An Official Statistics publication for Scotland

The Scottish Government
Riaghaltas na h-Alba

AGRICULTURE, ENVIRONMENT AND MARINE

Scottish Greenhouse Gas Emissions 2014

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

SOURCE EMISSIONS

A measure of the actual emissions or removals in Scotland. Includes international aviation and shipping Used for UK and international comparisons

46.7 $MtCO_2e$ in 2014

39.5% from 1990

8.6% from 2013

ADJUSTED EMISSIONS: FOR REPORTING AGAINST TARGETS

Emissions adjusted to account for Scotland's participation in EU-wide emissions trading are used to measure progress against targets.

41.886 $MtCO_2e$ in 2014

45.8% from Baseline Period

12.5% from 2013

The Climate Change (Scotland) Act 2009 provides for a fixed annual target for 2014 of 46.958 $MtCO_2e$, which has been met. The Act also contains a 2050 target for at least an 80% reduction from baseline levels and an interim 2020 target for at least a 42% reduction. By 2014 a reduction of 45.8% had been achieved.

$MtCO_2e$ refers to million tonnes of carbon dioxide equivalent. This is a consistent measure of assessing the contribution of greenhouse gases to global warming.

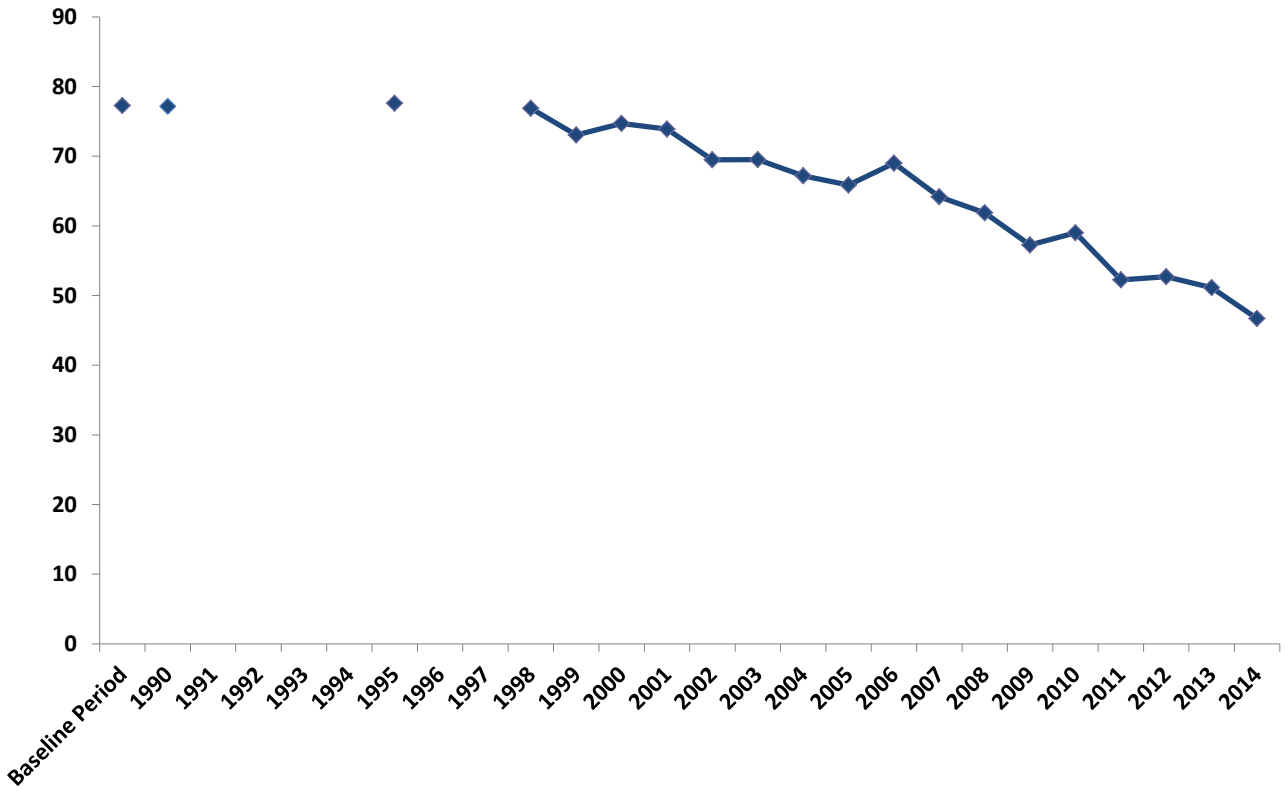
The Baseline Period uses 1990 for carbon dioxide, methane and nitrous oxide and 1995 for hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride

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

Section A of this release states what the greenhouse gases are, how they are categorised and when to use source and adjusted emissions. **Section B** contains results in more detail. **Section C** provides an explanation of how and why there are differences between the source and adjusted emissions. **Section D** contains information on revisions to the greenhouse gas statistics.

KEY TREND – SOURCE EMISSIONS

Scottish Greenhouse Gas Emissions, 1990 to 2014. Values in $MtCO_2e$



In 2014, Scottish emissions of the basket of seven greenhouse gases are estimated to be 46.7 million tonnes carbon dioxide equivalent ($MtCO_2e$). This is 8.6 per cent lower than the 2013 figure of 51.1 $MtCO_2e$, a 4.4 $MtCO_2e$ decrease.
The 2 main contributors to this reduction between 2013 and 2014 are:

- Fall in Energy Supply emissions (such as power stations) (2.1 $MtCO_2e$; 13.4 per cent reduction)
- Fall in Residential Emissions (such as space heating of homes) (1.2 $MtCO_2e$; 16.4 per cent reduction)

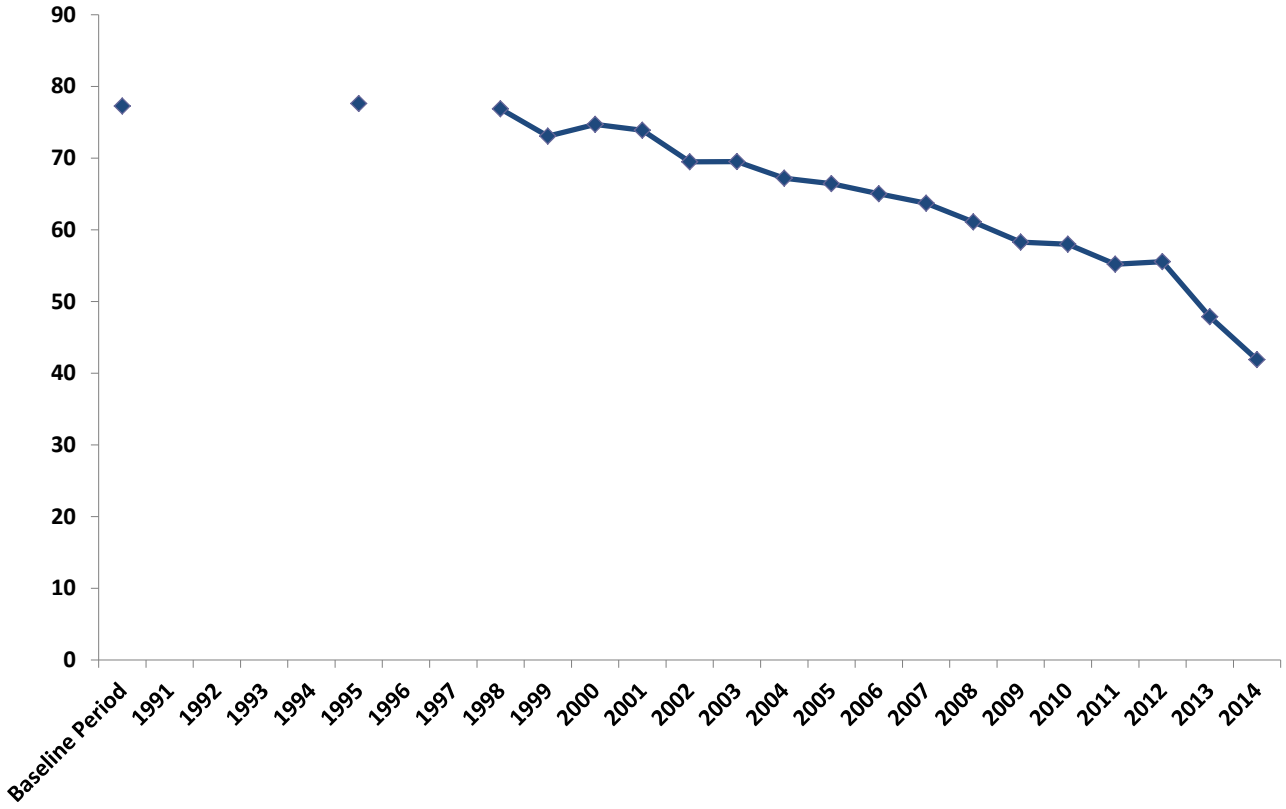
Between 1990 and 2014, there was a 39.5 per cent reduction in estimated emissions, a 30.5 $MtCO_2e$ decrease.
The 2 main contributors to this reduction are:

- Fall in Energy Supply emissions (such as Power stations) (8.9 $MtCO_2e$; 39.2 per cent reduction)
- Fall in Waste Management Emissions (such as Landfill) (7.6 $MtCO_2e$; 77.3 per cent reduction)

Section A states what the greenhouse gases are and how they are categorised. Scotland's net source emissions are comprised of sources of greenhouse gas emissions and sinks, which remove greenhouse gases from the atmosphere. Section B contains results in more detail. In particular, charts B2 ,B5 and B6 provide more information about individual sectoral trends.

KEY TREND – EU ETS ADJUSTED EMISSIONS

Scottish Greenhouse Gas Emissions, Adjusted for the EU Emissions Trading System, (EU ETS). 1990 to 2014. Values in $MtCO_2e$



- When emissions are adjusted to take account of trading in the EU Emissions Trading System (EU ETS), emissions decreased by 12.5 per cent between 2013 and 2014 (from 47.9 $MtCO_2e$ to 41.9 $MtCO_2e$). This is the basis against which progress towards the targets outlined within the Climate Change (Scotland) Act 2009 are measured.
- The EU ETS is an EU policy aimed at mitigating climate change by limiting greenhouse gas emissions from large point source emitters (primarily electricity generation and energy-intensive industries) and in aviation. Under accounting rules of the Climate Change (Scotland) 2009 Act, the contribution of those sectors to the annual targets is determined by the Scottish share of emissions allowances in the EU ETS, rather than the actual level of emissions. Section C provides information on what the EU ETS is and what it means for Scotland's Greenhouse Gas Emissions statistics.
- Compared with the Baseline Period [1], emissions in 2014 (after taking account of trading in the EU ETS) were 45.8 per cent lower. Section A contains more information on how the Baseline Period is defined and Section C contains results in more detail.
- In both 2013 and 2014, Scotland's EU ETS adjusted emissions showed a drop from the previous year. This is because the amount of available emissions

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

allowances in the EU ETS at a UK and EU-wide level is much lower than previously and this is reflected in the Scottish figures.

REVISIONS TO GREENHOUSE GAS EMISSIONS STATISTICS

Note that as part of this release all of the figures have been revised since the previous publication in June 2015, to incorporate methodological improvements and new data. Comparing the 2014 figures with the 2013 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.

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Section A. Introduction to Greenhouse Gases

Purpose of this Publication

The "Scottish Greenhouse Gas Emissions 2014" Official Statistics publication contains the results of the Scottish Greenhouse Gas Inventory for 1990-2014. 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 2014" 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-based emission estimates. This refers to greenhouse gas emissions which are associated with the spending of Scottish residents on goods and services, wherever in the world these emissions arise together with emissions directly generated by Scottish households, through private heating and motoring. This information was most recently published in March 2015 for the years 1998 to 2012 as part as part of the Official Statistics publication: "Scotland's Carbon Footprint 1998-2012". Section E contains some information on what territorial emissions are excluded from the greenhouse gas inventory.

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

	Estimated Source Emissions (Section B)	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 – note that comparable data for 1990-2014 will not be available for the time of this release	✓	✗
Can be compared with UK [2]	✓	✗
Includes International Aviation and Shipping	✓	✓
Includes Offshore Emissions	✗	✗
Data on individual greenhouse gases	✓	✗
Data on Scottish Government source sectors	✓	✓
Base Year	**1990**	**Baseline Period (Variable)**

[1] Further information on Scotland's Climate Change Targets can be found in Section C.
[2] Direct comparisons between Scotland and the UK can be made by adding up the results for the four Devolved Administrations separately. The UK figure in this case would exclude offshore emissions.

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

The basket of greenhouse gases consists of carbon dioxide, methane, nitrous oxide, and the four F-gases (hydrofluorocarbons- HFCs, perfluorocarbons – PFCs, sulphur hexafluoride- 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 A1. List of Greenhouse Gases and their contribution to Scotland's net greenhouse gas emissions, 2014

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 2014 (in $MtCO_2e$)	Percentage of Scotland's Net Greenhouse Gas Emissions in 2014 (in $MtCO_2e$)	Examples of sources of gas
Carbon dioxide	**CO_2**	**1**	**34.4**	**73.7%**	All other sources of greenhouse gases, including removals (carbon sinks)
Methane	**CH_4**	**25**	**7.5**	**16.1%**	Waste management, enteric fermentation and animal waste
Nitrous oxide	**N_2O**	**298**	**3.3**	**7.0%**	Agricultural soils
F-gases			**1.5**	**3.2%**	Industrial air conditioning, aluminium smelting, refrigeration, use as tracer gases, semiconductors
- *Hydrofluorocarbons*	**HFC**	12 - 14,800	1.3	2.8%	
- *Perfluorocarbons*	**PFC**	7,390 - 17,340	0.1	0.3%	
- *Sulphur hexafluoride*	**SF_6**	22,800	0.0	0.1%	
- *Nitrogen trifluoride*	**NF_3**	17,200	0.0	0.0%	
Total Net Greenhouse Gases			**46.7**	**100.0%**	

The Global Warming Potentials (GWPs) are based on international reporting standards, as set by the Intergovernmental Panel on Climate Change (IPCC)[2].

Section B contains further data on the individual greenhouse gases. Section D contains a more detailed discussion of the causes and impacts of revisions between the 1990-2013 and 1990-2014 inventories.

Reporting of the Baseline Period and 1990

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

A different baseline is used for the reporting progress against Scotland's Climate Change Targets only, using the emissions adjusted for trading in the EU Emissions Trading System (EU ETS). This is referred to as "Baseline Period" when referring to changes over time in the charts, tables and text.

[2] IPCC's 4th Assessment Report: http://www.ipcc.ch/report/ar4/

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): hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), nitrogen trifluoride (NF_3)

Within this publication, data are estimated for the Baseline Period; and the years 1990, 1995 and 1998 to 2014.

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 both emissions and removals resulting from afforestation, reforestation, deforestation and forest management together with changes in land use. These are known as “removals” as they offset emissions.

Sectors

This publication provides the latest estimates of Scotland's greenhouse gas emissions by source from 1990-2014. 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, and fugitive emissions from fuels (such as from mining or onshore oil and gas extraction activities). Offshore emissions are not allocated to Scotland.

Business and industrial processes - Emissions from industry and from those in combustion in industrial/commercial sectors, industrial off-road machinery, process sources from decarbonisation of raw materials (such as from limestone use in cement plants) and refrigeration and air conditioning.

Transport (including International Aviation and Shipping) - Emissions from domestic aviation, road transport, railways, domestic navigation, fishing and aircraft support vehicles. It also includes international aviation and shipping emissions attributed to Scotland.

Public Sector Buildings - Emissions from combustion of fuel in public sector buildings.

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

Agriculture and Related Land Use - Net emissions from cropland, grassland along with net emissions from land converted to cropland and grassland. It also covers emissions from livestock, agricultural soils, stationary combustion sources and off-road machinery.

Development - Net emissions from settlements and from land converted to settlements.

Forestry - Changes in net 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. It also contains information on which greenhouse gas emissions are excluded from the greenhouse gas inventory and why they are excluded.

The sectoral breakdowns 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 made the following changes to the grouping of the *Land Use, Land Use Change and Forestry* (LULUCF) and *Agriculture sectors* in the NC classifications.

Firstly, we have created an *Agriculture and Related Land Use* sector, which includes all emissions in the NC sector Agriculture together with those LULUCF emissions associated with agricultural practices, such as croplands and grasslands. The remaining LULUCF emissions are grouped into a *Forestry* sector (changes in emissions relating mainly to stock changes resulting from afforestation, deforestation and harvested wood products) and a *Development* sector (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".

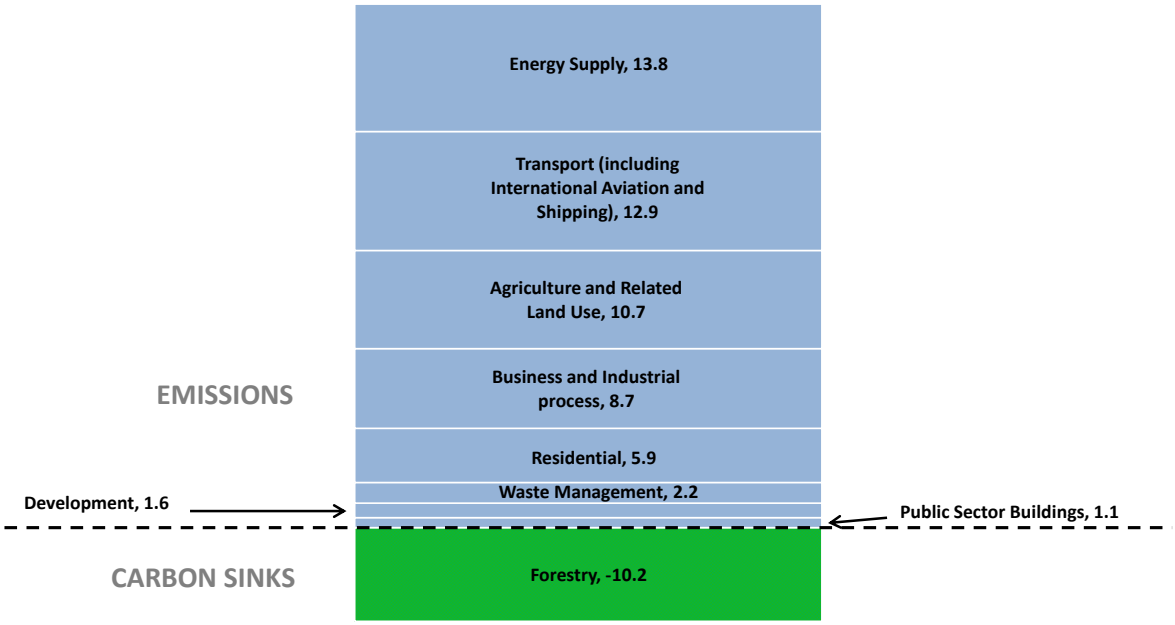
The Scottish Government also reports on International Aviation and Shipping emissions attributed to Scotland, along with other Transport emissions. International Aviation and Shipping emissions are categorised as an IPCC international “Memo” item. A detailed mapping between the sectors used in this report and the NC sectors and Intergovernmental Panel on Climate Change (IPCC) sectors is given in Section E.

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

2014 figures

Chart B1 presents the sources and sinks of Scottish Greenhouse Gas Emissions in 2014, grouped by Scottish Government sector.

