Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2010

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

August 2012

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17th July 2012	Approved and uploaded to www.http://naei.defra.gov.uk/reports.php
23rd July 2012	Correction to **Tables 2.11** and **2.12**
22nd Aug 2012	Correction to "Change in GHG Emissions" sector tables and LULUCF summary data
27th September	Fixed broken link on page 1

Executive Summary

This report presents estimates of greenhouse gas (GHG) emission inventories for the constituent countries of the UK. Separate GHG emission inventories have been estimated for England, Scotland, Wales and Northern Ireland for the years 1990, 1995 and 1998 to 2010. The GHGs reported are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (N_2O)

The estimates are consistent with the United Nations Framework Convention on Climate Change (UNFCCC) reporting guidelines and the 2010 UK Greenhouse Gas Inventory (Brown et al., 2012). Emissions from offshore oil and gas exploration and production activities are not allocated to any country, and are reported separately within an "Unallocated" inventory category.

UK territorial coverage in this report excludes the Crown Dependencies of Jersey, Guernsey and Isle of Man, and also excludes emissions for those Overseas Territories joining UK instruments of ratification for the UNFCCC and the Kyoto Protocol namely: Cayman Islands, Falkland Islands, Bermuda, Montserrat and Gibraltar. The Devolved Administration (DA) inventory data presented in this report also exclude the emissions from international shipping and aviation; consistent with the UK GHG inventory reporting protocol, emissions from international shipping and aviation are reported only as "memo items" to the national inventory, and are excluded from national totals. Estimates of the DA emissions from international shipping and international aviation are provided separately in Appendix 6 of this report.

The main focus of the report is emissions presented on a *by source* (emissions are allocated to the source sector in which they occur) basis for the DA countries, and figures and percentages within this report refer to this dataset, unless otherwise stated.

Country-Specific Climate Change Commitments and Related Inventory Improvements

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

Each of the devolved Governments tailors their climate change policy legislation and policies to target their specific local and regional priorities. 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, together with emissions from the traded sector[1], and also a "Scottish share" of GHG emissions from international shipping and international aviation. In contrast, the Welsh emissions account excludes emissions from the traded sector and international transport sources, with specific sector targets to be established. The current Northern Ireland Programme for Government has increased Northern Ireland's target reduction for 2025 from 25 to 35% and an action plan is currently being developed.

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

By Source DA GHG Emission Estimates in 2010

The UK distribution of regional net[2] greenhouse gas emissions in 2010, expressed in terms of global warming potentials (GWP), is[3] detailed below, in addition to the trends in emissions from the Base Year[4].

- England has a **76.5%** share of total net GHG emissions in **2010** and emissions have declined by **26.0%** since the Base Year.
- Scotland has a **9.1%** share of total net GHG emissions in **2010**, and the trend since the Base Year is a decline of **23.7%**.
- Wales has an **8.0%** share of total net GHG emissions in **2010** and emissions have declined by **15.0%** since the Base Year.
- Northern Ireland has a **3.5%** share of total net GHG emissions in **2010**, and the trend since the Base Year is a decline of **14.7%**.
- **3.0%** of the UK emissions total is unallocated in **2010.** Unallocated emissions have increased by **7.6%** since the Base Year.

Tables ES1.1 to ES1.4 present the time series of emissions for each constituent country.

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

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

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

Table ES1.1: England GHG Emissions, 1990 to 2010 (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% Change Base Year to 2010
By Gas including LULUCF																	
Carbon	463.93	463.93	422.99	420.39	412.64	416.37	429.50	423.75	433.62	432.81	431.31	425.91	425.12	412.73	372.97	383.24	-17%
CH_4	72.44	72.44	61.43	52.67	49.16	45.70	41.60	39.64	34.85	33.54	32.27	31.27	29.97	29.32	28.48	27.78	-62%
HFCs	15.11	11.38	15.11	16.11	9.38	8.25	9.02	9.34	10.33	9.47	10.23	10.79	11.02	11.50	11.78	12.09	-20%
N_2O	53.15	53.15	42.79	42.73	32.12	31.91	29.53	28.42	28.07	29.05	28.40	26.59	26.59	26.05	24.17	24.57	-54%
PFCs	0.23	0.97	0.23	0.20	0.18	0.25	0.21	0.13	0.14	0.23	0.18	0.18	0.12	0.09	0.06	0.17	-26%
SF_6	1.12	0.94	1.12	1.13	1.28	1.62	1.28	1.35	1.18	0.99	0.96	0.75	0.68	0.61	0.57	0.59	-47%
LULUCF only by Gas																	
Carbon	5.66	5.66	5.22	4.22	4.04	3.68	3.48	3.06	2.89	2.48	2.14	2.00	1.78	1.55	1.27	1.38	-76%
CH_4	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.02	0.02	0.01	0.01	39%
N_2O	0.31	0.31	0.31	0.30	0.30	0.30	0.29	0.29	0.28	0.27	0.27	0.26	0.26	0.26	0.25	0.25	-20%
LULUCF Net Emissions	**5.98**	**5.98**	**5.54**	**4.53**	**4.36**	**3.99**	**3.79**	**3.37**	**3.18**	**2.77**	**2.42**	**2.28**	**2.06**	**1.83**	**1.53**	**1.64**	**-73%**
By National Communication Sector																	
Agriculture	40.09	40.09	38.64	37.64	37.19	35.91	33.60	33.83	33.41	33.70	34.00	32.40	31.90	31.84	31.35	31.67	-21%
Business	86.76	85.77	83.05	82.49	82.64	83.75	86.56	82.57	84.00	82.52	84.16	81.59	80.56	79.70	71.06	69.08	-20%
Energy Supply	211.56	211.56	167.49	154.94	145.86	150.04	158.99	160.59	166.95	165.24	165.44	166.65	167.74	160.12	142.57	145.22	-31%
Industrial Process	50.74	48.90	40.55	39.65	22.31	20.13	18.21	16.07	16.22	15.47	14.32	12.91	14.22	12.89	8.08	8.12	-84%
Land Use Change	5.98	5.98	5.54	4.53	4.36	3.99	3.79	3.37	3.18	2.77	2.42	2.28	2.06	1.83	1.53	1.64	-73%
Public	10.69	10.69	10.75	10.62	10.41	9.84	10.22	8.72	8.74	9.48	9.32	8.47	7.82	7.78	6.83	6.99	-35%
Residential	63.30	62.98	65.08	71.75	71.65	72.36	74.29	71.69	72.84	74.25	71.09	68.69	65.77	67.11	62.62	72.34	14%
Transport	101.06	101.06	101.36	105.24	106.04	105.08	105.10	107.02	106.32	107.29	107.63	107.86	109.07	105.11	100.50	100.34	-1%
Waste Management	35.77	35.77	31.20	26.39	24.29	22.98	20.35	18.77	16.54	15.37	14.96	14.65	14.37	13.91	13.50	13.03	-64%
Total Net Emissions	**605.97**	**602.80**	**543.67**	**533.24**	**504.76**	**504.09**	**511.13**	**502.65**	**508.19**	**506.09**	**503.35**	**495.49**	**493.51**	**480.30**	**438.02**	**448.44**	**-26%**

Table ES1.2: Scotland GHG Emissions, 1990 to 2010 (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% Change Base Year to 2010
By Gas including LULUCF																	
Carbon	50.91	50.91	49.99	50.47	47.62	49.94	50.08	46.60	46.57	44.34	43.17	46.82	42.93	41.38	37.91	41.35	-19%
CH_4	11.87	11.87	10.74	9.53	8.75	8.32	7.69	7.08	6.43	6.26	6.26	6.10	5.99	5.81	5.64	5.59	-53%
HFCs	0.11	0.00	0.11	0.40	0.45	0.55	0.65	0.72	0.83	0.89	0.96	1.02	1.07	1.12	1.15	1.18	950%
N_2O	6.75	6.75	6.32	6.52	6.36	6.16	6.10	6.03	5.89	5.76	5.54	5.50	5.23	5.11	5.03	5.02	-26%
PFCs	0.09	0.11	0.09	0.11	0.12	0.11	0.06	0.08	0.08	0.07	0.07	0.06	0.06	0.05	0.05	0.05	-43%
SF_6	0.03	0.02	0.03	0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.07	0.06	0.05	0.05	0.05	0.05	51%
LULUCF only by Gas																	
Carbon	-2.45	-2.45	-3.41	-3.59	-3.66	-3.90	-4.17	-4.50	-4.65	-5.25	-5.48	-5.50	-5.66	-5.87	-5.89	-5.77	136%
CH_4	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.01	0.01	0.01	93%
N_2O	0.35	0.35	0.37	0.37	0.37	0.37	0.36	0.35	0.34	0.34	0.33	0.32	0.31	0.31	0.30	0.30	-15%
LULUCF Net Emissions	**-2.09**	**-2.09**	**-3.03**	**-3.21**	**-3.28**	**-3.53**	**-3.81**	**-4.14**	**-4.29**	**-4.90**	**-5.15**	**-5.17**	**-5.33**	**-5.55**	**-5.57**	**-5.46**	161%
By National Communication Sector																	
Agriculture	9.83	9.83	9.76	9.93	9.74	9.37	9.12	9.11	8.98	8.86	8.75	8.57	8.26	8.08	7.95	7.95	-19%
Business	11.38	11.26	8.12	8.19	8.30	8.60	9.19	8.33	8.27	8.09	8.62	8.33	8.11	8.37	7.37	7.51	-34%
Energy Supply	22.32	22.32	26.47	26.33	23.18	25.98	25.46	23.43	23.42	21.75	20.49	24.67	21.30	19.83	18.54	20.74	-7%
Industrial Process	1.82	1.88	0.56	0.62	0.59	0.58	0.56	0.59	0.61	0.62	0.54	0.55	0.53	0.52	0.40	0.39	-79%
Land Use Change	-2.09	-2.09	-3.03	-3.21	-3.28	-3.53	-3.81	-4.14	-4.29	-4.90	-5.15	-5.17	-5.33	-5.55	-5.57	-5.46	161%
Public	1.23	1.23	1.07	1.12	1.13	1.04	1.10	0.93	0.91	1.03	1.06	0.96	0.91	0.95	0.85	0.87	-29%
Residential	8.18	8.15	8.13	8.48	8.40	8.28	8.72	8.08	8.06	8.16	7.99	7.77	7.55	7.78	7.30	8.37	2%
Transport	10.52	10.52	10.53	10.91	11.01	10.83	10.79	11.08	11.12	11.20	11.30	11.46	11.64	11.26	10.77	10.72	2%
Waste Management	6.57	6.57	5.66	4.70	4.26	3.98	3.47	3.15	2.76	2.55	2.48	2.42	2.35	2.29	2.22	2.15	-67%
Total Net Emissions	**69.77**	**69.67**	**67.28**	**67.07**	**63.33**	**65.13**	**64.62**	**60.57**	**59.85**	**57.37**	**56.06**	**59.56**	**55.33**	**53.53**	**49.83**	**53.24**	-24%

Table ES1.3: Wales GHG Emissions, 1990 to 2010 (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% Change Base Year to 2010
By Gas including LULUCF																	
Carbon	43.16	43.16	40.74	43.02	44.26	46.37	43.83	37.35	38.48	42.34	40.44	42.09	39.76	41.74	35.71	39.06	-9%
CH_4	7.31	7.31	6.24	5.76	5.63	5.39	4.94	4.77	4.55	4.50	4.49	4.50	4.16	3.94	3.87	3.89	-47%
HFCs	0.06	0.00	0.06	0.21	0.24	0.29	0.33	0.36	0.42	0.41	0.49	0.52	0.53	0.55	0.57	0.58	868%
N_2O	4.10	4.10	4.09	3.99	4.07	3.86	3.71	3.52	3.59	3.50	3.60	3.45	3.17	2.96	2.93	3.06	-25%
PFCs	0.15	0.31	0.15	0.08	0.07	0.10	0.11	0.10	0.05	0.04	0.02	0.06	0.04	0.06	0.03	0.00	-98%
SF_6	0.08	0.07	0.08	0.08	0.10	0.12	0.10	0.10	0.09	0.07	0.07	0.05	0.05	0.04	0.04	0.04	-47%
LULUCF only by Gas																	
Carbon	-0.10	-0.10	-0.02	0.06	0.12	0.03	-0.01	-0.08	-0.14	-0.20	-0.21	-0.20	-0.24	-0.24	-0.27	-0.10	4%
CH_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	154%
N_2O	0.06	0.06	0.06	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	-10%
LULUCF Net Emissions	**-0.03**	**-0.03**	**0.04**	**0.13**	**0.18**	**0.10**	**0.06**	**-0.02**	**-0.07**	**-0.14**	**-0.15**	**-0.14**	**-0.18**	**-0.18**	**-0.21**	**-0.04**	**23%**
By National Communication Sector																	
Agriculture	7.17	7.17	7.20	7.08	7.21	6.81	6.58	6.37	6.49	6.40	6.53	6.42	5.85	5.53	5.48	5.66	-21%
Business	13.35	13.30	14.35	15.07	16.42	16.30	13.22	9.29	10.41	11.09	9.77	10.10	10.24	9.64	8.13	9.83	-26%
Energy Supply	17.47	17.47	12.78	13.76	13.44	16.16	17.21	15.54	14.84	17.74	17.19	18.74	16.48	19.36	16.36	16.64	-5%
Industrial Process	2.71	2.87	3.05	2.93	3.14	3.18	2.44	1.91	2.49	2.57	2.90	2.76	2.78	2.45	1.55	2.20	-19%
Land Use Change	-0.03	-0.03	0.04	0.13	0.18	0.10	0.06	-0.02	-0.07	-0.14	-0.15	-0.14	-0.18	-0.18	-0.21	-0.04	23%
Public	0.75	0.75	0.68	0.55	0.54	0.53	0.54	0.45	0.45	0.51	0.52	0.47	0.43	0.43	0.38	0.39	-49%
Residential	4.98	4.96	5.12	5.55	5.47	5.30	5.40	5.06	5.09	5.18	4.85	4.80	4.53	4.69	4.39	4.97	0%
Transport	6.13	6.13	6.11	6.30	6.30	6.21	6.19	6.36	6.38	6.50	6.50	6.55	6.64	6.45	6.16	6.11	0%
Waste Management	2.33	2.33	2.04	1.77	1.64	1.56	1.37	1.25	1.09	1.02	0.99	0.97	0.95	0.93	0.90	0.88	-62%
Total Net Emissions	**54.85**	**54.95**	**51.37**	**53.14**	**54.36**	**56.14**	**53.01**	**46.20**	**47.17**	**50.86**	**49.10**	**50.67**	**47.72**	**49.30**	**43.15**	**46.64**	**-15%**

Table ES1.4: Northern Ireland GHG Emissions, 1990 to 2010 (Mt CO_2e)

	Base Year	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% Change Base Year to 2010
By Gas including LULUCF																	
Carbon	16.74	16.74	16.93	16.39	16.75	16.74	17.22	15.45	15.47	15.36	16.27	16.71	15.51	15.60	13.91	14.66	-12%
CH_4	3.68	3.68	3.52	3.44	3.30	3.17	3.09	3.03	2.96	2.93	3.05	2.98	2.94	2.90	2.85	2.86	-22%
HFCs	0.04	0.00	0.04	0.13	0.15	0.19	0.20	0.22	0.26	0.32	0.31	0.33	0.35	0.36	0.37	0.38	885%
N_2O	3.51	3.51	3.73	3.82	3.83	3.60	3.63	3.12	3.10	3.03	2.90	2.87	2.70	2.63	2.61	2.56	-27%
PFCs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-100%
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	164%
LULUCF only by Gas																	
Carbon	-0.02	-0.02	-0.11	-0.21	-0.19	-0.16	-0.14	-0.12	-0.08	-0.06	-0.03	-0.02	0.02	0.06	0.11	0.08	-448%
CH_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-21%
N_2O	0.07	0.07	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	-62%
LULUCF Net Emissions	**0.05**	**0.05**	**-0.05**	**-0.16**	**-0.14**	**-0.12**	**-0.09**	**-0.08**	**-0.04**	**-0.02**	**0.01**	**0.02**	**0.05**	**0.10**	**0.14**	**0.11**	**93%**
By National Communication Sector																	
Agriculture	5.85	5.85	6.03	6.25	6.07	5.78	5.84	5.79	5.78	5.73	5.75	5.63	5.42	5.32	5.29	5.26	-10%
Business	2.73	2.71	2.49	2.12	2.30	2.30	2.55	1.96	2.02	2.13	2.45	2.40	2.44	2.32	2.14	2.30	-16%
Energy Supply	5.31	5.31	6.54	6.16	6.22	6.34	6.57	5.17	4.96	4.85	5.36	5.75	4.66	4.84	3.69	3.95	-26%
Industrial Process	0.76	0.76	0.78	0.83	0.94	0.68	0.65	0.21	0.22	0.22	0.42	0.43	0.49	0.40	0.18	0.17	-77%
Land Use Change	0.05	0.05	-0.05	-0.16	-0.14	-0.12	-0.09	-0.08	-0.04	-0.02	0.01	0.02	0.05	0.10	0.14	0.11	93%
Public	0.46	0.46	0.29	0.19	0.19	0.15	0.18	0.12	0.13	0.15	0.17	0.17	0.19	0.21	0.21	0.21	-54%
Residential	4.37	4.36	3.61	3.83	3.81	3.82	3.78	3.87	3.84	3.78	3.53	3.63	3.27	3.46	3.40	3.82	-13%
Transport	3.33	3.33	3.56	3.72	3.88	4.00	4.03	4.19	4.34	4.33	4.38	4.40	4.52	4.37	4.24	4.20	26%
Waste Management	1.10	1.10	0.98	0.84	0.78	0.74	0.65	0.60	0.53	0.49	0.48	0.48	0.47	0.46	0.45	0.44	-60%
Total Net Emissions	**23.97**	**23.94**	**24.23**	**23.79**	**24.05**	**23.69**	**24.15**	**21.83**	**21.79**	**21.66**	**22.54**	**22.91**	**21.51**	**21.49**	**19.75**	**20.46**	**-15%**

- 1995 is used as the Base Year (BY) for emissions of HFCs, PFCs and N_2O and 1990 for all other gases in the UK's Climate Change Programme, 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 Land Use, Land Use Change and Forestry sectors;
- The percentage changes presented in this chapter are calculated from emission estimates held at full precision within a database. The emissions quoted in Table ES1 and other tables relevant to this Chapter are values rounded from estimates 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 can be found in the tables that accompany this report "DA_GHGi_1990-2010_Issue 1.xls"

Uncertainties for the By Source estimates

The 2010 emission estimates for the DAs have between +-14% and +-38% uncertainty overall and are presented below. Uncertainties result from the variability in and limit to DA-specific activity and emission factor data. The DAs with higher contributions to emissions from more uncertain sources, such as LULUCF, Agriculture, solid and liquid fuel combustion, (Scotland and Northern Ireland) are subject to the greatest uncertainty.

- UK (+-16%).
- England (+-14%)
- Scotland (+-27%),
- Wales (+-19%)
- Northern Ireland (+-38%)

Appendix 1 outlines the overall uncertainties of the DA GHG inventories.

Non-Traded and Traded GHG Estimates

The 2010 EU Emissions Trading System (ETS) data has been analysed and used to derive a split for non-traded estimates for the DA GHG emission inventories. This method takes account of observed data discrepancies for specific IPCC sectors and presents a "Non-Traded" component to the by source estimates. The data for the 2010 dataset show that:

- Across the **UK**, the non-traded share of total GHG emissions is ***59.5 %***;
- **England** has a high share of EU ETS (traded) emissions from a number of categories including iron and steelworks, power generation and public sector traded emissions. England non-traded emissions are estimated to be around ***62.2%*** of total GHG emissions in **2010**.
- 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 steelworks). As a result, the non-traded share of the total GHG emissions in Wales in **2010** is only ***48.4%***;
- **Scotland** also has a higher than UK-average share of EU ETS emissions, due to a high proportion of emissions from categories such as refineries, chemicals and paper & pulp. The non-traded share of the total GHG emissions in Scotland in **2010** is ***54.9%***;
- **Northern Ireland** has much lower share of the EU ETS emissions, reflecting the fact that there are no refineries, iron and steelworks or oil & gas terminals in Northern Ireland. The non-traded share of the Northern Ireland GHG emissions in **2010** is ***77.4%***.

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 "DAGHGI_1990-2010_v1.xls".

DA GHG Estimates on an End User Basis

Analysis of emissions re-allocated across the DAs to represent energy consumption patterns rather than production patterns are presented within this report. In this analysis, all emissions associated with energy supply (e.g. power generation, coal mining, oil and gas extraction, refineries) are allocated to the final users of

the energy. The net[5] greenhouse gas end user emissions in 2010 and emission trends derived from the end user calculations are summarised below[6]. 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.

- England has a **79.9%** share of total net GHG emissions in **2010** (over 3% more than for the by source emissions as a result of imported emissions from electricity generation and the majority share of the unallocated emissions in the Energy Supply sector) and emissions have declined by 23.4**%** since 1990.
- Scotland has an **8.9%** share of total net GHG emissions in **2010** (0.2% less than for the by source emissions as a result of exported electricity generation emissions), and the trend since the Base Year is a decline of **31.1%**.
- Wales has a **7.4%** share of total net GHG emissions in **2010** (over 0.5% less than for the by source emissions as a result of exported electricity generation emissions) and emissions have declined by **22.2%** since the Base Year.
- Northern Ireland has a **3.8%** share of total net GHG emissions in **2010** (0.3% more than for the by source emissions as a result of imported emissions from electricity generation), and the trend since the Base Year is a decline of **9.6%**.

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_1990-2010_Issue 1.xls".

Data Sources and Inventory Methodology

In the compilation of GHG inventories for the constituent countries of the UK, where possible the same methodology has been used to calculate emission estimates as for the UK Inventory. However, for many emission sources the data available for constituent country emissions are less detailed than for the UK as a whole, and for some sources country-level data are not available at all.

In particular, complete sets of fuel consumption data are not available for England, Wales, Scotland or Northern Ireland. In order to make emission estimates for fuel consumption, therefore, the available data has been supplemented with surrogate statistics.

Sub-national energy statistics are published annually by the Department for Energy and Climate Change (DECC) within the quarterly *Energy Trends*[7] publication. These sub-national statistics are limited in their detail when compared to UK-level energy statistics (used in the UK GHG Inventory compilation), but do provide estimated fuel use data for England, Scotland, Wales and Northern Ireland for the following source sectors:

- Industry and Commercial
- Agriculture
- Residential

The DECC sub-national energy statistics have been developed in recent years to provide estimates of fuel use and carbon dioxide emissions data at Local Authority (LA) level across the UK. The latest available data include LA solid and liquid fuel use estimates for 2005 to 2009, with gas and electricity data also available up to 2010.

The DECC data at local and regional level are derived from analysis of gas and electricity meter point data, supplemented by additional research to estimate the distribution of solid fuels and petroleum-based fuels

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

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

[7] The latest available data are taken from the December 2010 Energy Trends:

http://www.decc.gov.uk/en/content/cms/statistics/publications/trends/trends.aspx

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. These DECC sub-national energy statistics continue to evolve and improve, reducing data inaccuracies, but nevertheless are subject to greater uncertainty and less detail than the UK energy statistics presented within Digest of UK Energy Statistics (DUKES) which are used to underpin the UK GHG inventory. However, they are regarded as the best dataset available to inform the patterns of fuel use across the DAs and are therefore 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 Greenhouse Gas 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 (published in September 2011) covered the years up to and including 2009, whilst this report gives emission estimates for the years up to and including 2010.

The nature of emission inventories is such that on-going improvements to data collection or estimation techniques will inevitably lead to some revisions of historic data. The inventories are also updated to take account of any amendments to core activity or emission factor data, 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”) are revised annually and hence the data provided (e.g. for “coal used in energy generation in 2009”) may be different in the latest edition of the Digest, compared to that used in the compilation of the previous inventory report. In addition, since the previous inventory report (2011), a more representative emission factor for one or more GHGs may have been derived for a given process. Use of a new emission factor in emission estimation calculations may lead to revisions of historic data in the time series.

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, should more suitable statistics become available.

Therefore, it is not appropriate to use data from previous reports and compare them with the figures in this report, without taking account of any changes to either the emission estimation methodology or the source data. There is normally a comment in the report to indicate where such changes have occurred.

Since the publication of the 2011 (1990-2009) GHG inventories for England, Scotland, Wales and Northern Ireland, some of the methodologies used to compile the inventories have been revised due to either changes within the UK GHG inventory compilation method, or the use of new or improved DA-specific data sources for a given source sector. Significant revisions have been made to DA estimates in the following categories:

- Energy production
- Industrial fuel combustion
- Domestic fuel combustion
- Oil and gas sector
- Road transport
- Agriculture
- Land Use, Land Use Change & Forestry
- Waste management

Full details of the changes in estimates between the 2011 (1990 – 2009) estimates and the estimates presented in this report (1990 – 2010) are presented in Appendix 7.

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.

Contacts

This work forms part of the Climate and Energy: Science and Analysis Research Programme of the Department for Energy and Climate Change. The land use, land use change and forestry estimates were provided by the Centre for Ecology and Hydrology (CEH) Edinburgh (Contract CPEG 1). Rothamsted Research provides the estimates of agricultural emissions under a separate contract to the Department for Environment, Food and Rural Affairs.

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

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[9] Table references apply to each DA chapter and are preceded by the relevant prefix: England = 2, Scotland = 3, Wales = 4, Northern Ireland = 5

Report Structure

This report is structured as follows:

Main body of the report: This part of the report presents and discusses the inventories for England, Scotland, Wales and Northern Ireland, providing GHG emissions data for the years 1990, 1995, and 1998 to 2010. Each inventory is discussed at a National Communications sector level, presenting the emissions by source sector, by traded and non-traded split and by end user contribution of each. The reasons for any significant trends in emissions, issues regarding data availability and uncertainty estimates are provided for each inventory.

The appendices present more detailed data and information about the methods used.

Appendix 1: Presents details of the uncertainties in the UK and DA estimates.

Appendix 2: Describes in detail the methodology used to derive the by source DA GHG emission estimates for each source, and how the DA inventories relate to the UK GHG Inventory.

Appendix 3: Contains the methods used for calculating End User emissions.

Appendix 4: Describes the detailed methods used for splitting DA emissions into traded (EU ETS) and non-traded.

Appendix 5: Presents a mapping between NAEI source name, IPCC category and National Communication category.

Appendix 6: Outlines the calculation approach and GHG emission estimates from international aviation and international shipping sources that can be allocated to each of the constituent countries across the time-series.
N.B. These data are not included within the main DA inventory data, but are presented as "memo items" to the DA inventories, in common with the international protocol adopted for the reporting of the UK GHG inventory to the UNFCCC.

Appendix 7: Provides details of recalculations between last year's (2011) and this year's (2012) DA estimates.

1 Introduction

1.1 Policy Background

The United Nations Framework Convention on Climate Change (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 in the atmosphere and reduce the anthropogenic interference with the climate system. In order to achieve this, the international community 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, has ratified the Kyoto Protocol and is required to submit to the 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 national communications periodically, according to dates established in the Conference of the Parties. The annual inventory reports must comply with the UNFCCC guidelines and meet IPCC good practice guidelines on quality (including transparency, completeness and accuracy). The Kyoto Protocol supplements the UNFCCC by committing parties, who have ratified the protocol, to achieve individual targets established for the reduction of their respective GHG emissions. Under the protocol, the UK is legally bound to reduce emissions of the 'basket of 6' GHGs by 12.5% against baseline emissions over the first commitment period (2008-2012). In the United Kingdom, the National GHG Inventory and associated National Inventory Report (Brown *et al.*, 2012) 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, 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 carbon dioxide emissions to be achieved by 2020. The Act also introduced a Carbon Budgeting System whereby emission caps are set over 5 year periods, with three budgets established at a time to map out the emission trajectory to 2050. While this Act represents the primary piece of climate change legislation relevant to England, an overview of the main components of UK and DA climate change legislation and strategies is presented in Figures 1.1a and 1.1b below. 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)
- the 'One Wales' Commitment to reduce greenhouse gas emissions and the Climate Change Strategy for Wales (2010)
- Northern Ireland Greenhouse Gas Emissions Reduction Action Plan (2011)

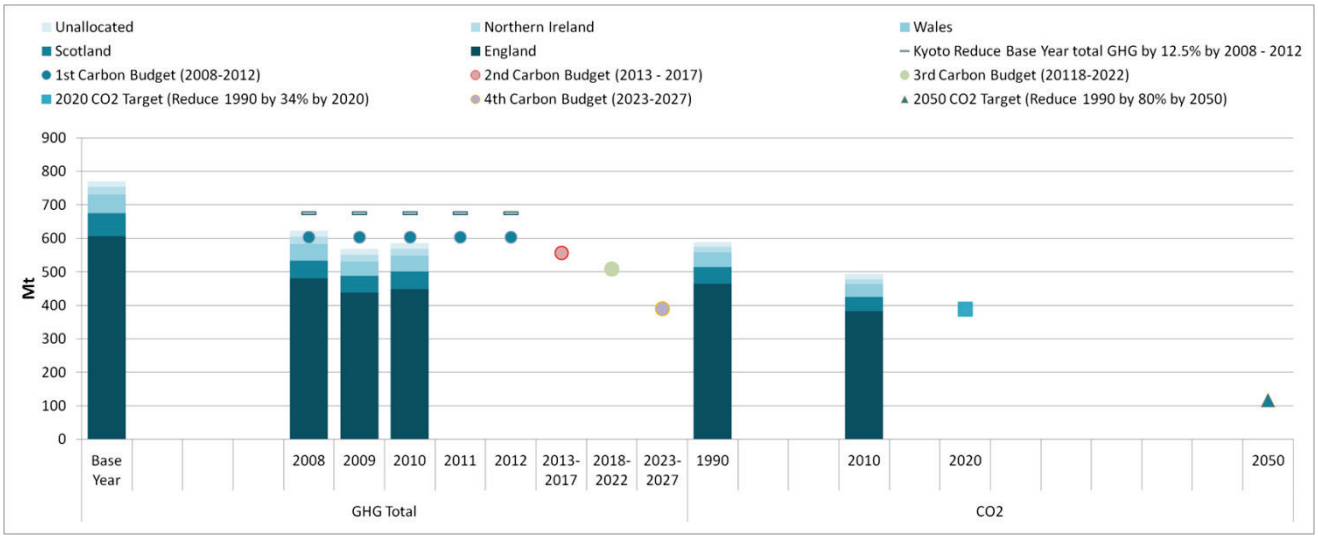
The Climate Change (Scotland) Act outlines that the net Scottish GHG emissions account shall include all existing anthropogenic sources and sinks of emissions in Scotland, together with emissions from the traded sector[10], and also a "Scottish share" of GHG emissions from international shipping and international aviation. In contrast, the Welsh emissions account excludes emissions from the traded sector and international transport sources, with specific sector targets to be established. The current Northern Ireland Programme for Government has increased Northern Ireland's target reduction for 2025 from 25 to 35% and an action plan is currently being developed.

The 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

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

that the requirements of the GHG inventories for the constituent countries is evolving, with a much greater focus on (i) sector-specific data accuracy, and (ii) sensitivity to policy impacts.

Figure 1.1a UK Greenhouse Gas Emission Reduction Targets: Kyoto, to 2020, to 2050



1.1 About the GHG emissions estimates used for this report

The Department of Energy and Climate Change (DECC) and the DAs commission an annual work programme to compile GHG inventories for the DAs in order to establish GHG emission baselines by source and to track progress towards reduction targets at DA level. This report summarises the findings of the joint research programme for the 1990-2010 GHG inventory cycle, which revises and updates the previous DA inventories that were published in September 2011.

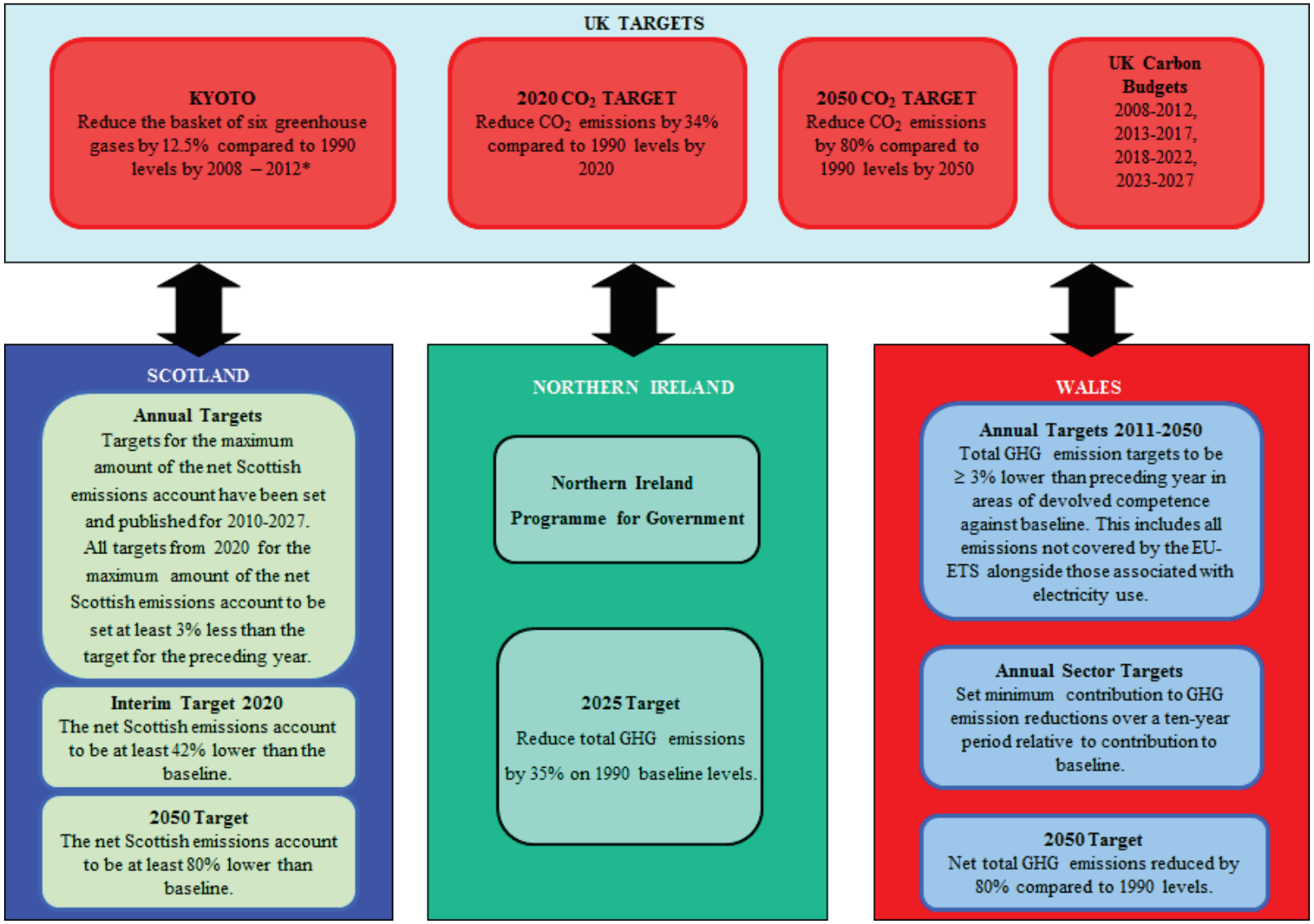
1.1.1 Inventory time series and revisions

This report presents separate GHG Inventories for England, Scotland, Wales and Northern Ireland for the years 1990, 1995, and 1998 to 2010. It is based on the latest UK GHG inventory which was submitted to the UNFCCC in April 2012 (Brown *et al.*, 2012). The UK emissions are combined with data on the split between the DAs of emissions or activities for each source sector in each year (known as DA 'drivers').

Each year, the GHG inventories for the UK and for England, Scotland, Wales and Northern Ireland are extended, improved where possible and updated. The time series of the inventories are extended to include the latest inventory year, and the inventories are revised to reflect any new or amended activity data or emission factors to include improvements to data collection or estimation techniques. Core energy statistics (all DECC references) are revised annually and hence historic data from DECC are often different from that used in the compilation of the previous inventory report. Similarly, where new research has derived a more representative emission factor or new data becomes available due to the implementation of new regulations, the GHG time-series estimates for the relevant source categories will be revised. For example, new data on fuel use and fuel quality across several source sectors has become available for use in the UK and DA GHG inventories through the EU ETS.

As data revisions may lead to changes to emission estimates for any year in the time-series it is not appropriate to use data from previous reports and compare them with the figures in this report, without taking account of any changes to either the emission estimation methodology or the source data. Improvements and updates that have been made to the methodology, data sources and assumptions will be evident by revised estimates. These are highlighted at the beginning of each DA section and summarised in inventory recalculations tables presented in Appendix 7.

Figure 1.1b Greenhouse Gas Emission Reduction Targets: UK, Scotland, Wales and Northern Ireland



1.1.2 Greenhouse Gases included in the DA inventories

Emissions are reported for the six direct GHGs listed in Table 1.1, 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 GWP is defined as the warming influence over a set time period of a gas relative to that of CO_2. 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 CO_2. 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, 1996). The 1996 values were agreed internationally as the values that Parties are required to use for reporting GHG emissions to the UNFCCC and the Kyoto Protocol, although they were updated in 2001. For consistency with international reporting, the 1996 values are also used in this report. A range of GWP values is shown for HFCs and 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 1.1 Global Warming Potential of GHGs on a 100-year Horizon (t CO_2 equivalent/ t gas)

Global Warming Potential on a 100-year Horizon	
Greenhouse Gas	Global Warming Potential (t CO_2 equivalent / t gas)
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310
Hydrofluorocarbons (HFCs)	140-11700
Perfluorocarbons (PFCs)	6500-9200
Sulphur hexafluoride ($SF_{6)}$	23900

1.1.3 Source Category Breakdown

The GHG inventories for England, Scotland, Wales and Northern Ireland in this report are presented in a different format to the UK GHG inventory, but the sum of the DA inventories are fully consistent with the UK GHG inventory. To provide information that is better aligned to the needs of DA policy teams, this report presents the data according to National Communication format at the top level, with additional detail by IPCC sector code below that. The National Communication format presents the GHG emissions for the following policy areas:

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

A table to show the mapping between IPCC sectors and National Communication sectors is provided in Appendix 5.

The data in this report are, unless otherwise stated, presented as emissions estimates at the point of emission, also called "by source" estimates. Emissions are accounted for in the country in which they are emitted. The estimates for each DA include emissions from fuel combustion (Energy), industrial processes, agricultural practices (Agriculture), Land Use, Land Use Change and Forestry (LULUCF) and waste disposal (Waste). National totals for DAs exclude emissions from international aviation and shipping (which are presented as memo items) and of carbon dioxide from the burning of biofuels. In addition, 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.

1.1.4 Uncertainties in emissions

Uncertainties for estimates of emissions by source for the DAs for the 2010 estimates are +-14%, +-27%, +-19% and +-38%% for England, Scotland, Wales and Northern Ireland respectively. Emissions of carbon dioxide from fuel consumption, which is based on reliable energy balance data and account for 84% of DA emissions, are the most accurate (+-2% England , +-10% Scotland, +-3% Wales and +-7% Northern Ireland). Emissions of nitrous oxide are the least certain (+-251% England, +-271% Scotland, +-281% Wales, +-297% Northern Ireland) due to high uncertainty in estimates for emissions from soils (for fertilizer application and variability of soil types). The methodology used to estimate the by source emissions by DA is presented in Appendix 2.

1.1.5 Traded and non-traded emissions

Emissions from the traded (EU ETS) and non-traded sectors represent an important component of emissions reporting in the UK and DA GHG inventories. As the EU ETS is an EU wide mechanism, the UK as wells as the Scottish Government, Welsh Government and Northern Ireland Executive have limited powers over activities within the traded sector and it is often important to analyse trends in emissions for the non-traded component of emissions sources. The segregation of emissions between traded and non-traded sectors is important for Wales where the net emissions account excludes emissions from the traded sectors, and for Scotland, where the Act requires quantification of the impact of both the traded and non-traded sectors. Where possible and for relevant source categories, the by source emissions have been 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 the Environment Agency and focuses on the years 2008-2010 only (as these are the years for which EU ETS data is available and of good enough quality and completeness for inclusion in the inventory). As a result of a difference in classification systems between the EU ETS and UK and DA GHG estimates, some difficulties exist in allocating traded emissions to specific GHG emissions categories and small revisions have had to be made to the allocation of emissions across source categories to prevent this subtraction from resulting in negative values. Most notably, emissions from all cement processes have been included in Business rather than split between Business and Industrial Processes because EU ETS emissions are not split into combustion (business) and process (Industrial Process) components. While the emissions estimates for the by source and EU ETS emissions are relatively accurate, the allocation between source categories for some of the categories is quite uncertain. The methodology used to estimate the split between traded and non-traded emissions by DA is presented in Appendix 4.

1.1.6 End User emission inventories

Emission estimates are also presented in this report on an "End User" basis. The end user basis allocates emissions from energy supply (electricity, refined petroleum fuels, gas and solid fuel production) to the end users (residential, transport, agriculture, public, businesses) of the energy supplied. The End User GHG inventories provide insights to the emissions from the energy supply sector driven by demand for energy from the different end user categories and can be used to help highlight where energy efficiency policies are and can be targeted. Although emissions from international transport (Air and shipping) are excluded from the DA estimates, the emissions associated with the production of international transport fuels sold within the DA are included and attributed to the "Exports" category.

The end user estimates undergo an additional layer of calculation therefore the estimates are less certain than the 'by source' estimates and should be treated with more caution when basing decisions on them. Note that the end user emission estimates for each country are regarded as uncertain 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 DA consumption of electricity is reported by DECC whilst the sector allocations of electricity use are based on limited data from a range of statistical sources. Therefore 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 within the National Communication Sections. The methodology used for estimating the End User emissions for each DA is presented in Appendix 3.

2 Emissions in England

2.1 1990-2010 GHG Inventory Estimates

The GHG emissions for England for 1990 – 2010 are presented in Table 2.1 below. Emissions in 2010 are 448,434 $ktCO_2e$ with 32% of emissions in 2010 from Energy Supply, 16% from Residential, 15% from Business and 22% from Transport sources.

Table 2.1: 1990-2010 England GHG Emission Inventory ($ktCO_2e$)

NC Format	Base Year	1990	1995	2000	2005	2008	2009	2010	% of 2010
Agriculture	40,094	40,094	38,642	35,910	34,002	31,835	31,347	31,668	7.1%
Business	86,764	85,767	83,048	83,754	84,162	79,702	71,058	69,082	15.4%
Energy Supply	211,563	211,563	167,493	150,045	165,437	160,119	142,568	145,218	32.4%
Industrial Process	50,738	48,897	40,552	20,133	14,322	12,892	8,076	8,121	1.8%
Land Use Change	5,980	5,980	5,539	3,990	2,418	1,829	1,528	1,642	0.4%
Public	10,694	10,694	10,755	9,840	9,323	7,784	6,827	6,994	1.6%
Residential	63,305	62,980	65,076	72,361	71,094	67,111	62,616	72,344	16.1%
Transport	101,057	101,057	101,361	105,077	107,631	105,113	100,500	100,343	22.4%
Waste Management	35,770	35,770	31,200	22,982	14,960	13,913	13,502	13,025	2.9%
Total	**605,965**	**602,803**	**543,666**	**504,092**	**503,348**	**480,298**	**438,022**	**448,436**	**100%**

Although total GHG emissions between 2009 and 2010 show a small increase (2.4%), emissions for England have reduced between the Base Year[11] and 2010 by 26.0%. Carbon dioxide emissions have increased by 3% between 2009 and 2010, and decreased by 17% between the Base Year and 2010 (see Figure 2.1 and Table 2.1).

Emission reductions (Table 2.2) are a result of declining manufacturing (e.g. in iron and steel, bulk chemical production), efficiencies in energy generation and business heating and using natural gas to replace some coal and other fuels as well as abatement in some chemical industries. Only residential (+14.3%) and transport (-0.7%) have not shown any real reduction in emissions between the Base Year and 2010. Emissions for the residential and transport sectors continued to buck the general trend as a result of increasing population and increasing demand for heating and transportation despite improvements in energy efficiency of vehicles and housing. Emissions from installations included in the EU ETS (see Figure 2.7) reduced by 13% between 2008 and 2009 as power demand in the economy dropped, with emissions staying relatively constant between 2009 and 2010. By comparison emissions from the non-EU ETS sources have reduced by only 3% between 2008 and 2010.

Detailed analysis of England's emissions in 2010 is presented in figures 2.4-2.9. The dominant emission sources in 2010 include road transport (21% of total GHG emissions), residential combustion for heating and cooking (15%), electricity production (28%) and industrial combustion for heat and electricity in the business sector (10%) (See Figure 2.5).

Emissions from installations in the EU ETS (see Figure 2.7) contribute 37.8% of total GHG emissions in England in 2010; the main contributors to these traded emissions are the Energy Supply sector (of which 95% total emissions are within the EU ETS, including all power stations) and the Business and Industrial Process sectors (see Figure 2.9) (of which, 39% of the two sector emissions are in the EU ETS, including all cement kiln emissions and 83% of total iron and steel production emissions). The majority of (Traded) emissions are carbon dioxide emissions from large industrial combustion plant, autogenerators, chemical production (ammonia primarily for fertilizers), cement and lime kilns, iron and steel works, aluminium and brick manufacture plant included in the EU ETS.

