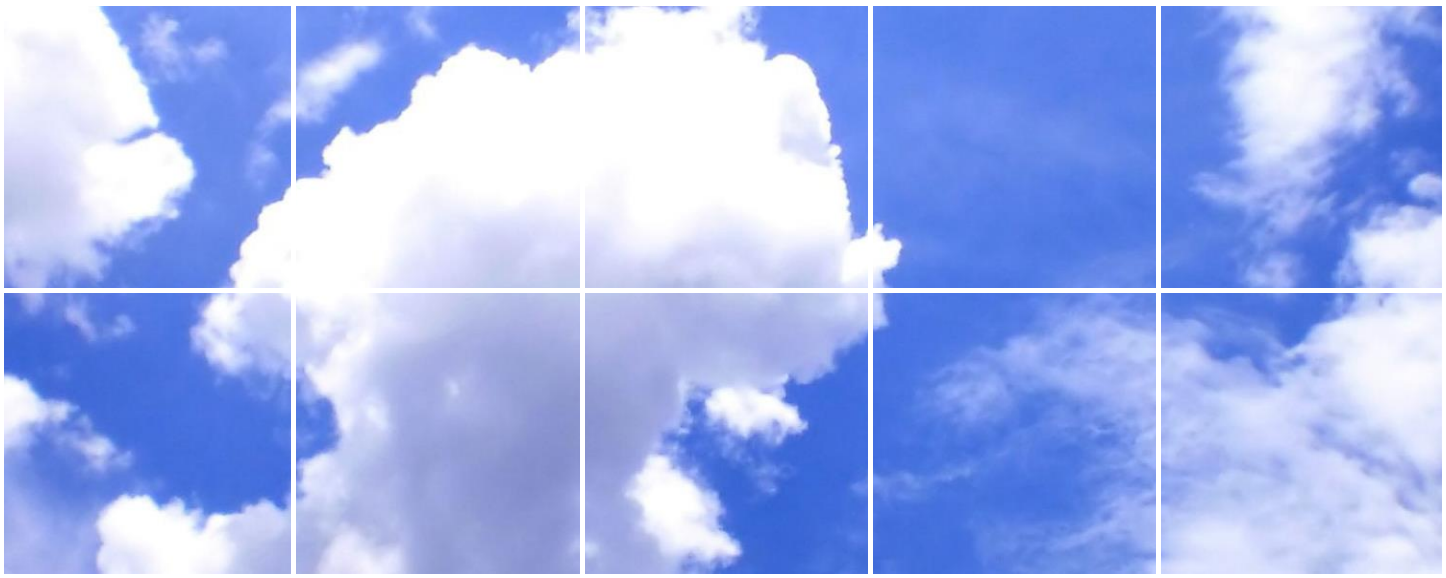
National Atmospheric Emissions Inventory



Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2014

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

June 2016

Aether

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A copy of this report and related data may be found on the NAEI website maintained by Ricardo Energy & Environment 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 2014. 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 1990-2014 (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 (Jersey, Guernsey and Isle of Man) and those Overseas Territories joining UK instruments of ratification for the UNFCCC and the Kyoto Protocol (Cayman Islands, Falkland Islands, Bermuda 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 Climate Change Strategy for Wales (2010) together with new legislation under the Well-being of Future Generations (Wales) Act and Environment (Wales) Act, 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. Alternatively, Wales sets both a total emissions target (all existing anthropogenic sources) and a devolved annual target which 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 2014

The UK distribution of regional net[2] greenhouse gas emissions in 2014, expressed in terms of global warming potentials (GWP), is detailed below.

England has a **76%** share of total net GHG emissions in **2014**. **England** has seen a decrease of 38% in greenhouse gas emissions between the Base Year[3] and 2014. Emissions between 2013 and 2014 have decreased by 7.9%, which was predominantly driven by a reduction in emissions from the use of coal in the power generation sector and natural gas in the residential sector.

Scotland has an **8.6%** share of total net GHG emissions in **2014**. **Scotland** has seen a decrease of 41% in greenhouse gas emissions between the Base Year and 2014. Emissions between 2013 and 2014 have decreased by 8.9%, which was largely driven by a reduction in emissions from the use of natural gas in the domestic and power generation sectors.

Wales has a **9.0%** share of total net GHG emissions in **2014**. **Wales** has seen a decrease of 18% in greenhouse gas emissions between the Base Year and 2014. Emissions between 2013 and 2014 have decreased by 8.0%, which was predominantly driven by a reduction in the use of coal in the power generation sector as well as a reduction in emissions from refineries and the residential sector.

Northern Ireland has a **4.0%** share of total net GHG emissions in **2014**. **Northern Ireland** has seen a decrease of 17% in greenhouse gas emissions between the Base Year and 2014. Emissions between 2013 and 2014 remained relatively stable decreasing by only 3%.

[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.

2.7% of the UK emissions total were unallocated in **2014** and these net emissions have decreased by 0.3% since the Base Year. These emissions from offshore oil and gas installations decreased by 2.1% between 2013 and 2014.

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 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_1990-2014_EmissionsData_v2.xlsx".

Uncertainties

The 2014 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 +-3% to +-10% 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 2014 Devolved Administrations GHG emission estimates are presented below:

- **England uncertainty in 2014 for all greenhouse gases** (+-3%): England inventory has a relatively low level of uncertainty because the inventory has the highest overall contribution from CO_2 and the lowest contribution from GHGs that are dominated by sources with higher uncertainty such as methane and nitrous oxide. The England CO_2 emissions are also mainly from combustion and industrial sources with estimates with low uncertainty.
- **Scotland uncertainty in 2014 for all greenhouse gases** (+-10%): Scotland has a notably higher level of overall uncertainty due to the much greater contribution to the Scotland total from sources and sinks with significant uncertainties. In addition, Scotland has a relatively high contribution to its overall GHG total from methane and nitrous oxide; these inventories are dominated by sources that are much harder to characterise, with emission factors that are highly uncertain.
- **Wales uncertainty in 2014 for all greenhouse gases** (+-3%): 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 also has a relatively low contribution from the uncertain sources of methane and nitrous oxide.
- **Northern Ireland uncertainty in 2014 for all greenhouse gases** (+-7%): The Northern Ireland inventory overall has a relatively high uncertainty due to the low overall contribution to the emissions total from CO_2; the CO_2 inventory is also relatively uncertain 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 and nitrous oxide, with high emissions from sources where emission factors are subject to considerable uncertainty.

Appendix 1 provides more detail on the uncertainties for 2014 as well as the uncertainty in the trend of the DA GHG inventories.

Table ES 1: Summary of By Source Emission Estimates for England (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Base Year to 2014	2013 to 2014
By Gas including LULUCF																						
Carbon Dioxide	468.00	468.00	429.50	424.35	417.16	420.50	432.12	424.90	435.38	434.42	433.41	426.79	425.74	411.93	372.51	384.09	353.14	369.83	357.11	324.73	-31%	-9%
Methane	101.62	101.62	95.69	89.83	86.33	82.67	78.80	77.43	73.32	69.40	65.16	62.01	59.07	54.75	49.72	45.30	42.93	40.63	36.95	35.13	-65%	-5%
Nitrous Oxide	40.47	40.47	31.02	30.96	20.99	20.98	19.48	18.21	18.06	18.91	18.14	17.29	17.47	17.14	15.35	15.60	14.59	14.45	14.40	14.95	-63%	4%
HFCs	18.86	14.39	18.86	19.31	10.63	8.85	9.68	10.03	11.23	10.18	11.22	11.98	12.32	12.75	13.34	14.15	12.88	13.36	13.68	13.89	-26%	2%
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	0.16	0.21	0.13	-58%	-39%
SF_6	1.14	1.14	1.14	1.19	1.34	1.63	1.30	1.34	1.17	0.98	0.91	0.77	0.73	0.59	0.51	0.60	0.52	0.50	0.42	0.40	-65%	-3%
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	0.0001	-68%	10%
LULUCF only by Gas																						
Carbon Dioxide	2.31	2.31	2.35	1.19	0.99	0.47	0.21	-0.06	-0.26	-0.74	-1.01	-1.33	-1.77	-2.03	-2.01	-2.29	-2.45	-2.64	-2.76	-3.14	-236%	14%
Methane	0.01	0.008	0.015	0.010	0.008	0.011	0.011	0.013	0.023	0.009	0.014	0.013	0.015	0.010	0.013	0.010	0.011	0.015	0.006	0.004	-54%	-38%
Nitrous Oxide	0.47	0.47	0.44	0.43	0.42	0.41	0.40	0.38	0.38	0.36	0.35	0.34	0.33	0.32	0.31	0.31	0.30	0.30	0.29	0.28	-39%	-2%
LULUCF Net Emissions	**2.78**	**2.78**	**2.81**	**1.63**	**1.42**	**0.89**	**0.61**	**0.34**	**0.15**	**-0.37**	**-0.64**	**-0.98**	**-1.42**	**-1.70**	**-1.69**	**-1.97**	**-2.13**	**-2.33**	**-2.46**	**-2.85**	**-202%**	**16%**
By National Communication Sector																						
Agriculture	36.12	36.12	35.13	34.11	33.77	32.45	30.55	30.43	30.33	30.40	29.83	29.19	29.19	28.80	28.62	28.77	28.65	28.27	28.35	29.17	-19%	3%
Business	87.08	86.42	85.82	85.39	86.32	86.84	88.39	84.10	86.50	86.13	86.77	84.52	83.71	82.03	72.23	73.62	67.69	69.78	70.04	68.66	-21%	-2%
Energy Supply	217.62	217.62	172.69	157.44	147.85	152.17	160.86	161.41	169.31	166.65	167.65	167.93	169.34	161.70	144.07	147.98	140.05	147.60	133.84	114.57	-47%	-14%
Industrial Process	56.82	54.40	46.50	44.08	25.24	22.68	20.84	18.50	18.58	17.67	17.08	15.48	16.84	14.95	9.65	10.00	8.78	8.56	9.69	9.03	-84%	-7%
Land Use Change	2.78	2.78	2.81	1.63	1.42	0.89	0.61	0.34	0.15	-0.37	-0.64	-0.98	-1.42	-1.70	-1.69	-1.97	-2.13	-2.33	-2.46	-2.85	-202%	16%
Public	10.56	10.56	10.45	10.38	10.26	9.70	9.83	8.35	8.28	9.01	9.00	8.13	7.55	8.63	7.41	7.84	7.51	7.46	7.62	6.55	-38%	-14%
Residential	63.92	63.37	65.77	72.30	71.98	72.66	74.55	71.78	72.74	73.96	70.55	68.03	64.95	66.34	63.49	71.39	54.72	63.04	63.00	52.11	-18%	-17%
Transport	101.71	101.71	101.83	105.59	106.38	105.39	105.29	107.05	106.31	107.16	107.75	107.98	108.95	104.12	99.87	98.70	97.36	96.87	95.86	96.94	-5%	1%
Waste Management	53.78	53.78	55.52	54.99	53.46	52.17	50.72	50.11	47.15	43.57	41.09	38.79	36.36	32.41	27.85	23.63	21.76	19.67	16.83	15.07	-72%	-10%
Total Net Emissions	**630.40**	**626.77**	**576.52**	**565.90**	**536.68**	**534.95**	**541.65**	**532.08**	**539.35**	**534.17**	**529.07**	**519.06**	**515.47**	**497.28**	**451.51**	**459.95**	**424.40**	**438.93**	**422.77**	**389.24**	**-38%**	**-8%**

Table ES 2: Summary of By Source Emission Estimates for Scotland (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Base Year to 2014	2013 to 2014
By Gas including LULUCF																						
Carbon Dioxide	52.60	52.60	53.28	52.19	49.73	52.11	51.83	48.33	48.77	46.86	45.79	49.05	44.94	43.47	39.78	42.58	36.25	37.34	36.22	32.15	-39%	-11%
Methane	17.68	17.68	17.64	17.08	16.21	15.74	15.14	14.60	13.91	13.30	12.86	12.30	11.70	10.84	9.91	9.23	8.89	8.43	7.88	7.52	-57%	-5%
Nitrous Oxide	4.15	4.15	3.81	3.89	3.83	3.75	3.75	3.69	3.66	3.53	3.41	3.39	3.25	3.16	3.26	3.23	3.16	3.16	3.25	3.26	-21%	0.4%
HFCs	0.13	0.002	0.13	0.40	0.44	0.54	0.65	0.72	0.84	0.93	1.03	1.12	1.18	1.22	1.29	1.34	1.23	1.27	1.30	1.33	946%	2%
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	0.14	23%	44%
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	0.03	0.03	-14%	-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	0.0003	-44%	10%
LULUCF only by Gas																						
Carbon Dioxide	-2.77	-2.77	-3.33	-4.07	-4.50	-4.45	-4.66	-5.00	-4.97	-5.23	-5.36	-5.63	-5.82	-5.99	-6.04	-6.18	-6.49	-6.55	-6.47	-6.50	135%	0.5%
Methane	0.006	0.006	0.013	0.008	0.006	0.017	0.017	0.015	0.030	0.019	0.021	0.017	0.023	0.017	0.020	0.016	0.013	0.023	0.016	0.018	190%	7%
Nitrous Oxide	0.42	0.42	0.44	0.44	0.44	0.43	0.41	0.39	0.39	0.36	0.35	0.34	0.33	0.31	0.30	0.29	0.28	0.29	0.28	0.27	-36%	-1%
LULUCF Net Emissions	**-2.34**	**-2.34**	**-2.89**	**-3.62**	**-4.06**	**-4.00**	**-4.24**	**-4.59**	**-4.55**	**-4.85**	**-4.99**	**-5.28**	**-5.47**	**-5.66**	**-5.72**	**-5.87**	**-6.19**	**-6.24**	**-6.17**	**-6.21**	**166%**	**0.53%**
By National Communication Sector																						
Agriculture	9.65	9.65	9.68	9.77	9.57	9.34	8.97	9.01	9.04	8.91	8.79	8.69	8.52	8.19	8.26	8.24	8.22	8.17	8.34	8.29	-14%	-1%
Business	12.50	12.39	10.40	10.44	10.68	10.58	10.93	10.08	10.21	10.13	10.54	10.26	9.83	9.95	8.75	8.95	8.62	8.44	8.69	8.11	-35%	-7%
Energy Supply	22.77	22.77	26.85	25.81	23.34	26.28	25.55	23.50	23.66	21.88	20.74	24.74	21.40	20.15	18.76	20.87	17.00	17.49	15.98	13.85	-39%	-13%
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	0.54	0.53	0.40	0.39	0.45	0.44	0.50	0.54	-71%	8%
Land Use Change	-2.34	-2.34	-2.89	-3.62	-4.06	-4.00	-4.24	-4.59	-4.55	-4.85	-4.99	-5.28	-5.47	-5.66	-5.72	-5.87	-6.19	-6.24	-6.17	-6.21	166%	1%
Public	1.68	1.68	1.80	1.77	1.75	1.64	1.68	1.44	1.43	1.55	1.50	1.36	1.28	1.47	1.24	1.31	1.25	1.24	1.25	1.07	-36%	-14%
Residential	8.01	7.95	7.80	8.03	7.92	7.79	8.28	7.58	7.57	7.71	7.62	7.43	7.21	7.40	7.12	7.96	6.21	7.05	7.04	5.88	-27%	-16%
Transport	10.74	10.74	10.72	11.14	11.22	11.05	11.02	11.34	11.37	11.47	11.61	11.79	11.97	11.51	11.05	10.87	10.64	10.67	10.59	10.65	-1%	1%
Waste Management	9.84	9.84	10.07	9.79	9.39	9.06	8.73	8.54	7.99	7.36	6.90	6.46	5.95	5.27	4.51	3.76	3.45	3.06	2.56	2.24	-77%	-13%
Total Net Emissions	**74.70**	**74.61**	**75.01**	**73.76**	**70.42**	**72.34**	**71.51**	**67.51**	**67.35**	**64.78**	**63.25**	**66.00**	**61.21**	**58.80**	**54.36**	**56.49**	**49.65**	**50.32**	**48.78**	**44.43**	**-41%**	**-9%**

Table ES 3: Summary of By Source Emission Estimates for Wales (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Base Year to 2014	2013 to 2014
By Gas including LULUCF																						
Carbon Dioxide	43.78	43.78	41.12	43.13	45.04	47.39	44.54	37.71	38.98	42.69	40.61	42.17	39.79	41.86	35.46	38.51	35.57	37.85	42.61	38.56	-12%	-10%
Methane	10.19	10.19	9.42	9.21	9.13	8.88	8.48	8.34	8.19	7.96	7.67	7.62	7.02	6.50	6.15	5.89	5.73	5.62	5.42	5.40	-47%	-0.5%
Nitrous Oxide	2.20	2.20	2.20	2.13	2.14	2.04	1.99	1.89	1.92	1.88	1.83	1.86	1.70	1.62	1.61	1.68	1.67	1.70	1.71	1.76	-20%	3%
HFCs	0.07	0.001	0.07	0.21	0.22	0.28	0.32	0.35	0.42	0.45	0.52	0.56	0.58	0.59	0.63	0.66	0.61	0.63	0.65	0.66	905%	1%
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	0.01	-96%	6%
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	0.04	0.04	0.03	0.03	0.03	-66%	-3%
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	0.00002	-20%	10%
LULUCF only by Gas																						
Carbon Dioxide	-0.40	-0.40	-0.21	-0.11	0.01	0.07	0.04	-0.06	-0.13	-0.17	-0.20	-0.25	-0.32	-0.29	-0.36	-0.36	-0.42	-0.38	-0.44	-0.38	-5%	-13%
Methane	0.002	0.002	0.004	0.003	0.003	0.005	0.004	0.003	0.007	0.003	0.005	0.005	0.005	0.005	0.004	0.007	0.005	0.008	0.002	0.009	275%	303%
Nitrous Oxide	0.099	0.099	0.102	0.102	0.102	0.100	0.095	0.091	0.093	0.086	0.084	0.082	0.080	0.077	0.075	0.076	0.0731	0.074	0.0681	0.0723	-27%	6%
LULUCF Net Emissions	**-0.29**	**-0.29**	**-0.10**	**-0.01**	**0.12**	**0.17**	**0.14**	**0.04**	**-0.03**	**-0.08**	**-0.11**	**-0.16**	**-0.23**	**-0.21**	**-0.29**	**-0.28**	**-0.34**	**-0.30**	**-0.36**	**-0.30**	**0.33%**	**-19%**
By National Communication Sector																						
Agriculture	6.85	6.85	6.90	6.84	6.92	6.57	6.39	6.18	6.36	6.32	6.17	6.32	5.73	5.49	5.46	5.58	5.61	5.59	5.60	5.82	-15%	4%
Business	13.73	13.70	14.39	14.97	16.82	16.67	13.43	9.33	10.59	11.33	9.94	10.29	10.42	9.65	7.89	9.62	8.87	7.70	9.69	9.27	-32%	-4%
Energy Supply	18.07	18.07	13.19	14.01	13.67	16.53	17.51	15.78	15.15	17.84	17.59	18.84	16.60	19.44	16.43	16.78	15.96	19.49	21.23	17.51	-3%	-18%
Industrial Process	2.78	2.97	3.11	2.96	3.26	3.30	2.54	1.97	2.57	2.65	2.59	2.69	2.68	2.62	1.57	2.11	1.91	1.52	2.62	3.23	16%	23%
Land Use Change	-0.29	-0.29	-0.10	-0.01	0.12	0.17	0.14	0.04	-0.03	-0.08	-0.11	-0.16	-0.23	-0.21	-0.29	-0.28	-0.34	-0.30	-0.36	-0.30	0.3%	-19%
Public	0.77	0.77	0.71	0.57	0.57	0.55	0.55	0.45	0.45	0.50	0.50	0.45	0.41	0.46	0.39	0.40	0.38	0.38	0.39	0.33	-57%	-15%
Residential	5.02	4.99	5.18	5.57	5.48	5.31	5.42	5.06	5.08	5.16	4.85	4.75	4.50	4.64	4.43	4.91	3.82	4.28	4.30	3.63	-28%	-15%
Transport	6.09	6.09	6.08	6.26	6.27	6.17	6.14	6.31	6.32	6.44	6.46	6.52	6.63	6.39	6.13	6.05	5.95	5.88	5.85	5.92	-3%	1%
Waste Management	3.48	3.48	3.61	3.69	3.61	3.55	3.44	3.38	3.18	2.93	2.77	2.63	2.47	2.21	1.91	1.62	1.46	1.31	1.11	0.99	-72%	-11%
Total Net Emissions	**56.49**	**56.62**	**53.07**	**54.86**	**56.72**	**58.83**	**55.56**	**48.51**	**49.66**	**53.09**	**50.76**	**52.33**	**49.20**	**50.68**	**43.93**	**46.79**	**43.63**	**45.85**	**50.42**	**46.40**	**-18%**	**-8%**

Table ES 4: Summary of By Source Emission Estimates for Northern Ireland (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Base Year to 2014	2013 to 2014
By Gas including LULUCF																						
Carbon Dioxide	16.56	16.56	16.83	16.18	16.61	16.63	16.95	15.05	15.16	15.08	16.01	16.51	15.46	15.44	14.05	15.01	13.78	14.00	14.37	13.83	-16%	-4%
Methane	5.64	5.64	5.81	6.04	5.86	5.70	5.65	5.62	5.50	5.38	5.34	5.23	5.08	4.92	4.71	4.60	4.55	4.58	4.39	4.34	-23%	-1%
Nitrous Oxide	2.36	2.36	2.61	2.47	2.60	2.47	2.42	1.96	1.97	1.91	1.85	1.80	1.73	1.65	1.66	1.71	1.70	1.72	1.79	1.74	-26%	-3%
HFCs	0.04	0.00	0.04	0.13	0.14	0.17	0.20	0.22	0.26	0.31	0.32	0.35	0.38	0.39	0.40	0.42	0.39	0.40	0.40	0.41	970%	1%
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	0	-100%	-100%
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	0.009	0.007	0.007	0.007	0.007	0.006	0.005	2%	-2%
NF_3	0	0.00002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%
LULUCF only by Gas																						
Carbon Dioxide	0.02	0.02	-0.05	-0.08	-0.09	-0.05	0.00	0.03	0.06	0.11	0.13	0.14	0.16	0.18	0.20	0.21	0.25	0.39	0.28	0.30	1395.2 %	7.3%
Methane	0.0013	0.0013	0.0005	0.0006	0.0009	0.0009	0.0017	0.0017	0.0011	0.0019	0.0017	0.0009	0.0016	0.0013	0.0011	0.0008	0.0019	0.0130	0.0010	0.0010	-20.1%	4.6%
Nitrous Oxide	0.096	0.096	0.089	0.086	0.085	0.086	0.087	0.087	0.088	0.089	0.090	0.090	0.091	0.091	0.092	0.092	0.094	0.102	0.095	0.095	-0.3%	0.8%
LULUCF Net Emissions	**0.12**	**0.12**	**0.04**	**0.00**	**0.00**	**0.04**	**0.09**	**0.12**	**0.15**	**0.20**	**0.22**	**0.23**	**0.26**	**0.27**	**0.29**	**0.31**	**0.34**	**0.51**	**0.38**	**0.40**	**238.7%**	**5.6%**
By National Communication Sector																						
Agriculture	6.10	6.10	6.43	6.53	6.45	6.23	6.19	6.17	6.19	6.09	6.08	5.96	5.80	5.68	5.65	5.76	5.78	5.82	5.82	5.78	-5%	-0.6%
Business	2.91	2.90	2.81	2.47	2.71	2.74	2.83	2.18	2.27	2.31	2.63	2.56	2.62	2.44	2.37	2.72	2.42	2.39	2.45	2.50	-14%	2.1%
Energy Supply	5.36	5.36	6.61	6.24	6.29	6.41	6.64	5.16	4.96	4.84	5.35	5.74	4.66	4.84	3.69	3.97	3.75	3.88	4.07	3.84	-28%	-5.8%
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	0.18	-76%	21.6%
Land Use Change	0.12	0.12	0.04	0.003	-0.002	0.04	0.09	0.12	0.15	0.20	0.22	0.23	0.26	0.27	0.29	0.31	0.34	0.51	0.38	0.40	239%	5.6%
Public	0.49	0.49	0.32	0.22	0.22	0.19	0.19	0.13	0.13	0.15	0.18	0.18	0.20	0.21	0.20	0.20	0.19	0.20	0.20	0.19	-62%	-7.0%
Residential	3.84	3.82	2.95	2.95	2.94	2.90	2.85	2.92	2.95	2.92	2.68	2.86	2.65	2.86	2.88	3.32	2.68	2.73	2.97	2.56	-33%	-13.6%
Transport	3.33	3.33	3.58	3.78	3.93	4.08	4.14	4.32	4.48	4.51	4.60	4.62	4.76	4.59	4.59	4.48	4.33	4.31	4.32	4.34	30%	0.5%
Waste Management	1.70	1.70	1.80	1.81	1.76	1.73	1.68	1.65	1.56	1.45	1.38	1.31	1.24	1.13	0.97	0.84	0.76	0.70	0.60	0.54	-68%	-10%
Total Net Emissions	**24.61**	**24.57**	**25.31**	**24.81**	**25.22**	**24.98**	**25.23**	**22.86**	**22.91**	**22.69**	**23.54**	**23.90**	**22.66**	**22.41**	**20.83**	**21.75**	**20.43**	**20.71**	**20.95**	**20.33**	**-17%**	**-3.0%**

Traded/Non-Traded Inventory Estimates for 2014

The 2014 European Union Emissions Trading System (EU ETS) data have 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 sectors and presents a "Non-Traded" component to the By Source estimates. The data for the 2014 emission estimates show that:

- Across the **UK**, the non-traded share of total GHG emissions was **61%** of total GHG emissions in **2014**.
- **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 **64%** of total GHG emissions in **2014**.
- **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 **2014** was **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 **2014** was only **44%**.
- **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 **2014** was **78%**.

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_21990-2014_EmissionsData_v2.xlsx".

End User Inventory Estimates for 2014

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). 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 2014 and emission trends derived from the End User calculations are summarised below[5].

- England had a **79%** share of total net End User GHG emissions in **2014** (compared to a 76% share of By Source emissions). End User emissions have declined by **36%** since 1990. End User emissions were 5% higher than the By Source estimates in 2014 as a result of emissions attributed to England from energy production activities (e.g. electricity generation) outside England.
- Scotland had an **8.9%** share of total net End User GHG emissions in **2014** (compared to an 8.6% share of By Source emissions). The trend since 1990 was a decline of **43%**. End User emissions were 3.3% higher than the By Source estimates in 2014 as a result of a net import of emissions attributed to energy production activities from Scotland.
- Wales had a **7.8%** share of total net End User GHG emissions in **2014** (compared to a 9.0% share of By Source emissions). Emissions have declined by **30%** since 1990. End User emissions were 13% lower than the By Source estimates in 2014 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 **4.1%** share of total net End User GHG emissions in **2014** (compared to a 4.0% share of By Source emissions). The trend since 1990 is a decline of **19%.** End User emissions are 2.4% 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_1990-2014_EmissionsData_v2".

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

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

[5] The percentages presented in these figures are rounded, 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.

mean that for many emission sources the data available for DA 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, Scotland, Wales or Northern Ireland separately. In order to make emission estimates for fuel consumption, the available data have been supplemented with surrogate/proxy statistics which are used to disaggregate UK total consumption data.

Sub-national energy statistics are published annually by the Department of Energy and Climate Change (DECC) within the quarterly Energy Trends publication (DECC, 2015a). 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 at a Local Authority level across the UK. The latest available data include Local Authority solid and liquid fuel use estimates for 2005 to 2013, with gas and electricity data also available up to 2014.

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, 2015b) 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 (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., 2015) covered the years up to and including 2013, whilst this report gives emission estimates for the years up to and including 2014.

The nature of emission inventories is such that ongoing improvements to data collection or estimation techniques will inevitably lead to some revisions of historical 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, 2015b), are revised annually and hence the data provided 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 these emissions, 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 GHG inventory reports. Significant revisions have been made to some DA estimates since the publication of the previous Devolved Administrations' GHG inventory (Salisbury et al., 2015) in the following categories:

- **Agriculture** – the inventory previously used international emission factors for some agricultural sectors; the estimates have now been improved by incorporating new country-specific emission factors resulting in a significant reduction in emissions across the time series.
- **Land Use, Land Use Change & Forestry** – corrections have been made to carbon stock change from Forest and Harvested Wood Product, emissions from drainage of Grassland, and soil carbon stock change following deforestation; methods have been updated for controlled burning and peat extraction. Carbon stock change in biomass from Cropland and Grassland management have been reported for the first time.

Further details of the changes in estimates between the previous inventory (1990-2013) and the estimates presented in this report (1990-2014) 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).

The second commitment period of the Kyoto Protocol will run for eight years, from 2013 to 2020 inclusive. For this second commitment period, alongside the EU and its member States, the UK (including Gibraltar) communicated an independent quantified economy-wide emission reduction target of a 20 percent emission reduction by 2020 compared with 1990 levels (base year). As ratification is not yet complete the exact details of the UK's target for the second commitment period are still being finalised.

In the United Kingdom, the National GHG Inventory and associated National Inventory Report (Brown et al., 2016) 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.

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 Climate Change Strategy for Wales (2010), Well-being of Future Generations (Wales) Act and Environment (Wales) Act.
- 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 (2010) established two separate emission reduction targets for Wales. These targets include:

- A commitment to reduce emissions within areas of devolved competence by 3% each year from 2011, against a baseline of average emissions over the period 2006-2010;
- A commitment to reduce all Welsh emissions by 40% from 1990 levels by 2020.

The 3% target has been adopted in Wales to reflect areas of devolved competence where the Welsh Government has the direct mandate to act to reduce emissions. The target includes all 'direct' greenhouse gas emissions in Wales, except those from the traded sector[10]. However, because the Welsh Government recognises the importance of reducing electricity consumption in order to reduce emissions, emissions associated with electricity generation are included within the 3% target by assigning them to the end-user of the electricity.

Whereas, the 40% target incorporates all emissions in Wales and reflects the contribution that Wales makes to the overall UK commitments under the Climate Change Act 2008.

Similarly to the UK targets, the Climate Change Strategy targets do not include emissions from international aviation and shipping (which are reported as memo items to national inventories in line with UNFCCC reporting requirements).

The Environment (Wales) Act introduces statutory emission reduction targets for Wales, including at least an 80% reduction in emissions by 2050 against a 1990 baseline, interim targets for 2020, 2030 and 2040 and a system of five-yearly carbon budgets to support the target delivery.

Northern Ireland

The Northern Ireland Executive's current Programme for Government (2011-2015) target is to achieve a 35% reduction in greenhouse gas emissions by 2025 based on 1990 levels.

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

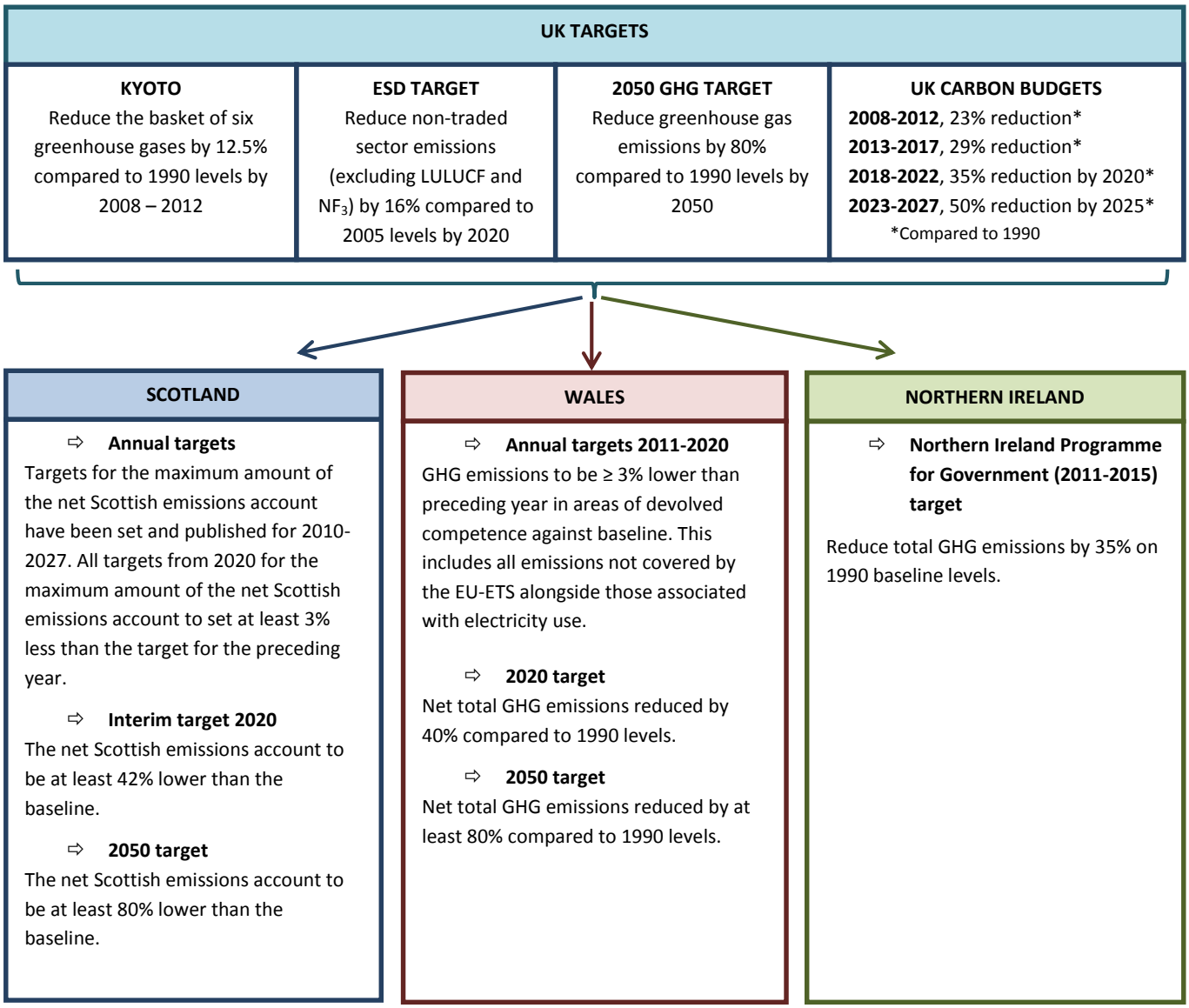
[7] The Climate Change (Annual Targets) (Scotland) Order 2010, SSI 2010 no. 359: http://www.legislation.gov.uk/ssi/2010/359/contents/made

[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: http://www.gov.scot/Topics/Statistics/Browse/Environment/Publications

[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.

Figure 1.1: 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 1990-2014 GHG inventory cycle, which revises and updates the previous DA GHG inventories (Salisbury et al., 2015).

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 2014. It is based on the latest UK GHG emissions statistics, which were published in February 2016 (DECC, 2016) 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., 2015) covered the years up to and including 2013, whilst this report gives emission estimates for the years up to and including 2014.

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

The nature of emission inventories is such that ongoing improvements to data collection or estimation techniques will inevitably lead to some revisions of historical 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, 2015b), are revised annually and hence the data provided 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.

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. Example: Methane has a GWP of 25 and thus, over 100 years, the cumulative radiative forcing is 25 times that of carbon dioxide.

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.

Table 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, 2016). 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. The National Communication format presents the GHG emissions for the policy areas described in the table below.

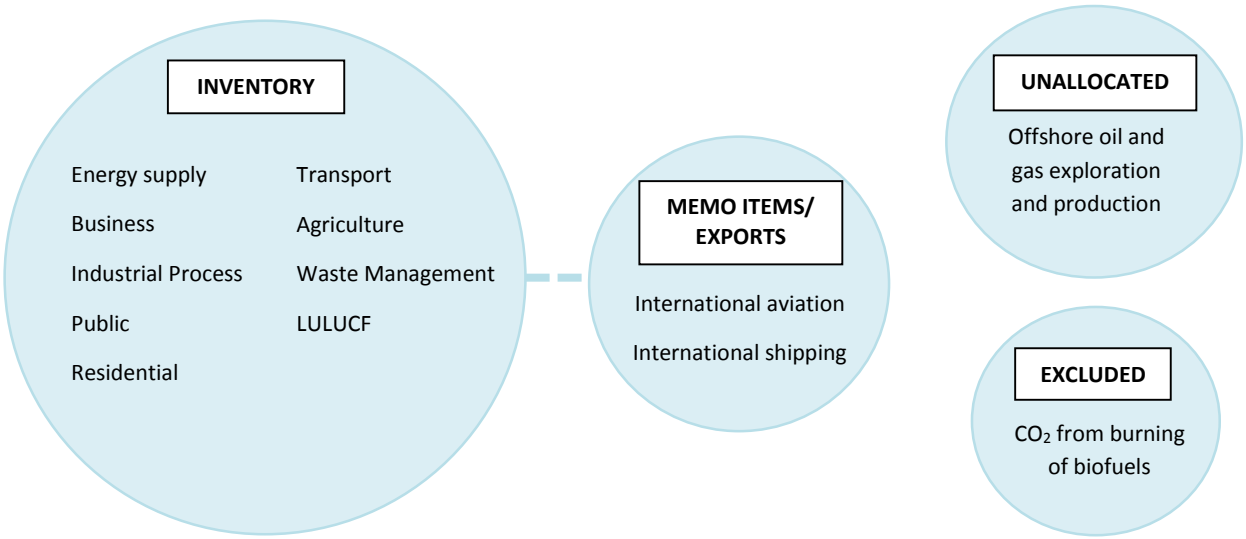
Table 2: Overview of National Communication categories

Sector	National Communication categories
Energy supply	Emissions are predominantly from power stations but also coal mining, oil refineries and other fuel production. Emissions are significantly affected by abatement technology at power stations and the type of fuel being produced or combusted.
Transport	Includes road transport, domestic shipping and aviation, and aircraft support vehicles. Road transport is the most significant source therefore emissions are affected by vehicle efficiency, distance travelled and number of vehicles.
Residential	Includes fuel combustion for heating, cooking, garden machinery, gases released from aerosols and inhalers, and emissions released from the breakdown of products such as detergents. Emissions are affected by energy efficiency, heating and hot water demands, and the fuel type for domestic combustion.
Business	Includes emissions from stationary combustion in the industrial and commercial sectors, industrial off-road machinery, and refrigeration and air conditioning.
Public	Includes emissions from fuel combustion in public sector buildings (e.g. public administration, defence, education and health and social work). Emissions are predominantly affected by fuel type.
Industrial process	Includes all emissions from industry except fuel combustion and therefore includes chemical and metal production, and mineral products (e.g. cement and lime). Emissions are significantly affected by abatement technology.
Agriculture	Includes emissions from livestock, agricultural soils, stationary combustion, and off-road machinery. Emissions are affected by the number of livestock, the quantity of fertiliser applied to land, and the intensity of activity.
Land use change	This covers sinks and sources of emissions from land use, land use change and forestry. Sinks remove GHGs from the atmosphere whilst sources emit GHGs. Emissions are affected by deforestation rates and land management.
Waste management	Emissions include those from waste disposed at landfills, wastewater treatment, and waste incineration. Emissions are affected by regulation of landfills and the proportion of waste that is recycled.

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[12]. 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. The figure below visualises these categories. A table to show the mapping between IPCC sectors and National Communication sectors is provided in Appendix 5.

[12] The combustion of biofuels and materials is considered to be carbon neutral as, providing there is no long-term decline in the total carbon embodied in standing biomass, this activity does not significantly add to atmospheric carbon concentrations. Therefore national level GHG inventories under the IPCC guidelines exclude carbon dioxide emissions from the combustion of biofuels and materials. Biogenic carbon is accounted for by the long-term changes in biomass stocks and land use.

Figure 1.2: Overview of the Categories within the Devolved Administrations' Inventory



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 emission 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 3% target 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 trends in non-traded emissions prior to 2008 would be impacted by the additional 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.

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.

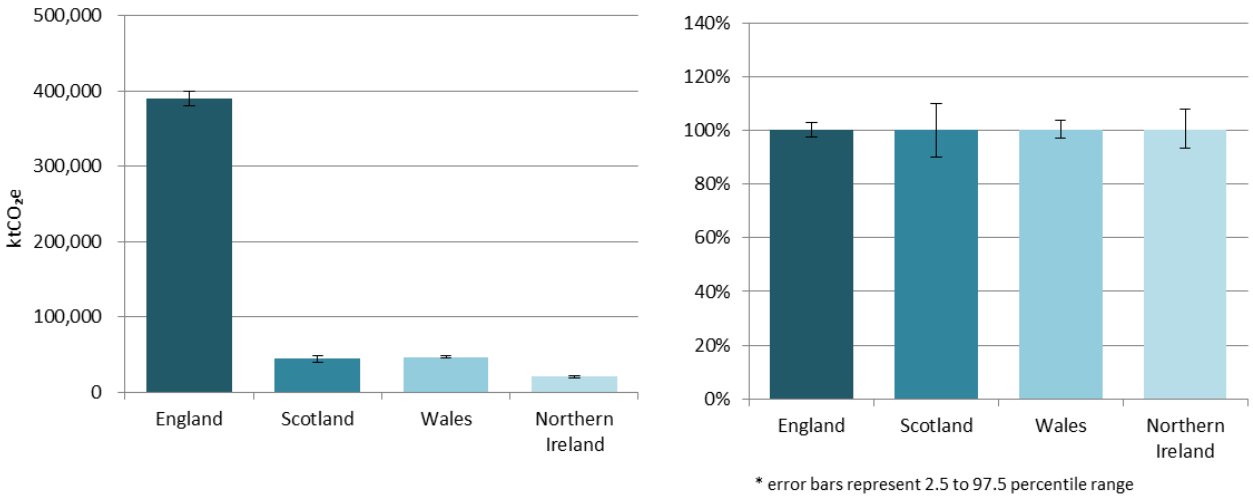
Uncertainties in Inventory Estimates

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.

This year an improved approach to uncertainties was adopted as developed for a project for Scottish Government (Brown & Abbott, 2015). Additional details of the uncertainties for each DA by gas can be found in each DA chapter. The methodology used to estimate the By Source emissions by DA is presented in Appendix 2.

Uncertainties for estimates of emissions by source for the Devolved Administrations for the 2014 estimates are presented in the figure below.

Figure 1.3: Total GHG Emissions and Uncertainties by Devolved Administration (2014)*



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:

- **England uncertainty in 2014 for all greenhouse gases** (+-3%): England has a relatively low overall uncertainty because the inventory has the highest overall contribution from CO_2 and the lowest contribution from GHGs that are dominated by sources with higher uncertainty such as methane and nitrous oxide. The England CO_2 emissions are also mainly from combustion and industrial sources with estimates with low uncertainty.
- **Scotland uncertainty in 2014 for all greenhouse gases** (+-10%): Scotland has a notably higher level of overall uncertainty due to the much greater contribution to the Scotland total from sources and sinks with significant uncertainties. In addition, Scotland has a relatively high contribution to its overall GHG total from methane and nitrous oxide; these inventories are dominated by sources that are much harder to characterise, with emission factors that are highly uncertain.
- **Wales uncertainty in 2014 for all greenhouse gases** (+-3%): 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 also has a relatively low contribution from the uncertain sources of methane and nitrous oxide.
- **Northern Ireland uncertainty in 2014 for all greenhouse gases** (+-7%): The Northern Ireland inventory overall has a relatively high uncertainty due to the low overall contribution to the emissions total from CO_2; the CO_2 inventory is also relatively uncertain 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 and nitrous oxide, 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 2014 are: +-2% England, +-12% Scotland, +-3% Wales and +-8% Northern Ireland.
- **Emissions of nitrous oxide** are the least certain (+-41% England, +-37% Scotland, +-45% Wales, +-39% Northern Ireland) due to high uncertainty in estimates for emissions from soils (for fertilizer application and variability of soil types).

