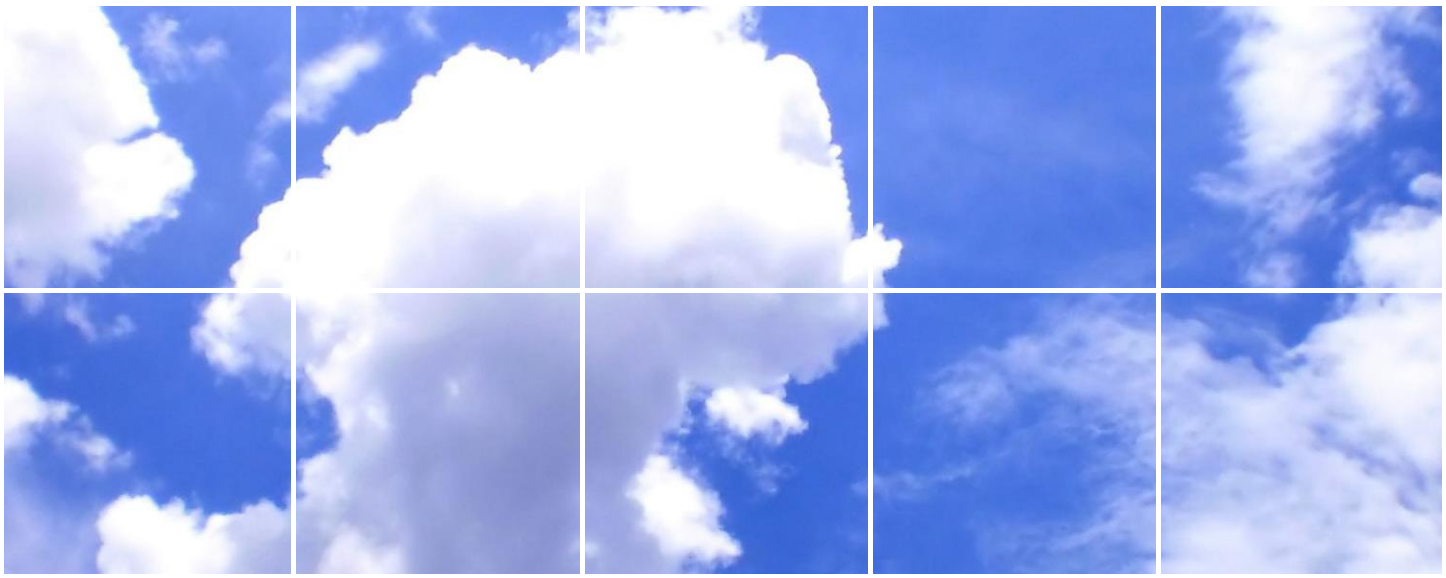
National Atmospheric Emissions Inventory



Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2013

Report to the Department of Energy and Climate Change, The Scottish Government, The Welsh Government and The Northern Ireland Department of the Environment.

June 2015

Aether RICARDO-AEA

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A copy of this report and related data may be found on the NAEI website maintained by Ricardo-AEA for DECC: http://naei.defra.gov.uk/.

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Tables in Devolved Administrations' Chapters

Executive Summary

This report presents the latest estimates of greenhouse gas (GHG) emissions for the UK Devolved Administrations (DAs): England, Scotland, Wales and Northern Ireland. Separate GHG emission inventories have been estimated for the years 1990, 1995 and 1998 to 2013. The estimates are expressed in terms of global warming potentials (GWPs) defined on a 100-year horizon (IPCC, 2006). The estimates and the GWPs are consistent with the United Nations Framework Convention on Climate Change (UNFCCC) reporting guidelines and based on UK emission statistics for 1990-2013 (DECC, 2015a).

Consistent with international and UK GHG inventory reporting protocol, the Devolved Administration (DA) inventory totals presented in this report exclude emissions from international shipping and aviation, which are reported as "memo items". There are some exceptions to this, which are clearly stated, due to Scotland's requirements for reporting against national mitigation targets. Emissions from offshore oil and gas exploration and production activities are not allocated to any country, and are presented as "Unallocated".

Estimates exclude the Crown Dependencies of Jersey, Guernsey and Isle of Man, and those Overseas Territories joining UK instruments of ratification for the UNFCCC and the Kyoto Protocol namely: Cayman Islands, Falkland Islands, Bermuda, Montserrat and Gibraltar.

The main focus of the report is emissions presented on a *by source* basis (emissions are allocated to the source sector in which they occur) and figures and percentages within this report refer to this dataset, unless otherwise stated. Data showing end user emissions (where energy supply emissions are allocated to energy users) and a breakdown of traded/non traded sources, derived from the by source estimates, are also included in the analysis in this report to provide additional perspectives on trends and "ownership" of emissions.

Devolved Administrations' Climate Change Commitments

The Climate Change (Scotland) Act (2009), the 'One Wales' Commitment to reduce greenhouse gas emissions together with the Climate Change Strategy for Wales (2010), and the Northern Ireland Greenhouse Gas Emissions Action Plan (2011) outline each of the Devolved Administrations' aims and objectives in reducing greenhouse gas emissions.

Each of the devolved Governments tailors their climate change policy legislation and policies to focus on specific local and regional priorities. The Climate Change (Scotland) Act identifies that the scope of net Scottish GHG emissions account shall include all existing anthropogenic sources and sinks of emissions in Scotland, as well as a "Scottish share" of GHG emissions from international shipping and international aviation. In contrast, the Welsh emissions account relating to the annual targets (2011-2020) excludes emissions from the traded sector[1] and international transport sources. The Northern Ireland Executive's current Programme for Government target is to continue to work towards a 35% reduction in greenhouse gas emissions (on the by-source basis presented in this report) by 2025 based on 1990 levels of the by source estimates.

By Source Inventory Estimates for 2013

The UK distribution of regional net[2] greenhouse gas emissions in 2013, expressed in terms of global warming potentials (GWP), is detailed below.

England has a **76%** share of total net GHG emissions in **2013**. **England** has seen a decrease of 32% in greenhouse gas emissions between the Base Year[3] and 2013. Emissions between 2012 and 2013 have decreased slightly (by 3.7%). This decrease of emissions is predominantly driven by a shift from coal to renewable energy sources in the power generation sector.

Scotland has an **8.9%** share of total net GHG emissions in **2013**. **Scotland** has seen a decrease of 35% in greenhouse gas emissions between the Base Year and 2013. Emissions between 2012 and 2013 have decreased slightly (by 3.8%). This is predominantly driven by a shift from coal to nuclear and renewable energy sources in the power generation sector.

Wales has a **9.0%** share of total net GHG emissions in **2013**. **Wales** has seen a decrease of 12% in greenhouse gas emissions between the Base Year and 2013. Emissions between 2012 and 2013 have increased by 10%. The increase is predominantly driven by an increased output from the iron and steel sector, due to the restart of Tata Steel's Port Talbot No.4 Blast Furnace in February, 2013.

Northern Ireland has a **4.0%** share of total net GHG emissions in **2013**. **Northern Ireland** has seen a decrease of 16% in greenhouse gas emissions between the Base Year and 2013. Emissions between 2012 and 2013 remained stable with only a very slight increase of 0.1%.

[1] The "traded sector" refers to emissions from installations that operate within the EU Emissions Trading System (EU ETS), the EU-wide trading system that has been operational since 2005 and includes emissions from large energy consumers within the industrial and commercial sectors.

[2] Total net emissions include removals in the Land Use Land Use Change and Forestry (LULUCF) sector and exclude emissions from international aviation and shipping.

[3] Base years for UK greenhouse gas emissions are: 1990 for carbon dioxide, methane and nitrous oxide, 1995 for the fluorinated gases.

There has been a shift from natural gas to coal (which has a higher carbon content per unit of energy) in the power generation sector leading to increased emissions in 2013. There was a large forest wildfire in 2012 leading to a spike in emissions from this source in 2012 and a decrease in emissions in 2013.

2.5% of the UK emissions total is unallocated in **2013** and these net emissions have decreased by 5% since the Base Year. These emissions from offshore oil and gas installations decreased by 2.2% between 2012 and 2013 due to the continued decline in UK oil and gas production.

Tables ES 1 - ES 4 present the time series of emissions for each Devolved Administration.

- 1995 is used as the Base Year (BY) for emissions of HFCs, PFCs, SF_6 and NF_3, and 1990 for all other gases (carbon dioxide (CO_2), Methane (CH_4) and nitrous oxide (N_2O)), in accordance with Article 3.8 of the Kyoto Protocol;
- All of the carbon dioxide data are based on the net emissions of carbon dioxide, including net emissions/removals of carbon dioxide in the Land Use, Land Use Change and Forestry (LULUCF) sector;
- The percentage changes presented in this chapter are calculated from estimates held at full precision within a database. The estimates quoted in Table ES 1-4 and other tables relevant to this Chapter are values rounded from data in the database. The percentages and emissions totals that could be calculated from these tables may therefore differ slightly from percentages that have been calculated from the emission estimates held at full precision.
- Emissions data at full precision i.e. data that have not been rounded, can be found in the tables that accompany this report: "DA_GHGI_1990-2013_v1.xlsx".

Uncertainties

The 2013 Devolved Administration GHG emission estimates are based on a wide range of data sources and include statistical differences, assumptions, proxy datasets and some expert judgement. In addition, the natural variability in processes (e.g. emissions from farming practices under different climatic conditions and across soil types, carbon content of fuels, and performance of industrial production plant and abatement plant) that are being "modelled" introduces a degree of uncertainty.

An overall analysis of the uncertainty in Devolved Administration inventory totals indicates that the uncertainties are in the range of +-4% to +-14% depending on the relative contributions to the Devolved Administration inventories of more uncertain categories where we understand less about the distribution and intensity of the estimates (e.g. nitrous oxide from agricultural soils, carbon dioxide from Land Use, Land Use Change and Forestry, solid and liquid fuel combustion).

The uncertainties for the 2013 DA estimates are presented below:

- **UK uncertainty in 2013 for all greenhouse gases** (+-5%): low uncertainty due to a high proportion of large industrial sources with estimates with low uncertainty.
- **England uncertainty in 2013 for all greenhouse gases** (+-4%): Overall low uncertainty than the UK inventory because the England inventory has the highest overall contribution from CO_2 (84% of the total) and the lowest contribution from GHGs that are dominated by sources with higher uncertainty such as methane (only 9% of the England total) and nitrous oxide (4% of the England total). The England CO_2 emissions are also mainly from combustion and industrial sources with estimates with low uncertainty.
- **Scotland uncertainty in 2013 for all greenhouse gases** (+-14%): Scotland has a notably higher level of overall uncertainty in the 2013 inventory due to the much greater contribution to the Scotland total from sources and sinks with significant uncertainties. For example, Scotland's CO_2 inventory is estimated to be +-17% uncertain (compared to +-2% uncertain in England) due to a much higher contribution from LULUCF sources. In addition, Scotland has a relatively high contribution to its overall GHG total from methane (16% of the Scotland total) and nitrous oxide (8% of the Scotland total); these inventories are dominated by sources that are much harder to characterise, with emission factors that are highly uncertain. A detailed study has been carried out in parallel to the compilation of the Scottish GHG inventory to review and improve the uncertainty calculations for the Scottish inventory.
- **Wales uncertainty in 2013 for all greenhouse gases** (+-5%): Similar to England, the Wales GHG inventory has a relatively low overall uncertainty due to the high contribution of CO_2 emissions from well-documented emission sources such as heavy industry (power generation, oil refining and iron and steel production). The Wales GHG inventory in 2013 also has a relatively low contribution from the uncertain sources of methane (~1% of the Wales total) and nitrous oxide (5% of the Wales total).
- **Northern Ireland uncertainty in 2013 for all greenhouse gases** (+-12%): The Northern Ireland inventory overall has a relatively high uncertainty due to the low overall contribution to the emissions total from CO_2 (only 67% of the Northern Ireland total inventory); the CO_2 inventory is also relatively uncertain (at 8%, compared with 2% for England and 4% for Wales) due to the

contribution of LULUCF sources and also the more uncertain fuel activity data for Northern Ireland compared to other DAs, due to the greater use of solid fuels and oils. The Northern Ireland inventory also has the greatest level of contribution compared to other DAs from both methane (20% of the Northern Ireland total) and nitrous oxide (11% of the total), with high emissions from sources where emission factors are subject to considerable uncertainty.

Appendix 1 provides more detail on the uncertainties for 2013 as well as the uncertainty in the trend of the DA GHG inventories.

Table ES 1: Summary of By Source Emission Estimates for England, Base Year to 2013 (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% Change Base Year - 2013
By Gas including LULUCF																				
Carbon Dioxide	466.54	466.54	427.80	423.83	417.12	420.03	431.50	425.15	435.72	434.84	433.31	427.19	426.24	412.68	373.42	385.44	354.61	370.98	358.66	-23%
Methane	101.24	101.24	95.05	89.27	85.76	81.95	78.36	77.06	73.00	69.16	64.99	61.85	58.99	54.76	49.70	45.74	43.28	41.00	37.19	-63%
Nitrous Oxide	45.30	45.30	35.47	35.34	25.32	25.21	23.48	22.26	22.12	22.92	22.02	21.08	21.35	20.91	19.14	19.46	18.32	18.29	18.18	-60%
HFCs	19.25	14.53	19.25	19.73	11.03	9.33	10.12	10.38	11.47	10.35	11.18	11.82	12.05	12.52	12.82	13.26	13.53	13.71	13.74	-29%
PFCs	0.31	1.14	0.31	0.25	0.23	0.31	0.26	0.17	0.18	0.28	0.22	0.23	0.15	0.12	0.08	0.21	0.33	0.17	0.15	-52%
SF_6	1.14	1.14	1.14	1.19	1.34	1.63	1.30	1.34	1.17	0.98	0.91	0.71	0.72	0.58	0.56	0.64	0.56	0.55	0.52	-54%
NF_3	0.0003	0.0001	0.0003	0.0005	0.0006	0.0007	0.0004	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-71%
LULUCF only by Gas																				
Carbon Dioxide	1.80	1.80	1.92	1.99	2.15	1.22	0.81	0.31	0.15	-0.30	-0.53	-0.79	-1.03	-1.15	-1.06	-0.99	-1.05	-1.19	-1.17	n/a
Methane	0.011	0.011	0.017	0.013	0.010	0.014	0.015	0.018	0.030	0.013	0.019	0.016	0.019	0.013	0.017	0.014	0.014	0.017	0.009	-14%
Nitrous oxide	0.46	0.46	0.44	0.43	0.42	0.41	0.39	0.38	0.38	0.36	0.35	0.34	0.33	0.32	0.31	0.30	0.30	0.30	0.29	-39%
LULUCF Net Emissions	**2.28**	**2.28**	**2.38**	**2.43**	**2.58**	**1.64**	**1.21**	**0.70**	**0.55**	**0.06**	**-0.17**	**-0.44**	**-0.68**	**-0.82**	**-0.74**	**-0.67**	**-0.74**	**-0.88**	**-0.88**	**n/a**
By National Communication Sector																				
Agriculture	40.48	40.48	39.26	38.25	37.89	36.44	34.28	34.20	34.06	34.20	33.54	32.80	32.90	32.42	32.24	32.45	32.34	31.88	31.71	-22%
Business	87.15	86.25	85.87	85.37	86.28	86.92	88.45	83.98	86.30	85.83	86.14	83.80	82.96	81.42	71.49	72.86	68.29	69.60	69.76	-20%
Energy Supply	217.17	217.17	171.77	156.43	146.90	151.20	159.83	161.56	169.48	166.80	167.80	168.28	169.52	161.94	144.15	147.71	140.02	147.65	133.81	-38%
Industrial Process	56.80	54.37	46.47	44.06	25.22	22.65	20.80	18.47	18.55	17.53	16.49	15.02	16.34	14.45	9.22	9.66	8.32	8.33	9.46	-83%
Land Use Change	2.28	2.28	2.38	2.43	2.58	1.64	1.21	0.70	0.55	0.06	-0.17	-0.44	-0.68	-0.82	-0.74	-0.67	-0.74	-0.88	-0.88	n/a
Public	10.57	10.57	10.45	10.38	10.26	9.70	9.83	8.35	8.28	9.02	8.96	8.10	7.54	8.60	7.39	7.82	7.50	7.46	7.66	-28%
Residential	64.06	63.51	65.61	72.22	71.95	72.53	74.35	71.59	72.56	73.80	70.41	67.92	64.86	66.24	63.37	71.25	54.61	62.86	63.06	-2%
Transport	101.17	101.17	101.43	105.32	106.12	105.14	105.10	106.91	106.22	107.16	107.73	107.99	109.00	104.06	99.99	98.78	97.42	96.95	95.94	-5%
Waste Management	54.08	54.08	55.76	55.15	53.57	52.25	51.16	50.58	47.65	44.15	41.73	39.40	37.05	33.25	28.60	24.88	22.87	20.83	17.92	-67%
Total Net Emissions	**633.77**	**629.88**	**579.01**	**569.61**	**540.79**	**538.47**	**545.03**	**536.35**	**543.65**	**538.54**	**532.64**	**522.88**	**519.49**	**501.56**	**455.72**	**464.75**	**430.63**	**444.69**	**428.44**	**-32%**

Table ES 2: Summary of By Source Emission Estimates for Scotland, Base Year to 2013 (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% Change Base Year - 2013
By Gas including LULUCF																				
Carbon Dioxide	54.95	54.95	55.76	54.29	52.08	54.29	53.87	50.18	50.47	48.44	47.28	50.43	46.37	44.83	41.33	44.04	37.66	38.45	37.01	-33%
Methane	17.63	17.63	17.55	17.01	16.14	15.65	15.08	14.55	13.87	13.28	12.84	12.28	11.70	10.84	9.92	9.30	8.95	8.48	7.87	-55%
Nitrous Oxide	5.32	5.32	4.93	5.04	4.94	4.86	4.83	4.77	4.72	4.61	4.50	4.47	4.29	4.20	4.27	4.26	4.20	4.17	4.22	-21%
HFCs	0.16	0.02	0.16	0.44	0.48	0.59	0.69	0.77	0.88	0.96	1.04	1.12	1.16	1.21	1.26	1.28	1.31	1.32	1.32	711%
PFCs	0.12	0.14	0.12	0.15	0.16	0.15	0.09	0.11	0.12	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.08	0.09	0.10	-15%
SF_6	0.04	0.05	0.04	0.05	0.05	0.06	0.05	0.05	0.05	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	1%
NF_3	0.0005	0.0002	0.0005	0.0007	0.0008	0.0009	0.0005	0.0007	0.0007	0.0004	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	-49%
LULUCF only by Gas																				
Carbon Dioxide	-0.34	-0.34	-0.70	-1.72	-1.93	-2.04	-2.45	-2.93	-3.08	-3.49	-3.79	-4.09	-4.27	-4.40	-4.39	-4.66	-5.11	-5.33	-5.48	n/a
Methane	0.006	0.006	0.013	0.009	0.007	0.023	0.024	0.021	0.037	0.028	0.028	0.022	0.031	0.024	0.027	0.024	0.017	0.028	0.022	238%
Nitrous Oxide	0.42	0.42	0.44	0.44	0.44	0.42	0.40	0.38	0.38	0.35	0.34	0.33	0.32	0.30	0.29	0.28	0.27	0.28	0.26	-38%
LULUCF Net Emissions	**0.09**	**0.09**	**-0.25**	**-1.28**	**-1.49**	**-1.60**	**-2.02**	**-2.52**	**-2.67**	**-3.10**	**-3.43**	**-3.74**	**-3.92**	**-4.07**	**-4.07**	**-4.36**	**-4.82**	**-5.03**	**-5.20**	**n/a**
By National Communication Sector																				
Agriculture	10.81	10.81	10.79	10.88	10.65	10.42	10.01	10.07	10.08	9.97	9.86	9.73	9.53	9.21	9.25	9.24	9.23	9.14	9.16	-15%
Business	12.50	12.38	10.39	10.43	10.67	10.58	10.92	10.07	10.20	10.12	10.49	10.20	9.76	9.90	8.69	8.88	8.72	8.43	8.61	-31%
Energy Supply	22.73	22.73	26.79	25.73	23.28	26.21	25.53	23.45	23.61	21.84	20.76	24.70	21.39	20.02	18.72	20.87	17.04	17.49	16.02	-30%
Industrial Process	1.85	1.92	0.57	0.64	0.61	0.59	0.57	0.61	0.62	0.63	0.54	0.55	0.53	0.52	0.40	0.39	0.45	0.44	0.49	-73%
Land Use Change	0.09	0.09	-0.25	-1.28	-1.49	-1.60	-2.02	-2.52	-2.67	-3.10	-3.43	-3.74	-3.92	-4.07	-4.07	-4.36	-4.82	-5.03	-5.20	n/a
Public	1.68	1.68	1.80	1.77	1.75	1.64	1.68	1.44	1.43	1.55	1.53	1.38	1.28	1.48	1.25	1.32	1.25	1.24	1.24	-26%
Residential	8.05	7.99	7.78	8.03	7.93	7.78	8.25	7.55	7.55	7.69	7.61	7.41	7.19	7.38	7.09	7.93	6.19	7.00	7.00	-13%
Transport	10.64	10.64	10.61	10.99	11.07	10.91	10.89	11.20	11.24	11.35	11.49	11.68	11.87	11.42	10.97	10.79	10.58	10.62	10.53	-1%
Waste Management	9.86	9.86	10.08	9.80	9.39	9.06	8.77	8.59	8.04	7.42	6.97	6.52	6.02	5.36	4.60	3.93	3.60	3.21	2.70	-73%
Total Net Emissions	**78.22**	**78.11**	**78.56**	**76.98**	**73.86**	**75.60**	**74.61**	**70.44**	**70.11**	**67.46**	**65.82**	**68.44**	**63.65**	**61.21**	**56.89**	**58.99**	**52.23**	**52.54**	**50.56**	**-35%**

Table ES 3: Summary of By Source Emission Estimates for Wales, Base Year to 2013 (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% Change Base Year - 2013
By Gas including LULUCF																				
Carbon Dioxide	44.08	44.08	40.91	42.62	44.38	46.68	43.79	37.11	38.43	42.19	40.40	41.86	39.54	41.67	35.36	38.24	35.24	37.28	42.24	-4%
Methane	10.18	10.18	9.37	9.19	9.10	8.83	8.44	8.30	8.16	7.93	7.65	7.60	7.01	6.49	6.13	5.91	5.74	5.62	5.40	-47%
Nitrous Oxide	3.03	3.03	3.01	2.93	2.97	2.84	2.78	2.65	2.71	2.67	2.61	2.66	2.43	2.33	2.31	2.39	2.38	2.42	2.42	-20%
HFCs	0.08	0.01	0.08	0.23	0.25	0.31	0.34	0.38	0.44	0.44	0.53	0.56	0.57	0.59	0.61	0.63	0.65	0.65	0.66	681%
PFCs	0.17	0.37	0.17	0.09	0.09	0.13	0.13	0.12	0.06	0.05	0.07	0.07	0.05	0.07	0.04	0.01	0.01	0.01	0.01	-96%
SF_6	0.08	0.08	0.08	0.09	0.10	0.12	0.09	0.10	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.05	0.04	0.04	0.04	-55%
NF_3	0.00003	0.00007	0.00003	0.00011	0.00013	0.00015	0.00009	0.00005	0.00005	0.00003	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002	0.00002	-28%
LULUCF only by Gas																				
Carbon Dioxide	0.00	0.00	-0.27	-0.45	-0.48	-0.48	-0.56	-0.62	-0.65	-0.65	-0.68	-0.68	-0.69	-0.61	-0.67	-0.70	-0.77	-0.72	-0.71	n/a
Methane	0.002	0.002	0.004	0.003	0.003	0.006	0.005	0.003	0.007	0.004	0.006	0.006	0.005	0.007	0.005	0.008	0.006	0.009	0.003	35%
Nitrous Oxide	0.099	0.099	0.102	0.101	0.101	0.098	0.094	0.091	0.092	0.085	0.083	0.080	0.079	0.075	0.073	0.074	0.0708	0.070	0.0644	-35%
LULUCF Net Emissions	**0.10**	**0.10**	**-0.16**	**-0.35**	**-0.38**	**-0.38**	**-0.46**	**-0.53**	**-0.55**	**-0.57**	**-0.59**	**-0.59**	**-0.61**	**-0.53**	**-0.59**	**-0.62**	**-0.69**	**-0.64**	**-0.64**	**n/a**
By National Communication Sector																				
Agriculture	7.63	7.63	7.67	7.62	7.72	7.34	7.14	6.92	7.12	7.08	6.92	7.09	6.45	6.16	6.12	6.26	6.29	6.26	6.25	-18%
Business	13.74	13.70	14.39	14.97	16.82	16.69	13.44	9.33	10.59	11.30	9.91	10.25	10.38	9.63	7.86	9.60	8.89	7.67	9.83	-28%
Energy Supply	18.01	18.01	13.09	13.90	13.57	16.43	17.41	15.80	15.17	17.86	17.56	18.86	16.59	19.49	16.47	16.78	15.96	19.43	21.14	17%
Industrial Process	2.79	2.98	3.12	2.97	3.27	3.31	2.55	1.98	2.58	2.66	2.95	2.86	2.89	2.78	1.82	2.26	2.04	1.52	2.65	-5%
Land Use Change	0.10	0.10	-0.16	-0.35	-0.38	-0.38	-0.46	-0.53	-0.55	-0.57	-0.59	-0.59	-0.61	-0.53	-0.59	-0.62	-0.69	-0.64	-0.64	n/a
Public	0.77	0.77	0.71	0.57	0.57	0.55	0.55	0.45	0.45	0.50	0.52	0.46	0.42	0.47	0.40	0.41	0.39	0.39	0.39	-49%
Residential	5.04	5.01	5.15	5.56	5.48	5.28	5.38	5.03	5.04	5.13	4.82	4.73	4.48	4.62	4.40	4.88	3.79	4.24	4.25	-16%
Transport	6.06	6.06	6.04	6.21	6.22	6.12	6.10	6.27	6.28	6.41	6.41	6.46	6.56	6.32	6.05	5.95	5.84	5.76	5.72	-6%
Waste Management	3.49	3.49	3.62	3.70	3.62	3.55	3.47	3.40	3.21	2.97	2.81	2.67	2.51	2.26	1.96	1.70	1.53	1.38	1.18	-66%
Total Net Emissions	**57.63**	**57.75**	**53.63**	**55.15**	**56.89**	**58.91**	**55.57**	**48.65**	**49.88**	**53.34**	**51.31**	**52.80**	**49.66**	**51.20**	**44.49**	**47.22**	**44.04**	**46.02**	**50.76**	**-12%**

Table ES 4: Summary of By Source Emission Estimates for Northern Ireland, Base Year to 2013 (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% Change Base Year - 2013
By Gas including LULUCF																				
Carbon Dioxide	17.91	17.91	18.09	17.36	17.80	17.79	18.09	16.25	16.30	16.16	17.03	17.49	16.39	16.37	14.86	15.89	14.70	14.89	15.06	-16%
Methane	5.62	5.62	5.78	6.01	5.84	5.68	5.65	5.61	5.50	5.39	5.35	5.23	5.09	4.93	4.72	4.62	4.57	4.59	4.38	-22%
Nitrous Oxide	3.09	3.09	3.39	3.27	3.40	3.23	3.18	2.71	2.72	2.66	2.60	2.54	2.46	2.38	2.38	2.44	2.43	2.46	2.51	-19%
HFCs	0.05	0.00	0.05	0.15	0.16	0.20	0.21	0.23	0.28	0.35	0.33	0.36	0.38	0.39	0.40	0.41	0.42	0.42	0.42	695%
PFCs	0.00087	0.00337	0.00087	0.00010	0.00013	0.00014	0.00015	0.00014	0.00013	0.00011	0.00009	0.00006	0.00003	0.00001	0.00001	0	0.00022	0.00033	0.00011	-87%
SF_6	0.005	0.010	0.005	0.007	0.008	0.008	0.008	0.009	0.009	0.012	0.015	0.011	0.010	0.008	0.008	0.007	0.007	0.007	0.006	15%
NF_3	0	0.00002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
LULUCF only by Gas																				
Carbon Dioxide	1.42	1.42	1.23	1.12	1.10	1.11	1.14	1.15	1.15	1.17	1.18	1.18	1.20	1.22	1.24	1.27	1.32	1.47	1.38	-3.0%
Methane	0.0014	0.0014	0.0006	0.0007	0.0012	0.0012	0.0020	0.0021	0.0016	0.0023	0.0021	0.0013	0.0021	0.0017	0.0015	0.0013	0.0023	0.0136	0.0014	2.5%
Nitrous Oxide	0.095	0.095	0.089	0.086	0.085	0.086	0.087	0.088	0.088	0.089	0.089	0.089	0.090	0.090	0.090	0.091	0.092	0.101	0.093	-2.6%
LULUCF Net Emissions	**1.52**	**1.52**	**1.32**	**1.21**	**1.19**	**1.20**	**1.22**	**1.24**	**1.24**	**1.26**	**1.27**	**1.27**	**1.30**	**1.31**	**1.33**	**1.37**	**1.41**	**1.58**	**1.47**	**-3.0%**
By National Communication Sector																				
Agriculture	6.83	6.83	7.19	7.33	7.24	6.99	6.95	6.92	6.94	6.85	6.84	6.70	6.53	6.41	6.38	6.47	6.51	6.54	6.49	-5%
Business	2.91	2.89	2.81	2.47	2.71	2.75	2.82	2.17	2.26	2.34	2.63	2.55	2.61	2.42	2.36	2.74	2.44	2.39	2.43	-17%
Energy Supply	5.31	5.31	6.54	6.16	6.22	6.34	6.57	5.17	4.96	4.84	5.36	5.75	4.66	4.84	3.69	3.95	3.74	3.87	4.05	-24%
Industrial Process	0.76	0.76	0.76	0.81	0.92	0.67	0.63	0.21	0.22	0.22	0.42	0.43	0.49	0.40	0.18	0.17	0.16	0.16	0.15	-80%
Land Use Change	1.52	1.52	1.32	1.21	1.19	1.20	1.22	1.24	1.24	1.26	1.27	1.27	1.30	1.31	1.33	1.37	1.41	1.58	1.47	-3%
Public	0.49	0.49	0.32	0.23	0.22	0.19	0.19	0.13	0.13	0.15	0.18	0.18	0.20	0.20	0.20	0.20	0.19	0.20	0.22	-54%
Residential	3.79	3.77	2.97	3.02	3.04	3.02	2.98	3.06	3.07	3.03	2.76	2.91	2.67	2.89	2.90	3.34	2.70	2.75	2.83	-25%
Transport	3.36	3.36	3.58	3.74	3.90	4.03	4.07	4.24	4.40	4.40	4.47	4.49	4.62	4.45	4.33	4.25	4.16	4.14	4.09	22%
Waste Management	1.71	1.71	1.81	1.81	1.76	1.73	1.69	1.67	1.57	1.47	1.40	1.33	1.26	1.16	1.00	0.88	0.80	0.74	0.64	-63%
Total Net Emissions	**26.67**	**26.63**	**27.31**	**26.79**	**27.21**	**26.91**	**27.13**	**24.82**	**24.81**	**24.57**	**25.32**	**25.62**	**24.33**	**24.09**	**22.37**	**23.37**	**22.12**	**22.37**	**22.38**	**-16%**

Traded/Non-Traded Inventory Estimates for 2013

The 2013 EU Emissions Trading System (EU ETS) data has been analysed and used to derive a split for non-traded estimates for the By Source DA GHG emission inventories. This method takes account of observed data discrepancies for specific IPCC sectors and presents a "Non-Traded" component to the by source estimates. The data for the 2013 emission estimates show that:

- Across the **UK**, the non-traded share of total GHG emissions is **60%** of total GHG emissions in **2013**.
- **England**'s share of EU ETS (traded) emissions comes from a number of categories including power generation, iron and steel works and refineries. England non-traded emissions are estimated to be around **62%** of total GHG emissions in **2013**.
- **Scotland** has a similar share of EU ETS emissions, due to a high proportion of emissions from categories such as refineries, upstream oil and gas and chemicals. The non-traded share of the total GHG emissions in Scotland in **2013** is **62%**.
- In **Wales** the coverage of the EU ETS is higher than the rest of the UK, reflecting the high share of heavy industry in Wales (e.g. emissions from power stations, refineries and integrated iron and steel works) and as a result, the non-traded share of the total GHG emissions in Wales in **2013** is only **42%**.
- **Northern Ireland** has much lower share of the EU ETS emissions, reflecting the fact that there are no refineries, iron and steel works or oil and gas terminals in Northern Ireland. The non-traded share of the Northern Ireland GHG emissions in **2013** is **79%**.

Full details of methods used to separate emissions into Traded and non-Traded are provided in Appendix 4. Detailed emissions data can be found in the tables that accompany this report: "DA_GHGI_21990-2013_EmissionsData_v1.xlsx".

End User Inventory Estimates for 2013

In this analysis, all emissions associated with energy supply (e.g. power generation, coal mining, oil and gas extraction, refineries) are allocated to the end users of the energy (consumers). Estimates are presented excluding emissions associated with exports, (such as the generation of electricity subsequently exported from the UK) unless otherwise stated; this is to present the most accurate assessment of changes in DA consumption-based emission levels and trends. It must be noted that there is a high level of uncertainty in the reported data, due to limited data availability on electricity generation and consumption, especially at the DA level in 1990. The net[4] greenhouse gas End User emissions in 2013 and emission trends derived from the End User calculations are summarised below[5].

- England has a **79%** share of total net End User GHG emissions in **2013** (compared to a 76% share of by source emissions). End User emissions have declined by **30%** since 1990. End User emissions are 2% higher than the by source estimates as a result of emissions attributed to England from energy production activities (e.g. electricity generation) outside England.
- Scotland has a **9.2%** share of total net End User GHG emissions in **2013** (compared to an 8.9% share of by source emissions). The trend since 1990 is a decline of **38%**. End User emissions are higher (1.0%) than the by source estimates as a result of a net import of emissions attributed to energy production activities from Scotland. Although Scotland is a net exporter (from Scotland to other DAs) of electricity, the Scottish power generation mix has a lower carbon intensity than the rest of the UK, so by allocating total UK emissions from electricity generation based on electricity used (effectively using the same emission factor across all DAs), Scottish end user emissions are higher. Scottish power generation emissions are 11.5 Mt CO_2e, compared with emissions allocated to Scottish electricity use of 16.0 Mt CO_2e.
- Wales has a **7.2%** share of total net End User GHG emissions in **2013** (compared to a 9.0% share of by source emissions). Emissions have declined by **22%** since 1990. End User emissions are 30% lower than the by source estimates as a result of a net export of emissions attributed to energy production activities from Wales (e.g. exported electricity and refined oils that are generated in Wales and used in other DAs).
- Northern Ireland has a **4.2%** share of total net End User GHG emissions in **2013** (compared to a 4.0% share of by source emissions). The trend since 1990 is a decline of **17%.** End User emissions are 3.2% higher than the by source estimates as a result of emissions attributed to Northern Ireland from energy production activities outside Northern Ireland supplying Northern Ireland with fuels and electricity (e.g. emissions associated with imported electricity and emissions from collieries, upstream oil and gas extraction and refining of petroleum fuels).

Full details of methods used to estimate End User emissions are provided in Appendix 3. Emissions data can be found in the tables that accompany this report "DA_GHGI_1990-2012_Issue 1.xlsx".

[4] Net emissions include removals in the LULUCF sector.

[5] The percentages presented in these figures are rounded to one decimal place, but are calculated from emission estimates calculated at full precision. Note that all percentages quoted in this report are based on net emission estimates held at full precision and they may differ slightly from those that can be calculated from summary tables presented in the report.

Data Sources and Inventory Methodology

In the compilation of GHG inventories for the Devolved Administrations, where possible the same methodology has been used to calculate emission estimates as for the UK Inventory. However, the structure of the DA and UK statistical datasets and data collection processes mean that for many emission sources the data available for Devolved Administrations emissions are less detailed than for the UK as a whole, and for some sources DA-level data are not available at all.

In particular, complete sets of fuel consumption data (similar to those available for the UK as a whole) are not available for England, Wales, Scotland or Northern Ireland separately. In order to make emission estimates for fuel consumption, the available data has been supplemented with surrogate/proxy statistics which are used to disaggregate UK total consumptions data.

Sub-national energy statistics are published annually by the Department for Energy and Climate Change (DECC) within the quarterly Energy Trends publication (DECC, 2014a). These sub-national statistics are limited in their detail when compared to UK-level energy statistics (used in the UK GHG Inventory compilation), but do provide estimated fuel use data for England, Scotland, Wales and Northern Ireland for the following source sectors:

- Industry and Commercial,
- Agriculture,
- Residential.

The DECC sub-national energy statistics have been developed in recent years to provide estimates of fuel use and carbon dioxide emissions data at a Local Authority level across the UK. The latest available data include Local Authority solid and liquid fuel use estimates for 2005 to 2012, with gas and electricity data also available up to 2013.

The DECC data at local and regional level are derived from analysis of gas and electricity meter point data, supplemented by additional modelling to estimate the distribution of solid fuels and petroleum-based fuels across the UK. Since the initial study and presentation of experimental data for 2003 and 2004, each annual revision to the local and regional data has included data improvements through targeted sector research, although the statistics remain subject to greater uncertainty and less detail than the UK energy statistics presented within the Digest of UK Energy Statistics (DUKES) (DECC, 2014b) which are used to underpin the UK GHG inventory.

These DECC sub-national energy statistics are the best data available to inform the patterns of fuel use across the DAs. These data are used to underpin the carbon dioxide emission estimates from fuel combustion sources within the inventories presented here, in conjunction with other data sources such as EU ETS fuel use data for large industrial sites and other DA-specific energy data.

For other significant GHG emission sources there are more reliable and complete country level datasets available including (although some of these are less detailed than data used for the UK Inventory):

- Industrial process emissions are based on plant operator estimates reported to environmental agencies under regulatory systems such as Integrated Pollution Prevention and Control (IPPC). Major sources include cement and lime kilns, iron and steel works, aluminium and other non-ferrous metal plant, chemical industries;
- Agricultural emissions are based on UK emission factors and annual survey data across each of the DAs including estimates of arable production and livestock numbers;
- Land Use, Land Use Change and Forestry (LULUCF) estimates are based on emission factors and regional survey data of land use, modelled to calculate GHG emissions and carbon fluxes between sources and sinks;
- Emissions from waste disposal activities are estimated based on modelled emissions from the UK GHG inventory, split out across the DAs based on local authority waste disposal activity reporting which provides an insight into the local shares of UK activity for recycling, landfilling, incineration and other treatment and disposal options.

Revisions and Updates to the Inventories

Each year, the GHG inventories for England, Scotland, Wales and Northern Ireland are extended and updated. The time series of the inventories are extended by including a new inventory year – i.e. the previous inventory (Salisbury et al., 2014) covered the years up to and including 2012, whilst this report gives emission estimates for the years up to and including 2013.

The nature of emission inventories is such that on-going improvements to data collection or estimation techniques will inevitably lead to some revisions of historic data and our understanding of the trends. The inventories are updated to take account of any new or revised activity or emission factors, and these amendments may result in revisions to emission estimates for a given year. Core energy statistics, mainly provided by DECC in their annual publication “The Digest of UK Energy Statistics” (DECC, 2014b), are revised annually and hence the data provided (e.g. for “coal used in energy generation in 2012”) may be different in the latest edition of the Digest, compared to that used in the compilation of the previous inventory report.

In addition, there may also be changes to the methodology used to allocate emissions to each of the DAs, especially where full and consistent sets of fuel use data are not available. For example, where emissions may previously have been allocated using surrogate statistics such as regional GVA or population, this methodology may be improved to use data more closely related to the activities producing emissions involved, should more suitable statistics become available.

As a result of these improvements to underlying activity datasets and methods used to estimate and distribute emissions across DAs, data in this report are likely to differ from figures presented in previous DA inventory reports. Significant revisions have been made to some DA estimates since the publication of the previous Devolved Administrations' GHG inventory (Salisbury et al., 2014) in the following categories:

- **All inventory sectors –** the 2006 IPCC Guidelines have been adopted, which has led to the implementation of updated methodologies and emission factors, inclusion of additional sources and emissions of NF_3, improvements to the global warming potential (GWP) factors used;
- **Waste Management** – in addition to the effect of the implementation of the 2006 IPCC Guidelines, new data on landfill methane flaring from site operators and regulators has improved methane recovery data; the method to estimate methane formation within landfills has been improved to incorporate new data;
- **Land Use, Land Use Change & Forestry** – in addition to the effect of the implementation of the 2006 IPCC Guidelines, new area data have become available for cropland, deforestation and improved grassland on drained organic soils;
- **Business –** in addition to the effect of the implementation of the 2006 IPCC Guidelines, a revised time-series has been included for the group of petroleum fuels that are regarded as non-energy use (NEU).

Full details of the changes in estimates between the previous inventory (1990-2012) and the estimates presented in this report (1990-2013) are presented in Appendix 6.

Over the last few years a programme of inventory improvement for the DAs has been implemented, with several strands of research commissioned or planned to (i) meet the current and future reporting needs outlined in climate change legislation relevant to each DA, and (ii) improve the accuracy and sensitivity of estimates from source sectors where current GHG emission estimates are known to be most uncertain.

1 Introduction

1.1 Policy Background

The Greenhouse Gas (GHG) inventories for England, Scotland, Wales and Northern Ireland help to support evidence-based development of climate change policy by the Scottish Government, Welsh Government and the Northern Ireland Executive, and are a mechanism by which tracking progress towards country-specific GHG emission reduction targets may be achieved. The implementation of new UK and country-specific legislation means that the requirements of the GHG inventories for the Devolved Administrations (DAs) is evolving, with a much greater focus on (i) sector-specific data accuracy, and (ii) sensitivity to policy impacts.

The United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC was ratified by the United Kingdom in December 1993 and came into force on the 21st March 1994. The objective of the Convention is to stabilise greenhouse gas (GHG) emissions to the atmosphere and reduce the anthropogenic interference with the climate system. In order to achieve this, the international community needs to monitor progress, which requires accurate information on trends of emissions of GHGs, and the collective ability to alter these trends.

The UK, as an Annex I Party to the Convention, having ratified the Kyoto Protocol, is required to submit to the UNFCCC Secretariat net national GHG inventories, including all anthropogenic emissions of GHGs by sources and removals by sinks. Parties are required to submit information on their national inventories on an annual basis and within National Communications periodically, according to dates established in the Conference of the Parties.

The annual inventory reports must comply with UNFCCC requirements, using source data and methods consistent with Inter-governmental Panel on Climate Change (IPCC) inventory reporting guidelines and good practice guidance, to meet underlying data quality objectives: transparency, completeness, consistency, comparability and accuracy.

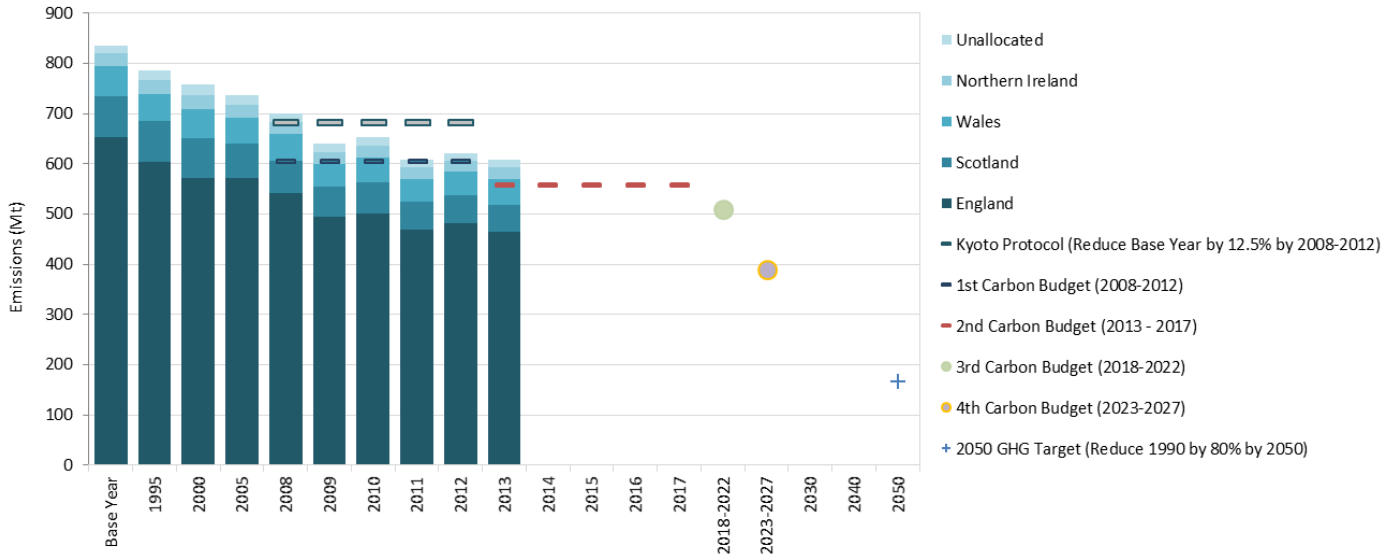
The Kyoto Protocol supplements the UNFCCC by committing parties, who have ratified the protocol, to achieve individual targets established for the reduction of their respective GHG emissions. Under the protocol, the UK is legally bound to reduce emissions of the 'basket of 6' GHGs by 12.5% against baseline emissions over the first commitment period (2008-2012). In the United Kingdom, the National GHG Inventory and associated National Inventory Report (Webb et al., 2014) are prepared to ensure that the UK fulfils its requirements under the UNFCCC and to monitor the legally binding commitments under the Kyoto Protocol to reduce GHG emissions.

The UK Climate Change Act

The UK Climate Change Act, which received Royal Assent on the 26th November 2008 established new legal requirements to monitor and report UK GHG emission reductions. The Act set a statutory target to reduce emissions of GHGs in the UK by 80% against the 1990 baseline by 2050 with a minimum 34% reduction in greenhouse gas emissions to be achieved by 2020. The Act also introduced a Carbon Budgeting System whereby emission caps are set over 5 year periods, to map out the emission trajectory to 2050. The Government set the first three carbon budgets in May 2009, covering the periods 2008-12, 2013-17 and 2018-2022. The fourth carbon budget, covering the period 2023-27, was set in June 2011.

While this Act represents the primary piece of climate change legislation relevant to England, an overview of the main components of UK and Devolved Administrations (DAs) climate change legislation and strategies is presented in Figure 1.1 below.

Figure 1.1 UK Greenhouse Gas Emission Reduction Targets



Devolved Administrations' Climate Change Commitments

Powers to implement measures to deliver reductions in emissions of GHGs in Scotland, Wales and Northern Ireland are devolved to the Scottish Government, Welsh Government and the Northern Ireland Executive. Each of the Devolved Administrations (DAs) has developed national climate change legislation or strategies establishing targets for reductions in GHG emissions together with accompanying national climate change policy frameworks:

- The Climate Change (Scotland) Act (2009)[6]
- The 'One Wales' Commitment to reduce greenhouse gas emissions and the Climate Change Strategy for Wales (2010)
- Northern Ireland Greenhouse Gas Emissions Reduction Action Plan (2011)

A summary of the greenhouse gas emission reduction targets for the UK and all Devolved Administrations can be found in Figure 1.2 below.

Scotland

The Climate Change (Scotland) Act (2009) creates a statutory framework for greenhouse gas emissions reductions in Scotland by setting two targets: an interim target of at least a 42 per cent reduction for 2020, and a target of at least an 80 per cent reduction for 2050. These reductions are based on a 1990 baseline (1995 for the fluorinated gases). It also requires the Scottish Ministers to set 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[7]. Targets for 2023-2027 were set in October 2011[8], and will continue to be set at 5-year intervals. In reporting emissions reductions against these targets, Scotland is able to take account of emissions trading through the European Union Emissions Trading System (EU ETS). The latest Scottish Government statistics release[9] includes a section on progress towards targets.

The Climate Change (Scotland) Act outlines that the net Scottish GHG emissions account shall include all existing anthropogenic sources and sinks of emissions in Scotland and also a Scottish share of GHG emissions from international shipping and international aviation.

Wales

The Climate Change Strategy for Wales established emission accounts and targets that include emissions attributed to electricity use in the DA, exclude emissions from the traded sector[10] and (similar to UK targets) do not include emissions from international aviation and

[6] Climate Change (Scotland) Act 2009: http://www.legislation.gov.uk/asp/2009/12/contents

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

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

[9] Scottish Greenhouse Gas Emissions 2011: http://www.scotland.gov.uk/ghg11

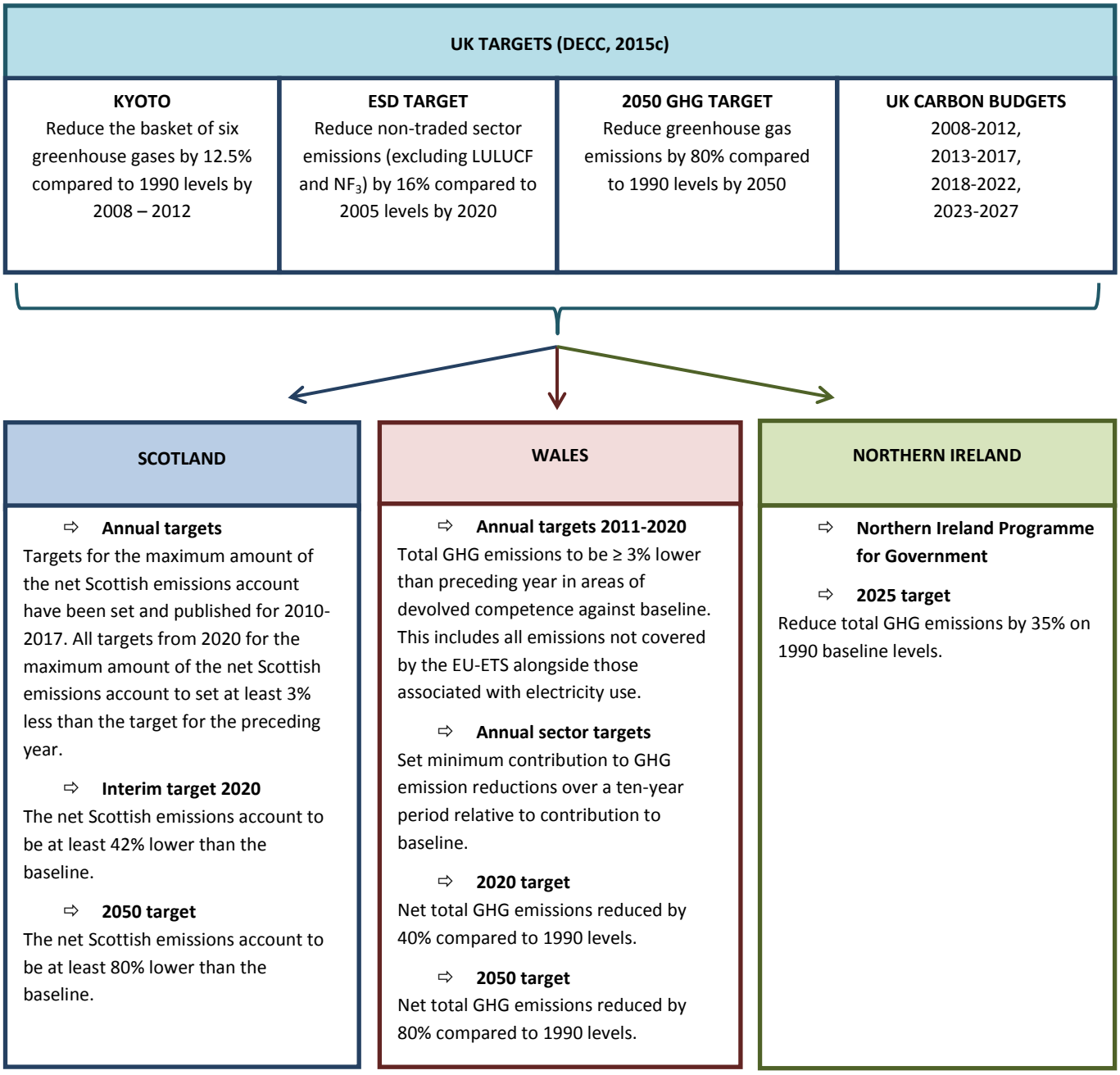
[10] The "traded sector" refers to emissions from installations that operate within the EU ETS, the EU-wide trading system that has been operational since 2005 and includes emissions from large energy consumers within the industrial and commercial sectors.

shipping (which are reported as memo items to national inventories in line with UNFCCC reporting requirements). The Welsh Government has set 3% annual reductions from 2011 against a baseline of average emissions between 2006 and 2010, as well as a 40% reduction target by 2020 against a 1990 baseline, and an 80% reduction target for total GHGs by 2050 against a 1990 baseline.

Northern Ireland

The Northern Ireland Executive's current Programme for Government target is to achieve a 35% reduction in greenhouse gas emissions by 2025 based on 1990 levels.

Figure 1.2 Greenhouse Gas Emission Reduction Targets: UK, Scotland, Wales and Northern Ireland



1.2 About the Greenhouse Gas Emission Estimates

The Department of Energy and Climate Change (DECC) and the Devolved Administrations (DAs) commission this annual work programme to compile greenhouse gas (GHG) inventories for the DAs in order to establish GHG emission baselines by source and to track progress towards reduction targets at the DA level. This report summarises the findings of the joint research programme for the 1990-2013 GHG inventory cycle, which revises and updates the previous DA GHG inventories that were published in June 2014.

Inventory Time Series and Revisions

This report presents separate GHG Inventories for England, Scotland, Wales and Northern Ireland and "unallocated"[11] for the years 1990, 1995, and 1998 to 2013. It is based on the latest UK GHG emissions statistics, which were published in February 2015 (DECC, 2015a) as UK national statistics. For many emission sources and sinks (e.g. agriculture and LULUCF), the UK estimates are derived from bottom-up data at DA level, whereas for other sources the DA estimates are derived top-down, i.e. from the UK-wide estimates and applying the best available proxy data to estimate the DA share of UK emissions.

Each year, the GHG inventories for England, Scotland, Wales and Northern Ireland are extended and updated. The time series of the inventories are extended by including a new inventory year – i.e. the previous inventory (Salisbury et al., 2013) covered the years up to and including 2012, whilst this report gives emission estimates for the years up to and including 2013.

The nature of emission inventories is such that on-going improvements to data collection or estimation techniques will inevitably lead to some revisions of historic data and our understanding of the trends. The inventories are updated to take account of any new or revised activity or emission factors, and these amendments may result in revisions to emission estimates for a given year. Core energy statistics, mainly provided by DECC in their annual publication "The Digest of UK Energy Statistics" (DECC, 2014b), are revised annually and hence the data provided (e.g. for "coal used in energy generation in 2012") may be different in the latest edition of the Digest, compared to that used in the compilation of the previous inventory report.

In addition, there may also be changes to the methodology used to allocate emissions to each of the DAs, especially where full and consistent sets of fuel use data are not available. For example, where emissions may previously have been allocated using surrogate statistics such as regional GVA or population, this methodology may be improved to use data more closely related to the activities producing emissions involved, should more suitable statistics become available.

As a result of this programme of improvements for the UK and DA inventories, data from previous DA inventory reports may be different to the figures in this report due to improvements to underlying activity datasets and methods used to estimate and distribute emissions across DAs. Improvements and updates that have been made to the methodology, data sources and assumptions will be evident by revised estimates. Inventory improvements are highlighted at the beginning of each DA section, method details are provided in Appendix 2 and the quantitative impact on the DA inventories is summarised in inventory recalculations tables presented in Appendix 6.

Greenhouse Gases Included in the Inventories

Emissions are reported for the seven direct greenhouse gases listed in Table 1.1 below, where they are presented together with their global warming potentials. Depending upon their molecular weights, radiative properties and residence times in the atmosphere, each GHG has a different capacity to cause global warming. This is the first inventory to include estimates from NF_3 (nitrogen trifluoride)[12].

The Global Warming Potential (GWP) is an attempt to encapsulate these parameters and provide a simple measure of the relative radiative effects of the emissions of the relevant GHGs. The index is defined as the cumulative radiative forcing between the present and some chosen time horizon caused by a unit mass of gas emitted now, expressed relative to that of carbon dioxide. It is necessary to define a time horizon because the gases have different lifetimes in the atmosphere.

Table 1.1 GWPs are defined on a 100-year horizon (IPCC, 2007). The 2007 values were agreed internationally as the values that Parties are required to use for reporting GHG emissions to the UNFCCC and the Kyoto Protocol. For consistency with international reporting, the 2007 values are also used in this report.

A range of GWP values is shown for hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) because these refer to a number of species, each with its own GWP. By weighting the emission of a gas with its GWP it is possible to undertake a comparison of the impacts of the emissions and reductions of different gases and estimate the total contribution to global warming of UK GHG emissions.

[11] The component of emissions not attributed to a Devolved Administration such as emissions from the off shore oil and gas industry.