[11] 1995 for F-Gases and 1990 for all other gases

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

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 to illustrate the share of total emissions attributable to the end users of energy in the economy; emissions by end user present a breakdown of emissions on a consumption basis, whereas emissions in the by source inventories present a breakdown of emissions on a production basis. The end user basis allocates emissions from energy supply (electricity, refined petroleum fuels, gas and solid fuel production) to the end users (residential, transport, agriculture, public and businesses) of the energy supplied (See Appendix 3 for more details of the end user inventory methodology). Figure 2.6 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. 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 contribution to England total emissions in 2010 are: 31% from Business, 28% from the Residential sector and 25% from Transport sources. As illustrated in Figure 2.3 England is a net importer of electricity which results in slightly higher (4%) emissions in England for End User (468,490 kt CO_2e) compared to By Source (448,434 kt CO_2e) estimates for 2010.

Emissions from the Land Use Change 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.

A more detailed assessment of emissions by sector is presented below for each of the 9 NC sectors.

2.1.1 Inventory Recalculations

Revisions to the estimates since the last inventory report (2011) have resulted in a 0.5% (2027 ktCO_2e) increase in the 2009 estimates for England. The most significant revisions to the 2009 estimates have been for the following sectors:

1. **Business**: (1,747 ktCO_2e increase) primarily as a result of changes to the model for refrigeration and air conditioning equipment);
2. **Energy Supply**: (1,427 ktCO_2e increase) primarily from the revision of OPG use in petroleum refining and reallocated from 1A4a to 1A1 of combustion of MSW, landfill gas and sewage gas for heat generation;
3. **Waste:** (600 ktCO_2e decrease) from revisions to the UK waste model and also revisions to use more DA-specific input data to derive country-specific estimates.

The most significant revisions to the Base Year estimates have been for the following sectors:

1. **Business**: (430kt CO_2e decrease) and **Public**: (709 kt CO_2e decrease) primarily as a result of revisions to UK inventory allocations of gas oil with lower estimates evident for iron and steel combustion plant, commercial and public sector combustion, offset to some degree by increases in industrial combustion;
2. **Transport**: (485 CO_2e decrease) due to revisions the UK road transport petroleum fuel allocation, revisions in overall gas oil consumption, and revised allocations of petrol, gas oil and DERV to inland shipping;
3. **Waste:** (11,491 kt CO_2e decrease) due to the combined impacts of revisions to the UK GHGI landfill waste model and revisions to the DA landfill waste method to utilise more country-specific data for waste disposals to landfill.

For more details of revisions to DA GHG emission estimates, see Appendix 7.

England Trends in Emissions

Percentage Change in GHG Emissions by NC: Base Year - 2010 and 2009 - 2010

The % changes for LULUCF are based on net change to emissions and removals throughout the time series

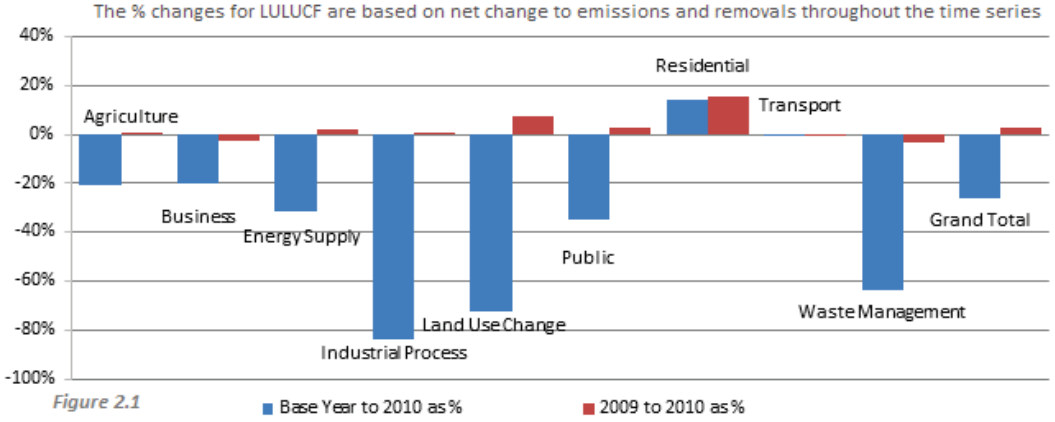


Figure 2.1

Percentage Change in Total GHG and CO2 Emissions by NC: Base Year - 2010 and 2009 - 2010

Change in emissions from the Base Year to 2010 and 2009 to 2010	Agriculture	Business	Energy Supply	Industrial Process	Land Use Change	Public	Residential	Transport	Waste Management	Total	
Base Year to 2010 as %	-21%	-20%	-31%	-84%	-73%	-35%	14%	-1%	-64%	-26%	Total GHG as CO2e
2009 to 2010 as %	1%	-3%	2%	1%	7%	2%	16%	0%	-4%	2%	
Base Year to 2010 as %	-22%	-31%	-25%	-47%	-76%	-34%	13%	0%	-77%	-17%	Total CO2 only
2009 to 2010 as %	1%	-4%	2%	-3%	9%	2%	16%	0%	2%	3%	
Base Year to 2010 kt	-8,426	-17,682	-66,345	-42,617	-4,339	-3,700	9,039	-715	-22,745	-157,529	Total GHG as CO2e
2009 to 2010 kt	321	-1,976	2,650	45	114	167	9,728	-157	-477	10,414	
Base Year to 2010 kt	-676	-25,783	-47,476	-5,699	-4,282	-3,654	7,769	-19	-864	-80,682	Total CO2 only
2009 to 2010 kt	34	-2,325	2,891	-219	111	166	9,766	-152	4	10,276	

Table 2.2

Total GHG Emissions by NC category for Base Year to 2010, as CO2e

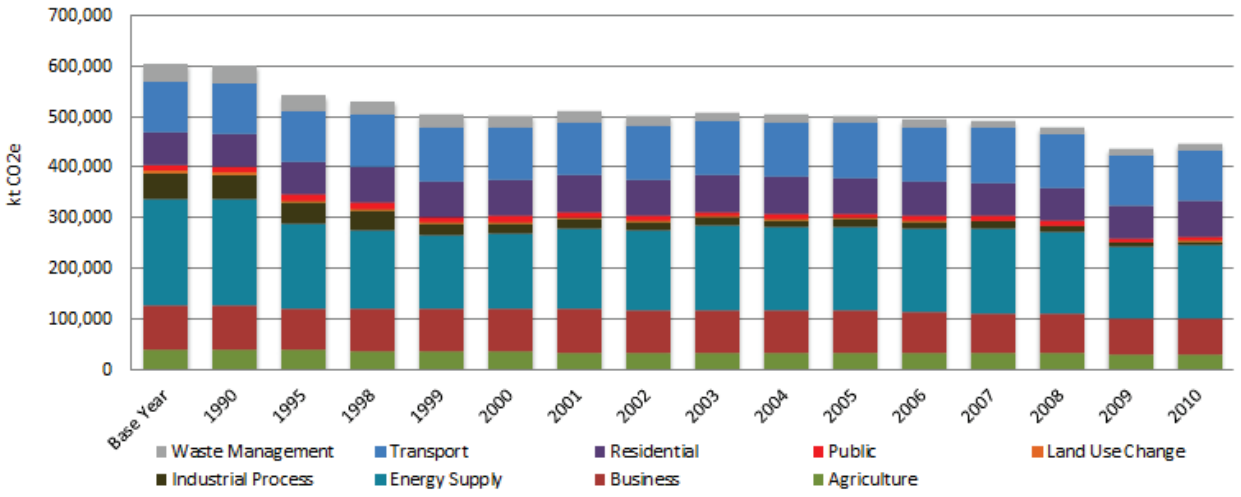
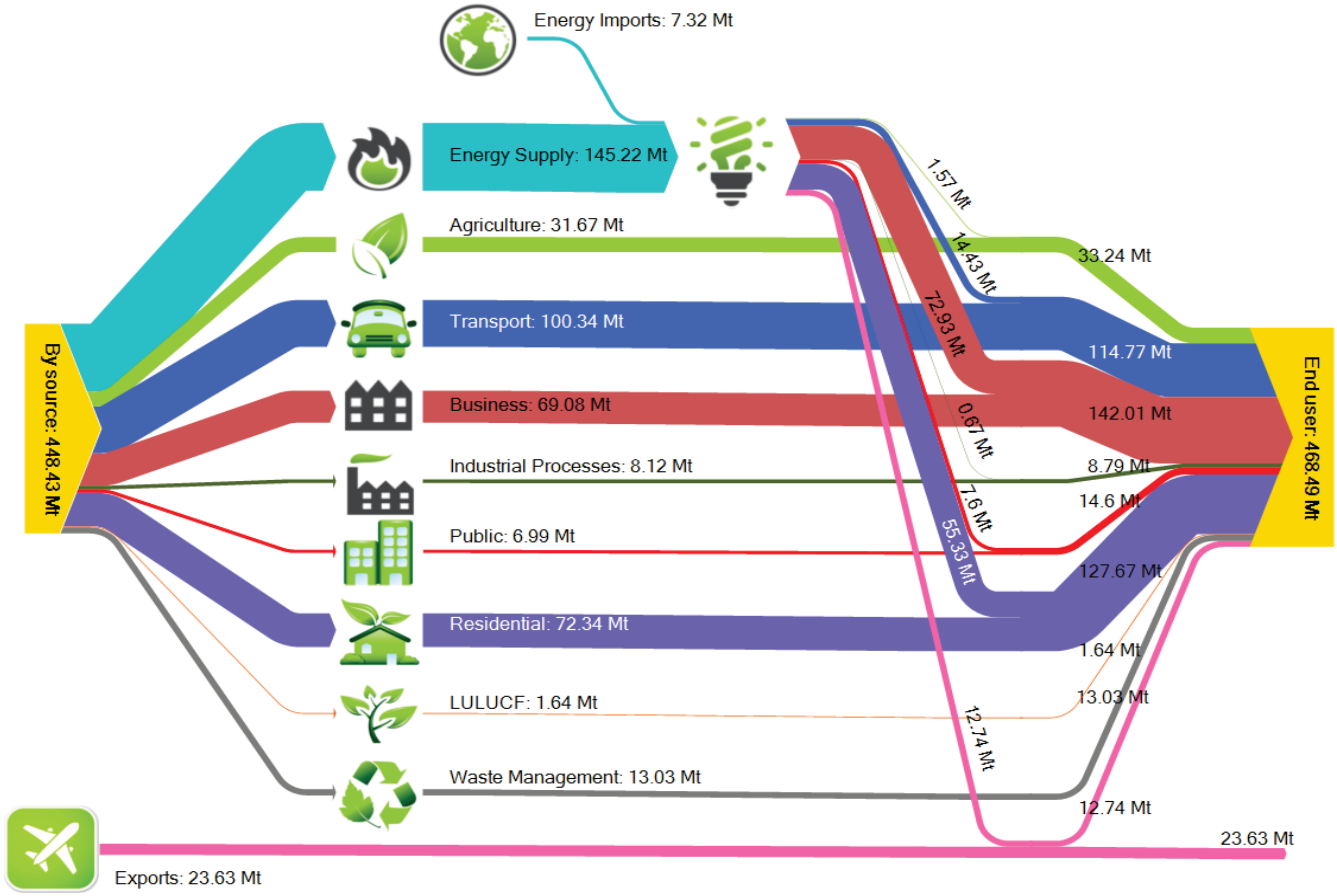


Figure 2.2

Figure 2.3 Sankey diagram showing By Source and End User[12] GHG emission transfers for England in 2010 (Mt CO_2e)[13]



[12] 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.

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

England 2010 Emissions Summary

Total GHG Emissions by NC and pollutant, 2010

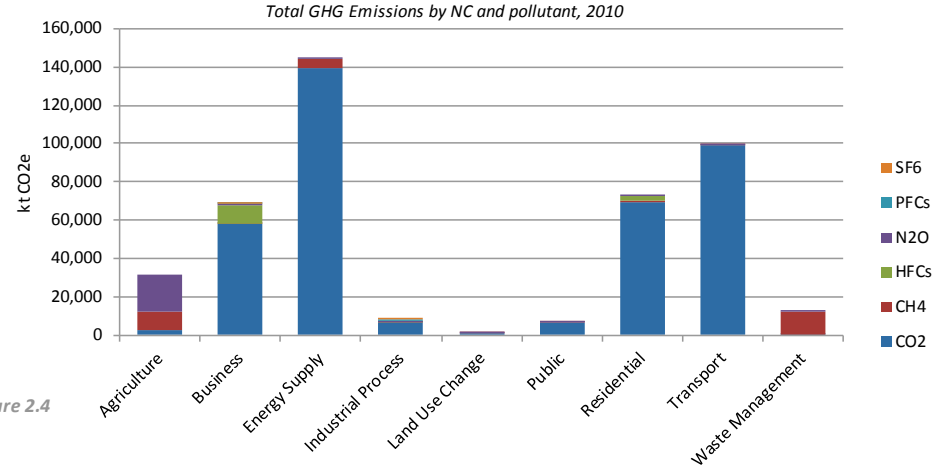


Figure 2.4

Total GHG Emissions by NC and sub-category highlighting the important sources, 2010

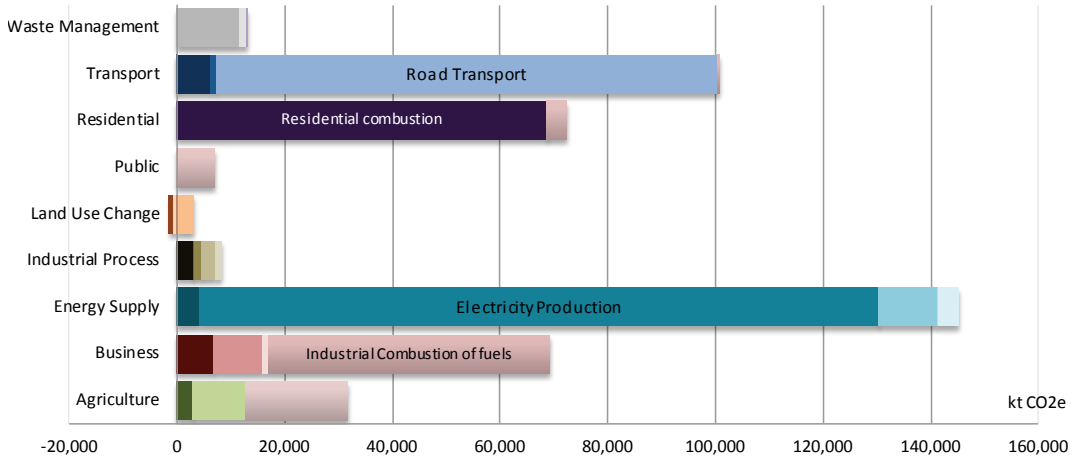


Figure 2.5

Comparison of End User and By Source Emissions, 2010 ***(Mt CO2e)***

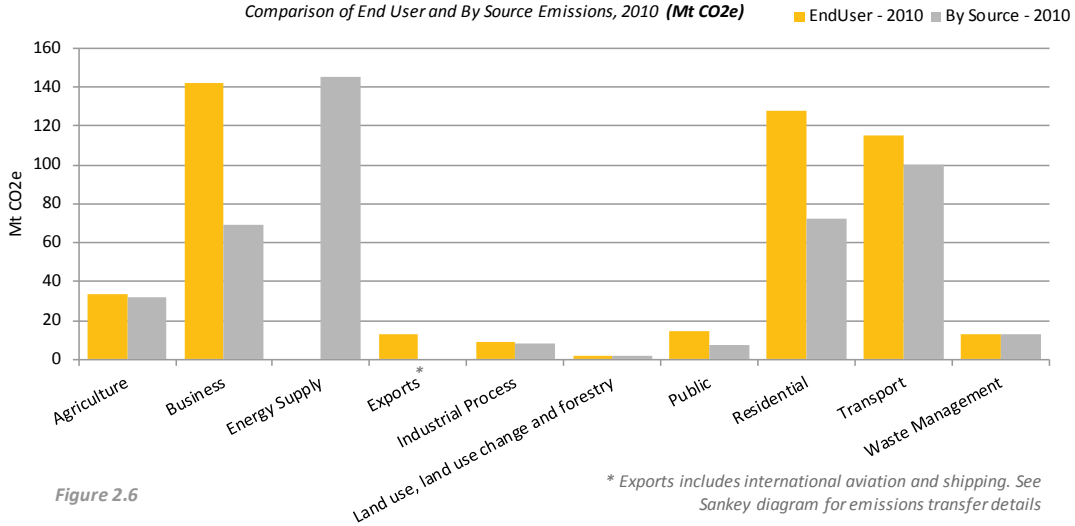


Figure 2.6

** Exports includes international aviation and shipping. See Sankey diagram for emissions transfer details*

England 2010 Traded and Non-Traded Emissions Summary

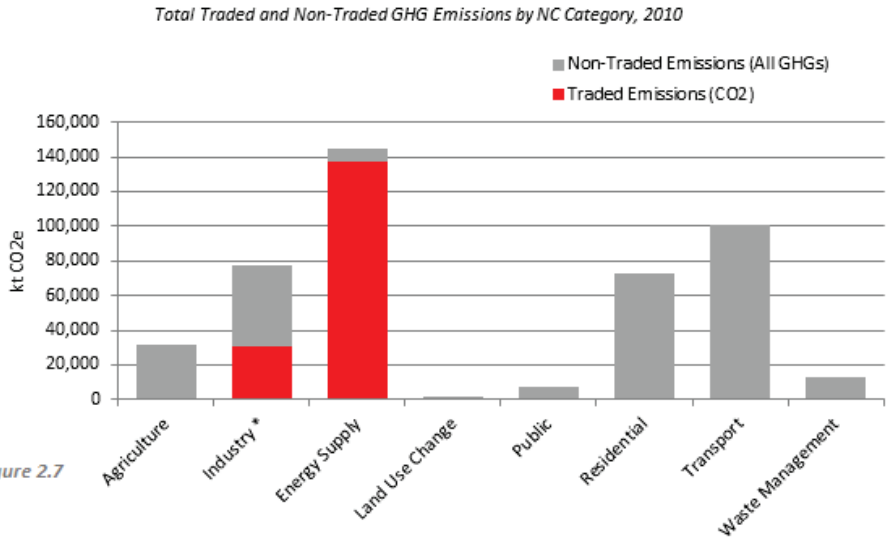


Figure 2.7

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

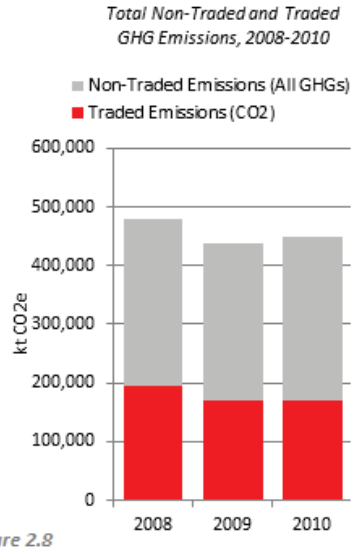
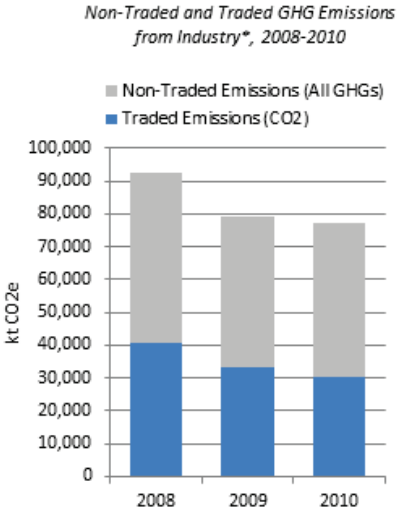


Figure 2.8



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

Figure 2.9

2.2 Energy Supply

Energy Supply — *England*

Overall Contribution of Energy Supply to 2010 GHG emissions

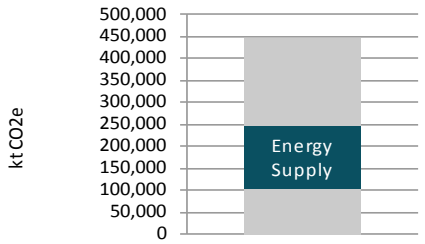


Figure 2.10

32.4%

Percentage of total emissions

GHG Contribution for Energy Supply Emissions, 2010

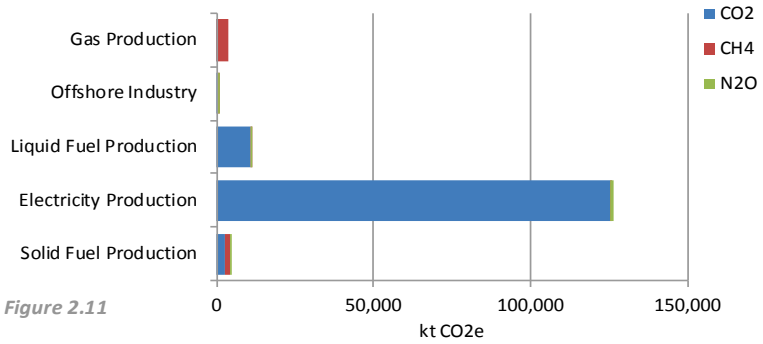


Figure 2.11

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 2.3

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Electricity Production	-27%	-47,238	2%	2,629
Gas Production	-48%	-3,414	-2%	-85
Liquid Fuel Production	-5%	-524	2%	231
Offshore Industry	-14%	-54	-25%	-111
Solid Fuel Production	-79%	-15,114	0%	-14
Total	-31%	-66,345	2%	2,650

Total GHG Emissions from Energy Supply, Base Year to 2010

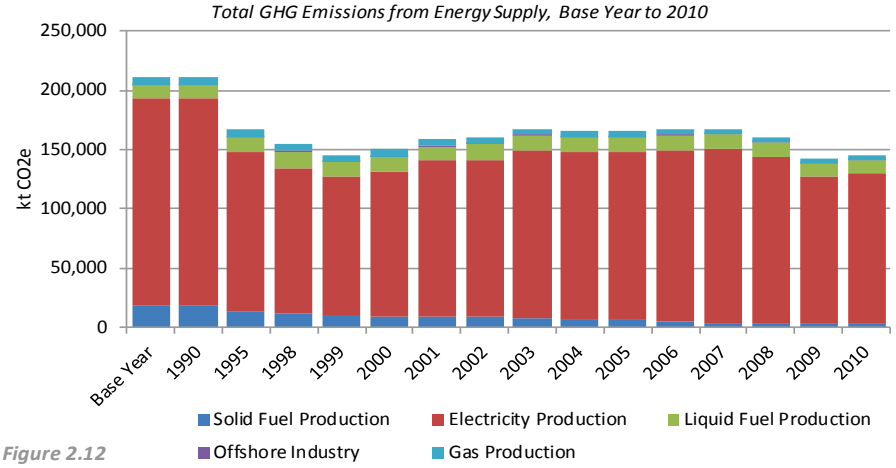


Figure 2.12

NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions

NC Category	EndUser
Agriculture	0.95%
Transport	1.23%
Business	53.40%
Industrial Process	0.01%
Public	5.31%
Residential	37.54%

Table 2.4

Emissions and Electricity Production by Fuel Tyoe from Major Power Producers (1A1a)

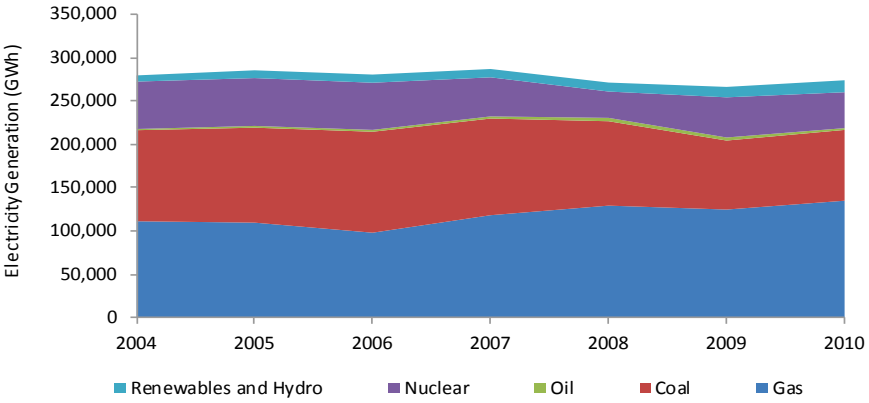


Figure 2.13

Traded and Non-Traded Energy Supply Emissions, 2008-2010

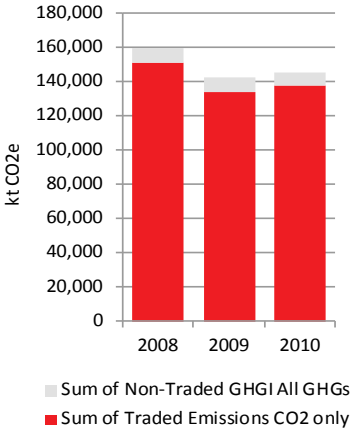


Figure 2.14

Figures 2.10 – 2.14 show detailed emissions and trends for the Energy Supply sector. In England, Energy Supply contributes 32.4% to total 2010 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 accounts for 86.6% of Energy Supply emissions in 2010; refinery emissions account for a further 7.5% of the Energy Supply sector emissions in 2010.

Table 2.3 shows the change in emissions between the Base Year and 2010 and 2009 and 2010 for the sector. Energy Supply sector emissions have reduced steadily since 1990 (by 31% between the Base Year and 2010) 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.

Only those emissions arising from on-shore installations in England have been included within the English GHG inventory; emissions from offshore oil & gas exploration and production off-shore facilities are reported as “Unallocated”.

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

Carbon is the predominant gas accounting for over 96% of emissions from the Energy supply sector in 2010 as a result of the combustion of fossil fuels.

The mix of generation capacity in England is shown in Figure 2.13. Emissions in England have 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[14]. The “by source” inventories presented here allocate emissions to the constituent countries that those emissions occur in, and hence the GHG emissions from the power generated in Wales and Scotland and exported to England are allocated to Wales and Scotland respectively.

Energy Supply Emissions on an End User Basis

End user emissions from Electricity Production part of the Energy Supply sector are presented in Table 2.4. On an end user basis Business and Residential demand for electricity accounts for 53% and 38% of electricity supply emissions respectively.

[14] For details of regional electricity generation data, see the DECC Energy Trends publication from December 2011, article from page 16.

2.3 Transport

Transport — *England*

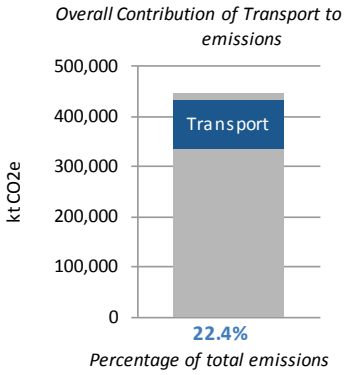


Figure 2.15

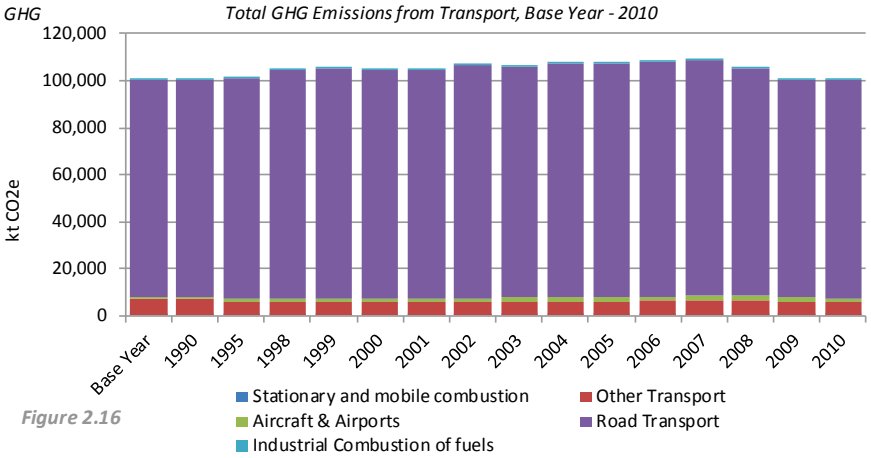


Figure 2.16

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 2.5

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Aircraft & Airports	38.6%	381	-6.8%	-100.6
Industrial Combustion of fuels	-99.3%	-475	11.9%	0.36
Other Transport	-16.5%	-1,198	-1.8%	-114.0
Road Transport	0.6%	579	0.1%	56.9
Stationary and mobile combustion	-21.1%	-2.4	2.9%	0.2
Total	-0.7%	-715	-0.2%	-157.0

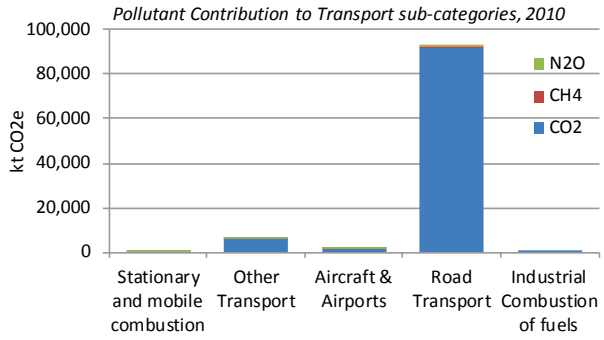


Figure 2.17

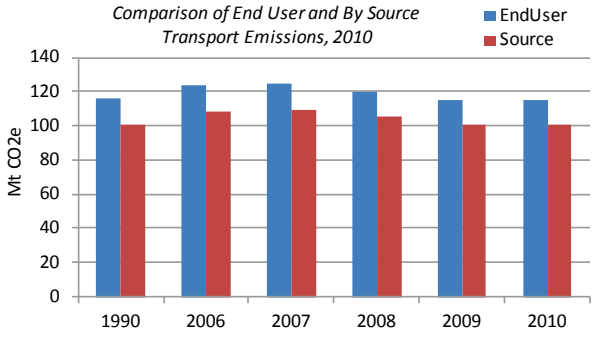


Figure 2.18

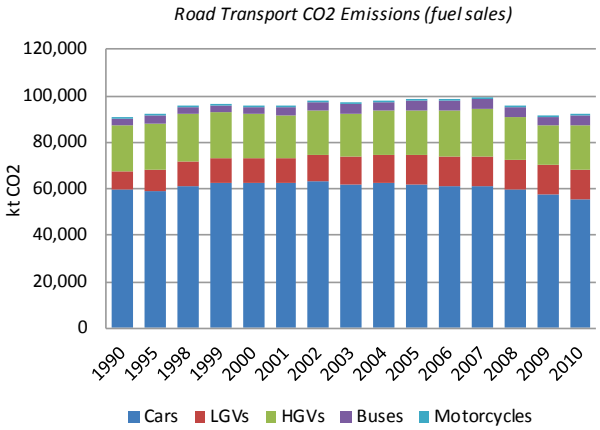


Figure 2.19

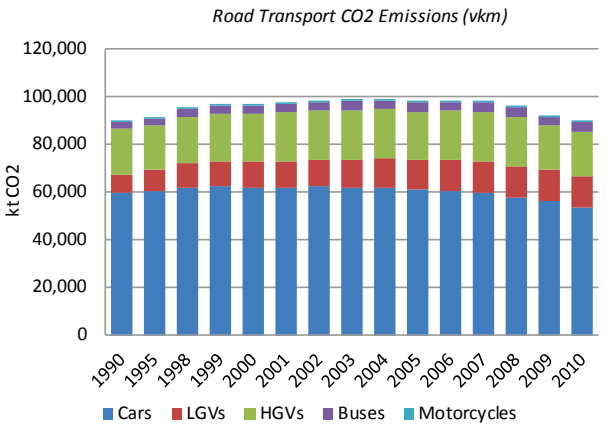


Figure 2.20

Figures 2.15 – 2.20 show detailed emissions and trends for the transport sector. Transport emissions account for 22.4% of England's total GHG emissions in 2010. Transport emissions are dominated by emissions from road transport (92.6% of all Transport emissions in 2010, with 56% of Transport emissions from cars alone). The Transport sector also includes 1.8% from rail (including stationary sources[15]), 1.7% from national navigation and coastal shipping, 1.0% from domestic aviation and 2.5% from military aviation and shipping. Emissions from international aviation are excluded from these estimates. Details of these emissions are included in appendix 6.

Table 2.5 shows the change in emissions between the Base Year and 2010 and 2009 and 2010 for the sector. Total GHG emissions from the Transport sector in England have decreased by only 0.71% between the Base Year and 2010 despite improvements in efficiency of transport vehicles, as a result of strong growth in transport demand and increased affordability of cars and fuel. Emissions between 2009 and 2010 have not seen any significant change.

Figure 2.19 shows the CO_2 emissions from road transport for England based on constrained (DUKES fuel sales) and unconstrained (vehicle kilometre, vkm) approaches. Total CO_2 emissions from the vkm approach are 0.8% and 2.1% lower than the estimates constrained to DUKES for 1990 and 2010 respectively. The differences between the two approaches fluctuate year on year but they remain within 2.1% of difference for England. These disparities will also be reflected in the trends derived from the two approaches to a different extent. The long term trend (between base year and 2010) for each individual vehicle type is generally similar between the two approaches. The vkm approach indicates that the overall CO_2 emissions from road transport in 2010 are almost the same as the base year level, while the constrained approach indicates that CO_2 emissions have increased by 1.3% between the base year and 2010. Between 2009 and 2010, there is a big difference in the trend for HGVs as indicated by the two approaches: the vkm approach shows a 1.5% increase in England's HGV CO_2 emissions while the constrained approach shows an 11.1% increase. Apart from modelling uncertainty, there are possibly a number of combining factors causing the disparity. One of which may due to a higher percentage rise (4%) in diesel fuel sales reported by DUKES between 2009 and 2010 while the traffic (i.e. vkm) activity did not reflect similar growth rate for diesel dominated vehicles (<1 % for LGVs, HGVs, buses and coaches). As the constrained method adjusts vkm-based HGVs emissions so that the overall diesel emissions are consistent with the fuel sales reported in DUKES (see Brown et al., 2012 for further details on fuel normalisation process), the level of disparity will distort the trend for HGVs to a different degree.

Transport Emissions on an End User Basis

The end user estimates in recent years are a steady 14% higher than the by source estimates, reflecting the additional emissions from upstream oil extraction and the oil refining sector. A small proportion of electricity generation emissions are also attributed to the End User Transport sector from electric rail use.

The trend in end user emissions (Figure 2.18) since 1990 shows a decline of around 1.4% to 2010, which is a slightly larger reduction 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.

[15] Electricity use from rail sector is not included in the By Source estimates but is attributed to the transport sector in the end user estimates.

2.4 Residential

Residential — *England*

Overall Contribution of Residential sector to 2010 GHG emissions

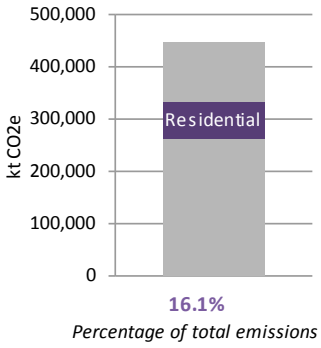


Figure 2.21

Total GHG Emissions by sub-sector, Base Year - 2010

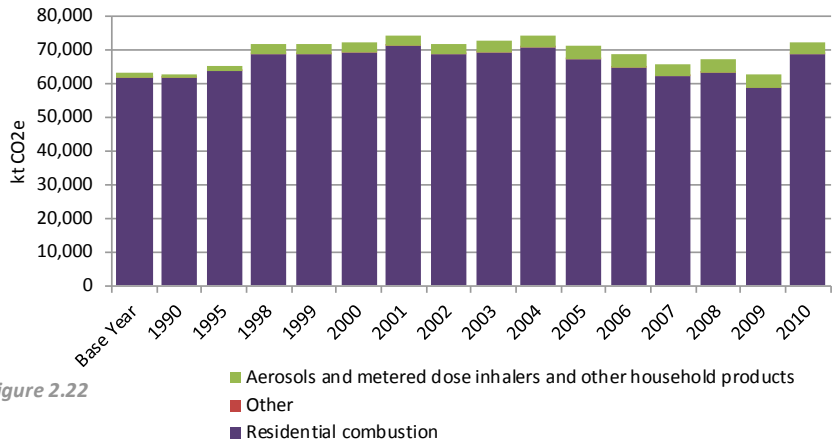


Figure 2.22

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 2.6

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Aerosols and metered dose inhalers and other household products	164.1%	2223	-1.7%	-61
Other	-29.5%	-0.33	0.1%	0.0
Residential combustion	11.0%	6817	16.6%	9,788.5
Total	14.3%	9039	15.5%	9,727.5

Pollutant contribution to Residential Emissions, 2010

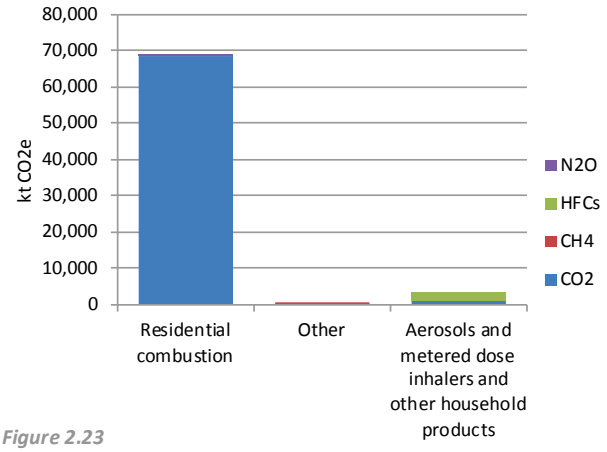


Figure 2.23

Comparison between End User and By Source Inventory Totals, 2010 ***(Mt CO2e)***

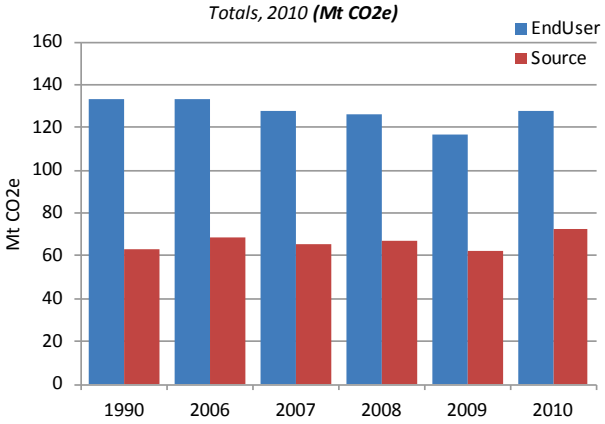


Figure 2.24

Figures 2.21 – 2.24 show detailed emissions and trends for the sector. The Residential sector accounts for 16.1% of England's total GHG emissions in 2010. The sector comprises emissions from domestic combustion (95% of emissions for the residential sector) from heating and cooking, household products, accidental vehicle fires and Hydrofluorocarbon (HFC) emissions from the use of aerosols and metered dose (usually asthma) inhalers. Over 96% of all residential GHG emissions are from the release of carbon dioxide from the direct combustion of fossil fuels (see Figure 2.23).

Total GHG emissions from the Residential sector (Table 2.6) in England have increased by 14.3% between the Base Year and 2010. There was a large increase in fuel use and GHG emissions from the sector in 2010

(16% increase in emissions between 2009 and 2010) primarily driven by two successive cold winters and a resultant high demand for fossil[16] fuel heating in many parts of England.

Residential Emissions on an End User Basis

In 2010 England end user emissions for the residential sector are 166% of the by source emission estimates, reflecting the high consumption of electricity in the sector (Figure 2.24). This increases the overall significance of this sector in the end user inventory to 28% of the England total, compared to just 16% of the by source inventory total. The trend in residential End user emissions since 1990 shows a decline of around 5% to 2010 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.

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

2.5 Business

Business — England

Overall Contribution to 2010 GHG emissions

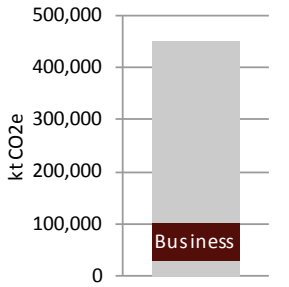


Figure 2.25 **15.41%**

Percentage of total emissions

Total GHG Emissions from Business, Base Year - 2010

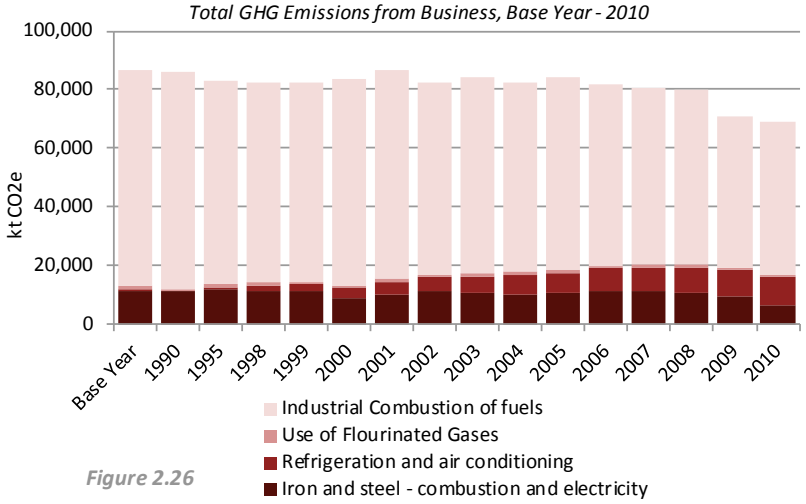


Figure 2.26

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 2.7

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Industrial Combustion of fuels	-29.2%	-21,474.3	1.2%	617.4
Iron and steel - combustion and electricity	-41.9%	-4,868.4	-30.6%	-2,967.3
Refrigeration and air conditioning	1320.8%	8,577.7	4.2%	373.9
Use of Flourinated Gases	9.1%	83.3	0.03%	0.3
Total	-20.4%	-17,681.7	-2.8%	-1,975.8

Pollutant Contribution for Business Emissions, 2010

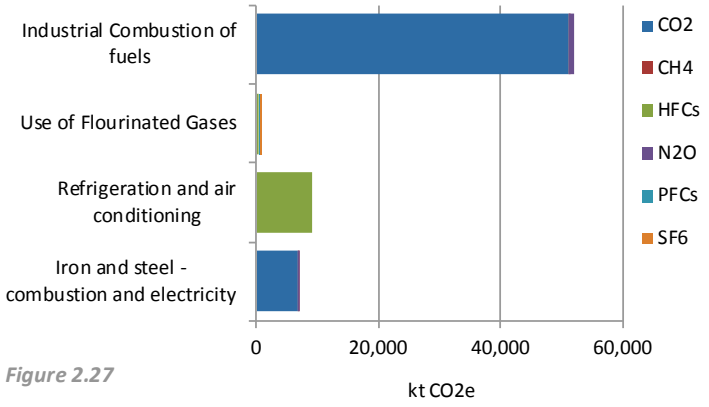


Figure 2.27

Comparison between End User and By Source Inventory for the Business Sector, 1990 and 2006-2010 ***(Mt CO2e)***

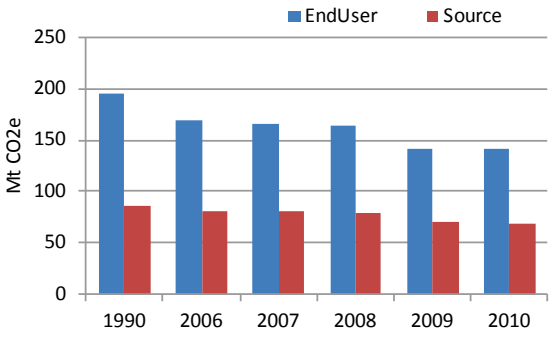


Figure 2.28

Figures 2.25 – 2.28 show detailed emissions and trends for the sector. In England, the Business sector contributes 15.4% to total 2010 GHG emissions in England. The business sector in 2010 includes emissions from industrial combustion of fuels (75% of total GHGs) from manufacturing and construction industry, Iron and Steel combustion (10% of total GHGs), refrigeration & air conditioning (13.4% of total GHGs), arising from losses of HFCs during equipment manufacture, leaks and disposal; as well as HFC emissions from foam production, fire fighting solvents and electronics (1.4% of total GHGs). In 2010 85% of emissions were carbon dioxide released from the combustion of fossil fuels in the business sector with 15% from the use of F-Gases (predominantly HFCs).

Overall Business sector emissions have reduced steadily since the Base Year, and by 2010 a 20.4% reduction in GHG emissions has been achieved in the sector in England. These reductions have primarily

been achieved as a result of declining manufacturing and iron and steel industry emissions. Despite this general decline in emissions, emissions of HFC from refrigeration and air conditioning have risen by over 1300% since 1995; these emissions now account for around 15% of total Business emissions in 2010 since the introduction of these gases as replacement to CFCs banned by the Montreal Protocol.

Business traded and non-traded emissions.

Emissions in the Business sector include significant contributions from installations. However, due to the lack of detail in the EU ETS dataset Business and Industrial Process emissions are not easy to separate. The contribution to total emissions from the traded and non-traded sector for Business plus Industrial Process is presented in figure 2.9 in the summary section.

Business Emissions on an End User Basis

In 2010 England's End User emissions for the Business sector are 206% 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 over 30% of total emissions for England compared to just 15% of the by source inventory total.

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. Non-combustion emissions account for a total of 14% of the total business emissions in England. These data 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.

