

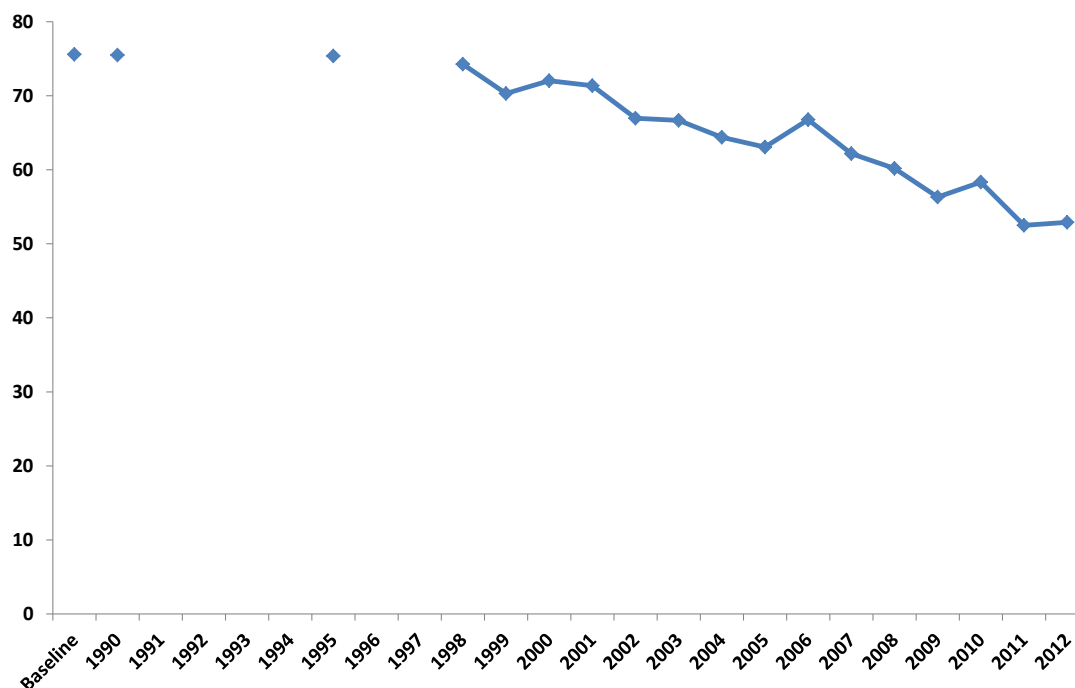
Scottish Greenhouse Gas Emissions 2012

An Official Statistics Publication for Scotland

This publication provides estimates of greenhouse gas emissions in Scotland for the years 1990 to 2012. Except where stated, the emissions figures shown in this release include an estimate of emissions from international aviation and shipping.

The release also provides information on the performance against emission reduction targets, taking account of trading in carbon units. These targets are prescribed in the Climate Change (Scotland) Act 2009.

Scottish Greenhouse Gas Emissions, 1990 to 2012. Values in Mt CO₂e



- In 2012, Scottish emissions of the basket of six greenhouse gases are estimated to be 52.9 million tonnes carbon dioxide equivalent (MtCO₂e).
- This is 0.8 per cent higher than the 2011 figure of 52.5 MtCO₂e, a 0.4 MtCO₂e increase.
- Between 1990 and 2012, there was a 29.9 per cent reduction in estimated emissions. [Section A](#) states what the greenhouse gases are and how they are categorised. [Section B](#) contains results in more detail. The main contributors to this reduction have been a fall in energy supply emissions (such as in the production of electricity) and from business and industrial emissions.
- When emissions are adjusted to take account of trading in the EU Emissions Trading System (EU ETS), emissions increased by 0.5 per cent between 2011 and 2012 (from 55.4 MtCO₂e to 55.7 MtCO₂e). [Section C](#) provides information on what the EU ETS is and what it means for Scotland's Greenhouse Gas Emissions statistics.
- Compared with the Baseline¹, emissions in 2012 (after taking account of trading in the EU ETS) were 26.4 per cent lower. [Section A](#) contains more information on how the Baseline is defined and [Section C](#) contains results in more detail.

The annual target for 2012, as published in the Climate Change (Annual Targets) (Scotland) Order 2010, is 53.226 MtCO₂e. The target is assessed using the adjusted emissions.

Note that as part of this release all of the figures have been revised since the previous publication in June 2013, to incorporate methodological improvements and new data. Comparing the 2012 figures with the 2011 figures published a year ago will therefore give a different year-on-year percentage change; one which is incorrect and should not be used. Details of these revisions can be found later in this statistical release in [Section D](#).

¹ The baseline uses 1990 for carbon dioxide, methane and nitrous oxide and 1995 for hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride

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Section A – Introduction to Greenhouse Gases

Purpose of this Publication

The “Scottish Greenhouse Gas Emissions 2012” Official Statistics publication contains the results of the Scottish Greenhouse Gas Inventory for 1990-2012. The Scottish Greenhouse Gas Inventory is the key tool for understanding the origins and magnitudes of the emissions and the assessment of policies designed to control or reduce 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 “Scottish Greenhouse Gas Emissions 2012” Official Statistics publication 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.
- **Estimated net source emissions which have been adjusted to take into account of trading in the EU Emissions Trading System (EU ETS).** [Section C](#) contains results using this categorisation.

The publication does not contain information on “consumption” estimates, with the spending of Scottish residents on goods and services, wherever in the world these emissions arise along the supply chain, and those which are directly generated by Scottish households through private motoring and heating. This information will be published as part of the Official Statistics publication: “[Scotland's Carbon Footprint](#)” later this year.

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

	Estimated Source Emissions (Section B)	Estimated Source Emissions Adjusted to take into account of EU Emissions Trading System (Section C)
Adjusted for EU Emissions Trading System	✗	✓
Used for reporting progress against Scotland's Climate Change Targets ¹	✗	✓
Can be compared with EU countries ²	✓	✗
Can be compared with UK ³	✓	✗
Includes International Aviation and Shipping	✓	✓
Includes Offshore Emissions	✗	✗
Data on individual greenhouse gases	✓	✗
Data on Scottish Government source sectors	✓	✓
Base Year	1990	Baseline (Variable)

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

² Data for EU countries include figures offshore emissions which cannot be broken down at present, so are not directly comparable with Scottish estimates. Figures on offshore emissions are available at a UK level, but not for devolved administrations.

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 three F-gases (hydrofluorocarbons- HFCs, perfluorocarbons – PFCs and sulphur hexafluoride- SF₆). 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* (CO₂e) units. In the case 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 A1. List of Greenhouse Gases and their contribution to Scotland's net greenhouse gas emissions, 2012

Name of Greenhouse Gas	Chemical Formula	Global Warming Potential (GWP) (Conversion factor to carbon dioxide equivalent)	Contribution to Scotland's Net Greenhouse Gas Emissions in 2012 (in Mt CO ₂ e)	Percentage of Scotland's Net Greenhouse Gas Emissions in 2012 (in Mt CO ₂ e)	Examples of sources of gas
Carbon dioxide	CO ₂	1	39.8	75.2%	All other sources of greenhouse gases, including removals of emissions (carbon sinks)
Methane	CH ₄	21	6.8	12.9%	Waste management, enteric fermentation and animal waste
Nitrous oxide	N ₂ O	310	5.1	9.6%	Agricultural soils
F-gases			1.2	2.3%	Industrial air conditioning, aluminium smelting, refrigeration, use as tracer gases
- Hydrofluorocarbons	HFC	140 - 11,700	1.1	2.1%	
- Perfluorocarbons	PFC	6,500 - 9,200	0.1	0.1%	
- Sulphur hexafluoride	SF ₆	23,900	0.0	0.1%	
Total Net Greenhouse Gases			52.9	100.0%	

The Global Warming Potentials (GWPs) are based on international reporting standards, as set by the Intergovernmental Panel on Climate Change (IPCC). The IPCC guidelines are being updated for the 1990-2013 inventory to reflect updates in scientific knowledge and these will be reflected in figures published in 2015. At this time, the GWP of methane will increase from 21 to 25. The GWP of Nitrous oxide will fall from 310 to 298.

The basket of greenhouse gases is determined by international reporting standards, as set by the Intergovernmental Panel on Climate Change (IPCC). The IPCC guidelines are being updated for the 1990-2013 inventory to reflect updates in scientific knowledge and this will incorporate a new greenhouse gas, nitrogen trifluoride (NF₃), which will be reported on in 2015.

Section B contains further data on the individual greenhouse gases.

Reporting of the Baseline 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 reporting progress against Scotland’s Climate Change Targets only. This is referred to as “Baseline” in charts, tables and text.

The Baseline in 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): hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF₆)

Within this publication, data are estimated for the Baseline; and the years 1990, 1995 and 1998 to 2012.

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 incorporated within the three sectors of agriculture and related land use, development, and forestry, which include emissions as well as removals resulting from afforestation, reforestation, deforestation and forest management together with changes in land use.

Sectors

The sector breakdowns used in this report are primarily based on the National Communication (NC) sectors, which are used in the UK Greenhouse Gas Inventory. However, in order to associate emissions from conversion of grassland to and from cropland, and liming of agricultural land with other agricultural activities, we have generated three new sectors from the previous two sectors *Land Use, Land Use Change and Forestry* (LULUCF) and *Agriculture*. The first new sector, *Agriculture and related land use*, includes all emissions in the NC sector Agriculture together with those LULUCF emissions associated with agricultural practices. The remaining LULUCF emissions are grouped into *Forestry* (changes in emissions relating mainly to stock changes resulting from afforestation, deforestation and harvested wood products) and *Development* (changes in emissions resulting from land use change to settlements). These new sectors are the same as those that were reported in the Scottish Government publication "[Low Carbon Scotland - Meeting the Emissions Reductions Targets 2013-2027](#)". A detailed mapping between the sectors used in this report and the NC sectors and Intergovernmental Panel on Climate Change (IPCC) sectors is given in [Section E](#).

This publication provides the latest estimates of Scotland's greenhouse gas emissions by source from 1990-2012. For the purposes of reporting, greenhouse gas emissions are allocated into sectors as follows:

Energy supply

Emissions from fuel combustion for electricity and other energy production sources.

Business and industrial processes

Emissions from industry and from those in combustion in industrial/commercial sectors, industrial off-road machinery and refrigeration and air conditioning

Transport

Emissions from domestic aviation, road transport, railways, domestic navigation, fishing and aircraft support vehicles.

Public

Emissions from combustion of fuel in public sector buildings.

Residential

Emissions from fuel combustion for heating/cooking, garden machinery and fluorinated gases released from aerosols/metered dose inhalers.

Agriculture and Related Land Use

Net emissions from cropland, grassland livestock, agricultural soils, stationary combustion sources and off-road machinery

Development

Net emissions from settlements and from land converted to settlements

Forestry

Changes in emissions relating mainly to stock changes, resulting from afforestation, deforestation and harvested wood products

Waste management

Emissions from waste disposed of to landfill sites, waste incineration, and the treatment of waste water

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

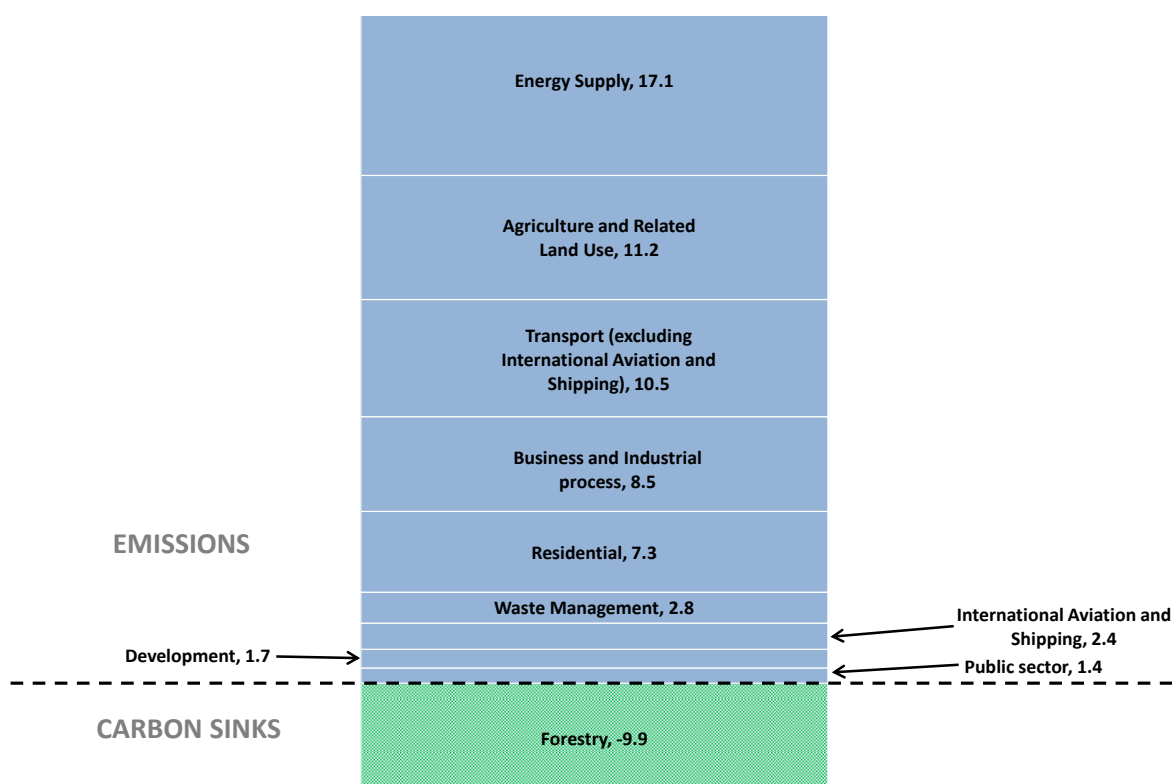
(IPCC), and which are used in international reporting tables which are submitted to the United Nations Framework Convention on Climate Change (UNFCCC) every year. [Section E](#) contains a more detailed mapping of what is included in each source.

Section B. Results – Estimated Sources of Scottish Greenhouse Gas Emissions

2012 figures

Chart B1 presents the sources and sinks of Scottish Greenhouse Gas Emissions in 2012, grouped by Scottish Government sector.

Chart B1. Sources of Scottish Greenhouse Gas Emissions, 2012. Values in Mt CO₂e



Main points

- In 2012, Energy supply was the largest source of net emissions (17.1 Mt CO₂e), followed by Agriculture and Related Land Use (11.2 Mt CO₂e), and Transport (excluding International Aviation and Shipping), (10.5 Mt CO₂e).
- Emissions from the energy supply sector were greater than emissions from public sector, development, international aviation and shipping, waste management and residential emissions combined.
- Forestry was the only aggregate sector in which there has been a net emissions sink (-9.9 Mt CO₂e).

