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An Official Statistics publication for Scotland

AGRICULTURE, ENVIRONMENT AND MARINE

Scottish Greenhouse Gas Emissions 2015

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.

48.1 $MtCO_2e$ in 2015

37.6% from 1990

3.0% from 2014

ADJUSTED EMISSIONS: FOR REPORTING AGAINST TARGETS

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

45.504 $MtCO_2e$ in 2015

41.0% from Baseline Period

1.8% from 2014

The Climate Change (Scotland) Act 2009 provides for a fixed annual target for 2015 of 45.928 $MtCO_2e$, **which has been met**. The Act also contains a 2050 target for at least an 80 per cent reduction from baseline levels and an interim 2020 target for at least a 42 per cent reduction. By 2015 a reduction of 41.0 per cent 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.

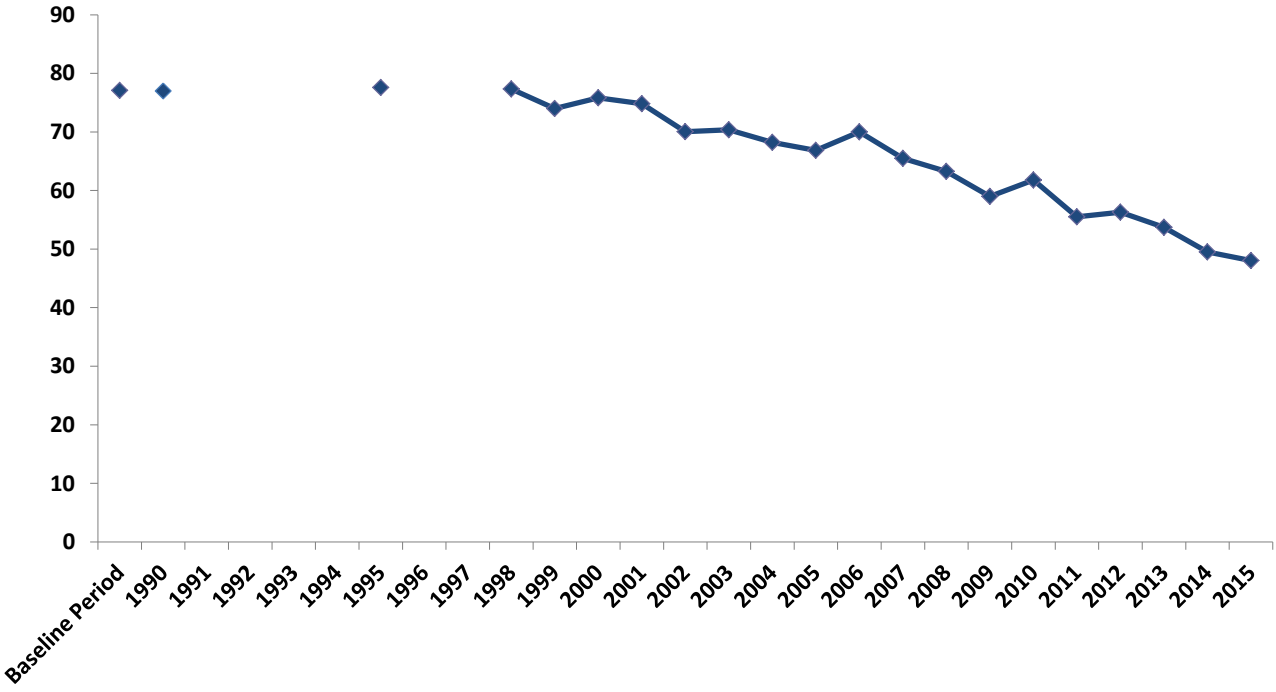
The Baseline Period uses 1990 for carbon dioxide, methane and nitrous oxide and 1995 for hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride

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 or 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 2015. Values in $MtCO_2e$



In 2015, Scottish emissions of the basket of seven greenhouse gases are estimated to be 48.1 million tonnes carbon dioxide equivalent ($MtCO_2e$). This is 3.0 per cent lower than the 2014 figure of 49.5 $MtCO_2e$, a 1.5 $MtCO_2e$ decrease.
The main contributor to this reduction between 2014 and 2015 is:

- Fall in Energy Supply emissions (such as power stations) (1.7 $MtCO_2e$; 12.0 per cent reduction)

Between 1990 and 2015, there was a 37.6 per cent reduction in estimated emissions, a 28.9 $MtCO_2e$ decrease.
The 3 main contributors to this reduction are:

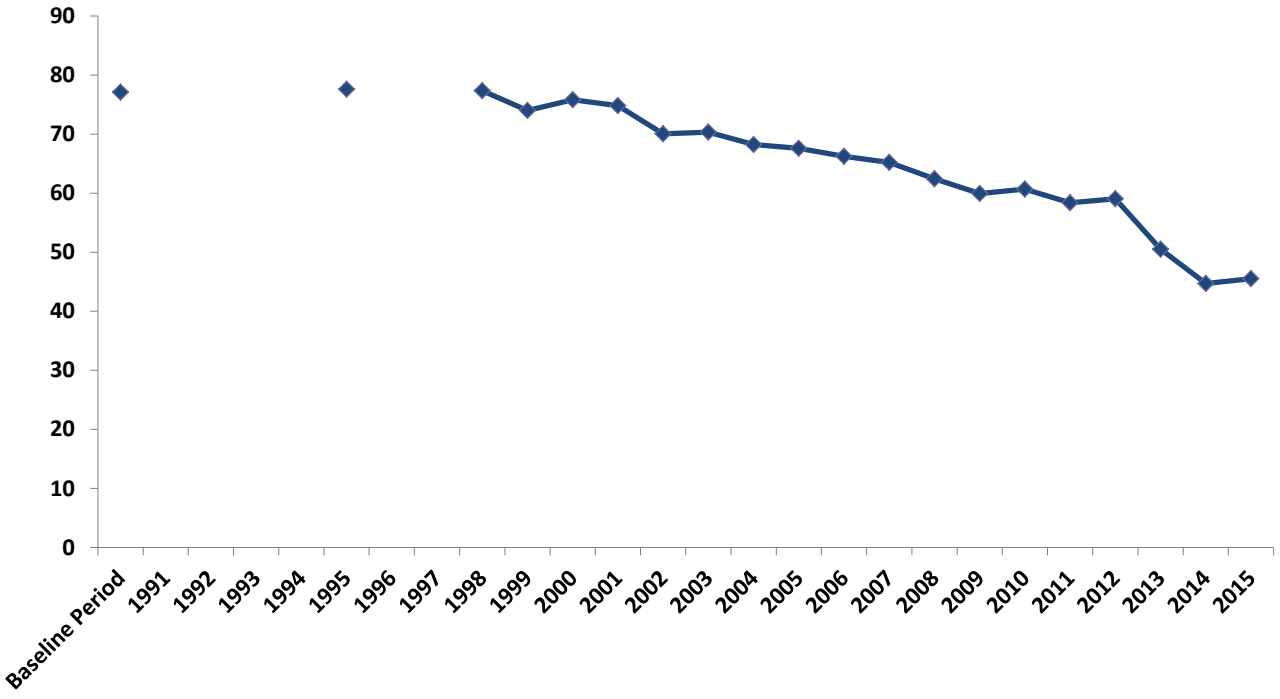
- Fall in Energy Supply emissions (such as power stations) (10.5 $MtCO_2e$; 46.4 per cent reduction)
- Fall in Business and Industrial Process(such as manufacturing) (5.8 $MtCO_2e$; 40.2 per cent reduction)

- Fall in Waste Management Emissions (such as Landfill) (4.2 $MtCO_2e$; 74.9 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 sector trends.

KEY TREND – EU ETS ADJUSTED EMISSIONS

Scottish Greenhouse Gas Emissions, Adjusted for the EU Emissions Trading System, (EU ETS). 1990 to 2015. Values in $MtCO_2e$



- When emissions are adjusted to take account of trading in the EU Emissions Trading System (EU ETS), emissions increased by 1.8 per cent between 2014 and 2015 (from 44.7 $MtCO_2e$ to 45.5 $MtCO_2e$). 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 2015 (after taking account of trading in the EU ETS) were 41 per cent lower. Section A contains more information on how the Baseline Period is defined and Section C contains results in more detail.

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 2016, to incorporate methodological improvements and new data. Comparing the 2015 figures with the 2014 figures published a year ago will therefore give a different year-on-year percentage change; one which is incorrect and should not be used. Details of these revisions can be found later in this statistical release in Section D.

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

Contents

Section A. Introduction to Greenhouse Gases

Purpose of this Publication

The "Scottish Greenhouse Gas Emissions 2015" Official Statistics publication contains the results of the Scottish Greenhouse Gas Inventory for 1990-2015. The Scottish Greenhouse Gas Inventory is the key tool for understanding the origins and magnitudes of the emissions. The inventory is compiled in line with international guidance from the Intergovernmental Panel on Climate Change (IPCC). Data are reported by source sector (such as energy supply) and by greenhouse gas (such as carbon dioxide). The inventory is also used to report data against targets as required under the Climate Change (Scotland) Act 2009.

Using the Statistics. Which measure to use and when?

The "Scottish Greenhouse Gas Emissions 2015" 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 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 April 2017 for the years 1998 to 2013 as part as part of the Official Statistics publication: "Scotland's Carbon Footprint 1998-2013". Section E contains information on what territorial emissions are excluded from the greenhouse gas inventory.

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

	Estimated Source Emissions (Section B)	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 1990-2015 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, 2015

Name of Greenhouse Gas	Chemical Formula	Global Warming Potential (GWP) (Conversion factor to carbon dioxide equivalent) [1]	Contribution to Scotland's Net Greenhouse Gas Emissions in 2015 (in $MtCO_2e$)	Percentage of Scotland's Net Greenhouse Gas Emissions in 2015 (in $MtCO_2e$)	Examples sources of gas
Carbon dioxide	**CO_2**	**1**	**36.2**	**75.4%**	All other sources of greenhouse gases, including removals (carbon sinks)
Methane	**CH_4**	**25**	**6.7**	**13.9%**	Waste management, enteric fermentation and animal waste
Nitrous oxide	**N_2O**	**298**	**3.7**	**7.7%**	Agricultural soils
F-gases [2]			**1.4**	**3.0%**	Industrial air conditioning, refrigeration, use as tracer gases, semiconductors
Hydrofluorocarbons	**HFC**	12 - 14,800	1.3	2.7%	
Perfluorocarbons	**PFC**	7,390 - 17,340	0.1	0.2%	
Sulphur hexafluoride	**SF_6**	22,800	0.0	0.1%	
Nitrogen trifluoride	**NF_3**	17,200	0.0	0.0%	
Total Net Greenhouse Gases			**48.1**	**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 1990-2014 and 1990-2015 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, 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)[3]: 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 2015.

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.

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

Sectors

This publication provides the latest estimates of Scotland's greenhouse gas emissions by source from 1990-2015. 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[4].

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/cooling 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

[4] Emissions of GHGs from offshore oil and gas exploration and production are classified within the Greenhouse Gas Inventory as "Unallocated" emissions and not attributed to any of the devolved administrations.

contains information on which greenhouse gas emissions are excluded from the greenhouse gas inventory and why they are excluded.

The sector 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 sector definitions were aligned with those that were reported in the Scottish Government publication "Low Carbon Scotland - Meeting the Emissions Reductions Targets 2013-2027". The sector definitions used in the Draft Climate Change Plan publication published earlier in the year differ slightly and consideration will be given to the reporting structure of future Scottish Greenhouse Gas Emissions publications once a final Climate Change Plan has been published.

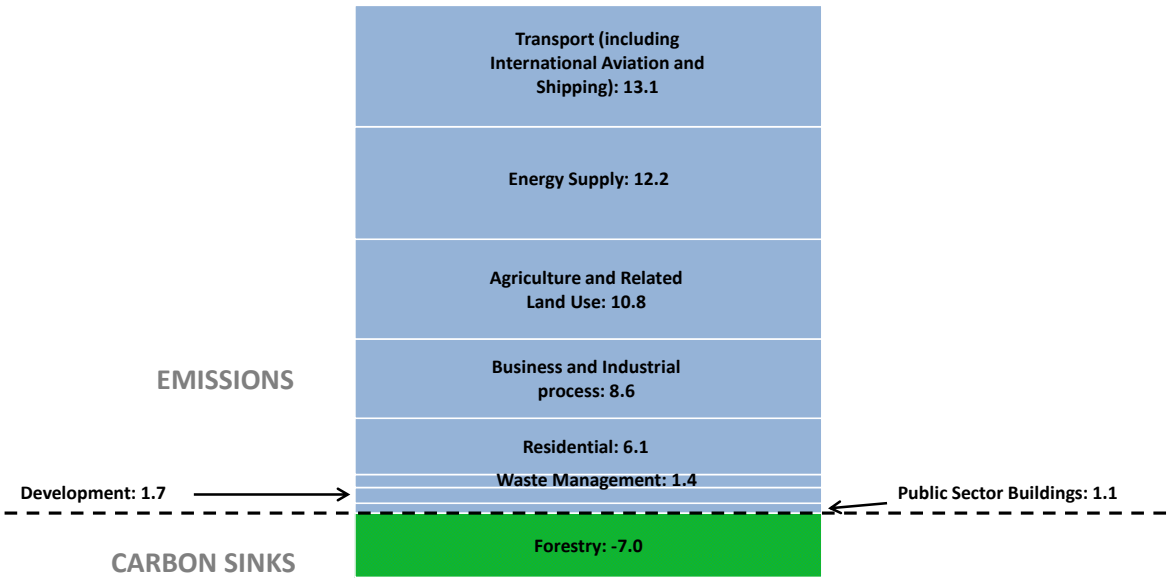
The Scottish Government also reports on International Aviation and Shipping emissions attributed to Scotland, along with other Transport emissions. International Aviation and Shipping emissions are categorised as an IPCC international “Memo” item. A detailed mapping between the sectors used in this report 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

2015 figures

Chart B1 presents the sources and sinks of Scottish Greenhouse Gas Emissions in 2015, grouped by Scottish Government sector.

