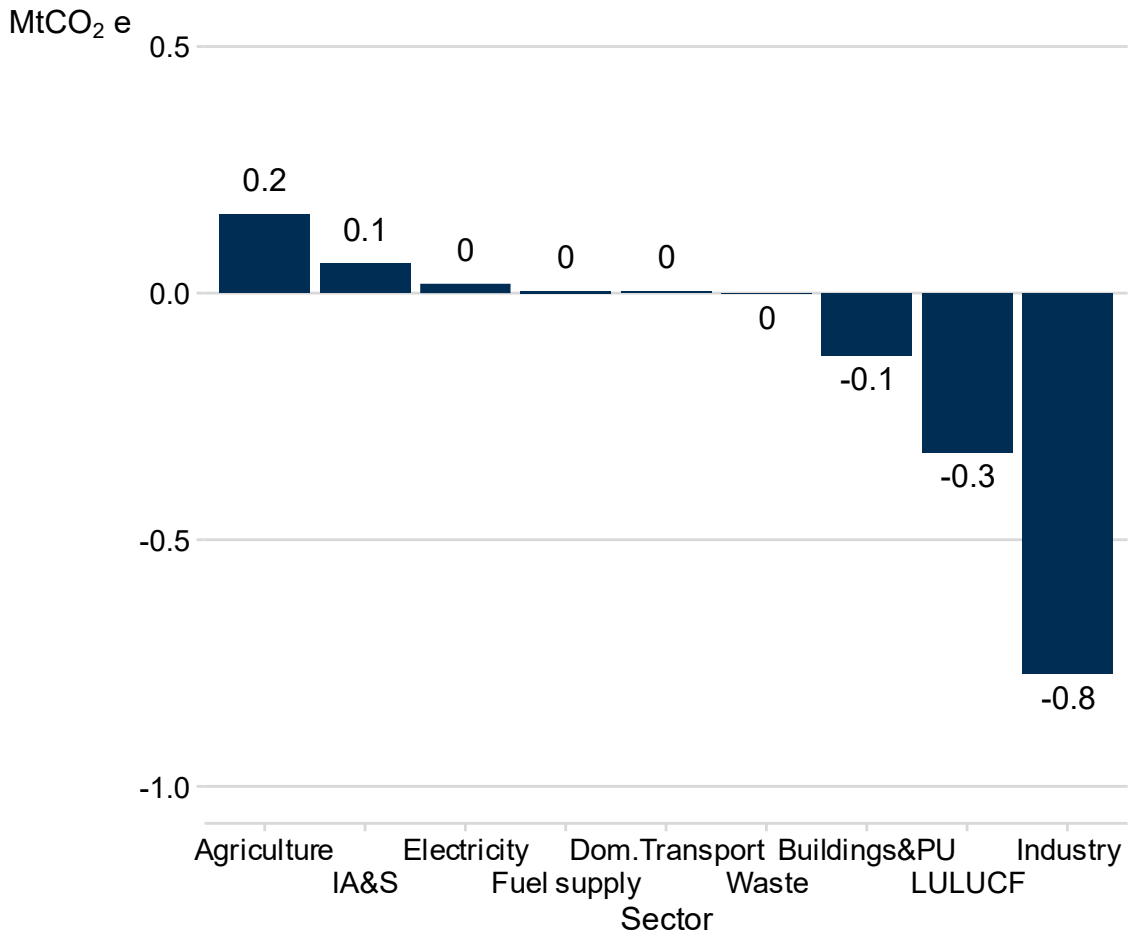


Chart 16 shows revisions to the data for the year 2022, between the two most recent inventories.

