

The Scottish Greenhouse Gas Emissions Annual Target 2012

**Report laid in The Scottish Parliament in
accordance with Section 33 of the Climate
Change (Scotland) Act 2009 (SG2014/215)**

THE SCOTTISH GREENHOUSE GAS EMISSIONS ANNUAL TARGET 2012

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Contents

Summary

Introduction

Part 1 – Annual target for 2012

Part 2 – Net Scottish emissions

Part 3 – Net Scottish Emissions Account (NSEA) for 2012

Part 4 – Scottish electricity consumption and generation for 2012

Annex A – Methodology (electricity generation) Summary

Summary

This is the third report on the Scottish greenhouse gas emissions annual target required under the Climate Change (Scotland) Act 2009. It sets out whether the annual target for 2012 has been met and if not, why not. It also states whether or not the domestic effort target in the target year was met.

In 2012, net Scottish emissions of the basket of six greenhouse gases are estimated to have been 52,895,245 tCO₂e. This was 0.8 per cent higher than the 2011 figure of 52,487,243 tCO₂e, or a 408,002 tCO₂e increase. Between 1990 and 2012, there was a 29.9 per cent reduction in actual, or source emissions **before** adjustment for trading in the European Emissions Trading Scheme (EU ETS). This percentage decrease is greater than the average reduction for the EU 15 member states (13.9 per cent), when accounting for international aviation and shipping and emissions and removals from the land use, land use change and forestry sector.

Achievement of Scotland's greenhouse gas emissions targets is measured against the level of the Net Scottish Emissions Account (NSEA). This 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 2012, the NSEA figure, after adjustment for EU ETS allowances, was 55,665,180 tCO₂e. This means that the statutory 2012 target, as expressed under the terms of the Climate Change (Scotland) Act 2009, to reduce greenhouse gas emissions to 53,226,000 tCO₂e in 2012 was missed by 2,439,180 tCO₂e. However, it is worth noting that actual, or source emissions recorded in the same year were 52,895,245 tCO₂e, or 330,755 tCO₂e better than the target.

When taking emissions trading into account, Scotland's emissions rose by 0.5 per cent in 2012 on the previous year. The longer term trend to date shows a substantial emissions reduction of 26.4 per cent from the 1990 baseline (1995 for the F-gases). This compares with a 24.2 per cent reduction assumed when the 2012 target was set based on the 1990-2008 greenhouse gas inventory. This percentage reduction demonstrates that the **Scottish Government is over half way to achieving its Climate Change Act target of reducing emissions by 42 per cent by 2020.**

Emissions are subject to considerable volatility centred on demand for space heating and energy demands. In 2010 the annual target was missed largely due to extreme winter weather experienced at the beginning and end of that year. In 2011 despite a reduction of around 3.2 per cent in emissions in the NSEA we missed the annual target again, and in 2012 emissions again rose primarily driven by an increase in residential emissions, due to greater space heating of homes, which is associated with cooler temperatures in that year and by changes in the fuel mix for electricity production.

Between 2011 and 2012, there were increases in greenhouse gas emissions in the energy supply and residential sectors, of 0.2 and 0.7 MtCO₂e respectively (increases of 1.4 and 11.1 per cent). There was a decrease of 2.8 per cent from the agriculture and related land use sector (0.3 MtCO₂e) while the transport sector (excluding international aviation and shipping) saw a 0.5 per cent increase (0.1 MtCO₂e). Public sector emissions increased by 4.3 per cent (up 0.1 MtCO₂e). Net emissions from

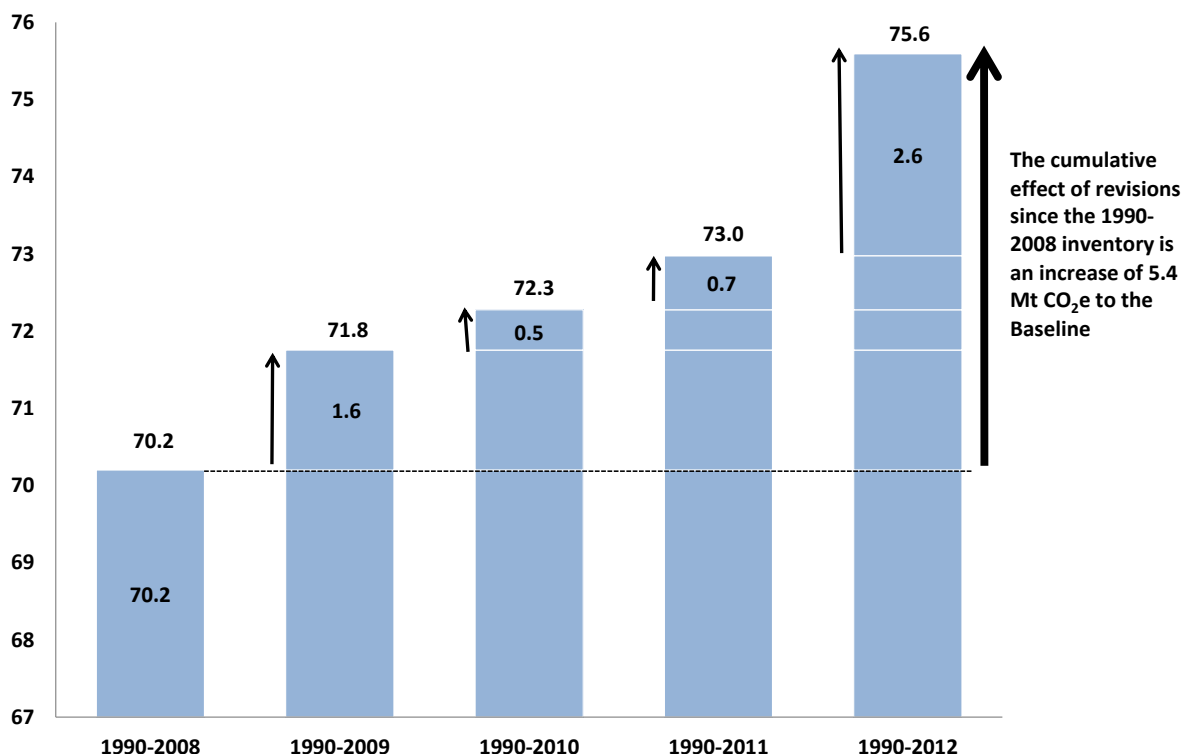
waste management decreased by 5.3 per cent (0.2 MtCO₂e). There was a decrease of 0.2 MtCO₂e for international aviation and shipping and little change in the business and industrial process sector (increase of 0.1 Mt CO₂e; 0.6 per cent). Emissions from the development sector increased by 0.03 MtCO₂e, or an increase of 2 per cent over levels in 2011. Net removals from the forestry sector remained static at 9.9 MtCO₂e continuing a trend arising from historic low planting rates in the previous decade. The total reduction in source emissions from 1990 to 2012 was 29.9 per cent.

Key factors influencing the 2012 emissions figures also include revisions to the historic greenhouse gas emissions data, as a result of new data and latest changes in methodology, which further increased emissions in 2012. By this summer's data release the baseline emissions had been revised up by 5.4 MtCO₂e (7.7 per cent) compared to the data available when the annual targets were first set.

These revisions will apply to future years as well. For example we understand that methane's potency will be upgraded from 21 to 25 times the impact of CO₂ in the 1990 - 2013 inventory. This is likely to make forthcoming annual targets even more difficult to achieve, because, while the baseline emissions have been revised significantly upwards the statutory annual greenhouse gas emissions targets remain unmoved as they are based on the 2008 Greenhouse Gas Inventory data.