Chart B1. Sources of Scottish Greenhouse Gas Emissions, 2014. Values in $MtCO_2e$



Main points

- In 2014, Energy supply was the largest source of net emissions (13.8 $MtCO_2e$), followed by Transport (including International Aviation and Shipping) (12.9 $MtCO_2e$) and Agriculture and Related Land Use (10.7 $MtCO_2e$).
- Emissions from Business and Industrial Processes and the Residential sector were the next largest net emissions sources (8.7 $MtCO_2e$ and 5.9 $MtCO_2e$ respectively).
- The combined total of emissions from the other net sources (Waste Management, Development and Public Sector Buildings) was less than 5 $MtCO_2e$.
- Forestry was the only aggregate sector in which there has been a net emissions sink (-10.2 $MtCO_2e$).

Table B1. Scottish Greenhouse Gas Emissions by Gas and by Scottish Government Source Sector, 2014. Values in $MtCO_2e$

	TOTAL	*Percentage share by sector*	Carbon dioxide	Methane	Nitrous oxide	Fluorinated gases
TOTAL	**46.7**	***100.0%***	**34.4**	**7.5**	**3.3**	**1.5**
Energy Supply	13.8	*29.7%*	13.3	0.5	0.1	0.0
Transport (including International Aviation and Shipping)	12.9	*27.7%*	12.8	0.0	0.1	0.0
Transport (excluding IA&S)	*10.6*	*22.8%*	*10.5*	*0.0*	*0.1*	*0.0*
International Aviation and Shipping (IA&S)	*2.3*	*4.9%*	*2.3*	*0.0*	*0.0*	*0.0*
Agriculture and related land use	10.7	*22.8%*	3.2	4.7	2.7	0.0
Business and Industrial process	8.7	*18.5%*	7.2	0.0	0.1	1.3
Residential	5.9	*12.6%*	5.6	0.1	0.0	0.2
Waste Management	2.2	*4.8%*	0.0	2.2	0.1	0.0
Development	1.6	*3.4%*	1.5	0.0	0.1	0.0
Public Sector Buildings	1.1	*2.3%*	1.1	0.0	0.0	0.0
Forestry	-10.2	*-21.8%*	-10.2	0.0	0.0	0.0

Main points

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

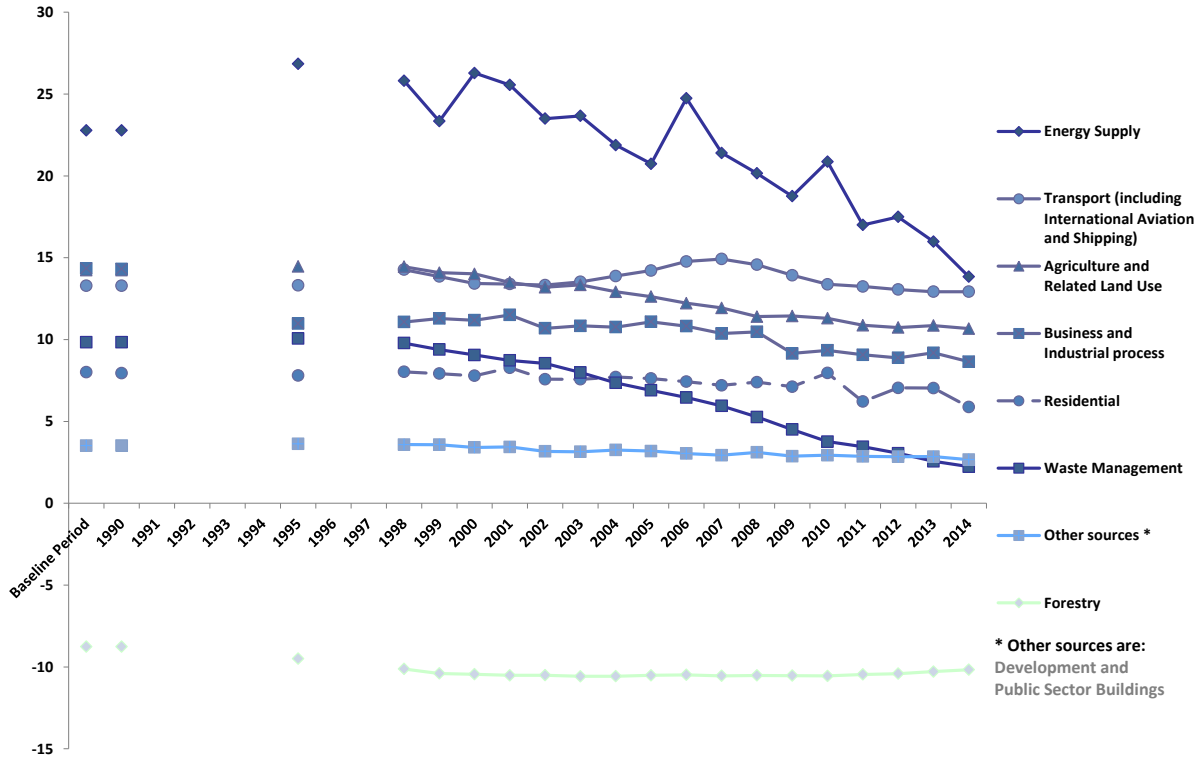
- Methane was the main net gas emitted in the Agriculture and Related Land Use sector (4.7 $MtCO_2e$), followed by carbon dioxide (3.2 $MtCO_2e$) and nitrous oxide (2.7 $MtCO_2e$).
- Almost all emissions in the Waste Management sector were emitted in the form of methane (2.2 $MtCO_2e$)

Where F gases are emitted, they have been in relatively small amounts via the Business and Industrial Process source sector, as well as in the Residential sector.

Key Trends By Scottish Government Source Sector

Chart B2 presents the main sources of Scottish Greenhouse Gas Emissions in Scotland from 1990 to 2014, broken down by Scottish Government source sector. Note that for the purposes of presentation, some sectors have been grouped together on this chart. Chart B3 and Chart B4 specifically explore the trend in Energy Supply emissions. Chart B5 contains information on the absolute and percentage reductions in greenhouse gas emissions in every Scottish Government source sector over the entire time period, with Chart B6 containing the same information for the latest year.

Chart B2. Main Sources of Greenhouse Gas Emissions in Scotland, 1990 to 2014. Values in $MtCO_2e$



Main Points

Most sectors exhibit a general downward trend between 1990 and 2014, most clearly evident since 1998.

- In all years, energy supply is the main source of greenhouse gas emissions, although it has a seen a sharp fall in 2013 and 2014. This is partly linked to the closure and mothballing of power stations and means that energy supply emissions in 2014 are now 0.9 $MtCO_2e$ higher than emissions from transport (including international aviation and shipping). The chart shows that energy supply is a very volatile sector. This is driven by the fact that energy demand is linked to the ambient temperature, particularly during the winter months; and fuel

used for electricity production, which in turn is partly driven by the price of coal relative to “cleaner” fuels. Charts B3 and B4 demonstrate these effects in more detail.

- Much of the fall in emissions from the Business and Industrial Process sector 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.

- Net emissions from the agriculture and related land use sector have seen a gradual decline between 1998 and 2014, which can be linked to the impact of historic changes in land use, change to cropland and grassland and also a decline in cattle and sheep numbers.

- Emissions from transport (including international aviation and shipping) have seen a small overall reduction between 1990 and 2014. Emissions in this sector rose to a peak in 2007, before falling slightly. The recent falls in emissions reflects a number of factor including changes in emissions from cars stemming from improvements in car energy efficiency. Road transport emissions have been affected by changes in the make-up of the passenger car fleet. In recent years, there has been an increase in more fuel efficient diesel engines compared with petrol vehicles.

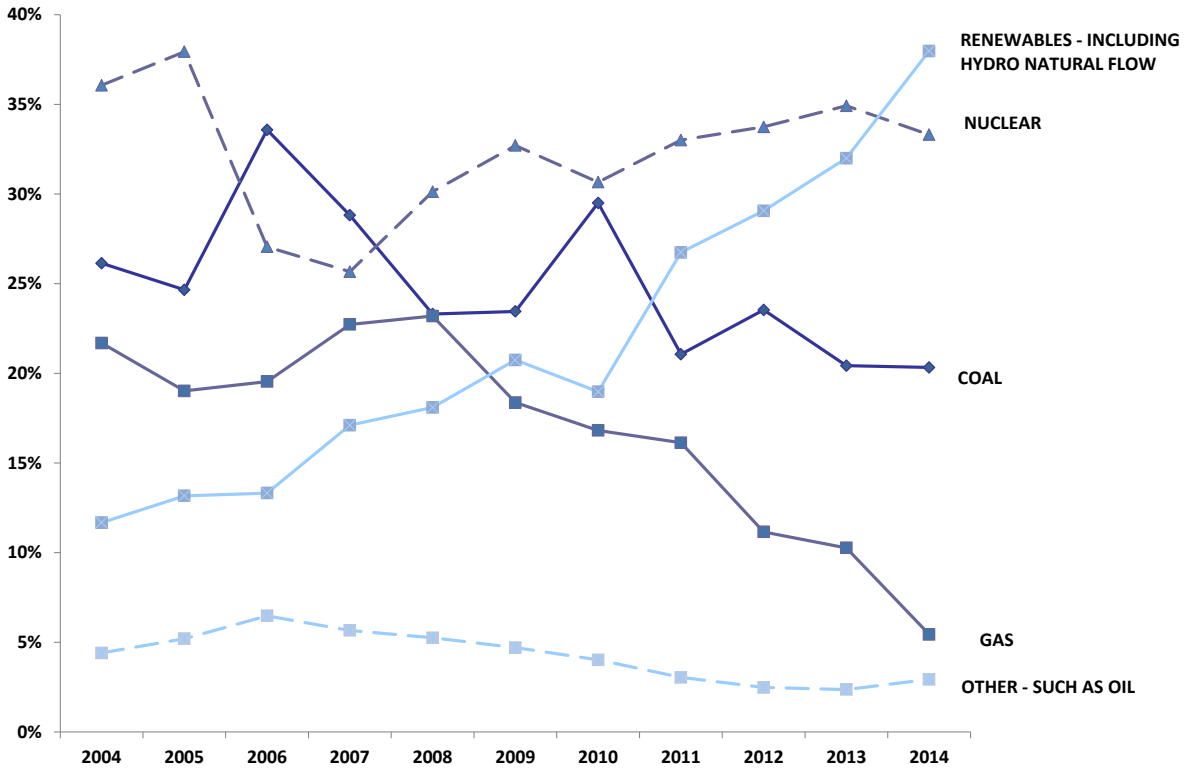
- Residential emissions have shown a downward trend between 1990 and 2014, although they have fluctuated substantially in recent years and are partly generated by heating of homes. Residential emissions in 2014 were the lowest in the series, due to the warmer external temperatures in that year.

- Waste management emissions have fallen between 1998 and 2014. This is due to the progressive introduction of landfill gas being captured and used for energy. There could also be other factors which are contributing to this reduction such as improvements in the standards of landfill sites and changes to the types of waste going to landfill.

- The size of the net carbon sink from forestry increased between 1990 to 1999, before remaining broadly constant in more recent years. Between 1990 and 2014, there has been an increase in the area of forest land. However, the rate at which land is being converted to forestry from other land uses has decreased over time. This is partly because the rate of afforestation has decreased over the last 40 years. In addition, conifer plantations, which were established in the mid-20th century, have reached their planned rotation age and are now being felled and replanted – leading to a fairly constant level of carbon sequestration since 1999, albeit with a slight reduction in the sink in recent years.

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 2014. Percentage of Electricity Generated by Year



Data obtained from DECC Energy Trends, published December 2015[3]

Main Points

- The share of Scottish electricity generation arising from the renewables sector (including hydro natural flow) has increased from 11.7 per cent in 2004 to 38.0 per cent in 2014.

- There was a sharp drop in the proportion of electricity generation coming from gas between 2013 and 2014 (from 10.3 per cent to 5.4 per cent). This is likely to be the result of a gas fired power station being

[3] https://www.gov.uk/government/statistics/energy-trends-december-2015-special-feature-article-electricity-generation-and-supply-figures-for-scotland-wales-northern-ireland-and-england-2

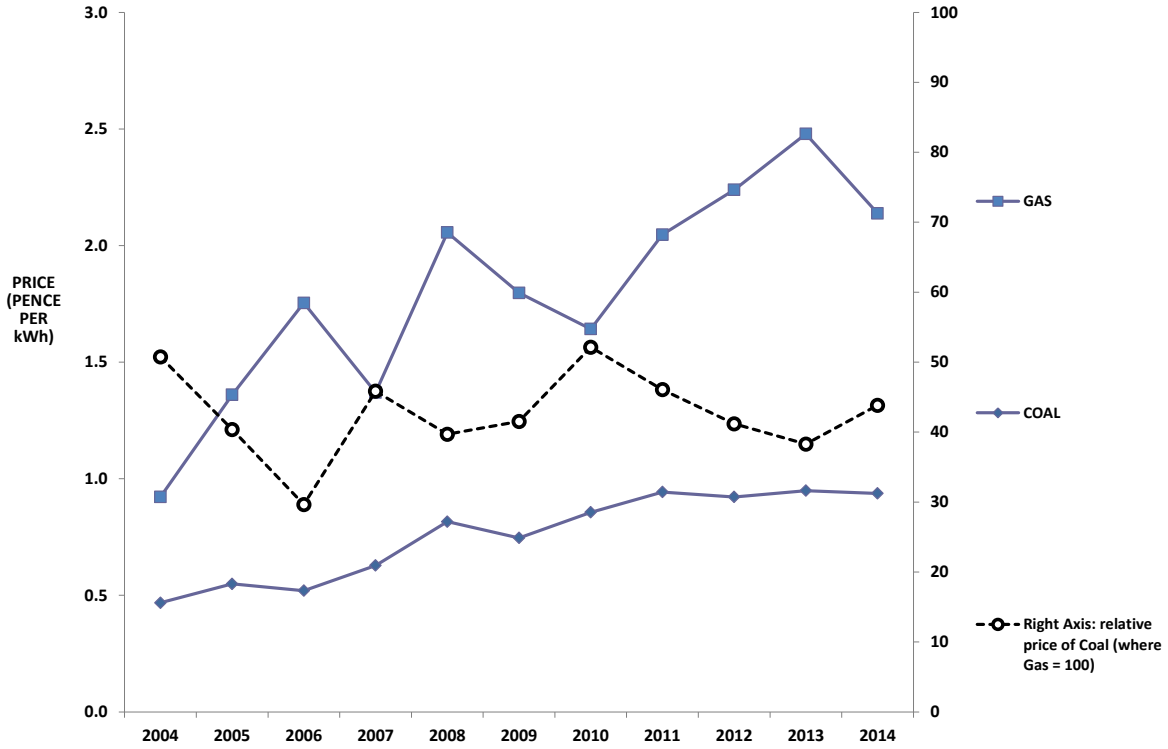
mothballing in 2014. This latest drop continues the decline in the share of electricity generation from gas from 2008 onwards, when it was 23.2 per cent.

- The proportion of electricity generation coming from coal has changed little between 2013 and 2014. However, the amount of electricity generated from coal has fallen between 2013 and 2014. This is likely to be because of the closure of a coal fired power station in the early months of 2013. Overall, there has been a fall in the proportion of electricity generated from coal since 2006, although this series is volatile, with 29.5 per cent of Scottish electricity supply being fuelled by coal in 2010.

- A third of Scotland's electricity supply came from nuclear energy in 2014. This represents an increase from 2007, when nuclear energy represented 25.7 per cent of Scotland's electricity supply.

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. In 2014, the relative price of coal per kilowatt hour was slightly less than half that of gas, although it was higher than in 2013.

Chart B4. Gas and Coal Prices for Large Users in the UK (2004 to 2014) – pence per kWh



Data obtained from DECC: Digest of UK Energy Statistics[4]

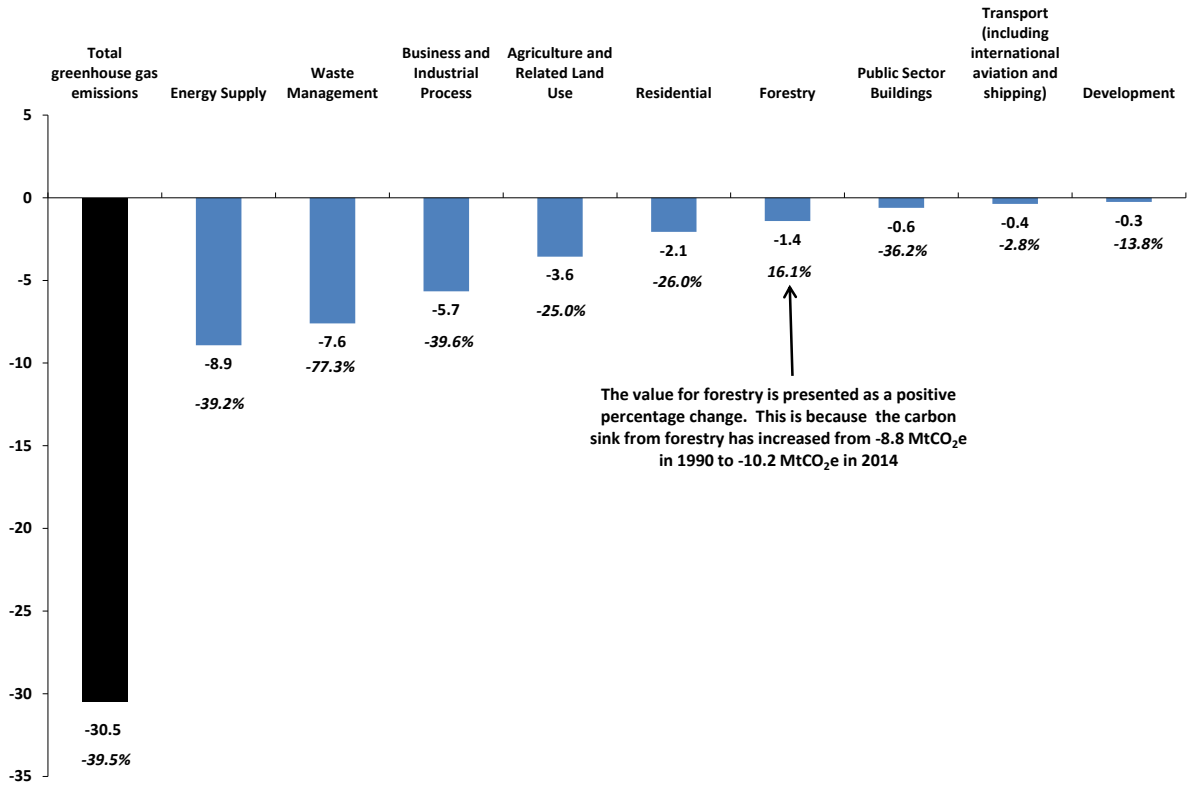
4

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

Long term (1990 to 2014) and short term (2013 to 2014) trends by sector

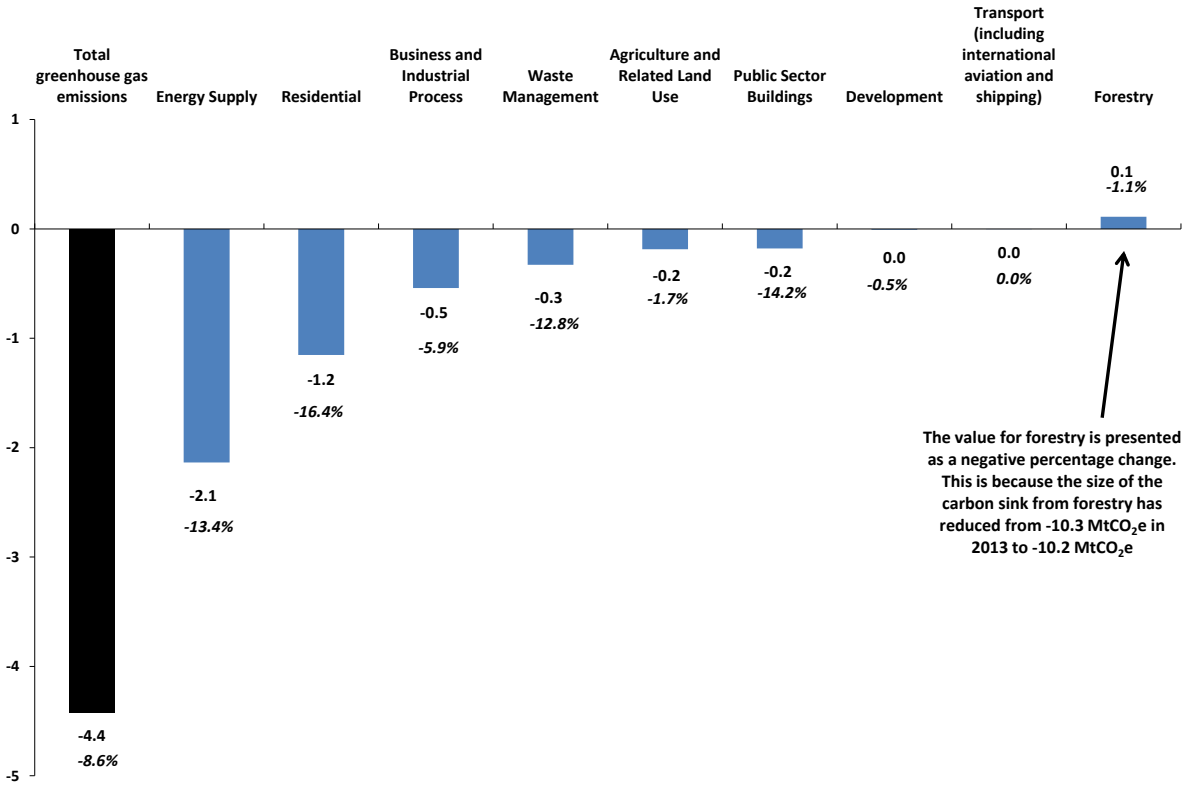
Chart B5 shows how emissions have changed between 1990 and 2014 in all source sectors. Chart B6 shows how emissions have changed between 2013 and 2014.