Table B1. Scottish Greenhouse Gas Emissions by Gas and by Scottish Government Sector, 2012. Values in Mt CO₂e

	TOTAL	Carbon dioxide	Methane	Nitrous oxide	Fluorinated gases
TOTAL	52.9	39.8	6.8	5.1	1.2
Energy Supply	17.1	16.5	0.4	0.1	0.0
Agriculture and related land use	11.2	3.0	3.6	4.6	0.0
Transport (excluding international aviation and shipping)	10.5	10.4	0.0	0.1	0.0
Business and Industrial process	8.5	7.4	0.0	0.1	1.1
Business	8.1	6.9	0.0	0.1	1.1
Industrial Process	0.4	0.4	0.0	0.0	0.0
Residential	7.3	7.0	0.1	0.0	0.2
Waste Management	2.8	0.0	2.7	0.1	0.0
International Aviation and Shipping	2.4	2.3	0.0	0.0	0.0
International aviation	1.1	1.0	0.0	0.0	0.0
International Shipping	1.3	1.3	0.0	0.0	0.0
Development	1.7	1.7	0.0	0.0	0.0
Public	1.4	1.4	0.0	0.0	0.0
Forestry	-9.9	-10.0	0.0	0.0	0.0

Main points

Carbon dioxide was the main greenhouse gas emitter or sink in most sectors, with the exceptions of Agriculture and related land use and Waste Management.

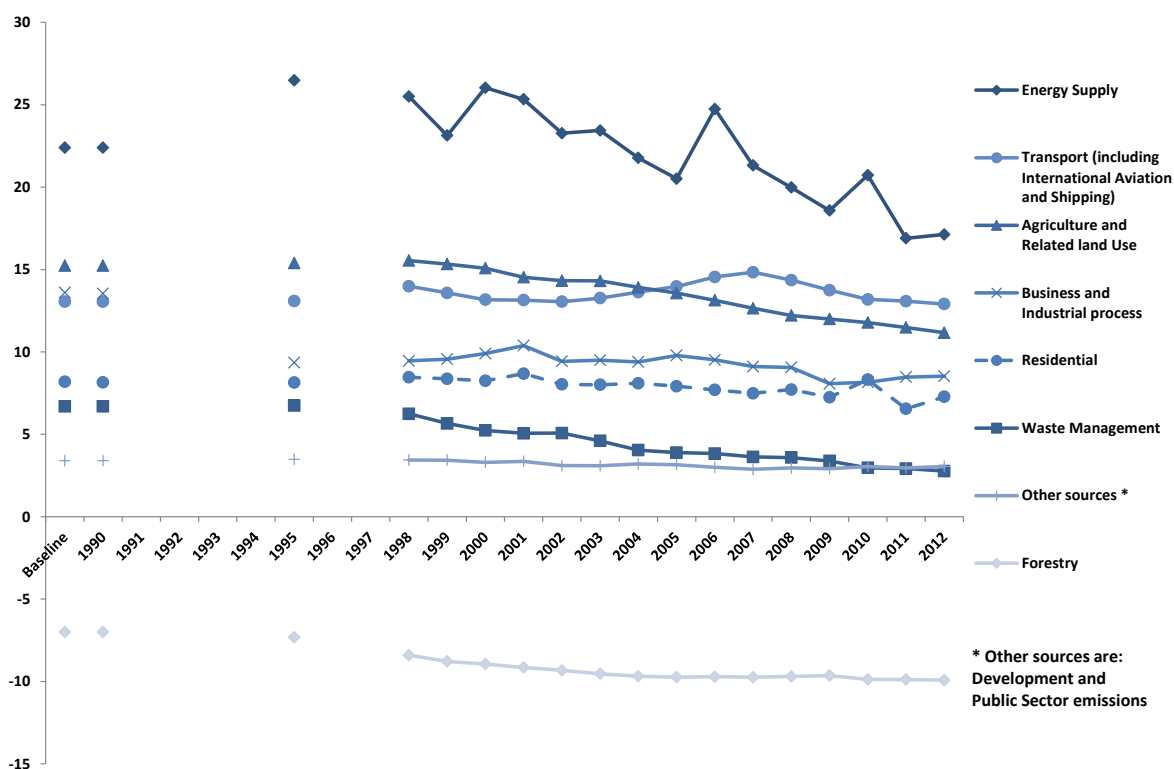
- Nitrous oxide was the main emitter in Agriculture and Related Land Use (4.6 Mt CO₂e), followed by methane (3.6 Mt CO₂e) and carbon dioxide (3.0 Mt CO₂e).
- Almost all emissions in the Waste Management sector were emitted in the form of methane (2.7 Mt CO₂e)

F gases were not the key emitters in any sector. Where these are emitted, it is in relatively small amounts via the Business and Industrial Process source sector, as well as the Residential sector.

Key Trends By Scottish Government Sector

Chart B2 presents the main sources of Scottish Greenhouse Gas Emissions in Scotland from 1990 to 2012, broken down by Scottish Government sector. Note that for the purposes of presentation, some sectors have been grouped together on the chart. Chart B6 contains information on the absolute and percentage reductions in greenhouse gas emissions in every Scottish sector over the entire time period, with Chart B7 containing the same information for the latest year.

Chart B2. Main Sources of Greenhouse Gas Emissions in Scotland, 1990 to 2012. Values in Mt CO₂e



Main Points

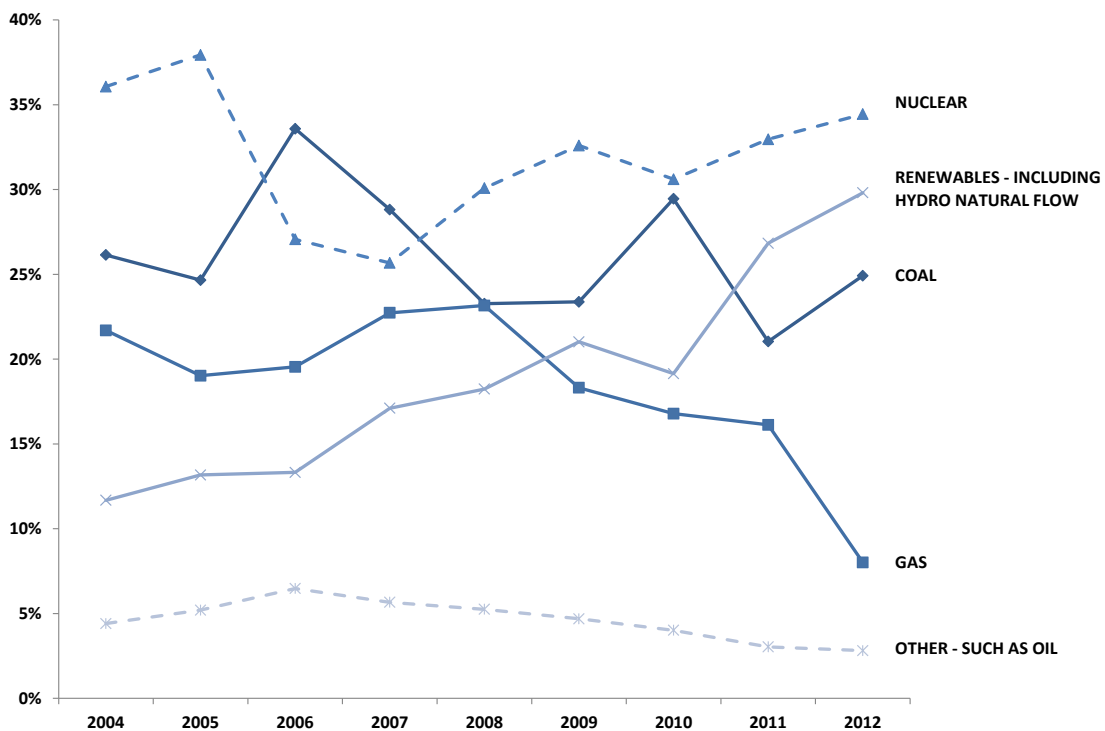
Most sectors exhibit a general downward trend between 1990 and 2012, most clearly evident since 1998.

- In all years, energy supply is the main source of greenhouse gas emissions. The chart shows that energy supply is a very volatile sector, which is linked to the ambient temperature, particularly during the winter months; and fuel used for electricity production, which in turn is largely driven by the price coal relative to “cleaner” fuels. Charts B3 and B4 demonstrate these effects in more detail.
- Most of the fall in emissions from the Business and Industrial Processes has occurred between 1990 and 1995. This has been driven by a decline in emissions from manufacturing and the iron and steel industry over this time period.

- Agriculture and related land use has seen a gradual decline between 1998 and 2012, which can be linked to a decline in cattle and sheep numbers and in fertiliser use.
- Emissions from transport (including international aviation and shipping) have seen little overall change between 1990 and 2012, emissions rose to a peak in 2007, before falling slightly. This peak was caused by changes in road transport emissions which in turn has been driven by a drop in new car registrations between 2007 and 2008.
- Waste management emissions have fallen between 1998 and 2012. This has been driven by the progressive introduction of methane capture within landfill management.

Chart B3 shows that the generation of Scotland’s electricity changes over time. Emissions from the electricity supply sector (such as power stations) are associated with these changes.

Chart B3. Generation of Electricity by Fuel, Scotland, 2004 to 2012. Percentage of Electricity Generated by Year



Data obtained from DECC Energy Trends, published December 2013²

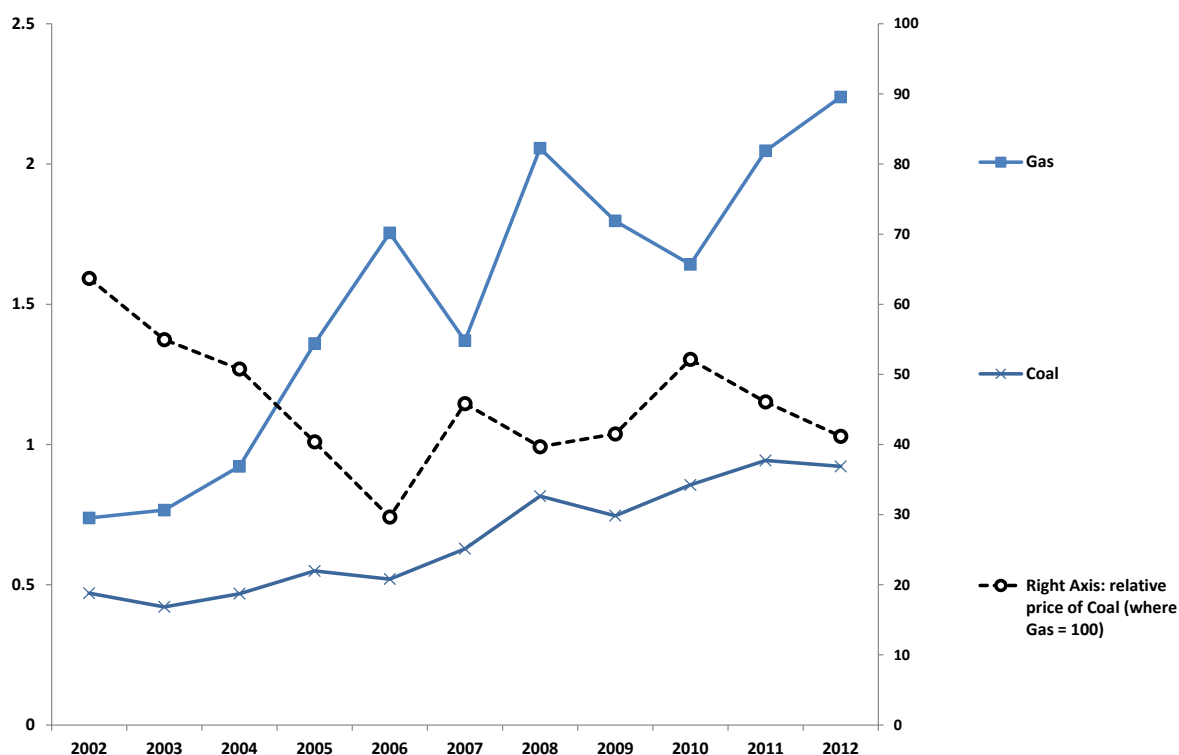
² <https://www.gov.uk/government/publications/energy-trends-december-2013-special-feature-article-electricity-generation-and-supply-figures-for-scotland-wales-northern-ireland-and-england-2>

Main Points

- There was a sharp decrease between 2011 and 2012 in the percentage of gas being used for Scotland’s electricity mix (from 16.1 per cent to 8.0 per cent). This follows a decline in the relative share of gas from 2006 onwards.
- There was an increase in the percentage of coal being used for the generation of electricity between 2011 and 2012 (from 21.0 per cent to 24.9 per cent). Overall, there has been an relative increase in the relative share of coal since 2005, although this series is volatile, with 29.5 per cent of Scottish electricity supply being fuelled by coal in 2010.
- The renewables sector (including hydro natural flow) has seen an overall increase from 11.7% in 2004 to 29.9% in 2012, and this increase has been greatest between 2010 and 2012.

Chart B4 shows the gas and coal prices for large users in the UK. The use of coal rather than gas in electricity generation can be sourced to these price effects in many cases.

Chart B4. Gas and Coal Prices for Large Users in the UK (2002 to 2012) – pence per kWh



Data obtained from DECC: Digest of UK Energy Statistics³

³ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/295522/qep314.xls

Long term (1990 to 2012) and short term (2011 to 2012) trends by sector

Chart B5 shows how emissions have changed between 1990 and 2012 in all source sectors and chart B6 shows how emissions have changed between 2011 and 2012.