[12] This is in line with new revised reporting requirements under the UNFCCC (Decision 25/CP.19).

Table 1.1 Global Warming Potential of GHGs on a 100-year Horizon (t CO_2 equivalent/ t gas) (IPCC, 2007)

Greenhouse Gas		Global Warming Potential (t CO_2 equivalent / t gas)
Carbon Dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_2O	298
Hydrofluorocarbons	HFCs	124 – 14,800
Perfluorocarbons	PFCs	7,390 – 17,700
Sulphur hexafluoride	SF_6	22,800
Nitrogen trifluoride	NF_3	17,200

Inventory Sector Definitions

The GHG inventories for England, Scotland, Wales and Northern Ireland in this report are presented in the same format as DECC's UK GHG emissions statistics (DECC, 2015a). The sum of the DA inventories is fully consistent with the UK GHG emissions statistics. To provide information that is aligned to the needs of DA policy teams, this report presents the data according to National Communication (NC) format at the top level, with additional detail by IPCC source category below that. The National Communication format presents the GHG emissions for the following policy areas:

- Energy Supply,
- Business,
- Industrial Process,
- Transport,
- Public sector,
- Residential,
- Agriculture,
- Land Use, Land Use Change and Forestry (LULUCF),
- Waste Management.

National totals for DAs exclude emissions from international aviation and shipping (which are presented as memo items to national inventories, in accordance with UNFCCC reporting requirements) and of carbon dioxide from the burning of biofuels. Emissions of GHGs from offshore oil and gas exploration and production are classified within this report as "Unallocated" emissions and not attributed to any of the DAs. A table to show the mapping between IPCC sectors and National Communication sectors is provided in Appendix 5.

Types of Inventory

This report presents DA emission estimates in three different ways.

By Source Inventory

The data in this report are, unless otherwise stated, presented as emissions estimates at the point of emission, also called "by source" estimates. Emissions are accounted for in the country and source sector in which they are emitted.

Traded/Non-Traded Inventory

Emissions within the By Source inventory are split into two categories:

- Traded sector – emissions that are controlled under the EU Emissions Trading System (EU ETS)
- Non-Traded sector – all emissions that are outside of the scope of the EU ETS

Emissions from the traded (i.e. within the EU ETS) and non-traded sectors represent an important component of emissions reporting in the UK and DA GHG inventories. The EU ETS is a reserved UK Government policy, and the policy levers available to the Scottish Government, Welsh Government and Northern Ireland Executive have limited influence over activities within the traded sector. Conversely, the devolved Governments have a wide range of policy levers available for the non-traded sectors of the UK economy, which are dominated by sources such as transport, residential, commercial and small-scale industrial emissions. It is therefore important to analyse trends in emissions for the non-traded sectors of the DA inventories.

The segregation of emissions between traded and non-traded sectors is especially important for the Welsh Government where the net emissions account for the Wales Climate Change Strategy excludes emissions from the traded sectors. Where possible and for relevant source categories, the by source emissions are presented with an additional split to show the relative contribution of the traded and non-traded emissions within each DA. The split is calculated by subtracting the traded emissions from the total emissions.

The EU ETS data are based on returns from operators to UK environmental regulatory agencies which are subject to third party verification as part of the EU ETS quality assurance process. EU ETS data are available since inception of the scheme in 2005, but the analysis presented in this report focuses on the EU ETS data from 2008 onwards as there was a notable change in scope of EU ETS emissions between Phase I (2005 to 2007) and Phase II (2008 to 2012); hence to present trends in non-traded emissions prior to 2008 would be misleading, as there were many more emission sources brought into the EU ETS from 2008 onwards.

The EU ETS scope expanded again in 2013, as Phase III of the EU ETS commenced, with new emission sources included in the reporting scope. This change brought in new installations to the EU ETS, and also expanded the scope of reporting on some installations that were already reporting under Phase II. Overall at UK level, the impact of moving from Phase II to Phase III has been small, with additional emissions mainly within sectors such as chemical production and the iron and steel sector where smaller non-integrated works are now included under EU ETS.

The EU ETS reporting format used by operators provides installation-specific emissions and activity data, but does not provide emissions allocated to specific source categories used in the UK and DA inventories. There is not always a one-to-one relationship between installations and emission source categories, and therefore the direct comparison between the GHG inventory data and EU ETS is problematic in some instances. Installations that typically report EU ETS emissions from across more than one National Communication include cement kilns (Business, Industrial Processes) and integrated iron and steel plant (Business, Energy, Industrial Processes). Therefore in the presentation of the traded/non-traded split for each DA, there is some need to aggregate source emission estimates and present "best estimate" traded/non-traded data for the Business, Industrial Process and Energy NC sectors. At the overall DA level, there is no uncertainty from this allocation issue, but at NC level there is some uncertainty as a result of this reporting limitation.

Figures 7 and 8 in each DA chapter show the % traded and non-traded emissions for 2008-2013 with Figure 7 showing emissions from all sectors and Figure 8 showing emissions from Industry. The methodology used to estimate the split between traded and non-traded emissions by DA is presented in Appendix 4.

End User Inventory

The End User inventory allocates emissions from the Energy Supply sector (electricity, production of refined petroleum fuels, gas and solid fuel) to the users (end users: Residential, Transport, Agriculture, Public and Business sectors) of the energy supplied (see Figure 9 in each DA chapter). This re-allocation of the upstream Energy Supply sector emissions to the ultimate consumers of the processed fuels provides a much better representation of the sector-specific consumption patterns that can be targeted through climate change and energy efficiency policies, improving the understanding of demand-side energy use in the UK economy.

Note that whilst emissions from international transport (aviation and shipping) are excluded from the DA by source inventory estimates (as they are reported as memo items), the Energy Supply sector emissions associated with the production of international transport fuels (i.e. from upstream oil and gas extraction and oil refining) are included and attributed to the "Exports" category in the End User inventories.

The End User estimates are derived from the By Source emission inventories, applying a secondary set of calculations based on additional data such as electricity use estimates by DA by sector. For some sectors, the DA estimates of electricity use are based on proxy data, and introduce additional uncertainty to the End User inventories. As a result, the DA End User inventory estimates are associated with greater uncertainty than the By Source estimates and Policy makers must consider this when using the End User inventory data.

In particular, the End User emission estimates for each country are associated with higher uncertainty for 1990 due to the lack of detailed electricity consumption data by country available for that year, whereas the estimates of total emissions from 2003 onwards are subject to lower uncertainty due to the development of the DECC sub-national energy statistics in the early 2000s. Within the End User inventories, the overall consumption of electricity by DA are reported by DECC whilst the sector allocations of electricity use are based on data from a range of statistical sources.

The End User emission estimates at sector level are more uncertain than the country totals, and hence the absolute sector End User emission estimates and reported trends by sector since 1990 should be regarded as indicative. The End User inventories are presented in

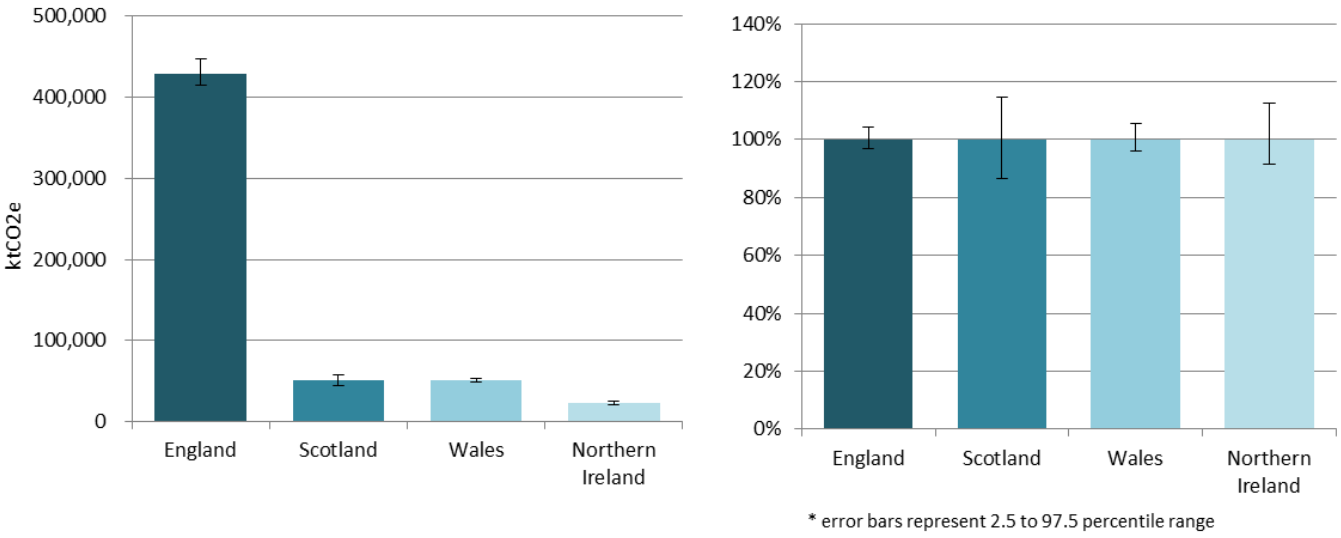
each DA Chapter using National Communication reporting format. The methodology used for estimating the End User emissions for each DA is presented in Appendix 3.

Uncertainties in Inventory Estimates

Uncertainties provide an indication of the level of confidence that can be put into the inventory estimates; the higher the uncertainty, the less reliable the estimate. Uncertainties can be used to provide a range within which the estimates may change. Decisions based on these data should consider this range and allow for it when defining targets and measures. The levels of uncertainty and the sources and gases responsible for the uncertainty also contribute to the identification and prioritisation of inventory improvements research at UK and DA level.

Uncertainties for estimates of emissions by source for the Devolved Administrations for the 2013 estimates are presented in Figure 1.3 below.

Figure 1.3 Total GHG emissions and uncertainties by Devolved Administration (2013)*



UK uncertainties for the GHG estimates in 2013 are (+-6%). Uncertainties are calculated as ± 2×(standard deviation)/mean emissions, which approximates the 95% confidence interval approach shown in Figure 1.3 above. Uncertainties in each of the DA inventories vary according to the relative contribution to each DA inventory total of emission sources with high uncertainty:

- **UK uncertainty in 2013 for all greenhouse gases** (+-5%): low uncertainty due to a high proportion of large industrial sources with estimates with low uncertainty.
- **England uncertainty in 2013 for all greenhouse gases** (+-4%): Overall low uncertainty than the UK inventory because the England inventory has the highest overall contribution from CO_2 (84% of the total) and the lowest contribution from GHGs that are dominated by sources with higher uncertainty such as methane (only 9% of the England total) and nitrous oxide (4% of the England total). The England CO_2 emissions are also mainly from combustion and industrial sources with estimates with low uncertainty.
- **Scotland uncertainty in 2013 for all greenhouse gases** (+-14%): Scotland has a notably higher level of overall uncertainty in the 2013 inventory due to the much greater contribution to the Scotland total from sources and sinks with significant uncertainties. For example, Scotland's CO_2 inventory is estimated to be +-17% uncertain (compared to +-2% uncertain in England) due to a much higher contribution from LULUCF sources. In addition, Scotland has a relatively high contribution to its overall GHG total from methane (16% of the Scotland total) and nitrous oxide (8% of the Scotland total); these inventories are dominated by sources that are much harder to characterise, with emission factors that are highly uncertain. A detailed study has been carried out in parallel to the compilation of the Scottish GHG inventory to review and improve the uncertainty calculations for the Scottish inventory.
- **Wales uncertainty in 2013 for all greenhouse gases** (+-5%): Similar to England, the Wales GHG inventory has a relatively low overall uncertainty due to the high contribution of CO_2 emissions from well-documented emission sources such as heavy industry (power generation, oil refining and iron and steel production). The Wales GHG inventory in 2013 also has a relatively low contribution from the uncertain sources of methane (~1% of the Wales total) and nitrous oxide (5% of the Wales total).

- **Northern Ireland uncertainty in 2013 for all greenhouse gases** (+-12%): The Northern Ireland inventory overall has a relatively high uncertainty due to the low overall contribution to the emissions total from CO_2 (only 67% of the Northern Ireland total inventory); the CO_2 inventory is also relatively uncertain (at 8%, compared with 2% for England and 4% for Wales) due to the contribution of LULUCF sources and also the more uncertain fuel activity data for Northern Ireland compared to other DAs, due to the greater use of solid fuels and oils. The Northern Ireland inventory also has the greatest level of contribution compared to other DAs from both methane (20% of the Northern Ireland total) and nitrous oxide (11% of the total), with high emissions from sources where emission factors are subject to considerable uncertainty.

Inventory uncertainties can also be considered by gas, where there is a large range in uncertainty due to the different sources that dominate for each specific greenhouse gas:

- Emissions of carbon dioxide are typically associated with the lowest uncertainty due to the high contribution from fuel consumption sources where the carbon content of fuels is generally very well documented. The main source of uncertainty in carbon dioxide estimates at the DA level is the lack of detailed DA-specific energy balances. The "outlier" in carbon dioxide inventory terms is Scotland, where there is a much greater contribution from more uncertain LULUCF sources and sinks, whilst Northern Ireland carbon dioxide inventory uncertainties are somewhat higher than the UK average due to the uncertain activity data for off-gas-grid use of oils and solid fuels outlined above. DA uncertainties in carbon dioxide inventories in 2013 are: +-4% England, +-17% Scotland, +-4% Wales and +-8% Northern Ireland.
- Emissions of nitrous oxide are the least certain (+-75% England, +-79% Scotland, +-80% Wales, +-85% Northern Ireland) due to high uncertainty in estimates for emissions from soils (for fertilizer application and variability of soil types).

Additional details of the uncertainties for each DA by gas can be seen in Figure 3 in each DA chapter. The methodology used to estimate the By Source emissions by DA is presented in Appendix 2.

2 Emission Estimates in England (1990-2013)

2.1 Overview of Total Emissions

By Source Emissions

Overview

The greenhouse gas (GHG) emissions for England for 1990 – 2013 are presented in Table 2.1 and in the graph in Figure 2.1 below.

Table 2.1: 1990-2013 England GHG Emission Inventory ($ktCO_2e$)

NC Format	Base Year	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	% of 2013
Agriculture	40,483	40,483	39,261	36,445	33,541	32,425	32,243	32,446	32,340	31,881	31,709	7%
Business	87,155	86,246	85,870	86,915	86,145	81,423	71,490	72,855	68,291	69,603	69,764	16%
Energy Supply	217,172	217,172	171,770	151,197	167,800	161,941	144,154	147,714	140,017	147,651	133,809	31%
Industrial Process	56,801	54,374	46,474	22,647	16,494	14,448	9,222	9,665	8,324	8,332	9,461	2%
LULUCF	2,278	2,278	2,384	1,643	-169	-817	-737	-670	-736	-875	-877	-0.2%
Public	10,572	10,572	10,453	9,701	8,958	8,602	7,390	7,822	7,498	7,461	7,661	2%
Residential	64,060	63,510	65,613	72,529	70,414	66,239	63,365	71,255	54,609	62,865	63,056	15%
Transport	101,170	101,170	101,431	105,135	107,730	104,059	99,986	98,781	97,420	96,952	95,939	22%
Waste Management	54,077	54,077	55,755	52,254	41,725	33,246	28,605	24,879	22,870	20,825	17,922	4%
Total	**633,768**	**629,882**	**579,011**	**538,466**	**532,639**	**501,564**	**455,718**	**464,746**	**430,634**	**444,695**	**428,443**	**100%**

Trends

Figure 2.2 shows the change in emissions from the Base Year and 2012 to the latest year, 2013. Total GHG emissions for England show a steady decrease between the Base Year[13] and 2013 with an overall decrease of 32% over this time.

The 2012 to 2013 decrease of emissions is predominantly driven by a shift from coal to renewable energy sources in the power generation sector.

The following list provides an overview of the trend for each NC sector:

- **Energy Supply** sector emissions have decreased by 38% between the Base Year and 2013. There was a decrease in overall emissions between 2012 and 2013. This 9% decrease was mainly due to a shift from coal and natural gas to renewable energy sources.
- **Waste Management** sector emissions have significantly declined by 67% since the Base Year, largely due to the progressive introduction of methane capture and oxidation systems within landfill management. Emissions decreased by 14% between 2012 and 2013.
- **Industrial Process** emissions have decreased significantly since the Base Year by 83% mainly as a result of a declining chemical and fluorocarbon production industry. However, emissions significantly increased by 14% between 2012 and 2013 due to an increase of over 20% in emissions from iron and steel works.
- **Transport** sector emissions have decreased by 5% between the Base Year and 2013 due to improvements in efficiency of transport vehicles despite growth in transport demand over the period. Emissions between 2012 and 2013 decreased by 1% due to a small decrease in fuel consumption and improvement in engine efficiency.
- **Public** sector emissions have reduced by 28% since the Base Year. This is due to increased energy efficiency measures and the switch to gas-fired heating. However, emissions between 2012 and 2013 increased by 3% due mainly to an increase in natural gas consumption in 2013.

[13] 1995 for fluorinated greenhouse gases (F-Gases) and 1990 for all other gases

- **Residential** sector emissions have decreased by 2% since the Base Year as a result of a switch from less efficient solid and liquid fuels to natural gas for heating, and improvements in energy efficiency. Emissions between 2012 and 2013 have slightly increased by 0.3% and this generally stable trend is due to the similar annual temperatures in 2012 and 2013 (DECC, 2015b) leading to no significant changes in emissions from space heating.
- **Agriculture** sector emissions have reduced by 22% since the Base Year mainly due to reductions in fertiliser use and resulting nitrous oxide emissions from soils and reduced animal numbers resulting in reduced methane from dairy cattle. There was a small decrease of 0.5% in emissions from 2012 to 2013 mainly due a decrease in emissions from liming and urea application, which slightly outweigh increases driven by manure management of swine and enteric fermentation from sheep.
- **Business** sector emissions have reduced by 20% since the Base Year as a result of reduced emissions in manufacturing industry (led by chemicals, non-ferrous metals and other manufacturing) through industrial decline and efficiency improvements. Emissions have slightly increased by 0.2% between 2012 and 2013 caused mainly by an increase in emissions from natural gas combustion partially offset by a decrease in emissions from coal combustion and industrial off-road machinery.
- **LULUCF** sector was a source of emissions between the Base Year and 2004 after which the LULUCF sector was a sink. This was as a result of significant decreases in the conversion of land to cropland and settlements, and an increase in grassland carbon storage. This change to a sink was slowed by increased carbon emissions from cropland activities and the harvesting of some of the forest carbon stocks. The net sink slightly increased by 0.2% between 2012 and 2013 as a result of small changes in emissions and removals from grassland (reduced emissions), cropland (reduced emissions) and forest (reduced sink) and because of the absence of wildfires in 2013.

Emissions Detail

Figure 2.3 shows the emissions split by GHG and highlights the 2.5 and 97.5 percentile range of uncertainties. The range of uncertainty is greatest for nitrous oxide emissions. See Appendix 1 for further details on uncertainties.

Carbon dioxide is the most common gas emitted for all National Communication (NC) categories except Agriculture and Waste. For Agriculture, methane from livestock and nitrous oxide from soils are dominant. For Waste Management, methane from landfills is the most important gas (see Figure 2.4).

The dominant emission sources in 2013 include electricity production (27% of total GHG emissions), road transport (21%), residential combustion for heating and cooking (14%), and industrial combustion for heat and electricity in the Business sector (11%) as shown in Figure 2.5.

Recalculations

Revisions to the estimates since the last inventory report (Salisbury et al., 2013) have resulted in a 0.6% (2,970 $ktCO_2e$) increase in the 2012 estimates for England. The 2006 IPCC Guidelines (IPCC, 2006) have been adopted and supersede the 1996 IPCC Guidelines (IPCC, 1996). This change has led to the implementation of updated methodologies and emission factors, inclusion of additional sources and emissions of NF_3, improvements to the global warming potential (GWP) factors used. This has affected all sectors in the inventory. The most significant revisions to the 2012 estimates have been for the following sub-categories:

1. **Waste Management (3,729 $ktCO_2e$ increase)**: New data on landfill methane flaring from site operators and regulators has improved methane recovery data. The method to estimate methane formation within landfills has been improved to incorporate new data. The industrial waste water treatment method was revised to be consistent with 2006 IPCC Guidelines and a calculation error identified and corrected, which increased emissions across the time series for this source. Domestic waste water treatment and sludge disposal estimates have also been revised to comply with the 2006 IPCC Guidelines and to include new data from water companies.
2. **Agriculture (3,506 $ktCO_2e$ decrease):** Emission factors and methodologies have been updated from the 1996 IPCC Guidelines to the 2006 IPCC Guidelines. Livestock emissions have, through the various changes to comply with the 2006 IPCC Guidelines, increased whilst emissions from crops have decreased.
3. **Business (1,700 $ktCO_2e$ increase):** Implementation of a revised time-series for the group of petroleum fuels that are regarded as non-energy use (NEU) due to their use in petrochemical manufacture led to an increase in emissions in all years. There has also been incorporation of Phase III ETS data which has led to improvements in the completeness and allocation of the inventory for chemical sites.

For more details of revisions to GHG emission estimates, see Appendix 6.

Figure 2.1: Total GHG Emissions by NC category for Base Year to 2013, as kt CO2e, England

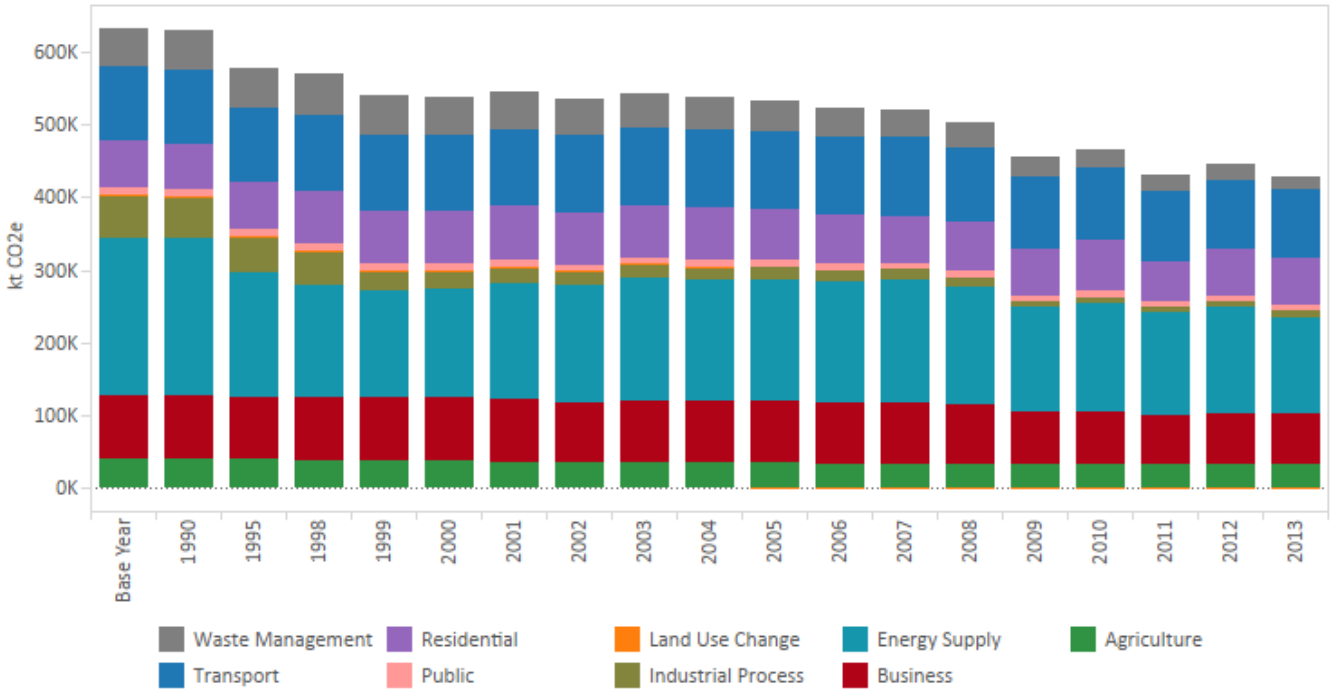
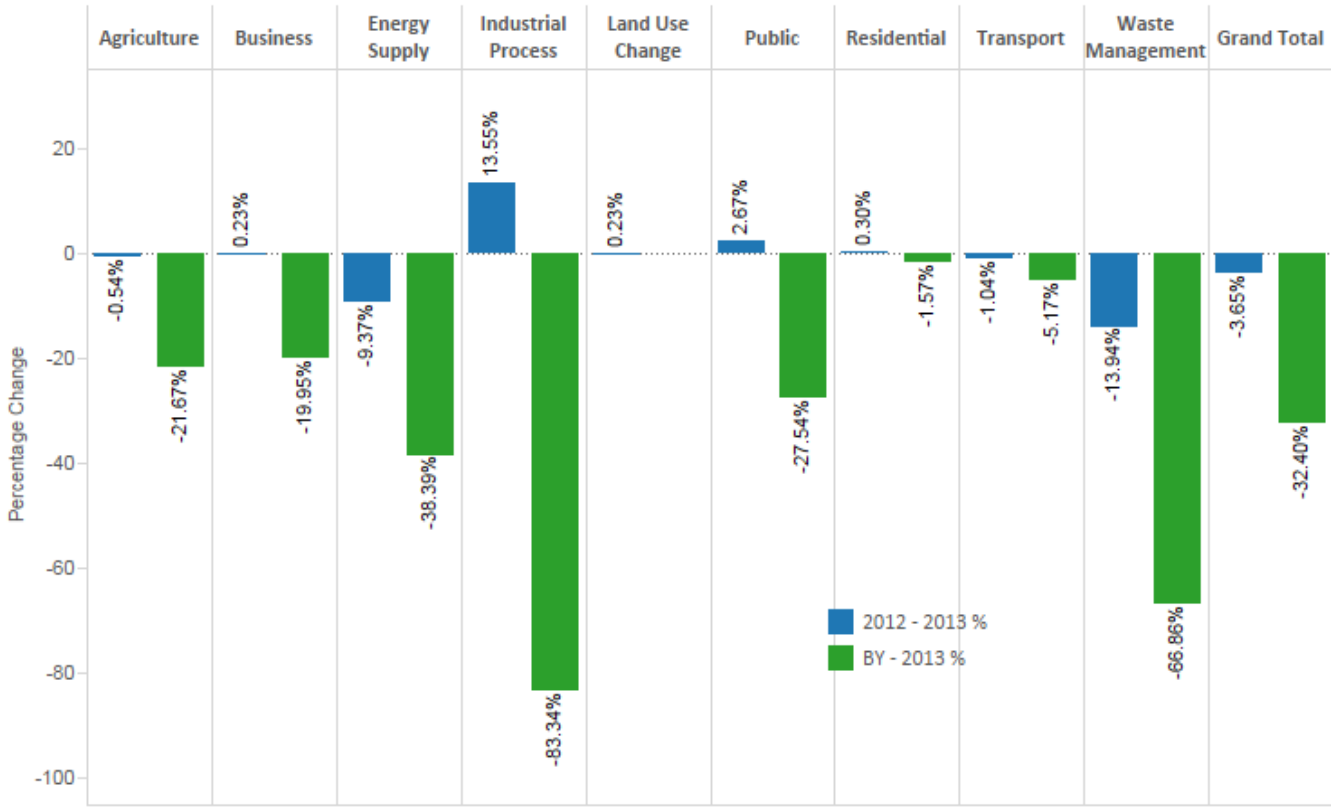


Figure 2.2: Percentage Change and Absolute (kt CO2e) Change in GHG Emissions by NC: 2012 - 2013 and Base Year (BY) - 2013, England

The LULUCF Base Year - 2013% change is excluded from the figure if LULUCF emissions changed from a sink to source, or source to sink, across the time series.



	Agriculture	Business	Energy Supply	Industrial Process	Land Use Change	Public	Residential	Transport	Waste Management	Grand Total
BY - 2013 kt	-8,774	-17,391	-83,363	-47,340	-3,156	-2,911	-1,004	-5,230	-36,155	-205,325
2012 - 2013 kt	-172	161	-13,842	1,129	-2	199	191	-1,012	-2,903	-16,251

Figure 2.3: Total GHG emissions and uncertainties by pollutant, 2013, England

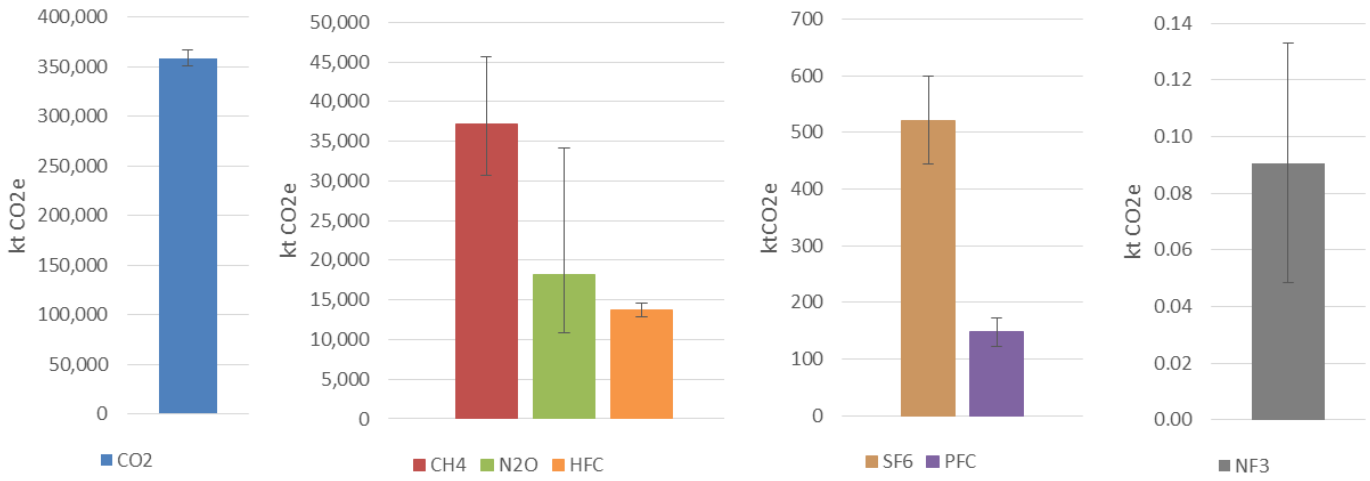


Figure 2.4: Total GHG Emissions by NC and pollutant, 2013, England

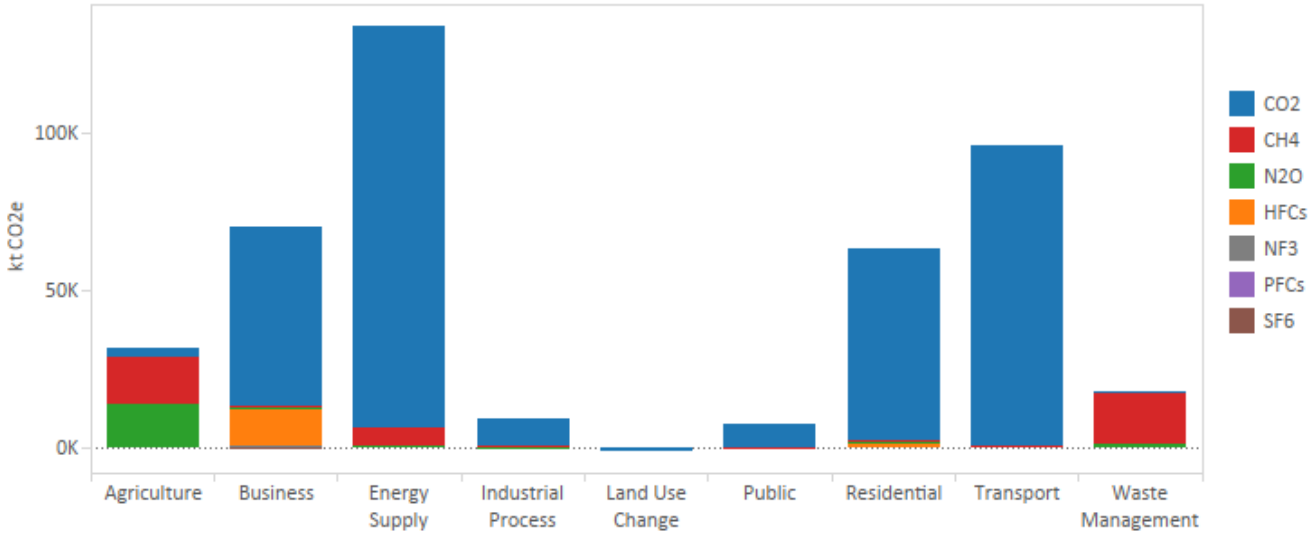
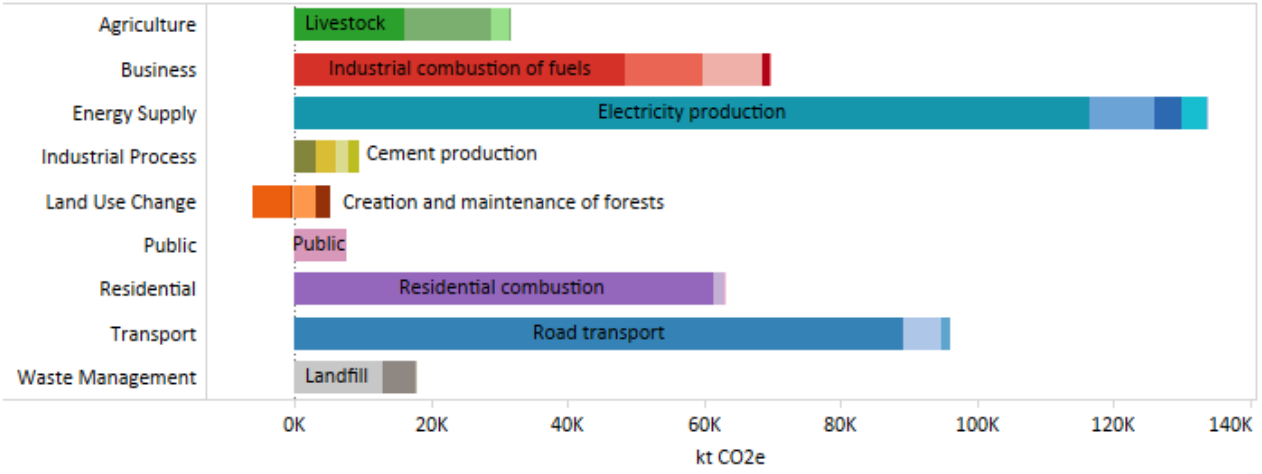


Figure 2.5: Total GHG Emissions labelling the largest sub-category in each NC, 2013, England



Traded and Non-Traded Emissions

Emissions from installations in the EU ETS contribute 38% of total GHG emissions in England in 2013. See Figure 2.6 for the Traded/Non-Traded split for each sector. The main contributors to these traded emissions are the Energy Supply, Business and Industrial Process sectors. The majority of EU ETS emissions are carbon dioxide emissions from large industrial combustion plant, autogenerators, oil and gas terminals, chemical production, cement and lime kilns, iron and steel works, aluminium and brick manufacture plant.

Emissions from installations included in the European Union Emissions Trading Scheme (EU ETS) have shown a general decrease between 2008 and 2013 (see Figure 2.7). The decrease between 2010 and 2011 was due to a decrease in power demand as the economy dropped. The significant increase in traded emissions within the Industry sector (see Figure 2.8) is due to increased emissions from iron and steel works.

Figure 2.6: Total Traded and Non-Traded GHG Emissions by NC Category, 2013, England

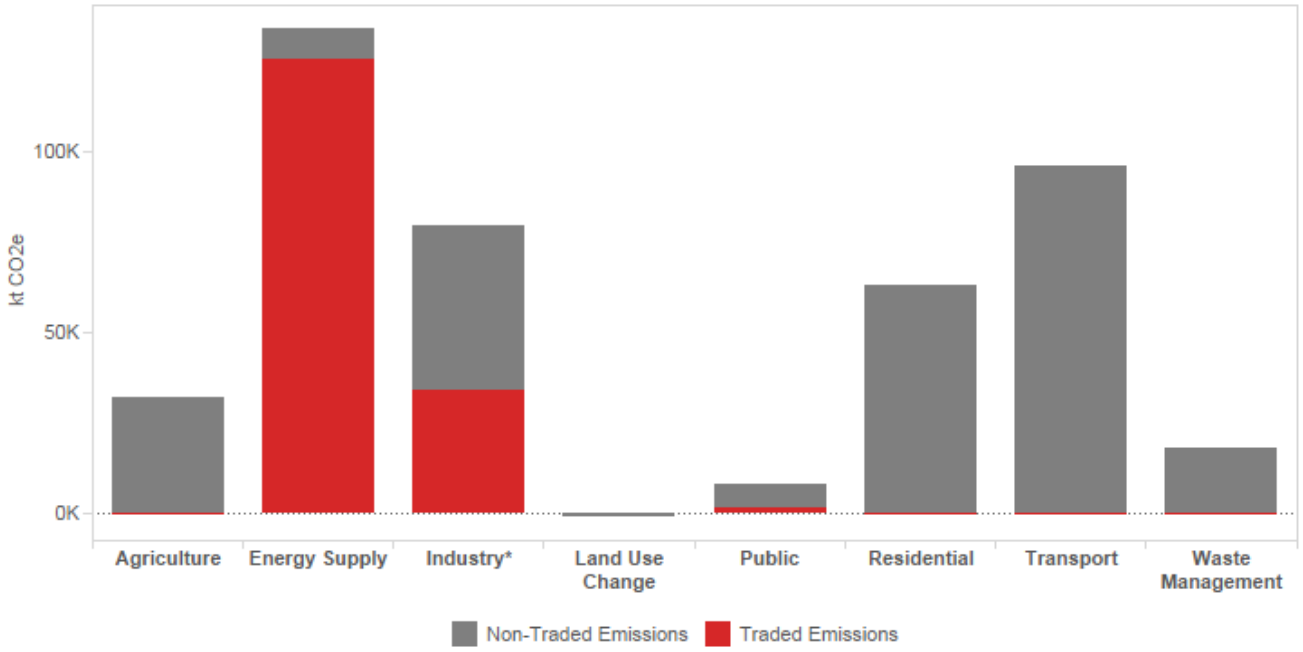


Figure 2.7: Total Traded and Non-Traded GHG Emissions 2008-2013, England

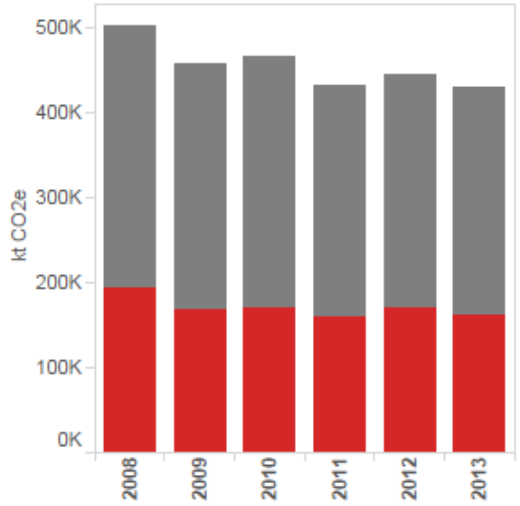
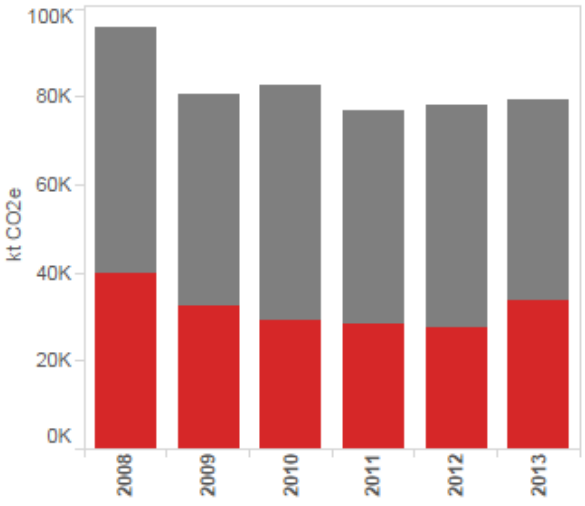


Figure 2.8: Traded and Non-Traded GHG Emissions from Industry 2008-2013, England*



* Industry includes emissions from the NC categories: Industrial Process and Business

Emissions on an End User Basis

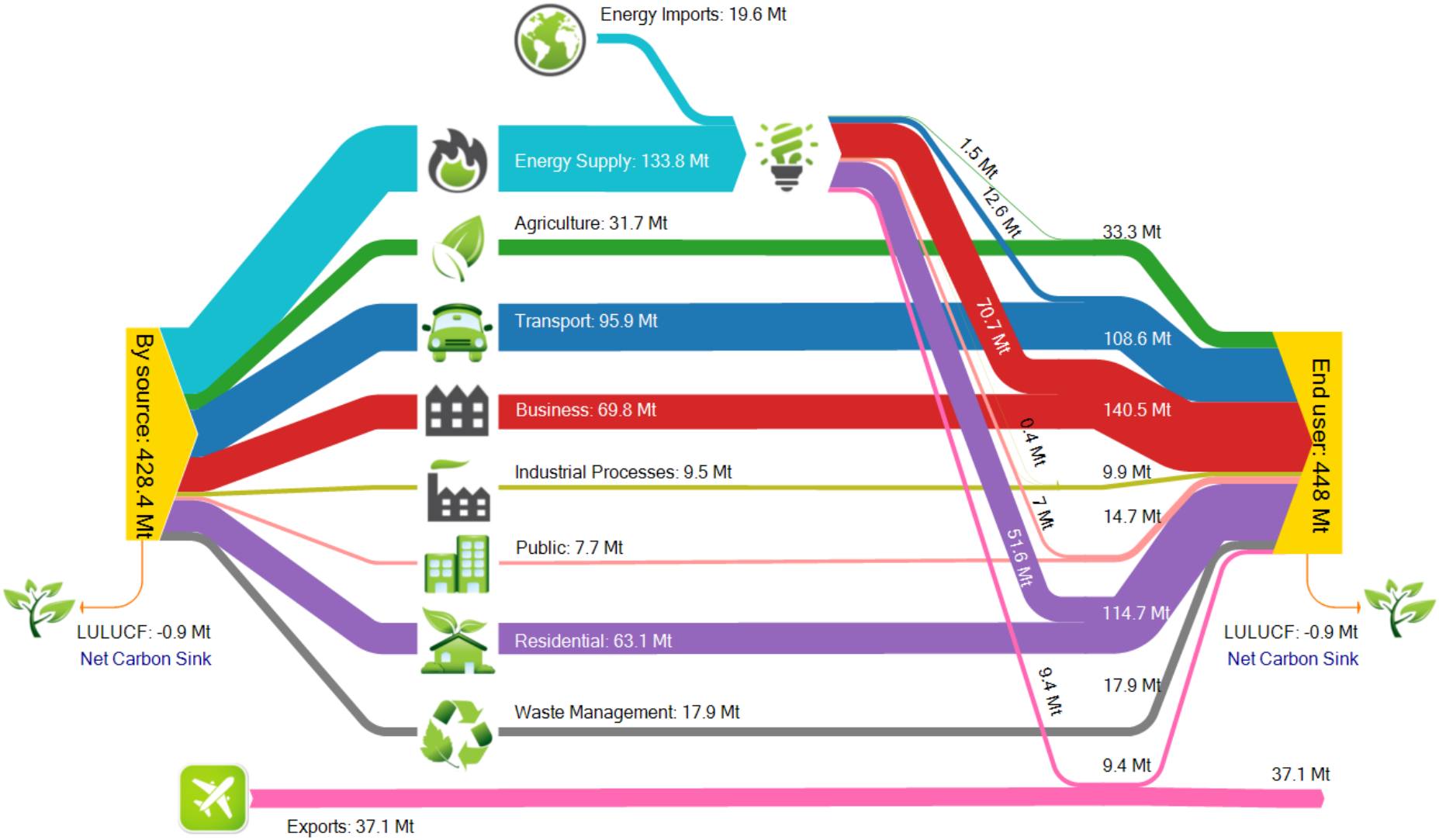
In addition to presenting emissions based on direct emissions from processes or combustion of fuels in England, the emissions from the Energy Supply sector can be attributed to the users of the energy (see Appendix 3 for more details of the End User inventory methodology). Figure 2.9 illustrates the difference between the By Source and End User inventory emission estimates and how emissions from energy supply are attributed to the End User NC categories.

This shows that on an End User basis in 2013, the Business sector had the highest contribution to England total emissions followed by the residential and transport sectors. As illustrated in Figure 2.9, England is a net importer of electricity which results in slightly higher emissions in England for End User (448 $MtCO_2e$) compared to By Source (428 $MtCO_2e$) estimates for 2013.

Emissions from the Land Use, Land Use Change and Forestry (LULUCF) and Waste Management sectors are unchanged between the By Source and End User approaches, since there are no emissions from energy use allocated to these sources. The End User increment within the Industrial Process sector is limited to the use of fuels in ammonia production (feedstock use of natural gas), and iron and steel (where emissions are allocated to process use, rather than combustion). For Agriculture, the increase in emissions using the End User approach is limited to the emissions from energy use within the sector (e.g. gas oil use in mobile machinery).

A more detailed assessment of emissions by sector is presented below for each of the National Communication sectors.

Figure 2.9 Sankey diagram showing By Source and End User[14] GHG emission transfers for England in 2013 (Mt CO_2e)[15]



[14] The pink line from 'Energy Supply' to 'End User' represents emissions from energy supply in the production of fuels used in international aviation and shipping.

[15] 'Exports' equates to emissions from international aviation and shipping.

2.2 Energy Supply Sector

Figure 2.10: Overall Contribution to 2013 GHG emissions, England

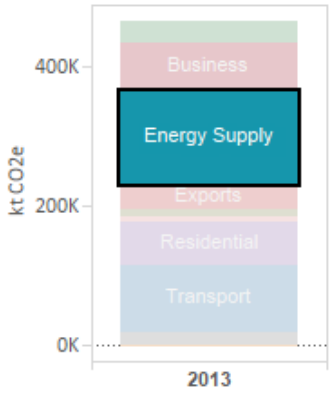


Figure 2.11: GHG Contribution to Energy Supply Emissions, 2013, England

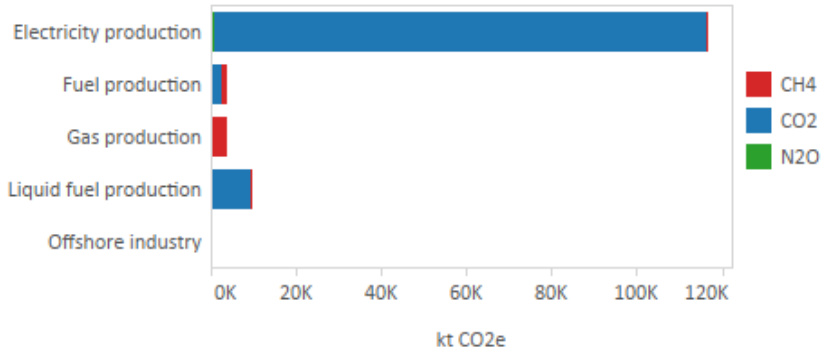


Table 2.2: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, England

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Electricity production	-33%	-56,828	-9%	-11,355
Gas production	-56%	-4,873	-2%	-99
Liquid fuel production	-18%	-2,138	-14%	-1,538
Offshore industry	-61%	-246	-50%	-158
Fuel production	-84%	-19,277	-15%	-691
Energy Supply Total	-38%	-83,363	-9%	-13,842

Table 2.3: NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions, England

Agriculture	1%
Business	54%
Industrial Process	0%
Public	5%
Residential	37%
Transport	2%
Exports	0%

Figure 2.12: Total GHG Emissions from Energy Supply, Base Year to 2013, England

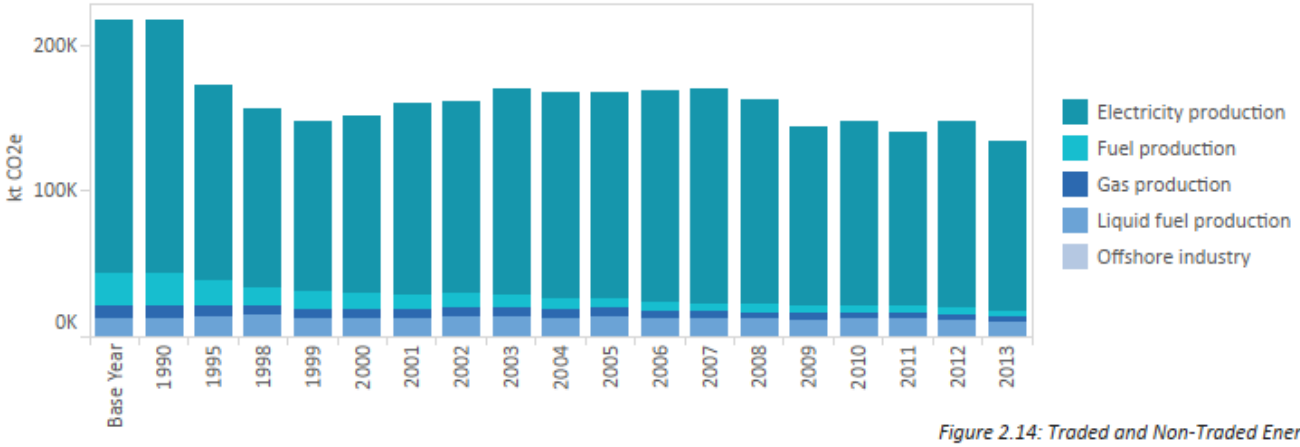


Figure 2.13: Emissions and Electricity Production by Fuel Type from Major Power Producers (1A1a), England

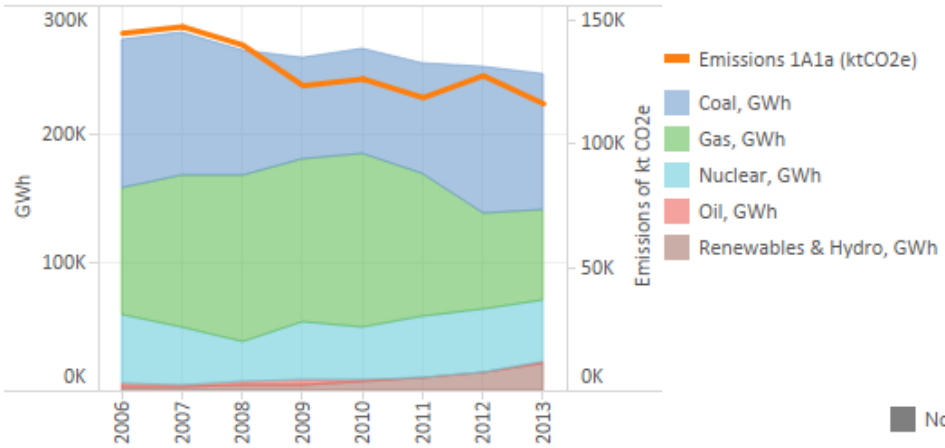
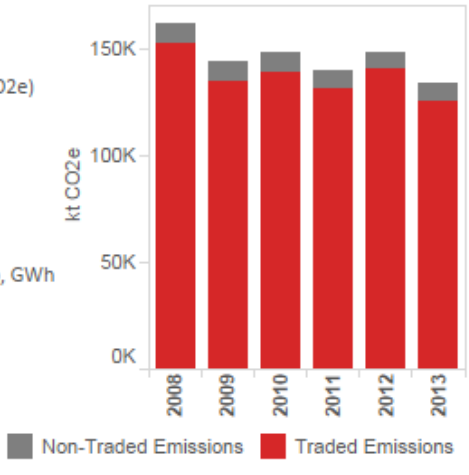


Figure 2.14: Traded and Non-Traded Energy Supply Emissions, 2008-2013, England



*Exports includes emissions from energy production for international aviation, international shipping and exported fuels

By Source Emissions

Overview

Figures 2.10 – 2.14 show detailed emissions and trends for the Energy Supply sector. In England, Energy Supply contributes 31% to total 2013 GHG emissions. Energy Supply includes emissions from power generation, refineries, coal mines, solid fuel transformation, oil and gas extraction and processing, other energy industries. The main source of emissions in England within the Energy Supply sector is Electricity Production at power stations, which accounted for 87% of Energy Supply emissions in 2013; refinery emissions account for a further 7% of the Energy Supply sector emissions in 2013.

Features of the Trends

Table 2.2 shows the change in emissions between the Base Year and 2013, and between 2012 and 2013 for the sector. Energy Supply sector emissions have reduced by 38% between the Base Year and 2013 due to increased efficiency in power generation through a switch from coal-fired to gas- fired combined cycle gas turbines (CCGT) and large reductions in methane emissions from significantly reduced coal mining activities. Emission reductions have also been achieved through an increase in nuclear capacity and utilisation in England and the import of electricity from Wales and Scotland. Energy Supply emissions have decreased by 9% between 2012 and 2013, due mainly to a shift from coal to renewable energy sources in power stations. The spike that can be seen in 2012 is due to an increase in the use of coal, which reflected the drop in the global price of this commodity.

In addition, refinery emissions declined by 14% between 2012 and 2013 as the sector continued to shrink, with the closure of the Coryton refinery in mid-2012. Emissions of methane from deep coal mining have dropped significantly in 2013 (down 40% on 2012) with the closure of the Maltby colliery in early 2013 and a fire forcing the closure of the Daw Mill colliery in February 2013.

Sector Detail

Only those emissions arising from on-shore installations in England have been included within the English GHG inventory; emissions from off-shore oil and gas facilities are reported as “Unallocated”. Carbon dioxide is the predominant gas accounting for over 95% of emissions from the Energy Supply sector in 2013 as a result of the combustion of fossil fuels.

The mix of generation capacity in England is shown in Figure 2.13. Power generation in England consists of a high proportion of CCGT stations, a lower proportion of conventional fossil fuel stations, a lower proportion of nuclear generation and no hydroelectricity. In addition, England is a net importer of electricity from both Wales and Scotland. The By Source inventories presented here allocate emissions to the Devolved Administrations in which those emissions are produced, and hence the GHG emissions from the power generated in Wales and Scotland and exported to England are allocated to Wales and Scotland, respectively.

Traded and Non-Traded Emissions

Emissions in the Energy Supply sector (Figure 2.14) are dominated by Traded (EU ETS) installations with 94% of emissions in Energy Supply from Traded operations; these traded emissions are primarily from power stations, refineries and coke ovens. The trends in the traded emissions reflect those discussed above in the by source inventory.

Emissions on an End User Basis

The End User inventory method re-allocates all emissions from the Energy Supply sector on to the final users of the refined / processed fuels, and hence the Energy Supply End User emissions are zero. Table 2.3 indicates the reallocation of emissions related to the production of electricity to the other sectors. The Business and Residential sectors are the most prominent once emissions from the production of electricity have been reallocated in this way.