Chart B5. Change in Net Emissions by Scottish Government Sector Between 1990 and 2014 – in $MtCO_2e$, *and percentage changes* [5]



[5] Unlike for other source sectors, downward changes to net emissions from forestry are presented as a positive percentage change. This is because forestry causes a net removal of emissions

Chart B6. Change in Net Emissions by Scottish Government Sector between 2013 and 2014 - in $MtCO_2e$, *and percentage changes* [6]



Total Emissions

Overall, there has been a 30.5 $MtCO_2e$ (39.5 per cent) decrease in net emissions between 1990 and 2014 and there has been a 4.4 $MtCO_2e$ (8.6 per cent) decrease in net emissions between 2013 and 2014.

Energy Supply

This sector has seen an 8.9 $MtCO_2e$ (39.2 per cent) fall in emissions between 1990 and 2014 – the largest absolute fall of any sector. Charts B2 to B4 shows that this series is very volatile. This is largely driven by changes in the fuel mix for electricity production. The Energy Supply sector also saw the largest absolute decrease of any sector between 2013 and 2014 - a 2.1 $MtCO_2e$ (13.4 per cent) decrease.

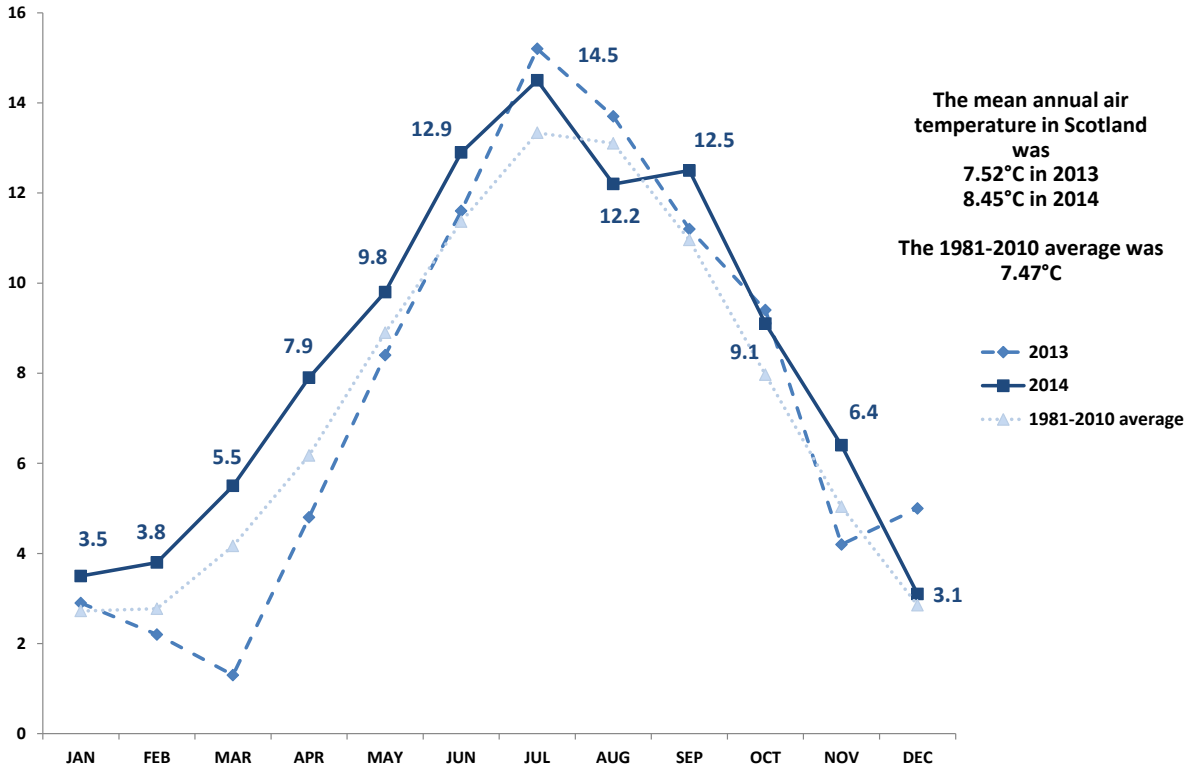
The largest contributor to the reduction in energy supply emissions between 2013 and 2014 has been power stations. In particular, a gas fired power station was mothballed in May 2014. A coal fired power station was also closed in March 2013 with some remaining emissions being reported for 2013, but not in 2014. There have also been falls in emissions from combustion in refineries and from gas production between 2013 and 2014.

[6] Unlike for other source sectors, upward changes to net emissions from forestry are presented as a negative percentage change. This is because forestry causes a net removal of emissions

Residential

This sector has seen a 2.1 $MtCO_2e$ (26.0 per cent) fall in emissions between 1990 and 2014. Between 2013 and 2014, there was a 1.2 $MtCO_2e$ (16.4 per cent) fall in residential emissions – the largest percentage reduction of any source sector in the latest year. Residential emissions are partly generated by space-heating homes and thus are related to external temperatures. The mean annual temperature in 2014 in Scotland was the highest in a series going back to 1910. It was 0.93°C higher than in 2013 and 0.98°C higher than the 1981-2010 average[7]. Chart B7 shows that the first 6 months of 2014 were considerably warmer than in the equivalent period in 2013 and the 1981-2010 average. As a result of this relationship to external temperatures, residential emissions can exhibit some large annual fluctuations.

Chart B7. Mean air temperature by month, Scotland. 2013 and 2014 and 1981-2010 average. Values in °C



Data obtained from Met Office, May 2016[8]

Waste Management

[7] Source Met Office: http://www.metoffice.gov.uk/pub/data/weather/uk/climate/datasets/Tmean/date/Scotland.txt

[8] Source Met Office: http://www.metoffice.gov.uk/pub/data/weather/uk/climate/datasets/Tmean/date/Scotland.txt

This sector has seen a 7.6 $MtCO_2e$ (77.3 per cent) fall in emissions between 1990 and 2014 – the largest percentage fall of any sector over this time period. This is due to the progressive introduction of landfill gas being captured and used for energy and due to the reduction in biodegradable municipal waste going to landfill. There could also be other factors which contribute to this reduction, such as improvements in the standards of landfill and changes to the types of waste going to landfill. Between 2013 and 2014, the Waste Management sector saw a fall of 0.3 $MtCO_2e$ (12.8 per cent).

Business and Industrial Process

This sector has seen a 5.7 $MtCO_2e$ (39.6 per cent) fall in emissions between 1990 and 2014. As shown in Chart B2, 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 has been a further smaller decrease between 2008 and 2009, coinciding with the recession. Figures have then been more level in recent years, albeit with small fluctuations in emissions from this sector since 2009. There was another decrease (0.5 $MtCO_2e$; 5.9 per cent) in emissions in this sector between 2013 and 2014. This has been driven a number of factors, which include a reduction in emissions from combustion in the petrochemicals industry, and from the space heating of offices, which is partly linked to external temperatures. There was also a smaller drop in emissions from pulp and paper making.

Agriculture and Related Land Use

This sector has seen a 3.6 $MtCO_2e$ (25.0 per cent) fall in net emissions between 1990 and 2014. This has been driven by a fall in emissions of carbon dioxide (Chart B9), methane (Chart B10) and nitrous oxide (Chart B11).

The fall in carbon dioxide emissions from the agriculture and related land use sector has partly been due to the effects of historic land use changes. For instance, there have been changes in the area of land being converted from other uses to cropland. Between 1990 to 2014, the rate at which land has been converted to cropland has fallen, with more land now remaining as cropland and not being changed to other uses. The process of land being converted to cropland releases carbon dioxide. Over time, this process gradually emits less carbon dioxide. There has also been an increase in the net sequestration of carbon dioxide from grassland.

Methane emissions from agriculture have fallen from 1990 to 2014 due to a decline in cattle and sheep numbers – with a corresponding fall in emissions from enteric fermentation and animal wastes. Nitrous oxide emissions have also fallen over this time period, albeit with a slight increase in recent years. The overall decrease in emissions between 1990 and 2014 could be due to

improvements in practices on agricultural soils and a decline in livestock numbers.

Between 2013 and 2014, there was a 0.2 $MtCO_2e$ (1.7 per cent) decrease in net emissions of overall greenhouse gases from this sector. This is due to a continued reduction in emissions from land being converted to cropland and an increase in the net greenhouse gas sink from grasslands. There has been a very slight (around 1 per cent) increase in emissions from agricultural soils in the latest year – despite a general downward trend over time. This could be due to increased use of nitrogenous fertilisers.

Forestry

This sector has seen a 1.4 $MtCO_2e$ (16.1 per cent) increase in its carbon sink between 1990 and 2014. The majority of the sink arises from the large area of conifer plantations in Scotland, which is subject to forest management such as thinning and harvesting. The increase in the carbon sink is due to an increase in the area of forest land over this time period. The area of land being converted to forest from other land uses has been decreasing over time, with more land remaining as forestry.

Carbon sequestration from forestry increased between 1990 and 1999. However, over the last 40 years the rate of afforestation has decreased and 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 the annual sink remaining relatively constant from 1999 onwards, albeit with a slight reduction in sequestration in recent years. Between 2013 and 2014, there was a small reduction (0.1 $MtCO_2e$) in the size of the carbon sink from forestry.

Transport (Including International Aviation and Shipping)

Between 1990 and 2014, emissions from transport (including international aviation and shipping) fell slightly. Chart B2 shows that emissions rose to a peak in 2007, before falling slightly. This slight fall has been largely caused by changes in road transport emissions. As well as reflecting improvements in car energy efficiency, road transport emissions have been affected by changes in the make-up of the passenger car fleet, with an increase in more fuel efficient diesel engines compared with petrol vehicles. Up to 2007, there was a large increase in car vehicle kilometres travelled. There was a slight drop in car vehicle kilometres travelled in the years after 2007, but this value has increased by 2014 to around 2007 levels.

Breaking transport emissions down further, between 1990 and 2014, there was a 0.8 per cent decrease in transport emissions (excluding international aviation and shipping) and a 10.9 per cent decrease in emissions from

international aviation and shipping. International aviation emissions have more than doubled between 1990 and 2014 (from 0.5 $MtCO_2e$ to 1.2 $MtCO_2e$). This reflects the growth in aviation and the increase in international routes at airports. Emissions from international shipping have fallen by 46.8 per cent between 1990 and 2014 (from 2.0 $MtCO_2e$ to 1.1 $MtCO_2e$). This is primarily due to a decrease in Scotland's port freight movements.

Between 2013 and 2014, there was a 0.5 per cent increase in emissions from transport (excluding international aviation and shipping). There has been an increase in emissions from light good vehicles (0.06 $MtCO_2e$; 4.1 per cent) between 2013 and 2014. There has also been a slight increase in emissions from cars between 2013 and 2014 (0.04 $MtCO_2e$; 0.7 per cent), which is linked to an increase in car vehicle kilometres.

Between 2013 and 2014, there was a 5.5 per cent increase in emissions from international aviation and a 10.2 per cent decrease in international shipping. It should be noted that the data series for international shipping is particularly volatile.

Public Sector Buildings

This sector contributes a small proportion of Scotland's net greenhouse gas emissions. The main source of emissions from this sector is the use of natural gas for heating public buildings. There was a 0.6 $MtCO_2e$ (36.2 per cent) fall in emissions from public sector buildings between 1990 and 2014. This has been largely driven by a reduction in the use of oil and coal for space heating. Between 2013 and 2014, there has been a 0.2 $MtCO_2e$ (14.2 per cent) fall in emissions from this sector, and this has been partly linked to less space heating for buildings because of the warmer external temperatures in 2014.

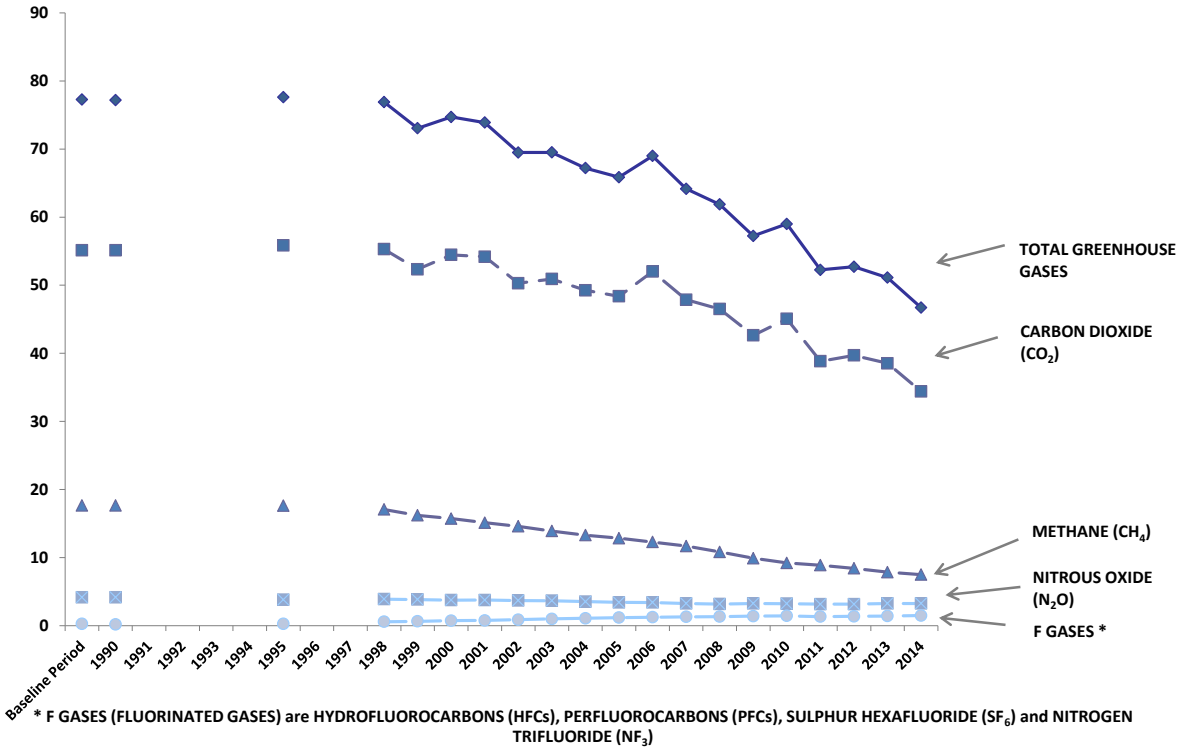
Development Emissions

This sector captures net emissions from settlements and from land converted to settlements. It accounts for only a small proportion of Scotland's net greenhouse gas emissions. There was a 0.3 $MtCO_2e$ (13.8 per cent) decrease in development emissions between 1990 and 2014. Between 2013 and 2014, there was very little change in emissions from this sector.

Emissions by type of gas

Chart B8 shows the trends in emissions, broken down by gas from 1990 to 2014.

Chart B8. Scottish Greenhouse Gas Emissions, by Gas, 1990-2014. Values in $MtCO_2e$



* F GASES (FLUORINATED GASES) are HYDROFLUOROCARBONS (HFCs), PERFLUOROCARBONS (PFCs), SULPHUR HEXAFLUORIDE (SF_6) and NITROGEN TRIFLUORIDE (NF_3)

Main Points

- Carbon dioxide is by far the largest contributor of Scottish greenhouse gas emissions in all years (73.7 per cent of all emissions in 2014) 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 residential and business and industrial process sectors.

- Methane in the second most common greenhouse gas in 2014 (16.1 per cent of all net emissions) followed by nitrous oxide (7.0 per cent) and F-gases making up the remainder (3.2 per cent).

