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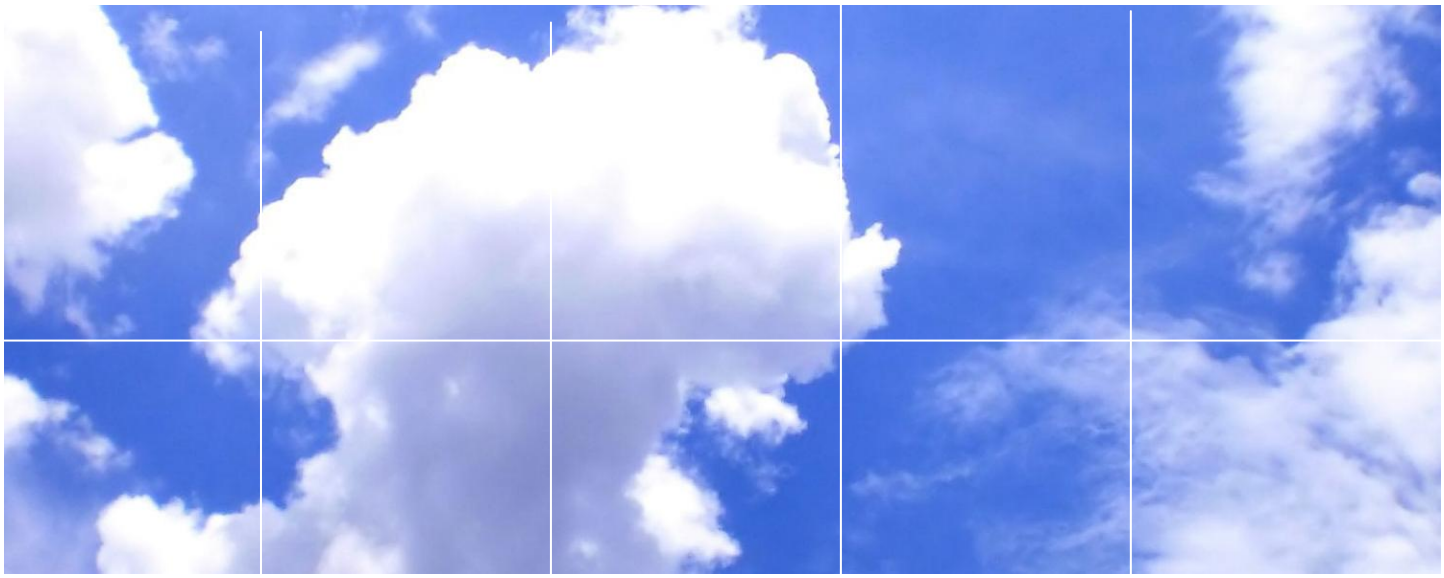

Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 - 2007

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

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Executive Summary

Overview

This report presents estimates of greenhouse gas emission inventories for the constituent countries of the UK. Separate greenhouse gas emission inventories have been estimated for England, Scotland, Wales and Northern Ireland for the years 1990, 1995 and 1998 to 2007. The greenhouse gases reported are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6)

The estimates are consistent with the United Nations Framework Convention on Climate Change (FCCC) reporting guidelines and the 2007 UK Greenhouse Gas Inventory (Choudrie et al., 2009). Emissions from offshore sources are not allocated to any country, and are reported separately within an "Unallocated" inventory category. These offshore emissions are primarily those from oil and gas exploration and production activities.

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 FCCC and the Kyoto Protocol namely: Cayman Islands, Falkland Islands, Bermuda, Montserrat and Gibraltar.

The study shows that the UK distribution of regional net[1] greenhouse gas emissions in 2007, expressed in terms of global warming potentials (GWP), is[2]:

- England 77.8%
- Scotland 8.6%
- Wales 7.4%
- Northern Ireland 3.4%
- Unallocated 2.8%

Table ES1 (below) presents emissions of the six greenhouse gases in more detail for the base year and 2007. Tables ES2.1.1 to ES2.5.3 present the time series of emissions for each constituent country, and for unallocated emissions.

UK trends in emissions of greenhouse gases over recent years[3] are as follows:

- **Carbon dioxide**: Overall UK emissions have fallen by 8.5% between 1990 and 2007, mainly driven by the installation of combined cycle gas turbines (CCGT) in the power generation sector in England and reductions in CO_2 emissions from industry in England, Scotland and Wales.

- **Methane**: Overall UK emissions have fallen by 53.2% between 1990 and 2007, due primarily to significant reductions in methane emissions from waste disposal and coal mining.

[1] Net emissions include removals in the LULUCF sector.
[2] 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.
[3] Base years for UK greenhouse gas emissions are: 1990 for carbon dioxide, methane and nitrous oxide, 1995 for the fluorinated gases.

- **Nitrous oxide**: Overall UK emissions have fallen by 47.0% between 1990 and 2007, driven predominantly by a large reduction in emissions following the installation of abatement measures at an adipic acid plant in England.

- **HFCs**: Overall UK emissions have fallen by 38.7% between 1995 and 2007, primarily due to improved emission abatement at HCFC production plant in England. Offsetting that reduction, there has been a rising trend in emissions across all countries from sources such as losses from refrigeration and air conditioning equipment and emissions from industrial aerosols and metered dose inhalers, although this is now beginning to level off.

- **PFCs**: Overall UK emissions have fallen by 54.2% between 1995 and 2007, mainly due to improved control measures in aluminium production in England and Wales and a reduction in aluminium production capacity in Scotland.

- **SF_6**: Overall UK emissions have decreased by 36.1% between 1995 and 2007. This is mostly due to decreases in emissions from the magnesium industry.

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.

Regional energy statistics are published annually by the Department for Energy and Climate Change (DECC) within the quarterly *Energy Trends*[4] publication. These regional statistics are limited in their detail when compared to UK-level energy statistics, 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 regional energy statistics have been developed in recent years to provide estimates of fuel use and CO_2 emissions data at Local Authority (LA) level across the UK. The latest available data include LA solid and liquid fuel use estimates for 2003 to 2006, with gas and electricity data also being available up to 2007.

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 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 Regional Energy Statistics continue to evolve and improve, reducing data inaccuracies, but nevertheless are subject to greater uncertainty and contain less detail than the UK energy statistics presented within DUKES (DUKES is used to underpin the UK GHG inventory). However, the Regional Statistics are regarded as the best dataset available to inform the patterns of fuel use across the Devolved Administrations and are therefore used to underpin the CO_2 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.

[4] The latest available data are taken from the December 2008 Energy Trends, http://www.berr.gov.uk/files/file49202.pdf

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 steelworks, 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 Devolved Administrations, including estimates of arable production and livestock numbers;

Land Use, Land Use Change and Forestry 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.

As a result of the more limited DA-specific activity and emission factor data, the emission estimates for the England, Scotland, Wales and Northern Ireland inventories are subject to greater uncertainty than the equivalent UK estimates. Chapter 8 outlines the overall uncertainties of the DA GHG inventories.

Since the publication of the 1990-2006 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; for details, see Chapter 7:

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

Developing Regional Climate Change Objectives and Related Inventory Improvements

The climate change policy agenda has been changing rapidly at Devolved Administration Government level within the UK in the last year, with significant new challenges to data management and reporting now developing through new legislation, strategy documents and policy instruments. The Climate Change (Scotland) Act (2009), the One Wales Commitment and associated Welsh Strategy (2008), and the Northern Ireland Sustainable Development Strategy (2006), outline each of the Devolved Administrations' 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.

For example, the Climate Change (Scotland) Act outlines that the Scottish GHG emissions account shall include all existing anthropogenic sources of emissions from Scotland, including emissions from the traded sector[5], and also a "Scottish share" of GHG emissions from international shipping and

[5] 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.

international aviation. In contrast, the Welsh emissions account will exclude emissions from the traded sector and international transport sources, with specific sector targets to be established.

In view of these developing data requirements, a new programme of inventory improvement for the Devolved Administrations has been implemented, with several new strands of research commissioned or planned to (i) meet the current and future reporting needs outlined in climate change legislation relevant to each Devolved Administration, and (ii) improve the accuracy and sensitivity of estimates from source sectors where current GHG emission estimates are known to be most uncertain.

This report includes the first results from a number of new pieces of research:

- Analysis of the traded (EUETS) / non-traded split of emissions for each DA, with estimates provided for each IPCC sector (*see Appendix 4*);
- Analysis of the uncertainties in the reported trends of GHG emission estimates for each DA, with preliminary data provided for the uncertainties in reported trends between 1990-2007 and 2006-2007 (*see Chapter 8*); and
- Estimates of the emissions from international aviation and shipping sources that may be allocated to each of the constituent countries (*see Appendix 3*)[6].

Revisions and Updates to the Greenhouse Gas Inventories

Each year, the greenhouse gas 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 2008) covered the years up to and including 2006, whilst this report gives emission estimates for the years up to and including 2007.

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 2004") 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 (2008), a more representative emission factor for one or more greenhouse gases 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. The nature of emission inventories is such that ongoing improvements to data collection or estimation techniques will inevitably lead to some revisions of historic data.

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.

[6] Note that these international aviation and shipping emission estimates are not included within the DA inventory totals and summary tables / graphs, but (similar to the approach in the UK GHG inventory, as reported to the UNFCCC) they are regarded as "memo items" to the DA inventories. The shipping data presented in Appendix 3 are regarded as indicative only, due to limited access to data on international shipping activity and fuel use by DA.

Summary of Greenhouse Gas Emission Trends for the UK and Constituent Countries

Table ES1 contains a summary of greenhouse gas emission trends for the UK and constituent countries. The following notes apply to this table:

- 1995 is used as the Base Year (BY) for emissions of HFCs, PFCs and SF_6 in the UK's Climate Change Programme, in accordance with Article 3.8 of the Kyoto Protocol;
- All of the CO_2 data are based on the net emissions of CO_2, including net emissions/removals of CO_2 in Land Use, Land Use Change and Forestry sectors; and
- 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_1990-2007_Issue 1.xls"

Table ES1: Summary of Greenhouse Gas Emission Trends for UK and Constituent Countries (as GWP-Equivalent Mass of Carbon Dioxide)

Greenhouse Gas		Units	England	Scotland	Wales	Northern Ireland	Unallocated	UK
CO_2	1990	kt CO_2e	467,392	50,487	43,129	17,352	13,162	591,521
	1990 Percentage	%	79.0%	8.5%	7.3%	2.9%	2.2%	100.0%
	2007	kt CO_2e	426,911	43,065	39,011	15,842	16,359	541,189
	2007 Percentage	%	78.9%	8.0%	7.2%	2.9%	3.0%	100.0%
	Percentage change from BY	%	-8.7%	-14.7%	-9.5%	-8.7%	24.3%	-8.5%
CH_4	1990	kt CO_2e	78,958	11,012	7,875	4,344	1,855	104,044
	1990 Percentage	%	75.9%	10.6%	7.6%	4.2%	1.8%	100.0%
	2007	kt CO_2e	33,661	6,180	4,577	3,297	1,006	48,721
	2007 Percentage	%	69.1%	12.7%	9.4%	6.8%	2.1%	100.0%
	Percentage change from BY	%	-57%	-44%	-42%	-24%	-46%	-53%
N_2O	1990	kt CO_2e	51,205	6,302	3,603	3,186	228	64,522
	1990 Percentage	%	79.4%	9.8%	5.6%	4.9%	0.4%	100.0%
	2007	kt CO_2e	24,390	4,399	2,737	2,378	302	34,206
	2007 Percentage	%	71.3%	12.9%	8.0%	7.0%	0.9%	100.0%
	Percentage change from BY	%	-52%	-30%	-24%	-25%	33%	-47%
HFCs	1995	kt CO_2e	15,322	139	71	41	0.0	15,573
	1995 Percentage	%	98.4%	0.9%	0.5%	0.3%	0.0%	100.0%
	2007	kt CO_2e	8,124	779	397	252	0	9,552
	2007 Percentage	%	85.1%	8.2%	4.2%	2.6%	0.0%	100.0%
	Percentage change from BY	%	-47%	460%	460%	512%	NA	-39%
PFCs	1995	kt CO_2e	235	88	147	1	0	471
	1995 Percentage	%	49.9%	18.6%	31.3%	0.2%	0.0%	100.0%
	2007	kt CO_2e	116	57	43	0	0	216
	2007 Percentage	%	53.7%	26.4%	19.9%	0.0%	0.0%	100.0%
	Percentage change from BY	%	-51%	-35%	-71%	-100%	NA	-54%
SF6s	1995	kt CO_2e	1,124	31	83	2	0	1,239
	1995 Percentage	%	90.7%	2.5%	6.7%	0.2%	0.0%	100.0%
	2007	kt CO_2e	682	54	49	7	0	792
	2007 Percentage	%	86.1%	6.8%	6.2%	0.9%	0.0%	100.0%
	Percentage change from BY	%	-39%	75%	-41%	286%	NA	-36%
Total	Base year	kt CO_2e	614,236	68,058	54,908	24,925	15,244	777,371
	Base year Percentage	%	79.0%	8.8%	7.1%	3.2%	2.0%	100.0%
	2007	kt CO_2e	493,884	54,534	46,814	21,776	17,667	634,675
	2007 Percentage	%	77.8%	8.6%	7.4%	3.4%	2.8%	100.0%
	Percentage change from BY	%	-19.6%	-19.9%	-14.7%	-12.6%	15.9%	-18.4%

Tables ES2.1.1 and ES2.1.2 summarise the emissions of each of the greenhouse gases for England expressed in terms of carbon dioxide and carbon equivalent, respectively.

Table ES2.1.1: GHG emissions for England ($MtCO_2$ equivalent)

England	Mt CO_2 Equivalent												% change
	1990	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**BY to 2007**
CO_2	467.4	426.5	423.9	415.5	419.5	432.7	425.9	436.5	434.8	434.1	428.2	426.9	**-8.7%**
CH_4	79.0	68.0	58.2	54.3	50.8	46.2	44.1	39.1	37.3	35.6	35.0	33.7	**-57.4%**
N_2O	51.2	40.7	40.5	30.1	29.8	27.5	26.3	25.9	26.7	25.7	24.5	24.4	**-52.4%**
HFCs	11.4	15.3	16.7	10.1	8.8	9.4	9.6	9.9	8.5	8.6	8.5	8.1	**-47.0%**
PFCs	1.0	0.2	0.2	0.2	0.3	0.2	0.1	0.1	0.2	0.2	0.2	0.1	**-50.8%**
SF6s	0.9	1.1	1.1	1.3	1.6	1.3	1.4	1.2	1.0	1.0	0.8	0.7	**-39.3%**
Total (Net Emissions)	**610.9**	**551.8**	**540.7**	**511.5**	**510.8**	**517.4**	**507.4**	**512.7**	**508.6**	**505.2**	**497.1**	**493.9**	**-19.6%**
Net CO_2 Emissions from LULUCF	5.7	5.2	4.2	4.0	4.0	3.9	3.6	3.7	3.3	3.2	3.1	3.1	
Net CH_4 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net N_2O Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table ES2.1.2: GHG emissions for England (MtC equivalent)

England	Mt Carbon Equivalent												% change
	1990	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**BY to 2007**
CO_2	127.5	116.3	115.6	113.3	114.4	118.0	116.2	119.0	118.6	118.4	116.8	116.4	**-8.7%**
CH_4	21.5	18.5	15.9	14.8	13.8	12.6	12.0	10.7	10.2	9.7	9.5	9.2	**-57.4%**
N_2O	14.0	11.1	11.0	8.2	8.1	7.5	7.2	7.1	7.3	7.0	6.7	6.7	**-52.4%**
HFCs	3.1	4.2	4.6	2.8	2.4	2.6	2.6	2.7	2.3	2.4	2.3	2.2	**-47.0%**
PFCs	0.3	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	**-50.8%**
SF_6	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.3	0.3	0.3	0.2	0.2	**-39.3%**
Total (Net Emissions)	**166.6**	**150.5**	**147.5**	**139.5**	**139.3**	**141.1**	**138.4**	**139.8**	**138.7**	**137.8**	**135.6**	**134.7**	**-19.6%**
Net CO_2 Emissions from LULUCF	1.6	1.4	1.2	1.1	1.1	1.1	1.0	1.0	0.9	0.9	0.9	0.9	
Net CH_4 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net N_2O Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table ES2.1.3: Aggregated emission trends per source category for England (Mt CO_2 Equivalent)

England	Aggregate Emission Trends by Source Category											
IPCC Source Category	**1990**	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
1. Energy	478.5	433.6	427.7	418.2	421.2	434.4	428.1	435.9	433.7	432.0	426.3	422.8
2. Industrial Processes	49.3	42.5	44.7	28.0	27.1	26.0	24.2	24.8	24.3	23.7	22.3	23.1
3. Solvent and Other Product Use[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Agriculture	34.9	32.9	32.6	32.4	31.2	28.8	29.1	28.6	28.8	28.2	27.4	26.9
5. LULUCF	5.7	5.2	4.2	4.0	4.0	3.9	3.7	3.7	3.4	3.2	3.2	3.1
6. Waste	42.4	37.6	31.5	28.9	27.3	24.2	22.3	19.8	18.4	18.1	18.0	18.0
Total	**610.9**	**551.8**	**540.7**	**511.5**	**510.8**	**517.4**	**507.4**	**512.7**	**508.6**	**505.2**	**497.1**	**493.9**

[a] Solvents and other product use emissions occur as NMVOC and so do not appear in this table, which covers direct greenhouse gases only.

Tables ES2.2.1 and ES2.2.2 summarise the emissions of each of the greenhouse gases for Scotland expressed in terms of carbon dioxide and carbon equivalent, respectively.

Table ES2. 2.1: GHG emissions for Scotland ($MtCO_2$ equivalent)

Scotland	Mt CO_2 Equivalent												% change
	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	BY to 2007
CO_2	50.5	49.5	49.8	46.4	49.4	49.4	46.2	46.5	44.4	43.4	46.8	43.1	**-14.7%**
CH_4	11.0	10.2	9.2	8.4	8.1	7.4	6.9	6.2	6.2	6.2	6.3	6.2	**-43.9%**
N_2O	6.3	5.7	5.5	5.3	5.1	5.1	5.1	5.0	4.8	4.7	4.6	4.4	**-30.2%**
HFCs	0.0	0.1	0.5	0.5	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	**459.5%**
PFCs	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**-35.0%**
SF6s	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	**74.8%**
Total (Net Emissions)	**67.9**	**65.6**	**65.1**	**60.8**	**63.4**	**62.7**	**59.0**	**58.6**	**56.3**	**55.2**	**58.7**	**54.5**	**-19.9%**
Net CO_2 Emissions from LULUCF	-2.5	-3.6	-3.8	-3.9	-3.9	-4.0	-4.2	-4.2	-4.6	-4.6	-4.5	-4.5	
Net CH_4 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net N_2O Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table ES2. 2.2: GHG emissions for Scotland (MtC equivalent)

Scotland	Mt Carbon Equivalent												% change
	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	BY to 2007
CO_2	13.8	13.5	13.6	12.7	13.5	13.5	12.6	12.7	12.1	11.8	12.8	11.7	**-14.7%**
CH_4	3.0	2.8	2.5	2.3	2.2	2.0	1.9	1.7	1.7	1.7	1.7	1.7	**-43.9%**
N_2O	1.7	1.6	1.5	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.2	**-30.2%**
HFCs	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	**459.5%**
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-35.0%**
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**74.8%**
Total (Net Emissions)	**18.5**	**17.9**	**17.7**	**16.6**	**17.3**	**17.1**	**16.1**	**16.0**	**15.4**	**15.1**	**16.0**	**14.9**	**-19.9%**
Net CO_2 Emissions from LULUCF	-0.7	-1.0	-1.0	-1.1	-1.1	-1.1	-1.1	-1.1	-1.3	-1.3	-1.2	-1.2	
Net CH_4 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net N_2O Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table ES2.2.3: Aggregated emission trends per source category for Scotland (Mt CO_2 Equivalent)

Scotland	Aggregate Emission Trends by Source Category											
IPCC Source Category	**1990**	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
1. Energy	54.3	54.8	54.9	51.4	54.3	54.5	51.0	51.0	49.3	48.5	51.8	47.9
2. Industrial Processes	1.7	0.9	1.3	1.4	1.5	1.5	1.6	1.7	1.7	1.6	1.6	1.5
3. Solvent and Other Product Use[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Agriculture	8.7	8.4	8.3	8.1	7.8	7.6	7.6	7.5	7.4	7.2	7.2	6.9
5. LULUCF	-2.5	-3.6	-3.8	-3.9	-3.9	-4.0	-4.1	-4.2	-4.6	-4.6	-4.5	-4.4
6. Waste	5.8	5.1	4.3	3.9	3.7	3.1	2.9	2.6	2.5	2.5	2.6	2.6
Total	**67.9**	**65.6**	**65.1**	**60.8**	**63.4**	**62.7**	**59.0**	**58.6**	**56.3**	**55.2**	**58.7**	**54.5**

[a] Solvents and other product use emissions occur as NMVOC and so do not appear in this table, which covers direct greenhouse gases only.

Tables ES2.3.1 and ES2.3.2 summarise the emissions of each of the greenhouse gases for Wales expressed in terms of carbon dioxide and carbon equivalent, respectively.

Table ES2.3.1: GHG emissions for Wales (MtCO2 equivalent)

Wales	Mt CO_2 Equivalent												% change
	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	BY to 2007
CO_2	43.1	40.6	42.8	43.9	46.1	43.6	37.2	38.5	42.2	40.5	41.9	39.0	**-9.5%**
CH_4	7.9	6.8	6.2	6.0	5.8	5.3	5.1	4.9	4.8	4.9	4.8	4.6	**-41.9%**
N_2O	3.6	3.6	3.7	3.6	3.3	3.2	3.1	3.1	3.0	3.1	2.9	2.7	**-24.0%**
HFCs	0.0	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	**460.2%**
PFCs	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	**-70.8%**
SF6s	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	**-40.9%**
Total (Net Emissions)	**55.0**	**51.3**	**53.1**	**54.0**	**55.8**	**52.6**	**46.0**	**47.0**	**50.5**	**49.0**	**50.2**	**46.8**	**-14.7%**
Net CO_2 Emissions from LULUCF	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	
Net CH_4 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net N_2O Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table ES2.3.2: GHG emissions for Wales (MtC equivalent)

Wales	Mt Carbon Equivalent												% change
	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	BY to 2007
CO_2	11.8	11.1	11.7	12.0	12.6	11.9	10.2	10.5	11.5	11.0	11.4	10.6	**-9.5%**
CH_4	2.1	1.9	1.7	1.6	1.6	1.4	1.4	1.3	1.3	1.3	1.3	1.2	**-41.9%**
N_2O	1.0	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.9	0.8	0.7	**-24.0%**
HFCs	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**460.2%**
PFCs	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-70.8%**
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-40.9%**
Total (Net Emissions)	**15.0**	**14.0**	**14.5**	**14.7**	**15.2**	**14.3**	**12.5**	**12.8**	**13.8**	**13.4**	**13.7**	**12.8**	**-14.7%**
Net CO_2 Emissions from LULUCF	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	
Net CH_4 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net N_2O Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table ES2.3.3: Aggregated emission trends per source category for Wales (Mt CO2 Equivalent)

Wales	Aggregate Emission Trends by Source Category											
IPCC Source Category	**1990**	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
1. Energy	44.1	40.7	42.4	43.4	45.6	43.5	37.5	38.2	41.8	40.2	41.6	38.4
2. Industrial Processes	2.2	2.2	2.4	2.5	2.6	2.0	1.7	2.1	2.2	2.2	2.3	2.4
3. Solvent and Other Product Use[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Agriculture	6.0	6.0	6.2	6.1	5.8	5.5	5.4	5.5	5.4	5.4	5.2	4.9
5. LULUCF	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
6. Waste	2.9	2.6	2.2	2.0	1.9	1.7	1.5	1.4	1.4	1.4	1.3	1.3
Total	**55.0**	**51.3**	**53.1**	**54.0**	**55.8**	**52.6**	**46.0**	**47.0**	**50.5**	**49.0**	**50.2**	**46.8**

[a] Solvents and other product use emissions occur as NMVOC and so do not appear in this table, which covers direct greenhouse gases only.

Tables ES2.4.1 and ES2.4.2 summarise the emissions of each of the greenhouse gases for Northern Ireland expressed in terms of carbon dioxide and carbon equivalent, respectively.

Table ES2.4.1: GHG emissions for Northern Ireland (MtCO2 equivalent)

Northern Ireland	Mt CO_2 Equivalent												% change
	1990	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**BY to 2007**
CO_2	17.4	17.0	16.4	16.7	16.6	16.9	15.5	15.6	15.5	16.4	17.1	15.8	**-8.7%**
CH_4	4.3	4.1	4.0	3.8	3.6	3.5	3.4	3.3	3.3	3.3	3.3	3.3	**-24.1%**
N_2O	3.2	3.3	3.4	3.5	3.2	3.2	2.8	2.7	2.6	2.5	2.5	2.4	**-25.4%**
HFCs	0.0	0.0	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	**512.5%**
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-100.0%**
SF6s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**286.5%**
Total (Net Emissions)	**24.9**	**24.5**	**23.9**	**24.1**	**23.6**	**23.9**	**21.9**	**21.9**	**21.7**	**22.5**	**23.1**	**21.8**	**-12.6%**
Net CO_2 Emissions from LULUCF	0.0	-0.1	-0.2	-0.2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	
Net CH_4 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net N_2O Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table ES2.4.2: GHG emissions for Northern Ireland (MtC equivalent)

Northern Ireland	Mt Carbon Equivalent												% change
	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	BY to 2007
CO_2	4.7	4.6	4.5	4.6	4.5	4.6	4.2	4.3	4.2	4.5	4.7	4.3	**-8.7%**
CH_4	1.2	1.1	1.1	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	**-24.1%**
N_2O	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.7	0.7	0.7	0.7	0.6	**-25.4%**
HFCs	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**512.5%**
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-100.0%**
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**286.5%**
Total (Net Emissions)	**6.8**	**6.7**	**6.5**	**6.6**	**6.4**	**6.5**	**6.0**	**6.0**	**5.9**	**6.1**	**6.3**	**5.9**	**-12.6%**
Net CO_2 Emissions from LULUCF	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	
Net CH_4 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net N_2O Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table ES2.4.3: Aggregated emission trends per source category for Northern Ireland (Mt CO2 Equivalent)

Northern Ireland	Aggregate Emission Trends by Source Category											
IPCC Source Category	**1990**	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
1. Energy	17.5	17.2	16.5	16.8	16.9	17.3	15.8	15.9	15.8	16.5	17.2	15.9
2. Industrial Processes	0.8	0.9	1.0	1.1	0.9	0.9	0.5	0.5	0.5	0.7	0.7	0.8
3. Solvent and Other Product Use[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Agriculture	5.0	5.1	5.4	5.2	5.0	5.0	5.0	5.0	4.9	4.8	4.7	4.6
5. LULUCF	0.0	-0.1	-0.2	-0.2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
6. Waste	1.6	1.5	1.2	1.1	1.1	1.0	0.9	0.8	0.8	0.8	0.8	0.8
Total	**24.9**	**24.5**	**23.9**	**24.1**	**23.6**	**23.9**	**21.9**	**21.9**	**21.7**	**22.5**	**23.1**	**21.8**

[a] Solvents and other product use emissions occur as NMVOC and so do not appear in this table, which covers direct greenhouse gases only

Tables ES2.5.1 and ES2.5.2 summarise the Unallocated emissions of each of the greenhouse gases expressed in terms of carbon dioxide and carbon equivalent, respectively.

Table ES2.5.1: Unallocated GHG emissions (MtCO2 equivalent)

Unallocated	**Mt CO_2 Equivalent**												**% change**
	1990	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**BY to 2007**
CO_2	13.2	18.0	18.9	18.7	17.8	18.5	18.8	17.9	17.9	17.5	15.7	16.4	**24.3%**
CH_4	1.9	1.8	1.6	1.4	1.2	1.2	1.1	1.1	1.2	0.9	0.8	1.0	**-45.8%**
N_2O	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	**32.6%**
HFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**NA**
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**NA**
SF6s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**NA**
Total (Net Emissions)	**15.2**	**20.1**	**20.9**	**20.5**	**19.5**	**20.1**	**20.4**	**19.4**	**19.4**	**18.7**	**16.8**	**17.7**	**15.9%**
Net CO_2 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net CH_4 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net N_2O Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table ES2.5.2: Unallocated GHG emissions (MtC equivalent)

Unallocated	**Mt Carbon Equivalent**												**% change**
	1990	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**BY to 2007**
CO_2	3.6	4.9	5.2	5.1	4.9	5.0	5.1	4.9	4.9	4.8	4.3	4.5	**24.3%**
CH_4	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.3	**-45.8%**
N_2O	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**32.6%**
HFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**NA**
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**NA**
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**NA**
Total (Net Emissions)	**4.2**	**5.5**	**5.7**	**5.6**	**5.3**	**5.5**	**5.6**	**5.3**	**5.3**	**5.1**	**4.6**	**4.8**	**15.9%**
Net CO_2 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net CH_4 Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net N_2O Emissions from LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table ES2.5.3 Emission trends per source category for unallocated emissions (Mt CO2 Equivalent)

Unallocated	Aggregate Emission Trends by Source Category											
IPCC Source Category	**1990**	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
1. Energy	15.2	20.1	20.9	20.5	19.5	20.1	20.4	19.4	19.4	18.7	16.8	17.7
2. Industrial Processes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Solvent and Other Product Use[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5. LULUCF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6. Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**15.2**	**20.1**	**20.9**	**20.5**	**19.5**	**20.1**	**20.4**	**19.4**	**19.4**	**18.7**	**16.8**	**17.7**

[a] Solvents and other product use emissions occur as NMVOC and so do not appear in this table, which covers direct greenhouse gases only.

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). North Wyke Research (NWRes) provide 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.org.uk

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Tables & Figures

Document Revision History	
Version	Comment
Draft for comment	Report and tables of emissions issued for comment to the DAs.
Issue 1	Revised version following feedback from DAs, DECC and North Wyke Research.

1 Introduction

1.1 Background to Inventory Development for the Devolved Administrations

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.

Annex I Parties to the Convention, that have ratified the Kyoto Protocol are required to submit to the secretariat net national greenhouse gas inventories, including all anthropogenic emissions of GHGs by sources and removals by sinks. The 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 UNFCC guidelines. 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 greenhouse gas emissions. Under the protocol, the UK is legally bound to reduce emissions of the 'basket of 6' greenhouse gases by 12.5% against baseline emissions over the first commitment period (2008-2012). However, the UK has also adopted a domestic target aimed at reducing emissions of carbon dioxide to 20% below 1990 levels by 2010.