2 Emission Estimates in England (1990-2014)

2.1 Overview of Total Emissions

By Source Emissions

Overview

The greenhouse gas (GHG) emissions for England for 1990 – 2014 are presented in Figure 2.1 and Table 2.1 below:

Figure 2.1: Total GHG Emissions by NC Category for Base Year to 2014, as kt CO_2e, England

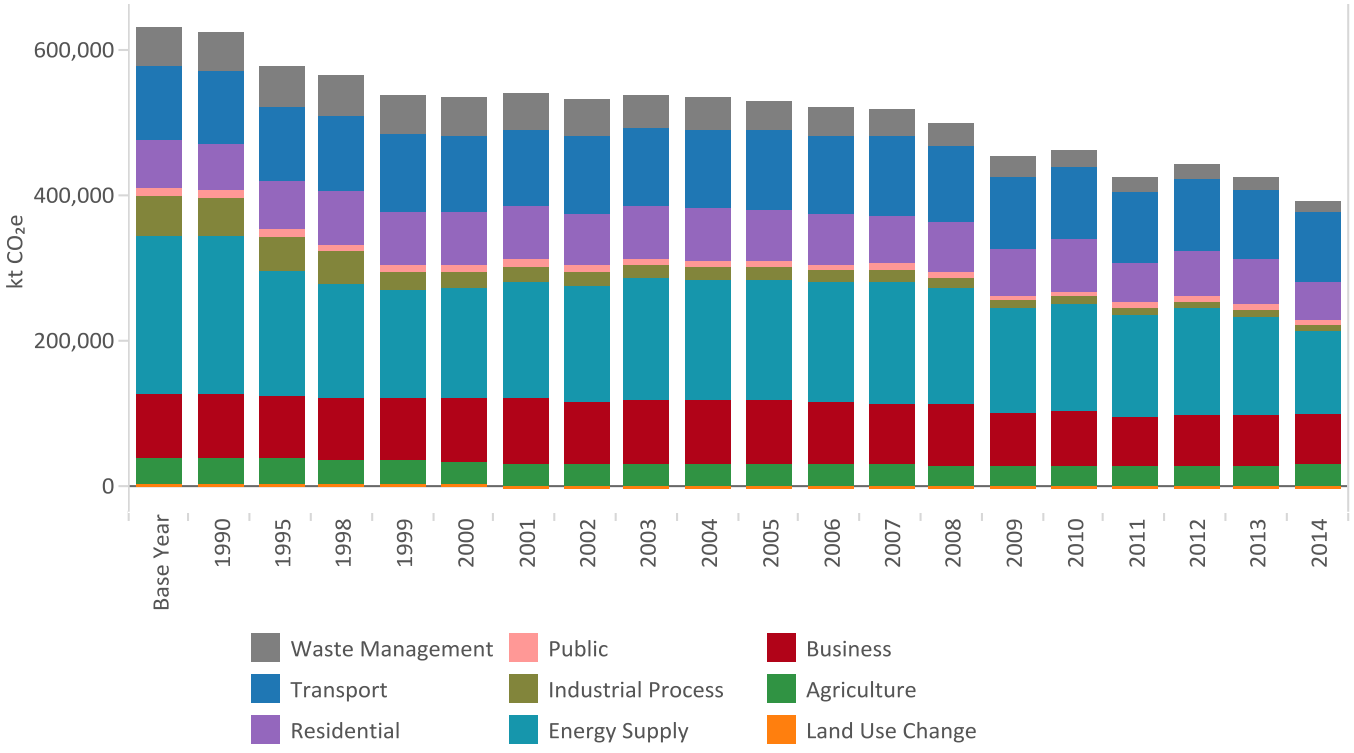
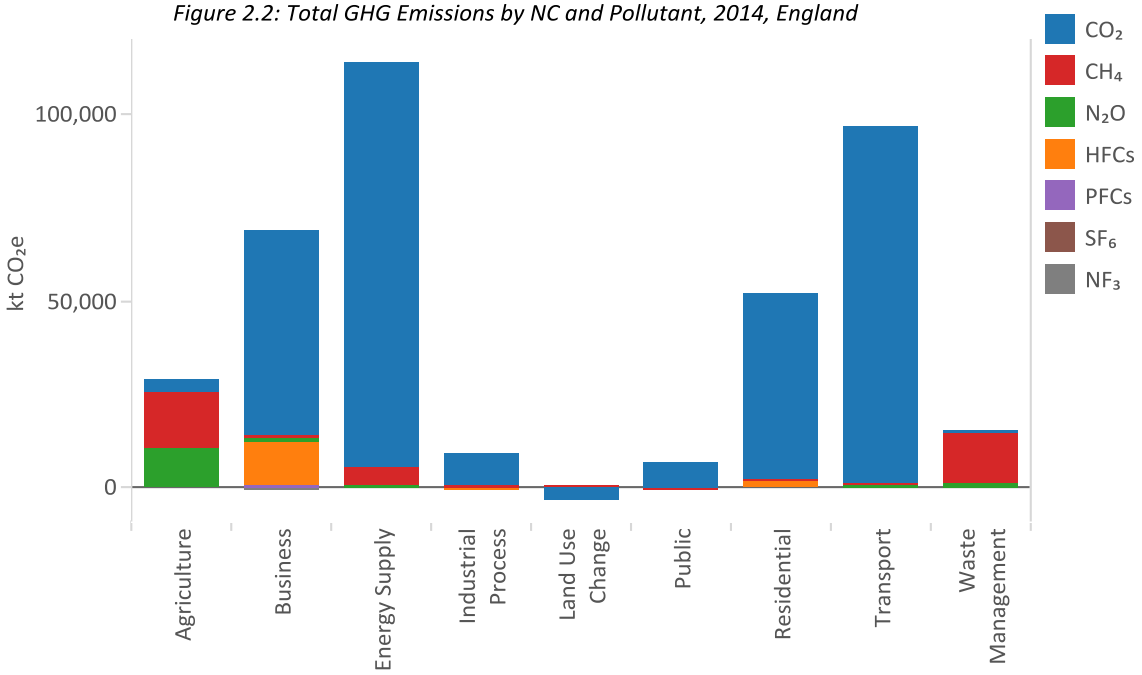


Table 2.1: 1990-2014 England GHG Emission Inventory ($ktCO_2e$)

NC Format	Base Year	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	% of 2014	BY-2014
Agriculture	36,123	36,123	35,132	32,446	29,829	28,795	28,618	28,769	28,651	28,270	28,349	29,167	7%	-19%
Business	87,081	86,425	85,819	86,844	86,770	82,031	72,231	73,619	67,691	69,777	70,043	68,659	18%	-21%
Energy Supply	217,622	217,622	172,692	152,173	167,652	161,703	144,075	147,981	140,054	147,603	133,844	114,568	29%	-47%
Industrial Process	56,822	54,395	46,498	22,678	17,084	14,946	9,654	9,999	8,785	8,562	9,688	9,032	2%	-84%
LULUCF	2,783	2,783	2,808	892	-644	-1,701	-1,687	-1,971	-2,134	-2,325	-2,462	-2,851	-1%	-202%
Public	10,557	10,557	10,448	9,697	9,001	8,635	7,409	7,835	7,505	7,460	7,622	6,549	2%	-38%
Residential	63,924	63,374	65,772	72,662	70,547	66,342	63,494	71,392	54,724	63,040	62,998	52,106	13%	-18%
Transport	101,713	101,713	101,831	105,394	107,747	104,116	99,874	98,700	97,360	96,874	95,863	96,944	25%	-5%
Waste Management	53,776	53,776	55,525	52,165	41,085	32,411	27,846	23,627	21,762	19,672	16,827	15,069	4%	-72%
Total	**630,401**	**626,768**	**576,524**	**534,952**	**529,069**	**497,280**	**451,514**	**459,952**	**424,397**	**438,933**	**422,771**	**389,242**	**100%**	**-38%**

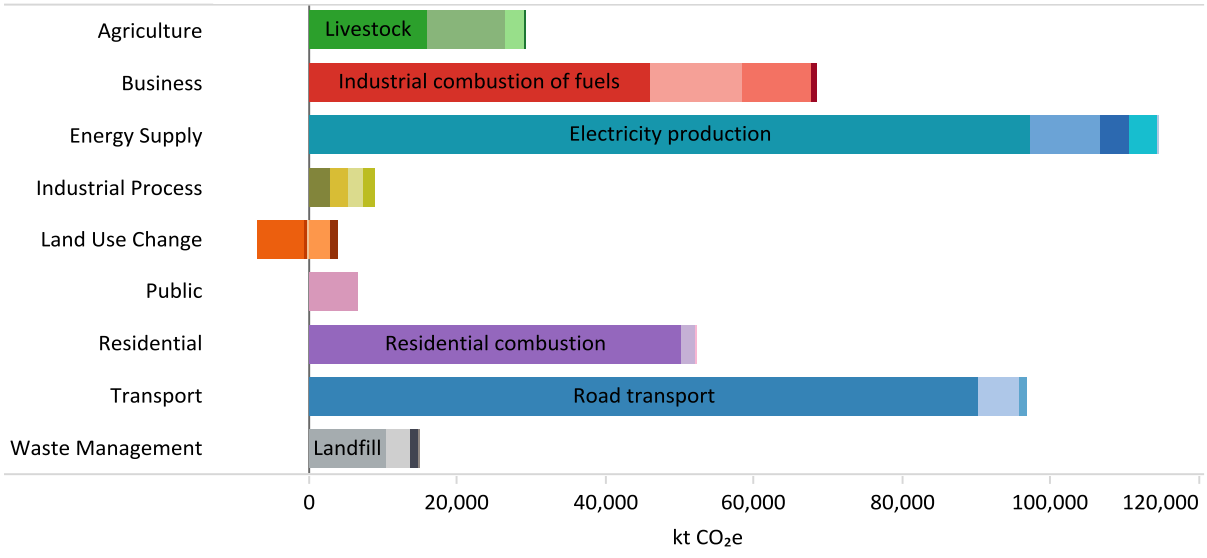
Carbon dioxide is the most common gas emitted for all National Communication (NC) categories except Agriculture and Waste. For Agriculture, methane from livestock and nitrous oxide from soils are dominant. For Waste Management, methane from landfills is the most important gas (see Figure 2.2).

Figure 2.2: Total GHG Emissions by NC and Pollutant, 2014, England



The dominant emission sources in 2014 include electricity production (25% of total GHG emissions), road transport (23%), residential combustion for heating and cooking (13%), and industrial combustion for heat and electricity in the Business sector (12%) as shown in Figure 2.3. The detailed breakdown of each sector can be found in the sector-specific sections of this report.

Figure 2.3: Total GHG Emissions Labelling the Largest Sub-Category in each NC, 2014, England



Trends

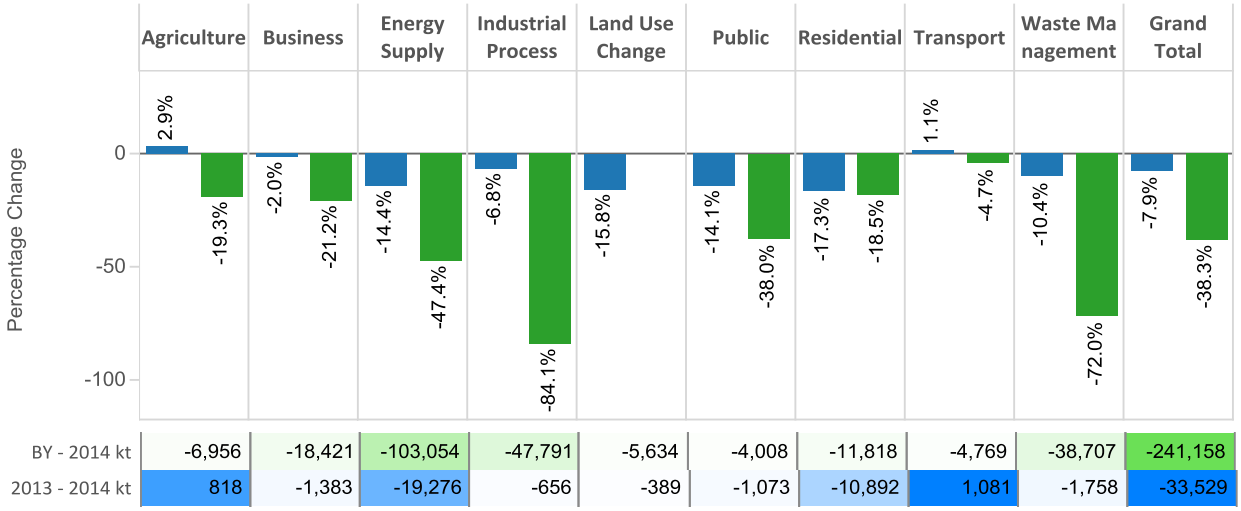
Figure 2.4 shows the change in emissions from the Base Year and 2013 to the latest year, 2014. Total GHG emissions for England show a steady decrease between the Base Year[13] and 2014 with an overall decrease of 38% over this time. The 2013 to 2014 decrease of emissions is predominantly driven by a reduction in the use of coal in the power generation sector and natural gas in the residential sector. The following list provides an overview of the trend for each NC sector:

- **Energy Supply**: Emissions have decreased by 47% between the Base Year and 2014. There was a 14% decrease in overall emissions between 2013 and 2014. This decrease was mainly due to a reduction in the use of coal in the power generation sector.
- **Industrial Process:** Emissions have decreased significantly since the Base Year by 84% mainly as a result of a declining chemical and fluorocarbon production industry. There was a 7% decrease in overall emissions between 2013 and 2014, primarily due to reduced emissions from the iron and steel industry.
- **Waste Management:** Emissions have significantly declined by 72% since the Base Year, largely due to the progressive introduction of methane capture and oxidation systems within landfill management. Emissions decreased by 10% between 2013 and 2014, primarily due to UK-wide reductions in methane emission estimates from landfill due to improved management systems.
- **Business:** Emissions have reduced by 21% since the Base Year as a result of reduced emissions in manufacturing industries (led by chemicals, non-ferrous metals and other manufacturing) through industrial decline and efficiency improvements. Emissions have recently remained relatively stable, decreasing by 2% between 2013 and 2014
- **Residential:** Emissions have decreased by 18% 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 2013 and 2014 decreased by 17%. This decrease is likely to be linked to higher annual average temperatures, and consequently a reduced energy demand from natural gas for residential heating.
- **Agriculture:** Emissions have reduced by 19% 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 an increase of 3% in emissions from 2013 to 2014 due mainly to an increase in the number of dairy cattle.
- **LULUCF:** This sector was a source of emissions between the Base Year and 2003 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 increased by 16% between 2013 and 2014 as a result of changes in emissions and removals from land converted to grassland (reduced emissions) and cropland (reduced emissions).
- **Transport:** Emissions have decreased by 5% between the Base Year and 2014 due to improvements in efficiency of transport vehicles despite growth in transport demand over the period. Emissions between 2013 and 2014 remained relatively stable increasing by only 1%.
- **Public:** Emissions have reduced by 38% since the Base Year. This is due to increased energy efficiency measures and the switch to gas-fired heating. Emissions between 2013 and 2014 decreased by 14%, primarily due to a decrease in natural gas consumption in 2014.

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

Figure 2.4: Percentage Change and Absolute (kt CO_2e) Change in GHG Emissions by NC: 2013 - 2014 and Base Year (BY) - 2014, England

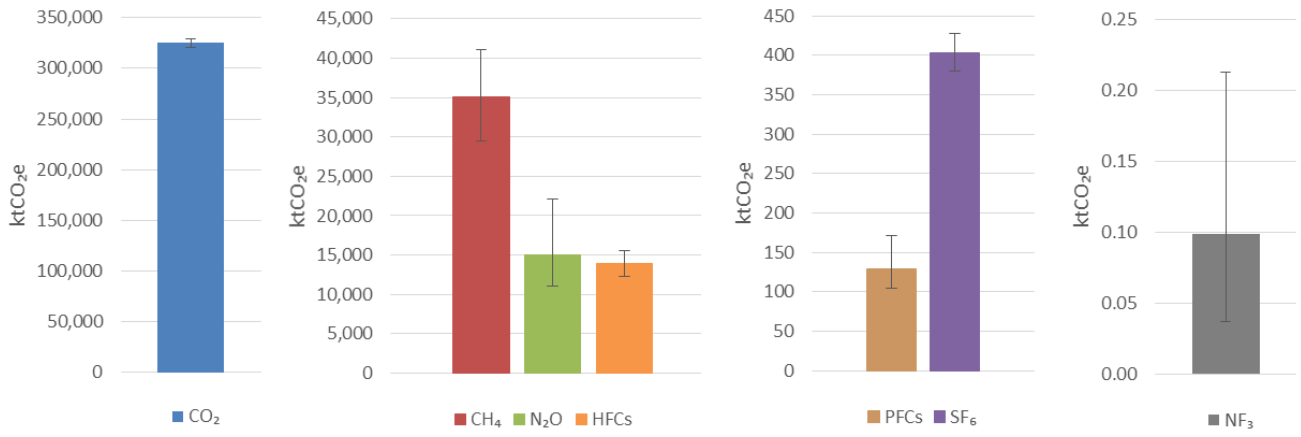
The LULUCF Base Year - 2014% change is excluded from the figure if LULUCF emissions changed from a sink to source, or source to sink, across the time series.



Uncertainty

The uncertainty of the England inventory is lower than that of the UK due to the highest overall contribution of carbon dioxide and a low contribution from GHGs with high uncertainty such as methane. Emissions are predominantly from combustion and industrial sources which have a low uncertainty associated with the estimates. Figure 2.5 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 Introduction and Appendix 1 for further details on uncertainties.

Figure 2.5: Total GHG emissions and uncertainties by pollutant, 2014, England



Recalculations

Revisions to the estimates since the last inventory report (Salisbury et al., 2015) have resulted in a 1.1% (5,261 $ktCO_2e$) decrease in the 2013 estimates for England. The most significant revisions to the 2013 estimates have been for the following sub-categories:

1. **Agriculture (3,360 $ktCO_2e$ decrease):** Emission factors for agricultural soil emissions have been updated to include the implementation of UK-specific N_2O emissions factors, which were previously based on standard non-UK specific values.
2. **Waste Management (1,095 $ktCO_2e$ decrease)**: New data on emission factors for domestic wastewater treatment have been implemented to align with the 2006 IPCC Guidelines (IPCC, 2006), and is the main cause for the decrease in emissions.
3. **LULUCF (1,585 $ktCO_2e$ decrease):** Correction to the CARBINE forest model has increased the sink and changes the trend of removals for Forest and Harvested Wood Products. The correction of the emissions factor for Grassland on drained organic soils has increased the sink for this category. Other revisions have led to minor changes in the Cropland, Wetlands and Settlements categories.

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

Traded and Non-Traded Emissions

Emissions from installations in the European Union Emissions Trading Scheme (EU ETS) contribute 36% of total GHG emissions in England in 2014. 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 EU ETS have shown a general decrease between 2008 and 2014 (see Figure 2.7). The decrease between 2010 and 2011 was due to a decrease in power demand. The increase in traded emissions within the Industry sector (see Figure 2.8) was due to increased emissions from iron and steel works.

Figure 2.6: Total Traded and Non-Traded GHG Emissions by NC Category, 2014, England

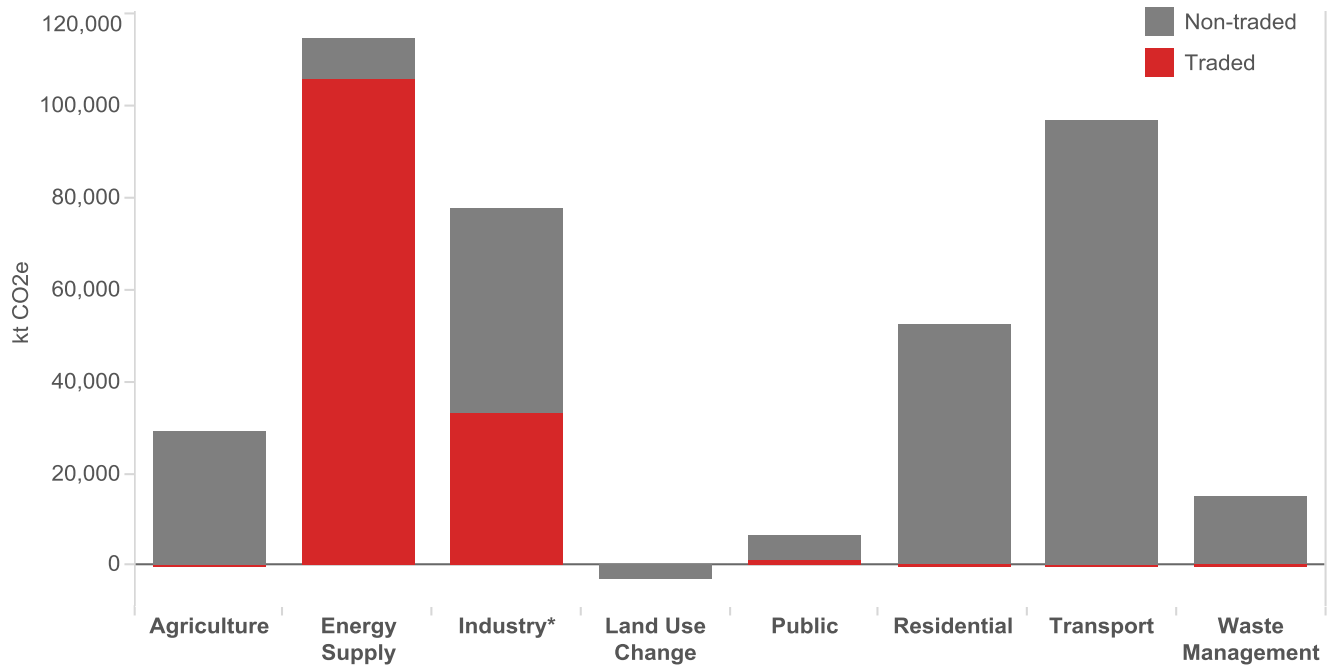


Figure 2.7: Total Traded and Non-Traded GHG Emissions 2008-2014, England

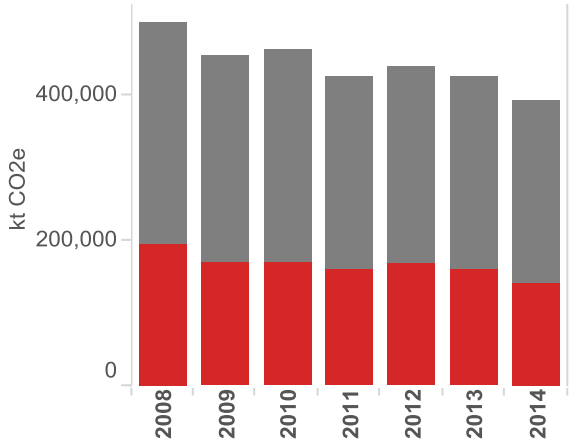
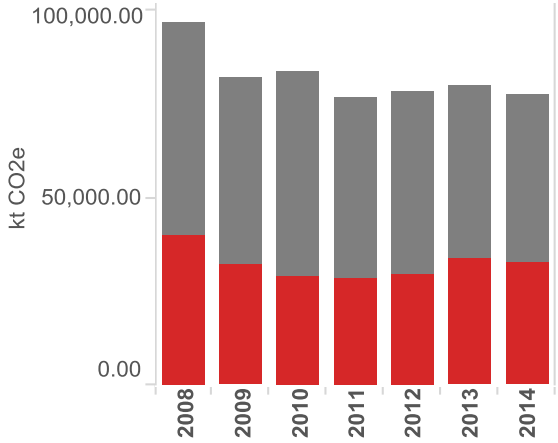


Figure 2.8: Traded and Non-Traded GHG Emissions from Industry 2008-2014, England*



* 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 2014, the Business sector had the highest contribution to England total emissions followed by the Transport and Residential 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 (407 $MtCO_2e$) compared to By Source (389 $MtCO_2e$) estimates for 2014.

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 sector.

Figure 2.9: Sankey diagram showing By Source and End User[14] GHG emission transfers for England in 2014 (Mt CO_2e)[15]

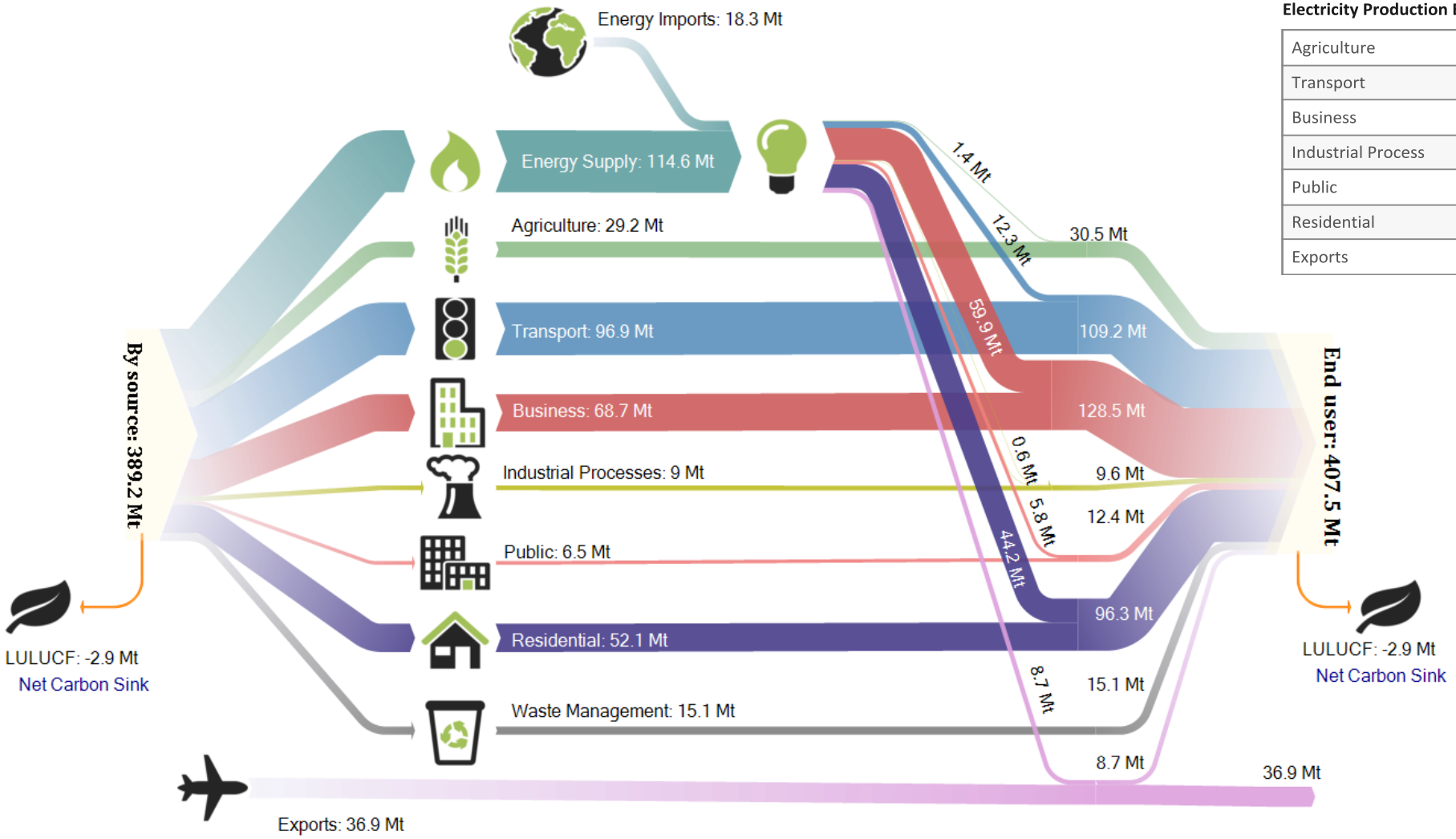


Table 2.2: NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions, England

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

[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 from the Energy Supply Sector to 2014 GHG Emissions, England

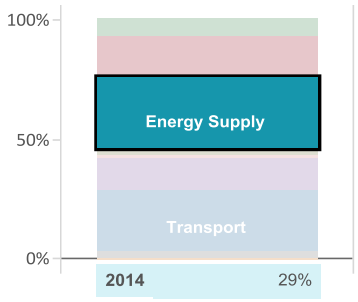


Figure 2.11: GHG Contribution to Energy Supply Sector Emissions, 2014, England

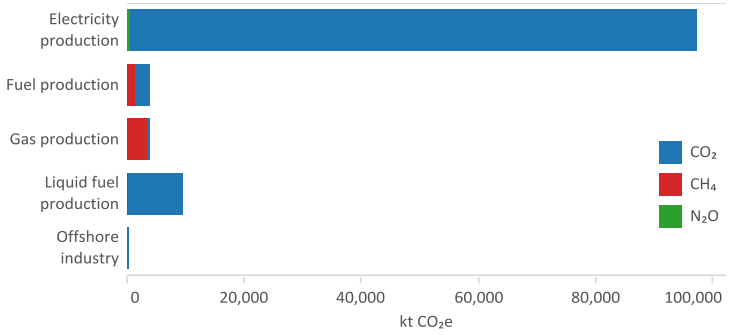


Figure 2.12: Total GHG Emissions from Energy Supply Sector, Base Year to 2014, England

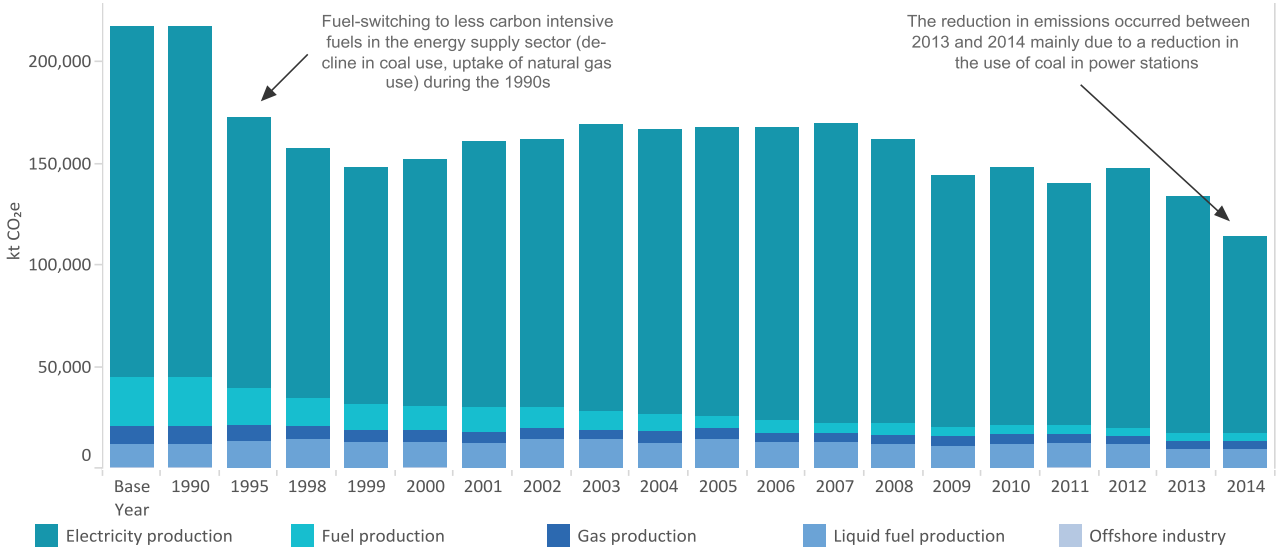


Table 2.3: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Energy Supply Sector, England

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Electricity production	-16.4%	-19,121.9	-43.7%	-75,614.8
Gas production	-3.8%	-149.8	-56.8%	-4,978.6
Liquid fuel production	0.8%	72.7	-18.0%	-2,086.1
Offshore industry	15.5%	24.8	-54.5%	-221.4
Fuel production	-2.6%	-101.3	-84.2%	-20,152.9
Energy Supply Sector Total	-14.4%	-19,275.6	-47.4%	-103,053.6

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

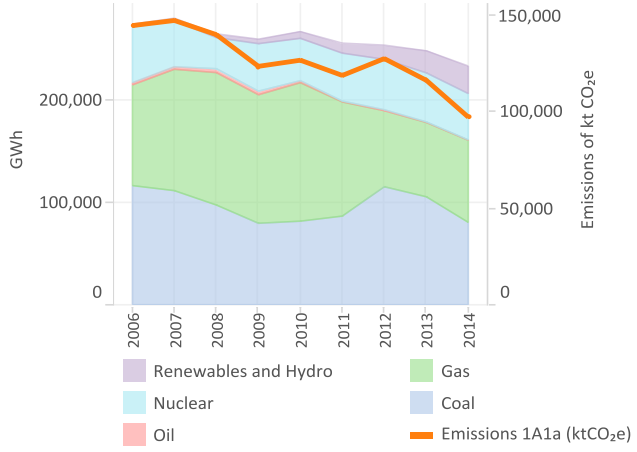


Figure 2.14: Traded and Non-Traded Energy Supply Sector Emissions, 2008-2014, England

By Source Emissions

Overview

Figures 2.10 – 2.14 show detailed emissions and trends for the Energy Supply sector. In England, Energy Supply contributes 29% to total 2014 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 85% of Energy Supply emissions in 2014; refinery emissions account for a further 8% of the Energy Supply sector emissions in 2014.

Features of the Trends

Table 2.3 shows the change in emissions between the Base Year and 2014, and between 2013 and 2014 for the sector. Energy Supply sector emissions have reduced by 47% between the Base Year and 2014 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 14% between 2013 and 2014, due mainly to a reduction in the use of coal 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.

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 95% of emissions from the Energy Supply sector in 2014 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 92% 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 2.2 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 from the Transport Sector to 2014 GHG Emissions, England

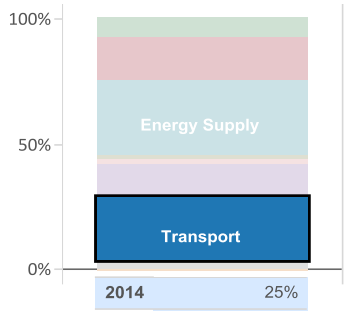


Figure 2.16: GHG Contribution for Transport Sector Emissions, 2014, England

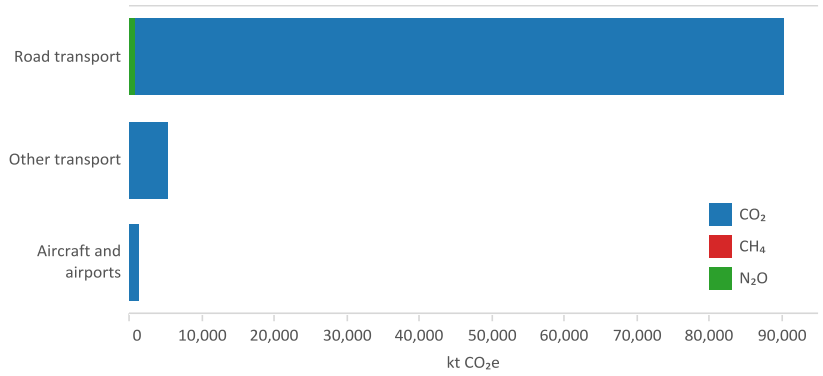


Figure 2.17: Total GHG Emissions from Transport Sector, Base Year to 2014, England

Table 2.4: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Transport Sector, England

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Road transport	1.4%	1,245.2	-2.7%	-2,495.7
Other transport	-2.1%	-114.1	-31.9%	-2,487.9
Aircraft and airports	-3.8%	-50.5	20.4%	214.6
Transport Sector Total	1.1%	1,080.6	-4.7%	-4,769.0

Figure 2.18 Road Transport CO_2 Emissions, England

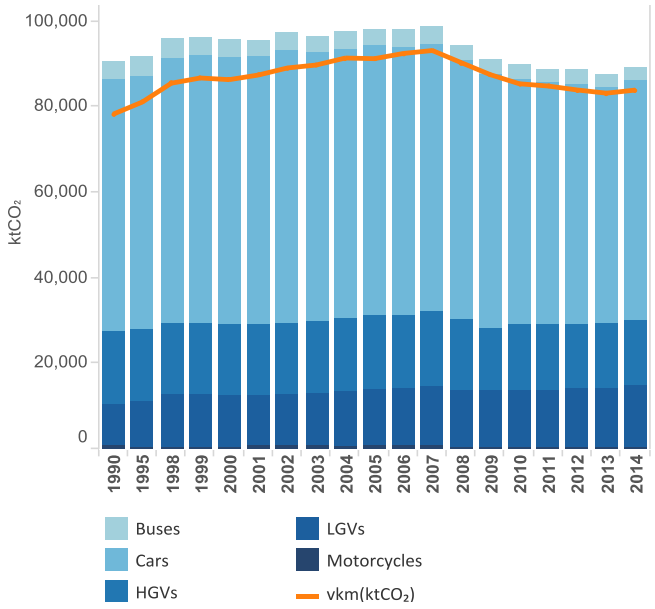
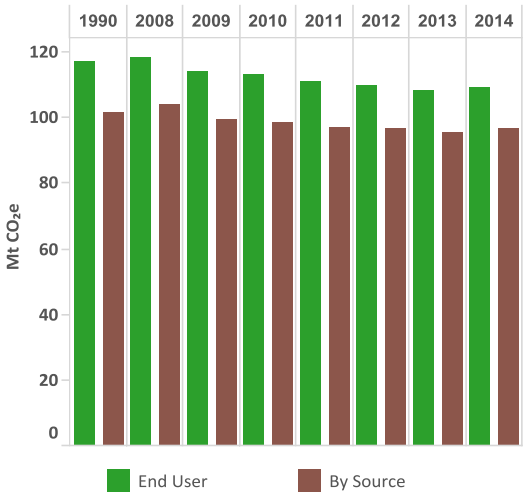


Figure 2.19: Comparison of End User and By Source for Transport Sector, England



By Source Emissions

Overview

Figures 2.15 – 2.19 show detailed emissions and trends for the Transport sector. Transport emissions accounted for 25% of England's total GHG emissions in 2014. Transport emissions are dominated by emissions from road transport (93% of all Transport emissions in 2014, with 58% 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 2014, and between 2013 and 2014 for the sector. Total GHG emissions from the Transport sector in England have decreased by only 5% between the Base Year and 2014 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. However, emissions have slightly increased by 1% between 2013 and 2014. Recent trends for the sector are due to increased emissions from diesel vehicles which were partially offset by a decrease in emissions from petrol vehicles.

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, 2015b); 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 2.18 shows 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. The differences between the two approaches have changed when comparing to last year's DA GHG inventory (Salisbury et al., 2015), resulting from a change in the methodology to estimate fuel consumption at the UK level. The differences are larger in the early part of the time series (14% in 1990) but gradually improve over the time (6% in 2014).

Emissions on an End User Basis

In 2014, 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 2.19) since 1990 shows a decline of 7% to 2014, 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 2.20: Overall Contribution from the Residential Sector to 2014 GHG Emissions, England

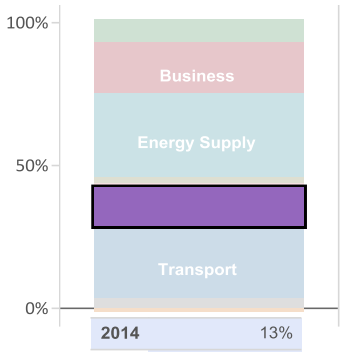


Figure 2.21: GHG Contribution for Residential Sector Emissions, 2014, England

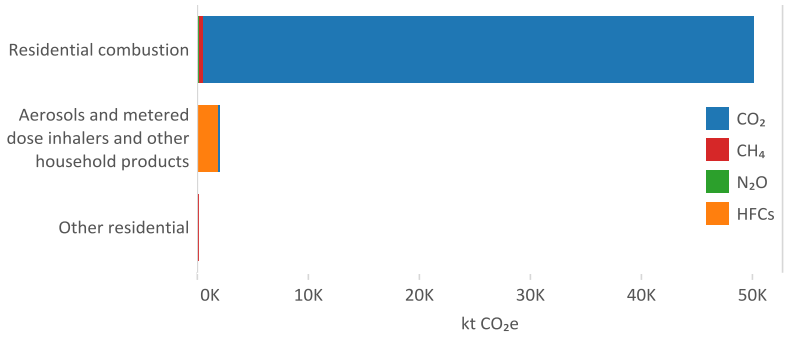


Figure 2.22: Total GHG Emissions from Residential Sector, Base Year to 2014, England

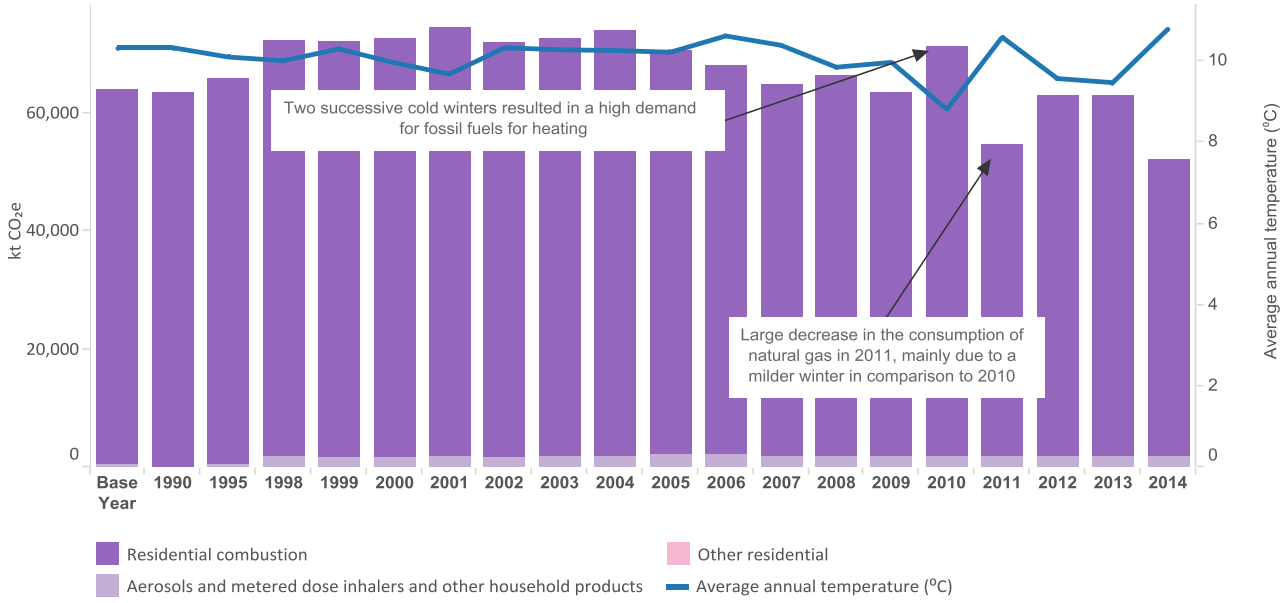
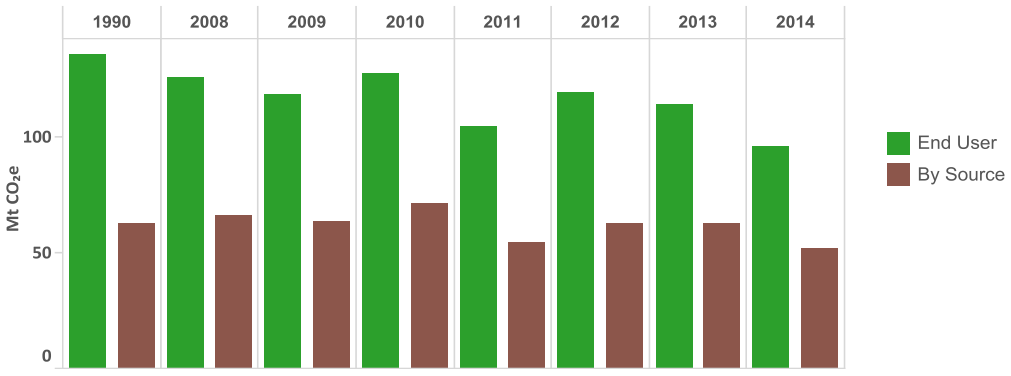


Table 2.5: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Residential Sector, England

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Aerosols and metered dose inhalers and other household products	1.8%	32.9	219.1%	1,264.6
Other residential	9.8%	3.0	123.6%	18.7
Residential combustion	-17.9%	-10,927.9	-20.7%	-13,101.4
Residential Sector Total	-17.3%	-10,892.1	-18.5%	-11,818.1

Figure 2.23: Comparison of End User and By Source for Residential Sector, England



By Source Emissions

Overview

Figures 2.20 – 2.23 show detailed emissions and trends for the sector. The Residential sector accounted for 13% of England's total GHG emissions in 2014. The sector comprises emissions from residential stationary and mobile combustion (96% of emissions for the residential sector) from activities such as heating and cooking, household products, accidental vehicle fires and hydrofluorocarbon (HFC) emissions from the use of aerosols and metered dose (usually asthma-related) inhalers. The majority of all residential GHG emissions (95%) are from the release of carbon dioxide from the direct combustion of fossil fuels.

Features of the Trends

Total GHG emissions from the Residential sector (Table 2.5) in England have decreased by 18% between the Base Year and 2014. A 17% reduction in emissions between 2013 and 2014 was mainly due to a reduction in domestic combustion of natural gas. The recent sector emission trends reflect mean annual temperatures, with a very cold year in 2010 and the warmest year since 2006 in 2014 (MetOffice, 2014).

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 2.23). This increases the overall significance of this sector in the End User inventory to 24% of the England total, compared to just 13% of the By Source inventory total.

The trend in Residential End User emissions since 1990 shows a decline of 29% to 2014 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. 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.

2.5 Business Sector

Figure 2.24: Overall Contribution from the Business Sector to 2014 GHG Emissions, England

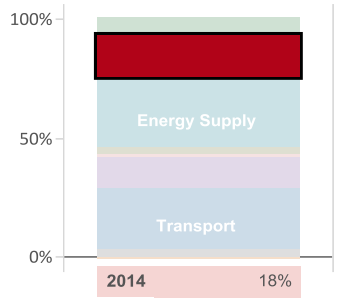


Figure 2.25: GHG Contribution for Business Sector Emissions, 2014, England

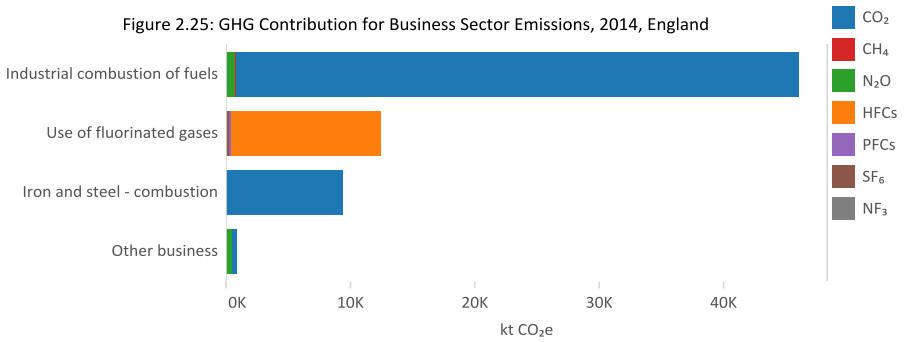


Figure 2.26: Total GHG Emissions from Business Sector, Base Year to 2014, England

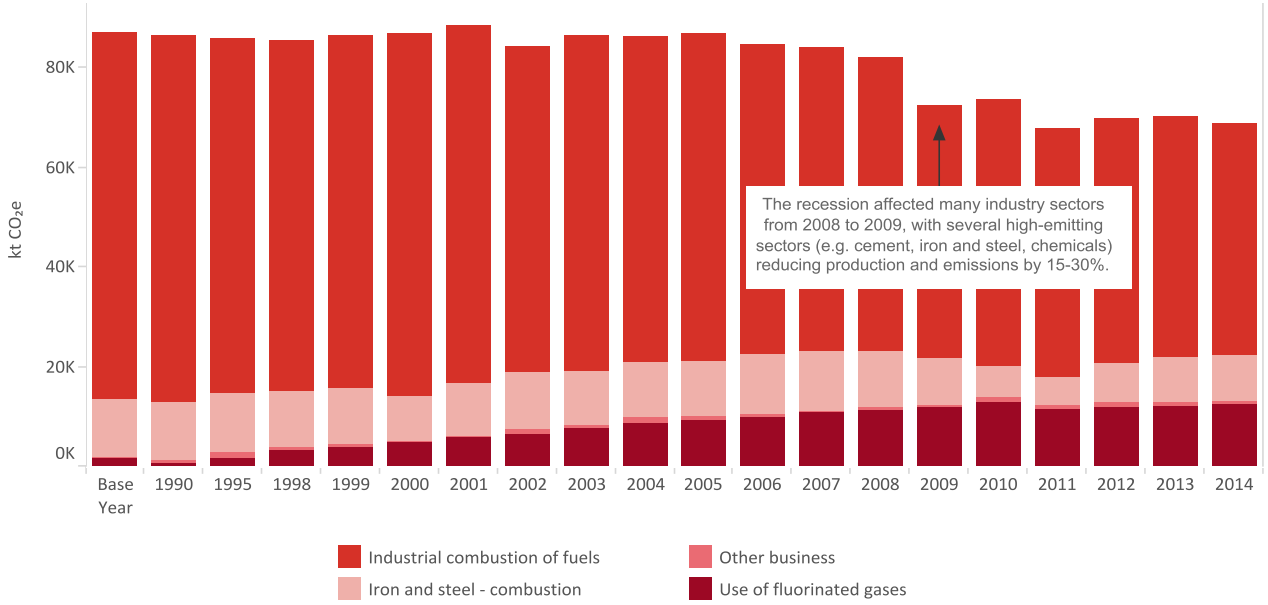
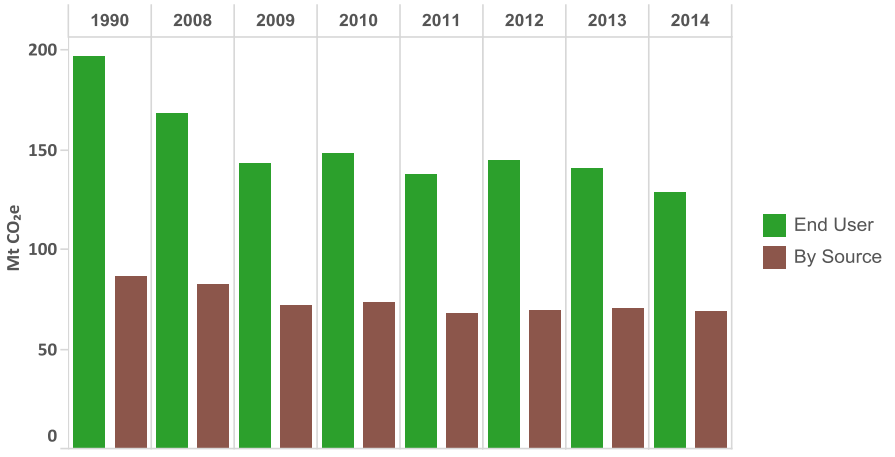


Table 2.6: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Business Sector, England

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Industrial combustion of fuels	-4.8%	-2,314.1	-37.3%	-27,418.6
Iron and steel - combustion	6.6%	578.8	-19.8%	-2,308.4
Use of fluorinated gases (including refrigeration and air conditioning)	1.7%	204.1	741.7%	10,920.8
Other business	21.4%	147.7	85.0%	384.9
Business Sector Total	-2.0%	-1,383.5	-21.2%	-18,421.4

Figure 2.27: Comparison of End User and By Source for Business Sector, England



By Source Emissions

Overview

Figures 2.24 – 2.27 show detailed emissions and trends for the sector. In England, the Business sector contributed 18% to total emissions in 2014. The sector in 2014 includes emissions from industrial combustion of fuels (67% of Business emissions, iron and steel fuel combustion (14% of Business emissions) and the use of fluorinated gases (18% of Business emissions). In 2014, 80% of emissions in the Business sector were carbon dioxide released from the combustion of fossil fuels with 18% from the release 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 21% from the Base Year to 2014 (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 from the use of fluorinated gases were negligible in 1990 and have risen to account for 18% of the sector total in 2014. This is due to the introduction of these gases as replacements to CFCs banned by the Montreal Protocol.