Chart 1 shows the impact of revisions to the 1990 Baseline in successive inventories. This demonstrates that the Baseline value has increased by 5.4 Mt CO₂e (7.7 per cent) since the 1990-2008 inventory on which the fixed annual Climate Change targets (expressed in tonnes of CO₂ equivalents) were set – an average yearly increase of 1.3 Mt CO₂e.

Chart 1. Revisions to the Baseline, from the 1990-2008 Inventory, to the Latest Inventory. Impact of Successive Revisions. Values in Mt CO₂e.



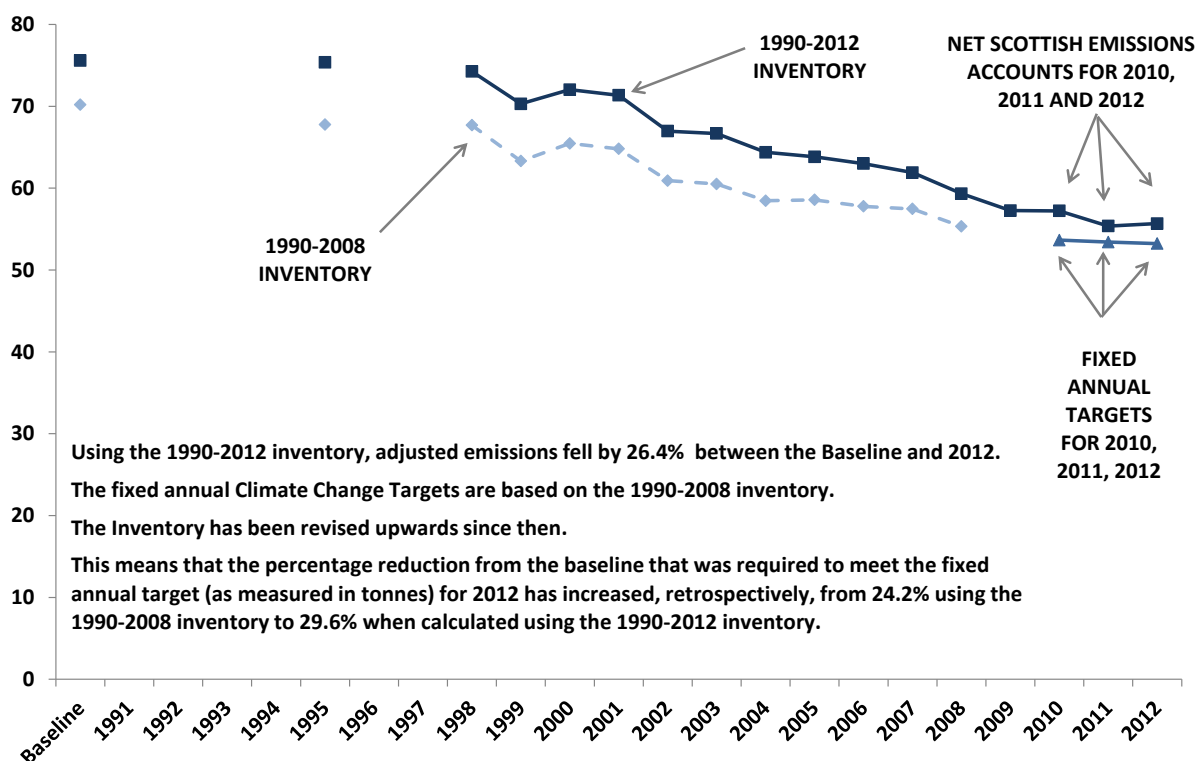
Source emissions for 2010 have been revised upwards from 55.7 Mt CO₂e to 56.9 Mt CO₂e between the 1990-2010 inventory and the 1990-2011 inventory – an increase of 1.2 Mt CO₂e. This figure was revised upwards by a further 1.4 Mt CO₂e to 58.3 Mt CO₂e in the latest inventory. Source emissions for 2011 have been revised upwards from 51.3 Mt CO₂e in the 1990-2011 inventory to 52.5 Mt CO₂e in the 2012 inventory – an increase of 1.2 Mt CO₂e.

The NSEA for 2010 has been revised upwards from 54.7 Mt CO₂e to 55.9 Mt CO₂e between the 1990-2010 inventory and the 1990-2011 inventory – an increase of 1.2 Mt CO₂e. This figure has been revised upwards to 57.2 Mt CO₂e in the latest (1990-2012) inventory – an increase of 1.3 Mt CO₂e.

The NSEA for 2011 has been revised upwards from 54.3 Mt CO₂e in the 1990-2011 inventory to 55.4 Mt CO₂e in the latest (1990-2012) inventory – an increase of 1.1 Mt CO₂e.

Annual fluctuations in emissions are to be expected, however the longer term trend shows emissions are reducing in Scotland. **Chart 2** shows that the actual percentage decrease from the revised 1990 baseline is 26.4 per cent. This compares with an expectation of a 24.2 per cent reduction by 2012, when the target was originally set.

Chart 2. Comparison of the NSEA, which is based on the 1990-2012 inventory and the Fixed Annual Targets which are based on the 1990-2008 inventory. Values in Mt CO₂e



Introduction

The Climate Change (Scotland) Act 2009, “the Act”, set targets to reduce Scotland's greenhouse gas emissions by 80% below the 1990 baseline¹ in 2050, with an interim target to reduce emissions by at least 42% by 2020. Unlike the approach taken by the UK, which uses 5 year carbon budgets, Scotland's annual targets are not only measured against emissions from sources in Scotland, but also include an estimate of Scotland's share of emissions from international aviation and shipping is included in the targets².

The Act also requires Scottish Ministers to set Scottish greenhouse gas emissions annual targets for emissions at least 12 years in advance. In October 2010 the Scottish Parliament passed legislation introducing the first batch of annual targets, for the years 2010 to 2022³ and these were set based upon data published under the 2008 Greenhouse Gas Inventory. Targets for 2023-2027 were set in October 2011⁴, and will continue to be set at 5-year intervals.

Table 1: Annual Targets for the period 2010-2027

Year	Targets (in tCO ₂ e)	Percentage reduction against 1990 baseline when targets were set - using the 1990-2008 inventory
2010	53,652,000	-23.6%
2011	53,404,000	-23.9%
2012	53,226,000	-24.2%
2013	47,976,000	-31.7%
2014	46,958,000	-33.1%
2015	45,928,000	-34.6%
2016	44,933,000	-36.0%
2017	43,946,000	-37.4%
2018	42,966,000	-38.8%
2019	41,976,000	-40.2%
2020	40,717,000	-42.0%
2021	39,495,000	-43.7%
2022	38,310,000	-45.4%
2023	37,161,000	-47.1%
2024	35,787,000	-49.0%
2025	34,117,000	-51.4%
2026	32,446,000	-53.8%
2027	30,777,000	-56.2%

¹ The basket of Kyoto Protocol greenhouse gases comprises carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), for which the baseline is 1990; and hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆), for which the baseline is 1995.