2.3 Transport Sector

Figure 2.15: Overall Contribution to 2013 GHG emissions, England

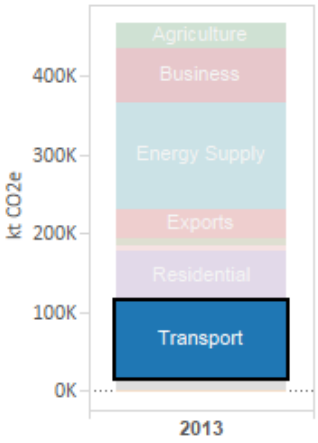


Figure 2.16: Total GHG Emissions from Transport, Base Year to 2013, England

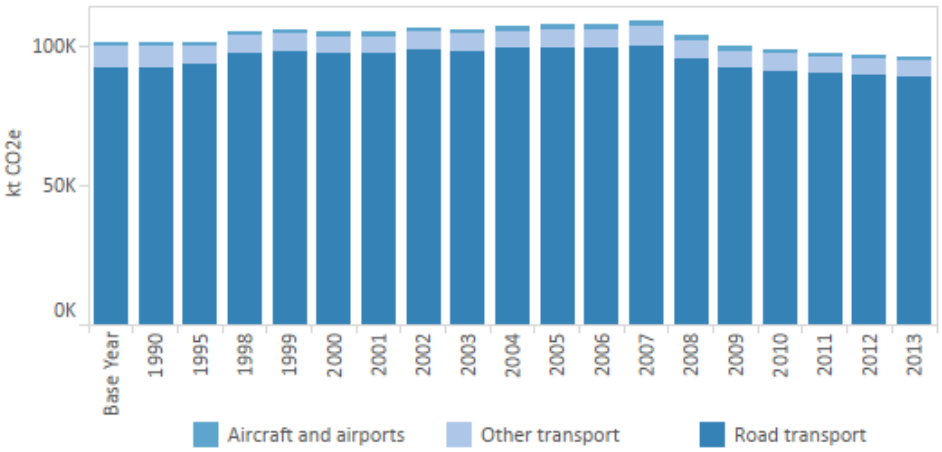


Table 2.4: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, England

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Road transport	-3%	-3,045	-1%	-707
Other transport	-31%	-2,423	-6%	-325
Aircraft and airports	22%	238	2%	20
Transport Total	-5%	-5,230	-1%	-1,012

Figure 2.17: GHG Contribution for Transport Emissions, 2013, England

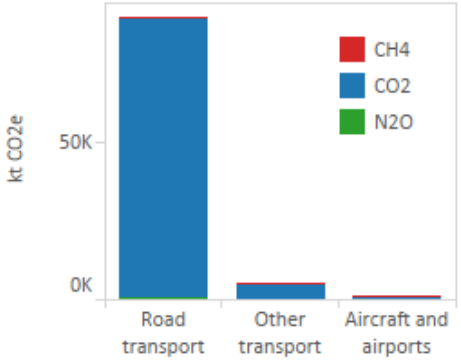


Figure 2.18: Comparison of End User and By Source for Transport, England

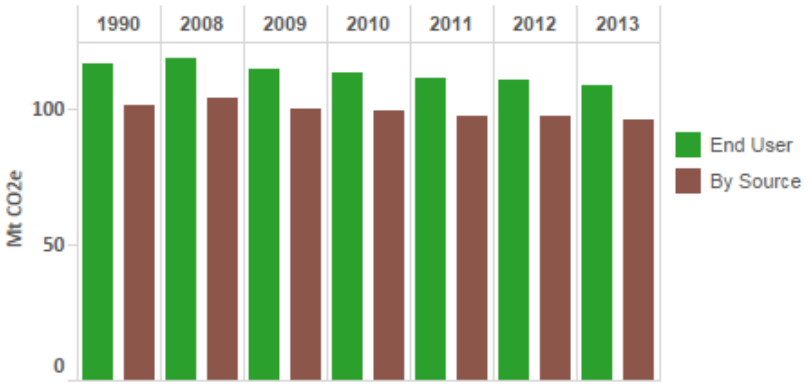


Figure 2.19 Road Transport CO2 Emissions (fuel sales basis), England

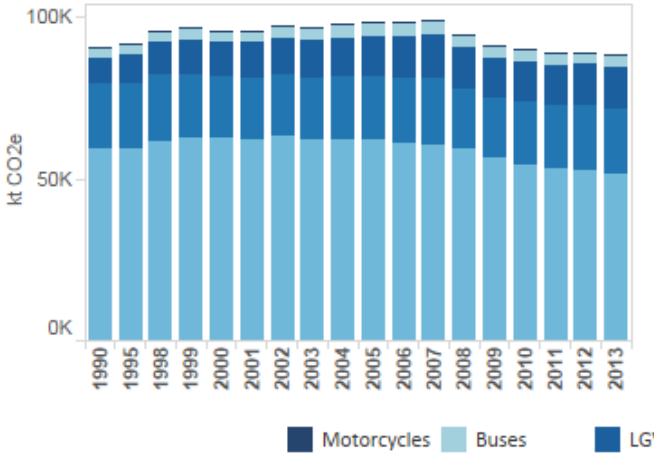
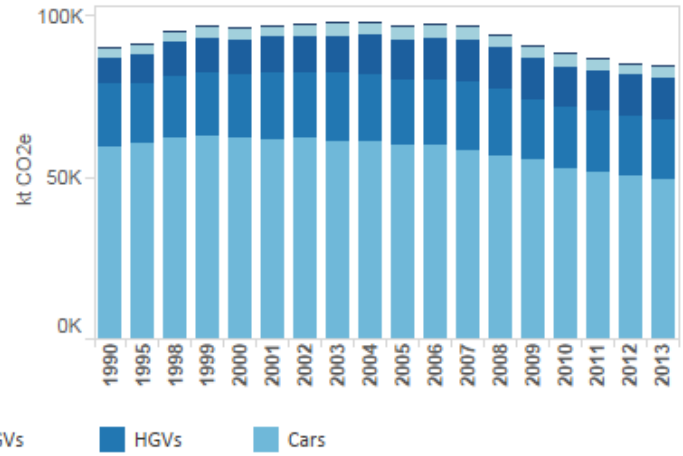


Figure 2.20: Road Transport CO2 Emissions (vkm basis), England



By Source Emissions

Overview

Figures 2.15 – 2.20 show detailed emissions and trends for the Transport sector. Transport emissions accounted for 22% of England's total GHG emissions in 2013. Transport emissions are dominated by emissions from road transport (93% of all Transport emissions in 2013, with 54% of Transport emissions from cars alone). The Transport sector also includes small contributions from rail (including stationary sources), national navigation and coastal shipping, domestic aviation and, most significantly, from military aviation and shipping. Emissions from international aviation are excluded from these estimates and are reported as memo items to the inventory.

Features of the Trends

Table 2.4 shows the change in emissions between the Base Year and 2013, and between 2012 and 2013 for the sector. Total GHG emissions from the Transport sector in England have decreased by only 5% between the Base Year and 2013 despite improvements in efficiency of transport vehicles, as a result of growth in transport demand and increased affordability of cars over the period. Emissions peaked in 2007 and have since declined partly due to improvements in average fuel efficiency of vehicles and the switch from petrol to diesel cars and from a reduction in traffic volumes.

Emissions between 2012 and 2013 have decreased by 1%. Recent trends for the sector are driven by the changes in emissions from passenger cars. Although emissions from diesel cars have increased, emissions from petrol have decreased, which has led to this overall reduction in emissions between 2012 and 2013.

Sector Detail

There are two approaches used to calculate emissions from Road Transport: fuel sales basis – emissions are constrained to the total fuel sold within the UK as stated in DUKES (DECC, 2014b); vehicle kilometre basis – emissions are estimated using vehicle km data and are not constrained by the total fuel sold, so estimate emissions based on fuel used within the UK. The inventory emission estimates for Road Transport are calculated on a fuel sold basis and are, therefore, consistent with DUKES.

Figures 2.19 and 2.20 show the carbon dioxide emissions from road transport for England based on constrained (to the Digest of UK Energy Statistics (DUKES) fuel sales) and unconstrained (vehicle kilometre, vkm) approaches. Total carbon dioxide emissions from the vkm approach differ from the estimates constrained to DUKES. These differences fluctuate year on year but they remain within a 4.2% difference for England.

These disparities will also be reflected in the trends derived from the two approaches to a different extent. The long term trend (between Base Year and 2013) for each individual vehicle type is generally similar between the two approaches. The vkm approach indicates that the overall carbon dioxide emissions from road transport in 2013 are 6.1% lower than in the Base Year, while the constrained approach indicates that carbon dioxide emissions have decreased by 2.7% between the Base Year and 2013.

Emissions on an End User Basis

In 2013, the End User estimates were 13% higher than the By Source estimates, reflecting the additional emissions from upstream oil extraction and the oil refining sector. A small proportion of electricity generation emissions are also attributed to the End User Transport sector from electric rail use.

The trend in End User emissions (Figure 2.18) since 1990 shows a decline of 7% to 2013, which is a larger reduction than reported in the By Source inventory (5%), reflecting the improved energy efficiency of upstream production and refining of crude oil to produce the fuels used in the transport sector.

2.4 Residential Sector

Figure 2.21: Overall Contribution to 2013 GHG emissions, England

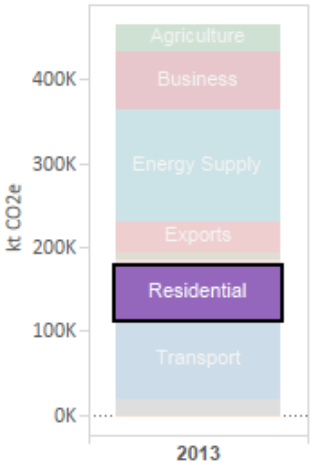


Figure 2.22: Total GHG Emissions from Residential, Base Year to 2013, England

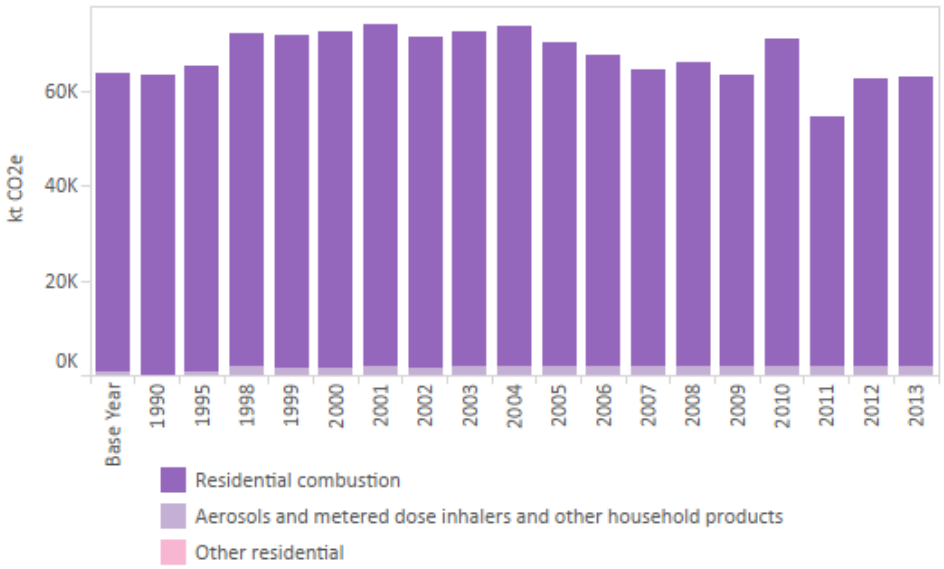


Table 2.5: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, England

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Aerosols and metered dose inhalers and other household products	213.4%	1,231.9	-0.4%	-7.4
Other residential	113.0%	18.0	2.8%	0.9
Residential combustion	-3.6%	-2,253.7	0.3%	197.9
Residential Total	-1.6%	-1,003.8	0.3%	191.4

Figure 2.23: GHG Contribution for Residential Emissions, 2013, England

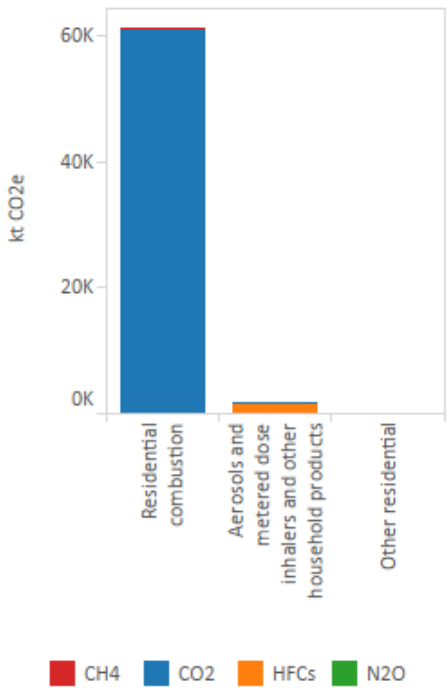
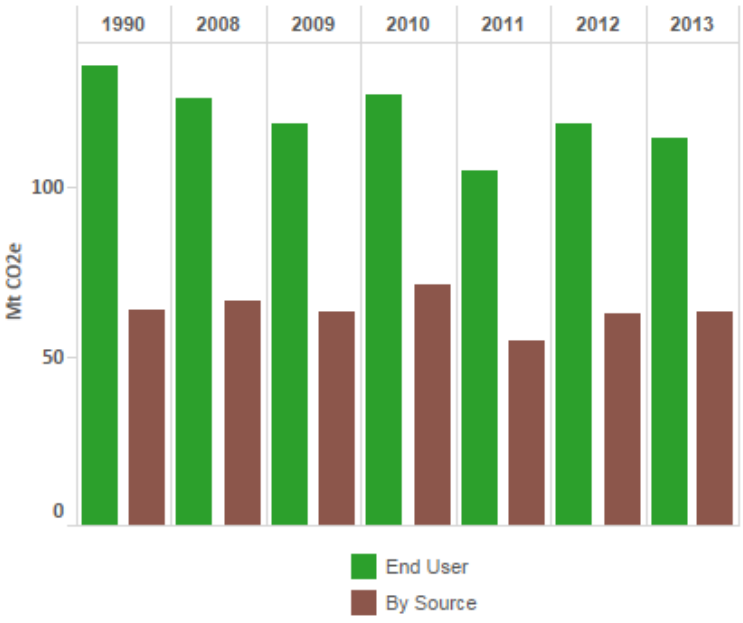


Figure 2.24: Comparison of End User and By Source for Residential, England



By Source Emissions

Overview

Figures 2.21 – 2.24 show detailed emissions and trends for the sector. The Residential sector accounted for 15% of England's total GHG emissions in 2013. The sector comprises emissions from domestic combustion (97% of emissions for the residential sector) from heating and cooking, household products, accidental vehicle fires and hydrofluorocarbon (HFC) emissions from the use of aerosols and metered dose (usually asthma) inhalers. 96% of all residential GHG emissions are from the release of carbon dioxide from the direct combustion of fossil fuels (see Figure 2.23).

Features of the Trends

Total GHG emissions from the Residential sector (Table 2.5) in England have decreased by only 2% between the Base Year and 2013. The recent sector emission trends reflect the mean annual temperatures, with notably higher emissions during the very cold year 2010, followed by a notable decline in the relatively warm year of 2011. Years 2012 and 2013 show similar mean annual temperatures.

Emissions on an End User Basis

In England End User emissions for the Residential sector are nearly twice as large as the by source emission estimates, reflecting the high consumption of electricity in the sector (Figure 2.24). This increases the overall significance of this sector in the End User inventory to 26% of the England total, compared to just 15% of the By Source inventory total. The trend in Residential End User emissions since 1990 shows a decline of around 16% to 2013 as a result of improvements in energy efficiency of housing combined with the less carbon intensive fuel mix of the electricity generation sector since 1990.

2.5 Business Sector

Figure 2.25: Overall Contribution to 2013 GHG emissions, England

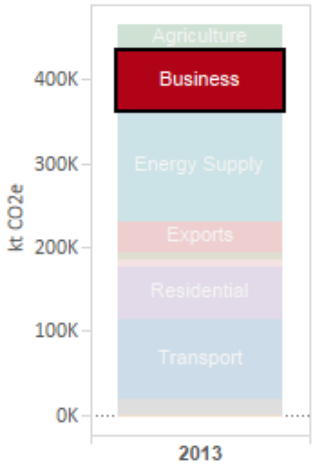


Figure 2.26: Total GHG Emissions from Business, Base Year to 2013, England

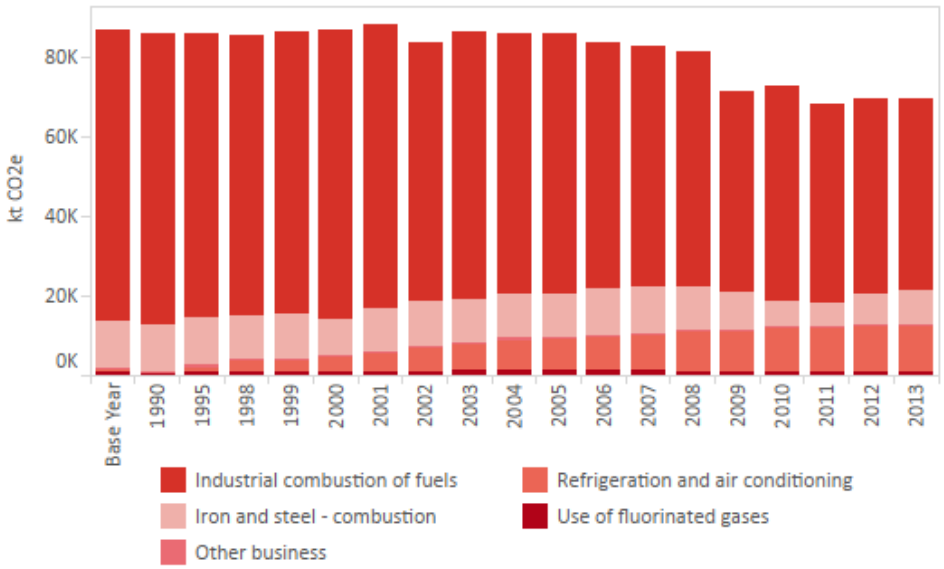


Table 2.6: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, England

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Industrial combustion of fuels	-34.3%	-25,220.7	-1.1%	-540.6
Refrigeration and air conditioning	1,205.1%	10,373.7	0.5%	60.8
Use of fluorinated gases	7.7%	77.2	-3.0%	-33.8
Iron and steel - combustion	-24.7%	-2,877.3	9.0%	724.2
Other business	1,294.7%	256.6	-15.2%	-49.4
Business Total	-20.0%	-17,390.6	0.2%	161.2

Figure 2.27: GHG Contribution for Business Emissions, 2013, England

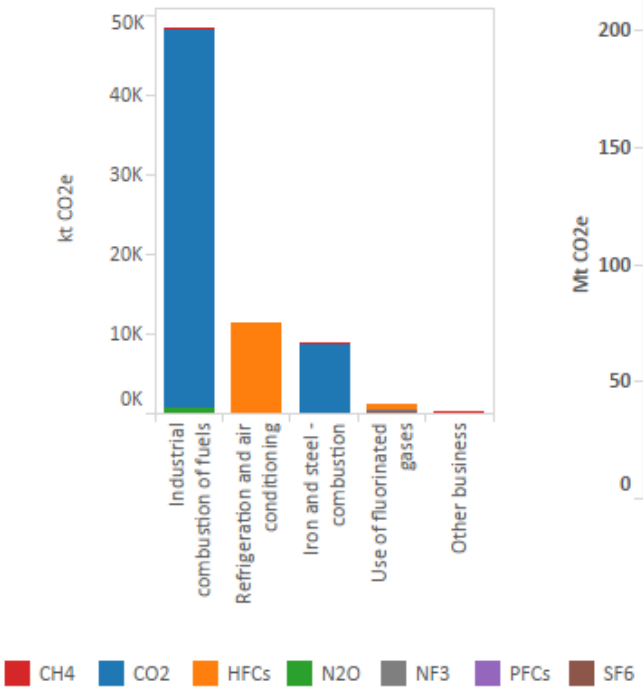
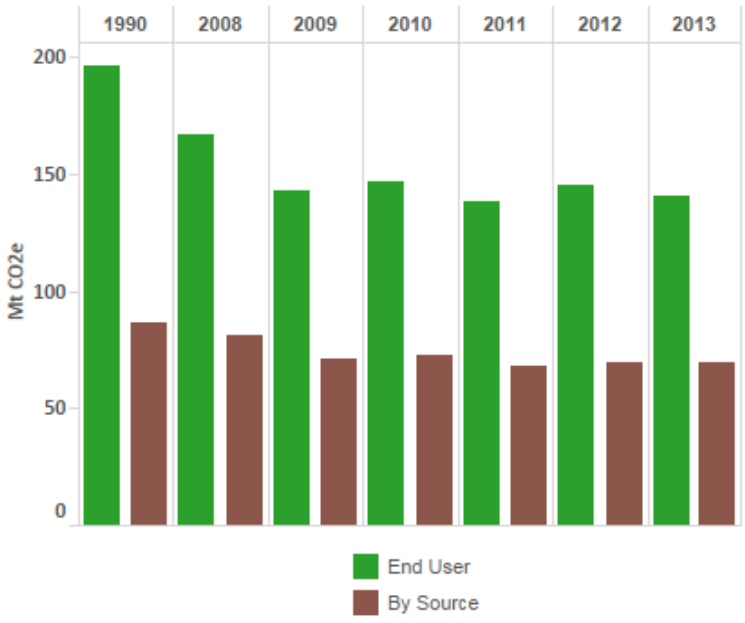


Figure 2.28: Comparison of End User and By Source for Business, England



By Source Emissions

Overview

Figures 2.25 – 2.28 show detailed emissions and trends for the sector. In England, the Business sector contributed 16% to total 2013 GHG emissions in England. The sector in 2013 includes emissions from industrial combustion of fuels (69% of Business emissions) from manufacturing and construction industry, iron and steel fuel combustion (13% of Business emissions), refrigeration & air conditioning (16% of Business emissions), arising from losses of HFCs during equipment manufacture, leaks and disposal; as well as HFC emissions from foam production, firefighting solvents and electronics (1.5% of Business emissions). In 2013, 81% of emissions in the Business sector were carbon dioxide released from the combustion of fossil fuels with 18% from the use of fluorinated greenhouse gases (F-Gases), predominantly HFCs.

The combustion emission estimates in the Business sector are associated with high uncertainty due to the absence of comprehensive, detailed fuel use data specific to each DA, particularly for solid and liquid fuels. Non-combustion emissions are also uncertain due to the lack of DA-specific data on F-gas sources and the use of proxies such as economic indices and population to estimate the DA share of UK emissions for these sources.

Features of the Trends

Overall Business sector emissions have reduced by 20% from the Base Year to 2013 (see Table 2.6). These reductions have primarily been achieved as a result of declining manufacturing and iron and steel industry emissions and fuel switching from coal to natural gas. Despite this general decline in emissions, emissions of HFC from refrigeration and air conditioning were negligible in 1990 and have risen to account for 18% of the sector total in 2013. This is due to the introduction of these gases as replacement to CFCs banned by the Montreal Protocol.

Emissions from the sector have increased since 2011, caused mainly by an increase in the iron and steel sector as the Teesside plant that resumed production in April, 2012.

Traded and Non-Traded Emissions

Emissions in the Industrial Process sector include significant contributions from installations reporting in the EU ETS. However, due to the lack of detail in the EU ETS dataset, the Business and Industrial Process emissions are not easy to separate.

The contribution to total aggregate emissions from the traded and non-traded sector across the Business and Industrial Process sectors are presented in Figure 2.8 in the Overview section under the category: “Industry”.

Emissions on an End User Basis

In 2013, England’s End User emissions for the Business sector are 201% of the by source emission estimates, reflecting the high consumption of electricity for heating, lighting and operating equipment (and therefore share of emissions from electricity production) in the sector. From this End User perspective, the Business sector represents 31% of total emissions for England compared to just 16% of the by source inventory total.

2.6 Public Sector

Figure 2.29: Overall Contribution to 2013 GHG emissions, England

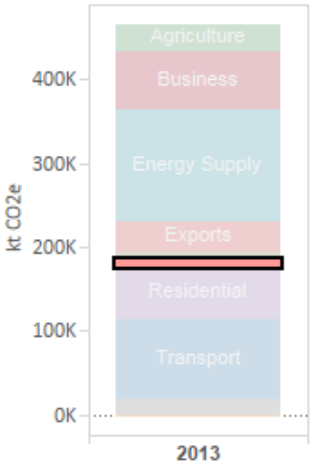


Figure 2.30: Total GHG Emissions from Public, Base Year to 2013, England

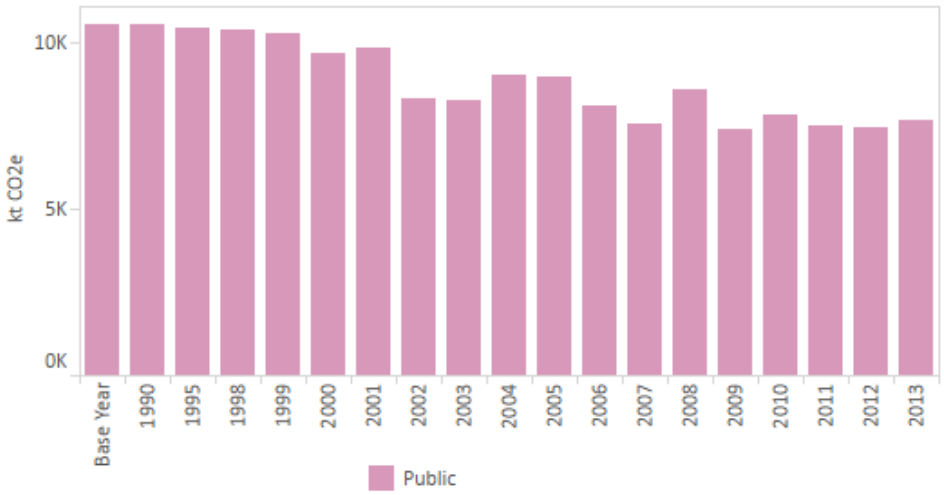


Table 2.7: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, England

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Public	-28%	-2,911	3%	199
Public Total	-28%	-2,911	3%	199

Figure 2.31: GHG Contribution for Public Emissions, 2013, England

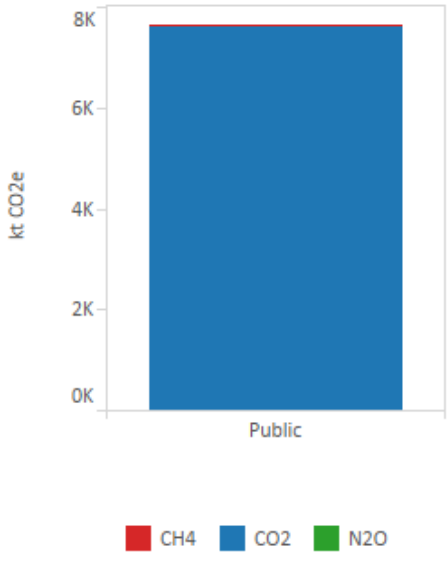
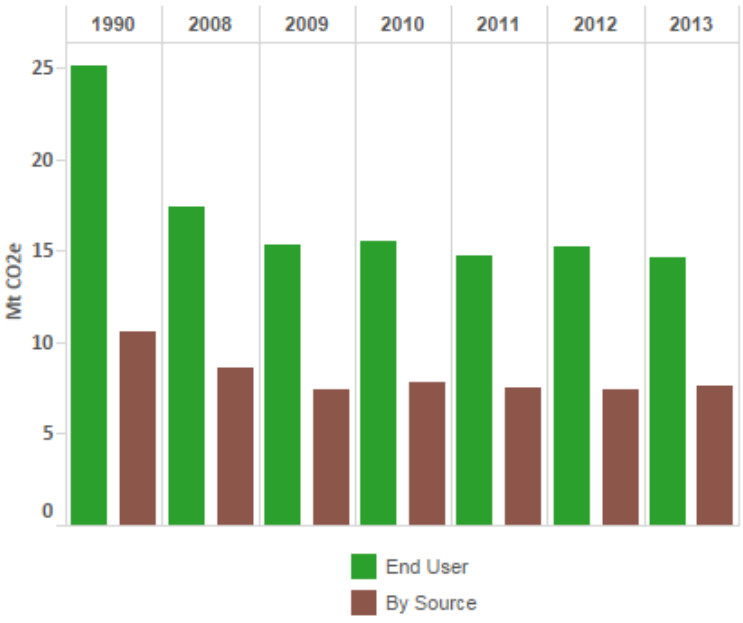


Figure 2.32: Comparison of End User and By Source for Public, England



By Source Emissions

Overview

Figures 2.29 – 2.32 show detailed emissions and trends for the sector. Emissions from Public sector combustion account for 1.8% of GHG emissions in England in 2013. Almost 100% of emissions in this sector are from carbon dioxide from the combustion of fossil fuels (predominantly natural gas).

Note that the emission estimates in the public sector are associated with high uncertainty due to the absence of comprehensive, detailed DA-specific fuel use data, particularly for solid and liquid fuels.

Features of the Trends

Overall Public sector emissions have reduced steadily between the Base Year and 2013, with an overall reduction of 28% over the period (Table 2.7). This has been achieved through more efficient use of fuels and a switch to gas fired heating across England for many Public sector buildings since 1990. Public sector GHG emissions slightly increased between 2012 and 2013, due to a slight increase in natural gas consumption in 2013.

Emissions on an End User Basis

In 2013, England End User emissions for the Public sector are 191% of the By Source emission estimates (Figure 2.32), reflecting the high consumption of electricity in the sector and increasing the sector's share of total England emissions from 1.8% to 3.3% in 2013 on an End User basis. The trend in End User emissions since 1990 shows a decline of around 42% to 2013.

2.7 Industrial Process Sector

Figure 2.33: Overall Contribution to 2013 GHG emissions, England

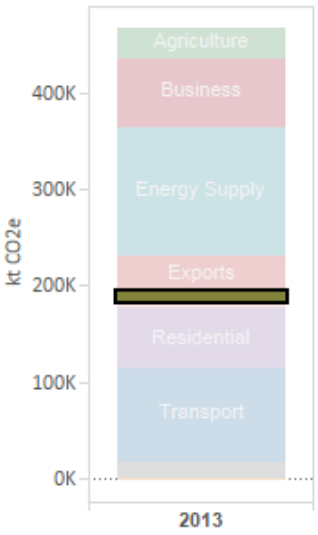
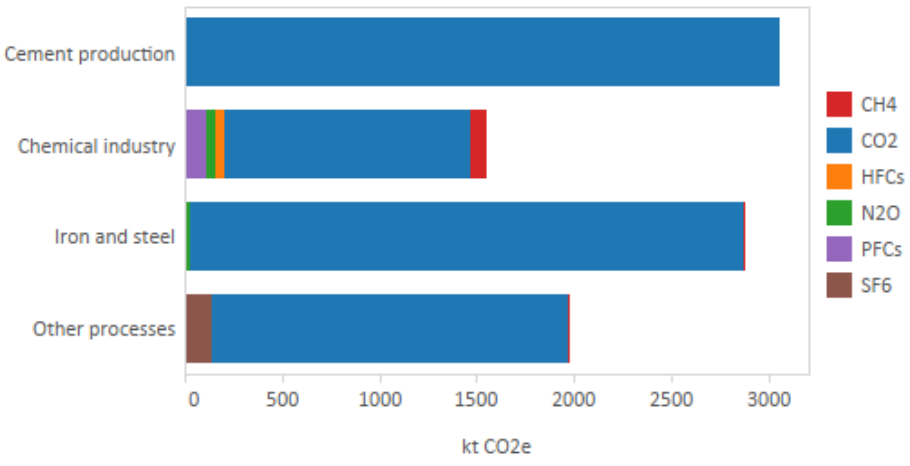


Figure 2.34: Total GHG Emissions from Industrial Process, Base Year to 2013, England

Table 2.8: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, England

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Cement production	-47%	-2,738	8%	238
Other processes	-55%	-2,415	2%	40
Chemical industry	-96%	-41,961	-7%	-110
Iron and steel	-7%	-225	50%	960
Industrial Process Total	-83%	-47,340	14%	1,129

Figure 2.35: GHG Contribution to Industrial Process Emissions, 2013, England



By Source Emissions

Overview

Figures 2.33 – 2.35 show detailed emissions and trends for the sector. The Industrial Process sector contributes 2.2% to total 2013 GHG emissions in England. The Industrial Process sector includes non-combustion sources such as the use of limestone in cement production (32% of total sector emissions); chemical production including fertilizers and other bulk chemicals; iron and steel processes excluding the use of electricity and fossil fuels for heating processes (30% of total sector emissions); other processes including lime production.

In 2013, 95% of total GHG emissions for the sector were from emissions of carbon dioxide from processes (primarily cement and iron and steel production). 3% of total GHGs emissions are from the use/production of F-Gases, predominantly HFCs from its use in refrigeration and air conditioning.

Features of the Trends

Overall, Industrial Process sector emissions in England have reduced by 83% since the Base Year to 2013 (Table 2.8). This large decline in emissions is due to several factors including: improved abatement and subsequent closure of the adipic acid production, a decline in manufacturing (e.g. closure of several cement plants and the Britannia Zinc smelter), abatement and plant closures in the chemical sector (e.g. nitric acid production, carbon black production), and a large reduction in emissions from the manufacture of HFCs through installation of improved abatement systems on HCFC production plant.

Emissions increased from 2012 to 2013 due to increased output from the iron and steel industry as well as the cement industry.

Traded and Non-Traded Emissions

Emissions in the Industrial Process sector include significant contributions from installations reporting in the EU ETS. However, due to the lack of detail in the EU ETS dataset, the Business and Industrial Process emissions are not easy to separate.

The contribution to total aggregate emissions from the traded and non-traded sector across the Business and Industrial Process sectors are presented in Figure 2.8 in the Overview section under the category: “Industry”.

Emissions on an End User Basis

As the majority of emissions in the Industrial Process sector are not due to energy consumption, Industrial Process sector emissions on an End User basis are very similar to the By Source inventory emissions: in 2013, the End User estimates are only 4% higher for the Industrial Process sector, reflecting the relatively low contribution to sector emissions from the use of electricity or fossil fuels as feedstock or for energy.

2.8 Agriculture Sector

Figure 2.36: Overall Contribution to 2013 GHG emissions, England

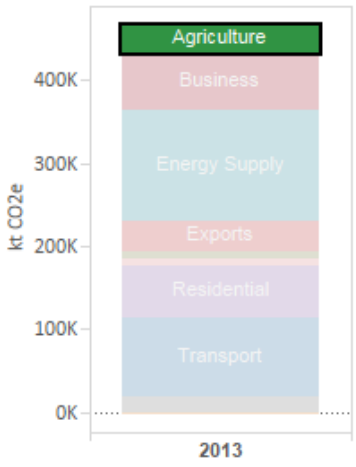


Figure 2.37: Total GHG Emissions from Agriculture, Base Year to 2013, England

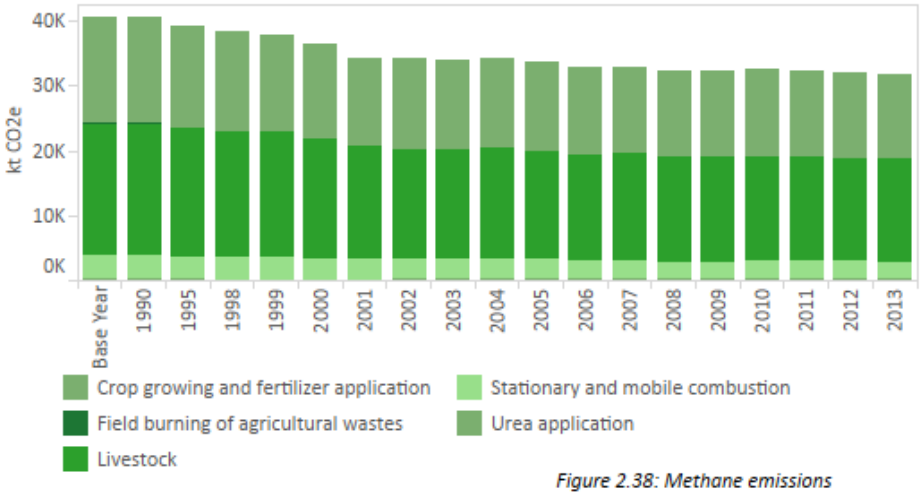


Table 2.9: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, England

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Crop growing and fertilizer application	-20.0%	-3,232.8	-1.1%	-142.0
Field burning of agricultural wastes	-100.0%	-246.7	N/A	0.0
Livestock	-21.6%	-4,395.5	0.5%	81.6
Stationary and mobile combustion	-24.1%	-837.7	-1.4%	-38.0
Urea application	-23.2%	-61.7	-26.5%	-73.6
Agriculture Total	-21.7%	-8,774.3	-0.5%	-172.0

Figure 2.38: Methane emissions from livestock by type, 2013, England

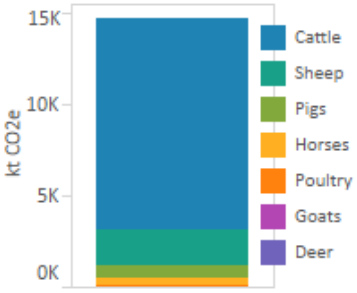


Figure 2.39: GHG Contribution for Agriculture Emissions, 2013, England

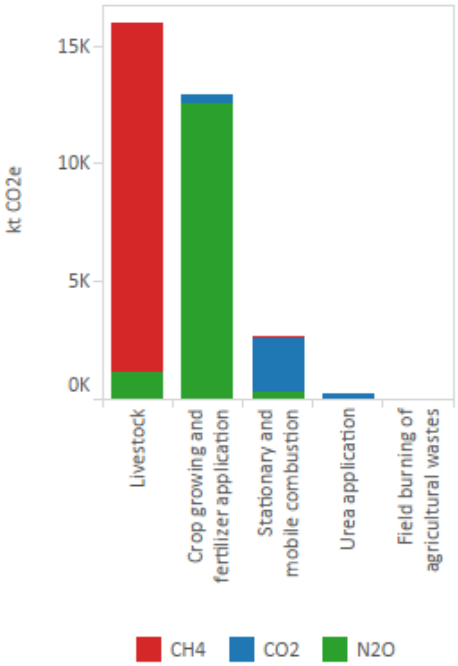


Table 2.10: Emissions of nitrous oxide from agricultural sources in 2013 (kt CO2e), England*

Manure management				1,131
Soils				12,409
	Direct			9,705
		Crop residues		2,024
		Fertiliser		3,709
		Grazing returns		2,563
		Histosols		511
		Manure application		705
		Sewage sludge		193
	Indirect			2,704
		Deposition		862
			Fertiliser	371
			Grazing returns	311
			Manure application	141
			Sewage sludge	39
		Leaching		1,842
			Crop residues	455
			Fertiliser	835
			Grazing returns	350
			Manure application	159
			Sewage sludge	43
Mineralisation				99
TOTAL				13,638

*Total emissions comprise manure management, soils and mineralization. Soils include direct and indirect emissions; indirect emissions include leaching and deposition.

By Source Emissions

Overview

Figures 2.36 – 2.39 show detailed emissions and trends for the sector. The Agriculture sector contributed 7% to total 2013 GHG emissions in England. GHG emissions from this sector comprise mainly of nitrous oxide (44%) from fertilizer application to soils including management of manure (related to handling of manure before it is added to the soil) and methane (47%) from livestock including enteric fermentation and management of manure, with a small amount of carbon dioxide (9%) from agricultural combustion and agrochemical use.

Features of the Trends

Overall emissions from the Agriculture sector have reduced by 22% since the Base Year (Table 2.9). Methane emissions from agriculture are largely dependent on the numbers of livestock and have fallen by 22% from 1990 to 2013, mainly due to a decline in cattle and sheep numbers. Nitrous oxide emissions from agriculture have fallen by 18% from 1990 to 2013 resulting from a general decline in livestock numbers and in fertiliser nitrogen use.

There was a small decrease (0.5%) in total agricultural emissions from 2012 to 2013 primarily due to a decrease in emissions from liming and urea application.

Sector Detail

Methane livestock emissions include two main sub-categories: emissions from enteric fermentation (a digestive process by which carbohydrates are broken down by microorganisms into simple molecules) and emissions from manure management. Emissions from dairy and beef cattle (enteric and manure management emissions combined) accounted for 69% of the total agricultural methane emissions. Total emissions from sheep made up 13% of the total methane from agriculture in England, 2013.

Nitrous oxide emissions are largely driven by fertiliser nitrogen use, manure applications and grazing returns to soils. 90% of nitrous oxide emissions from agriculture arise from the agricultural soils category (see Figure 2.39). A relatively small proportion is emitted from the management of animal manure (emissions related to handling of manure before it is added to the soil). Table 2.10 gives a detailed breakdown of nitrous oxide emissions from agriculture for England.

Emissions on an End User Basis

As the majority of emissions in the Agriculture sector are not due to energy consumption, agriculture sector emissions on an End User basis are very similar to the emissions By Source; in 2013, the End User estimates are only 5% higher for the Agriculture sector, reflecting the relatively low contribution to sector emissions from the use of oils and electricity, compared to the higher-emitting sources of nitrous oxide and methane from soils and livestock sources.

2.9 Land Use, Land Use Change and Forestry Sector

Figure 2.40: Overall Contribution to 2013 GHG emissions, England

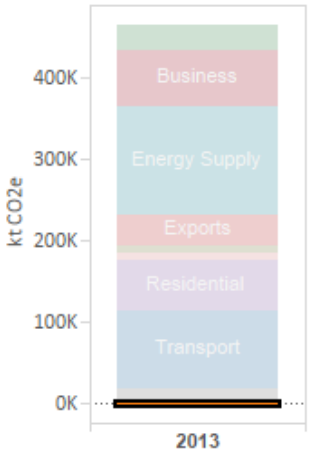


Figure 2.41: GHG Contribution to Land Use Change Emissions, 2013, England

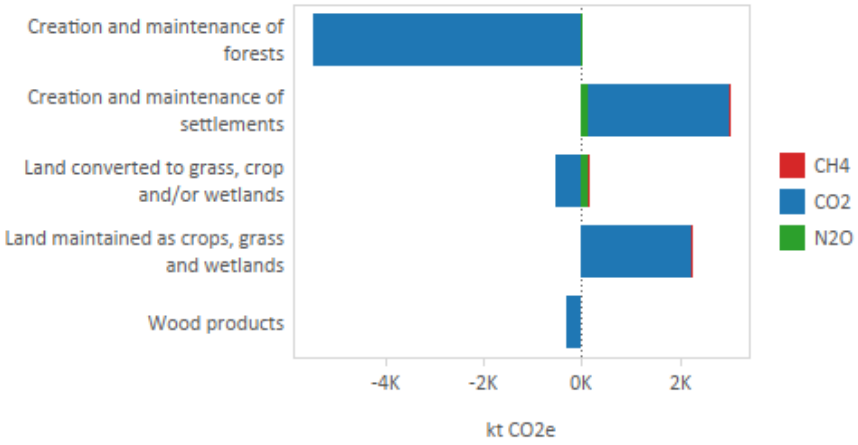
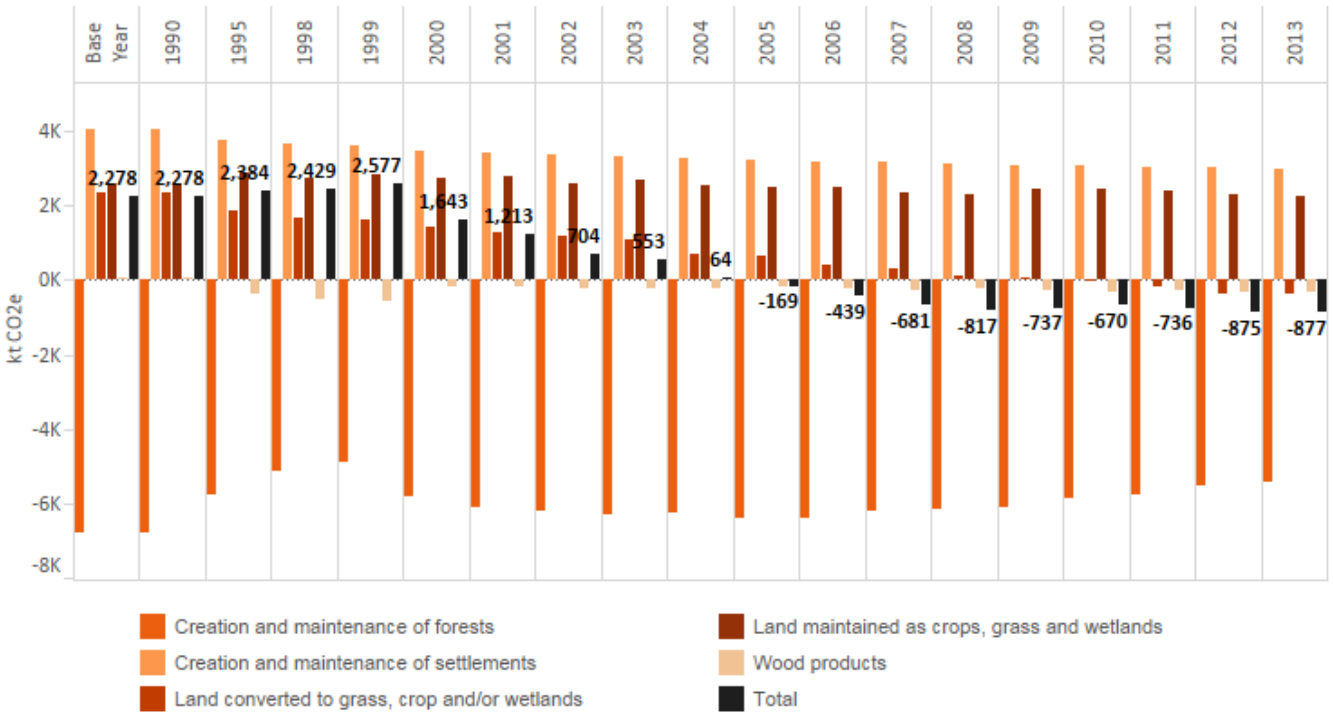


Table 2.11: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, England

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Creation and maintenance of settlements	-26%	-1,055	-1%	-24
Creation and maintenance of forests	-20%	1,342	-1%	77
Land converted to grass, crop and/or wetlands	N/A	-2,712	N/A	-17
Land maintained as crops, grass and wetlands	-13%	-343	-3%	-58
Wood products	N/A	-387	N/A	20
Land Use Change Total	N/A	-3,156	N/A	-2

Figure 2.42: Total GHG Emissions from LULUCF, Base Year - 2013, England



By Source Emissions

Overview

Figures 2.40 – 2.42 show detailed emissions and trends for the sector. England was a net sink of greenhouse gases from Land Use, Land Use Change and Forestry (LULUCF) activities in 2013. In the Base Year England was a net source of emissions from LULUCF changing to a net sink in 2005.

Emissions arise from the clearing of land (burning and decomposition of material) for the creation of settlements (towns and urban areas), grasslands, croplands and sometimes also for new forest planting. Carbon dioxide is removed from the atmosphere[16] by activities that manage and maintain grass and forest lands encouraging vegetation growth and minimising losses to the atmosphere of carbon dioxide from decomposition of materials.

More details regarding this sector can be found in Appendix 8.

Features of the Trends

Table 2.11 shows a less than 1% increase in the net removal of CO_2e from LULUCF between 2012 and 2013 (an increase in the size of the sink), along with the trends in emissions and removals from land converted to settlements, cropland and wetland drainage and removals from Creation and maintenance of forests, which have continued to be a significant sink across the time series. While the emission sources have continued to decline, the forest sinks have also declined since the Base Year due to increased harvesting.

Emissions from Land Converted to Grass, Crop and Forest has decreased significantly due to a reduction in the amount of land converted from forest/grass land to cropland (which releases carbon from clearing of biomass and from ploughing of soils) while removals as a result of land converted to grassland (which allows carbon to build-up and be stored in the soils) have increased, resulting in a switch of the category from a source to sink across the time series.

Emissions on an End User Basis

As emissions and removals from LULUCF do not related to energy supply the End User emissions are the same as emissions By Source.

[16] Removals are presented as negative emissions in the inventory tables.

2.10 Waste Management Sector

Figure 2.43: Overall Contribution to 2013 GHG emissions, England

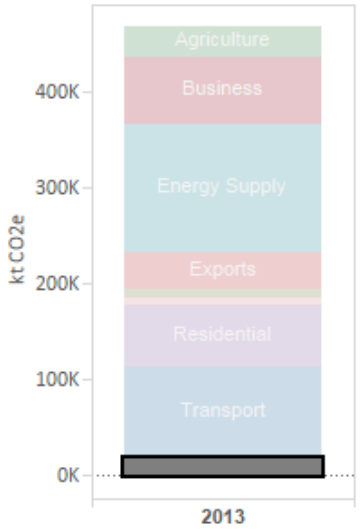


Figure 2.44: Total GHG Emissions from Waste Management, Base Year to 2013, England

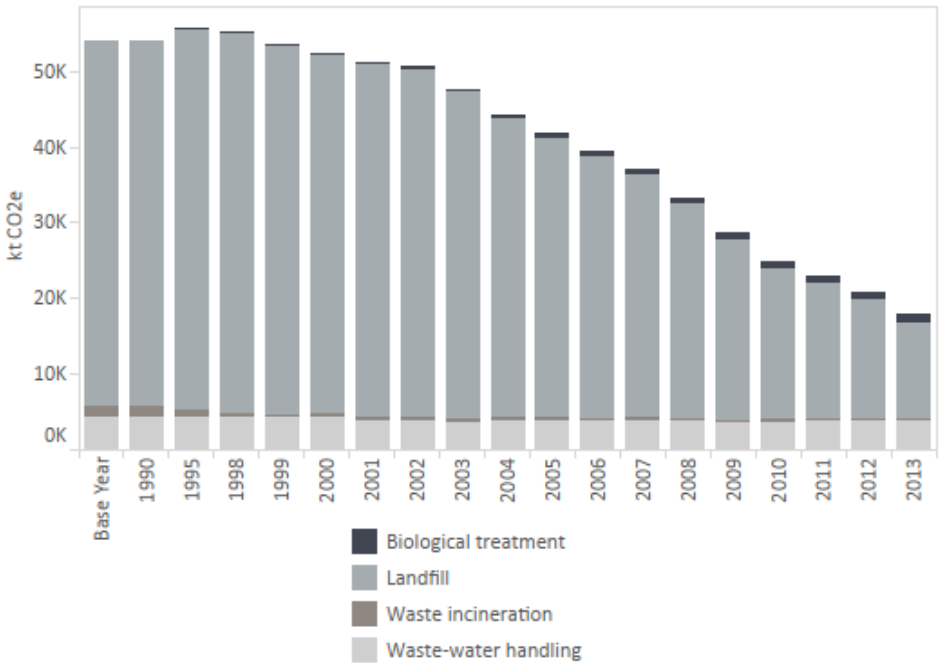
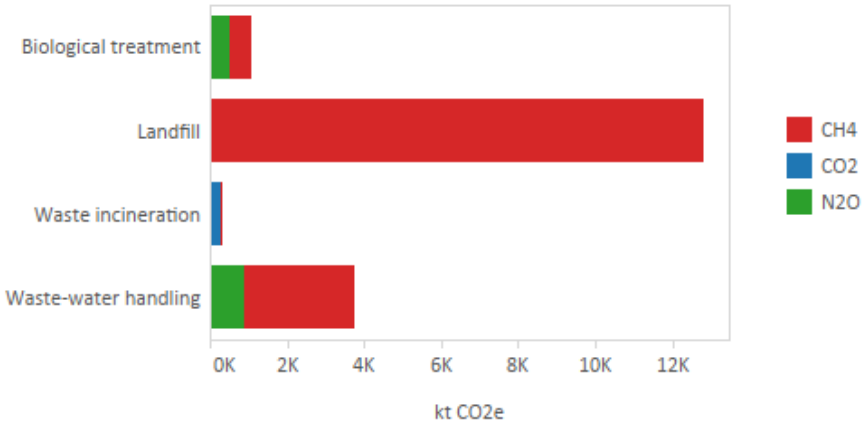


Table 2.12: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, England

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Landfill	-73.5%	-35,608.4	-18.8%	-2,964.1
Waste incineration	-79.1%	-1,040.7	1.4%	3.7
Waste-water handling	-13.5%	-584.3	-0.2%	-7.0
Biological treatment	N/A	1,078.5	6.3%	64.3
Waste Management Total	-66.9%	-36,154.9	-13.9%	-2,903.2

Figure 2.45: GHG Contribution to Waste Management Emissions, 2013, England



By Source Emissions

Overview

Figures 2.43 – 2.45 show detailed emissions and trends for the sector. The Waste Management sector contributes 4% to total GHG emissions in England, and is the largest source sector for methane emissions, representing 44% of total methane emissions in 2013. Emissions from this sector are dominated by methane from landfill (72% of total GHGs from the Waste Management sector), with a smaller contribution of emissions of methane and nitrous oxide from wastewater treatment (21%).

The majority of total GHG emissions from Waste Management are methane (91% in 2013). Nitrous oxide emissions from waste water treatment represent 5% of emissions in the sector, and contribute 5% to the total emissions of nitrous oxide in England in 2013.

Features of the Trends

Table 2.12 shows the change in emissions between the Base Year and 2013, and between 2012 and 2013 for the sector. Emissions of GHGs from the Waste Management sector in England have shown a significant decline of 67% in total for the sector and by 74% from landfill between 1990 and 2013, due largely to the progressive introduction of methane capture and oxidation systems within landfill management. Sector GHG emissions have decreased between 2012 and 2013 by 14%, which is mainly due to UK-wide reductions in methane emission estimates from landfill due to improved management systems.

Emissions on an End User Basis

As emissions from the Waste Management sector do not include any energy consumption sources, and no electricity use is allocated to the Waste Management sector (due to a lack of data to correctly allocate to the Waste Management sector), the End User emission estimates for the sector are unchanged from the emissions presented here on a by source basis.

3 Emission Estimates in Scotland (1990-2013)

3.1 Overview of Total Emissions

By Source Emissions

Overview

The greenhouse gas (GHG) emissions for Scotland for 1990 – 2013 are presented in Table 3.1 and in the graph in Figure 3.1 below. The table below includes a summary of emissions from International Aviation and Shipping; the subsequent tables and figures and the discussion of trends and percentage shared by sector do not include emissions from these sectors.

Table 3.1: 1990-2013 Scotland GHG Emission Inventory ($ktCO_2e$)

NC Format	Base Year	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	% of 2013
Agriculture	10,814	10,814	10,790	10,418	9,856	9,209	9,250	9,243	9,232	9,139	9,163	18%
Business	12,502	12,377	10,391	10,583	10,488	9,902	8,689	8,883	8,716	8,431	8,608	17%
Energy Supply	22,729	22,729	26,786	26,212	20,762	20,017	18,716	20,867	17,044	17,493	16,017	32%
Industrial Process	1,853	1,921	572	592	540	523	401	388	447	441	495	1%
LULUCF [17]	92	92	-248	-1,599	-3,425	-4,073	-4,071	-4,357	-4,821	-5,030	-5,199	-10%
Public	1,684	1,684	1,803	1,640	1,528	1,477	1,252	1,315	1,249	1,239	1,243	2%
Residential	8,046	7,988	7,778	7,775	7,606	7,378	7,091	7,929	6,187	7,004	7,000	14%
Transport	10,637	10,637	10,608	10,915	11,495	11,415	10,966	10,791	10,576	10,619	10,529	21%
Waste Management	9,862	9,862	10,082	9,060	6,967	5,362	4,598	3,933	3,599	3,207	2,703	5%
Sub-total [18]	**78,220**	**78,105**	**78,562**	**75,595**	**65,817**	**61,211**	**56,892**	**58,992**	**52,232**	**52,543**	**50,558**	**100%**
International aviation & shipping	2,566	2,566	2,597	2,379	2,611	3,079	2,893	2,519	2,611	2,397	2,403	
Total	**80,786**	**80,671**	**81,159**	**77,974**	**68,428**	**64,290**	**59,784**	**61,511**	**54,843**	**54,940**	**52,961**	

Trends

Figure 3.1 shows the full trend of emissions from the sectors, highlighting that the Energy Supply sector has consistently been the most prominent sector and is the source of much of the reduction in emissions that has been seen since 1990, along with Waste Management and LULUCF. This can also be seen in Figure 3.2, which also shows the change in emissions. This considers the change from 2012 to 2013 as well as the overall trend: 1990-2013.

As indicated in these graphs and the table above, emissions in Scotland have decreased between 2012 and 2013 by 3.8%, with emission reductions between the Base Year[19] and 2013 of 35% for all GHGs. Net emission reductions are the result of many factors from across the economy, including: improvements to landfill gas management practices, efficiency improvements and fuel switching in power generation, a decline in manufacturing (e.g. the closure of the Ravenscraig Steel works in 1992), efficiencies in energy generation and Business heating, an increase in the storage of carbon in forests and grassland and reduced carbon losses from cropland.

The reasons for the decrease in emissions between 2012 and 2013 are given below for each sector along with the significance of this change. **It is predominantly driven by a shift from coal to nuclear and renewable energy sources in the energy sector.**

The following list provides an overview of the trend for each NC sector:

[17] Land Use, Land Use Change and Forestry (LULUCF)

[18] Emission estimates from International Aviation and Shipping are not included in this total because these sources are "memo items" and thus not included in the UK emission estimates.

[19] 1995 for fluorinated greenhouse gases (F-Gases) and 1990 for all other gases

- **Energy Supply** sector emissions have decreased by 30% between the Base Year and 2013. Emissions reduced by 8% between 2012 and 2013, primarily due to the shift from coal- and oil-fired power generation to nuclear and renewable energy sources in power stations.
- **Waste Management** sector emissions have significantly decreased since the Base Year, largely due to the progressive introduction of methane capture and oxidation systems within landfill management. Emissions decreased by 16% between 2012 and 2013 due to reductions in landfill methane emissions.
- **Business** sector emissions have declined since the Base Year by 31% mainly from significant reductions in the iron and steel industry. However, emissions increased by 2% between 2012 and 2013 mainly due to an increase in natural gas combustion from miscellaneous industry and commercial sector, and the chemicals industry.
- **LULUCF** sector has been a net sink since 1995, and this sink has increased between 1995 and 2013. This has been due to an increase in the size of the forest carbon stocks and reduced emissions from the conversion of grassland and forests to cropland. Many changes have taken place resulting in an increase in the size of the sink between 2012 and 2013. The most significant is a reduction in emissions from land converted to cropland.
- **Transport** sector emissions have decreased by only 1% between the Base Year and 2013. Improvements in efficiency of transport vehicles have been offset by a growth in transport demand over the period. Emissions between 2012 and 2013 decreased by less than 1%.
- **Industrial Process** emissions have decreased significantly since the Base Year due to the closure of Iron and Steel works, nitric acid plant and reductions in cement production. Emissions increased by 12% between 2012 and 2013 due to increased production of cement and aluminium.
- **Agriculture** sector emissions have reduced since the Base Year mainly due to a decrease in livestock numbers. There was a small increase of less than 1% in emissions from 2012 to 2013 due to increased emissions from fertilizers applied to grass being partially offset by a decrease in the number of dairy cows and the corresponding reduction in emissions.
- **Public** sector emissions have reduced since the Base Year through improvements to building energy efficiency and a trend towards the use of gas-fired boilers and heating for many Public sector buildings since 1990. This is due to increased energy efficiency measures and the switch to gas-fired heating. Emissions between 2012 and 2013 increased by less than 1% due to an increase in emissions from natural gas combustion, which was partially offset by a decrease in emissions from fuel oil combustion.
- **Residential** sector emissions have decreased by 13% since the Base Year as a result of improvements to energy efficiency and fuel switching from solid and liquid to gaseous fuels. Small reported changes in solid and liquid fuels, with a decline in gas combustion estimates, led to marginally lower emissions in 2013 compared to 2012.