In the United Kingdom, the National Inventory and associated annual report is 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 greenhouse gas emissions. However, following devolution in the UK, some of the powers to implement measures to deliver reductions in emissions of GHGs passed to each of the devolved administrations (Scottish Government, Welsh Assembly Government and the Northern Ireland Executive). As a result, each of the devolved administrations has developed (or is in the process of developing) national Climate Change legislation and Strategies establishing targets for reductions in emissions of GHG emissions together with accompanying regional climate change policy frameworks. The reductions in GHG emissions targeted in the UK as a whole, and in each of the respective devolved administrations are discussed in Section 1.5.

In 1999, Defra and the Devolved Administrations (DAs) recognised the future need to quantify GHG emissions from each of the four countries that comprise the UK, and agreed to undertake a joint research project to provide the first estimates of GHG emissions from England, Scotland, Wales and Northern Ireland. The resulting study: *'Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 and 1995: A Scoping Study'*[7] was published in 1999 and formed the framework for the development of the Devolved Administration (DA) Inventories from 1998 to the present.

This report updates and revises the earlier studies and presents separate GHG Inventories for England, Scotland, Wales and Northern Ireland for the years 1990, 1995, and 1998 to 2007. Emissions of the six direct greenhouse gases are reported, namely:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6)

[7] Salway et al. (1999)

These inventories are reported using Intergovernmental Panel on Climate Change (IPCC) sectoral tables, which are a subset of the IPCC Common Reporting Format (CRF) and consistent with the UK greenhouse gas inventory (Jackson *et al.*, 2009). The latest inventory was submitted to the UNFCCC in April 2009. This report follows the convention used in Jackson *et al.*, 2009 of reporting carbon dioxide emissions and removals as net totals.

Where emissions cannot be allocated to a specific country, they are reported in a table for unallocated emissions; unallocated emissions presented in the DA inventories are limited to offshore emissions from the oil and gas exploration and production industry.

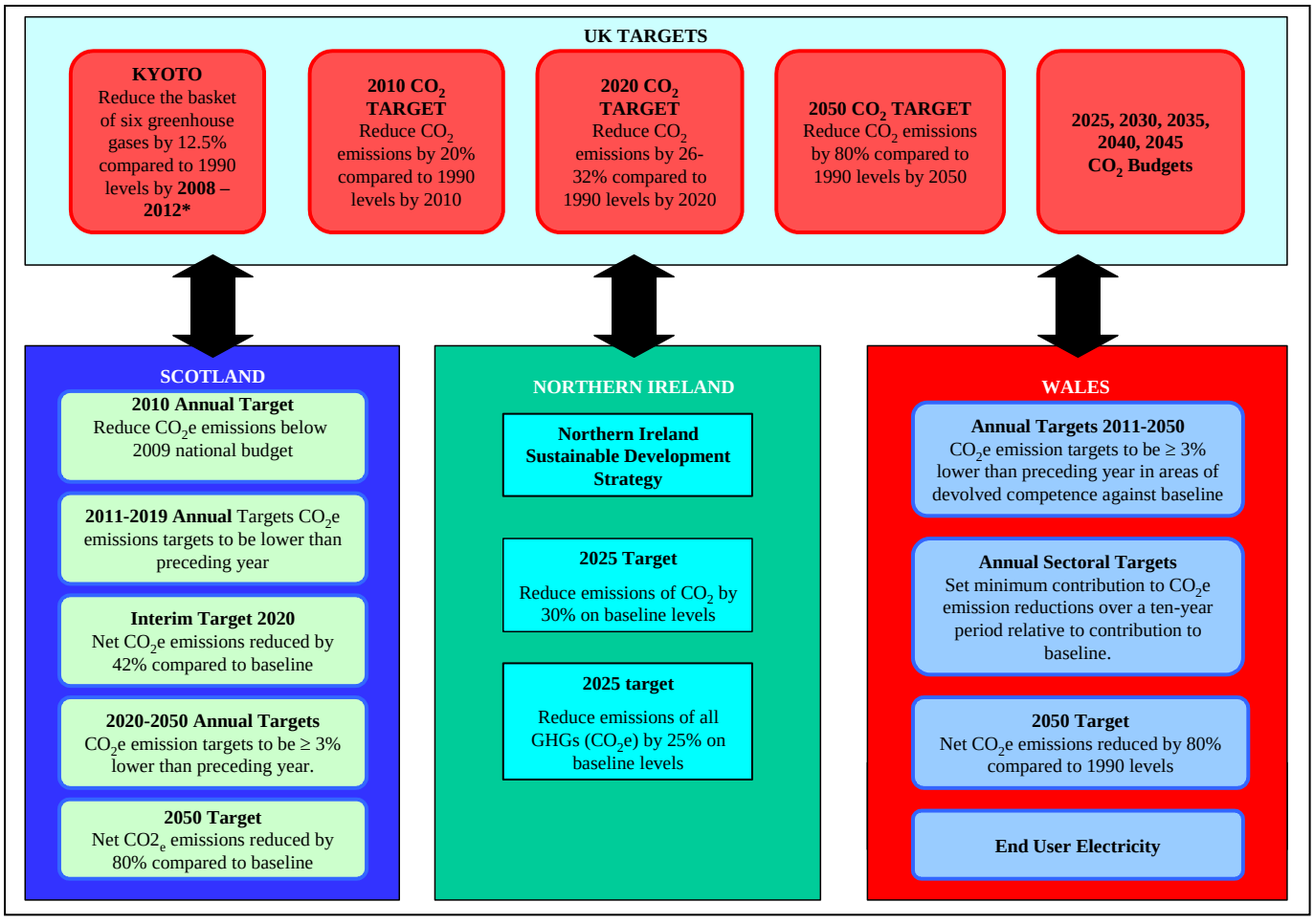
1.2 The UK Climate Change Act and Country-Specific Climate Change Programmes

The Government's Climate Change Act, which received Royal Assent on the 26th November 2008 has established new legal requirements to monitor and report UK GHG emission reductions. The Act set a statutory target to reduce emissions of greenhouse gases in the UK by 80 % against the baseline by 2050 with a minimum 26% reduction 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. The UK Climate Change Act represents the primary piece of climate change legislation relevant to England.

In parallel with the development of the UK Climate Change Act, over recent years each of the devolved Governments has developed their own national Climate Change programme. These country-specific programmes vary in their design and scope, but across Scotland, Wales and Northern Ireland new national objectives have been set (i.e. country-specific GHG reduction targets) and new policies, strategies and programmes are being implemented to drive forward domestic action.

An overview of the main components of UK and DA climate change legislation and strategies is presented in Figure 1.2 below.

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



These new national targets for GHG emission reductions are in addition to those established for the UK as a whole within international mechanisms and through domestic legislation. To ensure that domestic action in the UK progresses to address the challenging GHG reduction targets, there is an increasing focus on the evaluation of the impact of both reserved (UK) and devolved (DA) policies upon GHG emission sources.

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 Assembly Government and the Northern Ireland Executive, and are a mechanism by which tracking progress towards country-specific GHG emission reduction targets may be achieved. The implementation of new UK and country-specific legislation means that the requirements of the GHG inventories for the constituent countries is evolving, with a much greater focus on (i) sector-specific data accuracy, and (ii) sensitivity to policy impacts.

1.2.1 Scotland

The Climate Change (Scotland) Bill 2009 received Royal Assent on the 4th August 2009, allowing it to pass into law as the Climate Change (Scotland) Act 2009. The Act establishes a long-term framework to address climate change and sets statutory targets to reduce Scotland's greenhouse gas emissions by at least 80% against the baseline by 2050, in line with the requirements of the UK Climate Change Act 2008, but extending beyond that to include emissions from international aviation and shipping from the outset. Furthermore, the Scottish Act establishes an interim target of a 42% reduction to be achieved by 2020, with a power for this to be modified based on expert advice. This 42% target is higher than reductions outlined for the same period in the UK Act. The Scottish Act also specifies the requirement to set annual GHG emissions targets (net emissions with allowance for trading) in line with the attainment of the interim and 2050 targets, and the need to quantify emissions from all anthropogenic sources in Scotland, as well as a share of emissions from international aviation and shipping.

Under the Act, Scottish Ministers are required to set annual targets in the form of net emissions with allowance for trading for each calendar year from 2010 to 2050. In addition, from 2012, the Act places an obligation on the Scottish Government to prepare annual reports relating to emissions of GHG from Scotland. These annual reports must include a statement on the net emissions of the 'basket of 6' GHG from Scotland for the relevant year, together with information relating to the number of carbon units credited and debited within the traded sector and data relating to electricity generation and consumption.

1.2.2 Wales

In Wales, the 'One Wales Commitment'[8], established targets for reductions in GHG emissions from Wales, targeting a 3% annual reduction in Carbon equivalent emissions in all areas of devolved competence by 2011 and delivering the Welsh share of the statutory UK targets (80% of the 'basket of six' GHG by 2050) required by the Climate Change Act. In the One Wales commitment and the Wales Climate Change Strategy, the Assembly also outlined the intention to set sector-specific targets for reductions in emissions from sectors that fall within the remit of devolved competence, including residential, public and transport sectors. Further commitments were made to work with heavy industry and power generation sectors to promote reductions in emissions of GHGs from these sectors and to report CO_2e emissions from electricity consumption across Wales using a carbon intensiveness factor[9].

As outlined in the Climate Change Strategy High Level Policy Statement, released for consultation in January 2009, the Welsh Assembly Government will be required to prepare annual progress reports detailing emissions of GHG from the relevant sectors outlined in the One Wales Commitment. The Strategy identifies the disaggregated GHG Inventory as the principal tool that will be used to quantify progress against the defined targets.

[8] The 'One Wales: A Progressive Agenda for the Government of Wales (2007)
[9] Wales Climate Change Strategy

1.2.3 Northern Ireland

In Northern Ireland, the Sustainable Development Strategy (2006)[10] outlines the key approaches to be adopted in Northern Ireland towards addressing climate change and its potential impacts. In Strategic Objective 1, the Strategy outlined key targets to reduce emissions of CO_2 and total GHGs to 30% and 25% below 1990 levels by 2025 respectively. In line with these ambitious targets, key sectors are identified where improvements in emissions of greenhouse gases are required to enable these targets to be achieved. The sectors targeted for improvements included the transport sector, emissions from the disposal of domestic waste to landfill, the energy efficiency of the domestic sector, general electricity consumption, the contribution of energy from indigenous renewable energy, and the Government estate, where a target of attaining carbon neutrality by 2015 was identified.

The Strategy identifies many sectors where reductions in emissions can be targeted and proposes numerous approaches as to how this may be achieved, including the promotion of renewable energy, increased forestry cover and a series of measures to reduce emissions from the transport sector.

1.3 DA GHG Inventories Improvement Programme

As a consequence of the development of DA-specific climate change legislation and strategies to reduce GHG emissions in each of the Devolved Administrations, the emissions data and trends reported within the DA GHG inventories are coming under ever-greater scrutiny. The sensitivity of the DA data to changes in activities within sectors from implemented action has been researched by recent climate change policy studies.

Measures, policies and strategies continue to be developed to reduce greenhouse gas emissions; some policies and measures impact upon one sector, whilst others (e.g. promoting energy efficiency) may impact across many source sectors. Wales, Scotland, Northern Ireland and England each have devolved responsibility to address GHG emissions, and there are an increasing range of country-specific statutory and policy commitments.

To support the actions implemented within each country, the DA GHG inventories continue to be developed, aiming to provide an effective and accurate reporting tool and reflect the impact upon emissions from the implementation of both devolved and reserved measures.

The programme of improvement for the DA inventories includes periodic review of the available source data and estimation methods, in parallel with the programme of improvement to the UK GHG inventory. Greater integration of research effort to improve GHG emission estimates at UK and DA level are planned for 2009-10. Source sectors that may be focused upon for future data and method improvements at DA-level include:

- Residential fuel use
- Commercial and public sector fuel use
- Landfill waste
- Agricultural livestock sources (i.e. from both waste management and enteric fermentation)

1.3.1 End User Inventories for England, Scotland, Wales and Northern Ireland

In parallel to the improvement of the point source GHG inventories for England, Scotland, Wales and Northern Ireland, further research is ongoing to develop End User GHG inventories for the constituent countries, whereby emissions from energy supply (electricity, refined petroleum fuels, gas and solid fuel production) are re-allocated to energy demand patterns across the UK. The development of End User GHG inventories enables better interrogation of the impacts of energy efficiency policies, as these impact upon both primary and secondary fuel use within the UK. The development of End User inventories provides a different picture of consumption patterns within the UK, compared to the production-based data presented in this report.

[The findings of the ongoing study into End User inventories for England, Scotland, Wales and Northern Ireland are to be reported separately, during autumn 2009.]

[10] First Steps Towards Sustainability, Northern Ireland Sustainability Strategy (May 2006)

1.3.2 Traded and Non-Traded Emissions

In line with the requirements of the climate change legislation and strategies applicable in each DA, the segregation of emissions from the traded and non-traded sectors represents an important aspect for development in the UK and DA GHG inventories. Whilst the Scottish Government, Welsh Assembly Government and Northern Ireland Executive have limited powers over activities within the traded sector, the segregation of emissions between traded and non-traded sectors within the inventories is not only important for Wales where the net emissions account excludes emissions from the traded sectors, but also in Scotland where the Act requires quantification of the impact of both the traded and non-traded sectors, including a 'domestic effort target', and the emissions account includes emissions from the traded sector.

As an extension to the core DA inventory work programme, for the first time this year an additional piece of research into the analysis of the EUETS data against the DA GHG inventories has therefore been undertaken. The findings are outlined within Appendix 4, and for many sectors the information are regarded as experimental at this stage. The analysis has highlighted areas of inconsistency between the data available from the EU ETS and other data sources used in the compilation of the DA GHG inventories, such as the UK energy statistics (DUKES) and other industrial emissions data (e.g. from pollution inventories of the environmental regulatory agencies in the UK). Further work is needed in several sectors to research data inconsistencies and resolve them satisfactorily.

1.4 Global Warming Potential

Depending upon their molecular weights, radiative properties and residence times in the atmosphere, each greenhouse gas 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 greenhouse gases. The GWP is defined as the warming influence over a set time period of a gas relative to that of carbon dioxide. 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.

Figure 1.1 shows GWPs 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 greenhouse gas emissions.

Table 1.1 Global Warming Potential of Greenhouse Gases on a 100-year Horizon (t CO_2 equiv/ 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
HFCs	140-11700
PFCs	6500-9200
SF_6	23900

1.5 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 greenhouse gas emissions data for the years 1990, 1995, and 1998 to 2007. The reasons for any significant trends in emissions, issues regarding data availability and uncertainty estimates are provided for each inventory. Figures 9.1 to 9.6 present the summary data for these years as global warming potential (GWP) weighted emissions. New analysis of uncertainties in the reported trends in the inventories since the Base Years is presented within Chapter 8.

Appendix 1: This appendix describes in detail the methodology used to derive the Devolved Administration GHG emission estimates for each source, and how the Devolved Administration inventories relate to the UK Greenhouse Gas Inventory.

Appendix 2: This appendix provides IPCC sectoral tables for 1990 and 2007 for England, Scotland, Wales and Northern Ireland. Summary tables (IPCC Sectoral Table 7A) are provided for 1995 to 2007 for England, Scotland, Wales and Northern Ireland. UK summary tables are also reported. Table 3 of the sectoral tables are omitted because this table is only used to report Volatile Organic Compounds (VOCs), which are not relevant to this study. In IPCC tables, emissions are reported in Gigagrammes (Gg).[11]

Appendix 3: This appendix outlines the calculation approach and GHG emission estimates from international aviation and international shipping sources that may be allocated to each of the constituent countries across the timeseries. 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 4: This appendix outlines the findings from an additional piece of research which compares the EUETS data against the DA GHG inventories, analysing where possible the traded share of emissions for each country in 2007. This analysis has been undertaken for the first time in this inventory cycle, and for many IPCC sectors the information are regarded as experimental at this stage. Further work is needed in several sectors to investigate data inconsistencies and resolve them satisfactorily.

1.6 Revisions and Updates to the Greenhouse Gas Inventories

Each year, the greenhouse gas inventories for England, Scotland, Wales and Northern Ireland are extended 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 or emission factor data.

Data revisions may lead to changes to emission estimates for any year in the time-series. Core energy statistics (all DECC references) are revised annually and hence historic data from DECC may be different from that used in the compilation of the previous inventory report. Similarly, where new research has derived a more representative emission factor for a given activity, then the GHG time-series estimates will be revised accordingly.

New data may become available due to the implementation of new regulations, or through the commissioning of bespoke research into activities and emissions for a given source. 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 EUETS.

The nature of emission inventories is such that improvements to data collection or estimation techniques will inevitably lead to some revisions of historic data. 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.

[11] One Gigagramme (Gg) equals one thousand tonnes, or one kilotonne (kt)

2 Emissions in England

2.1 Summary of GHG Emission Sources

The main GHG emission sources for England in 2007 are summarised in Figure 2.1 below, expressed as a percentage of the total English GHG emissions in 2007 of 493.9 Mt CO_2-equivalent. Trends in English GHG emissions since the base years of 1990 (for CO_2, CH_4 and N_2O) and 1995 (for fluorinated gases) are as follows:

- CO_2 emissions have reduced by 8.7%
- CH_4 emissions have reduced by 57.4%
- N_2O emissions have reduced by 52.4%
- HFC emissions have reduced by 47.0%
- PFC emissions have reduced by 50.8%
- SF_6 emissions have reduced by 39.3%
- Total GHG emissions (as CO_2-equivalents) have reduced by 19.6%

The largest emissions source is CO_2 from power stations, which accounted for 29% of total English greenhouse gas emissions in 2007. The largest methane source is from waste landfill emissions, and the largest source of N_2O emissions is agricultural soils. Together, the ten categories below account for 88% of the total 2007 English GHG emissions.

Figure 2.1: Summary of main GHG emission sources (% kt CO2e) for England, 2007

[Total 2007 England GHG emissions = 493.9 Mt CO_2-equivalent]

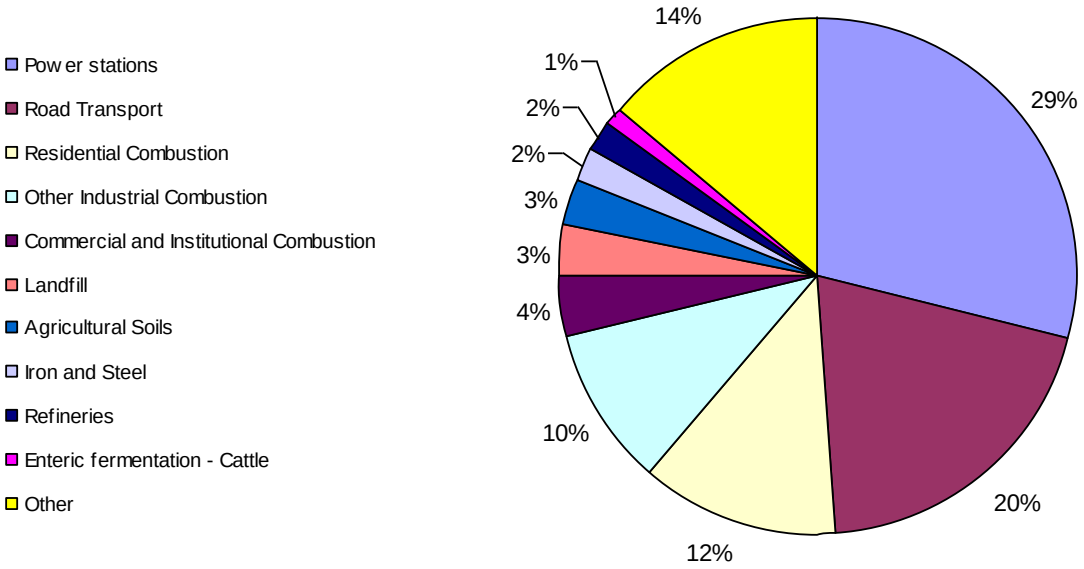


Table 2.1: Emissions Summary for England, 2007 (kt CO2e)

Summary of Main Emission Sources, England 2007 (kt CO_2e)				
Gas	Sector Name	IPCC code	Emission	Percentage of total GWP Weighted Emissions
CO_2	Power stations	1A1a	145578	29%
CO_2	Road Transport	1A3b	100115	20%
CO_2	Residential Combustion	1A4b	61661	12%
CO_2	Other Industrial Combustion	1A2f	49776	10%
CO_2	Commercial and Institutional Combustion	1A4a	17642	4%
CH_4	Landfill	6A1	15814	3%
N_2O	Agricultural Soils	4D	15617	3%
CO_2	Iron and Steel	1A2a	12034	2%
CO_2	Refineries	1A1b	10007	2%
CH_4	Enteric fermentation - Cattle	4A1	6584	1%

Note that in the IPCC sector discussion text below, the percentages quoted are derived from the inventory and emissions data stored at full precision. These data can be found on the NAEI web site and on the CD-ROM that accompanies this report. The percentages in the text of this chapter do not in all cases match directly with percentages in the above table (which are quoted as % of the total of all six GHG emissions).

2.2 Energy

The energy sector includes all emissions from fuel combustion sources, as well as fugitive emissions from energy industries. In England, the energy sector contributes 86% to total GWP weighted emissions. 97% of energy sector emissions are CO_2. Energy Industries (IPCC Sector 1A1) represent the largest source of CO_2 in England, contributing 37.1% of the total CO_2 for the country in 2007, down 2.9% on the England total of CO_2 emissions in 1990. The energy sector includes power generation, refineries, solid fuel transformation processes and the oil and gas industry.

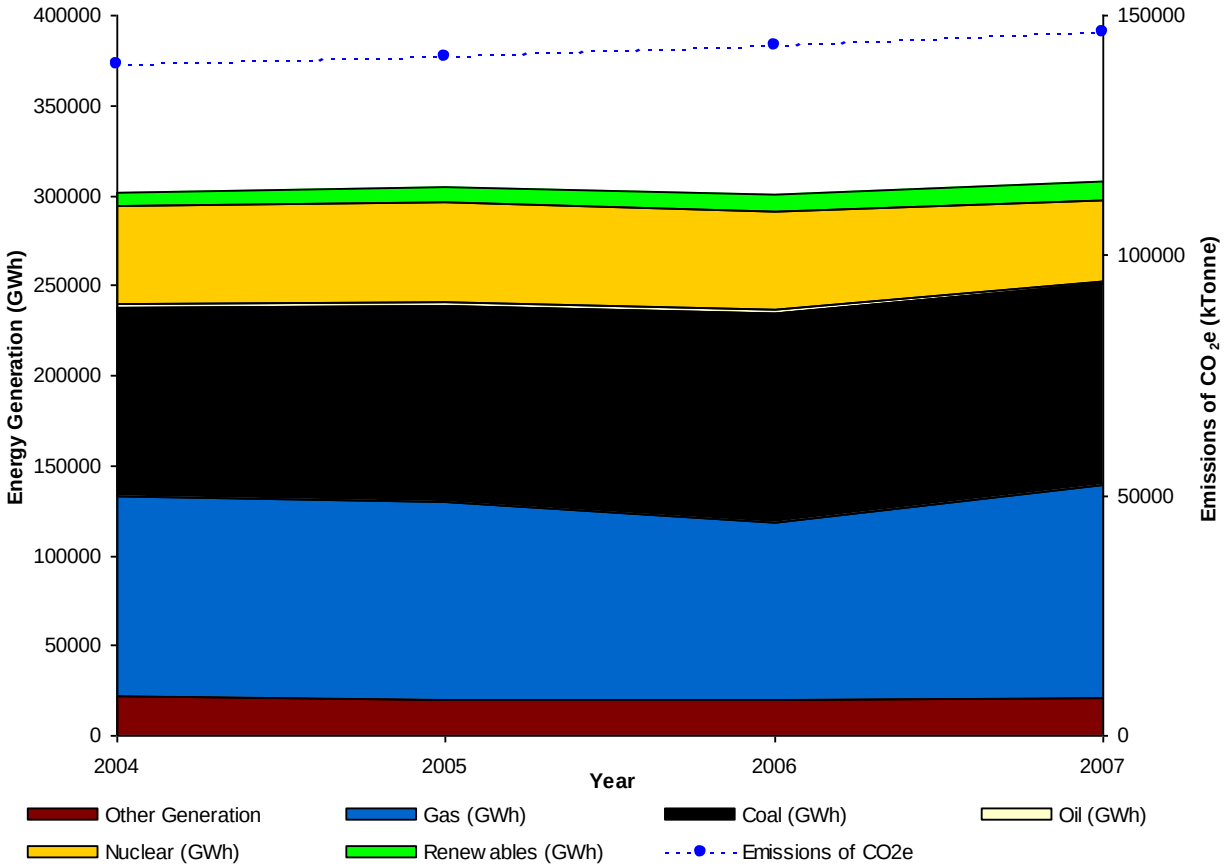
Power generation in England contributed 34.1% of the total English CO_2 emission in 2007, which is slightly higher than the UK proportion of 32.7%. The mix of generation capacity in England (see Figure 2.2 below) differs from the other devolved administrations due to a much higher proportion of combined cycle gas turbines (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[12]. The 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.

CO_2e emissions from power generation in England have shown a gradual increase year-on -year from 1999, with gas and coal representing the principle sources of power generation, generating 131 TWh and 116 TWh in 2007 respectively. Nuclear energy contributes a significant proportion of power in England, although the contribution declined to 45 TWh in 2007, down from approximately 55 TWh during 2004-2006. The decline in nuclear power generation in England in 2007 has been offset by an increase in output from gas-fired stations, which was around 20 TWh higher than in 2006.

There was also a small increase in generation from renewable energy sources, but despite this, the switch from nuclear to gas has led to an increase in CO_2e emissions from the power generation sector in England in 2007.

[12] For details of regional electricity generation data, see the DECC Energy Trends publication from December 2008, article from page 16.

Figure 2.2: Power Generation By Fuel and Cumulative GHG Emissions: England, 2004 to 2007



Overall, emissions of CO_2 from Energy Industries in England have decreased by 15.2% since 1990, significantly more than across the whole of the UK where only an 11.3% reduction has occurred over 1990-2007. This difference can be explained, in part, by the installation of CCGTs in England, which have a higher efficiency than conventional thermal stations and produce lower emissions per GWh electricity generated. However, the general increased in nuclear capacity and utilisation in England over the period and the importation of electricity from Wales and Scotland also contribute significantly to this difference.

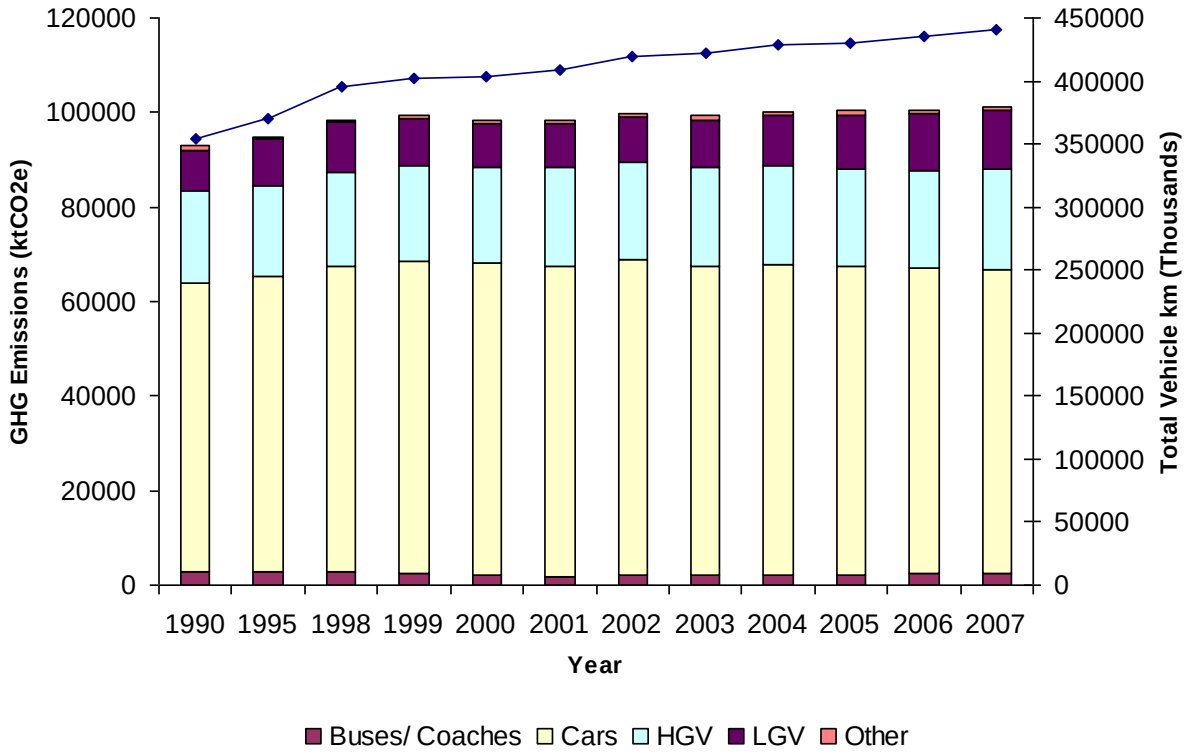
Petroleum refining emissions have declined by 15% since 1990, and constitute 2.3% of CO_2 emissions in England in 2007, lower than the UK mean contribution of 2.8% of total CO_2 emissions from refineries in 2007. Other energy emissions are relatively small and are mostly from gas consumption at oil and gas terminals, gas separation plant, coking and solid fuel production. Other energy industry emissions in England have increased by 8% from 1990 to 2007, although there is now a declining trend now evident from a reduction in own gas use at oil terminals from 2005 onwards. Note that 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 facilities are reported as "Unallocated".

Road Transport represents the second largest single source of CO_2 in England behind power generation, contributing 23.5% to the English total CO_2 emission. The contribution of English road transport to UK road transport CO_2 emissions is 82.6%, which is slightly less than that which would be anticipated from England's population (83.8% of UK[13]). Emissions from the road transport sector have risen by 9.6% from 1990 to 2007 compared with an 11.0% rise for the UK as a whole.

[13] Where population percentages are quoted throughout this report, they are taken from ONS data for 2007.

This rise in emissions from the road transport sector reflects the observed increase in total vehicle km travelled by road transport in England (Figure 2.3) which has increased from 354,001 thousand vkm in 1990 to over 440,324 thousand vkm in 2007. Emissions from the sector are dominated by emissions from cars that constitute approximately 63% of emissions in 2007. Heavy goods vehicles represent the second most significant source of CO_2.

Figure 2.3: Total Road Traffic Vehicle Kilometres and GHG Emissions from Different Vehicle Types: England 1990-2007



Combustion emissions from the Manufacturing Industry and Construction sector (IPCC Sector 1A2) account for 14.5% of the English CO_2 total, with the iron and steel industry in England accounting for 64.2% of the combustion emissions from UK Iron and Steel production. The 'Other industry' category (IPCC sector 1A2f) for England contributes 82.8% towards the UK 'Other industry' CO_2 total.