Chart B5. Change in Emissions by Scottish Government Sector Between 1990 and 2012 – in Mt CO₂e, and percentage changes

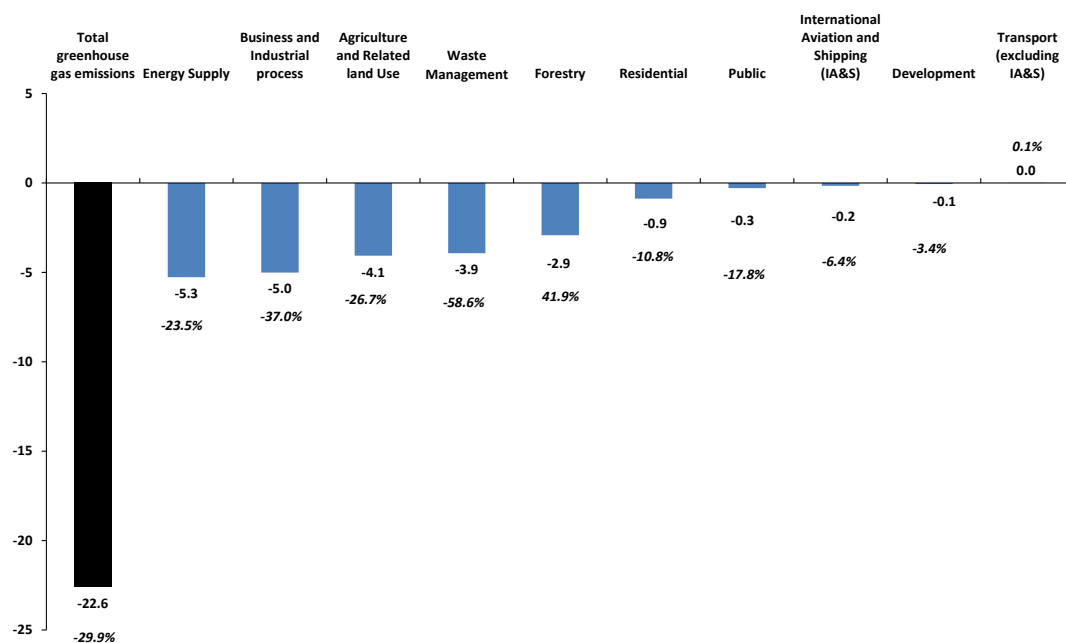
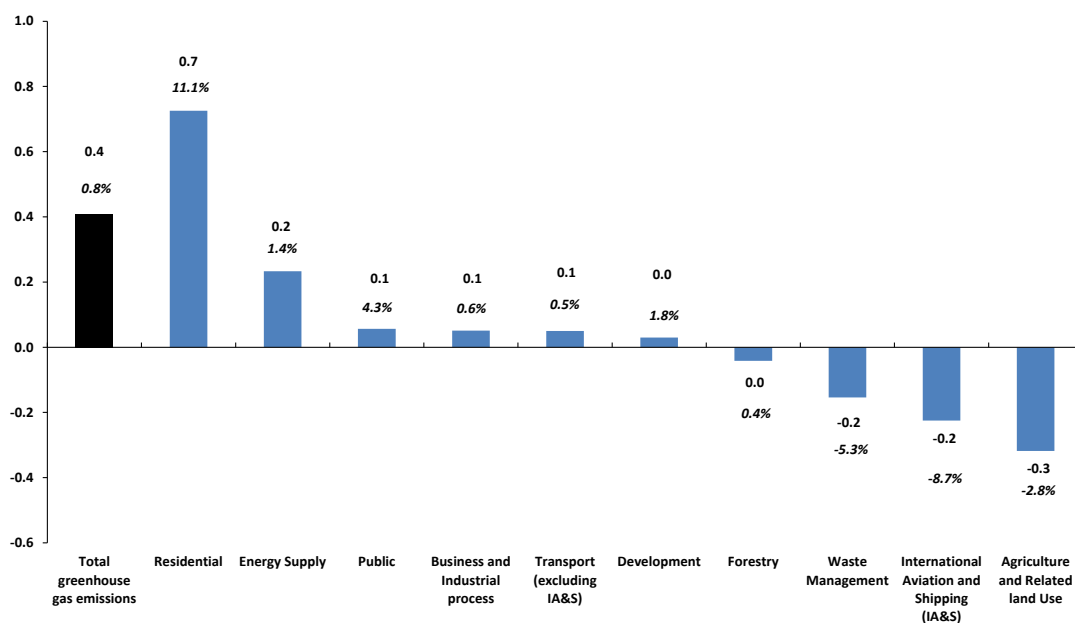


Chart B6. Change in Emissions by Scottish Government Sector between 2011 and 2012 - in Mt CO₂e, and percentage changes



Total Emissions

Overall, there has been a 22.6 Mt CO₂e (29.9 per cent) decrease in net emissions between 1990 and 2012 and there has been a 0.4 Mt CO₂e (0.8 per cent) increase in net emissions between 2011 and 2012.

Energy Supply

This sector has seen a 5.3 Mt CO₂e (23.5 per cent) fall in emissions between 1990 and 2012 – the biggest absolute fall of any sector. Between 2011 and 2012, there was a 0.2 Mt CO₂e (1.4 per cent) increase in energy supply emissions. Charts B2 to B4 shows that this series is very volatile and this is largely driven by changes in the fuel mix for electricity production.

Business and Industrial Process

This sector has seen a 5.0 Mt CO₂e (37.0 per cent) fall in emissions between 1990 and 2012. As shown in Chart B2, much of this decrease occurred between 1990 and 1995. There has been a decline in emissions from manufacturing and the iron and steel industry over this time period. Between 2011 and 2012, there was very little change in emissions in this sector (0.6 per cent increase)

Waste Management

This sector has seen a 3.9 Mt CO₂e (58.6 per cent) fall in emissions between 1990 and 2012 – the biggest percentage fall of any sector. There has been a reduction in landfill emissions and this has been achieved by the progressive introduction of methane capture within landfill management. Between 2011 and 2012, there was a fall of 0.2 Mt CO₂e (5.3 per cent), in line with the long-term decline.

Forestry

This sector has seen a 2.9 Mt CO₂e (41.9 per cent) increase in the carbon sink between 1990 and 2012. The majority of the sink arises from the large area of conifer plantations, which is subject to forest management such as thinning and varying harvesting rotations. There is an increasing trend in removals between 1990 and 2005, during which time there was harvesting of mature conifers planted in the 1920 to 1940s and a reduced rate of forest planting. Over the last 40 years the rate of afforestation has decreased. Combined with conifer plantations established in the mid-20th century reaching their planned rotation age now being felled and replanted, this has resulted in the size of this annual sink remaining relatively constant. Between 2011 and 2012, there was very little change in the size of the carbon sink from forestry.

Transport (Including International Aviation and Shipping)

Between 1990 and 2012, emissions from transport (including international aviation and shipping) have been fairly stable, although Chart B2 shows that emissions rose to a peak in

2007, before falling slightly. This has been caused by changes in road transport emissions which in turn has been driven by a drop in new car registrations between 2007 and 2008.

Breaking this category down further, between 1990 and 2012, there was no real change in transport emissions (excluding international aviation and shipping) and a 0.2 Mt CO₂e decrease in emissions from international aviation and shipping. International aviation emissions have more than doubled between 1990 and 2012 (from 0.5 Mt CO₂e to 1.1 Mt CO₂e). This reflects the growth in aviation and the increase in international routes at airports. Emissions from international shipping have fallen by 35.1 per cent between 1990 and 2012 (from 2.0 Mt CO₂e to 1.3 Mt CO₂e). This is primarily due to a decrease in Scotland's port freight movements.

In the latest year, there was a 0.1 Mt CO₂e increase in emissions from transport (excluding international aviation and shipping). This may be due to strong growth in transport demand but mitigated by improvements in efficiency of transport vehicles. There was a 0.2 Mt CO₂e (8.7 per cent) decrease in emissions from international aviation and shipping. It should be noted that the data series for international shipping is particularly volatile.

Agriculture and Related Land Use

This sector has seen a 4.1 Mt CO₂e (26.7 per cent) fall in net emissions between 1990 and 2012. This has been driven by a fall in emissions of methane (Chart B9) and nitrous oxide (Chart B10). Methane emissions from agriculture have fallen due to a decline in cattle and sheep numbers. Nitrous oxide emissions have fallen due to a decline in livestock numbers and nitrogen fertiliser use. Between 2011 and 2012, there was a 0.3 Mt CO₂e (2.8 per cent) decrease in net emissions in this sector. This has been mainly driven by a reduction in wheat production and the resulting reduction in emissions from crop residues and fertilisers.

Residential

This sector has seen a 0.9 Mt CO₂e (10.8 per cent) fall in emissions between 1990 and 2012. Between 2011 and 2012, there was 0.7 Mt CO₂e (11.1 per cent) increase in emissions from this sector. Residential emissions are partly generated by space-heating homes and thus are related to external temperatures. Mean annual temperatures in 2012 were 0.7°C lower than in 2011⁴. This is due to relatively colder weather in late autumn and early winter 2012 and a cold snap in April. As a result of this relationship to external temperatures, residential emissions can exhibit some large annual fluctuations.

⁴ Source Met Office:

<http://www.metoffice.gov.uk/pub/data/weather/uk/climate/datasets/Tmean/ranked/Scotland.txt>

Public Sector

This sector contributes a small proportion of Scotland's net greenhouse gas emissions. The was a 0.3 Mt CO₂e (17.8 per cent) fall in public sector emissions between 1990 and 2012. Between 2011 and 2012, there was an increase of 0.1 Mt CO₂e (4.3 per cent) in emissions from this sector. This is due to an increase in natural gas consumption in 2012 which is associated with colder winter temperatures in that year.

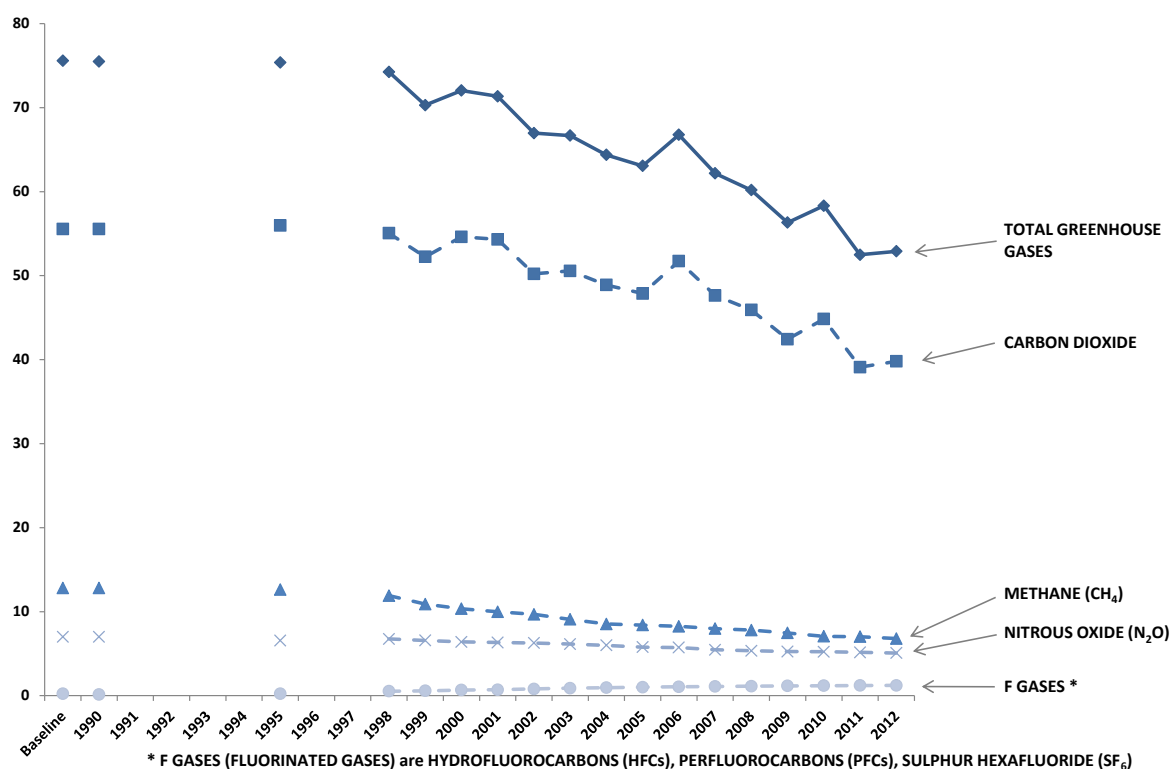
Development Emissions

This sector contributes to a small proportion of Scotland's net greenhouse gas emissions. There was a 0.1 Mt CO₂e decrease in development emissions between 1990 and 2012. Between 2011 and 2012, there was very little change in emissions from this sector.

Emissions by type of gas

Chart B7 shows the trends in emissions, broken down by gas from 1990 to 2012.

Chart B7. Scottish Greenhouse Gas Emissions, by Gas, 1990-2012. Values in Mt CO₂e



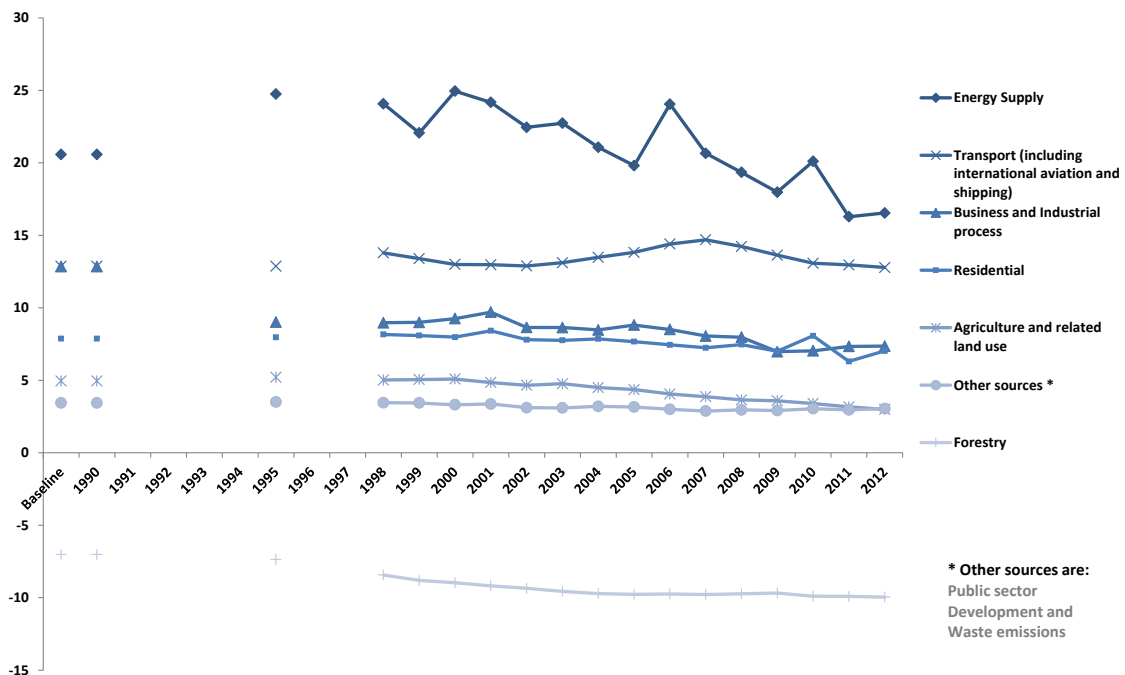
Main Points

- Carbon dioxide is by far the largest contributor of Scottish greenhouse gas emissions in all years (75.2 per cent of all emissions in 2012) and is the most volatile series of all gases – largely driven by changes in energy supply emissions and to a lesser extent, residential emissions.
- Methane in the second most common greenhouse gas in 2012 (12.9 per cent of all net emissions) followed by nitrous oxide (9.6 per cent) and F-gases making up the remainder (2.3 per cent).
- Methane has seen the largest percentage reduction from 1990 to 2012 (46.9 per cent), driven by a reduction in waste management emissions. There have been similar percentage reductions for both carbon dioxide (28.4 per cent) and nitrous oxide (27.4 per cent). Fluorinated gases have shown an 8-fold increase from 1990 to 2012 and this increase is driven by the introduction of hydrofluorocarbons (HFCs) from 1995 onwards. These HFCs replace chlorofluorocarbons (CFCs) which were banned by the Montreal Protocol due to their impact on the ozone layer.