Emissions from the sector have increased between 2011 and 2013, caused mainly by an increase in the iron and steel sector as the Teesside plant resumed production in April, 2012. Emissions remained relatively stable between 2013 and 2014, decreasing by 2%, primarily due to a small reduction in the consumption of natural gas in the sector.

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 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 2014, England’s End User emissions for the Business sector were 187% 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 represented 32% of total emissions in 2014 compared to just 18% of the By Source inventory total.

2.6 Public Sector

Figure 2.28: Overall Contribution from the Public Sector to 2014 GHG Emissions, England

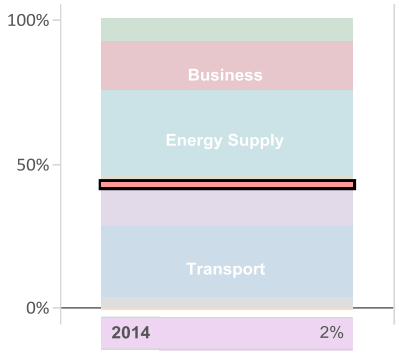


Figure 2.29: GHG Contribution for Public Sector Emissions, 2014, England

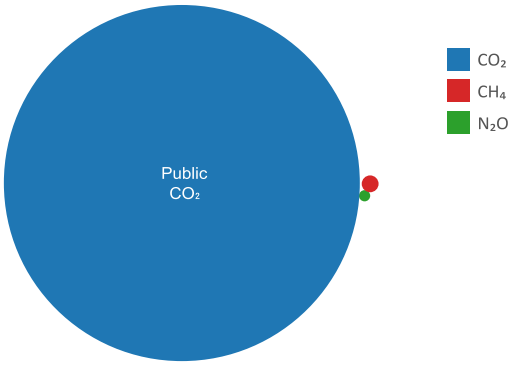


Figure 2.30: Total GHG Emissions from Public Sector, Base Year to 2014, England

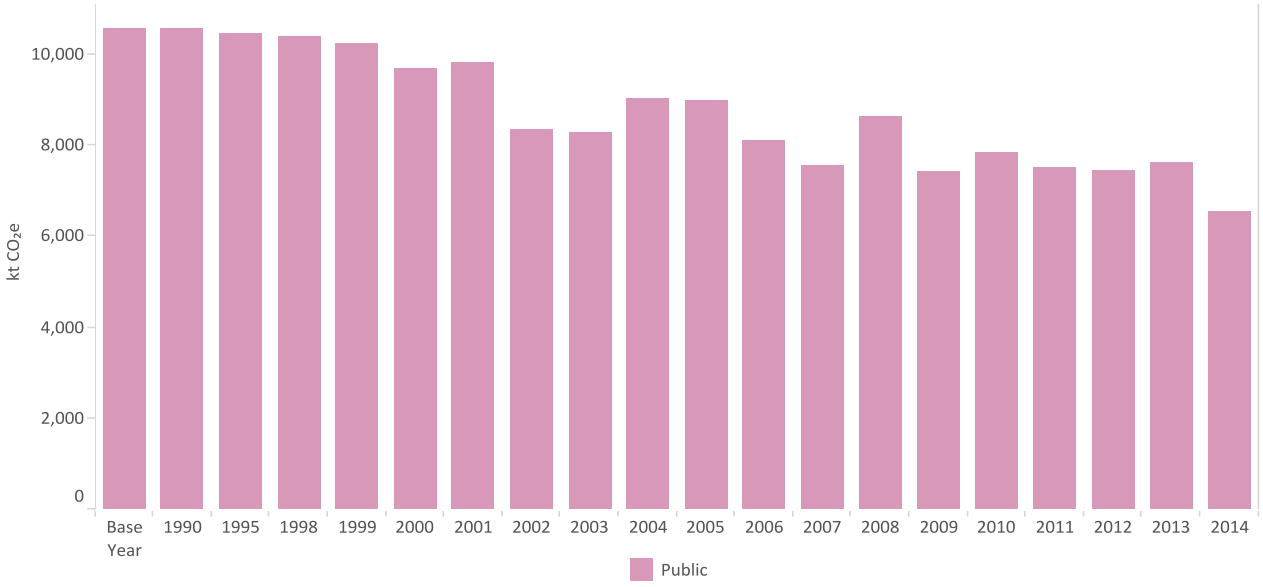
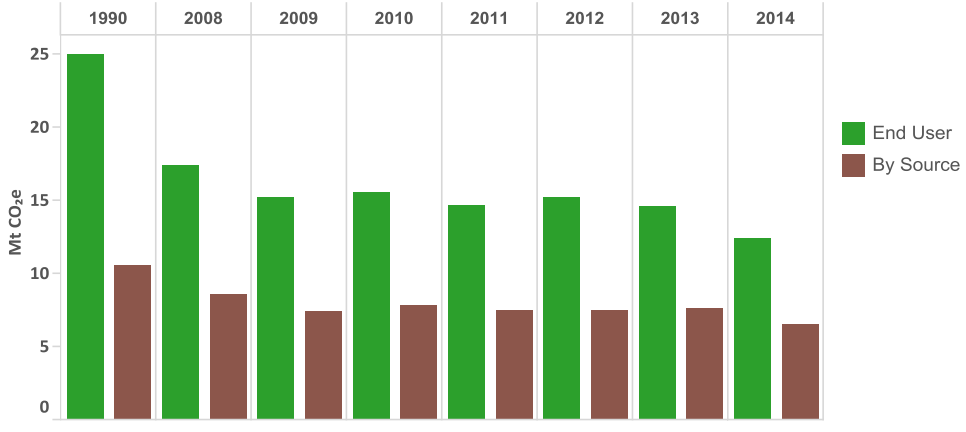


Table 2.7: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Public Sector, England

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Public	-14.1%	-1,073.1	-38.0%	-4,008.1
Public Sector Total	-14.1%	-1,073.1	-38.0%	-4,008.1

Figure 2.31: Comparison of End User and By Source for Public Sector, England



By Source Emissions

Overview

Figures 2.28 – 2.31 show detailed emissions and trends for the sector. Emissions from Public sector combustion account for 1.7% of GHG emissions in England in 2014. 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

Public sector emissions have reduced by 38% between the Base Year and 2014. Emissions have steadily decreased between the Base Year and 2013, however, a much greater reduction (14%) was seen between 2014 and 2013 compared to previous years (Table 2.7). This was due to a reduction in emissions from natural gas consumption.

Emissions on an End User Basis

In 2014, End User emissions for the Public sector were 189% of the By Source emission estimates (Figure 2.31), reflecting the high consumption of electricity in the sector. The sector's share of total emissions was 3% on an End user basis, compared to just 1.7% on a By Source basis. The trend in End User emissions since 1990 shows a decline of 51% to 2014.

2.7 Industrial Process Sector

Figure 2.32: Overall Contribution from the Industrial Process Sector to 2014 GHG Emissions, England

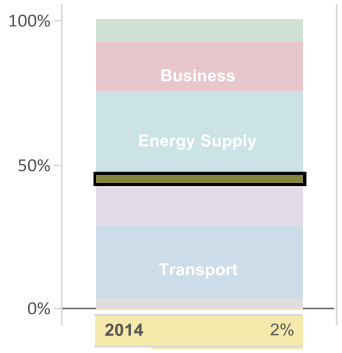


Figure 2.33: GHG Contribution for Industrial Process Sector Emissions, 2014, England

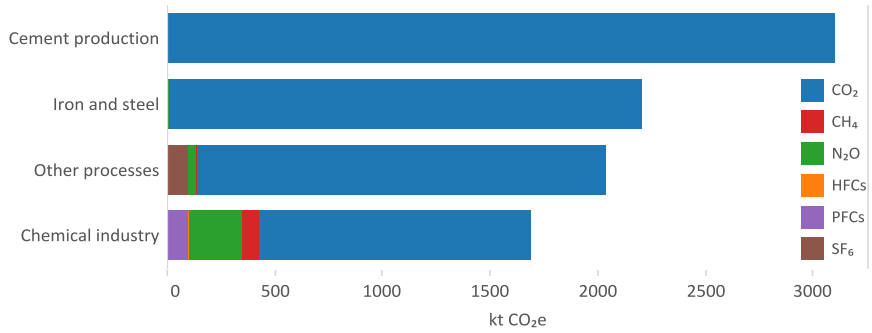


Figure 2.34: Total GHG Emissions from Industrial Process Sector, Base Year to 2014, England

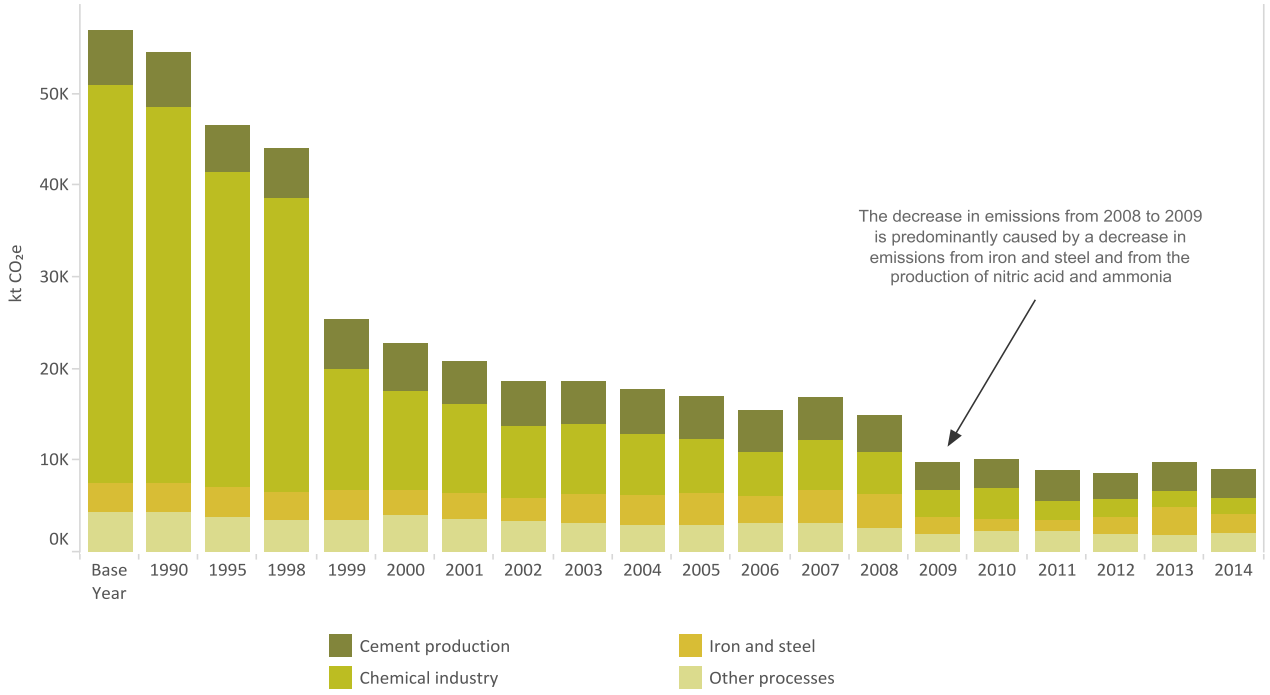


Table 2.8: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Industrial Process Sector, England

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Cement production	1.5%	45.7	-46.5%	-2,692.6
Other processes	3.5%	69.0	-53.8%	-2,371.4
Chemical industry	-6.7%	-121.4	-96.1%	-41,841.1
Iron and steel	-22.8%	-649.4	-28.7%	-885.6
Industrial Process Sector Total	-6.8%	-656.1	-84.1%	-47,790.8

By Source Emissions

Overview

Figures 2.32 – 2.34 show detailed emissions and trends for the sector. The Industrial Process sector contributes 2.3% to total 2014 GHG emissions in England. The Industrial Process sector includes non-combustion sources such as the use of limestone in cement production (34% of total sector emissions); iron and steel processes excluding the use of electricity and fossil fuels for heating processes (24% of total sector emissions; chemical production including fertilizers and other bulk chemicals (19% of total sector emissions); other processes including lime production (23% of total sector emissions).

In 2014, 94% of total GHG emissions for the sector were from emissions of carbon dioxide from processes (primarily cement and iron and steel production). 2.2% of total GHGs emissions are from the use and production of F-Gases, predominantly from the use of HFCs in refrigeration and air conditioning.

Features of the Trends

Industrial Process sector emissions in England have reduced by 84% since the Base Year to 2014 (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 decreased from 2013 to 2014 by 7% primarily due to reduced output from the iron and steel industry as well as decreasing emissions from the cement and lime 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 2014, the End User estimates are 7% 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 2.35: Overall Contribution from the Agriculture Sector to 2014 GHG Emissions, England

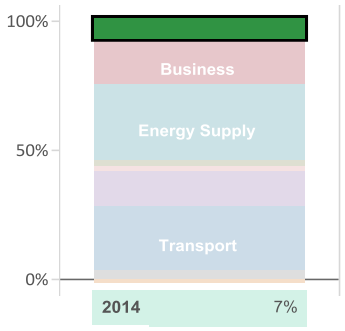


Figure 2.36: GHG Contribution for Agriculture Sector Emissions, 2014, England

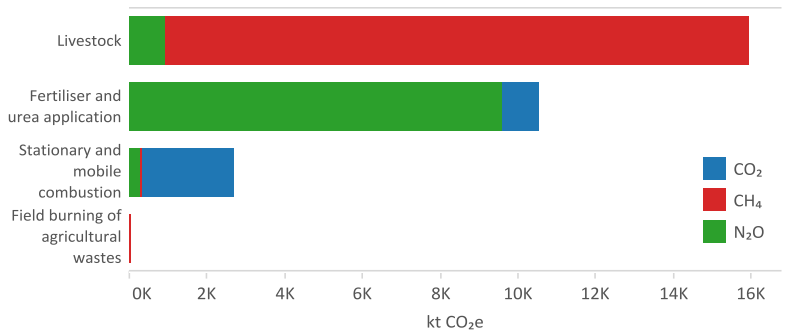


Figure 2.37: Total GHG Emissions from Agriculture Sector, Base Year to 2014, England

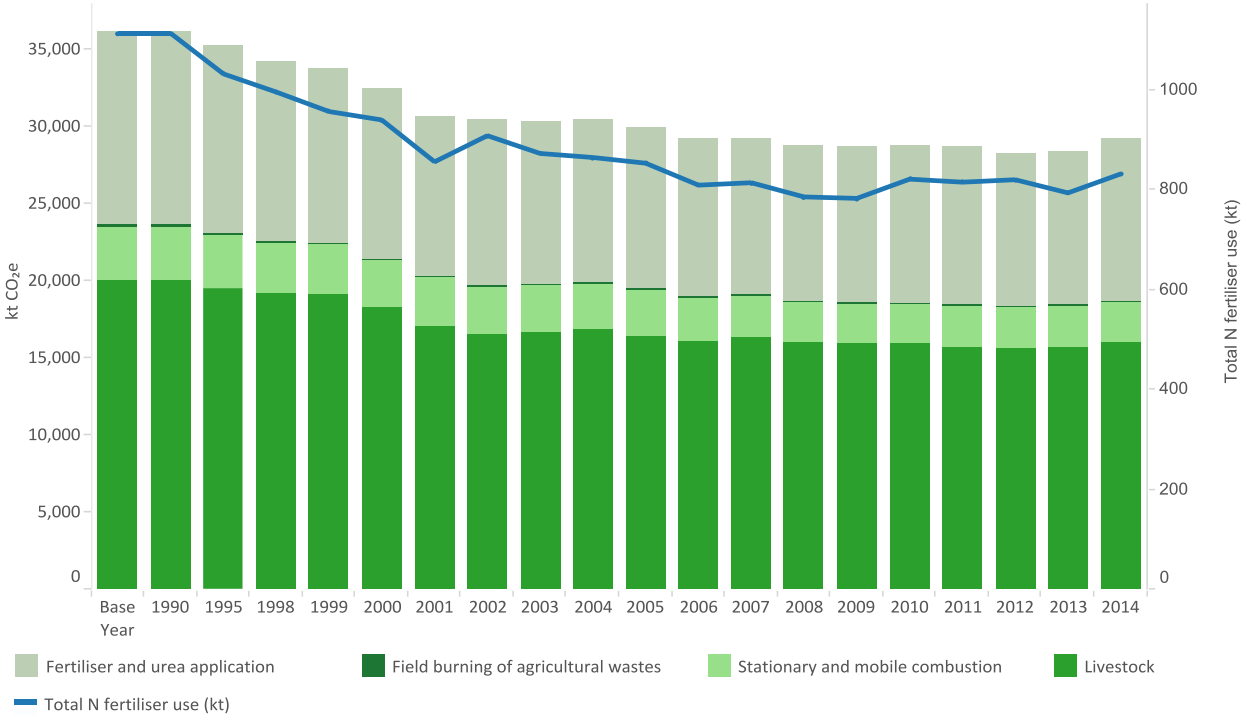
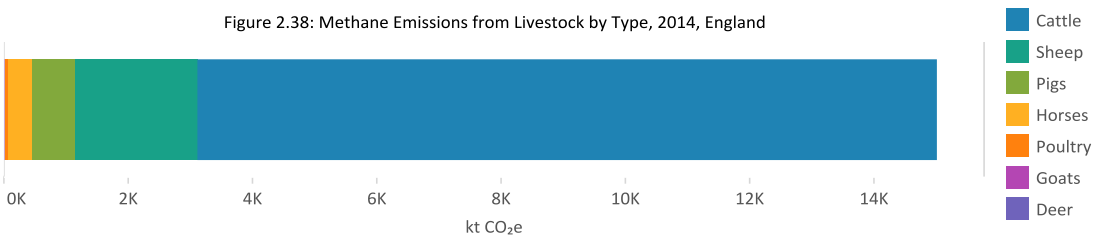


Table 2.9: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Agriculture Sector, England

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Fertiliser and urea application	6.5%	644.7	-15.3%	-1,899.3
Field burning of agricultural wastes	N/A	0.0	-100.0%	-246.7
Livestock	1.5%	240.0	-20.1%	-4,004.8
Stationary and mobile combustion	-2.4%	-66.7	-23.1%	-805.6
Agriculture Sector Total	2.9%	818.0	-19.3%	-6,956.4

Figure 2.38: Methane Emissions from Livestock by Type, 2014, England



By Source Emissions

Overview

Figures 2.35 – 2.38 show detailed emissions and trends for the sector. The Agriculture sector contributed 7% to total 2014 GHG emissions in England. GHG emissions from this sector comprise mainly of methane (52%) from livestock including enteric fermentation and management of manure, nitrous oxide (37%) from fertilizer application to soils including management of manure (related to handling of manure before it is added to the soil), with a smaller amount of carbon dioxide (11%) from agricultural combustion and agrochemical use.

Features of the Trends

Overall emissions from the Agriculture sector have reduced by 19% since the Base Year (Table 2.9). Methane emissions from agriculture are largely dependent on the number of livestock and have fallen by 21% from 1990 to 2014, mainly due to a decline in cattle and sheep numbers. Nitrous oxide emissions from agriculture have fallen by 15% from 1990 to 2014 resulting from a general decline in livestock numbers and in fertiliser nitrogen use.

Total agricultural emissions from 2013 to 2014 for nitrous oxide and methane have increased by 5% and 2%, respectively. Increases in nitrous oxide emissions between 2013 and 2014 are driven by increased emissions from agriculture soils. Whereas, increased methane emissions are driven by an increase in the number of dairy cattle in England.

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 79% of the total agricultural methane emissions in 2014. Total emissions from sheep made up 13% of the total methane from agriculture in 2014.

Nitrous oxide emissions are largely driven by fertiliser nitrogen use, manure applications and grazing returns to soils. 89% of nitrous oxide emissions from agriculture arise from the agricultural soils category (see Figure 2.36). 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).

Emissions on an End User Basis

As 91% of emissions in the Agriculture sector in 2014 were not due to energy consumption, agriculture sector emissions on an End User basis are very similar to the emissions By Source; in 2014, 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.

2.9 Land Use, Land Use Change and Forestry Sector

Figure 2.39: Overall Contribution from the Land Use Change Sector to 2014 GHG Emissions, England

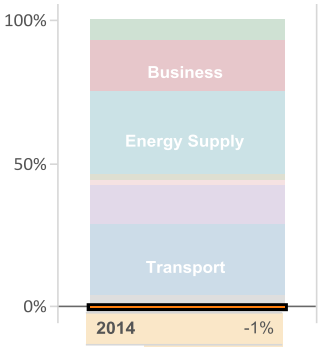


Figure 2.40: GHG Contribution to Land Use Change Sector Emissions, 2014, England

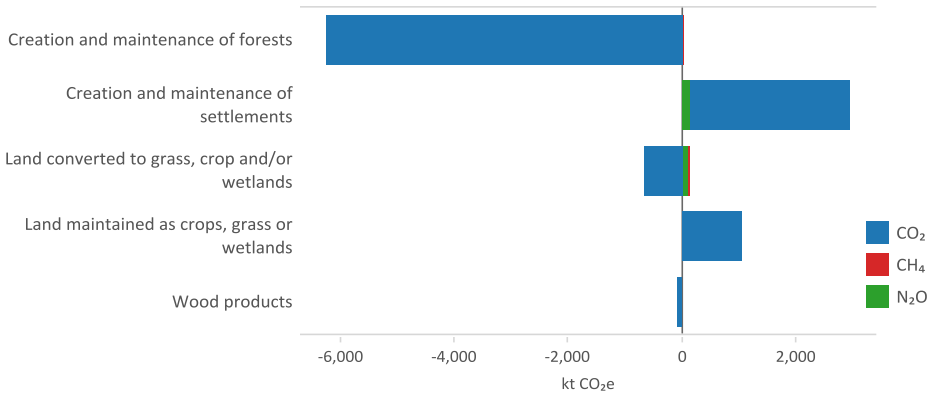


Figure 2.41: Total GHG Emissions from LULUCF Sector, Base Year to 2014, England

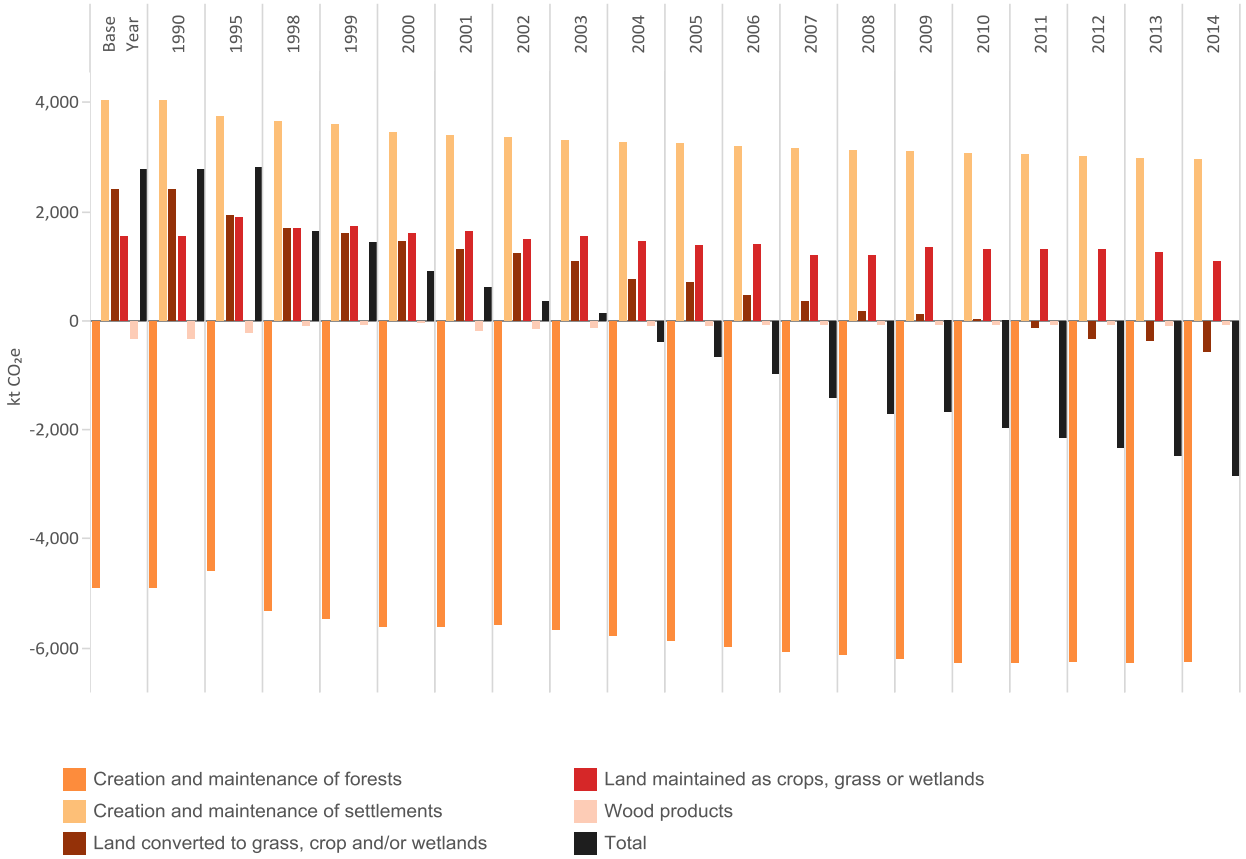


Table 2.10: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the LULUCF Sector, England

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Creation and maintenance of settlements	-0.8%	-25.1	-27.0%	-1,092.9
Creation and maintenance of forests	0.5%	28.9	-27.7%	-1,355.3
Land converted to grass, crop and/or wetlands	-62.0%	-211.8	N/A	-2,939.6
Land maintained as crops, grass or wetlands	-15.2%	-191.1	-31.2%	-483.1
Wood products	11.5%	9.9	75.6%	236.7
Land Use Change Sector Total	-15.8%	-389.3	N/A	-5,634.1

By Source Emissions

Overview

Figures 2.39 – 2.41 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 2014. In the Base Year England was a net source of emissions from LULUCF changing to a net sink in 2004.

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 2.10 shows a 16% increase in the net removal of CO_2e from LULUCF between 2013 and 2014 (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. The creation and maintenance of forests has continued to be a significant sink across the time series.

Land Converted to Grass, Crop and Wetlands has decreased significantly due to a reduction in the amount of Land Converted from Forest/ Grassland to Cropland (which releases carbon from clearing of biomass and from ploughing of soils) while removals as a result of land converted to grassland and Creation and maintenance of forests (which allows carbon to build-up and be stored in the soils and biomass) 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 relate 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 2.42: Overall Contribution from the Waste Management Sector to 2014 GHG Emissions, England

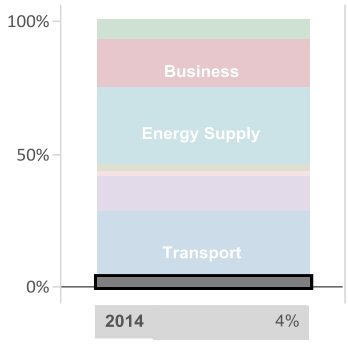


Figure 2.43: GHG Contribution for Waste Management Sector Emissions, 2014, England

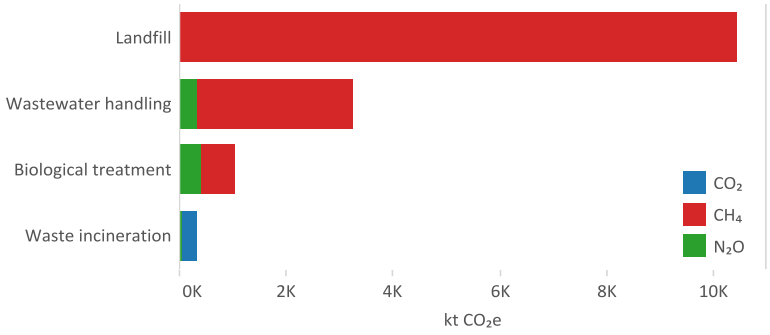


Figure 2.44: Total GHG Emissions from Waste Management Sector, Base Year to 2014, England

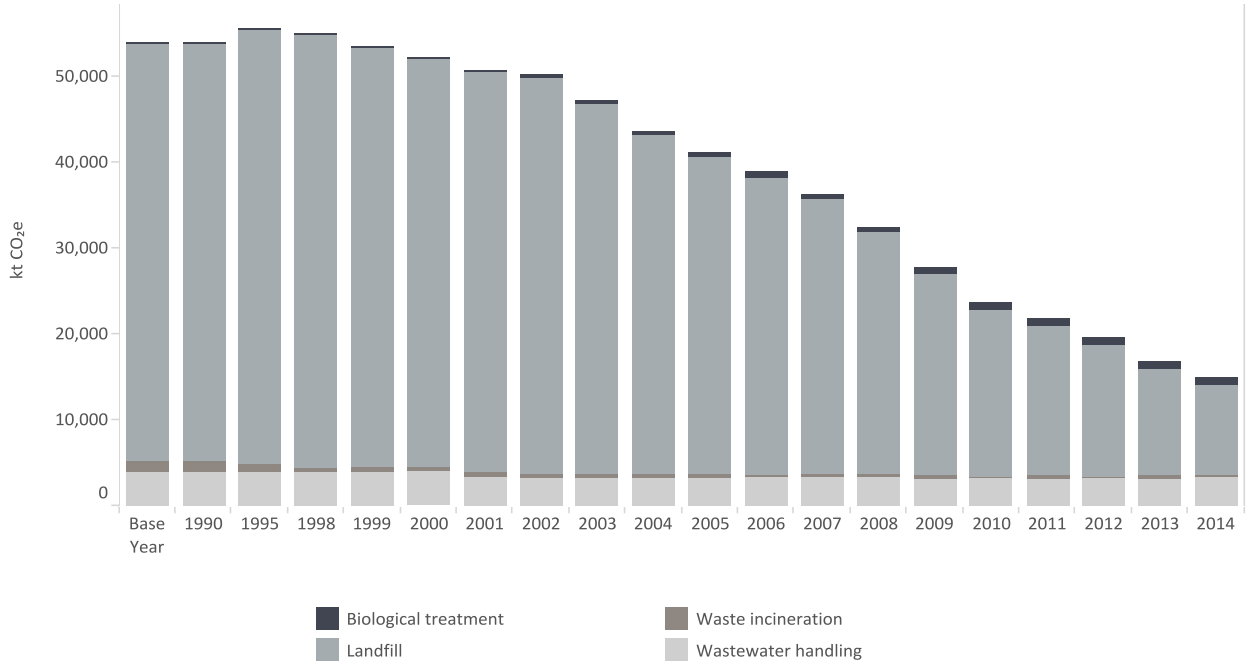


Table 2.11: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Waste Management Sector, England

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Landfill	-16.1%	-2,004.7	-78.5%	-38,096.3
Waste incineration	-5.2%	-17.7	-76.4%	-1,040.1
Wastewater handling	5.4%	166.3	-15.9%	-614.0
Biological treatment	10.4%	98.3	N/A	1,043.6
Waste Management Sector Total	-10.4%	-1,757.9	-72.0%	-38,706.8

By Source Emissions

Overview

Figures 2.42 – 2.44 show detailed emissions and trends for the sector. The Waste Management sector contributes 4% to total GHG emissions in England, and is the second largest source sector for methane emissions after Agriculture, representing 40% of total methane emissions in 2014. Emissions from this sector are dominated by methane from landfill (69% in 2014), with a smaller contribution of emissions of methane and nitrous oxide from wastewater treatment (22% in 2014).

The majority of emissions from this sector are methane (93% in 2014). Nitrous oxide emissions from wastewater treatment represent 2% of emissions in the sector, and contribute 2% to the total emissions of nitrous oxide in England in 2014.

Features of the Trends

Table 2.11 shows the change in emissions between the Base Year and 2014, and between 2013 and 2014 for the sector. Emissions of GHGs from the Waste Management sector in England have shown a significant decline of 72% in total for the sector and by 78% from landfill between 1990 and 2014, due largely to the progressive introduction of methane capture and oxidation systems within landfill management. Sector GHG emissions have decreased between 2013 and 2014 by 10%, 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 (1990-2014)

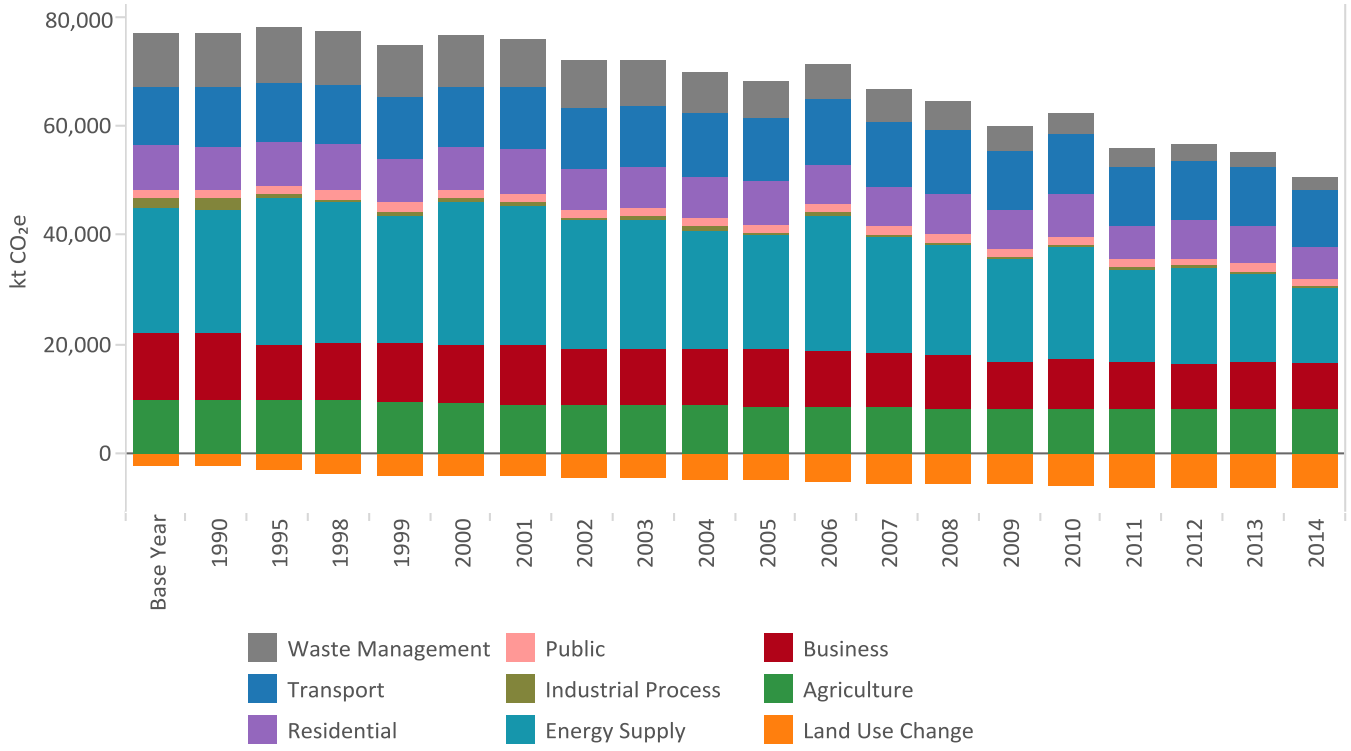
3.1 Overview of Total Emissions

By Source Emissions

Overview

The greenhouse gas (GHG) emissions for Scotland for 1990 – 2014 are presented in Figure 3.1 and in Table 3.1 below.

Figure 3.1: Total GHG Emissions by NC Category for Base Year to 2014, as kt CO_2e, Scotland



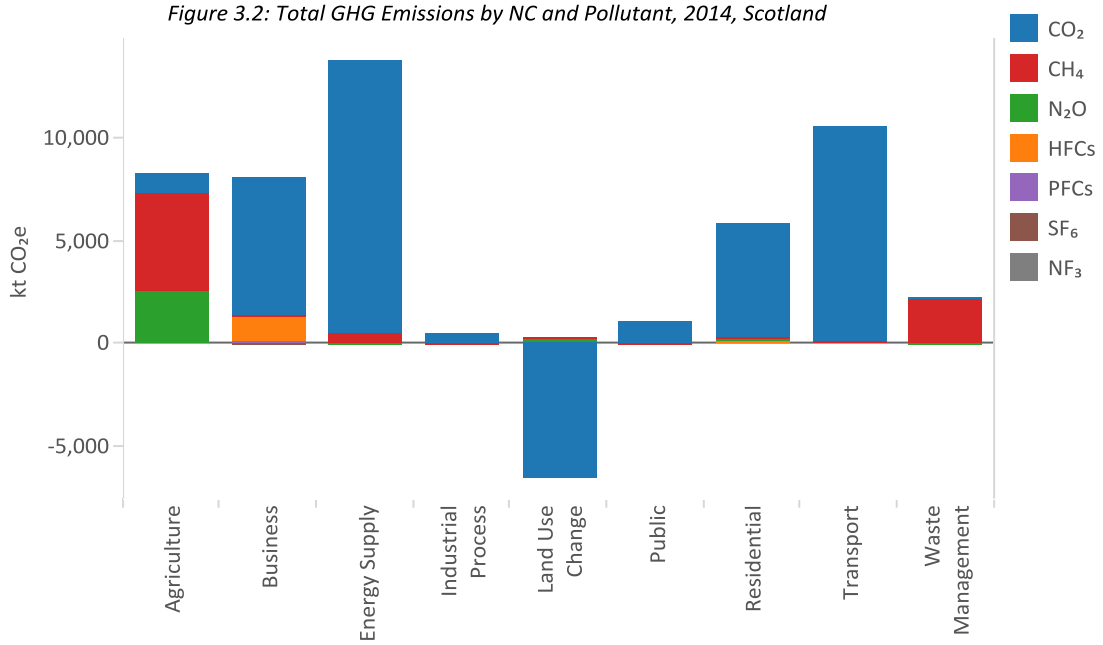
The table below includes a summary of emissions from International Aviation and Shipping; the subsequent tables and figures and the discussion of trends and percentage shared by sector do not include emissions from these sectors.

Table 3.1: 1990-2014 Scotland GHG Emission Inventory ($ktCO_2e$)

NC Format	Base Year	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	% of 2014	BY-2014
Agriculture	9,654	9,654	9,683	9,341	8,789	8,194	8,257	8,243	8,218	8,169	8,344	8,295	19%	-14%
Business	12,496	12,393	10,401	10,584	10,540	9,947	8,751	8,951	8,616	8,440	8,693	8,110	18%	-35%
Energy Supply	22,774	22,774	26,845	26,282	20,739	20,154	18,758	20,868	17,000	17,493	15,983	13,848	31%	-39%
Industrial Process	1,852	1,920	574	594	543	526	404	391	450	444	498	540	1%	-71%
LULUCF	-2,337	-2,337	-2,886	-4,002	-4,991	-5,662	-5,716	-5,865	-6,189	-6,238	-6,173	-6,206	-14%	166%
Public	1,683	1,683	1,802	1,639	1,498	1,465	1,241	1,309	1,249	1,240	1,251	1,073	2%	-36%
Residential	8,008	7,950	7,798	7,790	7,623	7,399	7,118	7,959	6,211	7,046	7,035	5,883	13%	-27%
Transport	10,736	10,736	10,724	11,054	11,613	11,512	11,045	10,872	10,642	10,671	10,589	10,646	24%	-1%
Waste Management	9,835	9,835	10,070	9,060	6,897	5,270	4,505	3,765	3,452	3,058	2,564	2,237	5%	-77%
Sub-total	**74,700**	**74,607**	**75,013**	**72,343**	**63,250**	**58,805**	**54,364**	**56,492**	**49,648**	**50,322**	**48,785**	**44,426**	**100%**	**-41%**
International aviation & shipping	2,558	2,558	2,587	2,370	2,605	3,062	2,883	2,505	2,604	2,389	2,337	2,278		-11%
Total	**77,257**	**77,165**	**77,600**	**74,712**	**65,856**	**61,867**	**57,247**	**58,998**	**52,253**	**52,711**	**51,122**	**46,704**		**-40%**

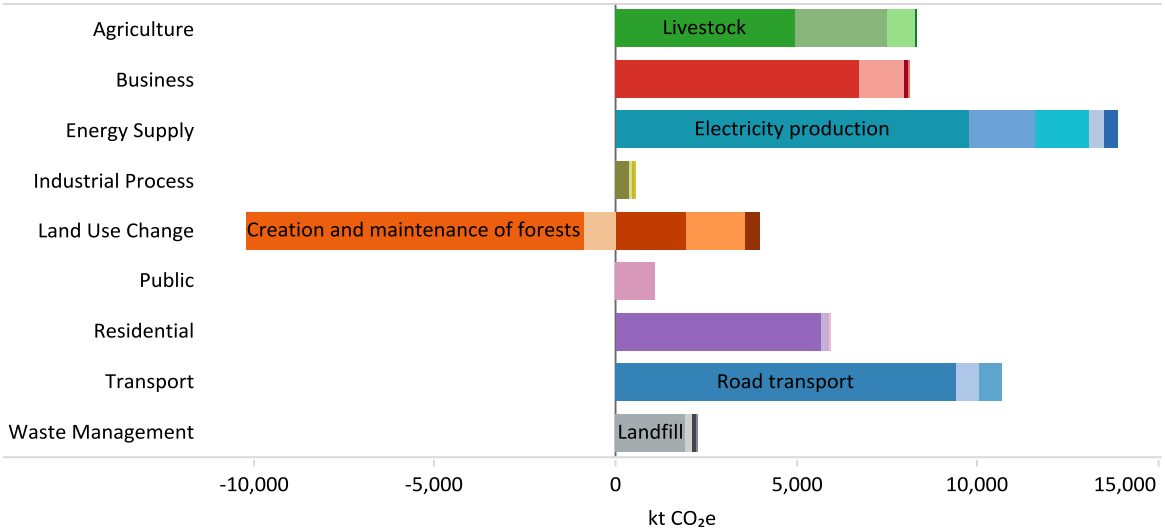
Carbon dioxide emissions make up the largest component of all National Communication (NC) sector emissions with two exceptions: Agriculture, where methane from livestock and nitrous oxide from soils make large contributions, and Waste Management where methane from landfills is the main GHG emission source (see Figure 3.2).

Figure 3.2: Total GHG Emissions by NC and Pollutant, 2014, Scotland



The dominant sub-categories in the inventory for 2014 are displayed in Figure 3.3. These include emissions from electricity production (22% of total), road transport (21% of total), industrial combustion for heat and electricity in the Business sector (15% of total), Residential combustion for heating and cooking (13% of total) as well as the significant sink from the removal of emissions from the creation and maintenance of forests. The detailed breakdown of each sector can be found in the sector-specific sections of this report.

Figure 3.3: Total GHG Emissions Labelling the Largest Sub-Category in each NC, 2014, Scotland



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 3.4, which also shows the change in emissions. This considers the change from 2013 to 2014 as well as the overall trend: 1990-2014.

As indicated in these graphs and the table above, emissions in Scotland have decreased between 2013 and 2014 by 9%, with emission reductions between the Base Year[17] and 2014 of 41% for all GHGs. Net emission reductions are the result of many factors from across the economy, including: reduction in the use of natural gas in the residential sector, 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.

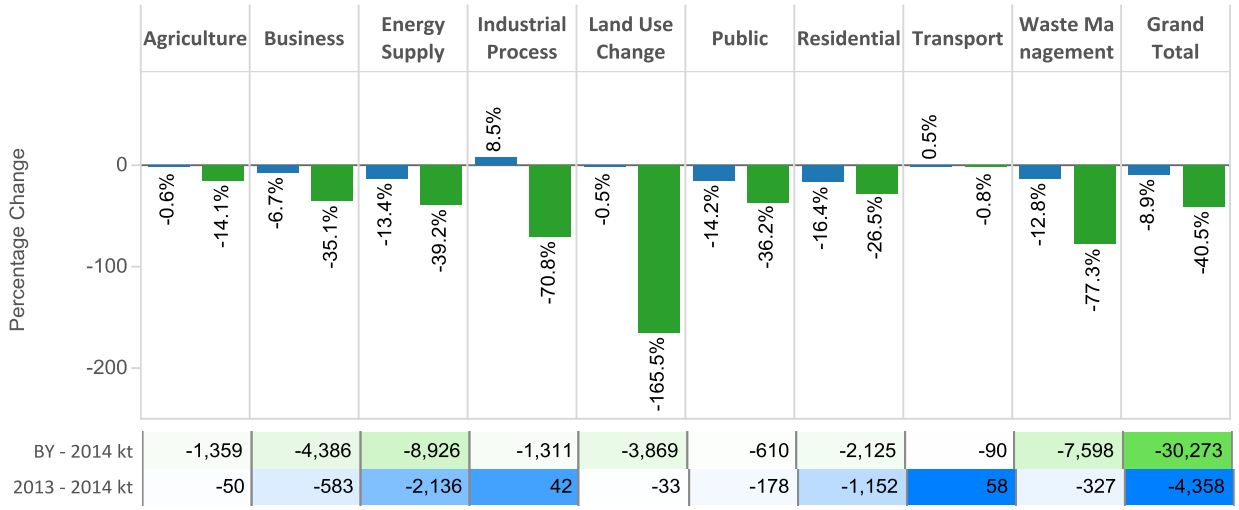
The 2013 to 2014 decrease of emissions is predominantly driven by a reduction in the use of natural gas in the residential and power generation sectors. The following list provides an overview of the trend for each NC sector:

- **Energy Supply:** Emissions have decreased by 39% between the Base Year and 2014. Emissions reduced by 13% between 2013 and 2014, primarily due to a general reduction in total power generation, specifically a reduction in the use of natural gas.
- **Waste Management:** Emissions have significantly decreased by 77% since the Base Year, largely due to the progressive introduction of methane capture and oxidation systems within landfill management. Emissions decreased by 13% between 2013 and 2014 due to reductions in landfill methane emissions.
- **Business:** Emissions have declined since the Base Year by 35% mainly from significant reductions in the iron and steel industry. Emissions decreased between 2013 and 2014 by 7% due to a decrease in emissions from natural gas for industrial/commercial combustion.
- **LULUCF:** This sector has been a net sink since 1990, and this sink has generally increased across the time series (small reductions in the size of the sink are seen in 2000 and 2003). 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. There has been a small increase in the size of the sink between 2013 and 2014 (less than 1%), predominantly due to a reduction in emissions from grassland converted to cropland.
- **Agriculture:** Emissions have reduced since the Base Year mainly due to a decrease in livestock numbers. There was a decrease of less than 1% in emissions from 2013 to 2014 due to small decreases in fertilizer use and urea application which offset the small increase in livestock numbers.
- **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 8% between 2013 and 2014, due to increased emissions from the production of cement and aluminium.
- **Residential:** Emissions have decreased by 27% since the Base Year as a result of improvements to energy efficiency and fuel switching from solid and liquid to gaseous fuels. Emissions decreased by 16% between 2013 and 2014 due to reduced emissions from natural gas for domestic combustion.
- **Public:** Emissions have reduced by 36% 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 2013 and 2014 decreased by 14% due to a decrease in emissions from natural gas combustion in the public sector.
- **Transport:** Emissions have decreased by only 1% between the Base Year and 2014. Improvements in efficiency of transport vehicles have been offset by a growth in transport demand over the period. Emissions between 2013 and 2014 remained relatively stable increasing by less than 1%.