2.6 Public

Public | *England*

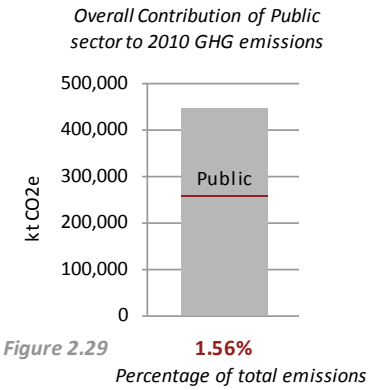


Figure 2.29

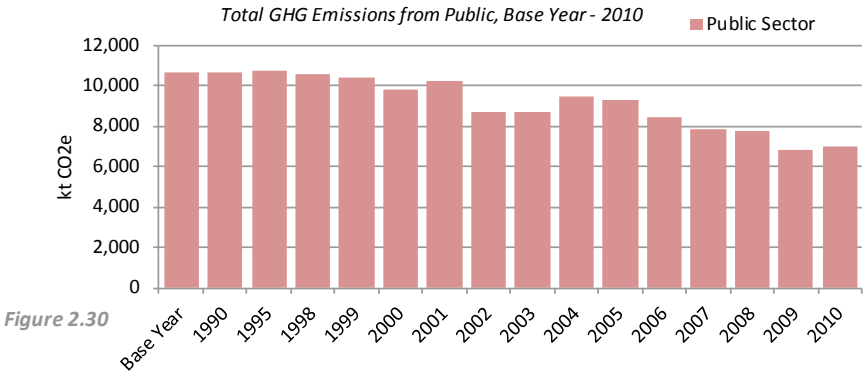


Figure 2.30

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 2.8

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Public Sector	-34.6%	-3700	2.4%	167

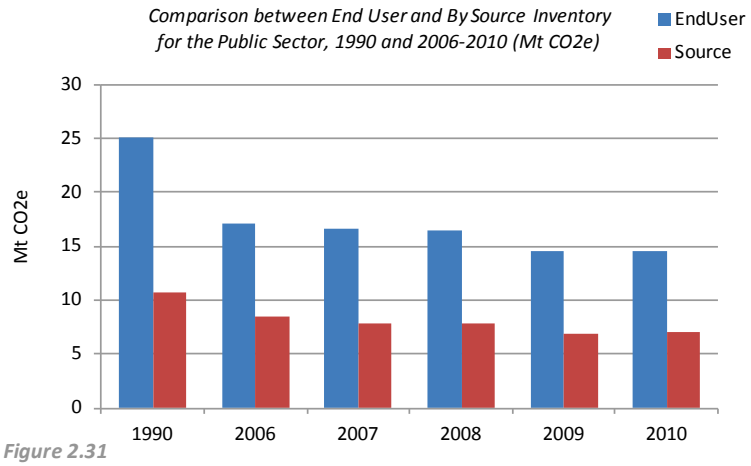


Figure 2.31

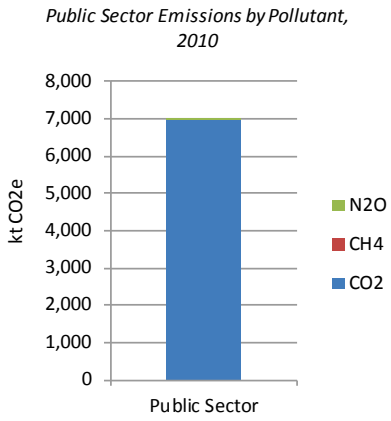


Figure 2.32

Figures 2.29 – 2.32 show detailed emissions and trends for the sector. Emissions from Public sector combustion (IPCC Sector 1A4a) account for 1.6% of GHG emissions in England in 2010. 99.7% of emissions in this sector are from carbon dioxide from the combustion of fossil fuels (predominantly natural gas).

Overall Public sector emissions have reduced steadily between the Base Year and 2010, with an overall reduction of 35% over the period (Table 2.8). This has been achieved through more efficient use of fuels and a switch to gas fired heating across England for many public sector buildings since 1990. Emissions between 2009 and 2010 rose by 2.4% as a result of recession recovery and the cold 2010 winter.

Public Sector Emissions on an End User Basis

In 2010 England end user emissions for the public sector are 208% of the by source emission estimates (Figure 2.31), reflecting the high consumption of electricity in the sector and increasing the sector's share of total England emissions to 3.2% in 2010. The trend in end user emissions since 1990 shows a decline of around 42% to 2010[17].

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.

[17] the trend data are uncertain and should be regarded as indicative only due to the limited data on electricity use by source;

2.7 Industrial Process

Industrial Process — *England*

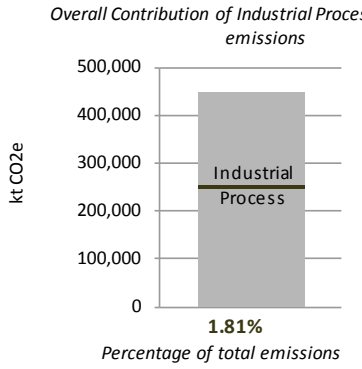


Figure 2.33

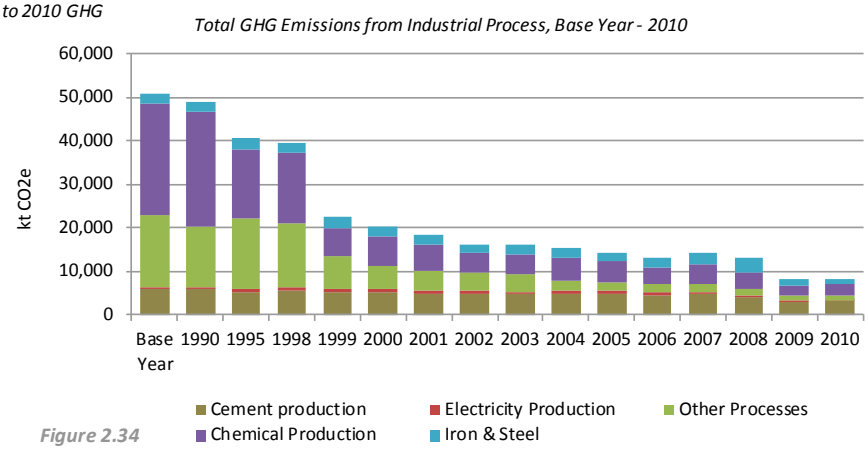


Figure 2.34

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 2.9

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Cement production	-47.0%	-2723	4.8%	139.4
Chemical Production	-89.7%	-22987	16.1%	366.8
Electricity Production	-53.6%	-336	-	-90.1
Iron & Steel	-52.7%	-1257	-29.0%	-461.2
Other Processes	-93.9%	-15315	10.0%	90.2
Total	-84.0%	-42617	0.6%	45.0

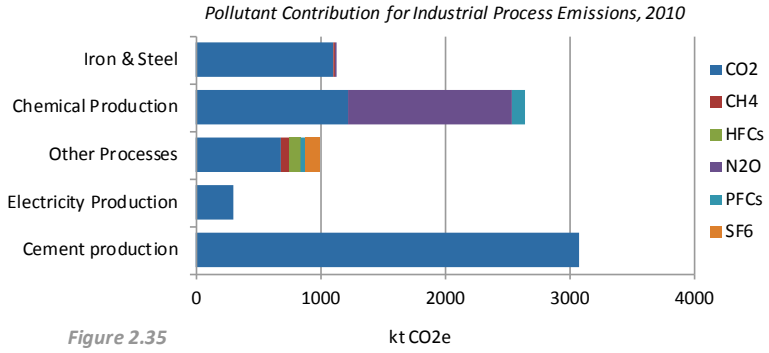


Figure 2.35

Figures 2.33 – 2.35 show detailed emissions and trends for the sector. In England in 2010, the Industrial Process sector contributes 1.8% to total 2010 GHG emissions in England. The Industrial Process sector includes non-combustion sources such as the use of limestone in cement production (38% of total sector GHG emissions); Chemical production (33% of total GHGs) including fertilizers and other bulk chemical feedstocks; Iron and Steel processes (14% of total GHGs) excluding the use of electricity and fossil fuels for heating processes; Other processes (12% of total GHGs) including glass & brick making, lime production; and Flue gas cleaning in the electricity production sector (4% of total GHGs).

In 2010, 78% of total GHGs emissions were from emissions of carbon dioxide from processes (primarily cement and iron and steel production) and 16% of total GHGs emissions in England are nitrous oxide emissions from Nitric acid production. Around 5% of total GHGs emissions are from the use/production of from F-Gases (predominantly HFCs) in industrial processes including: 1.5% of total GHG emissions of sulphur hexafluoride (SF_6) from its application as a cover gas in magnesium production. Emissions of methane from this sector are not significant, accounting for just 1% of total GHG emissions in this sector.

Overall Industrial Process sector emissions in England have reduced by 84% since the Base Year to 2010 (Table 2.9). This large decline in emissions is due to several factors including: improved abatement and subsequent closure of the adipic acid production facilities in England, a decline in manufacturing, bulk chemical and iron and steel industries, and a large reduction in emissions from the manufacture of HFCs through installation of improved abatement systems on HCFC production plant.

Industrial Process traded and non-traded emissions

Emissions in the Industrial Process sector include significant contributions from installations. However, due to the lack of detail in the EU ETS dataset, Business and Industrial Process emissions are not easy to separate. The contribution to total emissions from the traded and non-traded sector for Business plus Industrial Process is presented in Figure 2.9 in the summary section.

Industrial Process 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 2010, the end user estimates are only 8.3% 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.

2.8 Agriculture

Agriculture *England*

Overall Contribution to 2010 GHG emissions

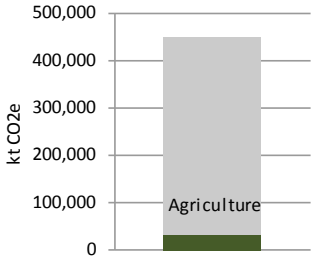


Figure 2.36

7.06%

Percentage of total emissions

Agriculture Emissions by category and pollutant, 2010

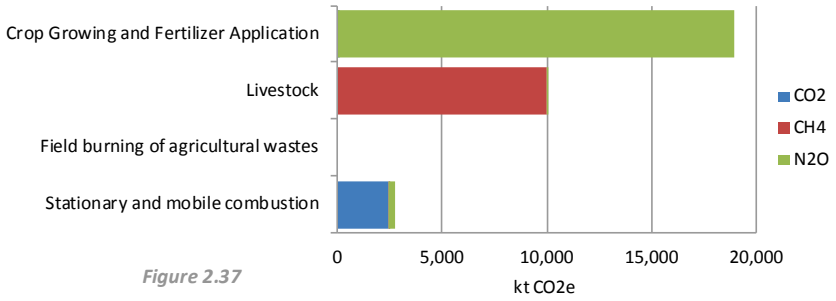


Figure 2.37

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 2.10

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Crop Growing and Fertilizer Application	-18.3%	-4,224.5	1.4%	255.0
Field burning of agricultural wastes	-100.0%	-304.7	-	0.00
Livestock	-24.0%	-3,175.3	0.2%	20.8
Stationary and mobile combustion	-20.9%	-721.3	1.7%	45.3
Total	-21.0%	-8,425.8	1.0%	321.1

Total GHG emissions from Agriculture, Base Year - 2010

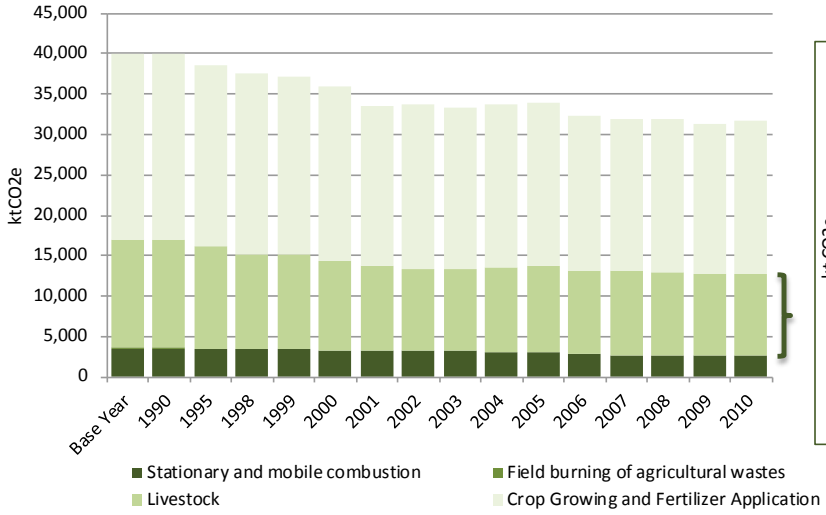


Figure 2.38

Livestock emissions by type, 2010

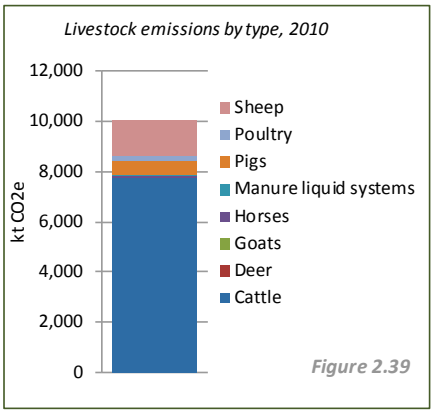


Figure 2.39

Figures 2.36 – 2.39 show detailed emissions and trends for the sector. In England in 2010, the Agricultural sector contributed 7.1% to total 2010 GHG emissions in England. GHG emissions from agriculture in England comprise mainly of nitrous oxide (59%) from fertilizer application to soils including management of manure (related to handling of manure before it is added to the soil) and methane (33%) from livestock including enteric fermentation and management of manure, with a small amount of carbon dioxide (8%) from Agricultural combustion and agrochemical use. Tables 2.11 and 2.12 give a detailed breakdown of methane and nitrous oxide emissions from agriculture for England respectively.

Overall emissions from the Agriculture sector have reduced by 21% since the Base Year (Table 2.10). Methane emissions from agriculture are largely dependent on the numbers of livestock and have fallen by 25% from 1990 to 2010, mainly due to a decline in cattle and sheep numbers. There was a small increase (0.2%) in total agricultural methane emissions from 2009 to 2010 largely due to a small increase in total cattle

numbers. Enteric fermentation contributed 83% (8,264 $ktCO_2e$) to the total agricultural methane emissions in England in 2010. Emissions from dairy and beef cattle (enteric and waste management emissions combined) accounted for 78% of the total agricultural methane emissions. Total emissions from sheep were 14.2% of the total methane from agriculture in England. Table 2.11 gives a detailed breakdown of methane emissions from agriculture for England.

Nitrous oxide emissions are largely driven by fertiliser nitrogen use, manure applications and grazing returns to soils. Emissions have fallen by 18.6% from 1990 to 2010 resulting from a general decline in livestock numbers and in fertiliser nitrogen use (particularly to grassland). Nitrous oxide emissions increased by 1.4% between 2009 and 2010, largely because of a small increase in fertiliser use following many years of decline. Most nitrous oxide emissions (94%) arise from the agricultural soils category (see Table 2.12). A relatively small proportion (1,060 $ktCO_2e$) is emitted from the management of animal manure (emissions related to handling of manure before it is added to the soil). Table 2.12 gives a detailed breakdown of nitrous oxide emissions from agriculture for England.

Table 2.11 Emissions of methane from agricultural livestock sources in England in 2010

	Livestock Category	Methane emissions ($ktCO_2e$)
TOTAL		**10,008**
Enteric fermentation		8,264
	Cattle	*6,674*
	Sheep	*1,383*
	Goats	*8.2*
	Pigs	*114*
	Horses	*81*
	Poultry	-
	Deer	*3.8*
Manure management		1,743
	Cattle	*1,079*
	Sheep	*41*
	Goats	*0.21*
	Pigs	*416*
	Horses	*6.3*
	Poultry	*201*
	Deer	-
Field burning		-

Table 2.12 Emissions of nitrous oxide from agricultural sources in England in 2010 ($ktCO_2e$)[1]

TOTAL				**18,901**
Manure management				1,060
Soils				17,841
	Direct			*11,582*
		Fertiliser		4,579
		Grazing returns		2,923
		Manure application		1,265
		Crop residues		2,161
		Biological fixation		211
		Improved grassland		93
		Histosols		130
		Sewage sludge		217
	Indirect			*6,259*
		Leaching		5,264
			Fertiliser	3,054
			Grazing returns	1,097
			Manure application	949
			Sewage sludge	164
		Deposition		995
			Fertiliser	406
			Grazing returns	291
			Manure application	254
			Sewage sludge	43
Field burning				-

[1]Total emissions comprise manure management, soils and field burning. Soils include direct and indirect emissions; indirect emissions include leaching and deposition

Agriculture Emissions on an End User Basis

As the majority of emissions in the agriculture sector are not due to energy consumption, agriculture sector emissions on an end user basis are very similar to the emissions by source; in 2010, the end user estimates are only 5% higher for the agriculture sector, reflecting the relatively low contribution to sector emissions from the use of oils and electricity, compared to the higher-emitting sources of nitrous oxide and methane from soils and livestock sources.

2.9 Land Use, Land Use Change and Forestry

LULUCF *England*

Overall Contribution to 2010 GHG emissions

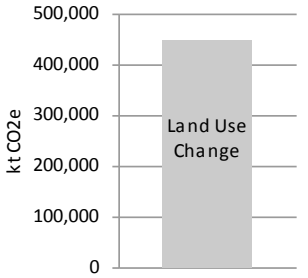


Figure 2.40

0.37%

Percentage of total emissions

Pollutant Contribution to LULUCF GHG Emissions, 2010

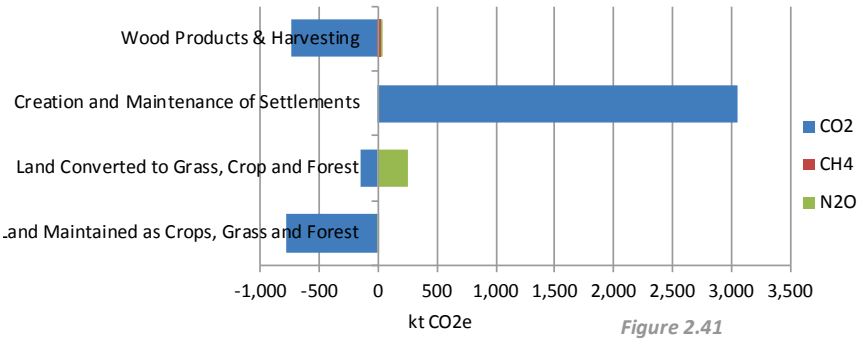


Figure 2.41

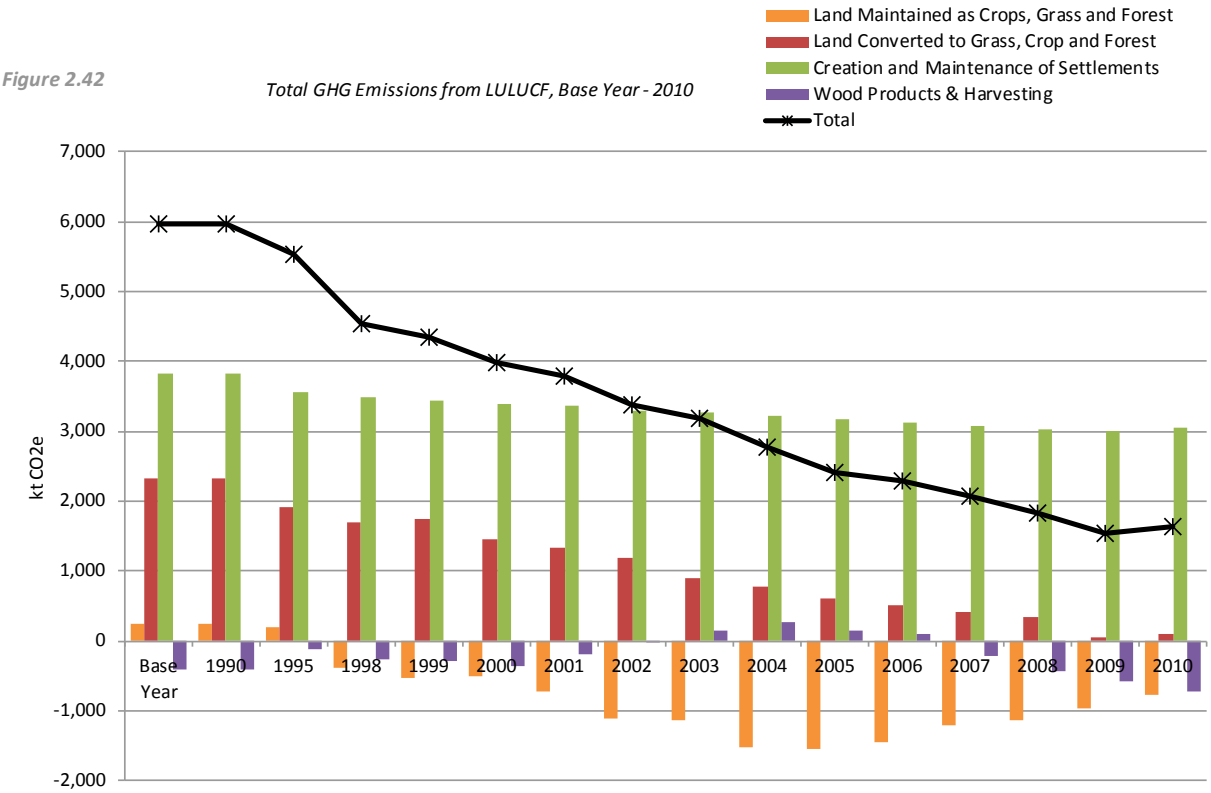
Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 2.13

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Creation and Maintenance of Settlements	-20.3%	-774.9	1.3%	38.5
Land Converted to Grass, Crop and Forest	-95.9%	-2,221.1	67.9%	38.2
Land Maintained as Crops, Grass and Forest	-427.7%	-1,016.9	-18.8%	180.7
Wood Products & Harvesting	81.7%	-325.7	24.8%	-143.9
Total	-72.5%	-4,338.7	7.4%	113.5

Figure 2.42

Total GHG Emissions from LULUCF, Base Year - 2010



Figures 2.40 – 2.42 show detailed emissions and trends for the sector. Net emissions from LULUCF contribute to 0.4% of England emissions in 2010. England is a net source of greenhouse gases from

LULUCF activities although the size of this source has diminished by 73% since the Base Year from 5,980 to 1,642 ktCO_2e. 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[18] 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. Net emissions have increased from 2009 – 2010 by 7.4% as a result of a decrease in removals from forest and grass lands. The change in emissions between the Base Year and 2010 and 2009 – 2010 are presented in Table 2.13.

Figure 2.42 and Table 2.13 show a 73% reduction in net emissions of CO_2e from LULUCF and the trends in emissions and removals from important activities in the LULUCF sector. The net emissions in England are dominated by emissions from Creation and Maintenance of Settlements, which have only reduced by 20% between 1990 and 2010, and are a result of emissions from biomass removal from built up & transport areas, gardens and mineral workings. Emissions from Land Converted to Grass, Crop and Forest has decreased significantly due to a reduction in the amount of land converted from forest/grass land to cropland (which releases carbon from clearing of biomass and from ploughing of soils) while removals as a result of land converted to grassland (which allows carbon to build-up and be stored in the soils) have remained relatively constant. Net removals from Land Maintained as Crops, Grass and Forest (which includes land converted to forest) have generally increased to 2005 with a decreased between 2005 and 2010 as a result of an increase in removals in harvesting of wood products (Wood Products and Harvesting).

Emissions and removals are primarily for carbon dioxide (95% of absolute emissions/removals in 2010) with 5% from nitrous oxide.

A more detailed report of LULUCF emissions in England, Wales, Scotland and Northern Ireland can be found on the NAEI website (A. M. Thomson et al. 2012) and more detailed information is also available in the UK Greenhouse Gas Inventory Report, available on the NAEI website.

LULUCF Emissions on an End User Basis

As emissions and removals from LULUCF do not related to energy supply the end user emissions are the same as emissions by source.

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

2.10 Waste Management

Waste *England*

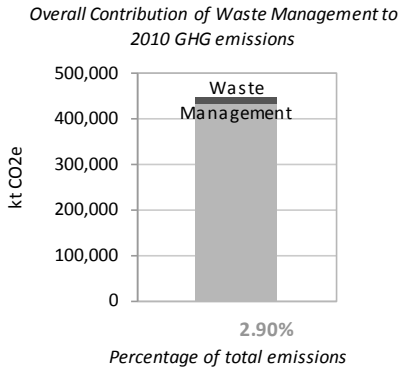


Figure 2.43

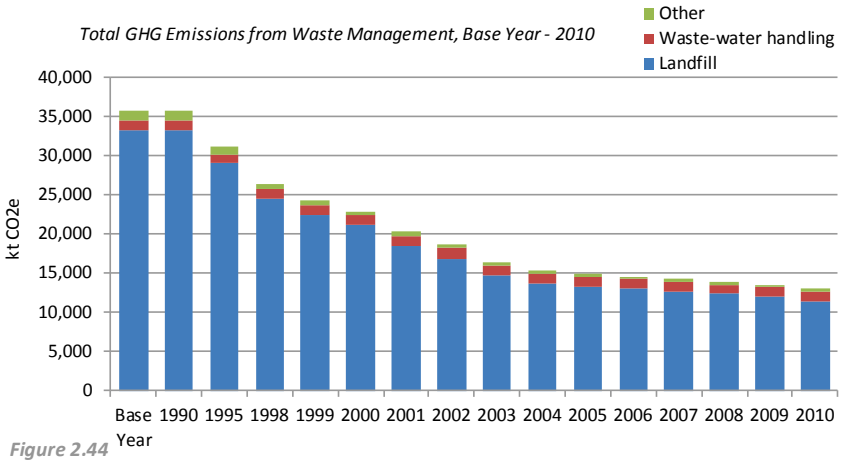


Figure 2.44

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 2.14

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Landfill	-65.5%	-21,798.8	-4.0%	-478.8
Other	-77.0%	-994.9	1.9%	5.5
Waste-water handling	4.1%	48.8	-0.3%	-3.8
Total	-63.6%	-22,744.9	-3.5%	-477.0

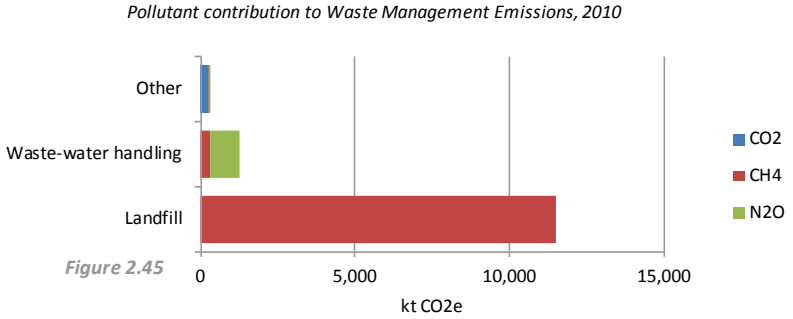


Figure 2.45

Figures 2.43 – 2.45 show detailed emissions and trends for the sector. The Waste Management sector contributes 2.9% to total GHG emissions in England, and is the largest source sector for methane emissions, representing 42% of total methane emissions. Emissions from this sector are dominated by methane from landfill (88% of total GHGs from the Waste sector), with a smaller contribution of emissions of methane and nitrous oxide from wastewater treatment (12%). Emissions from landfill in England constitute approximately 78% of UK landfill emissions.

The majority of total GHG emissions are of methane (90% of total sector GHG emissions in 2010). Nitrous oxide emissions from waste water treatment represent 7.7% of emissions in the sector, and contribute 3.9% to the total emissions of nitrous oxide in England.

Table 2.14 shows the change in emissions between the Base Year and 2010 and 2009 and 2010 for the sector. Emissions of GHGs from the Waste sector in England have shown a significant decline of 63.6% in total for the sector and by 66% for Landfill between 1990 and 2010, due largely to the progressive introduction of methane capture and oxidation systems within landfill management.

Waste Emissions on an End User Basis

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

Emissions in Scotland

2.11 1990-2010 GHG Inventory Estimates

The GHG emissions[19] for Scotland for 1990 – 2010 are presented in Table 3.1 below. Emissions in 2010 are 53,245 $ktCO_2e$ with 39.0% of net GHG emissions in 2010 from Energy Supply, 15.7% from Residential, 14.1% from Business and 20.1% from Transport sources.

Table 3.1: 1990-2010 Scotland GHG Emissions[19] ($ktCO_2e$)

NC Format	Base Year[20]	1990	1995	2000	2005	2008	2009	2010	% of 2010
Agriculture	9,828	9,828	9,757	9,369	8,751	8,079	7,949	7,951	14.9%
Business	11,383	11,263	8,123	8,598	8,616	8,368	7,366	7,505	14.1%
Energy Supply	22,323	22,323	26,469	25,982	20,485	19,834	18,535	20,744	39.0%
Industrial Process	1,824	1,882	560	582	539	518	403	388	0.7%
Land Use Change	-2,092	-2,092	-3,029	-3,531	-5,151	-5,545	-5,573	-5,459	-10.3%
Public	1,226	1,226	1,074	1,037	1,061	946	849	875	1.6%
Residential	8,180	8,146	8,135	8,280	7,987	7,783	7,304	8,369	15.7%
Transport	10,521	10,521	10,532	10,832	11,300	11,258	10,772	10,717	20.1%
Waste Management	6,572	6,572	5,661	3,978	2,476	2,285	2,223	2,154	4.0%
Total	**69,766**	**69,670**	**67,282**	**65,128**	**56,064**	**53,526**	**49,829**	**53,245**	**100%**

Although GHG emissions between 2009 and 2010 show an increase (6.9% CO_2e and 9.1% for CO_2), emissions in Scotland have reduced between the Base Year[20] and 2010 by 23.7% CO_2e and 18.8% CO_2 (see Figure 3.1 – and Table 3.1). Net emission reductions (Table 3.2) are the result of many factors from across the economy, including: a decline in manufacturing (e.g. closure of the Ravenscraig steelworks), efficiencies in energy generation and business heating, an increasing carbon sink in the land use sector, the increase in consumption of natural gas to replace more carbon-intensive solid and petroleum-based fuels, and a decline in landfill methane emissions. Only the residential (2.3% CO_2e) and transport (1.9% CO_2e) sectors have shown increases in emissions between the Base Year and 2010. Emissions for the transport sector have bucked the general trend as a result of increasing population and increasing demand for transportation despite improvements in energy efficiency of vehicles. Notably the cold winters at the start and end of 2010 have driven up the residential sector emissions in 2010, which were almost 15% higher than in 2009. This stands out from previous years showing steady emissions reductions, particularly between 2000 and 2009.

Detailed analysis of Scotland emissions in 2010 is presented in figures 3.4 – 3.9. The dominant sources of emission in 2010 include road transport (18% of total net GHGs), residential combustion for heating and cooking (15% of total net GHGs), electricity production (30% of total net GHGs) and industrial combustion for heat and electricity in the business sector (10.7% of total net GHGs) (See Figure 3.4).

Emissions from installations in the EU ETS (see Figure 3.7) contribute 45.1% of total net GHG emissions in Scotland in 2010; the main contributors to these traded emissions are the Energy Supply sector (of which 96% total emissions are within the EU ETS, including all power stations) and the Business and Industrial Process sector see figure 3.9 (of which, 49% of total sector emissions are in the EU ETS). Figure 3.8 shows emissions from installations included in the EU ETS reduce by 8% between 2008 and 2009 as a result of the reduced demand for energy and products due to the recession. However, the traded sector in Scotland then bounced back with an increase of over 9% between 2009 and 2010, which was a much higher growth than the UK average of around 2% due primarily to a 19% increase in power generation EU ETS emissions. In comparison, Scottish emissions from the non-traded sector reduced by less between 2008 and 2009 (down by 6%) and then increased by less between 2009 and 2010 (up by almost 5%).

[19] Excluding emissions from international aviation and shipping.
[20] 1995 for F-Gases and 1990 for all other gases.

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 where methane from landfills is the main GHG emission source (Figure 3.4).

Emissions on an End User Basis

In addition to presenting emissions based on direct emissions from processes or combustion of fuels in Scotland, the emissions from the Energy Supply sector can be attributed to the users of the energy to illustrate the share of total emissions attributable to the end users of energy in the economy; emissions by end user present a breakdown of emissions on a consumption basis, whereas emissions in the by source inventories present a breakdown of emissions on a production basis. The end user basis allocates emissions from energy supply (electricity, refined petroleum fuels, gas and solid fuel production) to the end users (residential, transport, agriculture, public and business) of the energy supplied (See Appendix 3 for more details of the end user inventory methodology). Figure 3.6 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. The primary difference in the end user inventory 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 contribution to Scotland total emissions in 2010 are: 32% from Business, 30% from the Residential sector and 24% from Transport sources. As illustrated in Figure 3.3 Scotland is a net exporter of electricity which results in slightly lower net GHG emissions in Scotland on an end user basis (50,496 $ktCO_2e$), 5.2% lower than the by source inventory estimates for 2010 (53,245 $ktCO_2e$).

Emissions from the Land Use Change, Industrial Process and Waste Management sectors in Scotland in 2010 are unchanged between the by source and end user inventories, since there are no emissions from energy use allocated to these sectors.

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

2.11.1 Inventory Recalculations

Inventory recalculations of source estimates due to new data and/or improved inventory estimation methodologies have led to revisions to the estimates since the last inventory report (2011); the impact of these revisions to the 2009 Scottish GHG inventory is an increase of 1,712 $ktCO_2e$ (3.6%) primarily due to:

1. **Business**: (1,007 $ktCO_2e$ increase) predominantly due to a revision to industrial combustion allocation of Other Petroleum Gases (OPG) use in Scotland across the inventory time series and revisions to energy mapping grids in the industry and commercial sectors through use of new data on UK sector energy use and an updated Inter-Departmental Business Register; these changes have increased estimates for industrial combustion by around 500 $ktCO_2e$ in Scotland in 2009. In addition, revisions to the UK-wide model for HFC emissions from refrigeration and air conditioning equipment have increased the estimates for Scotland in 2009 by 256 $ktCO_2e$;
2. **Energy Supply**: (324 $ktCO_2e$ increase) primarily from the revision of OPG use in petroleum refining and revisions to gas oil allocations to the upstream oil and gas sector. This sector has also seen a reduction in estimates for 2009 of emissions from closed coal mines due to updated analysis from the update to closed coal mine emission estimates.
3. **Waste Management:** (149 $ktCO_2e$ increase) from revisions to the UK waste model and also revisions to use more DA-specific input data to derive country-specific estimates.

The most significant revisions to the Base Year estimates have been for the following sectors:

1. **Business**: (789 kt CO_2e increase) predominantly due to a revision to industrial combustion allocation of OPG use in Scotland across the inventory time series and revisions to UK inventory allocations of gas oil.
2. **Agriculture**: (194 kt CO_2e decrease) due to revisions to emission estimates from agricultural soils.
3. **Waste Management:** (96 kt CO_2e increase) due to the combined impacts of revisions to the UK GHGI landfill waste model and revisions to the DA landfill waste method to utilise more country-specific data for waste disposals to landfill.

For more details of revisions to DA GHG emission estimates, see Appendix 7.

Scotland Trends in Emissions

Percentage Change in GHG Emissions by NC: Base Year - 2010 and 2009 - 2010

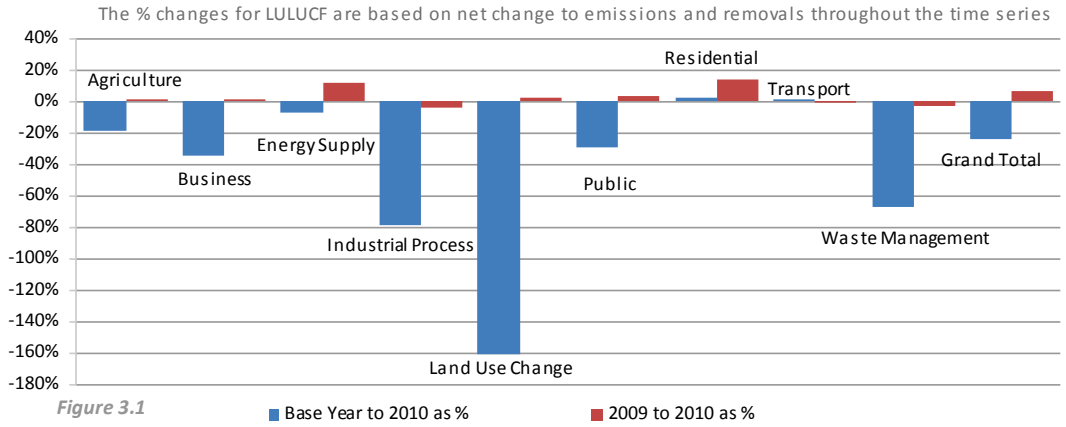


Figure 3.1

Percentage Change in Total GHG and CO2 Emissions by NC: Base Year - 2010 and 2009 - 2010

Change in emissions from the Base Year to 2010 and 2009 to 2010	Agriculture	Business	Energy Supply	Industrial Process	Land Use Change	Public	Residential	Transport	Waste Management	Total	
Base Year to 2010 as %	-19%	-34%	-7%	-79%	-161%	-29%	2%	2%	-67%	-24%	**Total GHG as CO2e**
2009 to 2010 as %	0%	2%	12%	-4%	2%	3%	15%	-1%	-3%	7%	
Base Year to 2010 as %	-21%	-42%	-2%	-73%	-136%	-28%	2%	3%	-80%	-19%	**Total CO2 only**
2009 to 2010 as %	1%	2%	12%	-4%	2%	3%	15%	-1%	3%	9%	
Base Year to 2010 kt	-1,877	-3,878	-1,578	-1,436	-3,368	-351	189	196	-4,417	-16,521	**Total GHG as CO2e**
2009 to 2010 kt	2	139	2,209	-15	114	26	1,065	-55	-68	3,416	
Base Year to 2010 kt	-187	-4,681	-440	-994	-3,320	-347	182	263	-35	-9,559	**Total CO2 only**
2009 to 2010 kt	9	108	2,188	-17	121	26	1,066	-55	0	3,447	

Table 3.2

Total GHG Emissions by NC category for Base Year to 2010, as CO2e

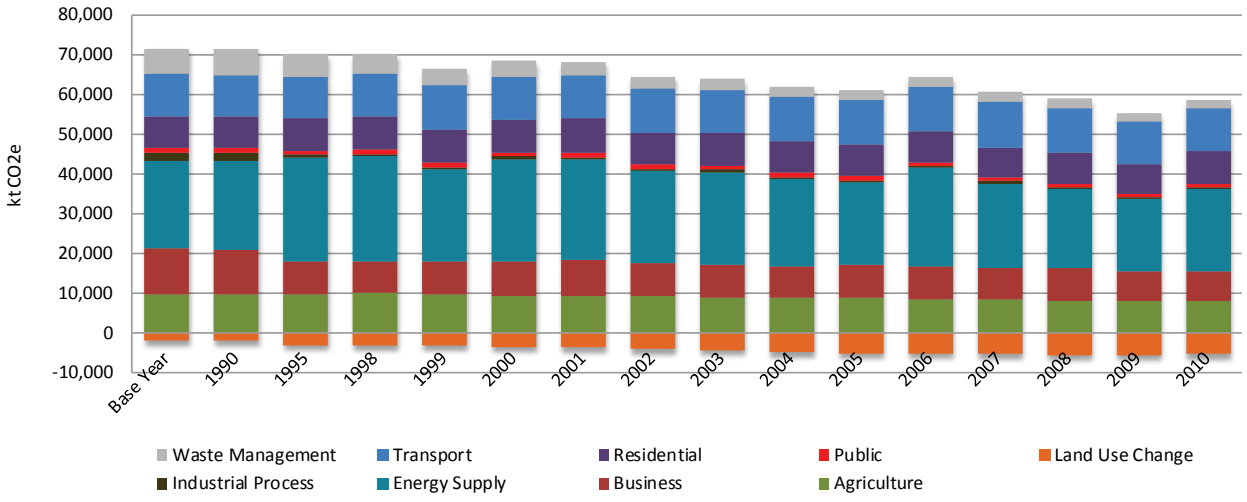
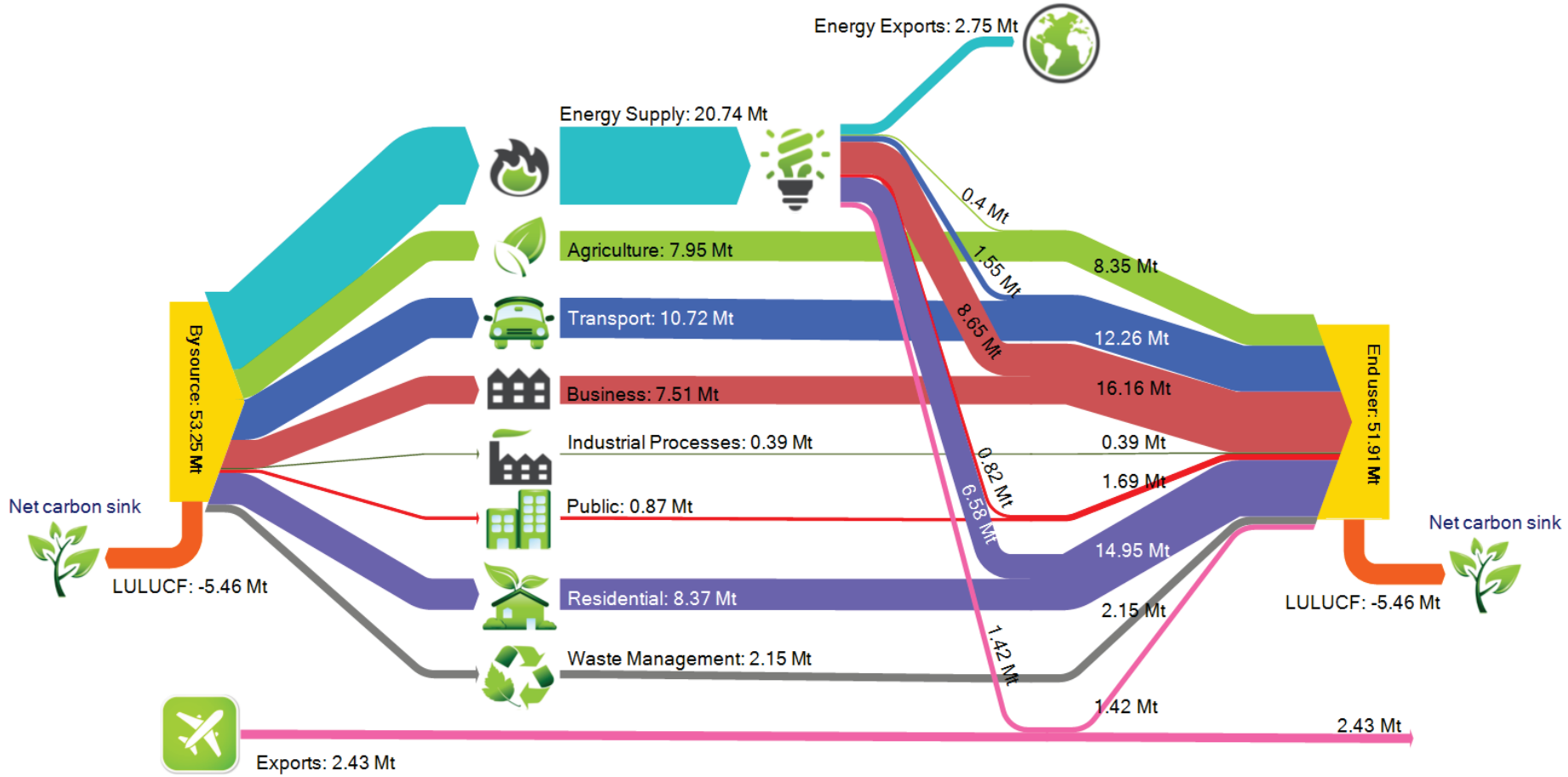


Figure 3.2

Figure 3.3 Sankey diagram showing By Source and End User[21] GHG emission transfers for Scotland in 2010 (Mt CO_2e) [22]



[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' equates to emissions from international aviation and shipping.