Charts B8 to B11 present results on individual gases broken down by main Scottish government sector over time. Table B3 contains figures on all greenhouse gas emissions across the time series. Chart B8 shows how carbon dioxide emissions have changed from 1990 to 2012.

Carbon Dioxide (CO₂)

Chart B8. Carbon Dioxide (CO₂) Emissions by Scottish Government Sector, 1990 to 2012.
Values in Mt CO₂e

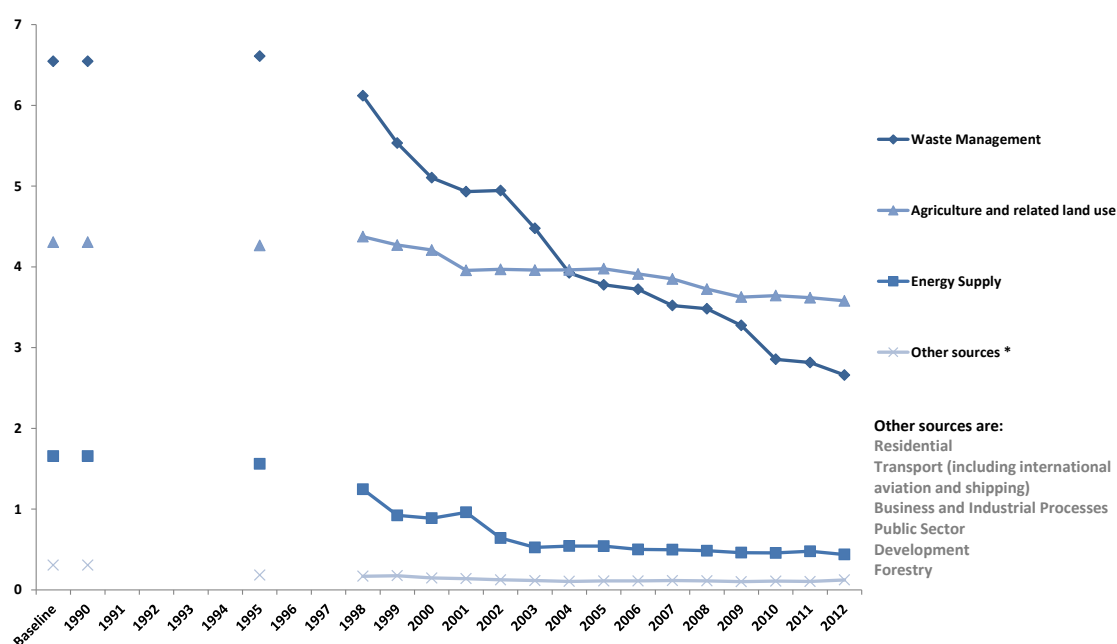


Main Points

- Chart B8 shows that energy supply is the key source of carbon dioxide emissions in all years between 1990 and 2012, followed by transport (including international aviation and shipping).
- Much of the decrease in carbon dioxide emissions between 1990 and 2012 has been driven by overall falls in the energy supply sector across the time period and in business and industrial processes between 1990 and 1995. Carbon dioxide emissions from the energy supply sector have been quite volatile over the time period, with the highest emissions occurring between 1995 and 2003, and a spike in 2006, related to a greater use of coal in that year.
- Forestry has been a net sink of carbon dioxide consistently between 1990 and 2012.

Methane (CH₄)

Chart B9. Methane (CH₄) Emissions by Scottish Government Sector, 1990 to 2012. Values in Mt CO₂e



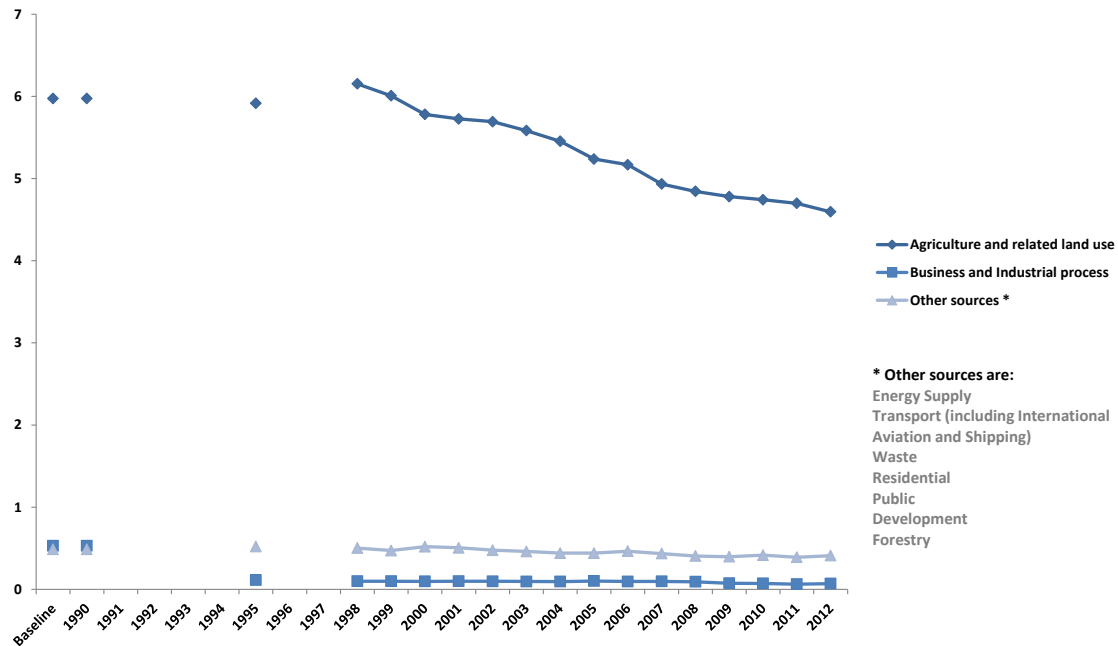
Main Points

- Methane emissions from waste management have fallen from 6.5 Mt CO₂e in 1990 to 2.7 Mt CO₂e in 2012 (a 59.4 per cent reduction) due to capture of methane from landfill.
- Methane emissions in the agriculture and related land use sector have fallen from 4.3 Mt CO₂e in 1990 to 3.6 Mt CO₂e in 2012.

- In the Energy Supply sector, methane emissions have fallen from 1.7 Mt CO₂e in 1990 to 0.4 Mt CO₂e in 2012.

Nitrous Oxide (N₂O)

Chart B10. Nitrous Oxide (N₂O) Emissions by Scottish Government Sector, 1990 to 2012.
Values in Mt CO₂e

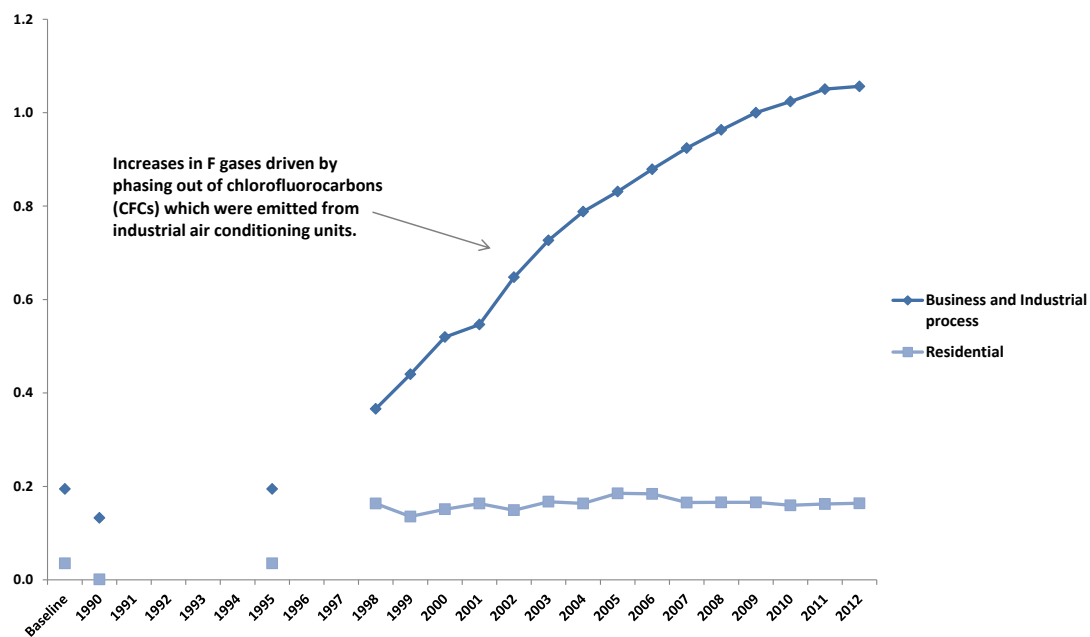


Main Points

- Agriculture and related land use is by far the main contributor to emissions of nitrous oxide.
- Emissions of nitrous oxide in this sector have fallen from 6.0 Mt CO₂e in 1990 to 4.6 Mt CO₂e in 2012 and has been driven by a decline in livestock numbers and in nitrogen fertiliser use.
- Business and industrial processes have seen a fall from 0.5 Mt CO₂e in 1990 to 0.1 Mt CO₂e in 2012.

Fluorinated gases (F-gases)

Chart B11. F-gas Emissions by Scottish Government Sector, 1990 to 2012. Values in Mt CO₂e



* F GASES (FLUORINATED GASES) are HYDROFLUOROCARBONS (HFCs), PERFLUOROCARBONS (PFCs), SULPHUR HEXAFLUORIDE (SF₆)

** Note: the Baseline for F gases is 1995 rather than 1990.

Main Points

- F gas emissions in Scotland contribute less to global warming than other greenhouse gases. They are the most potent gases with high global warming potentials but they are emitted in very small quantities.
- There has been a sharp increase in F gas emissions from business and industrial processes from 1990 and 2012 (0.1 Mt CO₂e in 1990 to 1.1 Mt CO₂e in 2012), although the year-on-year rate of increase is slowing in recent years. This is because F gases were introduced to replace chlorofluorocarbons (CFCs), which were used in, amongst others, industrial air conditioning units. CFCs were banned under the Montreal Protocol, as they were contributing to the depletion of the ozone layer.
- F gas emissions in the residential sector are caused by the use of aerosols and metered dose (usually asthma) inhalers.

Table B2. Greenhouse Gas Emissions in Scotland by source sector: 1990 to 2012. Values in Mt CO₂e

Source Sector	Baseline	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Change between 1990 and 2012	% change between 1990 and 2012
Total greenhouse gas emissions	75.6	75.5	75.4	74.2	70.3	72.0	71.3	67.0	66.7	64.4	63.1	66.8	62.2	60.2	56.3	58.3	52.5	52.9	-22.6	-29.9%
Energy Supply	22.4	22.4	26.5	25.5	23.1	26.0	25.3	23.3	23.4	21.8	20.5	24.7	21.3	20.0	18.6	20.7	16.9	17.1	-5.3	-23.5%
Agriculture and Related land Use	15.2	15.2	15.4	15.5	15.3	15.1	14.5	14.3	14.3	13.9	13.6	13.1	12.7	12.2	12.0	11.8	11.5	11.2	-4.1	-26.7%
Business and Industrial process	13.6	13.5	9.3	9.5	9.6	9.9	10.4	9.4	9.5	9.4	9.8	9.5	9.1	9.1	8.1	8.2	8.5	8.5	-5.0	-37.0%
Residential	8.2	8.2	8.1	8.5	8.4	8.2	8.7	8.0	8.0	8.1	7.9	7.7	7.5	7.7	7.3	8.3	6.6	7.3	-0.9	-10.8%
Waste Management	6.7	6.7	6.7	6.2	5.7	5.2	5.1	5.1	4.6	4.0	3.9	3.8	3.6	3.6	3.4	3.0	2.9	2.8	-3.9	-58.6%
Transport	13.1	13.1	13.1	14.0	13.6	13.2	13.1	13.1	13.3	13.6	14.0	14.5	14.8	14.4	13.8	13.2	13.1	12.9	-0.2	-1.2%
Transport (excluding IA&S)	10.5	10.5	10.5	10.9	11.0	10.9	10.8	11.1	11.2	11.3	11.4	11.6	11.9	11.3	10.9	10.7	10.5	10.5	0.0	0.1%
International Aviation and Shipping (IA&S)	2.5	2.5	2.5	3.1	2.6	2.3	2.3	1.9	2.1	2.4	2.6	3.0	2.9	3.1	2.9	2.5	2.6	2.4	-0.2	-6.4%
Other sources *	3.4	3.4	3.5	3.4	3.4	3.3	3.4	3.1	3.1	3.2	3.2	3.0	2.9	3.0	2.9	3.0	3.0	3.0	-0.4	-10.4%
Development	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.7	1.7	-0.1	-3.4%
Public	1.7	1.7	1.8	1.7	1.7	1.6	1.7	1.4	1.4	1.5	1.5	1.4	1.3	1.4	1.3	1.4	1.3	1.4	-0.3	-17.8%
Forestry	-7.0	-7.0	-7.3	-8.4	-8.8	-8.9	-9.1	-9.3	-9.5	-9.7	-9.7	-9.7	-9.7	-9.7	-9.6	-9.9	-9.9	-9.9	-2.9	41.9%

Table B3. Scottish Greenhouse Gases, by gas, 1990 to 2012. Values in Mt CO₂e

	Baseline	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	% Change from 1990 to 2012 (in Mt CO ₂ e)	Share of Greenhouse Gases, 2012
Total Greenhouse Gases	75.6	75.5	75.4	74.2	70.3	72.0	71.3	67.0	66.7	64.4	63.1	66.8	62.2	60.2	56.3	58.3	52.5	52.9	-29.9%	100.0%
Carbon dioxide (CO ₂)	55.6	55.6	56.0	55.1	52.2	54.6	54.3	50.2	50.6	48.9	47.9	51.7	47.6	45.9	42.4	44.8	39.1	39.8	-28.4%	75.2%
Methane (CH ₄)	12.8	12.8	12.6	11.9	10.9	10.3	10.0	9.7	9.1	8.5	8.4	8.2	8.0	7.8	7.5	7.1	7.0	6.8	-46.9%	12.9%
Nitrous oxide (N ₂ O)	7.0	7.0	6.5	6.8	6.6	6.4	6.3	6.3	6.1	6.0	5.8	5.7	5.5	5.3	5.3	5.2	5.2	5.1	-27.4%	9.6%
* F gases	0.2	0.1	0.2	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.2	812.6%	2.3%
<i>of which</i> HFCs	0.1	0.0	0.1	0.4	0.4	0.5	0.6	0.7	0.8	0.8	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.1	124357%	2.1%
PFCs	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	-54.9%	0.1%
SF ₆	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.3%	0.1%

Note on F-gases:

HFCs are hydrofluorocarbons

PFCs are perfluorocarbons

SF₆ is sulphur hexafluoride

Section C. Estimated Emissions Adjusted for Trading Within the EU Emissions Trading System (EU ETS)

What is the EU Emissions Trading System (EU ETS)?