[17] 1995 for fluorinated greenhouse gases (F-Gases) and 1990 for all other gases

Figure 3.4: Percentage Change and Absolute (kt CO_2e) Change in GHG Emissions by NC: 2013 - 2014 and Base Year (BY) - 2014, Scotland

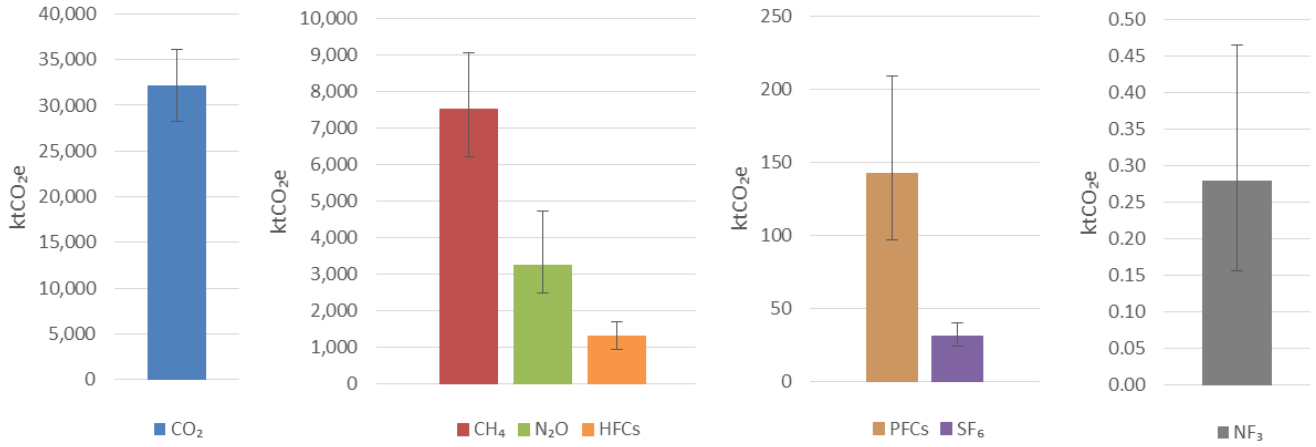
The LULUCF Base Year - 2014% change is excluded from the figure if LULUCF emissions changed from a sink to source, or source to sink, across the time series.



Uncertainty

Due to a greater contribution from sources and sinks with significant uncertainties, the Scottish inventory is higher in overall uncertainty than the UK inventory. For example, a higher contribution from LULUCF sources, methane and nitrous oxide, which have higher levels of uncertainty, contribute to making the overall emissions estimates more uncertain. Figure 3.5 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 the Introduction and Appendix 1 for further details on uncertainties.

Figure 3.5: Total GHG emissions and uncertainties by pollutant, 2014, Scotland



International Aviation and International Shipping

Emissions from international aviation in the UK have increased by 112% since 1990, and Scotland shows a similar trend increasing by 124% over that period. This reflects the growth in aviation and the increase in international routes. From 2013 to 2014, emissions from international flights have increased slightly across the UK, by less than 1%, whilst emissions in Scotland have increased by 6% reflecting the recent growth in international flight movements.

UK emissions from international shipping have decreased by 13% between 1990 and 2014 whilst emissions from Scotland have decreased by 47% over this time period. The UK shows a 9% decrease in international shipping emissions between 2013 and 2014, and Scotland emissions have decreased by 10%, reflecting the continued decline in Scotland's port freight movements.

Recalculations

Inventory recalculations of source estimates due to new data or improved inventory estimation methodologies have led to revisions to the estimates since the last inventory report (Salisbury et al., 2015). The impact of these revisions to Scotland GHG emission estimates for 2013 is a decrease of 1,839 $ktCO_2e$ (3.47%). The most significant revisions to the 2013 estimates in each sector are given below:

1. **LULUCF (-974 $ktCO_2e$)**: The CARBINE model output for Forestry and Harvested Wood Products has been corrected. The emissions factor for Grassland on drained organic soil has been revised which increases the sink in the Grassland category. Other revisions have resulted in small changes in the Cropland, Wetland and Settlements categories.
2. **Agriculture (-819 $ktCO_2e$)**: Implementation of UK-specific N_2O emission factors for grazing (pasture, range and paddock) of livestock. Previously these values were based on a standard non-UK specific value.
3. **Waste Management (-139$ktCO_2e$):** Recalculations in this sector are mainly due to an update to the emission factor for domestic wastewater treatment to align with international guidelines. In addition, there was an update to using 2006 IPCC calculation methodology for calculating methane formation and also updates to the activity data for composting of municipal solid waste in order to be consistent with the figures used in LULUCF calculations.
4. **Business (86 $ktCO_2e$):** Recalculations in this sector are due to changes in DUKES. This includes an increase in gas oil use in off-road machinery and a reduction in natural gas use in the commercial/industrial sector.
5. **Exports (-66 $ktCO_2e$):** Small recalculations have occurred due to changes in DUKES.

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

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 2014. The main contributors to these traded emissions are the Energy Supply, Business and Industrial Process sectors.

Figure 3.7 shows the share of traded emissions in the overall Scottish inventory. The peak in traded emissions in 2010 is primarily due to an increase in power generation EU ETS emissions, whilst the decline in traded emissions from 2013 to 2014 (where traded emissions dropped by 12.5%) is driven primarily by a 14% reduction in emissions from power stations and a 16% decline in refinery emissions in 2014.

Figure 3.6: Total Traded and Non-Traded GHG Emissions by NC Category, 2014, Scotland

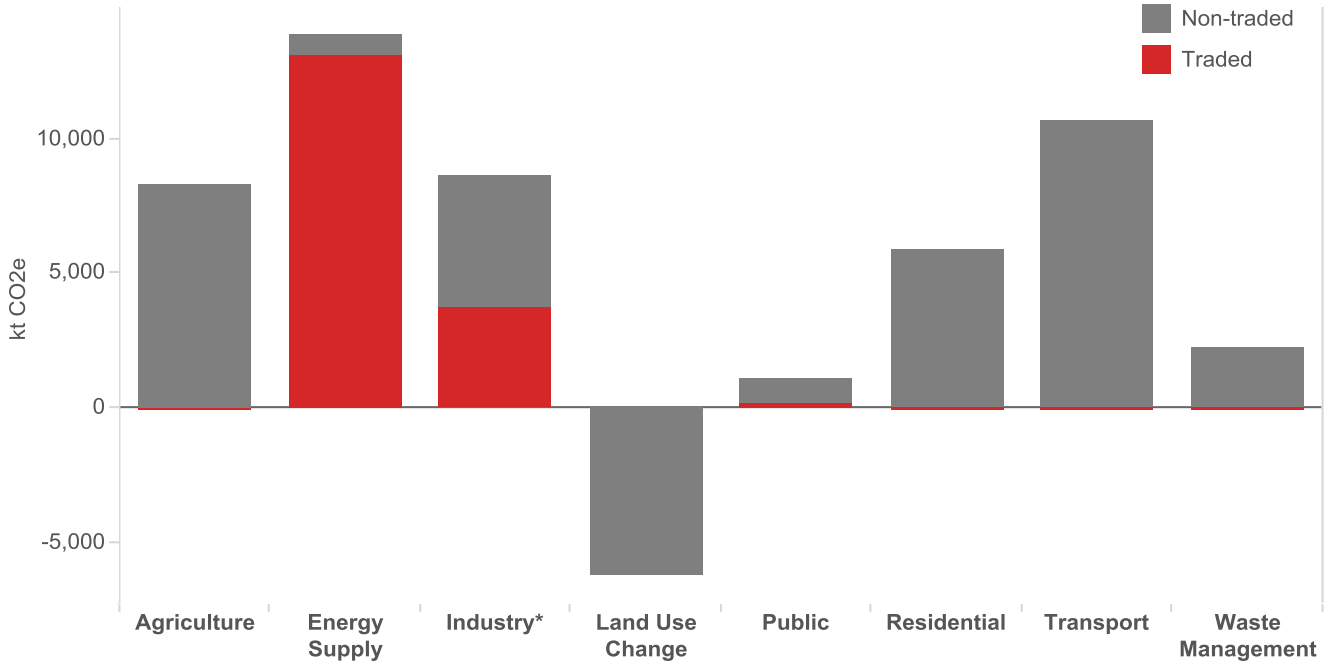


Figure 3.7: Total Traded and Non-Traded GHG Emissions 2008-2014, Scotland

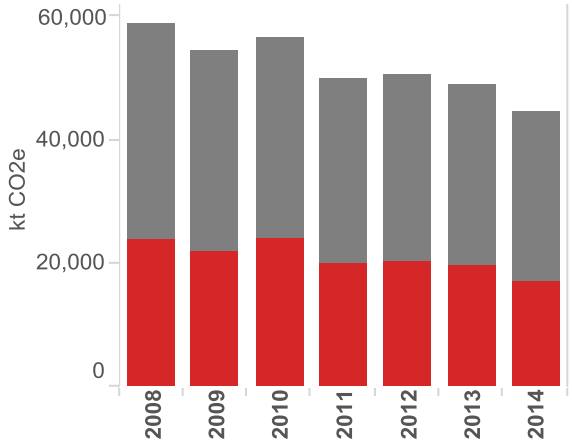
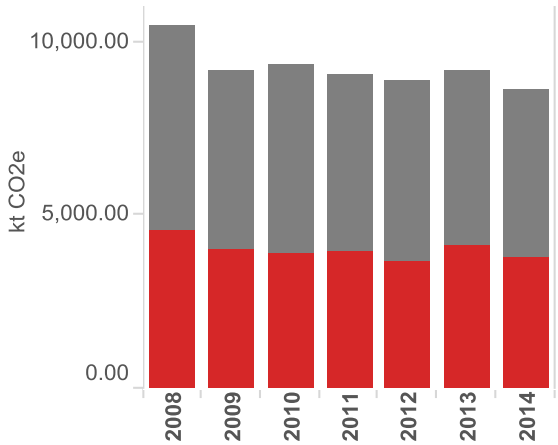


Figure 3.8: Traded and Non-Traded GHG Emissions from Industry 2008-2014, Scotland*



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

Emissions on an End User Basis

In addition to presenting emissions data 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 (45.9 $MtCO_2e$), compared to the By Source inventory estimates for 2014 (44.4 $MtCO_2e$). 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 less than 1% 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. The greenhouse gas emissions ($ktCO_2e$) per unit of electricity (GWh) in Scotland are very much lower than the UK average in 2014 due to the higher proportion of renewable and nuclear generation in the Scotland power sector. Emissions from the Land Use, Land Use Change and Forestry (LULUCF), Industrial Process and Waste Management sectors in Scotland in 2014 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[18] GHG emission transfers for Scotland in 2014 (Mt CO_2e)[19]

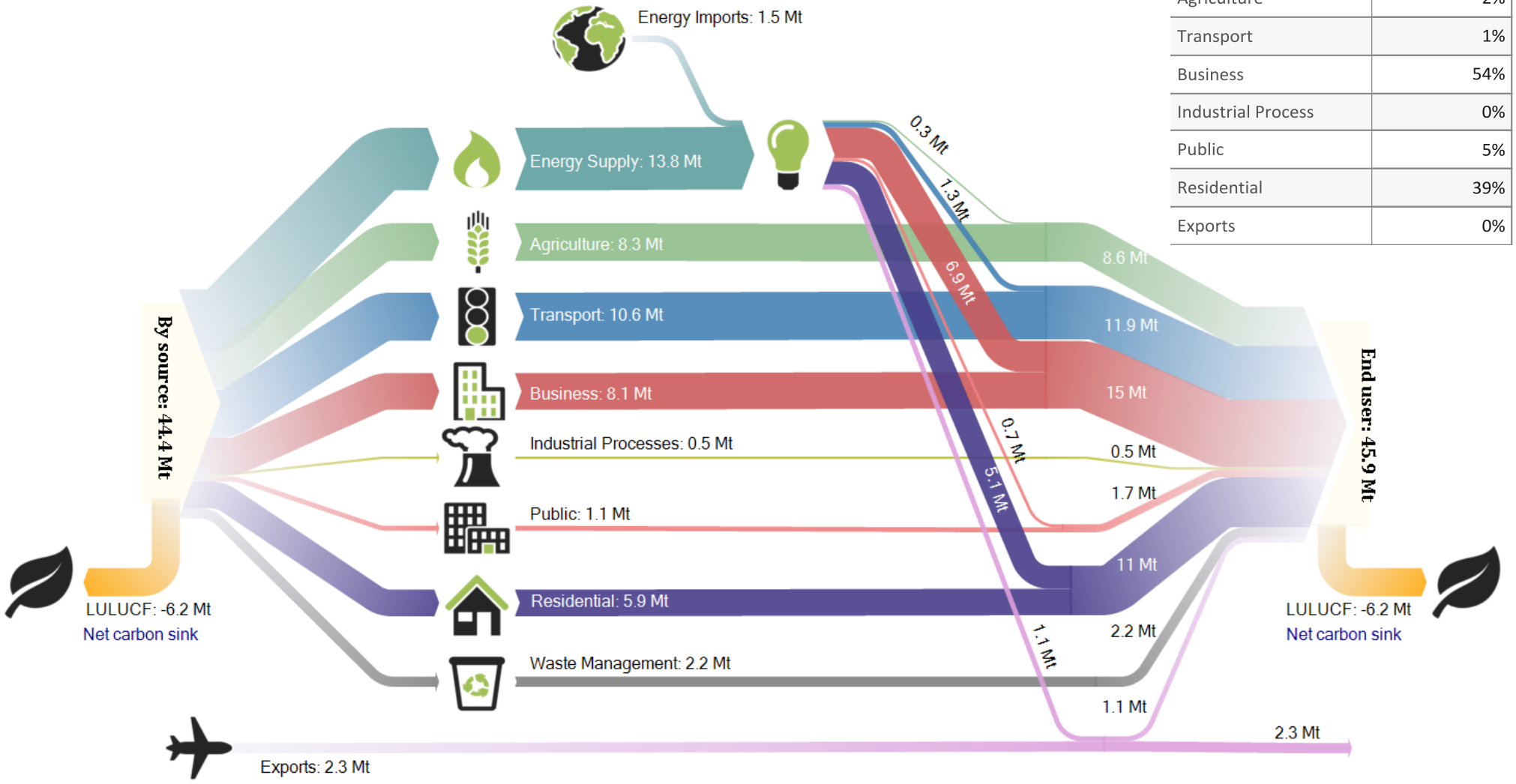


Table 3.2: NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions, Scotland

Agriculture	2%
Transport	1%
Business	54%
Industrial Process	0%
Public	5%
Residential	39%
Exports	0%

[18] 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.

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

3.2 Energy Supply Sector

Figure 3.10: Overall Contribution from the Energy Supply Sector to 2014 GHG Emissions, Scotland

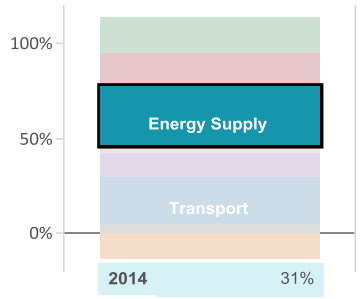


Figure 3.11: GHG Contribution to Energy Supply Sector Emissions, 2014, Scotland

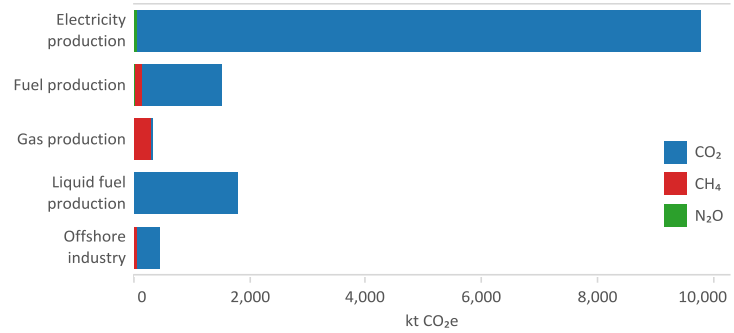


Figure 3.12: Total GHG Emissions from Energy Supply Sector, Base Year to 2014, Scotland

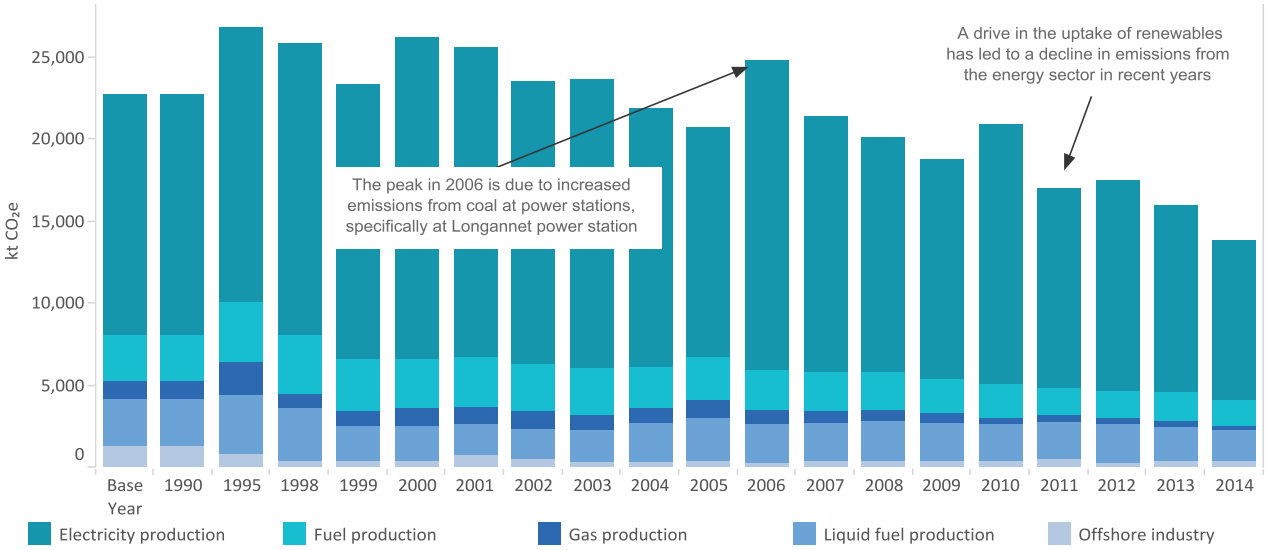


Table 3.3: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Energy Supply Sector, Scotland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Electricity production	-14.4%	-1,643.2	-33.6%	-4,958.1
Gas production	-12.9%	-50.4	-68.9%	-751.2
Liquid fuel production	-13.4%	-274.5	-40.2%	-1,194.0
Offshore industry	5.6%	23.2	-64.3%	-787.5
Fuel production	-11.3%	-190.5	-45.1%	-1,235.2
Energy Supply Sector Total	-13.4%	-2,135.5	-39.2%	-8,926.1

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

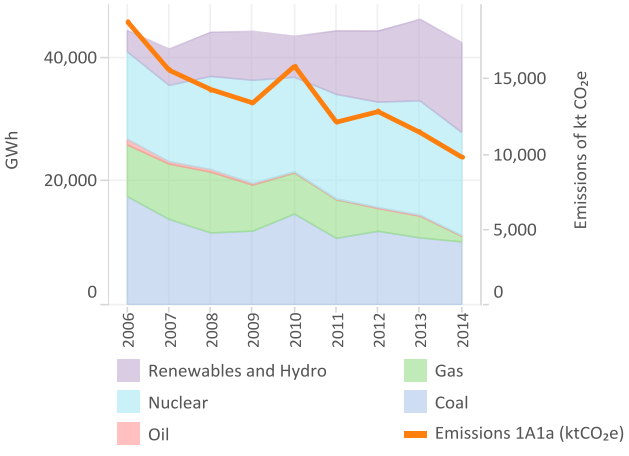


Figure 3.14: Traded and Non-Traded Energy Supply Sector Emissions, 2008-2014, Scotland

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 31% to total 2014 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 71% of Energy Supply emissions in 2014; refinery emissions account for a further 13% of the Energy Supply sector emissions in 2014.

Features of the Trends

Table 3.3 shows the change in emissions between the Base Year and 2014, and between 2013 and 2014 for the sector. Energy Supply sector emissions have reduced by 39% since the Base Year, compared to the UK average of 41% 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 34% between the Base Year and 2014, whereas the UK average is a 39% reduction.

Energy Supply sector emissions decreased by 13% between 2013 and 2014. This is primarily due to a reduction in natural gas use at power stations.

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 contributions in 2014 from nuclear power and renewable sources of energy. 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 2% of the Scottish electricity generation total in 2014 compared to a UK average of 30%.

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 2014.

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 3.2).

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 2014, 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 3.2.

3.3 Transport Sector

Figure 3.15: Overall Contribution from the Transport Sector to 2014 GHG Emissions, Scotland

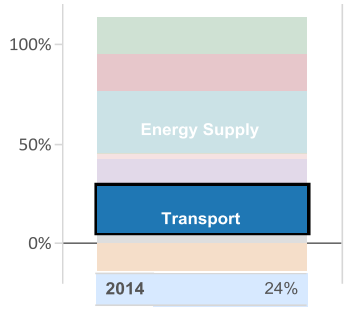


Figure 3.16: GHG Contribution for Transport Sector Emissions, 2014, Scotland

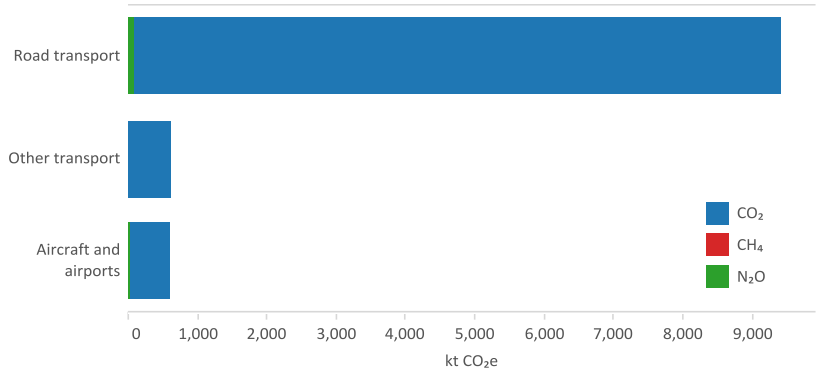


Figure 3.17: Total GHG Emissions from Transport Sector, Base Year to 2014, Scotland

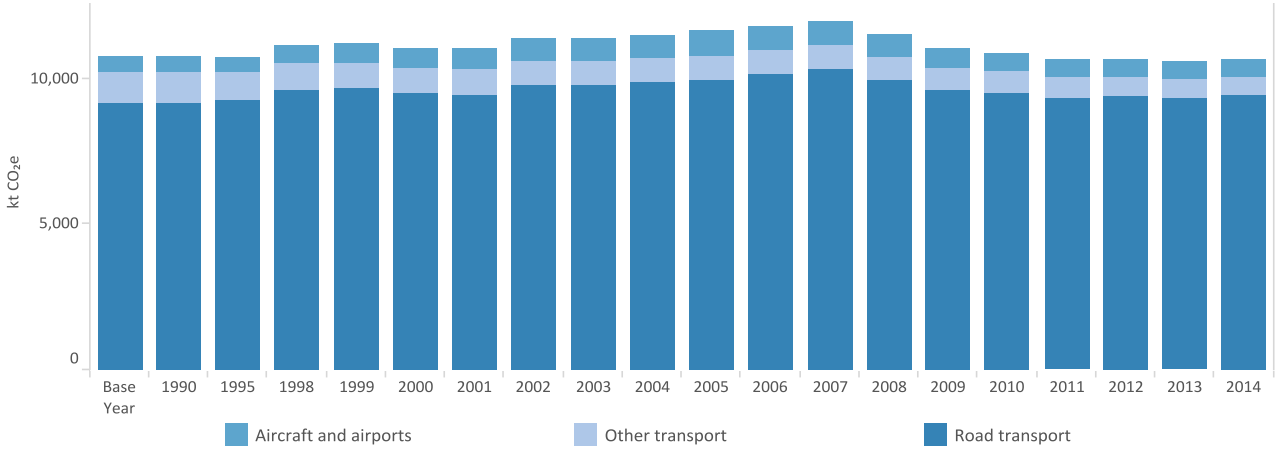


Table 3.4: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Transport Sector, Scotland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Road transport	0.9%	82.3	2.7%	252.1
Other transport	-1.2%	-7.7	-41.5%	-435.3
Aircraft and airports	-2.7%	-16.9	18.5%	93.7
Transport Sector Total	0.5%	57.8	-0.8%	-89.5

Figure 3.18 Road Transport CO_2 Emissions, Scotland

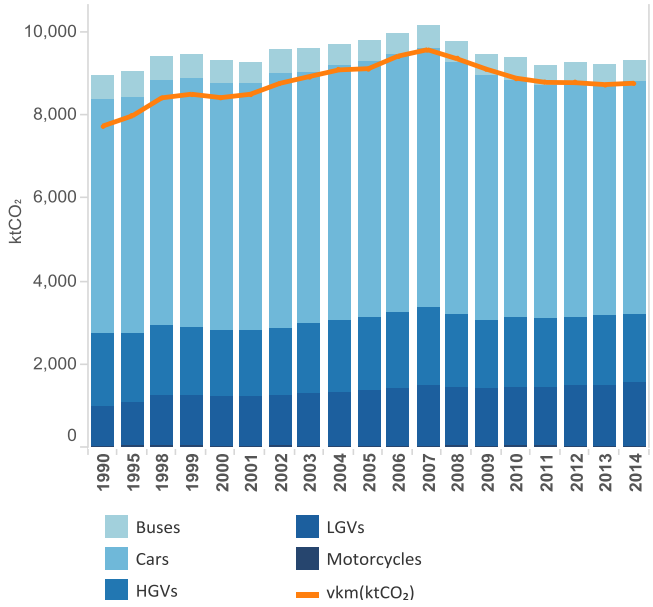
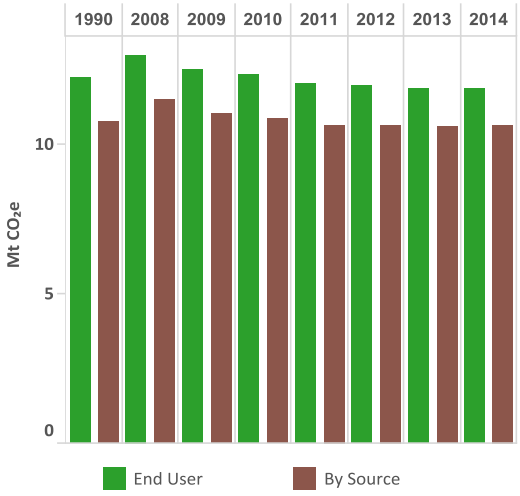


Figure 3.19: Comparison of End User and By Source for Transport Sector, Scotland



By Source Emissions

Overview

Figures 3.15 – 3.19 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 24% of Scotland's total GHG emissions in 2014. Transport emissions were dominated by emissions from road transport (89% of all Transport emissions in 2014, with 53% 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 2014, and between 2013 and 2014 for the sector. Total GHG emissions from the Transport sector in Scotland have decreased minimally (1%) between the Base Year and 2014 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 2013 and 2014 have not seen any significant change, with a small decrease of 0.5%. 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, 2015b); 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 3.18 shows 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 have changed when comparing to last year's DA GHG inventory (Salisbury et al., 2015), resulting from a change in the methodology to estimate fuel consumption at the UK level. The differences are larger in the early part of the time series (14% in 1990) but gradually improve over the time (6% in 2014).

Emissions on an End User Basis

Figure 3.19 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 2014, which is a 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 3.20: Overall Contribution from the Residential Sector to 2014 GHG Emissions, Scotland

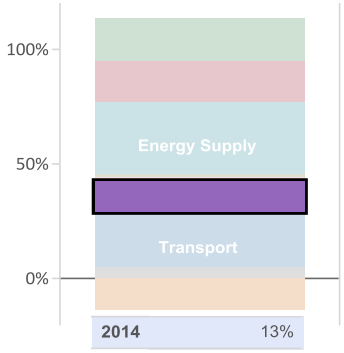


Figure 3.21: GHG Contribution for Residential Sector Emissions, 2014, Scotland

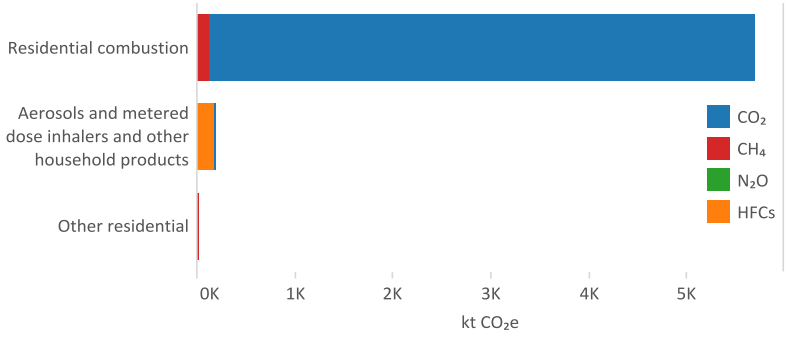


Figure 3.22: Total GHG Emissions from Residential Sector, Base Year to 2014, Scotland

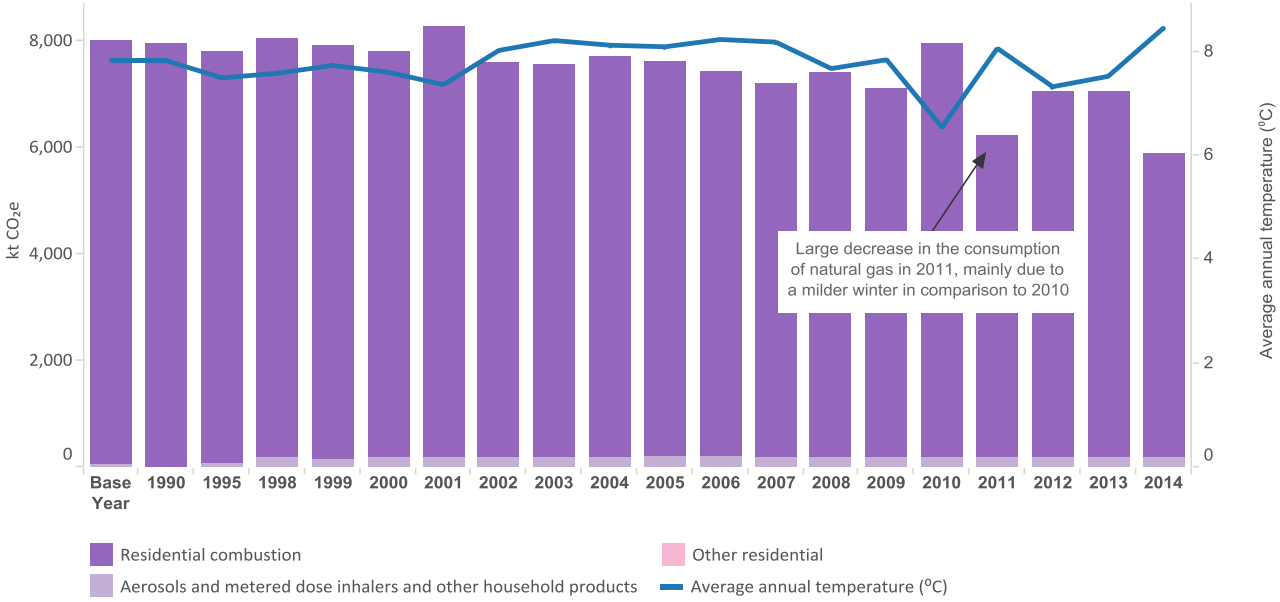
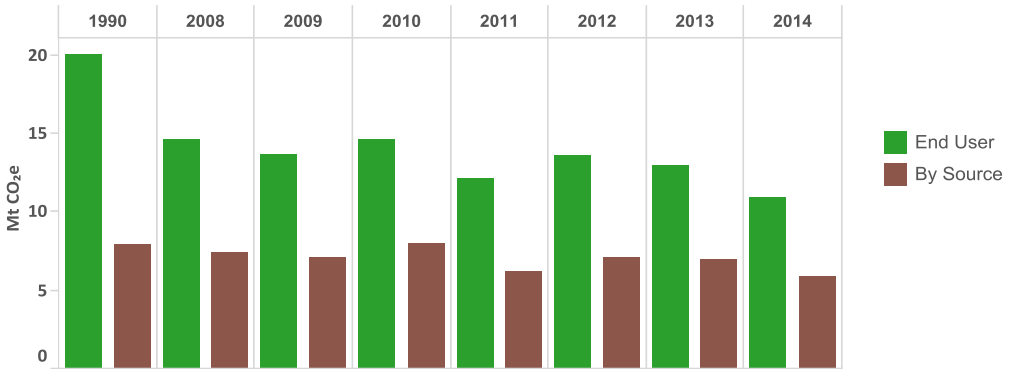


Table 3.5: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Residential Sector, Scotland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Aerosols and metered dose inhalers and other household products	1.6%	2.9	201.9%	123.0
Other residential	9.3%	0.3	106.7%	1.7
Residential combustion	-16.9%	-1,155.2	-28.3%	-2,249.6
Residential Sector Total	-16.4%	-1,152.1	-26.5%	-2,124.8

Figure 3.23: Comparison of End User and By Source for Residential Sector, Scotland



By Source Emissions

Overview

Figures 3.20 – 3.23 show detailed emissions and trends for the sector. The Residential sector accounted for 13% of Scotland's total net GHG emissions in 2014. The sector comprises emissions from domestic stationary and mobile combustion (from activities such as heating and cooking), household products, accidental vehicle fires and hydrofluorocarbon (HFC) emissions from the use of aerosols and metered dose (usually asthma-related) inhalers. Over 94% of all Residential sector GHG emissions are from the release of carbon dioxide from the direct stationary and mobile combustion of fossil fuels (see Figure 3.22).

Features of the Trends

Table 3.5 shows the change in emissions between the Base Year and 2014, and between 2013 and 2014 for the sector. Total GHG emissions from the Residential sector in Scotland have decreased by 27% between the Base Year and 2014. The recent sector emission trends reflect mean annual temperatures, with a very cold year in 2010 and the warmest year since 2006 in 2014 (MetOffice, 2014).

Emissions on an End User Basis

Figure 3.23 shows that in 2014 Scotland End User emissions for the Residential sector are 187% 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 24% of the Scotland total, compared to just 13% of the By Source inventory total.

The trend in the Residential sector End User emissions since 1990 shows a decline of 45% to 2014. 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 3.24: Overall Contribution from the Business Sector to 2014 GHG Emissions, Scotland

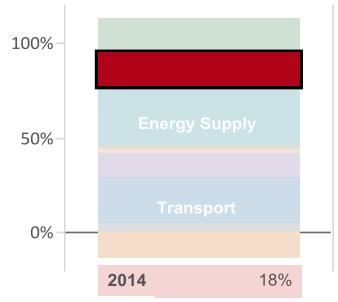


Figure 3.25: GHG Contribution for Business Sector Emissions, 2014, Scotland

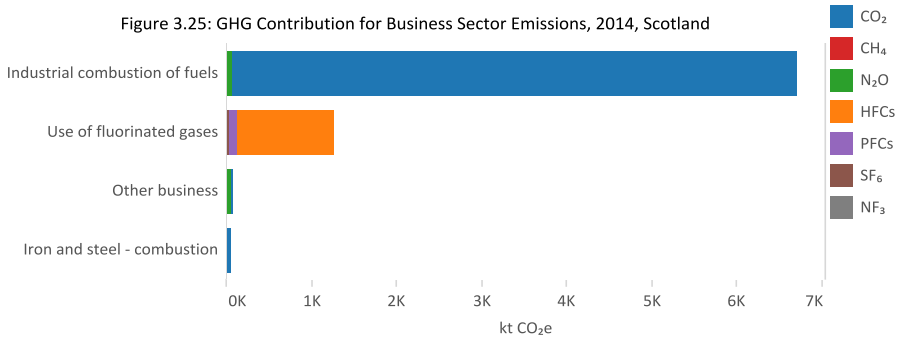


Figure 3.26: Total GHG Emissions from Business Sector, Base Year to 2014, Scotland

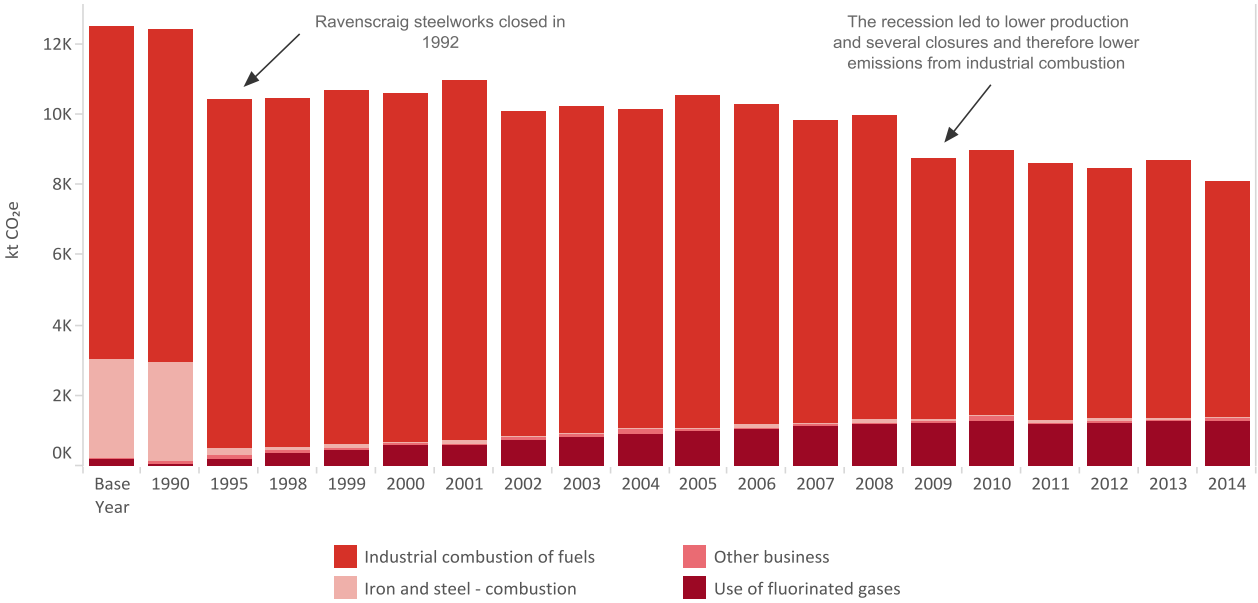
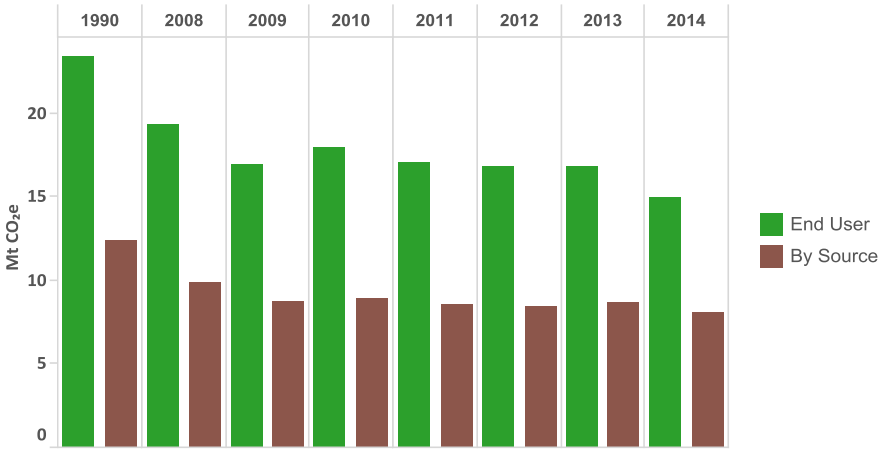


Table 3.6: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Business Sector, Scotland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Industrial combustion of fuels	-8.5%	-625.9	-29.0%	-2,739.6
Iron and steel - combustion	3.4%	1.8	-98.1%	-2,773.4
Use of fluorinated gases (including refrigeration and air conditioning)	2.3%	28.3	613.0%	1,096.2
Other business	19.7%	13.1	64.9%	31.3
Business Sector Total	-6.7%	-582.8	-35.1%	-4,385.6

Figure 3.27: Comparison of End User and By Source for Business Sector, Scotland



By Source Emissions

Overview

Figures 3.24 – 3.27 show detailed emissions and trends for the sector. In Scotland, the Business sector contributes 18% to total net GHG emissions in 2014. The Business sector in 2014 includes emissions from industrial combustion of fuels (83% of Business emissions); use of fluorinated gases (including refrigeration & air conditioning) (16% of Business emissions), and combustion emissions from the iron and steel sector (1% of Business emissions). In 2014, 83% of the Business sector GHG emissions were carbon dioxide, primarily released from the combustion of fossil fuels, with 16% as fluorinated gases, predominantly HFCs.

Features of the Trends

Table 3.6 shows the change in emissions between the Base Year and 2014, and between 2013 and 2014 for the sector. Total Business sector GHG emissions in Scotland have reduced by 35% 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 from the use of fluorinated gases were negligible in 1990 and have risen to account for 16% of the sector total in 2014. This is due to the introduction of these gases as replacement to CFCs banned by the Montreal Protocol.

Business emissions decreased by 7% between 2013 and 2014 a decrease in emissions from natural gas for industrial/commercial combustion and from petrochemical production.

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 2014, 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 3.27, 2014 Scotland End User emissions for the Business sector are 184% 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 33% of total emissions for Scotland compared to just 18% of the By Source inventory total.

3.6 Public Sector

Figure 3.28: Overall Contribution from the Public Sector to 2014 GHG Emissions, Scotland

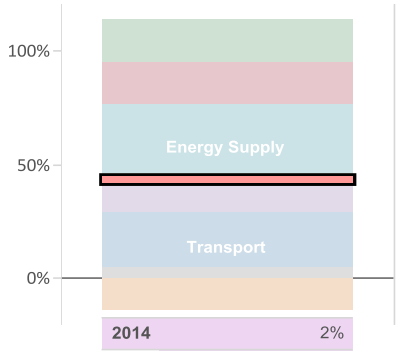


Figure 3.29: GHG Contribution for Public Sector Emissions, 2014, Scotland

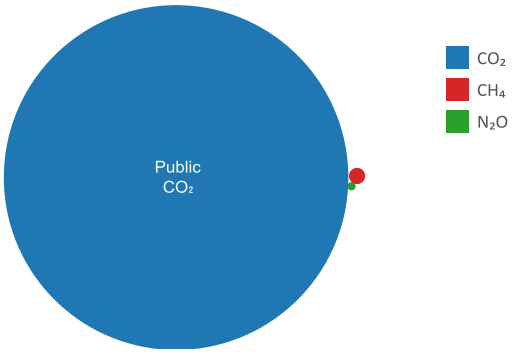


Figure 3.30: Total GHG Emissions from Public Sector, Base Year to 2014, Scotland

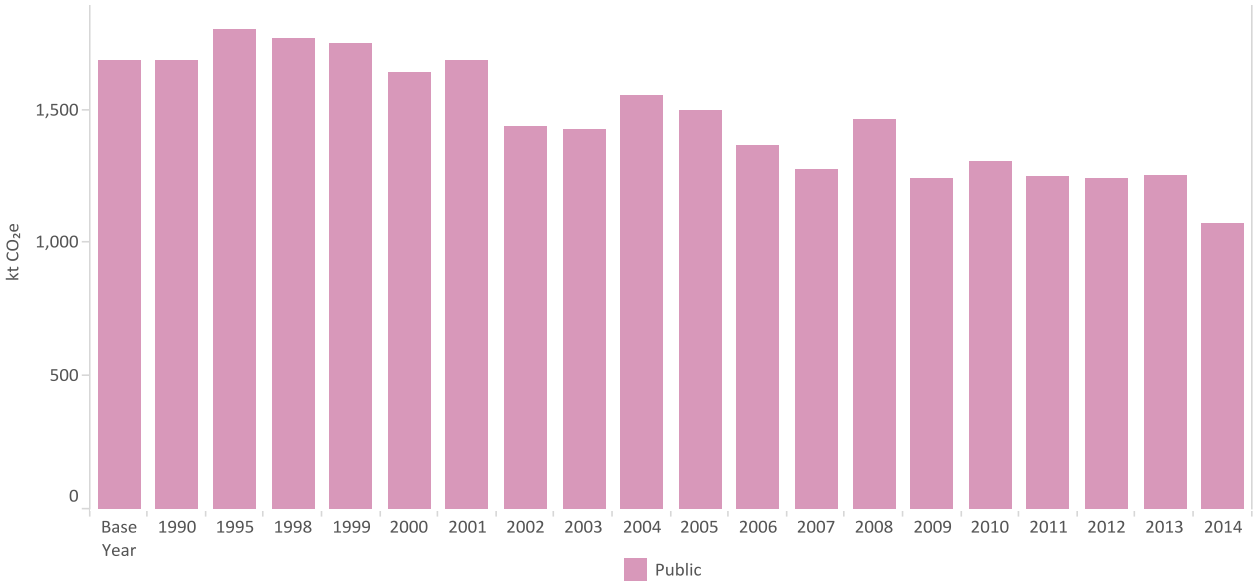
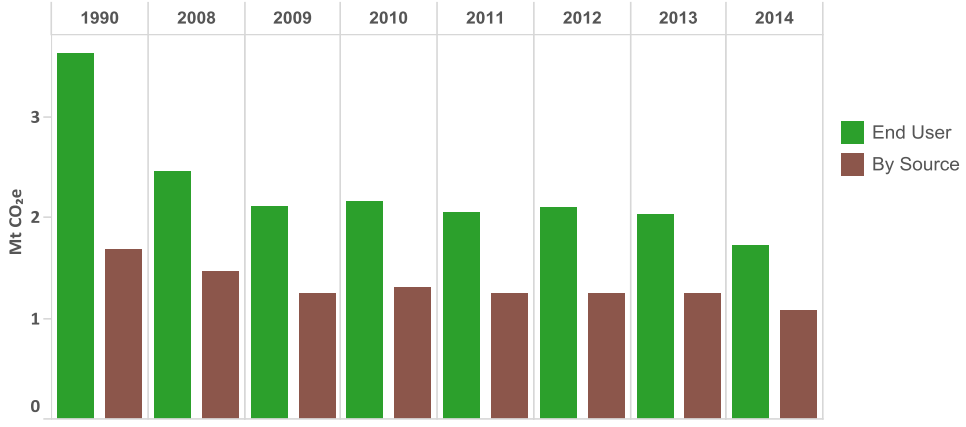


Table 3.7: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Public Sector, Scotland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Public	-14.2%	-178.1	-36.2%	-609.8
Public Sector Total	-14.2%	-178.1	-36.2%	-609.8

Figure 3.31: Comparison of End User and By Source for Public Sector, Scotland



By Source Emissions

Overview

Figures 3.28 – 3.31 show detailed emissions and trends for the sector. Emissions from Public sector combustion accounted for 2% of GHG emissions in Scotland in 2014. 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 2014, and between 2013 and 2014 for the sector. Public sector GHG emissions have reduced by 36% 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 decreased by 14% between 2013 and 2014, due to a decrease in emissions from natural gas for public sector combustion.

Emissions on an End User Basis

As illustrated in Figure 3.31, Scotland End User emissions in 2014 for the Public sector were 161% 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 2014. The trend in End User emissions since 1990 shows a decline of 53% to 2014.