Chart 16. Revisions to emissions in 2022, from the 1990-2022 inventory to the 1990-2023 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 1990-2023) 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 - 2023. Details of the most notable revisions are listed below:

- **Agriculture**
  - Recalculations early in the timeseries to agricultural stationary combustion are driven by an improvement to redistribute burning oil DUKES values to pre-1998 using the 2016-2019 DUKES reported totals for burning oil.
  - There are recalculations to agricultural non-road mobile machinery (NRMM) later in the timeseries due to changes to the gas oil reconciliation including the bottom up NRMM recalculations to incorporate revisions to the Defra agricultural statistics.
  - In both agricultural stationary combustion and NRMM there are revisions to DUKES allocations to end users back to 2009. Changes in the earlier years are due to sector splits in later years now used in earlier years to maintain timeseries consistency.
  - There are also DA level recalculations due to the incorporation of new agricultural offroad fuel use mapping from 2005-2023. Pre-2005 values were also updated to use the 2005 mapping grid resulting in reallocations of data across all the DAs. This results in a decrease for Scotland early in the timeseries and a slight increase throughout the rest of the timeseries.
- **Buildings and product uses**
  - "There have been Digest of UK Energy Statistics (DUKES) revisions at the UK level back to 2009 as well as an improvement to redistribute burning oil DUKES values to pre-1998 using the 2016-2019 DUKES reported totals for burning oil. This redistribution pre-1998 increases the timeseries consistency and is driving the recalculations to the base year. Following the DUKES revision, the wood data are used fully and plant and animal biomass are now reported separately in the inventory. Furthermore, waste is now split into renewable (biomass) and non-renewable (non-biomass) fractions and into municipal solid waste and non-municipal solid waste.
  - mapping grid updates for the non-domestic sector. There were also minor changes due to the incorporation of modelled estimated subnational gas use data from 2005-2014 using a DA specific heating degree day analysis. This was used to extrapolate the 2015 non-domestic gas use mapping grids before 2015. "
  - Revision to stove data. Furthermore, there was an inclusion of new activity for coffee logs from the 2019 and 2022 domestic burning surveys.
  - At the DA level, there were changes due to heating degree day analysis.
  - The Inter-Departmental Business Register (IDBR) analysis was used estimate f-gas emissions from commercial refrigeration in

supermarkets and other stores. This is an improvement from the previous methodology using GDP.

- **Domestic Transport**
  - Recalculations to the road transport model within the UK inventory from revisions to the cold start methodology to apply emissions factors related to Euro 2 to 5 petrol vehicles. This impacts non-CO2 emissions. Higher DERV consumption was estimated in cars in the last few years of the timeseries.
- **Industry**
  - improvement to redistribute burning oil DUKES values to pre-1998 using the 2016-2019 breakdown average.
  - Changes to the residual fuel dataset.
  - The UK sub-national residual fuel dataset revisions are driven by a improvement to the distribution of non-domestic energy use. Energy Performance Certificates (EPCs) and Display Energy Certificates (DECs) have been incorporated into the modelling to give a better indication of where oil and solid fuels are used.
  - mapping grid updates for chemical industry oil and solid fuel use. These recalculations affect the entire timeseries and drive the recalculations seen in 2022 in Scotland.
- **LULUCF**
  - "There were revisions to the Forest Land emissions across the timeseries due to a number of updates to the CARBINE model:
  - Improved early growth estimates.
  - Incorporate carbon from branches on dead trees into the soil.
  - Change the dead branch decay rate from 4% to 14% to match the model description.
  - Fix to the calculation of the anaerobic conditions of soil water availability in Scotland.
  - Update to latest data from 2024 preliminary Forestry Statistics.
  - Interpolation of Scotland data for 2022 where no cropland area data are available.
  - Recalculations to soil emissions for organic soil drainage and mineral soils as cropland management is calculated for mineral soils only and mineral soil area is assumed as total area minus organic area so there are small changes to the mineral soil.
    Small changes for forest land converted to cropland over the timeseries as biomass losses, dead organic matter losses and controlled burning emissions are all dependent on average forest biomass as calculated by the CARBINE model which had updates to activity data and methodology."
  - Peatland restoration areas for 2013-2023 updated from Peatland Action including changes in which year hectarage is reported due to overlapping projects.

- For wetlands there are recalculations to the areas of Forest land converted to Wetland to include new Forest to Wetland areas for Scotland (from 2013).

- **Waste**
  - "Recalculations are driven by changes to landfill emissions at the UK level. There was an emission factor revision to the delay time for the decay reaction in MELmod. This results in decreases in emissions earlier in the timeseries and an increase in later years.

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 website[4].

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.

[4] 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 D. 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 parties[5] 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 (CO_2) emissions from biomass combustion.** For example, this includes CO_2 emissions from biomass power stations
- **Process emissions in food and drink production**. These include CO_2 emissions from brewing, fermenting and malting and in the production of food.
- **CO_2 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.