Emissions Detail

Detailed analysis of Scotland emissions in 2013 is presented in Figures 3.1 – 3.5. The dominant sub-categories in the inventory for 2013 are displayed in Figure 3.5. These include emissions from electricity production (23% of total), road transport (18% of total), Residential combustion for heating and cooking (13% of total), industrial combustion for heat and electricity in the Business sector (14% of total) as well as the significant sink from the removal of emissions from the creation and maintenance of forests.

Figure 3.3 shows the emissions split by GHG and highlights the 2.5 and 97.5 percentile uncertainty range. The range of uncertainty is greatest for nitrous oxide emissions from agricultural soils. See Appendix 1 for further details on uncertainties. Carbon dioxide emissions make up the largest component of all National Communication (NC) sector emissions with two exceptions: Agriculture, where methane from livestock and nitrous oxide from soils make large contributions, and Waste Management where methane from landfills is the main GHG emission source (see Figure 3.4).

International Aviation and International Shipping

Emissions from international aviation in the UK have increased by 107% since 1990, and Scotland shows a similar trend increasing by 108% over that period. This reflects the growth in aviation and the increase in international routes. From 2012 to 2013, emissions from international flights have decreased slightly across the UK, down less than 1%, whilst emissions in Scotland have increased by almost 4%. Analysis of the detailed flight records shows that a growth in flights from Glasgow to Dubai is one of the reasons for this recent increase.

UK emissions from international shipping have decreased by around 4% between 1990 and 2013 whilst emissions from Scotland have decreased by 37% over this time period. The UK shows a 3% decrease in international shipping emissions between 2012 and 2013, and Scotland emissions have also decreased by 3%, reflecting the continued decline in Scotland's port freight movements.

Recalculations

Inventory recalculations of source estimates due to new data and/or improved inventory estimation methodologies have led to revisions to the estimates since the last inventory report (Salisbury et al., 2013). The impact of these revisions to Scotland GHG emission estimates for 2012 is an increase of 2,044 $ktCO_2e$ (3.9%).

The 2006 IPCC Guidelines (IPCC, 2006) have been adopted and supersede the 1996 IPCC Guidelines (IPCC, 1996). This change has led to the implementation of updated methodologies and emission factors, inclusion of additional sources and emissions of NF_3, improvements to the global warming potential (GWP) factors used. This has affected all sectors in the inventory. The most significant revisions to the 2012 estimates in each sector are given below:

1. **LULUCF (650 $ktCO_2e$)**: Revised data has enabled emissions from improved Grassland on drained organic soils to be reported for the first time, and allowed more complete reporting on emissions from Cropland on drained organic soils. Emissions of nitrous oxide from soil mineralisation following land use change and drainage of Forest soils have been estimated for the first time which as increased reported emissions.
2. **Agriculture (536 $ktCO_2e$)**: Emission factors and methodologies have been updated from the 1996 IPCC Guidelines to the 2006 IPCC Guidelines. Enteric emissions of methane from all livestock (especially cattle and sheep) have increased significantly compared to previous inventory estimates, and in Scotland this more than compensates for a decrease in emissions of nitrous oxide from agricultural soils, leading to an overall increase in the agriculture inventory emissions for Scotland.
3. **Waste Management (438 $ktCO_2e$):** New data on landfill methane flaring from site operators and regulators has improved methane recovery data. The method to estimate methane formation within landfills has been improved to incorporate new data. Industrial and domestic waste water treatment methods were revised to be consistent with 2006 IPCC Guidelines and a calculation error was identified and corrected, which increased emissions across the time series for this source. New emission estimates were included from private sewage treatment facilities and composting.
4. **Energy Supply (365 $ktCO_2e$):** Allocation of emissions from Lynemouth coal-fired power station has been corrected (from autogeneration to power generation) to be consistent with DUKES. This slightly increases the power sector emissions in Wales, Scotland and Northern Ireland. DUKES allocation for gas use in energy industries has been revised up increasing estimates for carbon dioxide emissions.
5. **Business (349 $ktCO_2e$):** Implementation of a revised time-series for the group of petroleum fuels that are regarded as non-energy use (NEU) due to their use in petrochemical manufacture has led to an increase in emissions in all years. There has also been incorporation of Phase III ETS data which has led to improvements in the completeness and allocation of the inventory for chemical sites. These increases are partly offset in Scotland by the reduction in emission estimates from fuel combustion due to DUKES revisions across several sectors including autogeneration and other (unclassified) industry.

For more details of revisions to GHG emission estimates, see Appendix 6.

Figure 3.1: Total GHG Emissions by NC category for Base Year to 2013, as kt CO2e, Scotland

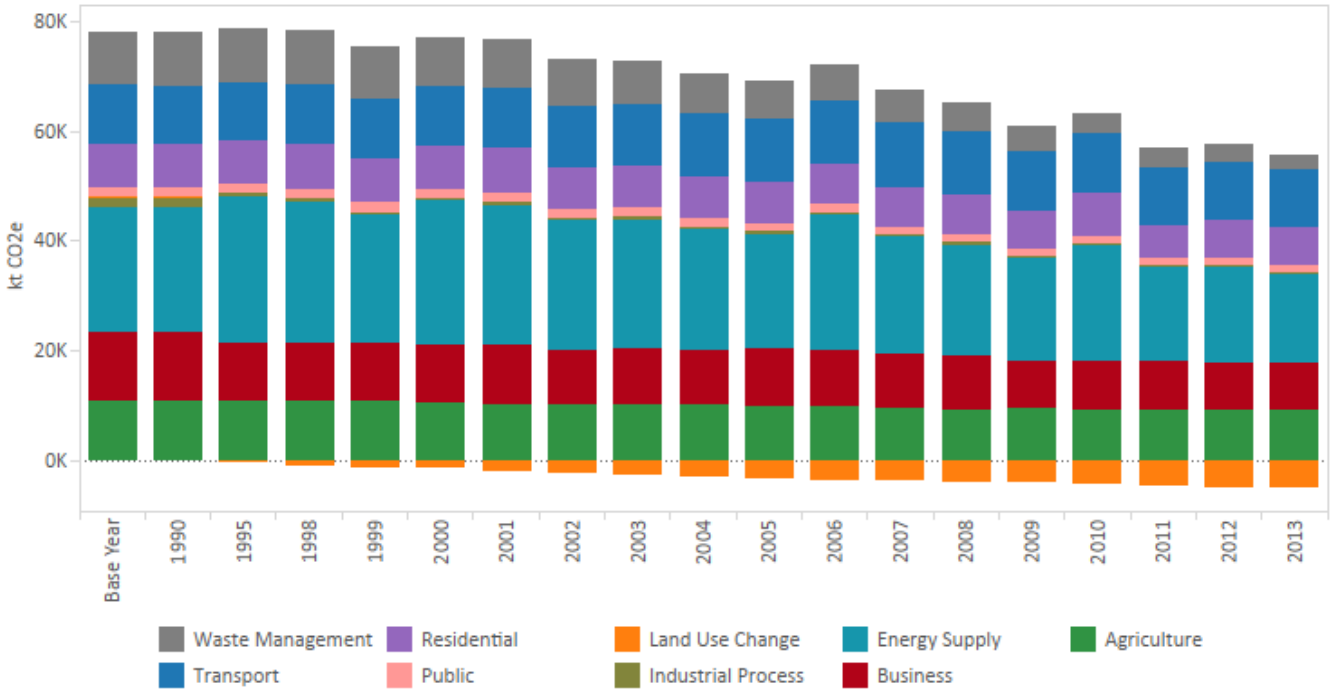
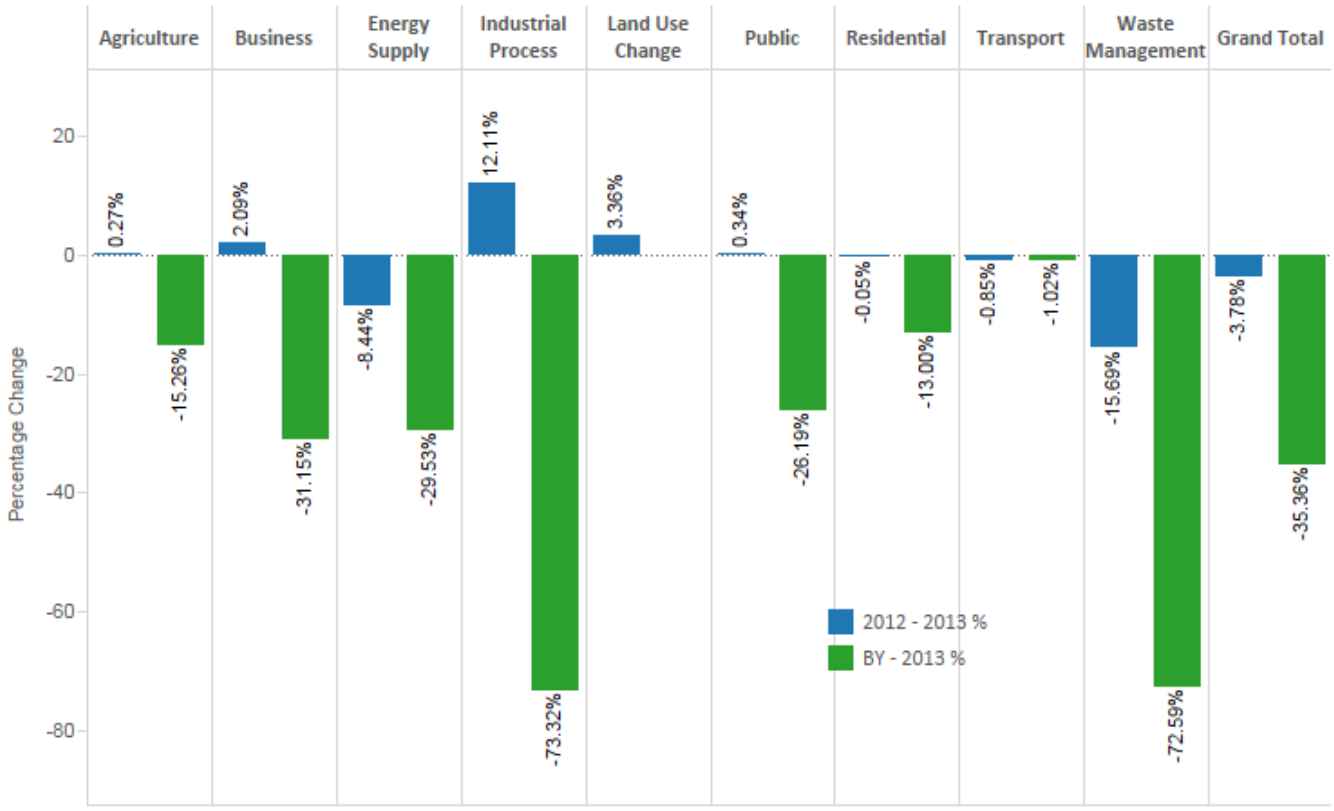


Figure 3.2: Percentage Change and Absolute (kt CO2e) Change in GHG Emissions by NC: 2012 - 2013 and Base Year (BY) - 2013, Scotland

The LULUCF Base Year - 2013% change is excluded from the figure if LULUCF emissions changed from a sink to source, or source to sink, across the time series.



	Agriculture	Business	Energy Supply	Industrial Process	Land Use Change	Public	Residential	Transport	Waste Management	Grand Total
BY - 2013 kt	-1,650	-3,894	-6,712	-1,359	-5,291	-441	-1,046	-108	-7,159	-27,662
2012 - 2013 kt	25	176	-1,477	53	-169	4	-3	-90	-503	-1,985

Figure 3.3: Total GHG emissions and uncertainties by pollutant, 2013, Scotland

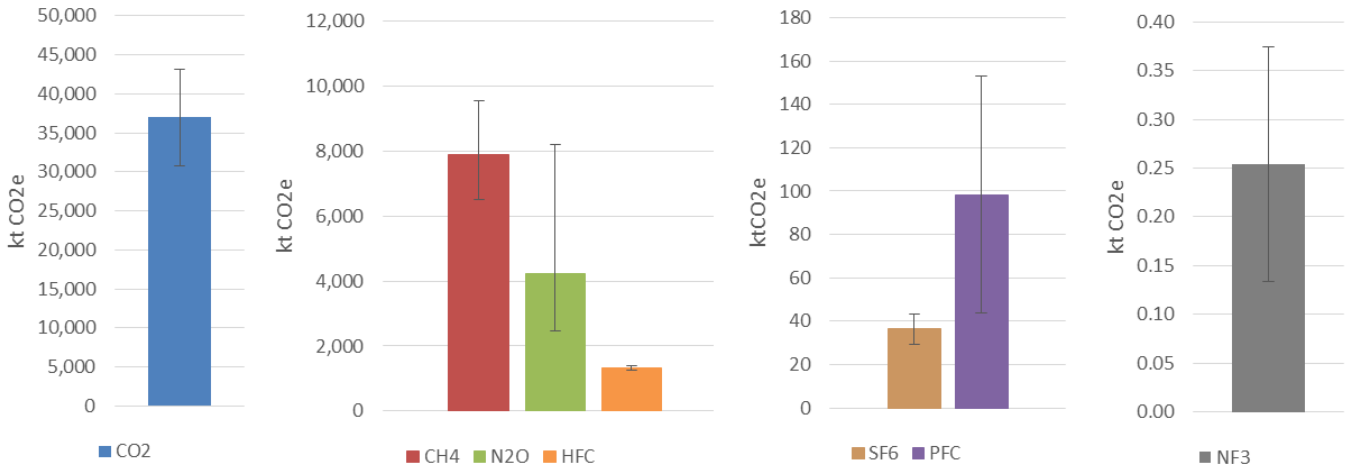


Figure 3.4: Total GHG Emissions by NC and pollutant, 2013, Scotland

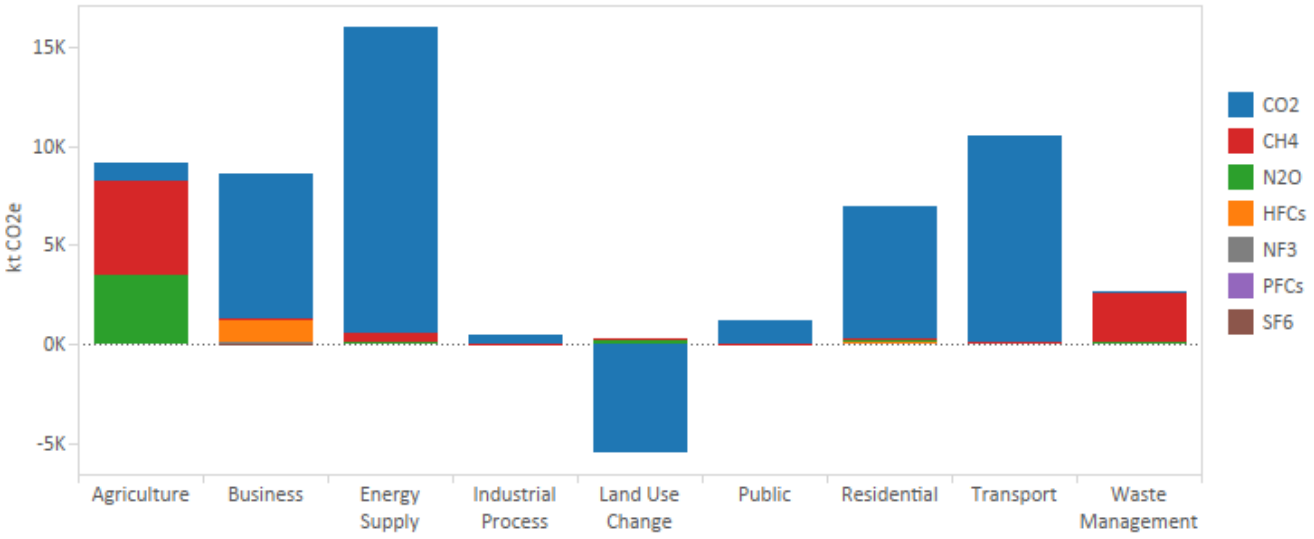
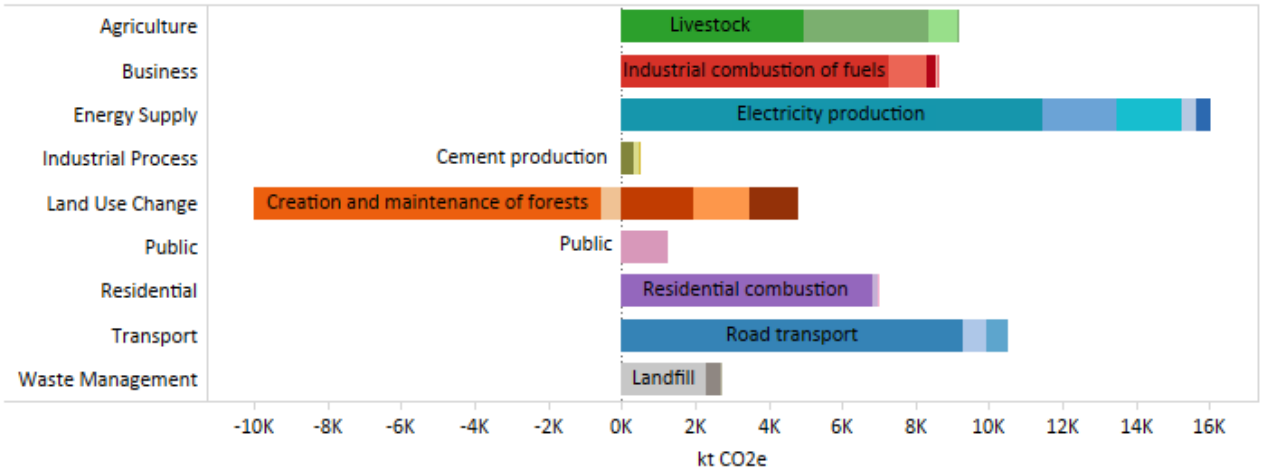


Figure 3.5: Total GHG Emissions labelling the largest sub-category in each NC, 2013, Scotland



Traded and Non-Traded Emissions

Emissions from installations in the European Union Emissions Trading System (EU ETS) (see Figure 3.6) contributed 38% of total net GHG emissions in Scotland in 2013. The main contributors to these traded emissions are the Energy Supply, Business and Industrial Process sectors.

Figure 3.7 shows emissions from installations included in the EU ETS reduced by 8% between 2008 and 2009 as a result of the reduced demand for energy and products due to the recession. However, the traded sector in Scotland then bounced back with an increase of over 9% between 2009 and 2010, which was a much higher growth than the UK average of 2% due, primarily, to an increase in power generation EU ETS emissions. Since 2011, the traded sector emissions have been relatively stable.

Figure 3.6: Total Traded and Non-Traded GHG Emissions by NC Category, 2013, Scotland

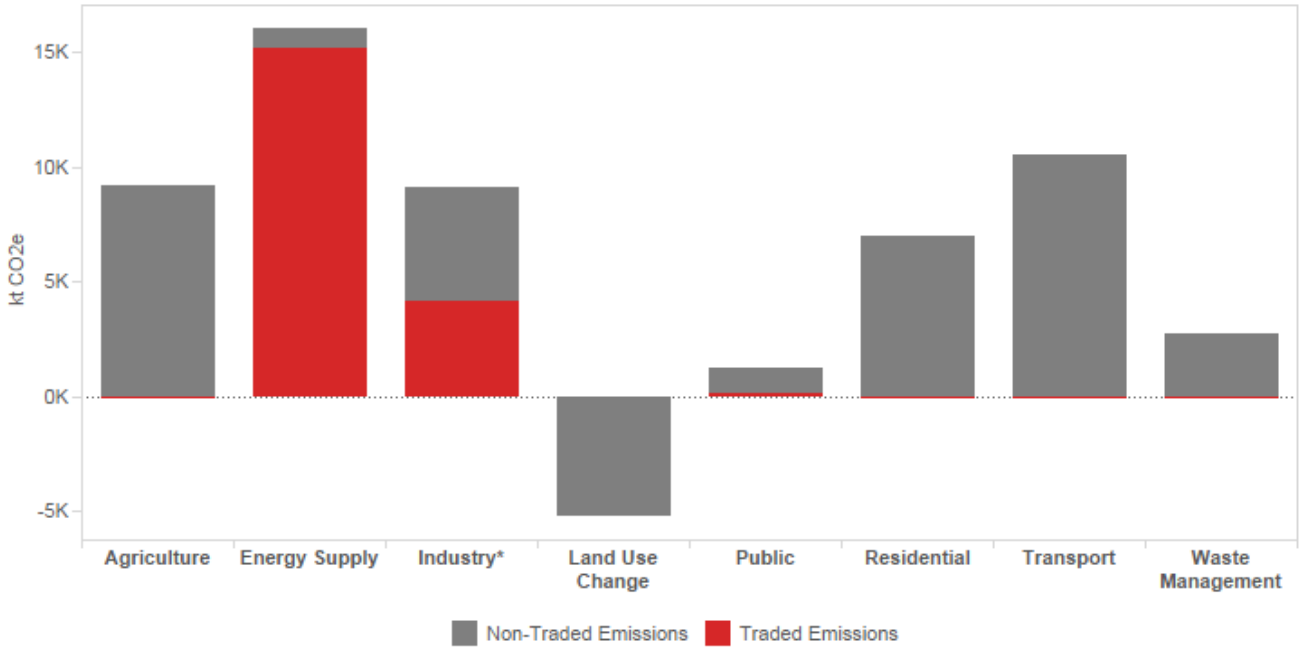


Figure 3.7: Total Traded and Non-Traded GHG Emissions 2008-2013, Scotland

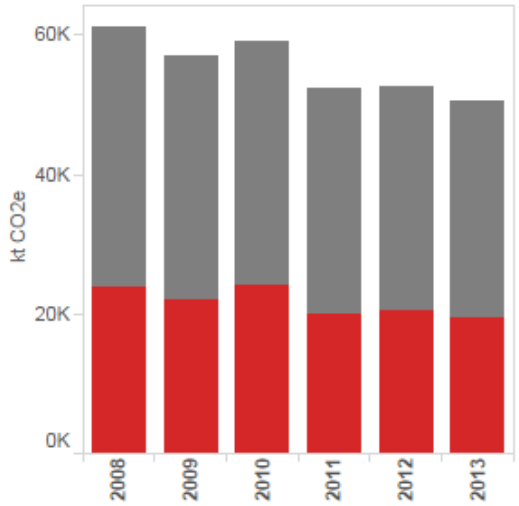
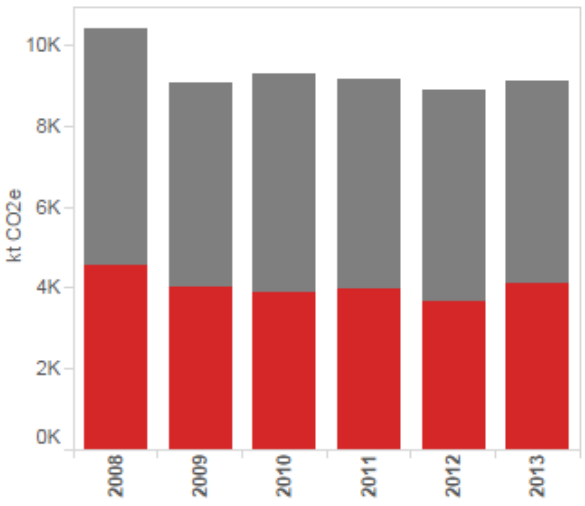


Figure 3.8: Traded and Non-Traded GHG Emissions from Industry 2008-2013, Scotland*



*Industry includes emissions from the NC categories: Industrial Process and Business

Emissions on an End User Basis

In addition to presenting emissions based on direct emissions from processes or combustion of fuels in Scotland, the emissions from the Energy Supply sector can be attributed to the users of the energy (see Appendix 3 for more details of the End User inventory methodology). Figure 3.9 illustrates the difference between the By Source and End User inventory emission estimates and how emissions from the Energy Supply sector are attributed to the other sectors.

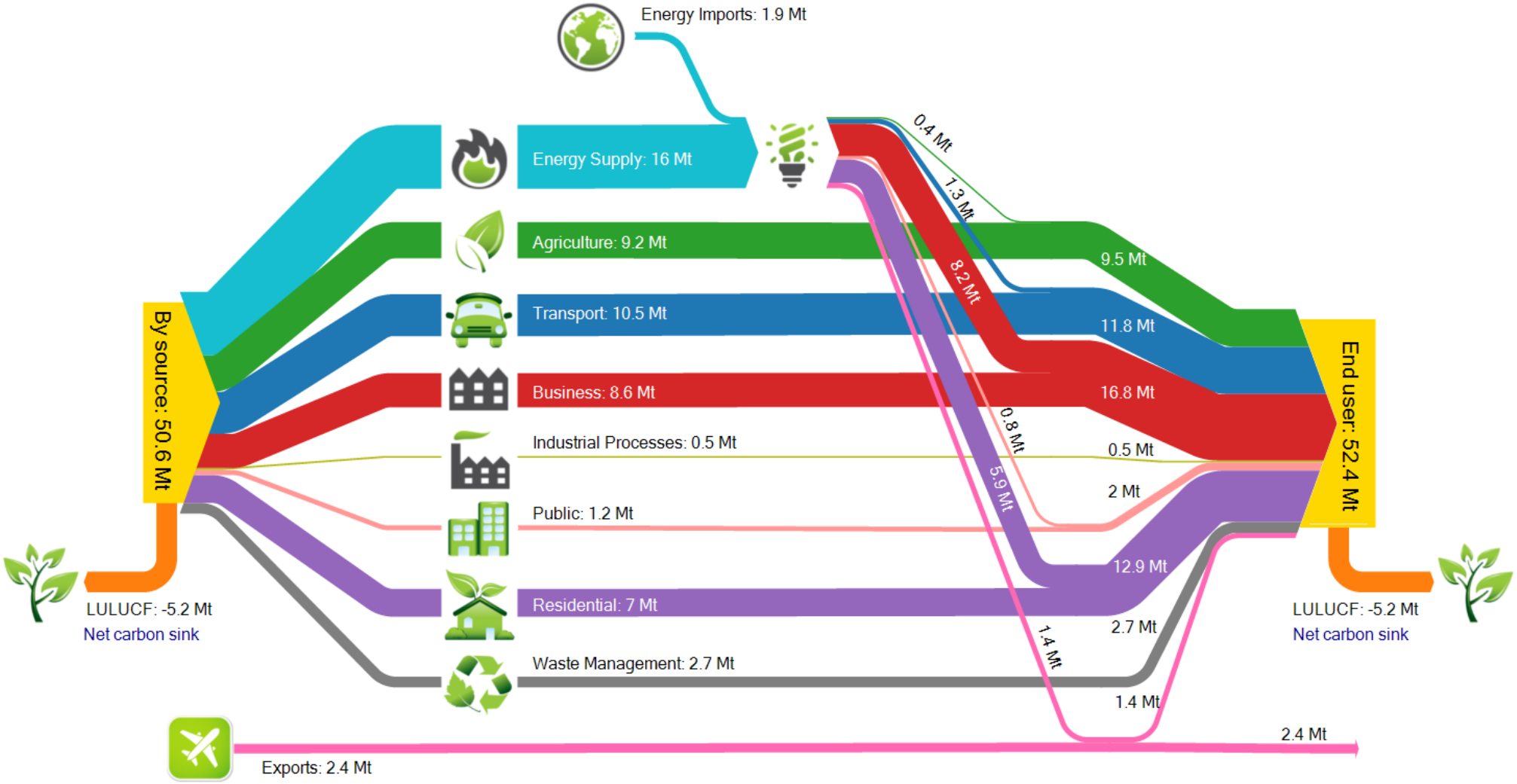
The primary difference in the End User inventory is the significant increase in emissions attributable to the Business, Residential, Transport and Public sectors. As illustrated in Figure 3.9, Scotland has slightly higher net GHG emissions in Scotland on an End User basis (52.4 $MtCO_2e$), compared to the By Source inventory estimates for 2013 (50.6 $MtCO_2e$). However, when emissions associated with exports (i.e. UK-based emissions associated with the generation of fuels – mainly refined oils and electricity – that are ultimately exported from the UK) are discounted from the DA inventories, Scotland End User emissions are only slightly higher than the By Source estimates.

The End User model applies a UK-wide greenhouse gas emission factor to electricity use, and this has an important impact on the data for Scotland, in particular. Scotland was a net exporter of electricity to the rest of the UK in 2013, but the application of a UK-wide factor for electricity generation to all UK electricity consumption means that Scotland is a net importer of electricity emissions in the End User inventories.

This is because the greenhouse gas emissions ($ktCO_2e$) per unit of electricity (GWh) in Scotland are very much lower than the UK average in 2013 due to the higher proportion of renewable and nuclear generation in the Scotland power sector. However, as previously stated, the End User model applies a UK-wide GHG emission factor to electricity use, so does not take into account the lower emission factor for Scotland. This increases the total emissions for Scotland in the End User model. As a result, the total End User emissions are actually higher than the By Source Energy Supply sector emissions. This implies that Scotland is a net importer of electricity, which is not the case.

Emissions from the Land Use, Land Use Change and Forestry (LULUCF), Industrial Process and Waste Management sectors in Scotland in 2013 are unchanged between the By Source and End User inventories, since there are no emissions from energy use allocated to these sectors.

Figure 3.9 Sankey diagram showing By Source and End User[20] GHG emission transfers for Scotland in 2013 (Mt CO_2e)[21]



[20] The pink line from 'Energy Supply' to 'End User' represents emissions from Energy Supply in the production of fuels used in international aviation and shipping.

[21] 'Exports' equates to emissions from international aviation and shipping.

3.2 Energy Supply Sector

Figure 3.10: Overall Contribution to 2013 GHG emissions, Scotland

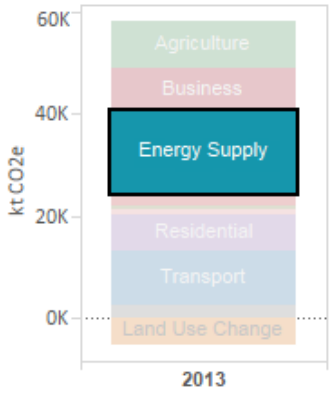


Figure 3.11: GHG Contribution to Energy Supply Emissions, 2013, Scotland

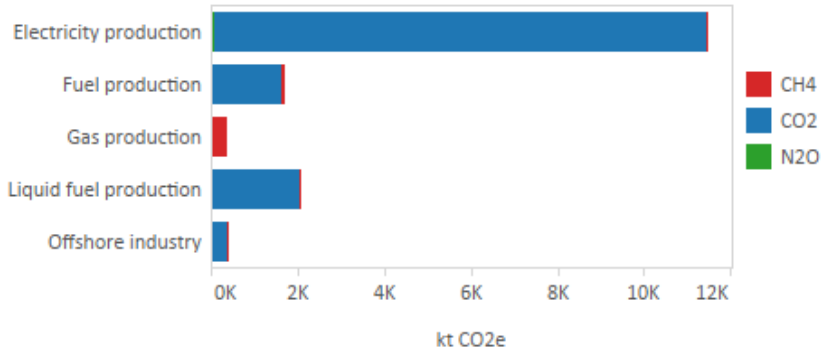


Table 3.2: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Scotland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Electricity production	-23%	-3,327	-11%	-1,384
Gas production	-66%	-715	-5%	-22
Liquid fuel production	-31%	-927	-10%	-234
Offshore industry	-66%	-811	26%	85
Fuel production	-35%	-933	5%	78
Energy Supply Total	-30%	-6,712	-8%	-1,477

Table 3.3: NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions, Scotland

Agriculture	2%
Business	54%
Industrial Process	0%
Public	5%
Residential	38%
Transport	1%
Exports	0%

Figure 3.12: Total GHG Emissions from Energy Supply, Base Year to 2013, Scotland

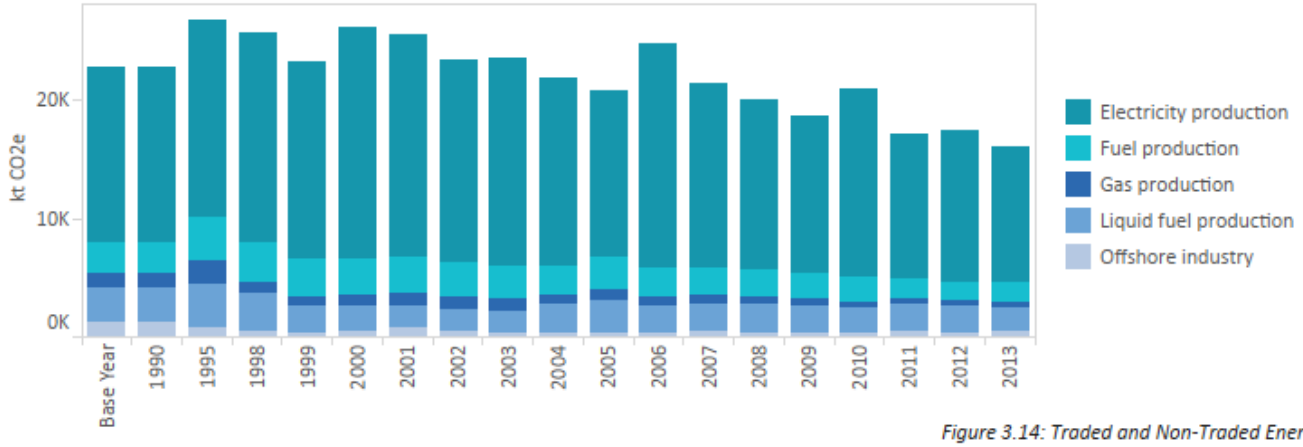


Figure 3.13: Emissions and Electricity Production by Fuel Type from Major Power Producers (1A1a), Scotland

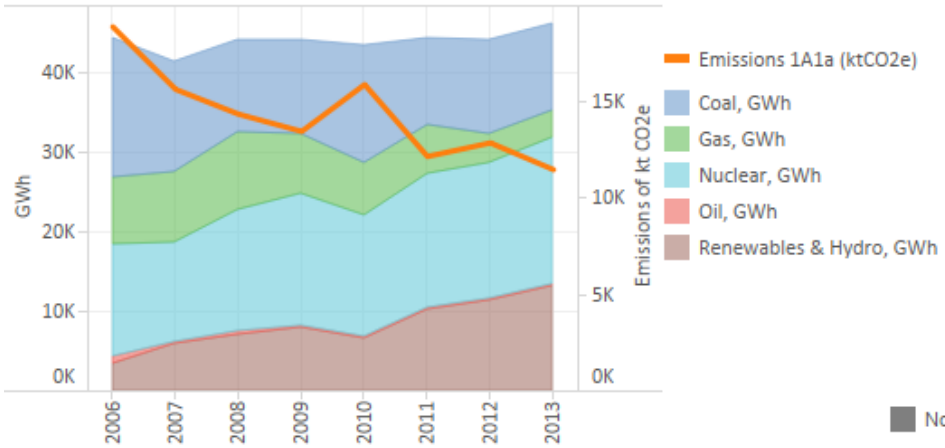
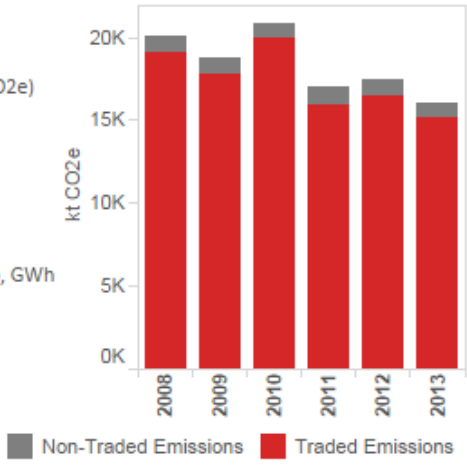


Figure 3.14: Traded and Non-Traded Energy Supply Emissions, 2008-2013, Scotland



*Exports includes emissions from energy production for international aviation, international shipping and exported fuels

By Source Emissions

Overview

Figures 3.10 – 3.14 show detailed emissions and trends for the Energy Supply sector. In Scotland, Energy Supply sources contribute 32% to total 2013 GHG emissions. Energy Supply includes emissions from power generation, refineries, coal mines, solid fuel transformation, oil and gas extraction and processing, and other energy industries. The main source of emissions in Scotland within the Energy Supply sector is electricity generation at power stations, which accounts for 72% of Energy Supply emissions in 2013; refinery emissions account for a further 13% of the Energy Supply sector emissions in 2013.

Features of the Trends

Table 3.2 shows the change in emissions between the Base Year and 2013, and between 2012 and 2013 for the sector. Energy Supply sector emissions have reduced by 30% since the Base Year, compared to the UK average of 32% reductions. Emissions have declined across many sectors such as coal mining, upstream oil and gas production, coke manufacture (due to closure of Ravenscraig Steel works) and oil refining.

Emissions from power stations in Scotland have reduced by 23% between the Base Year and 2013, whereas the UK average is a 28% reduction; this reflects the fact that Scotland generates a high proportion of the UK electricity output, and exports the electricity for consumption in England and Northern Ireland.

Energy Supply sector emissions decreased by 8% between 2012 and 2013. This is primarily due to a shift from coal- and oil-fired power generation to nuclear and renewable energy sources, and a 10% reduction in refinery emissions.

Sector Detail

The mix of power generation in Scotland is shown in Figure 3.13; the fuel mix is notably different from the rest of the UK with high contribution in 2013 from nuclear power and renewable sources of energy (mainly hydro-electricity and onshore wind). The remaining generation capacity is predominantly from coal-fired stations, whilst Scotland has a notably lower share of electricity production from gas-fired stations, at only 8% of the Scottish electricity generation total in 2013 compared to a UK average of 26%.

Only those emissions arising from on-shore installations in Scotland have been included within the Scottish GHG inventory; emissions from upstream oil & gas exploration and production off-shore facilities are reported as “Unallocated”. Carbon dioxide from the combustion of fossil fuels is the predominant gas accounting for 96% of total GHG emissions from the Energy Supply sector in Scotland in 2013.

Traded and Non-Traded Emissions

Emissions in the Energy Supply sector are dominated by installations within the European Union Emissions Trading Scheme (EU ETS), with 95% of emissions in this sector allocated to the traded sector (EU ETS). These traded emissions are primarily from power stations, refineries and upstream oil and gas terminals. See Figure 3.14 for the trend of Traded/Non-Traded emissions.

Emissions on an End User Basis

The “By Source” inventory allocates emissions to the Devolved Administrations in which the emissions occur, and hence the GHG emissions from the power generated in Scotland and subsequently exported to England and Northern Ireland remain allocated to Scotland. In the End User inventories, however, the By Source inventory emissions associated with energy production across the UK are re-allocated to the ultimate users of the energy (see Table 3.3).

However, as noted in the section above, the End User model applies a UK-wide GHG emission factor to electricity use, and therefore whilst Scotland was a net exporter of electricity to the rest of the UK in 2013, the application of a UK-wide factor for electricity generation to all UK electricity consumption means that Scotland is a net importer of electricity emissions in the End User inventories.

End User emissions from the electricity production part of the Energy Supply sector are presented in Table 3.3. On an End User basis, Business and Residential accounted for 32% and 25% of all emissions in 2013, and consumed nearly 88% of all electricity.

3.3 Transport Sector

Figure 3.15: Overall Contribution to 2013 GHG emissions, Scotland

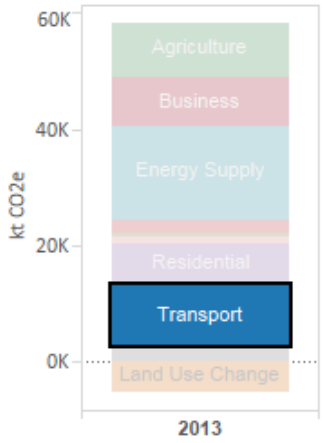


Figure 3.16: Total GHG Emissions from Transport, Base Year to 2013, Scotland

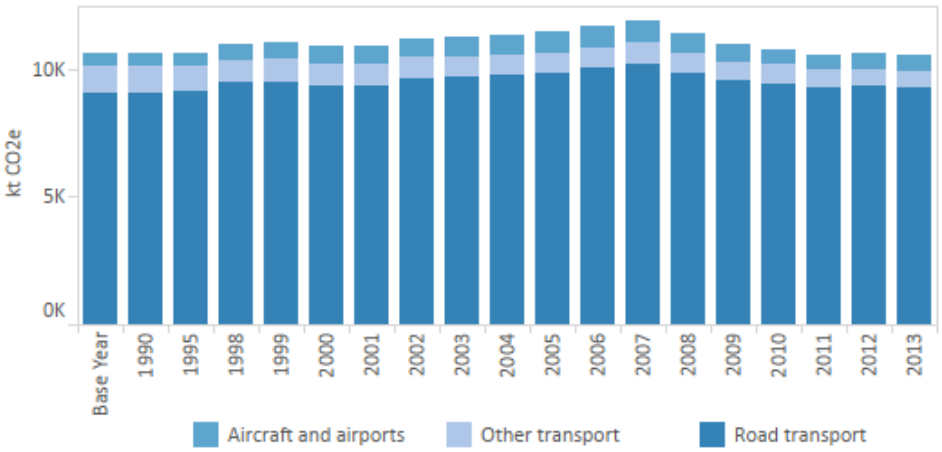


Table 3.4: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Scotland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Road transport	2.5%	226.6	-0.5%	-44.4
Other transport	-41.5%	-432.4	-8.1%	-53.4
Aircraft and airports	19.0%	97.3	1.3%	7.7
Transport Total	-1.0%	-108.5	-0.8%	-90.2

Figure 3.17: GHG Contribution for Transport Emissions, 2013, Scotland

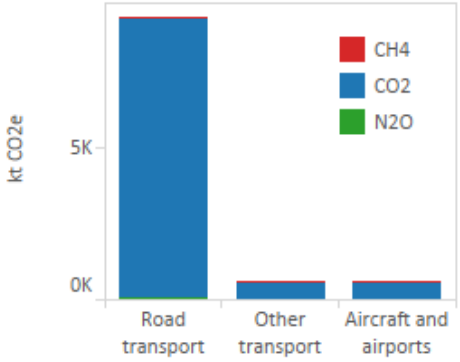


Figure 3.18: Comparison of End User and By Source for Transport, Scotland

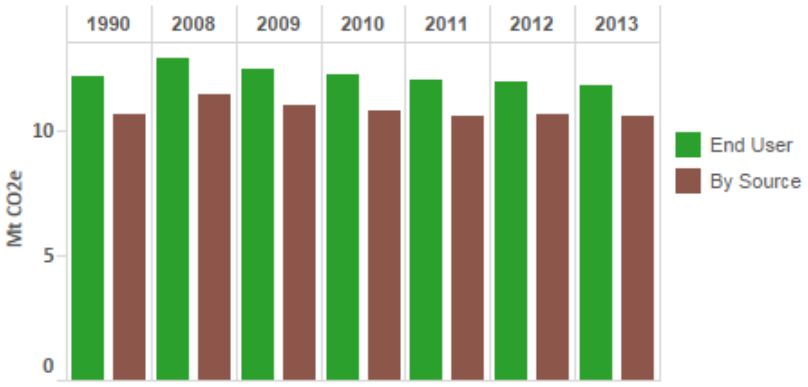


Figure 3.19 Road Transport CO2 Emissions (fuel sales basis), Scotland

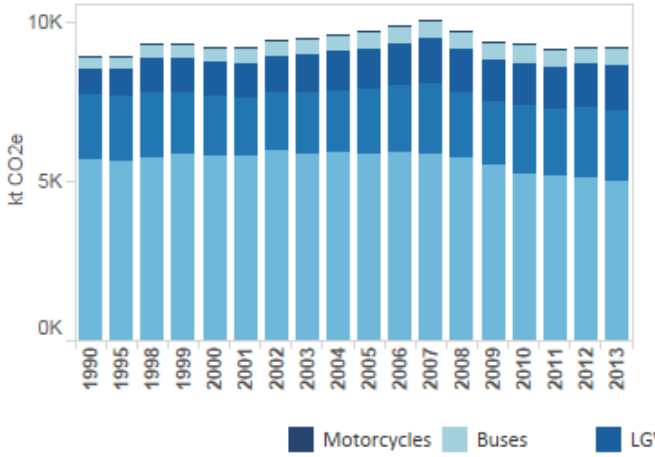
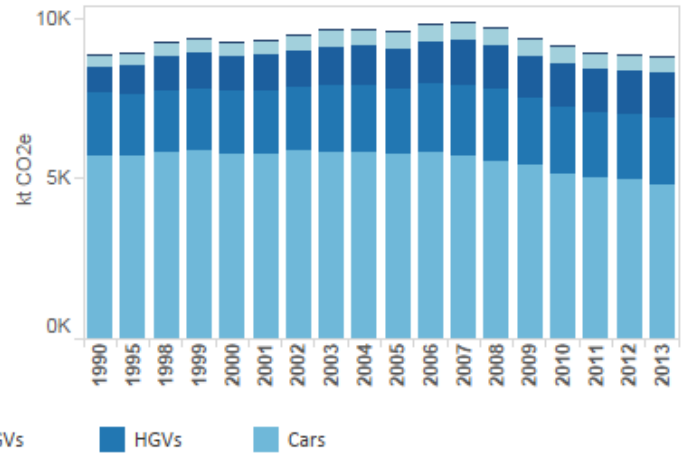


Figure 3.20: Road Transport CO2 Emissions (vkm basis), Scotland



By Source Emissions

Overview

Figures 3.15 – 3.20 show detailed emissions and trends for the sector. Note that the Transport emissions reported in this section exclude those from international aviation and shipping. Emissions from international aviation and shipping have been included in the Introduction of Scotland's chapter, and the methodologies for these emissions are presented in Appendix 2.

Transport emissions accounted for 21% of Scotland's total GHG emissions in 2013. Transport emissions were dominated by emissions from road transport (88% of all Transport emissions in 2013, with 48% of transport emissions from cars alone). The Transport sector also includes small contributions from rail (including stationary sources), national navigation and coastal shipping, domestic aviation military aviation and shipping.

Features of the Trends

Table 3.4 shows the change in emissions between the Base Year and 2013, and between 2012 and 2013 for the sector. Total GHG emissions from the Transport sector in Scotland have decreased minimally (1%) between the Base Year and 2013 despite improvements in efficiency of transport vehicles, as a result of growth in transport demand. Emissions peaked in 2007 and have since declined partly due to improvements in average fuel efficiency of vehicles and the switch from petrol to diesel cars and from a reduction in traffic volumes.

Emissions between 2012 and 2013 have not seen any significant change, with a small decrease of 0.8%. This sector is driven by the changes in emissions from passenger cars. Emissions from petrol have decreased, whilst emissions from road diesel (DERV) have increased offsetting much of the decrease from petrol cars.

Sector Detail

There are two approaches used to calculate emissions from Road Transport: fuel sales basis – emissions are constrained to the total fuel sold within the UK as stated in DUKES (DECC, 2013b); vehicle kilometre basis – emissions are estimated using vehicle km data and are not constrained by the total fuel sold, so estimate emissions based on fuel used within the UK. The inventory emission estimates for Road Transport are calculated on a fuel sold basis and are, therefore, consistent with DUKES.

Figures 3.19 and 3.20 show the carbon dioxide emissions from road transport for Scotland based on constrained (DUKES fuel sales) and unconstrained (vehicle kilometre, vkm) approaches. Total carbon dioxide emissions from the vkm approach vary from the estimates constrained to DUKES. The differences between the two approaches fluctuate year on year but they remain within 4.1% difference for Scotland.

These disparities will also be reflected in the trends derived from the two approaches to a different extent. The long term trend for each individual vehicle type is generally similar between the two approaches. The vkm approach indicates that the overall carbon dioxide emissions from road transport have decreased by 0.3% between the Base Year and 2013, while the constrained approach indicates a 3.1% increase.

Emissions on an End User Basis

Figure 3.18 shows the End User estimates in recent years are 12% higher than the By Source estimates, reflecting the additional emissions from upstream oil extraction and the oil refining sector. A small proportion of electricity generation emissions are also attributed to the End User Transport sector from electric rail use.

The trend in End User emissions since 1990 shows a decrease of 3% by 2013, which is a slightly greater decrease than reported in the By Source inventory, reflecting the improved energy efficiency of upstream production and refining of crude oil to produce the fuels used in the transport sector.

3.4 Residential Sector

Figure 3.21: Overall Contribution to 2013 GHG emissions, Scotland

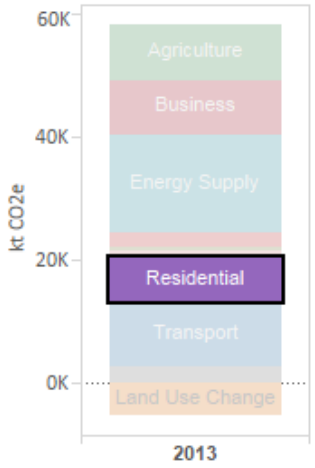


Figure 3.22: Total GHG Emissions from Residential, Base Year to 2013, Scotland

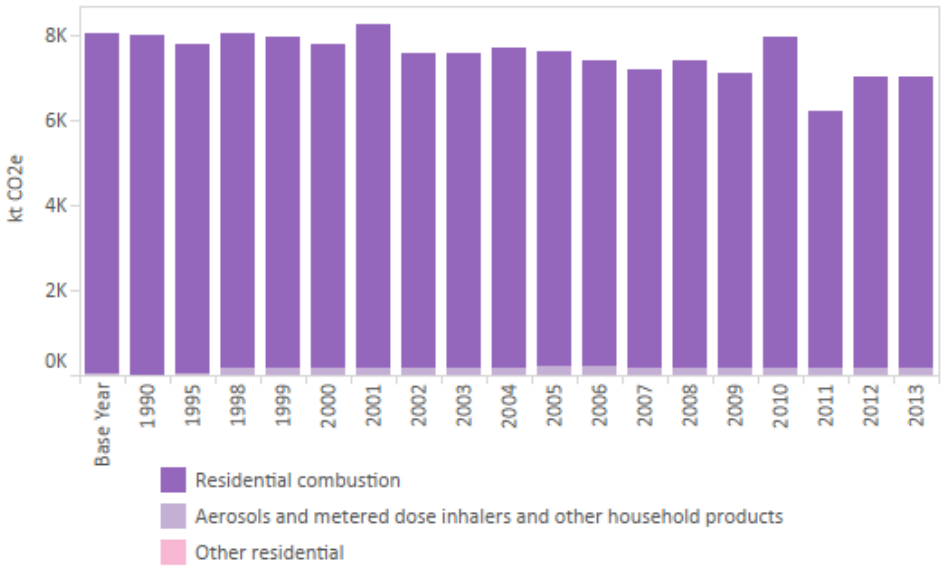


Table 3.5: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Scotland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Aerosols and metered dose inhalers and other household products	197.28%	120.17	-0.40%	-0.72
Other residential	97.78%	1.66	2.33%	0.08
Residential combustion	-14.63%	-1,167.61	-0.04%	-2.81
Residential Total	-13.00%	-1,045.79	-0.05%	-3.45

Figure 3.23: GHG Contribution for Residential Emissions, 2013, Scotland

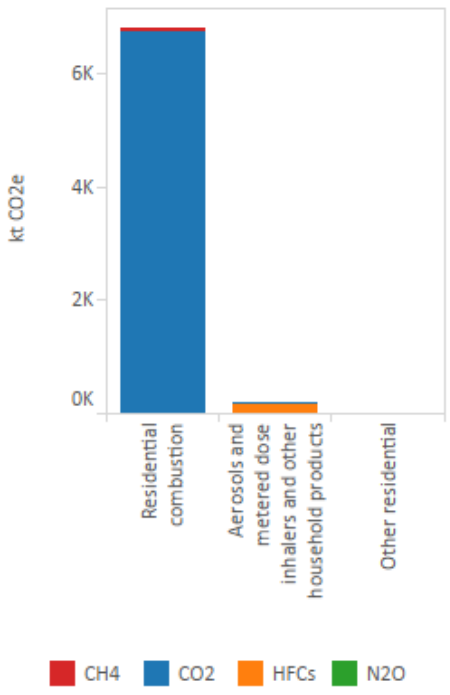
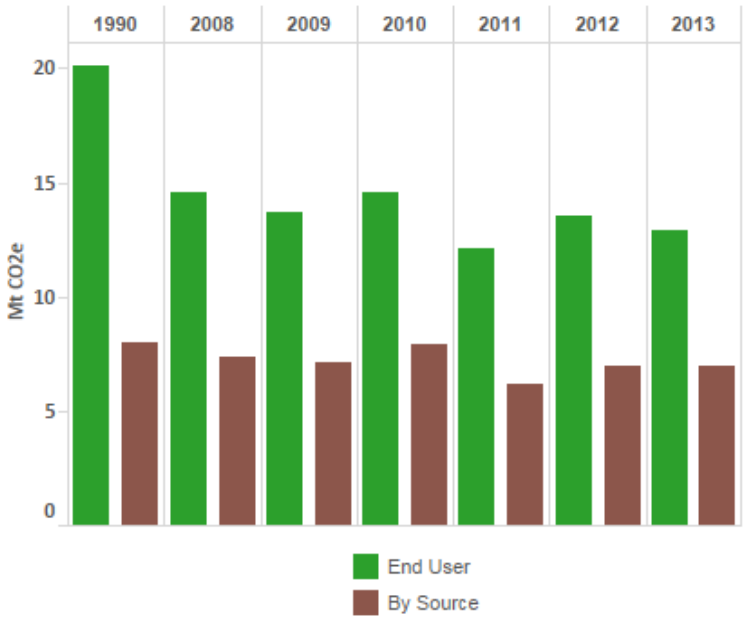


Figure 3.24: Comparison of End User and By Source for Residential, Scotland



By Source Emissions

Overview

Figures 3.21 – 3.24 show detailed emissions and trends for the sector. The Residential sector accounted for 14% of Scotland's total net GHG emissions in 2013. The sector comprises emissions from domestic combustion from heating and cooking, household products, accidental vehicle fires and HFC emissions from the use of aerosols and metered dose (usually asthma-related) inhalers. Over 96% of all Residential sector GHG emissions are from the release of carbon dioxide from the direct combustion of fossil fuels (see Figure 3.23).

Features of the Trends

Table 3.5 shows the change in emissions between the Base Year and 2013, and between 2012 and 2013 for the sector. Total GHG emissions from the Residential sector in Scotland have decreased by 13% between the Base Year and 2013. There was a large increase in fuel use and GHG emissions from the sector in 2010 (12% increase in emissions between 2009 and 2010) primarily driven by two successive cold winters and a resultant high demand for fossil fuel heating in many parts of Scotland. Emissions from this sector then decreased by 22% between 2010 and 2011 due to a warm winter, and then partially increased in 2012 and 2013. Again, this trend was driven by the annual mean temperatures in Scotland. These trends result in an overall decrease of emissions from 2009 to 2013 of only 1%.

Emissions on an End User Basis

Figure 3.24 shows that in 2013 Scotland End User emissions for the Residential sector are 185% of the By Source emission estimates, reflecting the high consumption of electricity in the sector. This increases the overall significance of this sector in the End User inventory to 25% of the Scotland total, compared to just 14% of the By Source inventory total.

The trend in the Residential sector End User emissions since 1990 shows a decline of 36% to 2013. These GHG reductions have been achieved through improvements in housing energy efficiency and lower carbon intensity of the UK electricity generation sector since 1990. However, the reported trends are uncertain and should be regarded as indicative only due to the limited data on electricity use By Source (particularly in early years) and also the high uncertainty in the By Source estimates for the sector.