3.7 Industrial Process Sector

Figure 3.32: Overall Contribution from the Industrial Process Sector to 2014 GHG Emissions, Scotland

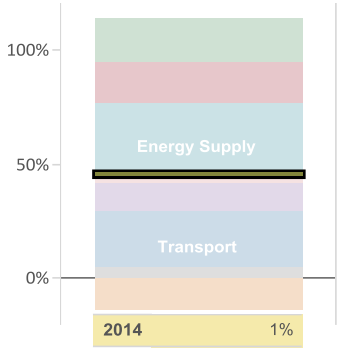


Figure 3.33: GHG Contribution for Industrial Process Sector Emissions, 2014, Scotland

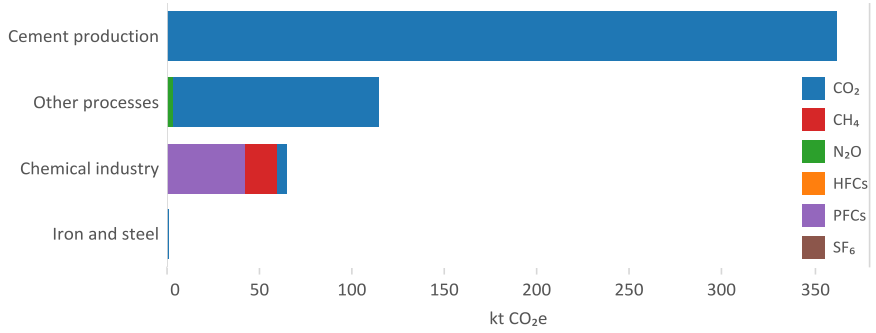


Figure 3.34: Total GHG Emissions from Industrial Process Sector, Base Year to 2014, Scotland

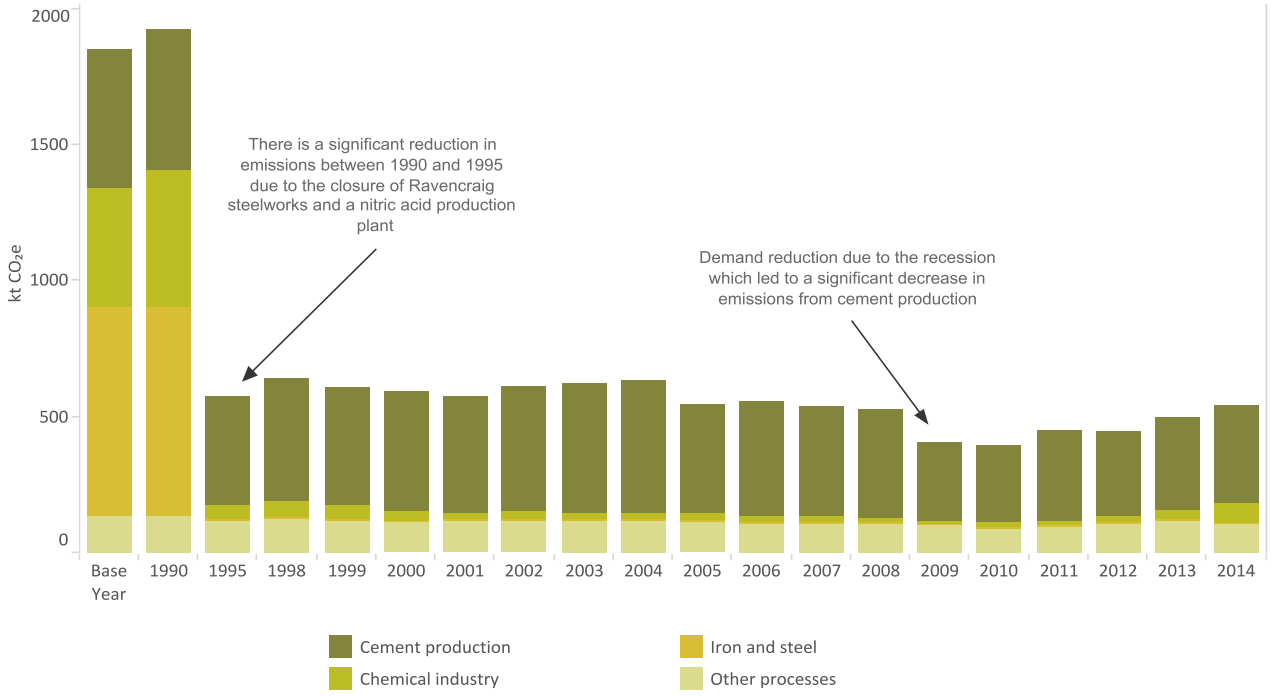


Table 3.8: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Industrial Process Sector, Scotland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Cement production	6.1%	20.7	-29.2%	-149.1
Other processes	-9.2%	-11.6	-16.6%	-22.7
Chemical industry	105.8%	33.2	-85.3%	-376.2
Iron and steel	0.3%	0.0	-100.0%	-763.4
Industrial Process Sector Total	8.5%	42.2	-70.8%	-1,311.3

By Source Emissions

Overview

Figures 3.32 – 3.34 show detailed emissions and trends for the sector. In 2014, 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 2014: 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 carbon dioxide accounted for 88% of total Industrial Process GHG emissions in 2014.

Features of the Trends

Table 3.8 shows the change in emissions between the Base Year and 2014, and between 2013 and 2014 for the sector. Overall Industrial Process sector emissions in Scotland have reduced by 71% between the Base Year and 2014. This large decline in emissions is primarily due to the closure of the nitric acid plant and 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 between 2013 and 2014 (8%) 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 2014, 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 2014, 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 3.35: Overall Contribution from the Agriculture Sector to 2014 GHG Emissions, Scotland

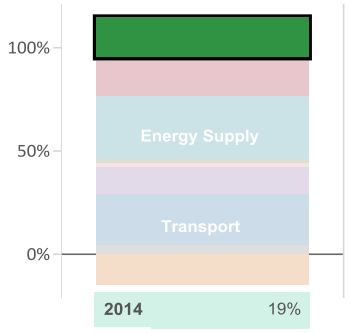


Figure 3.36: GHG Contribution for Agriculture Sector Emissions, 2014, Scotland

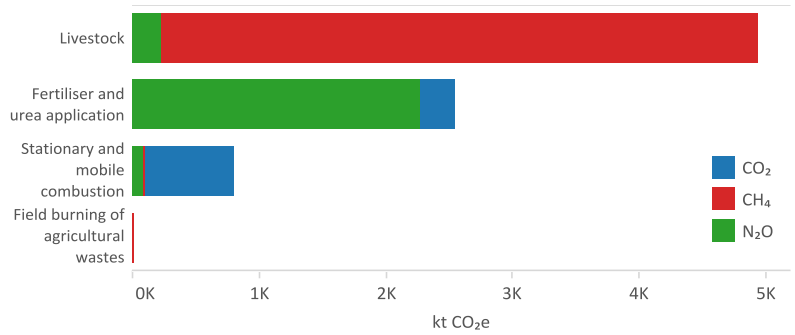


Figure 3.37: Total GHG Emissions from Agriculture Sector, Base Year to 2014, Scotland

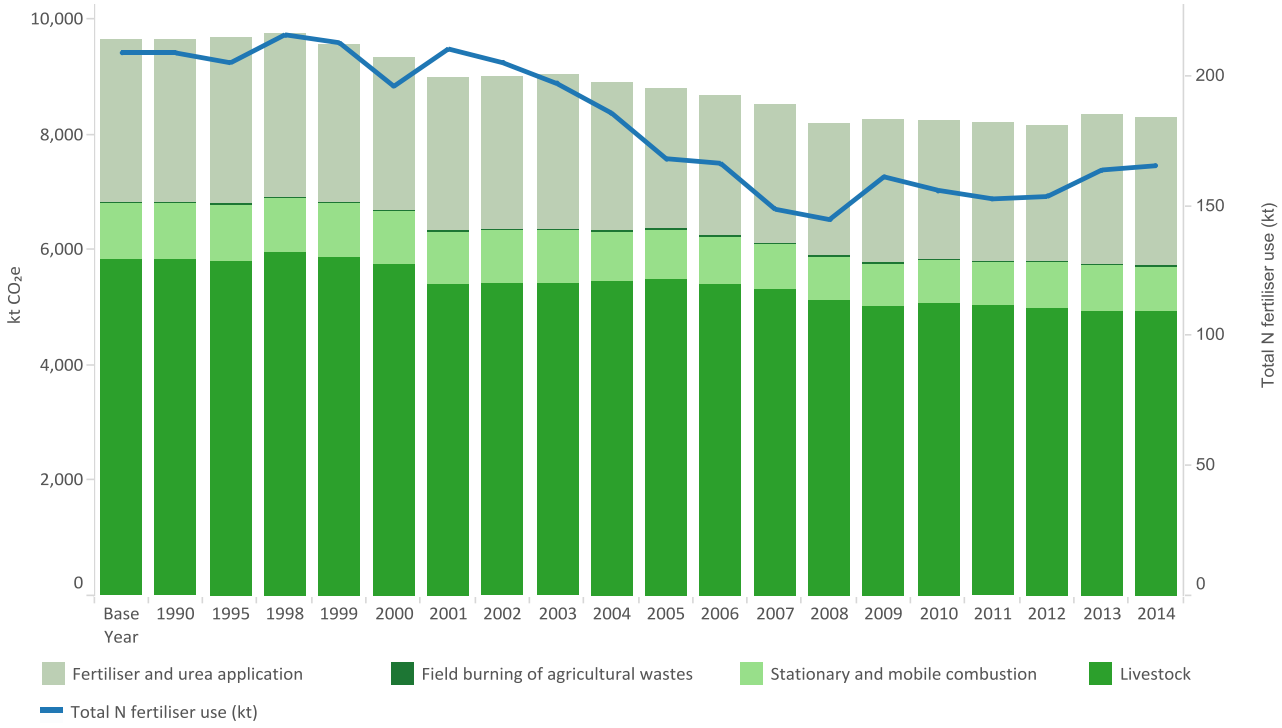
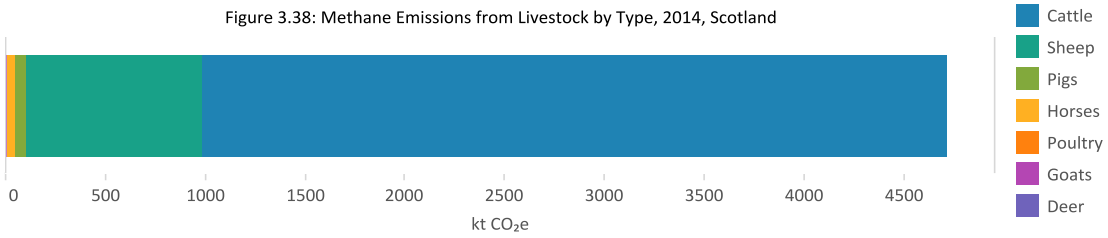


Table 3.9: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Agriculture Sector, Scotland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Fertiliser and urea application	-1.5%	-38.6	-9.4%	-263.8
Field burning of agricultural wastes	N/A	0.0	-100.0%	-19.0
Livestock	0.1%	6.9	-15.3%	-891.5
Stationary and mobile combustion	-2.2%	-17.9	-18.7%	-184.6
Agriculture Sector Total	-0.6%	-49.6	-14.1%	-1,359.0

Figure 3.38: Methane Emissions from Livestock by Type, 2014, Scotland



By Source Emissions

Overview

Figures 3.35 – 3.38 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 and from liming (see Figure 3.37). Agriculture accounted for 19% of total greenhouse gas emissions in Scotland in 2014, and is the most significant source sector for methane and nitrous oxide, accounting for 63% and 79% 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 2014, and between 2013 and 2014 for the sector. Emissions from the Agriculture sector decreased by 14% between the Base Year and 2014, with pollutant contributions of -15% for methane and -10% 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 decrease of less than 1% in agricultural emissions between 2013 and 2014 mainly due to a number of small changes including an increase in emissions from dairy cattle and a decrease in emissions from liming. 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 79% of the total agricultural methane emissions, whilst emissions from sheep accounted for a further 19% of the total.

Nitrous oxide emissions are largely driven by fertiliser nitrogen use, manure applications and grazing returns to soils.

Emissions on an End User Basis

As 90% of emissions in the Agriculture sector in 2014 were not due to energy consumption, emissions on an End User basis are very similar to the emissions By Source. In 2014, 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 3.39: Overall Contribution from the Land Use Change Sector to 2014 GHG Emissions, Scotland

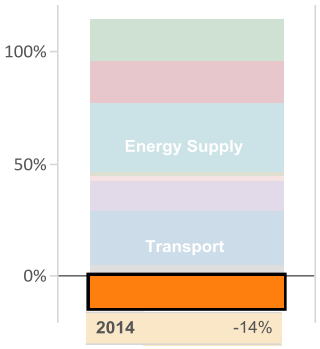


Figure 3.40: GHG Contribution to Land Use Change Sector Emissions, 2014, Scotland

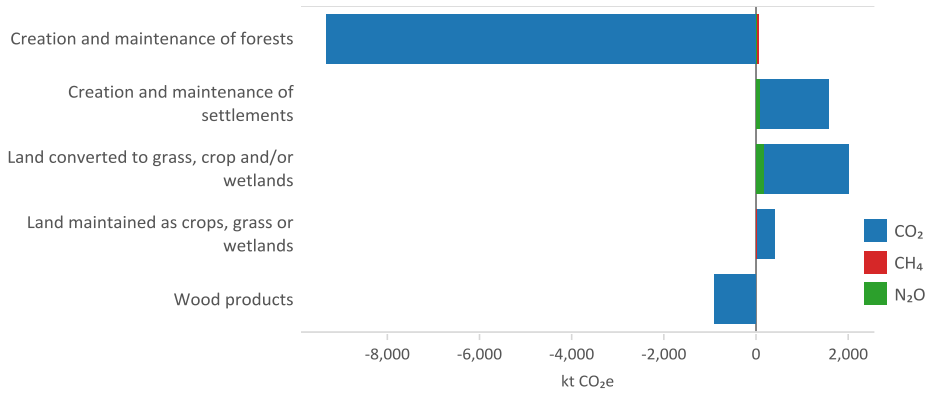


Figure 3.41: Total GHG Emissions from LULUCF Sector, Base Year to 2014, Scotland

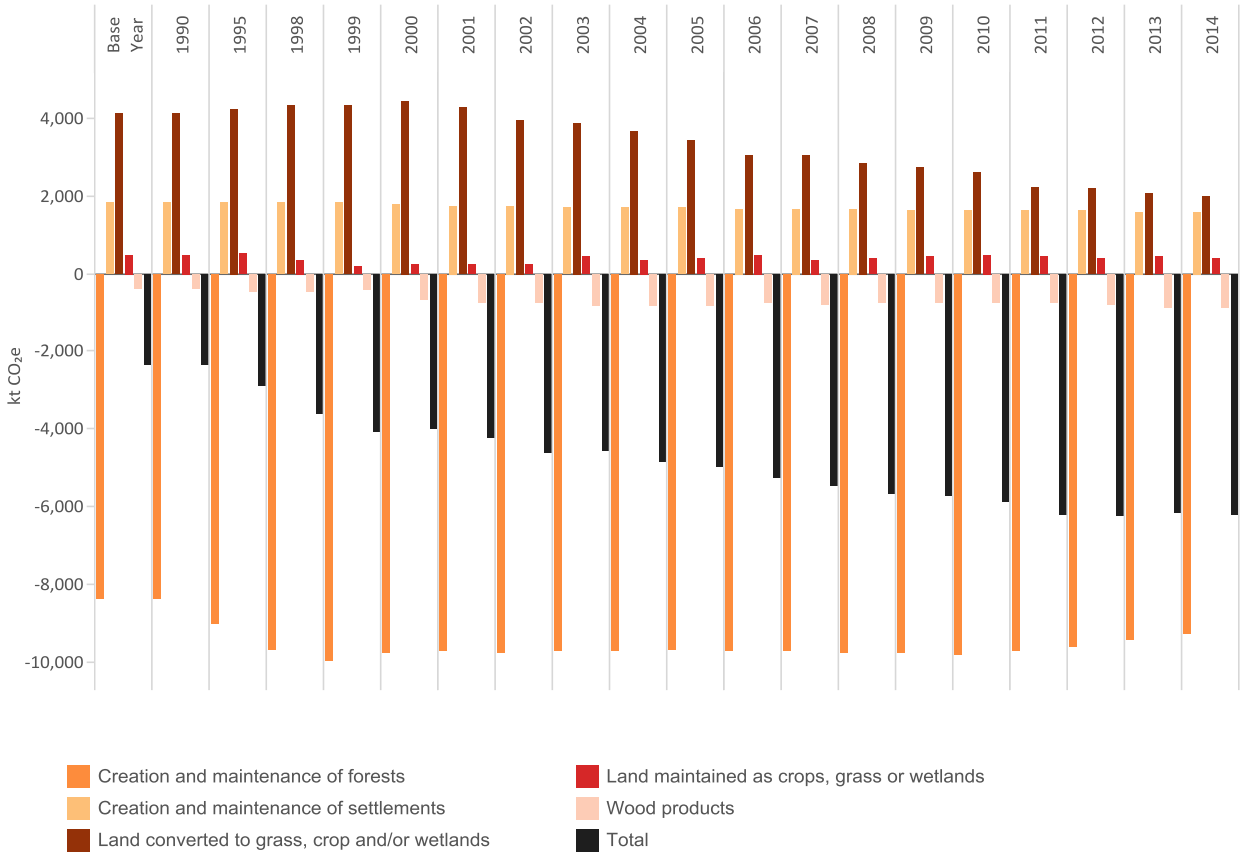


Table 3.10: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the LULUCF Sector, Scotland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Creation and maintenance of settlements	-0.5%	-8.2	-13.8%	-254.5
Creation and maintenance of forests	1.6%	148.8	-10.7%	-893.8
Land converted to grass, crop and/or wetlands	-4.6%	-95.5	-51.9%	-2,126.8
Land maintained as crops, grass or wetlands	-9.2%	-40.6	-16.6%	-79.8
Wood products	-4.3%	-37.4	-134.2%	-514.0
Land Use Change Sector Total	-0.5%	-32.9	-165.5%	-3,869.0

By Source Emissions

Overview

Figures 3.39 – 3.41 show detailed emissions and trends for the Land Use, Land Use Change and Forestry (LULUCF) sector. In 2014, Scotland was a large net sink of greenhouse gases from LULUCF activities removing 6,206 $ktCO_2e$ in 2014. 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 9,273 $ktCO_2e$ in 2014.

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 1990. The size of this sink (CO_2e removal) has grown by 166% between 1990 and 2014 from -2,337 to -6,206 $ktCO_2e$. This increase in net removals is primarily as a result of less conversion of grassland 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-20th 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 3.42: Overall Contribution from the Waste Management Sector to 2014 GHG Emissions, Scotland

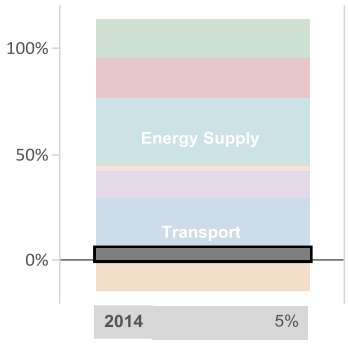


Figure 3.43: GHG Contribution for Waste Management Sector Emissions, 2014, Scotland

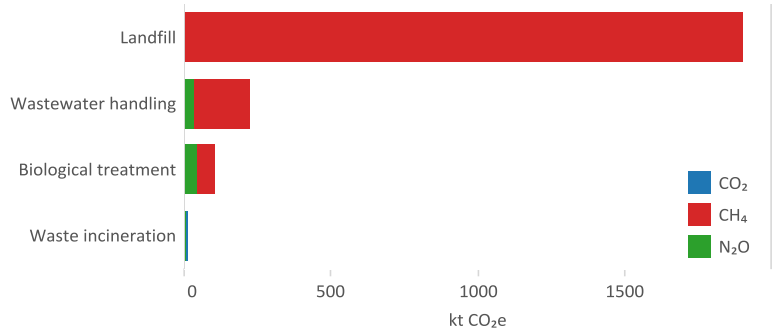


Figure 3.44: Total GHG Emissions from Waste Management Sector, Base Year to 2014, Scotland

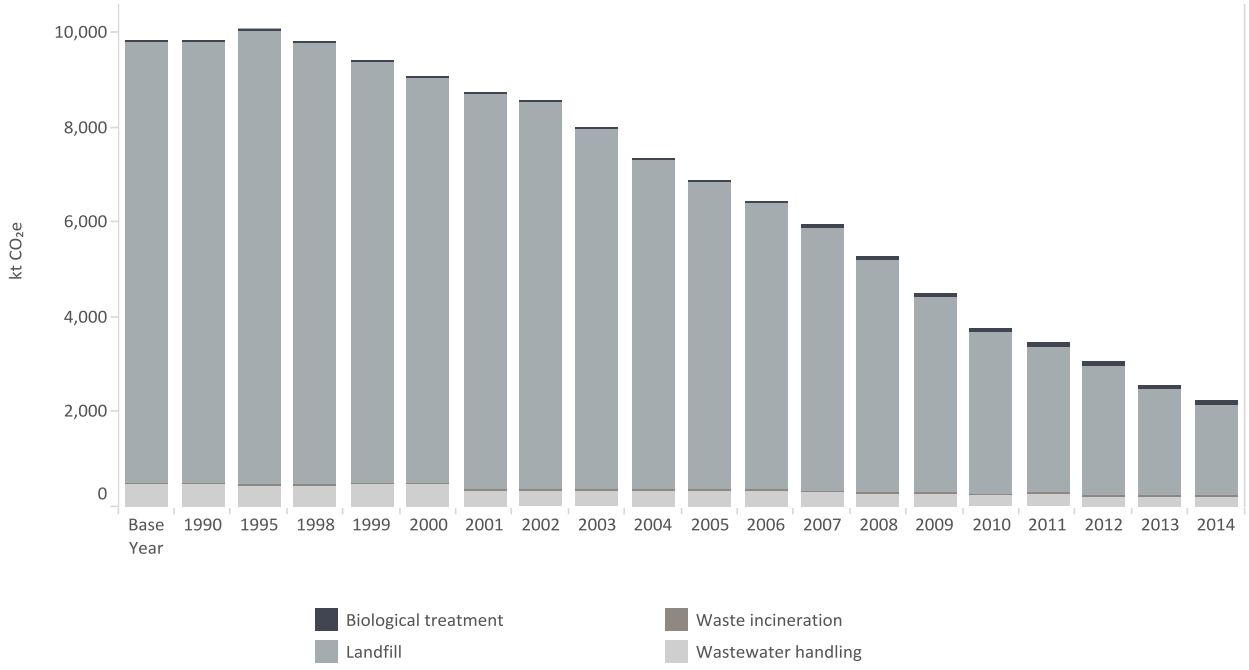


Table 3.11: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Waste Management Sector, Scotland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Landfill	-15.4%	-346.3	-79.6%	-7,416.5
Waste incineration	-0.8%	-0.1	-75.8%	-38.3
Wastewater handling	4.7%	9.9	-52.9%	-246.1
Biological treatment	9.9%	9.2	N/A	102.7
Waste Management Sector Total	-12.8%	-327.3	-77.3%	-7,598.2

By Source Emissions

Overview

Figures 3.42 – 3.44 show detailed emissions and trends for the sector. The Waste Management sector contributed 5% to total GHG emissions in Scotland in 2014, and was the second largest source sector for methane emissions, representing 29% of total methane emissions in 2014. Emissions from this sector in 2014 were dominated by methane from landfill (85% 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 wastewater treatment represented 1.4% of emissions in the sector in 2014, and contributed 1% to the total emissions of nitrous oxide in Scotland.

Features of the Trends

Table 3.11 shows the change in emissions between the Base Year and 2014, and between 2013 and 2014 for the sector. Emissions from the Waste Management sector in Scotland have reduced by 77% 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 13% between 2013 and 2014 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 (1990-2014)

4.1 Overview of Total Emissions

By Source Emissions

Overview

The greenhouse gas (GHG) emissions for Wales for 1990 – 2014 are presented in Figure 4.1 and in Table 4.1 below.

Figure 4.1: Total GHG Emissions by NC Category for Base Year to 2014, as kt CO_2e, Wales

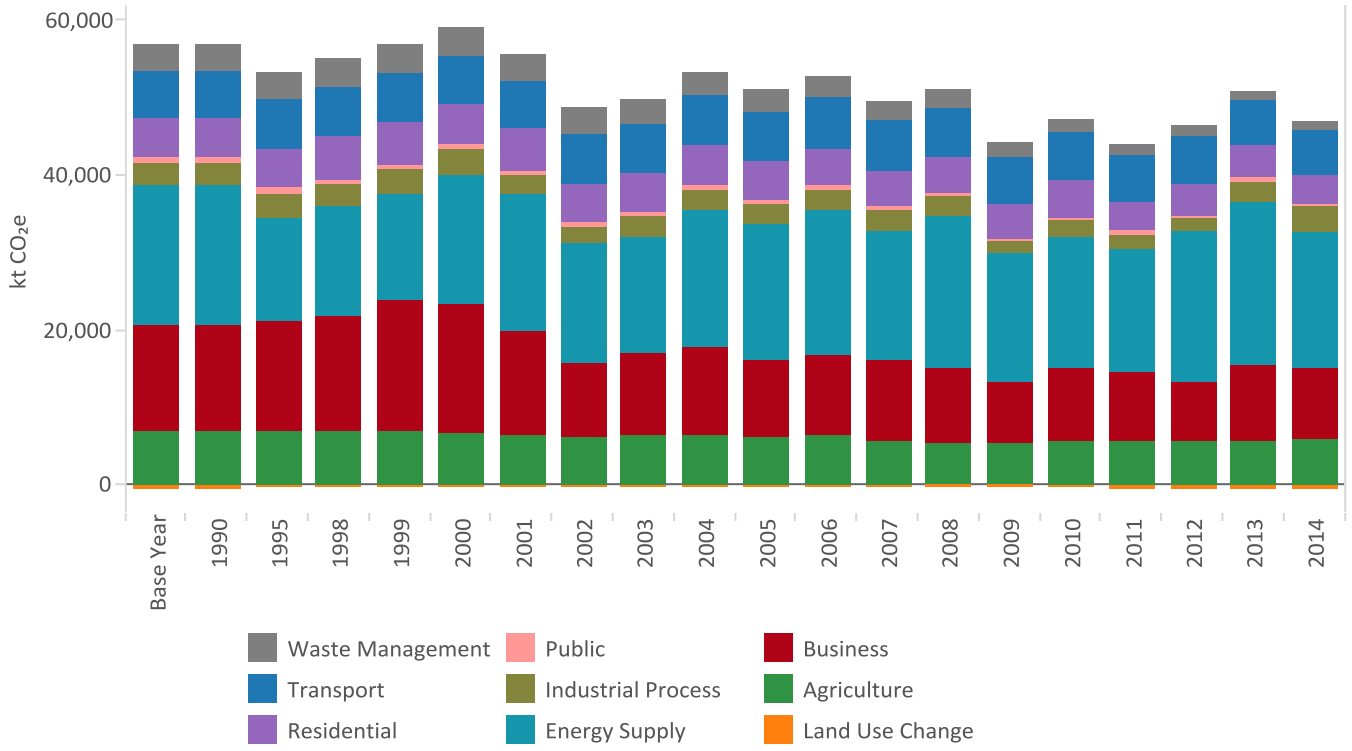
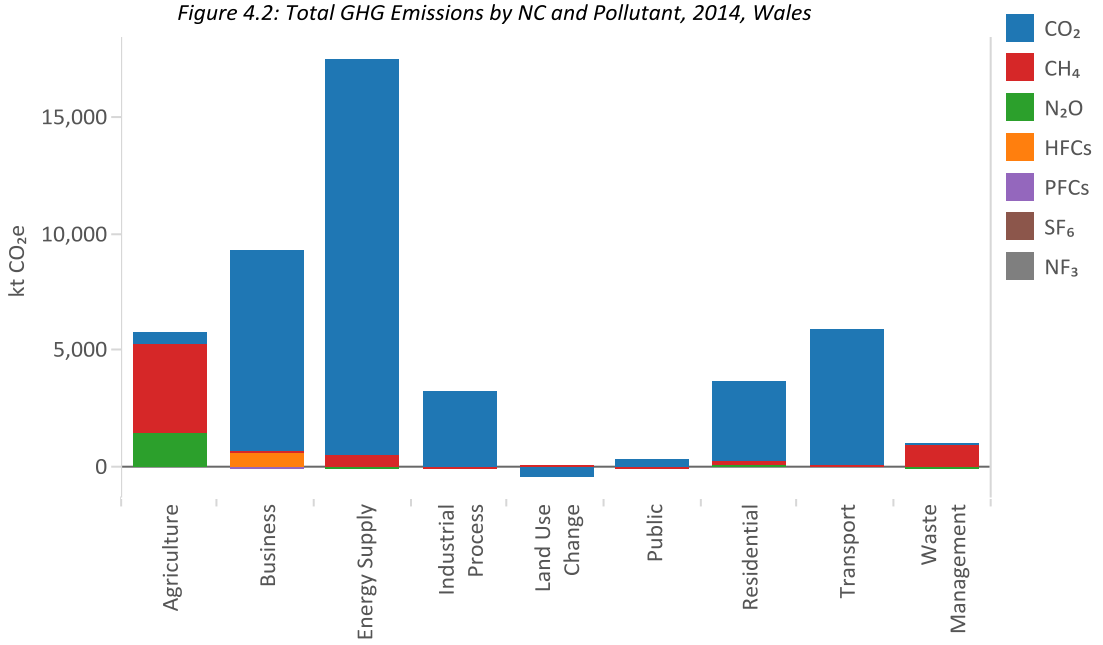


Table 4.1: 1990-2014 Wales GHG Emission Inventory ($ktCO_2e$)

NC Format	Base Year	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	% of 2014	% Change BY-2014
Agriculture	6,845	6,845	6,895	6,575	6,175	5,486	5,456	5,578	5,606	5,589	5,604	5,818	13%	-15%
Business	13,730	13,701	14,388	16,674	9,936	9,645	7,893	9,615	8,874	7,696	9,687	9,270	20%	-32%
Energy Supply	18,069	18,069	13,194	16,530	17,588	19,436	16,433	16,785	15,963	19,491	21,233	17,509	38%	-3%
Industrial Process	2,777	2,966	3,111	3,300	2,589	2,619	1,567	2,113	1,913	1,524	2,621	3,230	7%	16%
LULUCF	-295	-295	-99	173	-108	-206	-285	-281	-342	-299	-365	-296	-1%	0.3%
Public	771	771	706	552	499	460	387	403	382	380	385	328	1%	-57%
Residential	5,023	4,990	5,175	5,305	4,845	4,639	4,433	4,907	3,818	4,279	4,297	3,633	8%	-28%
Transport	6,093	6,093	6,083	6,175	6,463	6,392	6,134	6,053	5,951	5,885	5,845	5,923	13%	-3%
Waste Management	3,478	3,478	3,612	3,549	2,770	2,207	1,910	1,621	1,460	1,310	1,112	987	2%	-72%
Total	**56,492**	**56,620**	**53,065**	**58,834**	**50,758**	**50,679**	**43,926**	**46,794**	**43,625**	**45,855**	**50,420**	**46,402**	**100%**	**-18%**

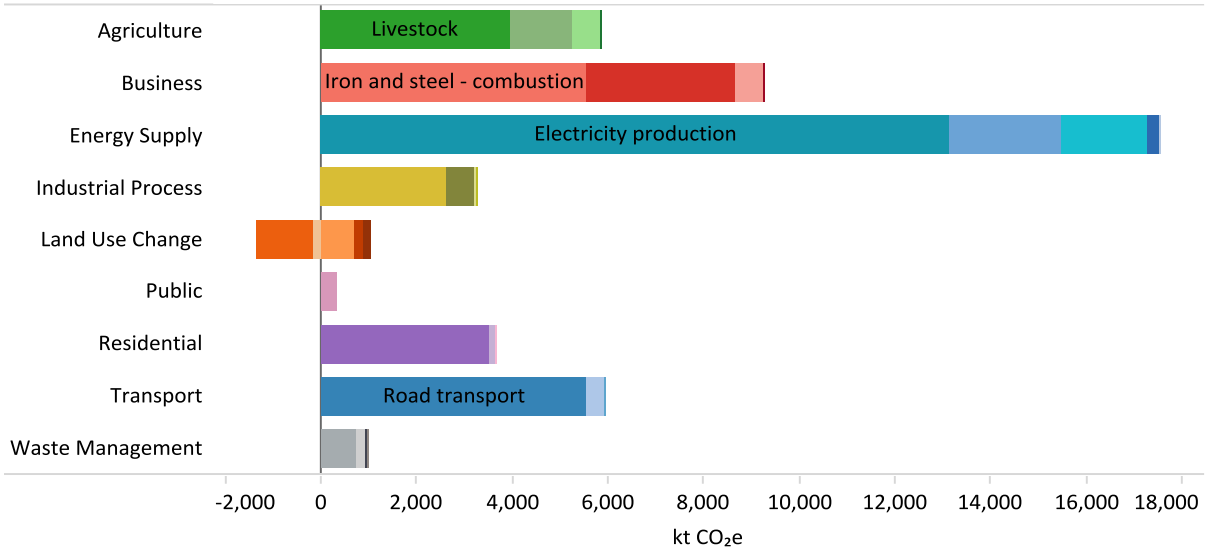
Carbon dioxide is the most common gas emitted for all National Communication (NC) categories except the Agriculture sector where methane from livestock and nitrous oxide from soils are the most important gases, and the Waste Management sector where methane from landfills is the most important gas (see Figure 4.2).

Figure 4.2: Total GHG Emissions by NC and Pollutant, 2014, Wales



The largest sources of emission in 2014 include electricity production (28% of total emissions), road transport (12% of total emissions), iron and steel combustion in the business sector (12% of total emissions) and livestock (9% of total emissions) as shown in Figure 4.3. The detailed breakdown of each sector can be found in the sector-specific sections of this report.

Figure 4.3: Total GHG Emissions Labelling the Largest Sub-Category in each NC, 2014, Wales



Trends

Figure 4.4 shows the change in emissions from the Base Year and 2013 to the latest year, 2014. Total GHG emissions from Wales have reduced between the Base Year[20] and 2014 by 18%, whilst carbon dioxide emissions have fallen by 12%. 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).

Total GHG emissions have decreased between 2013 and 2014 by 8%. **The 2013 to 2014 decrease of emissions is predominantly driven by a reduction in the use of coal in the power generation sector, a reduction in emissions from refineries and the residential sector.** The following list provides an overview of the trend for each NC sector:

- **Energy Supply** sector emissions have decreased by 3% between the Base Year and 2014 due to decreases in emissions from power stations. Emissions decreased by 18% between 2013 and 2014 due to a reduction in emissions from the use of coal in the power generation sector.

- **Transport** sector emissions have only decreased by 3% between the Base Year and 2014 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 2013 and 2014 remained relatively stable increasing by only 1%.

- **Residential** sector emissions have decreased by 28% since the Base Year partly due to a change in the fuel mix from coal towards natural gas and also energy efficiency measures. The 2013 to 2014 time series reflects the higher annual average temperatures, and consequently a reduced energy demand from natural gas for residential heating.

- **Business** sector emissions have reduced by 32% since the Base Year. The trends in this sector are primarily driven by the activities from the iron and steel industry.

- **Public** sector emissions have reduced by 57% 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 2013 and 2014 decreased by 15% due mainly to a decrease in emissions from natural gas for public sector combustion. This trend reflects the variation in mean annual temperature.

- **Industrial Process** emissions have increased by 16% since the Base Year and have shown significant fluctuations during this timeframe reflecting manufacturing output and abatement installations. The trend is heavily influenced by iron and steel production.

- **Agriculture** sector emissions have reduced by 15% since the Base Year mainly due to a decrease in livestock numbers. There was a small increase of 4% in emissions from 2013 to 2014 mainly due to an increase in the number of dairy cattle and sheep.

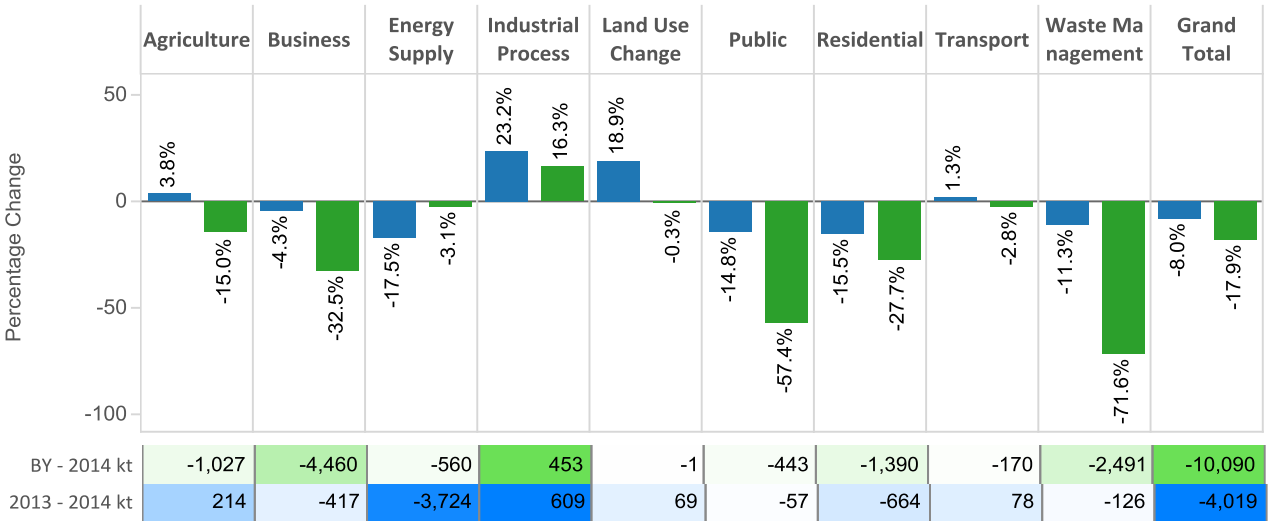
- **LULUCF** sector was a net sink of GHG emissions from Base Year to 1995 and from 2003 to 2014 but between 1995 and 2003 it has been a net source of GHG emissions. The size of the sink (CO_2e removal) has grown 951% between 2003 and 2014 from -28ktCO_2e to -296 ktCO_2e. This is predominantly due to a reduction in emissions from land converted to cropland and settlements. The sink decreased by 19% between 2013 and 2014 due predominantly to a reduction in the carbon stock in forests.

- **Waste Management** sector emissions have significantly declined by 72% since the Base Year, largely due to the progressive introduction of methane capture and oxidation systems within landfill management. Emissions continued to fall between 2013 and 2014, decreasing by 11%.

[20] 1995 for fluorinated greenhouse gases (F-Gases) and 1990 for all other gases

Figure 4.4: Percentage Change and Absolute (kt CO_2e) Change in GHG Emissions by NC: 2013 - 2014 and Base Year (BY) - 2014, Wales

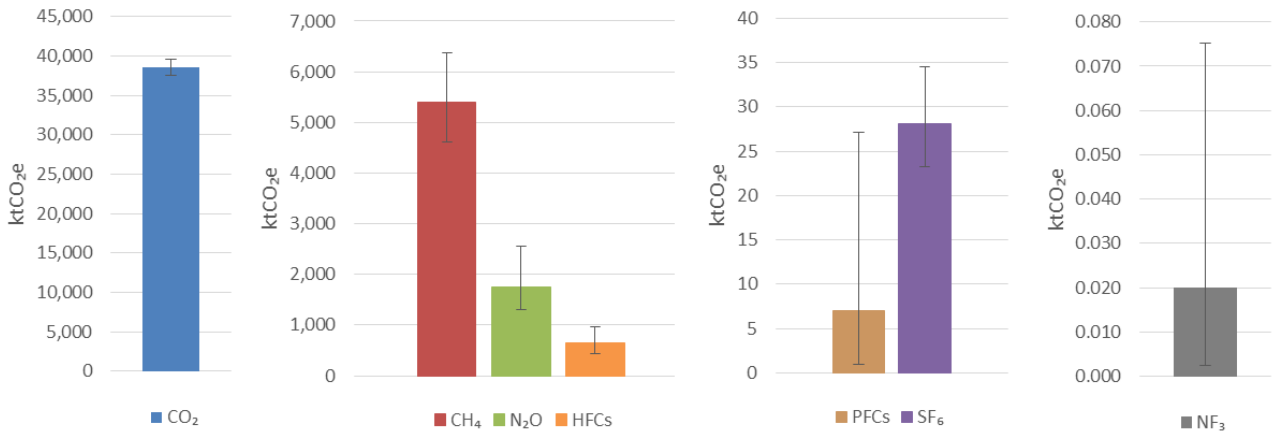
The LULUCF Base Year - 2014% change is excluded from the figure if LULUCF emissions changed from a sink to source, or source to sink, across the time series.



Uncertainty

Due to high contributions from carbon dioxide from well documented sources such as heavy industry, the Wales inventory has a relatively low uncertainty. The contribution from uncertain sources such as methane and nitrous oxide are relatively low. Figure 4.5 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 Introduction and Appendix 1 for further details on uncertainties.

Figure 4.5: Total GHG emissions and uncertainties by pollutant, 2014, Wales



Recalculations

Revisions to the estimates since the last inventory report (Salisbury et al., 2015) have resulted in a -0.5% (-278 $ktCO_2e$) reduction in the 2013 estimates for Wales. The most significant revisions to the 2013 estimates have been for the following sectors:

1. **Agriculture (-643 $ktCO_2e$)**: Implementation of UK-specific N_2O emission factors for grazing (pasture, range and paddock) of livestock. Previously these values were based on a standard non-UK specific value.
2. **LULUCF (278 $ktCO_2e$)**: The correction of the CARBINE forest model output has reduced the sink and altered the trend in the Forest and Harvested Wood Products categories. In the Grassland category the correction of the emissions factor for drainage of organic soil and the introduction of reporting of biomass carbon stock changes from grassland management has increased the sink. Other revisions have led to smaller changes in the Cropland, Wetland and Settlements categories.
3. **Business (-140 $ktCO_2e$)**: Increase in the use of gas oil in off-road machinery, as seen in DUKES. For Wales, there was also a recalculation in emissions from natural gas for other industry.
4. **Transport (126 $ktCO_2e$)**: An increase in emissions from passenger cars due to a revision in the emission factors based on COPERT 4v11. This revision affected cars for both petrol and diesel.

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

Traded and Non-Traded Emissions

Total GHG emissions from installations that operate within the European Union Emissions Trading Scheme (EUETS) (see Figure 4.7) decreased between 2013 and 2014 however traded emissions from business and industry emissions increased. This implies that energy supply is a strong driver of traded emissions in recent years.

Emissions from installations in the EU ETS (see Figure 4.7) accounted for 56% of total GHG emissions in Wales in 2014. 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, 2014, Wales

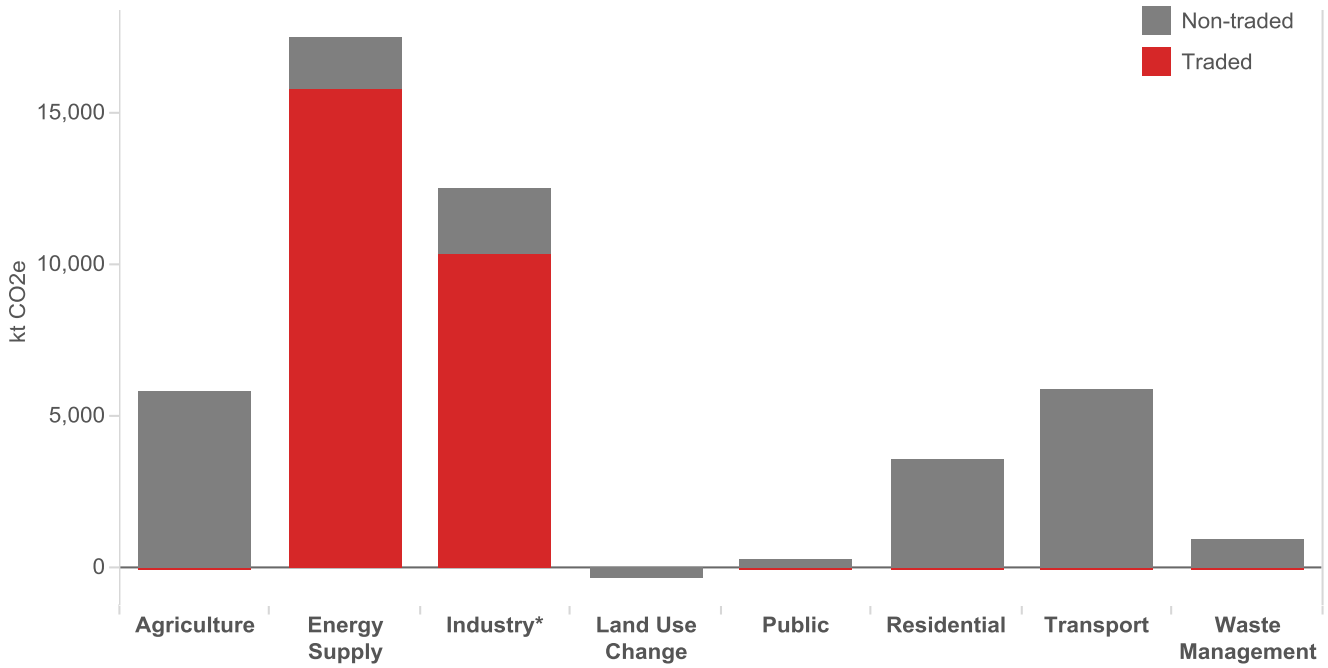


Figure 4.7: Total Traded and Non-Traded GHG Emissions 2008-2014, Wales

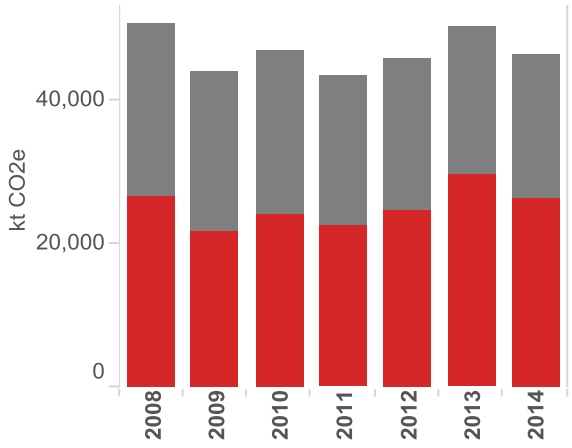
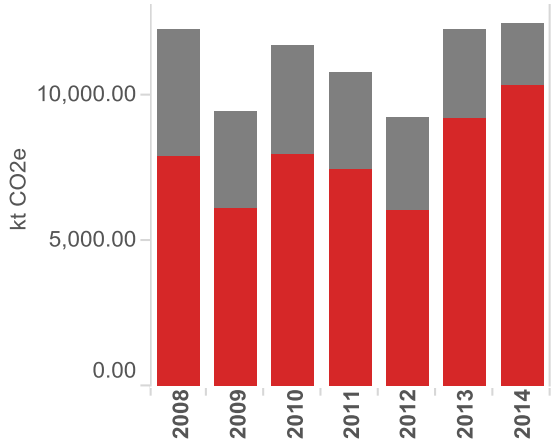


Figure 4.8: Traded and Non-Traded GHG Emissions from Industry 2008-2014, Wales*



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

Emissions on an End User Basis

In addition to presenting emissions data 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 2014.