Other combustion emissions arise from the domestic (residential), commercial, public sectors and agriculture stationary combustion. The emission estimations from these sectors are subject to quite significant uncertainty due to the absence of comprehensive, detailed fuel use data, particularly for solid and liquid fuels. Carbon dioxide emissions from domestic combustion sources are estimated to account for 14.4% of the English total, and as a proportion of UK domestic emissions, are estimated to represent 81.3%, which is slightly lower than would be anticipated from England's population as a percentage of the UK total (83.8%).

Nitrous oxide emissions from combustion sources in England account for 15.8% of the English total. The 1990-2006 inventory indicated that this proportion was 26% in 2006. This change is largely due the revisions to N_2O emissions from road transport from 15.7% of N_2O emissions in 2006 (in the 2006 inventory) to 4.2% in 2007. The reduction of N_2O emissions from road transport is due to the adoption of new N_2O emission factors for petrol cars and LGVs set out in the latest version of COPERT - COPERT 4.

Previously, the inventory assumed that petrol car emission factors for all Euro standards from Euro 1-4 were the same and larger than those for pre-Euro 1 cars, leading to an increase in the N_2O inventory since the introduction of three-way catalysts in the 1990s. However, the latest compilation of emission factors now shows that emission factors have been declining with successive Euro standards since the first generation of catalysts for Euro 1, presumably due to better catalyst formulations as well as reductions in fuel sulphur content. Full details of the revision to these factors can be found in Appendix 1.

Other N_2O emissions from this sector include, 4.2% from other Industrial Combustion and 3.8% from power stations Fuel combustion emissions only account for 2.4% of English methane emissions, mostly from residential combustion.

The category Fugitive Emissions from Fuels (IPCC Sector 1B) reports emissions of methane from coal mining, coking, the oil and gas industry and natural gas distribution. The combined emission from this category constitutes around 18.1% of the English total methane emission compared with the UK average of 16.6%. The higher emission from this category in England is due to the greater contribution of coal mining and leakage from the gas transmission system than in other parts of the UK. Of these fugitive methane emissions, coal mining contributes 6.5%, natural gas distribution 11.2% and oil and gas terminals 0.2% of the English total. Coal mining emissions have declined by 86.4% from 1990 to 2007 due to the decline in the coal industry whilst gas leakage from the gas transmission system has declined by approximately 46.6% between 1990 and 2007 as the mains and services have been renewed.

2.3 Industrial Processes

Industrial processes produce emissions from non-combustion sources such as the use of limestone in cement and glass making. Over half of the emissions from this sector in England are CO_2 (49%), with HFCs contributing a further 35%, although total greenhouse gas emissions from this sector only contribute 4.7% to the English total. All emissions of fluorinated gases occur in this sector.

The largest contribution of CO_2 emissions in this sector is from cement production, which constitutes 1.1% of the total English CO_2 emissions, with smaller emissions from glass, ammonia, aluminium, iron and steel production contributing a further 1.0% of the English total in 2007. England emits all of the UK's emissions from the production of lime and ammonia, but these emissions are not significant in terms of the English total. It should be noted that these emissions are non-combustion emissions; all fuel combustion emissions from industry are reported in category 1A2.

Historically the largest source of HFCs is fugitive emissions from the manufacture of HCFCs and HFCs. All such production is located in England and in 1998 this source contributed 72% of HFC emissions (as CO_2 equivalent) in England and 69% of total UK HFC emissions (as CO_2 equivalent). Over recent years, HFC emissions from the manufacture of HCFCs and HFCs have declined as a result of the installation of improved abatement systems on HCFC production plant. In 2007, HCFC and HFC production in England contributed only 2.2% of total English HFC emissions (as CO_2 equivalent) and 1.8% of total UK HFC emissions (as CO_2 equivalent). Refrigeration, air conditioning, and aerosols and metered dose inhalers constitute the most significant sources of HFC emissions in 2007, accounting for 90% of English HFC emissions and for 32% of total GHG emissions in the industrial process sector. Emissions from refrigeration arise from losses from refrigeration and air conditioning equipment during its manufacture and lifetime, whilst emissions from the aerosols sector occur mainly from industrial sources, and medical use as metered dose inhalers. Emissions from both of these sectors have risen significantly since the 1995 base year.

Nitrous oxide emissions account for 12% of total GHG emissions from the industrial process sector in England, and 11% of the total English N_2O emissions. Up until 1998, a more substantial proportion of England's nitrous oxide emissions were released from chemical processes, namely adipic acid production and to a lesser extent nitric acid production. In 1998, these processes constituted approximately 37% of England's total N_2O emissions and almost 100% of UK industrial process N_2O emissions. In October 1998 an N_2O abatement unit was commissioned on the one adipic acid production plant in England and as a consequence, emissions from this source were significantly reduced. In 2007, the sum of the English emissions from the nitric acid and adipic acid production is

around 2,753kt CO_2 equivalent, equivalent to 11.3% of total English N_2O emissions and 8.0% of the UK total.

Sulphur hexafluoride (SF_6) constitutes 3.0% of total GHG emissions from the industrial process sector in England, with the main sources of SF_6 emissions coming from its application in electrical insulation, which accounted for 80% of SF_6 emissions in England in 2007 and as a cover gas in magnesium production, which accounted for around 20%. Magnesium production is largely concentrated in England; and English emissions account for 93% of the UK magnesium production SF_6 emissions. Emissions of SF_6 have decreased by 39.3% since 1995.

PFC emissions only account for 1% of emissions in the industrial process sector in England, and for around 0.02% of total English GHG emissions. The largest sources in England in 2007 were by-product emissions from primary aluminium production (36%) and fugitive emissions from PFC manufacture (47%). English PFC emissions account for 53.7% of total UK PFC emissions, and have declined by 50.8% since 1995.

Emissions of methane from this sector are not significant.

2.4 Agriculture

GHG emissions from agriculture comprise entirely of CH_4 and N_2O. English emissions represent 62% of the UK total in this sector and the agriculture sector accounts for 5.4% of the English GHG total.

Agriculture is the second largest source of methane emissions in England[14], contributing 32% to the overall CH_4 emissions in England in 2007, with cattle responsible for 75% of agricultural methane emissions. Emissions from agriculture are largely dependent on the numbers of livestock and have fallen by 23% from 1990 to 2007 resulting from a decline in cattle and sheep numbers. Of the total emission from agriculture in England, 82% is due to enteric fermentation.

Of the total English emission of 78.7 kt N_2O in 2007, 54 kt N_2O of this was from agriculture, representing 68% of the total. Most of these agricultural N_2O emissions (94%) arise from the agricultural soils category deriving from, in order of magnitude[15]:

- Synthetic fertiliser application (28.4%);
- Leaching of fertiliser nitrogen and applied animal manures to ground and surface water (27.4%);
- Wastes from grazing animals (14.5%);
- Ploughing in crop residues (12.2%);
- Manure used as fertiliser (9.2%);
- Atmospheric deposition of ammonia (NH_3) and oxides of nitrogen (NOx) (6.1%);
- Cultivation of legumes (0.8%);
- Cultivation of histosols (i.e. high organic content soils) (0.8%); and
- Biological fixation in improved grass (0.6%).

A relatively small proportion (3.4 kt N_2O) is emitted from the management of animal manure. These emissions are related to handling of manure before it is added to the soil. English agricultural N_2O emissions have decreased by 24% in the period 1990-2007.

2.5 Land Use, Land Use Change and Forestry

The LULUCF sector contains both sources and sinks of carbon dioxide, as well as small sources of methane and nitrous oxide.

[14] Data pertaining to agriculture emissions are provided by North Wyke Research
[15] Note: numbers in brackets give the category value as a percentage of the total N_2O emissions from agricultural soils

England is a net source of carbon dioxide from LULUCF activities although the size of this source has diminished by 45% between 1990 and 2007 from 5.7 to 3.1 Mt CO_2. Net emissions from land use and land use change in the Cropland and Settlement categories are diminishing over time, while net removals from the Grassland category are increasing. Net removals from the Forest Land category are now diminishing. The Cropland category is the largest overall source.

Net emissions from the LULUCF sector in 1990 are estimated to be 5.72 Mt CO_2 as in the 2006 DA inventory report. For 2006, a net source of 3.14 Mt CO_2 is estimated here compared to 3.04 Mt CO_2 in the 2006 inventory. Differences between the inventories are primarily due to updating with 2007 estimates. Deforestation associated with harvested wood products is included in this year's inventory; the removal of timber from harvesting or thinning operations is considered as deforestation and therefore should be reported. Deforestation is the result of either a land use change or thinning. It is assumed that a change in land use will be to Grasslands or Settlements and will be reported in Sector 5.C.2 and 5.E.2 respectively. Forestland that is thinned will undergo a reduction in area; these changes are reported in 5.A.1. Appendix 1 contains details of the methods and data sources used to calculate LULUCF emission and sink estimates.

Estimates of methane and nitrous oxide emissions from LULUCF activities remain small, with 0.017 Mt CO_2 equivalent of methane and 0.002 Mt CO_2 equivalent of nitrous oxide in 2007 respectively.

2.6 Waste

The waste sector contributes 3.6% to total GHG emissions in England, and is the largest source sector for methane emissions, representing 49% of total methane emissions. Emissions from this sector are dominated by methane from landfill, with a small contribution from wastewater treatment. Emissions from landfill in England constitute approximately 78.2% of UK landfill emissions. This is slightly lower than would be expected from England's population (83.8%) as a proportion of the UK total. Emissions of GHG from landfill in England have shown a significant decline (60.2%) between 1990 and 2007, due largely to the progressive introduction of methane capture and oxidation systems within landfill management. This decline in emissions of GHG from landfills in England is slightly higher than the UK average of 59.2%.

Estimates of emissions from landfill are based on data on the disposal of municipal solid waste and sewage sludge in England. The use of waste management data from the www.wastedataflow.org website in recent years has provided a more detailed insight into the UK % share of waste disposals to landfill for England with data for 2000-2007 are currently available (and hence the 2000 split assumed as the best estimate for the 1990-1999 years). The available data indicates that total municipal waste deposited to landfill annually in England between 2000 and 2007 has fluctuated between 28,000-29,500 ktonnes but shown no significant increase or decrease during this time. However, following the adoption of the Landfill (England and Wales) Regulations (2002), which necessitates significant reductions in biodegradable waste deposited to landfill and places greater requirement on the control and monitoring of emissions from landfill, significant reductions of emissions of GHG from landfills is anticipated in future years.

Due to lack of detailed local data, the DA disaggregation method still retains the assumption that landfill methane recovery rates within each DA are the same as the UK average. Emissions from wastewater treatment represent around 2% of the English total methane emissions and comprise 83.8% of UK wastewater emissions.

2.7 Emission Maps: England 2007

As part of the NAEI, the UK produces mapped emissions of CO_2 (as C), CH_4 and N_2O. The maps are modelled estimates of emissions compiled at a 1 km^2 resolution and Figures 2.4 to 2.6 shown the emissions in England. The maps reveal the locations and intensities of the major sources of emissions and are used by AEA and other organisations for a variety of Government policy support work at the national scale, regional and local scale. Local area statistics are compiled from the maps and related data, for example, Local Authority level data on carbon dioxide emissions and fuel use have been produced for Defra and DECC (formerly BERR) since 2003 using data from the NAEI mapping work. As of March 2008, these datasets were reclassified as National Statistics (King et al and Bush et al, 2008). The distributions of CH_4 and N_2O emissions from agricultural sources are generated at a 5 km^2 resolution by the Centre for Ecology and Hydrology (CEH), and are then re-sampled at a resolution of 1 km^2 by the NAEI mapping team.

One set of maps is produced each year for the most recent NAEI year. The mapped emissions data are made freely available on the NAEI web site at

http://www.naei.org.uk/data_warehouse.php

and

http://www.naei.org.uk/mapping/mapping_2007.php

The most recent report on the mapping of emissions can be found at:

http://www.naei.org.uk/reports.php

Figure 2.4: Map of Emissions of CO2 (tonnes) in England in 2007

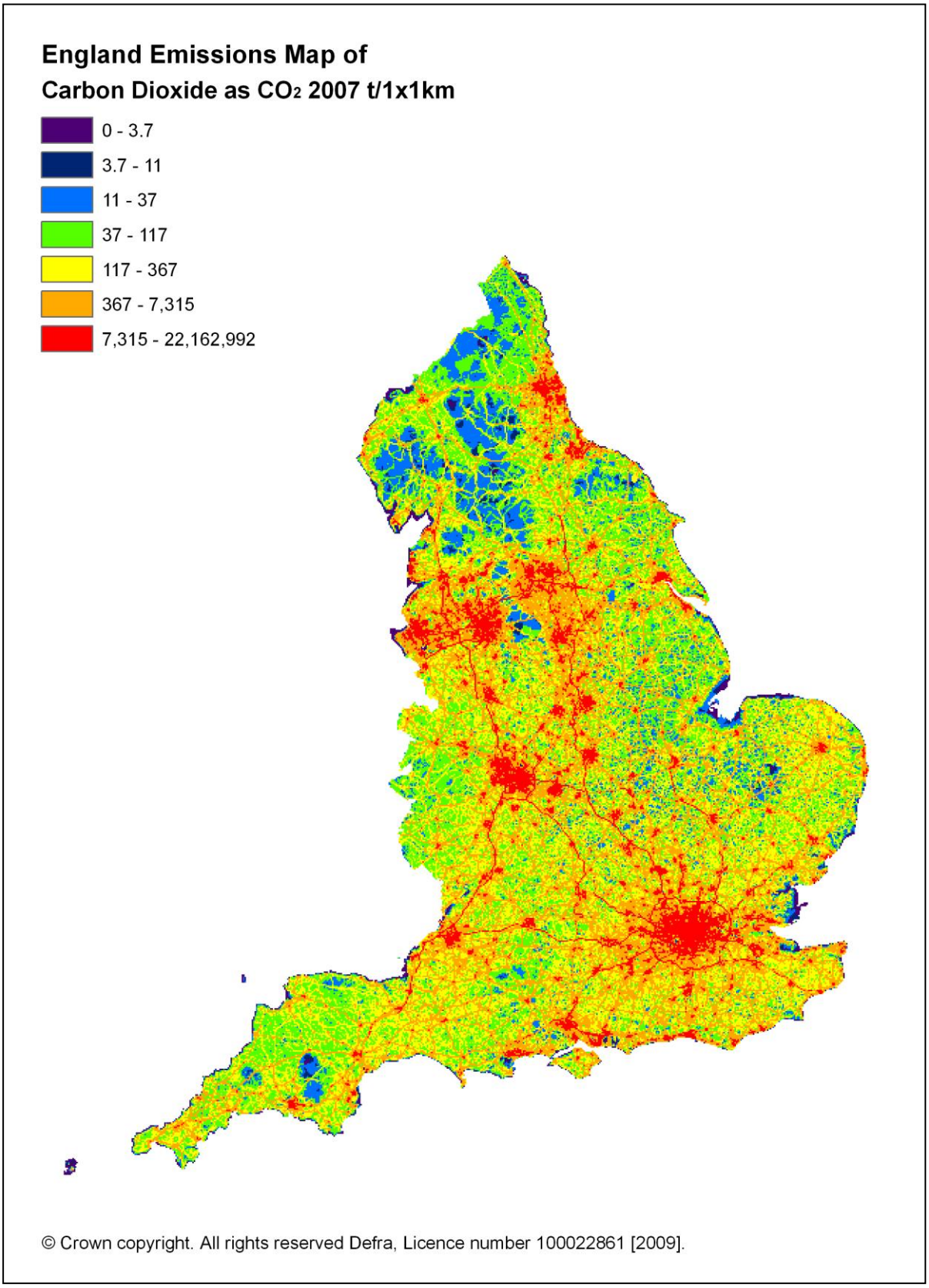


Figure 2.5: Map of Emissions of CH4 (tonnes CO2 equivalent) in England in 2007

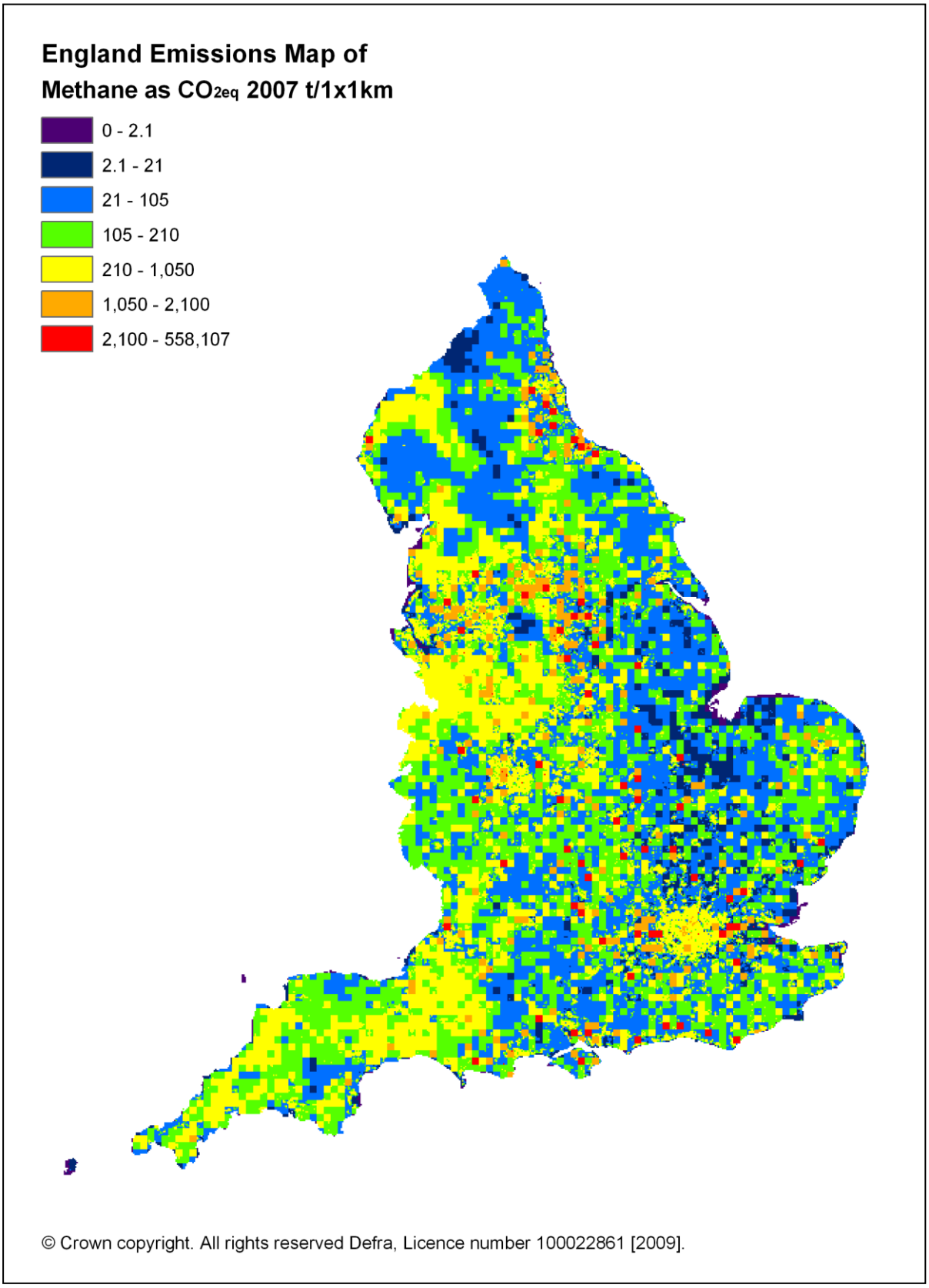
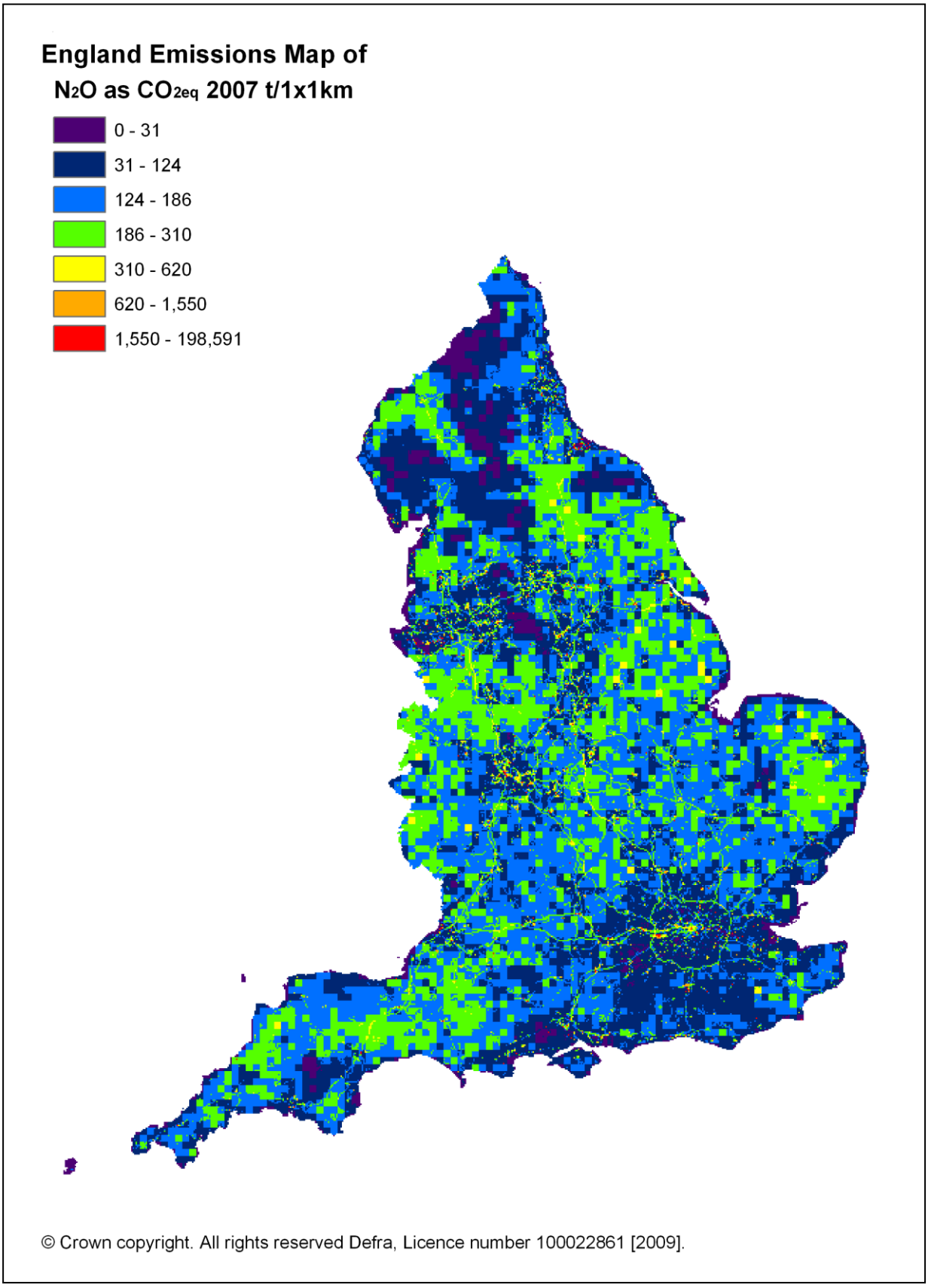


Figure 2.6: Map of Emissions of N2O (tonnes CO2 equivalent) in England in 2007



3 Emissions in Scotland

3.1 Summary of GHG Emission Sources

The main GHG emission sources for Scotland in 2007 are summarised in Figure 3.1 below, expressed as a percentage of the total Scottish GHG emissions in 2007 of 54.5 Mt CO_2-equivalent. The trends in Scottish GHG emissions since the base years of 1990 (for CO_2, CH_4 and N_2O) and 1995 (for fluorinated gases) are as follows:

- CO_2 emissions have reduced by 14.7%
- CH_4 emissions have reduced by 43.9%
- N_2O emissions have reduced by 30.2%
- HFC emissions have increased by 460%
- PFC emissions have reduced by 35.0%
- SF_6 emissions have increased by 74.8%
- Total GHG emissions (as CO_2-equivalents) have reduced by 19.9%

The largest emissions source in Scotland is CO_2 from power stations, which accounted for 28% of net Scottish emissions in 2007. The largest methane source is from landfill, and the largest source of N_2O emissions is agricultural soils. Together, these ten categories account for more than 100% of the Scottish total net GHG emissions. This is because there are large sinks in the land use, land use change and forestry category, which amounted to a removal of 12 $MtCO_2$ in 2007.

Figure 3.1: Summary of main emission sources (% kt CO2e) for Scotland, 2007

[Total 2007 Scotland GHG emissions = 54.5 Mt CO_2-equivalent]

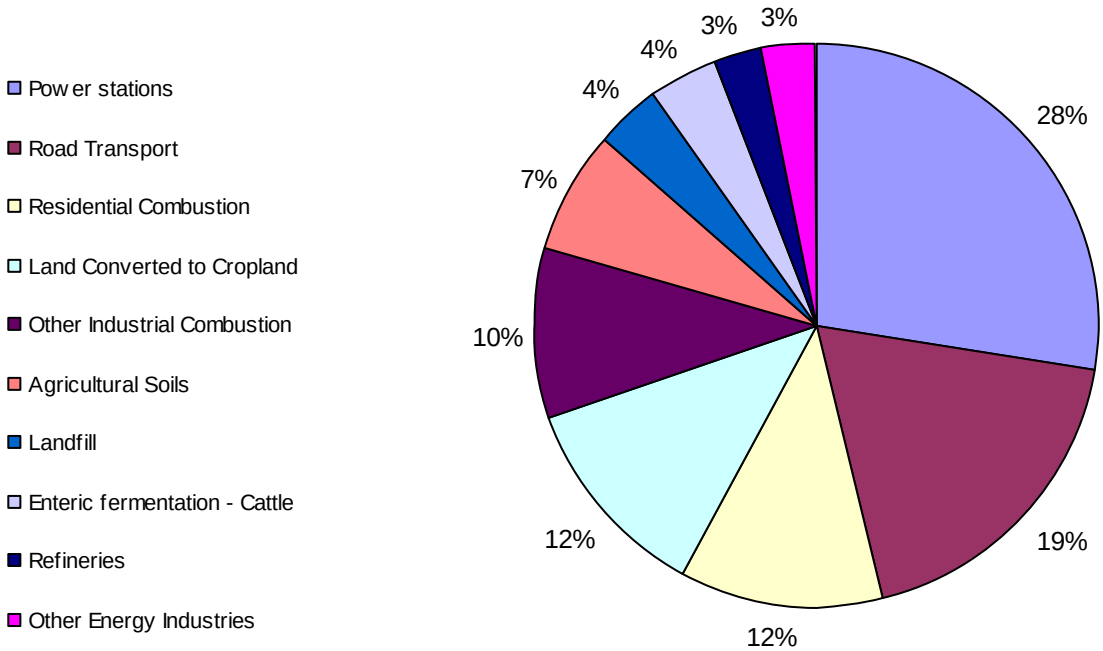


Table 3.1: Emissions Summary for Scotland, 2007 (kt CO2e)

Summary of Main Emission Sources, Scotland 2007 (kt CO_2e)				
Gas	Sector Name	IPCC code	Emission	Percentage of total GWP Weighted Emissions
CO_2	Power stations	1A1a	15509	28%
CO_2	Road Transport	1A3b	10135	19%
CO_2	Residential Combustion	1A4b	6747	12%
CO_2	Land Converted to Cropland	5B2	6609	12%
CO_2	Other Industrial Combustion	1A2f	5431	10%
N_2O	Agricultural Soils	4D	3545	7%
CH_4	Landfill	6A1	2447	4%
CH_4	Enteric fermentation - Cattle	4A1	1958	4%
CO_2	Refineries	1A1b	1890	3%
CO_2	Other Energy Industries	1A1c	1833	3%

Note that in the IPCC sector discussion text below, the percentages quoted are derived from the inventory and emissions data stored at full precision. These data can be found on the NAEI web site and on the CD-ROM that accompanies this report. The percentages in the text of this chapter do not in all cases match directly with percentages in Figure 3.1 (which are quoted as % of the total of all six GHG emissions).

3.2 Energy

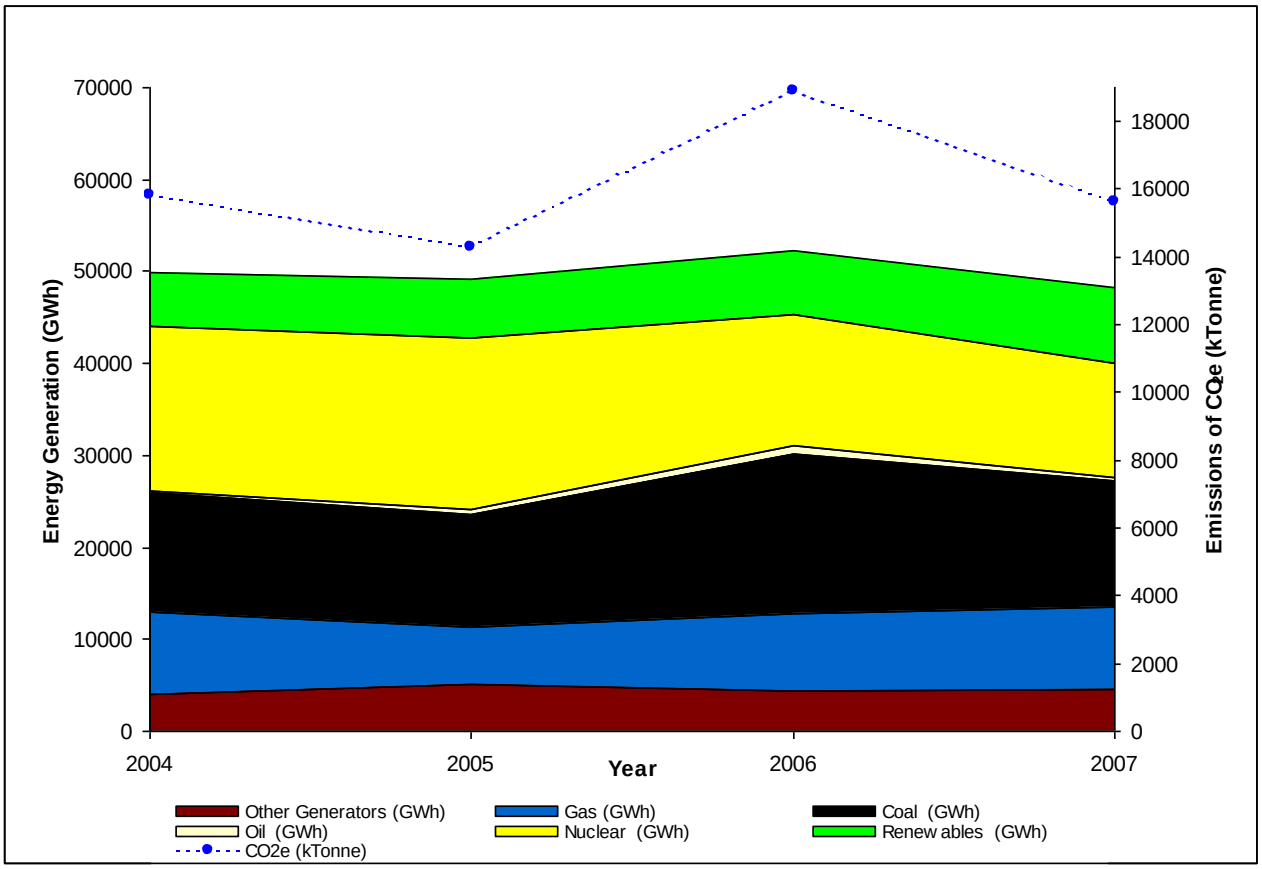
The energy sector accounts for 88% of total greenhouse gas emissions in Scotland, and CO_2 emissions contribute 98% of the emissions in this sector. This sector includes all emissions from fuel combustion, and also fugitive emissions from fuels.