3.5 Business Sector

Figure 3.25: Overall Contribution to 2013 GHG emissions, Scotland

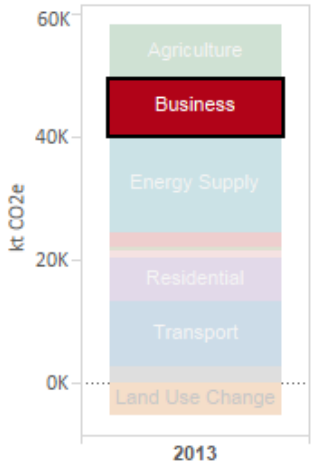


Figure 3.26: Total GHG Emissions from Business, Base Year to 2013, Scotland

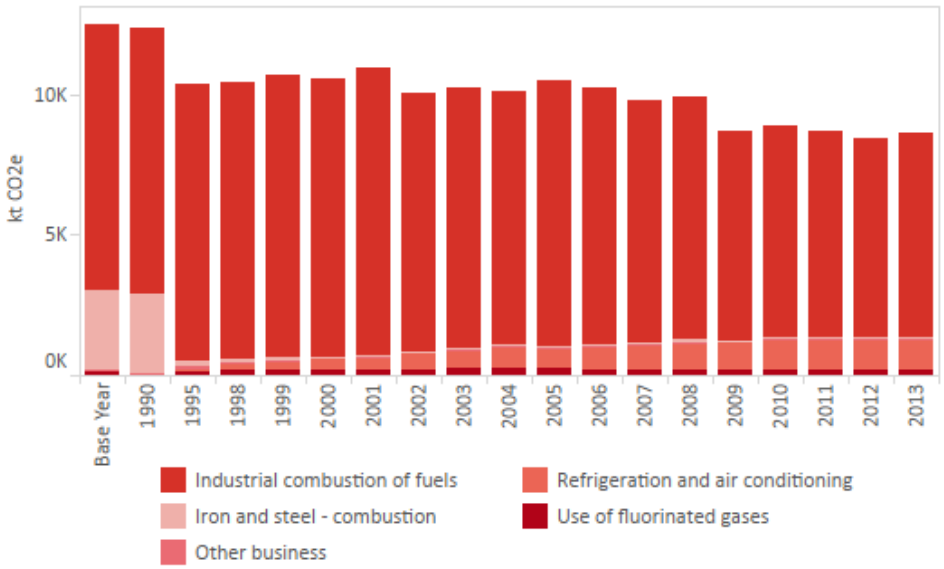


Table 3.6: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Scotland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Industrial combustion of fuels	-23.3%	-2,199.8	2.4%	170.5
Refrigeration and air conditioning	1,174.5%	985.7	0.2%	2.6
Use of fluorinated gases	54.4%	71.5	2.5%	5.0
Iron and steel - combustion	-98.1%	-2,774.7	5.0%	2.5
Other business	1,088.0%	22.9	-15.5%	-4.6
Business Total	-31.2%	-3,894.4	2.1%	176.0

Figure 3.27: GHG Contribution for Business Emissions, 2013, Scotland

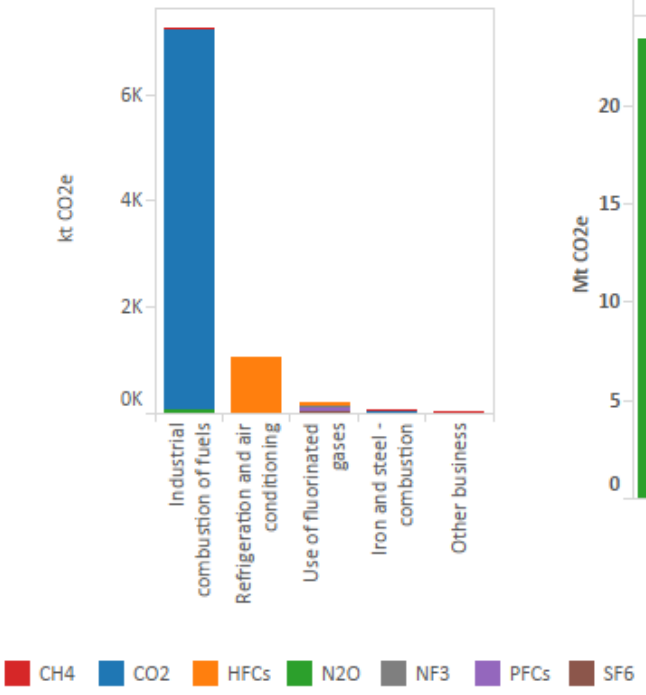
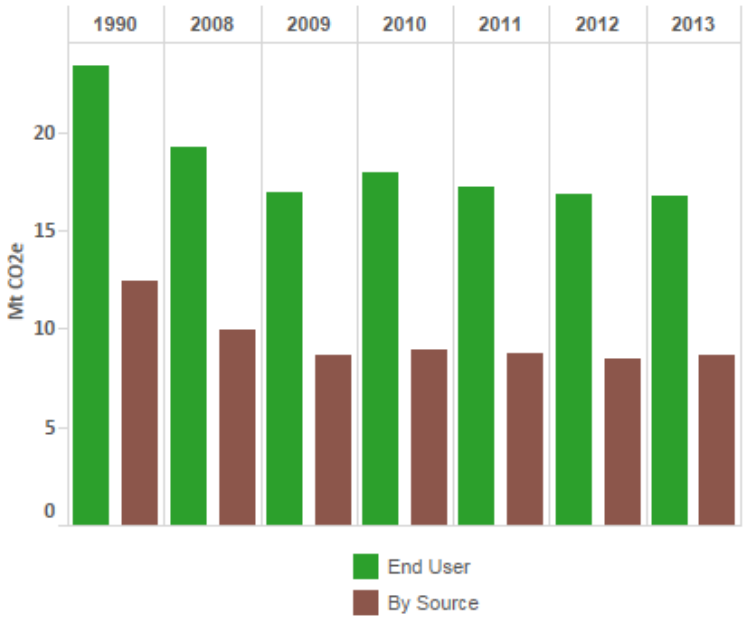


Figure 3.28: Comparison of End User and By Source for Business, Scotland



By Source Emissions

Overview

Figures 3.25 – 3.28 show detailed emissions and trends for the sector. In Scotland, the Business sector contributes 17% to 2013 total net GHG emissions in Scotland. The Business sector in 2013 includes emissions from industrial combustion of fuels (84% of Business emissions) from manufacturing and construction industry; refrigeration & air conditioning (12% of Business emissions), arising from losses of hydrofluorocarbons (HFCs) during equipment manufacture, leaks and disposal; as well as emissions from fluorinated gases from foam production, fire-fighting solvents and electronics (2% of Business emissions) and combustion emissions from the iron and steel sector (1% of Business emissions). In 2013, 84% of the Business sector GHG emissions were carbon dioxide, primarily released from the combustion of fossil fuels, with 15% as fluorinated gases, predominantly HFCs.

Features of the Trends

Table 3.6 shows the change in emissions between the Base Year and 2013, and between 2012 and 2013 for the sector. Total Business sector GHG emissions in Scotland have reduced by 31% since the Base Year. These reductions have primarily been achieved as a result of declining manufacturing and iron and steel industry emissions.

Contrary to the overall decline in emissions from the sector, emissions of HFC from refrigeration and air conditioning were negligible in 1990 and have risen to account for 15% of the sector total in 2013. This is due to the introduction of these gases as replacement to CFCs banned by the Montreal Protocol.

Business emissions increased by 2% between 2012 and 2013 due to an increase in natural gas combustion from miscellaneous industry and commercial sector, and the chemicals industry.

Traded and Non-Traded Emissions

Emissions in the Business sector include significant contributions from installations reporting in the EU ETS. However, due to the lack of detail in the EU ETS dataset, the Business and Industrial Process sector emissions are not easy to separate. The contribution of emissions from traded and non-traded sources across these sectors are presented in the Introduction section (see Figure 3.8), which groups together emissions from the Business sector and the Industrial Process sector as one category: Industry.

A high proportion of total emissions in the Business sector are from installations that are included in the EU ETS. Traded emissions have accounted for between 41-45% of total Business and Industrial Process sector emissions in Scotland during 2008 to 2013, and comprise cement kiln emissions and fuel combustion emissions from large industrial combustion plant and autogenerators.

Emissions on an End User Basis

As shown in Figure 3.28, 2013 Scotland End User emissions for the Business sector are 195% of the By Source emission estimates, reflecting the high consumption of electricity for heating, lighting and operating equipment (and therefore share of emissions from electricity production) in the sector. From this End User perspective, the Business sector represents 32% of total emissions for Scotland compared to just 17% of the By Source inventory total.

3.6 Public Sector

Figure 3.29: Overall Contribution to 2013 GHG emissions, Scotland

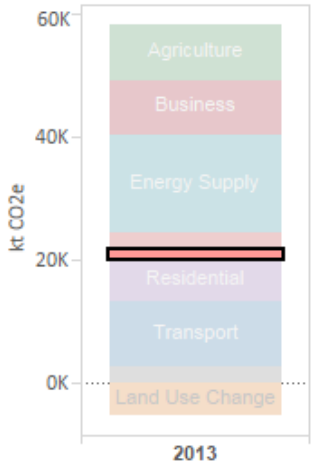


Figure 3.30: Total GHG Emissions from Public, Base Year to 2013, Scotland

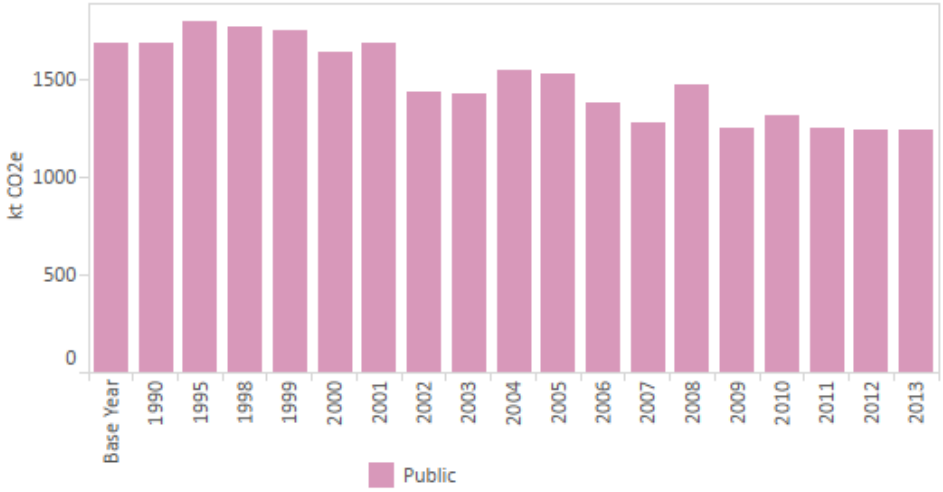


Table 3.7: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Scotland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Public	-26.2%	-441.1	0.3%	4.2
Public Total	-26.2%	-441.1	0.3%	4.2

Figure 3.31: GHG Contribution for Public Emissions, 2013, Scotland

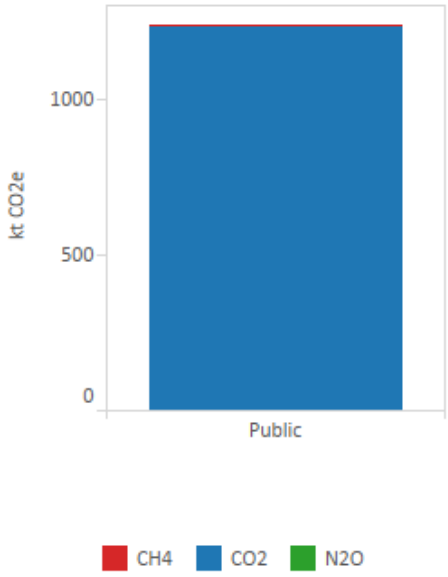
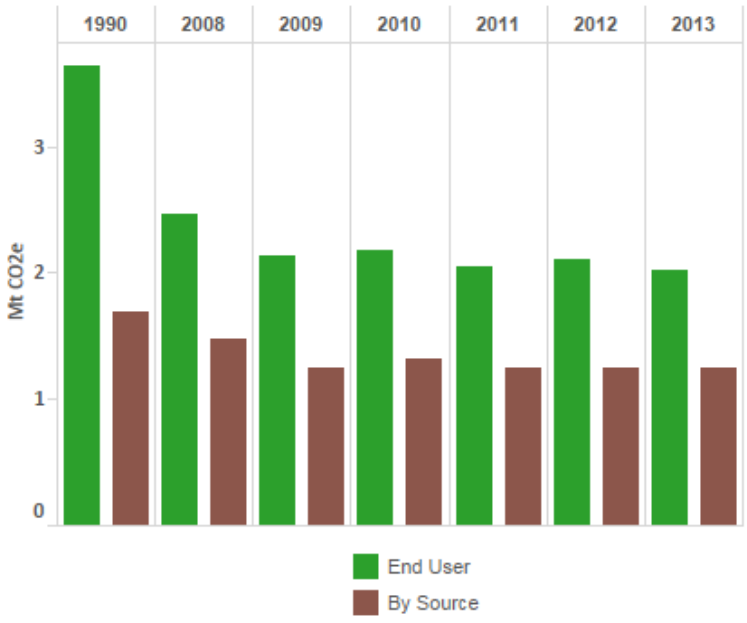


Figure 3.32: Comparison of End User and By Source for Public, Scotland



By Source Emissions

Overview

Figures 3.29 – 3.32 show detailed emissions and trends for the sector. Emissions from Public sector combustion accounted for 2% of GHG emissions in Scotland in 2013. Over 99% of emissions in this sector are from carbon dioxide from the combustion of fossil fuels (predominantly natural gas).

Emission estimates in the Public sector are associated with high uncertainty due to the absence of comprehensive, detailed DA-specific fuel use data, particularly for solid and liquid fuels and rely on estimates modelled on employment and GDP.

Features of the Trends

Table 3.7 shows the change in emissions between the Base Year and 2013, and between 2012 and 2013 for the sector. Public sector GHG emissions have reduced by 26% since the Base Year; these reductions have been achieved through improvements to building energy efficiency and a trend to convert to the use of gas-fired boilers and heating across Scotland for many Public sector buildings since 1990. Emissions increased by less than 1% between 2012 and 2013, due to an increase in emissions from natural gas combustion, which was partially offset by a decrease in emissions from fuel oil combustion.

Emissions on an End User Basis

As illustrated in Figure 3.32, Scotland End User emissions in 2013 for the Public sector were 163% of the By Source emission estimates, reflecting the high consumption of electricity in the sector. This increased the overall significance of this sector in the End User inventory to 4% of the Scotland total, compared to 2% of the By Source inventory total in 2013. The trend in End User emissions since 1990 shows a decline of around 44% to 2013.

3.7 Industrial Process Sector

Figure 3.33: Overall Contribution to 2013 GHG emissions, Scotland

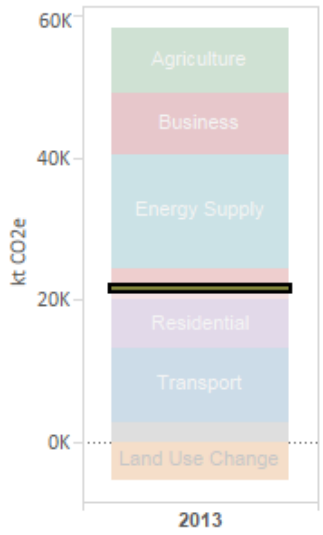
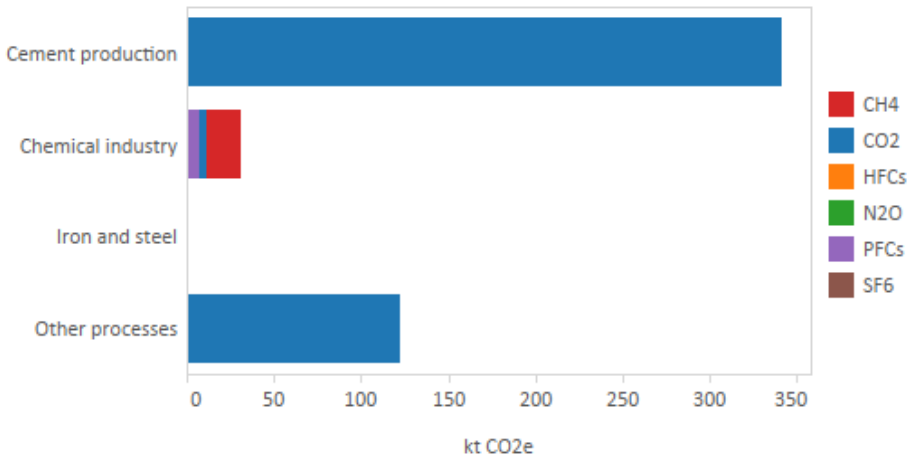


Figure 3.34: Total GHG Emissions from Industrial Process, Base Year to 2013, Scotland

Table 3.8: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Scotland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Cement production	-33.2%	-169.7	10.2%	31.6
Other processes	-8.7%	-11.7	14.6%	15.6
Chemical industry	-92.9%	-409.4	27.0%	6.7
Iron and steel	-100.0%	-768.0	-97.7%	-0.4
Industrial Process Total	-73.3%	-1,358.8	12.1%	53.4

Figure 3.35: GHG Contribution to Industrial Process Emissions, 2013, Scotland



By Source Emissions

Overview

Figures 3.33 – 3.35 show detailed emissions and trends for the sector. In 2013, the Industrial Process sector contributed 1% to total GHG emissions in Scotland. The Industrial Process sector emissions arise from non-combustion sources and in Scotland primarily comprised of three main sources in 2013: cement decarbonisation of limestone, process sources in the glass industry and primary aluminium production (decarbonisation of anodes leading to small emissions of perfluorocarbons [PFCs]). Emissions of methane accounted for only 4% of total GHG emissions from the Industrial Process sector, while emissions of carbon dioxide accounted for 95% of total GHG emissions in 2013.

Features of the Trends

Table 3.8 shows the change in emissions between the Base Year and 2013, and between 2012 and 2013 for the sector. Overall Industrial Process sector emissions in Scotland have reduced by 73% between the Base Year and 2013.This large decline in emissions is primarily due to the closure of the nitric acid plant, closure of Ravenscraig iron and steel works both of which occurred between 1990 and 1995, and a reduction in emissions from the chemicals and cement sectors. Emissions have increased significantly between 2012 and 2013 (12%) due to increased emissions from the cement sector and, to a lesser extent, increased emissions from the aluminium industry.

Traded and Non-Traded Emissions

Emissions in the Industrial Process sector include significant contributions from installations reporting in the EU ETS. However, due to the lack of detail in the EU ETS dataset, the Business and Industrial Process sector emissions are not easy to separate. The contribution of emissions from traded and non-traded sources across these sectors are presented in the Introduction section (see Figure 3.8), which groups together emissions from the Industrial Process sector and the Business sector as one category: Industry.

A high proportion of total emissions in the Industrial Process sector are from installations that are included in the EU ETS. Traded emissions have accounted for between 41-45% of total Industrial Process and Business sector emissions in Scotland during 2008 to 2013, and comprise cement kiln emissions and fuel combustion emissions from large industrial combustion plant and autogenerators.

Emissions on an End User Basis

As the majority of emissions in the Industrial Process sector are not due to energy consumption, Industrial Process sector emissions on an End User basis are very similar to the emissions By Source. In 2013, the End User estimates are less than 0.1% higher than those in the By Source inventory, reflecting a very low contribution to sector emissions from the use of electricity or fossil fuels as feedstock or for energy.

3.8 Agriculture Sector

Figure 3.36: Overall Contribution to 2013 GHG emissions, Scotland

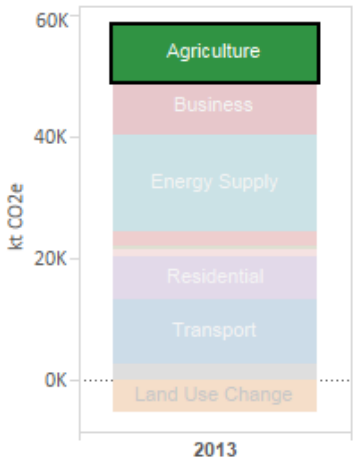


Figure 3.37: Total GHG Emissions from Agriculture, Base Year to 2013, Scotland

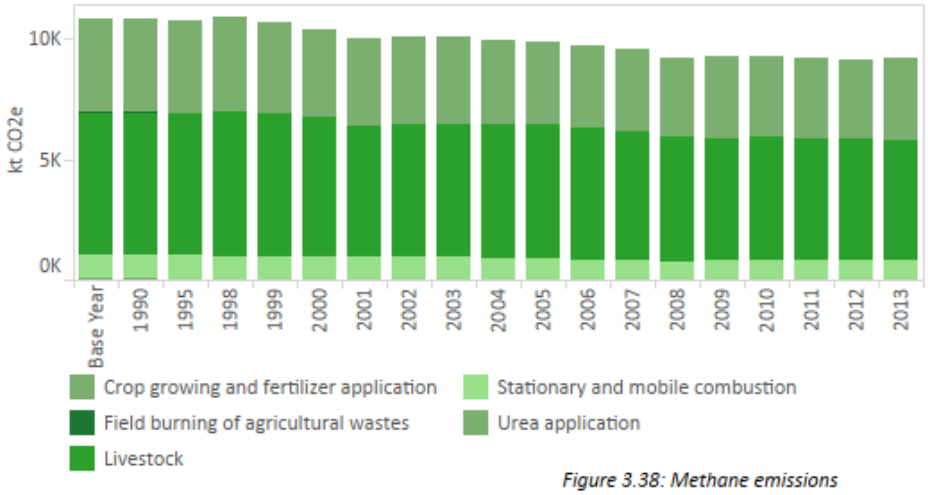


Table 3.9: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Scotland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Crop growing and fertilizer application	-11.1%	-427.3	3.7%	122.3
Field burning of agricultural wastes	-100.0%	-19.0	N/A	0.0
Livestock	-16.2%	-956.5	-1.7%	-86.7
Stationary and mobile combustion	-20.1%	-197.6	-1.3%	-10.2
Urea application	-76.3%	-50.0	-5.8%	-1.0
Agriculture Total	-15.3%	-1,650.4	0.3%	24.5

Figure 3.38: Methane emissions from livestock by type, 2013, Scotland

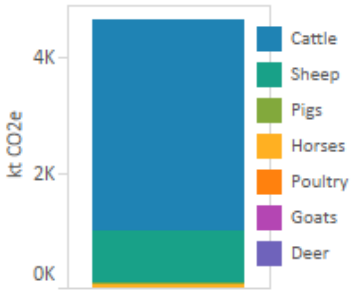


Figure 3.39: GHG Contribution for Agriculture Emissions, 2013, Scotland

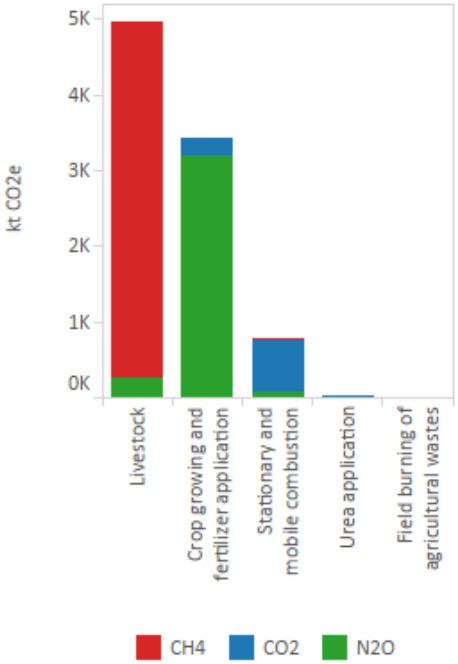


Table 3.10: Emissions of nitrous oxide from agricultural sources in 2013 (kt CO2e), Scotland*

Manure management				268
Soils				3,061
	Direct			2,431
		Crop residues		449
		Fertiliser		766
		Grazing returns		813
		Histosols		239
		Manure application		155
		Sewage sludge		9
	Indirect			631
		Deposition		209
			Fertiliser	77
			Grazing returns	99
			Manure application	31
			Sewage sludge	2
		Leaching		422
			Crop residues	101
			Fertiliser	172
			Grazing returns	112
			Manure application	35
			Sewage sludge	2
Mineralisation				120
TOTAL				3,449

*Total emissions comprise manure management, soils and mineralization. Soils include direct and indirect emissions; indirect emissions include leaching and deposition.

By Source Emissions

Overview

Figures 3.36 – 3.39 show detailed emissions and trends for the sector. GHG emissions from Agriculture are primarily methane and nitrous oxide from livestock and agricultural soils respectively, but there are also carbon dioxide emissions from fuel combustion in mobile and stationary units in the sector (see Figure 3.37). Agriculture accounted for 18% of total greenhouse gas emissions in Scotland in 2013, and is the most significant source sector for methane and nitrous oxide, accounting for 60% and 84% of total Scotland emissions of these two gases, respectively.

Features of the Trends

Table 3.9 shows the change in emissions between the Base Year and 2013, and between 2012 and 2013 for the sector. Emissions from the Agriculture sector decreased by 15% between the Base Year and 2013, with pollutant contributions of -16% for methane and -11% for nitrous oxide. The trends result from a general decline in livestock numbers (particularly cattle and sheep) and in nitrogen fertiliser use.

There was only a small increase of less than 1% in agricultural emissions between 2012 and 2013 mainly due to increased emissions from fertilizers applied to grass, which have been partially offset by a decrease in the number of dairy cows and corresponding reduction in emissions. Field burning has largely ceased in the UK since 1993, hence the significant decrease in emissions since the Base Year.

Sector Detail

Livestock emissions include two main sub-categories: emissions from enteric fermentation (a digestive process by which carbohydrates are broken down by microorganisms into simple molecules) and emissions from manure management. Total cattle emissions (dairy and beef enteric and manure management) accounted for 70% of the total agricultural methane emissions, whilst emissions from sheep accounted for a further 18% of the total.

Nitrous oxide emissions are largely driven by fertiliser nitrogen use, manure applications and grazing returns to soils. A further breakdown of these emissions is shown in Table 3.10.

Emissions on an End User Basis

As the majority of emissions in the Agriculture sector are not due to energy consumption, therefore, emissions on an End User basis are very similar to the emissions By Source. In 2013, the End User estimates were only 4% higher for the Agriculture sector, reflecting the relatively low contribution to sector emissions from the use of oils and electricity (e.g. for heating, lighting and machinery), compared to the higher-emitting sources of nitrous oxide and methane from soils and livestock sources.

3.9 Land Use, Land Use Change and Forestry Sector

Figure 3.40: Overall Contribution to 2013 GHG emissions, Scotland

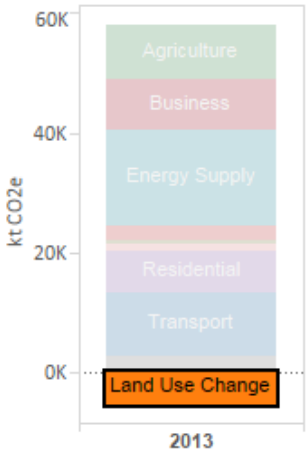


Figure 3.41: GHG Contribution to Land Use Change Emissions, 2013, Scotland

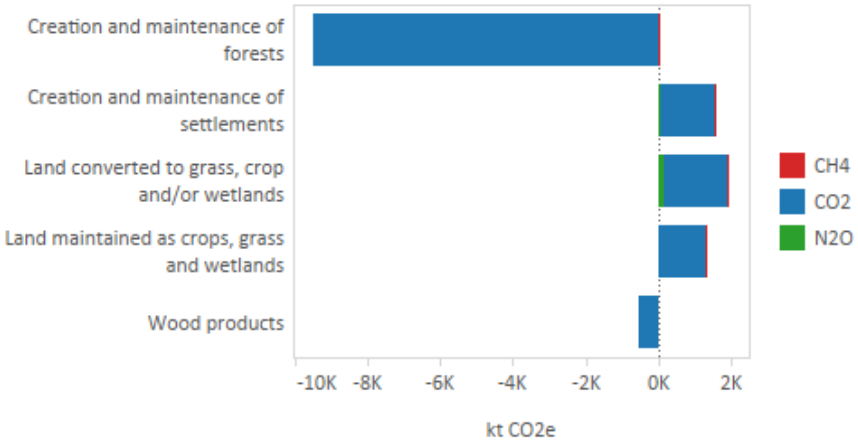
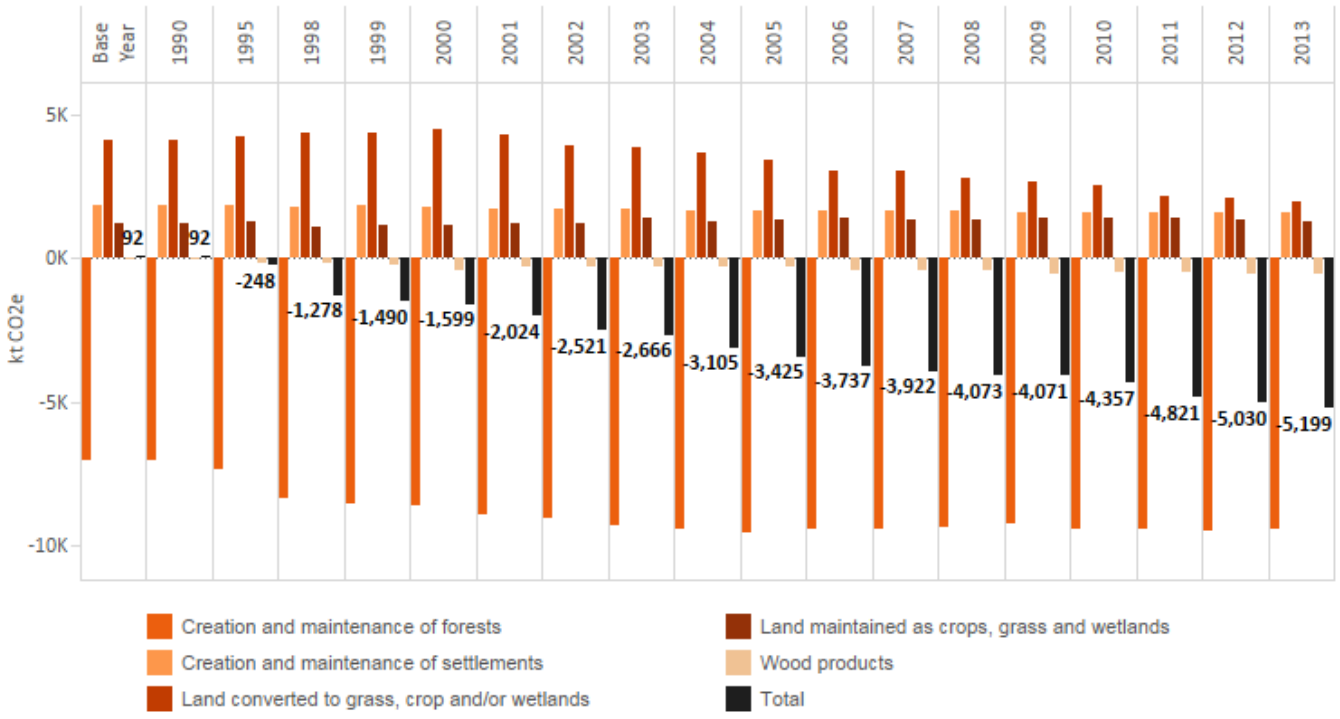


Table 3.11: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Scotland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Creation and maintenance of settlements	-14.7%	-269.6	-0.7%	-11.2
Creation and maintenance of forests	34.5%	-2,422.8	-0.3%	26.2
Land converted to grass, crop and/or wetlands	-52.7%	-2,158.4	-6.4%	-133.3
Land maintained as crops, grass and wetlands	7.5%	90.4	-2.6%	-34.8
Wood products	2,857.1%	-530.7	3.0%	-16.1
Land Use Change Total	N/A	-5,291.3	N/A	-169.1

Figure 3.42: Total GHG Emissions from LULUCF, Base Year - 2013, Scotland



By Source Emissions

Overview

Figures 3.40 – 3.42 show detailed emissions and trends for the Land Use, Land Use Change and Forestry (LULUCF) sector. In 2013, Scotland was a large net sink of greenhouse gases from LULUCF activities removing 5,199 $ktCO_2e$ in 2013. The LULUCF emissions and sinks arise from human activities that change the way land is used or affect the amount of biomass in existing biomass stocks. The most significant category is the creation and maintenance of forests, which accounted for the removal of 9,441 $ktCO_2e$.

More details regarding this sector can be found in Appendix 8.

Features of the Trends

The LULUCF sector has been a net sink of greenhouse gases since 1995. The size of this sink (CO_2e removal) has grown by nearly 2,000% between 1995 and 2013 from -248 to -5,199 $ktCO_2e$. This increase in net removals is primarily as a result of less conversion of grassland and forests to cropland over the period.

Net removals from the creation and maintenance of forests have also increased during this period. This is as a result of long-term forest management of extensive conifer plantations established in the mid-20^{th} century that are now reaching felling age, with reduced removals from forest but with increased carbon stocks in harvested wood products in recent years.

Emissions on an End User Basis

As emissions and removals from LULUCF do not related to Energy Supply the End User GHG inventory emissions are the same as emissions reported in the By Source GHG inventory.

3.10 Waste Management Sector

Figure 3.43: Overall Contribution to 2013 GHG emissions, Scotland

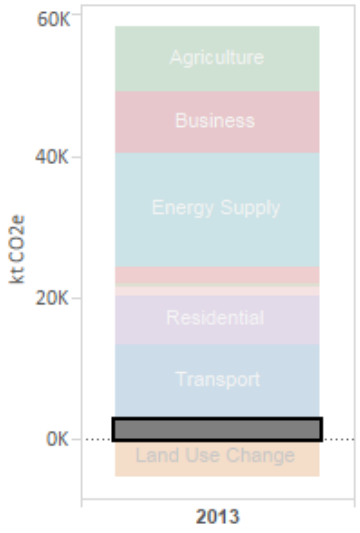


Figure 3.44: Total GHG Emissions from Waste Management, Base Year to 2013, Scotland

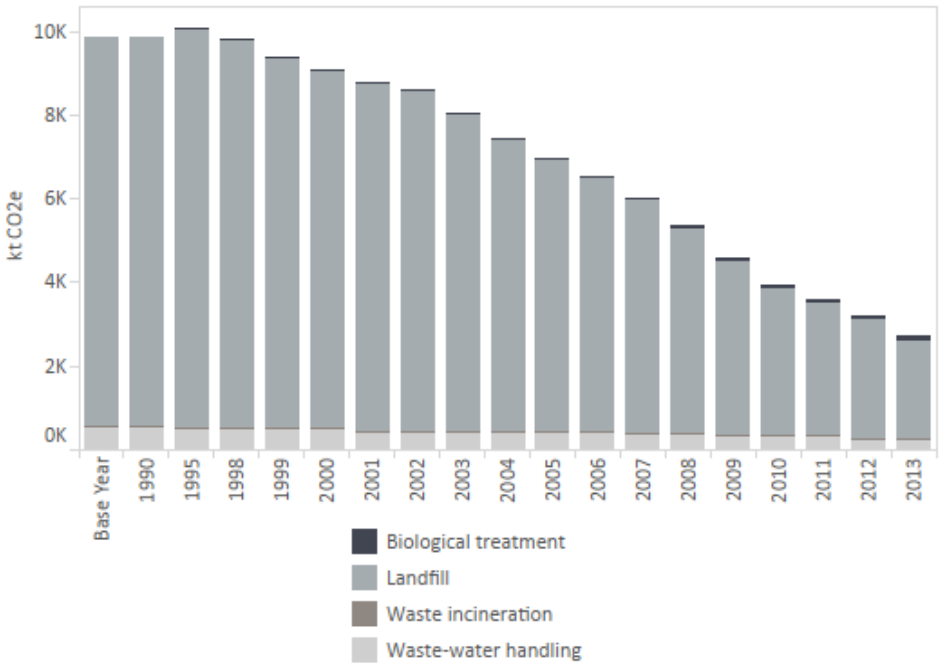
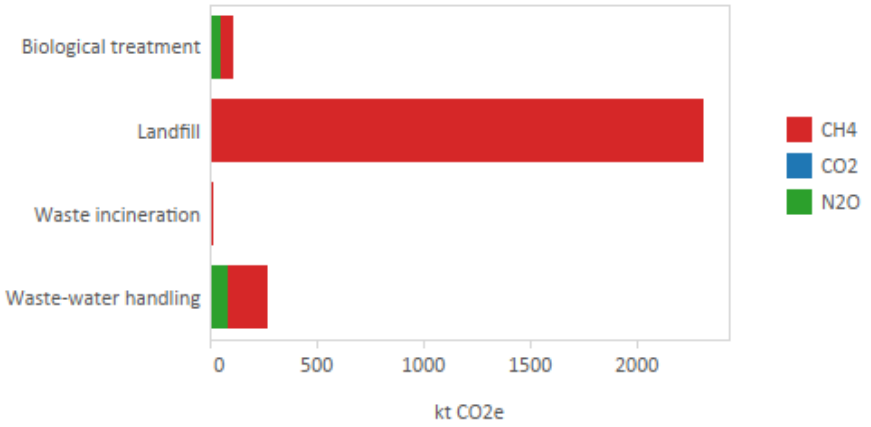


Table 3.12: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Scotland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Landfill	-75.09%	-6,981.73	-18.00%	-508.58
Waste incineration	-79.96%	-40.35	-0.17%	-0.02
Waste-water handling	-47.42%	-243.54	-0.21%	-0.57
Biological treatment	N/A	106.67	5.89%	5.93
Waste Management Total	-72.59%	-7,158.95	-15.69%	-503.23

Figure 3.45: GHG Contribution to Waste Management Emissions, 2013, Scotland



By Source Emissions

Overview

Figures 3.43 – 3.45 show detailed emissions and trends for the sector. The Waste Management sector contributed 5% to total GHG emissions in Scotland in 2013, and was the second largest source sector for methane emissions, representing 33% of total methane emissions in 2013. Emissions from this sector in 2013 were dominated by methane from landfill (86% of total GHGs from the Waste Management sector), with a smaller contribution of emissions of methane and nitrous oxide from wastewater treatment (10%).

Nitrous oxide emissions from waste water treatment represent 3% of emissions in the sector in 2013, and contribute 2% to the total emissions of nitrous oxide in Scotland.

Features of the Trends

Table 3.12 shows the change in emissions between the Base Year and 2013, and between 2012 and 2013 for the sector. Emissions from the Waste Management sector in Scotland have reduced by 73% since the Base Year, driven by reductions of emissions from landfill; these reductions have been achieved by the progressive introduction of methane capture and oxidation systems within landfill management.

Waste Management sector emissions have reduced by 16% between 2012 and 2013 due to a continued decline in methane emission estimates from landfill from improved management systems.

Emissions on an End User Basis

As emissions from the Waste Management sector do not include any energy consumption sources, and no electricity use is allocated to the Waste Management sector (due to a lack of data to correctly allocate to the Waste Management sector), the End User emission estimates for the sector are unchanged from the emissions presented here on a by source basis.

4 Emission Estimates in Wales (1990-2013)

4.1 Overview of Total Emissions

By Source Emissions

Overview

The greenhouse gas (GHG) emissions for Wales for 1990 – 2013 are presented in Table 4.1 and in the graph in Figure 4.1 below.

Table 4.1: 1990-2013 Wales GHG Emission Inventory ($ktCO_2e$)

NC Format	Base Year	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	% of 2013
Agriculture	7,628	7,628	7,668	7,344	6,924	6,162	6,122	6,259	6,289	6,265	6,248	12%
Business	13,738	13,697	14,393	16,687	9,905	9,626	7,863	9,605	8,890	7,671	9,827	19%
Energy Supply	18,012	18,012	13,089	16,433	17,562	19,489	16,467	16,778	15,961	19,433	21,140	42%
Industrial Process	2,786	2,975	3,122	3,311	2,952	2,779	1,820	2,259	2,044	1,518	2,648	5%
LULUCF	103	103	-161	-378	-589	-526	-592	-617	-692	-636	-642	-1.3%
Public	773	773	706	552	519	473	397	413	391	387	393	1%
Residential	5,042	5,009	5,147	5,282	4,820	4,617	4,404	4,878	3,794	4,238	4,246	8%
Transport	6,056	6,056	6,042	6,123	6,410	6,317	6,053	5,945	5,837	5,759	5,719	11%
Waste Management	3,493	3,493	3,622	3,552	2,810	2,258	1,956	1,701	1,530	1,382	1,181	2%
Total	**57,631**	**57,747**	**53,628**	**58,907**	**51,314**	**51,196**	**44,489**	**47,221**	**44,043**	**46,018**	**50,761**	**100%**

Trends

Figure 4.2 shows the change in emissions from the Base Year and 2012 to the latest year, 2013. Total GHG emissions from Wales have reduced between the Base Year[22] and 2013 by 12%, whilst carbon dioxide emissions have fallen by 4%. These emission reductions are mainly due to efficiencies in energy generation and business sector heating, the use of natural gas to replace some coal and other fuels as well as abatement in some chemical industries, and variations in manufacturing output (e.g. in iron and steel, bulk chemical production). Transport emissions have reduced by 6% since the Base Year due to increasing population and increasing demand for transportation off-set by improvements in energy efficiency of vehicles.

Total GHG emissions have increased between 2012 and 2013 by 10%. **The 2012 to 2013 increase of emissions is predominantly driven by an increase in emissions from the iron and steel sector due to the restart of Tata Steel's Port Talbot No.4 Blast Furnace in February, 2013, and a shift from natural gas to coal use in power stations.**

The following list provides an overview of the trend for each sector:

- **Business** sector emissions have reduced by 28% since the Base Year. The trends in this sector are primarily driven by the activities from the iron and steel industry, explaining the decline between the Base Year and 2012, but also the increased emissions between 2012 and 2013 due to increased iron and steel production following the restart of Tata Steel's Port Talbot No.4 Blast Furnace in February, 2013.
- **Energy Supply** sector emissions have increased by 17% between the Base Year and 2013 due to increases in emissions from power stations. Emissions increased by 9% between 2012 and 2013 due to a shift from natural gas to coal as a fuel for electricity generation.
- **Industrial Process** emissions have decreased by 5% since the Base Year and have shown significant fluctuations during this timeframe reflecting manufacturing output and abatement installations. This is due to several factors including a decline in manufacturing, cement, aluminium production, bulk chemical and iron and steel industries. Emissions increased significantly between 2012 and 2013 due to the restart of No.4 Blast Furnace in February, 2013.

[22] 1995 for fluorinated greenhouse gases (F-Gases) and 1990 for all other gases

- **Waste Management** sector emissions have significantly declined by 66% since the Base Year, largely due to the progressive introduction of methane capture and oxidation systems within landfill management. Emissions continued to decrease between 2012 and 2013, decreasing by 15%.
- **Transport** sector emissions have only decreased by 6% between the Base Year and 2013 despite improvements in efficiency of transport vehicles, as a result of growth in transport demand since 1990 and increased affordability of cars over the period. Emissions between 2012 and 2013 decreased by less than 1%. This sector is driven by the changes in emissions from passenger cars. There has been a continued shift from petrol to diesel vehicles.
- **Agriculture** sector emissions have reduced by 18% since the Base Year mainly due to a decrease in livestock numbers. There was a small decrease of less than 1% in emissions from 2012 to 2013 mainly due to a decrease in the number of beef cows and corresponding reduction in emissions, which has been partially offset by increased numbers and emissions from sheep.
- **Residential** sector emissions have decreased by 16% since the Base Year partly due to a change in the fuel mix from coal towards natural gas. The recent time series with an increase for 2010, a large drop in 2011 and stable emissions for 2012 and 2013 reflect the trend seen in the mean annual temperatures, which leads to variability in fuel consumption for space heating.
- **LULUCF** sector was a net source of GHG emissions in the Base Year, but since 1995 has been a net sink of GHG emissions. The size of this sink (CO_2e removal) has grown by nearly 300% between 1995 and 2013 from -161 ktCO_2e to -642 ktCO_2e. This is predominantly due to a reduction in emissions from land converted to cropland and settlements. The sink increased by 1% between 2012 and 2013 due a reduction in the carbon stock in forests partially offset by reduced emissions from croplands and wildfires.
- **Public** sector emissions have reduced by 49% since the Base Year. This is due to increased energy efficiency measures and fuel-switching from more carbon-intensive fuels such as coal and oil to natural gas. Emissions between 2012 and 2013 increased by 2% due mainly to an increase in natural gas consumption in 2013.

Emissions Detail

Detailed analysis of Wales GHG emissions in 2013 is presented in Figures 4.3 – 4.9. The largest sources of emission in 2013 include electricity production (32% of total emissions), road transport (11% of total emissions), iron and steel combustion in the business sector (12% of total emissions) and residential combustion for heating and cooking (8% of total emissions).

Figure 4.3 shows the emissions split by GHG and highlights the 2.5 and 97.5 percentile range. The range of uncertainty is greatest for nitrous oxide emissions. See Appendix 1 for further details on uncertainties.

Carbon dioxide is the most common gas emitted for all National Communication (NC) categories except the Agriculture sector where methane from livestock and nitrous oxide from soils are the most important gases, and the Waste Management sector where methane from landfills is the most important gas (see Figure 4.4).

Recalculations

Revisions to the estimates since the last inventory report (Salisbury et al., 2013) have resulted in a -0.4% (-192 ktCO_2e) reduction in the 2012 estimates for Wales.

The 2006 IPCC Guidelines (IPCC, 2006) have been adopted and supersede the 1996 IPCC Guidelines (IPCC, 1996). This change has led to the implementation of updated methodologies and emission factors, inclusion of additional sources and emissions of NF_3, improvements to the global warming potential (GWP) factors used. This has affected all sectors in the inventory. The most significant revisions to the 2012 estimates have been for the following sectors:

1. **Energy Supply (368 ktCO_2e)**: The impact of the change in global warming potentials (GWPs) for methane due to reporting under the 2006 IPCC Guidelines has increased the GHG emissions from sources such as closed coal mines and gas leakage, whilst the DUKES allocation for gas use in energy industries has been revised up significantly, increasing the estimates for carbon dioxide emissions. Updates to DUKES have also increased the refinery sector emissions by 1%, whilst a correction to the inventory allocation for Lynemouth coal-fired power station (in England) from autogeneration to power generation (to be consistent with DUKES) has the knock-on effect of increasing power sector estimates in Wales and other DAs by around 1%.
2. **Business (-305 ktCO_2e)**: Implementation of a revised time-series for non-energy use (NEU) fuels, and incorporation of Phase III ETS data which has led to improvements in the completeness and allocation of emissions from chemical sites. Reduction in emission estimates from fuel combustion due to DUKES revisions across several sectors including autogenerators and other (unclassified) industrial combustion.
3. **Waste Management (245 ktCO_2e)**: New data on landfill methane flaring from site operators and regulators has improved methane recovery data. The method to estimate methane formation within landfills has been improved to incorporate new data.

Industrial and domestic waste water treatment methods were revised to be consistent with 2006 IPCC Guidelines and a calculation error was identified and corrected, which increased emissions across the time series for this source. New emission estimates were included from private sewage treatment facilities and composting.

4. **LULUCF (-145 ktCO_2e)**: Revised data has become available on the area of Cropland and improved Grassland on drained organic soils and areas of deforestation due. Emissions of nitrous oxide from soil mineralisation following land use change and drainage of Forest soils have been estimated for the first time which has increased reported emissions.
5. **Agriculture (123 ktCO_2e)**: Emission factors and methodologies have been updated to the 2006 IPCC Guidelines. Enteric emissions of methane from all livestock (especially cattle and sheep) have increased compared to previous inventory estimates, and in Wales this outweighs a decrease in emissions of nitrous oxide from agricultural soils leading to an overall increase in the agriculture inventory emissions for Wales

For more details of revisions to GHG emission estimates, see Appendix 6.

Figure 4.1: Total GHG Emissions by NC category for Base Year to 2013, as kt CO2e, Wales

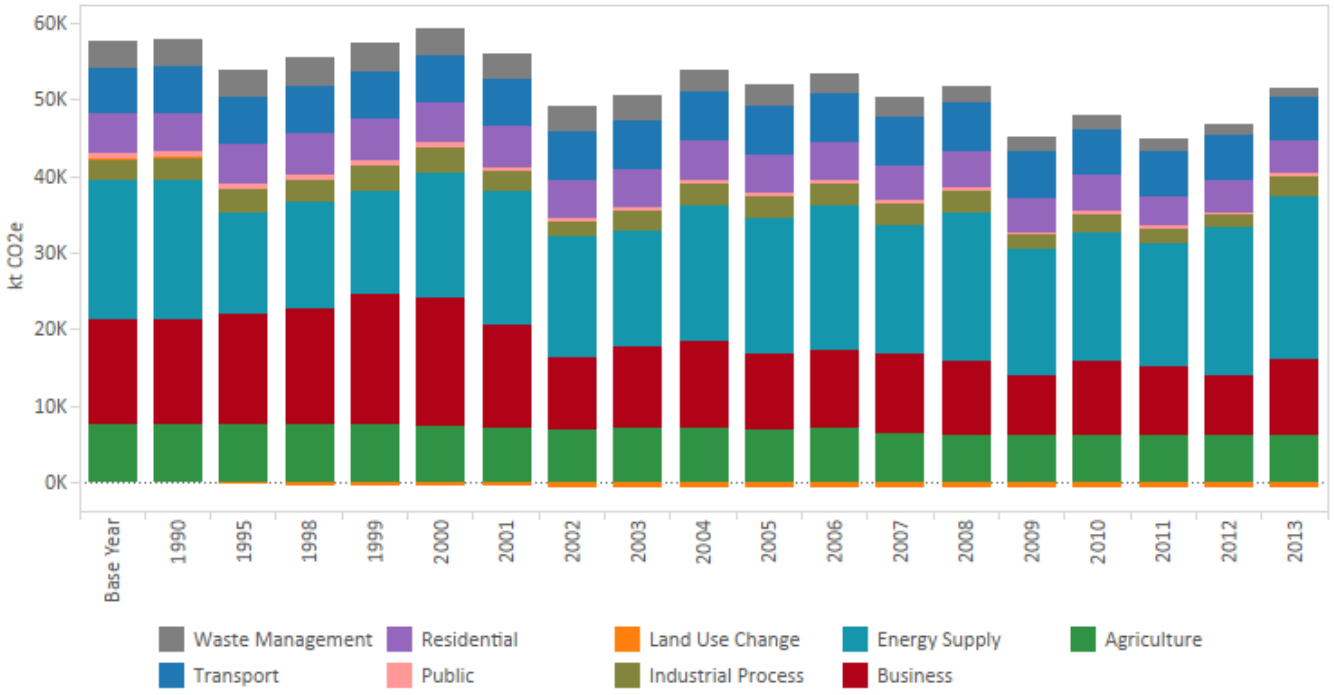
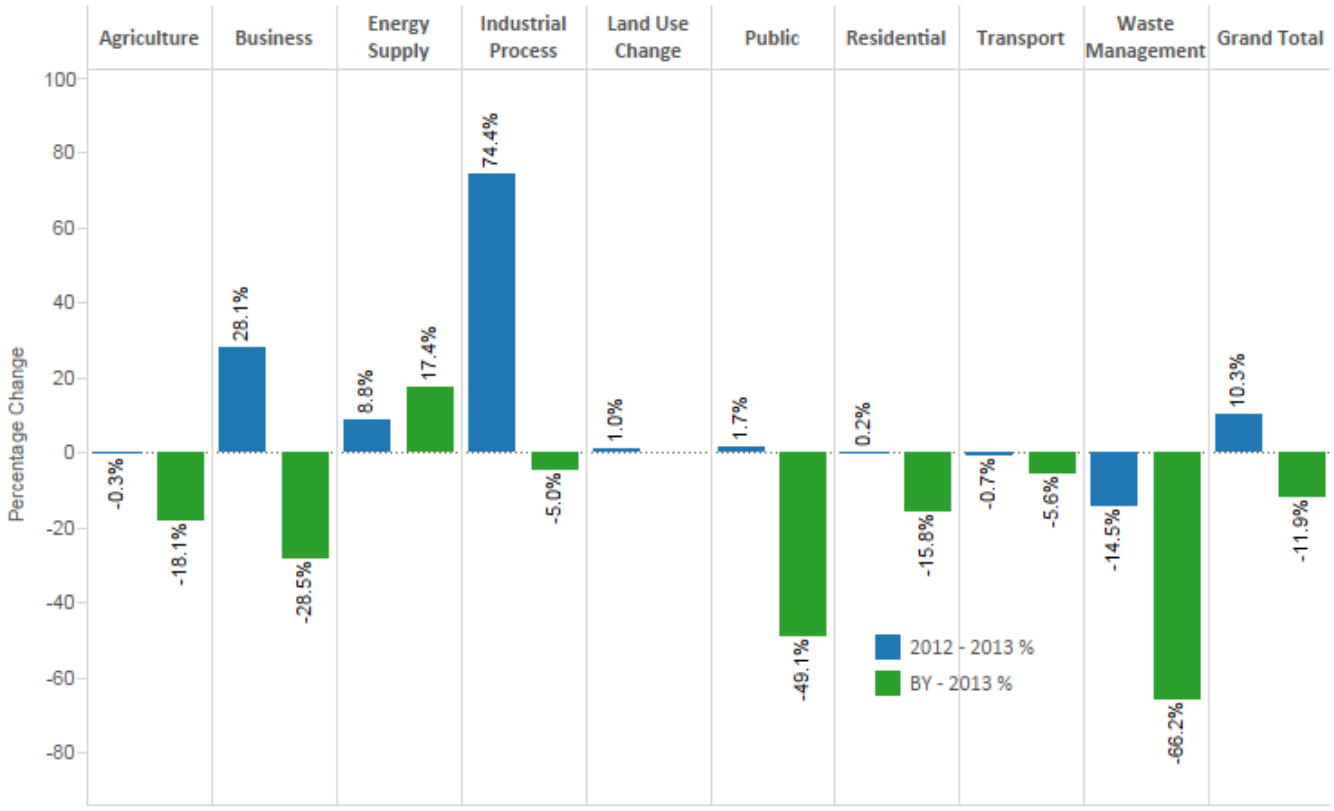


Figure 4.2: Percentage Change and Absolute (kt CO2e) Change in GHG Emissions by NC: 2012 - 2013 and Base Year (BY) - 2013, Wales

The LULUCF Base Year - 2013% change is excluded from the figure if LULUCF emissions changed from a sink to source, or source to sink, across the time series.