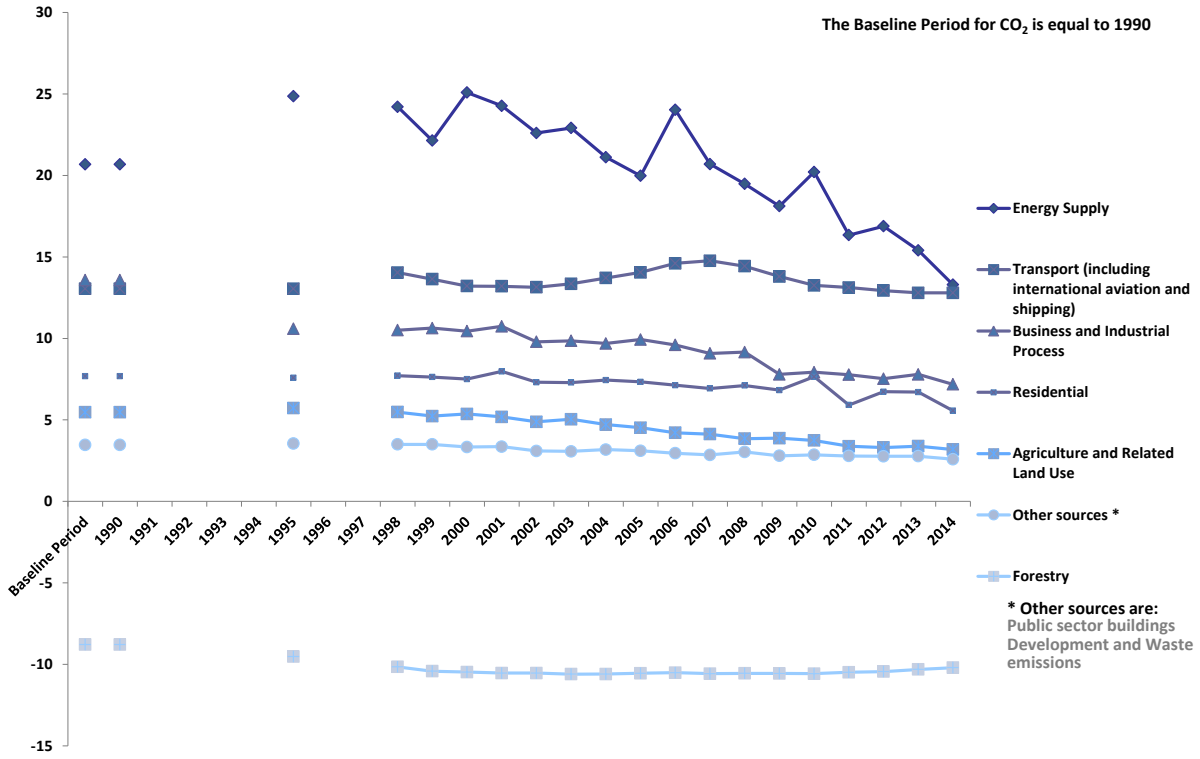
- Methane has seen the largest percentage reduction from 1990 to 2014 (57.5 per cent), which have been largely driven by a reduction in waste management emissions. There have also been percentage reductions for both carbon dioxide (37.6 per cent) and nitrous oxide (21.3 per cent). Emissions from fluorinated gases have shown a 7-fold increase from 1990 to 2014 and this increase is driven by the introduction of hydrofluourocarbons (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 B9 to B12 present results on individual gases broken down by main Scottish Government sectors over time. Table B3 contains figures on all greenhouse gas emissions across the time series. Chart B9 shows how carbon dioxide emissions have changed from 1990 to 2014.

Carbon Dioxide (CO_2)

Chart B9. Carbon Dioxide (CO_2) Emissions by Scottish Government Sector, 1990 to 2014. Values in $MtCO_2e$



Main Points

- Chart B9 shows that energy supply is the key source of carbon dioxide emissions in all years between 1990 and 2014. Transport (including international aviation and shipping) is the next most common source of carbon dioxide emissions in all years apart from 1990, and is only 0.5 $MtCO_2e$ lower than energy supply emissions in 2014.

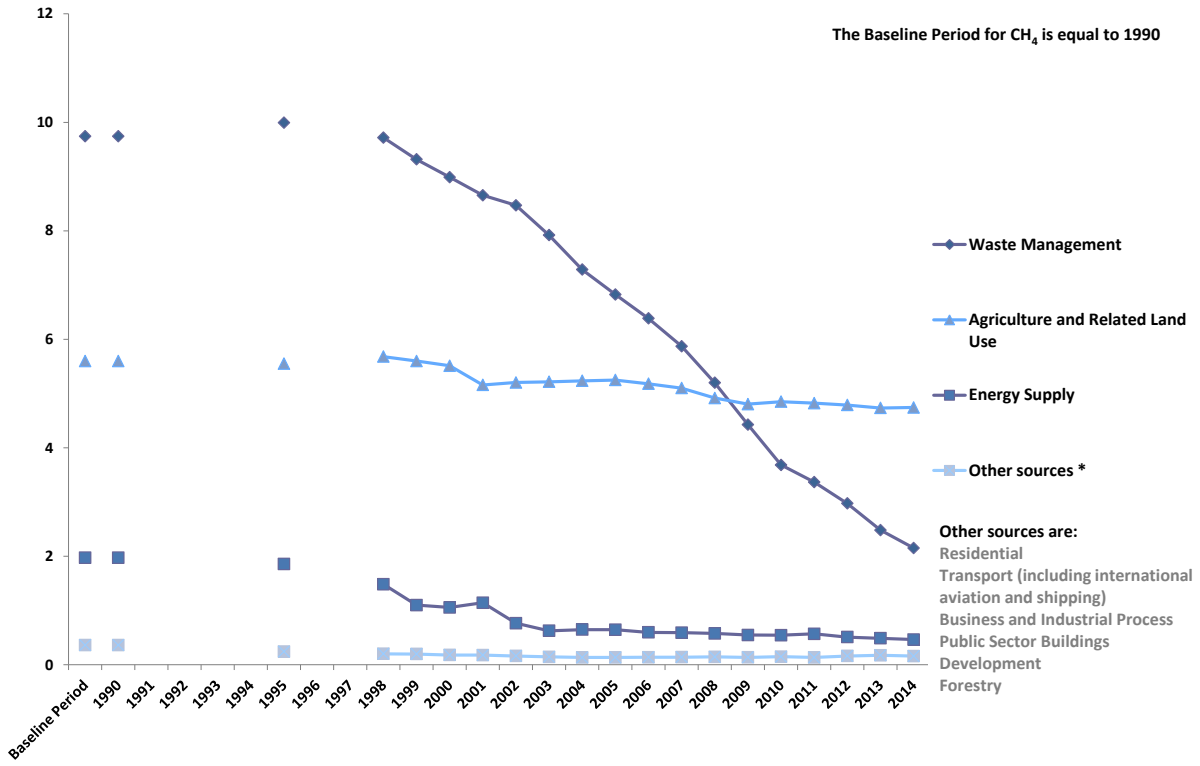
- Much of the decrease in carbon dioxide emissions between 1990 and 2014 has been driven by falls in the energy supply sector across the time period and in business and industrial processes between 1990 and 1995. Carbon dioxide emissions from the energy supply sector have been quite volatile, with the highest emissions occurring between 1995 and 2003, and a spike in 2006, related to a greater use of coal in that year.

- The agriculture and related land use sector has also seen a fall in net emissions of carbon dioxide – largely due to changes in land uses

- Forestry has been a net sink of carbon dioxide consistently between 1990 and 2014.

Methane (CH_4)

Chart B10. Methane (CH_4) Emissions by Scottish Government Sector, 1990 to 2014. Values in $MtCO_2e$



Main Points

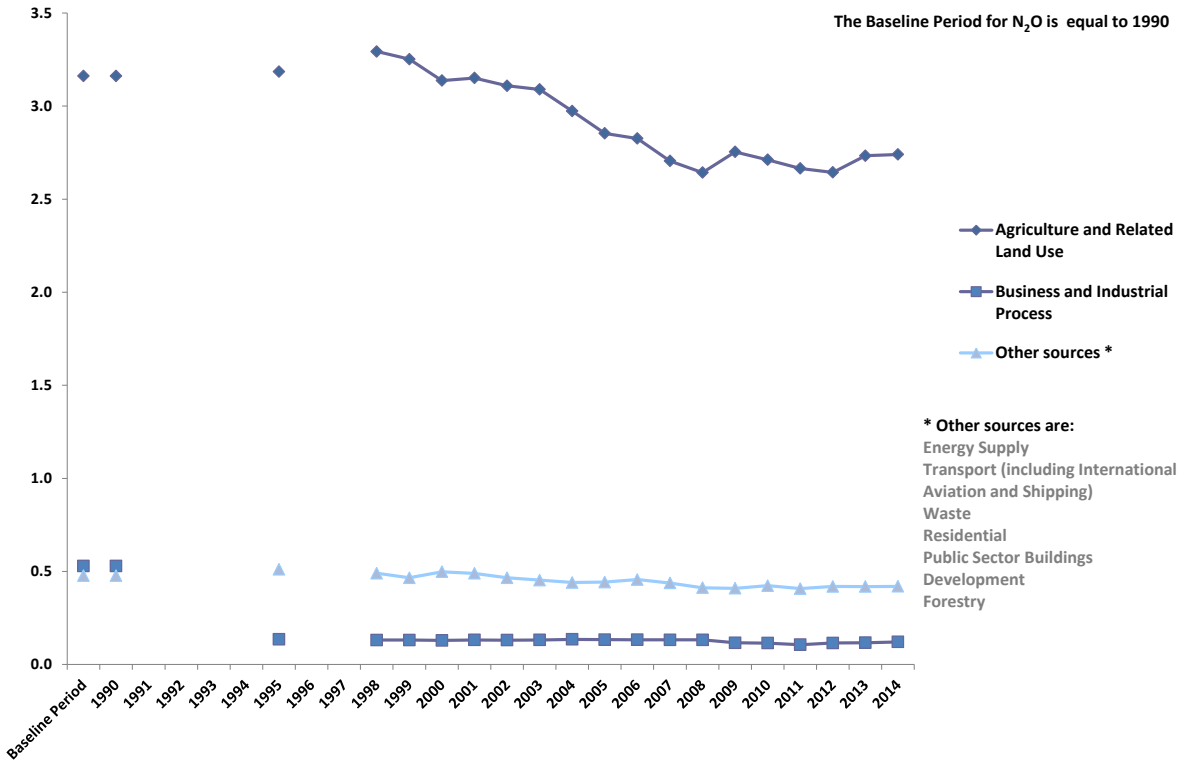
- Methane emissions from waste management have fallen from 9.7 $MtCO_2e$ in 1990 to 2.2 $MtCO_2e$ in 2014 (a 77.9 per cent reduction). This is due to the progressive introduction of landfill gas being captured and used for energy. There could also be other factors which contribute to this reduction, such as improvements in the standards of landfill and changes to the types of waste going to landfill.

- Methane emissions in the agriculture and related land use sector have fallen from 5.6 $MtCO_2e$ in 1990 to 4.7 $MtCO_2e$ in 2014 – a 15.3 per cent fall over this time period. This reduction is partly linked to a fall in livestock numbers.

- In the Energy Supply sector, methane emissions have fallen from 2.0 $MtCO_2e$ in 1990 to 0.5 $MtCO_2e$ in 2014, largely due to reductions in emissions from sources such as coal mining.

Nitrous Oxide (N_2O)

Chart B11. Nitrous Oxide (N_2O) Emissions by Scottish Government Sector, 1990 to 2014. Values in $MtCO_2e$



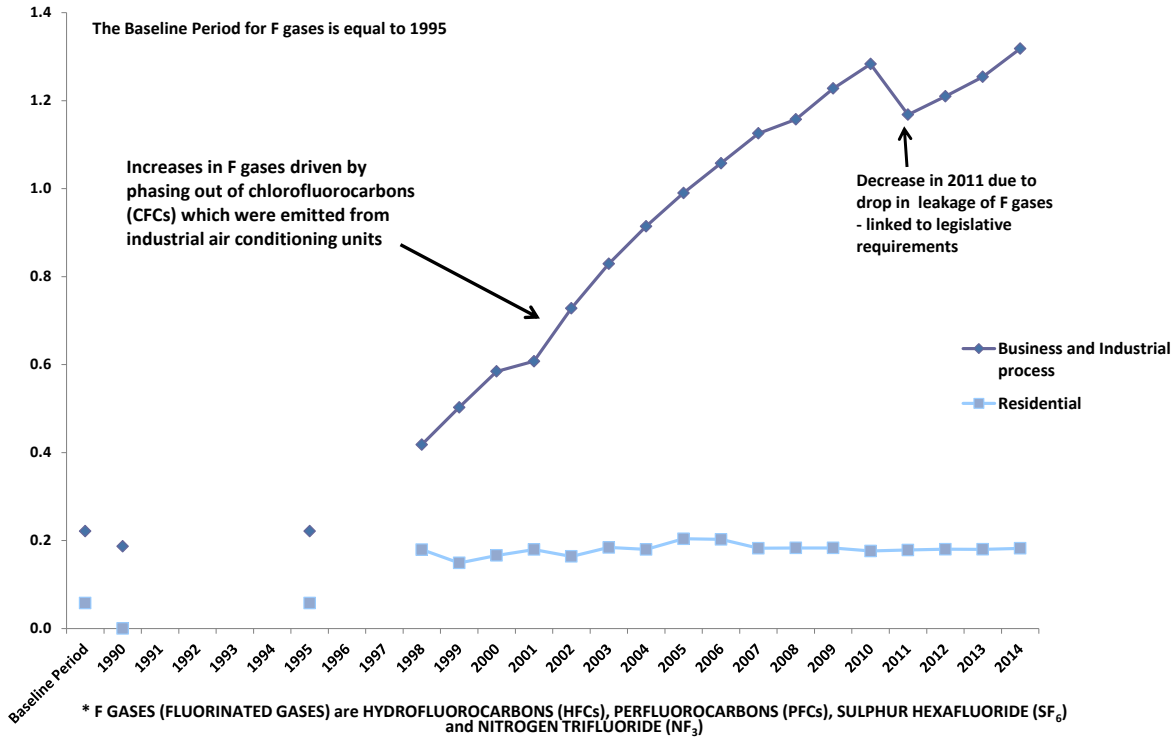
Main Points

- The Agriculture and related land use sector 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 from 3.2 $MtCO_2e$ in 1990 to 2.7 $MtCO_2e$ in 2014. This has been due to improvements in practices in agricultural soils and a decline in livestock numbers. There has been a very slight (around 1 per cent) increase in emissions from agricultural soils in 2014. This could be due to an increased use of nitrogenous fertilisers.

- Emissions of nitrous oxide in the business and industrial process sector have fallen from 0.5 $MtCO_2e$ in 1990 to 0.1 $MtCO_2e$ in 2014.

Fluorinated gases (F-gases)

Chart B12. F-gas Emissions by Scottish Government Sector, 1990 to 2014. Values in $MtCO_2e$



Main Points

- F gases are the most potent greenhouse gases with high global warming potentials but they are emitted in very small quantities. As a result, they contribute less to global warming than the other greenhouse gases in Scotland.

- There has been a sharp increase in F gas emissions from business and industrial processes between 1990 and 2014 (from 0.2 $MtCO_2e$ in 1990 to 1.3 $MtCO_2e$ in 2014). This 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.

- F gas emissions in the residential sector are caused by the use of aerosols and asthma inhalers, and represent between 0.15 and 0.20 $MtCO_2e$ in the years between 1998 and 2014.

Table B2. Greenhouse Gas Emissions in Scotland by source sector: 1990 to 2014. Values in $MtCO_2e$

Source Sector	Baseline Period	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Change between 1990 and 2014 (in $MtCO_2e$)	*% change between 1990 and 2014*
Total greenhouse gas emissions	**77.3**	**77.2**	**77.6**	**74.7**	**65.9**	**69.0**	**64.2**	**61.9**	**57.2**	**59.0**	**52.3**	**52.7**	**51.1**	**46.7**	**-30.5**	***-39.5%***
Energy Supply	22.8	22.8	26.8	26.3	20.7	24.7	21.4	20.2	18.8	20.9	17.0	17.5	16.0	13.8	-8.9	*-39.2%*
Transport (including International Aviation and Shipping)	13.3	13.3	13.3	13.4	14.2	14.8	14.9	14.6	13.9	13.4	13.2	13.1	12.9	12.9	-0.4	*-2.8%*
Excluding IA&S	*10.7*	*10.7*	*10.7*	*11.1*	*11.6*	*11.8*	*12.0*	*11.5*	*11.0*	*10.9*	*10.6*	*10.7*	*10.6*	*10.6*	-0.1	*-0.8%*
International Aviation and Shipping (IA&S)	*2.6*	*2.6*	*2.6*	*2.4*	*2.6*	*3.0*	*3.0*	*3.1*	*2.9*	*2.5*	*2.6*	*2.4*	*2.3*	*2.3*	-0.3	*-10.9%*
Agriculture and Related land Use	14.2	14.2	14.5	14.0	12.6	12.2	11.9	11.4	11.4	11.3	10.9	10.7	10.9	10.7	-3.6	*-25.0%*
Business and Industrial process	14.3	14.3	11.0	11.2	11.1	10.8	10.4	10.5	9.2	9.3	9.1	8.9	9.2	8.7	-5.7	*-39.6%*
Residential	8.0	7.9	7.8	7.8	7.6	7.4	7.2	7.4	7.1	8.0	6.2	7.0	7.0	5.9	-2.1	*-26.0%*
Waste Management	9.8	9.8	10.1	9.1	6.9	6.5	5.9	5.3	4.5	3.8	3.5	3.1	2.6	2.2	-7.6	*-77.3%*
Other sources	3.5	3.5	3.6	3.4	3.2	3.0	2.9	3.1	2.9	2.9	2.9	2.8	2.8	2.7	-0.9	*-24.5%*
Development	*1.8*	*1.8*	*1.8*	*1.8*	*1.7*	*1.7*	*1.7*	*1.6*	*1.6*	*1.6*	*1.6*	*1.6*	*1.6*	*1.6*	-0.3	*-13.8%*
Public Sector Buildings	*1.7*	*1.7*	*1.8*	*1.6*	*1.5*	*1.4*	*1.3*	*1.5*	*1.2*	*1.3*	*1.2*	*1.2*	*1.3*	*1.1*	-0.6	*-36.2%*
Forestry [9]	-8.8	-8.8	-9.5	-10.4	-10.5	-10.5	-10.5	-10.5	-10.5	-10.5	-10.5	-10.4	-10.3	-10.2	-1.4	*16.1%*

[9] Unlike for other source sectors, downward changes to net emissions from forestry are presented as a positive percentage change. This is because forestry causes a net removal of emissions.

Table B3. Scottish Greenhouse Gases, by gas, 1990 to 2014. Values in $MtCO_2e$

	Baseline Period	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Change from 1990 to 2014 (in $MtCO_2e$)	*% Change from 1990 to 2014*	*Share of Greenhouse Gases, 2014*
Total Greenhouse Gases	**77.3**	**77.2**	**77.6**	**74.7**	**65.9**	**69.0**	**64.2**	**61.9**	**57.2**	**59.0**	**52.3**	**52.7**	**51.1**	**46.7**	**-30.5**	***-39.5%***	***100.0%***
Carbon dioxide (CO_2)	55.1	55.1	55.8	54.5	48.4	52.0	47.9	46.5	42.6	45.1	38.8	39.7	38.5	34.4	-20.7	***-37.6%***	***73.7%***
Methane (CH_4)	17.7	17.7	17.6	15.7	12.9	12.3	11.7	10.8	9.9	9.2	8.9	8.4	7.9	7.5	-10.2	***-57.5%***	***16.1%***
Nitrous oxide (N_2O)	4.2	4.2	3.8	3.8	3.4	3.4	3.3	3.2	3.3	3.3	3.2	3.2	3.3	3.3	-0.9	***-21.3%***	***7.0%***
* F gases	0.3	0.2	0.3	0.8	1.2	1.3	1.3	1.3	1.4	1.5	1.3	1.4	1.4	1.5	1.3	***703.7%***	***3.2%***
of which HFCs	*0.1*	*0.0*	*0.1*	*0.5*	*1.0*	*1.1*	*1.2*	*1.2*	*1.3*	*1.3*	*1.2*	*1.3*	*1.3*	*1.3*	1.3	***62317.8%***	***2.8%***
PFCs	*0.1*	*0.1*	*0.1*	*0.2*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.0	***3.4%***	***0.3%***
SF_6	*0.0*	*0.0*	*0.0*	*0.1*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	0.0	***-34.3%***	***0.1%***
NF_3	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	0.0	***37.2%***	***0.0%***

* Note on F-gases:
HFCs are hydrofluorocarbons
PFCs are perfluorocarbons
SF_6 is sulphur hexafluoride
NF_3 is nitrogen trifluoride

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

Introduction

This section of the publication presents data on source greenhouse gas emissions which have been adjusted to take into account of trading in the EU Emissions Trading System (EU ETS). This is the basis on which Scotland's statutory targets are measured against under the Climate Change (Scotland) Act 2009.