² The Climate Change (International Aviation and Shipping) (Scotland) Order 2010, SSI 2010 no. 218: <http://www.legislation.gov.uk/ssi/2010/218/contents/made>. The Act requires Ministers to apply a "multiplier" to aviation emissions to take into account the fact that emissions at high altitude are thought to have a bigger impact on the climate. The Committee on Climate Change recommended that this multiplier is set to a neutral value until more conclusive evidence is available to show what the multiplier should be, and Scottish Ministers took this advice when setting secondary legislation. Ministers will introduce new legislation when more evidence becomes available.

³ The Climate Change (Annual Targets) (Scotland) Order 2010, SSI 2010 no. 359: <http://www.legislation.gov.uk/ssi/2010/359/contents/made>

⁴ The Climate Change (Annual Targets) (Scotland) Order 2011, SSI 2011 no. 353: <http://www.legislation.gov.uk/ssi/2011/353/contents/made>

This is an approach enshrined in the Climate Change (Scotland) 2009 Act, the terms of which do not allow for any scope to adjust targets in line with baseline revisions arising from an updated more accurate greenhouse gas inventory.

Reports on annual targets

Section 33 of the Act requires that Scottish Ministers lay before the Scottish Parliament a report in respect of each year in the period 2010 - 2050 for which an annual target has been set. Reports on greenhouse gas emissions annual targets must be laid before the Parliament no later than 31 October in the second year after the target year.

The report must state:

- Whether the annual target for the target year has been met. If the annual target has not been met, the report must explain why.
- Whether the domestic effort target has been met in the target year to which the report relates. If the domestic effort target has not been met, the report must explain why.
- The report must contain the information mentioned in section 34 of the Climate Change (Scotland) Act 2009⁵, including Scottish electricity consumption and generation. Section 38 of the Act is also reported on for the purposes of this report.

Structure of the report

This report contains four sections:

Part 1: Annual target for 2012.

Part 2: Net Scottish emissions.

Part 3: Net Scottish Emissions Account (NSEA) for 2012.

Part 4: Scottish electricity consumption and generation for 2012.

⁵ Climate Change (Scotland) Act 2009: <http://www.legislation.gov.uk/asp/2009/12/contents>

Part 1 – Annual target for 2012

The annual target for 2012 was not met

Achievement of Scotland's greenhouse gas emissions annual targets is measured against the level of the NSEA . This 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 sequestration (e.g. "carbon sinks" such as woodland) and the effect of the sale and purchase of relevant carbon units (tradable emissions allowances).

Table 2: Margin between the annual emissions target and the net Scottish Emissions Account (NSEA) in 2012

(tCO ₂ e)	
Annual target (A)	53,226,000
Net Scottish Emissions Account (B)	55,665,180
Margin by which target is met (+) or missed (-) (A – B)	- 2,439,180

Factors influencing progress to the target:

- Emissions affected by changes:
 - Between 2011 and 2012, there were increases in greenhouse gas emissions in the energy supply and residential sectors, of 0.2 and 0.7MtCO₂e respectively (increases of 1 and 11 per cent).
 - The energy supply sector is a very volatile sector, which is linked to the ambient temperature, particularly during the winter months; and fuel used for electricity production, which is in turn largely driven by the price of coal relative to “cleaner” fuels. There was a sharp decrease between 2011 and 2012 in the percentage of gas being used for Scotland's electricity mix (from 16.1 per cent to 8.0 per cent). This follows a decline in the relative share of gas from 2006 onwards. There was an increase in the percentage of coal being used for the generation of electricity between 2011 and 2012 (from 21.0 per cent to 24.9 per cent). Overall, there has been an increase in the relative share of coal since 2005, although this series is volatile. The renewables sector (including hydro natural flow) has seen an overall increase from 11.7 per cent in 2004 to 29.9 per cent in 2012, and this increase has been greatest between 2010 and 2012.
 - Residential emissions are partly generated by space-heating homes and thus are related to external temperatures. Mean annual temperatures in 2012 were 0.7°C lower than in 2011. This is due to relatively colder weather in late autumn and early winter 2012 and a cold snap in April. As a result of this relationship to external

temperatures, residential emissions can exhibit some large annual fluctuations.

- There were also increases in Public Sector emissions (0.1 MtCO₂e; 4 per cent), Business and Industrial process sector emissions (0.1 MtCO₂e; 1 per cent) and Transport emissions (excluding those from International Aviation and Shipping) (0.1 MtCO₂e; 0.5 per cent).
 - There was minimal change in Development emissions and in the carbon sink from Forestry
 - There were decreases in emissions from the Agriculture and Related Land Use sector (0.3 MtCO₂e; 2.8 per cent), Waste Management (0.2 MtCO₂e; 5.3 per cent) and from International Aviation and Shipping (0.2 MtCO₂e; 8.7 per cent).
- Further detail on the 2012 greenhouse gas emissions can be found in the Scottish Government Official Statistics publication: *Scottish Greenhouse Gas Emissions 2012*:
<http://www.scotland.gov.uk/Publications/2014/06/5527>
 - Scottish greenhouse gas emissions are reviewed every year, and the whole historical data series is revised to incorporate methodological improvements and new data. As a result the 2010 figure has been revised up from 55.7 MtCO₂e to 56.9 MtCO₂e for the 2011 inventory and subsequently revised upwards to 58.3 MtCO₂e for the 2012 inventory. The 2011 figure has been revised up from 51.3 MtCO₂e to 52.5 MtCO₂e for the 2012 inventory .
 - The UK inventory is assembled using international guidelines that require countries to keep it under review and take account of amongst other things:
 - New data and revisions to data;
 - International developments in inventory methods;
 - The need for the inventory to take account of policy needs as they evolve;
 - Results of research.
 - All of the revisions to the inventory were for one of the reasons above. The Scottish inventory is a subset of the UK inventory. In addition to revisions to the UK inventory, allocation to the devolved administrations is also affected by new input data and revised and improved methodologies.

Part 2 –Net Scottish emissions

Aggregate net Scottish emissions including international aviation and shipping are shown in Table 3.

Table 3: Aggregate net Scottish emissions of greenhouse gases (tCO₂e)				
	Baseline Year⁶	Target Year 2011	Target Year 2012	Change from previous target year⁷
Aggregate net greenhouse gas emissions	75,589,337	52,487,243	52,895,245	+408,002

Table 4 provides data for each of the six greenhouse gases covered by the Climate Change (Scotland) Act 2009. As required by the Act, this includes details of:

- The amount for 2012 of net Scottish emissions, of each gas; and,
- Whether any of those amounts represent an increase or decrease compared to the equivalent amount for the previous year.

Table 4: Net Scottish emissions for each greenhouse gas (tCO₂e)					
Greenhouse gas	Base year	Net base year emissions	Net Scottish emissions 2011	Net Scottish emissions 2012	Change in net Scottish emissions 2011 - 2012
Carbon dioxide CO ₂	1990	55,553,081	39,107,791	39,797,426	+689,635
Methane CH ₄		12,815,314	7,015,152	6,801,535	-213,617
Nitrous oxide N ₂ O		6,991,349	5,151,628	5,076,209	-75,419
Hydrofluorocarbons HFCs	1995	112,518	1,125,017	1,133,877	+8,861
Perfluorocarbons PFCs		86,815	51,519	51,151	-368
Sulphur hexafluoride SF ₆		30,259	36,137	35,047	-1,089

⁶ The basket of Kyoto Protocol greenhouse gases comprises carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), for which the baseline is 1990; and hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆), for which the baseline is 1995.