Chart B1. Sources of Scottish Greenhouse Gas Emissions, 2015. Values in $MtCO_2e$



Main points

- In 2015, Transport (including International Aviation and Shipping) (13.1 $MtCO_2e$) was the largest source of net emissions followed by Energy Supply emissions (12.2 $MtCO_2e$), and Agriculture and Related Land Use emissions (10.8 $MtCO_2e$).
- Emissions from Business and Industrial Processes and the Residential sector were the next largest net emissions sources (8.6 $MtCO_2e$ and 6.1 $MtCO_2e$ 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 (-7.0 $MtCO_2e$).

Table B1. Scottish Greenhouse Gas Emissions by Gas and by Scottish Government Source Sector, 2015. Values in $MtCO_2e$

	TOTAL	*Percentage share by sector*	Carbon dioxide	Methane	Nitrous oxide	Fluorinated gases
TOTAL	**48.1**	***100.0%***	**36.2**	**6.7**	**3.7**	**1.4**
Transport (including International Aviation and Shipping)	13.1	*27.4%*	13.0	0.0	0.1	0.0
Transport (excluding IA&S)	*10.8*	*22.4%*	*10.7*	*0.0*	*0.1*	*0.0*
International Aviation and Shipping (IA&S)	*2.4*	*4.9%*	*2.3*	*0.0*	*0.0*	*0.0*
Energy Supply	12.2	*25.4%*	11.7	0.4	0.1	0.0
Agriculture and related land use	10.8	*22.5%*	3.0	4.8	3.0	0.0
Business and Industrial process	8.6	*17.9%*	7.2	0.0	0.1	1.3
Residential	6.1	*12.7%*	5.8	0.1	0.0	0.1
Development	1.7	*3.6%*	1.6	0.0	0.1	0.0
Waste Management	1.4	*2.9%*	0.0	1.3	0.1	0.0
Public Sector Buildings	1.1	*2.2%*	1.1	0.0	0.0	0.0
Forestry	-7.0	*-14.5%*	-7.1	0.0	0.1	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.

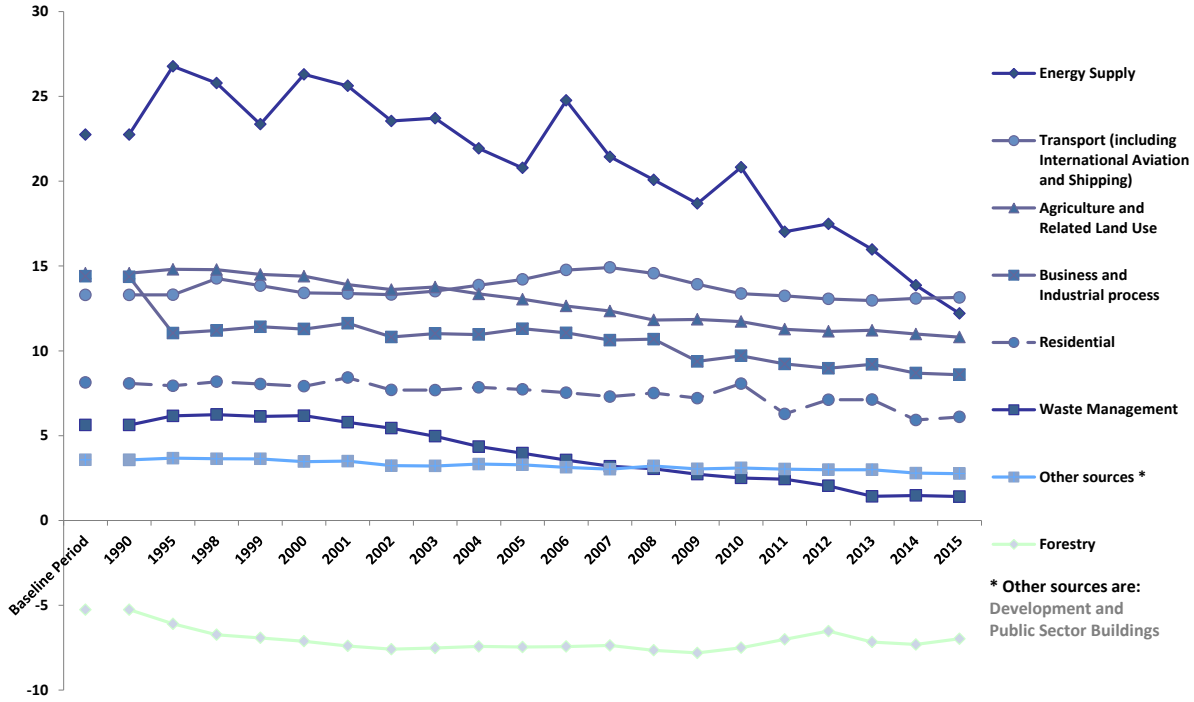
- Methane was the main net gas emitted in the Agriculture and Related Land Use sector (4.8 $MtCO_2e$), followed by carbon dioxide (3.0 $MtCO_2e$) and nitrous oxide (3.0 $MtCO_2e$).
- Almost all emissions in the Waste Management sector were emitted in the form of methane (1.3 $MtCO_2e$).

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 2015, 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 2015. Values in $MtCO_2e$



Main Points

Most sectors exhibit a general downward trend between 1990 and 2015, most clearly evident since 1998.

- From 2014 to 2015, emissions from transport (including international aviation and shipping) increased marginally by 0.4 per cent, and are now the largest single source of greenhouse gas emissions in Scotland – replacing the energy supply sector as the largest sector for the first time since the series began. Transport emissions have remained relatively steady from 1990 to 2015, and the increase in emissions in 2015 was mainly due to an increase in emissions from road transport, in particular passenger cars, light trucks, and lorries/buses.

- In 2015, the energy supply sector was the second largest source of greenhouse gas emissions, following a sharp fall in recent years. The reduction in emissions between 2014 and 2015 was driven almost entirely by a decrease in the use of coal in the power generation sector. Overall reduction in the energy sector was offset somewhat by an increase in emissions from the combustion of fuel at refineries. The chart shows that energy supply is a more volatile sector. This is driven by energy demand and 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.

- 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 2015, 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.

- Residential emissions have increased by 3.0 per cent between 2014 and 2015. There was a decrease from 1990 to 2015. The main driver for the increase in residential emissions is an increase in the combustion of fuel in households, dominated by an increase in natural gas use, reflecting cooler mean temperatures in 2015 compared to 2014. The fluctuation in the series in recent years is partly due to the fluctuation in demand for domestic heating.

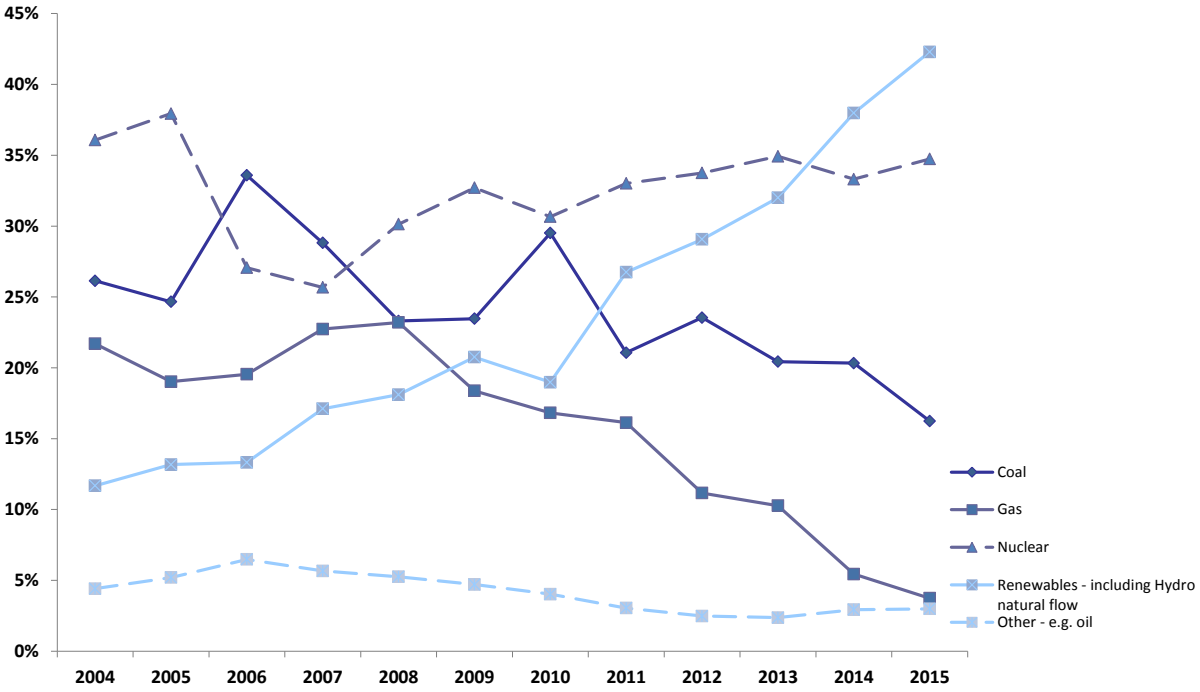
- Methodological change to the inventory have reduced waste management emissions across the series with more significant revisions towards the beginning of the series. Waste management emissions have fallen by 74.9 per cent between 1998 and 2015. This is due to the progressive introduction of landfill 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.

- Methodological change to the forestry data has reduced the sink across the whole time series. This is the single largest sectorial increase in emissions over the last year. The reduction in the carbon sink from forestry is primarily driven by the impact of the methodological changes affecting the soil carbon stocks following afforestation. In the 1990 to 2015 inventory the decrease in the sink in Scotland between 2014 and 2015 arises from the "Forest Land" category. The main source is losses

from biomass carbon stock change in the “Forest Remaining Forest” category, e.g. harvesting and thinning of trees.

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 2015. Percentage of Electricity Generated by Year



Data obtained from BEIS Energy Trends, published December 2016[5]

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 42.3 per cent in 2015.

- There was a drop in the proportion of electricity generation coming from gas between 2014 and 2015 (from 5.4 per cent to 3.7 per cent). This reflects the role Peterhead Power Station currently plays in the GB electricity market. This latest drop continues the decline in the share of

[5] https://www.gov.uk/government/statistics/energy-trends-december-2016-special-feature-article-electricity-generation-and-supply-figures-for-scotland-wales-northern-ireland-and-england-2

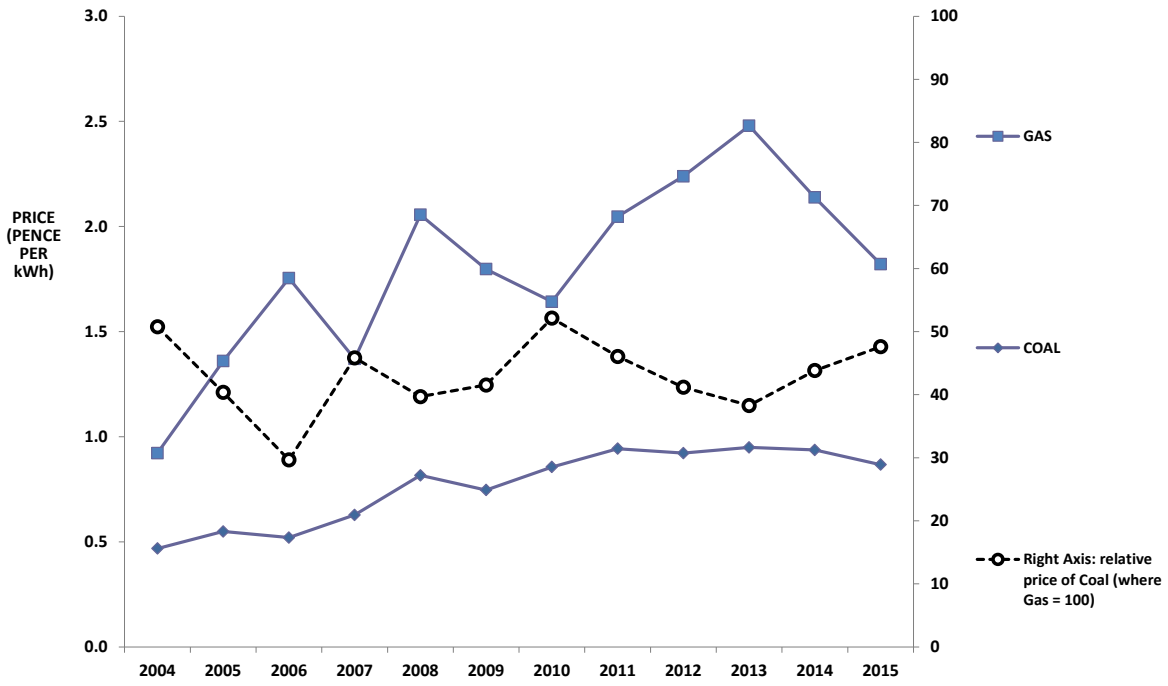
electricity generation from gas from 2008 onwards, when it was 23.2 per cent.