Launched in 2005, the EU ETS is an EU policy aimed at mitigating climate change by limiting greenhouse gas emissions from industry sectors and aviation. Participants include more than 11,000 heavy energy-using installations in power generation, the manufacturing industry and airlines across 31 countries in the European Economic Area (EEA).

How does it work?

The EU ETS is a 'cap and trade' system. A limit (cap) is placed on the overall volume of emissions from participants in the system. Within the cap, organisations receive or buy emissions allowances which they can trade (1 emissions allowance equals 1 tCO₂e). Each year, an organisation must surrender enough allowances to cover its emissions. The cap is reduced each year so that by 2020, the volume of emissions permitted within the system will be 21% lower than in 2005. The reducing cap alongside the financial considerations of trading emissions allowances, incentivises organisations within the system to find the most cost effective way of reducing their emissions.

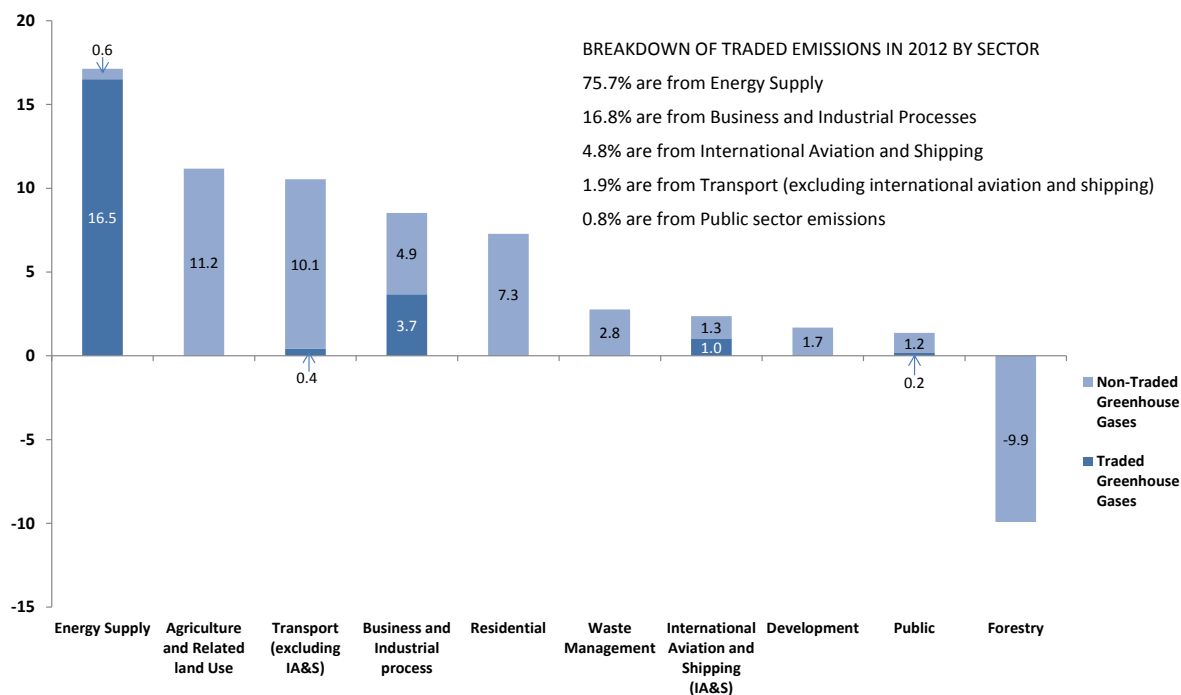
Scotland in the EU ETS

The EU ETS contributes to delivering Scotland's Climate Change Targets through incentivising the reduction in emissions from Scottish organisations participating in the system. In 2012, there were 86 Scottish installations that surrendered emissions allowances in the EU ETS.

What are 'traded emissions' and 'non-traded emissions'?

In the greenhouse gas inventory, source emissions can be categorised into traded and non-traded. Traded emissions capture those that come from installations covered by the EU ETS, whereas Non-traded emissions are those which do not fall within the scope of the EU ETS. The emissions from some sectors, such as the residential sector, are completely non-traded whereas emissions from other sectors, such as energy supply, business and industrial process are a combination of traded and non-traded. For 2012, CO₂ emissions from domestic and international aviation are estimated as being within the traded sector.

Chart C1. Traded and Non-Traded Greenhouse Gas Emissions by Scottish Government Sector, 2012 - Values in Mt CO₂e

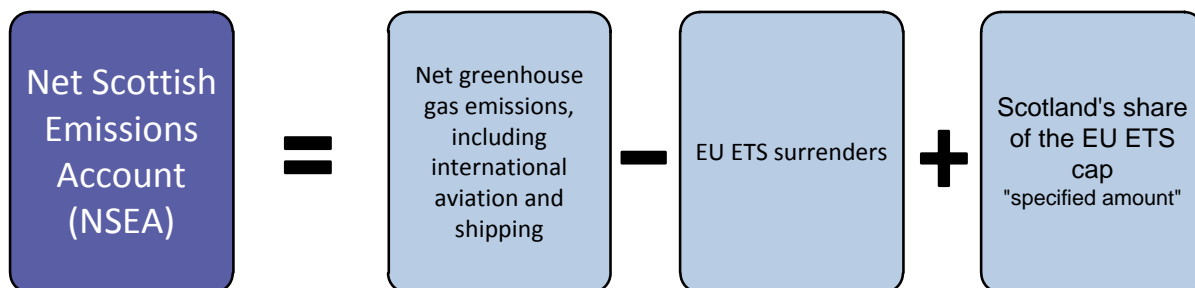


What are adjusted emissions and the Net Scottish Emissions Account (NSEA)?

The Scottish climate change targets are assessed against the Net Scottish Emissions Account (NSEA), which is detailed in the Climate Change (Scotland) Act 2009 and has been reported for the years 2010, 2011 and 2012 as part of the Act. The NSEA accounts for the greenhouse gas emissions from sources in Scotland, Scotland's share of emissions from international aviation and international shipping, the effect of any relevant emissions removals (e.g. "carbon sinks" such as woodland) and the effect of the sale and purchase of relevant carbon units (tradable emissions allowances) in the EU ETS.

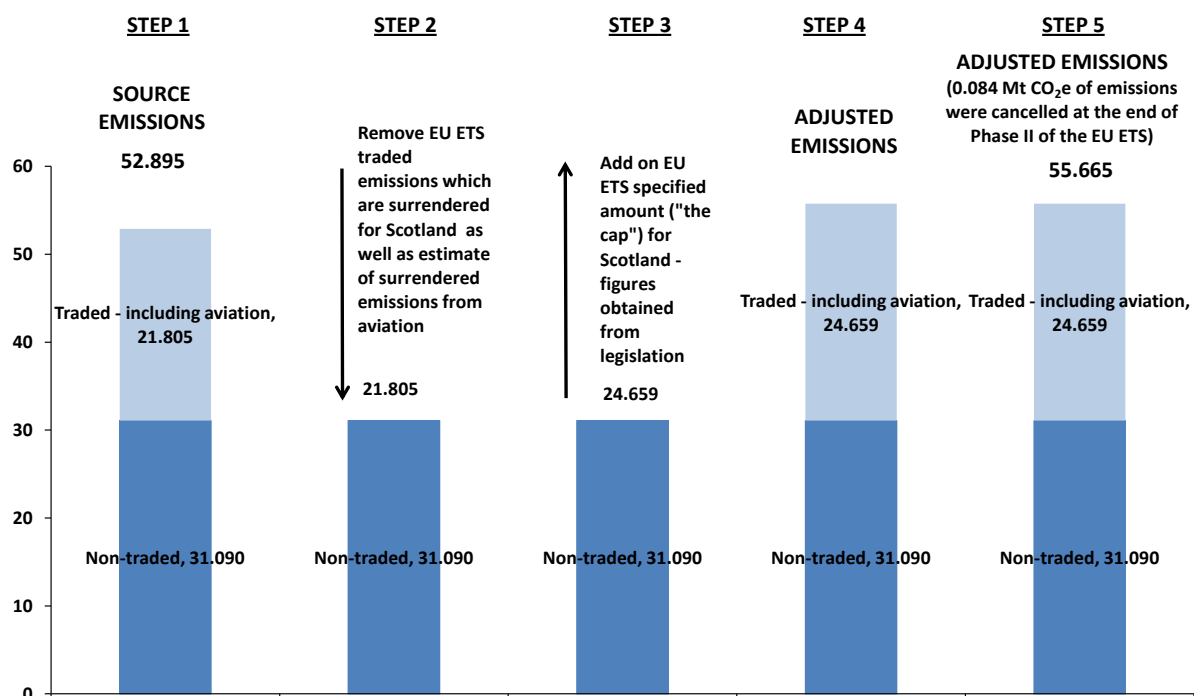
The EU ETS element of the NSEA is calculated by taking the difference between Scotland's notional share of the overall EU ETS cap and the number of emissions allowances surrendered from Scottish installations in a given year. This amount is then added to non-traded net emissions to get the NSEA.

The NSEA formula is as follows:



For 2012 emissions, the calculation of the NSEA are known as adjusted emissions, as they are adjusted to take into account of trading with the EU ETS. This adjustment takes the form of a 5-step process, which is outlined in Chart C2.

Chart C2. Calculation of Adjusted Emissions for Trading in the EU Emissions Trading System (EU ETS), 2012. Values in Mt CO₂e



Calculation of adjusted emissions

STEP 1

Take the Scottish greenhouse gas emissions from Scottish greenhouse gas inventory (for 2012, it is 52.895 Mt CO₂e). This figure has been comprised of:

- traded emissions units surrendered from Scottish Environment Protection Agency (SEPA) for fixed installations (20.349 Mt CO₂e)
- an estimation of surrendered CO₂ emissions from domestic and international aviation (1.456 Mt CO₂e)
- non-traded emissions from sources such as residential emissions (31.090 Mt CO₂e)

STEP 2

Remove an amount relating to surrendered emissions as well as an estimate of surrendered emissions from aviation. This amounts to 21.805 Mt CO₂e

STEP 3

Add on the value of the EU ETS cap which is the specified amount within The Carbon Accounting Scheme (Scotland) Regulations 2010. The specified amount is the amount of permitted CO₂e emissions by the traded sector for a given year. For 2012, this was 24.659 Mt CO₂e.

STEP 4

Adding on the value of the EU ETS cap gives a value of 55.749 Mt CO₂e.

STEP 5

At the end of Phase II of the EU ETS in 2012, the UK was required to cancel all allowances which have not been either issued or auctioned by that point. These cancelled allowances have the effect of reducing the overall cap for the whole of Phase II. For presentational purposes, this amount has been distributed evenly over the five years of Phase II, effectively reducing the cap for Scotland by 0.084 MtCO₂e each year from 2008 to 2012.

In 2012, the adjusted emissions to take into account of trading in the EU ETS in 2012 is 55.665 Mt CO₂e. This is 2.770 Mt CO₂e higher than the value of estimated source emissions in 2012.

Scottish Climate Change Targets

Scotland has a number of targets for reducing greenhouse gas emissions contained in legislation, within the Climate Change (Scotland) Act 2009. These targets can be summarised as follows:

The Act creates a statutory framework for greenhouse gas emissions reductions in Scotland by setting an interim target of at least a 42 per cent reduction for 2020, and at least an 80 per cent reduction target for 2050. These reductions are based on a 1990 baseline (1995 for the F-Gases). The Act also requires that Scottish Ministers set fixed annual targets for emissions at least 12 years in advance.

In October 2010 the Scottish Parliament passed legislation setting the first batch of annual targets, for the years up to 2022⁵. Targets for 2023-2027 were set in October 2011⁶, and will continue to be set at 5-year intervals.

The 2012 target is 53.226 MtCO₂e.

Achievement of Scotland's targets is measured against the level of the Net Scottish Emissions Account (NSEA). There is a limit on the net amount of carbon units that may be credited to the NSEA in addition to those from the EU Emissions Trading System. The Climate Change (Limit on Carbon Units) (Scotland) Order 2010⁷ specifies that the net amount of carbon units that may be credited to the Net Scottish Emissions Account for the period 2010-2012 is zero. The Climate Change (Limit on Carbon Units) (Scotland) Order 2011⁸ sets limits for the period 2013-2017.

⁵ The Climate Change (Annual Targets) (Scotland) Order 2010, SSI 2010 no. 359:
<http://www.legislation.gov.uk/ssi/2010/359/contents/made>

⁶ The Climate Change (Annual Targets) (Scotland) Order 2011, SSI 2011 no. 353:
<http://www.legislation.gov.uk/ssi/2011/353/contents/made>

⁷ The Climate Change (Limit on Carbon Units) (Scotland) Order 2010, SSI 2010 no. 217:
<http://www.legislation.gov.uk/ssi/2010/217/contents/made>

⁸ The Climate Change (Limit on Carbon Units) (Scotland) Order 2011, SSI 2011 no. 440:
<http://www.legislation.gov.uk/ssi/2011/440/contents/made>

Chart C3 contains data from the latest (1990-2012) inventory, adjusted for trading in the EU Emissions Trading System as well as progress against the 42 per cent and 80 per cent reduction targets. These percentage targets are based on a percentage reduction from the Baseline in the latest inventory.