Energy industries constitute the largest source of CO_2 emissions in Scotland. This includes power generation, refineries, solid fuel transformation processes and the oil and gas industry. In 2007, power generation (IPCC category 1A1a) contributed around 36.0% of the total Scottish CO_2 emission, which is slightly higher than the UK average of 32.7% due in part to the export of electricity from Scotland to other parts of the UK.

Scottish emissions from power generation have increased by 4.5% since 1990 in contrast with a fall of 13.2% from power generation across the UK as a whole. These observations are partly due to Scotland generating electricity that is subsequently exported and used elsewhere in the UK. Power generation and consumption data from DECC (DECC, 2008) indicated that in 2007, nearly 16% of all electricity generated in Scotland was exported to England and Northern Ireland, this is a decrease from 20% exported in 2006.

The mix of generation capacity in Scotland (see Figure 3.2) is significantly different from the rest of the UK, with a higher contribution from nuclear power and renewable forms of energy (largely hydro-electricity). As a consequence of this higher contribution from non-fossil fuel sources, lower carbon dioxide emissions may be anticipated, however, the remainder of power generation comes from conventional coal and gas fired stations, whilst in England and Wales there has been increased commissioning and utilisation of combined cycle gas turbines (CCGT) since the mid-1990s that have higher generation efficiencies than conventional thermal plant. This difference is exemplified by the notable increase in CO_2 emissions from power generation in Scotland in 2006 in comparison with emissions in 2005 and 2007 respectively. This increase in CO_2 from power generation coincided with a significant increase in power generation from coal in this year, from 12,092GWh in 2005 to 17,488GWh in 2006. This sharp increase in coal-fired power generation in 2006 influenced the overall Scotland GHG inventory significantly for that year, but emissions from coal-fired power generation are notably lower in 2007. Emissions in 2007 where 15.6MtCO_2 reflecting a 17% decrease in coal-fired generation from 17,488GWh in 2006 to 13,802GWh in 2007.

Figure 3.2: Power Generation By Fuel and Cumulative GHG Emissions: Scotland, 2004 to 2007



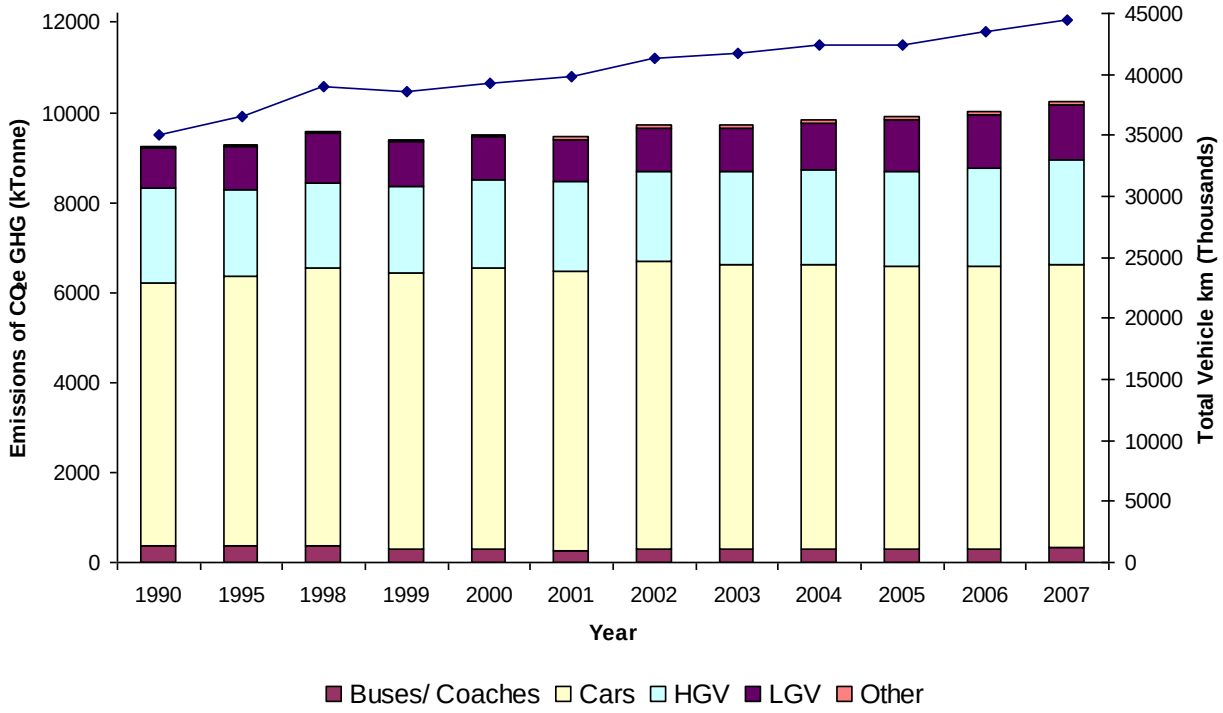
Carbon dioxide emissions from petroleum refining constitute a larger proportion of national emissions in Scotland at 4.4% of the CO_2 total, compared with 2.8% for the UK, and are a result of the greater occurrence of oil and gas landings in Scotland from offshore facilities compared to the UK average. Other energy emissions account for around 4.3% of Scottish emissions, and originate predominantly from gas consumption at oil and gas terminals and gas separation plant. Note that 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 facilities are reported as "Unallocated".

Carbon dioxide emissions from Manufacturing Industry and Construction (IPCC Sector 1A2) account for 12.8% of the Scottish CO_2 total compared with 14.6% for the UK. Between 1990 and 2007, CO_2 emissions from the Sector have declined by 43%, mainly due to the closure of the Ravenscraig steel plant.

After power generation, road transport is the second largest single source of CO_2 in Scotland and comprises approximately 23.5% of the Scottish CO_2 total. Road transport also represents the second most significant source of N_2O emissions from the energy sector in Scotland, accounting for 2.3% of total N_2O emissions in Scotland. The 1990-2006 inventory indicated that this proportion was 9% in 2006. This reduction in the estimate of N_2O emissions from road transport is due to a revision of emission factors over recent years now being reflected in the current inventory cycle. Full details of the revision to these factors can be found in Appendix 1. Scotland's contribution to UK road transport CO_2 emissions is 8.4%, which is equal to that anticipated from Scotland's population (8.4%) as a percentage of the UK total. CO_2 emissions from road transport in Scotland have shown a gradual increase over the period of 1990-2007, with emissions 11.5% higher in 2007 than in 1990, and slightly higher than the UK average during this period. This increase in GHG emissions over the period 1990-2007 parallels the notable increase in road traffic vehicle km recorded in Scotland. Emissions from road transport are dominated by emissions from cars (approximately 62%), followed by emissions from heavy goods vehicles (HGV), light duty vehicles (LDV) and buses/ coaches respectively.

The available data indicates that the relative contributions from each of these vehicle categories have remained relatively constant over the period 1990-2007.

Figure 3.3: Total Road Traffic Vehicle Kilometres and GHG Emissions from Different Vehicle Types: Scotland 1990-2007



Other combustion emissions arise from the domestic, commercial, public and agriculture sectors. The emission estimates from these sectors are subject to uncertainty due to the absence of comprehensive, detailed fuel use data, particularly for solid and liquid fuels. Carbon dioxide emissions from domestic combustion sources are estimated to account for 15.7% of the Scottish total. As a proportion of UK domestic emissions they are 8.9%, which is slightly higher than would be expected from Scotland's population (8.4%). Domestic combustion is also the largest combustion related source of methane, contributing 0.9% to total Scottish methane emissions.

The category Fugitive Emissions from Fuels (IPCC Sector 1B) is a significant source of methane emissions, reporting emissions of methane from coal mining, the oil and gas industry and natural gas distribution. The combined emission from this Sector is 7.2% of the Scottish methane total. This is a lower proportion compared with the UK as a whole, where fugitive emissions constitute around 16.6% of the total methane emissions. This is as a result of the greater contribution of coal mining and leakage from the gas transmission system elsewhere in the UK. Of these emissions, those from coal mining contributed 1.7%, oil and gas terminals 0.4% and natural gas distribution 4.6% of the Scottish methane total. Coal mining emissions have declined by 83.6% over the period due to the decline in the coal industry. Emissions from the oil and gas industry have fallen by 85% over the same period due to tighter regulation of environmental emissions, but it has been noted in 2007 that some installations in Scotland have unexpectedly reported very small fugitive emissions of methane and VOCs, perhaps in error. Hence there may be a slight under-estimate of methane emissions from the oil and gas terminals in Scotland in 2007. Gas leakage from the gas transmission system has reduced by 50% over 1990-2007 due to renewal of the mains and services infrastructure. The estimate of gas leakage from the gas transmission system is based on UK National Grid data.

Only around 1.7% of CO_2 emissions arise from oil and gas fugitives, mainly from processes at oil and gas terminals (0.9%), as well as oil and gas flaring (0.9%). Between 1990 and 2007, oil and gas process emissions increased by 12.4%, while emissions from flaring have decreased by 59.7%.

3.3 Industrial Processes

Industrial processes produce emissions from non-combustion sources such as chemical processes, the production and use of fluorinated gases, and the use of limestone in cement and glass making. The largest emission in this sector is of HFCs from refrigeration and air conditioning, which contributes 30% of total Scottish emissions from the industrial process sector.

In 2007, refrigeration and air conditioning contributed 58.7% of total Scottish HFC emissions (as CO_2 equivalent) due to losses from refrigeration and air conditioning equipment during its manufacture and lifetime. Aerosols contributed 32.7% to the total Scottish HFC emission in 2007, the main sources being industrial aerosols and medical use of metered dose inhalers. The remaining emission sources (foams, fire-fighting and solvents) contributed 8.6% of total Scottish HFC emissions.

Total Scottish emissions of HFCs have increased by over 400% since the 1995 base year, due to increases in emissions from refrigeration, air conditioning, domestic use of aerosols and Metered Dose Inhalers.

The largest CO_2 emission in this sector is from cement manufacture with smaller emissions from glass and aluminium production, and from stored carbon in products. Together these processes emitted around 1.5% of the Scottish total in 2007 and have decreased by 31% over the period 1990-2007.

In 1990, nitric acid manufacture and iron and steel were both important sources of GHG in the Scottish industrial process sector. However, emissions from these sources in 2007 are negligible following the closure of the Ravenscraig iron and steel plant in 1992, and the relocation of the only Scottish nitric acid plant to Dublin in 1995. In 1990 around 394 kt CO_2e of nitrous oxide were emitted from a nitric acid plant in Leith, and 244 kt CO_2 were emitted from iron and steel processes. These plant closures have made a significant contribution to the decreases in Scottish emissions for this sector since the 1990 base year.

Emissions of PFCs represent 3.7% of Scottish GHG emissions in the industrial process sector. The largest source of perfluorocarbons in Scotland is through their utilisation in the electronics industry. In 2007, this contributed around 98% to the total Scottish PFC emission (as CO_2 equivalent). The other main source of PFCs in Scotland is aluminium production and this contributes 2% to the total emissions of PFCs from Scotland. Overall, Scottish PFC emissions account for 26% of the UK total (as CO_2 equivalent) and have decreased by 35.0% over 1995-2007 as the decreases in emissions from the aluminium production have out-weighed the increase from the electronics industry.

Emissions of SF_6 represent 3.5% of Scottish industrial process GHG emissions. All emissions of SF_6 in Scotland occur in the IPCC category 2F8. This category includes emissions from the electronics industry, as well as leakage from electrical switchgear and from the soles of certain brands of training shoes. Overall emissions in 2007 are 6.8% of the UK total and in Scotland the emissions of SF_6 have increased by 75% over 1995-2007, due to increased emissions from all three major sources.

3.4 Agriculture

Emissions from the agriculture sector contribute 12.6% to total greenhouse gas emissions in Scotland, with emissions arising 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 of GHG emissions.

Enteric fermentation from cattle is the largest single source of methane emissions in Scotland (93 kt CH_4), contributing 32% of Scottish methane emissions. Total emissions from cattle (including

both waste management and enteric fermentation) represent 71% of total methane emissions from agriculture in Scotland, with sheep responsible for a further 25%.

Emissions are largely dependent on the numbers of livestock (cattle and sheep), numbers of which have fallen by 11% over the period 1990-2007. Scotland accounts for around 17% of UK agricultural methane emissions.

Of the total Scottish emission of 14.2 kt N_2O in 2007, approximately 12.2 kt of this was emitted from the agriculture sector, representing 79% of the total. Emissions from agricultural soils (11.4 kt N_2O) represented the most significant source of emissions, contributing 94% of total agricultural N_2O emissions, and 51% of total GHG emissions from the agriculture sector in Scotland. Emissions from the agricultural soils sector are broken down below[16]:

[Note: numbers in brackets show the percentage of the total agricultural soils N_2O emission]

- Leaching of fertiliser nitrogen and applied animal manures to ground and surface water (28.0%);
- Synthetic fertiliser application (23.8%);
- Wastes from grazing animals (22.5%);
- Manure used as fertiliser (9.9%);
- Ploughing in crop residues (7.8%)[17];
- Atmospheric deposition of ammonia (NH_3) and oxides of nitrogen (NO_x) (6.9%);
- Biological fixation in improved grass (0.8%);
- Cultivation of histosols (i.e. high organic content soils) (0.2%); and
- Cultivation of legumes (0.01%)[2.]

Emissions of N_2O in Scotland have declined by 27.3% over the period 1990-2007.

3.5 Land Use, Land Use Change and Forestry

The LULUCF sector contains both sources and sinks of carbon dioxide, as well as small sources of methane and nitrous oxide. Data are calculated and presented in this report for net emissions of carbon dioxide from Land Use Change and Forestry (LULUCF). LULUCF activities also include a very small source of methane and N_2O (from biomass burning), although these are not significant to total emissions of these gases.

The LULUCF sector contains both sources and sinks of carbon dioxide, as well as small sources of methane and nitrous oxide. Scotland is a net sink of carbon dioxide from LULUCF activities. Data indicates that the size of this sink has increased by 78%, from -2.5 to -4.5 Mt CO_2, between 1990 and 2007, although this trend has levelled off since 2004. Net emissions/removals in Scotland are dominated by the large Forestland sink (-9.3 Mt CO_2 in 2007) although the Cropland source is also significant (6.6 Mt CO_2 in 2007). Net removals in 1990 are estimated here to be -2.53 Mt CO_2, representing no change from the 2006 DA inventory report estimate. For 2006, a net sink of -4.46 Mt CO_2 is estimated here compared to -4.50 Mt CO_2 in the 2006 inventory.

Deforestation associated with harvested wood products is included in this year's inventory; the removal of timber from harvesting or thinning operations is considered as deforestation and therefore should be reported. Deforestation is the result of either a land use change or thinning. It is assumed that a change in land use will be to Grasslands or Settlements and will be reported in Sector 5.C.2 and 5.E.2 respectively. Forest land which is thinned will undergo a reduction in area; these changes are reported in 5.A.1. Appendix 1 contains details of the methods and data sources used.

Estimates of methane and nitrous oxide emissions due to LULUCF activities remain small: 0.01 Mt CO_2 equivalent of methane and 0.002 Mt CO_2 equivalent of nitrous oxide in 2007.

[16] Note: numbers in brackets give the category value as a percentage of the total N_2O emissions from agricultural soils
[17] Crop production data specific to Scotland for 2006 was missing, leading to an underestimation of nitrous oxide emissions (7.2%). This has been corrected in the 2007 inventory.

3.6 Waste

Waste emissions in Scotland are dominated by methane emissions from landfills. This accounts for 93% of total greenhouse gas emissions from the waste sector. Scottish landfill emissions represent 12% of total UK landfill methane emissions, which is more than would be expected from the Scottish proportion of the population (8.4%). The estimates are based on data on arisings of municipal solid waste (MSW) and sewage sludge in Scotland. Data is obtained from www.wastedataflow.org, providing summary data from LA waste management reporting, including a detailed insight into the ultimate fate of MSW arisings. This data source includes regional data such as tonnages and percentages of MSW treatment and disposal options such as recycling, incineration and landfill. This data enables a more detailed DA split of waste disposed to landfill to be derived, and includes data back to 1999, which has been used to back-calculate the estimates to 1990 by DA. However, due to a lack of detailed local data, the DA disaggregation method still retains the assumption that landfill methane recovery rates within each of the DAs are the same as the UK average. Landfill emissions in Scotland are estimated to have fallen by 56% since 1990 due an increase in the use of methane recovery systems, though this reduction assumes the UK trend.

The remainder of the emissions from this sector mostly arise from wastewater treatment. Emissions of methane and N_2O represent 6.6% of total greenhouse gas emissions in the waste sector. These emissions are estimated to be around 8.4% of UK wastewater treatment emissions. Emissions have increased since 1998 when the disposal of sewage to the sea ended and other disposal routes were adopted.

3.7 Emission Maps: Scotland 2007

As part of the NAEI, the UK produces mapped emissions of CO_2 (as C), CH_4 and N_2O. The maps are modelled estimates of emissions compiled at a 1 km^2 resolution and Figures 3.4 to 3.6 shown the emissions in Scotland. The maps reveal the locations and intensities of the major sources of emissions and are used by AEA and other organisations for a variety of Government policy support work at the national scale, regional and local scale. Local area statistics are compiled from the maps and related data, for example, Local Authority level data on carbon dioxide emissions and fuel use have been produced for Defra and DECC (formerly BERR) since 2003 using data from the NAEI mapping work. As of March 2008, these datasets were reclassified as National Statistics (King et al and Bush et al, 2008). The distributions of CH_4 and N_2O emissions from agricultural sources are generated at a 5 km^2 resolution by the Centre for Ecology and Hydrology (CEH), and are then re-sampled at a resolution of 1 km^2 by the NAEI mapping team.

One set of maps is produced each year for the most recent NAEI year. The mapped emissions data are made freely available on the NAEI web site at

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and

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The most recent report on the mapping of emissions can be found at:

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Figure 3.4: Map of Emissions of CO2 (tonnes) in Scotland in 2007

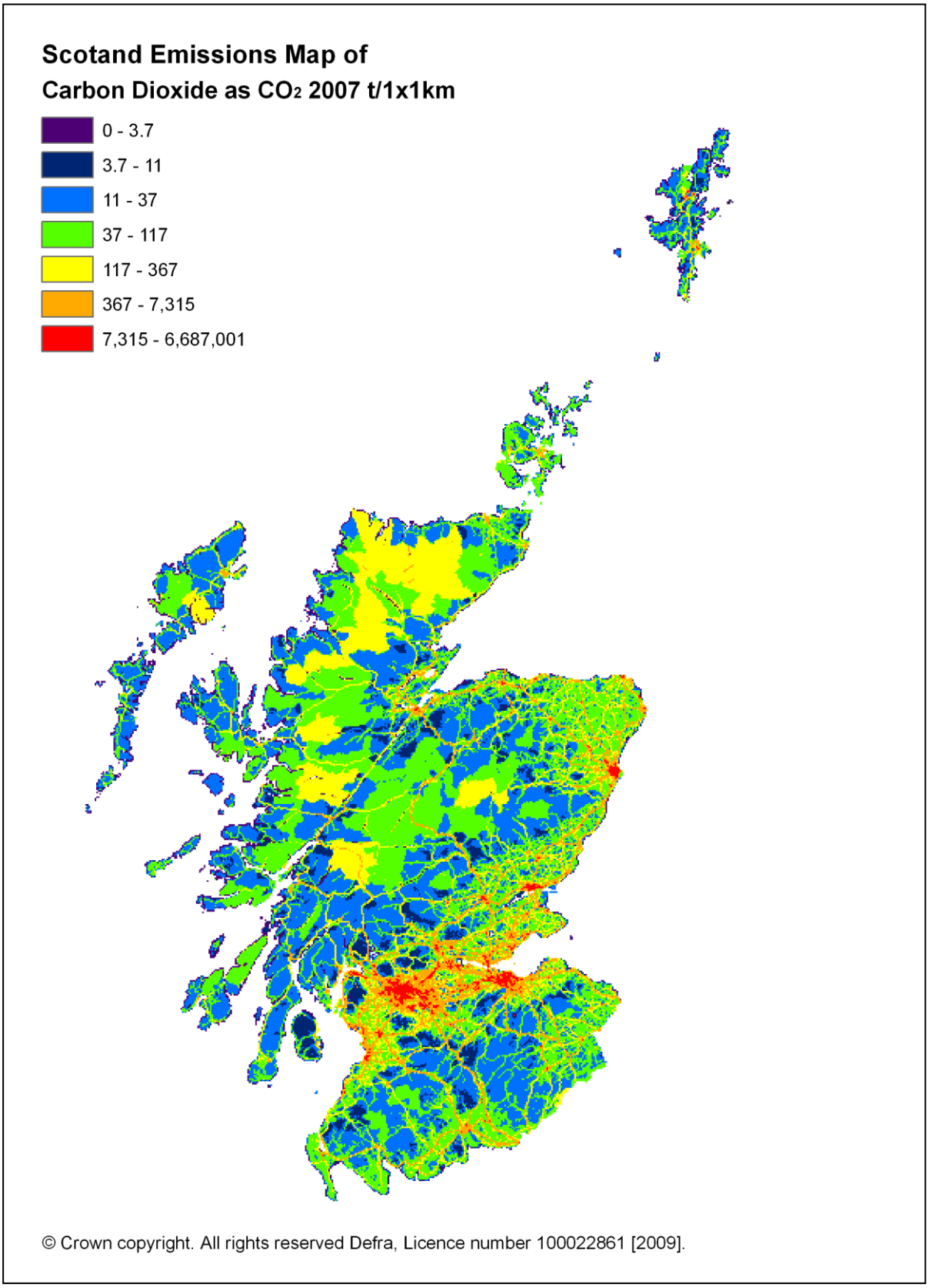


Figure 3.5: Map of Emissions of CH4 (tonnes CO2 equivalent) in Scotland in 2007

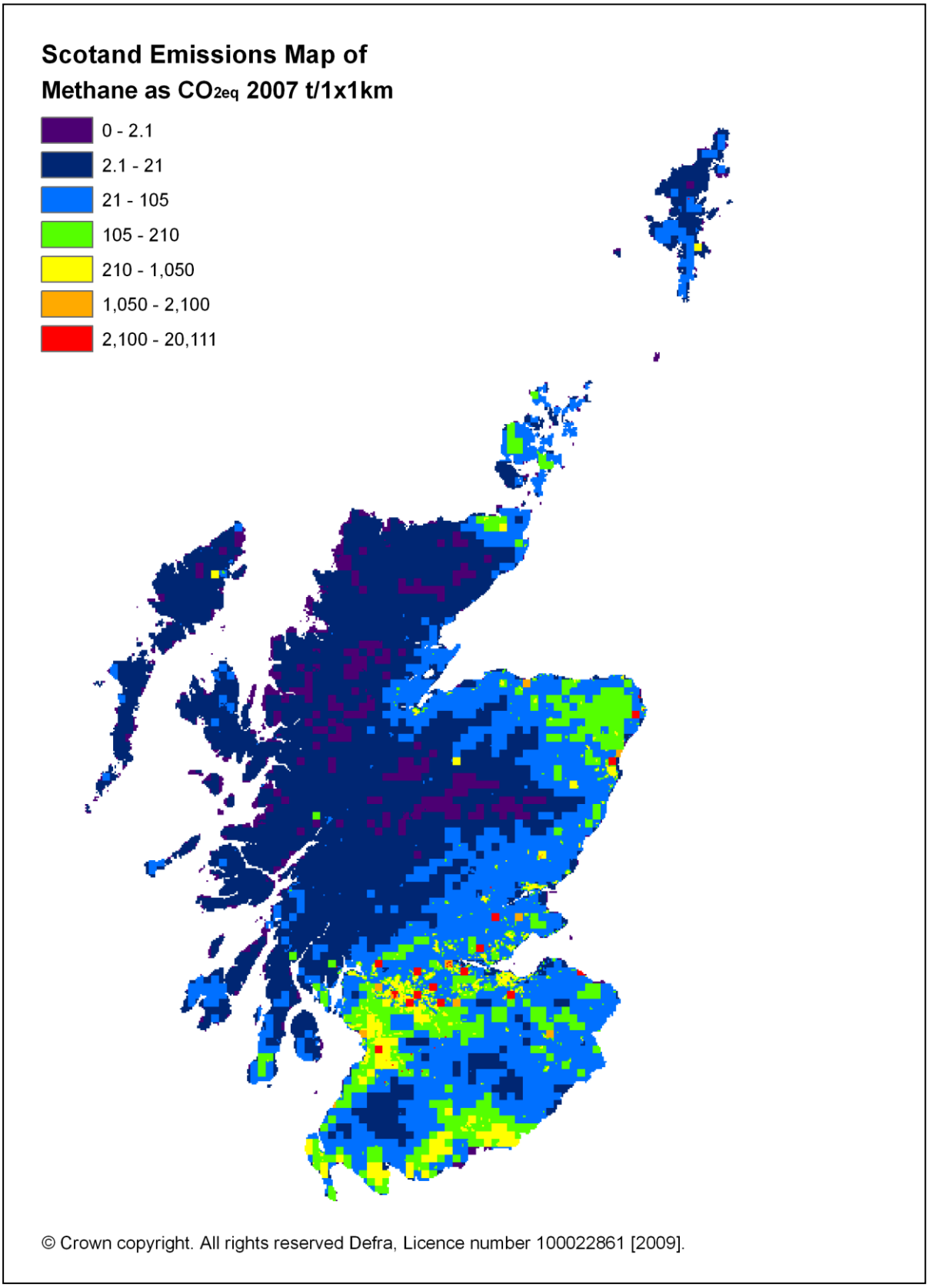
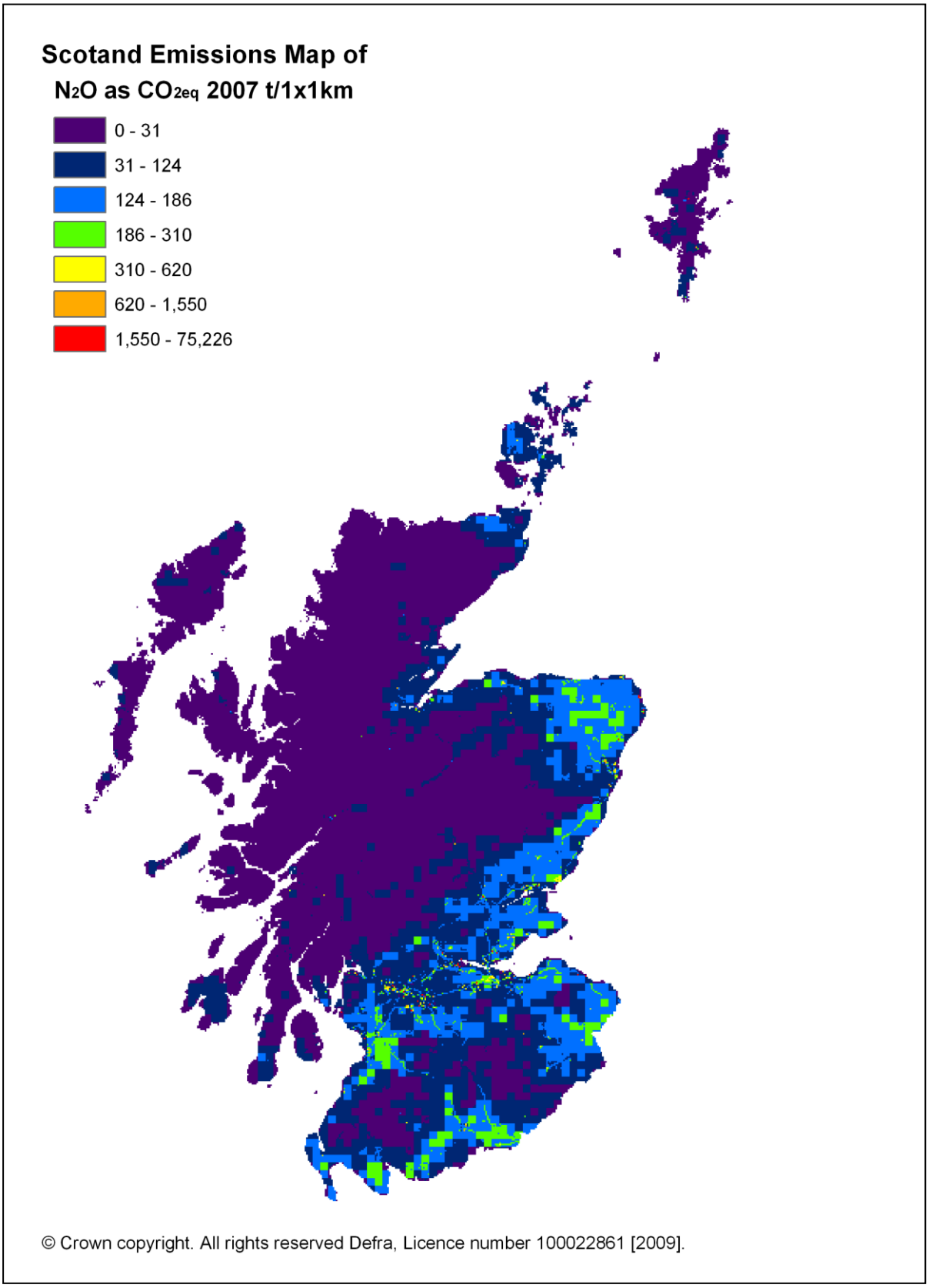


Figure 3.6: Map of Emissions of N2O (tonnes CO2 equivalent) in Scotland in 2007



4 Emissions in Wales

4.1 Summary of GHG Emission Sources

The main GHG emission sources for Wales in 2007 are summarised in Figure 4.1 below, expressed as a percentage of the total Welsh GHG emissions in 2007 of 46.8 Mt CO_2-equivalent. Trends in Welsh GHG emissions since the base years of 1990 (for CO_2, CH_4 and N_2O) and 1995 (for fluorinated gases) are as follows:

- CO_2 emissions have reduced by 9.5%
- CH_4 emissions have reduced by 41.9%
- N_2O emissions have reduced by 24.0%
- HFC emissions have increased by 460%
- PFC emissions have reduced by 70.8%
- SF_6 emissions have reduced by 40.9%
- Total GHG emissions (as CO_2-equivalents) have reduced by 14.7%

In Wales, after emissions from power stations, the second largest emission source is CO_2 from combustion in the iron and steel sector, which is a very significant source for Wales. The largest methane source is from enteric fermentation in cattle, and the largest source of N_2O emissions is agricultural soils. Together, the ten categories listed in Figure 4.1 accounted for 86% of the Welsh total net emissions in 2007.