- The amount of electricity generated from coal has fallen between 2014 and 2015. Overall, there has been a fall in the proportion of electricity generated from coal since 2006, although this can fluctuate from year to year.

- 34.7 per cent of Scotland's electricity supply came from nuclear energy in 2015. 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 2015, the relative price of coal per kilowatt hour was slightly less than half that of gas, although it was higher than in 2014.

Chart B4. Gas and Coal Prices for Large Users in the UK (2004 to 2015) – pence per kWh



Data obtained from BEIS: Digest of UK Energy Statistics[6]

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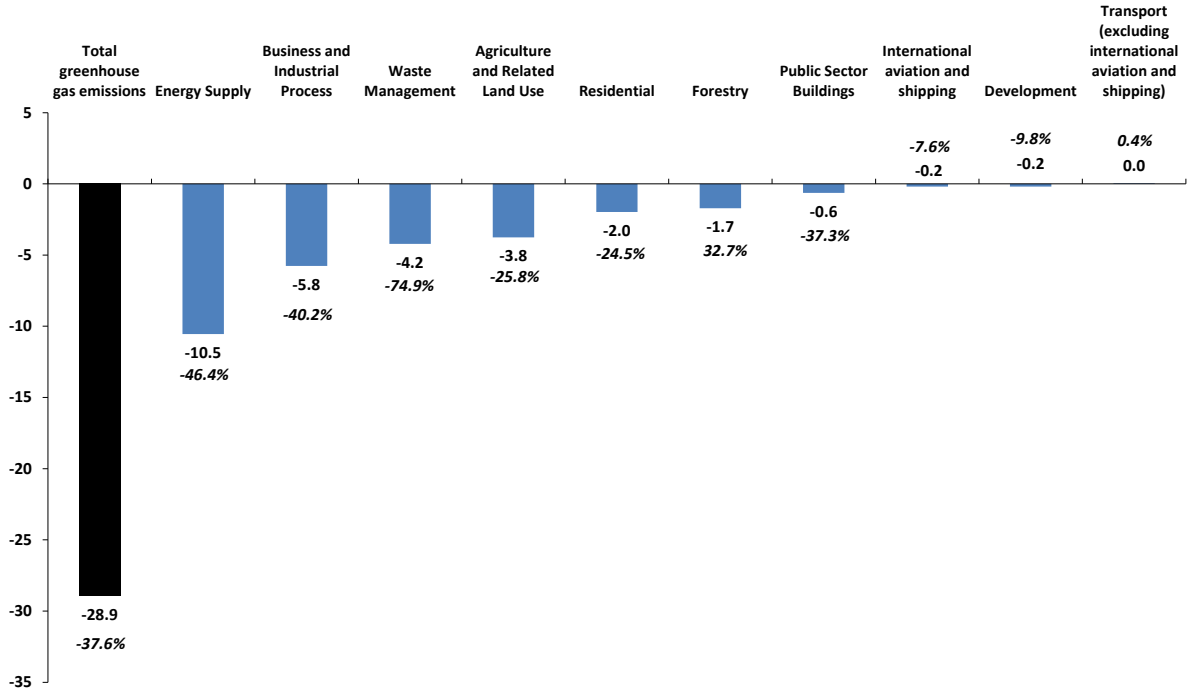
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/295522/qep314.xls

Long term (1990 to 2015) and short term (2014 to 2015) trends by sector

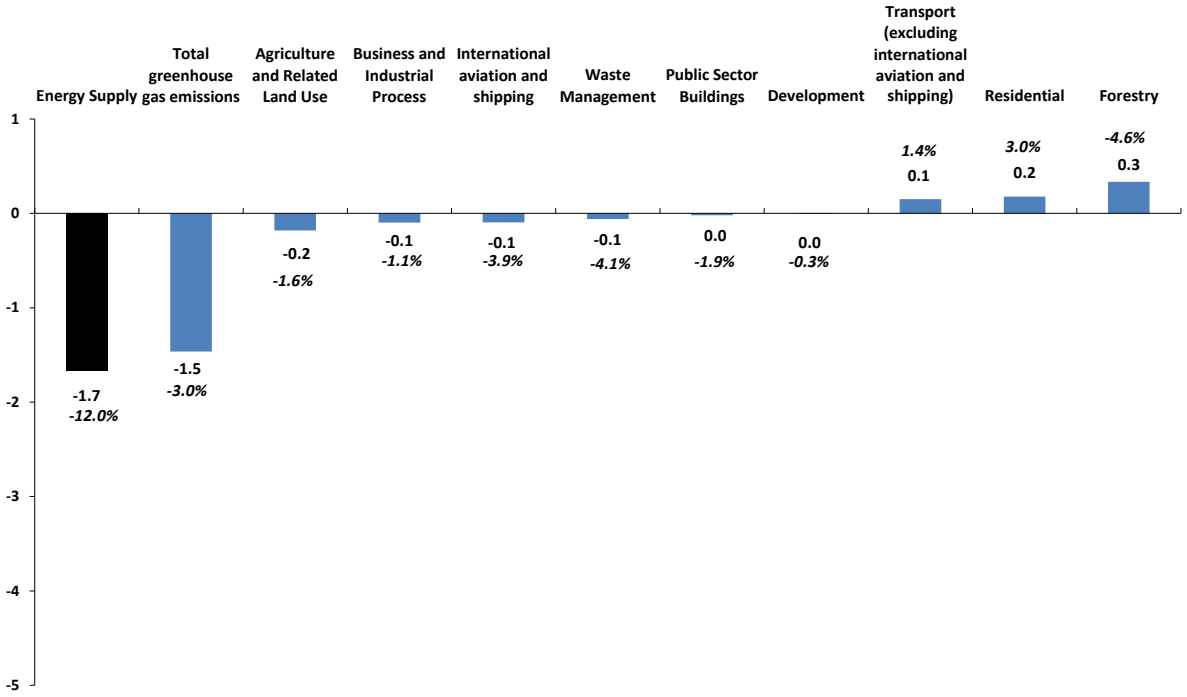
Chart B5 shows how emissions have changed between 1990 and 2015 in all source sectors. Chart B6 shows how emissions have changed between 2014 and 2015.

Chart B5. Change in Net Emissions by Scottish Government Sector Between 1990 and 2015 – in $MtCO_2e$, *and percentage changes* [7]



[7] 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 2014 and 2015 - in $MtCO_2e$, *and percentage changes* [8]



Total Emissions

Overall, there has been a 28.9 $MtCO_2e$ (37.6 per cent) decrease in net emissions between 1990 and 2015, and there has been a 1.5 $MtCO_2e$ (3.0 per cent) decrease in net emissions between 2014 and 2015.

Energy Supply

Energy sector emissions have decreased by 12 per cent from 2014-2015 from 13.9 MtCO2e to 12.2 MtCO2e, and have reduced by 46.4 per cent from 1990. Emissions reductions in this sector are mainly due to reductions in emissions from power stations.

A 21 per cent reduction in emissions from power stations between 2014 and 2015 was driven almost entirely by a decrease in the use of coal in the power generation sector.

Overall reduction in the energy sector was offset somewhat by a 14 per cent increase in emissions from the combustion of fuel at refineries.

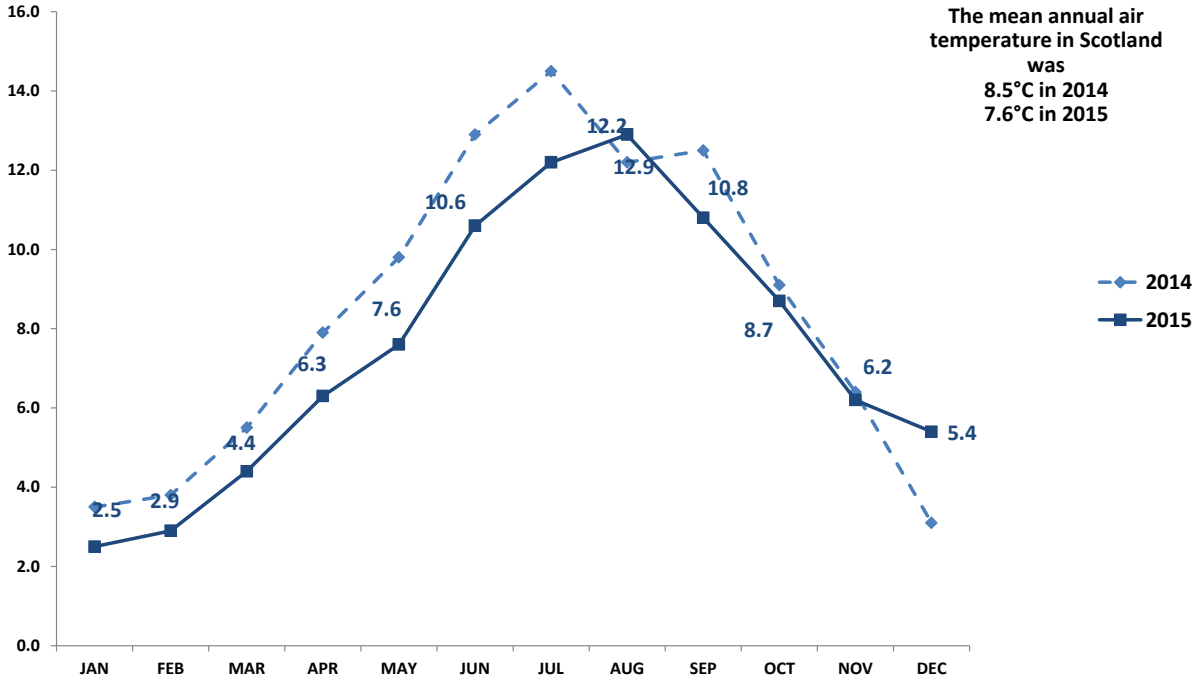
[8] Unlike for other source sectors, upward changes to net emissions from forestry are presented as a negative percentage change. This is because forestry causes a net removal of emissions

Residential

Residential emissions have increased between 2014 and 2015 from, 5.9 MtCO2e to 6.1 $MtCO_2e$ (3.0 per cent). However, there has been a decrease of 24.5 per cent from 1990-2015.

The main driver for the increase in residential emissions is an increase in the combustion of fuel in households, dominated by an increase in natural gas use, reflecting cooler mean temperatures in 2015 compared to 2014 (Chart B7).

Chart B7. Mean air temperature by month, Scotland. 2014 and 2015. Values in °C



Data obtained from Met Office, May 2017[9]

Waste Management

From 2014 to 2015 waste management decreased from 1.5 MtCO2e to 1.4 MtCO2e, a 4 per cent reduction.

Methodological changes to the series have reduced waste management by on average approximately 40 per cent across the series. The changes in waste management emissions between the 1990 to 2014 and 1990 to 2015 series is primarily driven by methodological changes to the Scottish waste management model, with larger revisions earlier in the series due to previous over estimation of Scotland's share of UK waste activity.

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

Business and Industrial Process

This sector has seen a 5.8 $MtCO_2e$ (40.2 per cent) fall in emissions between 1990 and 2015. 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. There was a decrease (0.1 $MtCO_2e$; 1.1 per cent) in emissions in this sector between 2014 and 2015. This has been driven by a number of factors, which include a reduction in emissions from manufacturing.

Agriculture and Related Land Use

This sector has seen a 3.8 $MtCO_2e$ (25.8 per cent) fall in net emissions between 1990 and 2015. Between 2014 and 2015, there was a 0.2 $MtCO_2e$ (1.6 per cent) decrease in net emissions of overall greenhouse gases from this sector.

Forestry

From 2014 to 2015, the forestry sink has reduced by 4.6 per cent from -7.3 $MtCO_2e$ to -7.0 MtCO2e. This is the single largest sectorial increase in emissions over the last year.

Methodological changes to the series has reduced the sink by approximately 3 MtCO2e on average (approximately 30 per cent) across the whole time series. The reduction in the carbon sink from forestry is primarily driven by the impact of the methodological changes affecting the soil carbon stocks following afforestation.

As each devolved administration has a different composition of tree species and different ratios of planting on organic and mineral soils, the changes to data and methodology have different magnitudes in each devolved administration. As Scotland has the greatest area of forestry on organic soils and this has a big influence on the differences between the 1990 to 2014 and 1990 to 2015 inventories.

In the 1990 to 2015 inventory the decrease in the sink in Scotland between 2014 and 2015 arises from the Forest Land category. The main source is losses from biomass carbon stock change in “Forest remaining Forest”, e.g. harvesting and thinning of trees.

Transport (Including International Aviation and Shipping)

Transport emissions have increased by 0.4 per cent from 2014 to 2015. Transport emissions decreased by 1.1 per cent from 1990 to 2015. The increase in emissions in 2015 was mainly due to an increase in emissions from road transport, in particular passenger cars, light trucks, and lorries/buses.

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. Up to 2007, there was a large increase in car vehicle kilometres travelled. Since 2007 there had been a slight drop in car vehicle kilometres travelled, but in 2015 this value has returned to 2007 levels.