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

However, methane (CH_4) 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 in underway to being to develop estimates of the environmental changes resulting from changes to coastal wetlands environments.

Glossary

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 (CO_2)
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.

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 (CH_4)

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 (NF_3)

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 (N_2O)

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 CO_2 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 (CO_2) 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 (SF_6)

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 CO_2 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: Requirements under section 34A of the Climate Change (Scotland) Act 2009

All of the information contained in Annex A is reported on the basis of the most up to date available greenhouse gas inventory methods, i.e. the 1990 – 2023 inventory.

Section 34A of the Climate Change (Scotland) Act 2009 ("the 2009 Act") requires that this report contains the information specified in subsection 34(1) of the 2009 Act.

The following paragraphs provide the information specified in section 34(1)(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 1990-2023 inventory the baseline amount of emissions was 81.2 MtCO2e.

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

On the basis of the 1990-2023 inventory, net Scottish emissions in 2023 were 39.6 MtCO2e.

(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 1990-2023 inventory, net Scottish emissions in 2023 were 51.3 % 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.

On the basis of the 1990-2023 inventory, net Scottish emissions in 2023 were 1.9% lower than in 2022.

(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 Report 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**

- Recalculations early in the timeseries to agricultural stationary combustion are driven by an improvement to redistribute burning oil DUKES values to pre-1998 using the 2016-2019 DUKES reported totals for burning oil.
- There are recalculations to agricultural non-road mobile machinery (NRMM) later in the timeseries due to changes to the gas oil reconciliation including the bottom up NRMM recalculations to incorporate revisions to the Defra agricultural statistics.
- In both agricultural stationary combustion and NRMM there are revisions to DUKES allocations to end users back to 2009. Changes in the earlier years are due to sector splits in later years now used in earlier years to maintain timeseries consistency.
- There are also DA level recalculations due to the incorporation of new agricultural offroad fuel use mapping from 2005-2023. Pre-2005 values were also updated to use the 2005 mapping grid resulting in reallocations of data across all the DAs. This results in a decrease for Scotland early in the timeseries and a slight increase throughout the rest of the timeseries.

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  - mapping grid updates for the non-domestic sector. There were also minor changes due to the incorporation of modelled estimated subnational gas use data from 2005-2014 using a DA specific heating degree day analysis. This was used to extrapolate the 2015 non-domestic gas use mapping grids before 2015. "
  - Revision to stove data. Furthermore, there was an inclusion of new activity for coffee logs from the 2019 and 2022 domestic burning surveys.
  - At the DA level, there were changes due to heating degree day analysis.
  - The Inter-Departmental Business Register (IDBR) analysis was used estimate f-gas emissions from commercial refrigeration in supermarkets and other stores. This is an improvement from the previous methodology using GDP.

- **Domestic Transport**
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- **Industry**
  - improvement to redistribute burning oil DUKES values to pre-1998 using the 2016-2019 breakdown average.
  - Changes to the residual fuel dataset.

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- mapping grid updates for chemical industry oil and solid fuel use. These recalculations affect the entire timeseries and drive the recalculations seen in 2022 in Scotland.

- **LULUCF**
  - "There were revisions to the Forest Land emissions across the timeseries due to a number of updates to the CARBINE model:
  - Improved early growth estimates.
  - Incorporate carbon from branches on dead trees into the soil.
  - Change the dead branch decay rate from 4% to 14% to match the model description.
  - Fix to the calculation of the anaerobic conditions of soil water availability in Scotland.
  - Update to latest data from 2024 preliminary Forestry Statistics.
  - Interpolation of Scotland data for 2022 where no cropland area data are available.
  - Recalculations to soil emissions for organic soil drainage and mineral soils as cropland management is calculated for mineral soils only and mineral soil area is assumed as total area minus organic area so there are small changes to the mineral soil.
    Small changes for forest land converted to cropland over the timeseries as biomass losses, dead organic matter losses and controlled burning emissions are all dependent on average forest biomass as calculated by the CARBINE model which had updates to activity data and methodology."
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  - For wetlands there are recalculations to the areas of Forest land converted to Wetland to include new Forest to Wetland areas for Scotland (from 2013).