	Agriculture	Business	Energy Supply	Industrial Process	Land Use Change	Public	Residential	Transport	Waste Management	Grand Total
BY - 2013 kt	-1,381	-3,911	3,129	-138	-746	-379	-796	-336	-2,312	-6,870
2012 - 2013 kt	-17	2,156	1,707	1,130	-7	6	8	-40	-201	4,743

Figure 4.3: Total GHG emissions and uncertainties by pollutant, 2013, Wales

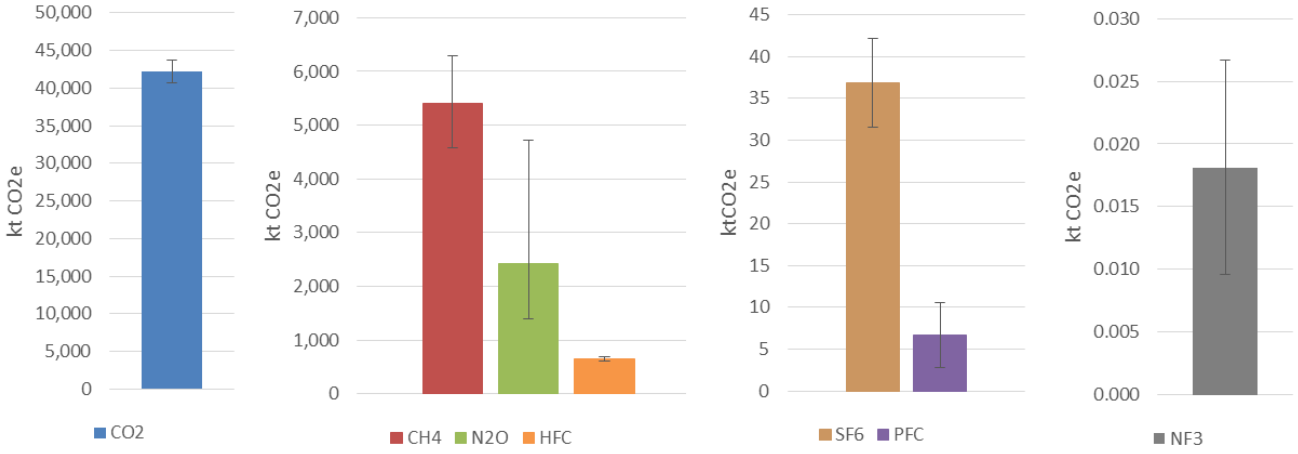


Figure 4.4: Total GHG Emissions by NC and pollutant, 2013, Wales

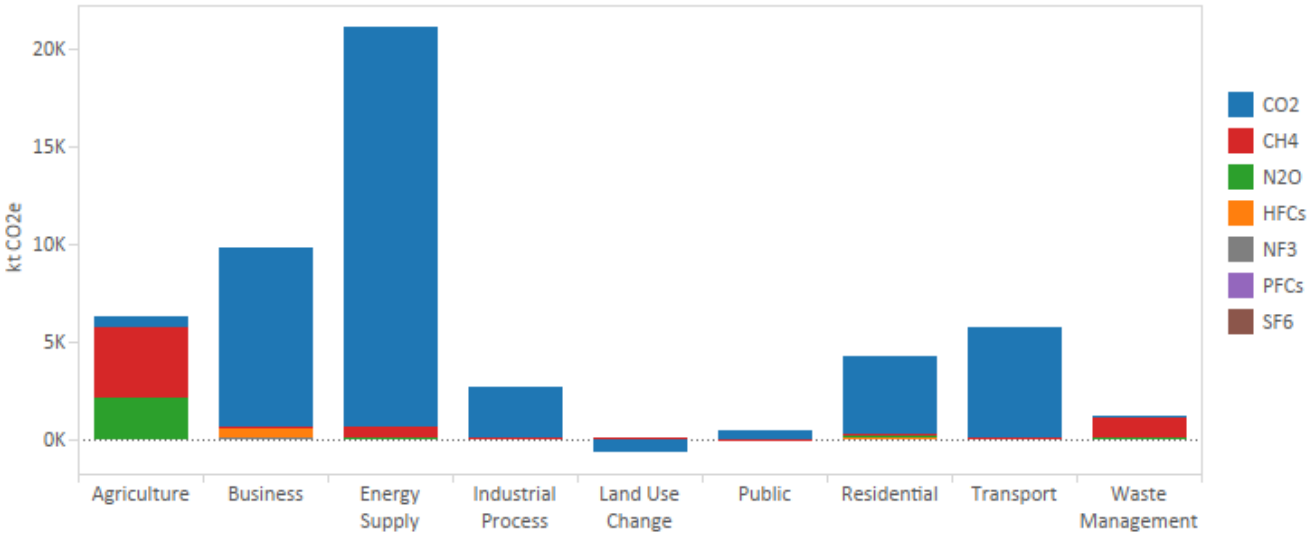
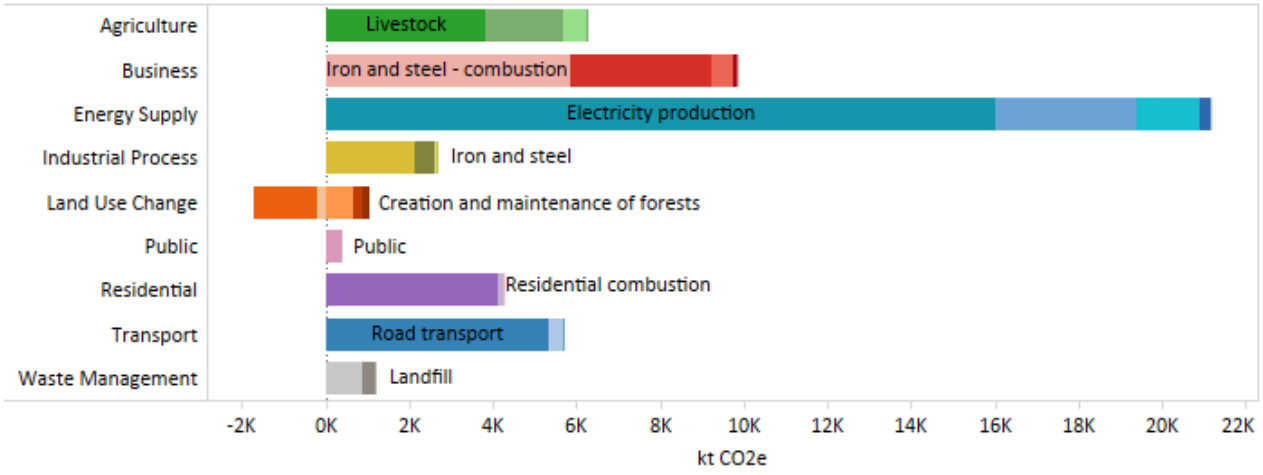


Figure 4.5: Total GHG Emissions labelling the largest sub-category in each NC, 2013, Wales



Traded and Non-Traded Emissions

Total GHG emissions from installations that operate within the European Union Emissions Trading Scheme (EU ETS) (see Figure 4.7) increased between 2011 and 2013 due to the fuel mix used in the energy sector and increased emissions from the iron and steel sector.

Emissions from installations in the EU ETS (see Figure 4.7) accounted for 58% of total GHG emissions in Wales in 2013. The main contributors to these traded emissions are the Energy Supply sector and the Business and Industrial Process sector (see Figure 4.6).

Figure 4.6: Total Traded and Non-Traded GHG Emissions by NC Category, 2013, Wales

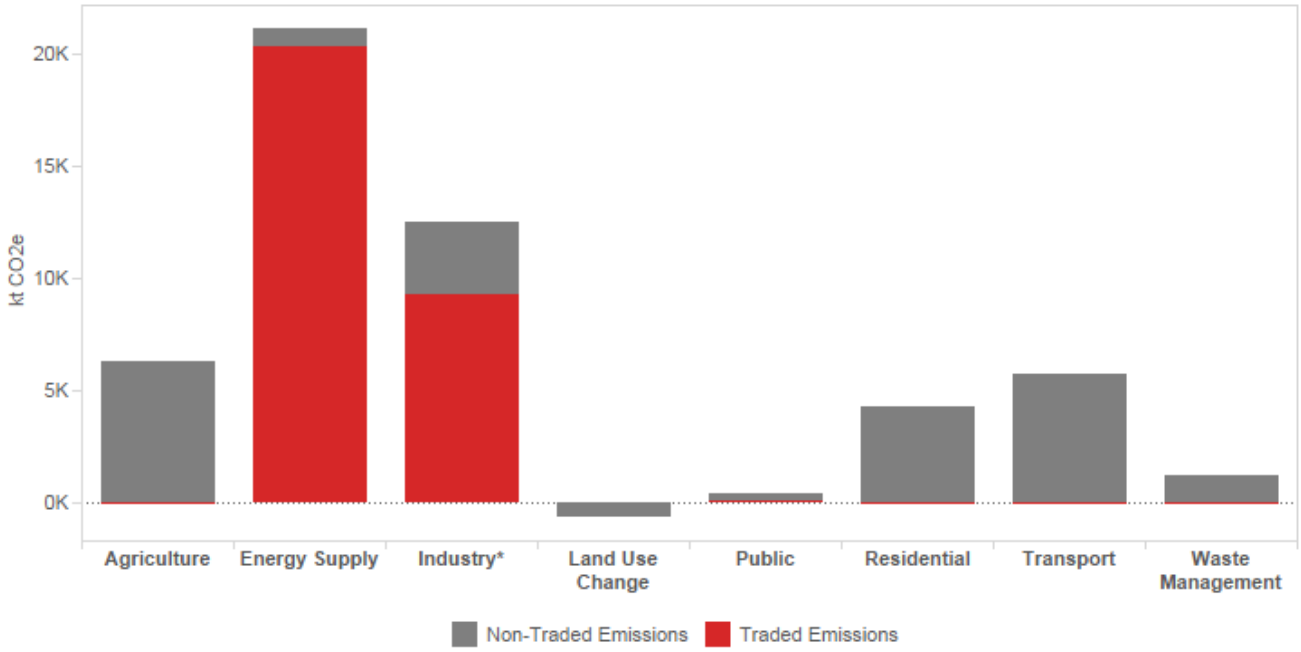


Figure 4.7: Total Traded and Non-Traded GHG Emissions 2008-2013, Wales

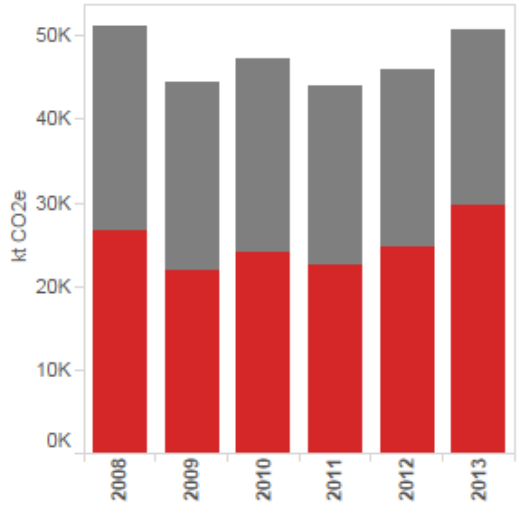
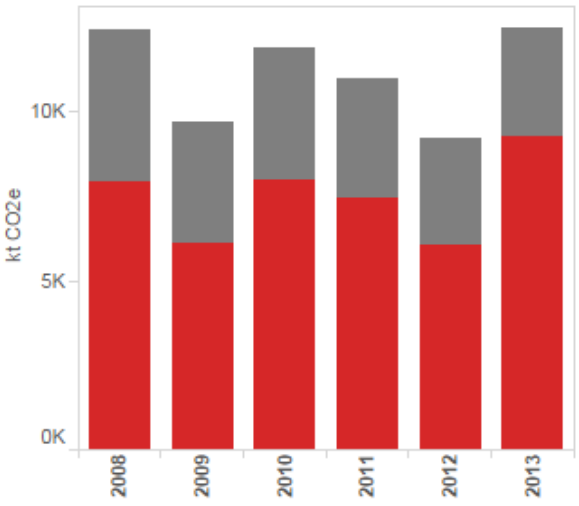


Figure 4.8: Traded and Non-Traded GHG Emissions from Industry 2008-2013, Wales*



*Industry includes emissions from the NC categories: Industrial Process and Business

Emissions on an End User Basis

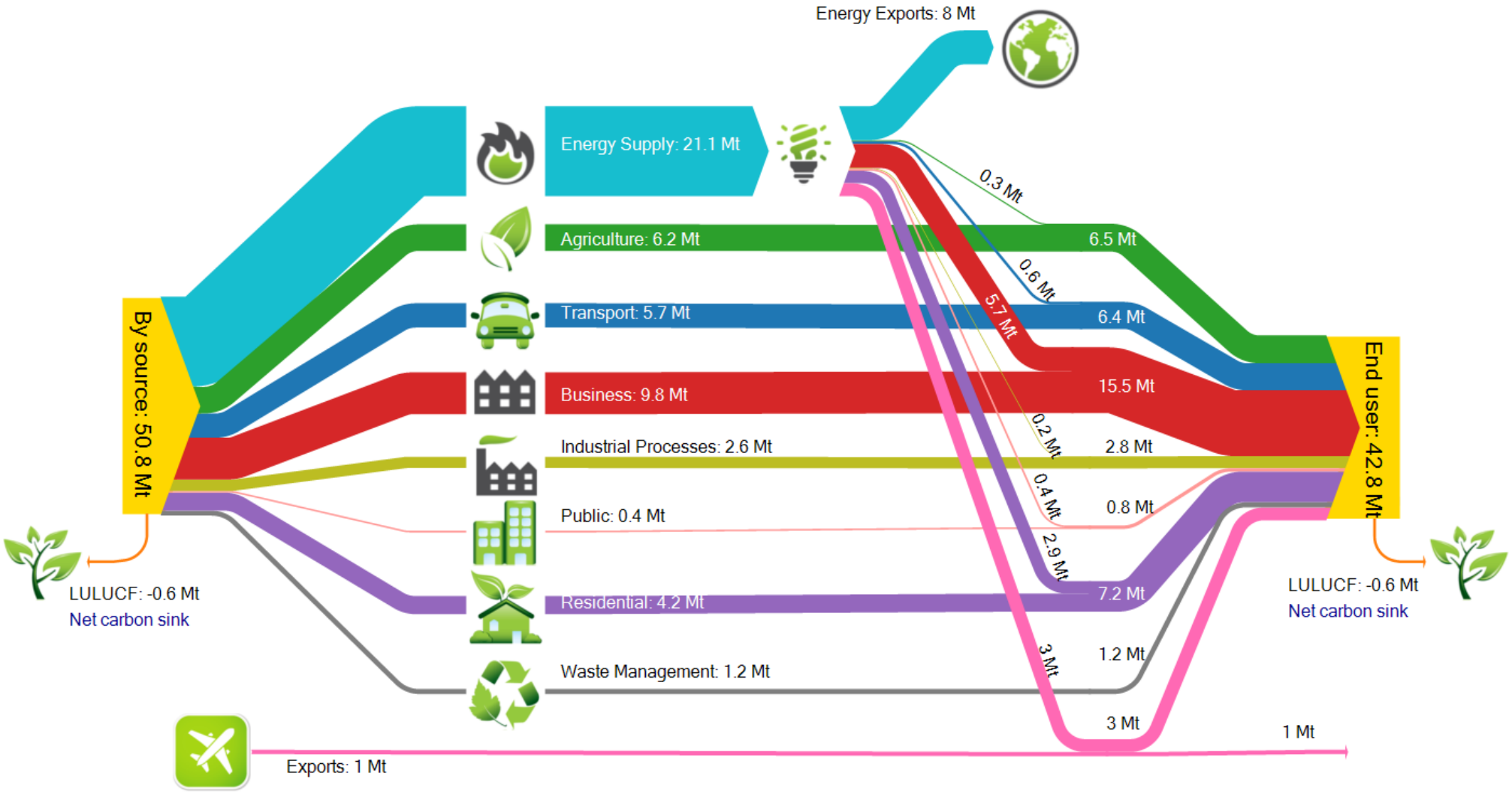
In addition to presenting emissions based on direct emissions from processes or combustion of fuels in Wales, the emissions from the Energy Supply sector can be attributed to the users of the energy (see Appendix 3 for more details of the End User inventory methodology).

Figure 4.9 illustrates the difference between the By Source and End User inventory emission estimates and how emissions from the Energy Supply sector are allocated to the End User National Communication (NC) sectors. The primary difference in the end user perspective is the significant increase in emissions attributable to the Business, Residential, transport and Public sectors. The End User inventory data illustrate that on an energy consumption basis, the most significant sector is Business, with Residential, Agriculture and Transport contributing similarly in 2013.

As illustrated in Figure 4.9 Wales is a net exporter of electricity which resulted in lower (-16%) emissions in Wales on an end user basis (42.8 $MtCO_2e$) compared to the by source (50.8 $MtCO_2e$) estimates.

Emissions from the Land Use, Land Use Change and Forestry (LULUCF) and Waste Management sectors are unchanged between the By Source and End User inventories, since there are no emissions from energy use allocated to these sources. The End User increment within the Industrial Process sector is limited to the use of fuels in the iron and steel sector, whilst in the Agriculture sector a small additional End User emission allocation is evident to reflect the fuel use in stationary and mobile combustion units within the sector.

Figure 4.9 Sankey diagram showing By Source and End User[23] GHG emission transfers for Wales in 2013 (Mt CO_2e)[24]



[23] The pink line from 'Energy Supply' to 'End User' represents emissions from Energy Supply in the production of fuels used in international aviation and shipping.

[24] Exports' includes emissions from energy production for international aviation, international shipping and exported fuel.

4.2 Energy Supply Sector

Figure 4.10: Overall Contribution to 2013 GHG emissions, Wales

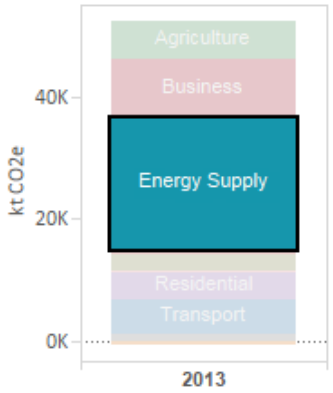


Figure 4.11: GHG Contribution to Energy Supply Emissions, 2013, Wales

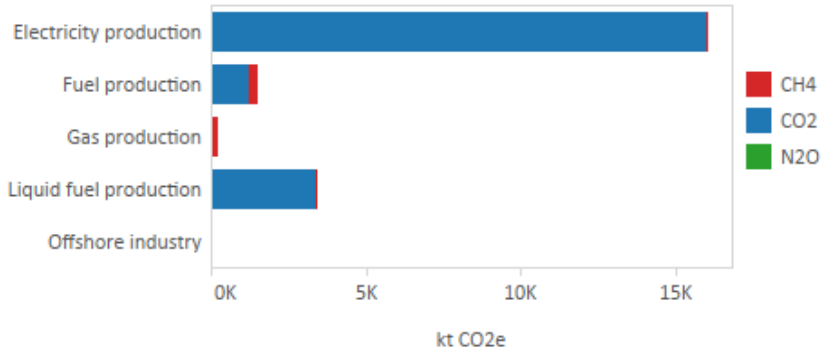


Table 4.2: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Wales

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Electricity production	42.19%	4,751.62	8.37%	1,237.04
Gas production	-41.49%	-178.02	-6.69%	-18.00
Liquid fuel production	-4.30%	-151.66	16.06%	466.62
Offshore industry	N/A	0.03	-64.08%	-0.05
Fuel production	-46.22%	-1,293.26	1.44%	21.35
Energy Supply Total	17.37%	3,128.71	8.78%	1,706.97

Table 4.3: NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions, Wales

Agriculture	2%
Business	54%
Industrial Process	0%
Public	4%
Residential	28%
Transport	0%
Exports	12%

Figure 4.12: Total GHG Emissions from Energy Supply, Base Year to 2013, Wales

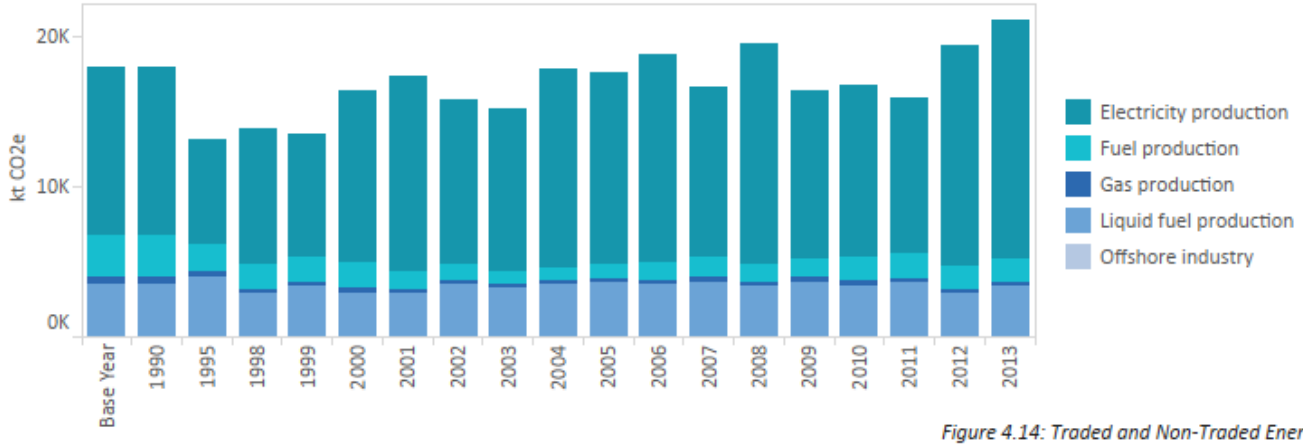


Figure 4.13: Emissions and Electricity Production by Fuel Type from Major Power Producers (1A1a), Wales

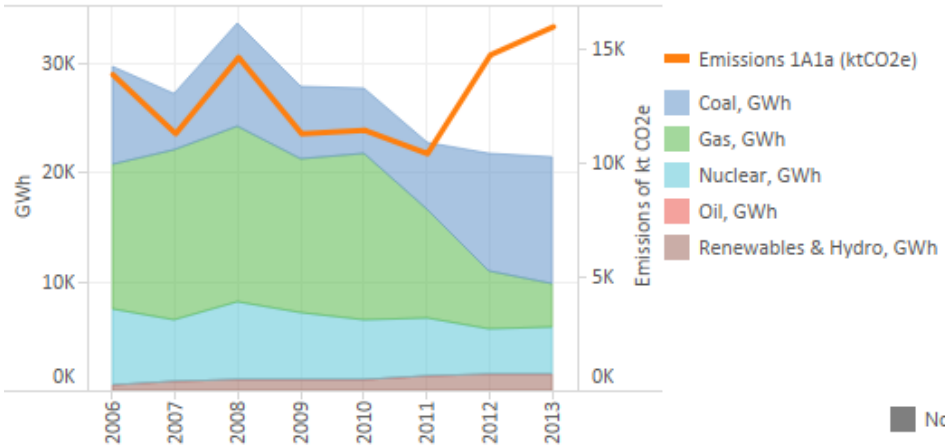
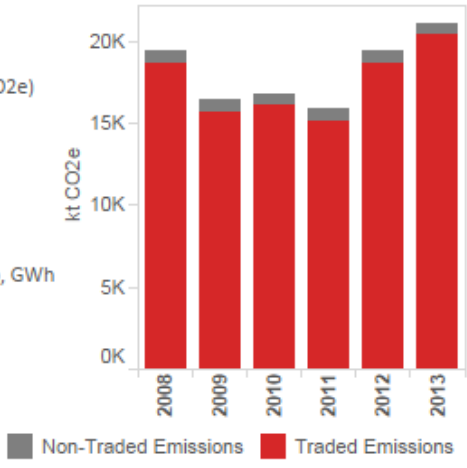


Figure 4.14: Traded and Non-Traded Energy Supply Emissions, 2008-2013, Wales



*Exports includes emissions from energy production for international aviation, international shipping and exported fuels

By Source Emissions

Overview

In Wales, Energy Supply sources contributed 42% to total 2013 GHG emissions. Energy Supply includes emissions from power generation, refineries, solid fuel transformation, oil and gas extraction and processing and other energy industries. The main source of emissions in Wales within the Energy Supply sector was electricity production at power stations, which accounted for 76% of Energy Supply emissions in 2013 and refinery emissions which accounted for a further 16%. Carbon dioxide is the predominant gas accounting for 97% of emissions from the Energy Supply sector in 2013, released through the combustion of fossil fuels.

Features of the Trends

Energy Supply sector emissions have increased by 17% between the Base Year and 2013 due to increases in emissions from power stations seen in 2012 and 2013. Figure 4.13 provides the fuel split for electricity production from 2006 to 2013. This clearly shows the significant shift in fuel use from natural gas to coal between 2010 and 2013. As a result of this recent time series, there is an overall increase in emissions since 1990.

Sector Detail

The generation output and emissions in Wales is shown in Figure 4.13. Natural gas combustion now accounts for 19% of total generation whereas in 2010 it accounted for 55% of total generation. This is due to the shift from natural gas to coal, which has increased from a 21% share in 2010 to 54% in 2013. Only those emissions arising from on-shore installations in Wales have been included within the Welsh GHG inventory; emissions from upstream oil & gas exploration and production off-shore facilities are reported as “Unallocated”.

Traded and Non-Traded Emissions

Emissions in the Energy Supply sector are dominated by installations that operate within the EU ETS, with over 95% of emissions in Energy Supply from traded (EU ETS) operations in 2013; these traded emissions are primarily from power stations, refineries and coke ovens.

Emissions on an End User Basis

In the End User inventory, the emissions from the Energy Supply sector are passed on to the end users of the electricity, refined oils, gas and solid fuels. The most significant re-allocation is to pass on the emissions from electricity generation to the Business and Residential sectors (54% and 28%) reflecting the high demand for electricity in these sectors.

4.3 Transport Sector

Figure 4.15: Overall Contribution to 2013 GHG emissions, Wales

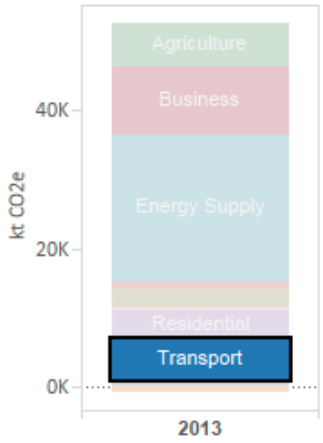


Figure 4.16: Total GHG Emissions from Transport, Base Year to 2013, Wales

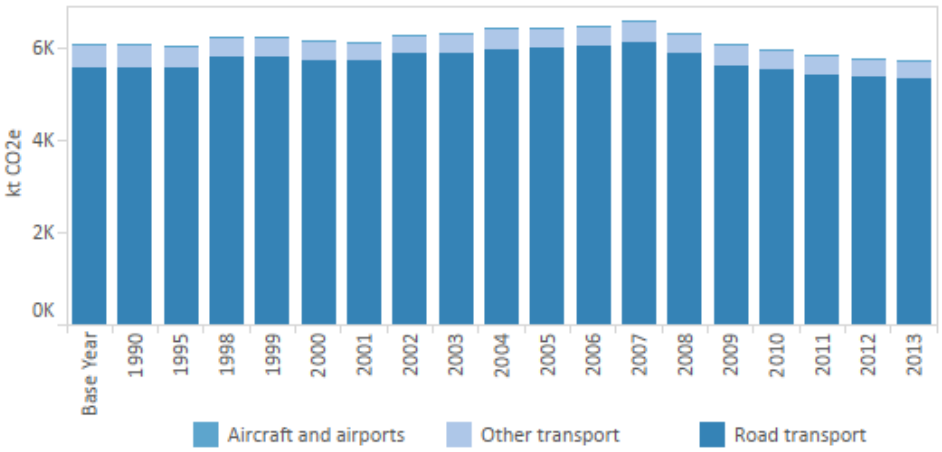


Table 4.4: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Wales

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Road transport	-3.8%	-208.8	-0.5%	-25.9
Other transport	-26.2%	-131.5	-3.2%	-12.2
Aircraft and airports	40.3%	4.2	-11.3%	-1.9
Transport Total	-5.6%	-336.2	-0.7%	-40.0

Figure 4.17: GHG Contribution for Transport Emissions, 2013, Wales

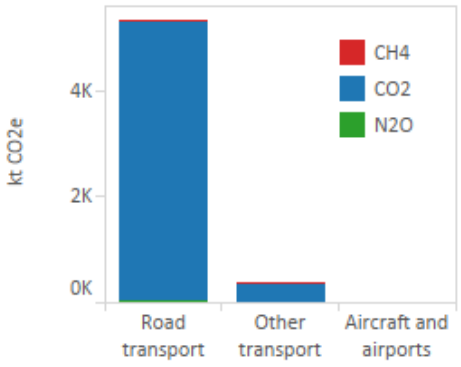


Figure 4.18: Comparison of End User and By Source for Transport, Wales

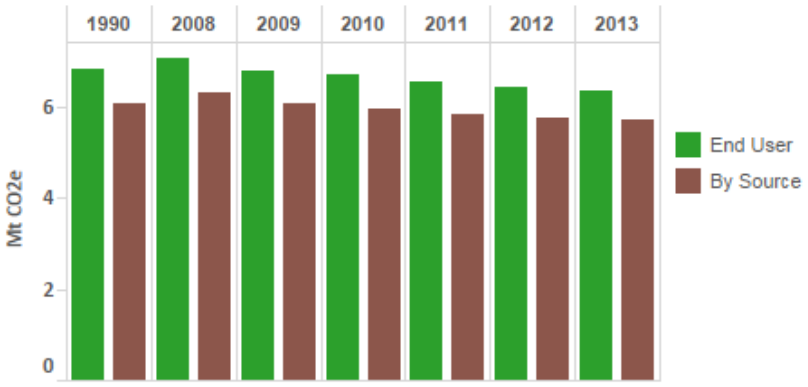


Figure 4.19 Road Transport CO2 Emissions (fuel sales basis), Wales

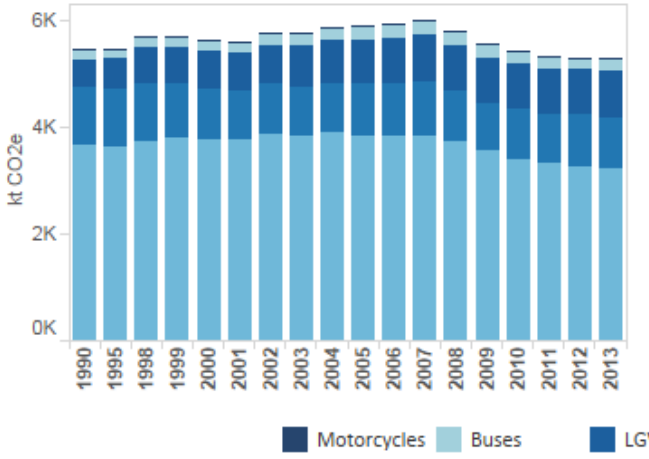
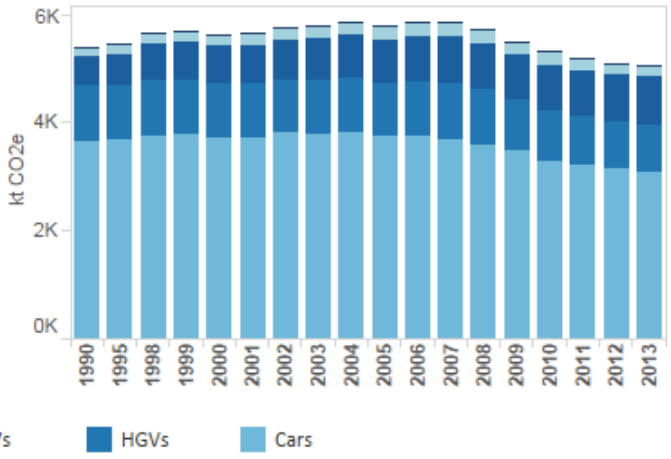


Figure 4.20: Road Transport CO2 Emissions (vkm basis), Wales



By Source Emissions

Overview

Transport emissions account for 11% of Wales' total GHG emissions in 2013. Transport emissions are dominated by emissions from road transport with 93% of all transport emissions in 2013, and 56% of transport emissions from cars alone. See Figures 4.16, 4.19 and 4.20. The Transport sector also includes small contributions from from rail (including stationary sources), national navigation and coastal shipping, military aviation and shipping and domestic aviation. Emissions from international aviation are excluded from these estimates.

Features of the Trends

Total emissions from the Transport sector in Wales have decreased by 6% between the Base Year and 2013 despite improvements in efficiency of transport vehicles, as a result of growth in transport demand since 1990 and increased affordability of cars over the period. Emissions peaked in 2007 and have since declined partly due to improvements in average fuel efficiency of vehicles and the switch from petrol to diesel cars in this latter part of the time series.

Emissions between 2012 and 2013 reduced by less than 1% (see Table 4.5). This sector is driven by the changes in emissions from passenger cars. Although emissions from road diesel (DERV) have increased, emissions from petrol have decreased leading to an overall reduction in emissions in the transport sector.

Sector Detail

There are two approaches used to calculate emissions from Road Transport: fuel sales basis – emissions are constrained to the total fuel sold within the UK as stated in DUKES (DECC, 2014b); vehicle kilometre basis – emissions are estimated using vehicle km data and are not constrained by the total fuel sold, so estimate emissions based on fuel used within the UK. The inventory emission estimates for Road Transport are calculated on a fuel sold basis and are, therefore, consistent with DUKES.

Figure 4.19 shows the carbon dioxide emissions from road transport for Wales based on constrained (DUKES fuel sales) and unconstrained (vehicle kilometre, vkm) approaches. Total carbon dioxide emissions from the vkm approach differ to the estimates constrained to DUKES for 1990 and 2012, respectively. The differences between the two approaches fluctuate year on year but they remain within 3.8% of difference for Wales. These disparities will also be reflected in the trends derived from the two approaches to a different extent. The long term trend for each individual vehicle type is generally similar between the two approaches.

The vkm approach indicates that the overall carbon dioxide emissions from road transport in 2013 are 6.3% lower than in the Base Year, while the constrained approach indicates that carbon dioxide emissions have decreased by 3.2% between the Base Year and 2013.

Emissions on an End User Basis

The End User inventory estimates in recent years are 11% higher than the By Source estimates, reflecting the additional emissions from upstream oil extraction and the oil refining sector (see Figure 4.18).

The trend in End User emissions since 1990 shows a decline of 7% to 2013, which is a slightly larger reduction than reported in the By Source inventory (6%), reflecting the improved energy efficiency of upstream production and refining of crude oil to produce the fuels used in the transport sector.

4.4 Residential Sector

Figure 4.21: Overall Contribution to 2013 GHG emissions, Wales

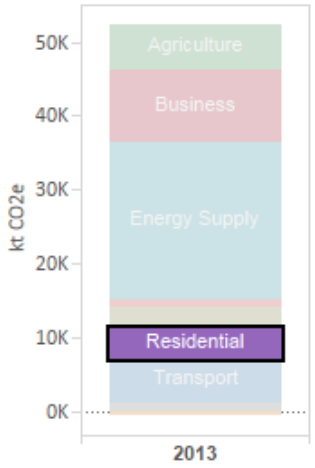


Figure 4.22: Total GHG Emissions from Residential, Base Year to 2013, Wales

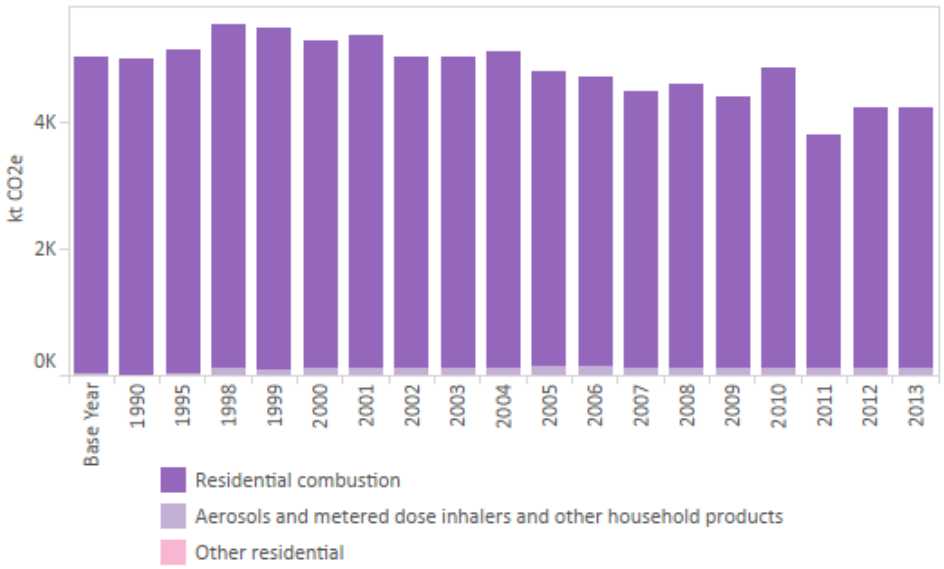


Table 4.5: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Wales

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Aerosols and metered dose inhalers and other household products	224.92%	77.55	-0.91%	-1.02
Other residential	103.20%	0.99	2.34%	0.04
Residential combustion	-17.47%	-874.58	0.23%	9.38
Residential Total	-15.79%	-796.05	0.20%	8.40

Figure 4.23: GHG Contribution for Residential Emissions, 2013, Wales

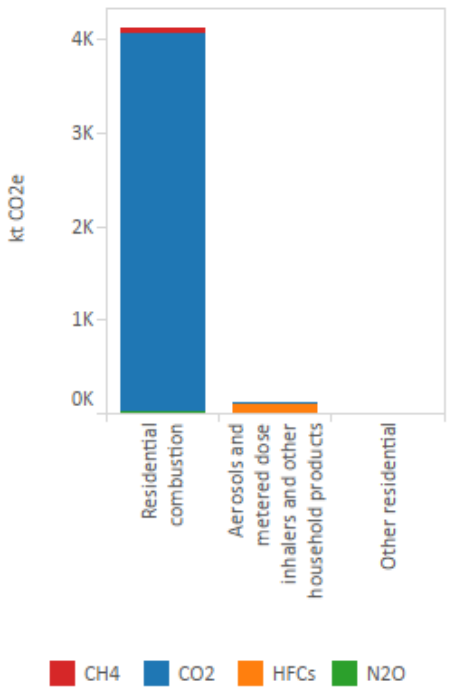
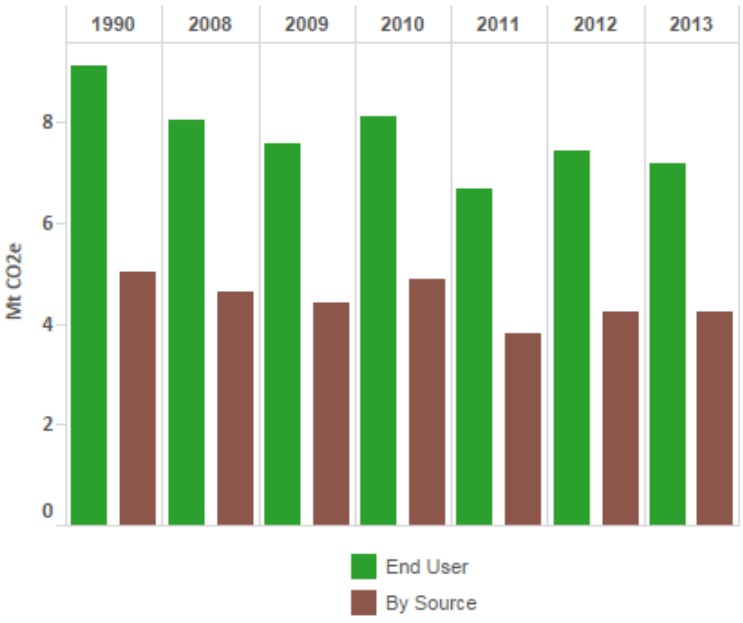


Figure 4.24: Comparison of End User and By Source for Residential, Wales



Overview of Emissions

Overview

Figures 4.21 – 4.24 show detailed emissions and trends for the sector. The Residential sector accounts for 8% of Wales' total emissions in 2013. The sector is dominated by emissions from residential combustion of fuels for heating and cooking, which account for 97% of emissions in this sector. The remaining 3% of emissions were from house and garden machinery, and HFC emissions from aerosols and metered-dose inhalers (MDIs), which would include some inhalers used for asthma.

Features of the Trends

Total GHG emissions from the Residential sector in Wales have decreased by 16% between the Base Year and 2013 (see Table 4.5) partly due to a change in the fuel mix from coal towards natural gas. The more recent trend follows the annual mean temperatures with a particularly cold year in 2010 followed by a particularly warm year in 2011.

Emissions on an End User Basis

In 2013, Wales End User emissions for the Residential sector are 169% of the By Source emission estimates, reflecting the high consumption of electricity in the sector (Figure 4.24). This increases the overall significance of this sector in the End User inventory to 17% of the Wales total, compared to just 8% of the By Source inventory total.

The trend in Residential End User emissions since 1990 shows a decline of around 21% to 2013 as a result of improvements in energy efficiency of housing combined with the less carbon intensive fuel mix of the electricity generation sector since 1990 (see Figure 4.13 in the Energy Supply section for fuel trends since 2006).

4.5 Business Sector

Figure 4.25: Overall Contribution to 2013 GHG emissions, Wales

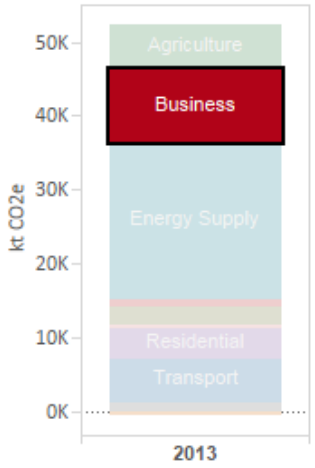


Figure 4.26: Total GHG Emissions from Business, Base Year to 2013, Wales

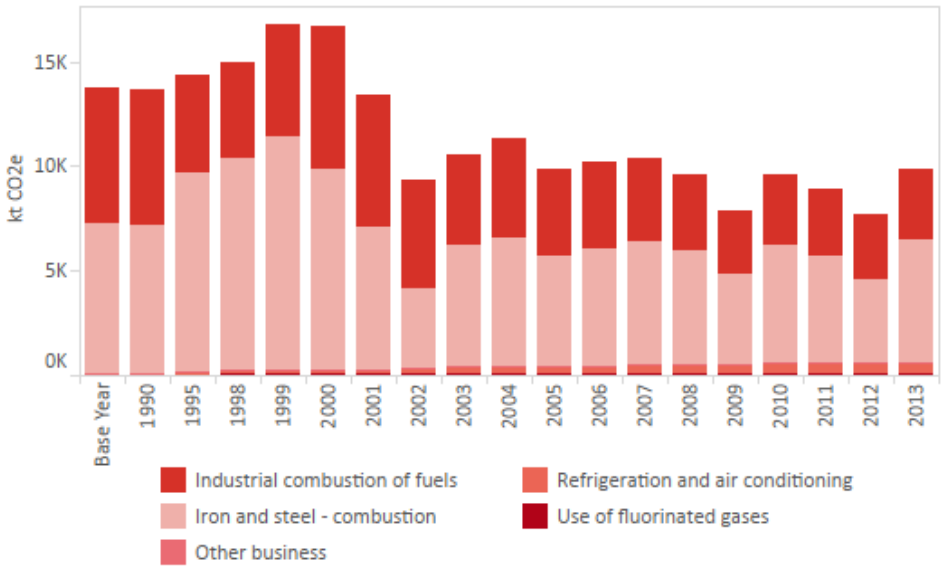


Table 4.6: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Wales

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Industrial combustion of fuels	-48.1%	-3,129.9	8.1%	253.2
Refrigeration and air conditioning	1,113.6%	463.9	0.9%	4.3
Use of fluorinated gases	2.3%	1.6	-1.7%	-1.2
Iron and steel - combustion	-17.6%	-1,256.3	48.0%	1,901.7
Other business	844.9%	10.0	-14.8%	-1.9
Business Total	-28.5%	-3,910.7	28.1%	2,156.0

Figure 4.27: GHG Contribution for Business Emissions, 2013, Wales

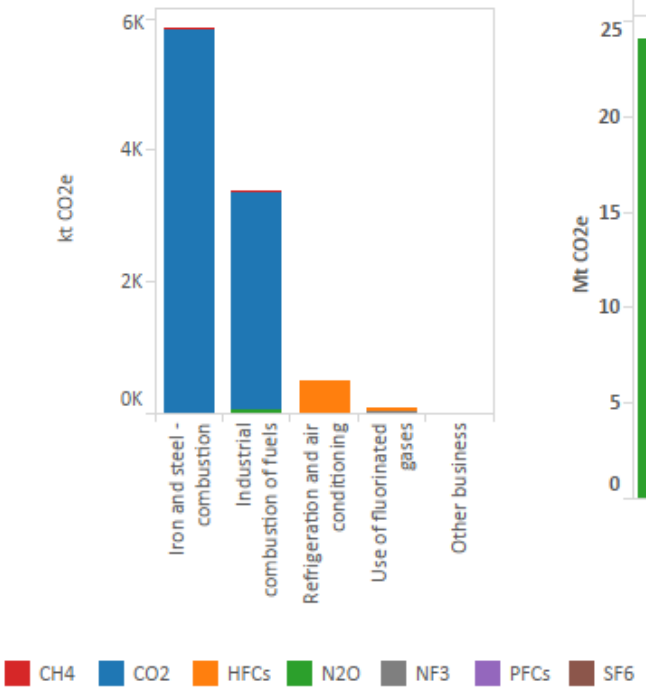
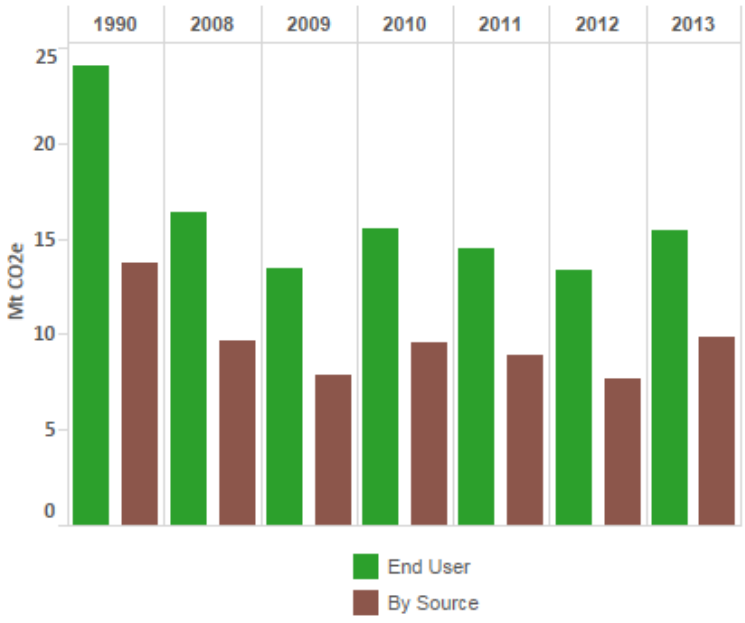


Figure 4.28: Comparison of End User and By Source for Business, Wales



By Source Emissions

Overview

Figures 4.25-4.28 show detailed emissions and trends for the sector. The Business sector contributes 19% to total 2013 GHG emissions in Wales. The Business sector in 2013 included emissions from industrial combustion of fuels (34% of total Business emissions); iron and steel fuel combustion (60% of total emissions); refrigeration & air conditioning (5% of total emissions), arising from losses of HFCs during equipment manufacture, leaks and disposal, and HFC emissions from foam production, fire-fighting solvents and electronics (0.7% of total emissions).

In 2013, 94% of emissions were carbon dioxide released from the combustion of fossil fuels in the business sector with 6% from the use of fluorinated greenhouse gases (F-Gases), predominantly HFCs in refrigeration and air conditioning and sulphur hexafluoride (SF_6) in electrical insulation systems).

Features of the Trends

Total GHG emissions from the Business sector have declined by 28% since the Base Year (see Table 4.6). These reductions primarily occurred between 2000 and 2002 due to the closure of the Llanwern steelworks. Since 2002, the trend has been variable and dependent on manufacturing output.

Emissions of HFC from refrigeration and air conditioning were negligible in 1990 and have risen to account for 6% of the sector total in 2013. This is due to the introduction of these gases as replacement to CFCs banned by the Montreal Protocol.

Emissions have increased by 28% between 2012 and 2013. The trend is driven largely by the restart of Tata Steel's Port Talbot No.4 Blast Furnace in February, 2013. A similar trend can be seen in the Iron and Steel sub-category of the Industrial Processes sector, which includes emissions from all non-combustion activities within the production of iron and steel. All combustion-related emissions are reported under this sector.

Traded and Non-Traded Emissions

Emissions in the Industrial Process sector include significant contributions from installations reporting in the EU ETS. However, due to the lack of detail in the EU ETS dataset, the Business and Industrial Process emissions are not easy to separate.

The contribution to total aggregate emissions from the traded and non-traded sector across the Business and Industrial Process sectors are presented in Figure 4.8 in the Overview section under the category: "Industry".

Emissions on an End User Basis

In 2013, Wales' End User emissions for the Business sector were 158% higher than the by source emission estimates, reflecting the high consumption of electricity for heating, lighting and operating equipment in the sector (see Figure 4.28). On an End User basis, therefore, Business sector represents 36% of total emissions for Wales compared to just 19% of the By Source inventory total.

4.6 Public Sector

Figure 4.29: Overall Contribution to 2013 GHG emissions, Wales

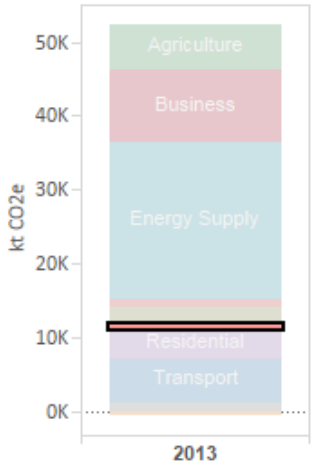


Figure 4.30: Total GHG Emissions from Public, Base Year to 2013, Wales

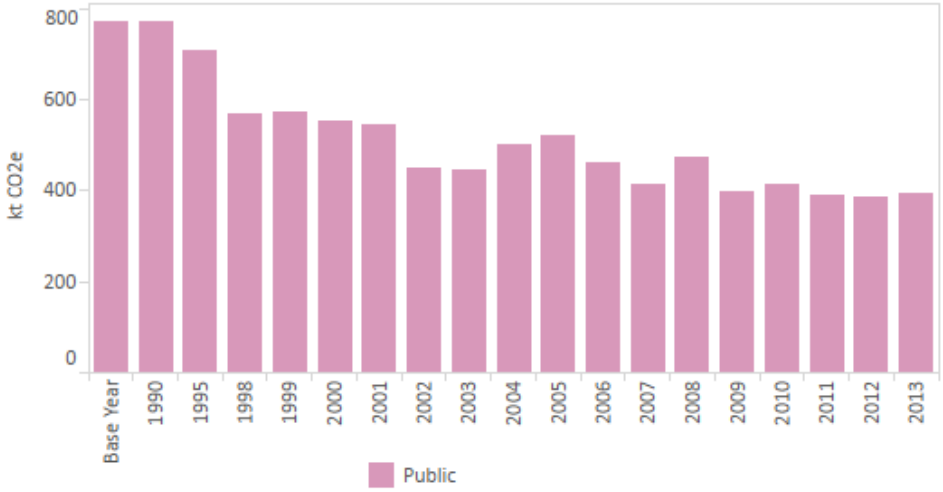


Table 4.7: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Wales

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Public	-49%	-379	2%	6
Public Total	-49%	-379	2%	6

Figure 4.31: GHG Contribution for Public Emissions, 2013, Wales

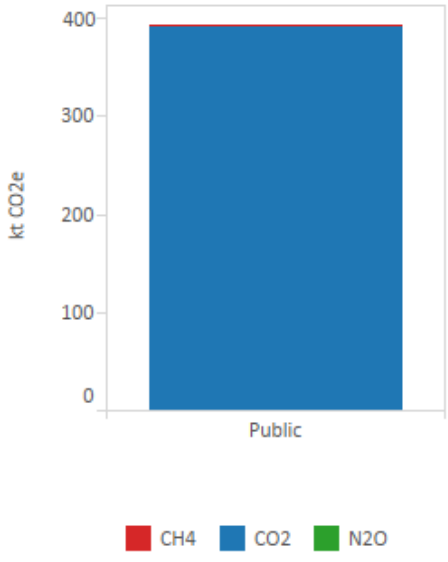
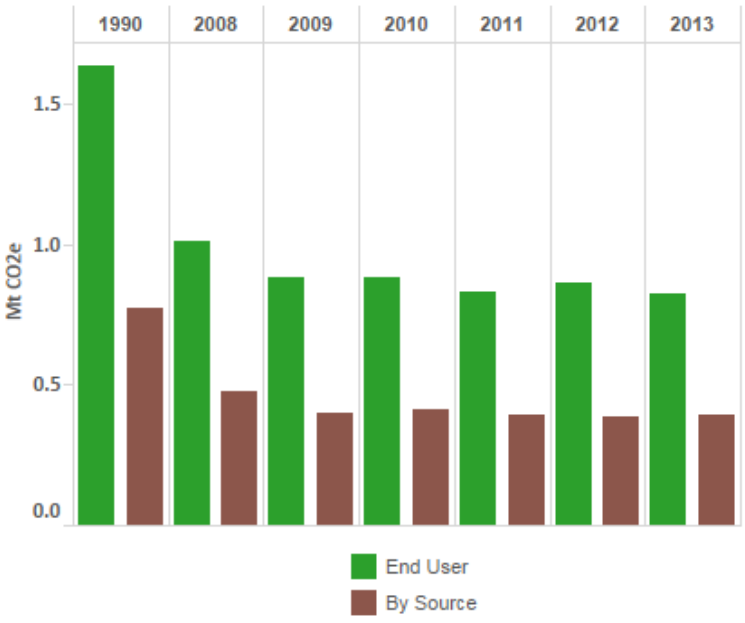


Figure 4.32: Comparison of End User and By Source for Public, Wales



By Source Emissions

Overview

Emissions from Public sector combustion account for 1% of GHG emissions in Wales in 2013. Carbon dioxide emissions from the combustion of fossil fuels accounts for over 99% of emissions in 2013. These emissions are primarily from the combustion of natural gas to heat buildings.

The emission estimates in the public sector are associated with high uncertainty due to the absence of comprehensive, detailed DA-specific fuel use data, particularly for solid and liquid fuels.

Features of the Trends

Public sector emissions have reduced by 49% since the Base Year (see Table 4.7); this has been achieved through more efficient use of fuels and a switch to gas fired heating across Wales for many public sector buildings since 1990. Public sector emissions increased by 2% between 2012 and 2013 primarily due to increased consumption of natural gas in the sector.

Emissions on an End User Basis

In 2013, Wales' End User emissions for the Public sector were 209% higher than the By Source emission estimates, reflecting the high consumption of electricity in the sector. This increased the sector's share of total national emissions from 0.8% in the By Source inventory to 1.9% in the End User inventory for 2013 (see Figure 4.32). The trend in End User emissions since 1990 shows a decline of 50% to 2013, which could, in part, be due to a shift in the fuel mix away from coal and oil towards natural gas. Trends in the End User inventory are highly uncertain and should be regarded as indicative.

4.7 Industrial Process Sector

Figure 4.33: Overall Contribution to 2013 GHG emissions, Wales

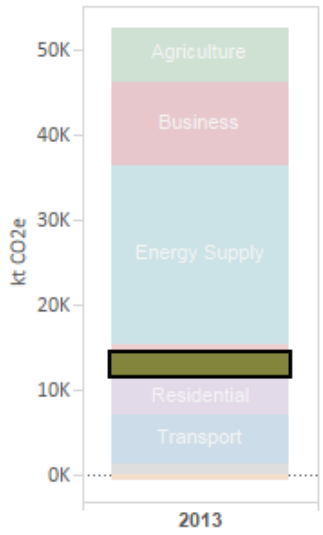
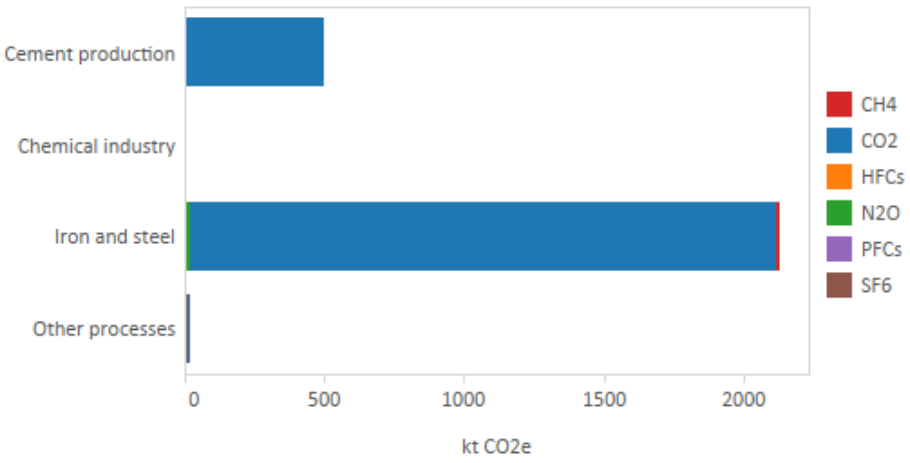


Figure 4.34: Total GHG Emissions from Industrial Process, Base Year to 2013, Wales

Table 4.8: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Wales

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Cement production	-13.1%	-75.5	10.8%	48.9
Other processes	-92.1%	-206.4	-6.1%	-1.2
Chemical industry	-99.6%	-178.3	8.8%	0.1
Iron and steel	17.8%	322.0	103.4%	1,082.1
Industrial Process Total	-5.0%	-138.2	74.4%	1,129.9

Figure 4.35: GHG Contribution to Industrial Process Emissions, 2013, Wales



By Source Emissions

Overview

In 2013, the Industrial Process sector contributed 5% to total GHG emissions. The Industrial Process sector includes non-combustion sources such as the use of limestone in cement production; iron and steel processes excluding the use of electricity and fossil fuels for heating processes; and other processes including fertilizers & other bulk chemical feedstocks, glass & brick making and lime production (see Figure 4.34).

In 2013, 99% of total GHGs emissions were from emissions of carbon dioxide from processes (primarily cement and iron and steel production). Less than 1% of total GHGs emissions are from the use of fluorinated greenhouse gases (F-Gases), predominantly HFCs in Industrial Processes including sulphur hexafluoride (SF_6) from its application as a cover gas in magnesium production (see Figure 4.36).

Features of the Trends

Overall, Industrial Process emissions in Wales have reduced by 5% between the Base Year and 2013 (see Table 4.8) but have shown significant fluctuations during this timeframe reflecting manufacturing output and abatement installations. The overall decline in emissions is due to several factors including a decline in iron and steel industries, aluminium production and cement production.

Total GHG emissions have increased significantly by 74% between 2012 and 2013. The trend is driven by the restart of Tata Talbot's No.4 Blast Furnace in February, 2013, leading to a significant increase in emissions from the iron and steel sector. A similar trend can be seen in the "Iron and Steel – combustion" sub-category of the Business sector, which includes emissions from all combustion activities within the production of iron and steel. All emissions from non-combustion activities are reported under the Industrial Processes sector.

Traded and Non-Traded Emissions

Emissions in the Industrial Process sector include significant contributions from installations reporting in the EU ETS. However, due to the lack of detail in the EU ETS dataset, the Business and Industrial Process emissions are not easy to separate.