Chart C3. Percentage Reductions Targets – Based on Adjusted Emissions. Values in Mt CO₂e

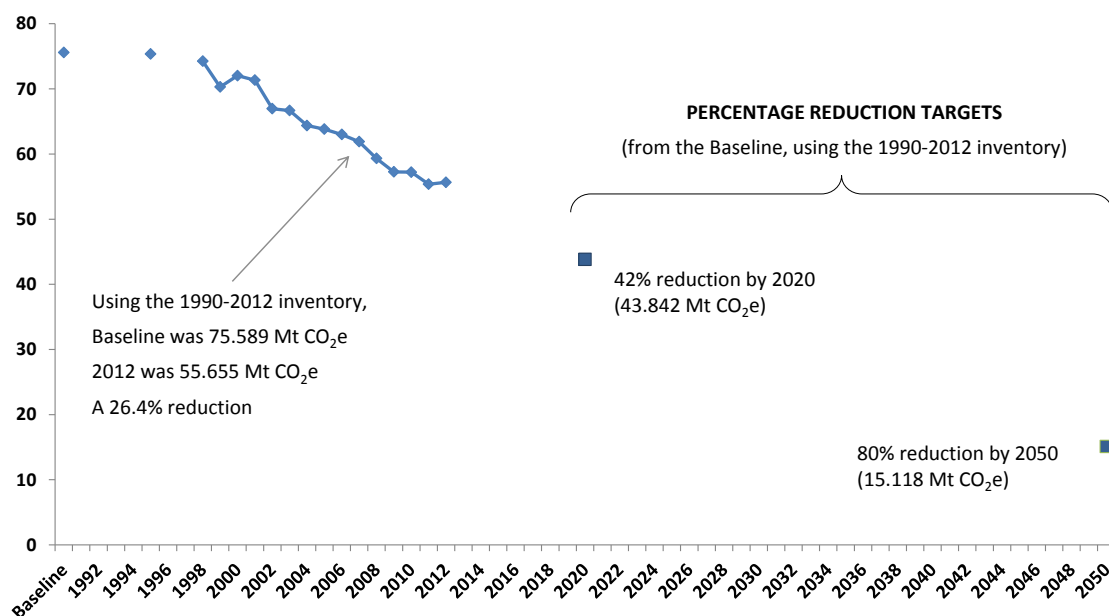
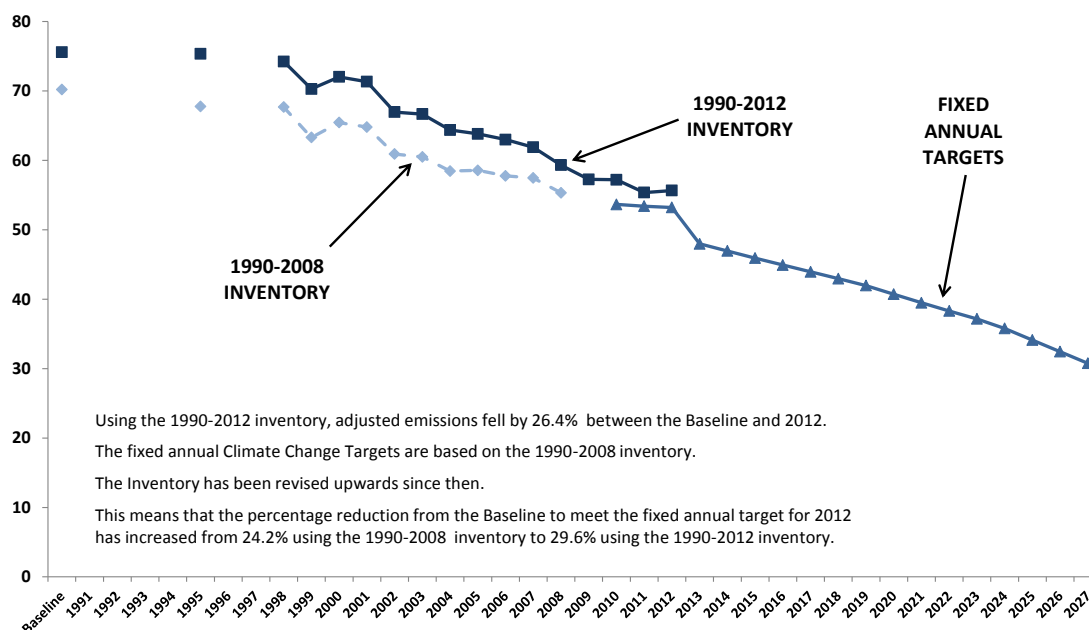


Chart C4 contains data from the latest (1990-2012) inventory, adjusted for trading in the EU Emissions Trading System. The fixed annual targets are also presented on this chart. The fixed annual targets were set at the time of the 1990-2008 inventory. Emissions adjusted for trading in the EU ETS using the 1990-2008 are shown for context.

Chart C4. Comparison of Adjusted Emissions and the Fixed Annual Targets which are based on the 1990-2008 Inventory. Values in Mt CO₂e



National performance framework sustainability purpose targets

In addition to the statutory Climate Change Targets, these statistics are used to monitor progress against the Scottish Government's Sustainability Purpose Targets

There are two targets:

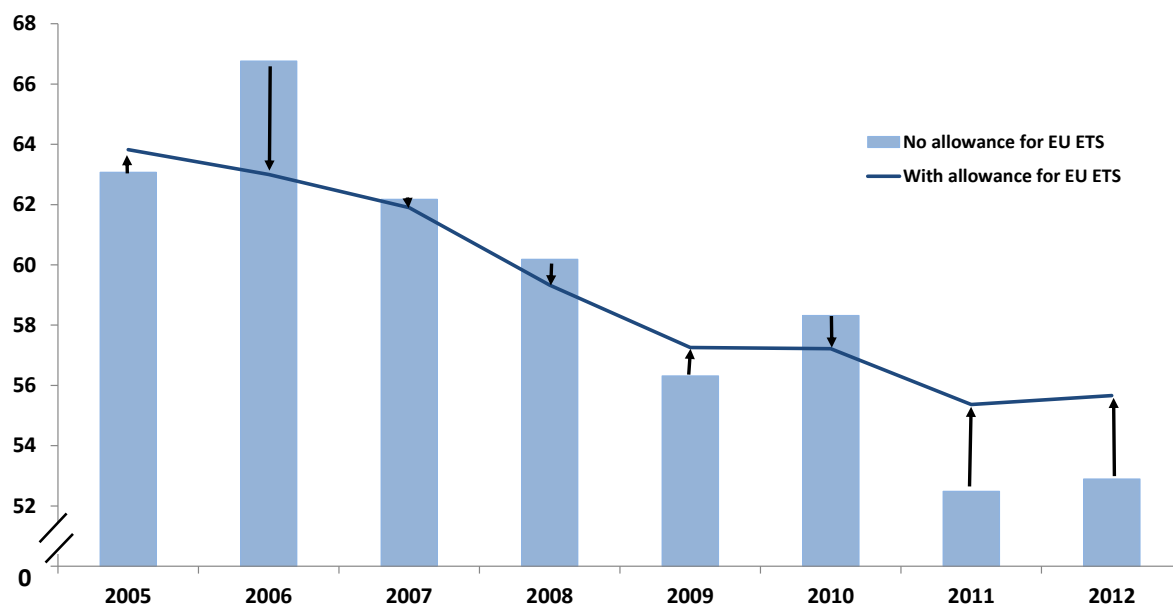
- The long term target (2050) now equates to the target in the Climate Change (Scotland) Act 2009.
- The Scottish Government has also set a short term target to reduce emissions by 2011 compared with a 2006 baseline.

Information on progress towards these targets can be found on the [Scottish Government Scotland Performs](#) website.

Effect of the adjustment to take into account of trading in the EU Emissions Trading System

Chart C5 demonstrates the smoothing effect of the adjustment for trading in the EU ETS, for calculation of the Net Scottish Emissions Account (NSEA).

Chart C5. Greenhouse Gases Adjusted for the Emissions Trading System (EU ETS). Values in Mt CO₂e



In four of the last 8 years, the adjustment has increased reported emissions, with the latest two years (2011 and 2012) showing sizeable increases from the adjustment.

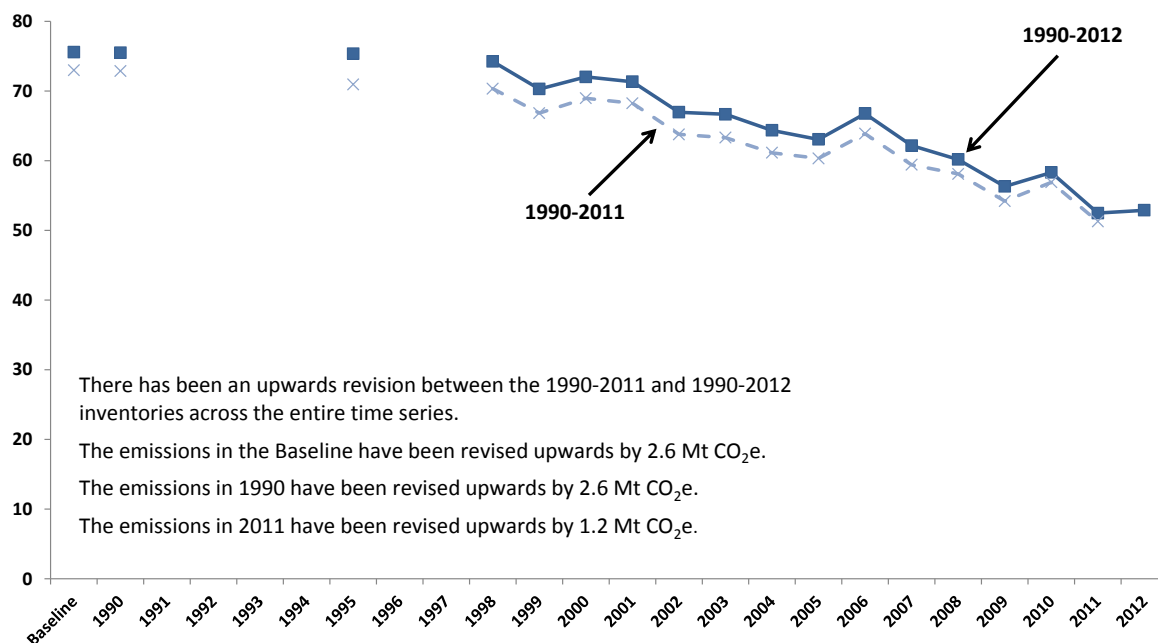
Table C1. Scottish greenhouse gas emissions adjusted to take account of trading in the EU Emissions Trading System. Baseline to 2012. Values in Mt CO₂e

		Baseline	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
No allowance for EU ETS	Total Scottish greenhouse gas emissions (including international aviation and shipping)	75.6	75.4	74.2	70.3	72.0	71.3	67.0	66.7	64.4	63.1	66.8	62.2	60.2	56.3	58.3	52.5	52.9	
	Percentage change from baseline		-0.3%	-1.8%	-7.0%	-4.7%	-5.6%	-11.4%	-11.8%	-14.8%	-16.6%	-11.7%	-17.7%	-20.4%	-25.5%	-22.8%	-30.6%	-30.0%	
	Differences between EU ETS cap and EU ETS surrendered emissions for Scotland										0.6	-4.0	-0.5	-0.8	1.0	-1.0	3.0	2.9	
	Scottish share of net purchases/(sales) by UK Government at the end of Phase I of EU ETS										0.2	0.2	0.2						
	Scottish share of cancelled allowances by UK Government at the end of Phase II of EU ETS														-0.1	-0.1	-0.1	-0.1	-0.1
	Differences between EU ETS cap and traded emissions for Scotland - adjustment to emissions											0.8	-3.8	-0.3	-0.9	0.9	-1.1	2.9	2.8
With allowance for EU ETS	Total Scottish greenhouse gas emissions	75.6	75.4	74.2	70.3	72.0	71.3	67.0	66.7	64.4	63.8	63.0	61.9	59.3	57.3	57.2	55.4	55.7	
	Percentage change from baseline		-0.3%	-1.8%	-7.0%	-4.7%	-5.6%	-11.4%	-11.8%	-14.8%	-15.6%	-16.7%	-18.1%	-21.5%	-24.2%	-24.3%	-26.7%	-26.4%	

Section D. Revisions Since the Last Inventory

This section examines key revisions in estimated source emissions between the latest inventory (1990-2012) and the previous inventory (1990-2011) published in June 2013. Chart D1 shows the impact of the revisions on Scottish greenhouse gas emissions between 1990-2011 and 1990-2012 inventories.

Chart D1. Scottish Greenhouse Gas Emissions. Comparison of 1990-2011 and 1990-2012 Inventories. Values in Mt CO₂e

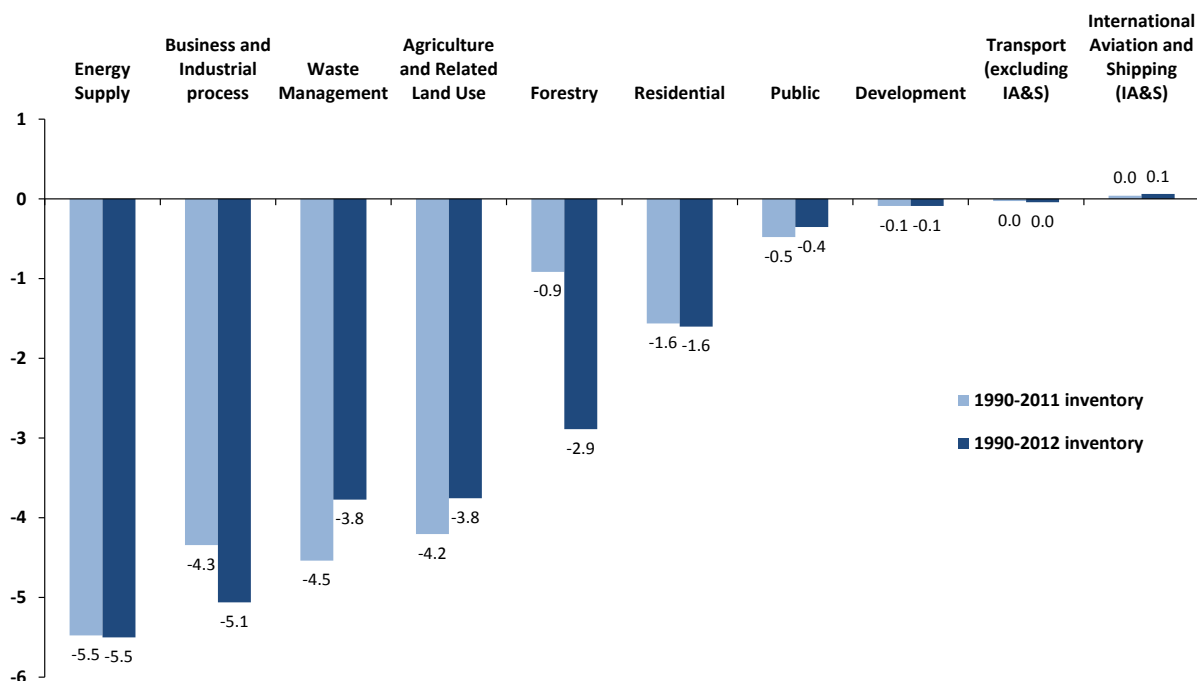


Main Points

- Between the latest and previous inventories, the extent of revisions to 1990 and the baseline are greater than those to 2011 (for 1990, an upwards revision of 2.6 Mt CO₂e; for the baseline, an upwards revision of 2.6 Mt CO₂e; for 2011, and an upwards revision of 1.2 Mt CO₂e)
- Using the previous inventory, the overall reduction in emissions between 1990 and 2011 was 21.6 Mt CO₂e (29.6 per cent)
- Using the latest inventory, the overall reduction in emissions between 1990 and 2011 was 23.0 Mt CO₂e (30.5 per cent)

Chart D2 shows the overall reduction in emissions between 1990 and 2011 using both the previous and latest inventories by Scottish Government sector.