International aviation has increased from 1.2 MtCO2e in 2014 to 1.3 MtCO2e in 2015. An increase of 9 per cent from 2014 to 2015. This reflects the growth in aviation and the increase in international routes at airports. Emissions from international shipping have fallen by 48.1 per cent between 1990 and 2015 (from 2.0 MtCO2e to 1.0 MtCO2e). Emissions from international shipping have decreased from 2014 to 2015 (1.3 MtCO2e to 1.0 MtCO2e). This is primarily due to a decrease in Scotland's port freight movements.

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 $MtCO_2e$ (37.3 per cent) fall in emissions from public sector buildings between 1990 and 2015. This has been largely driven by a reduction in the use of oil and coal for space heating. Between 2014 and 2015, there has been a 1.9 per cent fall in emissions from this sector.

Development Emissions

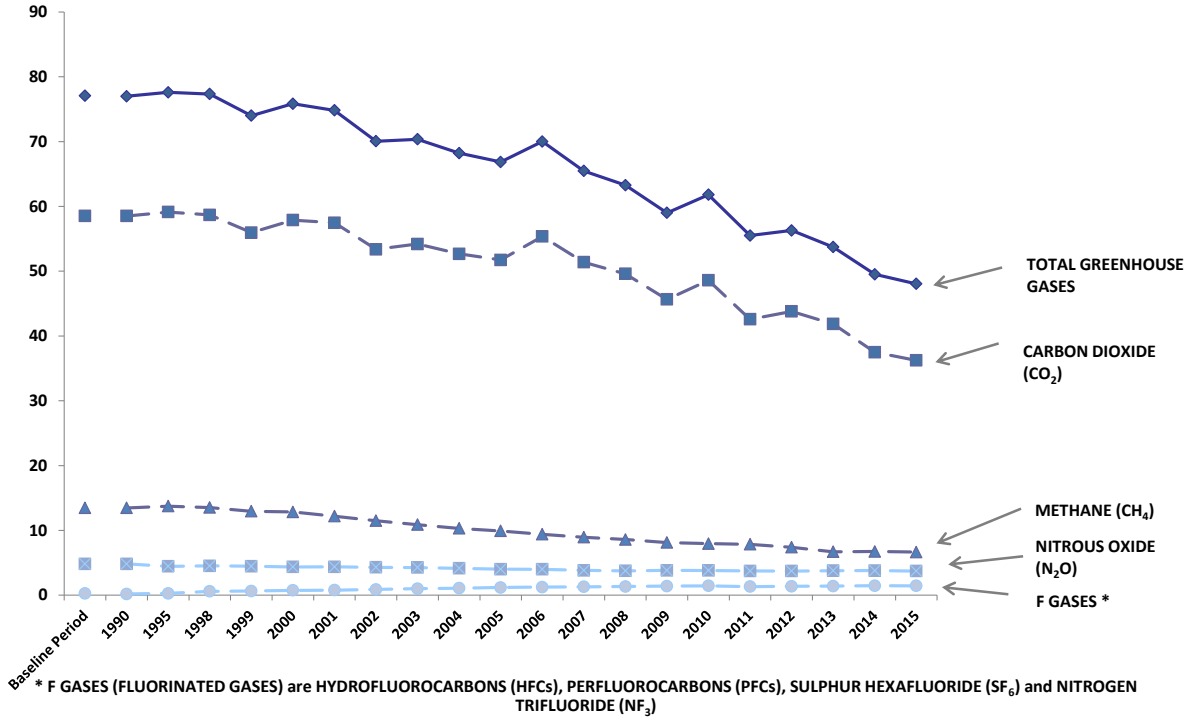
This sector captures net emissions from settlements and from land converted to settlements. It accounts for only a small proportion of Scotland's net greenhouse gas emissions. In 2009 there was a step change increase in development emissions (e.g. emissions from conversion of land to settlements). The longer term trend from 1990 to 2015 shows a 10.0 per cent decrease.

The increase in emissions in the "Land Converted to Settlement" category in 2009 arises from the "Forest Land to Settlement" subcategory. For the 1990 to 2015 inventory the annual deforestation area dataset was updated using spatial data from the National Forest Inventory. In Scotland, the new dataset estimates that the rates of deforestation for Settlement purposes from 2009 to 2011 were considerably higher than the previous 3 years (2006 to 2008).

Emissions by type of gas

Chart B8 shows the trends in emissions, broken down by gas from 1990 to 2015.

Chart B8. Scottish Greenhouse Gas Emissions, by Gas, 1990-2015. 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 to Scottish greenhouse gas emissions in all years (75.4 per cent of all emissions in 2015) 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 is the second most common greenhouse gas in 2015 (13.9 per cent of all net emissions) followed by nitrous oxide (7.7 per cent) and F-gases making up the remainder (3.0 per cent).

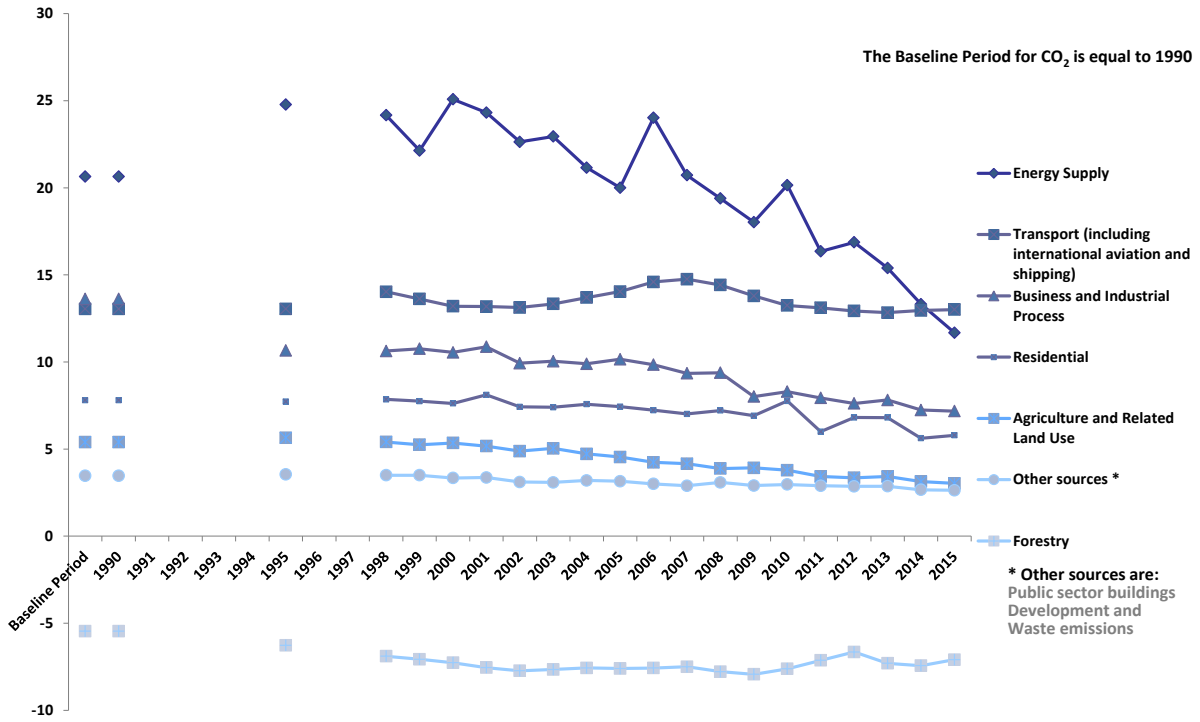
- Methane has seen the largest percentage reduction from 1990 to 2015 (50.6 per cent), largely driven by a reduction in waste management emissions. There have also been percentage reductions for both carbon dioxide (38.1 per cent) and nitrous oxide (22.9 per cent). Emissions from fluorinated gases have shown a large increase from 1990 to 2015 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 2015.

Carbon Dioxide (CO_2)

Chart B9. Carbon Dioxide (CO_2) Emissions by Scottish Government Sector, 1990 to 2015. Values in $MtCO_2e$



Main Points

- Chart B9 shows that energy supply is a key source of carbon dioxide emissions in all years between 1990 and 2015. Transport (including international aviation and shipping) is the next most common source of carbon dioxide emissions in all years apart from 1990 and 2015. Transport is 1.3 $MtCO_2e$ higher than energy supply emissions in 2015. In 2015 Transport became the highest source of emissions for the first time in the time series.

- Much of the decrease in carbon dioxide emissions between 1990 and 2015 has been driven by falls in the energy supply sector across the time period and in business and industrial processes between 1990 and

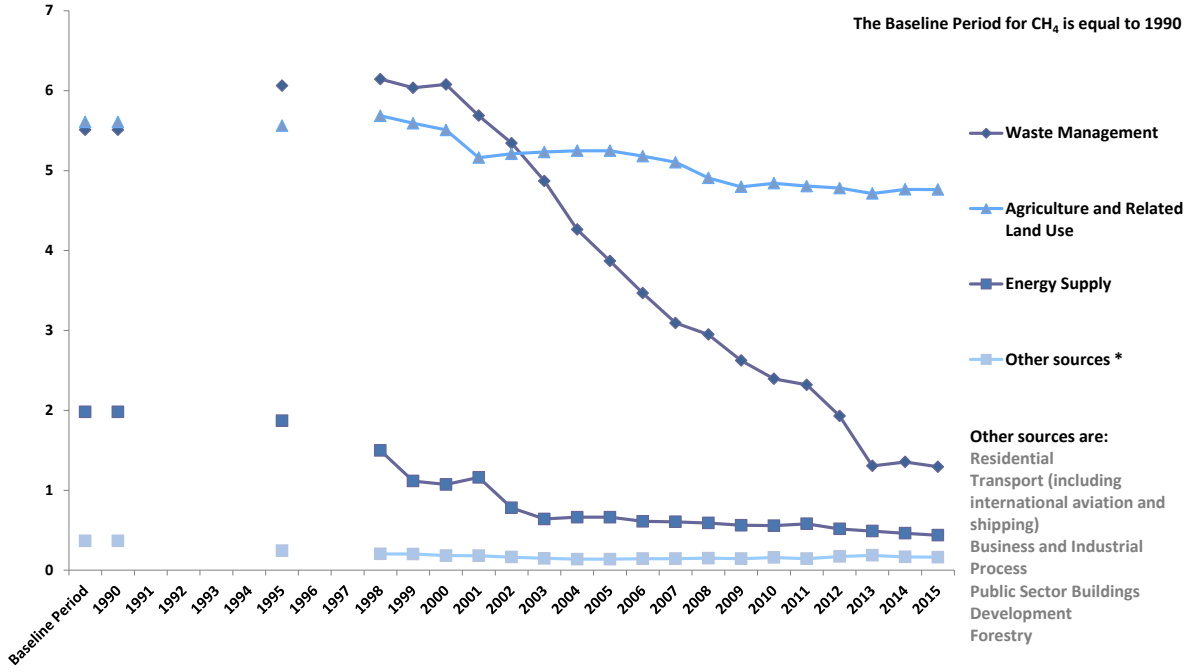
1995. Carbon dioxide emissions from the energy supply sector have been quite volatile, with the highest emissions occurring between 1995 and 2003, and a spike in 2006, related to a greater use of coal in that year.

- 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 2015.

Methane (CH_4)

Chart B10. Methane (CH_4) Emissions by Scottish Government Sector, 1990 to 2015. Values in $MtCO_2e$



Main Points

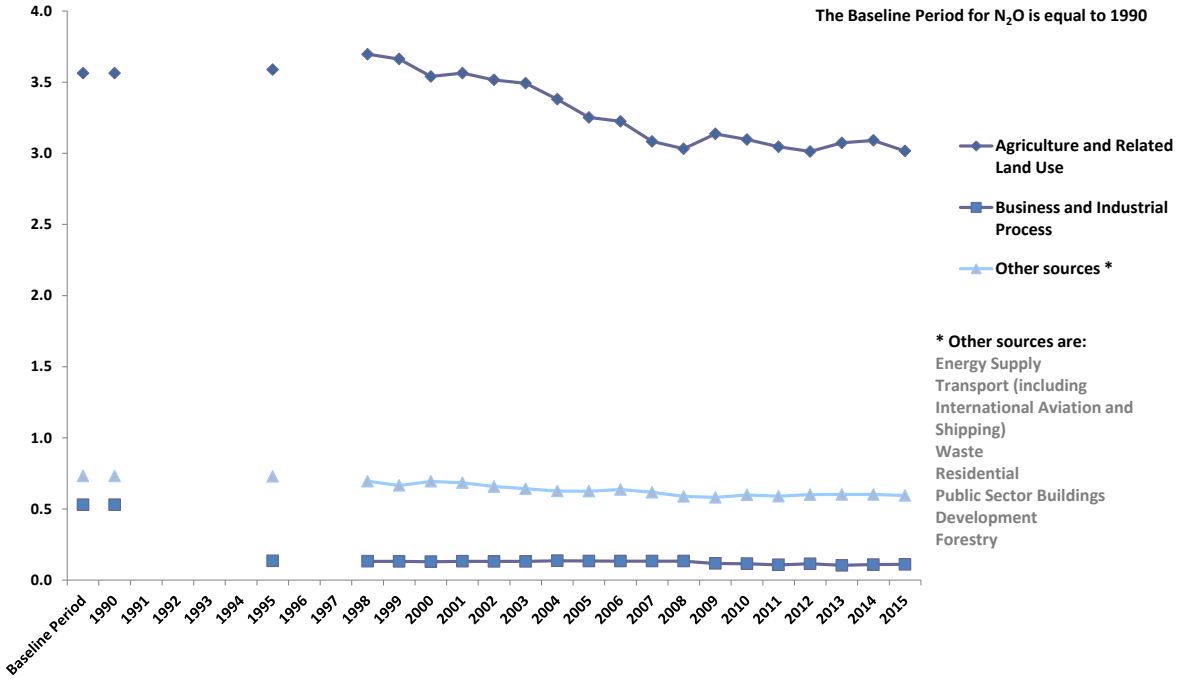
- Methane emissions from waste management have fallen from 13.5 $MtCO_2e$ in 1990 to 6.7 $MtCO_2e$ in 2015 (a 50.6 per cent reduction). This is due to the progressive introduction of landfill gas being captured and used for energy. There could also be other factors which contribute to this reduction, 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 4.8 $MtCO_2e$ in 2015 – a 15.0 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 0.4 $MtCO_2e$ in 2015, 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 2015. Values in $MtCO_2e$