The contribution to total aggregate emissions from the traded and non-traded sector across the Business and Industrial Process sectors are presented in Figure 4.8 in the Overview section under the category: "Industry".

Emissions on an End User Basis

As the majority of emissions in the Industrial Process sector are not due to energy consumption, Industrial Process sector emissions on an End User basis are very similar to the emissions by source. In 2013, the End User estimates are only 6% higher for the Industrial Process sector, reflecting the relatively low contribution to sector emissions from the use of electricity or fossil fuels as feedstock or for energy.

4.8 Agriculture Sector

Figure 4.36: Overall Contribution to 2013 GHG emissions, Wales

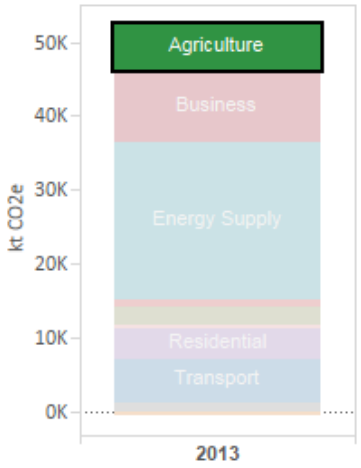


Figure 4.37: Total GHG Emissions from Agriculture, Base Year to 2013, Wales

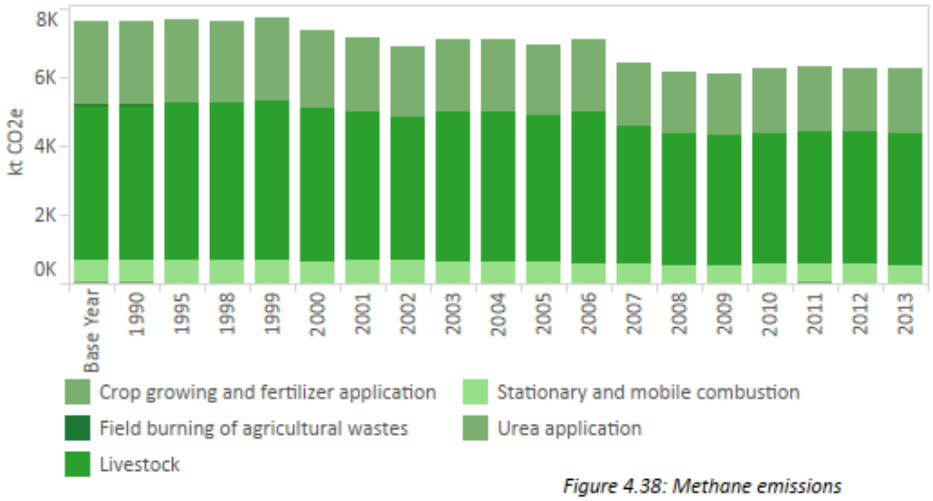


Table 4.9: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Wales

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Crop growing and fertilizer application	-22.59%	-542.95	-0.04%	-0.67
Field burning of agricultural wastes	-100.00%	-2.03	N/A	0.00
Livestock	-15.06%	-680.57	0.01%	0.30
Stationary and mobile combustion	-21.30%	-143.29	-1.92%	-10.36
Urea application	-38.27%	-11.80	-24.52%	-6.18
Agriculture Total	-18.10%	-1,380.64	-0.27%	-16.91

Figure 4.38: Methane emissions from livestock by type, 2013, Wales

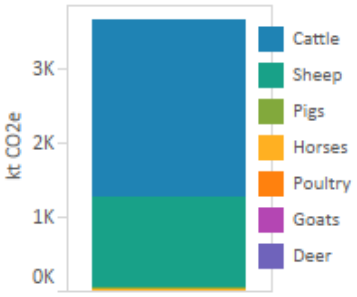


Figure 4.39: GHG Contribution for Agriculture Emissions, 2013, Wales

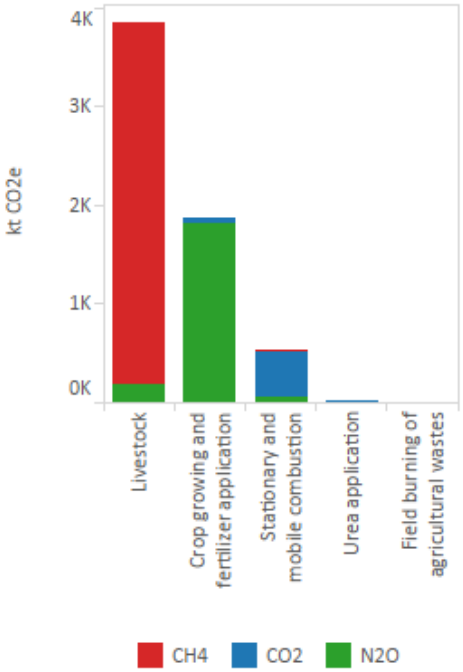


Table 4.10: Emissions of nitrous oxide from agricultural sources in 2013 (kt CO2e), Wales*

Manure management				178
Soils				1,796
	Direct			1,389
		Crop residues		248
		Fertiliser		346
		Grazing returns		646
		Histosols		24
		Manure application		112
		Sewage sludge		13
	Indirect			407
		Deposition		148
			Fertiliser	35
			Grazing returns	89
			Manure application	22
			Sewage sludge	3
		Leaching		259
			Crop residues	53
			Fertiliser	78
			Grazing returns	100
			Manure application	25
			Sewage sludge	3
Mineralisation				21
TOTAL				1,995

*Total emissions comprise manure management, soils and mineralization. Soils include direct and indirect emissions; indirect emissions include leaching and deposition.

By Source Emissions

Overview

GHG emissions from the Agriculture sector are primarily methane and nitrous oxide from livestock and agricultural soils, respectively, but there are also carbon dioxide emissions from fuel combustion in mobile and stationary units (such as tractors and generators) in the sector (see Figure 4.39). The Agriculture sector accounts for 12% of total greenhouse gas emissions in Wales in 2013, and is the most significant source sector for methane and nitrous oxide, accounting for 68% and 85% of total Welsh emissions of these two gases, respectively.

Features of the Trends

Emissions from the Agriculture sector have decreased by 18% between the Base Year and 2013, with methane and nitrous oxide emissions decreasing by 15% and 20%, respectively. The trends result from a general decline in livestock numbers and in fertiliser nitrogen use. There was no significant trend in Agriculture sector emissions between 2012 and 2013 (0.3% decrease). There has been a decrease in emissions from cattle, however, a more significant increase in emissions from sheep. Field burning has largely ceased in the UK since 1993, hence the significant decrease in emissions since the Base Year.

Sector Detail

Livestock emissions include two main sub-categories: emissions from enteric fermentation (a digestive process by which carbohydrates are broken down by microorganisms into simple molecules) and emissions from manure management. Total methane emissions from beef and dairy cattle (enteric and manure management sources combined) accounted for 57% of the all agricultural methane emissions. Total emissions from sheep were 32% of the total methane from Agriculture in 2013.

Nitrous oxide emissions are largely driven by fertiliser nitrogen use, manure applications and grazing returns to soils. Agriculture is the most important source of nitrous oxide in Wales and 89% of the total nitrous oxide emissions in the Agriculture sector arose from agricultural soils. This source accounted for 75% of total nitrous oxide emissions in 2013. A further breakdown of these emissions is shown in Table 4.10.

Emissions on an End User Basis

As the majority of emissions in the Agriculture sector are not due to energy consumption, Agriculture sector emissions on an End User basis are very similar to the emissions by source. In 2013, the End User estimates were only 5% higher for the Agriculture sector, reflecting the relatively low contribution to sector emissions from the use of oils and electricity, compared to the higher-emitting sources of nitrous oxide and methane from soils and livestock sources.

4.9 Land Use, Land Use Change and Forestry Sector

Figure 4.40: Overall Contribution to 2013 GHG emissions, Wales

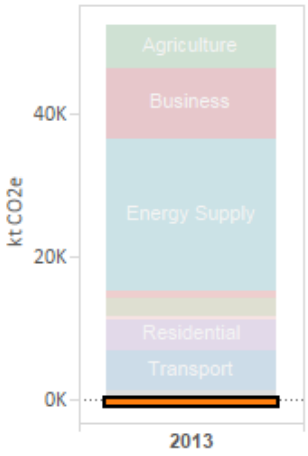


Figure 4.41: GHG Contribution to Land Use Change Emissions, 2013, Wales

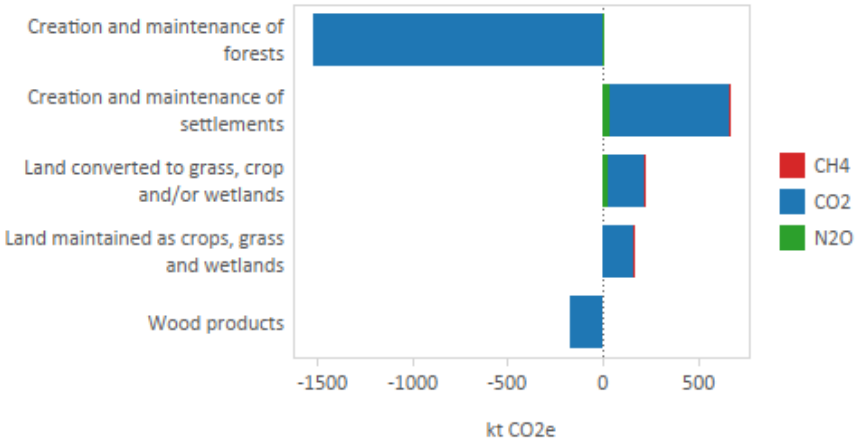
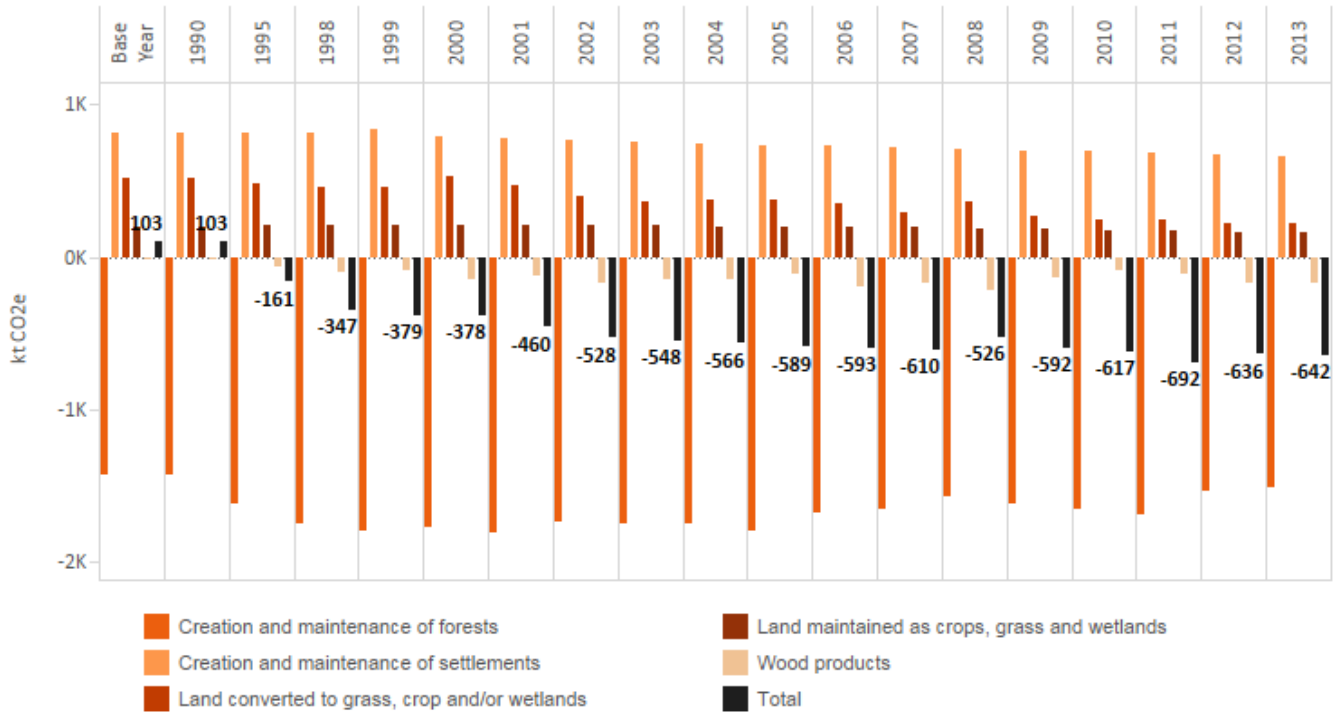


Table 4.11: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Wales

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Creation and maintenance of settlements	-18.9%	-154.2	-1.4%	-9.5
Creation and maintenance of forests	5.9%	-83.9	-0.9%	14.2
Land converted to grass, crop and/or wetlands	-57.2%	-300.0	-0.5%	-1.0
Land maintained as crops, grass and wetlands	-18.4%	-36.4	-4.1%	-6.8
Wood products	4,601.6%	-171.1	2.1%	-3.6
Land Use Change Total	N/A	-745.5	N/A	-6.6

Figure 4.42: Total GHG Emissions from LULUCF, Base Year - 2013, Wales



By Source Emissions

Overview

Figures 4.40 – 4.42 and Table 4.11 show detailed emissions and trends for the Land Use, Land Use Change and Forestry (LULUCF) sector. In 2013, Wales was a net sink of greenhouse gases from LULUCF activities removing 642 $ktCO_2e$ in 2013. The LULUCF emissions and sinks arise from human activities that change the way land is used or affect the amount of biomass in existing biomass stocks. The most significant category is the creation and maintenance of forests, which accounted for the removal of 1,515 $ktCO_2e$.

More details regarding this sector can be found in Appendix 8.

Features of the Trends

Table 2.11 shows a 1% increase in net removal of CO_2e from LULUCF between 2012 and 2013 (an increase in the size of the sink), along with the trends in emissions and removals from important activities in the LULUCF sector.

Wales was a net source of GHG emissions in 1990, but since has been a net sink of GHG emissions and the size of this sink (CO_2e removal) has grown by nearly 300% between 1995 and 2013 from -161 $ktCO_2e$ to -642 $ktCO_2e$. This is predominantly due decreased emissions from the creation and maintenance of settlements, which have reduced by 19% between the Base Year and 2013. These are a result of emissions from biomass removal from built-up and transport areas, gardens and mineral workings.

Emissions on an End User Basis

As emissions and removals from LULUCF do not relate to Energy Supply the End User emissions are the same as emissions By Source.

4.10 Waste Management Sector

Figure 4.43: Overall Contribution to 2013 GHG emissions, Wales

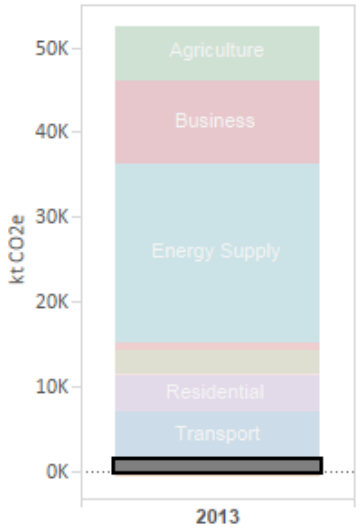


Figure 4.44: Total GHG Emissions from Waste Management, Base Year to 2013, Wales

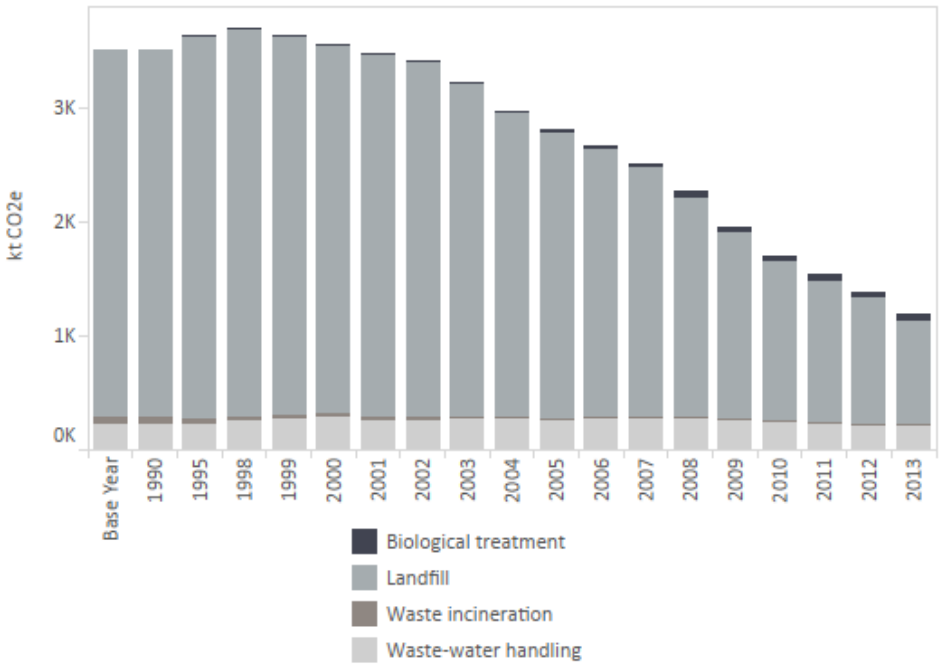
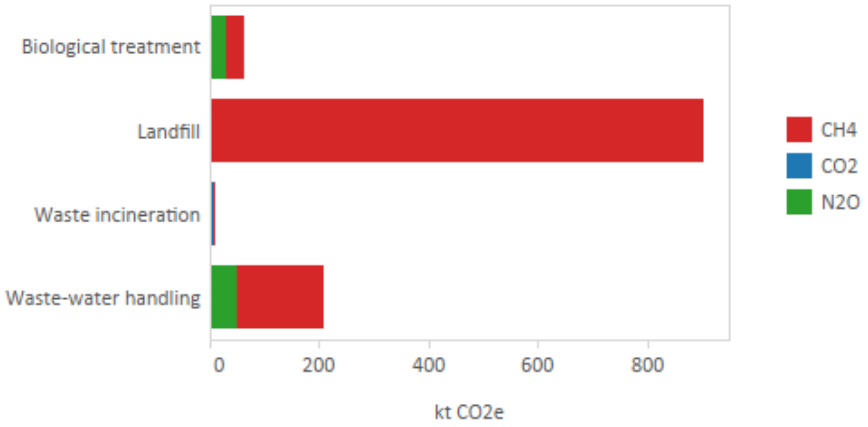


Table 4.12: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Wales

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Landfill	-71.85%	-2,307.39	-18.37%	-203.50
Waste incineration	-85.75%	-45.68	0.24%	0.02
Waste-water handling	-9.04%	-20.65	-0.34%	-0.72
Biological treatment	N/A	61.71	5.89%	3.43
Waste Management Total	-66.18%	-2,312.01	-14.53%	-200.77

Figure 4.45: GHG Contribution to Waste Management Emissions, 2013, Wales



By Source Emissions

Overview

In 2013, the Waste Management sector contributed 2% to total GHG emissions in Wales. It represented 20% of total methane emissions. Emissions from this sector are dominated by methane from landfill (77% of emissions) with a smaller contribution of methane and nitrous oxide emissions from wastewater treatment (18% of emissions) and a minimal remaining contribution from waste incineration (see Figure 4.45). Nitrous oxide emissions from wastewater treatment represented 4% of emissions in the sector, and contributed 2% to the total emissions of nitrous oxide in Wales.

Features of the Trends

Total GHG emissions from the Waste Management sector in Wales have shown a significant decline of 66% in total for the sector and by 72% for landfill between the Base Year and 2013, as shown in Table 4.12, due largely to the progressive introduction of methane capture and oxidation systems within landfill management.

There has been a decline in methane emission estimates from landfill between 2012 and 2013, which has been the primary driver for the overall decrease of 15% in emissions from the Waste Management sector due to improved management systems.

Emissions on an End User Basis

As emissions from the Waste Management sector do not include any energy consumption sources, and no electricity use is allocated to the Waste Management sector (due to a lack of data to correctly allocate to the Waste Management sector), the End User emission estimates for the sector are unchanged from the emissions presented here on a by source basis.

5 Emission Estimates in Northern Ireland (1990-2013)

5.1 Overview of Total Emissions

By Source Emissions

Overview

The greenhouse gas (GHG) emissions for Northern Ireland for 1990 – 2013 are presented in Table 5.1 and in the graph in Figure 5.1 below.

Table 5.1: 1990-2013 Northern Ireland GHG Emission Inventory ($ktCO_2e$)

NC Format	Base Year	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	% of 2013
Agriculture	6,828	6,828	7,189	6,987	6,842	6,406	6,378	6,473	6,507	6,539	6,495	29%
Business	2,914	2,891	2,810	2,746	2,626	2,423	2,363	2,736	2,441	2,389	2,431	11%
Energy Supply	5,315	5,315	6,542	6,341	5,355	4,844	3,688	3,949	3,738	3,865	4,046	18%
Industrial Process	757	757	762	666	420	401	178	171	163	162	148	1%
LULUCF	1,515	1,515	1,323	1,199	1,275	1,314	1,332	1,366	1,412	1,585	1,470	6.6%
Public	487	487	321	185	180	205	204	201	193	196	223	1%
Residential	3,786	3,768	2,972	3,015	2,755	2,887	2,900	3,338	2,704	2,750	2,834	13%
Transport	3,358	3,358	3,580	4,034	4,469	4,452	4,330	4,252	4,160	4,140	4,089	18%
Waste Management	1,714	1,714	1,813	1,732	1,399	1,155	996	884	802	740	642	3%
Total [25]	**26,674**	**26,632**	**27,311**	**26,905**	**25,323**	**24,086**	**22,370**	**23,370**	**22,120**	**22,367**	**22,379**	**100%**

Trends

Figure 5.2 shows the change in emissions from the Base Year and 2012 to the latest year, 2013. Total GHG emissions for Northern Ireland show an increase of less than 1% between 2012 and 2013, and a decrease between the Base Year[26] and 2012 of 16%. **The 2012 to 2013 trend is predominantly driven by a shift from natural gas to coal in the Energy Supply sector and the forest fires that occurred in 2012.**

The following list provides an overview of the trend for each NC sector:

- **Energy Supply** sector emissions have reduced by 24% between the Base Year and 2013 as a result of energy efficiency and switching from coal to gas for electricity generation. Emissions have increased by 8% between 2011 and 2013 due to a shift back from the use of natural gas to coal in power stations.
- **LULUCF** sector has been a source of emissions since the Base Year. In 2012, there was a large wildfire that resulted in a large increase in emissions for that one year, and as a result, emissions fell by 7% between 2012 and 2013.
- **Waste Management** sector emissions have significantly declined by 63% since the Base Year, largely due to the progressive introduction of methane capture and oxidation systems within landfill management. Emissions decreased by 13% between 2012 and 2013 in line with this decline.
- **Residential** sector emissions have, generally, decreased since the Base Year to 2013 due to fuel-switching to take advantage of natural gas supply from the late 1990s, displacing more carbon-intensive fuels such as coal. Emissions between 2012 and 2013, however, increased by 3% due to a small increase in domestic use of burning oil and a growth in natural gas use.
- **Transport** sector emissions have increased by 22% since the Base Year due to growth in transport demand over the period. Emissions between 2012 and 2013 decreased by 1% due to reduced emissions from petrol and diesel cars.

[25] International aviation and shipping are not included in the data above because these sources are "memo items" and thus not included in the UK emission estimates.

[26] 1995 for fluorinated greenhouse gases (F-Gases) and 1990 for all other gases

- **Agriculture** sector emissions have reduced by 5% since the Base Year mainly due to an overall decrease in livestock numbers and in fertilizer application. There was a small decrease in emissions of less than 1% between 2012 and 2013. This was mainly due to a decrease in number of cattle, which was partially offset by emissions from grass with increased fertilizer application rates.
- **Business** sector emissions have reduced by 17% since the Base Year reflecting the impacts of a gradual switch to natural gas over the last 15 years. Emissions have slightly increased by 2% between 2012 and 2013 caused by an increase in emissions from coal combustion, partially offset by a decrease in natural gas consumption and gas oil.
- **Public** sector emissions have reduced since the Base Year. This is due to increased energy efficiency measures and the switch to gas-fired heating. Emissions between 2012 and 2013 increased by 14% due to an increase in natural gas consumption.
- **Industrial Process** emissions have decreased by 80% since the Base Year due to the closure of a nitric acid plant, and the impact of the economic downturn on the cement production industry. Emissions decreased by 9% between 2012 and 2013 due to a decrease in emissions from cement production.

Emissions Detail

Detailed analysis of Northern Ireland emissions in 2013 is presented in Figures 5.4-5.9. The largest sources of emissions in 2013 include electricity production (18% of total GHGs), livestock emissions (18% of total GHGs), road transport (16% of total GHGs), residential combustion for heating and cooking (12% of total GHGs) and crop growing and fertilizer application (9% of total GHGs).

Figure 5.3 shows the emissions split by GHG and highlights the 2.5 and 97.5 percentile range. The range of uncertainty is greatest for nitrous oxide emissions. See Appendix 1 for further details on uncertainties.

Carbon dioxide is the most common gas emitted for all National Communication (NC) categories except the Agriculture sector, where methane from livestock and nitrous oxide from soils, and for Waste Management, where methane from landfills are the most important gases (see Figure 5.5).

Recalculations

Revisions to the estimates since the last inventory report (Salisbury et al., 2013) have resulted in a 6.5% (1,401 $ktCO_2e$) increase in the 2012 estimates for Northern Ireland.

The 2006 IPCC Guidelines (IPCC, 2006) have been adopted and supersede the 1996 IPCC Guidelines (IPCC, 1996). This change has led to the implementation of updated methodologies and emission factors, inclusion of additional sources and emissions of NF_3, improvements to the global warming potential (GWP) factors used. This has affected all sectors in the inventory. The most significant revisions to the 2012 estimates have been for the following sectors:

1. **LULUCF (1,355 $ktCO_2e$ increase)**: Revised data has become available on the area of Cropland and improved Grassland on drained organic soils. This has enabled emissions from improved Grassland on drained organic soils to be reported for the first time, and allowed more complete reporting on emissions from Cropland on drained organic soils. Emissions of nitrous oxide from soil mineralisation following land use change and drainage of Forest soils have been estimated for the first time which has increased reported emissions.
2. **Residential (-414 $ktCO_2e$ decrease)**: Natural gas data have been revised in DUKES and the estimation method for domestic combustion of non-gas fuels (i.e. coal, oil, SSF) has been revised to incorporate more detailed data on primary and secondary fuels from 2011 census data, scaled across 2005-2013 using housing stock data. Emission estimates for carbon dioxide from detergents have been removed since this is not identified as a source in the 2006 IPCC Guidelines.
3. **Agriculture (218 $ktCO_2e$ increase)**: Emission factors and methodologies have been updated from the 1996 IPCC Guidelines to the 2006 IPCC Guidelines. Enteric emissions (of methane) from all livestock (especially cattle and sheep) have increased compared to previous inventory estimates, and in Northern Ireland this outweighs a decrease in emissions of nitrous oxide from agricultural soils leading to an overall increase in emission estimates.
4. **Waste Management (164 $ktCO_2e$ increase):** New data on landfill methane flaring from site operators and regulators has improved methane recovery data. The method to estimate methane formation within landfills has been improved to incorporate new data. Industrial and domestic waste water treatment methods were revised to be consistent with 2006 IPCC Guidelines and a calculation error was identified and corrected, which increased emissions across the time series for this source. New emission estimates were included from private sewage treatment facilities and composting.

For more details of revisions to GHG emission estimates, see Appendix 6.

Figure 5.1: Total GHG Emissions by NC category for Base Year to 2013, as kt CO2e, Northern Ireland

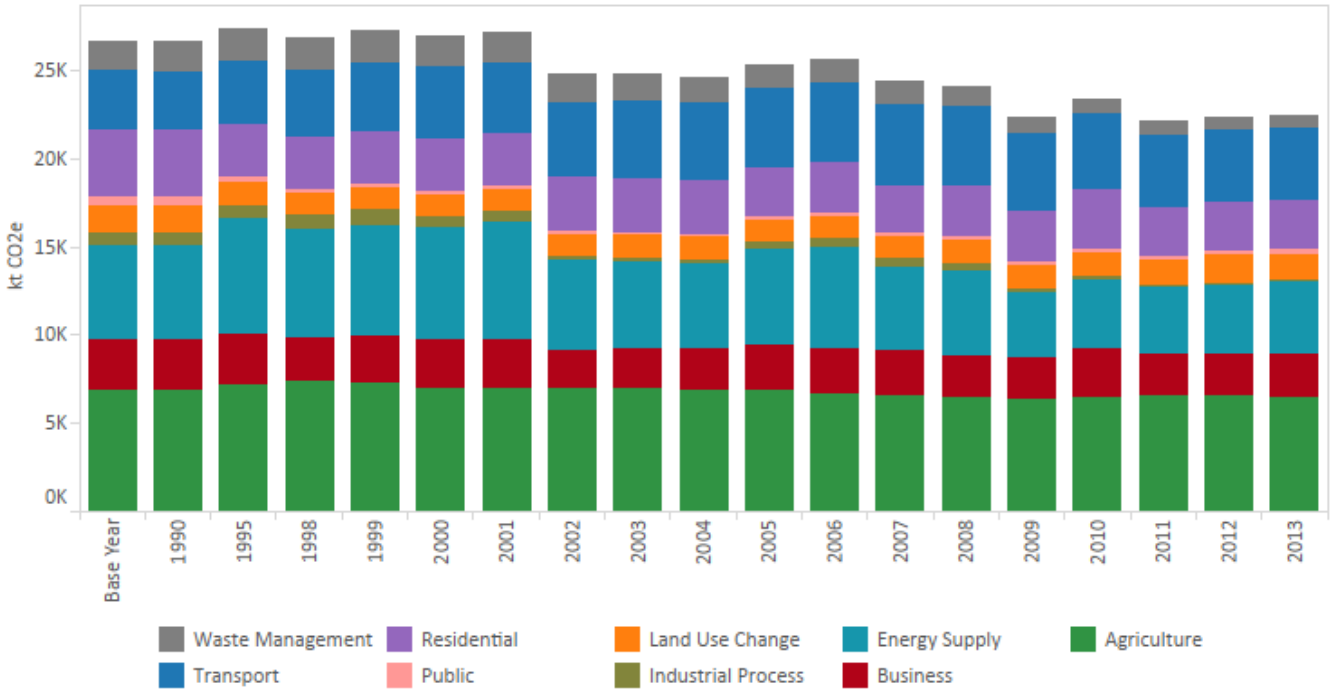
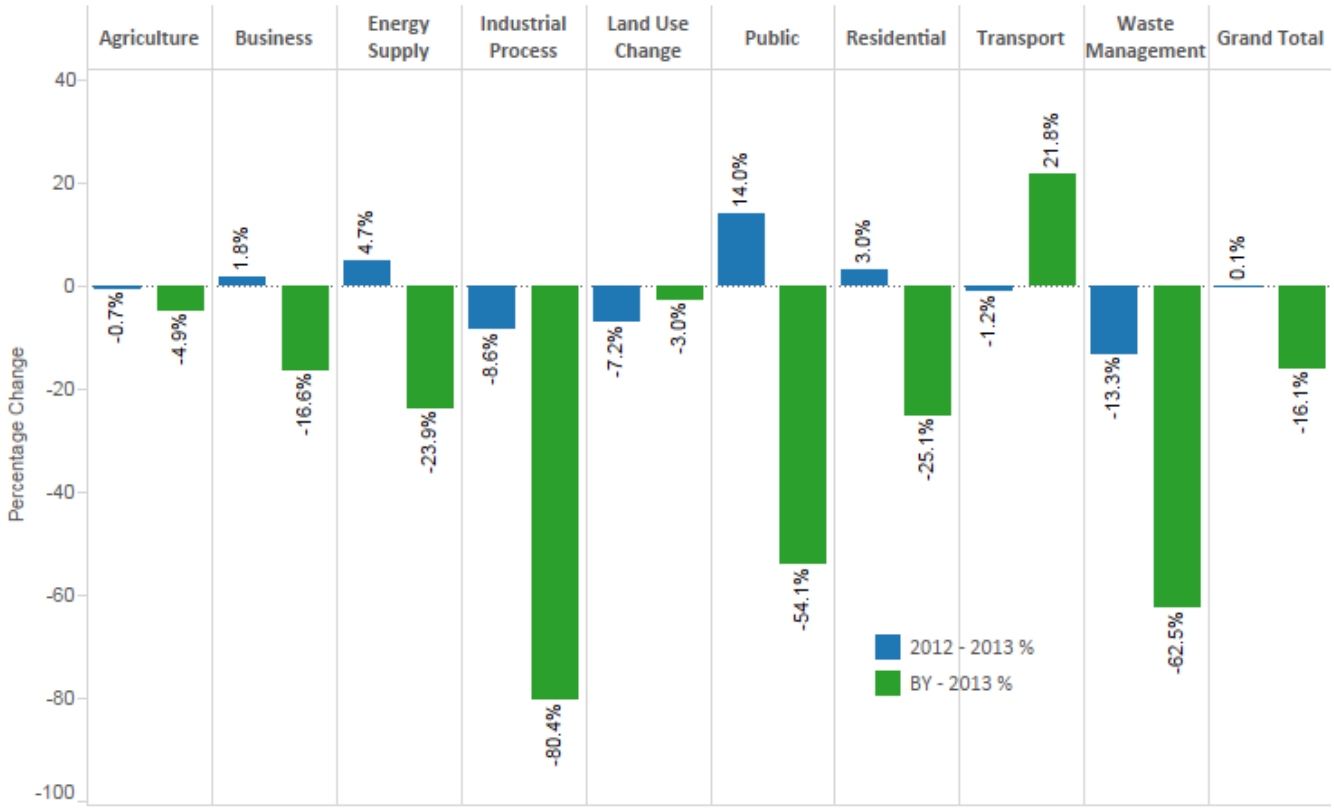


Figure 5.2: Percentage Change and Absolute (kt CO2e) Change in GHG Emissions by NC: 2012 - 2013 and Base Year (BY) - 2013, Northern Ireland

The LULUCF Base Year - 2013% change is excluded from the figure if LULUCF emissions changed from a sink to source, or source to sink, across the time series.



	Agriculture	Business	Energy Supply	Industrial Process	Land Use Change	Public	Residential	Transport	Waste Management	Grand Total
BY - 2013 kt	-333	-483	-1,269	-609	-45	-264	-952	731	-1,072	-4,295
2012 - 2013 kt	-44.5	42.0	180.8	-13.9	-114.6	27.4	83.8	-51.2	-98.2	11.7

Figure 5.3: Total GHG emissions and uncertainties by pollutant, 2013, Northern Ireland

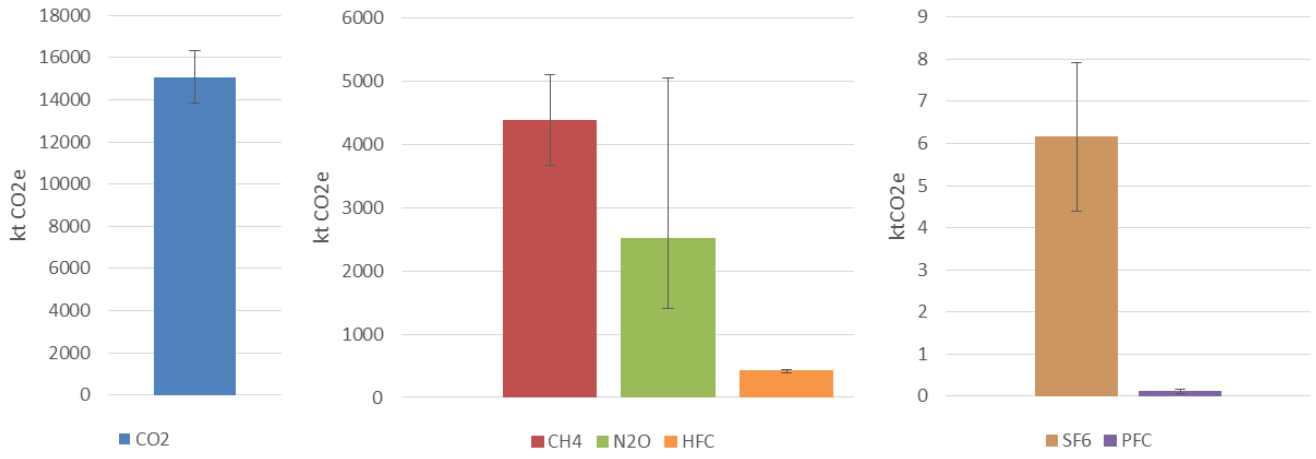


Figure 5.4: Total GHG Emissions by NC and pollutant, 2013, Northern Ireland

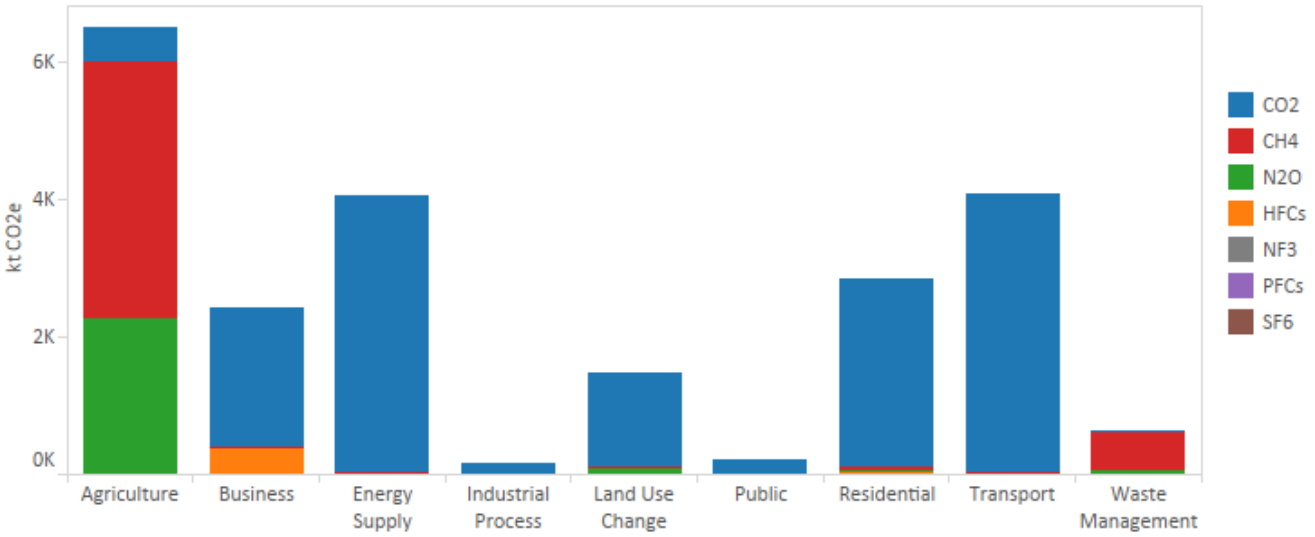
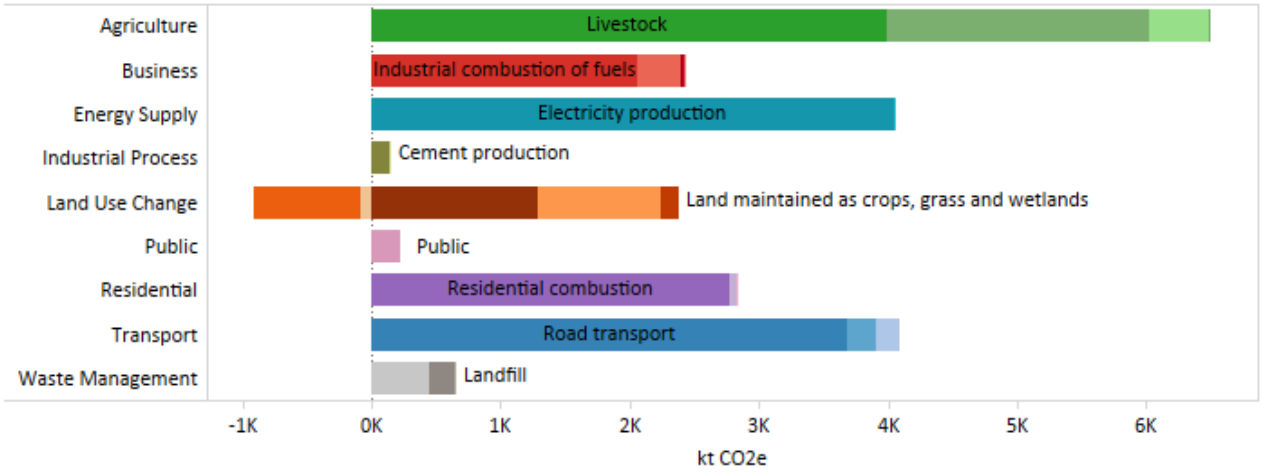


Figure 5.5: Total GHG Emissions labelling the largest sub-category in each NC, 2013, Northern Ireland



Traded and Non-Traded Emissions

Emissions from installations included in the European Union Emissions Trading Scheme (EU ETS) (see Figure 5.7) increased between 2011 and 2013. Emissions from installations in the EU ETS (see Figure 5.7) accounted for 21% of total GHG emissions in Northern Ireland in 2013; the main contributors to these traded emissions are the Energy Supply sector (of which over 99% of total emissions are within the EU ETS, including all power stations) and the Business and Industrial Process sectors (see Figure 5.8).

Figure 5.6: Total Traded and Non-Traded GHG Emissions by NC Category, 2013, Northern Ireland

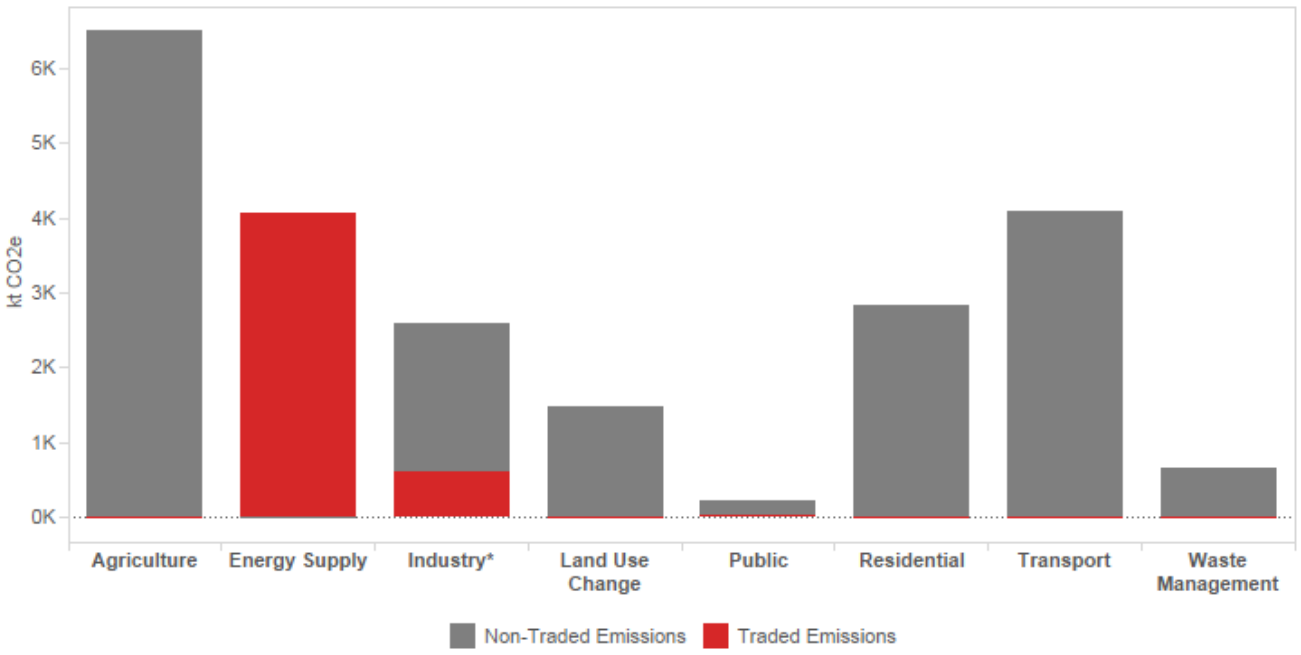


Figure 5.7: Total Traded and Non-Traded GHG Emissions 2008-2013, Northern Ireland

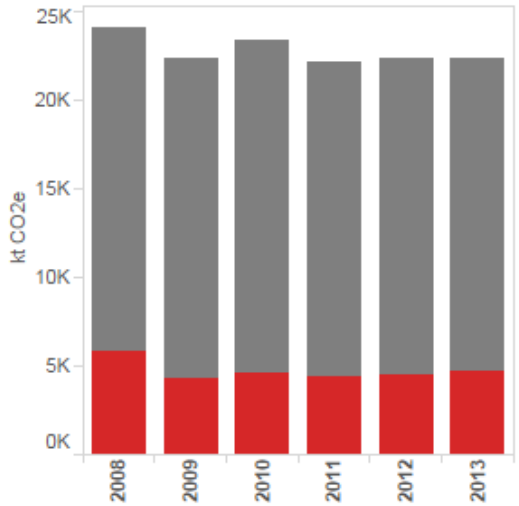
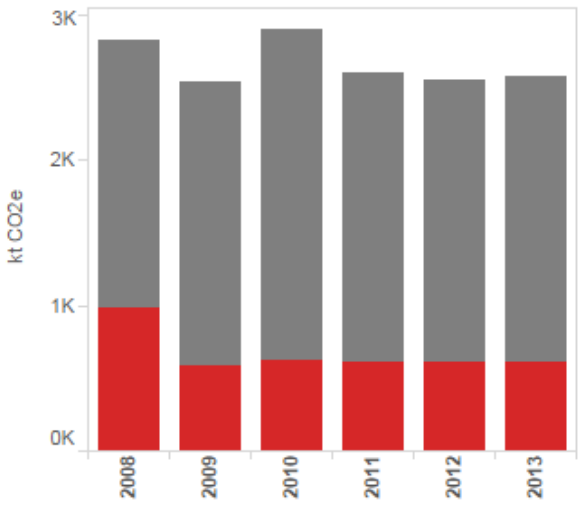


Figure 5.8: Traded and Non-Traded GHG Emissions from Industry 2008-2013, Northern Ireland*



*Industry includes emissions from the NC categories: Industrial Process and Business

Emissions on an End User Basis

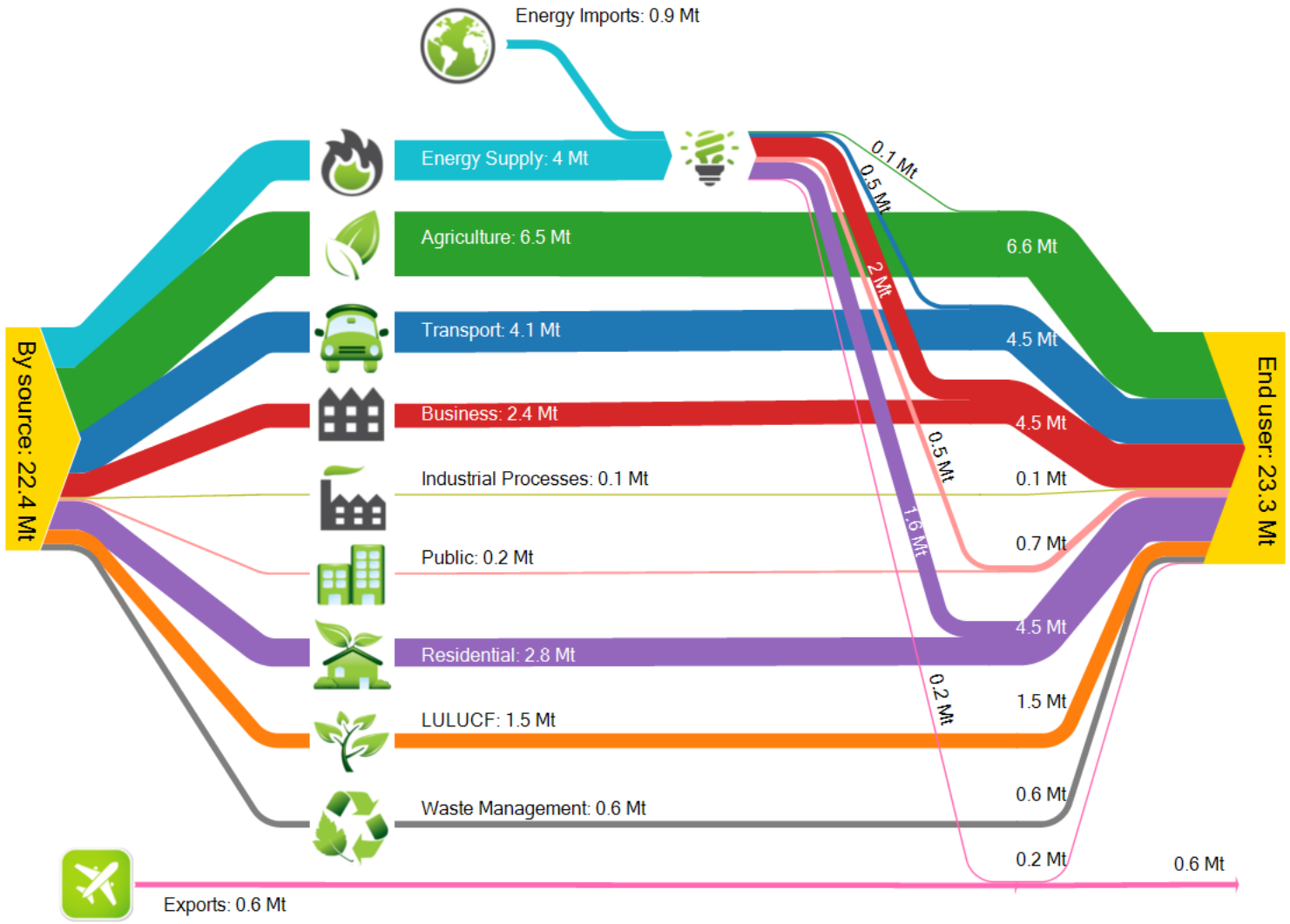
In addition to presenting emissions based on direct emissions from processes or combustion of fuels in Northern Ireland, the emissions from the Energy Supply sector can be attributed to the users of the energy (see Appendix 3 for more details of the End User inventory methodology).

Figure 5.9 illustrates the difference between the By Source and End User inventory emission estimates and how emissions from Energy Supply are allocated to the End User NC categories. The primary difference in the End User perspective is the significant increase in emissions attributable to the Business, Residential, Transport and Public sectors. The End User inventory data illustrate that on an End User basis, the contribution to Northern Ireland total emissions in 2013 are dominated by the Residential, Transport and Business sectors. As illustrated in Figure 5.9, Northern Ireland is a net importer of electricity which results in higher emissions in Northern Ireland on an End User basis (23.3 $MtCO_2e$) compared to by source (22.4 $MtCO_2e$) inventory estimates for 2013.

Emissions from the Land Use, Land Use Change and Forestry (LULUCF) and Waste Management sectors are unchanged between the By Source and End User approaches, since there are no emissions from energy use allocated to these sources. For Agriculture, the increase in emissions using the End User approach is limited to the emissions from energy use within the sector.

A more detailed assessment of emissions by sector is presented below for each of the National Communication sectors.

Figure 5.9 Sankey diagram showing By Source and End User[27] GHG emission transfers for Northern Ireland in 2013 (Mt CO_2e)[28]



[27] The pink line from 'Energy Supply' to 'End User' represents emissions from Energy Supply in the production of fuels used in international aviation and shipping.

[28] Exports' equates to emissions from international aviation and shipping.

5.2 Energy Supply Sector

Figure 5.10: Overall Contribution to 2013 GHG emissions, Northern Ireland

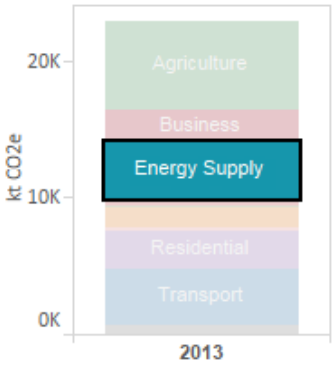


Figure 5.11: GHG Contribution to Energy Supply Emissions, 2013, Northern Ireland

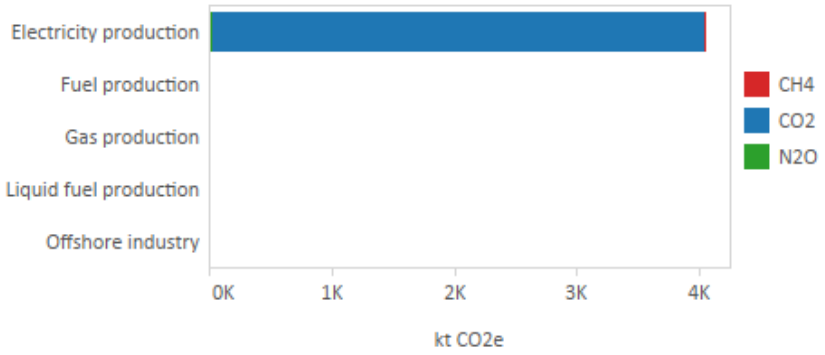


Table 5.2: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Northern Ireland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Electricity production	-23.89%	-1,269.41	4.68%	180.82
Gas production	N/A	0.63	4.22%	0.03
Liquid fuel production	N/A	0.00	N/A	0.00
Offshore industry	N/A	0.00	N/A	0.00
Fuel production	N/A	0.08	-1.98%	0.00
Energy Supply Total	-23.87%	-1,268.70	4.68%	180.84

Table 5.3: NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions, Northern Ireland

Agriculture	2%
Business	48%
Industrial Process	0%
Public	12%
Residential	34%
Transport	0%
Exports	3%

Figure 5.12: Total GHG Emissions from Energy Supply, Base Year to 2013, Northern Ireland

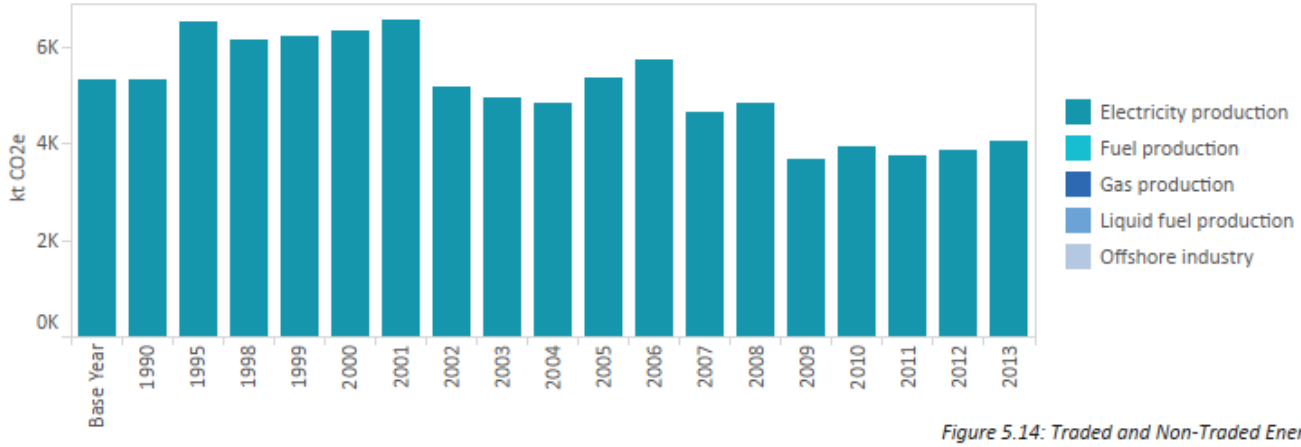


Figure 5.13: Emissions and Electricity Production by Fuel Type from Major Power Producers (1A1a), Northern Ireland

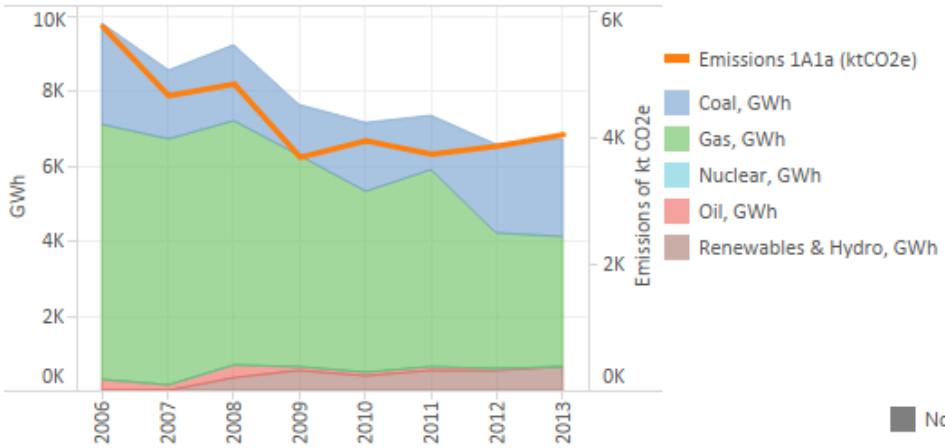
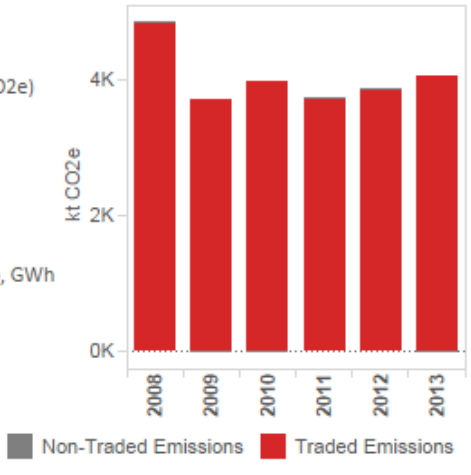


Figure 5.14: Traded and Non-Traded Energy Supply Emissions, 2008-2013, Northern Ireland



*Exports includes emissions from energy production for international aviation, international shipping and exported fuels

By Source Emissions

Overview

In Northern Ireland the Energy Supply sector contributes 18% to total 2013 GHG emissions (see Figure 5.10). Northern Ireland has a much lower contribution from this sector than the UK average because, unlike the other Devolved Administrations (DAs), Northern Ireland does not have any refineries, iron and steel industry (producing coke), oil and gas terminals or coal mining. In addition, leakage from the gas supply network in Northern Ireland is minimal due to the relatively new infrastructure in the developing network.