Chart D2. Change in Emissions Between 1990 and 2011 by Scottish Government Sector. Comparison of the 1990-2011 and 1990-2012 Inventories. Values in Mt CO₂e



Main Points

- For both inventories, the greatest absolute reduction in emissions continues to be found within the Energy Supply sector, with this sector being relatively immune to revision in the latest inventory.
- The magnitude of the reduction in emissions is greater in the latest inventory for Business and Industrial Processes sector (5.1 Mt CO₂e compared with a 4.3 Mt CO₂e in the previous inventory).
- For the forestry sector, there has been an increase in the rate at which CO₂ has been sequestered (captured) over time. Chart D2 shows that the amount of CO₂ sequestered has increased over the period in the forestry sector from 0.9 Mt CO₂e to 2.9 Mt CO₂e.
- The size of the absolute reduction has decreased between the latest and previous inventories for the Waste Management sector (from 4.5 Mt CO₂e to 3.8 Mt CO₂e) and for Agriculture and Related Land Use (from 4.2 Mt CO₂e to 3.8 Mt CO₂e).
- For the other sectors, there has been little or no change in the magnitude of emissions increases or reductions between the two inventories.

Table D1. Impact of revisions to the latest inventory (net source emissions), by Scottish Government sector. Values in Mt CO₂e

Source Sector	Previous inventory (1990-2011)			Latest inventory (1990-2012)		
	1990	2011	% changes. 1990 to 2011	1990	2011	% changes. 1990 to 2011
Total net greenhouse gas emissions	72.9	51.3	-29.6%	75.5	52.5	-30.5%
Energy Supply	22.4	16.9	-24.4%	22.4	16.9	-24.6%
Transport (excluding IA&S)	10.5	10.5	-0.2%	10.5	10.5	-0.4%
International Aviation and Shipping (IA&S)	2.4	2.5	1.7%	2.5	2.6	2.4%
Business and Industrial process	13.6	9.2	-32.0%	13.5	8.5	-37.4%
Residential	8.1	6.6	-19.2%	8.2	6.6	-19.6%
Public	1.2	0.7	-39.1%	1.7	1.3	-21.2%
Waste Management	6.7	2.2	-67.6%	6.7	2.9	-56.4%
Development	1.7	1.7	-5.0%	1.7	1.7	-5.1%
Agriculture and Related land Use	14.3	10.1	-29.3%	15.2	11.5	-24.6%
Forestry	-8.2	-9.1	11.1%	-7.0	-9.9	41.3%

Main Points

- This table presents the same overall messages as Chart D2 but with some additional points.
- When comparing the two inventories, the extent to which greenhouse gas emissions have been revised upwards is greater for 1990 than for 2011.
- The size of the carbon sink for Forestry in 1990 has decreased by 1.2 Mt CO₂e. However, as previously noted, the rate of carbon sequestration from this revised starting point has been greater in the latest inventory than last year's inventory.
- For the Agriculture and Related Land Use sector, net emissions in 1990 have been revised upwards between the previous and latest inventories by 0.9 Mt CO₂e. The extent of this upwards revision is greater for 2011 (an increase of 1.3 Mt CO₂e).
- For the Waste Sector, net emissions in 1990 have remained broadly the same between the two inventories. However, the 2011 value has been revised upwards by 0.7 Mt CO₂e. This results in a lower percentage reduction in this sector across the time period.
- Percentage reductions between 1990 and 2011 in the Business and Industrial Processes sector are greater in the latest inventory (37.4 per cent in the latest inventory; compared to 32.0 per cent in the previous inventory). There has been little change to the 1990 figure for this sector.

- There has been an increase to the public sector emissions for both 1990 and 2011. The percentage reduction in the latest inventory is also lower (from 39.1 per cent in the previous inventory to 21.2 per cent in the latest inventory).

A complete list of the revisions between the previous and latest inventories can be found in the National Atmospheric Emissions Inventory website⁹. Details of the most notable revisions are listed below:

Agriculture and Related Land Use

Estimates of methane (CH₄) emissions have increased. This is due to the revision in the allocation of manure in various cattle management systems. Previous information about the location of this waste has been superseded, with a knock-on effect on the quantity of methane emissions.

Waste Management

There have been higher estimates of methane (CH₄) emissions from landfills in recent years (with much lower revisions for the early part of the time series). This is because data are now available on methane directly emitted from landfill gas collected and burnt in landfill gas engines and flares. Previously, emissions were estimated using energy statistics on landfill gas use in generation and landfill gas capture rate assumptions and derived gas flaring volumes.

Forestry

Revisions affect the size of the net CO₂ sink from forestry, which cause the size of the reductions to increase. This is due to a change in the methodology in models of forest land area. There is now a better representation of forest areas which have been existence before 1920. There is a better distribution of tree species, growth rates and forest management practices and a better estimation of the capture and storage of carbon within forest soils.

Public Sector

Revisions affect CO₂ emissions. There has been an increase in public sector emissions since 2008 to take into account a revision in the natural gas consumption data. This revision has been caused by a reallocation of the economic classification of some buildings which consume natural gas in the underlying energy statistics. This has led to an increase in buildings classed as public sector, with a corresponding decrease in other buildings. Additionally, there have been improvements in energy mapping analysis such as the inclusion of new datasets such as Display Energy Certificates. These have over-written previous energy modelling assumptions on building energy demand, have led to a higher allocation of public sector emissions to Scotland than was previously estimated.

⁹ http://naei.defra.gov.uk/reports/reports?report_id=756

Business and Industrial Processes

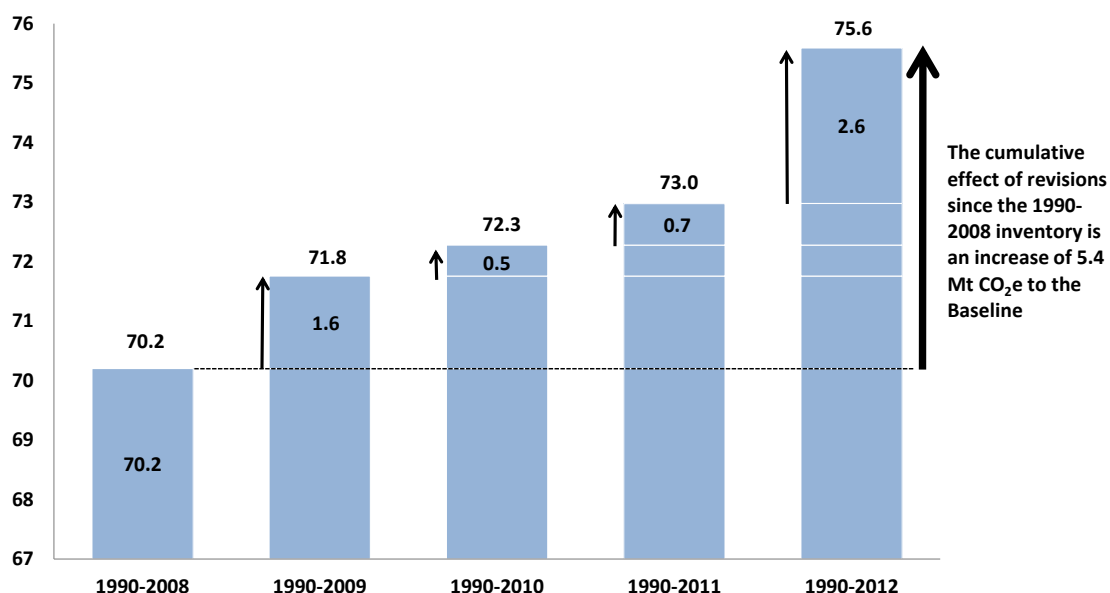
The revisions affect CO₂ emissions . There has been an increase in emissions from industrial and commercial buildings due to improved energy modelling using new data such as those on Energy Performance Certificates. The extent of this increase has not been as great as for public sector combustion from 2008 onwards, as some consumers of natural gas have been reallocated from commercial businesses to public sector combustion in the underlying energy statistics.

There has been some reallocation of emissions within the Business and Industrial Processes sector, from Manufacturing and Industry to the Chemical Industries, to maintain overall consistency in reporting of the greenhouse gas inventory and underlying energy statistics. This reallocation has been requested by reviewers from the United Nations Framework Committee on Climate Change (UNFCCC). These emissions relate to those from petrochemical and chemical industry use of various process gases and residues.

Cumulative revisions since 1990-2008

Revisions since the 1990-2008 inventory give a flavour of the scale of total revisions since the establishment of fixed annual Climate Change targets. Chart D3 shows that the average yearly increase in emissions in the Baseline has been between 1990-2008 and the latest inventory has been 1.3 Mt CO₂e.

Chart D3. Revisions to the Baseline, from the 1990-2008 Inventory, to the Latest Inventory. Impact of Successive Revisions. Values in Mt CO₂e



Uncertainties

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](#).

Future revisions to the inventory

Every year, the greenhouse gas inventories are updated to reflect improvements in the underpinning science, data and modelling which often result in revisions to the entire time series. These revisions also reflect changes to the Intergovernmental Panel on Climate Change (IPCC) guidelines. Some of the changes for the 1990-2013 inventory are already known and these are likely to increase Scotland's net emissions. Some are due to the implementation of IPCC (2006) reporting guidelines which are being implemented at a UK level. For the 1990-2013 inventory, the following changes will be incorporated and will be implemented across the time series:

- Changes to the global warming potential of methane from 21 to 25.
- Changes to the global warming potential of nitrous oxide from 310 to 298.
- Introduction of a new greenhouse gas: an F-gas, nitrogen trifluoride (NF₃)

Note that there are likely to be further revisions in the 1990-2013 inventory which have not been noted within this publication. For instance, developments are underway to better model emissions and sinks from land-use change. There is also a project underway to develop more geographically specific emissions factors for some agricultural practices.

Section E. Further information and Glossary

Further Information

Methodology and Source data

Full details of the methodology used to estimate Scottish greenhouse gas emissions together with further breakdowns are provided on the National Atmospheric Emissions Inventory website in the publication [Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2012](#).

Scotland's Carbon Footprint

Scottish Greenhouse Gas Emissions on a Consumption Basis ("[Scotland's Carbon Footprint](#)")

Climate Change (Scotland) Act 2009:

This legislation outlines the requirements for percentage reductions targets for 2020 and 2050 and fixed annual targets

<http://www.scotland.gov.uk/Topics/Environment/climatechange/scotlands-action/climatechangeact>

Relevant Secondary Legislation associated with Climate Change (Scotland) Act 2009

Climate Change (Annual Targets) (Scotland) Order 2010

This Order sets the first batch of annual emissions reduction targets, for the period 2010-2022.

<http://www.legislation.gov.uk/ssi/2010/359/introduction/made>

Climate Change (Annual Targets) (Scotland) Order 2011

This Order sets the second batch of annual emissions reduction targets, for the period 2023-2027.

<http://www.scotland.gov.uk/Topics/Environment/climatechange/scotlands-action/climatechangeact/order2011>

The Carbon Accounting Scheme (Scotland) Regulations 2010

These Regulations establish the scheme for monitoring compliance with the annual emissions reduction targets set for 2010-2012. They also cover a range of administrative issues relating to emissions accounting

<http://www.legislation.gov.uk/ssi/2010/216/contents/made>.

National Performance Framework Sustainability Purpose Targets

<http://www.scotland.gov.uk/About/Performance/scotPerforms/purpose/sustainability>

Department of Energy and Climate Change (DECC) statistics

<https://www.gov.uk/government/organisations/department-of-energy-climate-change/about/statistics#emissions-and-climate-change-statistics>

UK greenhouse gas inventory national system

<https://www.gov.uk/government/publications/uk-greenhouse-gas-emissions-statistics-user-guidance>

Committee on Climate Change (CCC)

The CCC is an independent body established under the Climate Change Act to advise the UK Government and devolved administrations on reducing greenhouse gas emissions.

<http://www.theccc.org.uk>

United Nations Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty. The objective of the treaty is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

The treaty itself set no binding limits on greenhouse gas emissions for individual countries and contains no enforcement mechanisms. In that sense, the treaty is considered legally non-binding. Instead, the treaty provides a framework for negotiating specific international treaties (called "protocols") that may set binding limits on greenhouse gases.

<http://unfccc.int/>

Intergovernmental Panel on Climate Change

The 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.

<http://www.ipcc.ch/>

EU Emissions Trading System (EU ETS)

Further information can be found in the Department for Energy and Climate Change (DECC) website.