⁷ 2010 is the first target year

TOTAL⁸	75,589,337	52,487,243	52,895,245	+408,002
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Methodology

Greenhouse gas emissions estimates are provided by Aether and Ricardo-AEA under contract to the Department of Energy and Climate Change, the Scottish Government, the Welsh Government and the Northern Ireland Department of Environment. Reports are published on the National Atmospheric Emissions Inventory (NAEI) website⁹ and the latest figures are published in *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 - 2012*¹⁰.

The basket of greenhouse gases consists of carbon dioxide, methane, nitrous oxide, and the three F-gases (hydrofluorocarbons - HFCs, perfluorocarbons - PFCs and sulphur hexafluoride- SF₆), all of which are weighted by global warming potential (GWP). The GWP for each gas is defined as its warming influence relative to that of carbon dioxide. Greenhouse gas emissions are then presented in *carbon dioxide equivalent* units.

The emissions reported are the combination of emissions minus removals from the atmosphere by *carbon sinks*¹¹. Carbon sinks are incorporated within the three sectors of agriculture and related land use, development, and forestry, which include emissions as well as removals resulting from afforestation, reforestation, deforestation and forest management together with changes between grassland, cropland and settlements.

The total emissions reported here include emissions resulting from international aviation and shipping. The data presented for international shipping are regarded as preliminary estimates, as there is limited data availability for regional marine shipping fuel use. The data presented for international aviation are regarded to be of low uncertainty. The aviation estimates are based on a database of UK flight movements and detailed calculations of emissions from different phases of flights (take off, cruise and landing cycles).

Revisions to the Inventory for Baseline and Previous Target Years

Scottish greenhouse gas emissions are reviewed every year, and the historical data series revised to incorporate methodological improvements and new data.

It is therefore not appropriate to compare the inventory from one year with that from another - the latest inventory represents a single consistent data series going back to 1990 (excluding 1992-1994 and 1996-1997¹²).

A discussion of revisions to the greenhouse gas inventory, for successive inventories from 1990-2008 to 1990-2012, by Scottish Government source sector can be found in the Scottish Government paper: *Scottish Greenhouse Gas Emissions 2012 – Key Revisions since 2008*:

⁸ Figures may not sum due to rounding.

⁹ <http://naei.defra.gov.uk/>

¹⁰ http://naei.defra.gov.uk/reports/reports?report_id=799

¹¹ Carbon sinks are defined by the UNFCCC as 'any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere'.

¹² Emissions data were estimated in 1990 and 1995 and full Scottish data only exists from 1998 onwards.

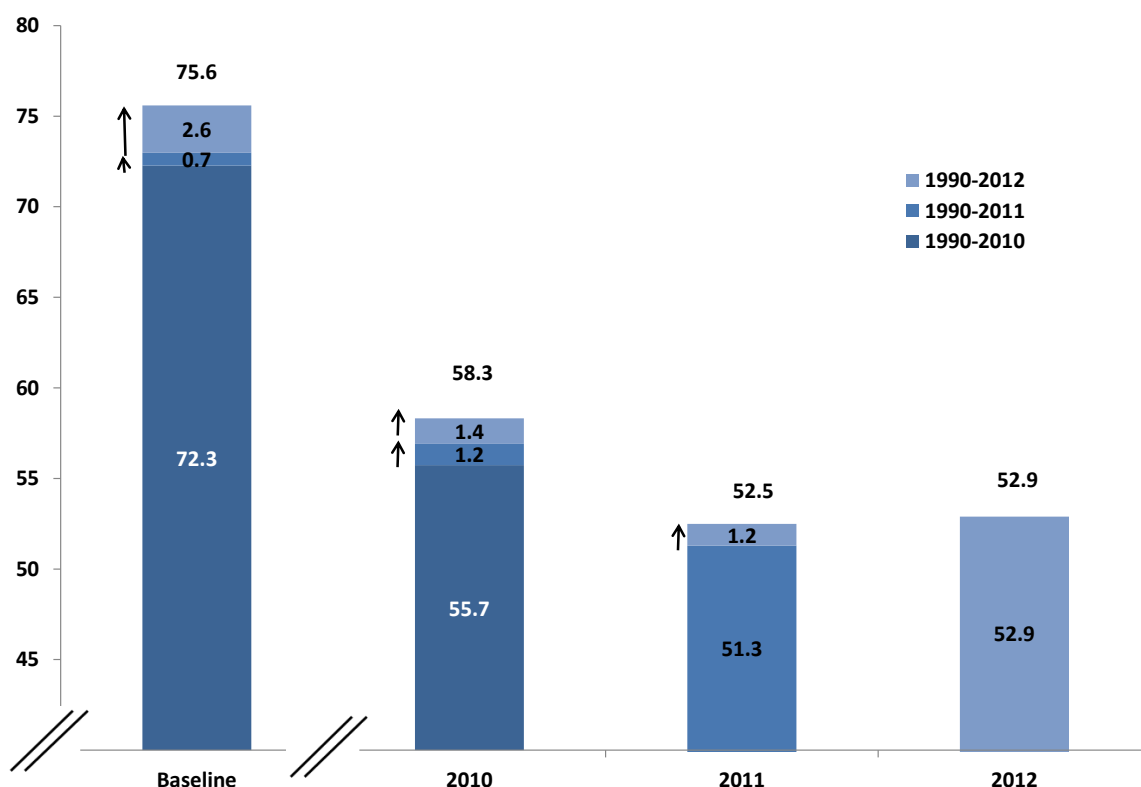
<http://www.scotland.gov.uk/Topics/Statistics/Browse/Environment/Publications/ghgrevisions> . This publication documents successive revisions across the time series from the 1990 Baseline to the latest reporting year (2012).

Chart 3 shows the impact of successive revisions of the inventory on the reported source emissions for the Baseline, 2010, 2011 and 2012. The total of all Scottish greenhouse gas emissions in the Baseline year (including international aviation and shipping) has been revised upwards from 72.3 MtCO₂e in the 1990-2010 inventory to 73.0 MtCO₂e as reported in the 1990-2011 inventory and again to 75.6 MtCO₂e as reported in the 1990-2012 inventory.

2010 emissions were revised upwards from 55.7 Mt CO₂e to 56.9 Mt CO₂e between the 1990-2010 inventory and the 1990-2011 inventory – and increase of 1.2 Mt CO₂e. This figure was revised upwards by a further 1.4 Mt CO₂e to 58.3 Mt CO₂e in the latest inventory.

For 2011, the figure was revised upwards from 51.3 Mt CO₂e to 52.5 Mt CO₂e as reported in the 1990-2012 inventory – an increase of 1.2 Mt CO₂e.

Chart 3. Impact of successive revisions of the inventory in 1990-2010, 1990-2011 and 1990-2012 on source emissions reported for the Baseline, 2010, 2011 and 2012. Values in Mt CO₂e



The main upward revisions to the 2010 figures for the 1990-2011 Inventory are listed below. These have been taken from the Ricardo-AEA / Aether report *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 - 2011*¹³.