Scotland 2010 Emissions Summary

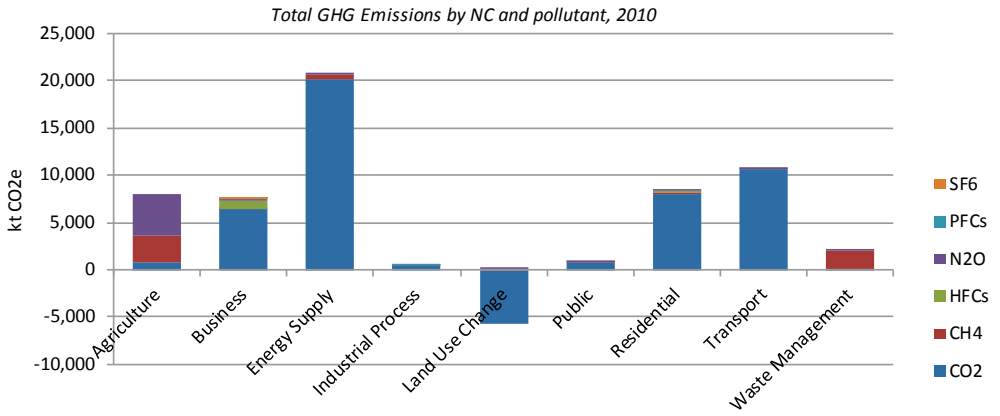


Figure 3.4

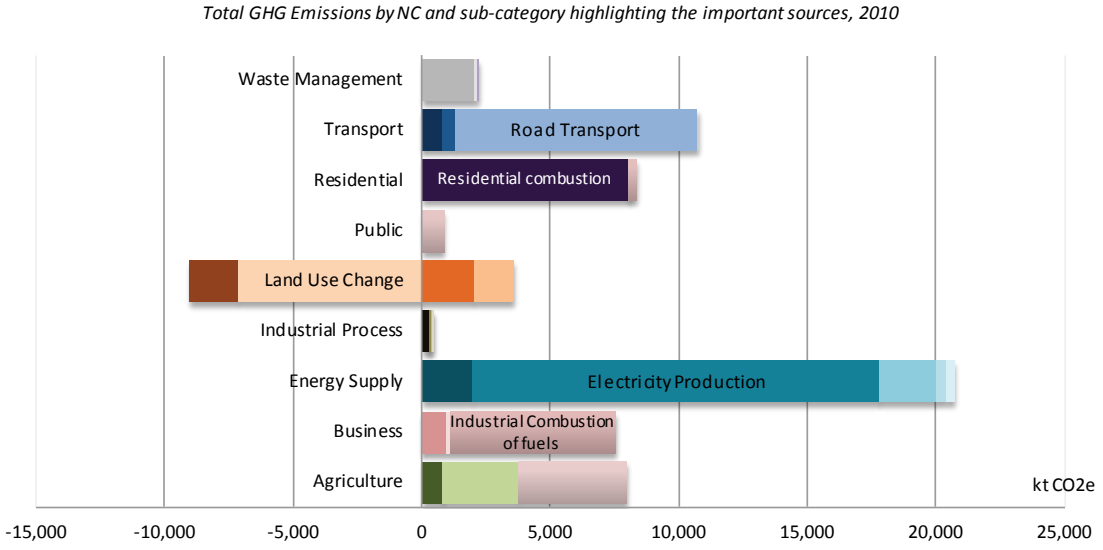


Figure 3.5

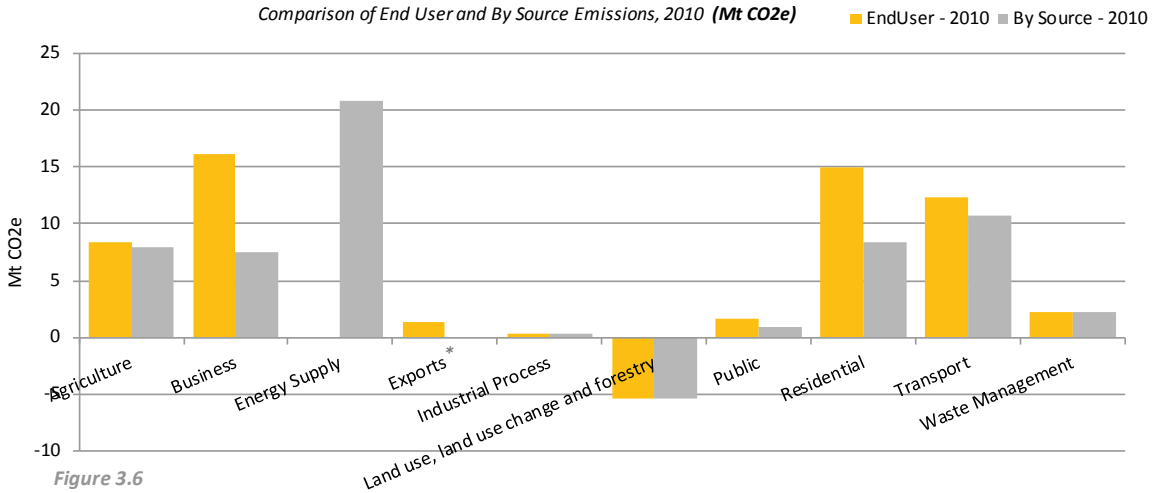


Figure 3.6

** Exports includes international aviation and shipping. See Sankey diagram for emissions transfer details*

Scotland 2010 Traded and Non-Traded Emissions Summary

Total Traded and Non-Traded GHG Emissions by NC Category, 2010

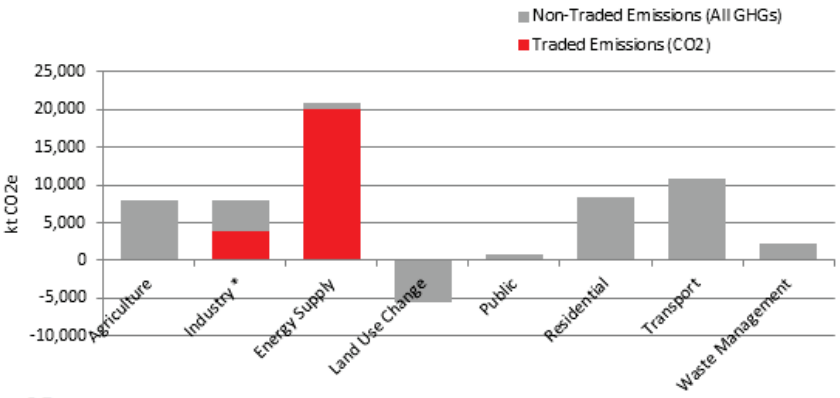


Figure 3.7

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

Total Non-Traded and Traded GHG Emissions, 2008-2010

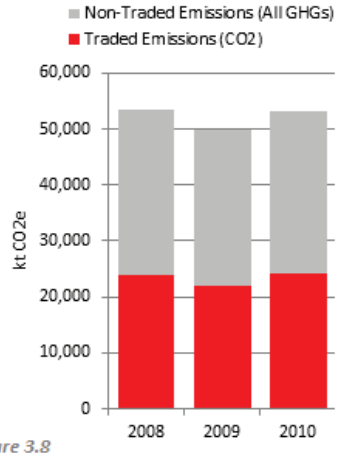
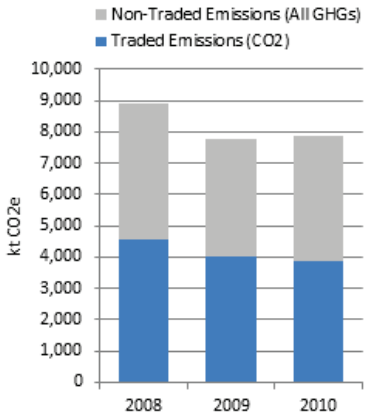


Figure 3.8

Non-Traded and Traded GHG Emissions from Industry, 2008-2010*



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

Figure 3.9

2.12 Energy Supply

Energy Supply — *Scotland*

Overall Contribution of Energy Supply to 2010 GHG emissions

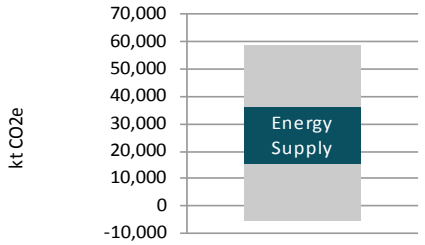


Figure 3.10

39.0%

Percentage of total emissions

GHG Contribution for Energy Supply Emissions, 2010

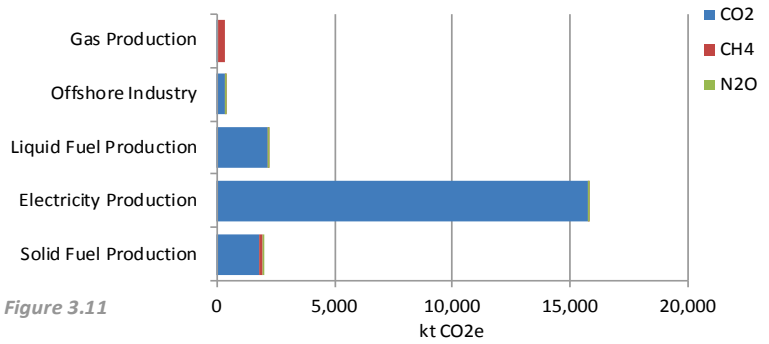


Figure 3.11

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 3.3

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Electricity Production	7%	1,065	18%	2,419
Gas Production	-57%	-494	-17%	-79
Liquid Fuel Production	-26%	-772	-5%	-122
Offshore Industry	-69%	-806	2%	7
Solid Fuel Production	-22%	-572	-1%	-16
Total	-7%	-1,578	12%	2,209

Total GHG Emissions from Energy Supply, Base Year to 2010

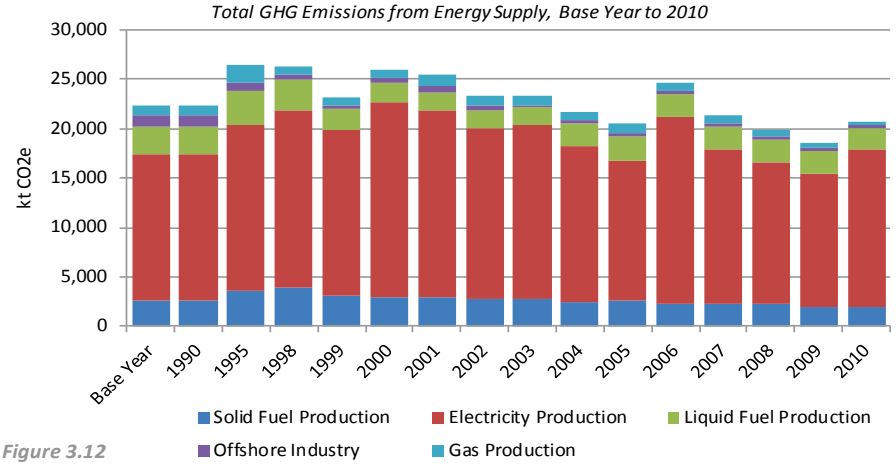


Figure 3.12

NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions

NC Category	EndUser
Agriculture	1.98%
Transport	1.21%
Business	53.68%
Industrial Process	0.00%
Public	4.86%
Residential	38.26%

Table 3.4

Emissions and Electricity Production by Fuel Type from Major Power Producers (1A1a)

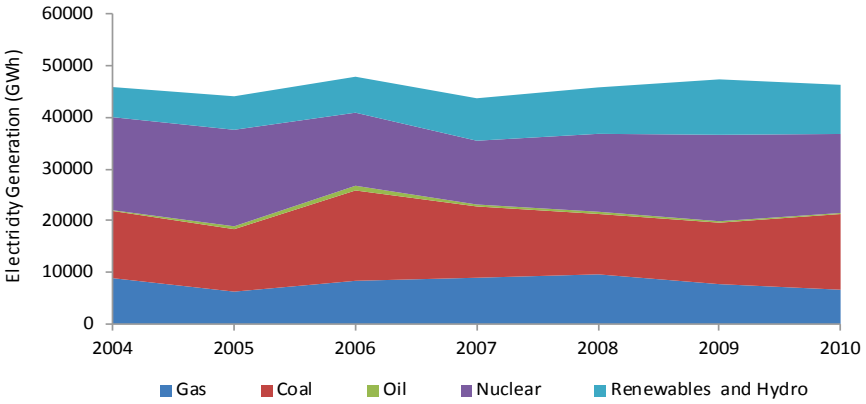


Figure 3.13

Traded and Non-Traded Energy Supply Emissions, 2008-2010

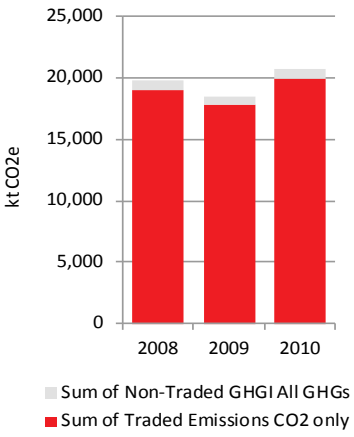


Figure 3.14

Figures 3.10 – 3.14 show detailed emissions and trends for the Energy Supply sector.

In Scotland, Energy Supply contributes 39.0% to total 2010 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 Scotland within the Energy Supply sector is electricity generation at power stations, which accounts for 76.4% of Energy Supply emissions in 2010; refinery emissions account for a further 10.4% of the Energy Supply sector emissions in 2010.

Table 3.3 shows the change in emissions between the Base Year and 2010 and 2009 and 2010 for the sector. Energy Supply sector emissions have reduced by only 7.1% since 1990 (Table 3.3), compared to the UK average of 25% reductions. Emissions have declined across many sectors such as coal mining, upstream oil and gas production, coke manufacture (due to closure of Ravenscraig steelworks) and oil refining, whilst power station emissions are higher in 2010 than 1990; this reflects the fact that Scotland generates a high proportion of the UK electricity output and exports the electricity for consumption in England and Northern Ireland.

Power generation and consumption data from DECC[23] (DECC, 2011b) indicates that in 2010 around 21% of all electricity generated in Scotland was exported to England and Northern Ireland. The mix of power generation in Scotland is shown in Figure 3.13; the fuel mix is notably different from the rest of the UK with high contribution in 2010 from nuclear power (31%) and renewable sources of energy (19%, mainly hydro-electricity and onshore wind). The remaining generation capacity is predominantly from coal-fired stations (29% of Scottish power generation in 2010), whilst Scotland has a notably lower share of electricity production from gas-fired stations, at only 13% of the Scottish electricity generation total in 2010 compared to a UK average of 42%.

Only those emissions arising from on-shore installations in Scotland have been included within the Scottish GHG inventory; emissions from offshore oil & gas exploration and production off-shore facilities are reported as “Unallocated”.

Emissions in the Energy Supply sector are dominated by installations within the EU ETS, with 96% of emissions in Energy Supply from the traded sector (EU ETS); these traded emissions are primarily from power stations, refineries and upstream oil and gas terminals.

Carbon dioxide from the combustion of fossil fuels is the predominant gas accounting for 97% of total GHG emissions from the Energy Supply sector in Scotland in 2010.

Energy Supply Emissions on an End User Basis

The “by source” inventories presented here allocate emissions to the constituent countries that those emissions occur in, and hence the GHG emissions from the power generated in Scotland and subsequently exported to England and Northern Ireland remain allocated Scotland. In the end user inventories, however, the emissions associated with the consumption of that electricity in England and Northern Ireland are re-allocated away from Scotland (using an average emission factor per GWh for the UK) to the DA and sector where the electricity is used, to better reflect the demand-side energy consumption pattern in the UK.

End user emissions from Electricity Production part of the Energy Supply sector are presented in Table 3.4 on the right side of the time series. On an end user basis, Business and Residential demand for electricity in Scotland in 2010 accounts for 54% and 38% of electricity supply emissions respectively.

[23] For details of regional electricity generation data, see the DECC Energy Trends publication from December 2011, article from page 16.

2.13 Transport

Transport — *Scotland*

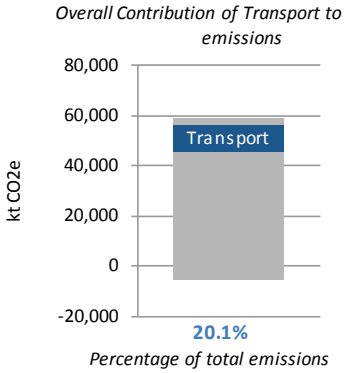


Figure 3.15

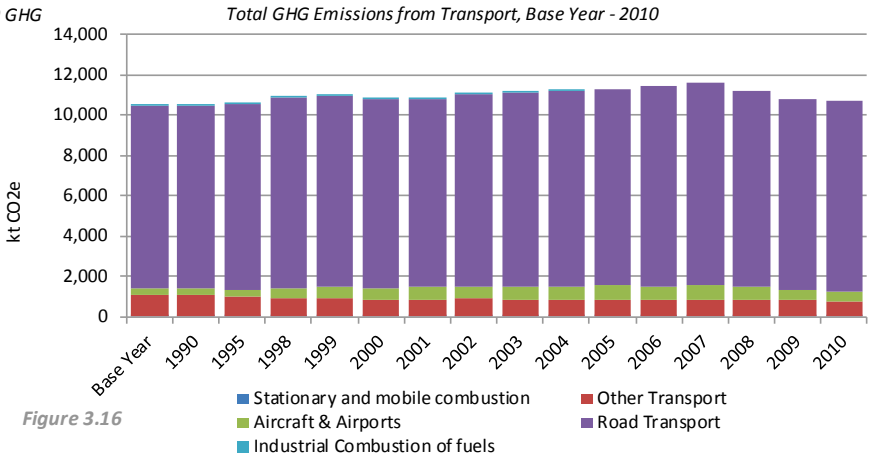


Figure 3.16

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 3.5

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Aircraft & Airports	42.4%	150	-9.4%	-52.6
Industrial Combustion of fuels	-100.0%	-6	-	0.00
Other Transport	-27.1%	-291	-3.1%	-25.0
Road Transport	3.8%	345	0.2%	22.5
Stationary and mobile combustion	-47.1%	-1.9	1.2%	0.0
Total	1.9%	196	-0.5%	-55.1

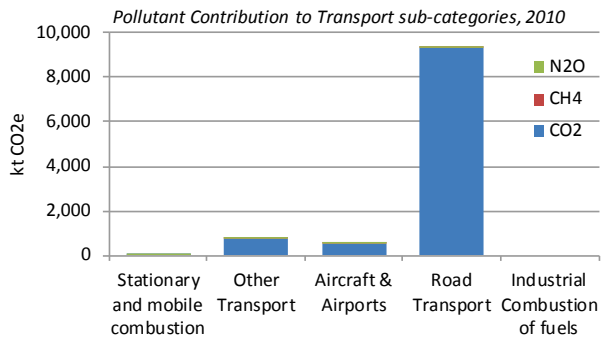


Figure 3.17

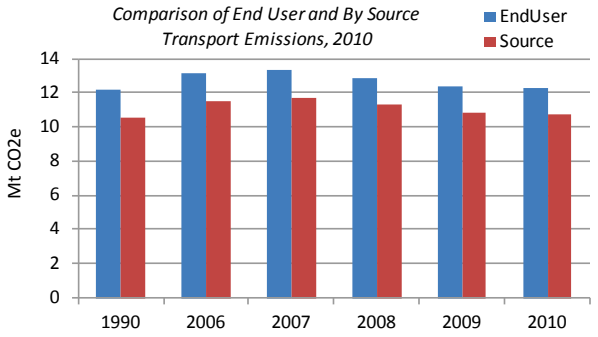


Figure 3.18

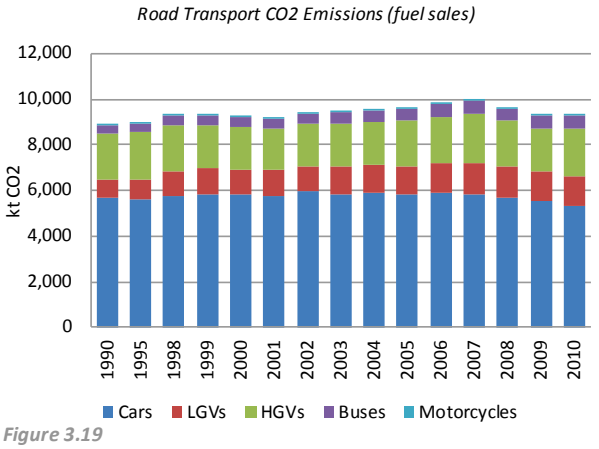


Figure 3.19

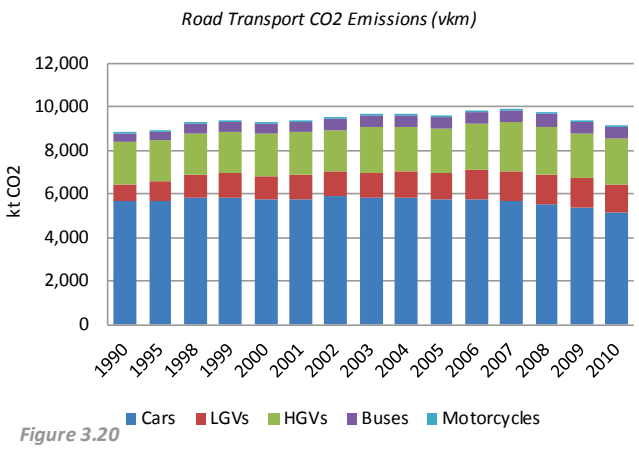


Figure 3.20

Figures 3.15 – 3.20 show detailed emissions and trends for the sector. Note that the transport emissions reported in this section exclude those from international aviation and shipping, which are reported in Appendix 6.

Transport emissions account for 20% of Scotland's total GHG emissions in 2010. Transport emissions are dominated by emissions from road transport (88% of all Transport emissions in 2010, with 50% of Transport emissions from cars alone). The Transport sector also includes: 2.0% from rail (including stationary sources[24]), 3.0% from national navigation and coastal shipping, 4.0% from domestic aviation and 2.3% from military aviation and shipping.

Table 3.5 shows the change in emissions between the Base Year and 2010 and between 2009 and 2010 for the sector. Total GHG emissions from the Transport sector in Scotland have increased by 1.9% between the Base Year and 2010 despite improvements in efficiency of transport vehicles, as a result of strong growth in transport demand and increased affordability of cars and fuel. Emissions between 2009 and 2010 have not seen any significant change, with a small reduction of around 0.5% in total.

Figure 3.19 shows the CO_2 emissions from road transport for Scotland based on constrained (DUKES fuel sales) and unconstrained (vehicle kilometre, vkm) approaches. Total CO_2 emissions from the vkm approach are 0.8% and 1.9% lower than the estimates constrained to DUKES for 1990 and 2010 respectively. The differences between the two approaches fluctuate year on year but they remain within 1.9% of difference for Scotland. These disparities will also be reflected in the trends derived from the two approaches to a different extent. The long term trend (between base year and 2010) for each individual vehicle type is generally similar between the two approaches. The vkm approach indicates that the overall CO_2 emissions from road transport have increased by 3.4 % between the base year level and 2010, while the constrained approach indicates a 4.5% increase. Between 2009 and 2010, there is a big difference in the trend for HGVs as indicated by the two approaches: the vkm approach shows a 0.7%[25] increase in Scotland's HGV CO_2 emissions while the constrained approach shows a 10.2% increase. Apart from modelling uncertainty, there are possibly a number of combining factors causing the disparity. One reason may due to a higher percentage rise (4%) in diesel fuel sales reported by DUKES between 2009 and 2010 while the traffic (i.e. vkm) activity did not reflect similar growth rate for diesel dominated vehicles (i.e. LGVs, HGVs, buses and coaches). As the constrained method adjusts vkm-based HGVs emissions so that the overall diesel emissions are consistent with the fuel sales reported in DUKES (see Brown et al., 2012 for further details on fuel normalisation process), the level of disparity will distort the trend for HGVs to a different degree.

Transport Emissions on an End User Basis

Figure 3.18 shows the end user estimates in recent years are 14% 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 and increase of 1.0% to 2010, which is a slightly lesser increase 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.

[24] Electricity use from rail sector is not included in the by source estimates but is attributed to the transport sector in the end user estimates.

[25] HGV activity has gone down by 0.3 % between 2009 and 2010 for Scotland, accompanied by a worsening of HGV fuel efficiency of around 1% as indicated by the Department for Transport's Road Freight Statistics (DfT, 2011) and hence the resulting 0.7% increase in Scotland's HGV emissions based on the vkm approach.

2.14 Residential

Residential *Scotland*

Overall Contribution of Residential sector to 2010 GHG emissions

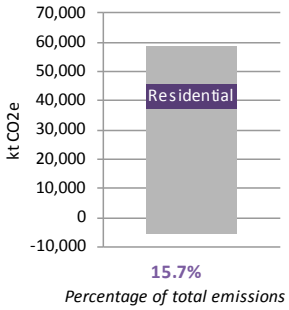


Figure 3.21

Total GHG Emissions by sub-sector, Base Year - 2010

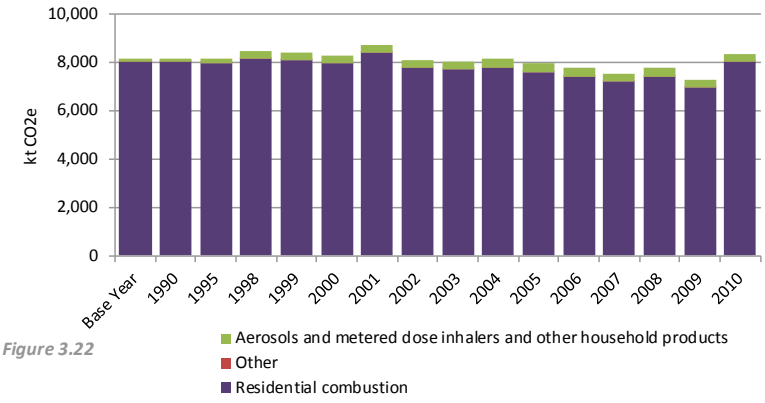


Figure 3.22

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 3.6

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Aerosols and metered dose inhalers and other household products	148.5%	214	-1.9%	-7
Other	-33.8%	-0.04	-0.2%	0.0
Residential combustion	-0.3%	-25	15.4%	1,071.8
Total	2.3%	189	14.6%	1,064.7

Pollutant contribution to Residential Emissions, 2010

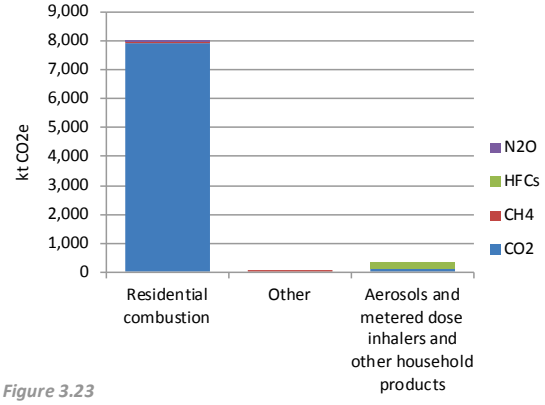


Figure 3.23

Comparison between End User and By Source Inventory Totals, 2010 ***(Mt CO2e)***

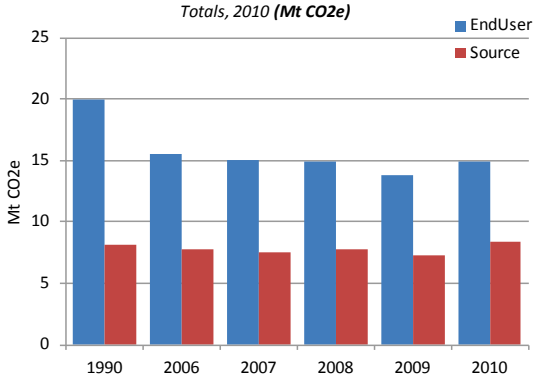


Figure 3.24

Figures 3.21 – 3.24 show detailed emissions and trends for the sector. The Residential sector accounts for 15.7% of Scotland's total GHG emissions in 2010. The sector comprises emissions from domestic combustion (95% of emissions for the Residential sector) from heating and cooking, household products, accidental vehicle fires and Hydrofluorocarbon (HFC) emissions from the use of aerosols and metered dose (usually asthma) inhalers. Over 96% of all Residential sector GHG emissions are from the release of carbon dioxide from the direct combustion of fossil fuels (see Figure 3.23).

Table 3.6 shows the change in emissions between the Base Year and 2010 and 2009 and 2010 for the sector. Total GHG emissions from the Residential sector in Scotland have increased by 2.3% between the Base Year and 2010. There was a large increase in fuel use and GHG emissions from the sector in 2010 (15% increase in emissions between 2009 and 2010) primarily driven by two successive cold winters and a resultant high demand for fossil[26] fuel heating in many parts of Scotland.

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

Residential Emissions on an End User Basis

Figure 3.24 shows that in 2010 Scotland end user emissions for the Residential sector are 179% 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 30% of the Scotland total, compared to just 16% of the by source inventory total. The trend in Residential sector end user emissions since 1990 shows a decline of around 25% to 2010; these GHG reductions have been achieved through improvements in housing energy efficiency and lower carbon intensity 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.

2.15 Business

Business — Scotland

Overall Contribution to 2010 GHG emissions

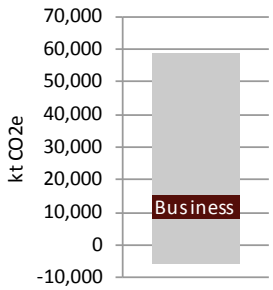


Figure 3.25 **14.10%**

Percentage of total emissions

Total GHG Emissions from Business, Base Year - 2010

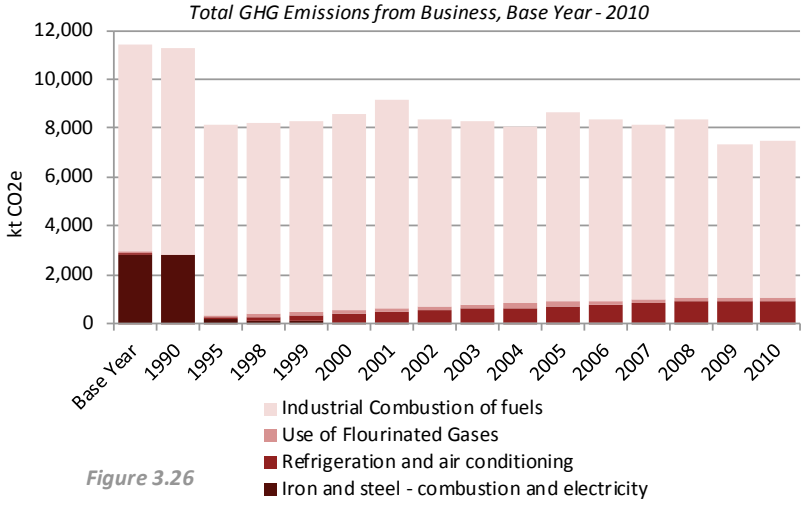


Figure 3.26

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 3.7

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Industrial Combustion of fuels	-23.8%	-2,003.8	1.5%	92.6
Iron and steel - combustion and electricity	-98.2%	-2,765.8	37.8%	14.3
Refrigeration and air conditioning	1350.8%	842.7	4.0%	34.4
Use of Flourinated Gases	50.5%	48.9	-1.6%	-2.3
Total	-34.1%	-3,878.1	1.9%	138.9

Pollutant Contribution for Business Emissions, 2010

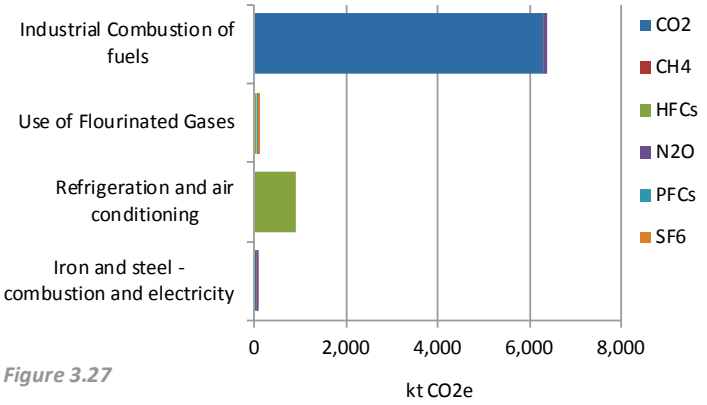


Figure 3.27

Comparison between End User and By Source Inventory for the Business Sector, 1990 and 2006-2010 ***(Mt CO2e)***

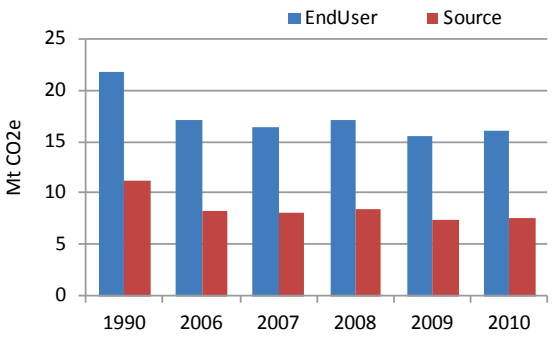


Figure 3.28

Figures 3.25 – 3.28 show detailed emissions and trends for the sector. In Scotland, the Business sector contributes 14.1% to total 2010 GHG emissions in Scotland. The business sector in 2010 includes emissions from industrial combustion of fuels (86% of Business GHGs) from manufacturing and construction industry, refrigeration & air conditioning (12.1% of Business GHGs), arising from losses of HFCs during equipment manufacture, leaks and disposal; as well as F-gas emissions from foam production, fire fighting solvents and electronics (1.9% of Business GHGs). In 2010, 85% of Scottish Business sector GHG emissions were CO_2, primarily released from the combustion of fossil fuels, with 14% from the use of F-Gases (predominantly HFCs).

Table 3.7 shows the change in emissions between the Base Year and 2010 and between 2009 and 2010 for the sector. Total Business sector GHG emissions in Scotland have reduced by 34% since the Base Year. These reductions have primarily been achieved as a result of declining manufacturing and iron and steel industry emissions. Contrary to the overall decline in emissions from the sector, emissions of fluorinated gases and especially HFC from refrigeration and air conditioning have risen by over 1300% since 1995 with the introduction of these gases as replacement to CFCs banned by the Montreal Protocol; these emissions now account for around 12% of total Business emissions in 2010.

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. Non-combustion emissions account for around 14% of the total business emissions in Scotland. These data are also uncertain due to the lack of DA-specific data on F-gas sources and the use of proxy data such as economic indices and population to estimate the DA share of UK emissions for these sources.

Business Traded and non-traded emissions.

Emissions in the Business sector include significant contributions from installations. However, due to the lack of detail in the EU ETS dataset Business and Industrial Process emissions are not easy to separate. The contribution to total emissions from the traded and non-traded sector for Business plus Industrial Process is presented in figure 3.9 in the summary section. 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 49-51% of total Business and Industrial Process sector emissions in Scotland during 2008 to 2010, and comprise cement kiln emissions and fuel combustion emissions from large industrial combustion plant and autogenerators.

Business Emissions on an End User Basis

As shown in Figure 3.28, 2010 Scotland End User emissions for the Business sector are 215% of the by source emission estimates, reflecting the high consumption of electricity for heating, lighting and operating equipment (and therefore share of emissions from electricity production) in the sector. From this End User perspective, the Business sector represents 32% of total emissions for Scotland compared to just 14% of the by source inventory total.

2.16 Public

Public | *Scotland*

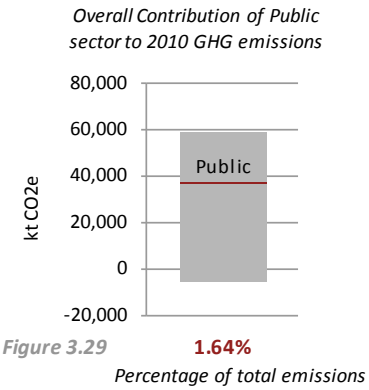


Figure 3.29

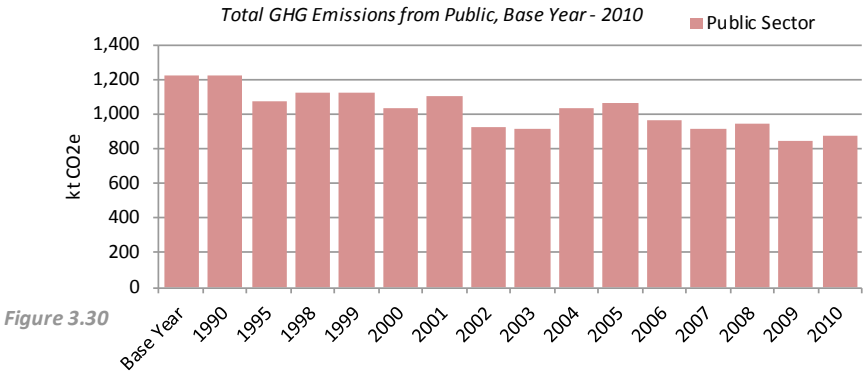


Figure 3.30

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 3.8

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Public Sector	-28.7%	-351	3.1%	26

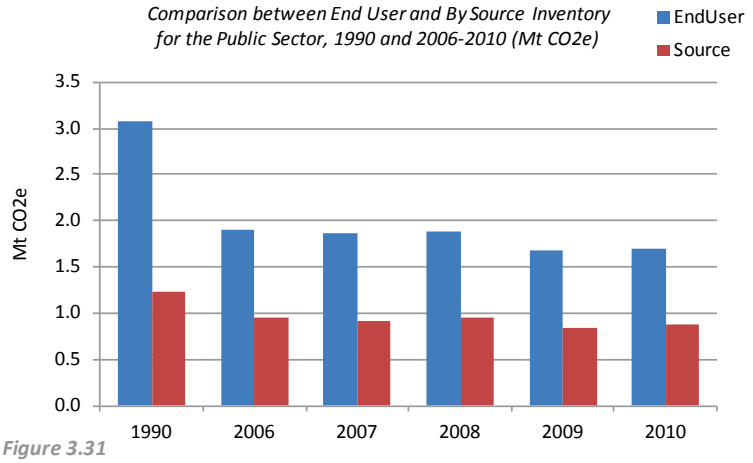


Figure 3.31

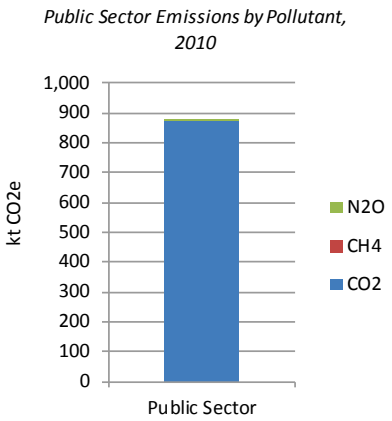


Figure 3.32

Figures 3.29 – 3.32 show detailed emissions and trends for the sector. Emissions from Public sector combustion (IPCC Sector 1A4a) account for 1.6% of GHG emissions in Scotland in 2010. 99.7% of emissions in this sector are from carbon dioxide from the combustion of fossil fuels (predominantly natural gas).

Table 3.8 shows the change in emissions between the Base Year and 2010 and 2009 and 2010 for the sector. Public sector GHG emissions have reduced by 28.5% 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 between 2009 and 2010 rose by around 3%, primarily due to the cold 2010 winter weather at the start and end of 2010 increasing the heating demand.

Public Emissions on an End User Basis

As illustrated in Figure 3.31, 2010 Scotland end user emissions for the public sector are 193% of the by source emission estimates, reflecting the high consumption of electricity in the sector and increasing the

sectors share of total Scotland emissions to 3.3% in 2010. The trend in end user emissions since 1990 shows a decline of around 45% to 2010[27],

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 and rely on estimates modelled on employment and GDP.

[27] the trend data are uncertain and should be regarded as indicative only due to the limited data on electricity use by source;

2.17 Industrial Process

Industrial Process — *Scotland*

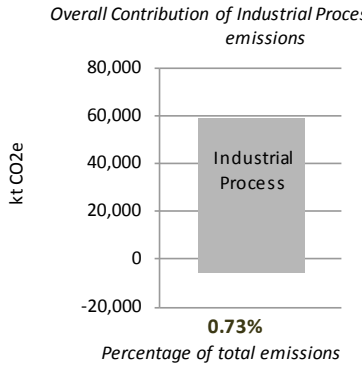


Figure 3.33

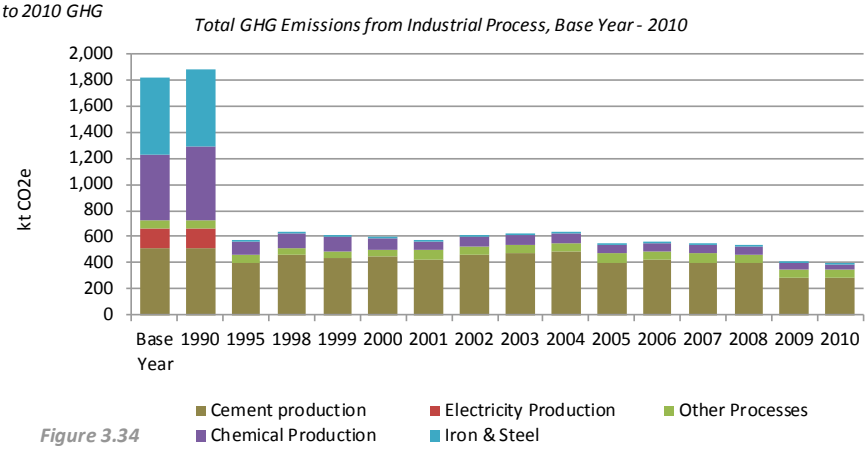


Figure 3.34

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 3.9

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Cement production	-44.8%	-229	-1.2%	-3.5
Chemical Production	-91.9%	-464	-23.1%	-12.3
Electricity Production	-100.0%	-152	-	0.0
Iron & Steel	-100.0%	-595	0.4%	0.0
Other Processes	6.5%	4	0.5%	0.3
Total	-78.7%	-1436	-3.8%	-15.4

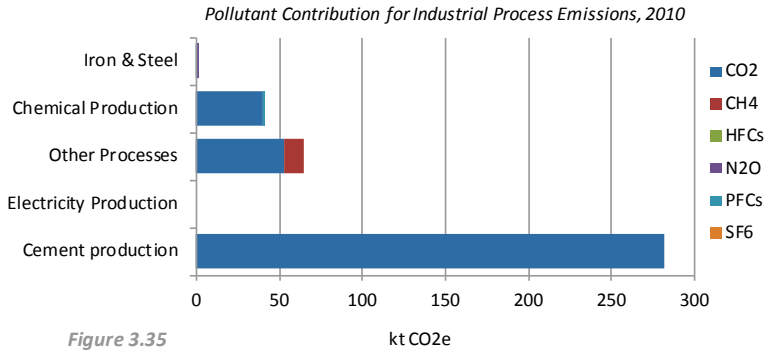


Figure 3.35

Figures 3.33 – 3.35 show detailed emissions and trends for the sector. In Scotland in 2010, the Industrial Process sector contributes 0.7% to total 2010 GHG emissions in Scotland. The Industrial Process sector emissions arise from non-combustion sources and in Scotland comprise four main sources in 2010: 73% of total sector emissions come from cement decarbonisation of limestone, with just under 14% from process sources in the glass industry, 10.5% from primary aluminium production (decarbonisation of anodes and a small emission of PFCs) and 3% from the chemical industry. Emissions of methane account for only 3% of total GHG emissions from the Industrial Process sector.

Table 3.9 shows the change in emissions between the Base Year and 2010 and 2009 and 2010 for the sector. Overall Industrial Process sector emissions in Scotland have reduced by 79% since the Base Year to 2010. This large decline in emissions is primarily due to the closure of the nitric acid plant, closure of Ravenscraig iron and steel works, and a reduction in emissions from the chemicals and cement sectors.

Industrial Process Traded and non-traded emissions

Emissions in the Industrial Process sector include significant contributions from installations. However, due to the lack of detail in the EU ETS dataset, Business and Industrial Process emissions are not easy to separate. The contribution to total emissions from the traded and non-traded sector for Business plus Industrial Process is presented in Figure 3.9 in the summary section.

Industrial Process 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 2010, the end user estimates are less than 0.1% higher than those in the “by source” Industrial Process sector, reflecting a very low contribution to sector emissions from the use of electricity or fossil fuels as feedstock or for energy.