- **Waste**
  - "Recalculations are driven by changes to landfill emissions at the UK level. There was an emission factor revision to the delay time for the decay reaction in MELmod. This results in decreases in emissions earlier in the timeseries and an increase in later years.

Section 34(1)(b) of the 2009 Act requires that this report contain the the following information In relation to the net Scottish emissions account.

(i) Its amount for the year covered by the report.

In 2023, the net Scottish emissions account was 39.6 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 1990-2023 inventory, the net Scottish emissions account in 2023 was 51.3 % 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 1990-2023 inventory, the net Scottish emissions account in 2023 was 1.9 % lower than in 2022.

(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 2022 and 2023 was accounted for by changes in net Scottish emissions of greenhouse gases.

Section 34(1)(c) requires that this report provides 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 2023.

(ii) Purchased by the Scottish Ministers in the year covered by the report.

No carbon units were purchased by Scottish Ministers in 2023.

(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 2023.

Section 34(1)(d) of the 2009 Act requires that for each target year preceding the year covered by this report states the following.

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

Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Net GHG emissions (MtCO2e)	64.9	57.7	57.7	56.0	52.1	51.2	46.4
Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
Net GHG emissions (MtCO2e)	45.6	46.6	45.4	40.3	40.6	40.3	

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

Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Net Scottish Emissions Account (MtCO2e)	64.4*	61.6*	61.8*	54.1*	48.8*	50.6*	51.4*
Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
Net Scottish Emissions Account (MtCO2e)	53.3*	46.6	45.4	40.3	40.6	40.3	

* 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 2050 is 1,028 $MtCO_2e$. The total amount of net Scottish emissions of greenhouse gases over the period from 2010 to 2023 is 684.5 MtCO2e.

Section 34A(6) of the 2009 Act 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 —

(6)

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

The latest greenhouse gas inventory (1990-2023) contains some relatively minor revisions to previous estimates of emissions, these mainly relate to revisions to energy. 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 2022 being decreased by 0.3 MtCO2e to the revised level of 40.3 MtCO2e.

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 $MtCO_2e$.

Sector	1990	2022	2023	1990-2023		2022-2023	
				Change	% Change	% Change	Change
Agriculture	8.6	7.5	7.5	-1.1	-13.0%	0.0	-0.1%
Buildings	11.2	7.8	7.7	-3.5	-31.0%	-0.1	-1.6%
Electricity supply	14.7	1.7	1.0	-13.8	-93.4%	-0.8	-44.0%
Industry	19.2	8.6	8.0	-11.2	-58.2%	-0.6	-6.6%
LULUCF	6.0	-0.1	0.5	-5.5	-91.0%	0.6	-971.2%
Transport	15.1	13.0	13.1	-2.0	-13.0%	0.1	1.1%
Waste Management	6.3	1.7	1.7	-4.6	-73.3%	-0.1	-3.2%
Net emissions	**81.2**	**40.3**	**39.6**	**-41.6**	**-51.3%**	**-0.8**	**-1.9%**

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	2022	2023	1990-2023		2022-2023	
				Change	% Change	% Change	Change
Agriculture	8.6	7.5	7.5	-1.1	-13.0%	0.0	-0.1%
Business	11.8	6.7	6.5	-5.2	-44.5%	-0.2	-2.9%
Energy Supply	21.7	5.1	3.9	-17.8	-82.0%	-1.2	-23.5%
Industrial processes	1.9	0.4	0.4	-1.4	-77.4%	0.0	-0.7%
International Aviation & Shipping	1.3	1.5	1.8	0.4	33.4%	0.3	18.6%
Land use, land use change and forestry	6.0	-0.1	0.5	-5.5	-91.0%	0.6	-971.2%
Public	1.9	0.9	0.9	-1.0	-51.0%	0.0	-0.5%
Residential	8.0	5.1	5.1	-2.9	-36.8%	-0.1	-1.1%
Transport	13.8	11.4	11.3	-2.5	-18.2%	-0.1	-1.2%
Waste Management	6.3	1.7	1.7	-4.6	-73.3%	-0.1	-3.2%
Net emissions	**81.2**	**40.3**	**39.6**	**-41.6**	**-51.3%**	**-0.8**	**-1.9%**

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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

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