As illustrated in Figure 4.9 Wales is a net exporter of electricity which resulted in lower emissions in Wales on an end user basis (40.2 $MtCO_2e$) compared to the By Source (46.4 $MtCO_2e$) 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[21] GHG emission transfers for Wales in 2014 (Mt CO_2e)[22]

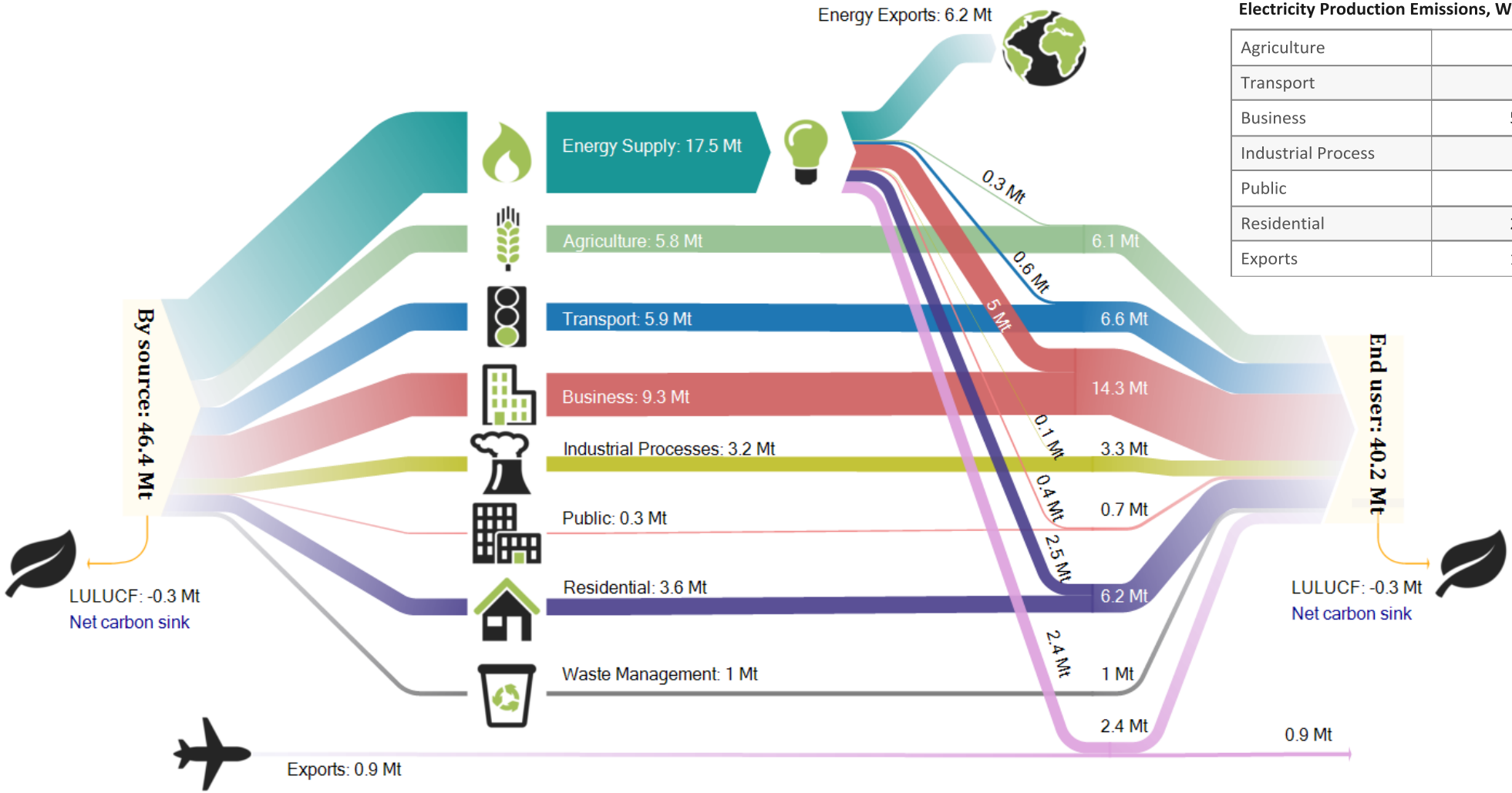


Table 4.2: NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions, Wales

Agriculture	3%
Transport	0%
Business	53%
Industrial Process	0%
Public	4%
Residential	27%
Exports	14%

[21] 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.

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

4.2 Energy Supply Sector

Figure 4.10: Overall Contribution from the Energy Supply Sector to 2014 GHG Emissions, Wales

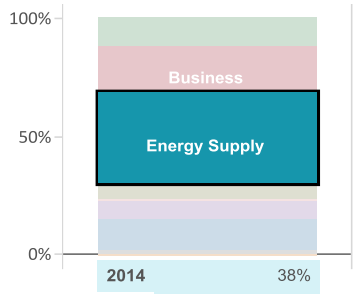


Figure 4.11: GHG Contribution to Energy Supply Sector Emissions, 2014, Wales

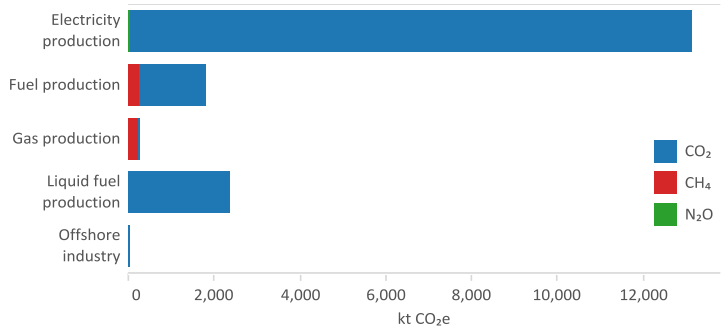


Figure 4.12: Total GHG Emissions from Energy Supply Sector, Base Year to 2014, Wales

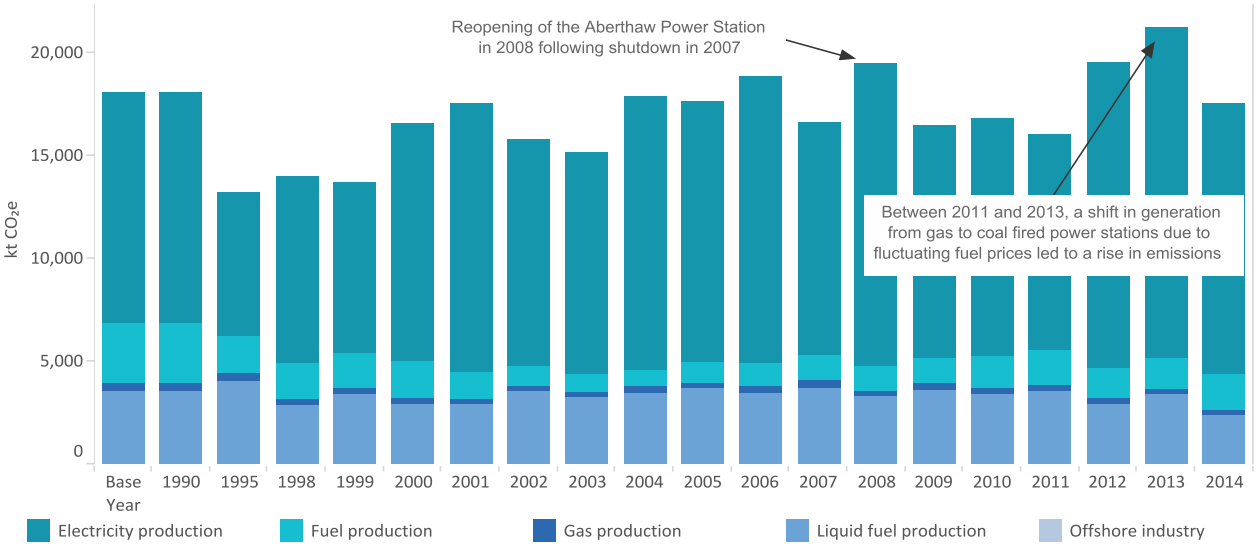


Table 4.3: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Energy Supply Sector, Wales

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Electricity production	-18.6%	-2,994.5	16.8%	1,887.1
Gas production	-8.7%	-22.1	-45.9%	-197.0
Liquid fuel production	-30.0%	-1,009.7	-33.1%	-1,165.1
Offshore industry	-100.0%	0.0	N/A	0.0
Fuel production	20.2%	302.2	-37.6%	-1,085.4
Energy Supply Sector Total	-17.5%	-3,724.1	-3.1%	-560.4

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

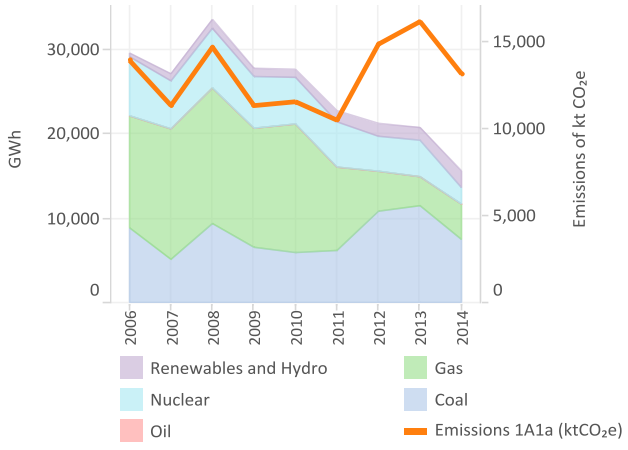


Figure 4.14: Traded and Non-Traded Energy Supply Sector Emissions, 2008-2014, Wales

By Source Emissions

Overview

In Wales, Energy Supply sources contributed 38% to total 2014 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 were electricity production at power stations, which accounted for 75% of Energy Supply emissions in 2014, and refinery emissions which accounted for a further 13%. Carbon dioxide is the predominant gas accounting for 97% of emissions from the Energy Supply sector in 2014, released through the combustion of fossil fuels.

Features of the Trends

Energy Supply sector emissions have decreased by 3.1% between the Base Year and 2014. The trend in Energy Supply emissions is largely dependent on the fuel mix for power generation. Figure 4.13 provides the fuel split for electricity production from 2006 to 2014. This shows the continued shift in fuel use from natural gas to coal between 2010 and 2014 but also an increasing use of renewable energy sources between 2013 and 2014. As a result of this recent time series, overall emissions in 2014 are only slightly reduced (3.1%) compared to 1990.

Sector Detail

The generation output and emissions in Wales are shown in Figure 4.13. Natural gas combustion now accounts for 27% 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 48% in 2014. 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 90% of emissions in Energy Supply from traded (EU ETS) operations in 2014; 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 reflecting the high demand for electricity in these sectors (29% and 14% respectively).

4.3 Transport Sector

Figure 4.15: Overall Contribution from the Transport Sector to 2014 GHG Emissions, Wales

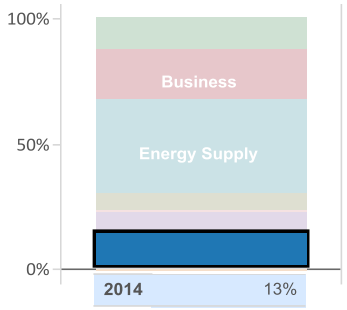


Figure 4.16: GHG Contribution for Transport Sector Emissions, 2014, Wales

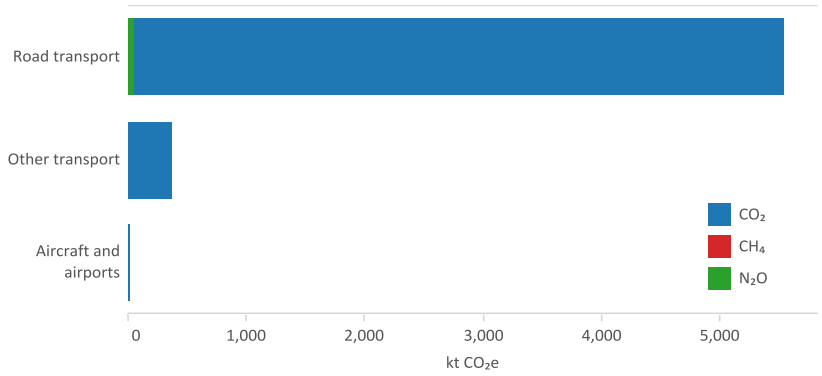


Figure 4.17: Total GHG Emissions from Transport Sector, Base Year to 2014, Wales

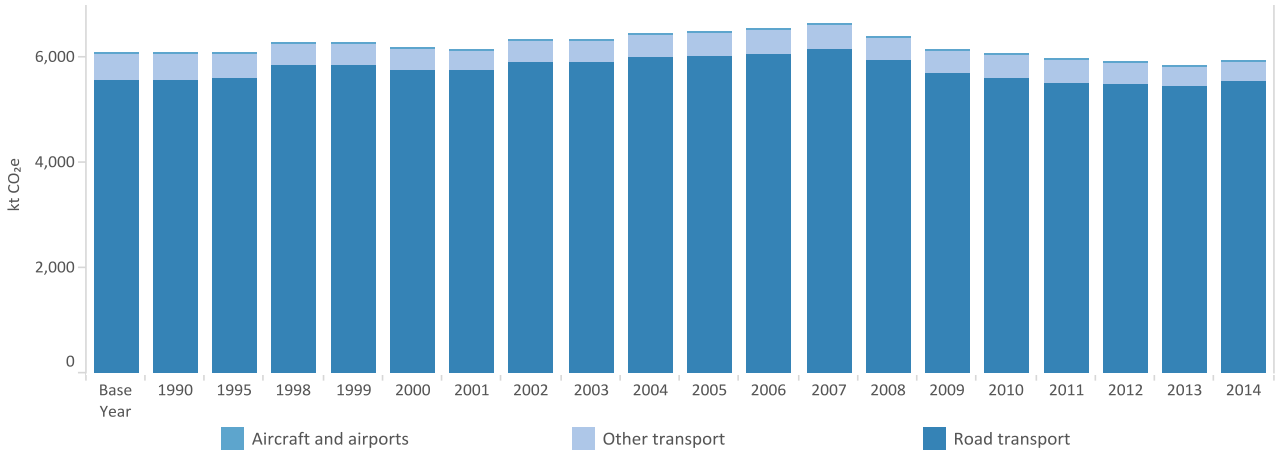


Table 4.4: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Transport Sector, Wales

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Road transport	1.7%	94.8	-0.6%	-31.5
Other transport	-4.0%	-15.3	-28.0%	-141.5
Aircraft and airports	-9.7%	-1.4	34.9%	3.4
Transport Sector Total	1.3%	78.2	-2.8%	-169.6

Figure 4.18 Road Transport CO_2 Emissions, Wales

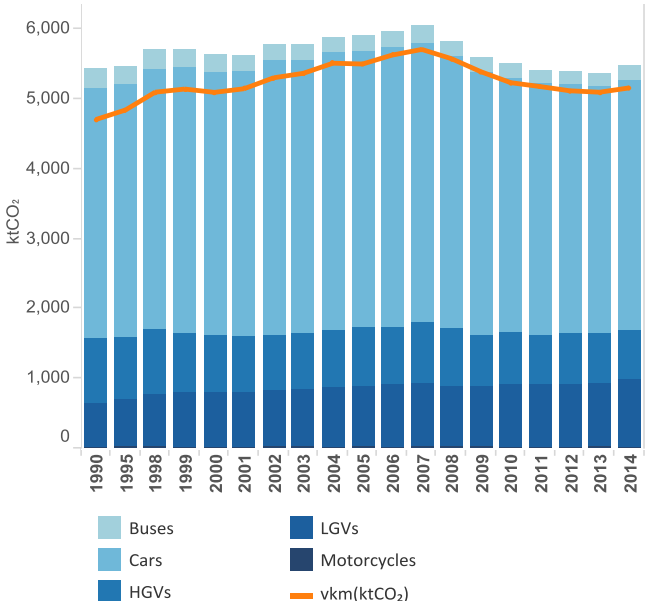
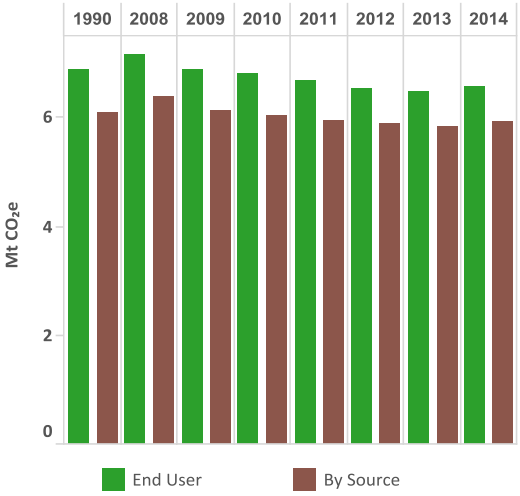


Figure 4.19: Comparison of End User and By Source for Transport Sector, Wales



By Source Emissions

Overview

Transport emissions account for 13% of Wales' total GHG emissions in 2014. Transport emissions are dominated by emissions from road transport with 94% of all transport emissions in 2014, and 61% of transport emissions from cars alone (see Figure 4.18). The Transport sector also includes small contributions 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 3% between the Base Year and 2014 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 2013 and 2014 increased by 1% (see Table 4.4). This sector is driven by the changes in emissions from passenger cars. Although emissions from petrol have remained relatively stable since 2013, emissions from road diesel (DERV) have increased, leading to a slight increase 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, 2015b); 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 4.18 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. The differences between the two approaches have changed when comparing to last year's DA GHG inventory (Salisbury et al., 2015), resulting from a change in the methodology to estimate fuel consumption at the UK level. The differences are larger in the early part of the time series (14% in 1990) but gradually improve over the time (6% in 2014) for Wales.

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 4.19).

The trend in End User emissions since 1990 shows a decline of 4.5% to 2014, which is a slightly larger reduction than reported in the By Source inventory (3%), 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 4.20: Overall Contribution from the Residential Sector to 2014 GHG Emissions, Wales

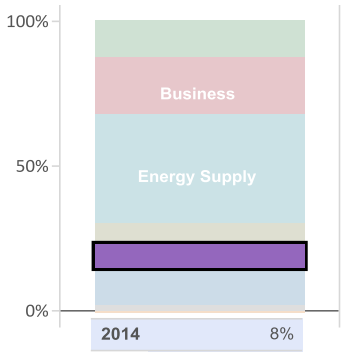


Figure 4.21: GHG Contribution for Residential Sector Emissions, 2014, Wales

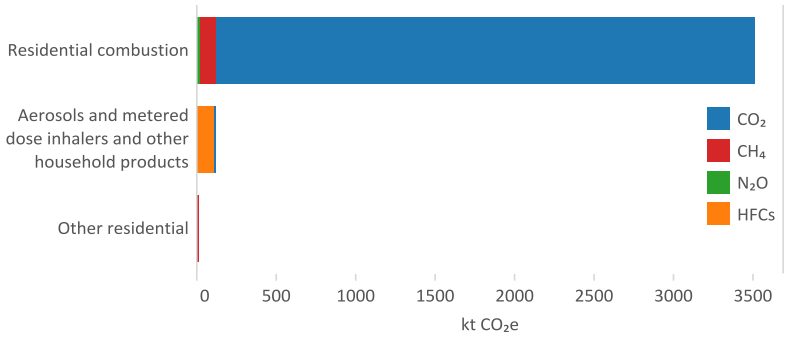
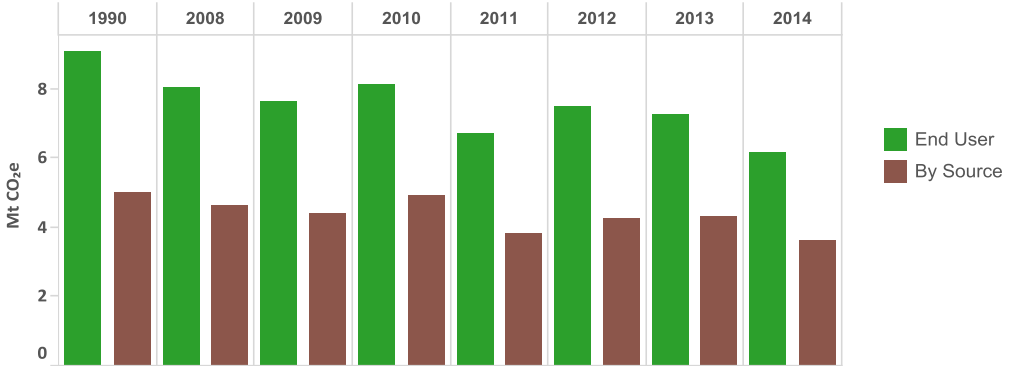


Figure 4.22: Total GHG Emissions from Residential Sector, Base Year to 2014, Wales

Table 4.5: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Residential Sector, Wales

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Aerosols and metered dose inhalers and other household products	1.7%	1.9	230.3%	79.4
Other residential	9.2%	0.2	112.2%	1.0
Residential combustion	-15.9%	-666.4	-29.5%	-1,470.8
Residential Sector Total	-15.5%	-664.3	-27.7%	-1,390.4

Figure 4.23: Comparison of End User and By Source for Residential Sector, Wales



Overview of Emissions

Overview

Figures 4.20 – 4.23 show detailed emissions and trends for the sector. The Residential sector accounts for 8% of Wales' total emissions in 2014. The sector is dominated by emissions from residential stationary and mobile combustion of fuels from activities such as 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 28% between the Base Year and 2014 (see Table 4.5) partly due to a change in the fuel mix from coal towards natural gas. The recent sector emission trends reflect mean annual temperatures, with a very cold year in 2010 and the warmest year since 2006 in 2014 (MetOffice, 2014).

Emissions on an End User Basis

In 2014, Wales End User emissions for the Residential sector are 170% of the By Source emission estimates, reflecting the high consumption of electricity in the sector (Figure 4.23). This increases the overall significance of this sector in the End User inventory to 15% 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 32% to 2014 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. 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).

4.5 Business Sector

Figure 4.24: Overall Contribution from the Business Sector to 2014 GHG Emissions, Wales

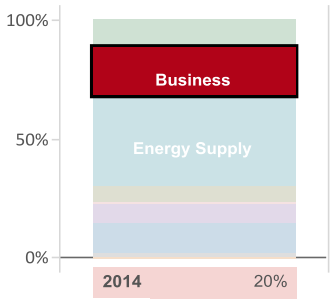


Figure 4.25: GHG Contribution for Business Sector Emissions, 2014, Wales

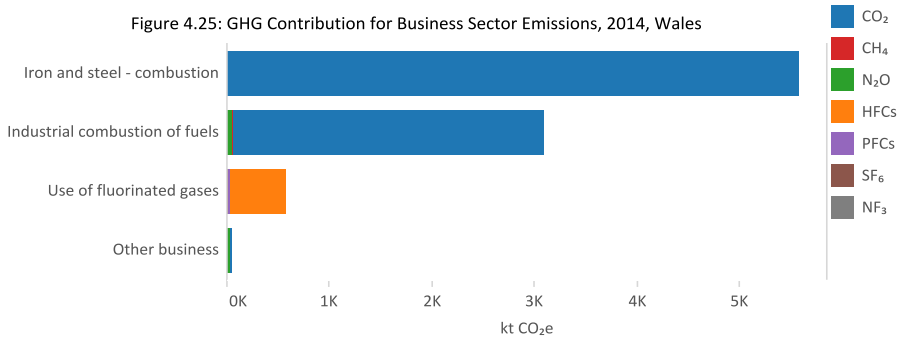


Figure 4.26: Total GHG Emissions from Business Sector, Base Year to 2014, Wales

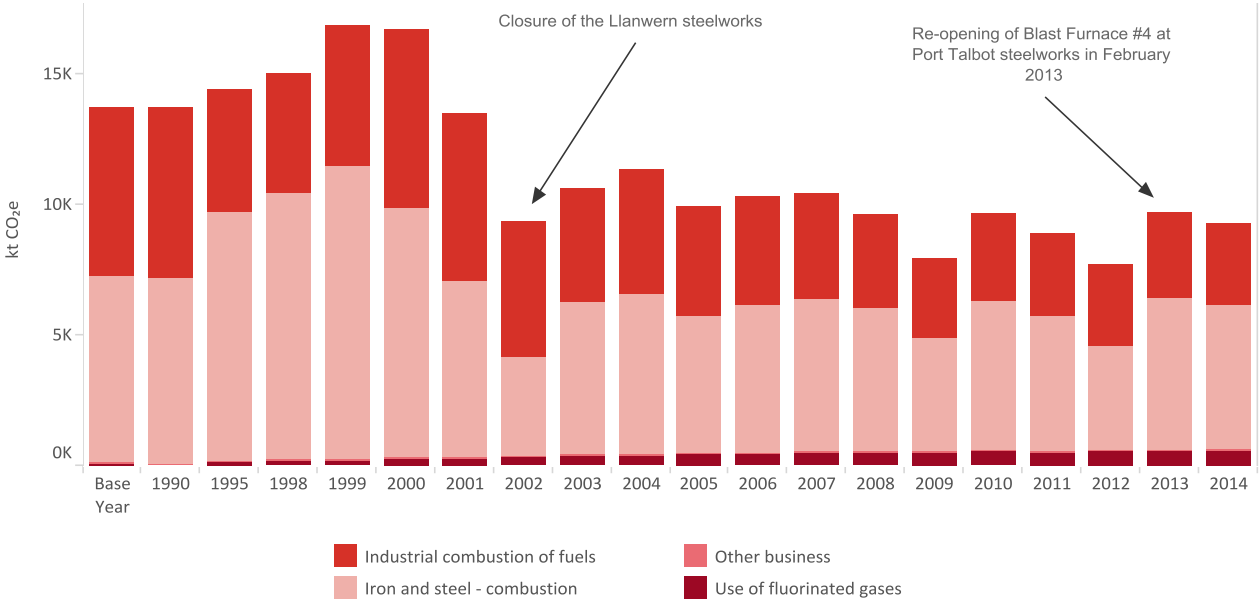
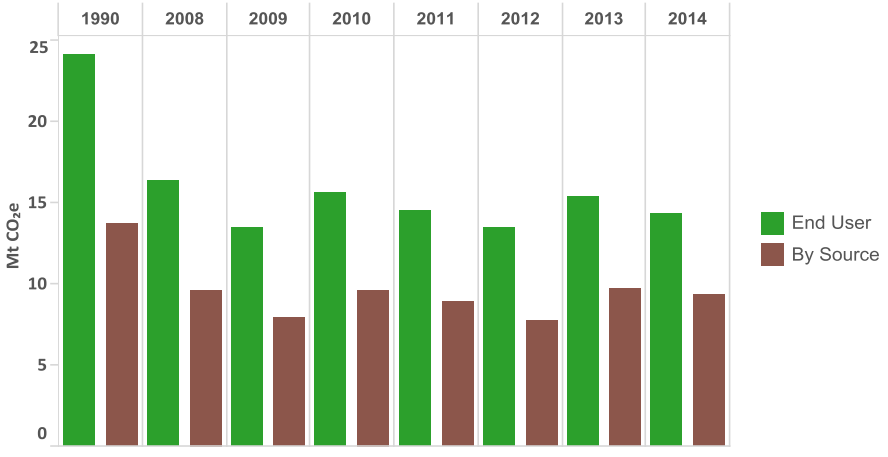


Table 4.6: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Business Sector, Wales

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Industrial combustion of fuels	-5.3%	-173.8	-52.4%	-3,403.1
Iron and steel - combustion	-4.4%	-254.0	-21.8%	-1,549.0
Use of fluorinated gases (including refrigeration and air conditioning)	1.0%	5.4	514.8%	477.6
Other business	15.5%	5.6	53.8%	14.6
Business Sector Total	-4.3%	-416.8	-32.5%	-4,459.9

Figure 4.27: Comparison of End User and By Source for Business Sector, Wales



By Source Emissions

Overview

Figures 4.24-4.27 show detailed emissions and trends for the sector. The Business sector contributed 20% to total GHG emissions in 2014. The Business sector in 2014 included emissions from iron and steel fuel combustion (60% of total emissions), other industrial combustion of fuels (33% of total emissions); use of fluorinated gases (6% of total emissions), including refrigeration and air conditioning, and other business emissions (0.5% of total emissions).

In 2014, 93% 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 32% 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 from the use of fluorinated gases were negligible in 1990 and have risen to account for 6% of the sector total in 2014. This is due to the introduction of these gases as replacements to CFCs banned by the Montreal Protocol.

The 26% increase in emissions between 2012 and 2013 was driven largely by the restart of Tata Steel's Port Talbot No.4 Blast Furnace in February 2013. Emissions decreased by 4% between 2013 and 2014 mainly due to a fall in emissions from blast furnace gas. 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 2014, Wales' End User emissions for the Business sector were 154% of the By Source emission estimates, reflecting the high consumption of electricity for heating, lighting and operating equipment in the sector (see Figure 4.27). On an End User basis, therefore, the Business sector represented 36% of total emissions in 2014 compared to just 20% of the By Source inventory total. The trend in the Business sector End User emissions since 1990 shows a decline of 41% to 2014.

4.6 Public Sector

Figure 4.28: Overall Contribution from the Public Sector to 2014 GHG Emissions, Wales

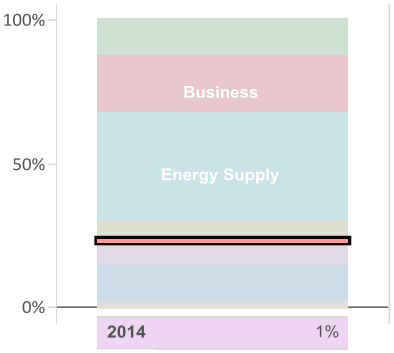


Figure 4.29: GHG Contribution for Public Sector Emissions, 2014, Wales

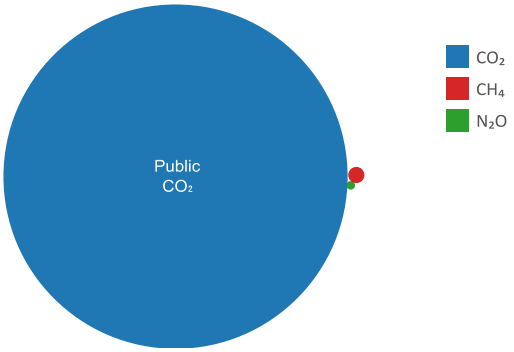


Figure 4.30: Total GHG Emissions from Public Sector, Base Year to 2014, Wales

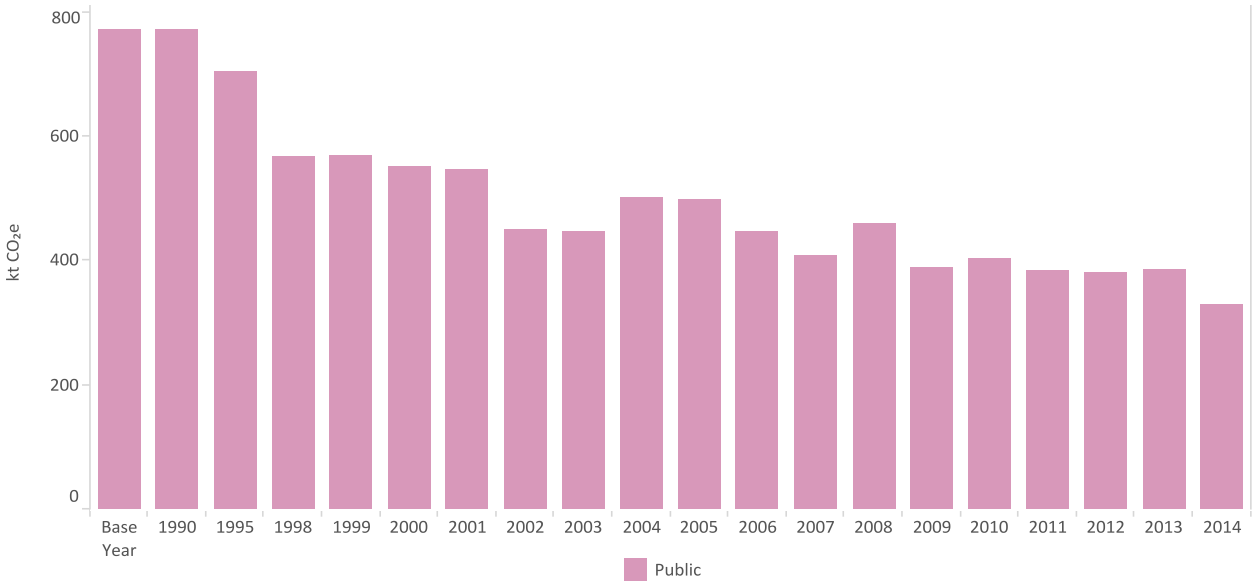
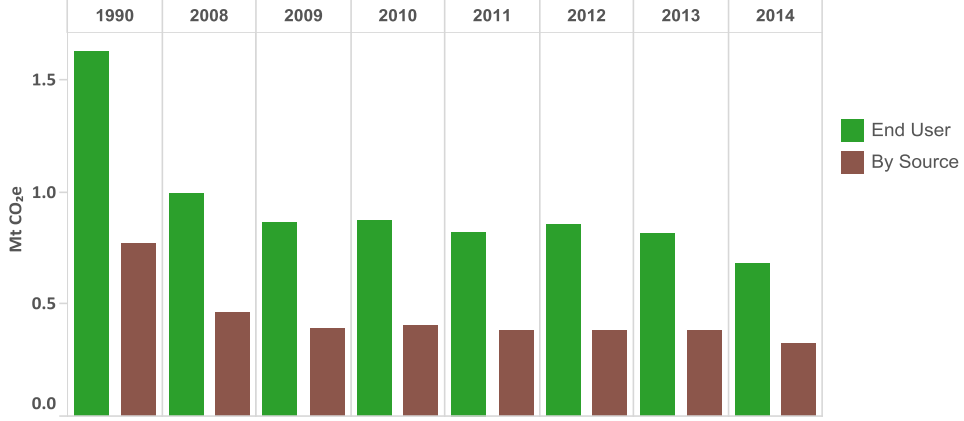


Table 4.7: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Public Sector, Wales

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Public	-14.8%	-57.0	-57.4%	-442.9
Public Sector Total	-14.8%	-57.0	-57.4%	-442.9

Figure 4.31: Comparison of End User and By Source for Public Sector, Wales



By Source Emissions

Overview

Emissions from Public sector combustion accounted for 1% of GHG emissions in Wales in 2014. Carbon dioxide emissions from the combustion of fossil fuels accounted for over 99% of emissions in 2014. 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 57% 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 decreased by 15% between 2013 and 2014 primarily due to decreased consumption of natural gas in the sector.

Emissions on an End User Basis

In 2014, Wales' End User emissions for the Public sector were 208% of 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 0.7% in the By Source inventory to 1.7% in the End User inventory for 2014 (see Figure 4.31). The trend in End User emissions since 1990 shows a decline of 58% to 2014, 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 4.32: Overall Contribution from the Industrial Process Sector to 2014 GHG Emissions, Wales

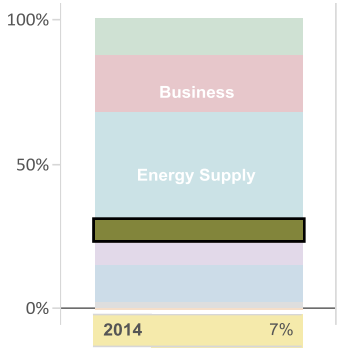


Figure 4.33: GHG Contribution for Industrial Process Sector Emissions, 2014, Wales

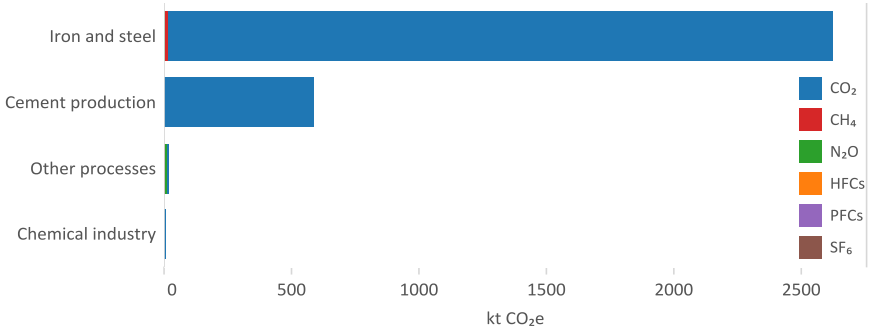


Figure 4.34: Total GHG Emissions from Industrial Process Sector, Base Year to 2014, Wales

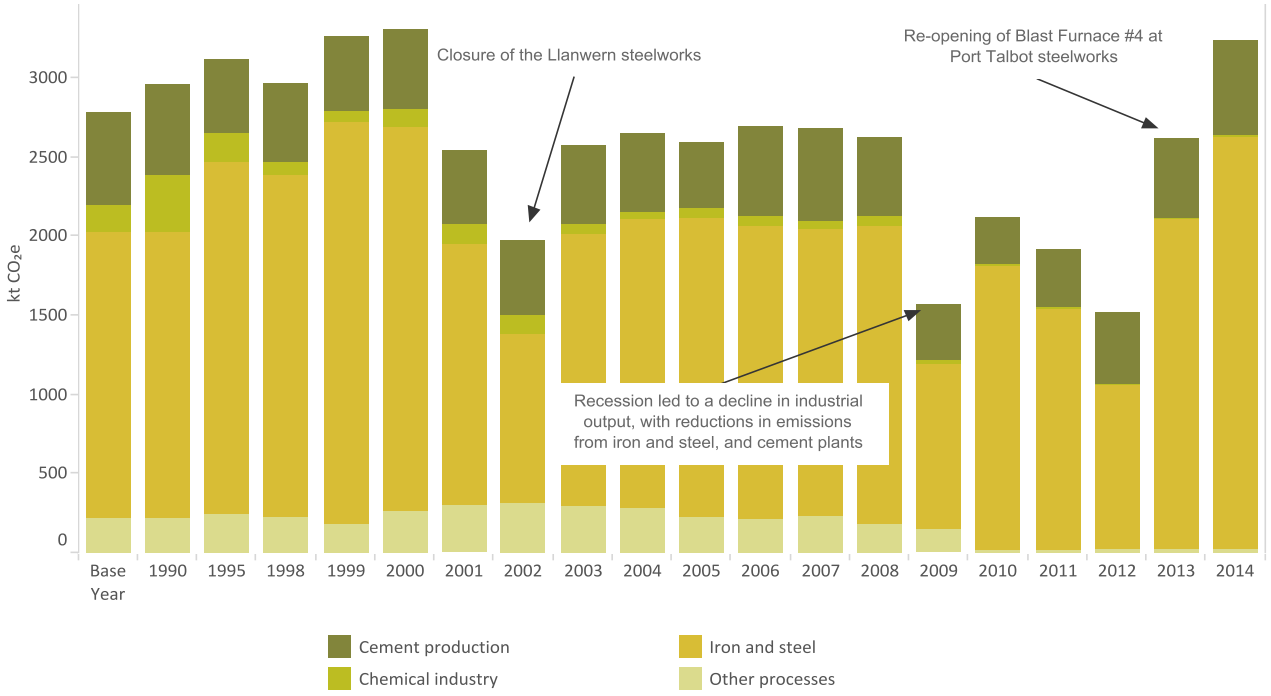


Table 4.8: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Industrial Process Sector, Wales

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Cement production	17.7%	88.5	2.3%	13.0
Other processes	0.7%	0.1	-92.5%	-208.9
Chemical industry	6.8%	0.0	-99.6%	-178.2
Iron and steel	24.7%	520.1	46.0%	826.7
Industrial Process Sector Total	23.2%	608.8	16.3%	452.7

By Source Emissions

Overview

In 2014, the Industrial Process sector contributed 7% 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 (such as sinter production and flaring) 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 2014, 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 4.33).

Features of the Trends

Overall, Industrial Process emissions in Wales have increased by 16% between the Base Year and 2014 (see Table 4.8) but have shown significant fluctuations during this timeframe reflecting manufacturing output and abatement installations. The overall trend is volatile depending on manufacturing output.

Total GHG emissions have increased by 23% between 2013 and 2014. 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. 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 2014, the End User estimates are only 3% 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 4.35: Overall Contribution from the Agriculture Sector to 2014 GHG Emissions, Wales

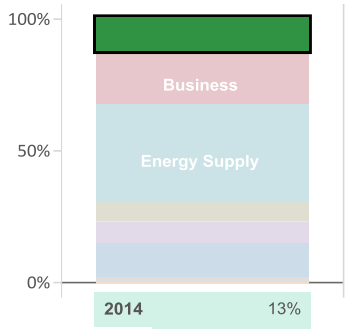


Figure 4.36: GHG Contribution for Agriculture Sector Emissions, 2014, Wales

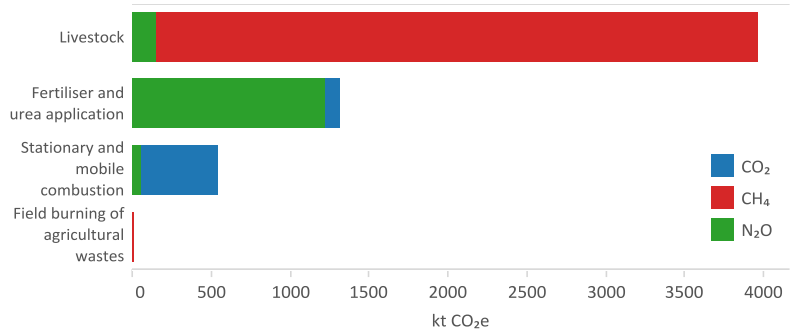


Figure 4.37: Total GHG Emissions from Agriculture Sector, Base Year to 2014, Wales

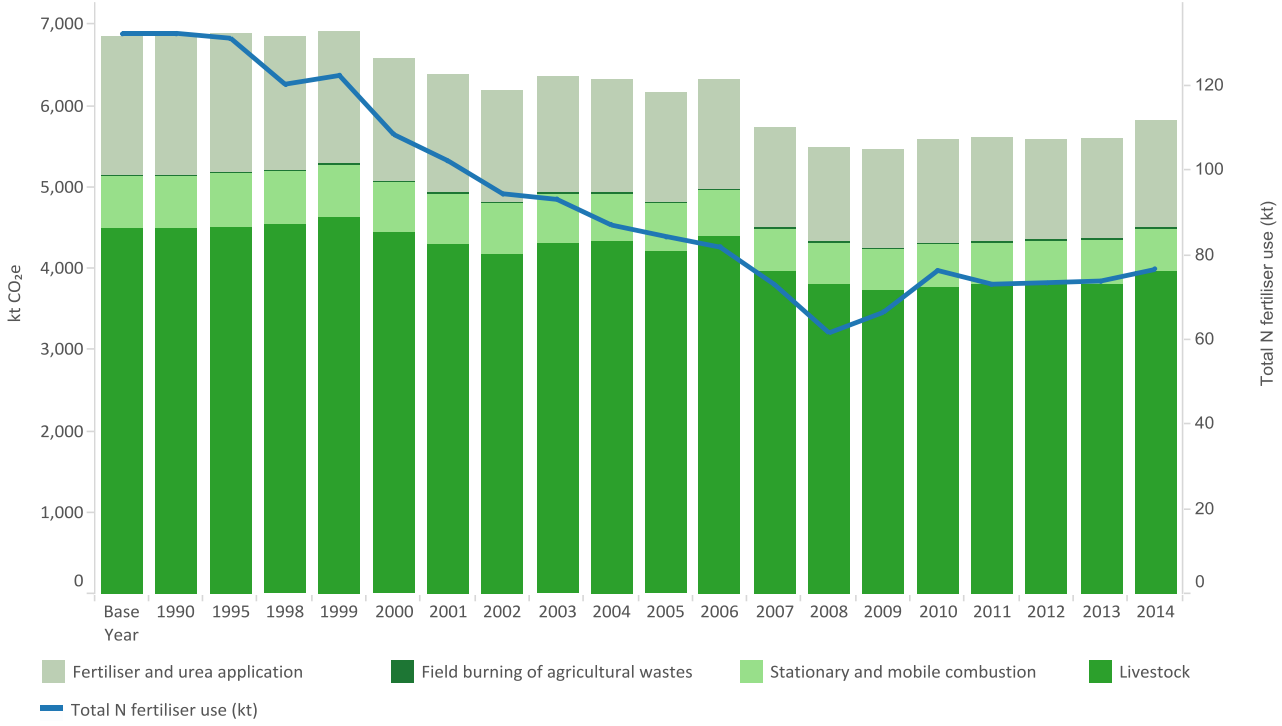
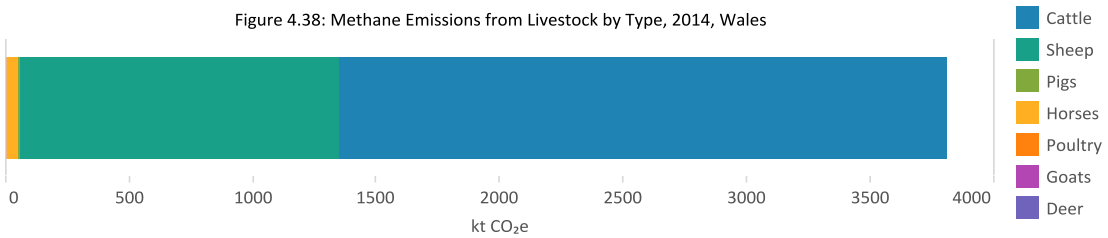


Table 4.9: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Agriculture Sector, Wales

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Fertiliser and urea application	6.2%	76.2	-22.1%	-372.4
Field burning of agricultural wastes	N/A	0.0	-100.0%	-2.0
Livestock	3.9%	147.7	-11.6%	-519.7
Stationary and mobile combustion	-1.9%	-10.4	-19.7%	-132.8
Agriculture Sector Total	3.8%	213.6	-15.0%	-1,027.0

Figure 4.38: Methane Emissions from Livestock by Type, 2014, Wales



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 and liming (see Figure 4.36). The Agriculture sector accounted for 13% of total greenhouse gas emissions in Wales in 2014, and is the most significant source sector for methane and nitrous oxide, accounting for 71% and 82% of total Welsh emissions of these two gases, respectively.

Features of the Trends

Emissions from the Agriculture sector have decreased by 15% between the Base Year and 2014, with methane and nitrous oxide emissions decreasing by 11% and 21%, respectively. The trends result from a general decline in livestock numbers and in nitrogen fertiliser use. There was an increase in Agriculture sector emissions between 2013 and 2014 of 4% and this is due to an increase in fertiliser use and an increase in the number of dairy cattle and 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 65% of all agricultural methane emissions. Total emissions from sheep were 34% of the total methane from Agriculture in 2014.

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 86% of the total nitrous oxide emissions in the Agriculture sector arose from agricultural soils. This source accounted for 70% of total nitrous oxide emissions in 2014.