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 the EU ETS 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 tCO_2e). Each year, an organisation must surrender enough allowances to cover its emissions. The cap is reduced over time 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. The EU ETS operates as a number of Phases. Phase III of the EU ETS began on 1 January 2013 and will operate until 31 December 2020.

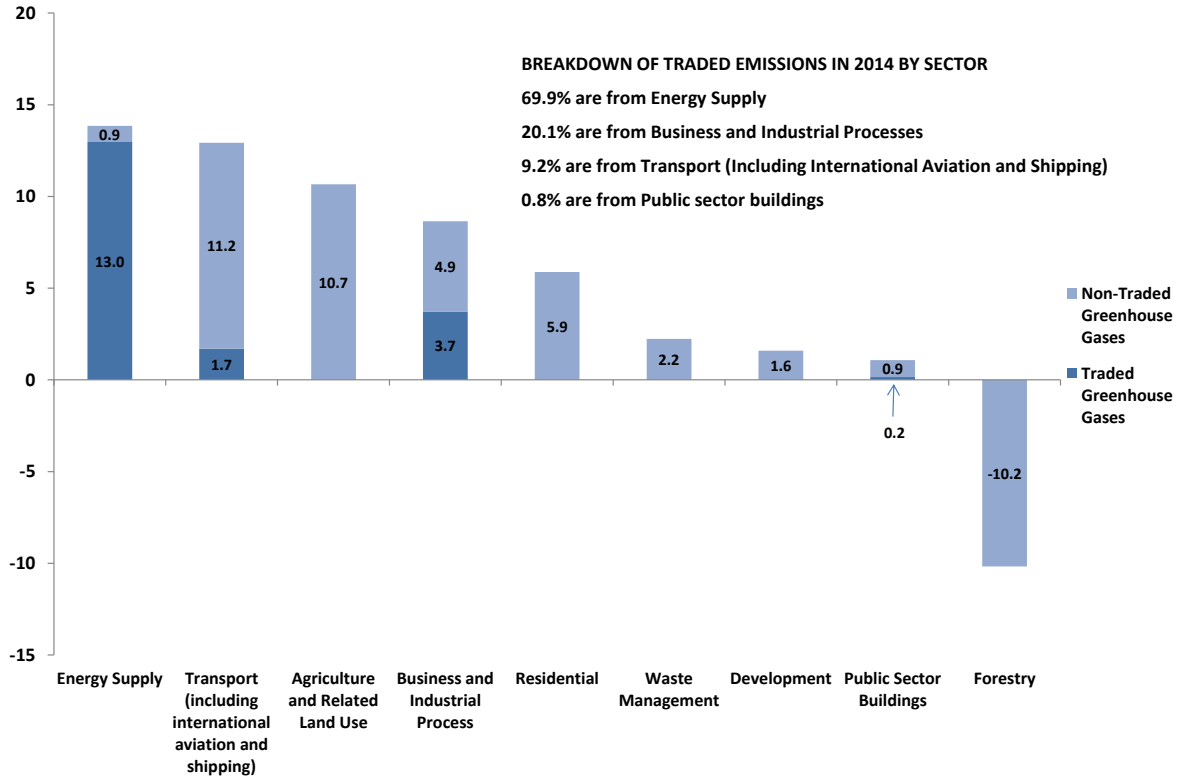
Scotland in the EU ETS

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 2014, there were 77 fixed Scottish installations which are regulated by Scottish Environment Protection Agency (SEPA) 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 and business and industrial process are a combination of traded and non-traded. For the years 2012 to 2014, CO_2 emissions from domestic and international aviation are classified as being within the traded sector.

Chart C1. Estimate of Traded Emissions Surrendered in the EU Emissions Trading System (EU ETS) and Non-Traded Greenhouse Gas Emissions by Scottish Government Sector, 2014. Values in $MtCO_2e$



Note that the Scotland figure for the emissions which have been surrendered in the EU ETS is slightly different to that reported for traded emissions in the Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2014 report produced by Ricardo-AEA and Aether on behalf of the devolved administrations.

There are number of reasons for this:

Firstly, the estimate of surrendered emissions include an estimate of carbon dioxide emissions surrendered from domestic and international aviation. Unlike for fixed installations, it is not possible to accurately estimate Scottish emissions which have been surrendered from aviation directly from aviation

operators. Instead, the Scottish Government has received advice from the Committee on Climate Change to estimate the aviation emissions surrendered in the EU ETS by using figures taken directly from the 1990-2014 greenhouse gas inventory.

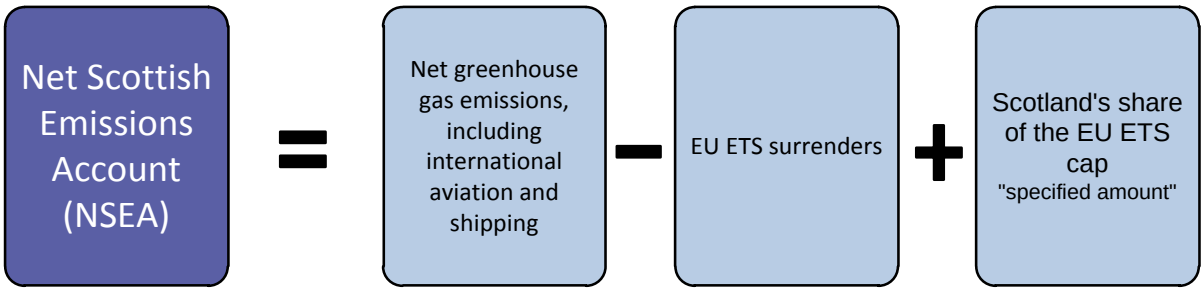
Secondly, operators who participate in the EU ETS must, by 30 April in each year, surrender a number of allowances equal to the annual reportable emissions which the installation made in the previous year. However, as a result of errors or non-compliance in the EU ETS, the figure on surrendered and reported emissions can differ, until both are finalised. These can be on-going situations throughout each Phase of the EU ETS. By the end of each Phase any difference between the two figures should be rectified.

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 each year from 2010 to 2014 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.

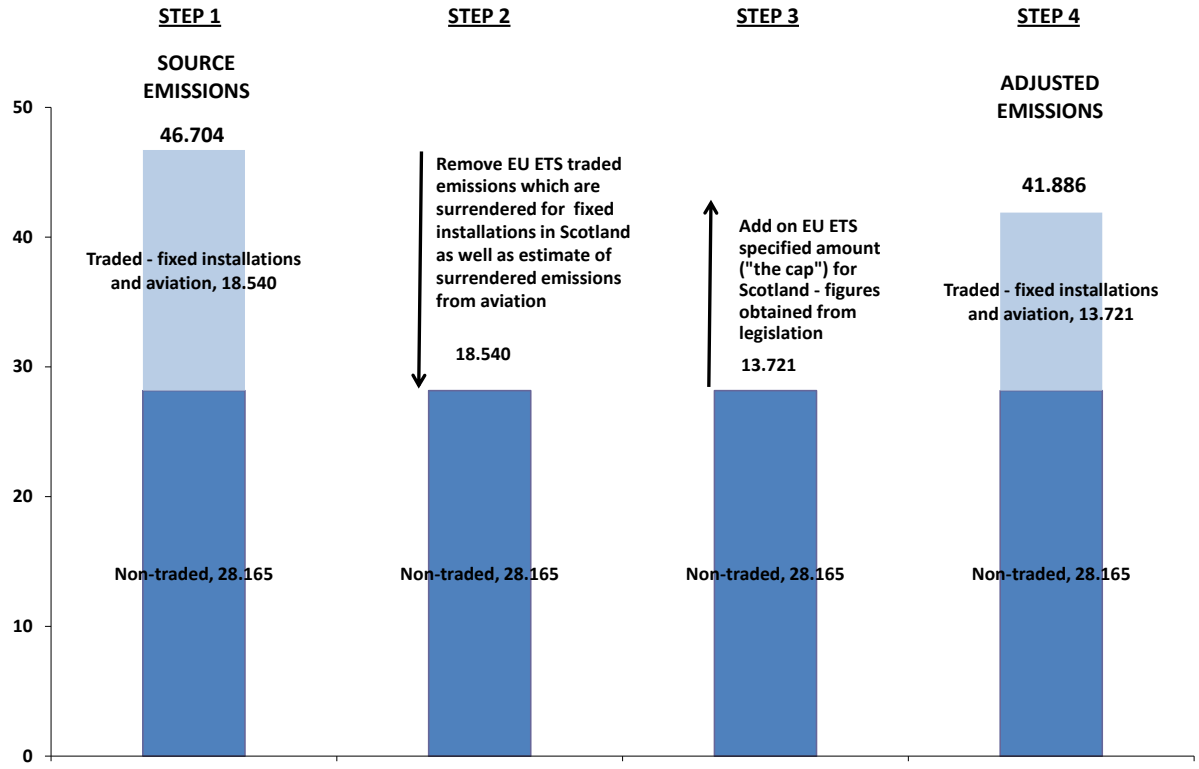
The EU ETS element of the NSEA is calculated by taking the difference between Scotland's notional share of the overall EU ETS cap and the number of emissions allowances surrendered from Scottish fixed installations in a given year, as well as an estimate of CO_2 emissions surrendered from Scotland's share of domestic and international aviation. This amount is then added to non-traded net emissions to get the NSEA.

The NSEA formula is as follows:



The figure for the NSEA are known as adjusted emissions, as they are adjusted to take account of trading within the EU ETS. This adjustment takes the form of a 4-step process, which is outlined in Chart C2.

Chart C2. Calculation of Adjusted Emissions for Trading in the EU Emissions Trading System (EU ETS), 2014. Values in $MtCO_2e$



Calculation of adjusted emissions

STEP 1

Take the Scottish greenhouse gas emissions from Scottish greenhouse gas inventory (for 2014, it is 46.704 $MtCO_2e$). This figure is comprised of:

- traded emissions units surrendered - sourced from Scottish Environment Protection Agency (SEPA) for fixed installations (16.843 $MtCO_2e$)
- an imputed estimate of surrendered CO_2 emissions from domestic aviation (0.504 $MtCO_2e$) and international aviation (1.193 $MtCO_2e$) - sourced from the Scottish Greenhouse Gas Inventory for 1990-2014
- non-traded emissions from sources such as residential emissions (28.165 $MtCO_2e$)

STEP 2

Remove an amount relating to surrendered emissions from fixed installations and an estimate of surrendered emissions from domestic and international aviation. This amounts to 16.843 $MtCO_2e$ + 0.504 $MtCO_2e$ + 1.193 $MtCO_2e$ = **18.540 $MtCO_2e$**.

STEP 3

Add on the value of the EU ETS cap which is outlined within The Carbon Accounting Scheme (Scotland) Amendment Regulations 2016 [10]. The cap reflects an estimate of the Scottish share of the European wide EU ETS cap that is used for emissions accounting. For 2014, this cap was separated into 3 components, as shown in the table below.

Total EU ETS cap for Scotland, 2014

Component	2014 Allocation tCO_2e
Fixed Installation Cap	12,356,118
Domestic Aviation Cap	443,255
International Aviation Cap	921,758
Total 2014 Cap	**13,721,131**

The Scottish EU ETS cap for 2014 is therefore **13.721 $MtCO_2e$**. The Scottish Government has published a methodological paper titled Determining a Scottish EU ETS cap for 2014, which documents the calculations that determine how a notional emissions cap has been calculated for: (i) greenhouse gas emissions from fixed installations located in Scotland, and (ii) Scotland's share of emissions from domestic and international aviation.

STEP 4

Adding on the value of the EU ETS cap gives a value of 41.886 $MtCO_2e$. **In 2014, the adjusted emissions which take account of trading in the EU ETS is 41.886 $MtCO_2e$. This is 4.818 $MtCO_2e$ lower than the value of estimated source emissions in 2014**. Under the Climate Change (Scotland) Act, 2009 [11], a downward adjustment to source emissions is referred to as a credit to the Net Scottish Emissions Account [12]**. This means that 4,818,393 units have been credited to the Net Scottish Emissions Account in 2014.**

[10] http://www.legislation.gov.uk/ssi/2016/46/contents/made

[11] http://www.legislation.gov.uk/asp/2009/12/2009-08-05

[12] Carbon units that are counted as **credits** reduce the level of the NSEA compared with source emissions.

Carbon units that are counted as **debits** increase the level of the NSEA compared with source emissions.

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 2022[13]. Targets for 2023-2027 were set in October 2011[14], and will continue to be set at 5-year intervals.

The 2014 target is 46.958 $MtCO_2e$.

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 2010[15] 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 2011[16] sets limits for the period 2013-2017. For 2014, no additional carbon units were credited to the Net Scottish Emission Account.

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

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

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

[16] 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 (1990-2014) inventory, adjusted for trading in the EU Emissions Trading System as well as data on progress against the 42 per cent and 80 per cent reduction targets. These percentage targets are based on a percentage reduction from the Baseline Period in the latest inventory.

Chart C3. Percentage Reductions Targets – Based on Adjusted Emissions. Values in $MtCO_2e$

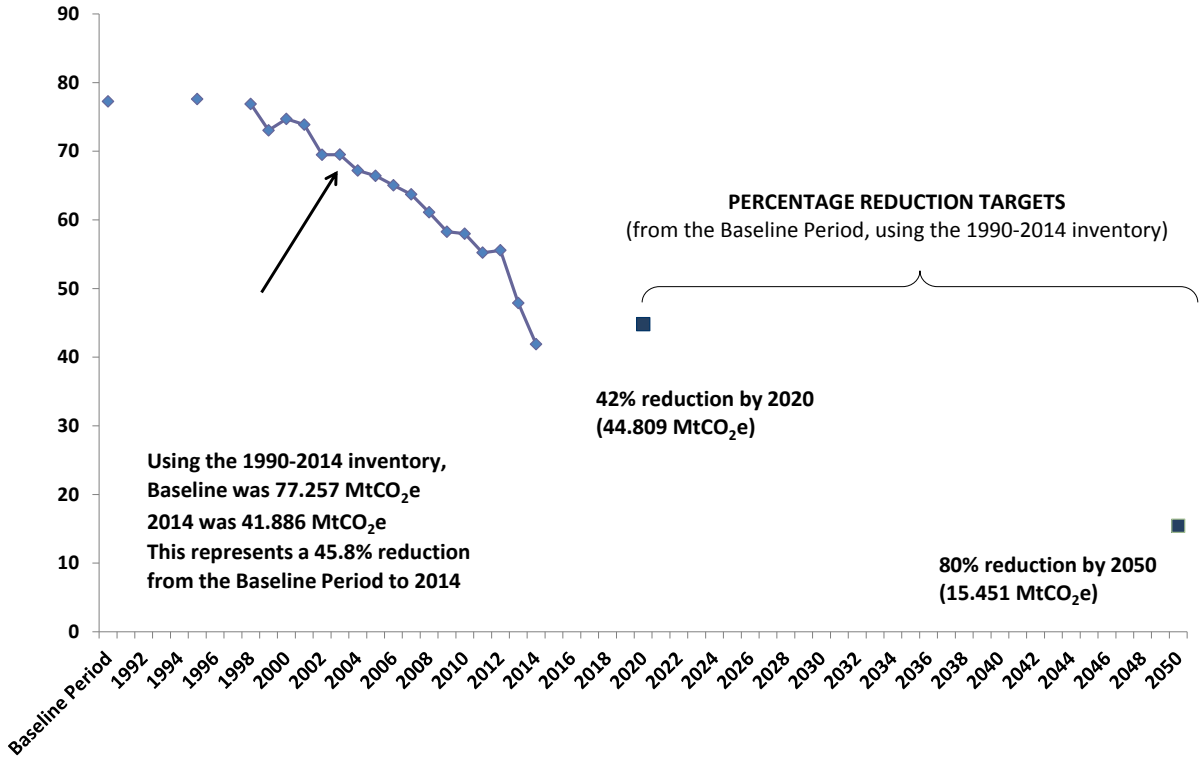
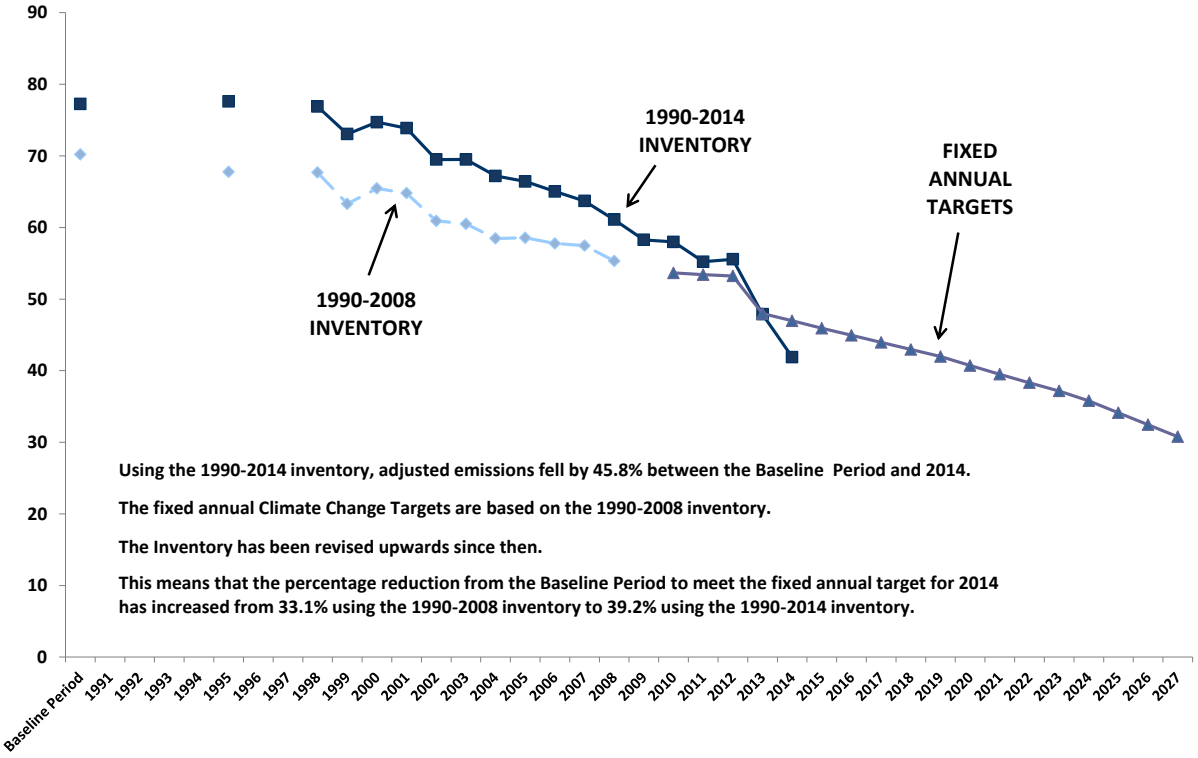


Chart C4 contains data from the latest (1990-2014) inventory, adjusted for trading in the EU Emissions Trading System. The fixed annual targets are also presented on this chart. The fixed annual targets were set at the time of the 1990-2008 inventory. Emissions adjusted for trading in the EU ETS using 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 $MtCO_2e$



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.