Figure 4.1: Summary of main emission sources (% kt CO2e) for Wales, 2007

[Total 2007 Wales GHG emissions = 46.8 Mt CO_2-equivalent]

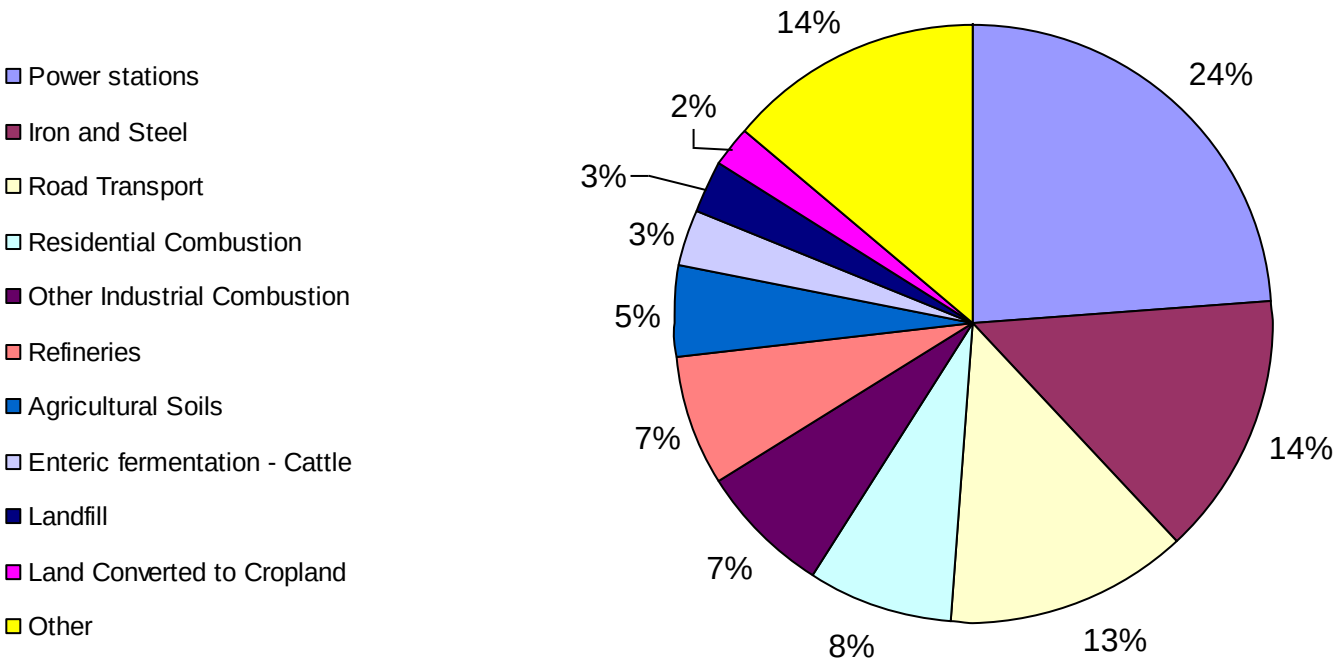


Table 4.1: Emissions Summary for Wales, 2007 (kt CO2e)

Summary of Main Emission Sources, Wales 2007 (kt CO_2e)				
Gas	Sector Name	IPCC code	Emission	Percentage of total GWP Weighted Emissions
CO_2	Power stations	1A1a	11268	24%
CO_2	Iron and Steel	1A2a	6636	14%
CO_2	Road Transport	1A3b	6158	13%
CO_2	Residential Combustion	1A4b	3943	8%
CO_2	Other Industrial Combustion	1A2f	3473	7%
CO_2	Refineries	1A1b	3106	7%
N_2O	Agricultural Soils	4D	2187	5%
CH_4	Enteric fermentation - Cattle	4A1	1344	3%
CH_4	Landfill	6A1	1193	3%
CO_2	Land Converted to Cropland	5B2	1053	2%

Note that in the IPCC sector discussion text below, the percentages quoted are derived from the inventory and emissions data stored at full precision. These data can be found on the NAEI web site and on the CD-ROM that accompanies this report. The percentages in the text of this chapter do not in all cases match directly with percentages in the above table (which are quoted as % of the total of all six GHG emissions).

4.2 Energy

Emissions from the energy sector are dominated by emissions of CO_2 from combustion sources, which represent 97% of total GHGs in this sector in 2007; emissions of CH_4 and N_2O from fuel combustion account for the remaining 3% of the total GHG emissions from the energy sector. Fugitive emissions from fuels are an important source of methane, accounting for 14.8% of the Welsh methane emissions in 2007; these emissions are primarily from leakage from the natural gas supply network and methane seepage from mining activities. Collectively, the energy sector accounts for 82% of total Welsh GHG emissions in 2007.

The largest source of CO_2 emissions in Wales is Energy Industries (IPCC sector 1A1), which includes power generation, refineries and solid fuel transformation processes. Electricity generation contributed an estimated 28.9% of the total Welsh carbon dioxide emissions in 2007, which is slightly lower than the UK proportion of 32.7%. Emissions from electricity generation in Wales have increased by 0.1% compared with a fall of 13.2% in UK emissions over 1990 to 2007 (Figure 4.2), but annual generation figures have varied considerably during this period.

Electricity generation and consumption data (DECC, 2008b) indicates that in 2007 Wales exported 5,401 GWh of electricity to England, which is just over 17% of all power generated in Wales. The amount of electricity exported from Wales in 2007 was slightly lower than that exported in 2006 (7,670 GWh). There is now only one nuclear power station in operation in Wales whilst there has been a growth of Combined Cycle Gas Turbines stations (CCGTs) partly to replace the generating capacity from Trawsfynydd Nuclear Station, which closed in 1991. The increase in generation capacity in Wales comes from the opening of a 500 MW CCGT at Deeside in 1994, a 1,420 MW CCGT at Connahs Quay in 1996, a 250 MW CCGT at Barry in 1998, and a 575 MW CCGT at Baglan Bay in 2002. The remaining fossil fuel generation is from two conventional coal stations; the coal-fired station at Uskmouth closed and subsequently re-opened as Fifoots after being upgraded and fitted with Flue Gas Desulphurisation. Aberthaw is the other conventional coal station. One power station (oil-fired) at Pembroke has closed.

Recent fluctuations in the fuel mix of electricity generation in Wales have had a noticeable impact on the inventory. For example, coal-fired generation increased by over 30% between 2005 and 2006 (6,772 GWh to 8,859 GWh), and then reduced by over 40% between 2006 and 2007 (to 5,121 GWh), partly as a result of a plant shut-down at Aberthaw to retro-fit 2 units with Flue Gas Desulphurisation

abatement. The impact of these temporal changes in power generation fuel mix is reflected in the noted increase in emissions of GHGs from Wales in 2006 and subsequent decline in 2007

Figure 4.2: Power Generation By Fuel and Cumulative GHG Emissions: Wales, 2004 to 2007

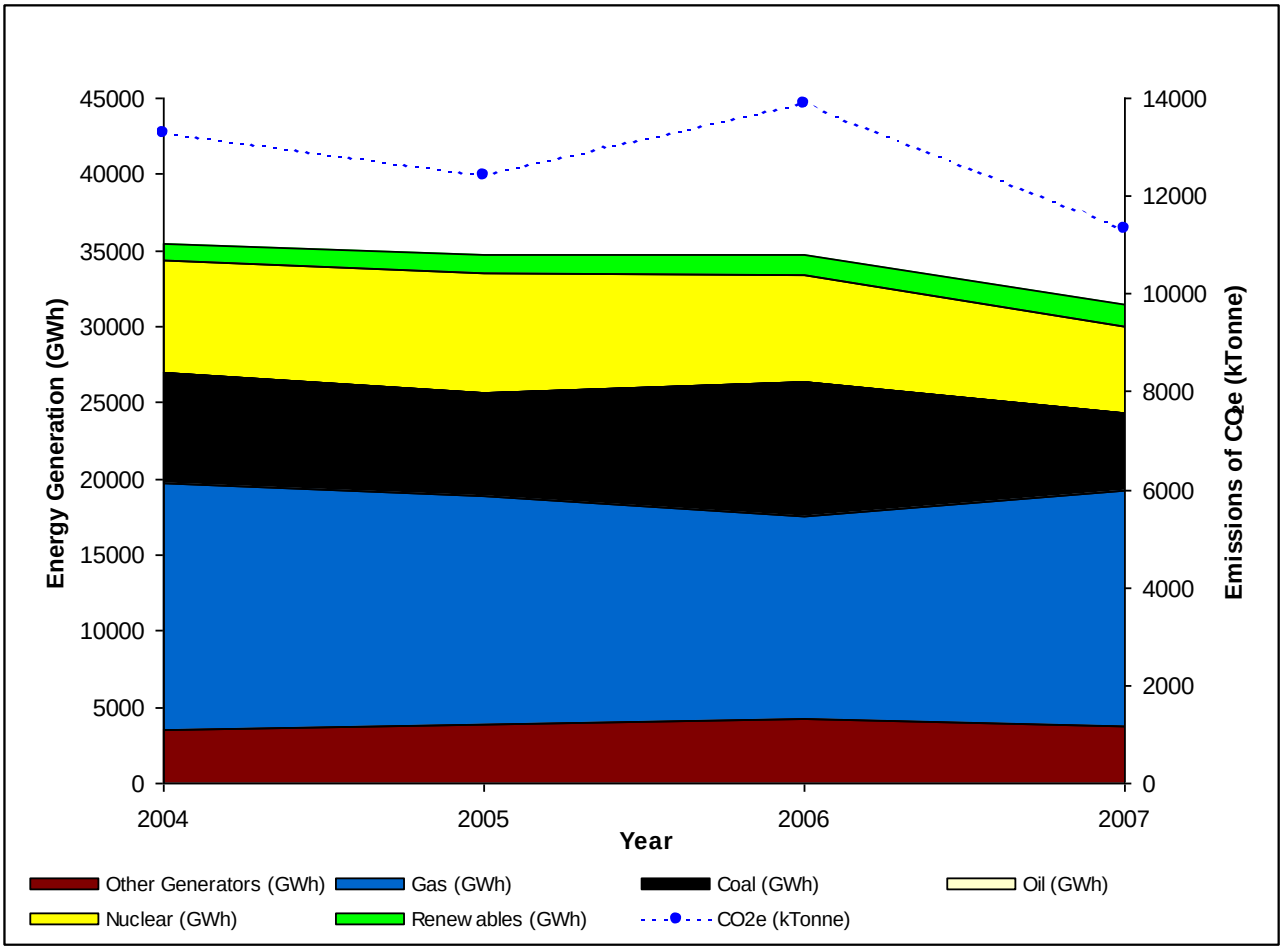


Figure 4.2 summarises data for the predominant sources of power-generation in Wales, and indicates that gas represents the principle source of power generation in Wales, with an estimated 15,461 GWh in 2007. Nuclear energy represented the second most significant source of power-generation (5,684 GWh), followed closely by coal (5,121 GWh). Energy generated from renewable sources was estimated to contribute 1,370 GWh in 2007, showing an increase of 341GWh from the 2004 estimate.

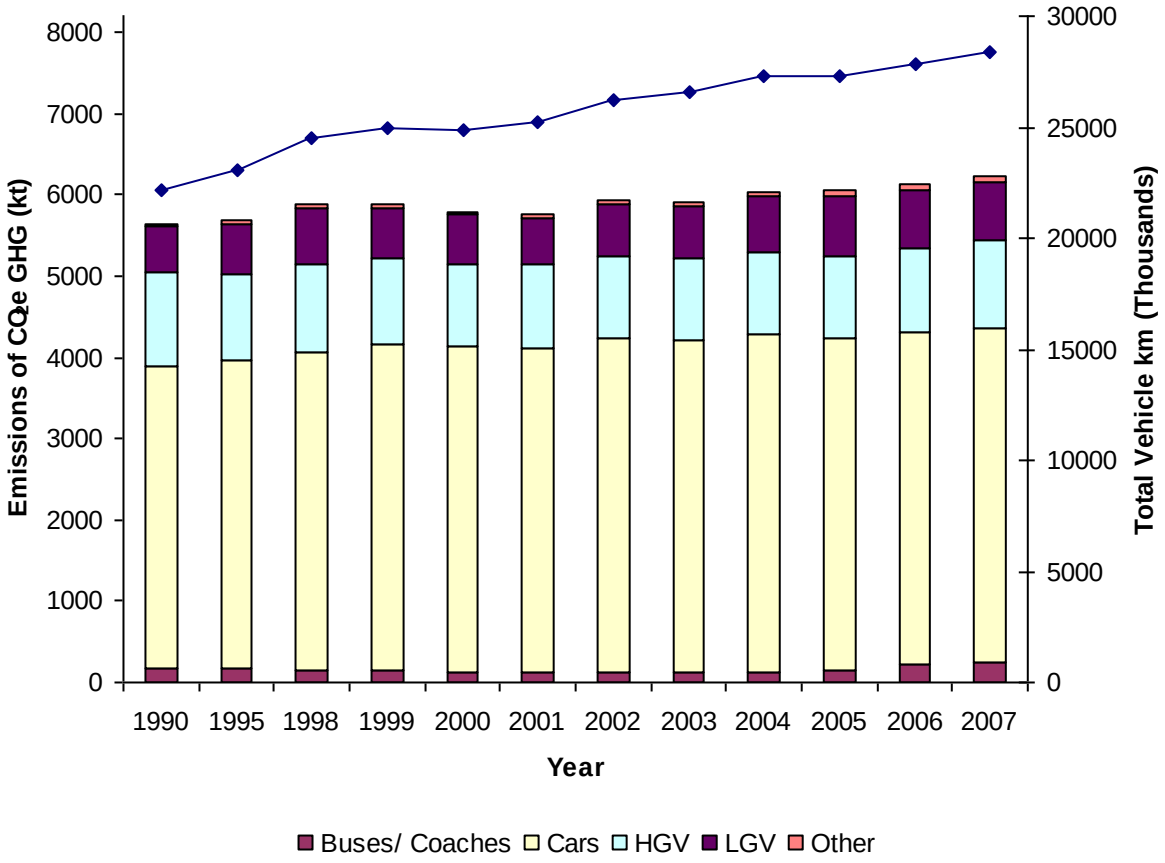
Petroleum refining constitutes 8.0% of Welsh CO_2 emissions in 2007 compared with 2.8% for the UK as a whole. The other energy emissions are mostly combustion emissions from coke ovens and solid fuel plant and account for 1.1% of the 2007 Welsh carbon dioxide total emission. There are no significant emissions from oil and gas production. Note that 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 facilities are reported as “Unallocated”.

Combustion emissions from Manufacturing Industries and Construction (IPCC sector 1A2) account for 25.9% of the Welsh CO_2 total compared with 14.6% for the UK. The high contribution from industry can be explained by the high concentration of iron and steel plant in Wales. This accounts for 35% of UK Iron and Steel combustion emissions of CO_2 in 2007. The sintering process in the iron and steel sector is also the most significant fuel combustion source of methane in Wales, accounting for 1.2% of total Welsh methane emissions in 2007. Welsh CO_2 emissions from the ‘other industry’ category (IPCC sector 1A2f) are estimated to be 5.8% of the UK CO_2 total for this sector in 2007.

Road transport represents the third largest single source of CO_2 in Wales after power generation and iron and steel, contributing 15.8% of the total Welsh carbon dioxide emission in 2007, and 13.3% of all

Welsh GHG emissions for the year. The contribution of Welsh road transport to UK road transport CO_2 emissions is 5.1%, which is consistent with Wales' population (4.9% of UK population). Emissions of CO_2 from road transport in Wales have risen by 10.9% from 1990 to 2007 compared with an 11.0% rise for the UK as a whole (Figure 4.3).

Figure 4.3: Total Road Traffic Vehicle Kilometres and GHG Emissions from Different Vehicle Types: Wales 1990-2007



This 10.9% rise in CO_2 emissions from the road transport sector reflects a 28% increase in vehicle km travelled by road transport in Wales over the period 1990-2007 (Figure 4.3) and the progressive improvement in engine efficiencies due to progressive fleet replacement. Emissions of CO_2e from various components of the road vehicle fleet in Wales in broadly similar to the rest of the UK, with emissions from cars constituting approximately 75% of emissions, followed by emissions from HGVs, LDVs and buses / coaches. The methodology used to calculate emissions from the road transport sector is provided in Appendix 1.

Other combustion emissions arise from the domestic, commercial, public and agriculture sectors. The emission estimates from these sectors are subject to quite significant uncertainty due to the absence of comprehensive, detailed fuel use data, particularly for solid and liquid fuels. Carbon dioxide emissions from domestic combustion sources are estimated to account for 10.1% of the Welsh total in 2007. As a proportion of UK domestic emissions they are estimated to represent 5.2%, which is consistent with the relative populations.

The category Fugitive Emissions from Fuels (IPCC Sector 1B) reports emissions from coal mining, coke production, oil and gas processes and natural gas distribution. The majority of these emissions are methane, with much smaller contributions from N_2O and CO_2. The largest methane source in this category is coal mining, which represents 7.7% of total Welsh methane emissions, and 13.3% of total

UK emissions from this sector. Emissions from this source have decreased by 77% since 1990 due to the decline in the mining industry in Wales. The other major source of methane is leakage from the gas network, which amounts to 7.1% of the Welsh methane total. This emission has decreased by 4% since 1990, due to the renewal of the gas supply network

4.3 Industrial Processes

The industrial process sector includes emissions from all non-fuel combustion sources in the industrial sector. In Wales, the largest emissions from the industrial process sector is CO_2 from processes in the iron and steel sector, which include limestone use in blast furnaces, flaring of blast furnace gas and electric arc furnaces. Emissions from iron and steel processes accounts for 44% of the Welsh total greenhouse gas emissions from all industrial processes in 2007. Other significant sources include CO_2 emissions from cement, aluminium and glass production, as well as HFC emissions from refrigeration and aerosols. All emissions of HFCs, PFCs and SF_6 occur in this sector. Emissions of methane and N_2O from this sector are not significant.

Carbon dioxide process emissions from cement and glass production account for 1.6% of the total CO_2 emissions in Wales. Aluminium production in Wales is a significant source of both CO_2 and PFC emissions, which together account for 9.8% of total greenhouse gas emissions from the industrial process sector in 2007.

In 2007, the total HFC emission in Wales comprised 4.2% of the UK HFC total (as CO_2 equivalent). Refrigeration and air conditioning represents the largest source of HFC emissions, contributing 53.1% to the Welsh HFC emission total (as CO_2 equivalent) in 2007 and result primarily due to losses from refrigeration and air conditioning equipment during its manufacture and lifetime. The uses of aerosols contribute 37.1% to total Welsh HFC emissions (as CO_2 equivalent), the main sources being industrial aerosols and the medical use of metered dose inhalers. The remaining emission sources (foams, fire-fighting and solvents) contributed 10% to the total Welsh HFC emission (as CO_2 equivalent) in 2007. The trend in emissions of HFCs in Wales has shown a significant increase since the 1995 base year, compared to a 47.0% decrease for England, and 38.7% for the UK as a whole..

Welsh emissions of sulphur hexafluoride are estimated at 6.2 % of the UK total in 2007. The largest source of emissions is from IPCC category 2F8, which accounts for 78.8% of SF6 emissions in Wales. This category includes leakage from the soles of certain brands of training shoes, emissions from the electrical switchgear used in electricity transmission, and emissions from the electronics sector. The other source of SF_6 in Wales is from its industry application as a cover gas in magnesium production. This application accounts for around 21.2% of total Welsh SF_6 emissions and comprises 7% of emissions of SF_6 from UK magnesium production.

4.4 Agriculture

Agriculture accounts for 10.4% of total greenhouse gases in Wales, and is the most significant source sector for methane and N_2O, accounting for 55% and 85% of total Welsh emissions of these two gases, respectively.

The largest single source of methane emissions in Wales in 2007 is enteric fermentation from cattle[18], which accounts for 29.4% of total Welsh methane emissions and 53% of methane emissions from the agriculture sector. Enteric fermentation in sheep accounts for a further 20.2% of methane emissions. Total emissions arising from enteric fermentation amount to 90.3% of methane emissions from agriculture, with the remaining 10% of emissions coming from animal wastes. Emissions from agriculture are largely dependent on livestock (cattle and sheep) numbers, which have declined by more than 11% during the period 1990-2007.

Revisions have been made to Welsh cattle numbers for 2006, following a review of the available data and a change in data source. Previously the Wales cattle data have been derived from the annual "June Survey" of farms, conducted by Defra. The trends in cattle numbers indicated by the June Survey for 2006 were questioned, as they bucked the UK trend of decreasing livestock numbers.

[18] Cattle data for Wales in 2006 and 2007 are taken from the newly-implemented Cattle Tracing System, rather than from the previous data source of annual farm surveys. This has led to a downward revision of the 2006 Wales cattle methane emissions, compared to the 1990-2006 inventory.

Following discussions with Defra and livestock data experts in Wales, it was decided that the newly established Cattle Tracing System (CTS) data is a more accurate data source and should be used in preference to the survey data for 2006 and in future years. This change led to a slight reduction in cattle data for Wales in 2006, which is regarded by the sector experts as a more accurate and consistent time-series trend.

The other major source of CO_2e emissions in the agriculture sector is agricultural soils, which constitutes a significant emission of N_2O (7.1 kt), 80% of the Welsh N_2O total and 94% of total emissions of N_2O from the agricultural sector in Wales. These emissions of N_2O from agricultural soils have declined by 25.5% over the period 1990-2007. A more detailed breakdown of N_2O emissions from agricultural activities is presented below:[19]

- Wastes from grazing animals (32.4%);
- Leaching of fertiliser nitrogen and applied animal manures to ground and surface water (28.5%);
- Synthetic fertiliser application (18.3%);
- Manure used as fertiliser (10.4%);
- Atmospheric deposition of ammonia (NH_3) and oxides of nitrogen (NOx) (7.6%);
- Ploughing in crop residues (1.0%);
- Biological fixation in improved grass (1.2%);
- Cultivation of histosols (i.e. high organic content soils) (0.5%); and
- Cultivation of legumes (0%).

4.5 Land Use, Land Use Change and Forestry

The LULUCF sector contains both sources and sinks of carbon dioxide, as well as small sources of methane and nitrous oxide. Wales is a net sink of carbon dioxide from LULUCF activities and the size of this sink has only slightly reduced between 1990 and 2007: from -0.24 to -0.20 Mt CO_2. Forestland net sink (-1.4 Mt CO_2 in 2007) and the Cropland net source (1.0 Mt CO_2 in 2007) are the largest contributors to the LULUCF sector in Wales. Net removals in 1990 are estimated here to be - 0.238 Mt CO_2 as in the 2006 DA inventory report, whilst for 2006, net removals are now estimated at - 0.195 Mt CO_2 in comparison to an estimated -0.205 Mt CO_2 in the 2006 inventory. Differences between the inventories are primarily due to new data being incorporated within the 2007 estimates.

Deforestation associated with harvested wood products has been included in this year's inventory; with the removal of timber from harvesting or thinning operations considered as deforestation, and therefore reported within the inventory. Deforestation is the result of either a land use change or thinning. It is assumed that a change in land use will be to Grasslands or Settlements and will be reported in Sector 5.C.2 and 5.E.2 respectively. Forestland, which is thinned will undergo a reduction in area; these changes are reported in 5.A.1 and details of the methods and data sources used are included in Appendix 1.

Estimates of methane and nitrous oxide emissions due to LULUCF activities remain small: 0.003 Mt CO_2 equivalent of methane and 0.0003 Mt CO_2 equivalent of nitrous oxide in 2007.

4.6 Waste

Greenhouse gas emissions in the waste sector are dominated by methane emissions from landfills, which represent 91% of total emissions from this sector. The remaining emissions are accounted for by wastewater treatment, and a small emission from waste incineration.

Emissions of methane from landfills represent 26.1% of total Welsh methane emissions, and have decreased by 57.1% since 1990, due to increasing use of methane capture and oxidation systems. Estimates were based on data on arisings of municipal solid waste and sewage sludge in Wales using data from www.wastedataflow.org.

[19] Note: numbers in brackets give the category value as a percentage of the total N_2O emissions from agricultural soils

This data source includes regional data such as tonnages and percentages of MSW treatment and disposal options such as recycling, incineration and landfill, enabling a detailed DA split of waste disposed to landfill to be derived. Data for 2000-2007 are currently available (and the 2000 split is assumed as the best estimate for the 1990-1999 years). Due to lack of detailed local data, the DA disaggregation method still retains the assumption that landfill methane recovery rates are the UK average within each DA.

Emissions from wastewater treatment are 2.2% of total Welsh N_2O emissions, and these emissions account for 4.9% of UK wastewater treatment N_2O emissions.

4.7 Emission Maps: Wales 2007

As part of the NAEI, the UK produces mapped emissions of CO_2 (as C), CH_4 and N_2O. The maps are modelled estimates of emissions compiled at a 1 km^2 resolution and Figures 4.4 to 4.6 shown the emissions in Wales. The maps reveal the locations and intensities of the major sources of emissions and are used by AEA and other organisations for a variety of Government policy support work at the national scale, regional and local scale. Local area statistics are compiled from the maps and related data, for example, Local Authority level data on carbon dioxide emissions and fuel use have been produced for Defra and DECC (formerly BERR) since 2003 using data from the NAEI mapping work. As of March 2008, these datasets were reclassified as National Statistics (King et al and Bush et al, 2008). The distributions of CH_4 and N_2O emissions from agricultural sources are generated at a 5 km^2 resolution by the Centre for Ecology and Hydrology (CEH), and are then re-sampled at a resolution of 1 km^2 by the NAEI mapping team.