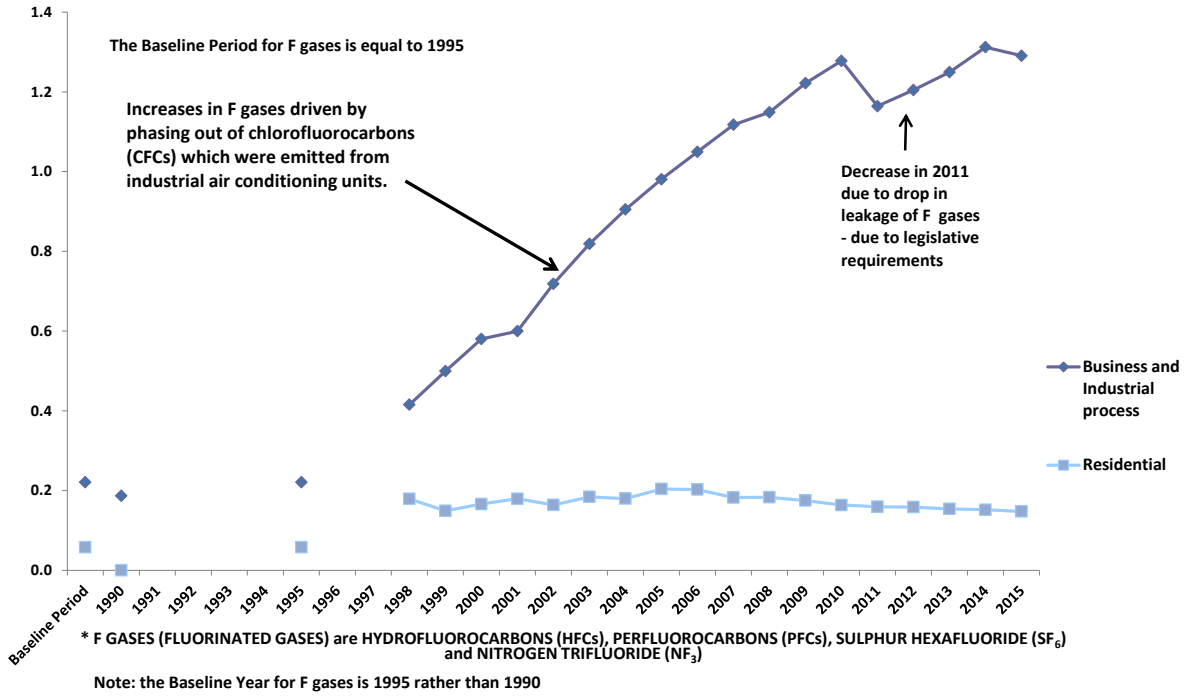
Main Points

- 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 4.8 $MtCO_2e$ in 1990 to 3.7 $MtCO_2e$ in 2015.

- 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 2015.

Fluorinated gases (F-gases)

Chart B12. F-gas Emissions by Scottish Government Sector, 1990 to 2015. 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 2015 (from 0.2 $MtCO_2e$ in 1990 to 1.3 $MtCO_2e$ in 2015). 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 2015.

Table B2. Greenhouse Gas Emissions in Scotland by source sector: 1990 to 2015. Values in $MtCO_2e$

Source Sector	Baseline Period	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change 1990 to 2015	*% change 1990 to 2015*
Total greenhouse gas emissions	**77.1**	**77.0**	**77.6**	**77.3**	**74.0**	**75.8**	**74.8**	**70.1**	**70.4**	**68.2**	**66.9**	**70.0**	**65.5**	**63.3**	**59.0**	**61.8**	**55.5**	**56.3**	**53.7**	**49.5**	**48.1**	**-28.9**	***-37.6%***
Energy Supply	22.7	22.7	26.8	25.8	23.4	26.3	25.6	23.5	23.7	21.9	20.8	24.8	21.4	20.1	18.7	20.8	17.0	17.5	16.0	13.9	12.2	-10.5	*-46.4%*
Transport (including International Aviation and Shipping)	13.3	13.3	13.3	14.3	13.8	13.4	13.4	13.3	13.5	13.9	14.2	14.8	14.9	14.6	13.9	13.4	13.2	13.1	13.0	13.1	13.1	-0.2	*-1.1%*
Transport (excluding IA&S)	*10.7*	*10.7*	*10.7*	*11.1*	*11.2*	*11.0*	*11.0*	*11.3*	*11.4*	*11.5*	*11.6*	*11.8*	*12.0*	*11.5*	*11.0*	*10.9*	*10.6*	*10.7*	*10.6*	*10.6*	*10.8*	*0.0*	*0.4%*
International Aviation and Shipping (IA&S)	*2.6*	*2.6*	*2.6*	*3.1*	*2.6*	*2.4*	*2.4*	*2.0*	*2.2*	*2.4*	*2.6*	*3.0*	*3.0*	*3.1*	*2.9*	*2.5*	*2.6*	*2.4*	*2.4*	*2.5*	*2.4*	*-0.2*	*-7.6%*
Agriculture and Related Land Use	14.6	14.6	14.8	14.8	14.5	14.4	13.9	13.6	13.8	13.4	13.0	12.6	12.3	11.8	11.9	11.7	11.3	11.1	11.2	11.0	10.8	-3.8	*-25.8%*
Business and Industrial process	14.4	14.4	11.0	11.2	11.4	11.3	11.6	10.8	11.0	11.0	11.3	11.1	10.6	10.7	9.4	9.7	9.2	9.0	9.2	8.7	8.6	-5.8	*-40.2%*
Residential	8.1	8.1	7.9	8.2	8.0	7.9	8.4	7.7	7.7	7.8	7.7	7.5	7.3	7.5	7.2	8.1	6.3	7.1	7.1	5.9	6.1	-2.0	*-24.5%*
Waste Management	5.6	5.6	6.2	6.2	6.1	6.2	5.8	5.4	5.0	4.4	4.0	3.6	3.2	3.0	2.7	2.5	2.4	2.0	1.4	1.5	1.4	-4.2	*-74.9%*
Other sources	3.6	3.6	3.7	3.6	3.6	3.5	3.5	3.2	3.2	3.3	3.3	3.1	3.0	3.2	3.0	3.1	3.0	3.0	3.0	2.8	2.8	-0.8	*-22.7%*
Development	*1.9*	*1.9*	*1.9*	*1.9*	*1.9*	*1.8*	*1.8*	*1.8*	*1.8*	*1.8*	*1.8*	*1.8*	*1.7*	*1.7*	*1.8*	*1.8*	*1.8*	*1.7*	*1.7*	*1.7*	*1.7*	*-0.2*	*-9.8%*
Public Sector Buildings	*1.7*	*1.7*	*1.8*	*1.8*	*1.8*	*1.6*	*1.7*	*1.4*	*1.4*	*1.6*	*1.5*	*1.4*	*1.3*	*1.5*	*1.3*	*1.3*	*1.3*	*1.2*	*1.3*	*1.1*	*1.1*	*-0.6*	*-37.3%*
Forestry	-5.3	-5.3	-6.1	-6.7	-6.9	-7.1	-7.4	-7.6	-7.5	-7.4	-7.5	-7.4	-7.4	-7.7	-7.8	-7.5	-7.0	-6.5	-7.2	-7.3	-7.0	-1.7	*32.7%*

Table B3. Scottish Greenhouse Gases, by gas, 1990 to 2015. Values in $MtCO_2e$

	Baseline Period	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	1990 to 2015 (in Mt CO_2 e)	*% Change from 1990 to 2015*	2014 to 2015 (in Mt CO_2 e)	*% Change from 2014 to 2015*	*% Share of GHG 2015*
Total Greenhouse Gases	**77.1**	**77.0**	**77.6**	**77.3**	**74.0**	**75.8**	**74.8**	**70.1**	**70.4**	**68.2**	**66.9**	**70.0**	**65.5**	**63.3**	**59.0**	**61.8**	**55.5**	**56.3**	**53.7**	**49.5**	**48.1**	**-28.9**	***-37.6%***	**-1.5**	***-3.0%***	***100.0 %***
Carbon dioxide (CO_2)	58.5	58.5	59.1	58.7	56.0	57.9	57.5	53.4	54.2	52.7	51.7	55.4	51.4	49.6	45.7	48.6	42.6	43.8	41.9	37.5	36.2	-22.3	***-38.1%***	-1.3	*-3.4%*	***75.4 %***
Methane (CH_4)	13.5	13.5	13.7	13.5	12.9	12.8	12.2	11.5	10.9	10.3	9.9	9.4	8.9	8.6	8.1	8.0	7.8	7.4	6.7	6.7	6.7	-6.8	***-50.6%***	-0.1	*-1.4%*	***13.9 %***
Nitrous oxide (N_2O)	4.8	4.8	4.5	4.5	4.5	4.4	4.4	4.3	4.3	4.1	4.0	4.0	3.8	3.8	3.8	3.8	3.7	3.7	3.8	3.8	3.7	-1.1	***-22.9%***	-0.1	*-2.1%*	***7.7%***
*** F gases**	0.3	0.2	0.3	0.6	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.3	1.3	1.4	1.4	1.3	1.4	1.4	1.5	1.4	1.3	***670.4%***	0.0	*-1.7%*	***3.0%***
of which HFCs	*0.1*	*0.0*	*0.1*	*0.4*	*0.4*	*0.5*	*0.6*	*0.7*	*0.8*	*0.9*	*1.0*	*1.1*	*1.2*	*1.2*	*1.3*	*1.3*	*1.2*	*1.2*	*1.3*	*1.3*	*1.3*	1.3	***60396.3 %***	*0.0*	*1.4%*	***2.7%***
PFCs	*0.1*	*0.1*	*0.1*	*0.1*	*0.2*	*0.2*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	0.0	***-12.9%***	*0.0*	*-15.8%*	***0.2%***
SF_6	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	0.0	***-31.8%***	*0.0*	*2.0%*	***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*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	0.0	***50.9%***	*0.0*	*10.0%*	***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.

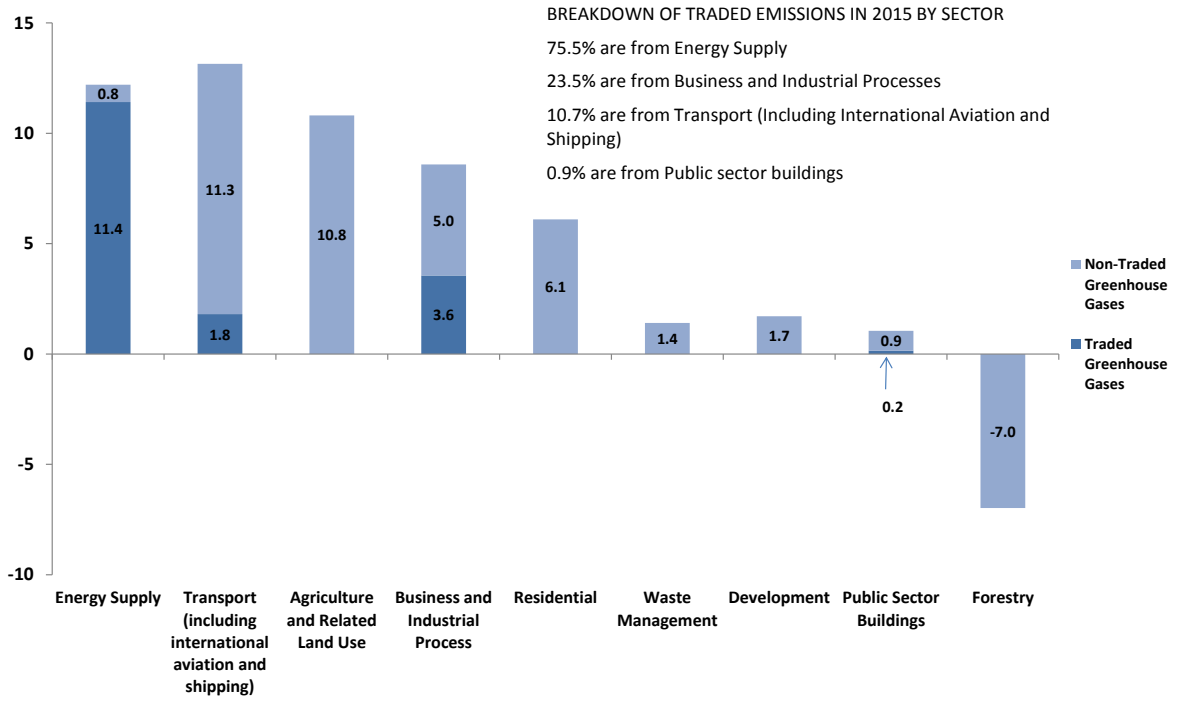
Scotland in the EU ETS

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 2015, there were 79 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 2015, 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, 2015. 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: 1990-2015 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 1990-2015 greenhouse gas inventory.