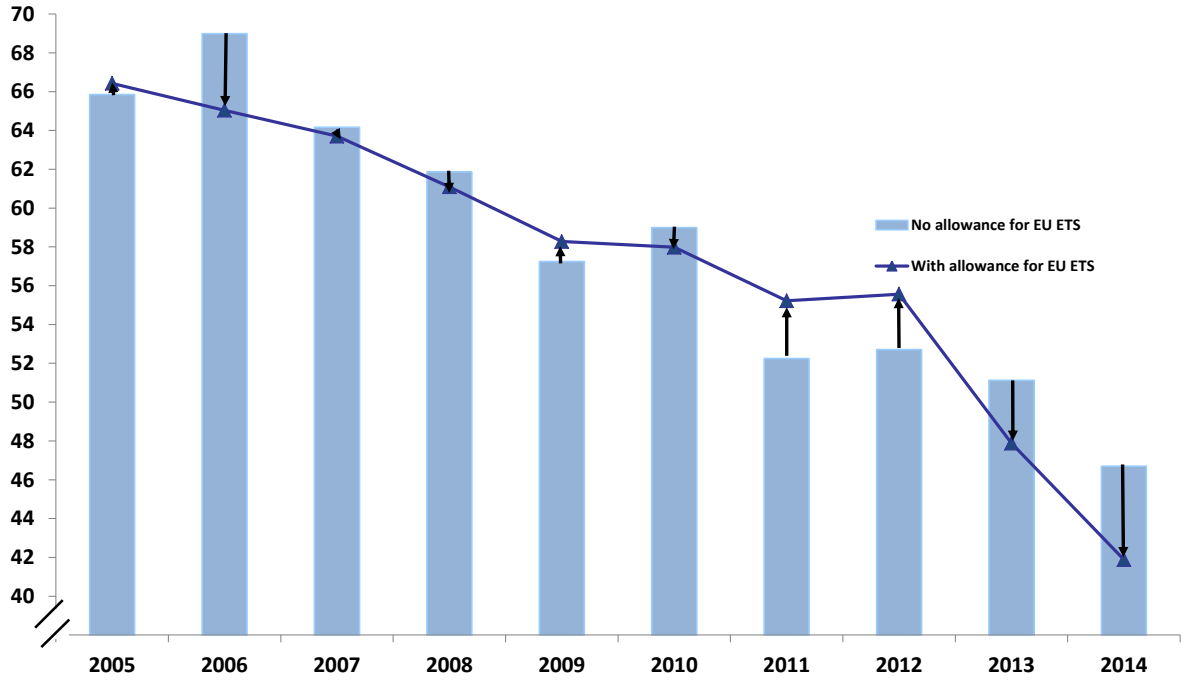
The Sustainability Purpose Targets were refreshed in March 2016 to align with the percentage reduction targets as prescribed in the Climate Change (Scotland) Act 2009. There are two Sustainability Purpose targets:

- The long term target (2050) equates to the 80% reduction target
- The short term target (2020) equates to the 42% reduction target 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 effect of the adjustment for trading in the EU ETS, for calculation of the Net Scottish Emissions Account (NSEA).

Chart C5. Greenhouse Gas Emissions Adjusted for the Emissions Trading System (EU ETS). Values in $MtCO_2e$



In four of the last 10 years, the adjustment has increased reported emissions, with 2011 and 2012 showing sizeable increases from the adjustment. In 2013 and 2014, the adjustment has seen sizeable decreases for the reported cap. In 2014, the adjustment represented a decrease of 4.818 $MtCO_2e$. This reflects Scotland's notional share of the EU ETS cap in 2014, due to withholding of allowances which can be used within the system at an EU level and the tightening of the EU ETS cap between Phases II and III.

Table C1. Scottish greenhouse gas emissions adjusted to take account of trading in the EU Emissions Trading System. Baseline Period to 2014. Values in $MtCO_2e$

		Baseline Period	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
No allowance for EU ETS	Total Scottish greenhouse gas emissions (including international aviation and shipping)	77.3	65.9	69.0	64.2	61.9	57.2	59.0	52.3	52.7	51.1	46.7
	Percentage change from Baseline Period		-14.8%	-10.7%	-16.9%	-19.9%	-25.9%	-23.6%	-32.4%	-31.8%	-33.8%	-39.5%
	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	-3.2	-4.8
	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 emisisons		0.8	-3.8	-0.3	-0.9	0.9	-1.1	2.9	2.8	-3.2	-4.8
With allowance for EU ETS	Total Scottish greenhouse gas emissions (including international aviation and shipping)	77.257	66.426	65.037	63.703	61.092	58.277	57.980	55.220	55.565	47.885	41.886
	Percentage change from Baseline Period		-14.0%	-15.8%	-17.5%	-20.9%	-24.6%	-25.0%	-28.5%	-28.1%	-38.0%	-45.8%
	Statutory Fixed Annual Targets							53.652	53.404	53.226	47.976	46.958

* Scotland's EU ETS adjusted emissions are presented to 3 decimal places. This is to allow direct comparison with Scotland's fixed annual targets, as set out in legislation

* Scotland's Statutory Fixed Annual Targets were first introduced in 2010 in legislation.

* Before 2005, the source emissions and EU ETS adjusted emissions are the same. This is because the EU ETS was introduced in 2005.

Section D. Revisions to the Inventory and Methodology

This section examines key revisions in estimated source emissions between the latest inventory (1990-2014) and the previous inventory (1990-2013) published in June 2015. It also provides a summary of the cumulative impact of revisions since the 1990-2008 inventory. In October 2015, the Scottish Government published a paper Scottish Greenhouse Gas Emissions 2013. Key Revisions Since 2008, which provides a breakdown of the key revisions to the data within the Scottish Greenhouse Gas Emissions Official Statistics publication over successive years from the 1990-2008 inventory to the 1990-2013 inventory. This section of the publication is intended to build on this revisions paper.

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 related 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 Energy and Climate Change (DECC) 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 1990-2013 and 1990-2014 inventories

Charts D1 to D3 and Table D1 illustrate the impacts of revisions between the 1990-2013 and 1990-2014 inventories, both by sector and by greenhouse gas. This is followed by a discussion of the reasons for the key revisions.

Chart D1. Scottish Greenhouse Gas Emissions. Comparison of 1990-2013 and 1990-2014 Inventories. Values in $MtCO_2e$

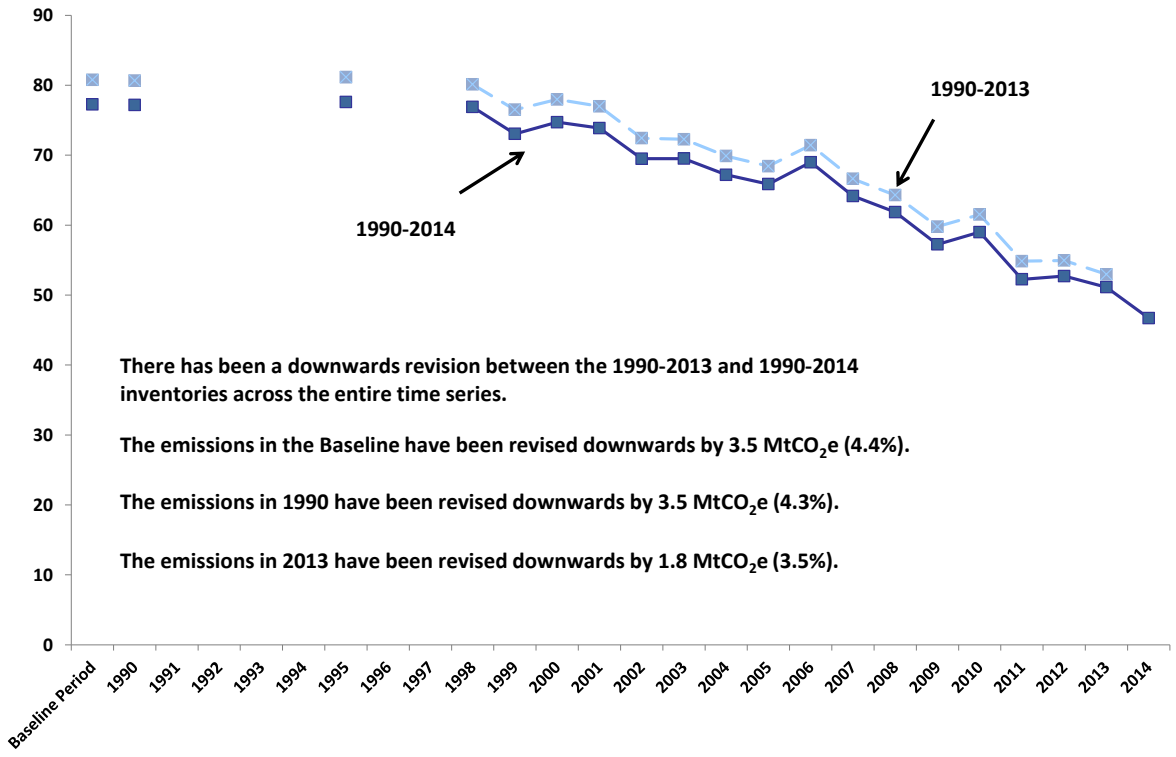


Chart D2 shows that the nearly all the downward revisions to the Baseline period occurred in the Agriculture and Related Land Use and Forestry sectors (revised downwards by 1.9 $MtCO_2e$ and 1.7 $MtCO_2e$ respectively). Other sectors saw very little change between the 1990-2013 and 1990-2014 inventories, with a slight (0.1 $MtCO_2e$) increase in emissions from transport (including international aviation and shipping).

Chart D2. Revisions to emissions in the Baseline Period, from the 1990-2013 inventory to the 1990-2014 inventory, by source sector. Values in $MtCO_2e$, *and percentage changes*

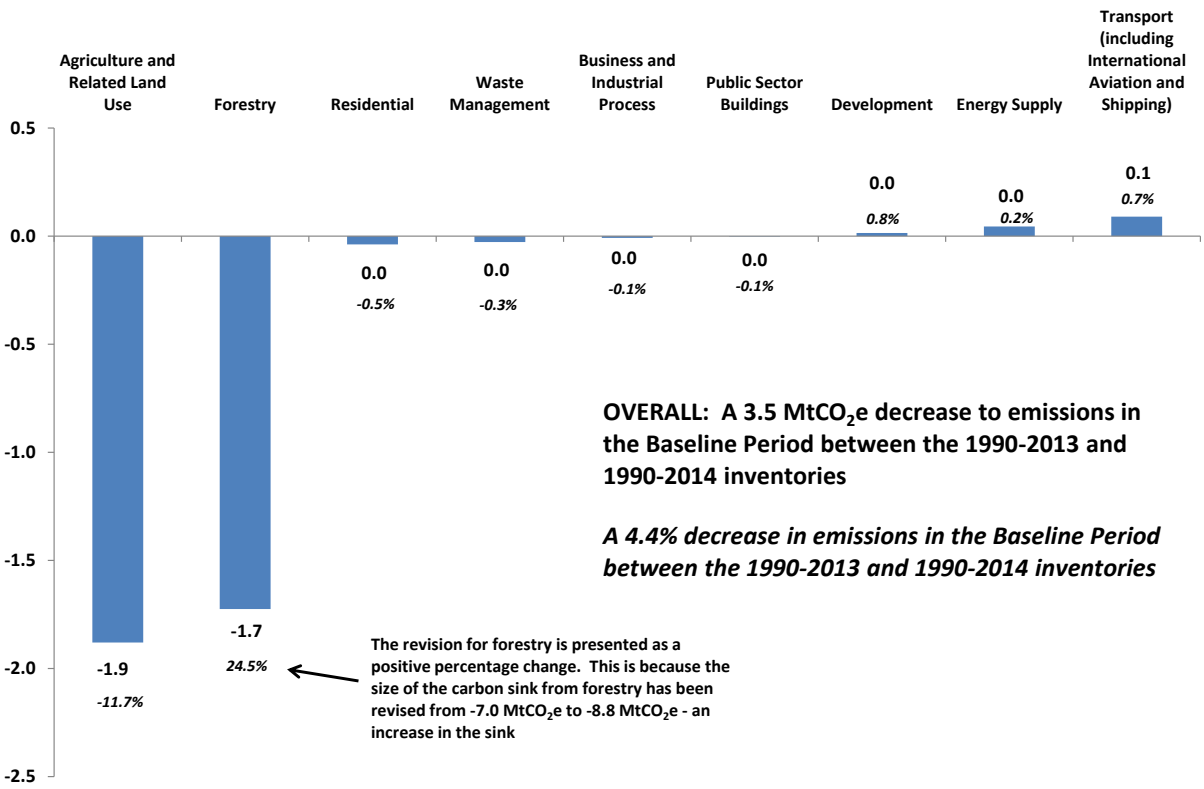


Chart D3 shows that the greatest downwards revision in 2013 occurred in the Agriculture and Related Land Use sector (1.5 $MtCO_2e$; contributing to 83.8 per cent of net downwards revisions). The second largest downwards revision occurred in forestry (0.3 $MtCO_2e$). There was a much smaller downward revision in the Waste Management sector (0.1 $MtCO_2e$) and a small upward revision in the Business and Industrial process sector (0.1 $MtCO_2e$).

Chart D3. Revisions to emissions in 2013, from the 1990-2013 inventory to the 1990-2014 inventory, by source sector. Values in $MtCO_2e$, *and percentage changes*

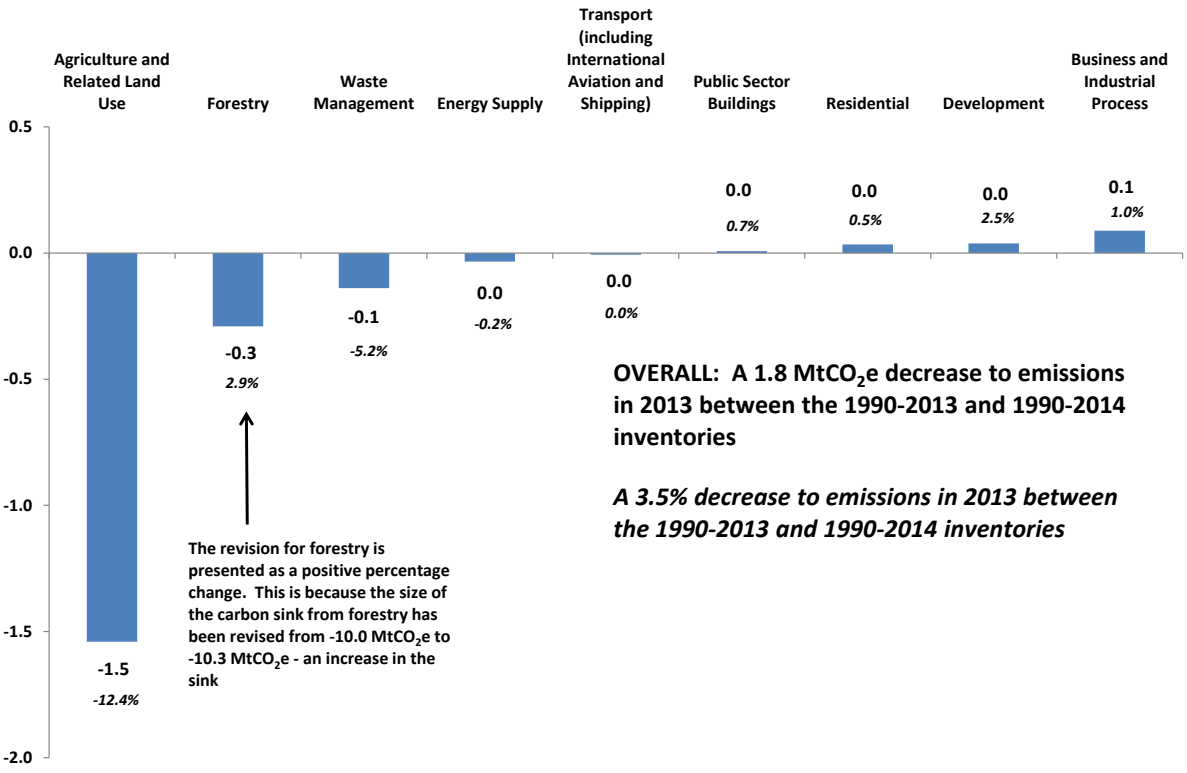


Table D1. Changes in emissions by source sector. Comparison of 1990-2013 and 1990-2014 inventories. Values in $MtCO_2e$

	Baseline Period	1990	2013	2014	*% change between Baseline Period and 2013*	*% change between 1990 and 2013*	*% change between Baseline Period and 2014*	*% change between 1990 and 2014*
Total								
1990-2013	**80.8**	**80.7**	**53.0**		***-34.4%***	***-34.3%***		
1990-2014	**77.3**	**77.2**	**51.1**	**46.7**	***-33.8%***	***-33.7%***	***-39.5%***	***-39.5%***
Difference between 1990-2013 and 1990-2014	**-3.5**	**-3.5**	**-1.8**					
Energy Supply								
1990-2013	22.7	22.7	16.0		*-29.5%*	*-29.5%*		
1990-2014	**22.8**	**22.8**	**16.0**	**13.8**	*-29.8%*	*-29.8%*	*-39.2%*	*-39.2%*
Difference between 1990-2013 and 1990-2014	**0.0**	**0.0**	**0.0**					
Transport (including International Aviation and Shipping)								
1990-2013	13.2	13.2	12.9		*-2.1%*	*-2.1%*		
1990-2014	**13.3**	**13.3**	**12.9**	**12.9**	*-2.8%*	*-2.8%*	*-2.8%*	*-2.8%*
Difference between 1990-2013 and 1990-2014	**0.1**	**0.1**	**0.0**					
Agriculture and Related Land Use								
1990-2013	16.1	16.1	12.4		*-23.1%*	*-23.1%*		
1990-2014	**14.2**	**14.2**	**10.9**	**10.7**	*-23.7%*	*-23.7%*	*-25.0%*	*-25.0%*
Difference between 1990-2013 and 1990-2014	**-1.9**	**-1.9**	**-1.5**					
Business and Industrial Process								
1990-2013	14.4	14.3	9.1		*-36.6%*	*-36.3%*		
1990-2014	**14.3**	**14.3**	**9.2**	**8.7**	*-35.9%*	*-35.8%*	*-39.7%*	*-39.6%*
Difference between 1990-2013 and 1990-2014	**0.0**	**0.0**	**0.1**					
Residential								
1990-2013	8.0	8.0	7.0		*-13.0%*	*-12.4%*		
1990-2014	**8.0**	**7.9**	**7.0**	**5.9**	*-12.1%*	*-11.5%*	*-26.5%*	*-26.0%*
Difference between 1990-2013 and 1990-2014	**0.0**	**0.0**	**0.0**					
Waste Management								
1990-2013	9.9	9.9	2.7		*-72.6%*	*-72.6%*		
1990-2014	**9.8**	**9.8**	**2.6**	**2.2**	*-73.9%*	*-73.9%*	*-77.3%*	*-77.3%*
Difference between 1990-2013 and 1990-2014	**0.0**	**0.0**	**-0.1**					
Development								

	Baseline Period	1990	2013	2014	*% change between Baseline Period and 2013*	*% change between 1990 and 2013*	*% change between Baseline Period and 2014*	*% change between 1990 and 2014*
1990-2013	1.8	1.8	1.6		*-14.7%*	*-14.7%*		
1990-2014	**1.8**	**1.8**	**1.6**	**1.6**	*-13.4%*	*-13.4%*	*-13.8%*	*-13.8%*
Difference between 1990-2013 and 1990-2014	**0.0**	**0.0**	**0.0**					
Public Sector Buildings								
1990-2013	1.7	1.7	1.2		*-26.2%*	*-26.2%*		
1990-2014	**1.7**	**1.7**	**1.3**	**1.1**	*-25.7%*	*-25.7%*	*-36.2%*	*-36.2%*
Difference between 1990-2013 and 1990-2014	**0.0**	**0.0**	**0.0**					
Forestry [17]								
1990-2013	-7.0	-7.0	-10.0		*42.0%*	*42.0%*		
1990-2014	**-8.8**	**-8.8**	**-10.3**	**-10.2**	*17.3%*	*17.3%*	*16.1%*	*16.1%*
Difference between 1990-2013 and 1990-2014	**-1.7**	**-1.7**	**-0.3**					

[17] Unlike for other source sectors, downward changes to net emissions from forestry are presented as a positive percentage change. This is because forestry causes a net removal of emissions.