Emissions on an End User Basis

As 91% of emissions in the Agriculture sector in 2014 were not due to energy consumption, Agriculture sector emissions on an End User basis are very similar to the emissions By Source. In 2014, 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 4.39: Overall Contribution from the Land Use Change Sector to 2014 GHG Emissions, Wales

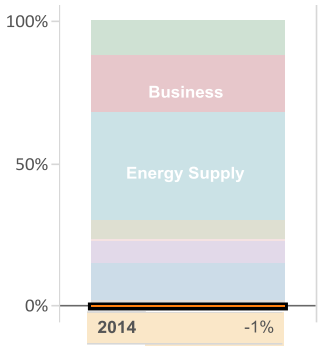


Figure 4.40: GHG Contribution to Land Use Change Sector Emissions, 2014, Wales

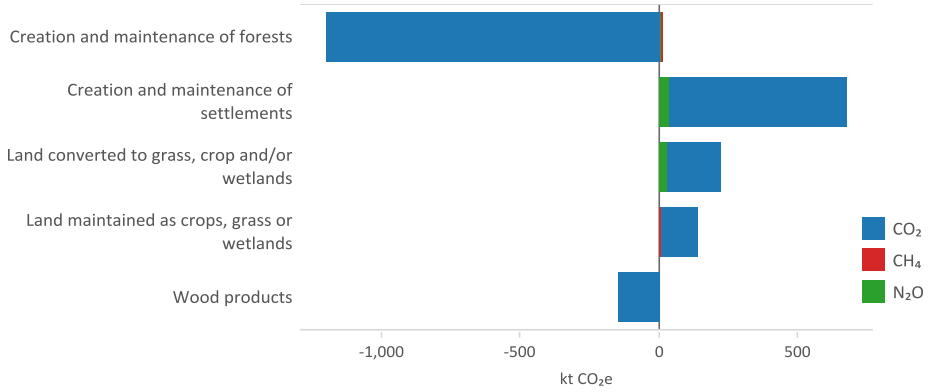


Figure 4.41: Total GHG Emissions from LULUCF Sector, Base Year to 2014, Wales

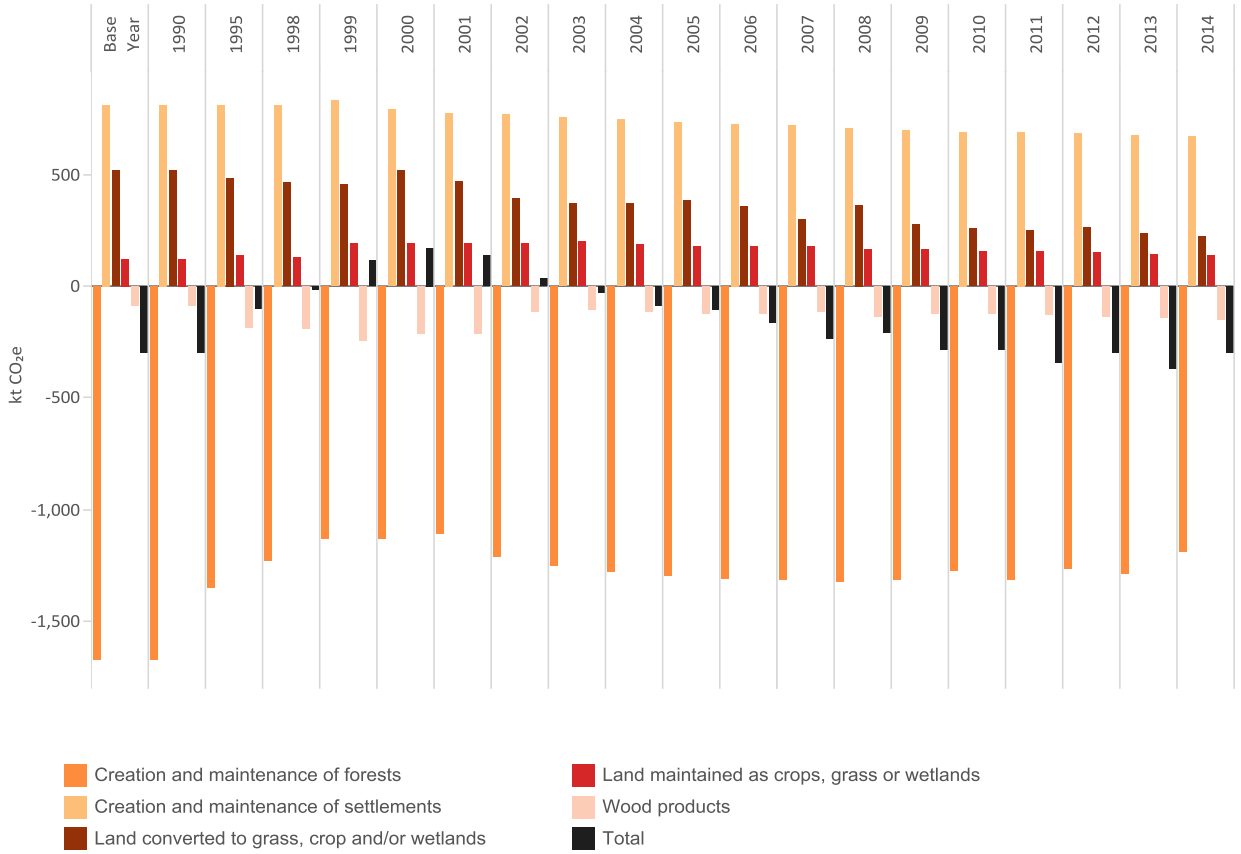


Table 4.10: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the LULUCF Sector, Wales

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Creation and maintenance of settlements	-0.8%	-5.4	-17.7%	-144.7
Creation and maintenance of forests	7.7%	99.3	29.1%	487.4
Land converted to grass, crop and/or wetlands	-4.4%	-10.3	-56.8%	-296.9
Land maintained as crops, grass or wetlands	-2.4%	-3.5	14.4%	17.7
Wood products	-8.1%	-11.2	-76.6%	-64.4
Land Use Change Sector Total	18.9%	68.9	-0.3%	-1.0

By Source Emissions

Overview

Figures 4.39 – 4.41 and Table 4.10 show detailed emissions and trends for the Land Use, Land Use Change and Forestry (LULUCF) sector. In 2014, Wales was a net sink of greenhouse gases from LULUCF activities removing 296 $ktCO_2e$. 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 1,187 $ktCO_2e$.

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

Features of the Trends

Table 4.10 shows a 19% decrease in net removal of CO_2e from LULUCF between 2013 and 2014 (a decrease in the size of the sink), along with the trends in emissions and removals from important activities in the LULUCF sector. The decrease in the size of the sink between 2013 and 2014 is primarily due to a reduction in the carbon stock in forests.

Wales was a net sink of GHG emissions in 1990, a net source between 1999 and 2002 and a net sink of GHG emissions for the remainder of the time series. The size of this sink (CO_2e removal) has grown between 2003 and 2014 from -28 $ktCO_2e$ to -296 $ktCO_2e$. This is predominantly due to a reduction in emissions from land converted to cropland and settlements. The sink decreased by 19% between 2013 and 2014 due predominantly to a reduction in the carbon stock in forests.

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 4.42: Overall Contribution from the Waste Management Sector to 2014 GHG Emissions, Wales

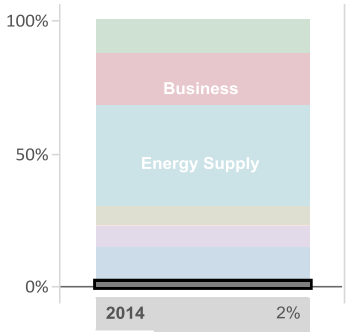


Figure 4.43: GHG Contribution for Waste Management Sector Emissions, 2014, Wales

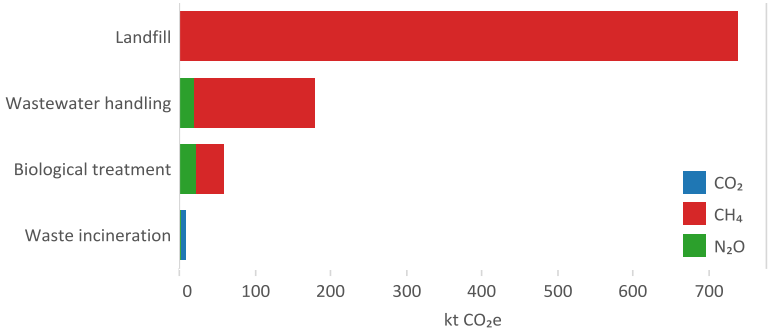


Figure 4.44: Total GHG Emissions from Waste Management Sector, Base Year to 2014, Wales

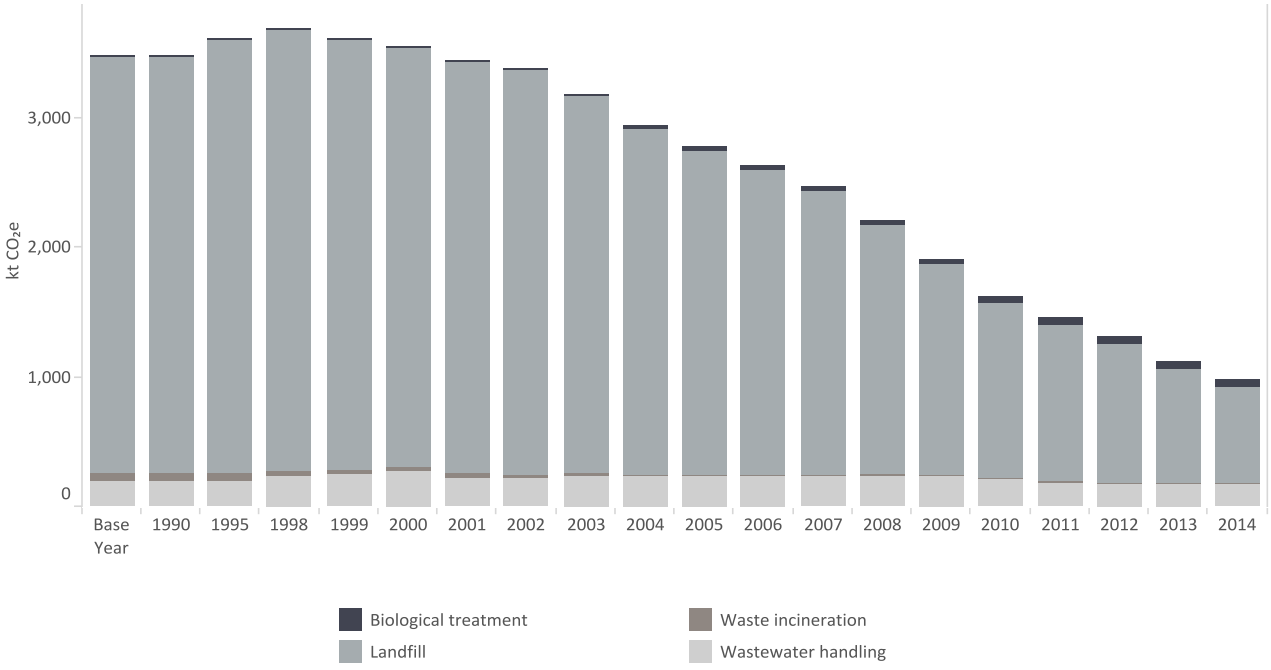


Table 4.11: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Waste Management Sector, Wales

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Landfill	-15.8%	-138.4	-77.0%	-2,479.4
Waste incineration	-2.5%	-0.2	-85.5%	-50.6
Wastewater handling	4.4%	7.6	-10.4%	-20.8
Biological treatment	9.8%	5.3	N/A	59.4
Waste Management Sector Total	-11.3%	-125.8	-71.6%	-2,491.4

By Source Emissions

Overview

In 2014, the Waste Management sector contributed 2% to total GHG emissions in Wales. It represented 17% of total methane emissions. Emissions from this sector are dominated by methane from landfill (75% 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 4.43). Nitrous oxide emissions from wastewater treatment represented 2% of emissions in the sector, and contributed 1% 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 72% in total for the sector and by 77% for landfill between the Base Year and 2014, as shown in Table 4.11, 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 2013 and 2014, which has been the primary driver for the overall decrease of 11% 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 (1990-2014)

5.1 Overview of Total Emissions

By Source Emissions

The greenhouse gas (GHG) emissions for Northern Ireland for 1990 – 2014 are presented in Figure 5.1 and in Table 5.1 below.

Figure 5.1: Total GHG Emissions by NC Category for Base Year to 2014, as kt CO_2e, Northern Ireland

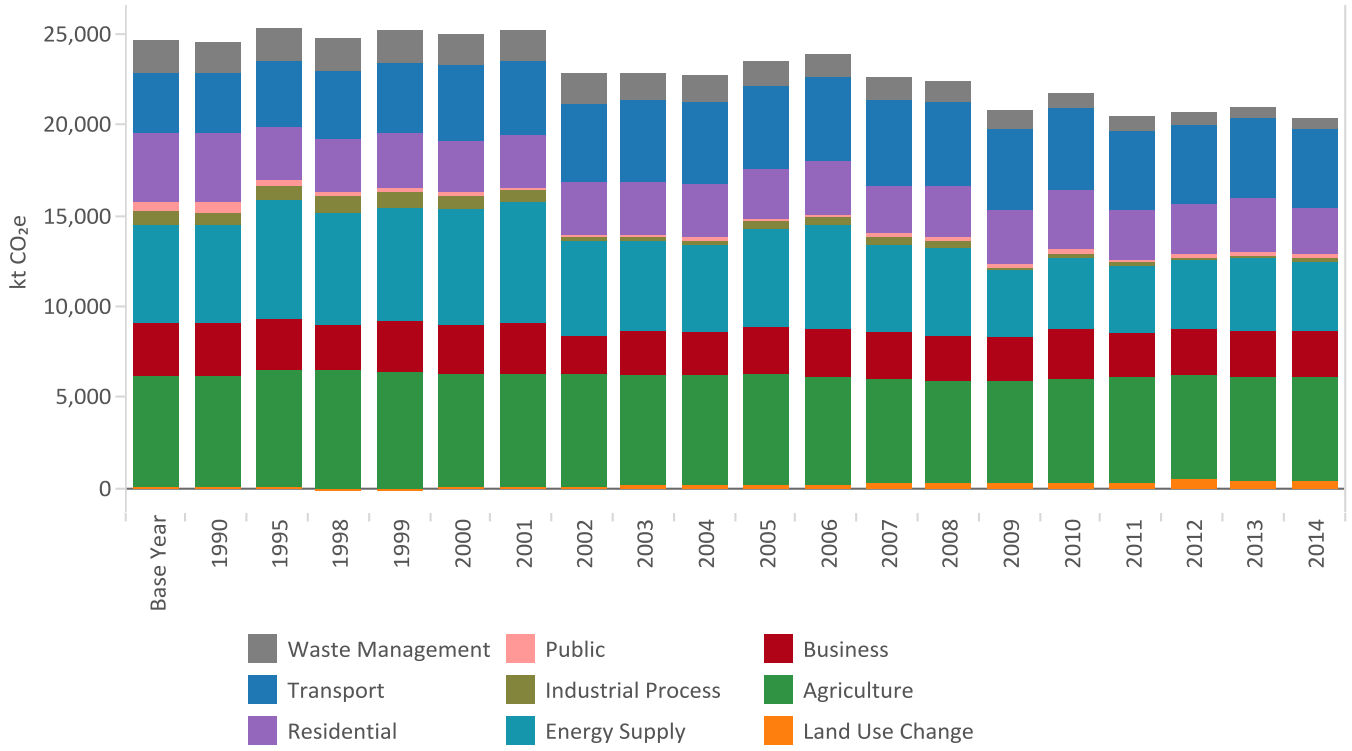
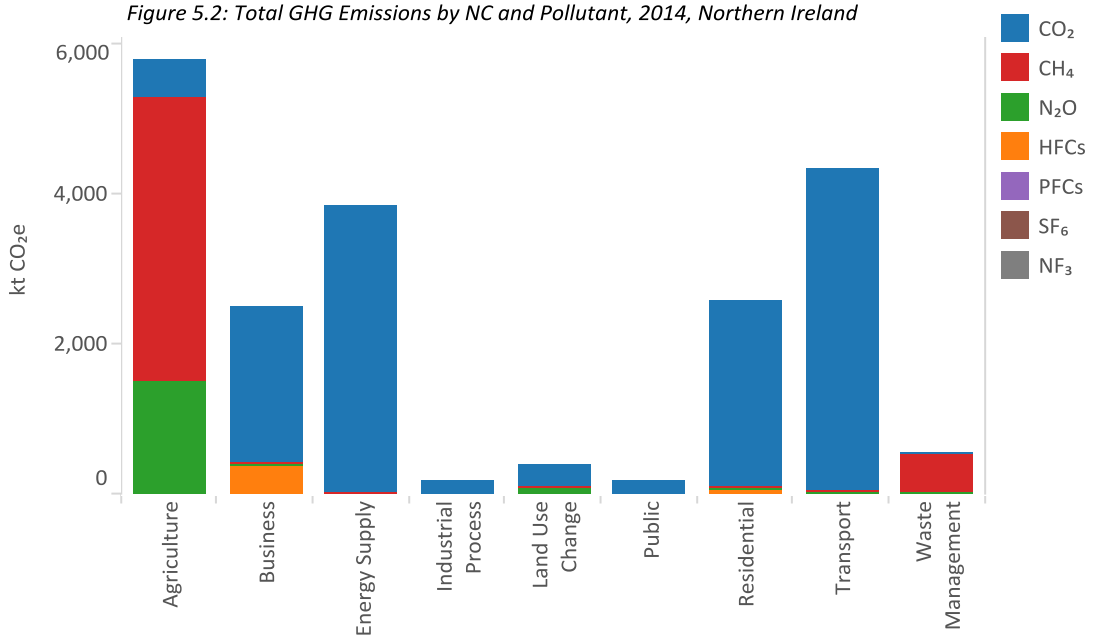


Table 5.1: 1990-2014 Northern Ireland GHG Emission Inventory ($ktCO_2e$)

NC Format	Base Year	1990	1995	2000	2005	2008	2009	2010	2011	2012	2013	2014	% of 2014	BY-2014
Agriculture	6,098	6,098	6,432	6,233	6,083	5,676	5,654	5,756	5,783	5,821	5,818	5,780	28%	-5%
Business	2,910	2,898	2,813	2,742	2,629	2,435	2,375	2,718	2,416	2,391	2,446	2,498	12%	-14%
Energy Supply	5,365	5,365	6,610	6,406	5,350	4,841	3,688	3,968	3,753	3,880	4,073	3,838	19%	-28%
Industrial Process	758	758	763	666	421	402	179	172	164	163	149	182	1%	-76%
LULUCF	117	117	36	36	217	274	290	307	343	508	375	397	2%	239%
Public	486	486	321	185	179	206	204	200	193	195	200	186	1%	-62%
Residential	3,843	3,824	2,951	2,905	2,680	2,861	2,879	3,316	2,679	2,732	2,969	2,564	13%	-33%
Transport	3,327	3,327	3,577	4,078	4,603	4,588	4,592	4,476	4,334	4,314	4,316	4,338	21%	30%
Waste Management	1,702	1,702	1,802	1,726	1,377	1,126	970	841	764	701	604	544	3%	-68%
Total	**24,605**	**24,575**	**25,306**	**24,978**	**23,538**	**22,409**	**20,831**	**21,754**	**20,429**	**20,705**	**20,951**	**20,327**	**100%**	**-17%**

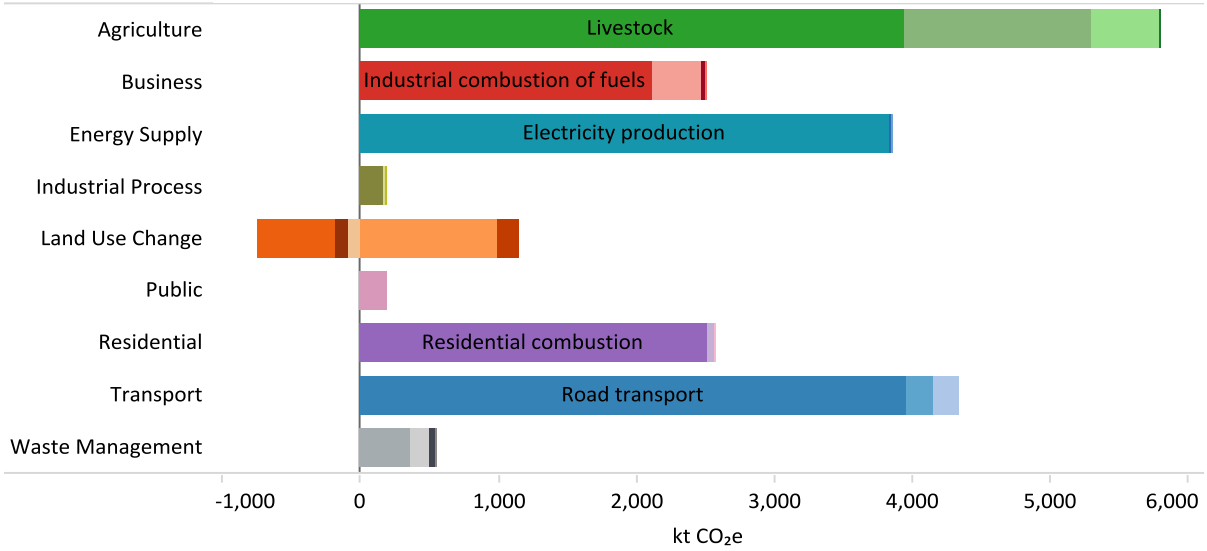
Carbon dioxide is the most common gas emitted for all National Communication (NC) categories except the Agriculture sector, where methane from livestock and nitrous oxide from soils dominate, and for Waste Management, where methane from landfills is the most important gas (see Figure 5.2).

Figure 5.2: Total GHG Emissions by NC and Pollutant, 2014, Northern Ireland



The largest sources of emissions in 2014 include electricity production (19% of total GHGs), livestock emissions (19% of total GHGs), road transport (19% of total GHGs), residential combustion for heating and cooking (12% of total GHGs) and crop growing and fertilizer application (7% of total GHGs) as seen in Figure 5.3. The detailed breakdown of each sector can be found in the sector-specific sections of this report.

Figure 5.3: Total GHG Emissions Labelling the Largest Sub-Category in each NC, 2014, Northern Ireland



Trends

Figure 5.4 shows the change in emissions from the Base Year and 2013 to the latest year, 2014. Total GHG emissions for Northern Ireland remained relatively stable between 2013 and 2014 showing a decrease of 3%. Emissions have decreased between the Base Year[23] and 2014 by 17%.

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

- **Energy Supply** sector emissions have reduced by 28% between the Base Year and 2014 as a result of energy efficiency and switching from coal to gas for electricity generation. Emissions have decreased between 2013 and 2014 by 6%, primarily due to a reduction in emissions from coal burning power stations for public electricity and heat production.

- **Transport** sector emissions have increased by 30% since the Base Year due to growth in transport demand over the period. Emissions between 2013 and 2014 have remained relatively stable (0.5% increase).

- **Residential** sector emissions have, generally, decreased since the Base Year to 2014 (33% overall decrease) due to fuel-switching to take advantage of natural gas supply from the late 1990s displacing more carbon-intensive fuels such as oil. Emissions have fluctuated over recent years, reflecting variations in mean annual temperatures and the impacts on heating demand as a result. Emissions decreased by 14% between 2013 and 2014 due a decrease in the combustion of fuels such as coal and biomass.

- **Business** sector emissions have reduced by 14% since the Base Year reflecting the impacts of a gradual switch to natural gas over the last 15 years. Emissions slightly increased by 2% between 2013 and 2014 caused by an increase in emissions from coal combustion.

- **Public** sector emissions have reduced by 62% since the Base Year. This is due to increased energy efficiency measures and the switch to gas-fired heating. Emissions between 2013 and 2014 decreased by 7%.This is linked to increased annual mean temperatures and reduced gas consumption.

- **Industrial Process** emissions have decreased by 76% 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 increased by 22% between 2013 and 2014 due to an increase in emissions from cement production.

- **Agriculture** sector emissions have reduced by 5% since the Base Year mainly due to an overall decrease in livestock numbers and in fertilizer application. Emissions remained relatively stable between 2013 and 2014, decreasing by less than 1%.

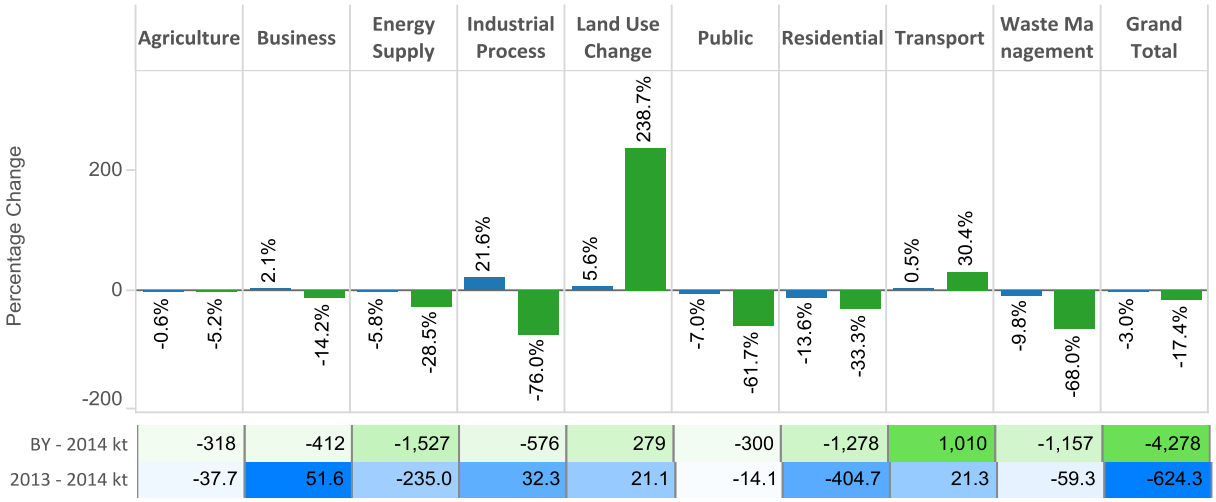
- **LULUCF** sector has been a source of emissions since the Base Year. Emissions slightly increased (6%) between 2013 and 2014 due to a slight reduction in the sink from the creation and maintenance of forests and a slight increase in emissions from the creation and maintenance of settlements.

- **Waste Management** sector emissions have significantly declined by 68% since the Base Year, largely due to the progressive introduction of methane capture and oxidation systems within landfill management. Emissions decreased by 10% between 2013 and 2014 in line with this decline.

[23] 1995 for fluorinated greenhouse gases (F-Gases) and 1990 for all other gases

Figure 5.4: Percentage Change and Absolute (kt CO_2e) Change in GHG Emissions by NC: 2013 - 2014 and Base Year (BY) - 2014, Northern Ireland

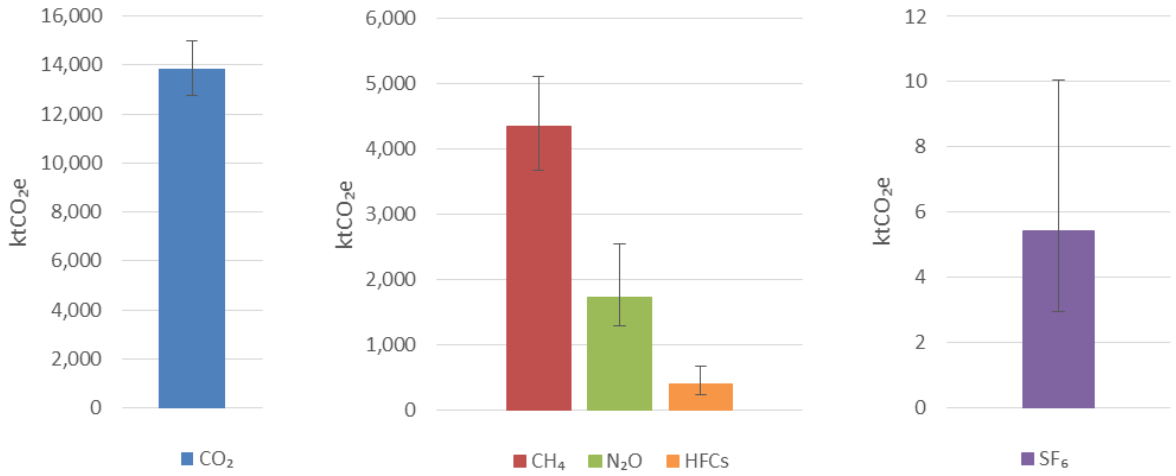
The LULUCF Base Year - 2014% change is excluded from the figure if LULUCF emissions changed from a sink to source, or source to sink, across the time series.



Uncertainty

Due to a relatively low contribution from carbon dioxide, a significant contribution from LULUCF sources, and more uncertain fuel activity data than the other DAs, the Northern Ireland inventory is relatively high in uncertainty. Northern Ireland also has the highest contribution from methane and nitrous oxide of all the DAs and these carry considerable uncertainty. Figure 5.5 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 Introduction and Appendix 1 for further details on uncertainties.

Figure 5.5: Total GHG emissions and uncertainties by pollutant, 2014, Northern Ireland



Recalculations

Revisions to the estimates since the last inventory report (Salisbury et al., 2015) have resulted in a 6.1% (1,401 $ktCO_2e$) increase in the 2013 estimates for Northern Ireland. The most significant revisions to the 2013 estimates have been for the following sectors:

1. **LULUCF (1,095 $ktCO_2e$ decrease)**: Correction of the emissions factor for Grassland on drained organic soils has increased the sink in this category. The correction of the CARBINE forest model output has decreased the sink and changed the trend in the Forest and Harvested Wood Product categories. Updated activity data on peat extraction has reduced the source from Wetlands. Other revisions have caused minor changes in the Cropland and Settlements categories.
2. **Agriculture (677 $ktCO_2e$ decrease)**: Emission factors for agricultural soil have been updated to include the implementation of UK-specific NO_2 emissions factors, which were previously based on standard non-UK specific values.
3. **Transport (227 $ktCO_2e$ increase):** New data from the Department for Transport for fuel consumption and methane have been used to update COPERT 4 emission factors as recommended in international guidelines, resulting in an increase in transport emissions. In addition, updated activity data have been used for the 2013 estimates in Northern Ireland.

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

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 2014. Emissions from installations in the EU ETS (see Figure 5.7) accounted for 22% of total GHG emissions in Northern Ireland in 2014; the main contributors to these traded emissions are the Energy Supply sector (of which 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, 2014, Northern Ireland

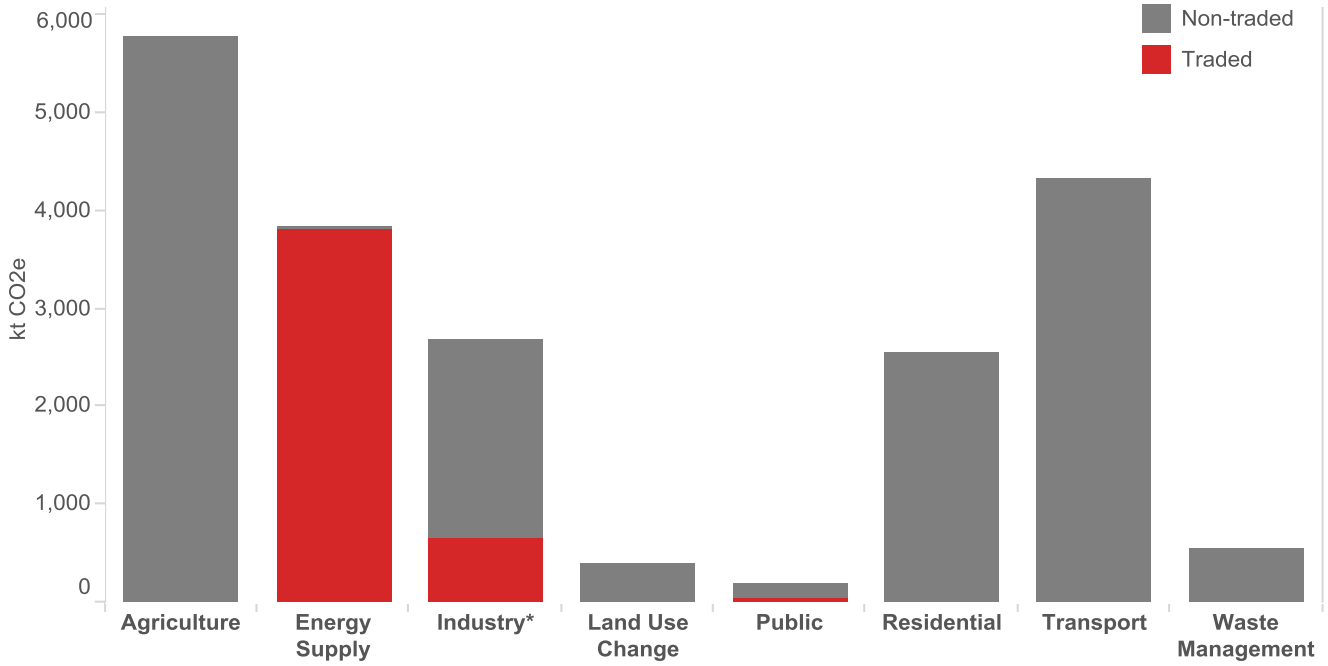


Figure 5.7: Total Traded and Non-Traded GHG Emissions 2008-2014, Northern Ireland

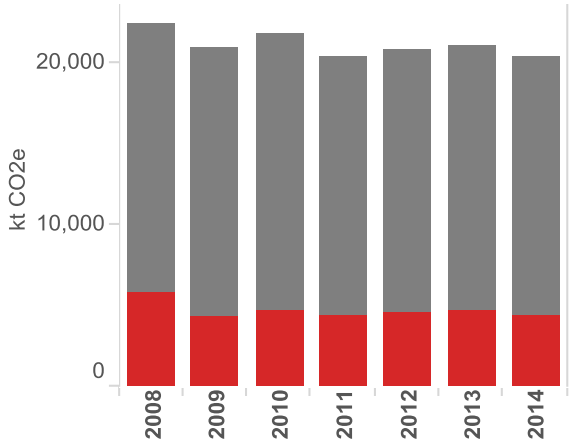
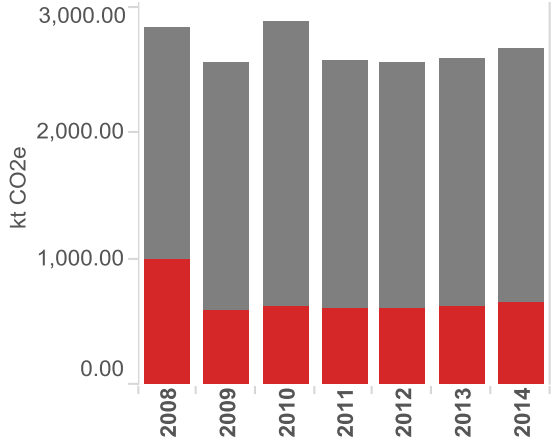


Figure 5.8: Traded and Non-Traded GHG Emissions from Industry 2008-2014, Northern Ireland*



*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 that on an End User basis, the contribution to Northern Ireland total emissions in 2014 are dominated by the Residential, Transport and Business sectors as well as the Agriculture sector. 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 (20.8 $MtCO_2e$) compared to By Source (20.3 $MtCO_2e$) inventory estimates for 2014.

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[24] GHG emission transfers for Northern Ireland in 2014 (Mt CO_2e)[25]

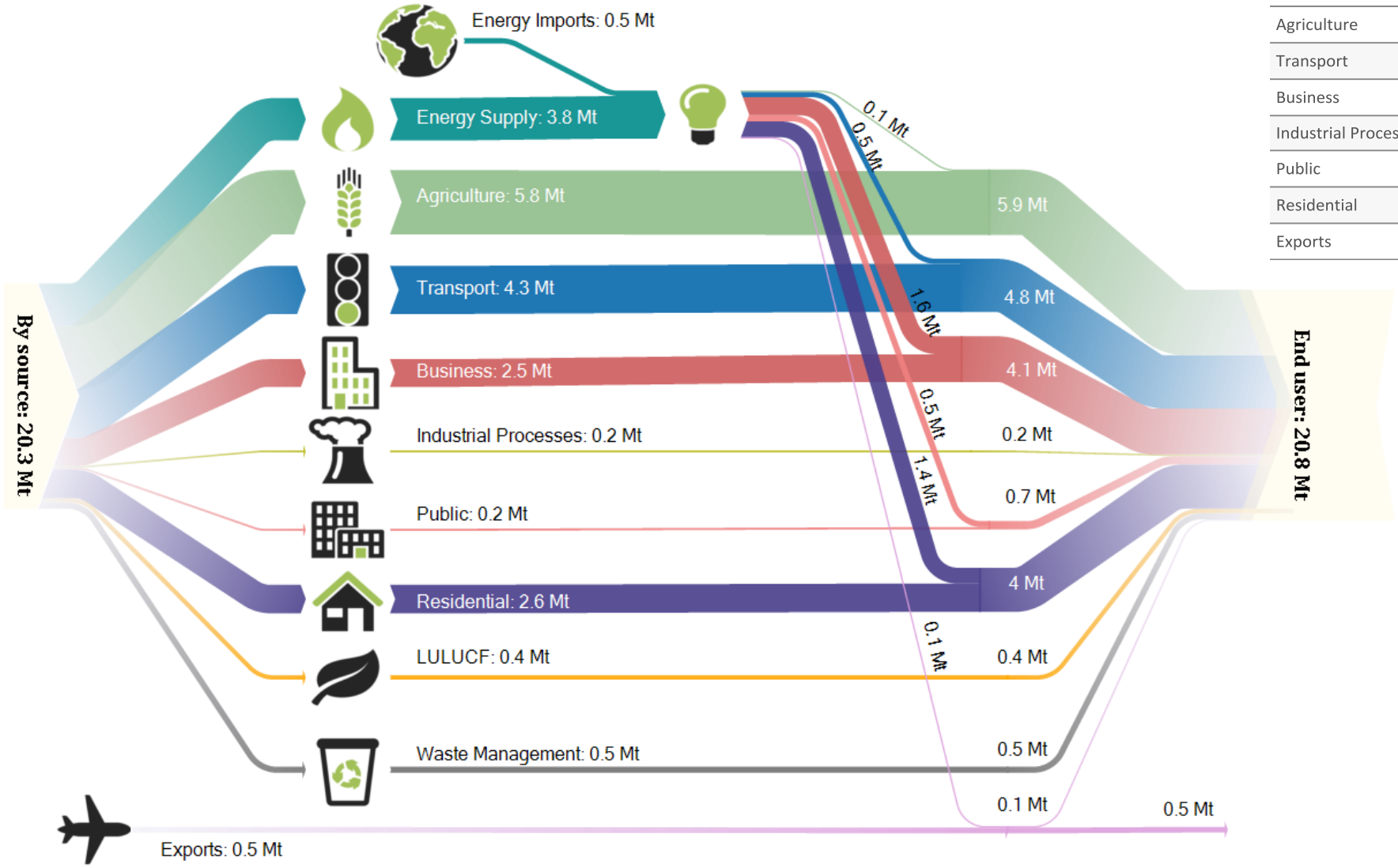


Table 5.2: NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions, Northern Ireland

Agriculture	2%
Transport	0%
Business	45%
Industrial Process	0%
Public	16%
Residential	35%
Exports	2%

[24] 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.

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

5.2 Energy Supply Sector

Figure 5.10: Overall Contribution from the Energy Supply Sector to 2014 GHG Emissions, Northern Ireland

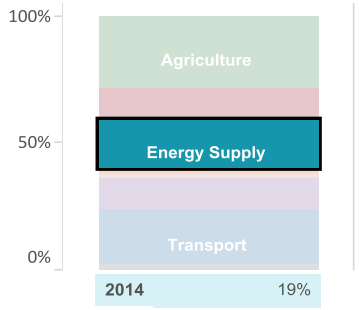


Figure 5.11: GHG Contribution to Energy Supply Sector Emissions, 2014, Northern Ireland

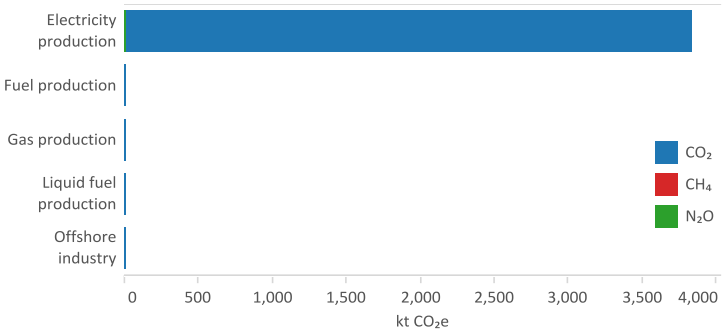


Figure 5.12: Total GHG Emissions from Energy Supply Sector, Base Year to 2014, Northern Ireland

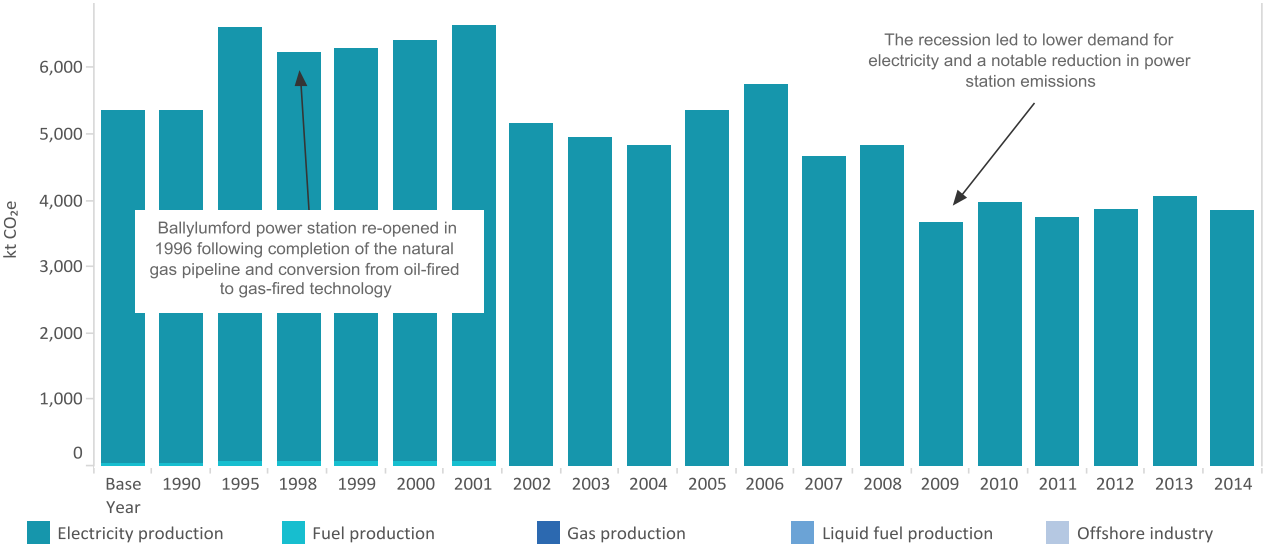


Table 5.3: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Energy Supply Sector, Northern Ireland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Electricity production	-5.8%	-235.1	-27.7%	-1,472.2
Gas production	17.4%	0.1	N/A	0.7
Liquid fuel production	N/A	0.0	N/A	0.0
Offshore industry	N/A	0.0	N/A	0.0
Fuel production	-1.8%	0.0	-99.9%	-55.2
Energy Supply Sector Total	-5.8%	-235.0	-28.5%	-1,526.7

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

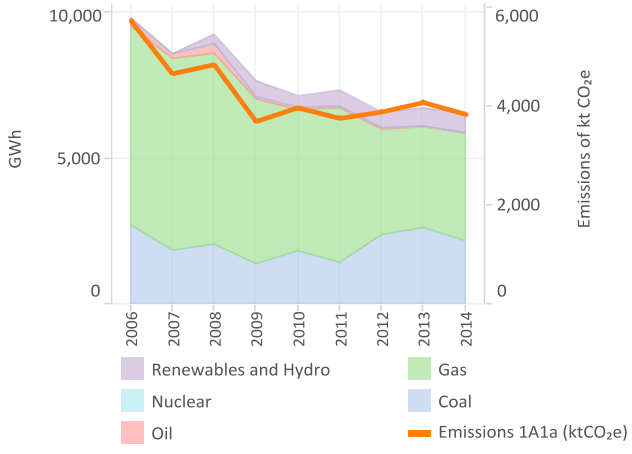
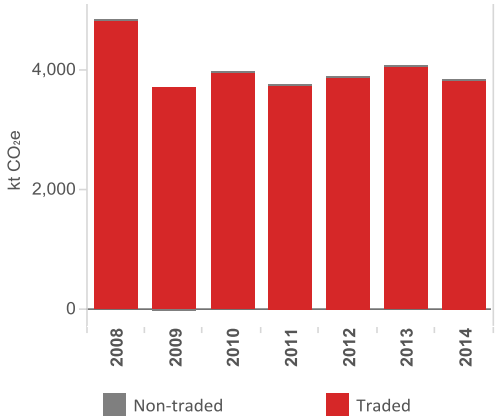


Figure 5.14: Traded and Non-Traded Energy Supply Sector Emissions, 2008-2014, Northern Ireland



By Source Emissions

Overview

In Northern Ireland, the Energy Supply sector contributes 19% to total 2014 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 28% between the Base Year and 2014 due to a reduction in the production of electricity (see Figure 5.13 above). Emissions have seen a reduction of 6% between 2013 and 2014, with the trend due mainly to a reduction in emissions from the combustion of coal in power stations.

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 2014; gas production accounts for less than 0.1% of emissions (see Figure 5.12). Carbon dioxide is the predominant gas accounting for over 99% of emissions from the Energy Supply sector in 2014 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

Emissions in the Energy Supply sector are dominated by installations that operate within the EU ETS, with 99% of emissions from traded (EU ETS) operations in 2014; these traded emissions are primarily from power stations.

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 and processed fuels, and hence the Energy Supply End User emissions are zero. Table 5.2 indicates the reallocation of emissions related to the production of electricity to the other sectors.

5.3 Transport Sector

Figure 5.15: Overall Contribution from the Transport Sector to 2014 GHG Emissions, Northern Ireland

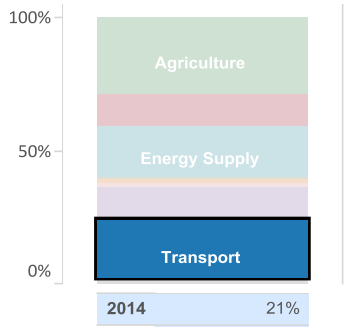


Figure 5.16: GHG Contribution for Transport Sector Emissions, 2014, Northern Ireland

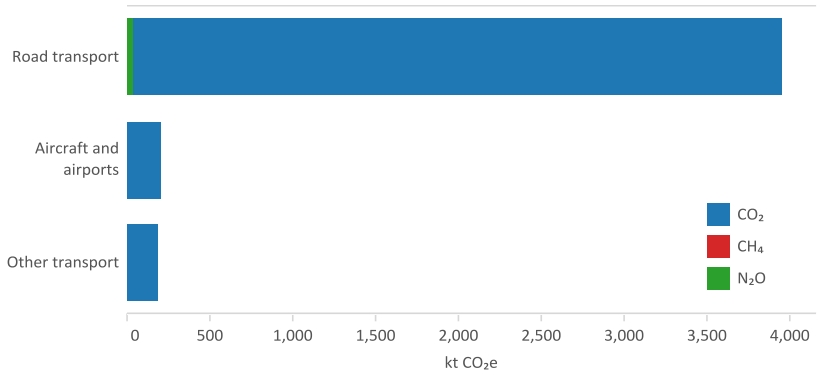


Figure 5.17: Total GHG Emissions from Transport Sector, Base Year to 2014, Northern Ireland

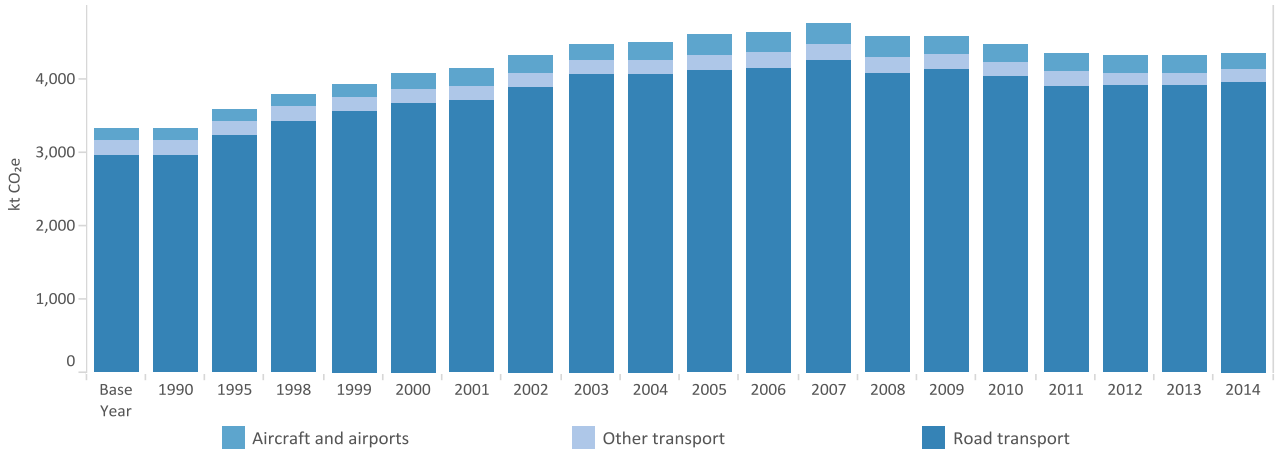


Table 5.4: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Transport Sector, Northern Ireland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Road transport	1.2%	48.2	33.6%	994.3
Other transport	-1.3%	-2.4	-16.7%	-36.2
Aircraft and airports	-10.8%	-24.4	35.0%	52.3
Transport Sector Total	0.5%	21.3	30.4%	1,010.3

Figure 5.18 Road Transport CO_2 Emissions, Northern Ireland

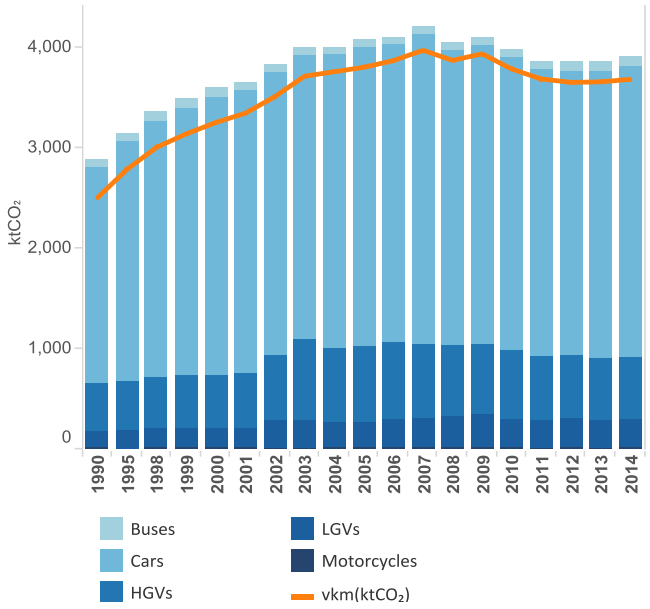
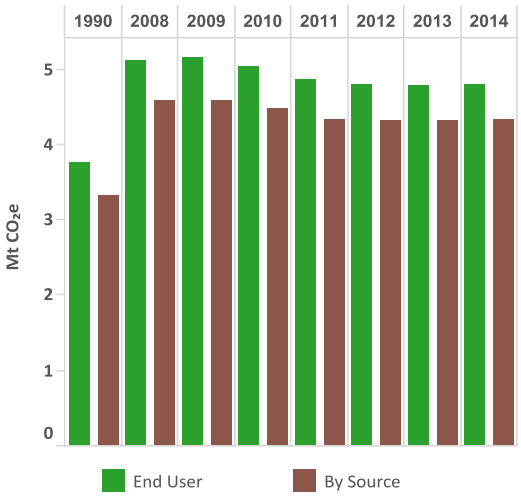


Figure 5.19: Comparison of End User and By Source for Transport Sector, Northern Ireland



By Source Emissions

Overview

Transport emissions account for 21% of Northern Ireland's total GHG emissions in 2014. Transport emissions are dominated by emissions from road transport, which accounted for 91% of all Transport emissions in 2014. Passenger cars alone accounted for 67% of Transport emissions (see Figure 5.18).