Features of the Trends

Energy Supply sector emissions have reduced by 24% between the Base Year and 2013 as a result of improved energy efficiency and switching from coal to gas for electricity generation. However, emissions have seen an increase of 8% between 2011 and 2013, with the trend due to a shift back from the use of natural gas to coal in power stations. The growth of renewable generation in Northern Ireland continues, however, with a 12% increase in electricity generation from renewable sources over 2012 to 2013, up to a total contribution of 9% of the electricity generated in 2013.

Sector Detail

The main source of emissions in Northern Ireland within the Energy Supply sector is electricity production at power stations, which accounted for more than 99% of Energy Supply emissions in 2013; gas production accounts for less than 1% of emissions (see Figure 5.12). Carbon dioxide is the predominant gas accounting for over 99% of emissions from the Energy Supply sector in 2013 as a result of the combustion of fossil fuels (see Figure 5.11).

The mix of generation capacity is quite different in Northern Ireland from the rest of the UK and from 1990 to 1995 consisted entirely of coal and oil fired stations. In 1996, the largest power station in Northern Ireland, Ballylumford, was converted from oil to use natural gas. The lack of nuclear and renewable generation up to 1996, together with the lack of natural gas contributed to the proportionately higher emissions from electricity generation compared to the other DAs. Moreover, the non-availability of natural gas led to a proportionately higher consumption of electricity than in the rest of the UK, also increasing emissions in the early part of the time-series. The emission of carbon dioxide per unit energy produced is lower for natural gas than other fossil fuels. Natural gas has been supplied to some industrial, commercial and domestic users since 1999 and gas use continues to grow as the supply infrastructure is developed.

Northern Ireland generates electricity that can, subsequently, be exported and sold into the Republic of Ireland electricity grid, whilst the country also imports electricity from Scotland via the Moyle interconnector.

Traded and Non-Traded Emissions

All emissions from electricity production in the Energy Supply sector originate from Traded (EU ETS) installations (see Figure 5.14).

Emissions on an End User Basis

The End User inventory method re-allocates all emissions from the Energy Supply sector on to the final users of the refined / processed fuels, and hence the Energy Supply End User emissions are zero. Table 5.3 indicates the reallocation of emissions related to the production of electricity to the other sectors.

5.3 Transport Sector

Figure 5.15: Overall Contribution to 2013 GHG emissions, Northern Ireland

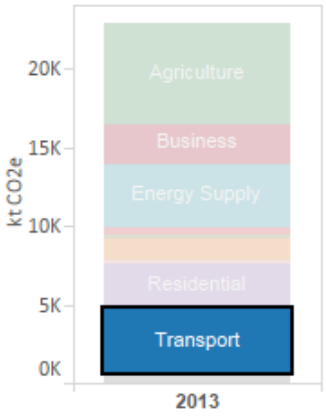


Figure 5.16: Total GHG Emissions from Transport, Base Year to 2013, Northern Ireland

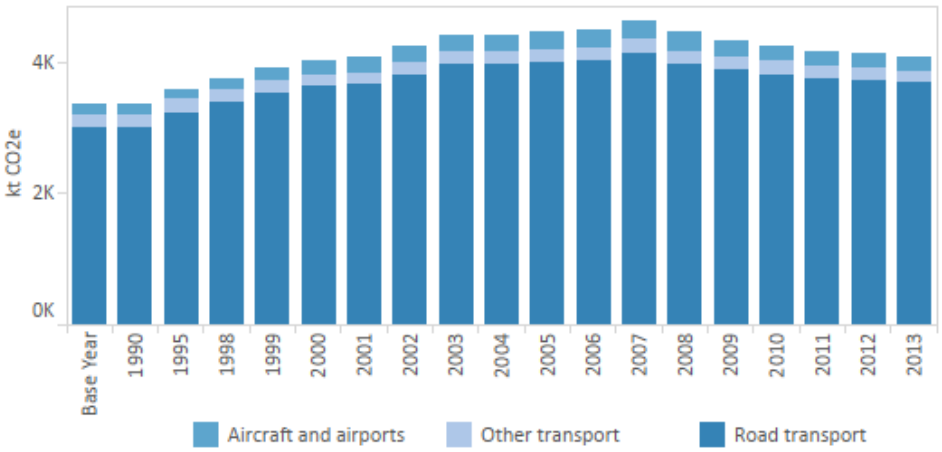


Table 5.4: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Northern Ireland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Road transport	23%	696	-1%	-41
Other transport	-17%	-37	-4%	-8
Aircraft and airports	48%	72	-1%	-2
Transport Total	22%	731	-1%	-51

Figure 5.17: GHG Contribution for Transport Emissions, 2013, Northern Ireland

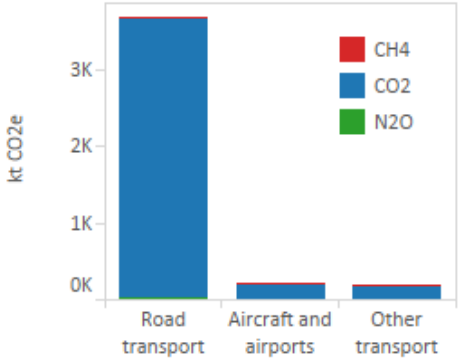


Figure 5.18: Comparison of End User and By Source for Transport, Northern Ireland

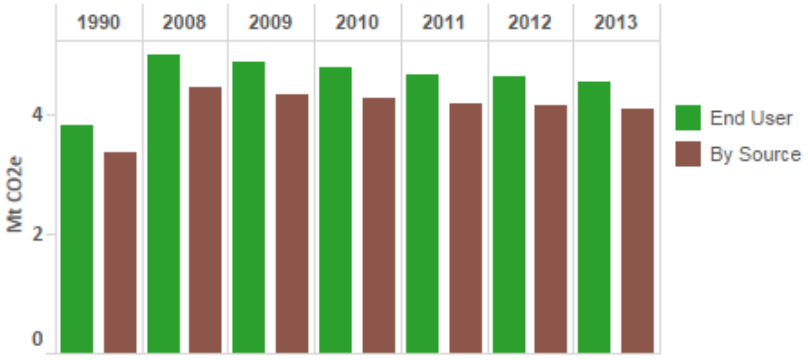


Figure 5.19 Road Transport CO2 Emissions (fuel sales basis), Northern Ireland

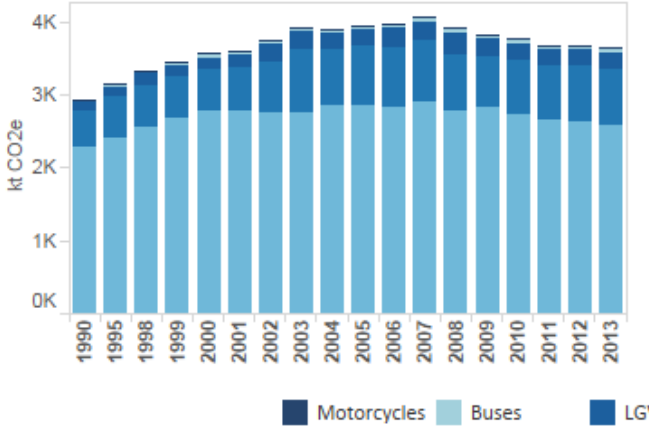
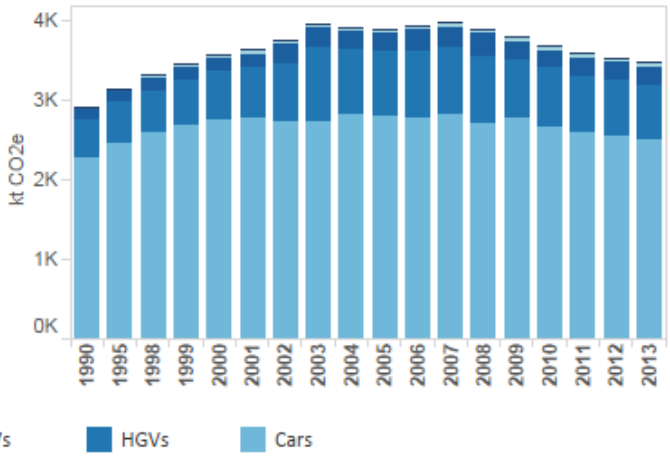


Figure 5.20: Road Transport CO2 Emissions (vkm basis), Northern Ireland



By Source Emissions

Overview

Transport emissions account for 18% of Northern Ireland's total GHG emissions in 2013. Transport emissions are dominated by emissions from road transport, which accounted for 90% of all Transport emissions in 2013. Passenger cars alone accounted for 64% of Transport emissions (see Figures 5.19 and 5.20).

The Transport sector also includes small contributions from rail (including stationary sources), domestic aviation, national navigation and coastal shipping, and military aviation and shipping. Emissions from international aviation are excluded from these estimates. Details of these emissions are included in Appendix 6.

Features of the Trends

Total GHG emissions from the Transport sector in Northern Ireland have increased by 22% between the Base Year and 2013 despite improvements in efficiency of vehicles, as a result of growth in demand. Emissions peaked in 2007 and have since declined partly due to improvements in average fuel efficiency of vehicles and the switch from petrol to diesel cars and from a reduction in traffic volumes. Emissions between 2012 and 2013 have not seen any significant change – decreasing by 1% (see Table 5.4).

Sector Detail

There are two approaches used to calculate emissions from Road Transport: fuel sales basis – emissions are constrained to the total fuel sold within the UK as stated in DUKES (DECC, 2014b); vehicle kilometre basis – emissions are estimated using vehicle km data and are not constrained by the total fuel sold, so estimate emissions based on fuel used within the UK. The inventory emission estimates for road transport are calculated on a fuel sold basis and are, therefore, consistent with DUKES.

Figures 5.20 and 5.21 show the carbon dioxide emissions from road transport for Northern Ireland based on constrained (DUKES fuel sales) and unconstrained (vehicle kilometre, vkm) approaches.

Total carbon dioxide emissions from the vkm approach differ from the estimates constrained to DUKES. The differences between the two approaches fluctuate year on year but they remain within 4.2% of difference for Northern Ireland. These disparities will also be reflected in the trends derived from the two approaches to a different extent. The long term trend for each individual vehicle type is generally similar between the two approaches. The vkm approach indicates that the overall carbon dioxide emissions from road transport have increased by 19.5% between the Base Year and 2013, while the constrained approach indicates a 4.0% increase.

Emissions on an End User Basis

The End User estimates for 2013 are 11% higher than the by source estimates, reflecting the additional emissions from upstream oil extraction and the oil refining sector (see Figure 5.18).

The trend in End User emissions since 1990 shows an increase of 20% to 2013, which is a slightly smaller increase than in the By Source inventory, reflecting the improved energy efficiency of upstream production and refining of crude oil to produce the fuels used in the Transport sector.

5.4 Residential Sector

Figure 5.21: Overall Contribution to 2013 GHG emissions, Northern Ireland

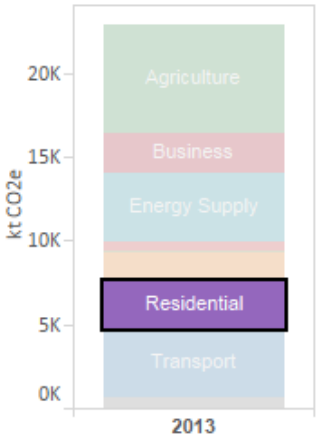


Figure 5.22: Total GHG Emissions from Residential, Base Year to 2013, Northern Ireland

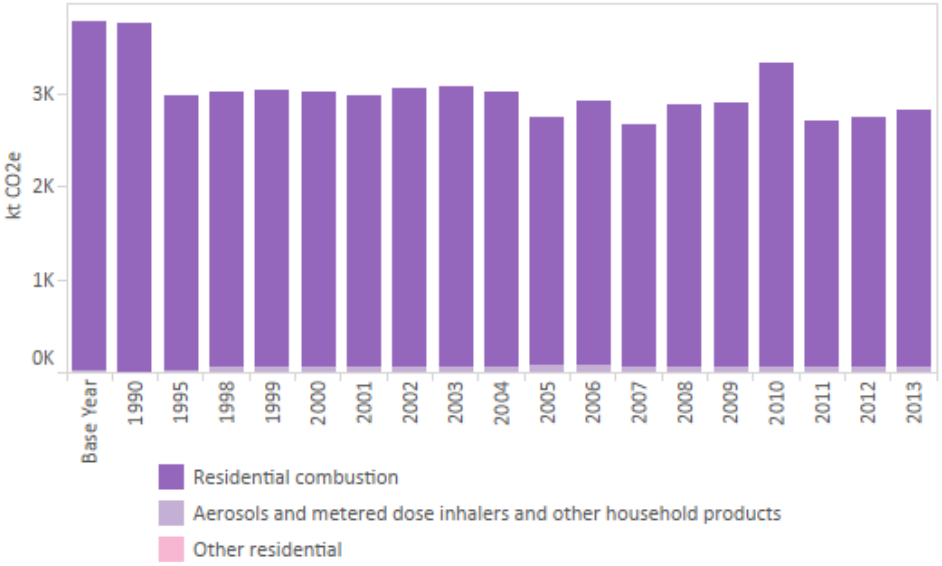


Table 5.5: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Northern Ireland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Aerosols and metered dose inhalers and other household products	182.41%	35.86	-9.91%	-6.10
Other residential	116.31%	0.62	2.40%	0.03
Residential combustion	-26.25%	-988.66	3.35%	89.92
Residential Total	-25.15%	-952.18	3.05%	83.85

Figure 5.23: GHG Contribution for Residential Emissions, 2013, Northern Ireland

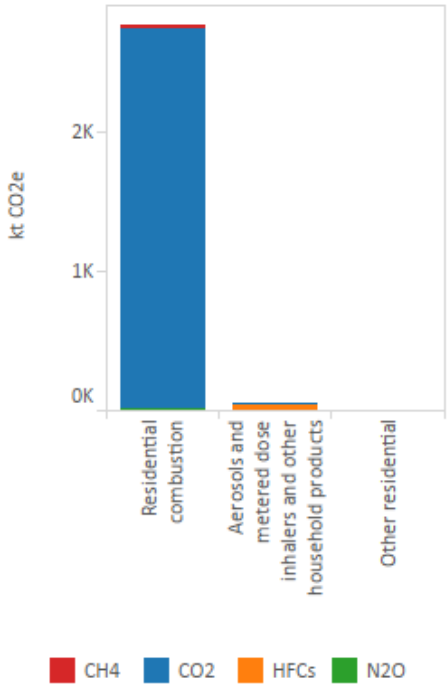
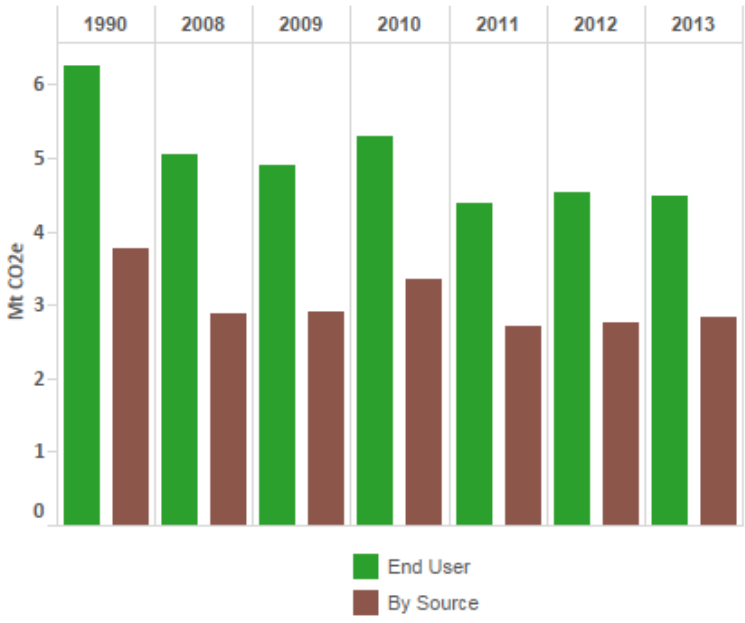


Figure 5.24: Comparison of End User and By Source for Residential, Northern Ireland



By Source Emissions

Overview

The Residential sector accounts for 13% of Northern Ireland's total GHG emissions in 2013. The sector comprises emissions from Residential combustion (98% of emissions for the Residential sector) from heating and cooking, household products, accidental vehicle fires and HFC emissions from the use of aerosols and metered dose (usually asthma) inhalers. 96% of all Residential GHG emissions are from the release of carbon dioxide from the direct combustion of fossil fuels (see Figure 5.23).

Emission estimates in the Residential sector for Northern Ireland are associated with high uncertainty due to the absence of comprehensive, detailed fuel use data, particularly for solid and liquid fuels.

Features of the Trends

Total GHG emissions from the Residential sector in Northern Ireland have decreased by 25% between the Base Year and 2013 due to fuel-switching to take advantage of natural gas supply from the late 1990s, displacing more carbon-intensive fuels such as coal. There has been an increase of 5% between 2011 and 2013 primarily driven by an increase in the consumption of natural gas and burning oil in the sector.

Sector Detail

As a proportion of UK residential emissions, Northern Ireland represents a higher share compared to Northern Ireland's share of UK population. The reason for this is the very limited availability of natural gas resulting in the high consumption of coal, burning oil and gas oil in the Residential sector. Natural gas has steadily become more widely available in the past 15 years. This factor, along with increased energy efficiency of buildings has led to the decrease in emissions since 1990 (see Table 5.5).

Emissions on an End User Basis

In 2013, Northern Ireland End User emissions for the Residential sector are 158% of the By Source emission estimates (see Figure 5.24), reflecting the high consumption of electricity in the sector. This increases the overall significance of this sector in the End User inventory to 19% of the Northern Ireland total, compared to just 13% of the by source inventory total.

The trend in Residential End User emissions since 1990 shows a decline of around 29% to 2013 as a result of improvements in the electricity generation sector since 1990. The trend data are uncertain and should be regarded as indicative only due to the limited data on electricity use by source.

5.5 Business Sector

Figure 5.25: Overall Contribution to 2013 GHG emissions, Northern Ireland

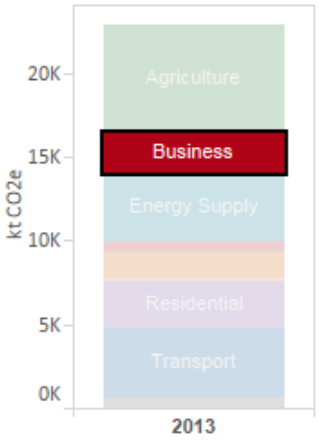


Figure 5.26: Total GHG Emissions from Business, Base Year to 2013, Northern Ireland

Table 5.6: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Northern Ireland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Industrial combustion of fuels	-28.5%	-817.9	2.3%	46.0
Refrigeration and air conditioning	1,092.2%	311.3	-0.4%	-1.3
Use of fluorinated gases	152.7%	17.2	-4.1%	-1.2
Iron and steel - combustion	N/A	0.0	N/A	0.0
Other business	959.1%	6.4	-16.7%	-1.4
Business Total	-16.6%	-483.0	1.8%	42.0

Figure 5.27: GHG Contribution for Business Emissions, 2013, Northern Ireland

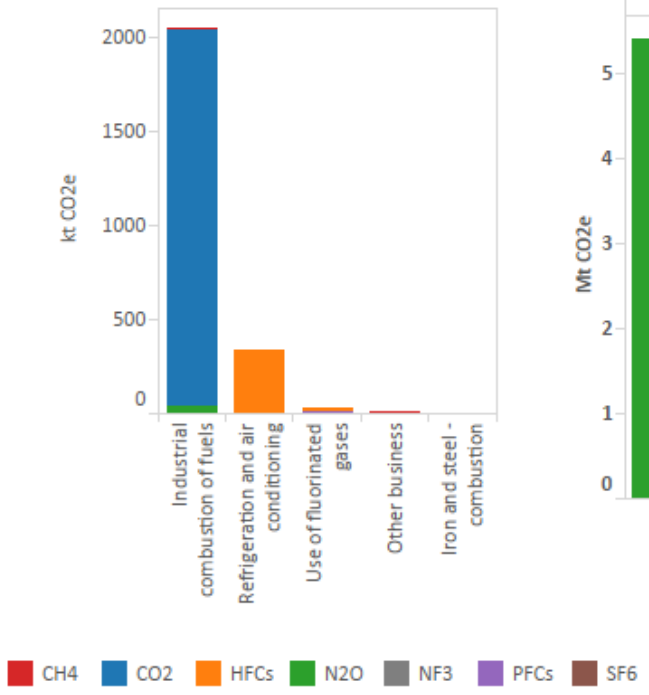
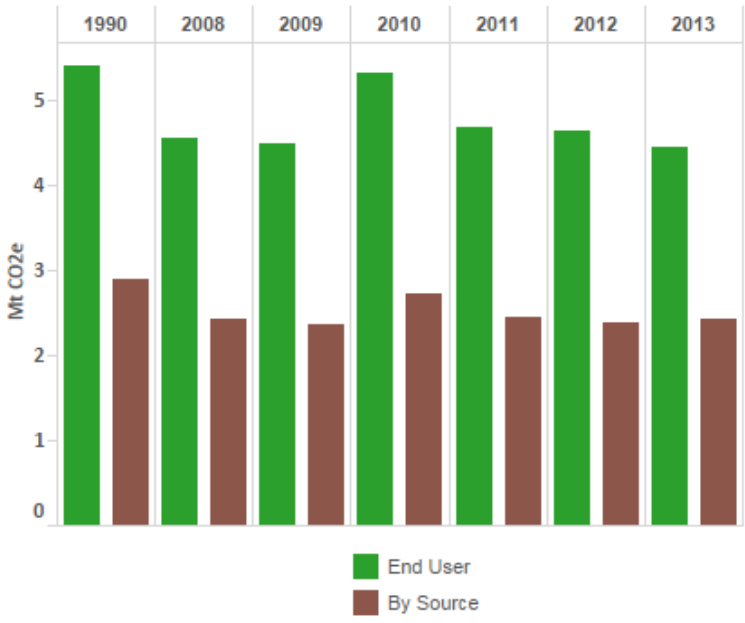


Figure 5.28: Comparison of End User and By Source for Business, Northern Ireland



By Source Emissions

Overview

The Business sector contributes 11% to total 2013 GHG emissions, with 85% of the sector GHG emissions being carbon dioxide from fuel combustion. These fuel combustion emissions contribute 13% of the total carbon dioxide emissions in Northern Ireland in 2013. Sulphur hexafluoride (SF_6) constitutes 0.3% of total GHG emissions from the business sector in Northern Ireland, with the main sources of SF_6 emissions coming from its application in electrical insulation. The Business sector accounts for all SF_6 emissions in Northern Ireland.

The main sources of HFC emissions come from refrigeration and air conditioning equipment, arising from losses during manufacture and the lifetime of equipment. Emissions from this source have increased significantly since the Base Year and now account for 14% of Business emissions, whereas they accounted for only 1% in 1995.

Features of the Trends

Emissions from the Business sector for Northern Ireland have decreased by 17% between the Base Year and 2013. This reflects the impacts of a gradual growth in access to the gas network over the last 15 years in Northern Ireland, enabling fuel-switching from more carbon-intensive oil- and coal-fired boilers to gas.

Business sector GHG emissions have slightly increased by 2% between 2012 and 2013 caused by an increase in emissions from coal combustion in the other industry sector, partially offset by a decrease in natural gas consumption, and decrease in gas oil for industrial off-road machinery.

Traded and Non-Traded Emissions

Emissions in the Industrial Process sector include significant contributions from installations reporting in the EU ETS. However, due to the lack of detail in the EU ETS dataset, the Business and Industrial Process emissions are not easy to separate.

The contribution to total aggregate emissions from the traded and non-traded sector across the Business and Industrial Process sectors are presented in Figure 5.8 in the Overview section under the category: “Industry”.

Emissions on an End User Basis

In 2013, Northern Ireland End User emissions for the Business sector are 183% of the By Source emission estimates, reflecting the high consumption of electricity for heating, lighting and operating equipment (and therefore share of emissions from electricity production) in the sector. From this End User perspective, the Business sector represents 19% of total emissions for Northern Ireland compared to just 11% of the By Source inventory total (see Figure 5.28).

The combustion emission estimates in the Business sector are associated with high uncertainty due to the absence of comprehensive, detailed DA-specific fuel use data, particularly for solid and liquid fuels. In 2013, non-combustion emissions accounted for a total of 14% of the total business emissions in Northern Ireland. These data are also uncertain due to the lack of DA-specific data on fluorinated greenhouse gases sources and the use of proxies such as economic indices and population to estimate the DA share of UK emissions for these sources.

5.6 Public Sector

Figure 5.29: Overall Contribution to 2013 GHG emissions, Northern Ireland

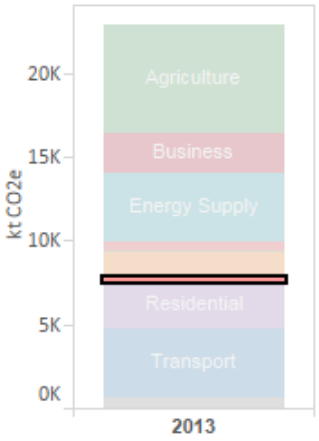


Figure 5.30: Total GHG Emissions from Public, Base Year to 2013, Northern Ireland

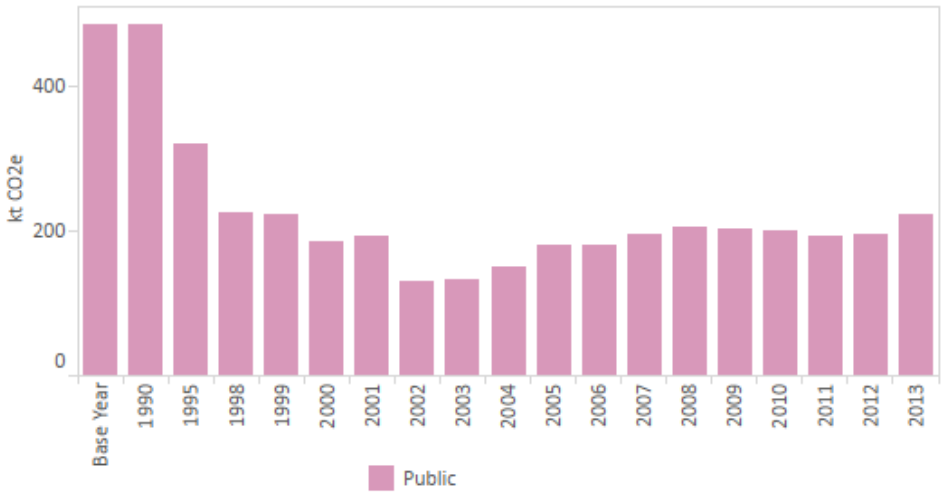


Table 5.7: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Northern Ireland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Public	-54%	-264	14%	27
Public Total	-54%	-264	14%	27

Figure 5.31: GHG Contribution for Public Emissions, 2013, Northern Ireland

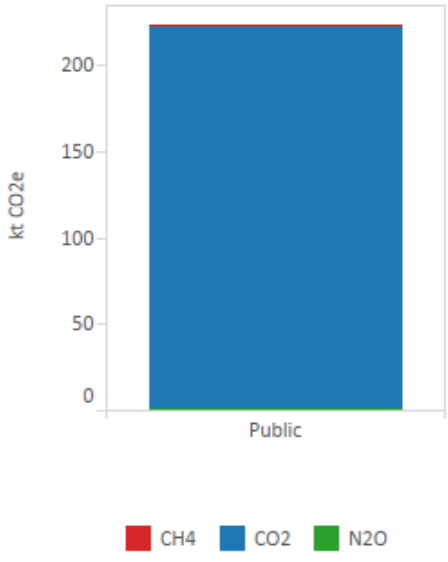
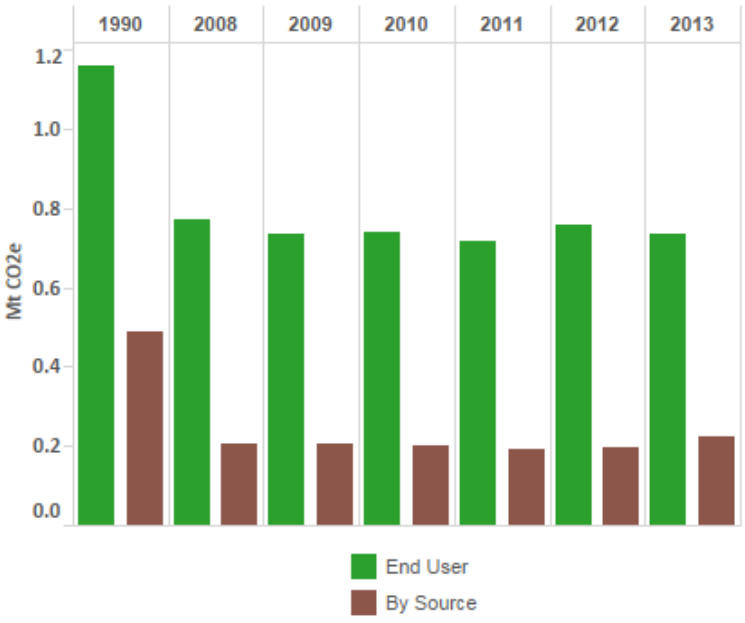


Figure 5.32: Comparison of End User and By Source for Public, Northern Ireland



By Source Emissions

Overview

Emissions from Public sector combustion account for 1% of GHG emissions in Northern Ireland in 2013. Over 99% of emissions in this sector are of carbon dioxide from the combustion of fossil fuels. See Figures 5.30 and 5.31.

Emission estimates in the Public sector are associated with high uncertainty due to the absence of comprehensive, detailed DA-specific fuel use data, particularly for solid and liquid fuels.

Features of the Trends

Overall Public sector emissions generally decreased from the Base Year up until 2002 after which they steadily increased from 2002 to 2008 and then levelled off until 2012. The most recent trend from 2012 to 2013 shows an increase of 14% in emissions due to an increase in natural gas consumption (see Table 5.7 and Figure 5.30). The overall reduction from the Base Year to 2013 is 54%. This has been achieved through more efficient use of fuels and a switch to gas fired heating across Northern Ireland for many Public sector buildings since 1990.

Emissions on an End User Basis

In 2013, Northern Ireland End User emissions for the Public sector are 328% of the by source emission estimates, reflecting the high consumption of electricity in the sector and increasing the sector's share of total Northern Ireland emissions to 3% in 2013 (see Figure 5.32) from 1% in the By Source inventory. The trend in End User emissions since 1990 shows a decline of around 37% to 2013. The trend data are uncertain and should be regarded as indicative only due to the limited data on electricity use by source.

5.7 Industrial Process Sector

Figure 5.33: Overall Contribution to 2013 GHG emissions, Northern Ireland

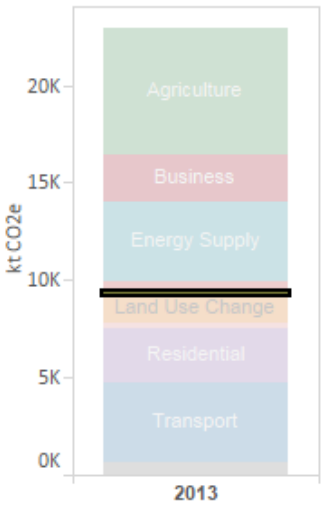
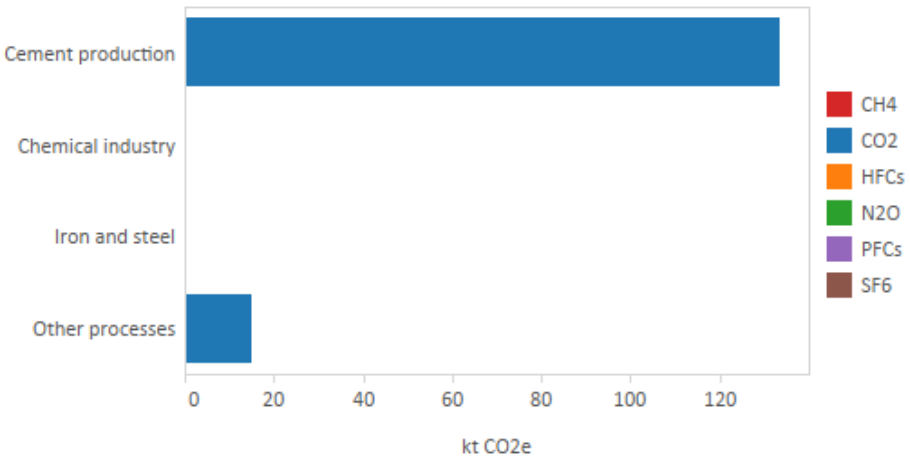


Figure 5.34: Total GHG Emissions from Industrial Process, Base Year to 2013, Northern Ireland

Table 5.8: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Northern Ireland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Cement production	-67.94%	-282.52	-9.05%	-13.26
Other processes	31,710.08%	14.84	-4.24%	-0.66
Chemical industry	-100.00%	-341.00	N/A	0.00
Iron and steel	N/A	0.00	N/A	0.00
Industrial Process Total	-80.42%	-608.68	-8.59%	-13.92

Figure 5.35: GHG Contribution to Industrial Process Emissions, 2013, Northern Ireland



By Source Emissions

Overview

The Industrial Process sector contributes less than 1% of the total 2013 GHG emissions in Northern Ireland. The Industrial Process sector includes cement production (90% of sector GHG emissions) and glass production, and all emissions in 2013 from this sector are carbon dioxide (see Figure 5.35).

Features of the Trends

In 2013, Industrial Process sector emissions are 80% lower than in 1990 (see Figure 5.34 and Table 5.8), partly due to the 2008-2009 down-turn in cement production resulting in a 58% decrease in emissions over this period, but also due to the closure of a nitric acid plant in 2001 and the consequent reduction in nitrous oxide emissions from the chemical industry sector. Between 2012 and 2013, emissions decreased by 9% predominantly due lower clinker production in the cement production industry.

Traded and Non-Traded Emissions

Emissions in the Industrial Process sector include significant contributions from installations reporting in the EU ETS. However, due to the lack of detail in the EU ETS dataset, the Business and Industrial Process emissions are not easy to separate.

The contribution to total aggregate emissions from the traded and non-traded sector across the Business and Industrial Process sectors are presented in Figure 5.8 in the Overview section under the category: “Industry”.

Emissions on an End User Basis

As all emissions in the Industrial Process sector in Northern Ireland are not related to energy consumption or use of fuels as feedstock, the Industrial Process sector emissions on an End User basis are the same as the emissions in the By Source inventory.

5.8 Agriculture Sector

Figure 5.36: Overall Contribution to 2013 GHG emissions, Northern Ireland

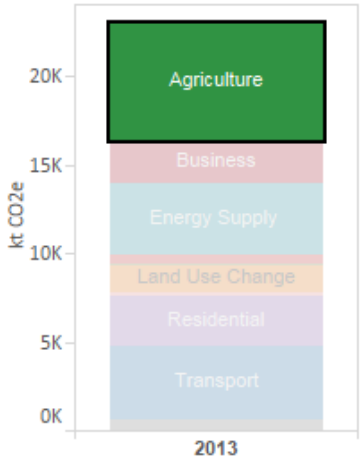


Figure 5.37: Total GHG Emissions from Agriculture, Base Year to 2013, Northern Ireland

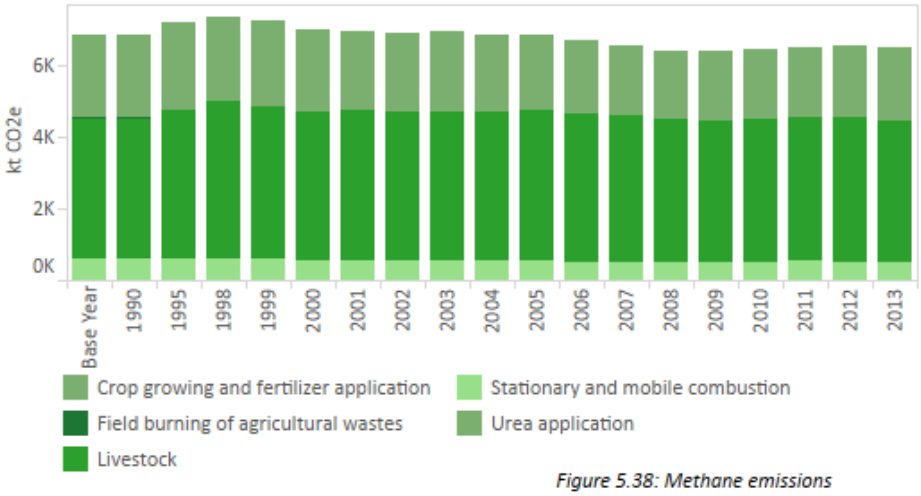


Table 5.9: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Northern Ireland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Crop growing and fertilizer application	-10.0%	-225.0	3.3%	65.5
Field burning of agricultural wastes	-100.0%	-1.3	N/A	0.0
Livestock	0.8%	30.2	-2.5%	-100.8
Stationary and mobile combustion	-20.3%	-120.3	-2.0%	-9.6
Urea application	-72.4%	-16.8	5.3%	0.3
Agriculture Total	-4.9%	-333.1	-0.7%	-44.5

Figure 5.38: Methane emissions from livestock by type, 2013, Northern Ireland

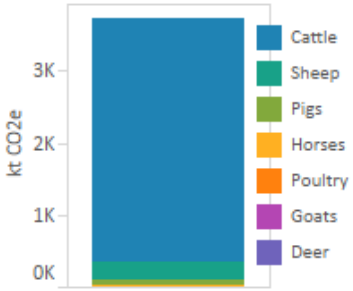


Figure 5.39: GHG Contribution for Agriculture Emissions, 2013, Northern Ireland

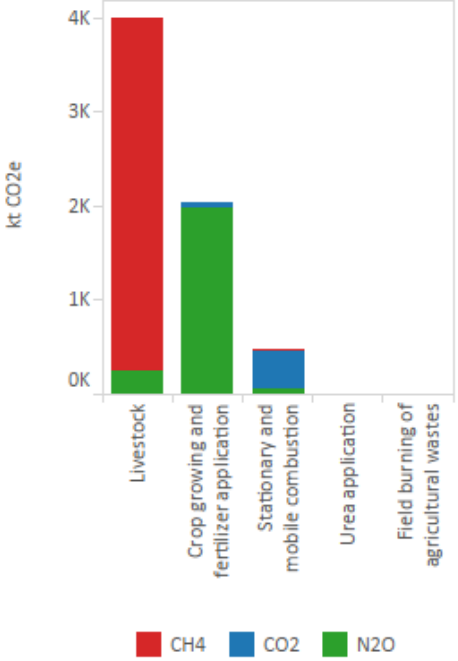


Table 5.10: Emissions of nitrous oxide from agricultural sources in 2013 (kt CO2e), Northern Ireland*

Manure management				245
Soils				1,951
	Direct			1,583
		Crop residues		71
		Fertiliser		418
		Grazing returns		633
		Histosols		296
		Manure application		163
		Sewage sludge		1
	Indirect			368
		Deposition		143
			Fertiliser	42
			Grazing returns	69
			Manure application	33
			Sewage sludge	0
		Leaching		224
			Crop residues	16
			Fertiliser	94
			Grazing returns	77
			Manure application	37
			Sewage sludge	0
Mineralisation				22
TOTAL				2,217

*Total emissions comprise manure management, soils and mineralization. Soils include direct and indirect emissions; indirect emissions include leaching and deposition.

By Source Emissions

Overview

The Agriculture sector contributes 29% to total 2013 GHG emissions in Northern Ireland. Agriculture is the most significant source sector for methane and nitrous oxide, accounting for 85% and 90% of total Northern Ireland emissions of these two gases, respectively. Stationary and mobile combustion within the Agriculture sector emit all the carbon dioxide emissions from the sector (see Figure 5.39).

Emissions from Agriculture represent a much higher proportion in Northern Ireland than the UK average because there is less industry and energy related emission sources in Northern Ireland than elsewhere in the UK, and hence Agriculture emissions are comparatively more important.

Features of the Trends

Emissions from Agriculture have decreased by 5% between the Base Year and 2013. This trend is mainly influenced by a reduction in nitrous oxide emissions of 9% due almost entirely to reductions in emissions from lower fertiliser application. This has been partially offset by a 1% increase in methane emissions due to higher emissions from cattle partly offset by lower emissions from sheep.

There was no significant change in Agriculture sector emissions for Northern Ireland between 2012 and 2013 (less than 1% decrease) mainly due to a decrease in the number of cattle, which was partially offset by emissions from grass with increased fertilizer application rates. Field burning has largely ceased in the UK since 1993, hence the significant decrease in emissions since the Base Year.

Sector Detail

Livestock emissions include two main sub-categories: emissions from enteric fermentation (a digestive process by which carbohydrates are broken down by microorganisms into simple molecules) and emissions from manure management. Total methane emissions from beef and dairy cattle (enteric and manure management sources combined) accounted for 80% of the all Northern Ireland agricultural methane emissions. Emissions from sheep accounted for 6% of the total methane from Agriculture in 2013.

Nitrous oxide emissions are largely driven by fertiliser nitrogen use, manure applications and grazing returns to soils. Emissions from agricultural soils are the most important source of nitrous oxide in Northern Ireland and accounted for 78% of total nitrous oxide emissions in 2013. A further breakdown of these emissions is shown in Table 5.10.

Emissions on an End User Basis

As the majority of emissions in the Agriculture sector are not due to energy consumption, Agriculture sector emissions on an End User basis are very similar to the emissions by source. In 2013, the End User estimates are only 2% higher for the Agriculture sector, reflecting the relatively low contribution to sector emissions from the use of oils and electricity, compared to the higher-emitting sources of nitrous oxide and methane from soils and livestock sources.

5.9 Land Use, Land Use Change and Forestry Sector

Figure 5.40: Overall Contribution to 2013 GHG emissions, Northern Ireland

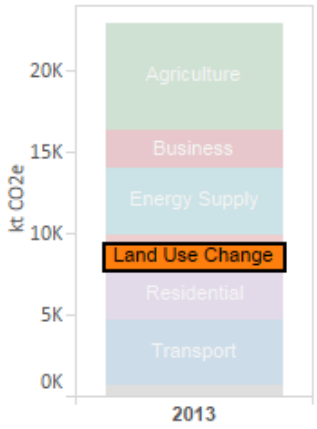


Figure 5.41: GHG Contribution to Land Use Change Emissions, 2013, Northern Ireland

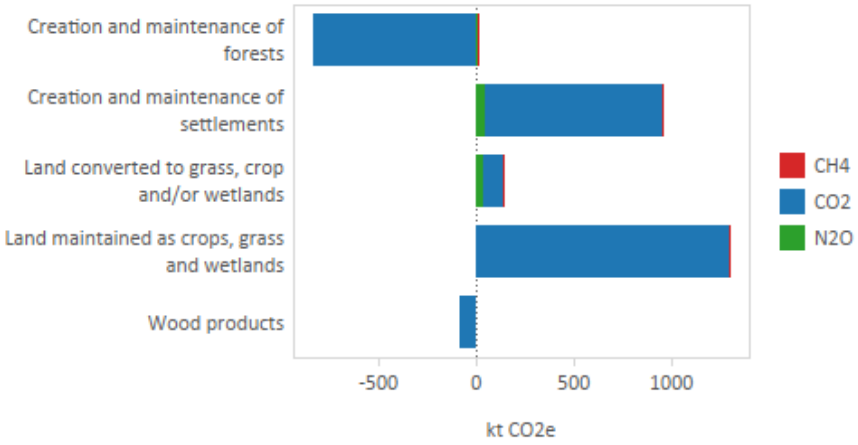
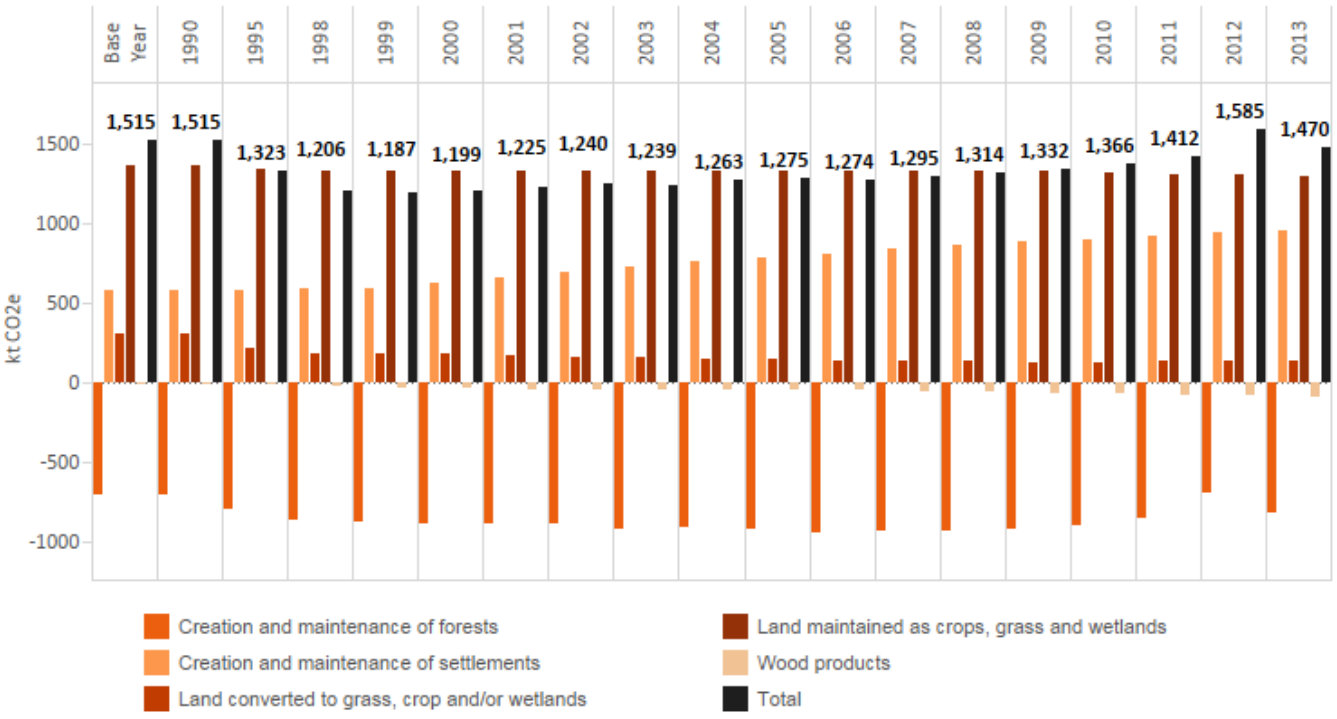


Table 5.11: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Northern Ireland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Creation and maintenance of settlements	65%	377	2%	17
Creation and maintenance of forests	16%	-112	18%	-122
Land converted to grass, crop and/or wetlands	-55%	-166	2%	2
Land maintained as crops, grass and wetlands	-5%	-72	-1%	-9
Wood products	455%	-73	3%	-3
Land Use Change Total	-3%	-45	-7%	-115

Figure 5.42: Total GHG Emissions from LULUCF, Base Year - 2013, Northern Ireland



By Source Emissions

Overview

Figures 5.40 – 5.42 and Table 5.11 show detailed emissions and trends for the Land Use, Land Use Change and Forestry (LULUCF) sector. This sector has been a net source of emissions across the time series. The LULUCF emissions and sinks arise from human activities that change the way land is used or affect the amount of biomass in existing biomass stocks. The most significant category is land maintained as crops, grass and forest, which accounted for emissions 1,289 $ktCO_2e$ in 2013.

More details regarding this sector can be found in Appendix 8, including detailed explanations for the reasons for change in Section A8.6.3.

Features of the Trends

The LULUCF sector has been a net source of greenhouse gases across the time series. The size of this source has grown by 24% since 1999 due in part to the increased emissions from the creation and maintenance of settlements, as well as the changing sink (CO_2 removal) from the creation and maintenance of forests.

In 2013, this sector was significantly affected by a large wildfire that spanned an area of 704ha, 14 times the average for Northern Ireland and the greatest total forest wildfire area in the UK in 2012. As a result of this, the sink from the creation and maintenance of forests was reduced 19% between 2011 and 2012.

Emissions on an End User Basis

As emissions and removals from LULUCF do not relate to Energy Supply the End User GHG inventory emissions are the same as emissions reported in the By Source GHG inventory.

5.10 Waste Management Sector

Figure 5.43: Overall Contribution to 2013 GHG emissions, Northern Ireland

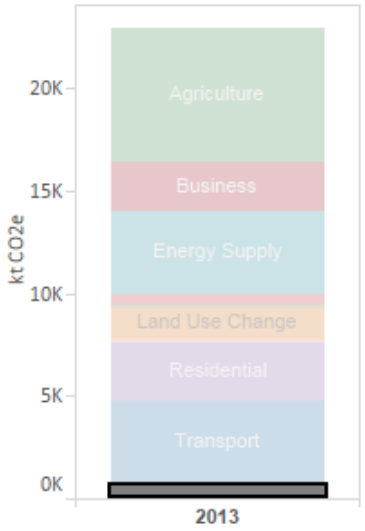


Figure 5.44: Total GHG Emissions from Waste Management, Base Year to 2013, Northern Ireland

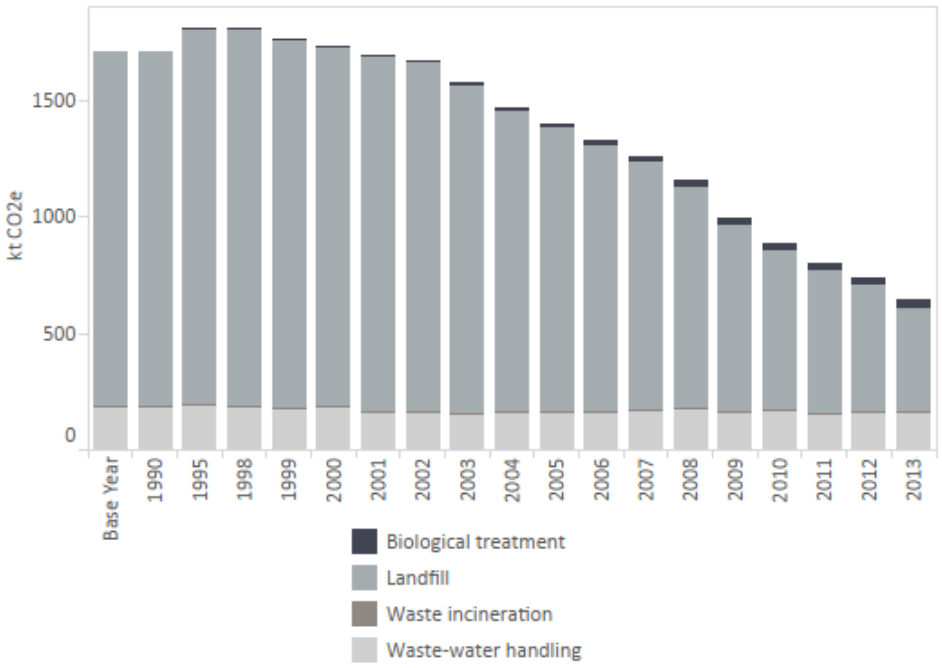
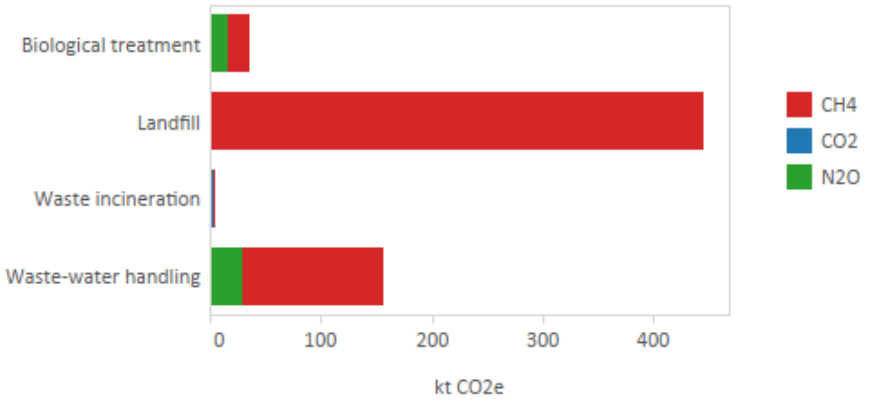


Table 5.12: Change in GHG Emissions from Base Year to 2013 and from 2012 to 2013, Northern Ireland

	Base Year to 2013 as %	Base Year to 2013 kt	2012 to 2013 as %	2012 to 2013 kt
Landfill	-70.84%	-1,082.81	-18.26%	-99.55
Waste incineration	-60.40%	-5.30	-0.10%	0.00
Waste-water handling	-11.40%	-20.13	-0.47%	-0.74
Biological treatment	N/A	36.63	5.96%	2.06
Waste Management Total	-62.53%	-1,071.60	-13.27%	-98.24

Figure 5.45: GHG Contribution to Waste Management Emissions, 2013, Northern Ireland



By Source Emissions

Overview

The Waste Management sector contributes 3% to total GHG emissions in Northern Ireland in 2013, and represents 14% of total methane emissions. Emissions from this sector are dominated by methane from landfill (69% of total GHGs from the Waste Management sector – see Figure 5.44), with a smaller contribution of emissions of methane and nitrous oxide from wastewater treatment (24%).

The majority of total GHG emissions are of methane (92% of total sector GHG emissions in 2013). Nitrous oxide emissions from waste water treatment represent 5% of emissions in the sector, and contribute 1% to the total emissions of nitrous oxide in Northern Ireland. See Figure 5.45 for the pollutant contribution within the Waste Management sector.

Features of the Trends

Emissions of GHGs from the Waste Management sector in Northern Ireland have shown a significant decline of 63% in total for the sector and by 71% for landfill between 1990 and 2013, as shown in Table 5.12, due largely to the progressive introduction of methane capture and oxidation systems within landfill management. Between 2012 and 2013 Waste Management sector GHG emissions decreased by 13%, which is mainly due to UK-wide reductions in methane emission estimates from landfill in line with improvements to the management systems.

Emissions on an End User Basis

As emissions from the Waste Management sector do not include any energy consumption sources, and no electricity use is allocated to the Waste Management sector (due to a lack of data to correctly allocate to the Waste Management sector), the End User emission estimates for the sector are unchanged from the emissions presented here on a by source basis.

6 References

Please note that the following references are relevant to the text in the main body of the report. A full list of all data sources related to the methodology of the report can be found in the accompanying Appendices file: "DA GHGI 1990-2013 Report_Appendices_v1.docx".

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7 Appendices

Appendix 1: Uncertainties in the UK and Devolved Administrations Greenhouse Gas Inventory estimates

Appendix 2: Devolved Administrations Greenhouse Gas Inventory compilation methods and data sources

Appendix 3: Methods used for calculating End User Inventory estimates

Appendix 4: Emissions analysis and methods used for Devolved Administrations Traded and Non-Traded Emissions

Appendix 5: Mapping between source name, IPCC category and National Communication Sector

Appendix 6: Recalculations between the previous and this current Devolved Administrations Inventory

Appendix 7: Supporting Data Tables and Graphs

Appendix 8: Emissions and Removals of Greenhouse Gases from Land Use, Land Use Change and Forestry (LULUCF) for England, Scotland, Wales and Northern Ireland: 1990-2013

Appendix 9: Aviation Data in the EU ETS