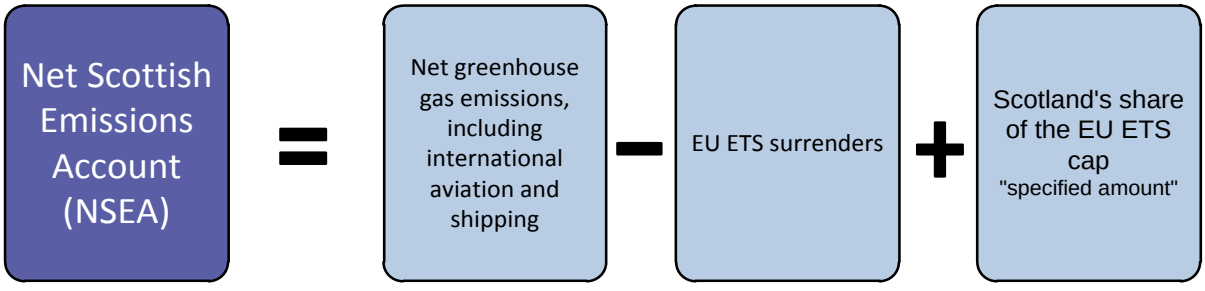
Secondly, operators who participate in the EU ETS must, by 30 April in each year, surrender a number of allowances equal to the annual reportable emissions which the installation made in the previous year. However, as a result of errors or non-compliance in the EU ETS, the figure on surrendered and reported 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 2015 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.

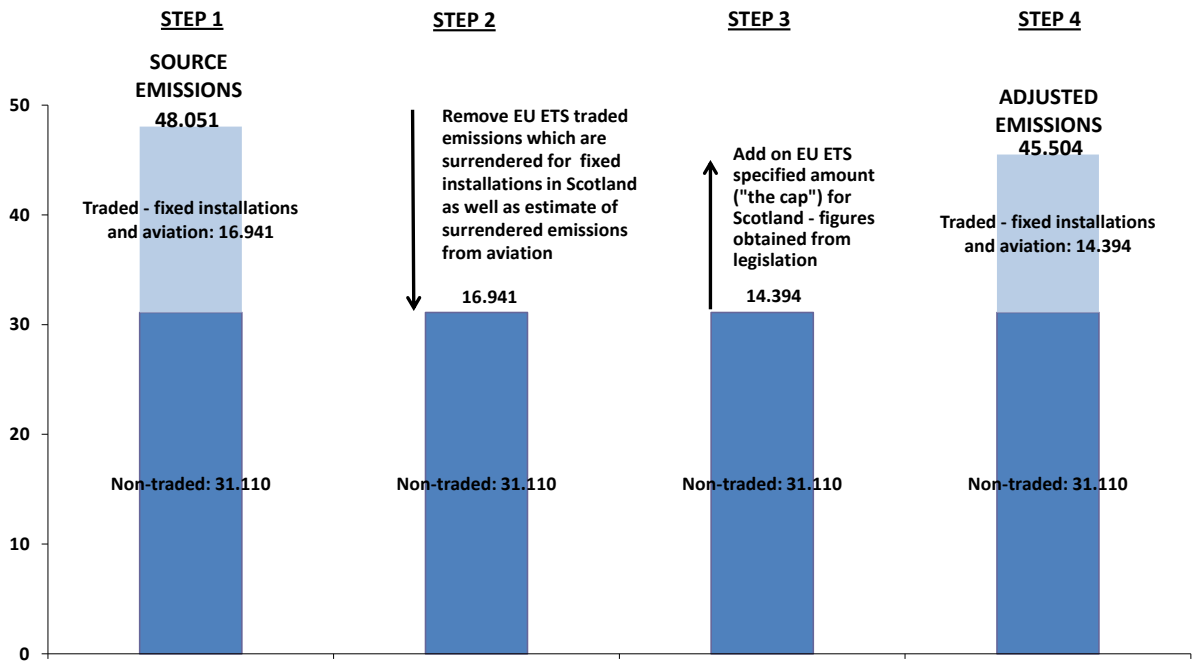
The EU ETS element of the NSEA is calculated by taking the difference between Scotland's notional share of the overall EU ETS cap and the number of emissions allowances surrendered from Scottish fixed installations in a given year, as well as an estimate of CO_2 emissions surrendered from Scotland's 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), 2015. Values in $MtCO_2e$



Calculation of adjusted emissions

STEP 1

Take the Scottish greenhouse gas emissions from Scottish greenhouse gas inventory (for 2015, it is 48.051 $MtCO_2e$). This figure is comprised of:

- traded emissions units surrendered - sourced from Scottish Environment Protection Agency (SEPA) for fixed installations (16.941 $MtCO_2e$)
- an imputed estimate of surrendered CO_2 emissions from domestic aviation (0.507 $MtCO_2e$) and international aviation (1.303 $MtCO_2e$) - sourced from the Scottish Greenhouse Gas Inventory for 1990 to 2015
- non-traded emissions from sources such as residential emissions (31.110 $MtCO_2e$)

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 15.132 $MtCO_2e$ + 0.507 $MtCO_2e$ + 1.303 $MtCO_2e$ = **16.941 $MtCO_2e$**.

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 2015, this cap was separated into 3 components, as shown in the table below.

Total EU ETS cap for Scotland, 2014

The Scottish EU ETS cap for 2015 is **14.394 $MtCO_2e$**. The Scottish Government has published a methodological paper titled Determining a Scottish EU ETS cap for 2015, 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 45.504 $MtCO_2e$. **In 2015, the adjusted emissions which take account of trading in the EU ETS is 45.504 $MtCO_2e$. This is 2.547 $MtCO_2e$ 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 2,546,649 units have been credited to the Net Scottish Emissions Account in 2015.**

[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 2015 target is 45.928 $MtCO_2e$.

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 2015, 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 (1990-2015) 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 $MtCO_2e$

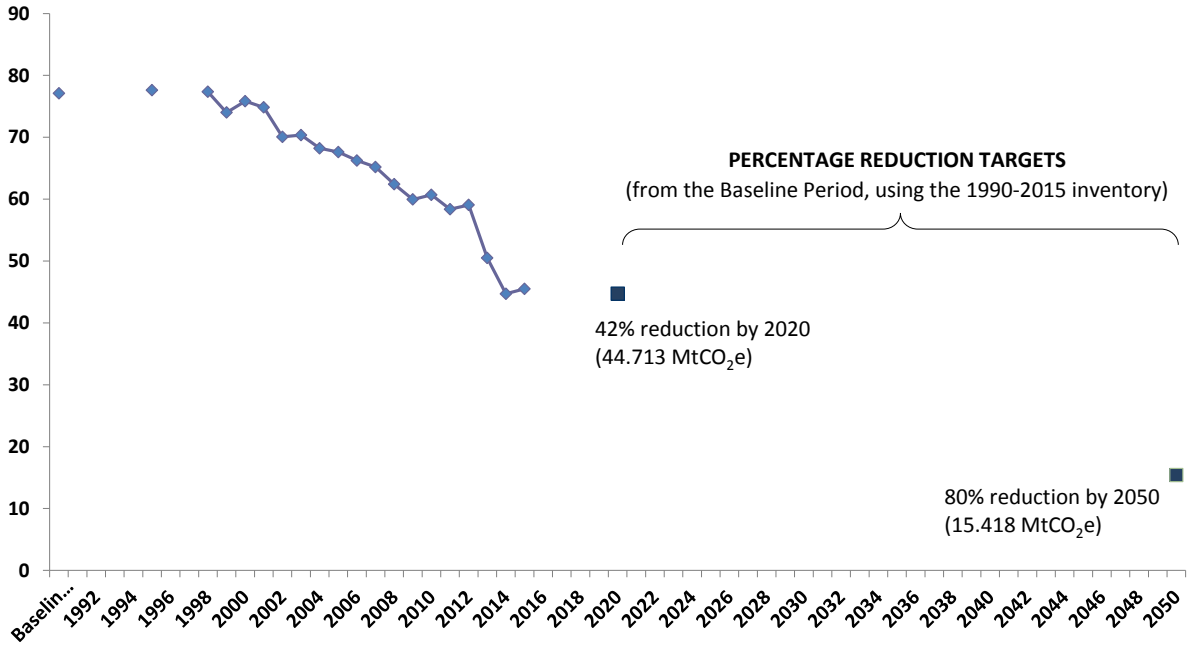
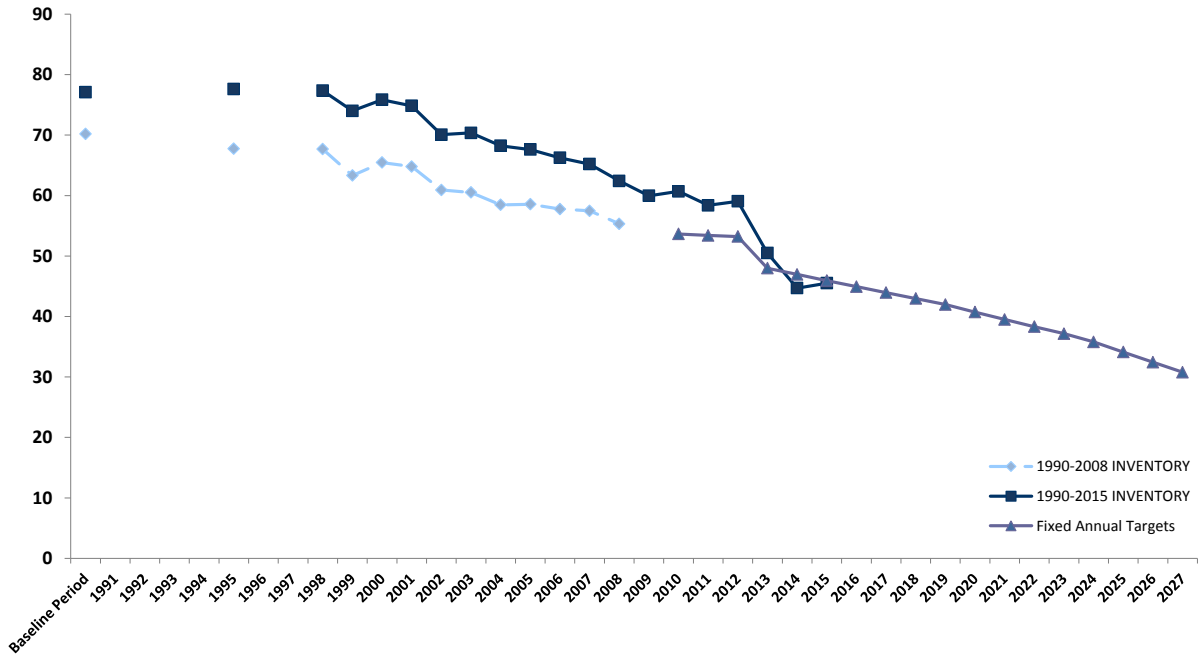


Chart C4 contains data from the latest (1990-2015) inventory, adjusted for trading in the EU Emissions Trading System. The fixed annual targets are also presented on this chart. The fixed annual targets were set at the time of the 1990-2008 inventory. Emissions adjusted for trading in the EU ETS using 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.