- **Business (Other manufacturing industry and construction):** 1.120 MtCO₂e increase) predominantly due to the addition of emissions due to new estimates in the UK inventory for the use of Other Petroleum Gas (OPG) in industrial boilers, following greater scrutiny of the EU ETS data for evidence of use of off-gases from petrochemical production processes being used in boilers on specific industrial sites. There have also been UK-wide revisions to gas oil allocations; a revision to Devolved Administration (DA) allocations of fuel use in industrial off-road machinery to use updated energy mapping analysis consistent with the Department of Energy and Climate Change (DECC) sub-national energy statistics; new UK-wide estimates for emissions from biomass; revisions to gas use in other industrial combustion across GB as a result of changes in point source analysis across 1A2 and revisions to the Digest of UK Energy Statistics (DUKES) activity data for gas-fired auto-generation; increased UK-wide allocation of fuel oil in industry of around 200% in 2010.
- **Business (Chemical industries):** (0.134 MtCO₂e increase) primarily due to the revision to the handling of data for large petrochemical plant, where natural gas was previously assumed to be the fuel, now allocated to 1A2f: "Other manufacturing industry and construction" as Other Petroleum Gas (OPG). This has led to a revision of the allocation of natural gas use in the Industrial Combustion sector.
- **Agriculture and Related Land Use (Land converted to cropland):** (0.101 MtCO₂e decrease) due to a revision to the methodology for emissions of nitrous oxide from the disturbance associated with land use conversion to cropland.

The main upward revisions to the 2011 figures for the 1990-2012 Inventory are listed below. These have been taken from the Ricardo-AEA report *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 - 2012*¹⁴.

- **Forestry (Harvested Wood):** (1.260 MtCO₂e increase) due to the methodological improvement of the use of the CARBINE carbon accounting model for carbon stock change modelling and the inclusion of emissions from all forests older than 20 years in the Forest remaining Forest Land category – instead of just from post-1921 forests as was reported in previous submissions. The deforestation areas have also been updated.
- **Commercial and Institutional combustion (Business and Public):** (0.878 MtCO₂e increase) due predominantly to a major revision to the UK natural gas allocation to the public sector within the Digest of UK Energy Statistics which affects recent years (from 2008 onwards, with very large revisions in 2010 and 2011). In addition, improvements to energy mapping analysis, to use new datasets such as Display Energy Certificates to over-write previous energy modelling assumptions on building energy demand, have led to a

¹³ http://naei.defra.gov.uk/reports/reports?report_id=756

¹⁴ http://naei.defra.gov.uk/reports/reports?report_id=799

higher allocation of public sector emissions to Scotland than was previously estimated.

- **Waste Management (Managed Waste Disposal on Land):** (0.746 MtCO₂e increase) due to revisions to the estimated methane recovery at UK landfills within the inventory model; the methane recovery rate is now based on the analysis of available data on landfill gas collected and burnt in landfill gas engines and flares.
- **Forestry (Land Converted to Forestry):** (0.647 MtCO₂e increase) due to the implementation of the CARBINE model to estimate emissions from LULUCF. This change in methodology has led to significant recalculations across the time series. CARBINE can represent a comprehensive range of forest tree species relevant to the UK, representing UK growth conditions and management practices, and combining area / age class information for carbon stocks. Compared to previous estimates, this more detailed methodology based on application of CARBINE provides greater representation of Forest Land and the range of forest management practices observed in the UK.
- **Agriculture and Related Land Use (Manure Management of Cattle):** (0.461 MtCO₂e increase) due to revisions of the allocation of manure into the various management systems. In particular, the estimated amounts going to daily spread were reduced significantly and the amounts previously allocated to solid storage were reallocated to deep litter leading to an increase from 1% to 39% in the methane conversion factor.

There are also a number of sub-categories that have seen a downward revision in estimated emissions for 2011, which offset part of the impact of the recalculations described above. The most notable of these revisions is for:

- **Forestry (Forest Land Remaining Forest Land):** (2.606 MtCO₂e decrease in 2011). The inventory now uses the CARBINE model to estimate emissions from forestry. This change in methodology has led to significant recalculations across the time series. CARBINE can represent a comprehensive range of forest tree species relevant to the UK, representing UK growth conditions and management practices, and combining area / age class information for carbon stocks. Compared to previous estimates, this more detailed methodology based on application of CARBINE provides greater representation of Forest Land and range of forest management practices

These revisions for the 2011 figures in the 1990-2012 inventory also result in further revisions for the 2010 emissions figures:

- **Forestry (Harvested Wood):** (1.551 MtCO₂e increase in emissions for 2010)
- **Commercial and Institutional combustion (Business and Public):** (0.800 MtCO₂e increase in emissions for 2010)
- **Waste Management (Managed Waste Disposal on Land):** (0.731 MtCO₂e increase in emissions for 2010)
- **Forestry (Land Converted to Forest Land):** (0.695 MtCO₂e increase in emissions for 2010)

- **Agriculture and Related Land Use (Manure Management of Cattle):**
(0.466 MtCO₂e increase in emissions for 2010)

Revisions to Net Scottish Emissions for earlier target years

Revisions to previously reported estimates of the Net Scottish Emissions for earlier target years are detailed in Table 5.

Table 5: Revisions to net Scottish emissions for earlier target years			
Target year	Net Scottish emission estimate previously reported (tCO₂e)	Revision required (tCO₂e)	Revised amount (tCO₂e)
2010 (as reported using 1990-2011 inventory)	55,731,486	+ 1,178,969	56,910,455
2010 (as reported using 1990-2012 inventory)	56,910,455	+ 1,407,176	58,317,632
2011 (as reported using 1990-2012 inventory)	51,285,207	+ 1,202,036	52,487,243

Part 3 – Net Scottish Emissions Account (NSEA) for 2012

The NSEA for a given year is calculated by taking net Scottish emissions for that year, with an adjustment made to reflect the amount of units to be credited to, and debited from, the NSEA for that year. Carbon units that are counted as credits reduce the level of the NSEA, while carbon units that are counted as debits increase the level of the NSEA.

This part of the report sets out the amount of units which are to be credited to and debited from the NSEA in 2012. The calculations are in line with The Carbon Accounting Scheme (Scotland) Regulations 2010¹⁵.

The Climate Change (Limit on Carbon Units) (Scotland) Order 2010¹⁶ specifies that the net amount of carbon units that Scottish Ministers agree may be credited to the Net Scottish Emissions Account for the period 2010-2012 is zero.

Table 6: Net amount of carbon units credited or debited to the net Scottish account for 2012		
	Number of Units	Type of Units
Number of carbon units purchased	0	Not applicable
Number of carbon units held and not surrendered	0	Not applicable
Amount of carbon units credited to the Net Scottish Emissions Account	0	Not applicable

Accounting for the EU Emissions Trading System (EU ETS)

The NSEA also takes account of emissions trading through the European Union Emissions Trading System (EU ETS).

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

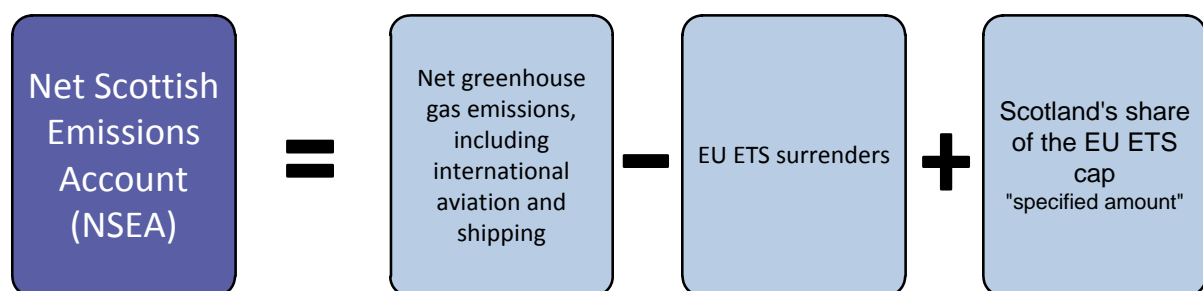
¹⁵ The Carbon Accounting Scheme (Scotland) Regulations 2010, SSI 2010 no. 216:
http://www.opsi.gov.uk/legislation/scotland/ssi2010/ssi_20100216_en_1

¹⁶ The Climate Change (Limit on Carbon Units) (Scotland) Order 2010, SSI 2010 No. 217:
<http://www.legislation.gov.uk/ssi/2010/217/contents/made>

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

The Scottish climate change targets are assessed against the Net Scottish Emissions Account (NSEA). The EU ETS element of the NSEA is calculated taking the difference between Scotland's notional share of the overall EU ETS cap and the number of emissions allowances surrendered from Scottish installations in a given year. This amount is then added to non-traded emissions to get the NSEA.