2.18 Agriculture

Agriculture *Scotland*

Overall Contribution to 2010 GHG emissions

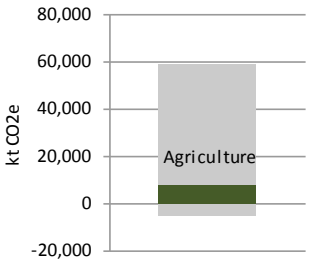


Figure 3.36

14.93%

Percentage of total emissions

Agriculture Emissions by category and pollutant, 2010

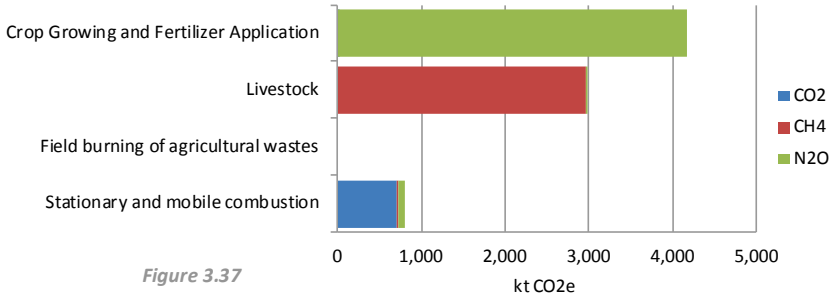


Figure 3.37

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 3.10

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Crop Growing and Fertilizer Application	-21.2%	-1,124.2	-0.6%	-23.2
Field burning of agricultural wastes	-100.0%	-8.2	-	0.00
Livestock	-15.4%	-542.6	0.5%	13.9
Stationary and mobile combustion	-20.0%	-202.2	1.4%	11.2
Total	-19.1%	-1,877.1	0.0%	1.9

Total GHG emissions from Agriculture, Base Year - 2010

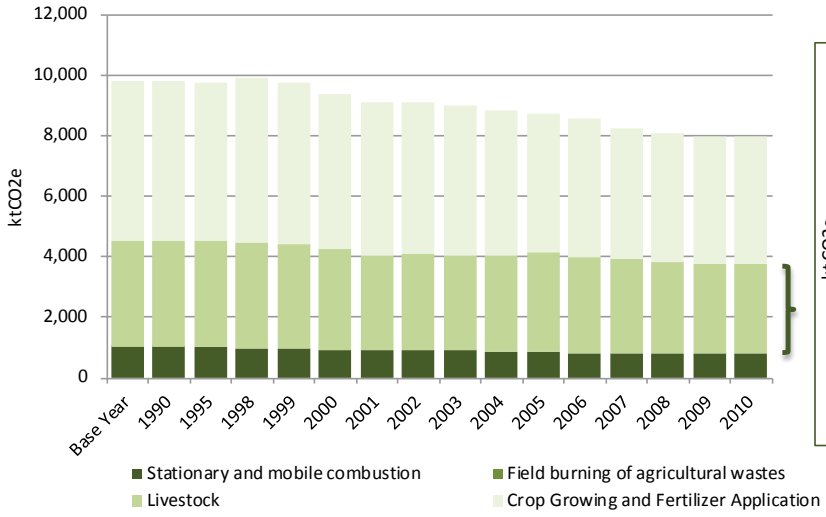


Figure 3.38

Livestock emissions by type, 2010

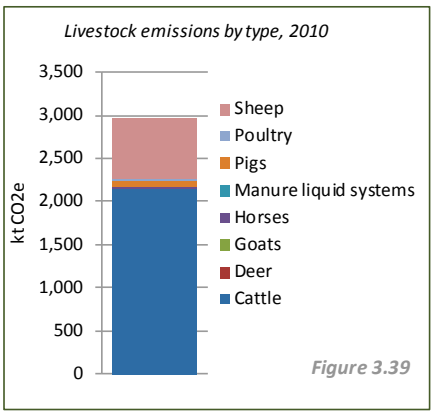


Figure 3.39

Figures 3.36 – 3.39 show detailed emissions and trends for the sector. GHG emissions from Agriculture under the IPCC reporting format comprise entirely of methane and nitrous oxide. However, within the NC sector for Agriculture there are also carbon dioxide emissions from fuel combustion in stationary (e.g. boilers) and mobile units (e.g. tractors and other machinery). Emissions from the Agriculture NC sector contribute 14.9% to total greenhouse gas emissions in Scotland in 2010. These emissions arise primarily from livestock (enteric fermentation and waste management) and agricultural soils. In 1990, a small emission was also included from field burning, but this practice has now ceased in the UK and is therefore no longer a source.

Table 3.10 shows the change in emissions between the Base Year and 2010 and between 2009 and 2010 for the sector. Agriculture is the largest source of methane emissions in Scotland in 2010 and Table 3.11 below gives a detailed breakdown of methane emissions from all livestock sources. Enteric fermentation contributed

89% (2,657 $ktCO_2e$) to total agricultural methane in Scotland in 2010. Total cattle emissions (dairy and beef enteric and waste management) accounted for 72.5% of the total agricultural methane emissions, whilst emissions from sheep accounted for a further 23.8% of the total.

Agriculture is also by far the largest source of nitrous oxide in Scotland, accounting for almost 85% of total national emissions in 2010. The largest source of nitrous oxide emissions is releases from agricultural soils (3,934 $ktCO_2e$) which accounts for 92% of total nitrous oxide emissions in the Agriculture sector and 78% of nitrous oxide emissions from all sources in Scotland in 2010. Emissions from the agricultural soils sector are broken down in Table3.12.

Methane emissions are largely dependent on the numbers of livestock and have fallen by 15.5% over the period 1990-2010, due to a decline in cattle and sheep numbers. Scotland accounts for around 16.6% of UK agricultural methane emissions. Emissions increased by 0.5% in 2010 compared to 2009 due to a small increase in total cattle numbers.

Nitrous oxide emissions are largely driven by fertiliser nitrogen use, manure applications and grazing returns to soils. Scottish emissions of nitrous oxide have declined by 21.6% over the period 1990-2010 due to a decline in livestock numbers and in fertiliser nitrogen use (particularly to grassland) Emissions decreased by 0.6% in 2010 relative to 2009.

Table 3.11 Emissions of methane from agricultural livestock sources in Scotland in 2010

	Livestock Category	Methane emissions ($ktCO_2e$)
TOTAL		**2,967**
Enteric fermentation		2,657
	Cattle	*1,940*
	Sheep	*688*
	Goats	*0.42*
	Pigs	*13*
	Horses	*14*
	Poultry	-
	Deer	*1.1*
Manure management		310
	Cattle	*215*
	Sheep	*20*
	Goats	-
	Pigs	*47*
	Horses	*1.1*
	Poultry	*27*
	Deer	-
Field burning		-

Table 3.12 Emissions of nitrous oxide from agricultural sources in Scotland in 2010 ($ktCO_2e$)[1]

TOTAL				**4,188**
Manure management				257
Soils				3,934
	Direct			*2,523*
		Fertiliser		862
		Grazing returns		1,035
		Manure application		273
		Crop residues		295
		Biological fixation		9.3
		Improved grassland		34
		Histosols		6.2
		Sewage sludge		9.3
	Indirect			*1,411*
		Leaching		1,175
			Fertiliser	574
			Grazing returns	388
			Manure application	205
			Sewage sludge	6.2
		Deposition		236
			Fertiliser	78
			Grazing returns	102
			Manure application	56
			Sewage sludge	3.1
Field burning				-

[1]Total emissions comprise manure management, soils and field burning. Soils include direct and indirect emissions; indirect emissions include leaching and deposition

Agriculture Emissions on an End User Basis

As the majority of emissions in the agriculture sector are not due to energy consumption, agriculture sector emissions on an end user basis are very similar to the emissions by source; in 2010, the end user estimates are only 5% higher for the agriculture sector, reflecting the relatively low contribution to sector emissions from the use of oils and electricity, compared to the higher-emitting sources of nitrous oxide and methane from soils and livestock sources.

2.19 Land Use, Land Use Change and Forestry

LULUCF *Scotland*

Overall Contribution to 2010 GHG emissions

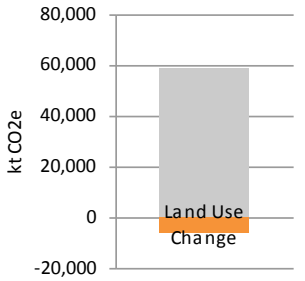


Figure 3.40

-10.25%

Percentage of total emissions

Pollutant Contribution to LULUCF GHG Emissions, 2010

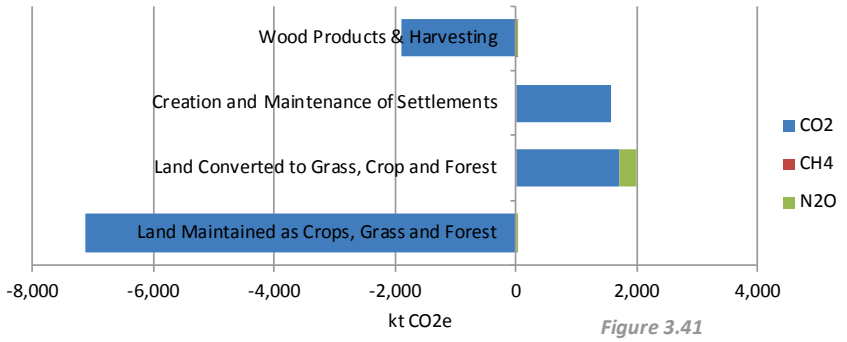


Figure 3.41

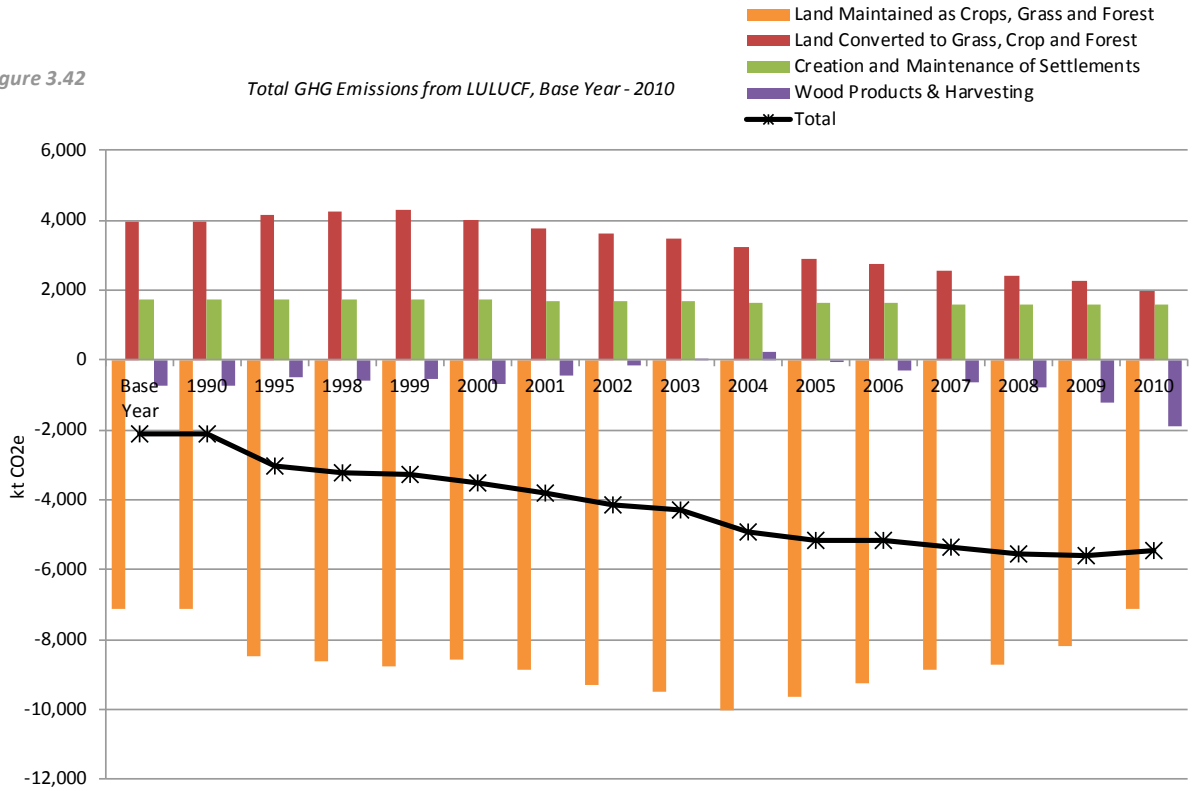
Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 3.13

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Creation and Maintenance of Settlements	-10.3%	-180.4	-0.8%	-13.1
Land Converted to Grass, Crop and Forest	-49.8%	-1,983.5	-11.1%	-249.3
Land Maintained as Crops, Grass and Forest	0.4%	-26.0	-13.0%	1,066.6
Wood Products & Harvesting	163.3%	-1,177.7	57.1%	-690.0
Total	161.0%	-3,367.7	-2.0%	114.1

Figure 3.42

Total GHG Emissions from LULUCF, Base Year - 2010



Figures 3.40 – 3.42 and Table 3.13 show detailed emissions and trends for the sector. Scotland is a large net sink of greenhouse gases from LULUCF activities and the size of this sink (CO_2e removal) has grown by

161% between 1990 and 2010 from -2,092 to -5,459 $ktCO_2e$. This increase in net removals is primarily as a result of the reduction in emissions from land conversion to cropland from less conversion of grassland and forests to cropland over the period. Net removals from the maintenance of, and conversion to, forestland during this period have also increased (contributing to the increase in net removals for the sector (Land Maintained as crop, Grass and Forest)). This is as a result of long-term forest management (the extensive conifer plantations established in the mid-20^{th} century are now reaching felling age, with reduced removals from forest but with increased carbon stocks in harvested wood products in recent years). Net emissions/removals in Scotland are dominated by removals from the Forest Land (including land maintained as forest, converted to forest and converted from forest to other uses) (-7,580 $ktCO_2e$ in 2010). The largest source of emissions is Cropland (5,321 $ktCO_2e$ in 2010) (including maintenance and conversion to) which releases carbon from clearing of biomass and from ploughing of soils.

A more detailed report of LULUCF emissions in Scotland, Wales, Scotland and Northern Ireland can be found on the NAEI website (A.M. Thomson *et al*. 2012) and more detailed information is also available in the UK Greenhouse Gas Inventory Report, available on the NAEI website.

LULUCF 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.

2.20 Waste

Waste *Scotland*

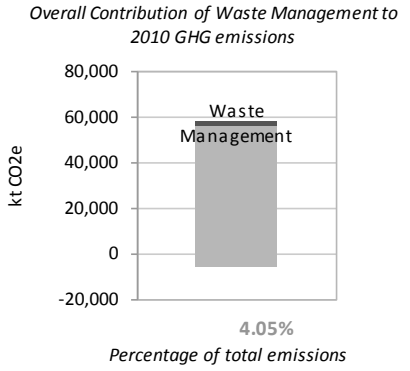


Figure 3.43

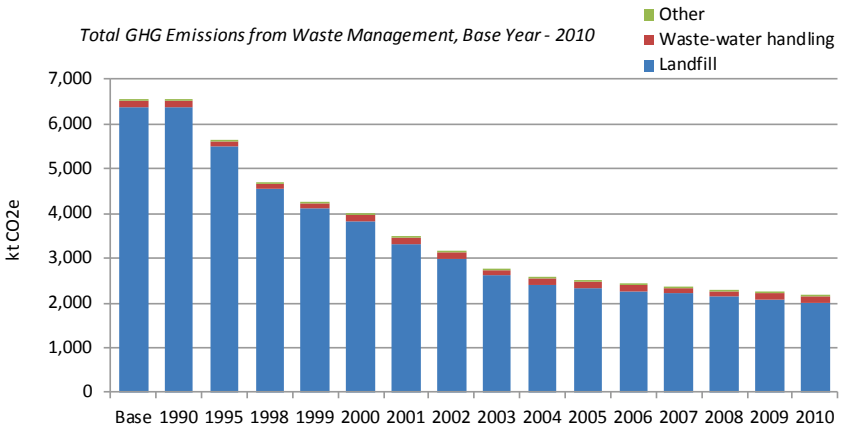


Figure 3.44

Table 3.14 *Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010*

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Landfill	-68.4%	-4,369.7	-3.3%	-68.4
Other	-74.3%	-37.2	3.4%	0.4
Waste-water handling	-7.9%	-10.5	-0.2%	-0.2
Total	-67.2%	-4,417.4	-3.1%	-68.2

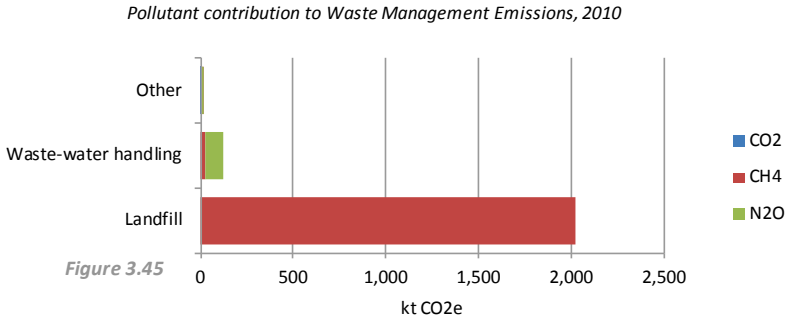


Figure 3.45

Figures 3.43 – 3.45 show detailed emissions and trends for the sector. The Waste sector contributes 4.0% to total GHG emissions in Scotland in 2010, and is the second largest source sector for methane emissions, representing 37% of total methane emissions in 2010. Emissions from this sector in 2010 are dominated by methane from landfill (94% of total GHGs from the Waste sector), with a smaller contribution of emissions of methane and nitrous oxide from wastewater treatment (5.7%). Emissions from landfill in Scotland constitute approximately 13.7% of UK landfill emissions.

Nitrous oxide emissions from waste water treatment represent 4.5% of emissions in the sector in 2010, and contribute 1.9% to the total emissions of nitrous oxide in Scotland.

Table 3.14 shows the change in emissions between the Base Year and 2010 and 2009 and 2010 for the sector. Emissions of GHGs from the Waste sector in Scotland have reduced by 67% since 1990, driven by reductions of emissions from landfill of 68% between 1990 and 2010; these reductions have been achieved by the progressive introduction of methane capture and oxidation systems within landfill management.

There are no energy consumption sources reported in the Waste NC sector, and no electricity use is allocated to the Waste sector in the UK and DA end user inventories. Hence the Waste NC sector emissions on an end user basis are identical to those presented on a by source basis.

3 Emissions in Wales

3.1 1990-2010 GHG Inventory Estimates

The GHG emissions for Wales for 1990 – 2010 are presented in Table 4.1 below. Emissions in 2010 are 46,639 $ktCO_2e$ with 36% of emissions in 2010 from Energy Supply, 11% from Residential, 21% from Business and 13% from Transport sources.

Table 4.1: 1990-2010 Wales GHG Emission Inventory ($ktCO_2e$)

NC Format	Base Year	1990	1995	2000	2005	2008	2009	2010	% of 2010
Agriculture	7,168	7,168	7,199	6,812	6,531	5,534	5,481	5,665	12.1%
Business	13,351	13,302	14,351	16,300	9,770	9,637	8,132	9,829	21.1%
Energy Supply	17,472	17,472	12,775	16,162	17,194	19,364	16,358	16,643	35.7%
Industrial Process	2,708	2,871	3,046	3,179	2,896	2,450	1,554	2,198	4.7%
Land Use Change	-34	-34	43	96	-150	-182	-208	-42	-0.1%
Public	752	752	682	526	525	429	379	387	0.8%
Residential	4,982	4,962	5,119	5,295	4,855	4,694	4,391	4,973	10.7%
Transport	6,127	6,127	6,109	6,210	6,498	6,446	6,156	6,108	13.1%
Waste Management	2,327	2,327	2,042	1,557	986	927	905	878	1.9%
Total	**54,853**	**54,947**	**51,366**	**56,136**	**49,104**	**49,300**	**43,146**	**46,639**	**100%**

Total GHG emissions from Wales have reduced between the Base Year[28] and 2010 by 15%, whilst carbon dioxide emissions have fallen by 9.5% (see Figure 4.1 and Table 4.1). These emission reductions (Table 4.2) are a result of a decline in manufacturing emissions (e.g. in iron and steel, bulk chemical production) in the Business and Industrial Process sectors, 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. Residential sector emissions (-0.2% CO_2e) and Transport emissions (-0.3% CO_2e.) have not reduced markedly since the Base Year due to increasing population and increasing demand for heating and transportation despite improvements in energy efficiency of vehicles and housing. The cold winters at the start and end of 2010 have impacted upon recent trends in the Residential sector, emissions from which increased by 13% between 2009 and 2010. In addition, an increase in production of iron and steel from sites in Wales underpinned an increase in emissions of 21% in the Business sector and 41% in the Industrial Process sector between 2009 and 2010; these increases contributed to an overall increase in GHG emissions in Wales of around 8% (and a 9% increase for CO_2) in 2010 compared to 2009.

Detailed analysis of Wales GHG emissions in 2010 is presented in Figures 4.4-4.9. The largest sources of emission in 2010 include electricity production (25% of total GHGs), road transport (12% of total GHGs), residential combustion for heating and cooking (10% of total GHGs), and industrial combustion for heat and electricity in the business sector (7% of total GHGs) (See Figure 4.5).

Total GHG emissions from installations that operate within the EU ETS (see Figure 4.8) reduced by 18% between 2008 and 2009 as demand in the economy dropped; traded sector emissions then increased by 10% between 2009 and 2010, driven by economic recovery and a colder winter in 2010. Across the two years the traded sector emissions are around 10% lower in 2010 compared to 2008, whilst emissions from the non-traded sources in Wales only reduced by around 1% during that time. Emissions from installations in the EU ETS (see Figure 4.7) account for 51.6% of total GHG emissions in Wales in 2010; the main contributors to these traded emissions are the Energy Supply sector (of which 92% total emissions are within the EU ETS, including all power stations) and the Business and Industrial Process sector (see figure 4.9) (of which, 73% of total sector emissions are in the EU ETS, including all cement kiln emissions and 83% of total iron and steel production emissions).

[28] 1995 for F-Gases and 1990 for all other gases

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

Emissions on an End User Basis

In addition to presenting direct emissions from processes or combustion of fuels in Wales, those from the Energy Supply sector can be allocated to the users to illustrate the share of total emissions attributable to the end users of energy in the economy; emissions by end user present a breakdown of emissions on a consumption basis, whereas emissions in the by source inventories present a breakdown of emissions on a production basis. The end user basis allocates emissions from energy supply (electricity, refined petroleum fuels, gas and solid fuel production) to the end users (residential, transport, agriculture, public and businesses) of the energy supplied (See Appendix 3 for more details of the end user inventory methodology). Figure 4.6 illustrates the difference between the by source and end user inventory emission estimates and how emissions from energy supply are allocated to the end user NC categories. The primary difference in the end user perspective is the significant increase in emissions attributable to the business, residential, transport and public sectors. The end user inventory data illustrate that on an energy consumption basis, the contribution to Wales total emissions in 2010 are: 37% from Business, 19% from the Residential sector and 16% from Transport sources. As illustrated in Figure 4.3 Wales is a net exporter of electricity which results in slightly lower (-8% of total GHGs) emissions in Wales for End User (43,372 $ktCO_2e$) compared to By Source (46,639 $ktCO_2e$) estimates for 2010.

Emissions from the Land Use Change 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 NC sector a small additional end user emission allocation is evident to reflect the fuel use in stationary and mobile combustion units within the sector.

A more detailed assessment of emissions by sector is presented below for each of the 9 NC sectors.

3.1.1 Inventory Recalculations

Revisions to the estimates since the last inventory report (2011) have resulted in a 1% (545 $ktCO_2e$) increase in the 2009 estimates for Wales compared to the 2009 figure presented in the previous (2011) report. Such revisions relate totally to improvements in how the estimates are derived, rather than actual changes in emissions. Whilst incorporating the effects of such revisions adds complexity to presented figures it is important that the latest and most accurate data is incorporated. The most significant revisions to the 2009 estimates have been for the following sectors:

1. **Energy Supply**: (276 $ktCO_2e$ increase) primarily from the revision of OPG use in petroleum refining and improvements to estimates from the iron and steel sector across all sources to use operator-reported emissions (CCA, EU ETS, PI/SPRI) to derive DA estimates for: blast furnaces, coke ovens, sinter plant, BOS plant, flaring. Also revisions to UK assumptions on deep coal mine methane have reduced emissions from this sector across DAs and by 518 $ktCO_2e$ in Wales.
2. **Agriculture**: (159 $ktCO_2e$ increase) due primarily to revisions to the agriculture soils inventory estimation method and data.
3. **Industrial Process**: (156 $ktCO_2e$ increase) from improved methods using operator-reported emissions data from across the sector (CCA, EU ETS, PI/SPRI) (see Energy supply above).
4. **Waste:** (110 $ktCO_2e$ decrease) from revisions to the UK waste model and also revisions to use more DA-specific input data to derive country-specific estimates.

The most significant revisions to the Base Year estimates have been for the following sectors:

1. **Agriculture**: (203 kt CO_2e increase) due to revisions to emission estimates from agricultural soils.
2. **Waste:** (-923 kt CO_2e decrease) due to the combined impacts of revisions to the UK GHGI landfill waste model and revisions to the DA landfill waste method to utilise more country-specific data for waste disposals to landfill.

For more details of revisions to DA GHG emission estimates, see Appendix 7.

Wales | Trends in Emissions

Percentage Change in GHG Emissions by NC: Base Year - 2010 and 2009 - 2010

The % changes for LULUCF are based on net change to emissions and removals throughout the time series

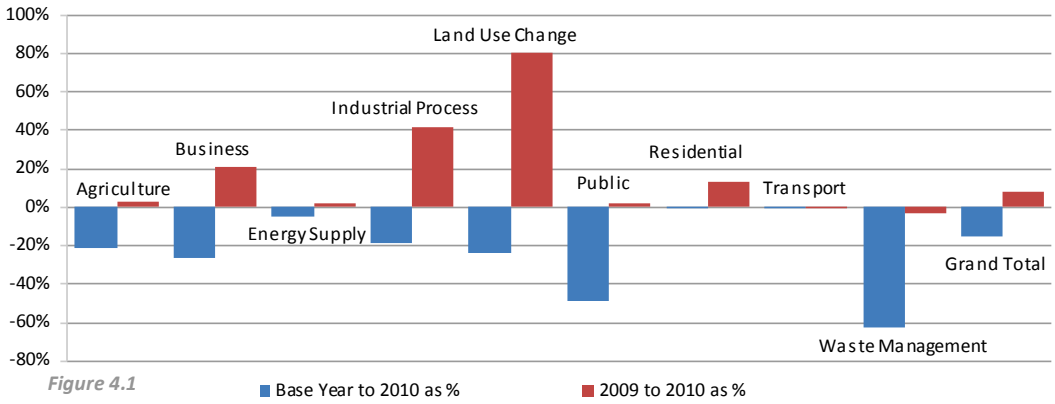


Figure 4.1

Percentage Change in Total GHG and CO2 Emissions by NC: Base Year - 2010 and 2009 - 2010

Change in emissions from the Base Year to 2010 and 2009 to 2010	Agriculture	Business	Energy Supply	Industrial Process	Land Use Change	Public	Residential	Transport	Waste Management	Total	
Base Year to 2010 as %	-21%	-26%	-5%	-19%	-23%	-49%	0%	0%	-62%	-15%	**Total GHG as CO2e**
2009 to 2010 as %	3%	21%	2%	41%	80%	2%	13%	-1%	-3%	8%	
Base Year to 2010 as %	-21%	-29%	4%	-13%	-4%	-48%	0%	0%	-87%	-9%	**Total CO2 only**
2009 to 2010 as %	1%	22%	2%	44%	62%	2%	14%	-1%	2%	9%	
Base Year to 2010 kt	-1,503	-3,523	-829	-511	-8	-366	-8	-19	-1,449	-8,215	**Total GHG as CO2e**
2009 to 2010 kt	184	1,697	285	644	167	8	582	-48	-27	3,492	
Base Year to 2010 kt	-129	-3,839	616	-333	-4	-361	-21	21	-45	-4,095	**Total CO2 only**
2009 to 2010 kt	6	1,665	313	655	167	8	583	-48	0	3,349	

Table 4.2

Total GHG Emissions by NC category for Base Year to 2010, as CO2e

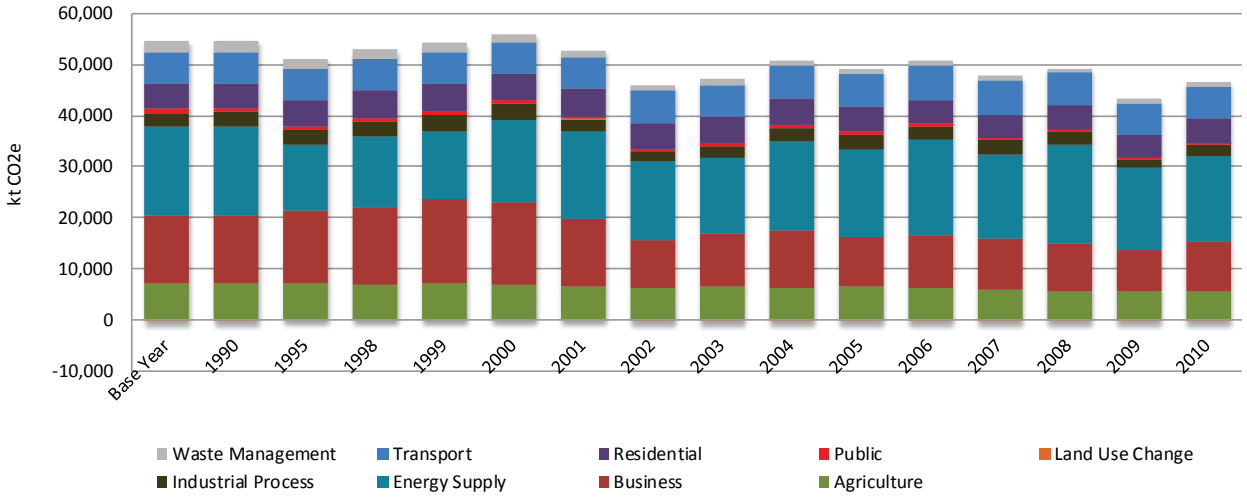
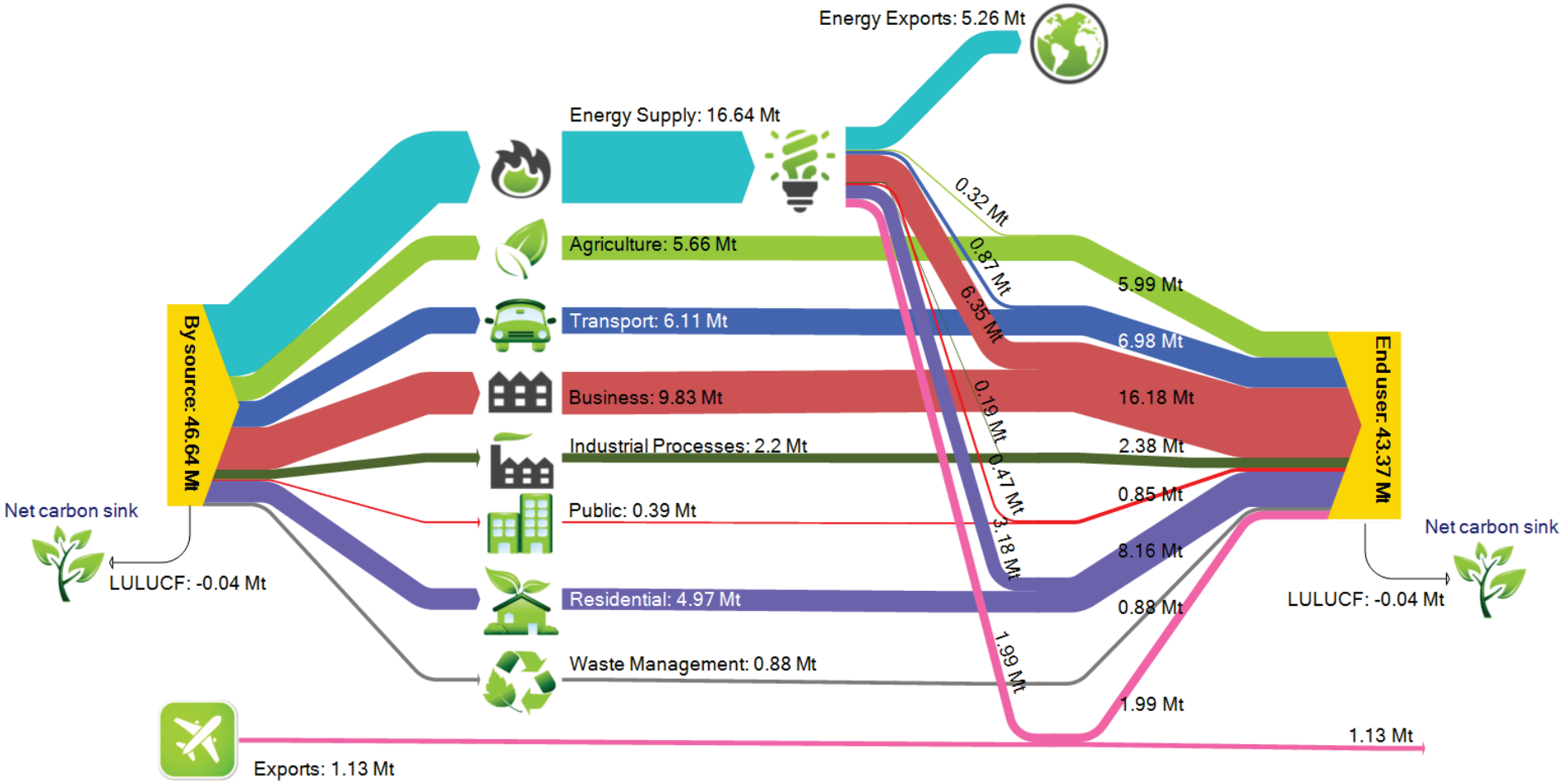


Figure 4.2

Figure 4.3 Sankey diagram showing By Source and End User[29] GHG emission transfers for Wales in 2010 (Mt CO_2e)[30]



[29] 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.

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

Wales 2010 Emissions Summary

Total GHG Emissions by NC and pollutant, 2010

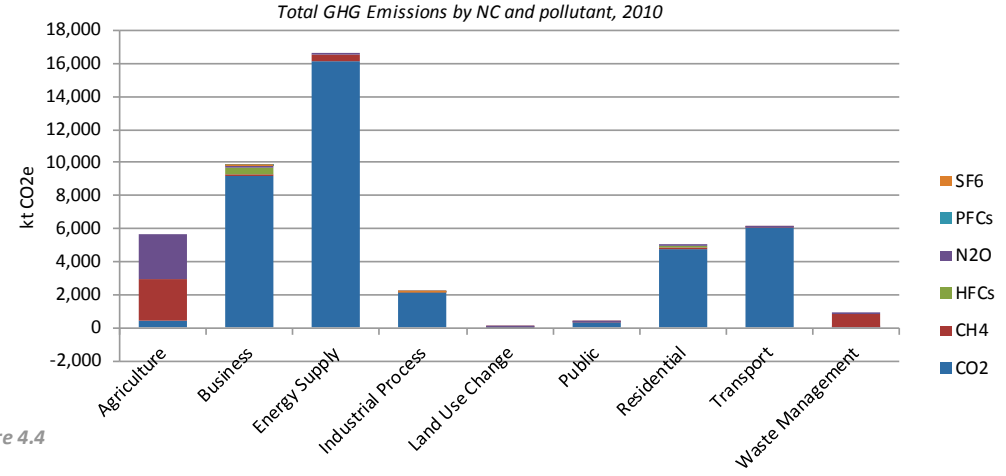


Figure 4.4

Total GHG Emissions by NC and sub-category highlighting the important sources, 2010

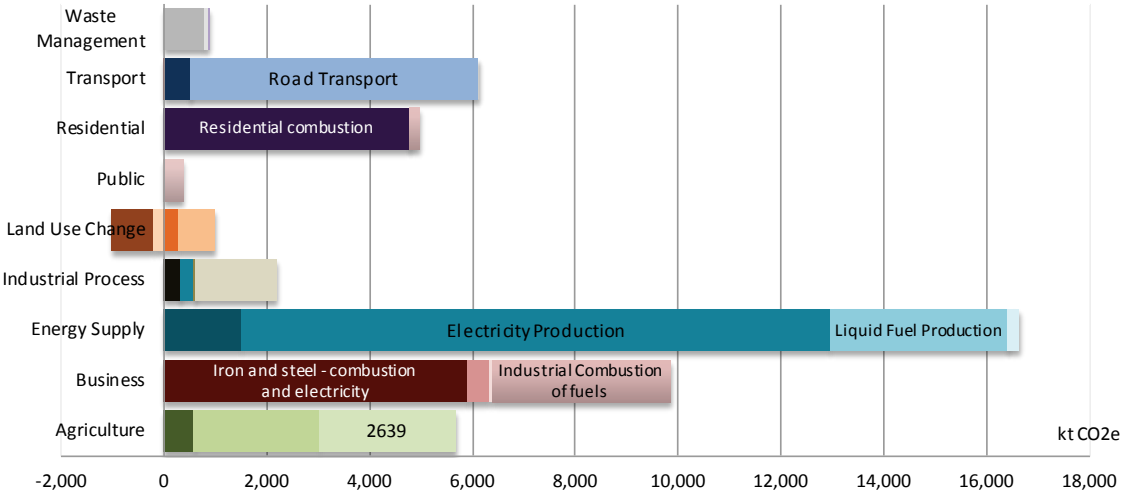


Figure 4.5

Comparison of End User and By Source Emissions, 2010 ***(Mt CO2e)***

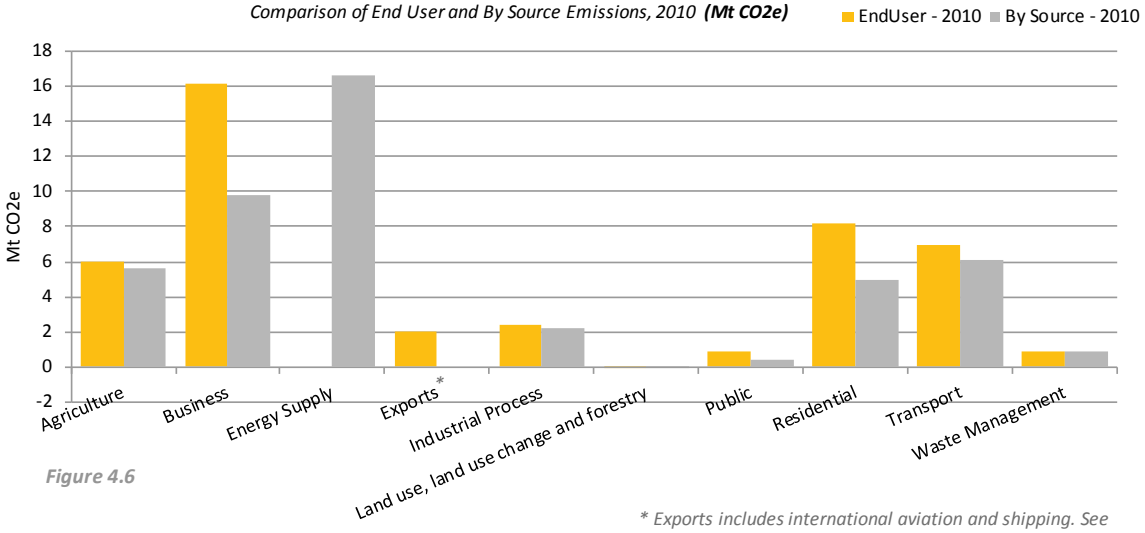


Figure 4.6

** Exports includes international aviation and shipping. See Sankey diagram for emissions transfer details*

Wales	2010 Traded and Non-Traded Emissions Summary

Total Traded and Non-Traded GHG Emissions by NC Category, 2010

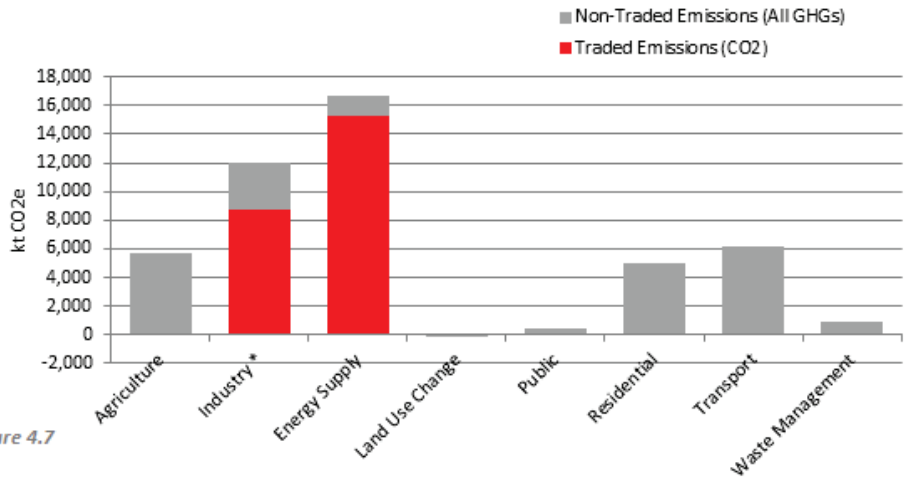


Figure 4.7

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

Total Non-Traded and Traded GHG Emissions, 2008-2010

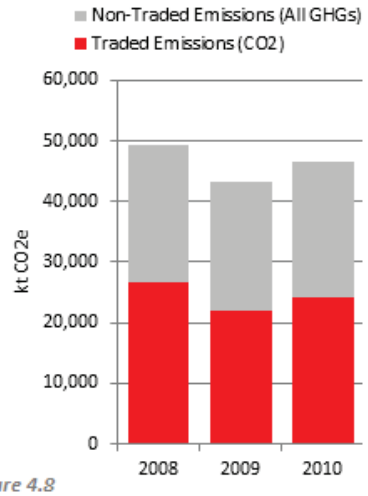
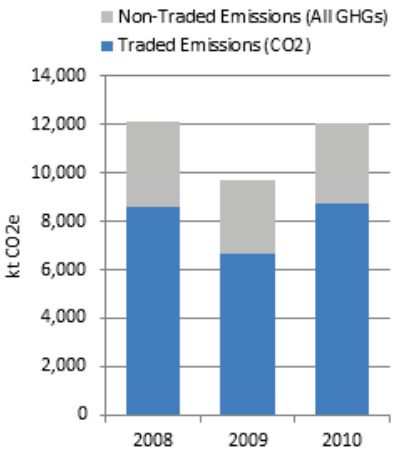


Figure 4.8

Non-Traded and Traded GHG Emissions from Industry, 2008-2010*



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

Figure 4.9

3.2 Energy Supply

Energy Supply — *Wales*

Overall Contribution of Energy Supply to 2010 GHG emissions

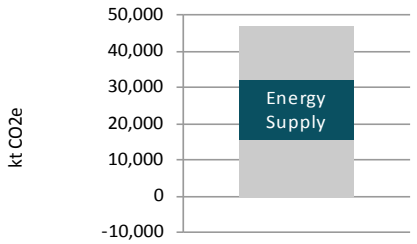


Figure 4.10

GHG Contribution for Energy Supply Emissions, 2010

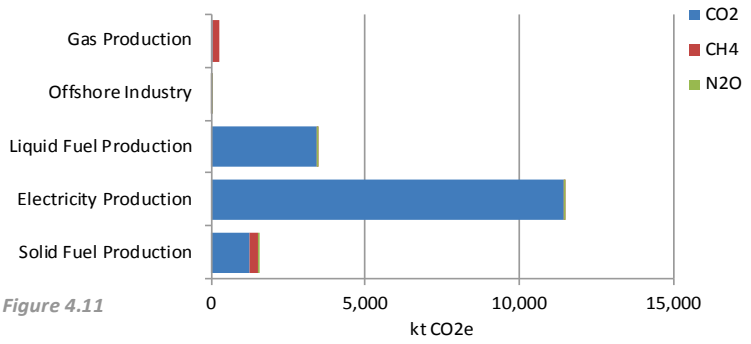


Figure 4.11

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 4.3

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Electricity Production	2%	206	1%	151
Gas Production	-27%	-92	-5%	-14
Liquid Fuel Production	-2%	-56	-6%	-207
Offshore Industry	-	1.1	3%	0.04
Solid Fuel Production	-37%	-888	31%	356
Total	-5%	-829	2%	285

Total GHG Emissions from Energy Supply, Base Year to 2010

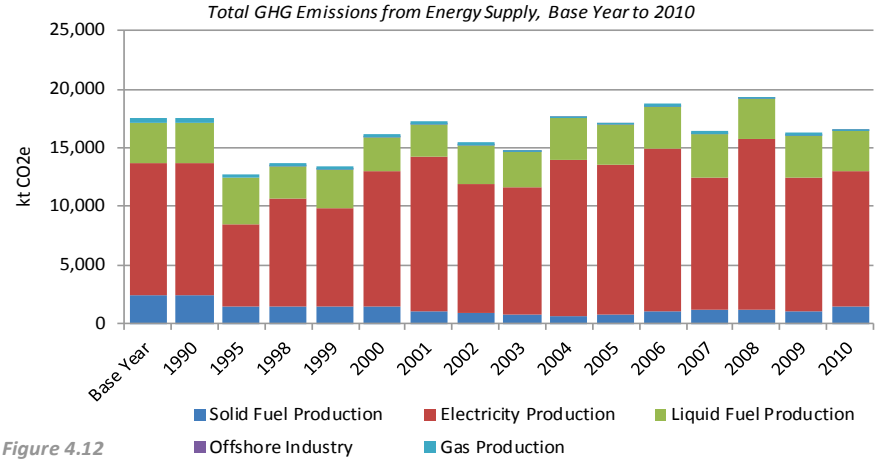


Figure 4.12

NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions

NC Category	EndUser
Agriculture	2.80%
Transport	1.02%
Business	61.56%
Industrial Process	0.06%
Public	4.68%
Residential	29.88%

Table 4.4

Emissions and Electricity Production by Fuel Type from Major Producers (1A1a)

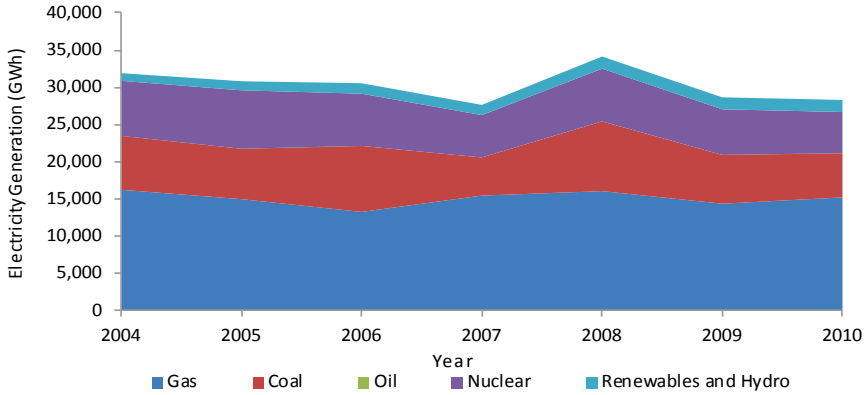


Figure 4.13

Traded and Non-Traded Energy Supply Emissions, 2008-2010

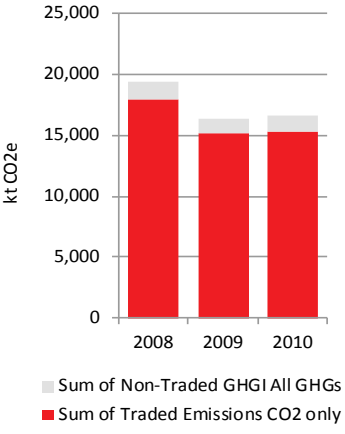


Figure 4.14

In Wales, Energy Supply contributes 35.7% to total 2010 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 is Electricity Production at power stations, which accounts for 69% of Energy Supply emissions in 2010; refinery emissions account for a further 21% of the Energy Supply sector emissions in 2010.