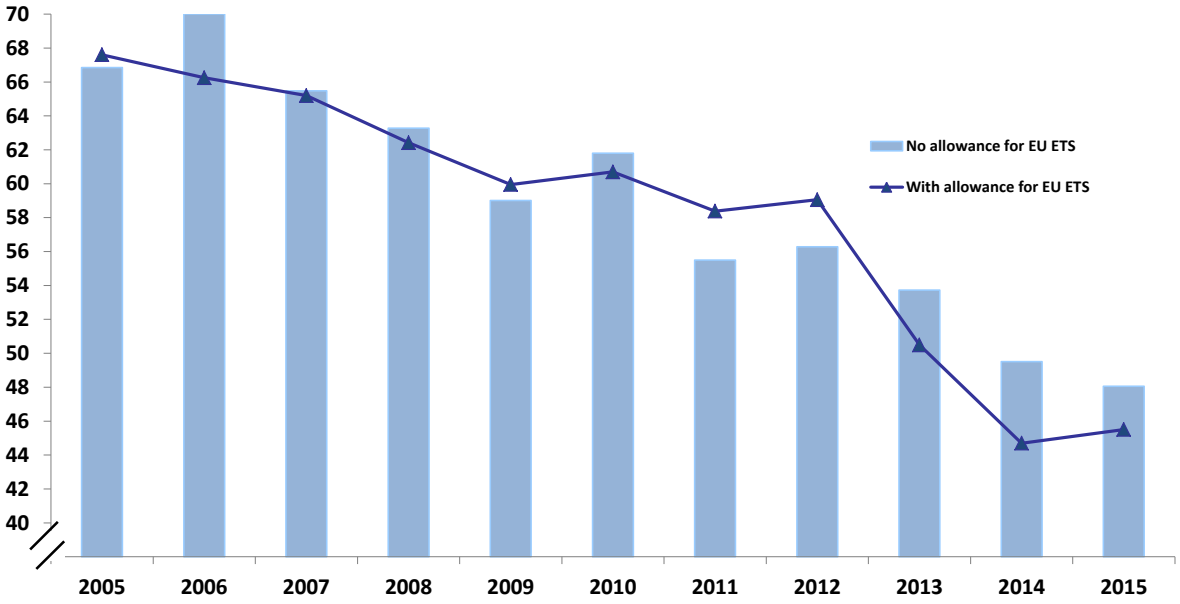
The Sustainability Purpose Targets were refreshed in March 2016 to align with the percentage reduction targets as prescribed in the Climate Change (Scotland) Act 2009. There are two Sustainability Purpose targets:

- The long term target (2050) equates to the 80 per cent reduction target
- The short term target (2020) equates to the 42 per cent 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 2015, the adjustment represented a decrease of 2.546 $MtCO_2e$. This reflects Scotland's notional share of the EU ETS cap in 2015, 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 2015. Values in $MtCO_2e$

		Baseline Period	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
No allowance for EU ETS	Total Scottish greenhouse gas emissions (including international aviation and shipping)	77.1	66.9	70.0	65.5	63.3	59.0	61.8	55.5	56.3	53.7	49.5	48.1
	Percentage change from Baseline Period		-13.3%	-9.2%	-15.1%	-17.9%	-23.5%	-19.8%	-28.0%	-27.0%	-30.3%	-35.8%	-37.7%
	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	-2.5
	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	-2.5
With allowance for EU ETS	Total Scottish greenhouse gas emissions (including international aviation and shipping)	77.091	67.424	66.067	65.015	62.502	60.038	60.781	58.464	59.138	50.491	44.697	45.504
	Percentage change from Baseline Period		-12.5%	-14.3%	-15.7%	-18.9%	-22.1%	-21.2%	-24.2%	-23.3%	-34.5%	-42.0%	-41.0%
	Statutory Fixed Annual Targets							53.652	53.404	53.226	47.976	46.958	45.928

* 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 (1990-2015) and the previous inventory (1990-2014) published in June 2016. 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 Business, Energy and Industrial Strategy (BEIS) Publication “Digest of UK Energy Statistics (DUKES)”. This approach is prompted by data availability on emissions being more limited at the sub-UK level.

Impact of Revisions

Revisions between the 1990-2014 and 1990-2015 inventories

Charts D1 to D3 and Table D1 illustrate the impacts of revisions between the 1990-2014 and 1990-2015 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 1990-2014 and 1990-2015 Inventories. Values in $MtCO_2e$

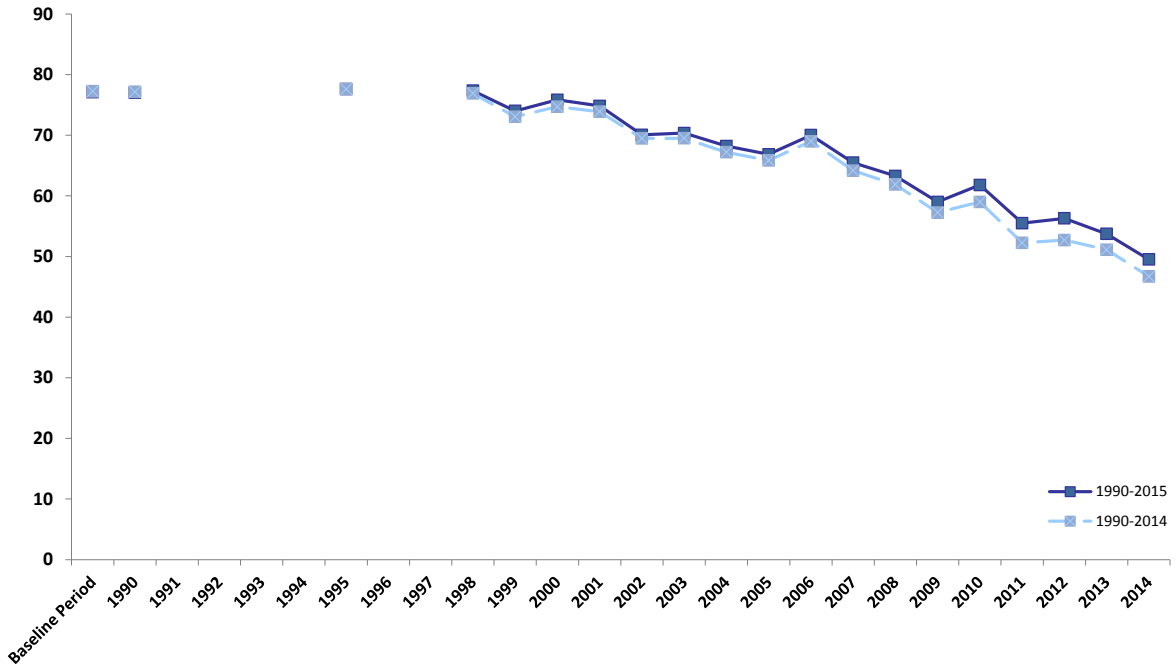


Chart D2 shows that the main downward revision to the Baseline period occurred in the Waste Management sector (revised downwards by 4.2 $MtCO_2e$). Forestry and Agriculture and Related Land Use saw an upward revision to the Baseline period (3.5 $MtCO_2e$ and 0.3 MtCO2e respectively). Other sectors saw very little change between the 1990-2014 and 1990-2015 inventories, with a slight (0.1 $MtCO_2e$) increase in emissions from Residential.

Chart D2. Revisions to emissions in the Baseline Period, from the 1990-2014 inventory to the 1990-2015 inventory, by source sector. Values in $MtCO_2e$, *and percentage changes*

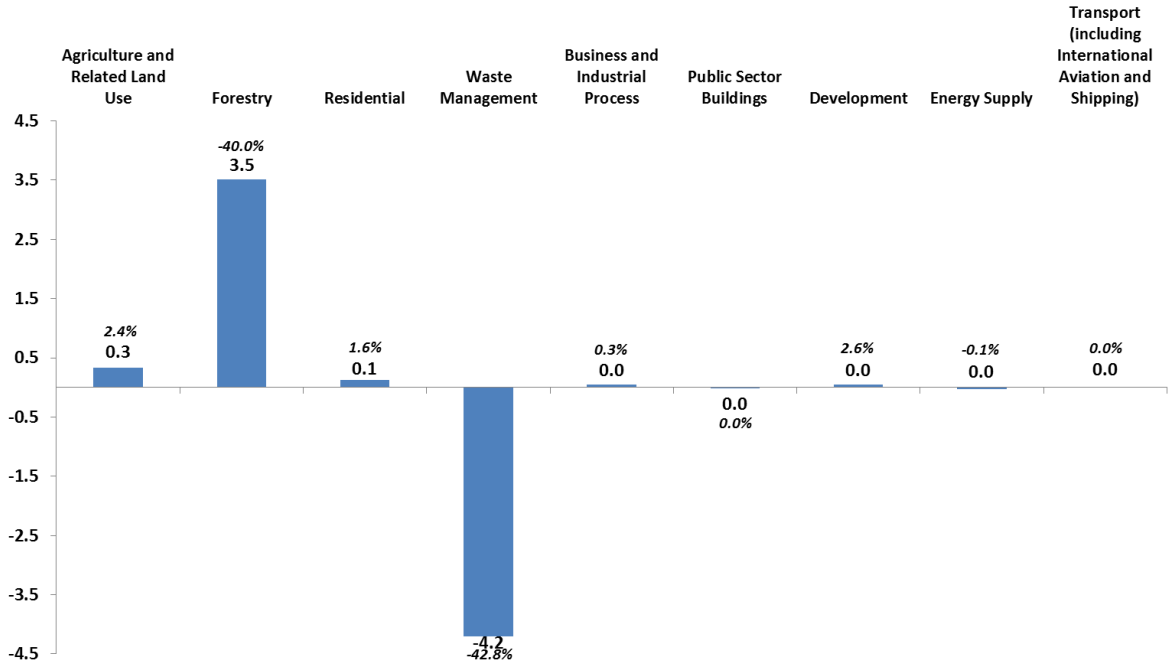


Chart D3 shows that the greatest downwards revision in 2015 occurred in the Waste Management sector (0.8 $MtCO_2e$). The greatest upwards revision occurred in forestry (2.9 $MtCO_2e$).

Chart D3. Revisions to emissions in 2014, from the 1990-2014 inventory to the 1990-2015 inventory, by source sector. Values in $MtCO_2e$, *and percentage changes*

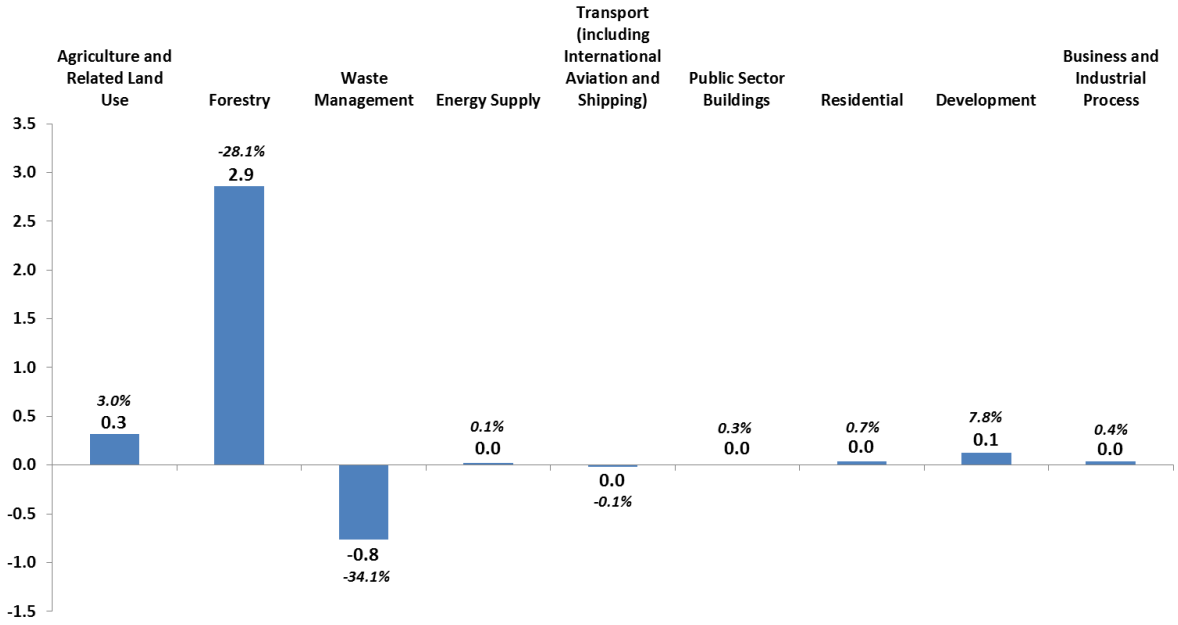


Table D1. Changes in emissions by source sector. Comparison of 1990-2014 and 1990-2015 inventories. Values in $MtCO_2e$

	Baseline Period	1990	2014	2015	*% change between Baseline Period and 2014*	*% change between 1990 and 2014*	*% change between Baseline Period and 2015*	*% change between 1990 and 2015*
Total								
1990-2014	**77.3**	**77.2**	**46.7**		***-39.5%***	***-39.5%***		
1990-2015	**77.1**	**77.0**	**49.5**	**48.1**	***-35.8%***	***-35.7%***	***-37.7%***	***-37.6%***
Difference between 1990-2014 and 1990-2015	**-0.2**	**-0.2**	**2.8**					
Energy Supply								
1990-2014	22.8	22.8	13.8		*-39.2%*	*-39.2%*		
1990-2015	**22.7**	**22.7**	**13.9**	**12.2**	*-39.0%*	*-39.0%*	*-46.4%*	*-46.4%*
Difference between 1990-2014 and 1990-2015	**0.0**	**0.0**	**0.0**					
Transport (including International Aviation and Shipping)								
1990-2014	13.3	13.3	12.9		*-2.8%*	*-2.8%*		
1990-2015	**13.3**	**13.3**	**13.1**	**13.1**	*-1.5%*	*-1.5%*	*-1.1%*	*-1.1%*
Difference between 1990-2014 and 1990-2015	**0.0**	**0.0**	**0.2**					
Agriculture and Related Land Use								
1990-2014	14.2	14.2	10.7		*-25.0%*	*-25.0%*		
1990-2015	**14.6**	**14.6**	**11.0**	**8.6**	*-24.6%*	*-24.6%*	*-41.0%*	*-41.0%*
Difference between 1990-2014 and 1990-2015	**0.3**	**0.3**	**0.3**					
Business and Industrial Process								
1990-2014	14.3	14.3	8.7		*-39.7%*	*-39.6%*		
1990-2015	**14.4**	**14.4**	**8.7**	**8.7**	*-39.6%*	*-39.5%*	*-39.9%*	*-39.8%*
Difference between 1990-2014 and 1990-2015	**0.0**	**0.0**	**0.0**					
Residential								
1990-2014	8.0	8.1	5.9		*-26.5%*	*-27.2%*		
1990-2015	**8.1**	**8.1**	**5.9**	**6.1**	*-27.2%*	*-26.7%*	*-25.0%*	*-24.5%*
Difference between 1990-2014 and 1990-2015	**0.1**	**0.0**	**0.0**					
Waste Management								
1990-2014	9.8	9.8	2.2		*-77.3%*	*-77.3%*		
1990-2015	**5.6**	**5.6**	**1.5**	**1.4**	*-73.8%*	*-73.8%*	*-74.9%*	*-74.9%*
Difference between 1990-2014 and 1990-2015	**-4.2**	**-4.2**	**-0.8**					
Development								
1990-2014	1.8	1.8	1.6		*-15.4%*	*-15.4%*		