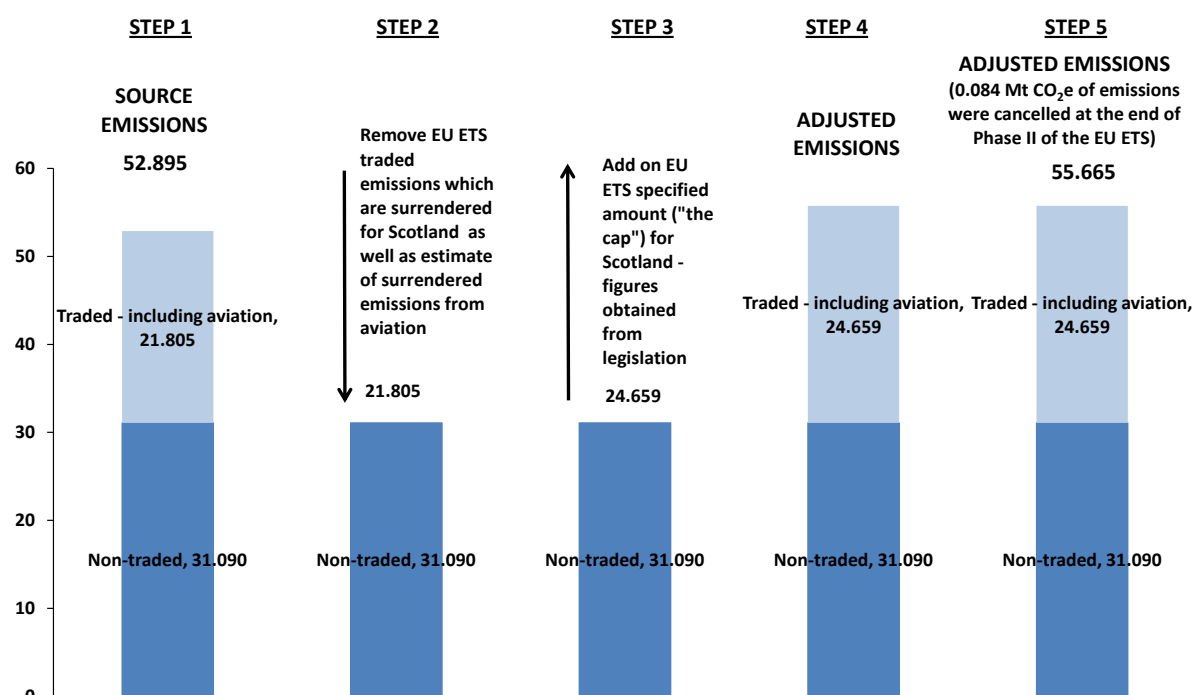
For 2012 reporting, the NSEA formula is as follows:



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

For 2012, the EU ETS element of the NSEA is calculated by taking the difference between Scotland's notional share of the overall EU ETS cap and the number of emissions allowances surrendered from Scottish installations in a given year

Chart 4. Calculation of Adjusted Emissions for Trading in the EU Emissions Trading System (EU ETS), 2012. Values in Mt CO₂e



Calculation of adjusted emissions

STEP 1

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

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

STEP 2

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

STEP 3

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

STEP 4

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

STEP 5

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

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

The specified amount for the period 2010-2012 is determined under section 8 of The Carbon Accounting Scheme (Scotland) Regulations 2010 and shown in Table 7.

Table 7: The specified amount under section 8 of the Carbon Accounting Scheme (Scotland) Regulations 2010 (tCO₂e)	
2010	23,025,000
2011	23,025,000
2012	24,659,000

Table 8 sets out the effect of the EU ETS on the NSEA in 2012.

Table 8: The effect of the EU ETS on the Net Scottish Emissions Account in 2012 (tCO₂e)	
Total amount of units surrendered by Scottish operators (A) ¹⁷	20,349,465
Estimate of surrendered CO ₂ emissions from domestic and international aviation (A)	1,455,601
Cancellation of allowances at the end of Phase II of the EU ETS (A)	84,000
2012 Specified Amount for Scotland (B)	24,659,000
Number of units to be credited (+) or debited (-) to the Net Scottish Emissions Account (A - B)	- 2,769,935

¹⁷ Sourced from SEPA analysis

Net Scottish Emissions Account 2012

As described above, the Net Scottish Emissions Account is calculated by taking net Scottish emissions, which are then adjusted to account for the amount of units to be debited from and credited to the NSEA.

The information in Table 9 is taken from preceding tables in this report and provides a figure for the Net Scottish Emissions Account in 2012.

Table 9: Net Scottish Emissions Account for 2012		(tCO₂e)
GHG Inventory	Net emissions reported for Scotland including international aviation and shipping – see table 3 (A)	52,895,245
Carbon Units	Number of units to be credited or debited to the Net Scottish Emissions Account - see table 8 (B)	-2,769,935
NSEA	A-B	55,665,180

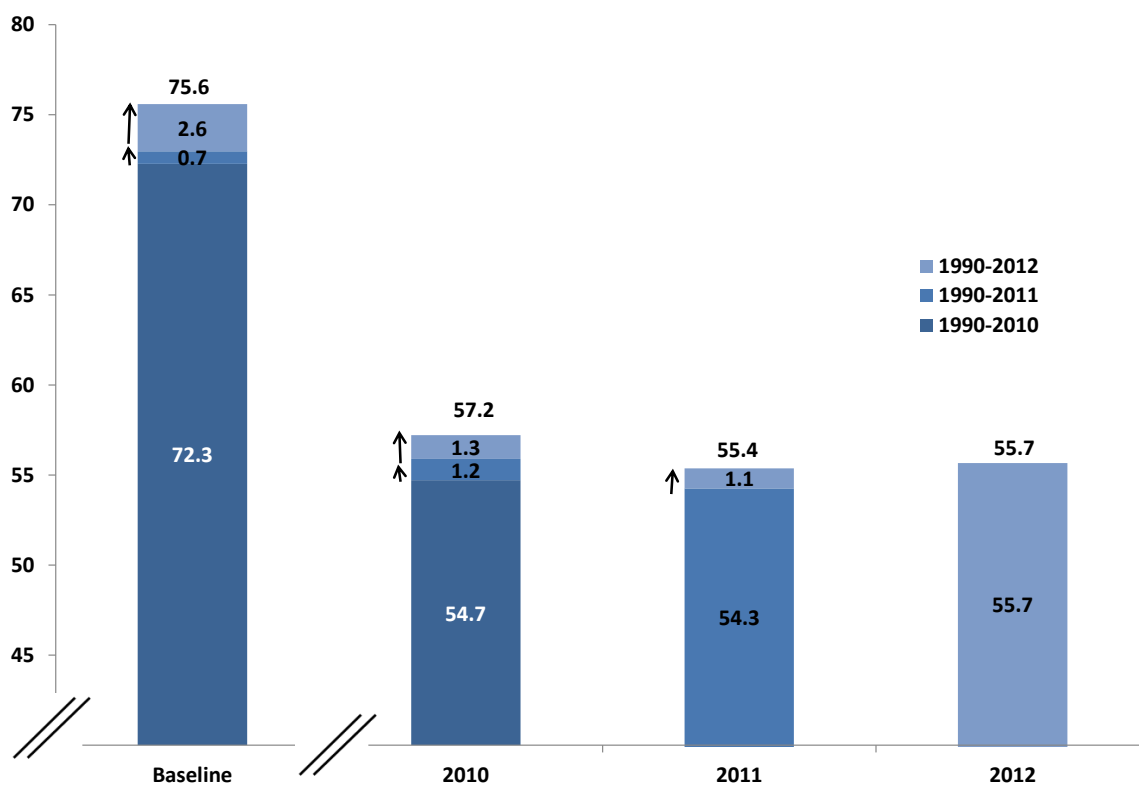
Revisions to Net Scottish Emissions Account for earlier target years