Energy Supply sector emissions have reduced since 1990 (by 5% between the Base Year and 2010) due to reductions (27%) in the production of coke in the iron and steel industry despite a 2% increase in emissions from power stations over the period.

Only those emissions arising from on-shore installations in Wales have been included within the Welsh GHG inventory; emissions from offshore oil & gas exploration and production off-shore facilities are reported as "Unallocated".

Emissions in the Energy Supply sector are dominated by installations that operate within the EU ETS, with 92% of emissions in Energy Supply from traded (EU ETS) operations in 2010; these traded emissions are primarily from power stations, refineries and coke ovens.

Carbon dioxide is the predominant gas accounting for over 97% of emissions from the Energy Supply sector in 2010, released through the combustion of fossil fuels.

The mix of generation capacity in Wales is shown in Figure 4.13. Emissions in Wales have a high proportion of combined cycle gas turbines (CCGT) stations; a lower proportion of conventional fossil fuel stations; a lower proportion of nuclear generation with a small amount of renewable. In addition, Wales is a net exporter of electricity (see Figure 4.3).

End user emissions from the Energy Supply sector

End user emissions from Electricity Production part of the Energy Supply sector are presented in Table 4.4 on the right side of the time series. 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 end users, and in Wales in 2010 the Business sector is estimated to use 61% of electricity whilst the Residential sector accounts for around 30% of electricity demand, and hence these sectors have the largest additional emissions allocation on an end user basis.

3.3 Transport

Transport *Wales*

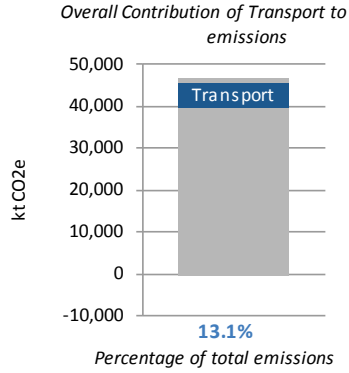


Figure 4.15

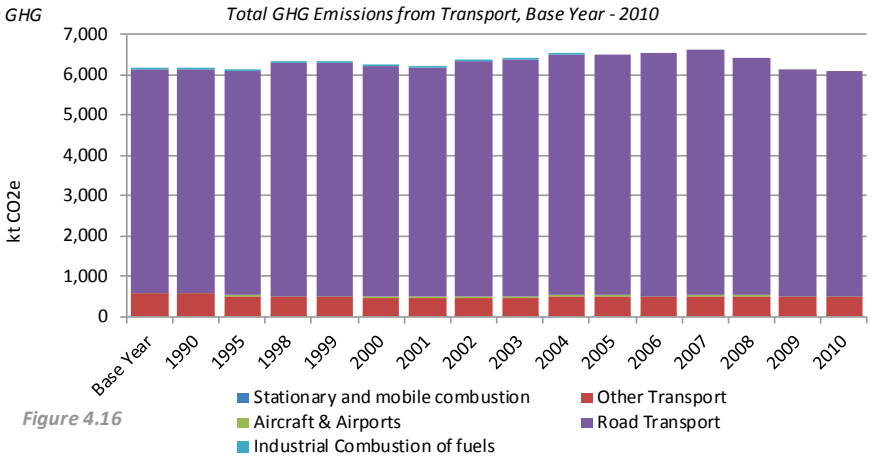


Figure 4.16

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 4.5

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Aircraft & Airports	140.5%	11	-20.0%	-4.6
Industrial Combustion of fuels	-100.0%	-4	-	0.00
Other Transport	-12.8%	-73	1.5%	7.2
Road Transport	0.9%	48	-0.9%	-51.0
Stationary and mobile combustion	-16.0%	-0.3	15.4%	0.2
Total	-0.3%	-19	-0.8%	-48.1

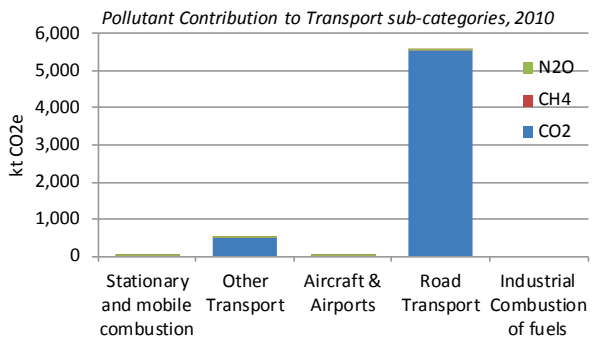


Figure 4.17

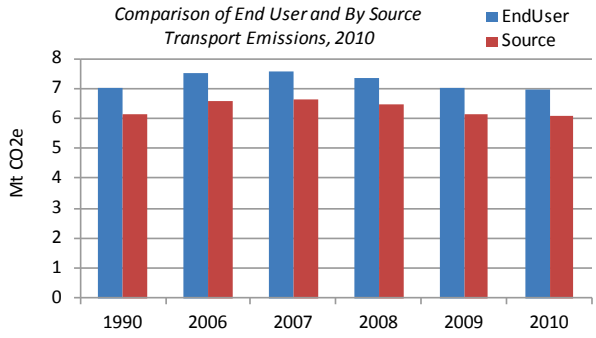


Figure 4.18

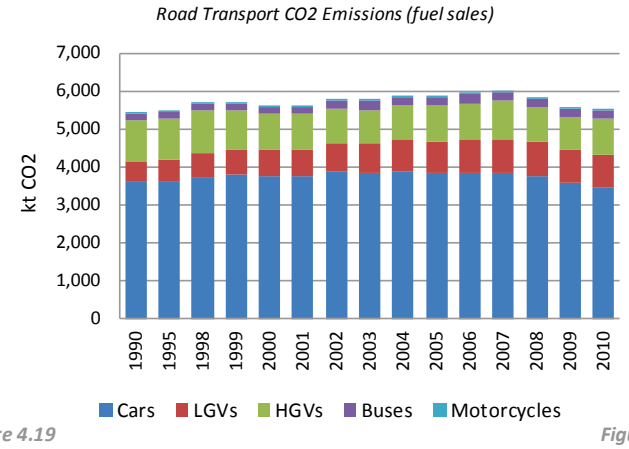


Figure 4.19

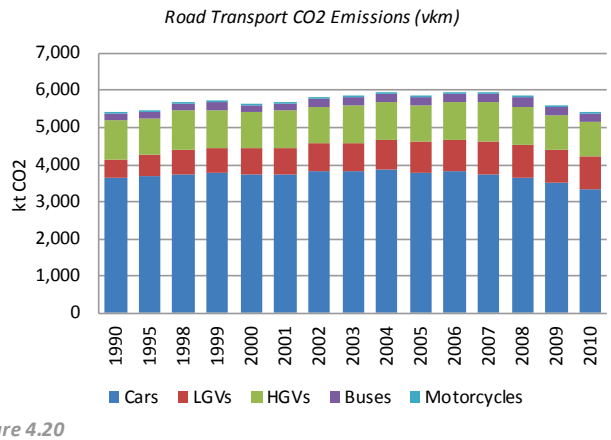


Figure 4.20

Transport emissions account for 13% of Wales' total GHG emissions in 2010. Transport emissions are dominated by emissions from road transport (92% of all Transport emissions in 2010, with 57% of Transport emissions from cars alone) (see Figures 4.19 and 4.20). The Transport sector also includes: 2.9% from rail (including stationary sources[31]), 3.6% from national navigation and coastal shipping, 0.3% from domestic aviation and 1.7% from military aviation and shipping. Emissions from international aviation are excluded from these estimates. Details of these emissions are included in Appendix 6.

Total GHG emissions from the Transport sector in Wales have decreased by only 0.3% between the Base Year and 2010 despite improvements in efficiency of transport vehicles, as a result of strong growth in transport demand and increased affordability of cars and fuel. Emissions between 2009 and 2010 have reduced by around 0.8%, see Table 4.5.

Figure 4.19 shows the CO_2 emissions from road transport for Wales based on constrained (DUKES fuel sales) and unconstrained (vehicle kilometre, vkm) approaches. Total CO_2 emissions from the vkm approach are 0.7% and 2.0% lower than the estimates constrained to DUKES for 1990 and 2010 respectively. The differences between the two approaches fluctuate year on year but they remain within 2.0% of difference for Wales. These disparities will also be reflected in the trends derived from the two approaches to a different extent. The long term trend (between base year and 2010) for each individual vehicle type is generally similar between the two approaches. The vkm approach indicates that the overall CO_2 emissions from road transport in 2010 are almost the same as the base year level, while the constrained approach indicates that CO_2 emissions have increased by 1.4% between the base year and 2010. Between 2009 and 2010, there is a big difference in the trend for HGVs as indicated by the two approaches: the vkm approach shows a 0.7%[32] decrease in Wales's HGV CO_2 emissions while the constrained approach shows an 8.8% increase. Apart from modelling uncertainty, there are possibly a number of combining factors causing the disparity. One reason may due to a higher percentage rise (4%) in diesel fuel sales reported by DUKES between 2009 and 2010 while the traffic (i.e. vkm) activity did not reflect similar growth rate for diesel dominated vehicles (i.e. LGVs, HGVs, buses and coaches). As the constrained method adjusts HGVs emissions so that the overall diesel emissions are consistent with the fuel sales reported in DUKES (see Brown et al., 2012 for further details on fuel normalisation process), the level of disparity will distort the trend for HGVs to a different degree.

Transport Emissions on an End User Basis

The end user estimates in recent years are 14% higher than the by source estimates, reflecting the additional emissions from upstream oil extraction and the oil refining sector (see Figure 4.18). A small proportion of electricity generation emissions are also attributed to the end user Transport sector to account for electric rail use, although the estimates of electrified rail operations across the UK are uncertain due to a lack of detailed data.

Wales is estimated to account for 5.0% of the UK 2010 end user emissions in the transport sector, which is identical to the reported share of the by source estimates.

The trend in end user emissions since 1990 shows a decline of around 0.9% to 2010, which is a slightly larger reduction 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.

[31] Electricity use from rail sector is not included in the By Source estimates but is attributed to the transport sector in the end user estimates.

[32] HGV activity has gone down by 1.7 % between 2009 and 2010 for Wales, accompanied by a worsening of HGV fuel efficiency of around 1% as indicated by the Department for Transport's Road Freight Statistics (DfT, 2011) and hence the resulting 0.7% decrease in Wales's HGV emissions based on the vkm approach.

3.4 Residential

Residential *Wales*

Overall Contribution of Residential sector to 2010 GHG emissions

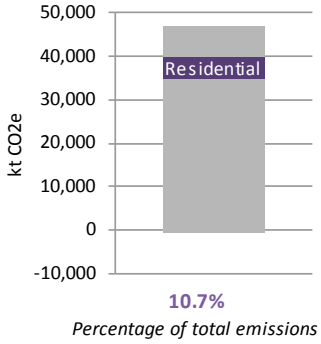


Figure 4.21

Total GHG Emissions by sub-sector, Base Year - 2010

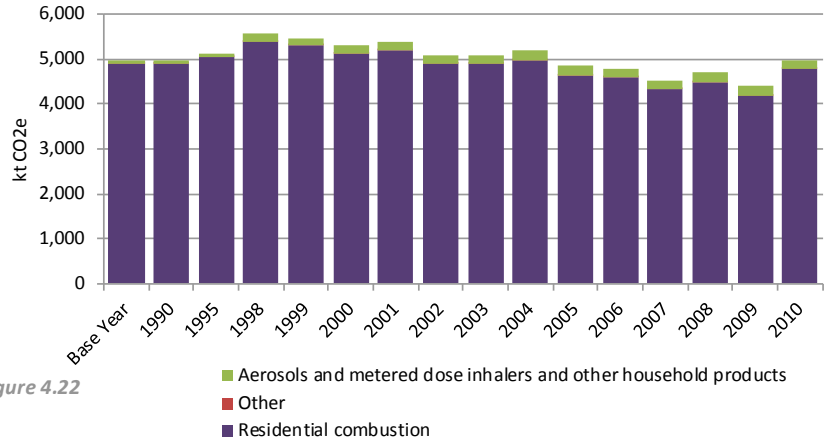


Figure 4.22

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 4.6

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Aerosols and metered dose inhalers and other household products	153.7%	125	-2.2%	-5
Other	-32.3%	-0.02	-0.5%	0.0
Residential combustion	-2.7%	-133	14.0%	587.2
Total	-0.2%	-8	13.3%	582.5

Pollutant contribution to Residential Emissions, 2010

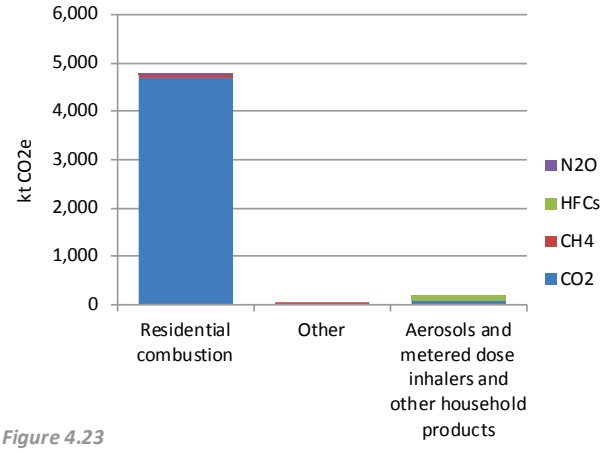


Figure 4.23

Comparison between End User and By Source Inventory Totals, 2010 ***(Mt CO2e)***

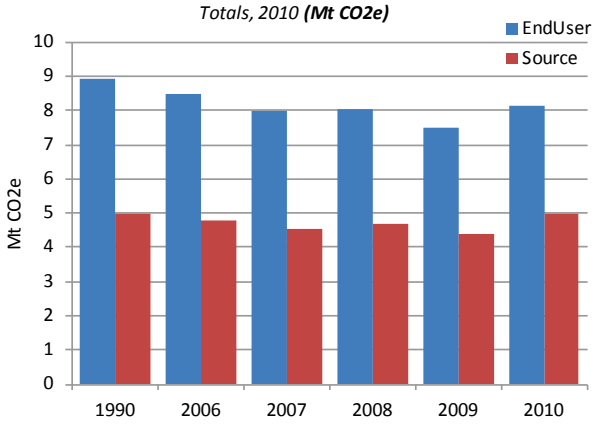


Figure 4.24

The Residential sector accounts for 11% of Wales's total GHG emissions in 2010. The sector comprises emissions from domestic combustion (96% of emissions for the residential sector) from heating and cooking, household products (see Figure 4.22). 4% of Residential emissions are from accidental vehicle fires and Hydrofluorocarbon (HFC) emissions from the use of aerosols and metered dose (usually asthma) inhalers. Over 96% of all residential GHG emissions are from the release of carbon dioxide from the direct combustion of fossil fuels (see Figure 4.23).

Total GHG emissions from the Residential sector in Wales have decreased by 0.2% between the Base Year and 2010 (see Table 4.6). There was a large increase in fuel use and GHG emissions from the sector in 2010

(13.3% increase in emissions between 2009 and 2010) primarily driven by two successive cold winters and a resultant high demand for fossil[33] fuel heating in many parts of Wales.

Residential Emissions on an End User Basis

In 2010 Wales end user emissions for the Residential sector are almost two thirds higher (164%) compared to 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 20% of the Wales total, compared to just 11% of the by source inventory total (see Figure 4.24). The trend in Residential end user emissions since 1990 shows a decline of around 9% to 2010 as a result of improvements in the energy efficiency of housing in Wales and also the reduction in GHG intensity of the UK electricity generation sector since 1990. However, the trend data are uncertain and should be regarded as indicative only due to the limited data on electricity use by source.

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

3.5 Business

Business | *Wales*

Overall Contribution to 2010 GHG emissions

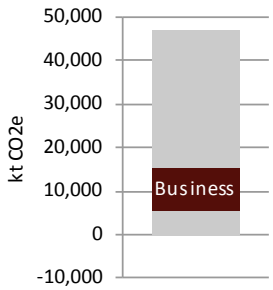


Figure 4.25 **21.07%**
Percentage of total emissions

Total GHG Emissions from Business, Base Year - 2010

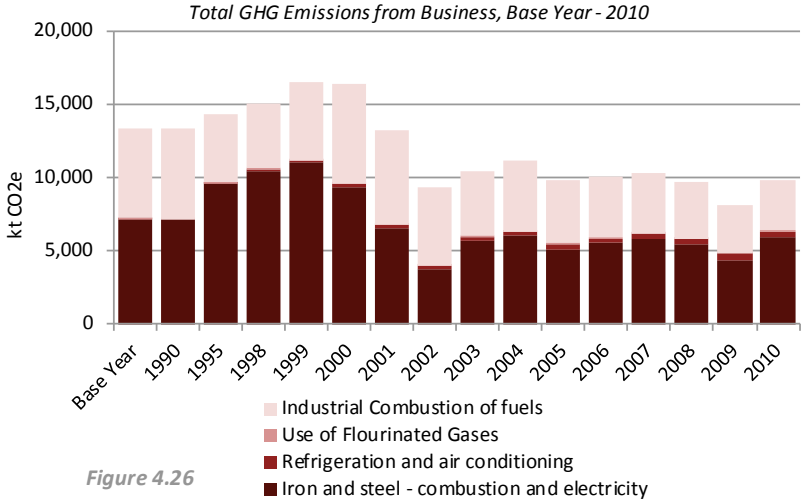


Figure 4.26

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 4.7

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Industrial Combustion of fuels	-44.0%	-2,708.4	5.2%	170.3
Iron and steel - combustion and electricity	-16.9%	-1,202.6	34.5%	1,511.3
Refrigeration and air conditioning	1233.8%	386.2	3.8%	15.4
Use of Flourinated Gases	3.4%	2.2	-0.4%	-0.3
Total	-26.4%	-3,522.6	20.9%	1,696.6

Pollutant Contribution for Business Emissions, 2010

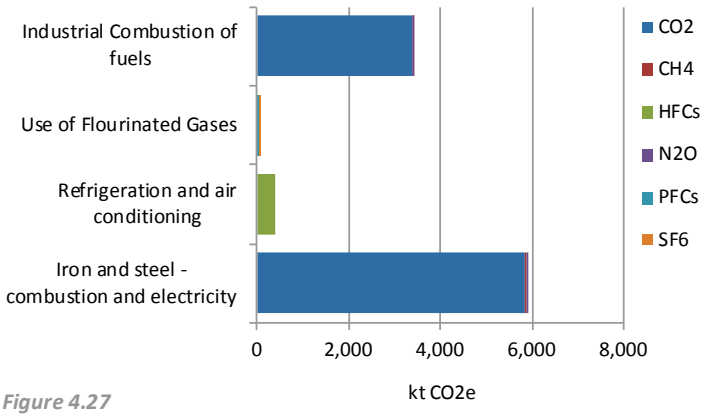


Figure 4.27

Comparison between End User and By Source Inventory for the Business Sector, 1990 and 2006-2010 ***(Mt CO2e)***

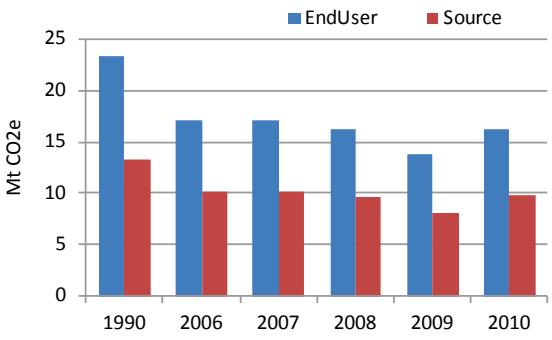


Figure 4.28

In Wales, the Business sector contributes 21.1% to total 2010 GHG emissions in Wales. The Business sector in 2010 includes emissions from industrial combustion of fuels (35.1% of total GHGs) from manufacturing and construction industry, Iron and Steel combustion (60% of total GHGs), refrigeration & air conditioning (4.0% of total GHGs), arising from losses of HFCs during equipment manufacture, leaks and disposal; as well as HFC emissions from foam production, fire fighting solvents and electronics (0.7% of total GHGs) (see Figure 4.26). In 2010, 93.7% of emissions were carbon dioxide released from the combustion of fossil fuels in the Business sector with 4.9% from the use of F-Gases (predominantly HFCs in refrigeration and air conditioning and sulphur hexafluoride (SF_6) in electrical insulation systems) (see Figure 4.26).

Total GHG emissions from the Business sector have declined by 26.4% since the Base Year (see Table 4.7). These reductions have primarily been achieved as a result of declining manufacturing and iron and steel industry emissions. Despite this general decline in emissions, emissions of HFC from refrigeration and air conditioning have risen by over 1000% since 1995; these emissions now account for around 4.9% of total Business emissions in 2010 since the introduction of these gases as replacement to CFCs banned by the Montreal Protocol.

Business Traded and non-traded emissions.

Emissions in the Business sector include significant contributions from installations. However, due to the lack of detail in the EU ETS dataset Business and Industrial Process emissions are not easy to separate. The contribution to total emissions from the traded and non-traded sector for Business plus Industrial Process (73% in 2010) is presented in figure 4.9 in the summary section.

Business Emissions on an End User Basis

In 2010 Wales end user emissions for the Business sector are almost two thirds higher (164%) compared to the by source emission estimates, reflecting the high consumption of electricity for heating, lighting and operating equipment in the sector (see Figure 4.28). On an end user basis, therefore, Business sector represents over 39% of total emissions for Wales compared to just 21% of the by source inventory total.

The trend since 1990 shows a decline of around 31% to 2010, but the trend data are uncertain and should be regarded as indicative only due to the limited data on electricity use by source.

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.

3.6 Public

Public | *Wales*

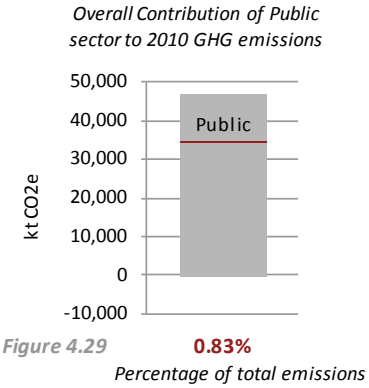


Figure 4.29

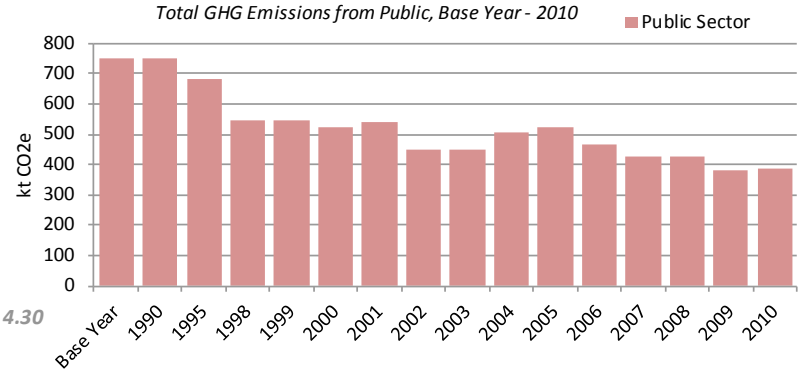


Figure 4.30

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 4.8

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Public Sector	-48.6%	-366	2.1%	8

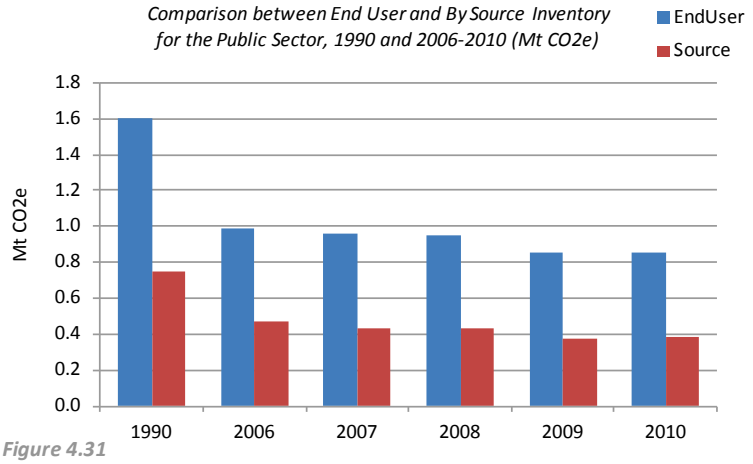


Figure 4.31

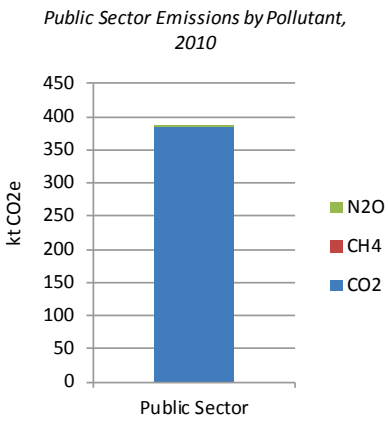


Figure 4.32

Emissions from Public sector combustion account for 0.8% of GHG emissions in Wales in 2010. 99.6% of emissions in this sector are from carbon dioxide from the combustion of fossil fuels (mainly natural gas) primarily to heat buildings. Public sector emissions have reduced by 49% since the Base Year (see Table 4.8); 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. However, emissions between 2009 and 2010 rose by around 2.1% as a result of the cold winters at the start and end of 2010. 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.

Public Emissions on an End User Basis

In 2010 Wales end user emissions for the public sector are more than twice that (220%) of the by source emission estimates, reflecting the high consumption of electricity in the sector and increasing the sector's

share of total Wales emissions to 2.1% in 2010 compared to 0.8% of the by source estimates (see Figure 4.31). The trend in end user emissions since 1990 shows a decline of around 47% to 2010[34].

[34] the trend data are uncertain and should be regarded as indicative only due to the limited data on electricity use by source;

3.7 Industrial Process

Industrial Process — *Wales*

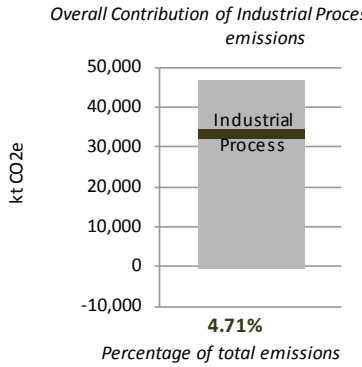


Figure 4.33

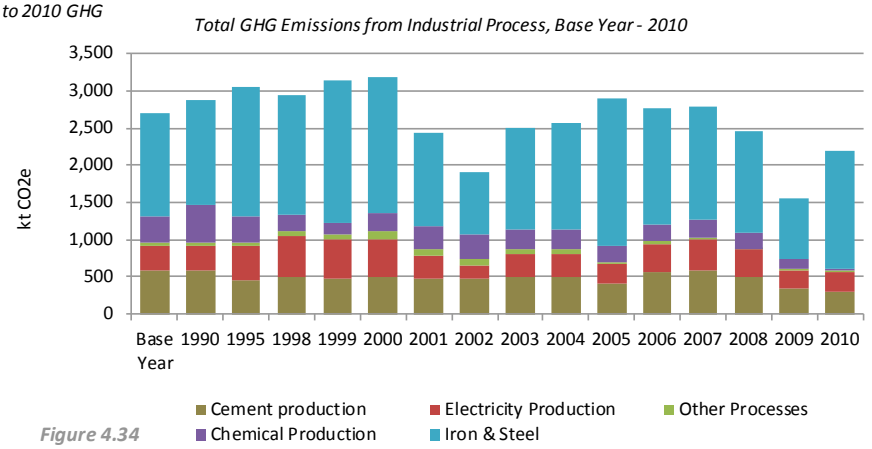


Figure 4.34

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 4.9

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Cement production	-49.0%	-283	-15.6%	-54.4
Chemical Production	-95.7%	-319	-90.5%	-137.3
Electricity Production	-20.7%	-72	-	44.0
Iron & Steel	13.2%	186	98.1%	788.6
Other Processes	-51.7%	-24	13.7%	2.7
Total	-18.9%	-511	41.4%	643.5

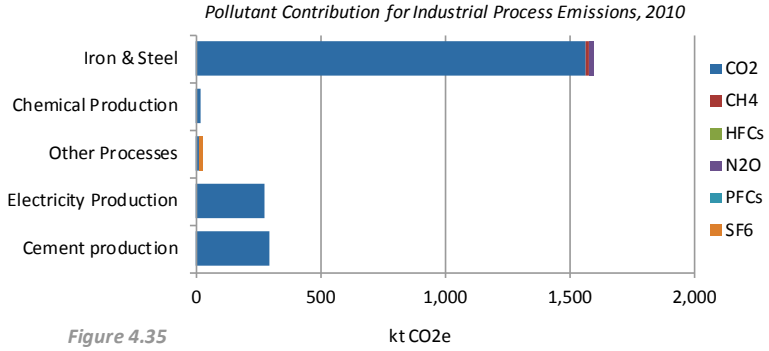


Figure 4.35

In Wales in 2010, the Industrial Process sector contributes 4.7% to total 2010 GHG emissions in Wales. The Industrial Process sector includes non-combustion sources such as Iron and Steel processes (72% of total GHGs) excluding the use of electricity and fossil fuels for heating processes; Flue gas cleaning in the electricity production sector (13% of total GHGs); the use of limestone in cement production (13% of total sector GHG emissions); Chemical production (1% of total GHGs) including fertilizers and other bulk chemical feedstocks; and Other processes (1% of total GHGs) including glass & brick making, lime production (see Figure 4.34). In 2010, 98% of total GHGs emissions were from emissions of carbon dioxide from processes (primarily cement and iron and steel production). Less than 3% of total GHGs emissions are from the use of F-Gases (predominantly HFCs) in industrial processes including sulphur hexafluoride (SF_6) from its application as a cover gas in magnesium production (see Figure 4.35). Emissions of methane and nitrous oxide from this sector are not significant, accounting for less than 1.5% of total GHG emissions in this sector.

Overall Industrial Process sector emissions in Wales have reduced by 18.9% since the Base Year to 2010 (see Table 4.9). This decline in emissions is due to several factors including a decline in manufacturing, cement, aluminium production, bulk chemical and iron and steel industries.

Industrial Process Traded and non-traded emissions

Emissions in the Industrial Process sector include significant contributions from installations. However, due to the lack of detail in the EU ETS dataset, Business and Industrial Process emissions are not easy to separate. The contribution to total emissions from the traded and non-traded sector for Business plus Industrial Process is presented in Figure 4.9 in the summary section.

Industrial Process 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 2010, the end user estimates are only 8.5% 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.

3.8 Agriculture

Agriculture *Wales*

Overall Contribution to 2010 GHG emissions

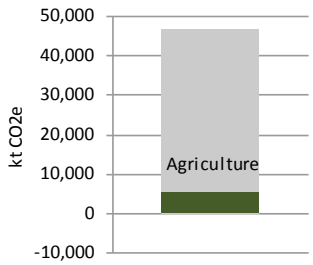


Figure 4.36 **12.15%**

Percentage of total emissions

Agriculture Emissions by category and pollutant, 2010

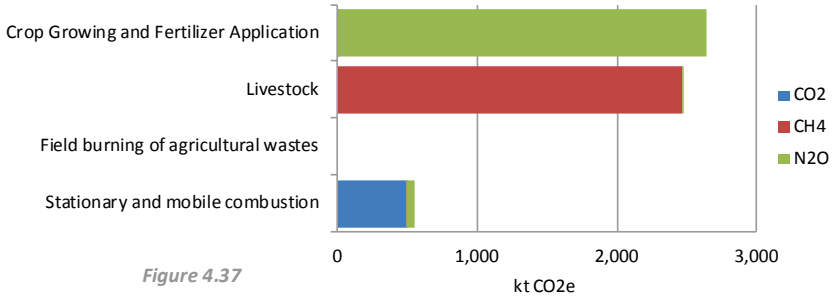


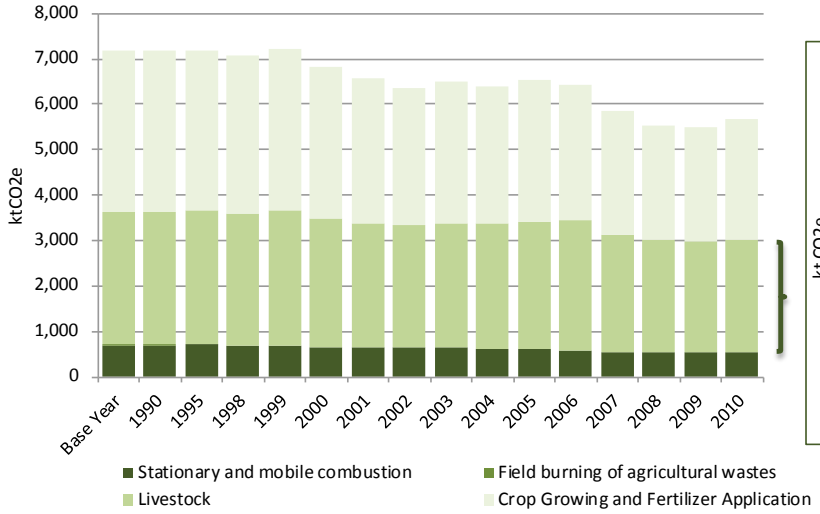
Figure 4.37

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 4.10

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Crop Growing and Fertilizer Application	-25.1%	-882.5	5.3%	132.1
Field burning of agricultural wastes	-100.0%	-20.2	-	0.00
Livestock	-15.6%	-457.8	1.9%	45.3
Stationary and mobile combustion	-20.6%	-142.7	1.2%	6.3
Total	-21.0%	-1,503.2	3.4%	183.8

Total GHG emissions from Agriculture, Base Year - 2010



Livestock emissions by type, 2010

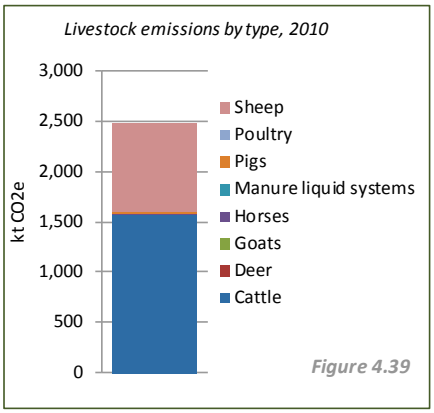


Figure 4.39

Figure 4.38

GHG emissions from Agriculture are primarily methane and nitrous oxide from livestock and agricultural soils respectively, but there are also carbon dioxide emissions from fuel combustion in mobile and stationary units in the sector (see Figure 4.37). Agriculture accounts for 12% of total greenhouse gas emissions in Wales in 2010, and is the most significant source sector for methane and nitrous oxide, accounting for 63.5% and 88.2% of total Welsh emissions of these two gases, respectively.

Agriculture is the largest source of methane emissions in Wales. Enteric fermentation contributed 90% (2,219 $ktCO_2e$) to total agricultural methane in Wales in 2010. Total methane emissions from beef and dairy cattle (enteric and waste management sources combined) accounted for 63% of the all Welsh agricultural methane emissions. Total emissions from sheep were 35% of the total methane from agriculture in 2010. Table 4.11 gives a detailed breakdown of methane emissions from agricultural livestock sources in Wales in 2010.

Agriculture is the most important source of nitrous oxide in Wales, with over 95% (2,502 $ktCO_2e$) of the sector total (and 5.7% of the national total from all emission sources) arising from agricultural soils. A further breakdown of these emissions is shown in Table 4.12.

Emissions from agriculture are largely dependent on livestock numbers, and have declined by 15% from 1990-2010 in line with a decrease in sheep and cattle numbers. Total methane emissions increased relative to 2009 by 1.9% due to a small increase in total cattle numbers.

Nitrous oxide emissions are largely driven by fertiliser nitrogen use, manure applications and grazing returns to soils. Welsh emissions of nitrous oxide have declined by 25% over the period 1990-2010 due to a general decline in livestock numbers and in fertiliser nitrogen use (particularly to grassland). Emissions increased by 5.3% in 2010 relative to 2009 a small increase in fertiliser nitrogen use following many years of decline.

Table 4.11 Emissions of methane from agricultural livestock sources in Wales in 2010

	Livestock Category	Methane emissions ($ktCO_2e$)
TOTAL		**2,469**
Enteric fermentation		2,219
	Cattle	*1,352*
	Sheep	*847*
	Goats	*0.84*
	Pigs	*0.84*
	Horses	*18*
	Poultry	-
	Deer	*0.21*
Manure management		249
	Cattle	*210*
	Sheep	*24*
	Goats	-
	Pigs	*3.2*
	Horses	*1.5*
	Poultry	*10*
	Deer	-
Field burning		-

Table 4.12: Emissions of nitrous oxide from agricultural sources in Wales in 2010 ($ktCO_2e$)[1]

TOTAL				**2,644**
Manure management				143
Soils				2,502
	Direct			*1,575*
		Fertiliser		419
		Grazing returns		880
		Manure application		189
		Crop residues		34
		Biological fixation		-
		Improved grassland		28
		Histosols		12
		Sewage sludge		16
	Indirect			*927*
		Leaching		763
			Fertiliser	279
			Grazing returns	329
			Manure application	143
			Sewage sludge	12
		Deposition		167
			Fertiliser	37
			Grazing returns	87
			Manure application	37
			Sewage sludge	3.1
Field burning				-

[1]Total emissions comprise manure management, soils and field burning. Soils include direct and indirect emissions; indirect emissions include leaching and deposition

Agriculture Emissions on an End User Basis

As the majority of emissions in the Agriculture sector are not due to energy consumption, Agriculture sector emissions on an end user basis are very similar to the emissions by source; in 2010, the end user estimates are only 5% higher for the agriculture sector, reflecting the relatively low contribution to sector emissions from the use of oils and electricity, compared to the higher-emitting sources of nitrous oxide and methane from soils and livestock sources.

3.9 Land Use, Land Use Change and Forestry

LULUCF *Wales*

Overall Contribution to 2010 GHG emissions

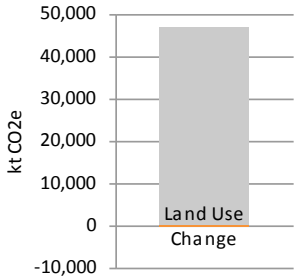


Figure 4.40

-0.09%

Percentage of total emissions

Pollutant Contribution to LULUCF GHG Emissions, 2010

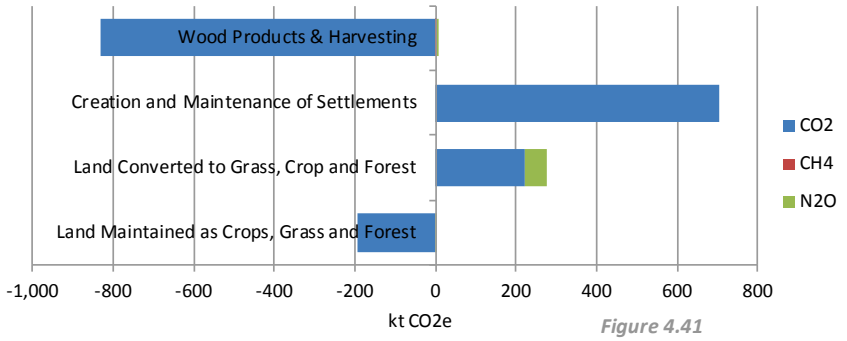


Figure 4.41

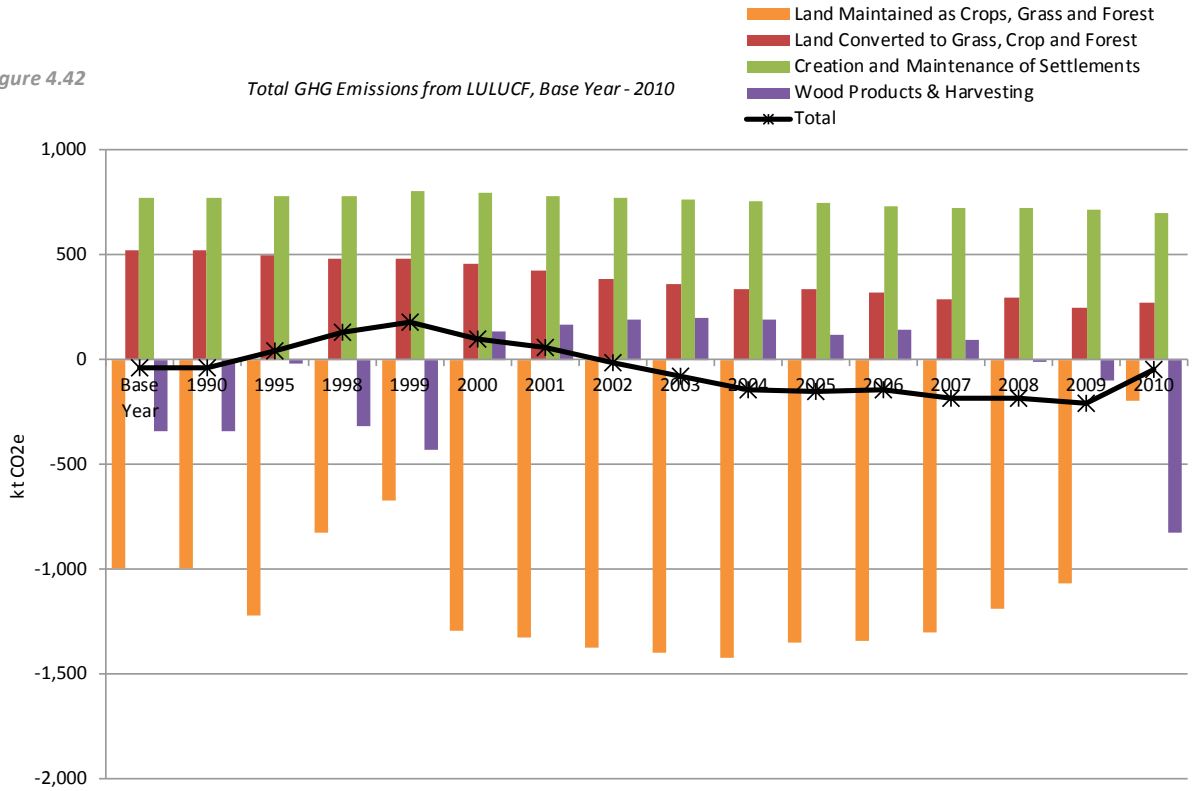
Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 4.13

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Creation and Maintenance of Settlements	-9.0%	-69.7	-1.4%	-9.9
Land Converted to Grass, Crop and Forest	-47.6%	-251.0	11.0%	27.4
Land Maintained as Crops, Grass and Forest	-80.4%	800.4	-81.7%	873.6
Wood Products & Harvesting	144.2%	-487.6	713.3%	-724.3
Total	23.5%	-7.9	-80.1%	166.8

Figure 4.42

Total GHG Emissions from LULUCF, Base Year - 2010



Figures 3.40 – 3.42 and table 3.13 show detailed emissions and trends for the sector. Wales has generally been a small net sink of greenhouse gases with net emissions only during the period between 1995 and 2002. Net removals have increased between the Base Year and 2010 from -34 to -42 ktCO_2e. This net decrease

has been contributed to by a reduction in net emissions from land cropland and conversion to cropland from grassland and forests over the 1990 -2010 period. In addition, the maintenance of forests (and for 2010 from harvested wood products; removals of 826 $ktCO_2e$ in 2010) dominates the removals in this sector, although removals has declined from 2004 as a result of maturation of forest stocks and harvesting for wood product. The creation and maintenance of settlements (704 $ktCO_2e$ in 2010), from biomass removal in built up & transport areas, gardens and mineral workings, dominate emissions from the sector and have changed very little over the period 1990 - 2010.

A more detailed report of LULUCF emissions in Scotland, Wales, Scotland and Northern Ireland can be found on the NAEI website (A.M. Thomson *et al*. 2012) and more detailed information is also available in the UK Greenhouse Gas Inventory Report, available on the NAEI website.