1990-2015	**1.9**	**1.9**	**1.7**	**1.7**	*-9.5%*	*-9.5%*	*-9.8%*	*-9.8%*
Difference between 1990-2014 and 1990-2015	**0.0**	**0.0**	**0.2**					
Public Sector Buildings								
1990-2014	1.7	1.7	1.1		*-36.2%*	*-36.2%*		
1990-2015	**1.7**	**1.7**	**1.1**	**1.1**	*-36.1%*	*-36.1%*	*-37.3%*	*-37.3%*
Difference between 1990-2014 and 1990-2015	**0.0**	**0.0**	**0.0**					
Forestry								
1990-2014	-8.8	-8.8	-10.2		*16.1%*	*16.1%*		
1990-2015	**-5.3**	**-5.3**	**-7.3**	**-7.0**	*39.1%*	*39.1%*	*32.7%*	*32.7%*
Difference between 1990-2014 and 1990-2015	**3.5**	**3.5**	**2.9**					

Details of Main Revisions and Interpretation of Revisions to the Inventory

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

The latest published Scotland greenhouse gas inventory (currently 1990-2015) 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 - 2015. Details of the most notable revisions are listed below:

1. Forestry.

Methodological changes affecting the soil carbon stocks following afforestation

Methodological change to series has reduced the sink. As each DA has a different composition of tree species and different ratios of planting on organic and mineral soils, the changes to data and methodology have different magnitudes in each devolved administration. As Scotland has the greatest area of forestry on organic soils and this has a big influence on the differences between the 1990-2014 and 1990-2015 inventories.

In the 1990-2015 inventory the decrease in the sink in Scotland between 2014 and 2015 arises from the Forest Land category. The main source is losses from biomass carbon stock change in “Forest Remaining Forest” category, e.g. harvesting and thinning of trees.

2. Waste Management

Methodological changes to the waste model for Scotland

The changes in waste management between the 1990-2014 and 1990-2015 series is primarily driven by methodological changes to the Scottish waste management model, with larger revisions earlier in the series due to over estimation of Scotland’s share of UK waste activity.

Across all UK estimates, there were changes made to the model assumptions to align with IPCC degradation rates for the various waste streams. Then for

Scotland the model was overhauled to use more accurate Scotland-specific waste arisings data over many years (where previously assumptions had been applied to UK-wide statistics).

The model takes all of these data inputs (back to the 1940s) and works out how quickly all of the different components of the waste degrades, how much methane is generated over time and then when it is generated, and how much of it is oxidised within the landfill boundary layer or captured and used in flares and engines.

The impact of the changes is that the overall reduction in emissions is greater at the start of the time series (early 1990s) than it is in the later years, and so this change does have a marked impact on the overall reported emissions trend for Scotland.

Scottish emissions now make use of a Scottish waste emissions model fed with Scottish data. Previously the waste emissions were obtained using a UK model. The current model suggests Scottish waste emissions in 1990 were similar to Scotland's population share. Previously Scotland had a much greater share of waste emissions. It assumes that there are more significant differences with the historic input data than the more recent data

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 1990-2014 Scottish greenhouse gas inventory to review and improve the uncertainty calculations. A link to this project and to the full report can be found in the Scottish Greenhouse Gas Inventory Uncertainties Project.

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 1990-2016 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;

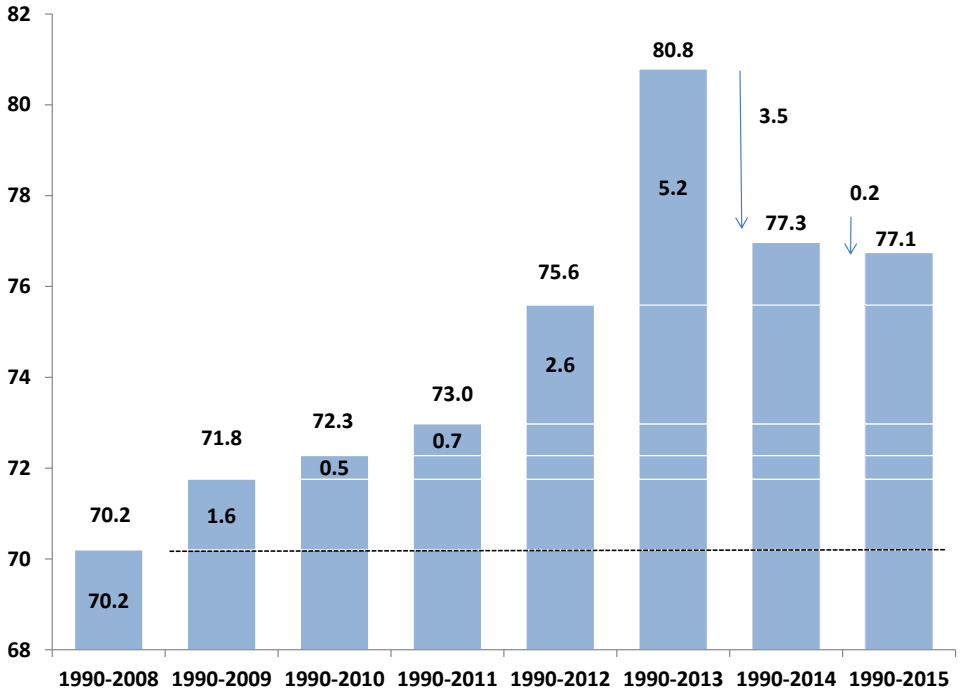
- There is likely to be a review of the carbon factors of some of the fuels not included in the EU Emissions Trading System (EU ETS), as these have not been reviewed for a number of years;

Note that there are likely to be further revisions in the 1990-2016 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 and 1990-2014 and 1990-2015. Overall there has 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 1.0 $MtCO_2e$.

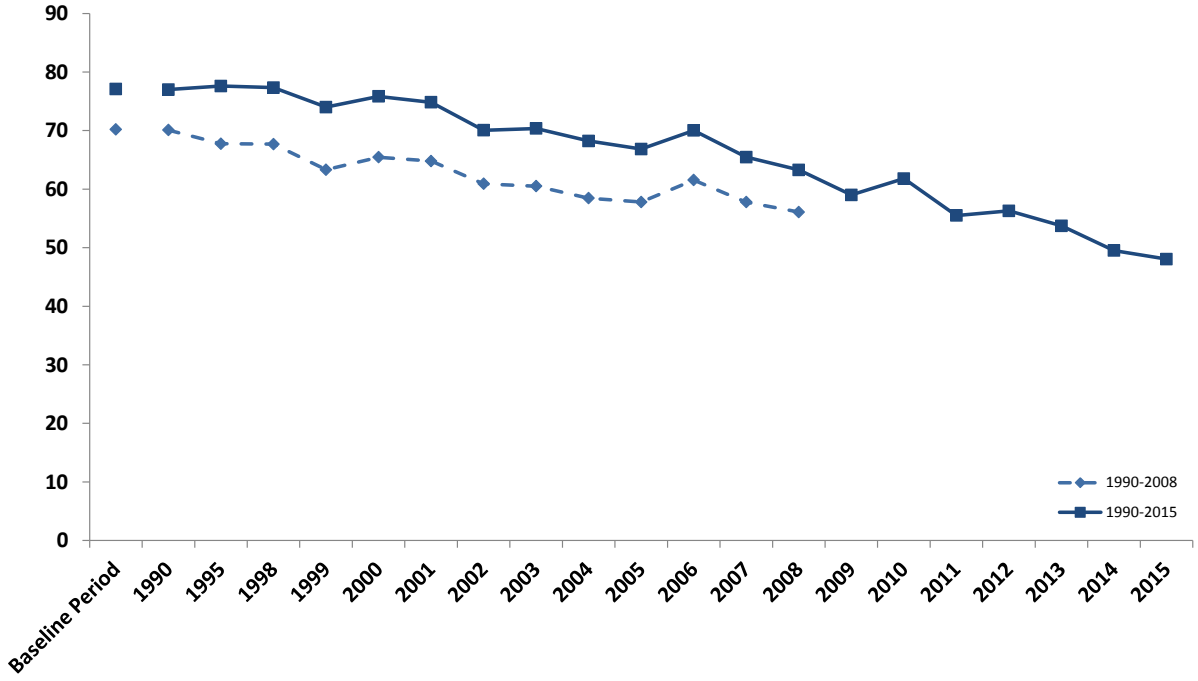
Chart D4. Revisions to emissions in the Baseline Period, from the 1990-2008 Inventory, to the Latest Inventory. Impact of Successive Revisions. Values in $MtCO_2e$



The cumulative effect of revisions since the 1990-2008 inventory is an increase of 6.9 $MtCO_2e$ to emissions in the Baseline Period, which represents a 9.8% increase

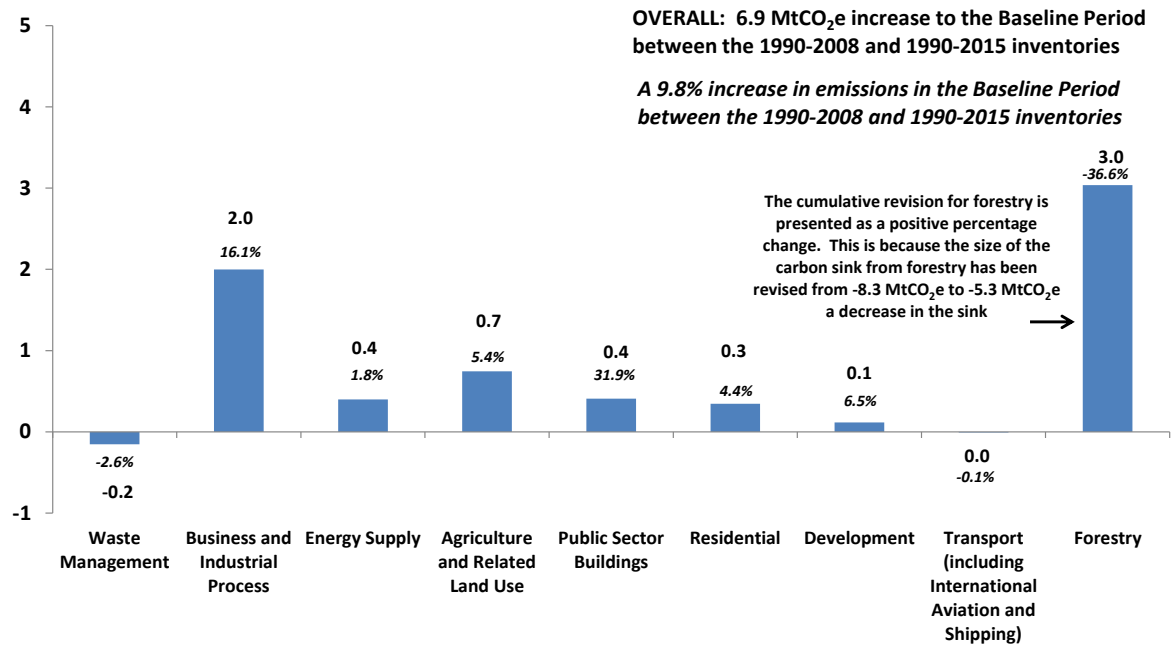
Charts D5 shows the cumulative effect of revisions to the greenhouse gas inventory from 1990-2008 to the latest (1990-2015) inventory across the time series. Chart D6 shows the cumulative effect of revisions to the Baseline from the 1990-2008 inventory, by source sector.

Chart D5. Scottish Greenhouse Gas Emissions, Comparison of 1990-2008 and 1990-2015 Inventories. Values in $MtCO_2e$



There has been a cumulative upwards revision between 1990-2008 and 1990-2015 across the entire time series.
The emissions in the Baseline have been revised upwards by 6.9 $MtCO_2e$ (9.8 per cent).

Chart D6. Revisions to the Baseline, from the 1990-2008 Inventory to the Latest Inventory (1990-2015), by source sector. Impact of Successive Revisions. Values in $MtCO_2e$, *and percentage changes* [17]



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.

[17] 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: 1990-2015

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 1998-2013")

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 Climate Change (Annual Targets) (Scotland) Order 2016

This Order sets annual emissions reduction targets for the period 2028-2032.
http://www.legislation.gov.uk/ssi/2016/328/contents/made

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 Carbon Accounting Scheme (Scotland) Amendment Regulations 2017

These Regulations establish the scheme for monitoring compliance with the annual emissions reduction targets set for 2015.
http://www.legislation.gov.uk/ssi/2017/121/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 Business, Energy and Industrial Strategy (BEIS) 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 BEIS website.

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

Scottish Government Methodology Paper: Determining the Scottish EU ETS cap for 2015

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/EUETScap2015

Scottish Energy Statistics

The Scottish Government's Energy in Scotland 2017 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 2017.
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

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[18] 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.

[18] 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 coastal wetlands will be 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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