Chart 5 shows the impact of successive revisions to the inventory on the NSEA for 2010, 2011 and 2012.

The NSEA for 2010 has been revised upwards from 54.7 Mt CO₂e to 55.9 Mt CO₂e between the 1990-2010 inventory and the 1990-2011 inventory – an increase of 1.2 Mt CO₂e. This figure has been revised upwards to 57.2 Mt CO₂e in the latest inventory – an increase of 1.3 Mt CO₂e.

The NSEA for 2011 has been revised upwards from 54.3 Mt CO₂e in the 1990-2011 inventory to 55.4 Mt CO₂e in the latest inventory – an increase of 1.1 Mt CO₂e.

Chart 5. Impact of successive revisions of the inventory in 1990-2010, 1990-2011 and 1990-2012 on the NSEA reported for the Baseline, 2010, 2011 and 2012. Values in Mt CO₂e



Revisions to previously reported estimates of the net Scottish emissions account for earlier target years together with the revised amount and reason for any revision are detailed in Table 10.

Table 10: Revised net Scottish emissions account for earlier target years				
Target year	Net Scottish Emission Account estimate previously reported (tCO₂e)	Revision required (tCO₂e)	Revised Net Scottish Emissions Account estimate amount (tCO₂e)	Reason for Revision
2010 (for 1990-2011 inventory)	54,713,907	+ 1,178,969	55,892,876	The revision follows similar revisions to the net Scottish emissions as described in pages 12, 13, and 14 of this report.
2010 (for 1990-2012 inventory)	55,892,876	+1,323,177	57,216,053	The revision follows similar revisions to the net Scottish emissions as described in pages 12, 13 and 14 of this report.
2011 (for 1990-2012 inventory)	54,251,910	+1,118,036	55,369,946	The revision follows similar revisions to the net Scottish emissions as described in pages 12, 13 and 14 of this report.

Net Scottish Emissions Account for all target years

Table 11 sets out the amount of the net Scottish emissions account for the target year and each preceding target year and the cumulative amount of the net Scottish emissions account for the target year and each preceding target year.

Table 11: Amount of the Net Scottish Emissions Account for each target year and the cumulative amount of the Net Scottish Emissions Account for all target years to date (tCO₂e)	
Target Year 2010	57,216,053
Target Year 2011	55,369,946
Target Year 2012	55,665,180
Cumulative 2010-2012	168,251,178

The Domestic Effort Target 2012

Section 8 of the Climate Change (Scotland) Act places a duty on the Scottish Ministers to ensure that reductions in net Scottish emissions of greenhouse gases, account for at least 80% of the reduction in the net Scottish emissions account in any target year. This limits the quantity of "carbon units" (i.e. tradable emissions allowances) that the Scottish Ministers may use to reduce the NSEA in any target year. The exception is carbon units surrendered by participants in the EU ETS (which are accounted for in line with international practice, as described above).

Table 12 sets out the proportion of the change in the NSEA which is accounted for by changes in adjusted net Scottish emissions. Adjusted net Scottish emissions take account of the surrendered carbon units under the EU ETS as described above. It shows that 100% of the reduction in the NSEA is accounted for by reductions in adjusted net Scottish emissions and thus the domestic effort target has been met.

Table 12: Change in adjusted net Scottish emissions between 2011 and 2012 as a proportion of the change in the Net Scottish Emissions Account between 2011 and 2012	
Change in adjusted net Scottish emissions (tCO₂e)	+ 295,234
Change in Net Scottish Emissions Account (tCO₂e)	+ 295,234
Proportion of the change in the Net Scottish Emissions Account which is accounted for by change in the adjusted net Scottish emissions	100%

Part 4 – Scottish electricity consumption and generation for 2012

Under the terms of the Climate Change (Scotland) Act 2009 this report must state the amount of Scottish gross electricity consumption and the average greenhouse gas emissions per megawatt hour of electricity generated in Scotland in the target year.

In 2012, gross electricity consumption in Scotland was 36,602GWh. There are various ways of estimating the average greenhouse gas emissions per megawatt hour of electricity generated in Scotland and three methods are outlined in Annex A to this report and will be replicated where possible in future years. For the purposes of this report, using data from the Scottish Environment Protection Agency's Scottish Pollutant Release Inventory (SPRI) the average greenhouse gas emissions per megawatt hour of electricity generated in Scotland is estimated to be 271 kgCO₂e /MWh in 2012. (CO₂ accounting for 99.4% of these greenhouse gas emissions).

Table 13: Scottish electricity consumption and generation in 2012

Scottish gross electricity consumption (GWh)	Scottish electricity generation (GWh)	Average greenhouse gas emissions/megawatt hour of electricity generated in Scotland (kgCO₂e/MWh)
36,602	49,498	271¹⁸

Table 14 below shows Scottish electricity generation by fuel for 2012.

Table 14: Generation of electricity by fuel in Scotland (GWh)	
Coal	12,334
Oil	724
Gas	3,966
Nuclear	17,050
Thermal renewables	1,649
Other thermal	27
Hydro natural flow	4,844
Hydro Pumped Storage	610
Non thermal renewables	8,264
Wastes	31
Total	49,498

¹⁸ There are various ways of estimating this figure – three methods are outlined in an annex to this paper and will be replicated where possible in future years. Using data from the Scottish Environmental Protection Agency's Scottish Pollutant Release Inventory (SPRI) the average greenhouse gas emissions per megawatt hour of electricity generated in Scotland is estimated to be 271 kgCO₂e/MWh in 2012 (CO₂ accounting for 99.4% of greenhouse gas emissions).

Estimated lifetime cumulative emissions of new electricity generation capacity greater than 50MW approved in 2012

In 2012, 6 projects were consented after consideration under section 36 of the Electricity Act 1989. Of these, five related to onshore wind projects (totalling 747 MW) and one related to a wave device (2.4 MW).

Estimating the cumulative impact of consenting decisions with regard to emissions on the GB wide electricity network is a complex task. First and foremost, there is an important distinction between when a plant is consented and when it becomes operational. This analysis assumes that all the plant consented becomes operational by 2020.