LULUCF 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

Waste *Wales*

Overall Contribution of Waste Management to 2010 GHG emissions

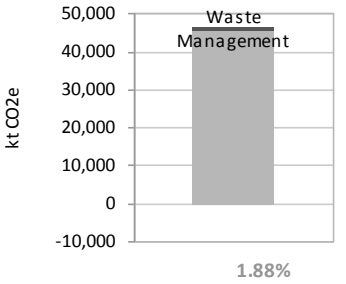


Figure 4.43

Total GHG Emissions from Waste Management, Base Year - 2010

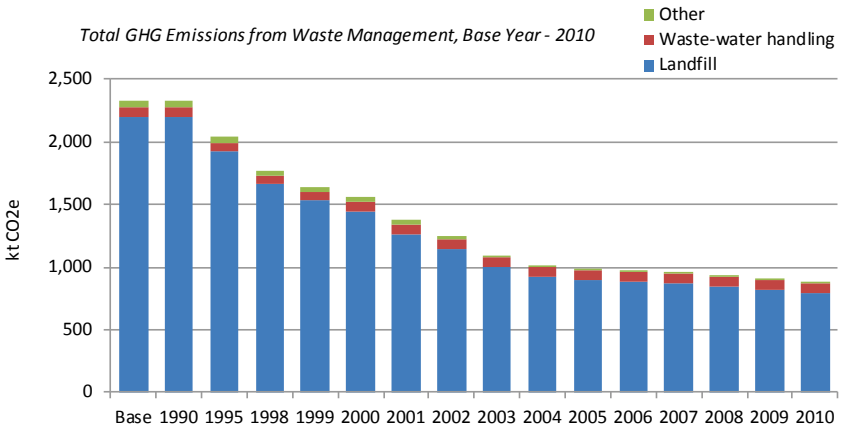


Figure 4.44

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 4.14

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Landfill	-63.9%	-1,410.2	-3.1%	-25.3
Other	-83.0%	-43.4	2.6%	0.2
Waste-water handling	7.2%	4.9	-2.0%	-1.5
Total	-62.3%	-1,448.7	-2.9%	-26.6

Pollutant contribution to Waste Management Emissions, 2010

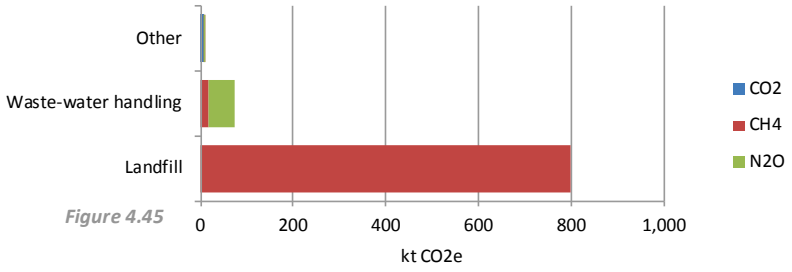


Figure 4.45

The Waste Management sector contributes 1.9% to total GHG emissions in Wales, and is the second largest source sector for methane emissions, representing 20.9% of total methane emissions in Wales. Emissions from this sector are dominated by methane from landfill (91% of total GHGs from the Waste sector in Wales), with a smaller contribution of emissions of methane and nitrous oxide from wastewater treatment (8%) and 1% from incineration (see Figure 4.44).

Nitrous oxide emissions from waste water treatment represent 7.7% of emissions in the sector, and contribute 3.9% to the total emissions of nitrous oxide in Wales.

GHG emissions from the Waste Management sector in Wales have shown a significant decline of 62.3% in total for the sector and by 63.9% for Landfill between 1990 and 2010, as shown in Table 4.14, due largely to the progressive introduction of methane capture and oxidation systems within landfill management.

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

4 Emissions in Northern Ireland

4.1 1990-2010 GHG Inventory Estimates

The GHG emissions for Northern Ireland for 1990-2010 are presented in Table 5.1 below. Emissions in 2010 are 20,460 $ktCO_2e$ with 26% from Agriculture, 21% from Transport, 19% from Energy Supply and 19% from the Residential sector.

Table 5.1: 1990-2010 Northern Ireland GHG Emission Inventory ($ktCO_2e$)

NC Format	Base Year	1990	1995	2000	2005	2008	2009	2010	% of 2010
Agriculture	5,848	5,848	6,032	5,780	5,750	5,323	5,291	5,264	25.7%
Business	2,734	2,708	2,485	2,299	2,447	2,323	2,144	2,300	11.2%
Energy Supply	5,315	5,315	6,541	6,341	5,356	4,844	3,691	3,950	19.3%
Industrial Process	761	761	779	682	419	400	181	173	0.8%
Land Use Change	55	55	-48	-116	5	96	137	105	0.5%
Public	461	461	290	151	170	213	212	213	1.0%
Residential	4,372	4,361	3,609	3,820	3,534	3,460	3,404	3,820	18.7%
Transport	3,331	3,331	3,565	3,997	4,379	4,374	4,241	4,199	20.5%
Waste Management	1,098	1,098	979	740	484	458	448	436	2.1%
Total	**23,974**	**23,937**	**24,230**	**23,693**	**22,544**	**21,492**	**19,749**	**20,460**	**100%**

Although total GHG emissions between 2009 and 2010 show a small increase of 3.6%, Northern Ireland total GHG emissions have reduced between the Base Year[35] and 2010 by 14.7% whilst carbon dioxide emissions have reduced by 12.5% (see Figure 5.1 and Table 5.1). Transport and LULUCF emissions have, however, increased since the Base Year with the Transport sector emitting 26% more GHG emissions in 2010 than the Base Year.

Emissions from the Transport sector continued to buck the general trend as a result of increasing population and increasing demand for transportation despite improvements in energy efficiency of vehicles; across the UK emissions from the Transport sector have shown a small increase since 1990, whereas in Northern Ireland the increase is notably larger, which reflects the growth in the Northern Ireland economy during the 2000's. Unlike other constituent countries, Northern Ireland has seen a reduction in emissions from the Residential sector due to its changing fuel profile away from oil and towards gas.

Detailed analysis of Northern Ireland emissions in 2010 is presented in Figures 5.4-5.9. The largest sources of emissions in 2010 include electricity production (19.3% of total GHGs), road transport (18.6% of total GHGs), residential combustion for heating and cooking (18% of total GHGs), livestock emissions (12.8% of total GHGs) and crop growing and fertilizer application (10.4% of total GHGs) (See Figure 5.5).

Emissions from installations included in the EU ETS (see Figure 5.8) reduced by 26% CO_2e between 2008 and 2009 as power demand in the economy dropped, whilst traded emissions then increased by nearly 7% between 2009 and 2010. Emissions from installations in the EU ETS (see Figure 5.7) accounted for 22.6% of total GHG emissions in Northern Ireland in 2010; the main contributors to these traded emissions are the Energy Supply sector (of which 100% total emissions are within the EU ETS, including all power stations) and the Business and Industrial Process sectors (see figure 5.9) of which, 25% of total sector emissions are in the EU ETS.

Carbon dioxide is the most common gas emitted for all National Communication (NC) categories except Agriculture, where methane from livestock and nitrous oxide from soils, and for Waste, where methane from landfills are the most important gases (see Figure 5.4).

[35] 1995 for F-Gases and 1990 for all other gases

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 Figure 5.6). This illustrates the share of total emissions attributable to the end users of energy in the economy. The end user basis allocates emissions from Energy Supply (electricity production) to the end users (residential, transport, agriculture, public and businesses) of the energy supplied (See Appendix 3 for more details of the end user inventory methodology). Figures 8 and 9 illustrate 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.

The primary difference in the end user perspective is the significant increase in emissions attributable to the business, residential, transport and public sectors. The end user inventory data illustrate that on an end user basis, the contribution to Northern Ireland total emissions in 2010 are: 21% from Business, 26% from the Residential sector and 21% from Transport sources. As illustrated in Figure 5.3, Northern Ireland is a net importer of electricity which results in higher (+8.6% of CO_2e.) emissions in Northern Ireland for End User (22,478 ktCO_2e) compared to By Source (20,460 ktCO_2e) estimates for 2010.

Emissions from the Land Use Change 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 9 NC sectors.

4.1.1 Inventory Recalculations

Revisions to the estimates since the last inventory report (2011) have resulted in a 1.2% (241 ktCO_2e) increase in the 2009 estimates for Northern Ireland. The most significant revisions to the 2009 estimates have been for the following sectors:

1. **Business**: (361.5 ktCO_2e increase) primarily as a result of changes to the approach for estimating emissions from 1A2 increasing estimates for Chemicals and Food and Drink and pulp and paper.
2. **Waste Management:** (263.4 ktCO_2e decrease) from revisions to the UK waste model and also revisions to use more DA-specific input data to derive country-specific estimates.

The most significant revisions to the Base Year estimates have been for the following sectors:

1. **Business**: (325 kt CO_2e increase) primarily as a result of revisions to UK inventory allocations of gas oil with lower estimates evident for commercial and public sector combustion, offset to some degree by increases in industrial combustion;
2. **Waste:** (-770 kt CO_2e decrease) due to the combined impacts of revisions to the UK GHGI landfill waste model and revisions to the DA landfill waste method to utilise more country-specific data for waste disposals to landfill.

For more details of revisions to DA GHG emission estimates, see Appendix 7.

Northern Ireland Trends in Emissions

Percentage Change in GHG Emissions by NC: Base Year - 2010 and 2009 - 2010

The % changes for LULUCF are based on net change to emissions and removals throughout the time series

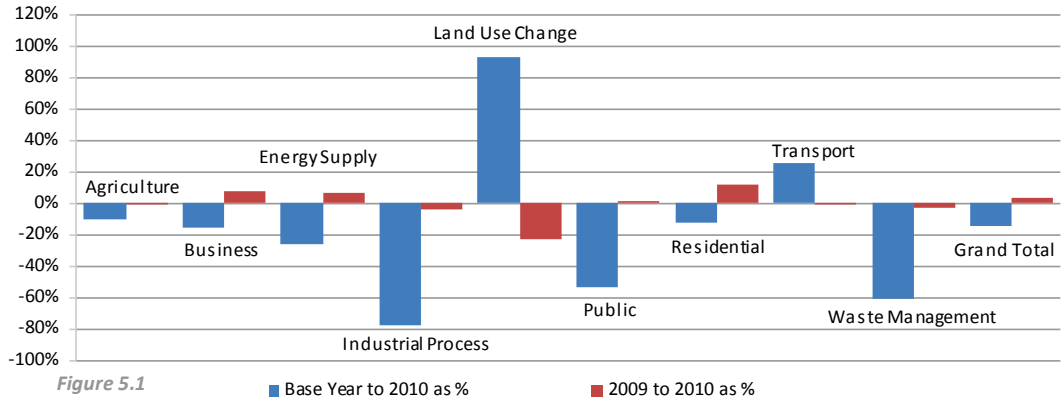


Figure 5.1

Percentage Change in Total GHG and CO2 Emissions by NC: Base Year - 2010 and 2009 - 2010

Change in emissions from the Base Year to 2010 and 2009 to 2010	Agriculture	Business	Energy Supply	Industrial Process	Land Use Change	Public	Residential	Transport	Waste Management	Total	
Base Year to 2010 as %	-10%	-16%	-26%	-77%	93%	-54%	-13%	26%	-60%	-15%	**Total GHG as CO2e**
2009 to 2010 as %	-1%	7%	7%	-4%	-23%	0%	12%	-1%	-3%	4%	
Base Year to 2010 as %	-15%	-26%	-26%	-58%	448%	-54%	-11%	27%	-63%	-12%	**Total CO2 only**
2009 to 2010 as %	2%	8%	7%	-4%	-29%	0%	13%	-1%	3%	5%	
Base Year to 2010 kt	-584	-434	-1,364	-588	51	-249	-552	868	-662	-3,515	**Total GHG as CO2e**
2009 to 2010 kt	-27	155	259	-8	-32	1	416	-43	-12	710	
Base Year to 2010 kt	-80	-695	-1,354	-243	97	-245	-442	882	-5	-2,085	**Total CO2 only**
2009 to 2010 kt	11	147	255	-8	-30	1	415	-42	0	748	

Table 5.2

Total GHG Emissions by NC category for Base Year to 2010, as CO2e

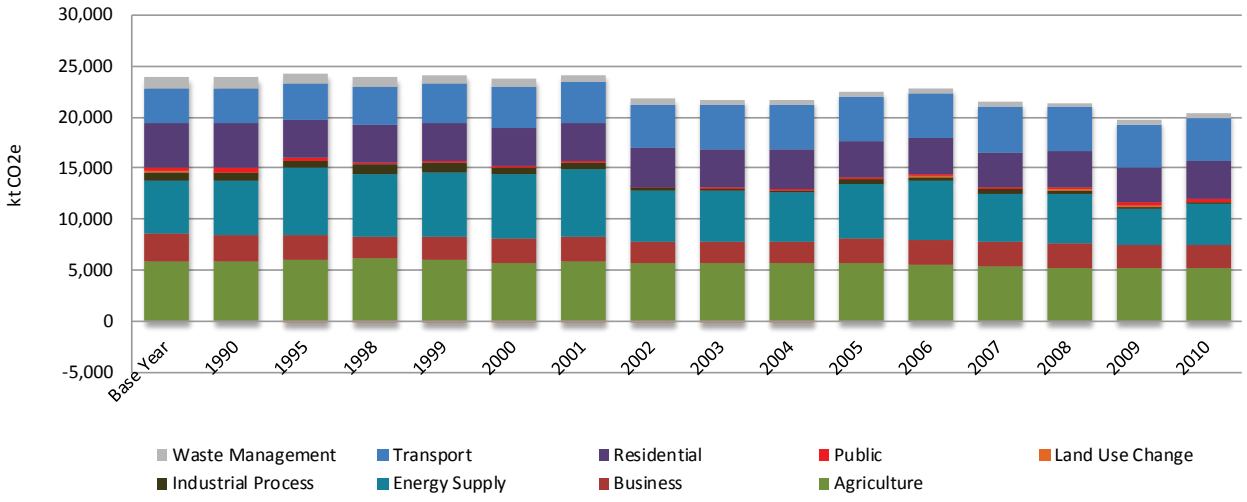
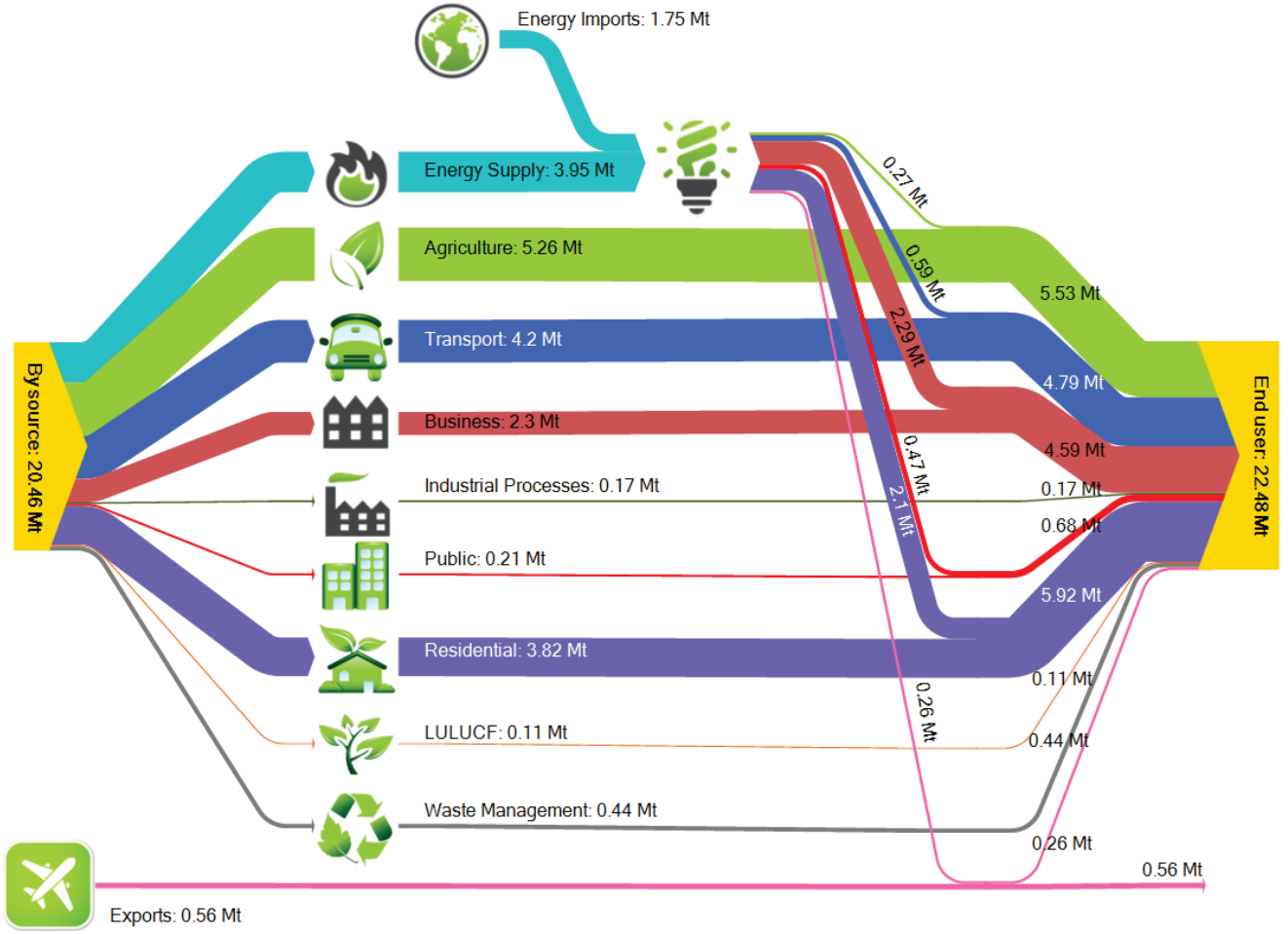


Figure 5.2

Figure 5.3 Sankey diagram showing By Source and End User[36] GHG emission transfers for Northern Ireland in 2010 (Mt CO_2e)[37]



[36] 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.
[37] Exports' equates to emissions from international aviation and shipping.

Northern Ireland 2010 Emissions Summary

Total GHG Emissions by NC and pollutant, 2010

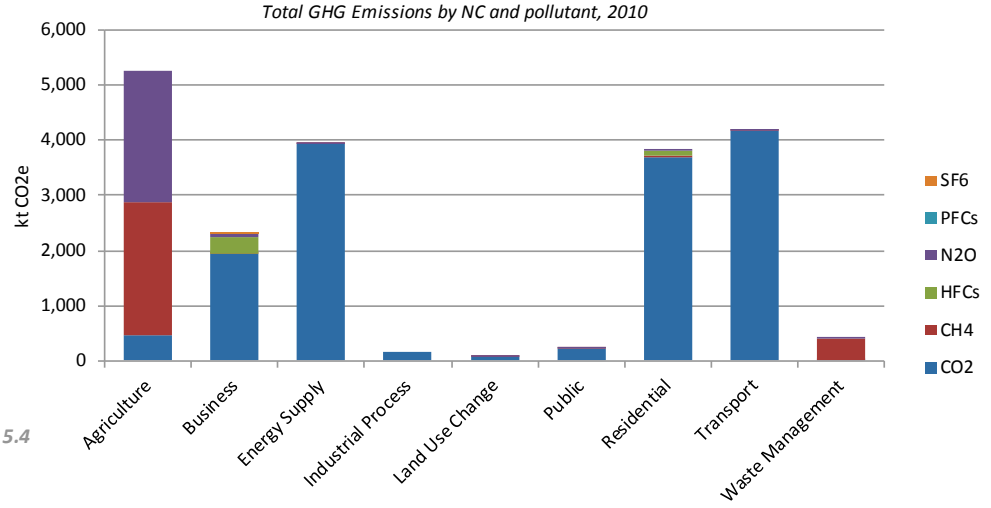


Figure 5.4

Total GHG Emissions by NC and sub-category highlighting the important sources, 2010

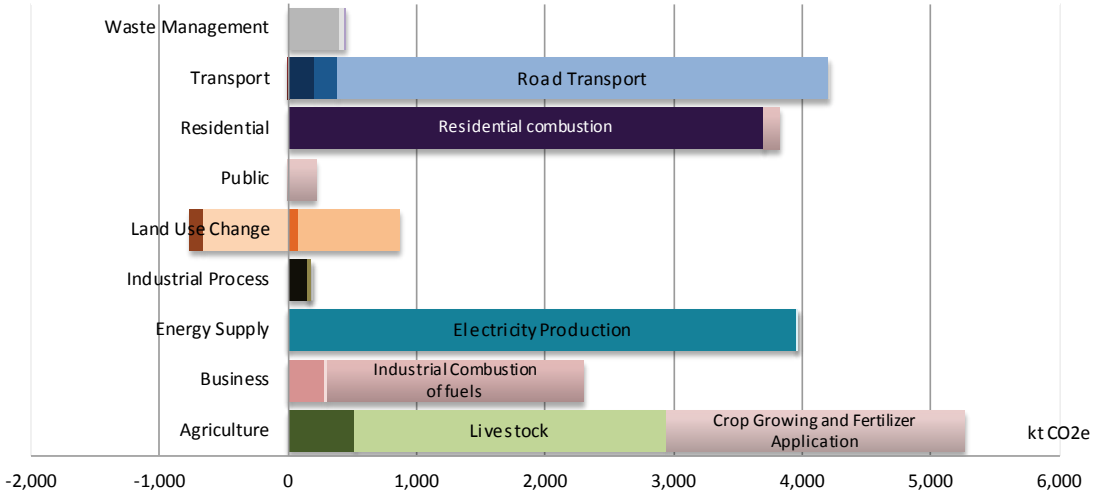


Figure 5.5

Comparison of End User and By Source Emissions, 2010 ***(Mt CO2e)***

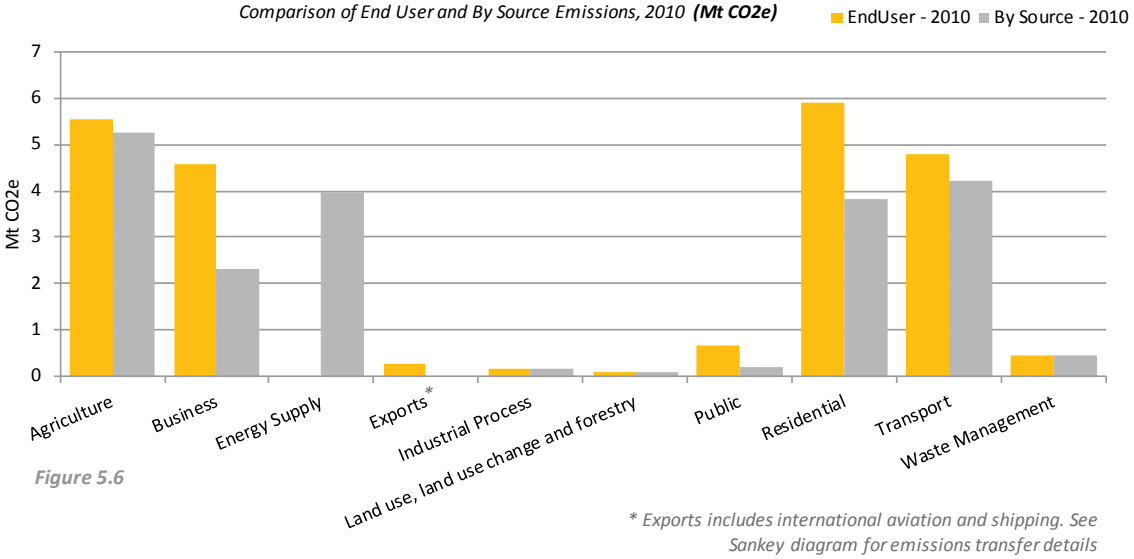


Figure 5.6

** Exports includes international aviation and shipping. See Sankey diagram for emissions transfer details*

Northern Ireland 2010 Traded and Non-Traded Emissions Summary

Total Traded and Non-Traded GHG Emissions by NC Category, 2010

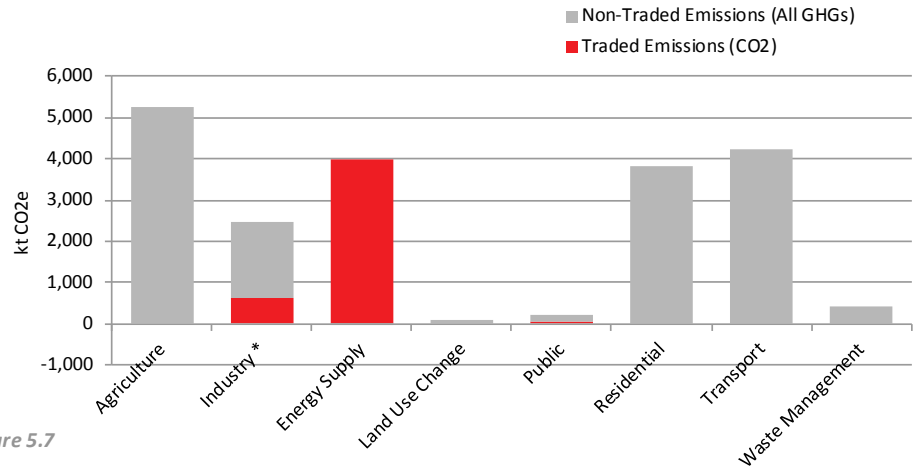


Figure 5.7

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

Total Non-Traded and Traded GHG Emissions, 2008-2010

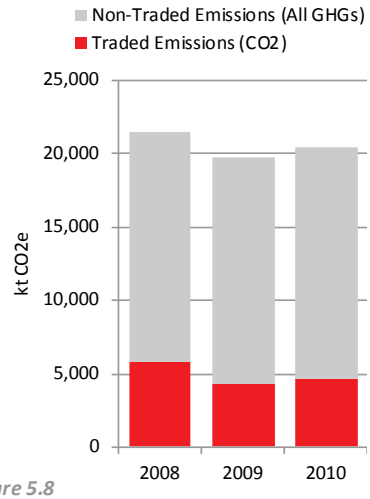
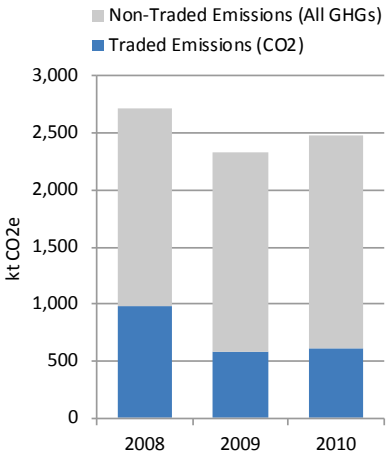


Figure 5.8

Non-Traded and Traded GHG Emissions from Industry, 2008-2010*



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

Figure 5.9

4.2 Energy Supply

Energy Supply — *Northern Ireland*

Overall Contribution of Energy Supply to 2010 GHG emissions

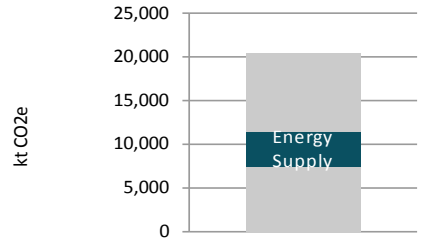


Figure 5.10

19.3%

Percentage of total emissions

GHG Contribution for Energy Supply Emissions, 2010

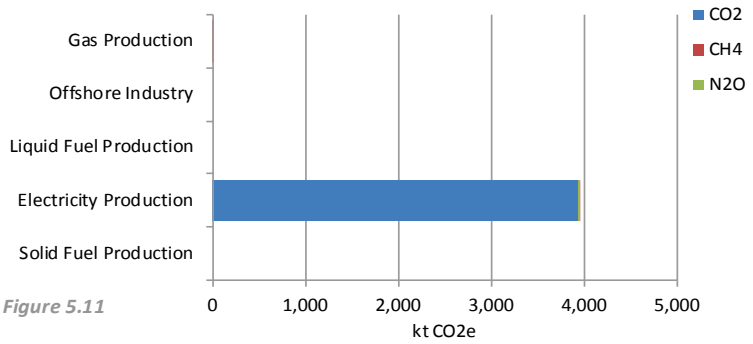


Figure 5.11

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 5.3

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Electricity Production	-26%	-1,364	7%	259
Gas Production	-	0	-73%	0
Liquid Fuel Production	-	0	-	0
Offshore Industry	-	0	-	0
Solid Fuel Production	-	0	-	0
Total	-26%	-1,364	7%	259

Total GHG Emissions from Energy Supply, Base Year to 2010

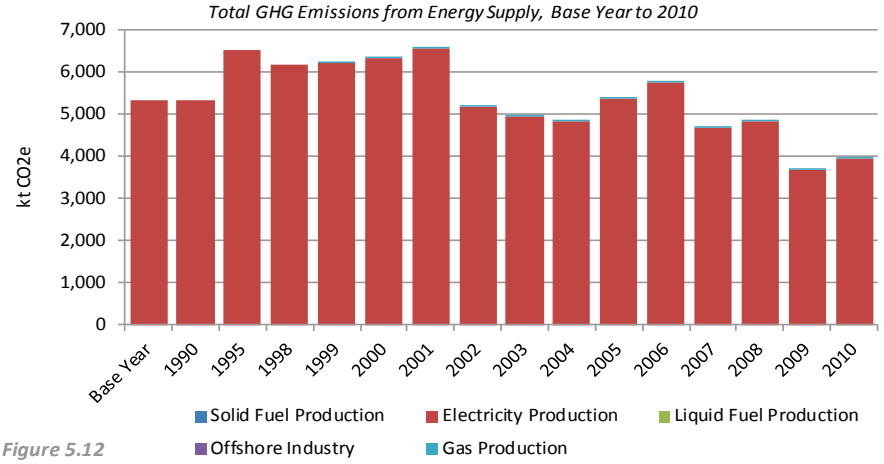


Figure 5.12

NC Category Contribution to End User Inventory by percentage of Electricity Production Emissions

NC Category	EndUser
Agriculture	4.51%
Transport	1.19%
Business	45.15%
Industrial Process	0.00%
Public	9.68%
Residential	35.32%

Table 5.4

Emissions and Electricity Production by Fuel Type from Major Producers (1A1a)

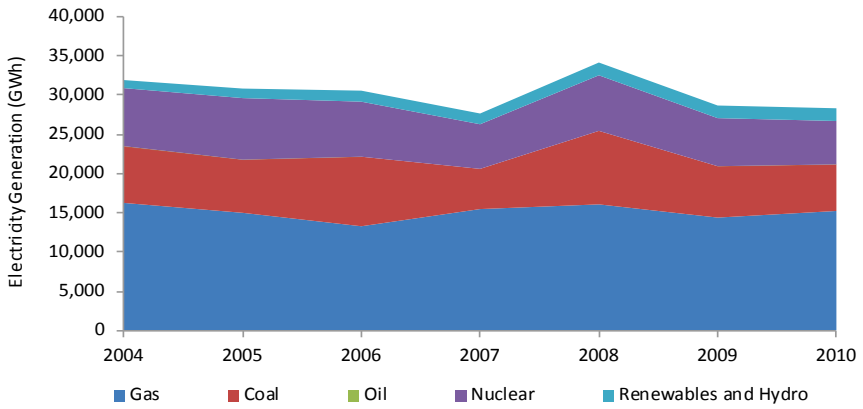


Figure 5.13

Traded and Non-Traded Energy Supply Emissions, 2008-2010

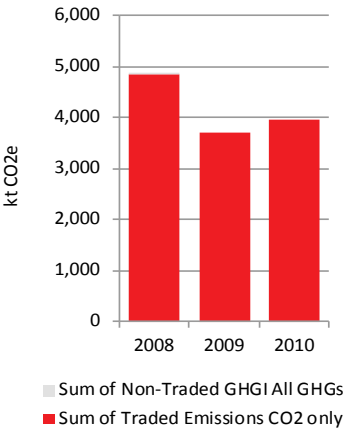


Figure 5.14

In Northern Ireland the Energy Supply contributes 19% to total 2010 GHG emissions (see Figure 5.10). Northern Ireland has a much lower contribution from this sector than the UK average because, unlike the other 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 young age of the network.

The main source of emissions in Northern Ireland within the Energy Supply sector is electricity production at power stations, which accounts for more than 99% of Energy Supply emissions in 2010; gas production accounts for less than 0.01% of emissions (see Figure 5.12). Energy Supply sector emissions have reduced since 1990 (by 26% between the Base Year and 2010). Carbon dioxide is the predominant gas accounting for 99.5% of emissions from the Energy supply sector in 2010 as a result of the combustion of fossil fuels (see Figure 5.11).

The impacts of the All Island Project, to develop a more integrated gas and electricity supply network and market across Northern Ireland and the Republic of Ireland, are unclear in the recent energy sector trends. On 1st November 2007 the Single Electricity Market (SEM) went live, commencing the trading of wholesale electricity in Ireland and Northern Ireland on an All-Island basis. The impacts of this development on power generation within Northern Ireland will be reviewed over the next few years. Generation and emissions from the power sector in Northern Ireland showed signs of a decreasing trend in 2007, 2008 and 2009 compared to 2006, but longer-term trends need to be observed to further understand the effects of the market changes.

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 be subsequently exported and sold into the Republic of Ireland electricity grid, whilst the country also imports electricity from Scotland via the Moyle interconnector. In 2005 and 2006 Northern Ireland was a net exporter of electricity (DECC, 2010b); in 2006, net exports from Northern Ireland amounted to 873 GWh of electricity, around 8.5% of all power generated in Northern Ireland.

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

Energy Supply Emissions on an End User Basis

End user emissions from Electricity Production part of the Energy Supply sector are presented in Table 5.4 on the right hand side of the time series. On an end user basis Business and Residential demand for electricity accounts for 45% and 35% of electricity supply emissions respectively.

4.3 Transport

Transport — *Northern Ireland*

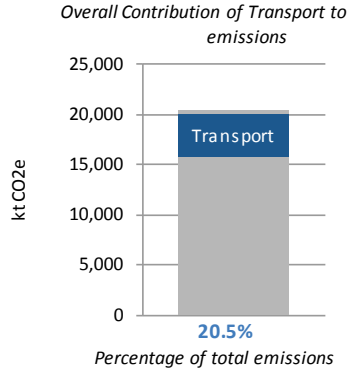


Figure 5.15

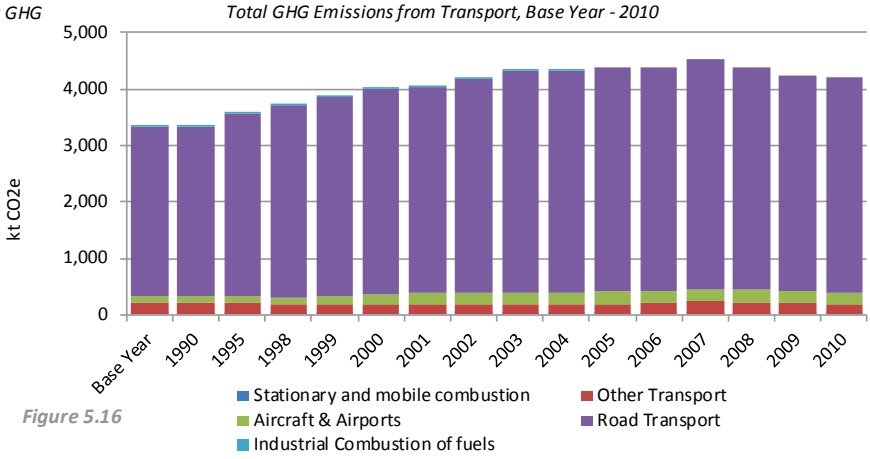


Figure 5.16

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 5.5

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Aircraft & Airports	62.8%	72	-7.7%	-15.4
Industrial Combustion of fuels	-100.0%	-2	-	0.00
Other Transport	-8.5%	-19	-2.5%	-5.0
Road Transport	27.3%	817	-0.6%	-22.2
Stationary and mobile combustion	-11.0%	-0.1	12.5%	0.1
Total	26.0%	868	-1.0%	-42.5

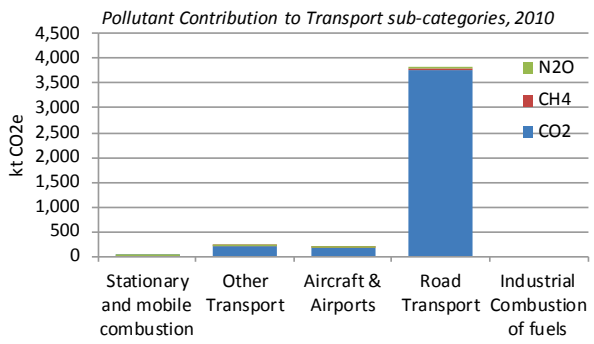


Figure 5.17

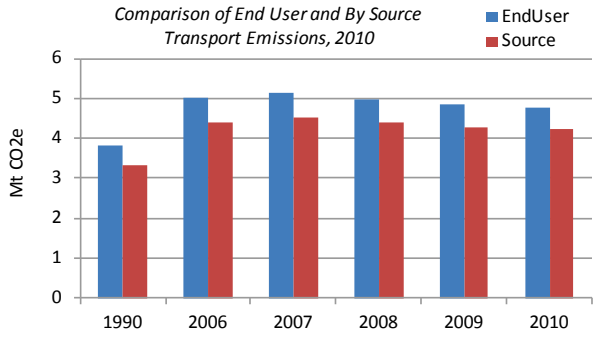


Figure 5.18

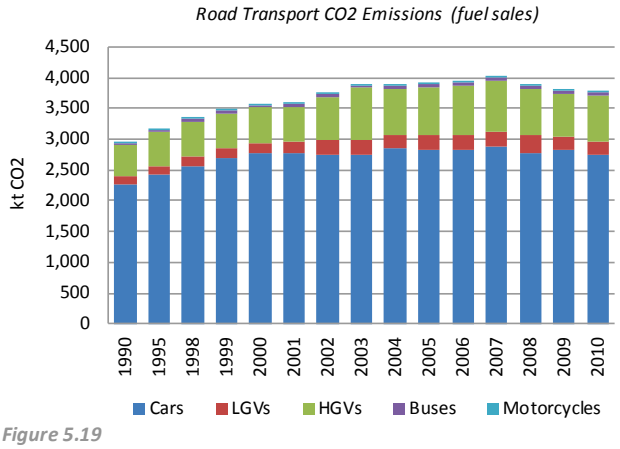


Figure 5.19

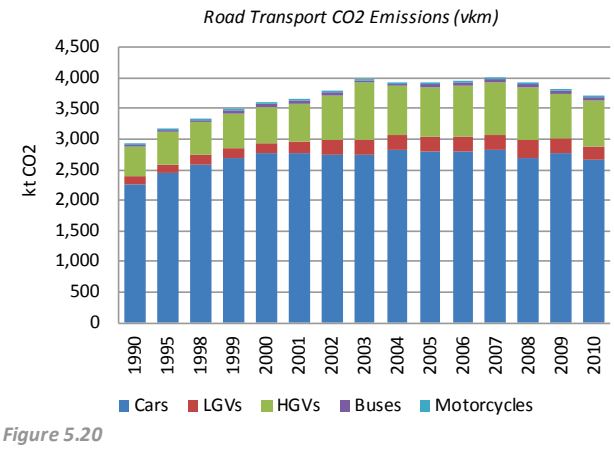


Figure 5.20

Transport emissions account for 21% of Northern Ireland's total GHG emissions in 2010. Transport emissions are dominated by emissions from road transport (91% of all Transport emissions in 2010, with 66% of Transport emissions from cars alone (see Figures 5.19 and 5.20). The Transport sector also includes 1.02% from rail (including stationary sources[38]), 2.2% from national navigation and coastal shipping, 3.9% from domestic aviation and 1.1% from military aviation and shipping. Emissions from international aviation are excluded from these estimates. Details of these emissions are included in Appendix 6.

Total GHG emissions from the Transport sector in Northern Ireland have increased by 26% between the Base Year and 2010 despite improvements in efficiency of transport vehicles, as a result of strong growth in transport demand and increased affordability of cars and fuel. Emissions between 2009 and 2010 have not seen any significant change – decreasing by 1% (see Table 5.5).

Figure 5.19 shows the CO_2 emissions from road transport for Northern Ireland based on constrained (DUKES fuel sales) and unconstrained (vehicle kilometre, vkm) approaches. Total CO_2 emissions from the vkm approach are 0.6% and 2.0% lower than the estimates constrained to DUKES for 1990 and 2010 respectively. The differences between the two approaches fluctuate year on year but they remain within 2.0% 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 (between base year and 2010) for each individual vehicle type is generally similar between the two approaches. The vkm approach indicates that the overall CO_2 emissions from road transport have increased by 26.4 % between the base year level and 2010, while the constrained approach indicates a 28.1% increase. Between 2009 and 2010, there is a big difference in the trend for HGVs as indicated by the two approaches: the vkm approach shows a 1.2%[39] increase in Northern Ireland's HGV CO_2 emissions while the constrained approach shows a 10.8% increase. Apart from modelling uncertainty, there are possibly a number of combining factors causing the disparity. One reason may due to a higher percentage rise (4%) in diesel fuel sales reported by DUKES between 2009 and 2010 while the traffic (i.e. vkm) activity did not reflect similar growth rate for diesel dominated vehicles (i.e. LGVs, HGVs, buses and coaches). In contrary, there have been reductions in LGVs and buses and coaches activity in Northern Ireland between 2009 and 2010. As the constrained method adjusts vkm-based HGVs emissions so that the overall diesel emissions are consistent with the fuel sales reported in DUKES (see Brown et al., 2012 for further details on fuel normalisation process), the level of disparity will distort the trend for HGVs to a different degree.

Transport Emissions on an End User Basis

The end user estimates in recent years are a steady 14% higher than the by source estimates, reflecting the additional emissions from upstream oil extraction and the oil refining sector (see Figure 5.18). 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 an increase of around 24.7%% to 2010, 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.

[38] Electricity use from rail sector is not included in the By Source estimates but is attributed to the transport sector in the end user estimates.

[39] HGV activity has gone up by 0.2% between 2009 and 2010 for Northern Ireland, accompanied by a worsening of HGV fuel efficiency of around 1% as indicated by the Department for Transport's Road Freight Statistics (DfT, 2011) and hence the resulting 1.2% increase in Northern Ireland's HGV emissions based on the vkm approach.

4.4 Residential

Residential *Northern Ireland*

Overall Contribution of Residential sector to 2010 GHG emissions

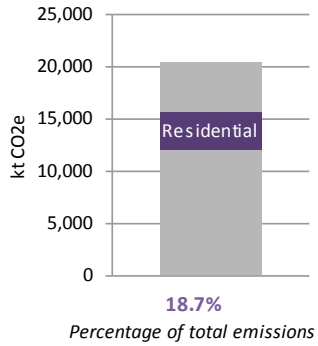


Figure 5.21

Total GHG Emissions by sub-sector, Base Year - 2010

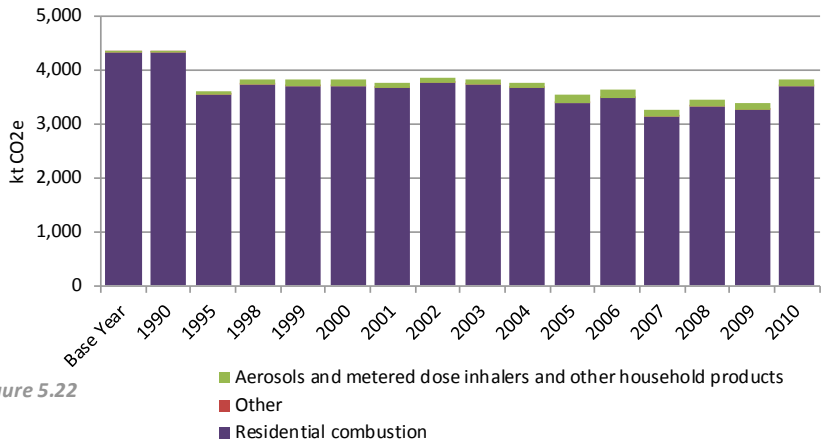


Figure 5.22

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 5.6

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Aerosols and metered dose inhalers and other household products	170.7%	78	-1.9%	-2
Other	-27.4%	-0.01	-0.2%	0.0
Residential combustion	-14.6%	-630	12.8%	418.7
Total	-12.6%	-552	12.2%	416.3

Pollutant contribution to Residential Emissions, 2010

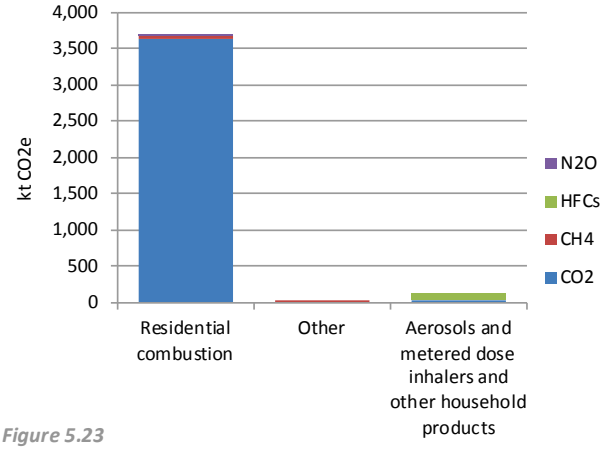


Figure 5.23

Comparison between End User and By Source Inventory Totals, 2010 ***(Mt CO2e)***

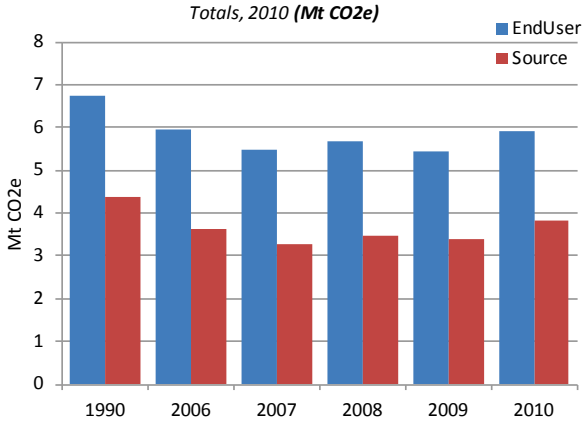


Figure 5.24

The Residential sector accounts for 19% of Northern Ireland's total GHG emissions in 2010. The sector comprises emissions from residential combustion (97% of emissions for the Residential sector) from heating and cooking, household products, accidental vehicle fires and Hydrofluorocarbon (HFC) emissions from the use of aerosols and metered dose (usually asthma) inhalers. 97% of all residential GHG emissions are from the release of carbon dioxide from the direct combustion of fossil fuels (see Figure 5.23).