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.

Features of the Trends

Total GHG emissions from the Transport sector in Northern Ireland have increased by 30% between the Base Year and 2014 as a result of growth in demand, despite improvements in efficiency of vehicles. 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 2013 and 2014 have not seen any significant change – increasing by less than 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, 2015b); 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 5.18 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 have changed when comparing to last year's DA GHG inventory (Salisbury et al., 2015), resulting from a change in the methodology to estimate fuel consumption at the UK level. The differences are larger in the early part of the time series (14% in 1990) but gradually improve over the time (6% of difference in 2014).

The differences between the two approaches fluctuate year on year but they remain within 14% 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 47.2% between the Base Year and 2014, while the constrained approach indicates a 35.1% increase.

Emissions on an End User Basis

The End User estimates for 2014 are 11% higher than the By Source estimates, reflecting the additional emissions from upstream oil extraction and the oil refining sector (see Figure 5.19).

The trend in End User emissions since 1990 shows an increase of 28% to 2014, 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 5.20: Overall Contribution from the Residential Sector to 2014 GHG Emissions, Northern Ireland

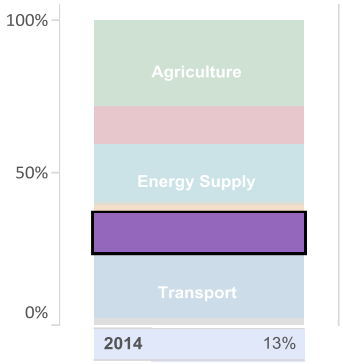


Figure 5.21: GHG Contribution for Residential Sector Emissions, 2014, Northern Ireland

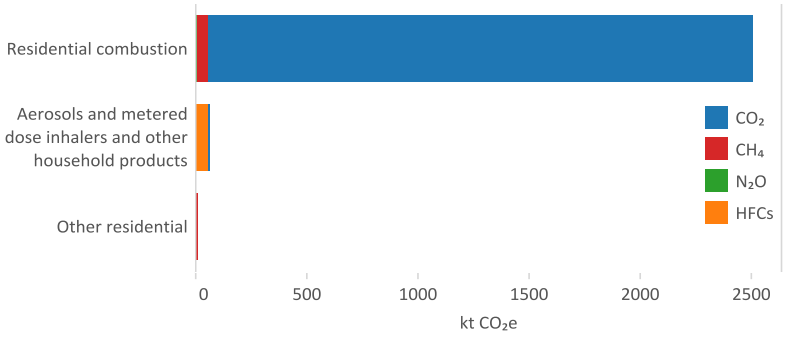


Figure 5.22: Total GHG Emissions from Residential Sector, Base Year to 2014, Northern Ireland

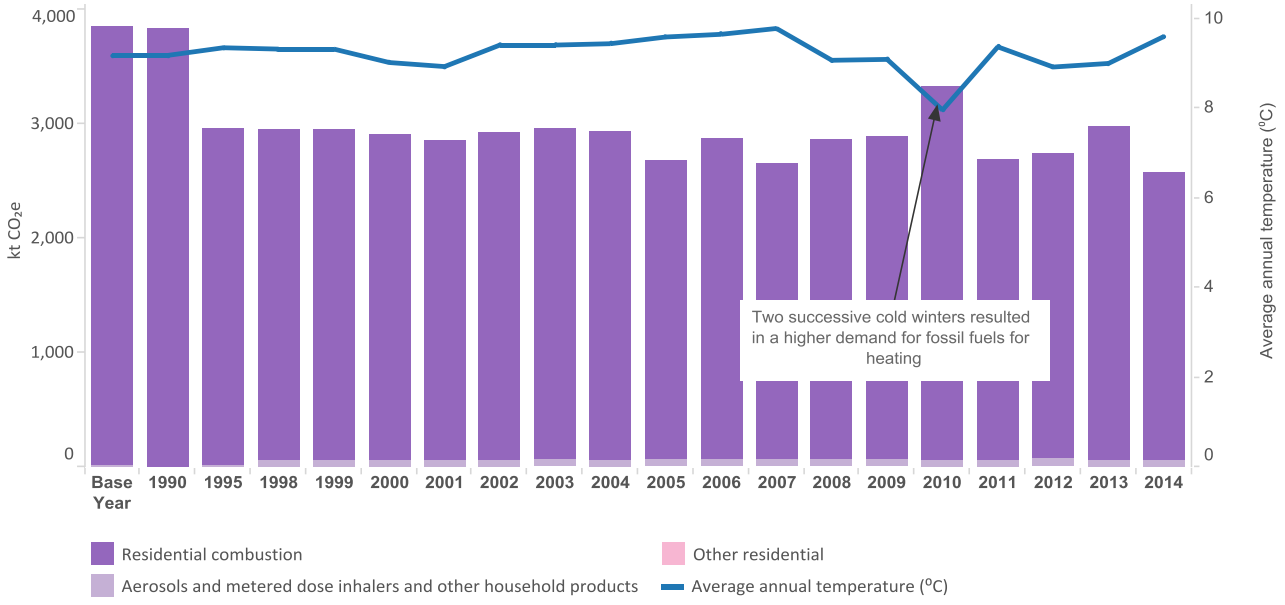
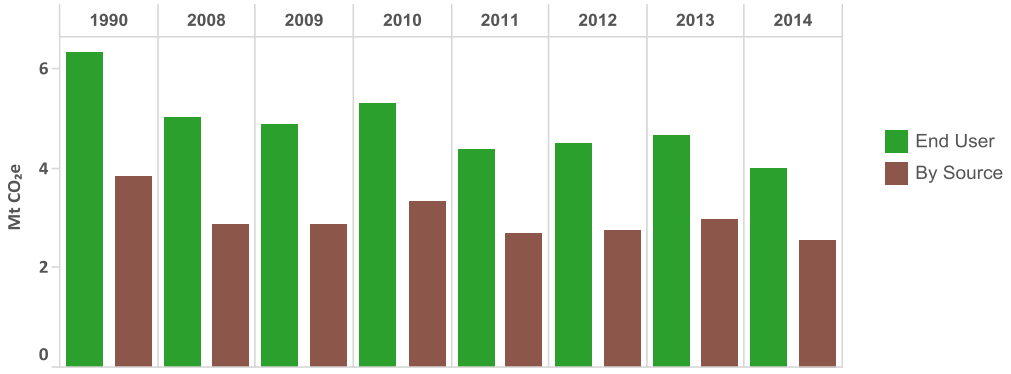


Table 5.5: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Residential Sector, Northern Ireland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Aerosols and metered dose inhalers and other household products	1.5%	0.8	186.6%	36.7
Other residential	9.5%	0.1	126.5%	0.6
Residential combustion	-13.9%	-405.6	-34.4%	-1,315.7
Residential Sector Total	-13.6%	-404.7	-33.3%	-1,278.3

Figure 5.23: Comparison of End User and By Source for Residential Sector, Northern Ireland



By Source Emissions

Overview

The Residential sector accounts for 13% of Northern Ireland's total GHG emissions in 2014. The sector comprises emissions from Residential stationary and mobile combustion (98% of emissions for the Residential sector) from activities such as heating and cooking, household products, accidental vehicle fires and HFC emissions from the use of aerosols and metered dose (usually asthma-related) inhalers. The majority (96%) of all Residential GHG emissions are from the release of carbon dioxide from the direct combustion of fossil fuels.

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 33% between the Base Year and 2014 due to fuel-switching to take advantage of natural gas supply from the late 1990s, displacing more carbon-intensive fuels such as oils and coal. The recent sector emission trends reflect mean annual temperatures, with a very cold year in 2010 (MetOffice, 2014).

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 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 2014, Northern Ireland End User emissions for the Residential sector are 156% of the By Source emission estimates (see Figure 5.23), 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 37% to 2014 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 5.24: Overall Contribution from the Business Sector to 2014 GHG Emissions, Northern Ireland

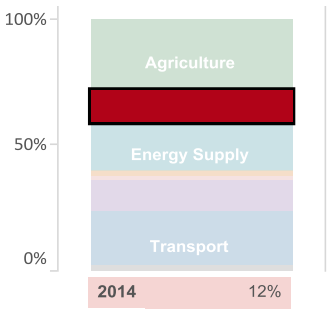


Figure 5.25: GHG Contribution for Business Sector Emissions, 2014, Northern Ireland

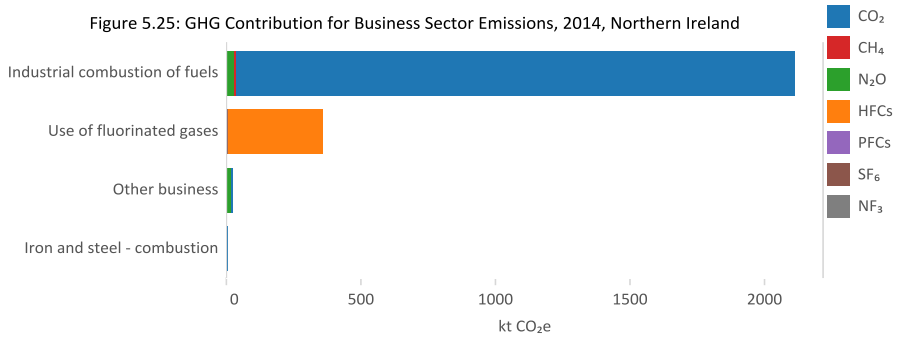


Figure 5.26: Total GHG Emissions from Business Sector, Base Year to 2014, Northern Ireland

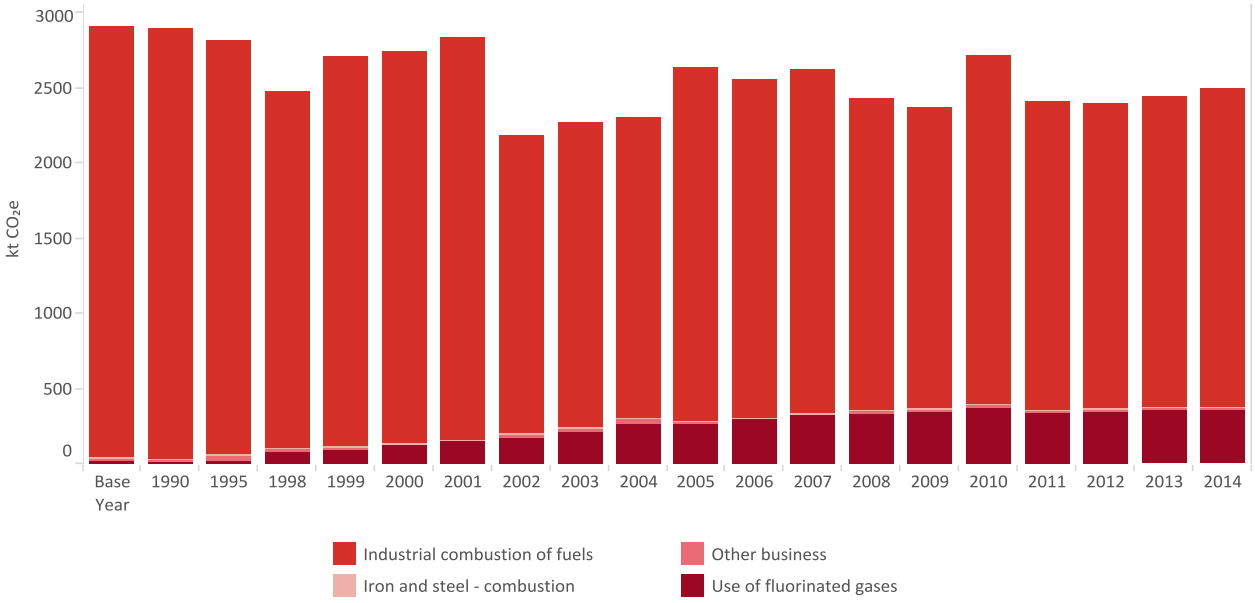
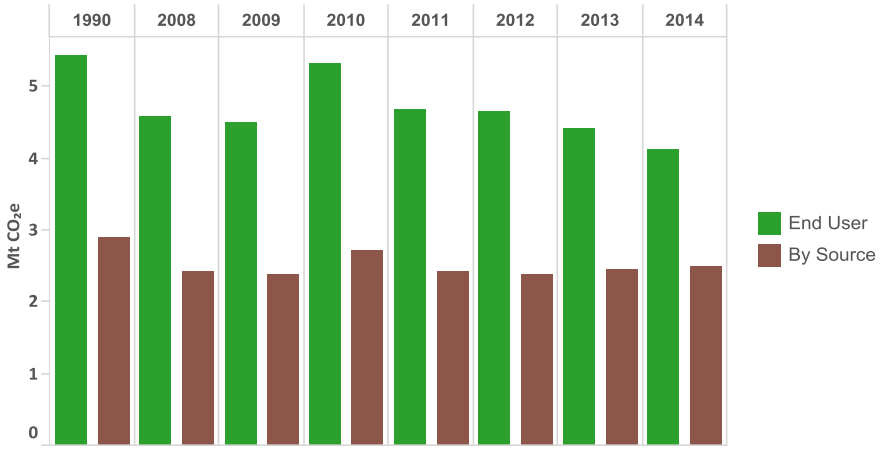


Table 5.6: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Business Sector, Northern Ireland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Industrial combustion of fuels	2.1%	44.2	-26.3%	-755.8
Iron and steel - combustion	N/A	0.0	N/A	0.0
Use of fluorinated gases (including refrigeration and air conditioning)	1.1%	3.8	1,304.8%	333.4
Other business	16.5%	3.6	67.5%	10.2
Business Sector Total	2.1%	51.6	-14.2%	-412.2

Figure 5.27: Comparison of End User and By Source for Business Sector, Northern Ireland



By Source Emissions

Overview

The Business sector contributes 12% to total 2014 GHG emissions, with 83% of the sector GHG emissions being carbon dioxide from fuel combustion. These fuel combustion emissions contribute 15% of the total carbon dioxide emissions in Northern Ireland in 2014. Sulphur hexafluoride (SF_6) constitutes 0.2% 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, as well as foam production, firefighting solvents and electronics. Emissions from this source (use of fluorinated gases) have increased significantly since the Base Year and now account for 14% of Business emissions, whereas they accounted for only 1% in 1995.

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 2014, 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.

Features of the Trends

Emissions from the Business sector for Northern Ireland have decreased by 14% between the Base Year and 2014. 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 2013 and 2014 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 Business sector include 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 2014, Northern Ireland End User emissions for the Business sector were 165% 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 represented 20% of total emissions in 2014 compared to just 12% of the By Source inventory total (see Figure 5.27).

5.6 Public Sector

Figure 5.28: Overall Contribution from the Public Sector to 2014 GHG Emissions, Northern Ireland

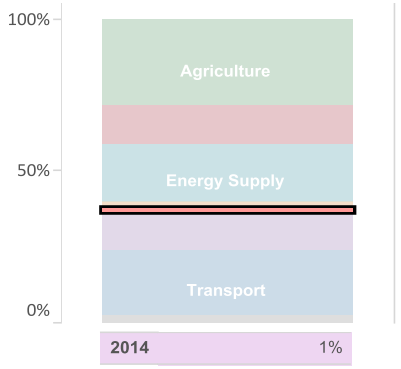


Figure 5.29: GHG Contribution for Public Sector Emissions, 2014, Northern Ireland

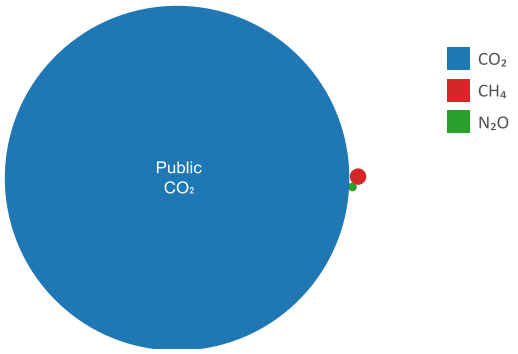


Figure 5.30: Total GHG Emissions from Public Sector, Base Year to 2014, Northern Ireland

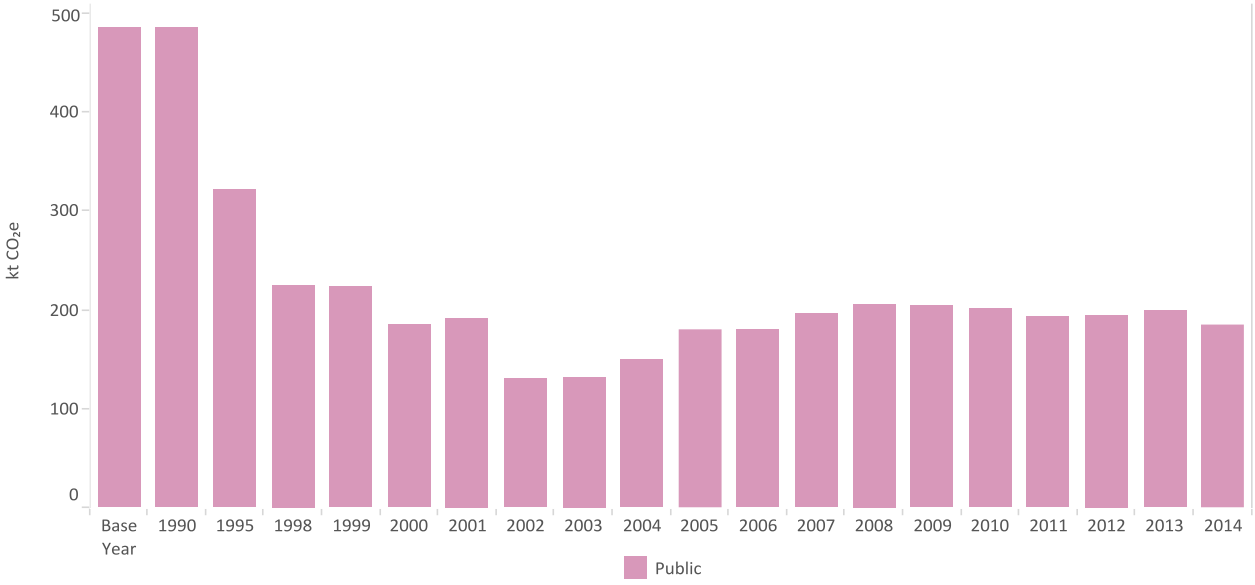
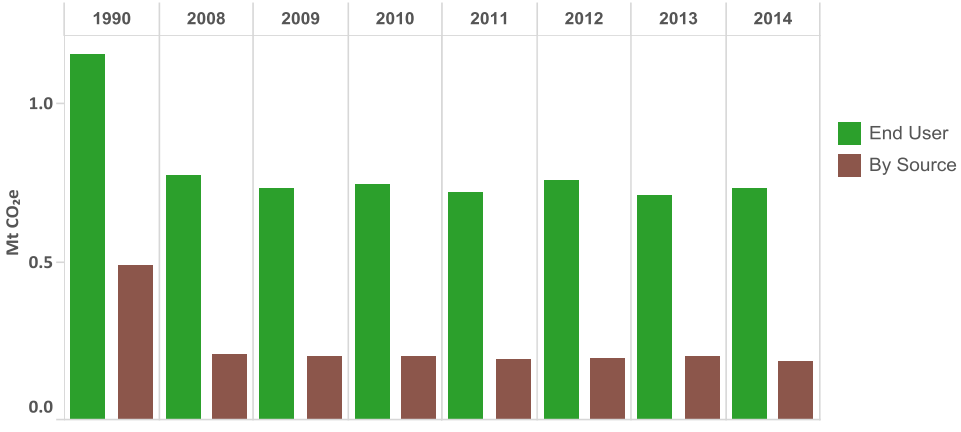


Table 5.7: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Public Sector, Northern Ireland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Public	-7.0%	-14.1	-61.7%	-299.9
Public Sector Total	-7.0%	-14.1	-61.7%	-299.9

Figure 5.31: Comparison of End User and By Source for Public Sector, Northern Ireland



By Source Emissions

Overview

Emissions from Public sector combustion account for 1% of GHG emissions in Northern Ireland in 2014. Over 99% of emissions in this sector are of carbon dioxide from the combustion of fossil fuels. See Figures 5.29 and 5.30.

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 2013 to 2014 shows a decrease of 7% in emissions due to a decrease in natural gas consumption (see Table 5.7 and Figure 5.30). The overall reduction from the Base Year to 2014 is 62%. 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 2014, Northern Ireland End User emissions for the Public sector were 394% 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 3.5% in 2014 (see Figure 5.31) from 1% in the By Source inventory. The trend in End User emissions since 1990 shows a decline of around 37% to 2014. The trend data are uncertain and should be regarded as indicative only due to the limited data on electricity use by sector.

5.7 Industrial Process Sector

Figure 5.32: Overall Contribution from the Industrial Process Sector to 2014 GHG Emissions, Northern Ireland

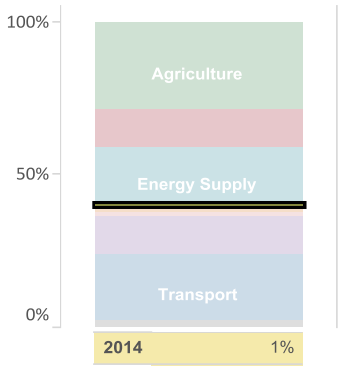


Figure 5.33: GHG Contribution for Industrial Process Sector Emissions, 2014, Northern Ireland

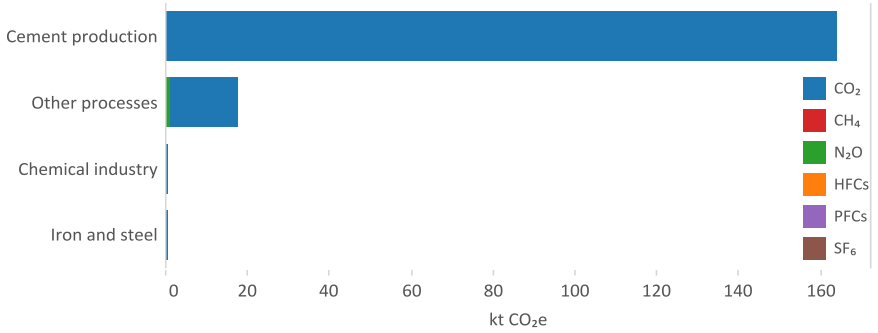


Figure 5.34: Total GHG Emissions from Industrial Process Sector, Base Year to 2014, Northern Ireland

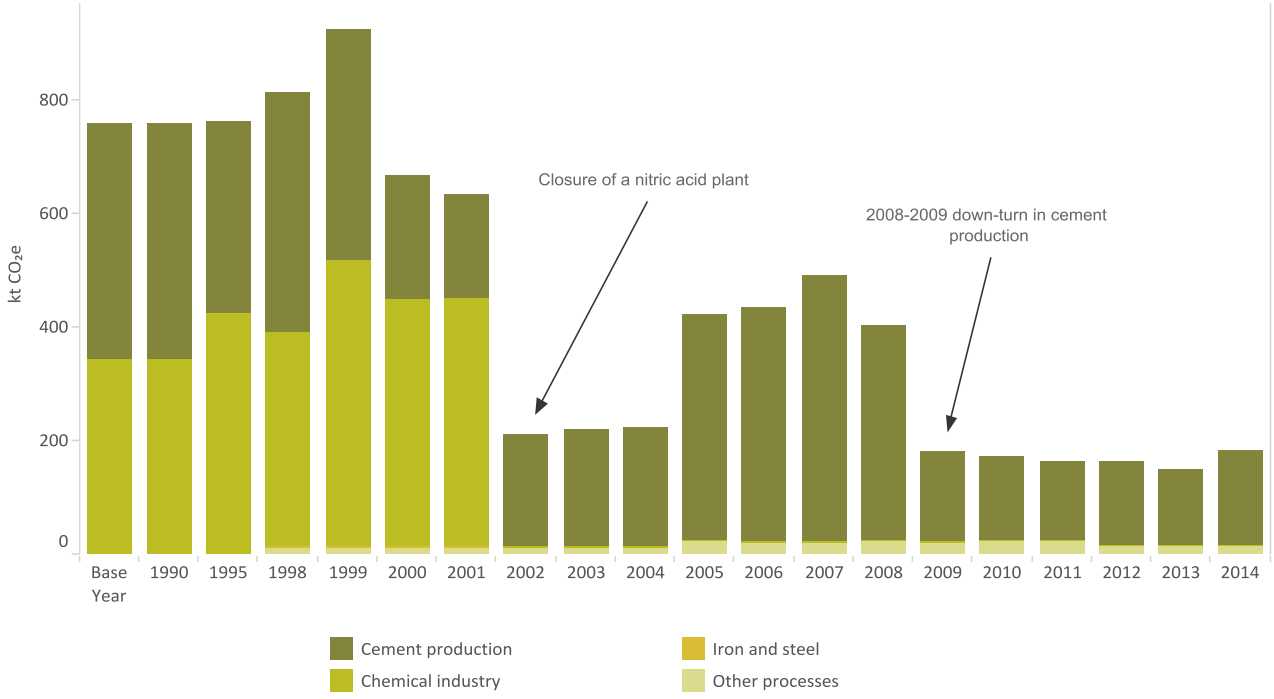


Table 5.8: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Industrial Process Sector, Northern Ireland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Cement production	23.1%	30.8	-60.5%	-251.8
Other processes	9.8%	1.6	1,758.6%	16.7
Chemical industry	N/A	0.0	-100.0%	-341.0
Iron and steel	N/A	0.0	N/A	0.0
Industrial Process Sector Total	21.6%	32.3	-76.0%	-576.0

By Source Emissions

Overview

The Industrial Process sector contributes less than 1% of the total 2014 GHG emissions in Northern Ireland. It includes cement and limestone production (90% of sector GHG emissions). Over 99% of all the emissions in 2014 from this sector were carbon dioxide (see Figure 5.33).

Features of the Trends

In 2014, Industrial Process sector emissions are 76% lower than in the Base Year (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 cessation of nitrous oxide emissions. Between 2013 and 2014, emissions increased by 22% due to an increase in cement production.

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 5.35: Overall Contribution from the Agriculture Sector to 2014 GHG Emissions, Northern Ireland

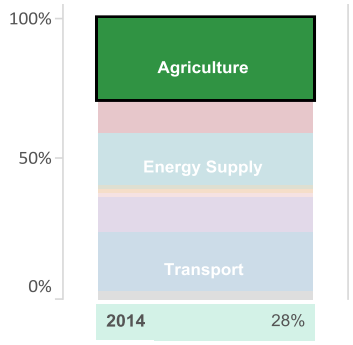


Figure 5.36: GHG Contribution for Agriculture Sector Emissions, 2014, Northern Ireland

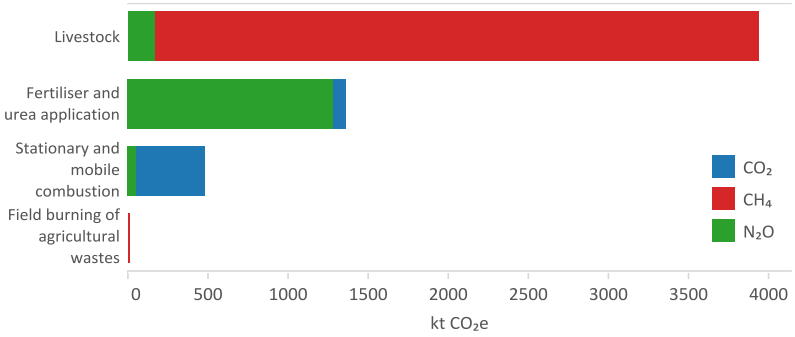


Figure 5.37: Total GHG Emissions from Agriculture Sector, Base Year to 2014, Northern Ireland

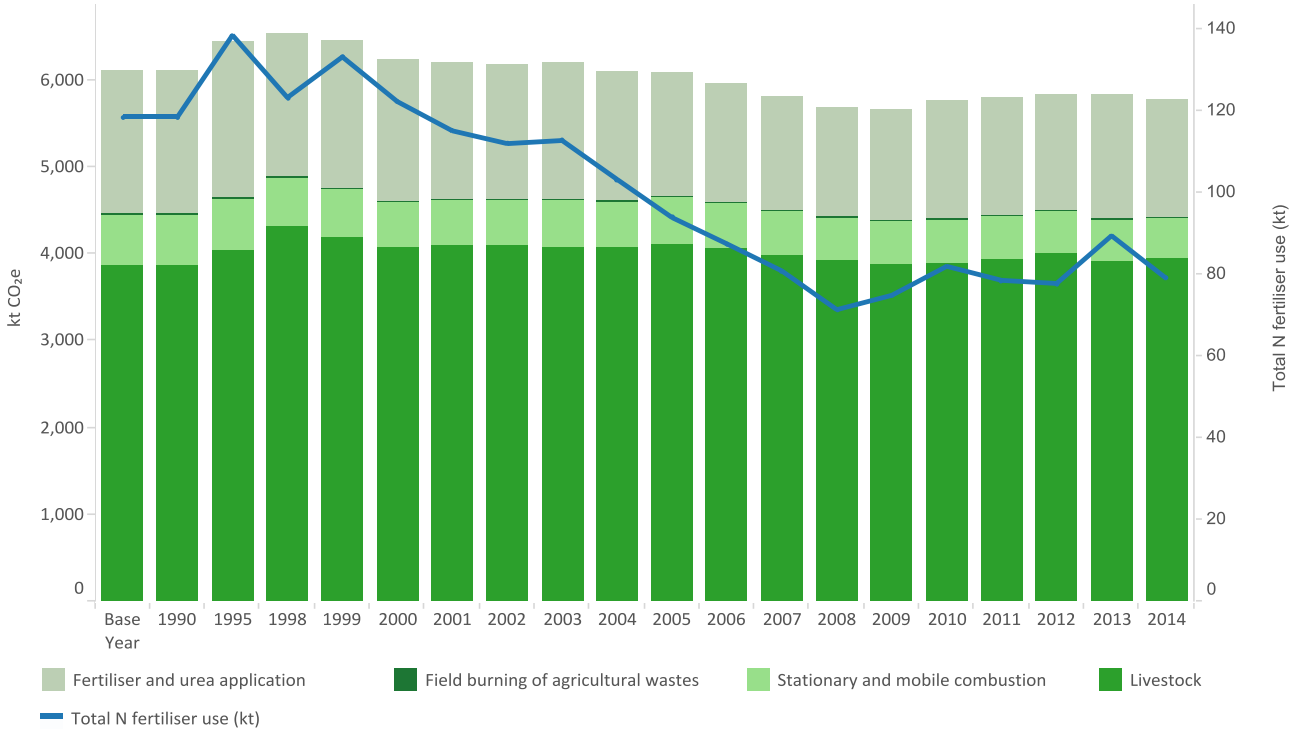
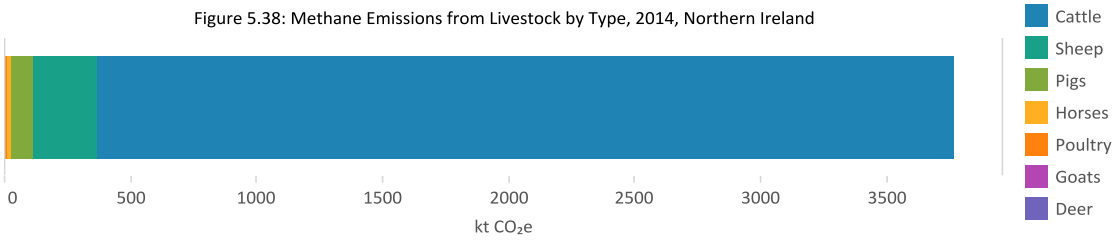


Table 5.9: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Agriculture Sector, Northern Ireland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Fertiliser and urea application	-3.9%	-54.4	-17.1%	-279.3
Field burning of agricultural wastes	N/A	0.0	-100.0%	-1.3
Livestock	0.6%	23.7	1.8%	70.5
Stationary and mobile combustion	-1.4%	-7.0	-18.2%	-107.8
Agriculture Sector Total	-0.6%	-37.7	-5.2%	-317.9

Figure 5.38: Methane Emissions from Livestock by Type, 2014, Northern Ireland



By Source Emissions

Overview

The Agriculture sector contributes 28% to total 2014 GHG emissions in Northern Ireland. Agriculture is the most significant source sector for methane and nitrous oxide, accounting for 87% and 86% of total Northern Ireland emissions of these two gases, respectively. Stationary and mobile combustion within the Agriculture sector and emissions from liming emit all the carbon dioxide emissions from the sector (see Figure 5.36).

Emissions from Agriculture represent a much higher proportion in Northern Ireland than the UK average because there are fewer 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 2014. This trend is mainly influenced by a reduction in nitrous oxide emissions of 15% due almost entirely to reductions in emissions from lower fertiliser application. This has been partially offset by a 2% increase in methane emissions due to higher emissions from livestock.

There was no significant overall change in Agriculture sector emissions for Northern Ireland between 2013 and 2014 (less than 1% decrease) mainly due to a decrease in emissions from agricultural soils, which was partially offset by an increase in the number of dairy cattle. Field burning has largely ceased in the UK since 1993, hence the significant decrease in emissions from that source 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 90% of all Northern Ireland agricultural methane emissions. Emissions from sheep accounted for 7% of the total methane from Agriculture in 2014.

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 85% of total nitrous oxide emissions from the agriculture sector in 2014.

Emissions on an End User Basis

As 92% of emissions in the Agriculture sector in 2014 were not due to energy consumption, Agriculture sector emissions on an End User basis are very similar to the emissions By Source. In 2014, 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 5.39: Overall Contribution from the Land Use Change Sector to 2014 GHG Emissions, Northern Ireland

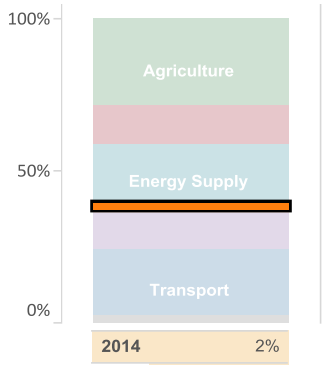


Figure 5.40: GHG Contribution to Land Use Change Sector Emissions, 2014, Northern Ireland

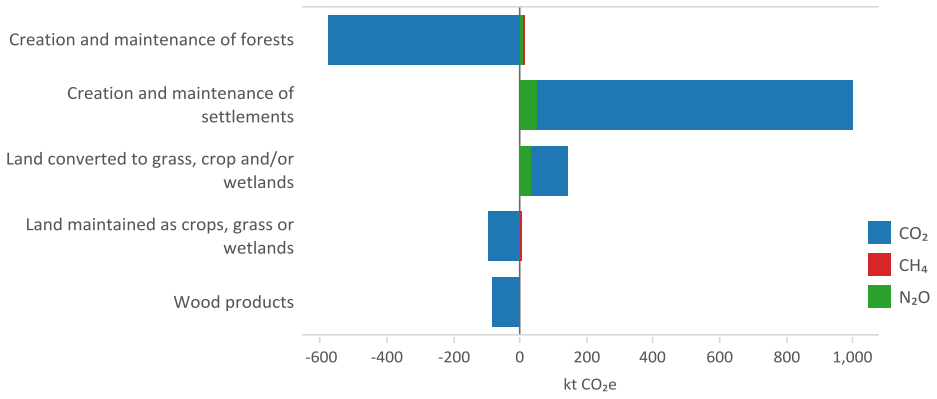


Figure 5.41: Total GHG Emissions from LULUCF Sector, Base Year to 2014, Northern Ireland

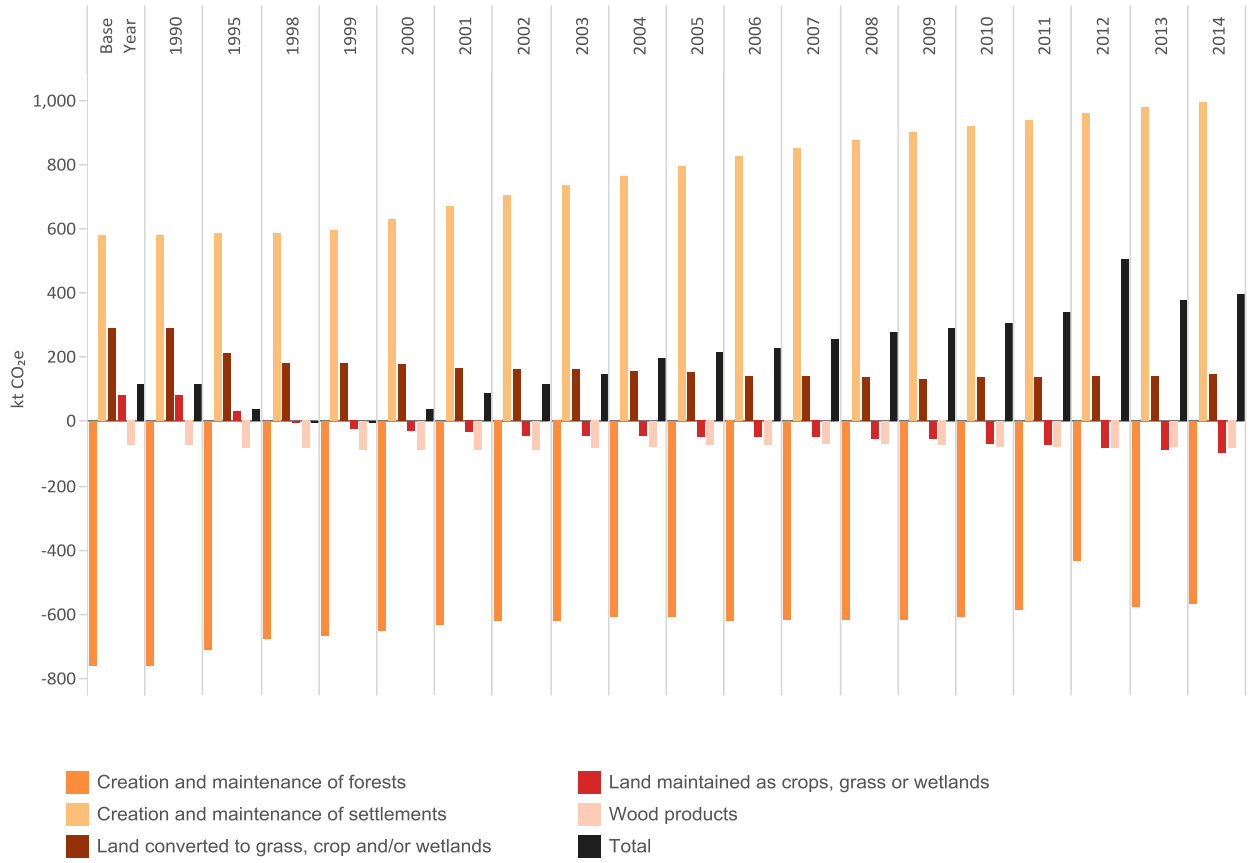


Table 5.10: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the LULUCF Sector, Northern Ireland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Creation and maintenance of settlements	1.8%	17.3	72.1%	417.9
Creation and maintenance of forests	2.2%	13.0	26.0%	198.3
Land converted to grass, crop and/or wetlands	1.9%	2.8	-49.7%	-143.7
Land maintained as crops, grass or wetlands	-9.2%	-8.3	N/A	-180.6
Wood products	-4.6%	-3.7	-17.6%	-12.4
Land Use Change Sector Total	5.6%	21.1	238.7%	279.5

By Source Emissions

Overview

Figures 5.39 – 5.41 and Table 5.10 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 creation of settlements, which accounted for 997 $ktCO_2e$ of emissions in 2014.

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

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 been increasing since 1999, when this sector was a very small net sink. Between 2003 and 2014 the size of this source has increased by 169%.

In 2011, 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 2011. This event (reported in the 2012 inventory year as forest activity data uses fiscal years) affected the sink from the creation and maintenance of forests, which reduced by 26% between 2011 and 2012. The overall size of the source increased by 6% between 2013 and 2014 mainly due to the conversion of land to settlements.

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 5.42: Overall Contribution from the Waste Management Sector to 2014 GHG Emissions, Northern Ireland

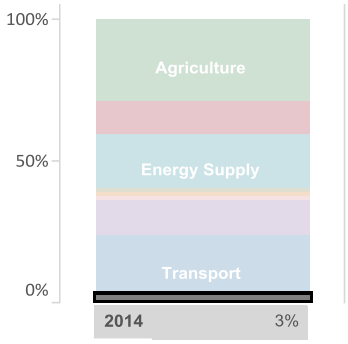


Figure 5.43: GHG Contribution for Waste Management Sector Emissions, 2014, Northern Ireland

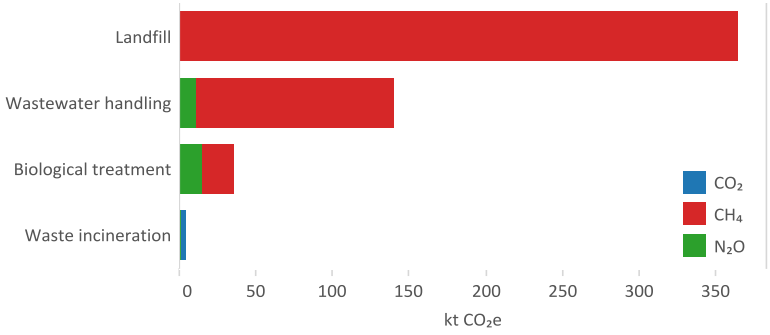


Figure 5.44: Total GHG Emissions from Waste Management Sector, Base Year to 2014, Northern Ireland

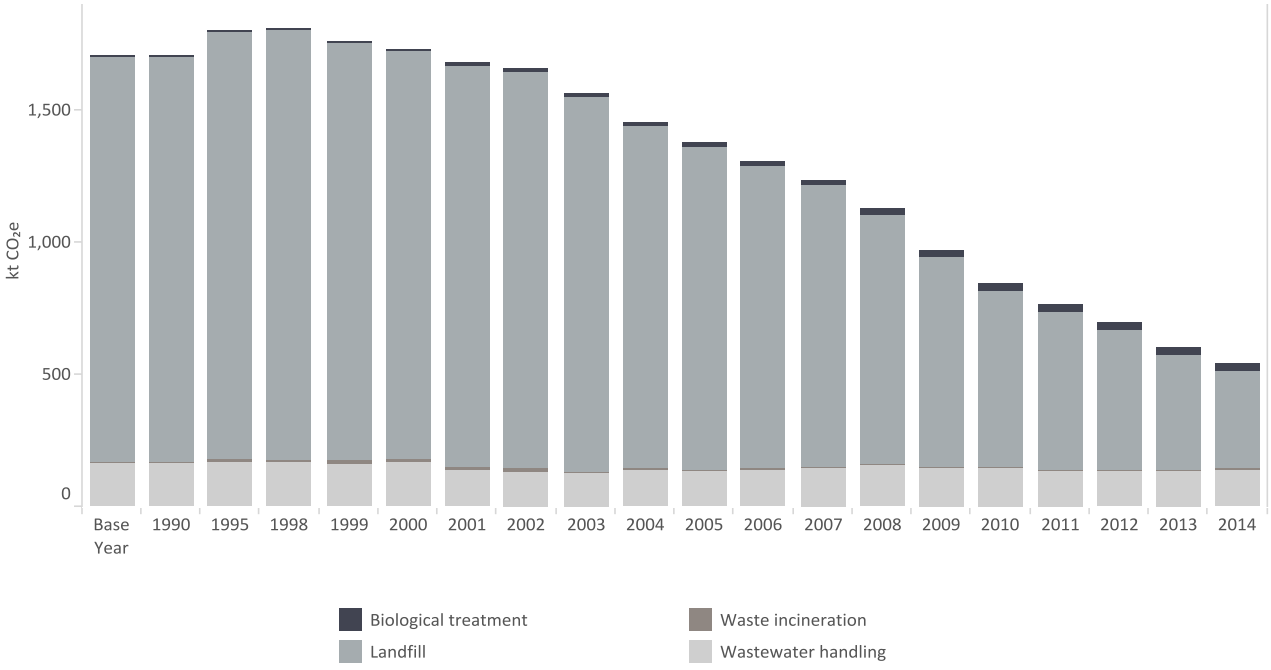


Table 5.11: Change in GHG Emissions from Base Year to 2014 and from 2013 to 2014 for the Waste Management Sector, Northern Ireland

	2013 to 2014 as %	2013 to 2014 kt CO_2e	Base Year to 2014 as %	Base Year to 2014 kt CO_2e
Landfill	-15.7%	-67.7	-76.2%	-1,167.0
Waste incineration	-0.5%	0.0	-52.2%	-4.6
Wastewater handling	3.9%	5.3	-13.1%	-21.1
Biological treatment	10.1%	3.3	N/A	35.4
Waste Management Sector Total	-9.8%	-59.3	-68.0%	-1,157.3

By Source Emissions

Overview

The Waste Management sector contributes 3% to total GHG emissions in Northern Ireland in 2014, and represents 12% of total methane emissions. Emissions from this sector are dominated by methane from landfill (67% 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 (26%).

The majority of total GHG emissions are of methane (95% of total sector GHG emissions in 2014). Nitrous oxide emissions from wastewater treatment represent 2% of emissions in the sector, and contribute 1% to the total emissions of nitrous oxide in Northern Ireland. See Figure 5.43 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 68% in total for the sector and by 76% for landfill between 1990 and 2014, as shown in Table 5.11, due largely to the progressive introduction of methane capture and oxidation systems within landfill management. Between 2013 and 2014 Waste Management sector GHG emissions decreased by 10%, 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 1990-2014 Report_Appendices_v1.docx".

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7 Appendices

Appendix 1: Uncertainties in the UK and Devolved Administrations' GHG Inventory estimates

Appendix 2: Devolved Administrations' GHG Inventory compilation methods and data sources

Appendix 3: Methods used for calculating End User emissions

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' GHG 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: 1990-2014

Appendix 9: Aviation Data in the EU ETS