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.

However, in 2014 there have been two revisions which have occurred as a result of errors in datasets supplied by a third party which feed into the UK and in turn the Scottish inventory. These have been corrected within the 1990-2014 inventory.

The latest published Scotland greenhouse gas inventory (currently 1990-2014) 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 - 2014 [18]. Details of the most notable revisions are listed below:

1. Forestry.

Correction to model used to estimate net emissions from forestry and harvested wood products

The output from the model used to estimate the net emissions from forestry was corrected by inventory compilers as part of the Land Use, Land Use Change and Forestry (LULUCF) inventory. This correction occurred because the estimates of carbon sequestered from forestry had been previously assigned to the wrong years in the UK-wide model. This affects the subcategories of forest land remaining forest land and harvested wood products. The impact of this correction has resulted in a downwards revision across the time series (of 1.7 $MtCO_2e$ in 1990 and of 0.3 $MtCO_2e$ in 2013), compared to the 1990-2013 inventory published in June 2015.

A series of steps are being put in place to reduce the likelihood of such errors occurring in future inventories. The Scottish Government is represented at the UK's National Inventory Steering Committee (NISC), where improvements to the Scottish and UK inventories are discussed. As part of the NISC, a major programme of work has been recently launched to review and improve the

[18] http://naei.defra.gov.uk/reports/reports?report_id=894

quality assurance and quality control processes within the models used in the greenhouse gas inventory. The UK Department for Energy and Climate Change (DECC) has published tools and guidance to help people with quality assurance of analytical models[19].

2. Agriculture and Related Land Use

Correction to emissions of drainage of grasslands on organic soils

The emission factor used for grassland drainage was corrected by inventory compilers as part of the Land Use, Land Use Change and Forestry (LULUCF) inventory. In the 1990-2013 inventory, the IPCC (2006)[20] emission factor for *cultivated organic soils* was used for grassland on drained organic soils. This has been replaced with the correct emission factor for *drainage of grasslands on organic soils* for the 1990-2014 inventory. This has resulted in an decrease in 0.96 $MtCO_2e$ across each year in the time series and has increased the size of carbon sink from grasslands.

3. Agriculture and Related Land Use

Impacts of research to derive more representative, UK-specific emission factors to Nitrous Oxide emissions in the Agriculture and Related Land Use sector

There is a large programme of work underway to better quantify and reduce uncertainty in UK and Scottish agriculture emissions. This is known as the Agricultural Greenhouse Gas Inventory Research Platform and consists of a consortia of a wide range of scientific expertise[21] including many leading academic experts from Scottish universities and institutions. The research programme over recent years has gathered evidence on agricultural processes and emissions, specific to UK conditions (soils, climate, farm management practices etc.) in order to improve the accuracy of emission factors for greenhouse gas emissions. The first improvements from the Agriculture Platform have been introduced for the 1990-2014 inventory and are as a result of new UK-specific emissions factors. These result in revisions to nitrous oxide (N_2O) emissions, with further improvements to methane (CH_4) emissions likely to be introduced for the 1990-2015 inventory.

The main revisions have been to the Agricultural Soils subcategory. These include:

[19] https://www.gov.uk/government/collections/quality-assurance-tools-and-guidance-in-decc

[20] http://www.ipcc-nggip.iges.or.jp/public/2006gl/

[21] http://www.ghgplatform.org.uk/

- the direct estimation of UK-specific emissions factors for N_2O from agricultural soils using IPCC (2006)[22] guidelines. Previously, the emission estimates were based on a standard non-UK specific value.

- new UK-specific emissions factors for indirect emissions from N_2O leaching and run-off which have replaced IPCC default values.

- the harmonisation of the models used to estimate indirect emissions of nitrous oxide from atmospheric deposition with those estimates of ammonia used for the UK's Air Pollution inventory [23].

In addition, new UK specific emissions factors have been calculated for direct N_2O sources from urine and dung deposited by grazing animals

The overall impact of these improvements has been to lower the emissions estimates in the Agriculture and Related Land Use sector across the time series, by around 1.16 $MtCO_2e$ in 1990 and by around 0.82 $MtCO_2e$ in 2013.

Note that prior to this UK research, the emissions of nitrous oxide from soils were by far the most uncertain single emission estimate in the UK and Scottish inventories. This was due to the considerable uncertainty in the emission factors for the sources listed above, where international defaults were previously applied to represent UK conditions and activities. This improvement was one of the key improvements which has lowered the overall level of uncertainty in the Scottish greenhouse gas inventory.

Interpretation of uncertainties in the inventory

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

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

The Scottish Government has 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 1990-2013 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.

[22] http://www.ipcc-nggip.iges.or.jp/public/2006gl/

[23] http://naei.defra.gov.uk/reports/reports?section_id=2

These uncertainty calculations have been updated for the 1990-2014 inventory. The outcome is a model that delivers more accurate and lower estimates of uncertainty for Scottish greenhouse gas emissions (9% uncertainty for 2014 emissions), and a narrower range of "Base year to latest year" Greenhouse Gas trends (-41%, within a -33% to -49% range). Note that these calculations exclude emissions from international aviation and shipping.

Future revisions to the inventory

Every year, 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. The Scottish Government is represented at the UK's National Inventory Steering Committee, where improvements to the Scottish and UK inventories are discussed. Some of the changes for the 1990-2015 inventory and for subsequent inventories are already known. However, the exact magnitude and direction of future revisions are not currently clear but on balance we might expect emissions to increase over subsequent inventories.

There are a number of projects underway which might result in considerable revisions for future inventories in a number of sectors. For instance:

- There is a large project underway to improve estimates of domestic and international shipping emissions;
- Further results from the Agriculture greenhouse gas platform will become available. For instance, improved estimates of methane will be introduced as well as potentially more specific emissions factors for devolved administrations;
- There is a project underway to better understand the behaviour of drained organic soils and the impact of this on how forests release or sequester carbon. This may increase net emissions in this sector. However, this may be counteracted by new data from the National Forest Inventory;
- There is likely to be a review of the carbon factors of some of the fuels not included in the EU Emissions Trading System (EU ETS), as these have not been reviewed for a number of years;

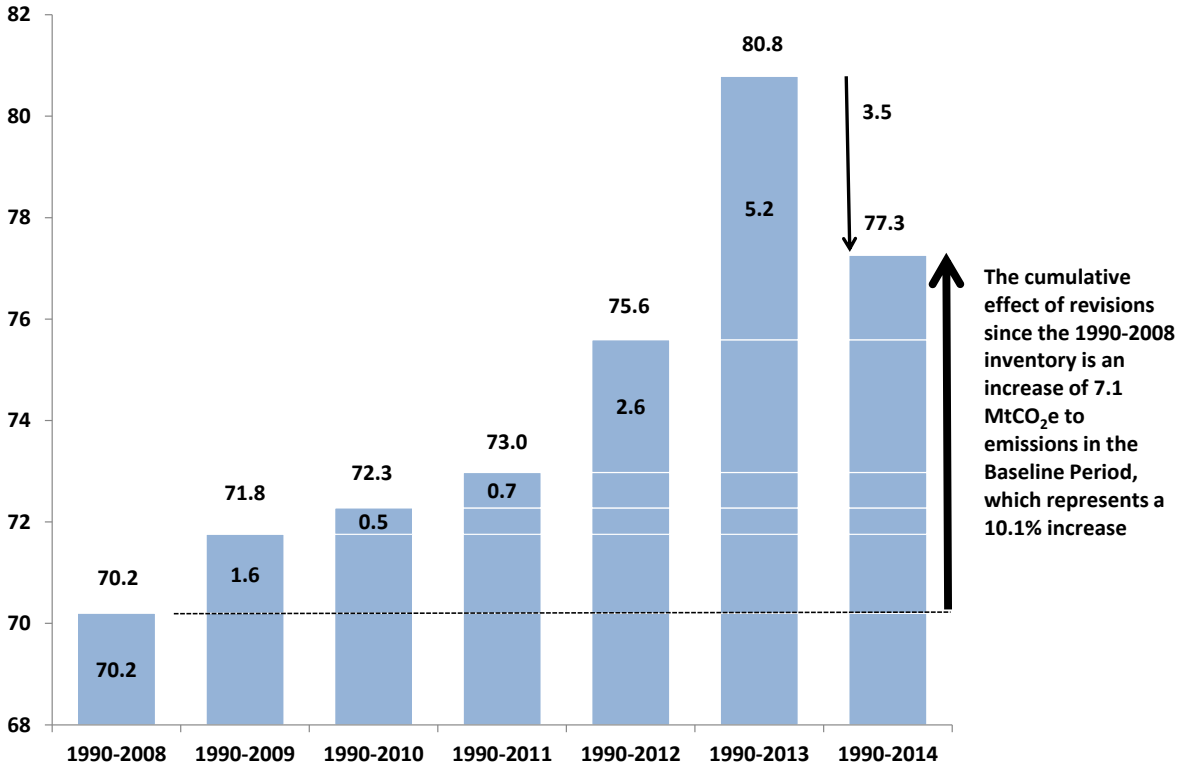
- An improved methodology is being developed to better represent emissions from land use changes, although this is not expected for the 1990-2015 inventory.

Note that there are likely to be further revisions in the 1990-2015 inventory which have not been noted within this publication.

Cumulative revisions since 1990-2008

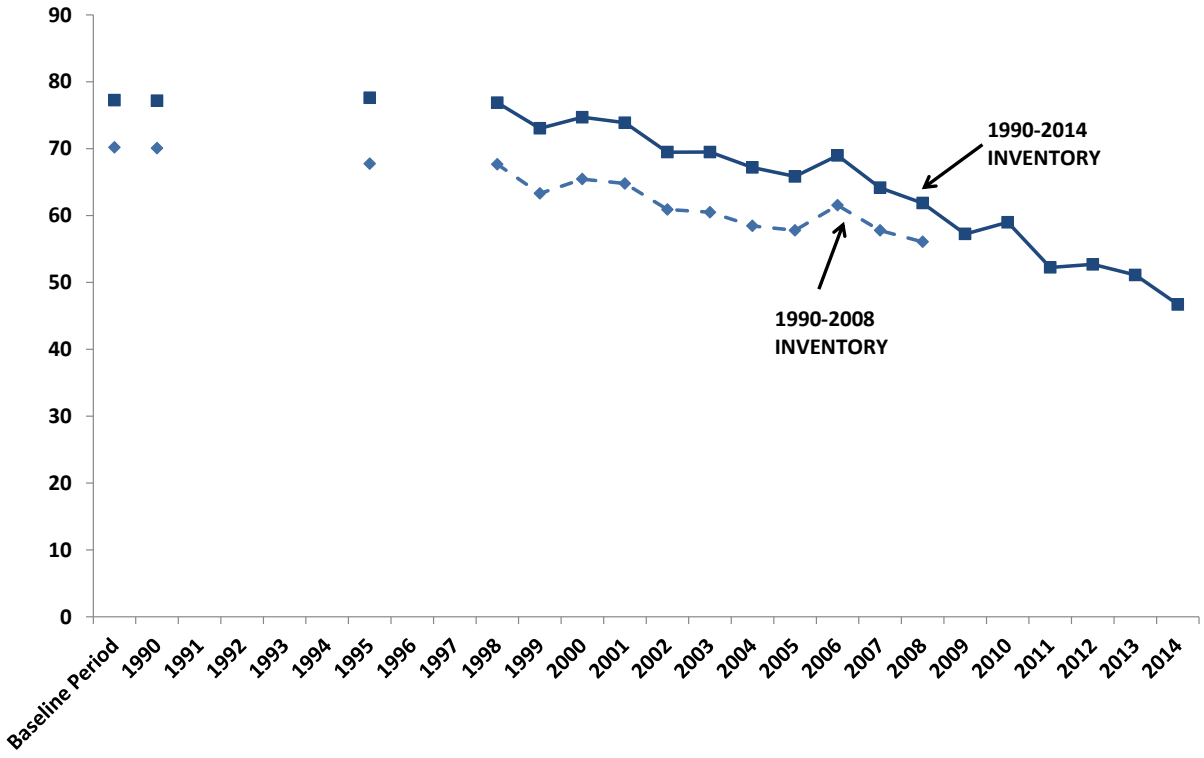
Revisions since the 1990-2008 inventory give a flavour of the scale of total revisions since the establishment of fixed annual Climate Change targets. Chart D4 shows that the Baseline has been revised upwards in every successive inventory from the 1990-2008 to 1990-2013, with a downwards revision to the Baseline between 1990-2013 and 1990-2014. Overall there was been a cumulative increase in emissions. Between the 1990-2008 inventory and the latest inventory, the average yearly increase in emissions in the Baseline Period has been 1.2 $MtCO_2e$.

Chart D4. Revisions to emissions in the Baseline Period, from the 1990-2008 Inventory, to the Latest Inventory. Impact of Successive Revisions. Values in $MtCO_2e$



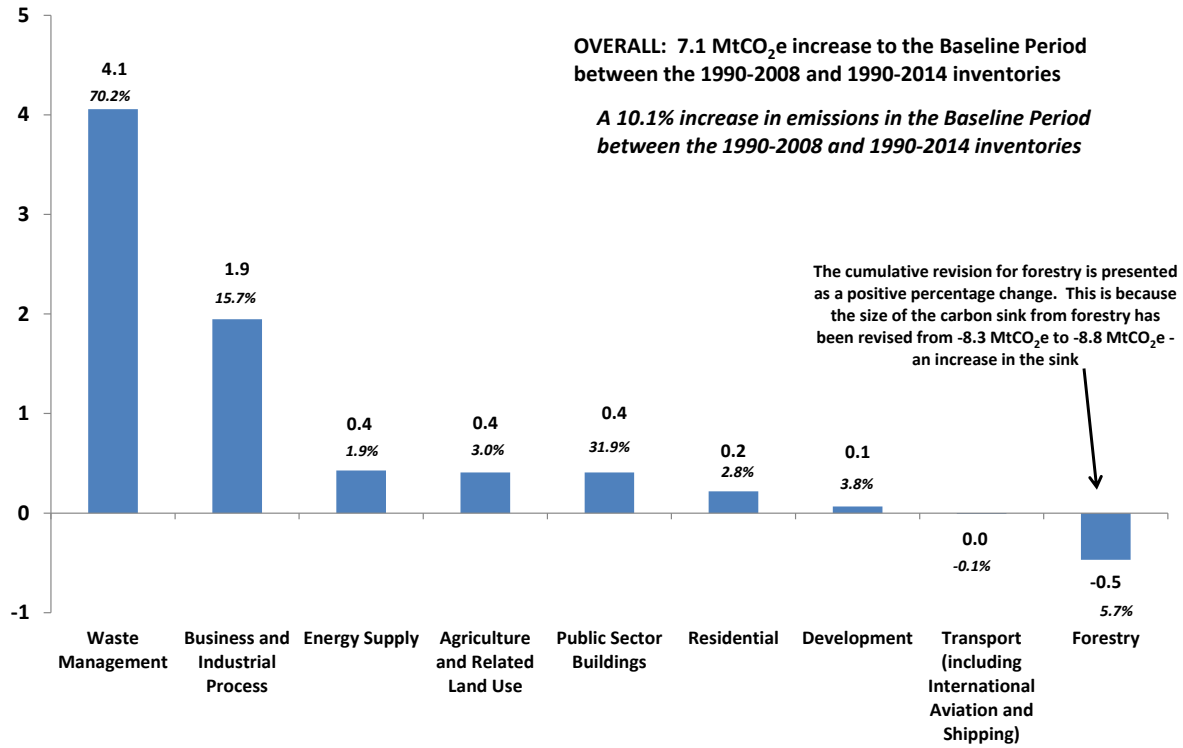
Charts D5 shows the cumulative effect of revisions to the greenhouse gas inventory from 1990-2008 to the latest (1990-2014) inventory across the time series. Chart D6 shows the cumulative effect of revisions to the Baseline from the 1990-2008 inventory, by source sector.

Chart D5. Scottish Greenhouse Gas Emissions, Comparison of 1990-2008 and 1990-2014 Inventories. Values in $MtCO_2e$



There has been a cumulative upwards revision between 1990-2008 and 1990-2014 across the entire time series.
The emissions in the Baseline have been revised upwards by 7.1 $MtCO_2e$ (10.1%)
The emissions in 1990 have been revised upwards by 7.1 $MtCO_2e$ (10.1%)
The emissions in 2008 have been revised upwards by 5.8 $MtCO_2e$ (10.3%)

Chart D6. Revisions to the Baseline, from the 1990-2008 Inventory to the Latest Inventory (1990-2014), by source sector. Impact of Successive Revisions. Values in $MtCO_2e$, *and percentage changes* [24]



A discussion of the main causes of the upwards revisions between 1990-2008 and the 1990-2013 inventories can be found within the methodology paper: Scottish Greenhouse Gas Emissions 2013. Key Revisions Since 2008.

[24] Unlike for other source sectors, downwards revisions to net emissions from forestry are presented as a positive percentage change. This is because forestry causes a net removal of emissions.

Section E. Further information, Glossary and Acknowledgements

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: 1990-2014

Scottish Greenhouse Gas Inventory Uncertainties Project

The Scottish Government commissioned a project to understand the uncertainties associated with the estimates of Scottish Greenhouse gas Emissions in 2013:
http://www.gov.scot/Topics/Statistics/Browse/Environment/Publications/GHGUncertainties2013Summary

Scotland's Carbon Footprint

Scottish Greenhouse Gas Emissions on a Consumption Basis ("Scotland's Carbon Footprint 1998-2012)

Scottish Greenhouse Gas Emissions 2013. Key Revisions since 2008

This paper was published in 2015 and provides a breakdown of the key revisions to the Scottish Greenhouse Gas Emissions Official Statistics publication over successive years from the 1990-2008 inventory to the 1990-2013 inventory.
http://www.gov.scot/Topics/Statistics/Browse/Environment/Publications/ghgrevisions-2013

Climate Change (Scotland) Act 2009

This legislation outlines the requirements for percentage reductions targets for 2020 and 2050 and fixed annual targets
http://www.gov.scot/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.gov.scot/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.
http://www.legislation.gov.uk/ssi/2010/216/contents/made.