In addition, the electricity system is a dynamic network, where asset owners dispatch their generation depending on a number of complex and competing factors. To provide an accurate representation of this network, a dispatch model is utilised to assess dispatch decisions and the resulting emissions that occur as a result of investment decisions.

Emissions impacts are assessed at a GB level, reflecting the fact that the system is operated as a GB wide wholesale electricity market. The approach adopted assumes that all consented plant becomes operational prior to 2020, and the results specify the estimated impact on emissions in that year. Clearly, this can only provide an approximation of the actual impact, considering the influence of future consenting decisions (in Scotland and the rest of GB) and the parallel program of transmission network upgrades, which will have a material impact on dispatch decisions.

The modelling results suggest that the consented projects, should they become operational, could reduce GB system wide carbon emissions by an estimated 1.2 MtCO₂ in 2020.

Impact on emissions of exercise of electricity generation related functions

In 2012, 6 projects were consented after consideration under section 36 of the Electricity Act 1989, with a further 8 projects licensed by Marine Scotland. Of the projects consented under section 36, five related to onshore wind projects (totalling 747 MW) and one related to a wave device (2.4 MW).

Estimating the cumulative impact of consenting decisions with regard to emissions on the GB wide electricity network is a complex task. First and foremost, there is an important distinction between when a plant is consented and when it becomes operational. This analysis assumes that all the plant consented becomes operational by 2020.

In addition, the electricity system is a dynamic network, where asset owners dispatch their generation depending on a number of complex and competing factors. To provide an accurate representation of this network, a dispatch model is utilised to assess dispatch decisions and the resulting emissions that occur as a result of investment decisions.

Emissions impacts are assessed at a GB level, reflecting the fact that the system is operated as a GB wide wholesale electricity market. The approach adopted assumes that all consented plant becomes operational prior to 2020, and the results specify the estimated impact on emissions in that year. Clearly, this can only provide an approximation of the actual impact, considering the influence of future consenting decisions (in Scotland and the rest of GB) and the parallel program of transmission network upgrades, which will have a material impact on dispatch decisions.

The modelling results suggest that the consented projects, should they become operational, could reduce GB system wide carbon emissions by an estimated 1.2 MtCO₂ in 2020.

ANNEX A

Methodology (Electricity Generation)

1. Scottish gross electricity consumption for the target year.

Annual gross electricity consumption figures for Scotland are sourced from the Department for Energy and Climate Change (DECC). 2012 figures were published in December 2013 (DECC Energy Trends).

The data are available at the link below:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/269439/regional-generation-2004-2012.xls

Gross consumption is calculated by subtracting net exports from the total generation figure.

2. Amount of Scottish electricity generation for the target year.

Annual electricity generation figures for Scotland are sourced from the Department for Energy and Climate Change (DECC). 2012 figures were published in December 2013 (DECC Energy Trends).

The data are available at the link below:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/269439/regional-generation-2004-2012.xls

3. The average greenhouse gas emissions per megawatt hour of electricity generated in Scotland in the target year

The amount of electricity generated in Scotland is sourced as in 2 above.

To estimate the total amount of greenhouse gas emissions in Scotland there are various sources available. The options are listed below. The SPRI (option 1) was chosen for the purposes of this report.

4. Scottish Pollutant Release Inventory (Option 1)

Scottish Pollutant Release Inventory (SPRI) data has been sourced from the Scottish Environment Protection Agency's Scottish Pollutant Release Inventory (SPRI). The SPRI is the system by which Scotland will comply with the requirements of a Community Regulation on the implementation of a European Pollutant Release and Transfer Register.

The SPRI database is publically available at the following link:

http://www.sepa.org.uk/air/process_industry_regulation/pollutant_release_inventory.aspx

The methodology for using this calculation method has been updated for this annual report, to better reflect actual electricity sector emissions. Previous calculations included emissions from combustion plants and compressor stations, which have been removed in this annual report. Radioactive substance emissions are not included.

The estimated greenhouse gas emissions figure in 2012 was 13.402 MtCO₂e.

Using this data source, the average greenhouse gas emissions per megawatt hour of electricity generated in Scotland is estimated to be 271 kgCO₂e/MWh in 2012.

To note that carbon dioxide (CO₂) emissions made up 99.4% of all greenhouse gas emissions in 2012. Focussing only on CO₂, the emissions per megawatt hour is estimated to be 269 kgCO₂/MWh in 2012.

To ensure that the revised methodology can be easily compared to the previous electricity emissions intensities, a table of the annual generation intensity figures has been set out below.

	Total Emissions (MtCO ₂ e)	Total Output (GWh)	Emissions Intensity (kgCO ₂ e/MWh)
2004	16,291	49,937	326
2005	14,908	49,237	303
2006	19,789	52,250	379
2007	16,578	48,080	345
2008	15,329	50,121	306
2009	14,526	51,173	284
2010	16,945	49,965	339
2011	13,140	51,237	256
2012	13,402	49,498	271

5. Greenhouse Gas Inventory for Scotland 2012 (option 2)

This publication provides estimates of greenhouse gas emissions in Scotland for 2012 and the data tables are available at the following link:

http://naei.defra.gov.uk/reports/reports?report_id=799

The pivot tables show greenhouse gas emissions by source. Within Energy Supply, the subsection 'Public Electricity & Heat Production' gives a figure of 12.659 MtCO₂e of emissions.

Using this data source, the average greenhouse gas emissions per megawatt hour of electricity generated in Scotland is estimated to be 256 kgCO₂e/MWh in 2012.

6. Data from Digest of United Kingdom Energy Statistics) (option 3)

Data published in DUKES provides average emissions intensity figures for coal and gas.

- Coal = 0.906 kgCO₂/MWh
- Gas = 0.400 kgCO₂/MWh

Using these intensity figures the estimated greenhouse gas emissions figure in 2012 was 13.418 MtCO₂. Consequently, the estimated average greenhouse gas emissions per megawatt hour of electricity generated in Scotland is estimated to be 271 kgCO₂/MWh in 2012.

7. New consented generation capacity in 2012

Under Section 34(4)(d) of the Climate Change (Scotland) Act 2009, the report must state the average greenhouse gas emissions per megawatt hour, and the estimated lifetime cumulative emissions, of any new electricity generation capacity greater than 50 megawatts approved in Scotland in the target year.

Statistics on the number of consented projects in 2012 have come from:

- Marine Scotland;
- Scottish Government Energy Consents and Deployment Unit.

8. Other appropriate information

Under Section 34(9) of the Climate Change (Scotland) Act 2009, the report may contain such other information as the Scottish Ministers consider appropriate and, in particular, may state the amount of Scottish electricity generation from each source for the target year.

Annual electricity generation figures for Scotland are sourced from the Department for Energy and Climate Change (DECC).

2012 figures by fuel type were published in December 2013 (DECC Energy Trends). The data are available at the link below:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/269439/regional-generation-2004-2012.xls

9. Impact on emissions of ministerial decisions in relation to electricity generation

Under Section 38(2) of the Climate Change (Scotland) Act 2009, this report must report on the impact on emissions of exercise of electricity generation related functions. The report must, in so far as reasonably practicable, set out the impact on net Scottish emissions during that year resulting from the exercise by the Scottish Ministers of the functions conferred on them by virtue of any enactment relating to electricity generation

Statistics on the number of consented projects in 2012 have come from:

- Marine Scotland;
- Scottish Government Energy Consents and Deployment Unit.



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