As a proportion of UK domestic emissions, Northern Ireland represents a higher than share considering Northern Irelands share of UK population. The reason for this is the very limited availability of natural gas resulting in the high consumption of coal, burning oil and gas oil in the residential sector, although natural gas

is becoming more widely available and residential carbon dioxide emissions have shown a decrease of -10.7% since 1990 (see Table 5.6).

Total GHG emissions from the Residential sector in Northern Ireland have decreased by 13% between the Base Year and 2010. There was a large increase in fuel use and GHG emissions from the sector in 2010 (12% increase in emissions between 2009 and 2010) primarily driven by two successive cold winters and a resultant high demand for fossil fuel heating in many parts of Northern Ireland[40].

Residential Emissions on an End User Basis

In 2010 Northern Ireland end user emissions for the residential sector are 155% of the by source emission estimates (see Figure 5.24), reflecting the high consumption of electricity in the sector. This increases the overall significance of this sector in the end user inventory to 26% of the Northern Ireland total, compared to just 19% of the by source inventory total. The trend in residential End user emissions since 1990 shows a decline of around 12% to 2010 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.

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

4.5 Business

Business *Northern Ireland*

Overall Contribution to 2010 GHG emissions

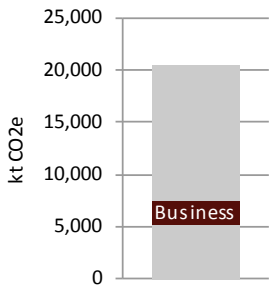


Figure 5.25 **11.24%**
Percentage of total emissions

Total GHG Emissions from Business, Base Year - 2010

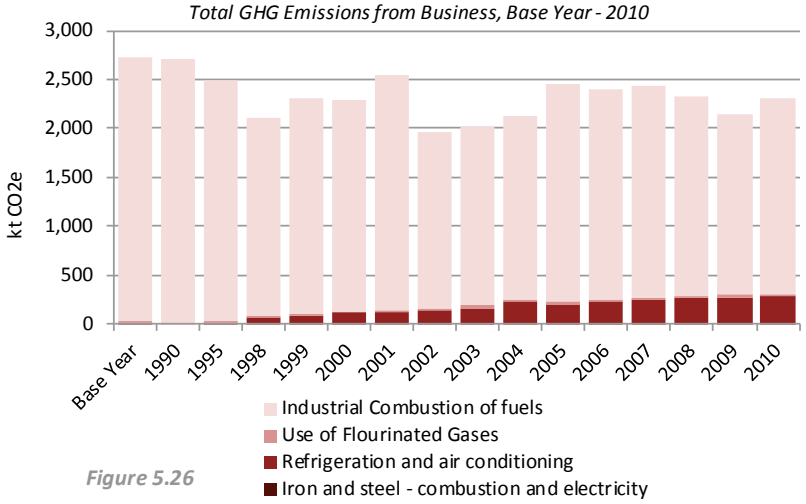


Figure 5.26

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 5.7

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Industrial Combustion of fuels	-26.3%	-711.3	8.0%	148.2
Iron and steel - combustion and electricity	-	0.0	-	0.0
Refrigeration and air conditioning	1173.9%	261.7	2.5%	6.9
Use of Flourinated Gases	206.5%	15.3	0.0%	0.0
Total	-15.9%	-434.3	7.2%	155.1

Pollutant Contribution for Business Emissions, 2010

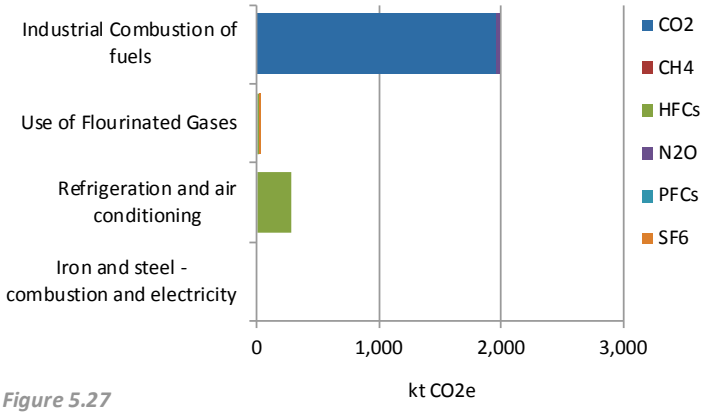


Figure 5.27

Comparison between End User and By Source Inventory for the Business Sector, 1990 and 2006-2010 ***(Mt CO2e)***

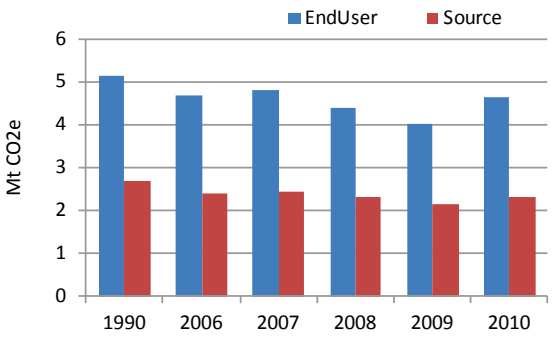


Figure 5.28

In Northern Ireland, the Business sector contributes 11% to total 2010 GHG emissions. Combustion emissions from manufacturing industry and construction account for 11% of the total Northern Ireland carbon dioxide emission in 2010. There is no iron and steel production in Northern Ireland, so the category is entirely 'Other Industry'. Emissions from the Other Industry category for Northern Ireland have decreased by an estimated 32% over the period 1990-2010. The reduction is higher than that seen in the UK reflecting the impacts of a gradual growth in access to the gas network over the last 10 years in Northern Ireland, enabling fuel-switching from more carbon-intensive oil- and coal-fired boilers to gas.

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, which accounted for 75% of HFC emissions in Northern Ireland in 2010 (see Figure 5.26). Emissions from these sectors have risen by over 1100% in Northern Ireland since the 1995 Base Year.

Business Emissions on an End User Basis

In 2010 Northern Ireland End User emissions for the Business sector are 202% 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 Business sector represents 21% of total emissions for Northern Ireland compared to just 11% of the by source inventory total (see Figure 5.28).

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

4.6 Public

Public *Northern Ireland*

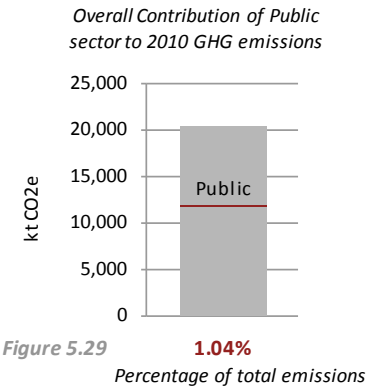


Figure 5.29 **1.04%**

Percentage of total emissions

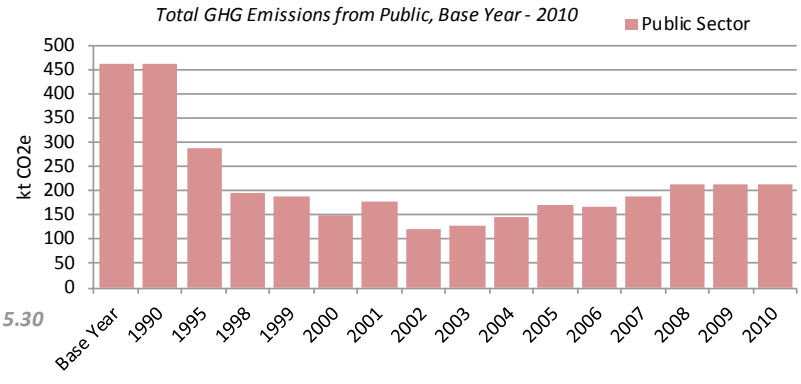


Figure 5.30

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 5.8

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Public Sector	-53.9%	-249	0.5%	1

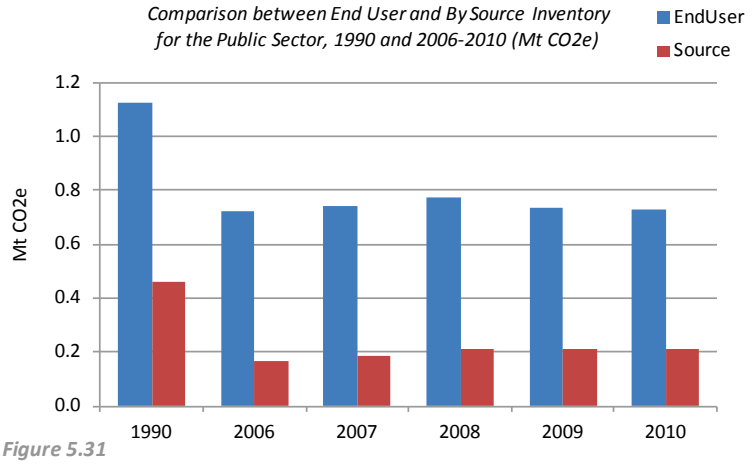


Figure 5.31

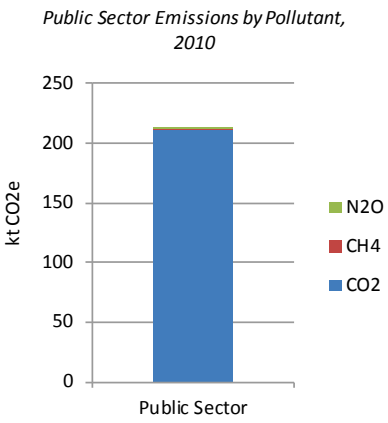


Figure 5.32

Emissions from Public sector combustion account for 1% of GHG emissions in Northern Ireland in 2010. 99.5% of emissions in this sector are from carbon dioxide from the combustion of fossil fuels (predominantly natural gas). See Figure 5.32.

Overall Public sector emissions have reduced steadily since the Base Year and up to 2002, steadily increasing from 2002 to 2010 (see Figure 5.30). The overall reduction from the Base Year to 2010 is 54%. This has been achieved through more efficient use of fuels and a switch to gas fired heating across Northern Ireland for many public sector buildings since 1990. Emissions between 2009 and 2010 rose by only 0.5% (see Table 5.8).

Public Emissions on an End User Basis

In 2010 Northern Ireland end user emissions for the public sector are 342% 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 3.2% in 2010 (see Figure 5.31). The trend in end user emissions since 1990 shows a decline of around 35% to 2010[41],

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.

[41] the trend data are uncertain and should be regarded as indicative only due to the limited data on electricity use by source;

4.7 Industrial Process

Industrial Process — *Northern Ireland*

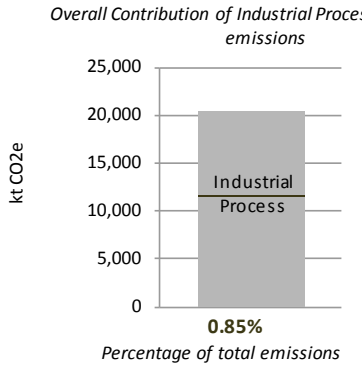


Figure 5.33

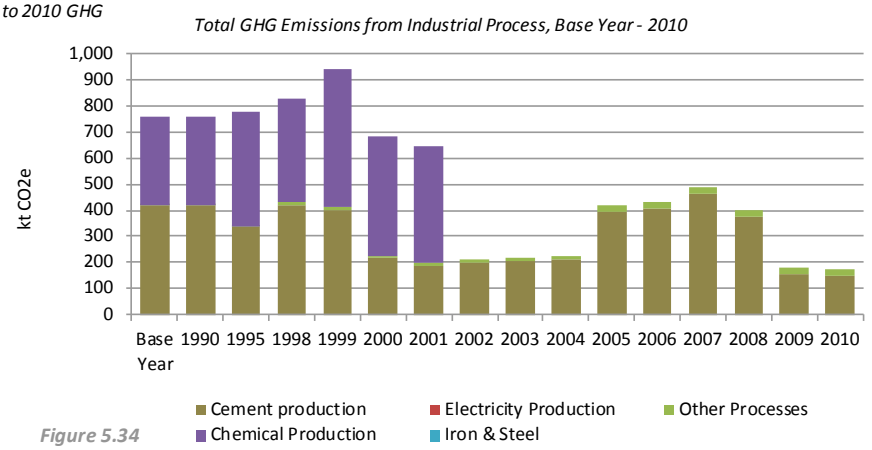


Figure 5.34

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 5.9

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Cement production	-64.6%	-269	-6.4%	-10.0
Chemical Production	-100.0%	-345	-	0.0
Electricity Production	-	0	-	0.0
Iron & Steel	-	0	-	0.0
Other Processes	63168.2%	26	8.1%	2.0
Total	-77.2%	-588	-4.4%	-8.0

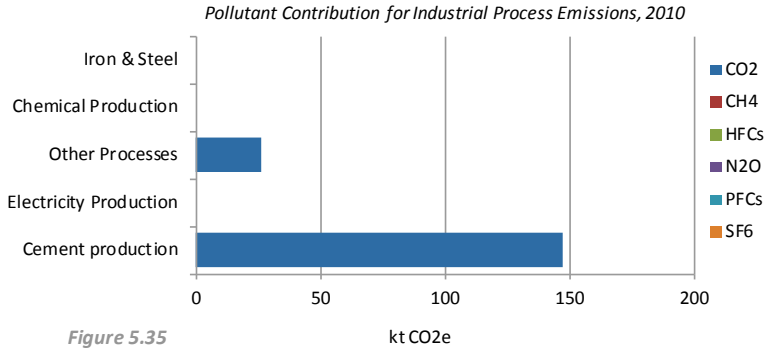


Figure 5.35

In Northern Ireland in 2010, the Industrial Process sector contributes 0.8% to total 2010 GHG emissions in Northern Ireland. The Industrial Process sector includes cement production (85% of sector GHG emissions) and glass production (15% of sector GHG emissions) and all emissions in 2010 from this sector are carbon dioxide emissions (see Figure 5.35).

In 2010 the sector emissions are 77% lower than in 1990 (see Figure 5.36 and Table 5.9), partly due to the 2008-2009 down-turn in cement production in Northern Ireland which decreased by 58% over this period, but also due to the closure of a nitric acid plant in 2001 and the consequent reduction in nitrous oxide emissions from the chemical industry sector.

Industrial Process traded and non-traded emissions

Emissions in the Industrial Process sector include significant contributions from installations. However, due to the lack of detail in the EU ETS dataset, Business and Industrial Process emissions are not easy to separate. The contribution to total emissions from the traded and non-traded sector for Business plus Industrial Process is presented in Figure 5.9 in the summary section.

Industrial Process Emissions on an End User Basis

As all emissions in the Industrial Process sector are not due to energy consumption, Industrial Process sector emissions on an end user basis are the same as the emissions by source.

4.8 Agriculture

Agriculture *Northern Ireland*

Overall Contribution to 2010 GHG emissions

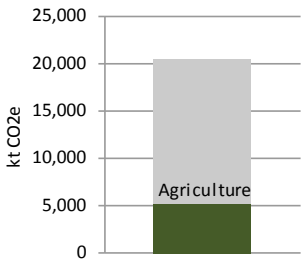


Figure 5.36

25.73%

Percentage of total emissions

Agriculture Emissions by category and pollutant, 2010

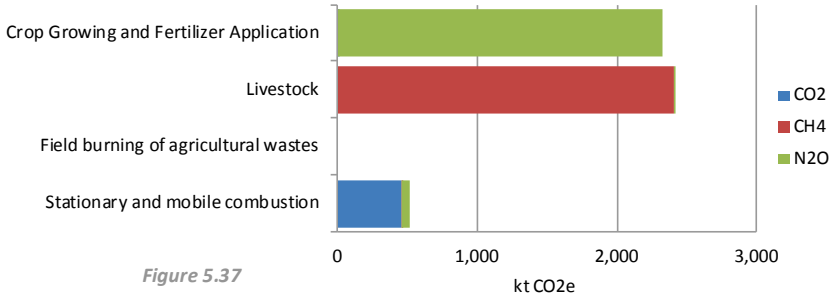


Figure 5.37

Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 5.10

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Crop Growing and Fertilizer Application	-17.4%	-491.1	-2.3%	-54.5
Field burning of agricultural wastes	-100.0%	-10.1	-	0.00
Livestock	0.4%	8.9	0.7%	15.8
Stationary and mobile combustion	-15.0%	-91.4	2.3%	11.8
Total	-10.0%	-583.7	-0.5%	-26.8

Total GHG emissions from Agriculture, Base Year - 2010

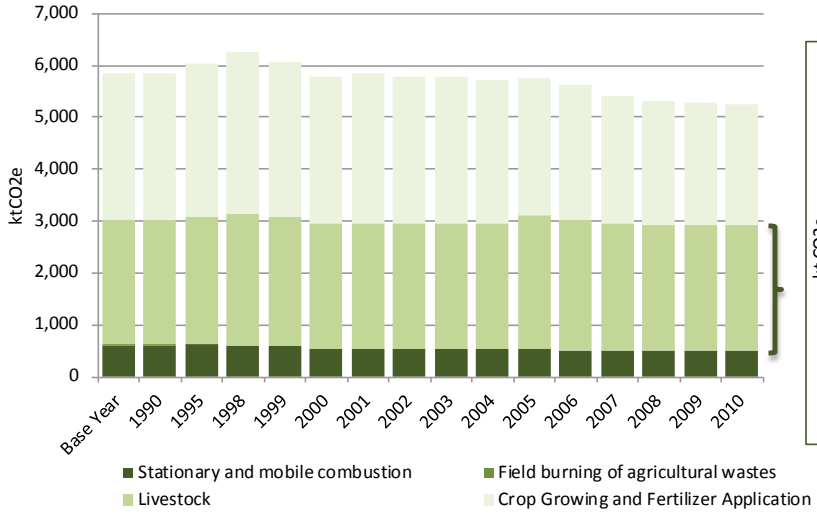


Figure 5.38

Livestock emissions by type, 2010

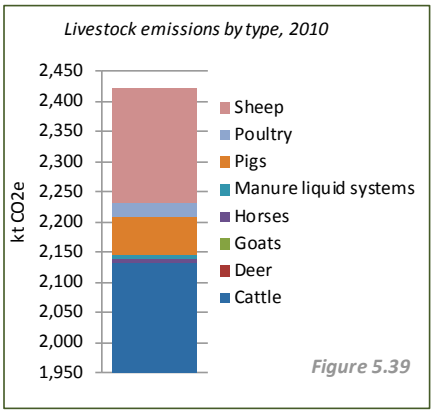


Figure 5.39

In Northern Ireland in 2010, the Agricultural sector contributes 26% to total 2010 GHG emissions in Northern Ireland. GHG emissions from agriculture, as reported under IPCC, comprise entirely of methane and nitrous oxide. Stationary and mobile combustion within the Agriculture sector emit all the carbon dioxide emissions from the sector (see Figure 5.37). Emissions from agriculture represent a much higher proportion in Northern Ireland than the UK average because there is less industry and energy related emission sources in Northern Ireland than elsewhere in the UK, and hence agriculture emissions are comparatively more important.

Agriculture is the second largest source of methane emissions in Northern Ireland. Enteric fermentation contributed 85% (2,062 $ktCO_2e$) to total agricultural methane in Northern Ireland in 2010. Cattle (dairy and beef enteric and waste management) were responsible for 88% of the total agricultural methane emissions

(enteric and waste management). Total emissions from sheep were 8% of the total methane from agriculture in Northern Ireland (see Table 5.11).

Agriculture is the most important source of nitrous oxide in Northern Ireland. Emissions from agricultural soils account for 91% (2,124 $ktCO_2e$) of the total Northern Irish nitrous oxide emission in 2010. A further breakdown of the agricultural soils sector emission is shown in Table 5.12.

Methane emissions are dependent on livestock numbers, and have increased by 0.3% since 1990, mainly influenced by an increase in dairy cattle numbers. Total CH_4 emissions increased relative to 2009 by 0.7% due to a small increase in total cattle numbers.

Nitrous oxide emissions are largely driven by fertiliser nitrogen use, manure applications and grazing returns to soils. Northern Irish agricultural N_2O emissions have fallen by 17.4% between 1990 and 2010 due to a decline in total livestock numbers and in fertiliser nitrogen use (particularly to grassland), Emissions decreased by 2.3% in 2010 relative to 2009.

Table 5.11 Emissions of methane from agricultural livestock sources in Northern Ireland in 2010

	Livestock Category	Methane emissions ($ktCO_2e$)
TOTAL		**2,413**
Enteric fermentation		2,062
	Cattle	*1,859*
	Sheep	*184*
	Goats	*0.21*
	Pigs	*13*
	Horses	*4.6*
	Poultry	-
	Deer	*0.63*
Manure management		351
	Cattle	*274*
	Sheep	*5.5*
	Goats	-
	Pigs	*49*
	Horses	*0.42*
	Poultry	*22*
	Deer	-
Field burning		-

Table 5.12 Emissions of nitrous oxide from agricultural sources in Northern Ireland in 2010 ($ktCO_2e$)[1]

TOTAL				**2,331**
Manure management				208
Soils				2,124
	Direct			*1,311*
		Fertiliser		285
		Grazing returns		691
		Manure application		279
		Crop residues		25
		Biological fixation		-
		Improved grassland		19
		Histosols		3.1
		Sewage sludge		6.2
	Indirect			*815*
		Leaching		663
			Fertiliser	192
			Grazing returns	260
			Manure application	208
			Sewage sludge	3.1
		Deposition		152
			Fertiliser	25
			Grazing returns	68
			Manure application	56
			Sewage sludge	-
Field burning				-

[1]Total emissions comprise manure management, soils and field burning. Soils include direct and indirect emissions; indirect emissions include leaching and deposition

Agriculture Emissions on an End User Basis

As the majority of emissions in the agriculture sector are not due to energy consumption, agriculture sector emissions on an end user basis are very similar to the emissions by source; in 2010, the end user estimates are only 3% 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

LULUCF *Northern Ireland*

Overall Contribution to 2010 GHG emissions

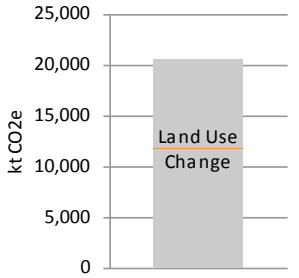


Figure 5.40

0.52%

Percentage of total emissions

Pollutant Contribution to LULUCF GHG Emissions, 2010

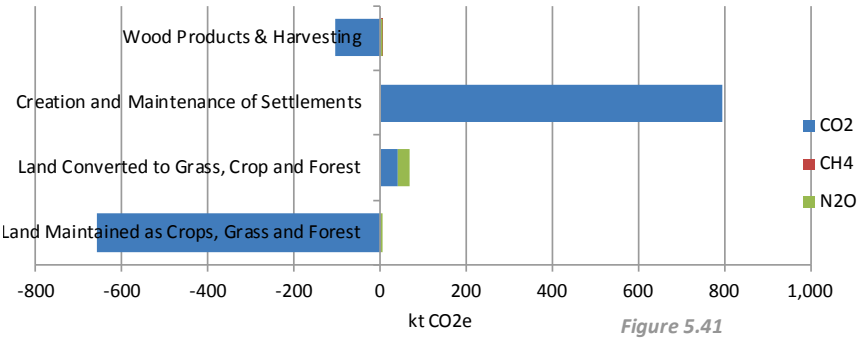


Figure 5.41

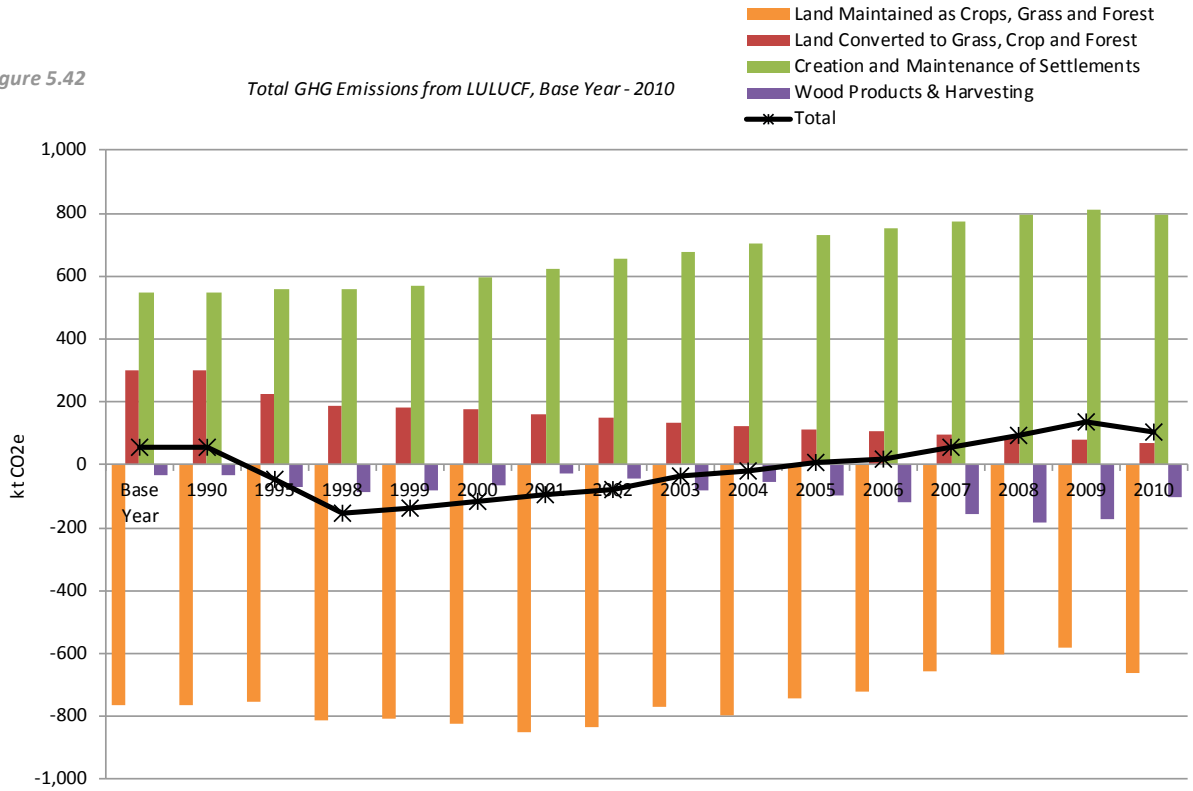
Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010

Table 5.13

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Creation and Maintenance of Settlements	45.0%	247.5	-2.0%	-16.5
Land Converted to Grass, Crop and Forest	-76.9%	-232.7	-11.5%	-9.1
Land Maintained as Crops, Grass and Forest	-13.7%	105.0	13.4%	-77.9
Wood Products & Harvesting	211.0%	-68.9	-41.3%	71.5
Total	93.2%	50.8	-23.3%	-32.0

Figure 5.42

Total GHG Emissions from LULUCF, Base Year - 2010



Net emissions from LULUCF contribute to 0.5% of Northern Ireland emissions in 2010. Net emissions have decreased between 2009 and 2010 by 23% as a result of an increase in removals from forest and a reduction in emissions from croplands and land converted to cropland. Northern Ireland was a small net source of

greenhouse gases from LULUCF activities in 1990 of 55 $ktCO_2e$, becoming a small net sink between 1992 and 2004 (reaching -155 $ktCO_2e$ in 1998), and has now returned to being a small net source (Figure 5.42) of 105 $ktCO_2e$ in 2010.

Emissions arise from the clearing of land (burning and decomposition of material) for the maintenance and creation of settlements (towns and urban areas) and croplands. Carbon dioxide is removed from the atmosphere[42] (1922 $ktCO_2e$ removal in 2010) by activities that manage and maintain, grass and forest lands encouraging vegetation growth and the storage of carbon in wood products. Emissions occur from Cropland and conversion to cropland (emissions of 985 $ktCO_2e$ in 2010) and from the creation and maintenance of settlements (797 $ktCO_2e$ in 2010), from biomass removal in built up & transport areas, gardens and mineral workings.

Emissions and removals are primarily for carbon dioxide (72% of net emissions/removals in 2010) with 27% from nitrous oxide.

A more detailed report of LULUCF emissions in Scotland, Wales, Scotland and Northern Ireland can be found on the NAEI website (A.M. Thomson *et al*. 2012) and more detailed information is also available in the UK Greenhouse Gas Inventory Report, available on the NAEI website.

LULUCF 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.

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

4.10 Waste Management

Waste *Northern Ireland*

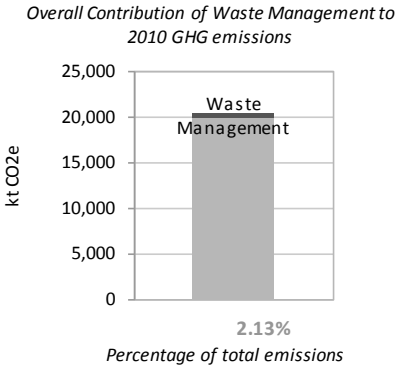


Figure 5.43

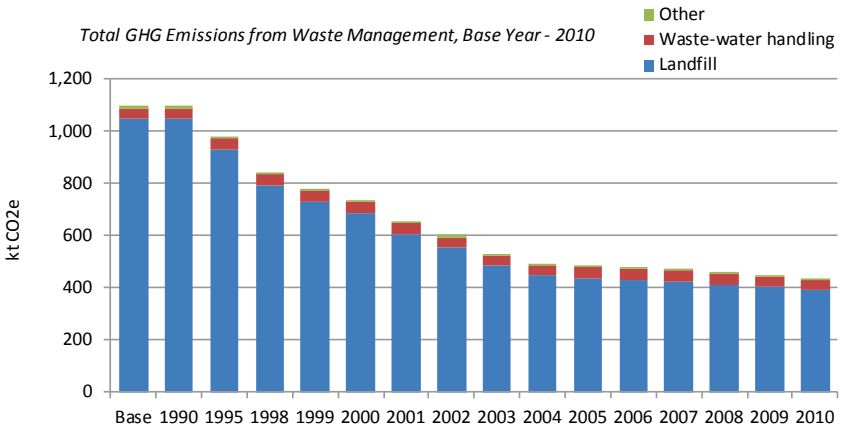


Figure 5.44

Table 5.14 *Change in GHG Emissions from Base Year to 2010 and from 2009 to 2010*

	BY-2010		2009-2010	
Sub-sector	**%**	**kt CO2e**	**%**	**kt CO2e**
Landfill	-62.8%	-659.4	-3.0%	-12.0
Other	-49.7%	-4.4	3.4%	0.1
Waste-water handling	4.4%	1.7	-0.6%	-0.3
Total	-60.3%	-662.0	-2.7%	-12.1

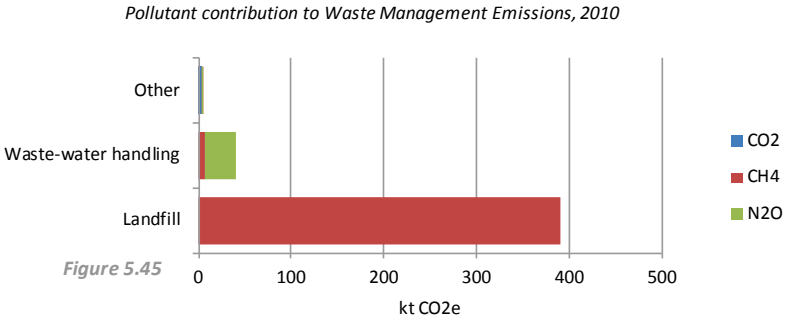


Figure 5.45

The Waste Management sector contributes 2% to total GHG emissions in Northern Ireland, and represents 14% of total methane emissions. Emissions from this sector are dominated by methane from landfill (90% of total GHGs from the Waste sector – see Figure 5.44), with a smaller contribution of emissions of methane and nitrous oxide from wastewater treatment (9%). Emissions from landfill in Northern Ireland constitute approximately 3% of UK landfill emissions.

The majority of total GHG emissions are of methane (91% of total sector GHG emissions in 2010). Nitrous oxide emissions from waste water treatment represent 7.6% of emissions in the sector, and contribute 1.3% to the total emissions of nitrous oxide in Northern Ireland. See Figure 5.45 for the pollutant contribution within the Waste Management sector.

Emissions of GHGs from the Waste sector in Northern Ireland have shown a significant decline of 60% in total for the sector and by 63% for Landfill between 1990 and 2010, as shown in Table 5.14, due largely to the progressive introduction of methane capture and oxidation systems within landfill management.

Waste Emissions on an End User Basis

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

5 References

Abbott, J, Jackson, J, Thistlethwaite, G, Thomas, J (2009), End User GHG Inventories for England, Scotland, Wales and Northern Ireland: 1990, 2003 to 2007. AEAT/ENV/R/2882

Alcan (2011), Personal Communication.

ATOC (2011), Fuel use by train operating companies, personal communication.

Boulter PG, TJ Barlow and IS McRae (2009). Emission Factors 2009: Report 3 - Exhaust Emission Factors for Road Vehicles in the UK. TRL Project Report PPR 356, June 2009. http://www.dft.gov.uk/pgr/roads/environment/emissions/report-3.pdf

Bell, D (2011), ISR and Power Station Fuel Consumption, Personal Communication, Northern Ireland Department of Environment.

BGS (1991, 1996, 2004, 2006-2011), United Kingdom Minerals Yearbook, British Geological Survey, Natural Environment Research Council.

Brown K, Cardenas L, MacCarthy J, Murrells T, Pang Y, Passant N, Thistlethwaite G, Thomson A, Webb N (2012) "UK Greenhouse Gas Inventory, 1990 to 2010." Annual report for submission under the Framework Convention on Climate Change, AEA April 2012.

BSFP (2011). The British Survey of Fertiliser Practice: Fertiliser Use on Farm Crops for Crop Year 2010, Defra http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-environ-fertiliserpractice-2010.pdf

CAA (2011), UK airport statistics 2010 – annual. CAA , 2011. http://www.caa.co.uk/default.aspx?catid=80&pagetype=88&sglid=3&fld=2010Annual

Coal Authority (2011), Regional Coal Production: open cast and deep mined, Personal Communication.

DANI (1991, 1996, 1999, 2000), The Agricultural Census in Northern Ireland: Results for June 1990, 1995, 1998, 1999.

DARDNI (2012), The Agricultural Census in Northern Ireland 2011. http://www.dardni.gov.uk/index/publications/pubs-dard-statistics/ni-agri-census-2011.htm

DECC (2011a), “Digest of UK Energy Statistics” Department of Energy & Climate Change, HMSO.

DECC (2011b), Energy Trends December 2010, articles on DA electricity generation and consumption patterns and the regional energy statistics for 2003 to 2010.

DECC (2011c), Local gas use data by LDZ, personal communication.

DECC (2011d), Oil & Gas flaring and venting volume data by installation and gas landings information, personal communication.

DECC (2011e), Site-specific emission estimates from the Environmental Emissions Monitoring Systems (EEMS) for upstream oil and gas installations, including terminals and offshore sites, personal communication.

DECC (2011f), Energy Trends March 2010, articles on DA electricity generation and consumption patterns and the regional energy statistics for 2003 to 2010.

DECC (2011g), Energy Trends December 2011, http://www.decc.gov.uk/en/content/cms/statistics/publications/trends/trends.aspx

DEFRA (2003a), Sewage Sludge Disposal Tables produced for Digest of Environmental Statistics.

DEFRA (2011a), Agricultural Census Statistics for UK, Annual Reference Tables, Labour Force. DEFRA Agricultural Statistics website.

DEFRA (2011c) Agriculture in the UK 2010. http://www.defra.gov.uk/statistics/files/defra-stats-foodfarm-crosscutting-auk-auk2010-110525.pdf

DETR (1997), Digest of Environmental Statistics, The Stationary Office.

DfT (2010a), personal communication with Mike Dark, Vehicle Licensing Statistics, Department for Transport

DfT (2011a, per comm), personal communication with Daryl Lloyd, Vehicle Licensing Statistics, Department for Transport, March 2011

DfT (2011b), Transport Statistics Great Britain 2011: Roads and traffic, December 2011 Release, Department for Transport. http://www.dft.gov.uk/statistics/releases/tsgb-2011-roads-and-traffic/

DfT (2008c), English Regional Traffic Growth and Speed Forecasts, Rev 1.1 April 2008, personal communication with Malcolm Jay, ITEA Division, DfT, April 2008

DfT (2011d), Maritime Statistics 2010. http://www.dft.gov.uk/statistics/releases/port-freight-statistics-2010-final-figures/

DfT (2011e), personal communication with Department for Transport, 2011

DfT (2011f) Transport Statistics Great Britain http://www.dft.gov.uk/statistics/releases/transport-statistics-great-britain-2011/

DfT (2010g) personal communication with Iain Ritchie, Statistics Roads, DfT, August 2010

DLTR (2004), Aircraft Movement data, Personal communication.

DRDNI (2010a), Northern Ireland Transport Statistics 2009-10, Central Statistics and Research Branch, Department for Regional Development. (Available at http://www.drdni.gov.uk/ni_transport_statistics_2009-10.pdf)

DRDNI (2011a), personal communication with David Compston, Traffic Information and Control, Department for Regional Development, Northern Ireland, October 2011

DTI (2001a), Development of UK Oil and Gas Resources, Department of Trade and Industry, The Stationary Office.

EEA, 2010. EMEP/EEA emission inventory guidebook 2009, updated June 2010

Eggleston, HS, Salway, AG, Charles, D, Jones, BMR, Milne, R (1998), "Treatment of Uncertainties for National Estimates of Greenhouse Gas Emissions", National Environmental Technology Centre, AEA Technology, Report AEAT - 2688.

Entec (2010), UK Ship Emissions Inventory. Final Report to Defra, November 2010. http://uk-air.defra.gov.uk/reports/cat15/1012131459_21897_Final_Report_291110.pdf

Environment Agency (2011a), database of emissions to atmosphere from authorised processes in England & Wales, as reported to the Pollution Inventory (data for 1998-2010).

Environment Agency (2011b), database of EUETS operator data including fuel use, process details and emissions totals, personal communication.

European Environment Agency (2000), "COPERT III: Computer Programme to Calculate Emissions from Road Transport - Methodology and Emission Factors (Version 2.1)", L. Ntziachristos and Z Samaras, European Topic Centre on Air Emissions, European Environment Agency, November 2000

Fernando, S. (2011). Update of Estimated Methane Emissions from UK Abandoned Coal Mines. At http://uk-air.defra.gov.uk/reports/cat07/1107080945_1775-ghg-improvement-project-wsp-report.pdf

Firmus Energy (2011), Northern Ireland gas sales for domestic and commercial & industrial customers for 2010, Personal Communication.

Haydock et al (2003) "Emissions & Projections of HFCs, PFCs and SF_6 for the UK and Constituent Countries", AEA Technology.

HECA NI (2005, 2010), Housing Condition Surveys 1996, 2001, 2004, 2009 personal communication.

Hobson, J, Palfrey, R, Sivil, D, Palfrey, E, Day, M, (1996) "Control Measures to Limit CH_4 Emissions from Sewage and Sludge Treatment and Disposal", WRc, Report No DOE 4118.

IPCC, (1997a), IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories, Volume 1, Greenhouse Gas Inventory Reporting Instructions, IPCC WGI Technical Support Unit, Hadley Centre, Meteorological Office, Bracknell, UK.

IPCC, (1997b), IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories, Volume 2, Greenhouse Gas Inventory Workbook, IPCC WGI Technical Support Unit, Hadley Centre, Meteorological Office, Bracknell, UK.

IPCC, (1997c), IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories, Volume 3, Greenhouse Gas Inventory Reference Manual, IPCC WGI Technical Support Unit, Hadley Centre, Meteorological Office, Bracknell, UK.

IPCC, (1996), Climate Change 1995. The Science of Climate Change. Contribution of Working Group 1 to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Ed. Houghton, JT, Cambridge University Press.

IPCC (2003). Good Practice Guidance for Land Use, Land-Use Change and Forestry. Institute for Global Environmental strategies (IGES) for the Intergovernmental Panel on Climate Change, Kanagawa, Japan.

ISSB, (2011) Iron & Steel Industry Annual Statistics for the UK, Consumption by Product by Region, personal communication.

MacCarthy J, Brown K, Webb N, Passant N, Thistlethwaite G, Murrells T, Watterson J, Cardenas L, Thomson A, Pang Y UK Greenhouse Gas Inventory, 1990 to 2009. Annual report for submission under the Framework Convention on Climate Change, AEA April 2011.

MAFF (1991, 1996,1999, 2000) June Agricultural Census for 1990, 1995, 1998 and 1999. Ministry of Agriculture, Fisheries and Food

MCG, (1999), UK Emissions of HFCs, PFCs and SF_6 Potential Emission Reduction Options. A study for the Department of the Environment carried out by March Consulting Group. Telegraphic House, Waterfront Quay, Salford Quays, Manchester

Mineral Products Association (2011), Cement capacity by site, sector-wide fuel use and process emissions, Personal Communication.

NAEI (2010), NAEI UK Emission Mapping Methodology, September 2010

National Grid (2011), natural gas leakage from high pressure, low pressure distribution systems and from Above Ground Installations, personal communication.

NIEA (2011a), spreadsheet of emissions to atmosphere from authorised processes in Northern Ireland, as reported to the Inventory of Statutory Releases (data for 2005-2010).

NIEA (2011b), spreadsheet of EUETS operator data including fuel use, process details and emissions totals, personal communication.

NIO (1996, 2001, 2002, 2003, 2004, 2005, 2006), Northern Ireland Abstract of Statistics

Northern Gas Networks (2011) Natural Gas leakage from LDZ and AGIs, personal communication

Office for National Statistics. (2007). "UK Standard Area Measurements." Retrieved 26/01/2010, 2010, from http://www.ons.gov.uk/about-statistics/geography/products/geog-products-other/sam/index.html

Office for National Statistics (2011a), Datasets available pertaining to a wide range of industrial and population-related activities via the publications “Annual Abstract of Statistics” and “Regional Trends”, Office for National Statistics.

Office of National Statistics (2011b). Mineral Extraction in Great Britain 2010. Business Monitor PA1007. www.statistics.gov.uk.

Pang, Y., Walker, H., and Murrells, T (2011) Improving the Greenhouse Gas Inventories for Road Transport in Scotland, Wales and Northern Ireland. Report for DECC, Welsh Assembly Government, the Scottish Government and the Department of the Environment for Northern Ireland, AEAT/ENV/R/3167, April 2011. http://uk-air.defra.gov.uk/reports/cat07/1106161316_IP_Task_23_DA_Road_Transport_Issue_1.pdf

Phoenix Natural Gas (2007), Gas consumption detailed by end-user sectors for 2005 and gas leakage data, Personal Communication

Phoenix Natural Gas (2011), Gas consumption and gas leakage data for 2010, Personal Communication

RCEP (1993), Royal Commission on Environmental Pollution, 17th Report, Incineration of Waste, HMSO, London

RWE Innogy (2006), Power station annual fuel consumption, Personal Communication.

Scotia Gas Networks (2011) Natural Gas leakage from LDZ and AGIs, personal communication

Scottish Executive Rural Affairs Department (2000). Economic Report on Scottish Agriculture: 2000 edition.

Scottish Office (1991, 1996, 1999, 2000). Economic Report on Scottish Agriculture 1990, 1995, 1998, 1999.

Scottish Power plc (2006), annual Power Station Fuel Consumption, Personal Communication

Scottish and Southern Energy plc. (2006). Power Station Fuel Consumption, Personal Communication.

SEPA (2011a), Annual atmospheric emissions data for authorised processes in Scotland, from SEPA's Pollution Release Inventory, Personal Communication.

SEPA (2011b), spreadsheet of EUETS operator data including fuel use, process details and emissions totals, personal communication.

SMMT (2002), Regional car sales, Personal Communication.

SO (1996), Economic Report on Scottish Agriculture, 1996

SO, (1999), Scottish Energy Statistics. Paper supplied by G Winter, Scottish Office.

Thomson, A.M., Hallsworth, S., Malcolm, H. (2012). Emissions and Removals of GHGs from Land Use Land Use Change and Forestry for England, Scotland, Wales and Northern Ireland: 1990-2010. At http://uk-air.defra.gov.uk/reports/cat07/1204120924_DA_LULUCF_GHG_Inventory_report_2012_fullreport_v2.pdf

Tomlinson (2010) Peat use within Scotland and Northern Ireland: summary of research findings from CEH, personal communication.

Transco (2004) Historic Gas Demands by Load Category, Personal Communication.

Translink (2011), Annual fuel consumption, Personal Communication.

UKOOA, (1999), Personal communication from P Russell, UKOOA (Environment Committee)

UKPIA (2011), Personal Communication, United Kingdom Petroleum Industry Association

Vayu Ltd. (2011), Northern Ireland gas sales for domestic and commercial & industrial customers for 2010, Personal Communication.

Wales & West Utilities (2011) Natural Gas leakage from LDZ and AGIs, personal communication

White Young Green (2005), Methane Emissions from Abandoned Coal Mines, research report: Defra.

Williams, A, (1993), Methane Emissions, Watt Committee Report Number 28, The Watt Committee on Energy, London.

WO, (1998), Digest of Welsh Historical Statistics 1974-1996, The Welsh Office