One set of maps is produced each year for the most recent NAEI year. The mapped emissions data are made freely available on the NAEI web site at

http://www.naei.org.uk/data_warehouse.php

and

http://www.naei.org.uk/mapping/mapping_2007.php

The most recent report on the mapping of emissions can be found at:

http://www.naei.org.uk/reports.php

Figure 4.4: Map of Emissions of CO2 (tonnes) in Wales in 2007

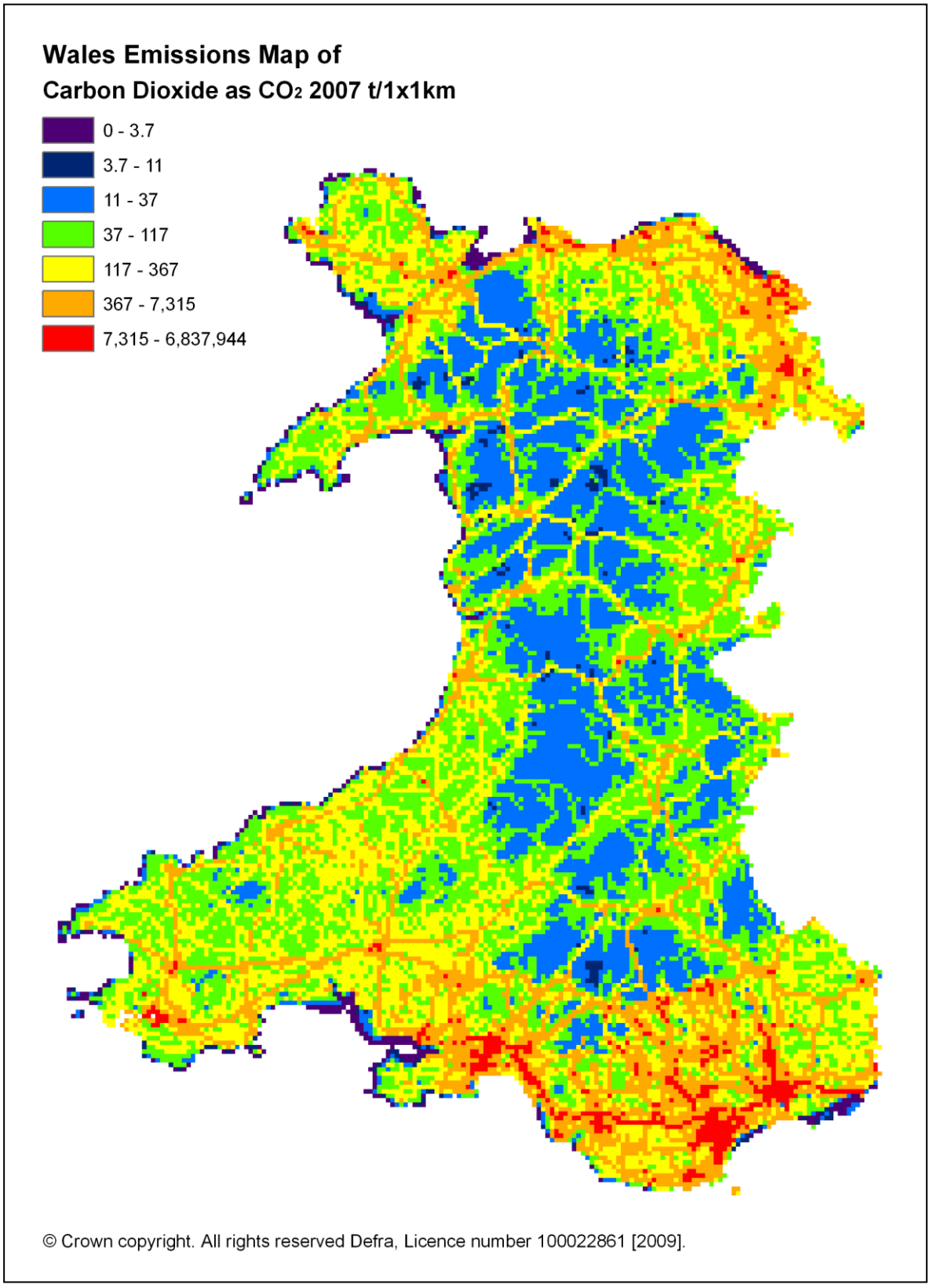


Figure 4.5: Map of Emissions of CH4 (tonnes CO2 equivalent) in Wales in 2007

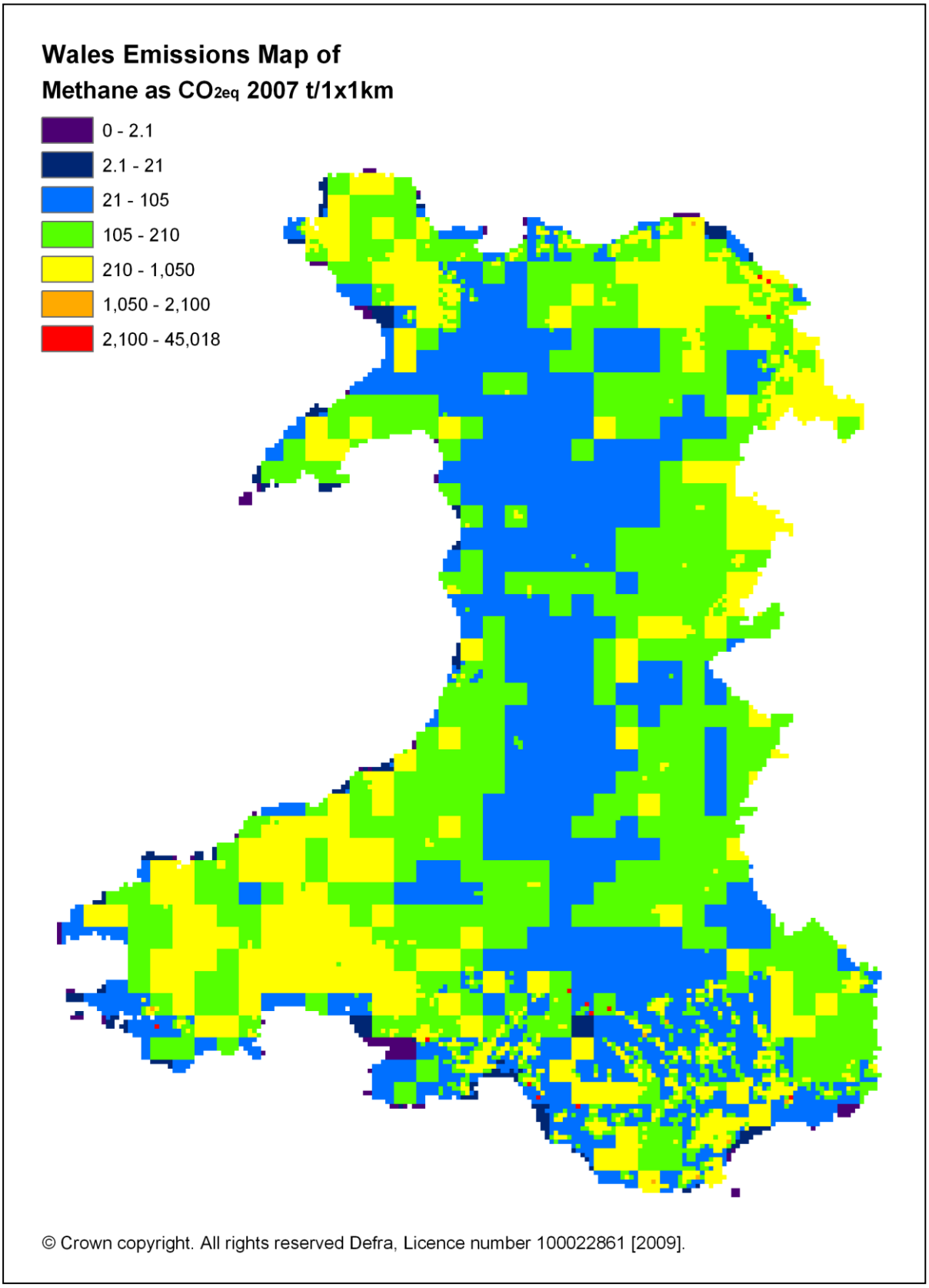
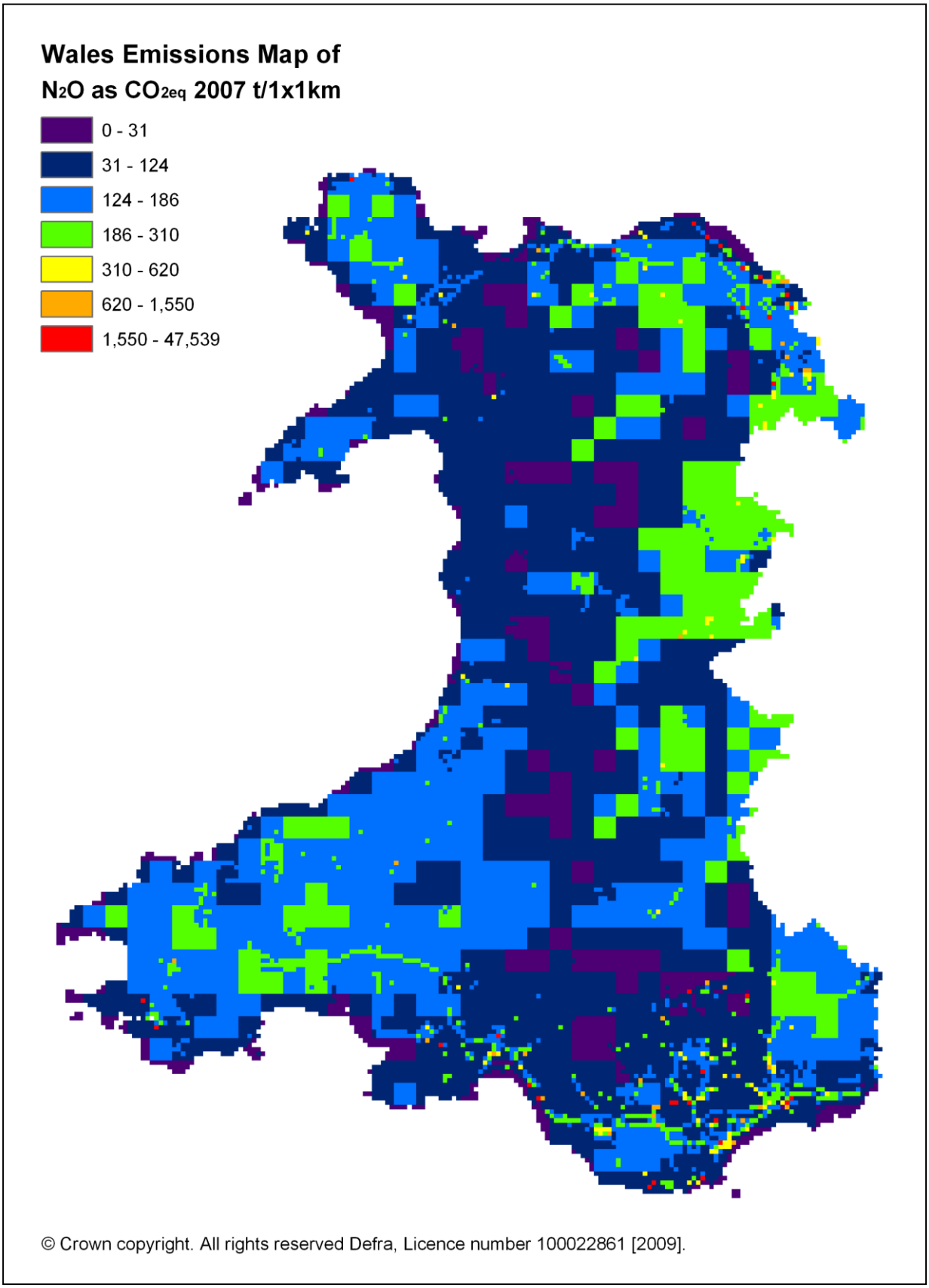


Figure 4.6: Map of Emissions of N2O (tonnes CO2 equivalent) in Wales in 2007



5 Emissions in Northern Ireland

5.1 Summary of GHG Emission Sources

The main GHG emission sources for Northern Ireland in 2007 are summarised in Figure 5.1 below, expressed as a percentage of the total Northern Irish GHG emissions in 2007 of 21.8 Mt CO_2-equivalent. The trends in Northern Irish GHG emissions since the base years of 1990 (for CO_2, CH_4 and N_2O) and 1995 (for fluorinated gases) are as follows:

- CO_2 emissions have reduced by 8.7%
- CH_4 emissions have reduced by 24.1%
- N_2O emissions have reduced by 25.4%
- HFC emissions have increased by 513%
- PFC emissions have reduced by 100%
- SF_6 emissions have increased by 287%
- Total GHG emissions (as CO_2-equivalents) have reduced by 12.6%

Emissions in Northern Ireland are dominated by CO_2 from power stations, road transport and residential combustion, which together account for 59% of the total net emissions. Agricultural sources, including N_2O from soils and CH_4 from enteric fermentation, in this sector all appear in the list of the ten largest sources.

Figure 5.1: Summary of main emission sources (% kt CO2e) for Northern Ireland, 2007

[Total 2007 Northern Ireland GHG emissions = 21.8 Mt CO_2-equivalent]

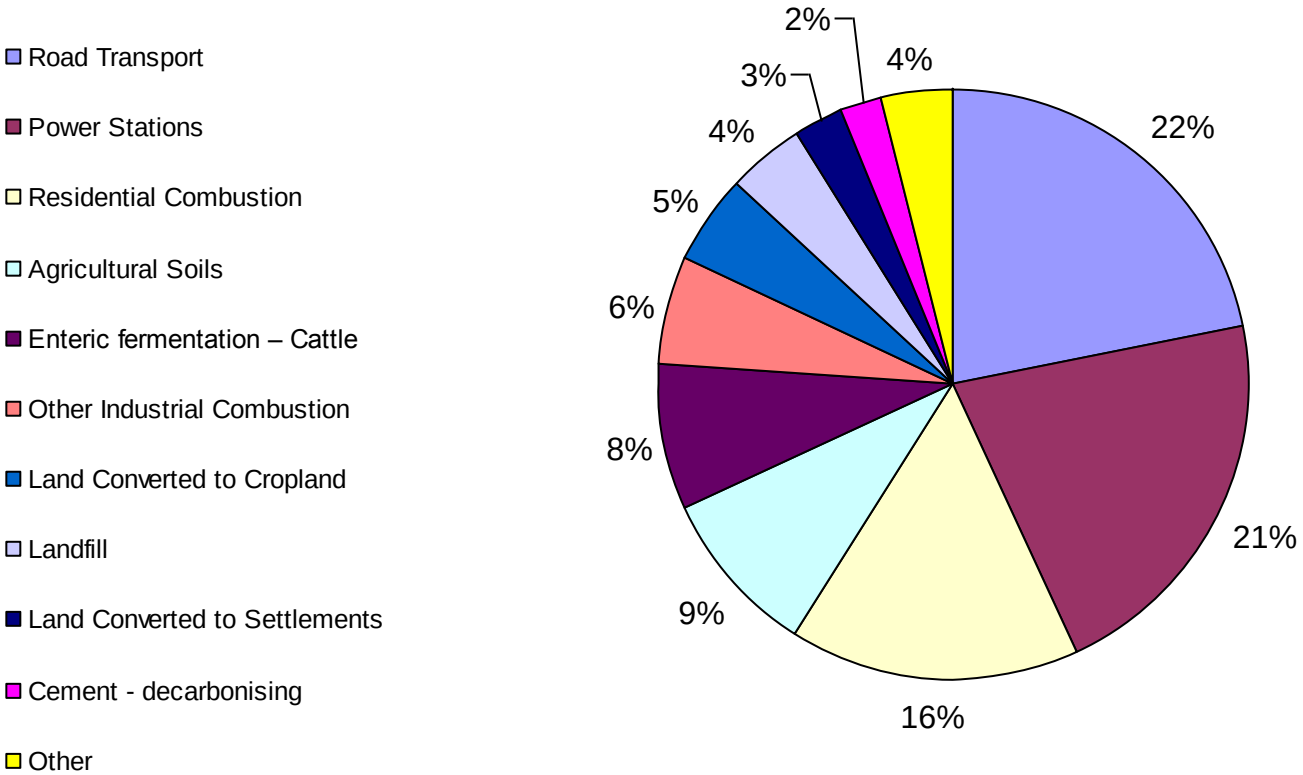


Table 5.1: Emissions Summary for Northern Ireland, 2007 (kt CO2e)

Summary of Main Emission Sources, Northern Ireland 2007 (kt CO_2e)				
Gas	Sector Name	IPCC code	Emission	Percentage of total GWP Weighted Emissions
CO_2	Road Transport	1A3b	4804	22%
CO_2	Power Stations	1A1a	4640	21%
CO_2	Residential Combustion	1A4b	3465	16%
N_2O	Agricultural Soils	4D	1932	9%
CH_4	Enteric fermentation – Cattle	4A1	1845	8%
CO_2	Other Industrial Combustion	1A2f	1406	6%
CO_2	Land Converted to Cropland	5B2	1128	5%
CH_4	Landfill	6A1	768	4%
CO_2	Land Converted to Settlements	5E2	569	3%
CO_2	Cement - decarbonising	2A1	440	2%

Note that in the IPCC sector discussion text below, the percentages quoted are derived from the inventory and emissions data stored at full precision. These data can be found on the NAEI web site and on the CD-ROM that accompanies this report. The percentages in the text of this chapter do not in all cases match directly with percentages in the above table (which are quoted as % of the total of all six GHG emissions).

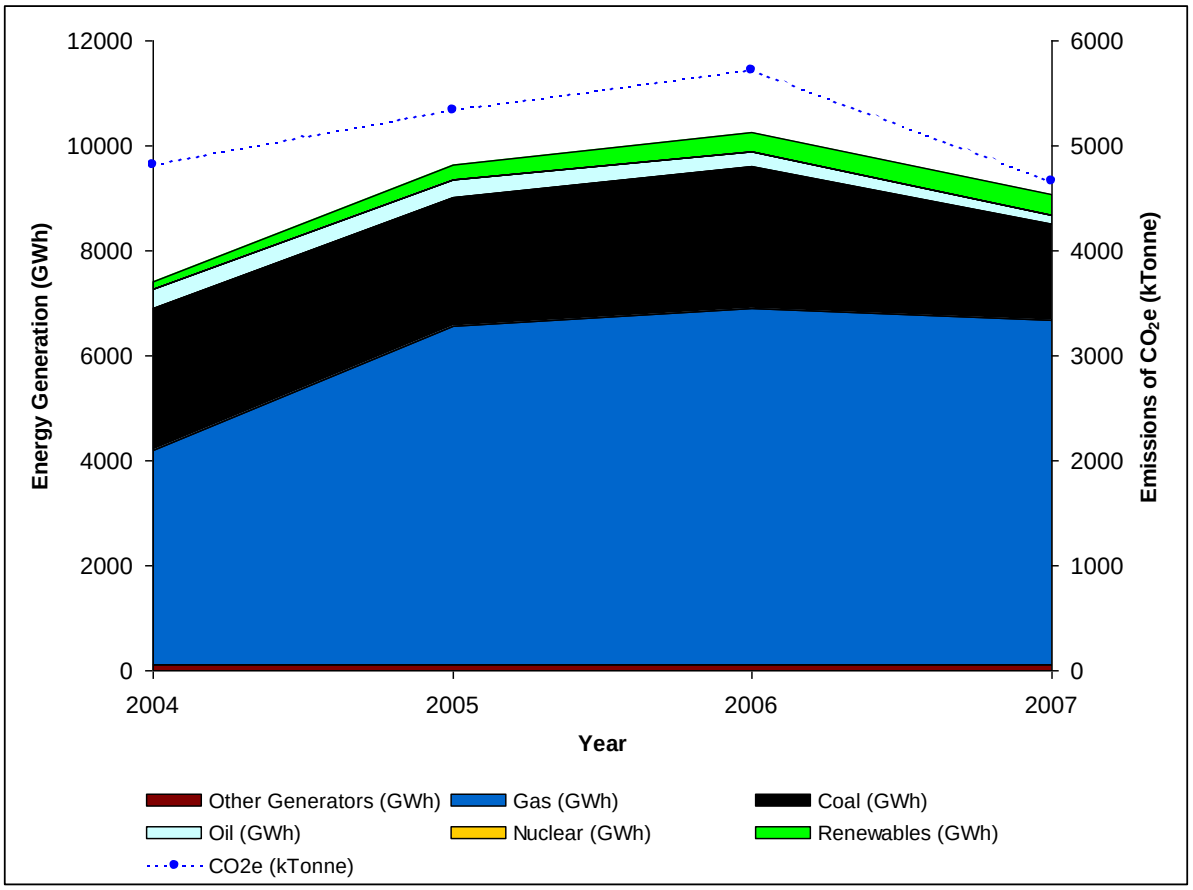
5.2 Energy

In Northern Ireland, emissions from the Energy sector represent 73% of total greenhouse gas emissions. This is much lower than the UK average contribution from this sector, which in 2007 was 85.5%. This is because, unlike the other DAs, Northern Ireland does not have any refineries, iron and steel industry, 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.

Unlike the other DAs, power generation is no longer the largest source of CO_2 in Northern Ireland, where emissions from road transport constitute the most significant source in 2007. This is partly due to a reduction in power generated from coal and gas fired power stations in Northern Ireland, which in 2007 were approximately 32% and 3% lower than in 2006 (Figure 5.2). GHG emissions from power generation represent 29% of total emissions from the energy sector, and 21% of total GHG emissions in Northern Ireland in 2007.

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. The emission of CO_2 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.

Figure 5.2: Power Generation By Fuel and Cumulative GHG Emissions: Northern Ireland, 2004 to 2007

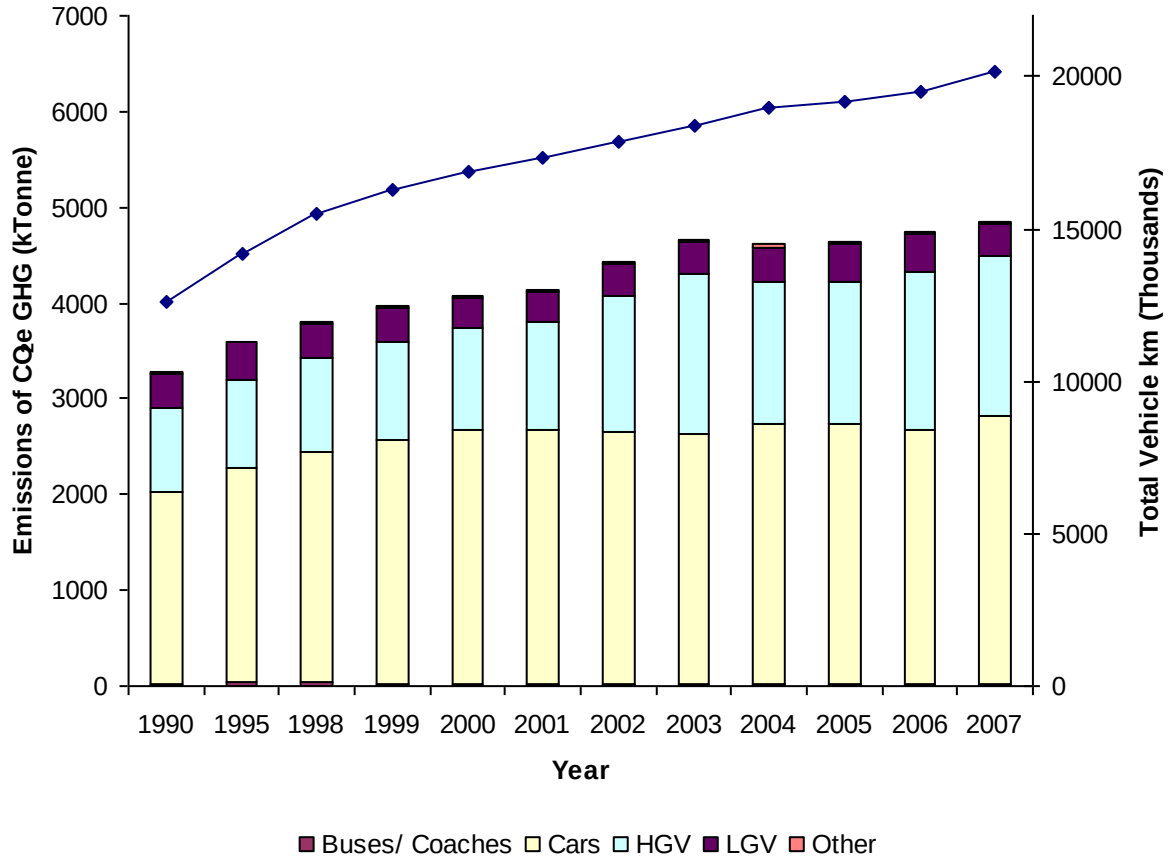


Carbon dioxide emissions from electricity generation in Northern Ireland have decreased by 15.2% between 1990 and 2007. The emissions have shown an 18.6% decrease from 2006 to 2007. This decrease reflects a 32% reduction in coal-fired generation from 2,701 GWh in 2006 to 1,833 GWh in 2007 and a 3% reduction in gas-fired generation from 6,799 GWh in 2006 to 6,576 GWh in 2007. This reduction in local generation did not reflect a significant reduction in local electricity consumption, however, as during 2007 Northern Ireland returned to being a net importer of electricity, rather than a net exporter (as in 2005 and 2006).

Northern Ireland generates electricity that is subsequently exported and sold into the Republic of Ireland electricity grid, whilst Northern Ireland also imports electricity from Scotland via the Moyle interconnector. In 2005 and 2006 Northern Ireland was a net exporter of electricity (DECC, 2008b); in 2006, net exports from Northern Ireland amounted to 873 GWh of electricity, around 8.5% of all power generated in Northern Ireland. However in 2007 Northern Ireland was a net importer of electricity, importing 399 GWh of electricity, around 4% of all power generated in Northern Ireland.

Emissions from road transport represent 30.3% of the 2007 Northern Ireland CO_2 total, with emissions having risen by 48.7% since 1990 (Figure 5.3), compared with an 11.0% increase for the UK over the same period. Road transport also contributed 2.0% of total Northern Ireland N_2O emissions in 2007. The 1990-2006 inventory indicated that this proportion was 7.2% in 2006. Estimates of N_2O emissions from road transport have been reduced for recent years within the latest inventory cycle, due to revisions in emission factors for some vehicle types. Full details of the emission factor revisions are presented in Appendix 1. The overall increases in road transport emissions reflect a parallel increase in vehicle km travelled by road transport in Northern Ireland during this period, where a 60% increase has been reported from 1990 to 2007 (see Figure 5.3). Cars represent the most significant source of CO_2 emissions from the road transport sector, contributing approximately 57% of CO_2 from the sector in 2007. HGVs contributed 34% of total Northern Ireland road transport CO_2 emissions in 2007, which is significantly higher than the UK average figure of 21.6%. A detailed discussion on the methodology used to estimate emissions from the road transport sector is presented in Appendix 1.

Figure 5.3: Total Road Traffic Vehicle Kilometres and GHG Emissions from Different Vehicle Types: Northern Ireland 1990-2007



Combustion emissions from Manufacturing Industry and Construction (IPCC Sector 1A2) account for 8.9% of the total Northern Ireland carbon dioxide emission in 2007 compared with 14.6% for the UK. There is no iron and steel production in Northern Ireland, so the category is entirely 'Other Industry'. The Other Industry category (IPCC sector 1A2f) for Northern Ireland contributes 2.3% towards the UK Other Industry total in 2007, and has decreased by approximately 32.6% over the period 1990-2007, compared with a UK average 19.6% decrease for this sector.

Other combustion emissions arise from the domestic, commercial, public sectors and agriculture stationary combustion. Carbon dioxide emissions from domestic combustion sources are estimated to account for 21.9% of the Northern Ireland CO_2 total in 2007. As a proportion of UK domestic emissions they are estimated to represent 4.6%, which is slightly higher than would be expected from Northern Ireland's population (2.9% of UK). 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 domestic sector, although natural gas is becoming more widely available and domestic CO_2 emissions have shown a decrease of 24.0% since 1990. Northern Ireland has a proportionately higher consumption of LPG (bottled gas) than the rest of the UK, but in absolute terms this is not a significant source of carbon dioxide emissions.

There are no emissions in the category Fugitive Emissions from Fuels, and there are therefore no significant sources of methane in the energy sector in Northern Ireland.

5.3 Industrial Processes

Total greenhouse gas emissions from industrial processes in Northern Ireland contribute 3.5% to the overall emissions total, and more than half of these emissions (58%) are process CO_2 emissions from the cement industry. There are no sources of methane, N_2O or PFCs in this sector in Northern Ireland in 2007, and the remainder of the emissions in this sector are made up of smaller CO_2 emission sources, and emissions of HFCs and SF_6.

Total emissions of HFCs from Northern Ireland in 2007 constituted 2.6% of the UK total (as CO_2 equivalent), and represent 33% of total greenhouse gas emissions in the Northern Ireland industrial process sector. Total HFC emissions in Northern Ireland have increased by over 500% since the 1995 base year, to 252kt CO_2 equivalent in 2007, driven mainly by increased emissions from refrigeration and air conditioning units. The largest source of emissions in 2007 was refrigeration (including air conditioning), which contributed 56.3% of the Northern Ireland HFC total due to losses from refrigeration and air conditioning equipment during its manufacture and lifetime. Aerosols contributed 34.5% to the total Northern Irish HFC emission in 2007, the main sources being industrial aerosols and the medical application of metered dose inhalers. The remaining emission sources (foams, fire-fighting and solvents) contributed 9.1% of total Northern Irish HFC emissions.

Emissions of sulphur hexafluoride from Northern Ireland accounted for 0.9% of the UK total in 2007. The main sources of SF_6 emissions are leakage from the electrical switching gear used in electricity transmission and the soles of certain brands of training shoes. The use of SF_6 in the electronics industry in Northern Ireland is negligible.

5.4 Agriculture

Emissions from agriculture represent 21% of total greenhouse gas emissions in Northern Ireland in 2007, a significantly higher proportion than the UK average (7%). This is because there are fewer industrial and energy related emission sources in Northern Ireland than there are elsewhere in the UK, and hence, agriculture emissions are comparatively more important.

Methane emissions from this sector arise from enteric fermentation in livestock (85%) and the management of animal wastes (15%). The largest single source of methane emissions in Northern Ireland is enteric fermentation from cattle. This source alone accounts for 56% of total methane emissions in Northern Ireland[20], and for 40.2% of total greenhouse gas emissions in the agriculture sector. These emissions are dependent on cattle numbers, which have increased by around 7% since 1990. This is in contrast to the overall trend for the UK, which shows a decrease in emissions of methane from this source. Emissions from Northern Ireland represent 13.3% of total UK agricultural methane.

The agriculture sector also constitutes the largest source of N_2O emissions in Northern Ireland, with emissions from agricultural soils (6.2 kt N_2O) accounting for 81% of all Northern Ireland N_2O emissions in 2007. Northern Irish agricultural nitrous oxide emissions have fallen by 16.4% between 1990 and 2007, and in 2007 represent 8.6% of UK agricultural N_2O emissions. A further breakdown of the agricultural soils sector emission is shown below:[21]

- Leaching of fertiliser nitrogen and applied animal manures to ground and surface water (29.4%);
- Wastes from grazing animals (26.5%);
- Synthetic fertiliser application (16.9%);
- Manure used as fertiliser (16.9%);
- Atmospheric deposition of ammonia (NH_3) and oxides of nitrogen (NOx) (8.1%);

[20] Cattle replacement numbers were overestimated for Northern Ireland for 2006, resulting in a slight overestimation of methane emissions (3.5%). This has been corrected in the 2007 inventory.

[21] Note: numbers in brackets give the category value as a percentage of the total N_2O emissions from agricultural soils

- Ploughing in crop residues (1.1%)[22];
- Improved grass (1.0%);
- Histosols (i.e. high organic content soils) (0.2%); and
- cultivation of legumes (0%)[6.]

5.5 Land Use, Land Use Change and Forestry

The LULUCF sector contains both sources and sinks of carbon dioxide, as well as small sources of methane and nitrous oxide. Northern Ireland is a net sink of carbon dioxide from LULUCF activities: the size of this sink has increased from -0.03 to -0.29 Mt CO_2 from 1990 to 2007. The Cropland net source (1.1 Mt CO_2 in 2007) and the Grassland net sink (-1.3 Mt CO_2 in 2007) are the largest contributors to the LULUCF sector in Northern Ireland. Net emissions from the Cropland category have diminished over time, while net removals from Grassland have increased.

Net removals in 1990 are estimated to be -0.030 Mt CO_2 here as in the 2006 DA inventory report. For 2006, a net sink of -0.295 Mt CO_2 is estimated here compared to a net source of -0.289 Mt CO_2 reported in the 2006 inventory. The differences between the inventories are primarily due to updated activity data using 2007 estimates, including revised estimates of forest area in Northern Ireland.

Deforestation associated with harvested wood products is included in this year's inventory. The removal of timber from harvesting or thinning operations is considered as deforestation and therefore should be reported. Deforestation is the result of either a land use change or thinning and it is assumed that a change in land use will be to Grasslands or Settlements and will be reported in Sector 5.C.2 and 5.E.2 respectively. Forestland which is thinned will undergo a reduction in area with these changes are reported in 5.A.1. Appendix 1 contains details of the methods and data sources used in to derive these figures.

Estimates of methane and nitrous oxide emissions due to LULUCF activities remain small: 0.001 Mt CO_2 equivalent of methane and 0.0001 Mt CO_2 equivalent of nitrous oxide in 2007.

5.6 Waste

Emissions from the waste sector represent 3.8% of total greenhouse gas emissions in Northern Ireland, and 3.7% of total UK waste emissions.

These emissions are dominated by methane emissions from landfills, which comprise 92% of total greenhouse gas emissions in the waste sector. Estimates are based on data on arisings of municipal solid waste and sewage sludge in Northern Ireland using data from www.wastedataflow.org. This data source includes regional data such as tonnages and percentages of MSW treatment and disposal options such as recycling, incineration and landfill. This enables a detailed DA split of waste disposed to landfill to be derived, and includes data back to 1999, which has been used to back-calculate the estimates to 1990 by DA. Due to lack of detailed local data, the DA disaggregation method still retains the assumption that landfill methane recovery rates are the UK average within each DA. On this basis the landfill emissions in Northern Ireland have fallen by 52% since 1990 due to increasing use of methane recovery systems.

Emissions from wastewater treatment represent 2.9% of UK emissions from this source, which is similar to the relative populations. Wastewater treatment is a relatively important source of N_2O emissions, representing 1.5% of total N_2O emissions in Northern Ireland in 2007.

[22] Crop production data specific to Northern Ireland for 2006 was missing, leading to a minor underestimation (0.9%) of nitrous oxide emissions. This has been corrected in the 2007 inventory.