<https://www.gov.uk/participating-in-the-eu-ets>

Scottish Energy Statistics

An overview of trends from energy generation statistics in Scotland can be found in the Scottish Government report: [Energy in Scotland 2014 - statistics compendium](#)

This publication provides a statistical overview of current and historic energy production, transformation, and consumption in Scotland. It includes sections on:

- the economic contribution of the energy sector
- fossil fuel extraction
- electricity
- energy consumption
- energy prices
- low carbon economy

Table E1. Mapping between Scottish Government sectors, National Communication sectors, International Panel for Climate Change sectors and source

SG Sector	NC Category	IPCC Sector	Source Name
Energy Supply	Energy Supply	1A1a Public Electricity & Heat Production	Miscellaneous industrial/commercial combustion
			Power stations
			Public sector combustion
		1A1b Petroleum Refining	Refineries - combustion
		1A1ci Manufacture of Solid Fuels-coke	Coke production
			Solid smokeless fuel production
		1A1cii Other Energy Industries	Collieries - combustion
			Gas production
			Nuclear fuel production
			Town gas manufacture
			Upstream Gas Production - fuel combustion
			Upstream oil and gas production - combustion at gas separation plant
			Upstream Oil Production - fuel combustion
		1B1a Post-MiningActivities	Coal storage and transport
		1B1a Surface Mines	Open-cast coal
		1B1a Underground Mines	Deep-mined coal
		1B1b Solid Fuel Transformation	Charcoal production
			Coke production
			Iron and steel - flaring
			Solid smokeless fuel production
		1B1c Closed Coal Mines	Closed Coal Mines
		1B2a Oil Exploration	Upstream Oil Production - Offshore Well Testing
		1B2a Oil Other	Upstream Oil Production - Onshore Oil Loading
		1B2a Oil Production	Upstream Oil Production - process emissions
		1B2a Oil Transport	Upstream Oil Production - Offshore Oil Loading
		1B2a Refining/Storage	Petroleum processes
			Upstream Oil Production - Oil terminal storage
		1B2b Distribution	Gas leakage
		1B2b Gas Exploration	Upstream Gas Production - Offshore Well Testing
		1B2b Gas Production	Upstream Gas Production - Gas terminal storage
			Upstream Gas Production - process emissions
		1B2b Transmission	Gas leakage

SG Sector	NC Category	IPCC Sector	Source Name
		1B2c Flaring Gas	Upstream Gas Production - flaring
		1B2ci Venting Gas	Upstream Gas Production - venting
		1B2ci Venting Oil	Upstream Oil Production - venting
		1B2cii Flaring Oil	Upstream Oil Production - flaring
		2A3 Limestone & Dolomite Use	Power stations - FGD
Business and Industrial process	Business	1A2a Manufacturing Industry&Construction:I&S	Blast furnaces
			Iron and steel - combustion plant
		1A2b Non-Ferrous Metals	Non-Ferrous Metal (combustion)
		1A2c Chemicals	Ammonia production - combustion
			Chemicals (combustion)
		1A2d Pulp Paper Print	Pulp, Paper and Print (combustion)
		1A2e Food drink tobacco	Food & drink, tobacco (combustion)
		1A2f Manufacturing Industry&Construction:Other	Autogeneration - exported to grid
			Autogenerators
			Cement production - combustion
			Lime production - non decarbonising
		1A2fii Manufacturing Industry&Construction:Off-road	Other industrial combustion
			Industrial engines
		1A4a Commercial/Institutional	Industrial off-road mobile machinery
			Miscellaneous industrial/commercial combustion
		2B5 Carbon from NEU of products	Other industrial combustion
		2F1 Refrigeration and Air Conditioning Equipment	Commercial Refrigeration
			Domestic Refrigeration
			Industrial Refrigeration
			Mobile Air Conditioning
			Refrigerated Transport
		2F2 Foam Blowing	Stationary Air Conditioning
			Foams
		2F3 Fire Extinguishers	Firefighting
		2F5 Solvents	Other PFC use
			Precision cleaning - HFC
2F9 Other	SF ₆ used as a tracer gas		
2F9 Other (one component foams)	One Component Foams		
2F9 Other (semiconductors electrical sporting goods)	2F9 other		

SG Sector	NC Category	IPCC Sector	Source Name
	Industrial Process	1A2a Manufacturing Industry&Construction:I&S	Sinter production
		2A1 Cement Production	Cement - decarbonising
		2A2 Lime Production	Lime production - decarbonising
		2A3 Limestone & Dolomite Use	Basic oxygen furnaces
			Sinter production
		2A7 (Fletton Bricks)	Brick manufacture - Fletton
		2A7 Glass Production	Glass - general
		2B1 Ammonia Production	Ammonia production - feedstock use of gas
		2B2 Nitric Acid Production	Nitric acid production
		2B3 Adipic Acid Production	Adipic acid production
		2B5 Chemical Industry Other	Chemical industry - ethylene
			Chemical industry - general
			Chemical industry - methanol
		2C1 Iron&Steel	Electric arc furnaces
			Iron and steel - flaring
			Ladle arc furnaces
		2C3 Aluminium Production	Primary aluminium production - general
			Primary aluminium production - PFC emissions
		2C4 Cover gas used in Al and Mg foundries	Magnesium cover gas
		2E1 Production of Halocarbons and Sulphur Hexafluoride	Halocarbons production - by-product
		2E2 Production of Halocarbons and Sulphur Hexafluoride	Halocarbons production - fugitive
3 Solvent and Other Product Use	Solvent use		
Transport (excluding international aviation and shipping)	Transport	1A3aii Civil Aviation Domestic	Aircraft - domestic cruise
			Aircraft - domestic take-off and landing
	1A3b Road Transportation	Road transport - all vehicles LPG use	
		Road transport - buses and coaches - motorway driving	
		Road transport - buses and coaches - rural driving	
		Road transport - buses and coaches - urban driving	
		Road transport - cars - cold start	
		Road transport - cars - motorway driving	
		Road transport - cars - rural driving	
		Road transport - cars - urban	

SG Sector	NC Category	IPCC Sector	Source Name
			driving
			Road transport - HGV articulated - motorway driving
			Road transport - HGV articulated - rural driving
			Road transport - HGV articulated - urban driving
			Road transport - HGV rigid - motorway driving
			Road transport - HGV rigid - rural driving
			Road transport - HGV rigid - urban driving
			Road transport - LGVs - cold start
			Road transport - LGVs - motorway driving
			Road transport - LGVs - rural driving
			Road transport - LGVs - urban driving
			Road transport - mopeds (<50cc 2st) - urban driving
			Road transport - motorcycle (>50cc 2st) - rural driving
			Road transport - motorcycle (>50cc 2st) - urban driving
			Road transport - motorcycle (>50cc 4st) - motorway driving
			Road transport - motorcycle (>50cc 4st) - rural driving
			Road transport - motorcycle (>50cc 4st) - urban driving
			Road vehicle engines
		1A3c Railways	Rail - coal
			Railways - freight
			Railways - intercity
			Railways - regional
		1A3dii National Navigation	Inland goods-carrying vessels
			Marine engines
			Motorboats / workboats (e.g. canal boats, dredgers, service boats, tourist boats, river boats)
			Personal watercraft e.g. jet ski
			Sailing boats with auxiliary engines
			Shipping - coastal
		1A3e Other Transportation	Aircraft - support vehicles
		1A4a Commercial/Institutional	Railways - stationary combustion
		1A4ciii Fishing	Fishing vessels

SG Sector	NC Category	IPCC Sector	Source Name
		1A5b Other:Mobile	Aircraft - military Shipping - naval
Residential	Residential	1A4bi Residential	Domestic combustion
		1A4bii Residential:Off-road	House and garden machinery
		2B5 Chemical Industry Other	Non-aerosol products - household products
		2F4 Aerosols	Aerosols - halocarbons Metered dose inhalers
		6C Waste Incineration	Accidental fires - vehicles
Public	Public	1A4a Commercial/Institutional	Public sector combustion
Waste Management	Waste Management	6A1 Managed Waste Disposal on Land	Landfill
		6B1 Industrial Wastewater Handling	Industrial Waste Water Treatment
		6B2 Wastewater Handling	Sewage sludge decomposition
		6C Waste Incineration	Incineration
			Incineration - chemical waste
Incineration - clinical waste Incineration - sewage sludge			
Agriculture and related land use	Agriculture	1A4ci Agriculture/Forestry/Fishing:Stationary	Agriculture - stationary combustion
			Miscellaneous industrial/commercial combustion
		1A4cii Agriculture/Forestry/Fishing:Off-road	Agricultural engines
			Agriculture - mobile machinery
		2B5 Chemical Industry Other	Agriculture - agrochemicals use
		4A10 Enteric Fermentation Deer	Agriculture livestock - deer enteric
		4A1a Enteric Fermentation Dairy	Agriculture livestock - dairy cattle enteric
		4A1b Enteric Fermentation Non-Dairy	Agriculture livestock - other cattle enteric
		4A3 Enteric Fermentation Sheep	Agriculture livestock - sheep enteric
		4A4 Enteric Fermentation Goats	Agriculture livestock - goats enteric
		4A6 Enteric Fermentation Horses	Agriculture livestock - horses enteric
		4A8 Enteric Fermentation Swine	Agriculture livestock - pigs enteric
		4B10 Manure Management Deer	Agriculture livestock - deer wastes
4B12 Liquid Systems	Agriculture livestock - manure liquid systems		

SG Sector	NC Category	IPCC Sector	Source Name
		4B13 Solid Storage and Drylot	Agriculture livestock - manure solid storage and dry lot
		4B14 Other	Agriculture livestock - manure other
		4B1a Manure Management Dairy	Agriculture livestock - dairy cattle wastes
		4B1b Manure Management Non-Dairy	Agriculture livestock - other cattle wastes
		4B3 Manure Management Sheep	Agriculture livestock - sheep goats and deer wastes
		4B4 Manure Management Goats	Agriculture livestock - goats wastes
		4B6 Manure Management Horses	Agriculture livestock - horses wastes
		4B8 Manure Management Swine	Agriculture livestock - pigs wastes
		4B9 Manure Management Poultry	Agriculture livestock - broilers wastes
			Agriculture livestock - laying hens wastes
			Agriculture livestock - other poultry wastes
		4D Agricultural Soils	Agricultural soils
		4F1 Field Burning of Agricultural Residues	Field burning
		4F5 Field Burning of Agricultural Residues	Field burning
	Land Use, Land Use Change and Forestry	5B Cropland (Biomass Burning - controlled)	Cropland - Biomass Burning\Controlled Burning
		5B Cropland (Biomass Burning - wildfires)	Cropland - Biomass Burning\Wildfires
		5B Liming	Cropland - Liming
		5B1 Cropland Remaining Cropland	Cropland remaining Cropland
		5B2 Land Converted to Cropland	Land converted to Cropland
		5B2 N ₂ O emissions from disturbance associated with land-use conversion to cropland	N ₂ O emissions from disturbance associated with land-use conversion to cropland
5C Grassland (Biomass burning - controlled)		Grassland - Biomass Burning\Controlled Burning	
5C Grassland (Biomass Burning - wildfires)		Grassland - Biomass Burning\Wildfires	
5C Liming		Grassland - Liming	
5C1 Grassland Remaining Grassland		Grassland remaining Grassland	
5C2 Land converted to grassland	Land converted to Grassland		
5D1 Wetlands remaining wetlands	Wetlands remaining Wetland		

SG Sector	NC Category	IPCC Sector	Source Name
		5D2 Land converted to wetlands	Land converted to Wetland
		5D2 Non-CO ₂ emissions from drainage of soils and wetlands	Non-CO ₂ emissions from drainage of soils and wetlands
Development (land use change)	Land Use, Land Use Change and Forestry	5E Settlements (Biomass burning - controlled)	Settlements - Biomass Burning\Controlled Burning
		5E1 Settlements remaining settlements	Settlements remaining Settlements
		5E2 Land converted to settlements	Land converted to Settlements
Forestry	Land Use, Land Use Change and Forestry	5A Forest Land (Biomass Burning - wildfires)	Forest Land - Biomass Burning\Wildfires
		5A Forest Land (Drainage of soils)	Forest Land - Drainage of Organic Soils
		5A1 Forest Land Remaining Forest Land	Forest Land remaining Forest Land
		5A2 Forest Land (N fertilisation)	Direct N ₂ O emission from N fertilisation of forest land
		5A2 Land Converted to Forest Land	Land converted to Forest Land
		5G Other (Harvested wood)	Harvested Wood Products
International Aviation and Shipping	International Aviation and Shipping	International aviation	Aircraft - international cruise
			Aircraft - international take-off and landing
			Aircraft between UK and CDs - Cruise
			Aircraft between UK and CDs - TOL
			Aircraft between UK and Gibraltar - Cruise
			Aircraft between UK and Gibraltar - TOL
			Aircraft between UK and other OTs (excl Gib.) - Cruise
			Aircraft between UK and other OTs (excl Gib.) - TOL
			International shipping
		Shipping between UK and Gibraltar	
		Shipping between UK and OTs (excl. Gib)	

GLOSSARY

Adjusted emissions

Greenhouse gas emissions that have taken into account purchases/sales through the EU ETS. Adjusted emissions may be higher or lower than actual emitted emissions depending on the quantity of purchases or sales. Scottish Government emission reduction targets are assessed using adjusted emissions.

Afforestation

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

Baseline

Emissions reduction is based on a baseline. 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 compound 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. 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.

EU ETS

The European Union Greenhouse Gas Emissions Trading System (EU ETS) is the largest multi-national emissions trading system in the world. Operating across Europe the system is mandatory for large energy-intensive industrial installations. Compared with 2005 levels, the EU ETS aims to deliver a 21 per cent reduction in emissions by 2020 and a 43 per cent reduction by 2030.

Over 10,000 installations throughout the EU are covered by the system, accounting for nearly 50 per cent of the EU's total CO₂ emissions.

The EU ETS began in 2005. Phase II commenced in January 2008 and runs to December 2012.

Fluorinated gases (F-gases)

F-gases are the generic name given to HFCs, PFCs and SF₆. 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 GWPs.

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 a 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 140 to 11,700 times that of CO₂, depending on the gas type.

Inventory

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

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 sink, absorbing more greenhouse gas emissions than it releases.

Methane (CH₄)

Methane is a greenhouse gas that is around 21 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 uses Scottish Government sectors. Mapping of these to NC sectors and IPCC sectors can be seen in [Section E](#).

Nitrous oxide (N₂O)

Nitrous oxide is a greenhouse gas that is around 310 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 6,500 - 9,200 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 GHG 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 GWP is some 23,900 times that of CO₂ over a 100-year time horizon.

UNFCCC

In 1992, the Convention 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.

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.

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How to access background or source data

The data collected for this <statistical bulletin >:

- are available in more detail through Scottish Neighbourhood Statistics
- are available from National Atmospheric Emissions Inventory website and from a separate Excel workbook accompanying this publication
- may be made available on request, subject to consideration of legal and ethical factors. Please contact <email address> for further information.
- cannot be made available by Scottish Government for further analysis as Scottish Government is not the data controller.

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,
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