The Carbon Accounting Scheme (Scotland) Amendment Regulations 2015

These Regulations establish the scheme for monitoring compliance with the annual emissions reduction targets set for 2013.
http://www.legislation.gov.uk/ssi/2015/189/contents/made

The Carbon Accounting Scheme (Scotland) Amendment Regulations 2016

These Regulations establish the scheme for monitoring compliance with the annual emissions reduction targets set for 2014.
http://www.legislation.gov.uk/ssi/2016/46/contents/made

The Climate Change (Additional Greenhouse Gas) (Scotland) Order 2015

This legislates for the inclusion of the new greenhouse gas (nitrogen trifluoride) to be added to the basket of gases in Scotland's greenhouse gas inventory.
http://www.legislation.gov.uk/ssi/2015/197/contents/made

National Performance Framework Sustainability Purpose Targets

http://www.gov.scot/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

UK greenhouse gas inventory summary factsheets

https://www.gov.uk/government/publications/uk-greenhouse-gas-inventory-summary-factsheets

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 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.

http://www.ipcc.ch/

Meteorological Office (Met Office)

The Meteorological (Met Office) publishes mean monthly and annual air temperature figures for Scotland from 1910 to 2015.
http://www.metoffice.gov.uk/pub/data/weather/uk/climate/datasets/Tmean/date/Scotland.txt

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 Government Methodology Paper: Determining the Scottish EU ETS cap for 2014

This documents the calculations which determine the 'specified amounts' for emissions from (i) fixed installations located in Scotland and covered by the EU emissions trading system (EU-ETS) and (ii) aviation covered by the EU-ETS.
http://www.gov.scot/Topics/Statistics/Browse/Environment/Publications/EUETScap2014

Scottish Energy Statistics

The Scottish Government's Energy in Scotland 2016 statistics compendium publication presents statistics on the energy sector in Scotland. It presents statistics and analysis for the following topics

- An overview of the energy sector in Scotland – including an Energy Balance for Scotland
- Energy Consumption
- Electricity
- Heat
- Transport
- Oil and Gas
- Energy Prices
- Climate Change
- Low Carbon Economy

A Key Facts booklet has been published to give users, at a glance, the headline statistics and key information for each of the main topic areas covered in Energy in Scotland 2016.
http://www.gov.scot/Topics/Statistics/Browse/Business/Energy

Scottish Transport Statistics

These statistics are produced by Transport Scotland on an annual basis, as part of a compendium publication on a wide range of transport issues. http://www.transportscotland.gov.uk/statistics/scottish-transport-statistics-all-editions

Detailed inventory mapping

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

Note that the inventory data can be mapped in a variety of different ways. Further mappings of the 1990-2014 inventory can be found in the Excel tables and Pivot Table which accompany this publication.

SG Sector	NC Category	IPCC Sector	Source Name
Energy Supply	Energy Supply	1A1ai Public Electricity & Heat Production	Miscellaneous industrial/commercial combustion
			Power stations
			Public sector combustion
		1A1b Petroleum Refining	Refineries - combustion
		1A1ci Manufacture of solid fuels	Coke production
			Solid smokeless fuel production
		1A1cii Oil and gas extraction	Upstream Gas Production - fuel combustion
			Upstream oil and gas production - combustion at gas separation plant
			Upstream Oil Production - fuel combustion
		1A1ciii Other energy industries	Collieries - combustion
			Gas production
			Nuclear fuel production
			Town gas manufacture
		1B1ai Underground mines:Abandoned	Closed Coal Mines
		1B1ai Underground mines:Mining activities	Deep-mined coal
		1B1ai Underground mines:Post-mining activities	Coal storage and transport
		1B1aii Surface mines:Mining activities	Open-cast coal
		1B1b Solid Fuel Transformation	Charcoal production
			Coke production
			Iron and steel - flaring
			Solid smokeless fuel production
		1B2a1 Oil exploration	Upstream Oil Production - Offshore Well Testing
		1B2a2 Oil production	Petroleum processes
			Upstream Oil Production - process emissions
		1B2a3 Oil transport	Upstream Oil Production - Offshore Oil Loading
			Upstream Oil Production - Onshore Oil Loading
		1B2a4 Oil refining/storage	Upstream Oil Production - Oil terminal storage
		1B2b1 Gas exploration	Upstream Gas Production - Offshore Well Testing
		1B2b3 Gas processing	Upstream Gas Production - process emissions
		1B2b4 Gas transmission and storage	Gas leakage
			Upstream Gas Production - Gas terminal storage
		1B2b5 Gas distribution	Gas leakage

SG Sector	NC Category	IPCC Sector	Source Name
		1B2c Flaring Gas	Upstream Gas Production - flaring
		1B2c Flaring Oil	Upstream Oil Production - flaring
		1B2c Venting Gas	Upstream Gas Production - venting
		1B2c Venting Oil	Upstream Oil Production - venting
		2A4d Other process uses of carbonates:other	Power stations – FGD
Transport (excluding International Aviation and Shipping)	Transport	1A3a Domestic aviation	Aircraft - domestic cruise
			Aircraft - domestic take off and landing
		1A3bi Cars	Road transport - cars - cold start
			Road transport - cars - motorway driving
			Road transport - cars - rural driving
			Road transport - cars - urban driving
		1A3bii Light duty trucks	Road transport - LGVs - cold start
			Road transport - LGVs - motorway driving
			Road transport - LGVs - rural driving
			Road transport - LGVs - urban driving
		1A3biii Heavy duty trucks and buses	Road transport - buses and coaches - motorway driving
			Road transport - buses and coaches - rural driving
			Road transport - buses and coaches - urban 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
		1A3biv Motorcycles	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
		1A3bv Other road transport	Road transport - all vehicles LPG use
		1A3c Railways	Rail - coal
			Railways - freight
			Railways - intercity
			Railways - regional
		1A3d Domestic navigation	Inland goods-carrying vessels
			Motorboats / workboats (e.g. canal boats, dredgers, service boats, tourist boats, river boats)

SG Sector	NC Category	IPCC Sector	Source Name
			Personal watercraft e.g. jet ski
			Sailing boats with auxiliary engines
			Shipping - coastal
		1A3eii Other Transportation	Aircraft - support vehicles
		1A4ai Commercial/Institutional	Railways - stationary combustion
		1A4ciii Fishing	Fishing vessels
		1A5b Other:Mobile	Aircraft - military
			Shipping - naval
		2D1 Lubricant Use	Marine engines
			Road vehicle engines
		2D3 Non-energy products from fuels and solvent use:Other	Road transport - urea
International Aviation and Shipping	International Aviation and Shipping	Aviation Bunkers	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
			Aircraft engines
		Marine Bunkers	Shipping - international IPCC definition
			Shipping between UK and Gibraltar
			Shipping between UK and OTs (excl. Gib)
Agriculture and Related Land Use	Agriculture	1A4ci Agriculture/Forestry/Fishing:Stationary	Agriculture - stationary combustion
		1A4cii Agriculture/Forestry/Fishing:Off-road	Agriculture - mobile machinery
		2D1 Lubricant Use	Agricultural engines
		3A1 Enteric Fermentation dairy cattle	Agriculture livestock - dairy cattle enteric
		3A1 Enteric Fermentation non-dairy cattle	Agriculture livestock - other cattle enteric
		3A2 Enteric Fermentation sheep	Agriculture livestock - sheep enteric
		3A3 Enteric Fermentation swine	Agriculture livestock - pigs enteric
		3A4 Enteric Fermentation other:deer	Agriculture livestock - deer enteric
		3A4 Enteric Fermentation other:goats	Agriculture livestock - goats enteric
		3A4 Enteric Fermentation other:horses	Agriculture livestock - horses enteric
		3B1 Manure Management dairy cattle	Agriculture livestock - dairy cattle wastes
		3B1 Manure Management non-dairy cattle	Agriculture livestock - other cattle wastes
		3B2 Manure Management sheep	Agriculture livestock - sheep wastes
		3B3 Manure Management swine	Agriculture livestock - pigs wastes
		3B4 Manure Management other:deer	Agriculture livestock - deer wastes
		3B4 Manure Management other:goats	Agriculture livestock - goats wastes
		3B4 Manure Management other:horses	Agriculture livestock - horses wastes
		3B4 Manure Management other:poultry	Agriculture livestock - all poultry wastes
			Agriculture livestock - broilers wastes

SG Sector	NC Category	IPCC Sector	Source Name
			Agriculture livestock - laying hens wastes
			Agriculture livestock - other poultry wastes
		3B4 Other	Agriculture livestock - manure leaching (indirect)
			Agriculture livestock - manure liquid systems (indirect)
			Agriculture livestock - manure other (indirect)
			Agriculture livestock - manure solid storage and dry lot (indirect)
		3D Agricultural Soils	Agricultural soils
		3D1 Agricultural soils-Mineralization/Immobilization	Agricultural soils - Mineralization/Immobilization Associated with change in Soil Organic Matter
		3F Field burning	Field burning
		3G1 Liming - limestone	Liming
		3G2 Liming - dolomite	Liming
		3H Urea application	Agriculture - application of urea
	Land Use, Land Use Change and Forestry	4B Cropland	Cropland - Drainage and rewetting and other management of organic and mineral soils
		4B1 Cropland remaining Cropland	Cropland remaining Cropland - Biomass Burning - Wildfires
			Cropland remaining Cropland - Carbon stock change
		4B2 1 Forest Land converted to Cropland	Forest Land converted to Cropland - Biomass Burning - Controlled Burning
			Forest Land converted to Cropland - Carbon stock change
			Forest Land converted to Cropland - Direct N_2O emissions from N Mineralization/Immobilization
		4B2 2 Grassland converted to Cropland	Grassland converted to Cropland - Carbon stock change
			Grassland converted to Cropland - Direct N_2O emissions from N Mineralization/Immobilization
		4B2 4 Settlements converted to Cropland	Settlements converted to Cropland - Carbon stock change
		4C Grassland	Grassland - Drainage and rewetting and other management of organic and mineral soils
		4C1 Grassland remaining Grassland	Grassland remaining Grassland - Biomass Burning - Wildfires
			Grassland remaining Grassland - Carbon stock change
			Grassland remaining Grassland - Direct N_2O emissions from N Mineralization/Immobilization
		4C2 1 Forest Land converted to Grassland	Forest Land converted to Grassland - Biomass Burning - Controlled Burning
			Forest Land converted to Grassland - Carbon stock change
			Forest Land converted to Grassland - Direct N_2O emissions from N Mineralization/Immobilization
		4C2 2 Cropland converted to Grassland	Cropland converted to Grassland - Carbon stock change
		4C2 3 Wetlands converted to	Wetlands converted to Grassland -

SG Sector	NC Category	IPCC Sector	Source Name
		Grassland	Carbon stock change
		4C2 4 Settlements converted to Grassland	Settlements converted to Grassland - Carbon stock change
		4D Wetlands	Wetlands - Drainage and rewetting and other management of organic and mineral soils
		4D1 Wetlands remaining wetlands	Peat Extraction Remaining Peat Extraction - Carbon stock change
		4D2 Land converted to wetlands	Grassland converted to flooded land - Carbon stock change
			Land converted for Peat Extraction - Carbon stock change
Business and Industrial Process	Business	1A2a Iron and steel	Blast furnaces
			Iron and steel - combustion plant
		1A2b Non-Ferrous Metals	Autogeneration - exported to grid
			Autogenerators
			Non-Ferrous Metal (combustion)
		1A2c Chemicals	Chemicals (combustion)
		1A2d Pulp Paper Print	Pulp, Paper and Print (combustion)
		1A2e food processing beverages and tobacco	Food & drink, tobacco (combustion)
		1A2f Non-metallic minerals	Cement production - combustion
			Lime production - non decarbonising
			Other industrial combustion
		1A2gvii Off-road vehicles and other machinery	Industrial off-road mobile machinery
		1A2gviii Other manufacturing industries and construction	Autogeneration - exported to grid
			Autogenerators
			Other industrial combustion
		1A4ai Commercial/Institutional	Miscellaneous industrial/commercial combustion
		2B1 Chemical Industry:Ammonia production	Ammonia production - combustion
		2B8g Petrochemical and carbon black production:Other	Chemicals (combustion)
		2D1 Lubricant Use	Industrial engines
			Other industrial combustion
		2D4 Other NEU	Non Energy Use: petroleum coke
		2E1 Integrated circuit or semiconductor	Electronics - HFC
			Electronics - NF_3
		2F1a Commercial refrigeration	Commercial Refrigeration
		2F1b Domestic refrigeration	Domestic Refrigeration
		2F1c Industrial refrigeration	Industrial Refrigeration
		2F1d Transport refrigeration	Refrigerated Transport
		2F1e Mobile air conditioning	Mobile Air Conditioning
		2F1f Stationary air conditioning	Stationary Air Conditioning
		2F2a Closed foam blowing agents	Foams
			Foams HFCs for the 2006 GLs
		2F2b Open foam blowing agents	One Component Foams
		2F3 Fire Protection	Firefighting
		2F5 Solvents	Precision cleaning - HFC
		2F6b Other Applications:Contained-Refrigerant containers	Refrigerant containers
		2G1 Electrical equipment	Electrical insulation
		2G2 Military applications	AWACS
		2G2 Particle accelerators	Particle accelerators
		2G2e Electronics and shoes	Electronics - PFC
			Electronics - SF_6
			Sporting goods
		2G2e Tracer gas	SF_6 used as a tracer gas
		2G3a Medical aplications	N_2O use as an anaesthetic
		5C2.2b Non-biogenic:Other	Accidental fires - other buildings

SG Sector	NC Category	IPCC Sector	Source Name
	Industrial Process	2A1 Cement Production	Cement - decarbonising
		2A2 Lime Production	Lime production - decarbonising
		2A3 Glass production	Glass - general
		2A4a Other process uses of carbonates:ceramics	Brick manufacture - all types
			Brick manufacture - Fletton
		2B1 Ammonia Production	Ammonia production - feedstock use of gas
		2B10 Chemical Industry:Other	Chemical industry - general
		2B2 Nitric Acid Production	Nitric acid production
		2B3 Adipic Acid Production	Adipic acid production
		2B6 Titanium dioxide production	Chemical industry - titanium dioxide
		2B7 Soda Ash Production	Chemical industry - soda ash
		2B8a Methanol production	Chemical industry - methanol
		2B8b Ethylene Production	Chemical industry - ethylene
		2B8c Ethylene Dichloride and Vinyl Chloride Monomer	Chemical Industry - ethylene dichloride
		2B8d Ethylene Oxide	Chemical industry - ethylene oxide
		2B8e Acrylonitrile	Chemical industry - acrylonitrile
		2B8f Carbon black production	Chemical industry - carbon black
		2B9a1 Fluorchemical production:By-product emissions	Halocarbons production - by-product
		2B9b3 Fluorchemical production:Fugitive emissions	Halocarbons production - fugitive
		2C1a Steel	Basic oxygen furnaces
			Electric arc furnaces
			Ladle arc furnaces
		2C1b Pig iron	Iron and steel - flaring
		2C1d Sinter	Sinter production
		2C3 Aluminium Production	Primary aluminium production - general
			Primary aluminium production - PFC emissions
		2C4 Magnesium production	Magnesium cover gas
		2C6 Zinc Production	Non-ferrous metal processes
		2G3b N_2O from product uses: Other	Other food - cream consumption
		2G4 Other product manufacture and use	Chemical Industry – other process sources
Residential	Residential	1A4bi Residential stationary	Domestic combustion
		1A4bii Residential:Off-road	House and garden machinery
		2D2 Non-energy products from fuels and solvent use:Paraffin wax use	Non-aerosol products - household products
		2F4a Metered dose inhalers	Metered dose inhalers
		2F4b Aerosols:Other	Aerosols - halocarbons
		5B1a composting municipal solid waste	Composting (household)
		5C2.2b Non-biogenic:Other	Accidental fires - dwellings
		5C2.2b Non-biogenic:Other Accidental fires (vehicles)	Accidental fires - vehicles
Waste Management	Waste Management	5A1a Managed Waste Disposal sites anaerobic	Landfill
		5B1a composting municipal solid waste	Total composting (non-household)
		5B2a Anaerobic digestion municipal solid waste	Anaerobic Digestion (other)
			Mechanical Biological Treatment
		5C1.1b Biogenic:Sewage sludge	Incineration - sewage sludge
		5C1.2a Non-biogenic:municipal solid waste	Incineration
		5C1.2b Non-biogenic:Clinical waste	Incineration - clinical waste
		5C1.2b Non-biogenic:Other Chemical waste	Incineration - chemical waste
		5D1 Domestic wastewater treatment	Sewage sludge decomposition
			Sewage sludge decomposition in

SG Sector	NC Category	IPCC Sector	Source Name
			private systems
		5D2 Industrial wastewater treatment	Industrial Waste Water Treatment
Development	Land Use, Land Use Change and Forestry	4E1 Settlements remaining Settlements	Settlements remaining Settlements - Carbon stock change
			Settlements remaining Settlements - Direct N_2O emissions from N Mineralization/Immobilization
		4E2 1 Forest Land converted to Settlements	Forest Land converted to Settlements - Biomass Burning - Controlled Burning
			Forest Land converted to Settlements - Carbon stock change
			Forest Land converted to Settlements - Direct N_2O emissions from N Mineralization/Immobilization
		4E2 2 Cropland converted to Settlements	Cropland converted to Settlements - Carbon stock change
			Cropland converted to Settlements - Direct N_2O emissions from N Mineralization/Immobilization
		4E2 3 Grassland converted to Settlements	Grassland converted to Settlements - Carbon stock change
			Grassland converted to Settlements - Direct N_2O emissions from N Mineralization/Immobilization
Public Sector Buildings	Public	1A4ai Commercial/Institutional	Public sector combustion
Forestry	Land Use, Land Use Change and Forestry	4A Forest Land	Forest Land - Drainage and rewetting and other management of organic and mineral soils
		4A1 Forest Land remaining Forest Land	Forest Land remaining Forest Land - Biomass Burning - Wildfires
			Forest Land remaining Forest Land - Carbon stock change
		4A2 1 Cropland converted to Forest Land	Cropland converted to Forest Land - Carbon stock change
		4A2 2 Grassland converted to Forest Land	Grassland converted to Forest Land - Carbon stock change
		4A2 4 Settlements converted to Forest Land	Settlements converted to Forest Land - Carbon stock change
		4A2 5 Other land converted to Forest Land	Other land converted to Forest Land - Carbon stock change
		4A2 Land converted to Forest Land	Direct N_2O emission from N fertilisation of forest land
		4G Harvested Wood Products	HWP Produced and Consumed Domestically - Carbon stock change
			HWP Produced and Exported - Carbon stock change

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[25] 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.

[25] 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: http://www.ipcc-nggip.iges.or.jp/home/wetlands.html http://www.ipcc-nggip.iges.or.jp/public/wetlands/. The Wetlands Supplements will estimate the carbon effects of drainage and rewetting peatland, although these not categories will not be fully included in the greenhouse gas inventory for a number of years.

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 is worth pointing out that that coastal wetlands will included in the IPCC (2006) wetlands supplement when it becomes included in the greenhouse inventory.

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 emissions 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 Period

Emissions reduction is based on a Baseline Period. For the greenhouse gases CO_2, CH_4 and N_2O, 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 CO_2 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 CO_2 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. 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. 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. 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).
Over 11,000 installations throughout the EU are covered by the system, accounting for around 45 per cent of the EU's total CO_2 emissions.
The EU ETS began in 2005. Phase III started in January 2013 and runs to December 2020.

Fluorinated gases (F-gases)

F-gases are the generic name given to HFCs, PFCs, SF_6 and NF_3. 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 CO_2.

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 12 to 14,800 times that of CO_2, 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 sink, absorbing more greenhouse gas emissions than it releases.

Methane (CH_4)

Methane is a greenhouse gas that is around 25 times more potent in the atmosphere than CO_2 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.

Nitrogen trifluoride (NF_3)

Nitrogen trifluoride is a greenhouse gas that is around 17,200 times more potent in the atmosphere than CO_2 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 298 times more potent in the atmosphere than CO_2 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 7,390 - 17,340 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 22,800 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.

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http://naei.defra.gov.uk/reports/reports?section_id=4

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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.

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