5.7 Emission Maps: Northern Ireland 2007

As part of the NAEI, the UK produces mapped emissions of CO_2 (as C), CH_4 and N_2O. The maps are modelled estimates of emissions compiled at a 1 km^2 resolution and Figures 5.4 to 5.6 shown the emissions in Northern Ireland. The maps reveal the locations and intensities of the major sources of emissions and are used by AEA and other organisations for a variety of Government policy support work at the national scale, regional and local scale. Local area statistics are compiled from the maps and related data, for example, Local Authority level data on carbon dioxide emissions and fuel use have been produced for Defra and DECC (formerly BERR) since 2003 using data from the NAEI mapping work. As of March 2008, these datasets were reclassified as National Statistics (King et al and Bush et al, 2008). The distributions of CH_4 and N_2O emissions from agricultural sources are generated at a 5 km^2 resolution by the Centre for Ecology and Hydrology (CEH), and are then resampled at a resolution of 1 km^2 by the NAEI mapping team.

One set of maps is produced each year for the most recent NAEI year. The mapped emissions data are made freely available on the NAEI web site at

http://www.naei.org.uk/data_warehouse.php

and

http://www.naei.org.uk/mapping/mapping_2007.php

The most recent report on the mapping of emissions can be found at:

http://www.naei.org.uk/reports.php

Figure 5.4: Map of Emissions of CO2 (tonnes) in Northern Ireland in 2007

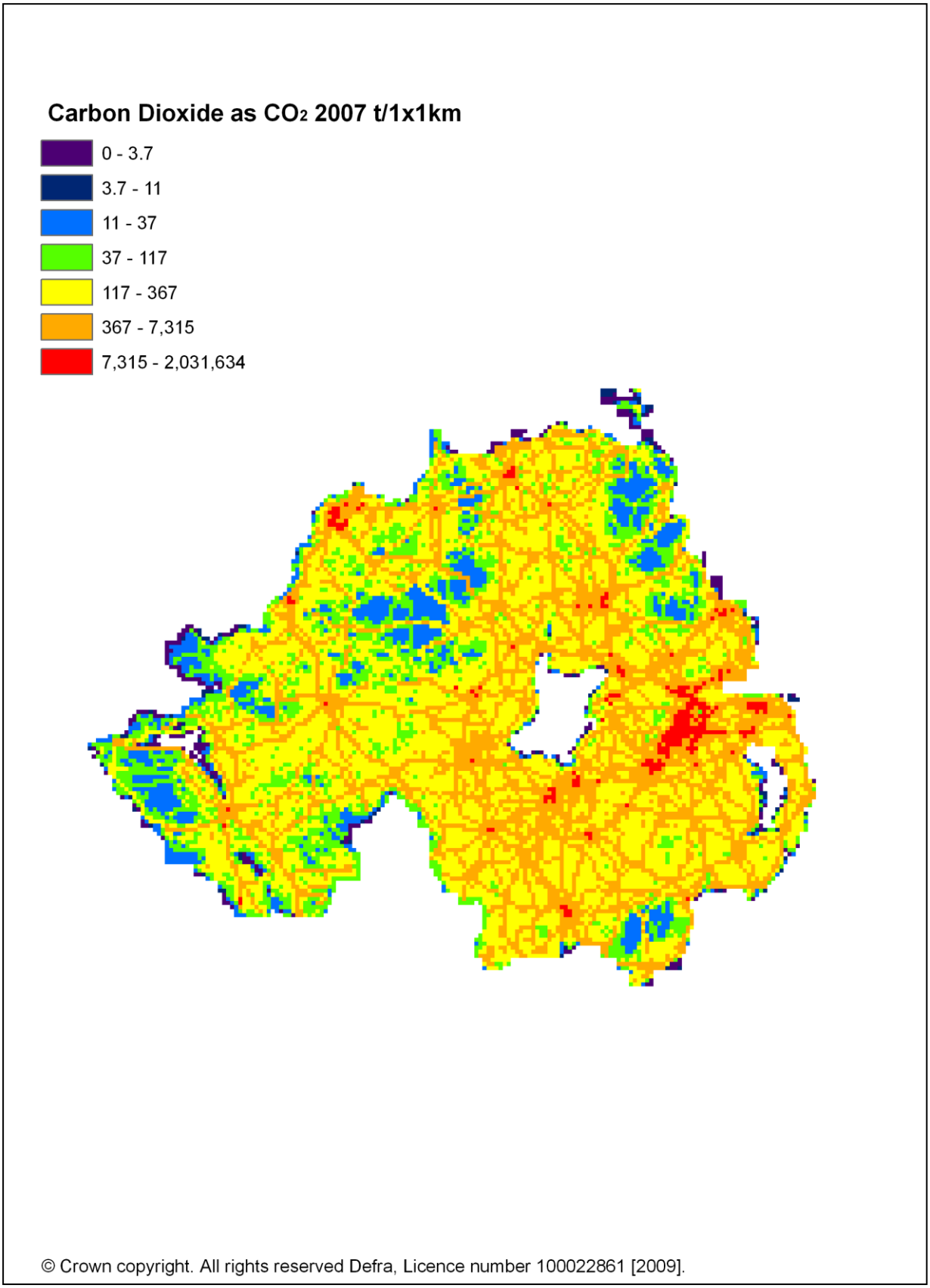


Figure 5.5: Map of Emissions of CH4 (tonnes CO2 equivalent) in Northern Ireland in 2007

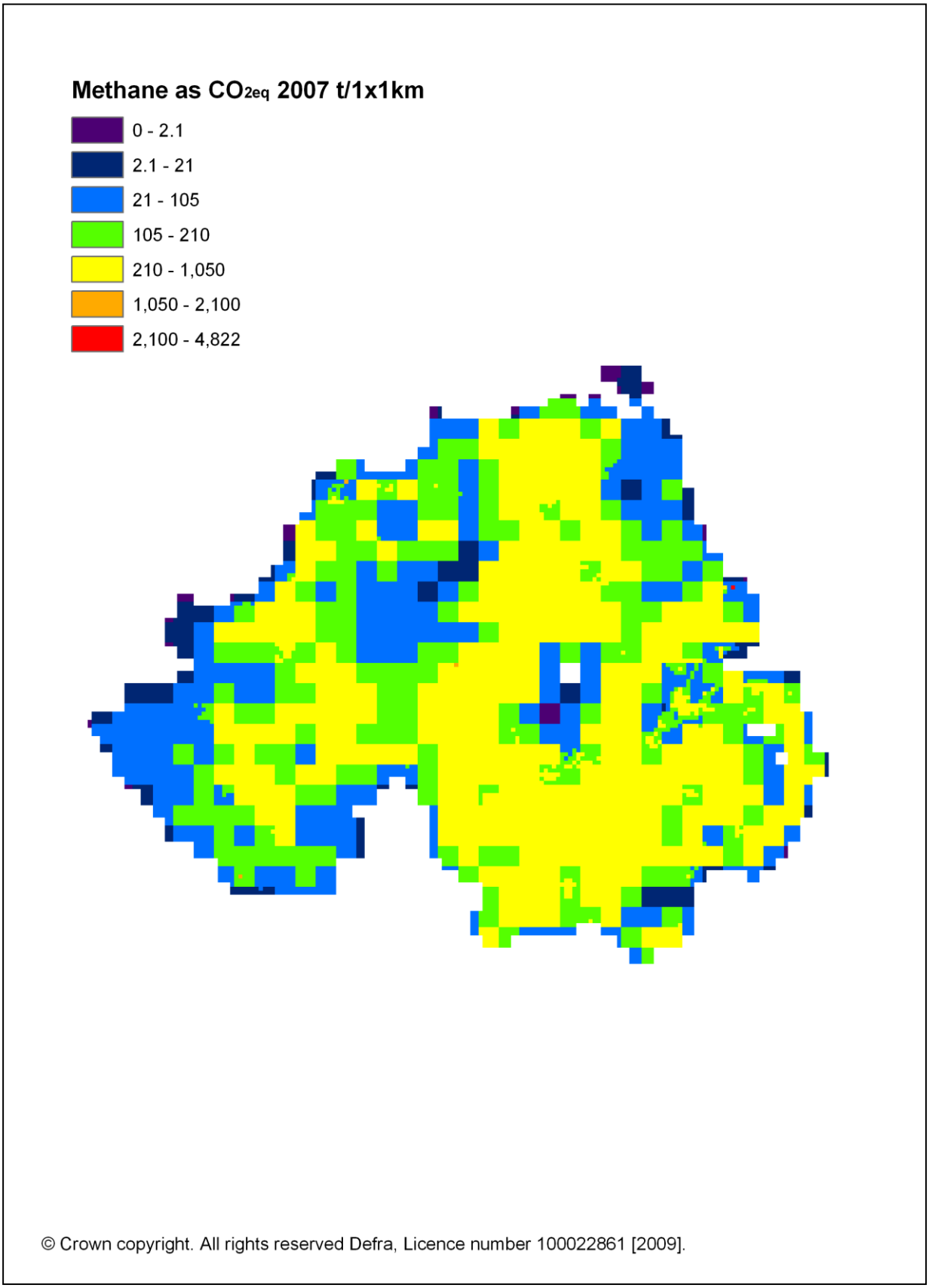
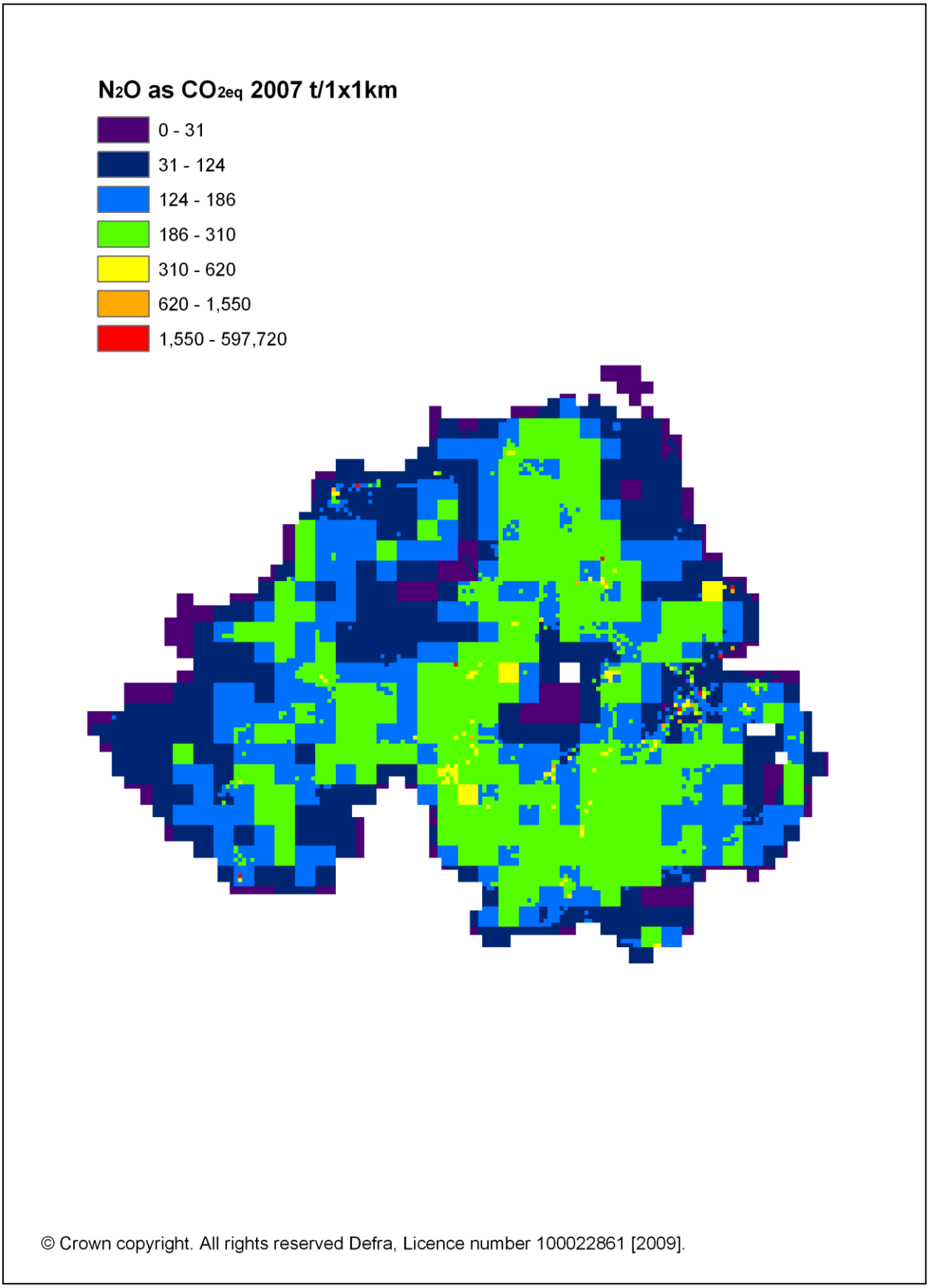


Figure 5.6: Map of Emissions of N2O (tonnes CO2 equivalent) in Northern Ireland in 2007



6 Unallocated Emissions

Emissions from offshore oil and gas installations are accounted as “unallocated” emissions. The total “unallocated” emissions in 2007 account for 2.8% of UK emissions, this is a small increase from 1990 figure of 2.0%. As a proportion of the 2007 UK totals they account for the following:

- Carbon dioxide 3.0% (up 24% since 1990)
- Methane 2.1% (down 46% since 1990)
- Nitrous oxide 0.9% (up 33% since 1990)

There are no unallocated emissions of halocarbons and sulphur hexafluoride.

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7 Data Availability and Inventory Revisions

In order to estimate a complete greenhouse gas inventory for each constituent country of the UK, it would be necessary to have a complete set of activity data for each country to the same level of detail as that used for the UK Inventory. Such a set of data is not available; in particular there are no comprehensive fuel use statistics for the constituent countries of the UK.

As environmental regulation and related monitoring mechanisms have developed within the UK, the availability of emissions and fuel use data has also developed. Each year the availability of data that could be used to inform or improve emission inventories is changing, but for many sources there is very limited data available to improve DA-estimates back to the Kyoto Protocol Base Years of 1990 (for CO_2, CH_4 and N_2O) and 1995 (for fluorinated gases). Since 2005, the EU Emissions Trading Scheme (EUETS) has provided a new data source for fuel consumption on a site-by-site basis for many of the most energy intensive industrial installations in the UK, and these new data have been used in conjunction with existing point-source emissions data (from the EA, SEPA and NI DoE) to improve the DA GHG estimates for recent years.

The availability of data and estimation methodologies employed to disaggregate UK across the constituent countries to compile the DA inventories are discussed in Appendix 1 for each source sector.

7.1 Data Availability by Sector

Generally, sufficient country-specific activity data are available for the following sectors:

- **Agriculture** (Defra and the DA Governments);
- **Land Use Change and Forestry** (Centre for Ecology and Hydrology);
- **Industrial Processes & Large Combustion Plant** (for most of these, country data are available from producers, trade associations, the Environment Agency's Pollution Inventory, the Scottish Environmental Protection Agency's SPRI and the Northern Ireland Department of Environment's ISR.); and
- **Road Transport** (DfT and DRDNI) Detailed road count point data are available for major roads across the DAs. Estimates are made based on assessments of vehicle kilometre data, broken down at detailed vehicle-type level. Some improvements may be possible if more detail regarding local fleet composition was to be made available.

7.1.1 Fuel Consumption

The availability of data across this wide-ranging sector of activity is very variable. The basis for all of the UK NAEI fuel consumption data are the *Digest of UK Energy Statistics* (DECC, 2008a), and this publication includes some regional data such as coal production, domestic gas consumption and consumption of liquid fuels. The liquid fuel data consist of totals of different types of liquid fuel for Northern Ireland, Scotland and England and Wales combined. This regional data is of limited use, since it provides no sector split for final consumption of oils and the data are based on sales information from refineries, and does not track secondary sales across the UK fuel market.

UK National Grid provides gas sales data for Great Britain disaggregated by region and consumer size, whilst Phoenix Gas and Firmus Energy provide data for natural gas consumption in Northern Ireland disaggregated by type of consumer. Therefore for each constituent country the overall gas consumption data is of good quality, but there is limited information to inform the allocation of gas use to a specific sector in each country.

Fuel consumption within the iron and steel industry is well documented by *Iron and Steel Industry Statistics* (ISSB, 2008). The ISSB data deal with primary iron and steel production but excludes most secondary processes. DUKES data are therefore also used to refine estimates for this sector.

Emissions from power generation and the cement and lime industry are calculated from emissions data within the Pollution Inventory (England and Wales) and point source data obtained directly from SEPA and DoE NI. However, there has only been a consistent UK-wide set of emissions data from these sources since 2002, and hence estimates for earlier years are more uncertain and are based on operator-supplied information, DECC fuel use data (e.g. for power stations) and plant production data from trade associations (e.g. cement industry data from the BCA). Emissions data for 2005 onwards are now also available through the EU Emissions Trading Scheme (EU ETS) for power generation and other large combustion sources, although the scope of reporting to date is limited in some energy-intensive sectors due to EU-ETS opt-outs (e.g. cement manufacture).

Emissions data for the refineries sector are provided annually by UKPIA, providing a detailed breakdown of plant-specific emission sources for each refinery in the UK. Once again, this detailed data has only been available for more recent years and historic emission estimates back to 1990 are based on industry estimates of plant production rather than on reported emissions or fuel use data, and hence are subject to greater uncertainty. The EU ETS data for refineries has proven to be of little use in the improvement of the UK and DA inventories to date as different refinery operators use different approaches to fulfilling reporting requirements, providing an inconsistent picture of fuel use across this industry. This is especially true for 2006 and 2007 data, as reported emissions to different mechanisms (PI/SPRI, EUETS, UK GHGI) by refinery operators differ by a very significant margin for some sites. There is ongoing research with DECC and UKPIA to resolve these data inconsistencies.

Detailed data are available for the oil and gas exploration & production industry (for both offshore and onshore installations) from the Oil & Gas UK Environmental Emissions Monitoring System (EEMS) database which includes installation and process-specific data for 1995, and 1998 to 2007 of varying coverage; earlier years in the Oil & Gas UK dataset are more sparsely populated and appear to be less consistent across the industry. All 1990 sector splits have been based on extrapolating back sector splits from later years. There are some data inconsistencies evident across the time-series of the EEMS data, and hence the trends in emissions from the oil and gas extraction sector are quite uncertain.

Northern Ireland produces an annual set of fuel statistics that include sector-specific consumption data for coal and total consumption for oil products. However, the usefulness of these statistics is somewhat unclear, as the Annual Coal Enquiry in Northern Ireland does not provide a breakdown of solid fuel use by type (i.e. steam coal, anthracite, coke data are not provided separately) and there is no detail regarding use of different oil grades by end-users.

Up until 1994, the Welsh Office produced a fairly detailed set of fuel statistics based on DTI estimates. However this has been discontinued since the privatisation of the energy industries, due to concerns of commercial confidentiality.

Scotland does not publish fuel statistics. Limited data on coal production and gas consumption in 1990 has previously been provided and forms the basis of some extrapolated data estimations.

Hence the main sources where fuel use data have been estimated are:

- Domestic use of solid fuels and petroleum-based fuels;
- Miscellaneous/Commercial and public sector use of solid fuels and petroleum-based fuels;
- Agriculture sector use of solid fuels and petroleum-based fuels ; and
- All fuel use within the “Other Manufacturing Industry” sector (excluding cement and autogeneration).

Various surrogates are used to derive regional estimates of fuel use for these source sectors:

- The regional disaggregation of agricultural sector fuel combustion emissions and oil consumption are based on employment statistics, except for oil use by mobile agricultural machinery which are disaggregated using land use, farm type and average machinery use factors;

- DECC Regional Energy Statistics are used for solid and liquid fuels in the commercial, public, small industrial and domestic sectors; and
- Domestic sector estimates are based on DECC Regional Energy Statistics and reported trends in fuel use from Northern Ireland Housing Condition Surveys, to ensure that the effects of the developing gas supply infrastructure in Northern Ireland is reflected in the inventory.

Regional energy statistics are published annually by the Department for Energy and Climate Change (DECC) within the quarterly *Energy Trends*[23] publication. These regional 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 & Commercial;
- Agriculture; and
- Residential.

The DECC regional energy statistics have been developed in recent years to provide estimates of fuel use and CO_2 emissions data at Local Authority (LA) level across the UK. The latest available data include LA solid and liquid fuel use estimates for 2005 and 2006, with gas and electricity data also available up to 2007.

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 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[24]. These DECC Regional 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 DUKES (DUKES is 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 Devolved Administrations and are therefore used to underpin the CO_2 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.

However, the usefulness of the DECC regional energy data to inform DA-specific trends in energy use since 1990 by sector are limited due to a number of factors:

- The DECC regional energy data only cover recent years in the time-series (2003 to 2006). These data provide the best estimate of DA fuel use for recent years, but their use do not guarantee any improvement to the accuracy of DA-specific emission trends since 1990. For some sectors (e.g. residential) where additional periodic publications give indications of relative trends in fuel use across the DAs, the recent data from DECC have been used to back-calculate the DA-specific fuel use and GHG emissions in 1990. For other sectors, the UK trends evident from DUKES data are all that is available to inform likely DA trends since 1990;

- The availability and detail of local energy use data is evolving as demands for new local and regional energy use data are developing. Comparison of the regional energy data available from DECC during the 1990-2007 DA GHGI compilation has highlighted a number of inconsistencies between reported UK and local data, for which comprehensive solutions have not been found. Notably the regional gas use data presented within the periodic DECC publication, Energy Trends, differ from the UK gas use totals reported in DUKES, due to different reporting criteria. Analysis of major installation gas use from EU-ETS data does not compare closely with the reported gas use by major industrial sites that are outlined within the DECC data. Although progress has been made to resolve many such data inconsistencies, issues of data confidentiality have inhibited complete resolution of these matters; and

[23] The latest available data are taken from the December 2008 Energy Trends, http://www.berr.gov.uk/files/file49202.pdf
[24] For more details regarding the research method that underpins the latest DECC Regional Energy Statistics for solid and liquid fuels, including details of improvements to fuel mapping methodologies, see http://www.berr.gov.uk/files/file48686.pdf

- The starting point for the regional energy calculations is gas and electricity meter data provided by fuel suppliers. The data comprise annual fuel consumption data allocated to broad end-user sub-sectors; gas use data are allocated to "domestic" and "industrial and commercial" users based on the annual consumption levels, whilst the electricity data are available at slightly greater resolution based on analysis of electricity tariff information. The detailed allocation of fuel use to end-user sector is therefore quite uncertain, and this has knock-on effects across the analysis conducted for the non-gas, non-electricity fuels. As a consequence, the sector-specific fuel use estimates (at UK, DA and LA level) are somewhat uncertain, whilst overall fuel use and emission estimates are more accurate.

7.2 Inventory Revisions to Data and Methods

A number of changes have been made to the estimates since the last study (Jackson *et al* 2008) due to: (i) revisions to methodologies and source data within the UK GHG inventory, and (ii) through revisions to available data at local and regional level such as revised local energy data within the DECC Regional Energy Statistics and updates to agriculture and LULUCF survey data.

The UK GHG inventory is updated each year to reflect changes in statistics for earlier years, or changes to emission factors or methodologies. These changes are explained in the National Inventory Report (Jackson *et al* 2009). The most significant changes affecting the inventories for England, Scotland, Wales and Northern Ireland are summarised in the table below.

Appendix 1 of this report provides for more information about the DA inventory compilation methodologies and source data.

Table 7.2: Revisions to UK and DA GHG Inventory Methods and Source Data

IPCC Sector	UK Method and Data Revisions	DA Method and Data Revisions
1A1a	Revisions to DUKES energy data; removal of Crown Dependency 1A1a emissions (now reported separately); use of emission factors derived from EU-ETS rather than UK defaults from previous research. Inclusion for first time of wood burnt in power stations.	Use of EU ETS emissions data (rather than derived estimates of activity data) to distribute emissions, thereby accounting for local fluctuations in emission factors.
1A1b	Revisions to DUKES energy data, including burning oil in refineries for the first time. There is a known problem with DUKES refinery data for recent years; data provided to DECC by two refineries is suspect and very different to their EUETS submissions.	No changes to method. Suspect an under-report of emissions in recent years, most notably in England.
1A1c	Base year revisions to methane and N_2O have been made through a method update (emissions for gas separation plant and offshore own gas use). Revisions to EFs from LPG and OPG use in gas separation plant, and in EFs from own gas use.	No change to method, but several site-specific revisions to emission estimates have been made, following review of the EEMS database. These are mainly relating to own gas use emissions and gas separation plant emissions.
1A2a	Revisions to energy statistics, mainly a reduction in fuel oil allocation to iron and steel combustion plant. Increased emissions from blast furnace gas and coke use in blast furnaces, due to revision of emission factors used.	Small re-allocation of gas use between England and Wales, from revised fuel statistics, otherwise no change to method.
1A2f	Significant fuel re-allocations from energy statistics, review of the timeseries of fuel use in lime production. Increased 2006 gas use data (DUKES), lower 2006 fuel oil data. Large reduction in emissions from lubricant use in UK industry in 2006 (only) due to revision to impacts of Waste Incineration Directive. Reductions in coal use allocation to UK industry during 2005 and 2006. Revisions to gas oil and LPG allocation to UK industry also. Decrease in emissions from coal use in autogenerators, due to use of new emission factors from EU ETS data, and revisions to energy statistics.	In N Ireland, some gas use re-allocated away from industrial use, to commercial/institutional use, due to new data. Many other revisions due to method improvements. Analysis of point source data (such as the EUETS data) led to greater allocation of the UK industry fuel use to major point sources. DA allocation of the remaining "area" sources revised, drawing on research that fed into the DECC regional energy statistics released within the December 2008 Energy Trends, including: revision of regional fuel allocations through analysis of employment data, taking out the estimated employment figures for the major point source sites (reducing double-counting between the point and area sources). The revised method has led to higher estimates for industrial gas use in Scotland and Wales, primarily from the detail now available on gas use in the chemical, pharmaceutical and petroleum industries.
1A3a	Revisions to the aviation model have led to increased estimates of CO_2 emissions and revisions to other GHGs also.	Crown Dependency flight data have been removed from the DA GHGI data, and are now reported separately, not as part of the England total. The revisions to the aviation model have led to revised emissions across all DA GHGIs.

IPCC Sector	UK Method and Data Revisions	DA Method and Data Revisions
1A3b	Large revision to the N_2O estimations across the timeseries, especially recent years, as new data on the emissions from newer technology catalytic converters is available (COPERT IV). Many emission factors revised. Major method change to re-allocate emissions within the RT sector, due to revisions to speed data for different road/area types, vehicle km and fleet composition data. HGV fuel consumption data revised to use latest DfT data on fuel efficiency for different size HGVs and LGVs.	The revision to the UK model has had a significant impact across the DA inventories, and new fleet data from Northern Ireland has also been used to revise the estimates for recent years.
1A4a	Revised fuel statistics. Reduced allocation of gas oil and fuel oil to the commercial sector across the timeseries. Large reduction in gas use allocated to commercial sector in 2006 (only). Small changes to the public sector fuel allocations (coal, gas, oil) in recent years.	In N Ireland, new data has led to increased allocation of gas use to this sector, and less gas use to the industry sector (1A2f). Method improvement for the allocation of gas has been made through more detailed analysis of the point source data to allocate large point source emissions and reduce the remaining "area source" that is disaggregated according to regional employment data. Revisions to 2005 and 2006 fuel use data within the DECC Regional Energy Statistics (DECC: Energy Trends, December 2008).
1A4b	Revised fuel statistics. Reduced allocation of gas oil, burning oil and LPG to the domestic sector across the timeseries. Increased allocation of coal and natural gas use in 2006 (only). Known uncertainties regarding the gas use split between 1A4a and 1A4b. Revisions to methane and nitrous oxide emission factors for wood combustion.	No revisions to method, but significant revisions to DA emissions due to revised fuel use data from the latest DECC Regional Energy Statistics for 2005 and 2006 (DECC: Energy Trends, December 2008). Large increase in the % share of burning oil use in Northern Ireland (formerly 22%, now 35% of UK total in latest analysis). Method of back-calculating emissions based on Housing Condition Survey data is retained, so this effectively means that burning oil use in N Ireland has been increased across the time-series. There is significant uncertainty attached to these data. During 2009-10, further work is scheduled to revise the domestic sector local and regional emissions maps.
1B2a	Revisions to source data from the EEMS dataset for oil and gas sector. 2006 estimates increased for several oil terminal sites.	Site-specific revisions to 2006 emissions data, following review of the EEMS data with DECC Oil & Gas. Increased emissions estimates for both England and Scotland. There remains some uncertainty regarding site-specific data.
1B2b	Revisions to gas leakage data from gas transmission operators, increasing estimates for 2005 and 2006.	Revisions to gas leakage data from gas transmission operators, increasing estimates for 2005 and 2006 across England, Scotland and Wales.
1B2c_Flaring	Small revisions to site-specific flaring emissions, through review of the EEMS data.	Site-specific revisions to 2006 emissions data, following review of the EEMS data with DECC Oil and Gas. Increased emissions estimates for England. There remains some uncertainty regarding site-specific data.

IPCC Sector	UK Method and Data Revisions	DA Method and Data Revisions
1B2c_Venting	Small revisions to site-specific venting emissions, through review of the EEMS data.	Site-specific revisions to 2006 emissions data, following review of the EEMS data with DECC Oil and Gas. Small increases to emissions estimates for England and Scotland. There remains some uncertainty regarding site-specific data.
2A3	Revision to activity data for gypsum produced through FGD in power stations, leading to a small increase in emissions.	Small increase in emissions in England only, due to FGD data revision in recent years.
2A7	Small revision to assumptions on fletton brick fuel use, across the timeseries, with a small reduction in emissions in 2006.	Small revision to assumptions on fletton brick fuel use, across the timeseries, with a small reduction in emissions in 2006 (England only).
2B1	2006 emissions revised down quite significantly due to a revision of ammonia production data.	2006 emissions revised down quite significantly due to a revision of ammonia production data. (England only)
2B5	Increased emission estimates across the timeseries due to a method revision for chemical industry process emissions.	Increased emission estimates across the timeseries due to a method revision for chemical industry process emissions. Affects England mostly.
2C3	Small revision to Aluminium production data for 2006.	UK revision affects England, Scotland and Wales inventories.
2E1	Timeseries emission estimates have been reviewed in consultation with plant operators, and revised to reflect the correct GWP weighted mixture of gases and to ensure that all fugitive sources were captured.	The emission estimates have been reviewed in consultation with plant operators, and revised to reflect the correct GWP weighted mixture of gases and to ensure that all fugitive sources were captured. (England only)
2F1	F-gas emissions revised significantly across the timeseries. Review of lifetime emission assumptions (leakage rates, precise F-gas composition and GWP etc.).	F-gas emissions revised significantly across the timeseries. Review of lifetime emission assumptions (leakage rates, precise F-gas composition and GWP etc.). Affects all DAs.
2F2	Emissions from foams have been updated to reflect the observed trends since the full phase out of HCFC was completed.	Emissions from foams have been updated to reflect the observed trends since the full phase out of HCFC was completed. Affects all DAs.
2F3	Emissions from fire fighting have been revised based on information from industry representatives.	Emissions from fire fighting have been revised based on information from industry representatives. Affects all DAs.

IPCC Sector	UK Method and Data Revisions	DA Method and Data Revisions
2F4	Emissions from aerosols have been updated to reflect actual data (rather than projections), and to update the precise F-gas composition and GWP data.	Emissions from aerosols have been updated to reflect actual data (rather than projections), and to update the precise F-gas composition and GWP data. Affects all DAs.
4A1, 4B1	Revision to cattle numbers in 2006.	Correction of mis-allocated cattle data for 2006. Increased emissions in England, lower emissions in Scotland, Wales and N Ireland.
4A10	Method revision to report UK territory emissions only.	England data now no longer include any emissions from Crown Dependencies.
4A3	Small reduction in sheep numbers for 2006.	Small reduction in sheep numbers for 2006, across all DAs.
4B13	Revision to livestock numbers in 2006.	Correction of mis-allocated livestock data for 2006. Increased emissions in England, lower emissions in Scotland, Wales and N Ireland.
4B14	Update to the emission factor used for poultry – but not laying hens – to use the value in IPCC Good Practice Guidelines 2000	UK revision affects all DAs.
4B8	Emissions in this sector increased significantly due to a change to the emissions factor for AWMS for swine. This emission factor is now taken from the IPCC Good Practice Guidelines 2000.	UK revision affects all DAs.
4D	Crop production data corrected for 2006 and timeseries revisions due to revised assumptions for livestock excretion rates.	UK revision affects all DAs.
5A2	Revisions to the emission factors for biomass burning on forest land.	In addition to the UK-level changes to emission factors, a small change has also occurred due to revision to area data for forests in Northern Ireland.
5C2	The estimates of emissions and removals have changed due to a method change. Previously, harvested wood products (5G) were accounted for as a result of deforestation with no corresponding loss of living biomass. Living biomass now accounted for in C2 and E2.	UK revision affects all DAs.

IPCC Sector	UK Method and Data Revisions	DA Method and Data Revisions
5E2	The estimates of emissions and removals have changed due to a method change. Previously, harvested wood products (5G) were accounted for as a result of deforestation with no corresponding loss of living biomass. Living biomass now accounted for in C2 and E2,	UK revision affects all DAs.
5G	Afforestation data has been updated.	UK revision affects all DAs.
6A1	Significant revisions to emissions across the timeseries through a review of the UK landfill model and inclusion of some new data sources to ensure a more comprehensive and representative estimate, including more data on commercial and industrial waste arisings.	UK model revision has affected emission levels in all DAs. Emission trends since 1990 are consistent with previous inventory trends.
6C	Small revision due to a change in CO_2 emission factor used for chemical waste incineration.	UK revision affects all DAs.

8 Uncertainty in the Inventories

A study (Eggleston et al, 1998) estimated the uncertainty in the UK Inventory, and these estimates are revised annually in the compilation of the UK GHG inventory to account for data and methodological changes (Jackson et al., 2009). In addition to the updates made annually to the model, over the past few years, the model has been reviewed and improved, to better account for correlations and lognormal distributions. These changes are described in Choudrie et al., 2008.

The improvements made to the UK model have also been reflected in the DA uncertainties model, and this year for the first time, an assessment of the uncertainty in the trend has also been made.

As a result of the activity data gaps in the DA inventories, the estimates will be more uncertain than for the UK inventory. Expert judgement has been used to assess the degree of additional uncertainty due to the use of proxy activity data, informed by the comparison of the new datasets such as EUETS and the DECC regional energy statistics with historic data. The uncertainties in the emission totals have been estimated using a Monte Carlo simulation. In recent years the revisions to UK fuel use statistics (DUKES) have been significant for several fuels, notably coal, gas oil and fuel oil. Overall data quality and sector allocations are improving, but for some source sectors, significant uncertainties remain, even at UK level.

The method used to estimate uncertainties in the DA inventories in a single year and the trend is described in Appendix 1.

The uncertainty estimates for the 1990-2007 DA GHG inventories are reported in Table 8.1 below.

The table presents the central estimate from the Monte Carlo simulation for each GHG and for each DA, for the base year and the latest year and the estimated uncertainty on the total. In addition, the central estimate of the trend (expressed as the percentage change from the base year) is presented together with the 2.5 and 97.5 percentile estimates.

Table 8.1: Estimated Uncertainties in the DA GHG Inventories: Base Years, 2007 and Trend

	Base Year		Latest Year (2007)		Trend (Base Year to 2007)		
Gas (kt CO_2e)	Central Estimate	Uncertainty Introduced on total	Central Estimate	Uncertainty Introduced on total	Central Estimate	2.5 Percentile	97.5 Percentile
Scotland							
CO_2	50479	10%	43064	11%	-14%	-26%	-2%
CH_4	11019	29%	6178	24%	-43%	-61%	-20%
N_2O	6221	283%	4391	310%	-31%	-53%	-16%
HFC	139	27%	779	22%	471%	299%	707%
PFC	88	17%	57	59%	-34%	-72%	6%
SF_6	31	17%	54	19%	76%	35%	124%
Total	67977	27%	54523	26%	-20%	-29%	-9%
Wales							
CO_2	43131	3%	39008	3%	-10%	-13%	-6%
CH_4	7882	21%	4576	18%	-41%	-56%	-24%
N_2O	3555	295%	2731	307%	-22%	-38%	-1%
HFC	71	25%	398	20%	471%	310%	686%
PFC	147	5%	43	19%	-71%	-76%	-65%
SF_6	83	17%	49	15%	-41%	-53%	-26%
Total	54869	20%	46806	18%	-15%	-19%	-10%
Northern Ireland							
CO_2	17365	9%	15845	7%	-9%	-18%	2%
CH_4	4347	23%	3296	18%	-23%	-43%	1%
N_2O	3145	277%	2373	325%	-31%	-63%	-15%
HFC	41	24%	252	20%	522%	351%	750%
PFC	1	16%	0	N/A	-100%	-100%	-100%
SF_6	2	20%	7	26%	291%	174%	430%
Total	24901	36%	21773	36%	-12%	-20%	-3%

(table continued below)

Table 8.1: Estimated Uncertainties in the DA GHG Inventories: Base Years, 2007 and Trend: *continued*

	Base Year		Latest Year (2007)		Trend (Base Year to 2007)		
Gas (kt CO_2e)	**Central Estimate**	**Uncertainty Introduced on total**	**Central Estimate**	**Uncertainty Introduced on total**	**Central Estimate**	**2.5 Percentile**	**97.5 Percentile**
England							
CO_2	467414	2%	426903	1%	-9%	-11%	-6%
CH_4	79065	27%	33657	26%	-57%	-70%	-39%
N_2O	50870	145%	24350	246%	-58%	-77%	-34%
HFC	15316	14%	8123	22%	-47%	-59%	-32%
PFC	235	7%	116	14%	-51%	-58%	-43%
SF_6	1123	17%	683	15%	-39%	-51%	-24%
Total	614024	13%	493832	12%	-20%	-23%	-16%
Unallocated							
CO_2	13161	15%	16360	7%	25%	7%	47%
CH_4	1853	27%	1005	25%	-45%	-62%	-22%
N_2O	227	100%	301	103%	63%	-64%	386%
HFC	0	N/A	0	N/A	N/A	N/A	N/A
PFC	0	N/A	0	N/A	N/A	N/A	N/A
SF_6	0	N/A	0	N/A	N/A	N/A	N/A
Total	15241	13%	17667	7%	16%	1%	35%
UK							
CO_2	591549	2%	541181	2%	-9%	-11%	-6%
CH_4	104167	26%	48713	23%	-52%	-67%	-34%
N_2O	64018	172%	34147	263%	-53%	-74%	-31%
HFC	15556	14%	9554	21%	-38%	-53%	-22%
PFC	471	7%	216	24%	-54%	-65%	-43%
SF_6	1239	17%	792	15%	-36%	-49%	-20%
Total	777000	15%	634602	14%	-18%	-22%	-15%

Notes

1. Uncertainty is defined as $\pm$ 2$\times$(standard deviation)/mean %, which closely approximates the 95% confidence interval
2. Emissions of PFC in Northern Ireland in 2007 are zero.
3. Base years are 1990 for CO_2, CH_4 and N_2O; 1995 for HFCs, PFCs and SF_6.

The estimates for Scotland show a high uncertainty estimate for CO_2 in both 1990 and 2007. This reflects the high contribution of LULUCF to the emissions total. This also impacts on the uncertainty in the trend, since LULUCF emissions are not considered to be correlated across the time series. The analysis on the over all trend in emission from Scotland indicates that there is a 95% probability that emissions are between 9 and 29% lower in 2007 than they were in the base year.

The analysis for Wales shows that CO_2 emissions are relatively certain. This is because the Welsh emissions are dominated by less uncertain sources, such as natural gas combustion (which accounted for 34% of CO_2 emissions in Wales in 2007), with a much lower contribution from more uncertain sources such as LULUCF. The trend analysis on total GHG emissions indicates that the reduction in emissions is likely to be between 19 and 10%. The relatively lower uncertainty in the trend for Wales is related to the lower uncertainty in the CO_2 emissions.

The reduction in the uncertainty estimate for CO_2 emissions in Northern Ireland from 1990 to 2007 reflects, in part, the increased consumption of natural gas, which is less uncertain than the statistics used for liquid and solid fuel consumption. The uncertainty in the trend in CO_2 emissions is high, however, in part due to the higher uncertainty in 1990. The uncertainty in the total GHG trend is dominated by the impact of the uncertainty in the CO_2 trend.

The uncertainties for England are calculated as the residual from the UK. Therefore in general, the uncertainties are similar to those for the UK.

The uncertainties in Unallocated CO_2 emissions are relatively low, since the majority of emissions arise from natural gas combustion. Therefore the uncertainty on the trend of these emissions is also low. N_2O emissions are very uncertain, reflecting a high uncertainty in the emission factors used. Since there are no correlations assumed for this sector, this leads to a very high uncertainty in the trend for this GHG also.

Scotland and England show a higher uncertainty in emissions of methane, reflecting a higher proportion of emissions arising from waste disposed to landfill than the other DAs. This source is very uncertain at UK level and additional uncertainty arises from the lack of DA-specific data to inform the country-specific estimates from the UK total.

The uncertainty in N_2O emissions across the DAs is dominated by the uncertainty in agricultural soils emissions. Across all four DAs, the uncertainty for this gas increases from 1990 to 2007, reflecting that this source makes up a higher proportion of emissions in later years, due to decreases in emissions from other sources. Emissions from this source are correlated across the years, which acts to reduce the uncertainty in the trend.

The variation in the uncertainties in the F-gas emissions across the DAs reflects the sources that make up the most significant proportion of the total for each country. For example, emissions in England contain most of the industrial point source emissions, which are regarded as much more certain than F-gas emissions arising from end use applications such as refrigeration and aerosols. Therefore emissions of F-gases in England are regarded as less uncertain than those in Scotland, Wales and Northern Ireland.

9 Summary Graphs

Graphs illustrating the net greenhouse gas emissions as CO_2 equivalent for 1990, 1995, and 1998 to 2007 for the Devolved Administrations are shown in Figures 9.2 to 9.7. The summary data and time-series trends are also presented in more detailed country-specific tables in Appendix 2, including a breakdown of total greenhouse gas emissions by IPCC Source Categories: Energy, Industrial Processes, Agriculture, Land Use, Land Use Change & Forestry, and Waste.

Figure 9.1: Summary of the 2007 GHG Inventories for England, Scotland, Wales and Northern Ireland

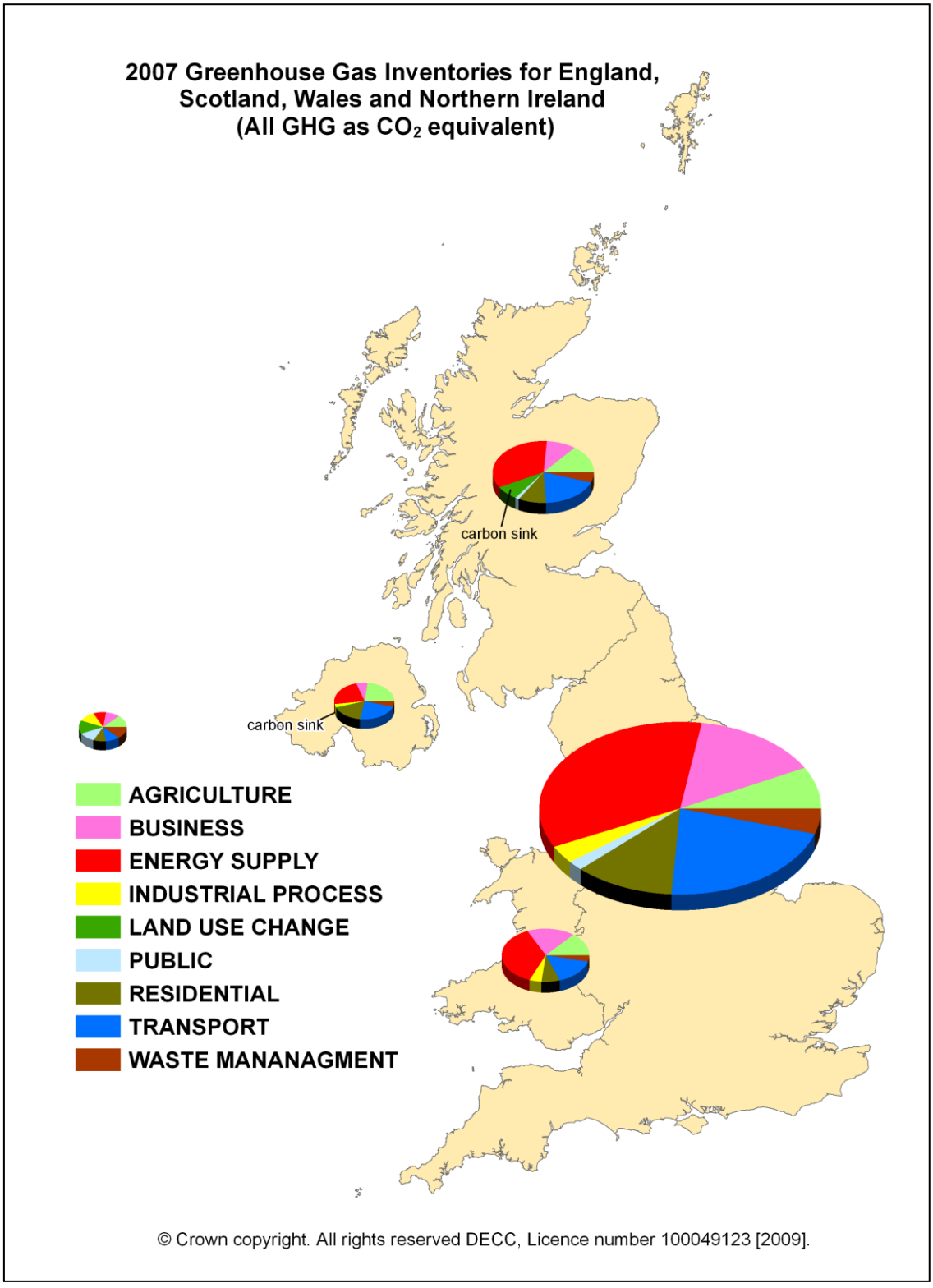


Figure 9.2: Graphs of Carbon Dioxide Emission Inventory Estimates for England, Scotland, Wales and Northern Ireland, 1990-2007

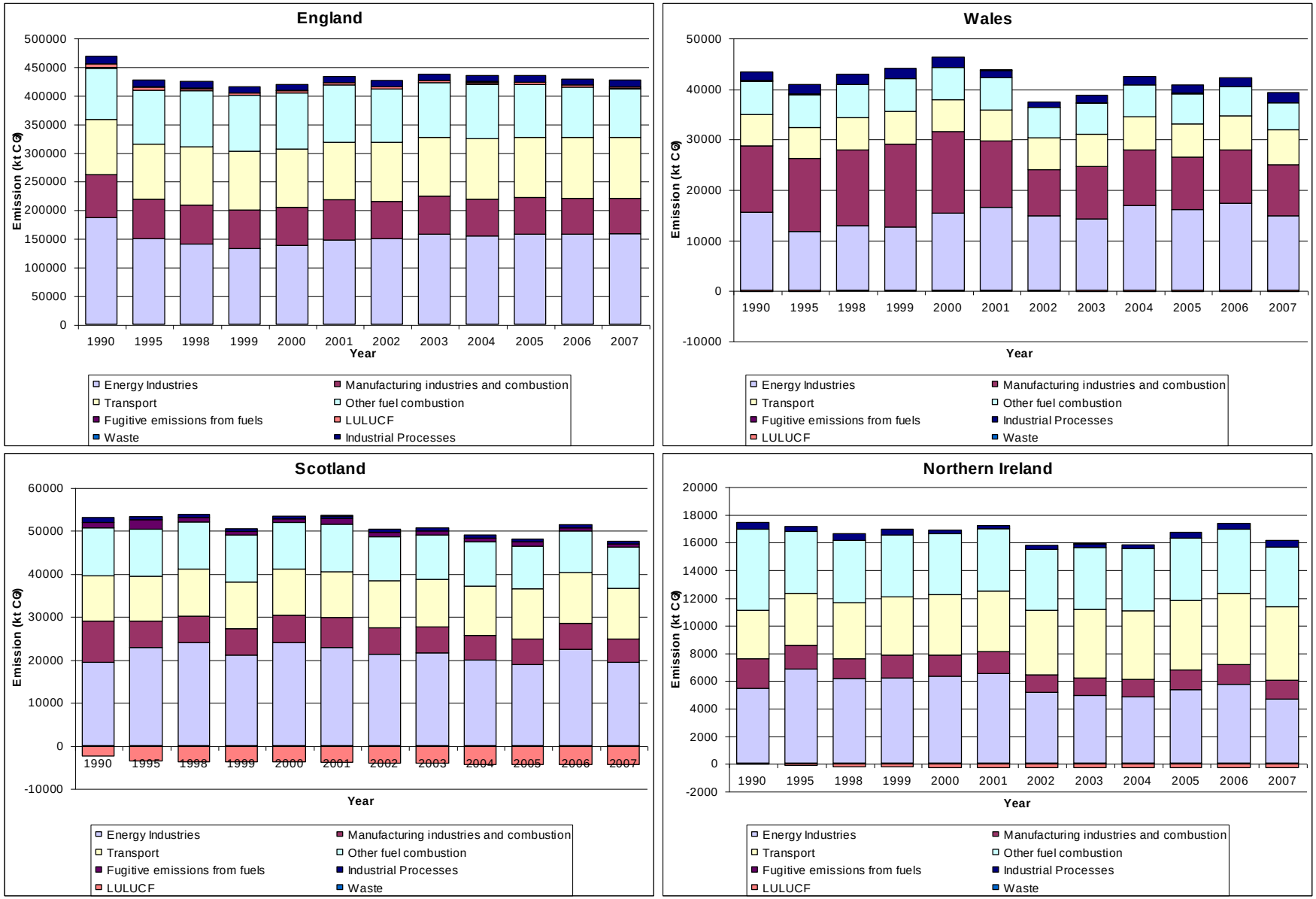


Figure 9.3: Graphs of Methane Emission Inventory Estimates for England, Scotland, Wales and Northern Ireland, 1990-2007

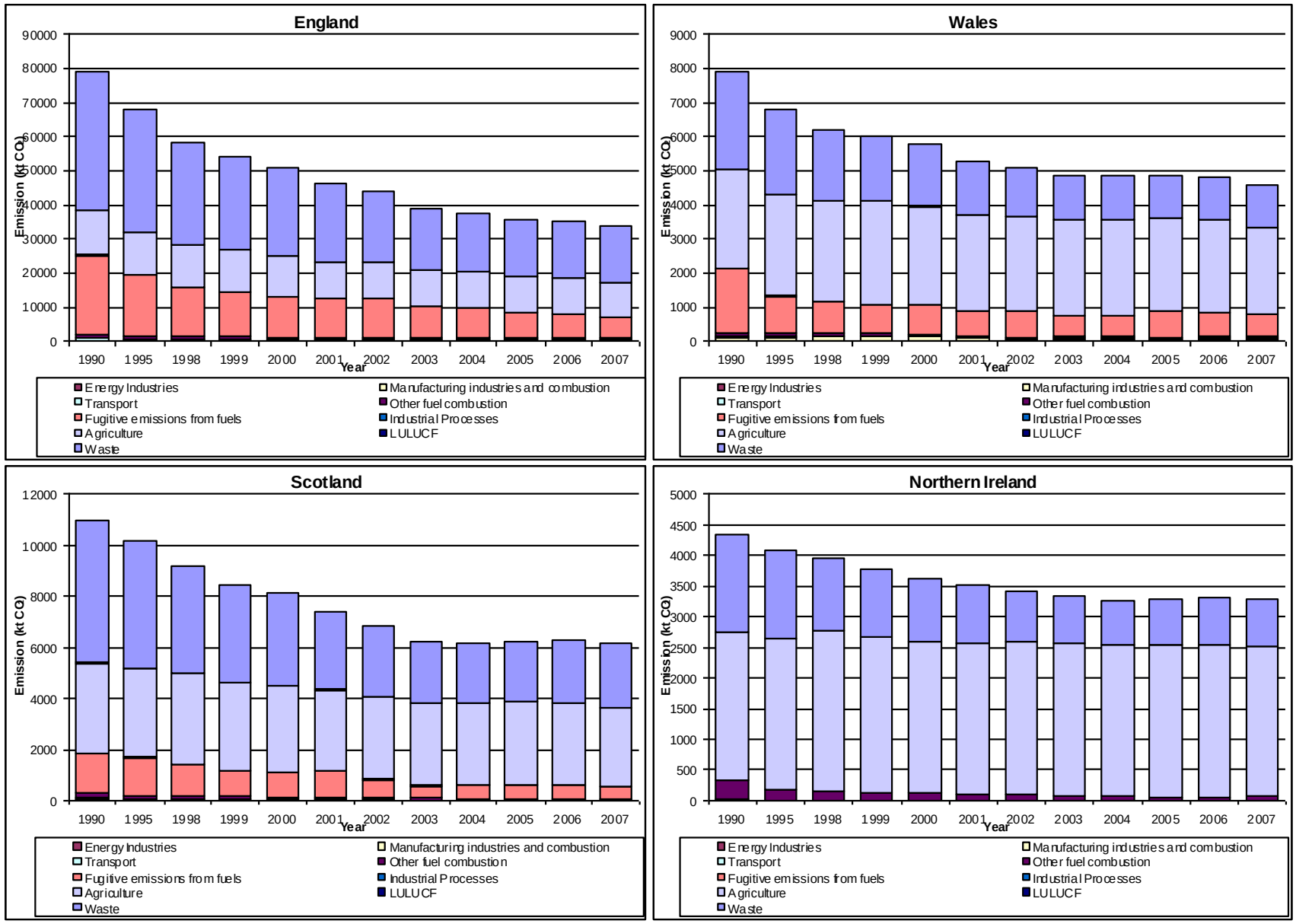


Figure 9.4: Graphs of Nitrous Oxide Emission Inventory Estimates for England, Scotland, Wales and Northern Ireland, 1990-2007

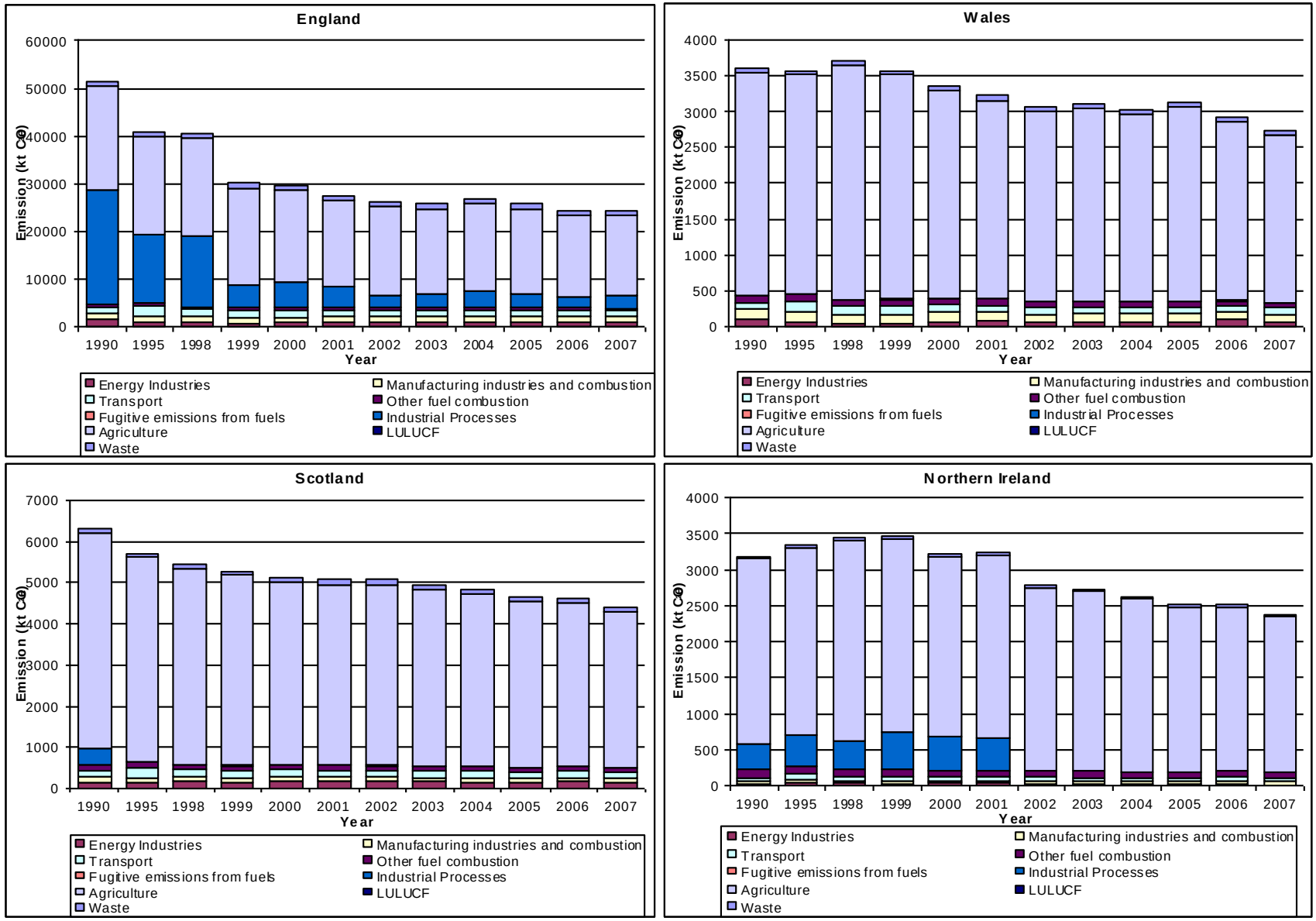


Figure 9.5: Graphs of HFC Emission Inventory Estimates for England, Scotland, Wales and Northern Ireland, 1990-2007

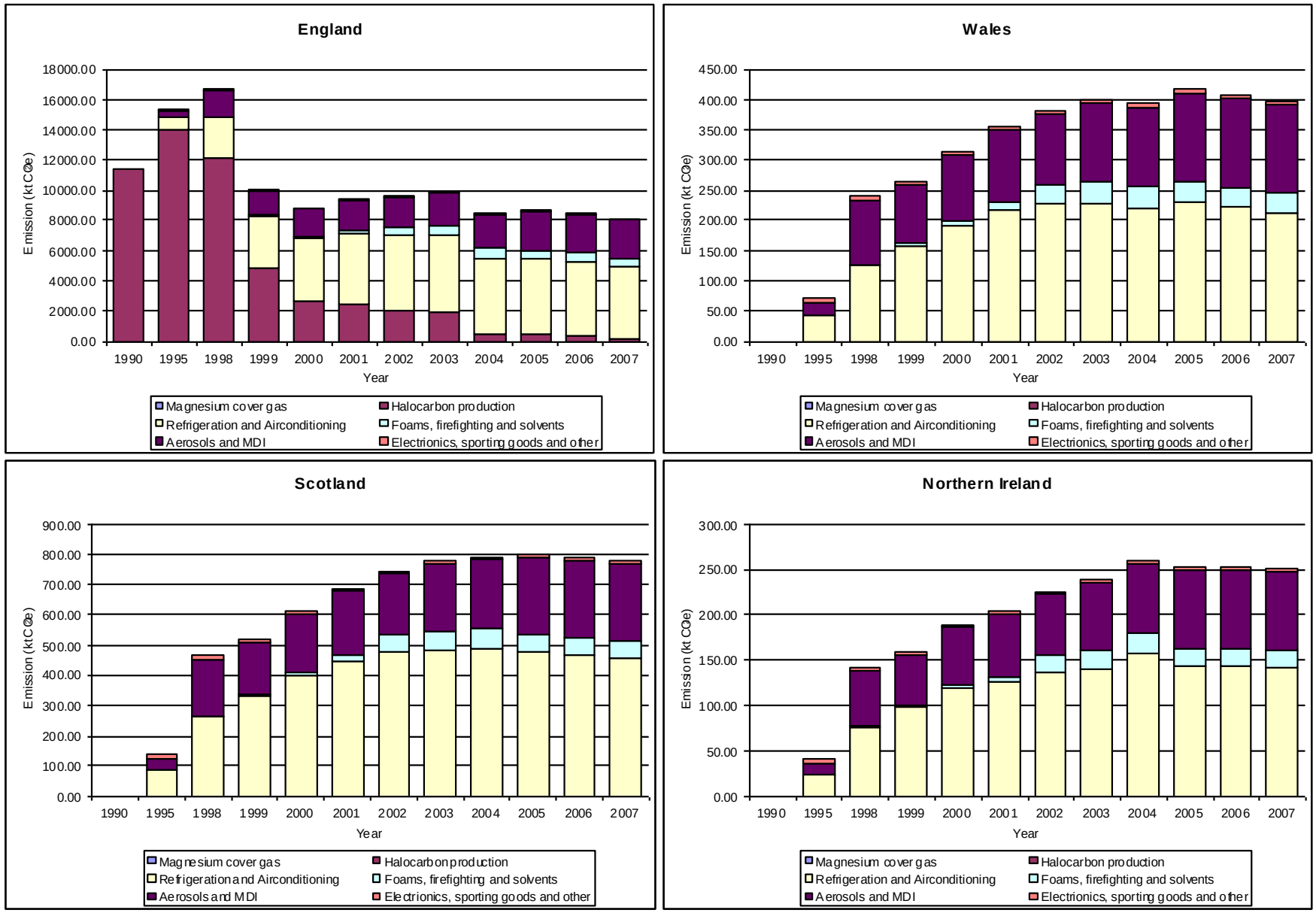


Figure 9.6: Graphs of PFC Emission Inventory Estimates for England, Scotland, Wales and Northern Ireland, 1990-2007

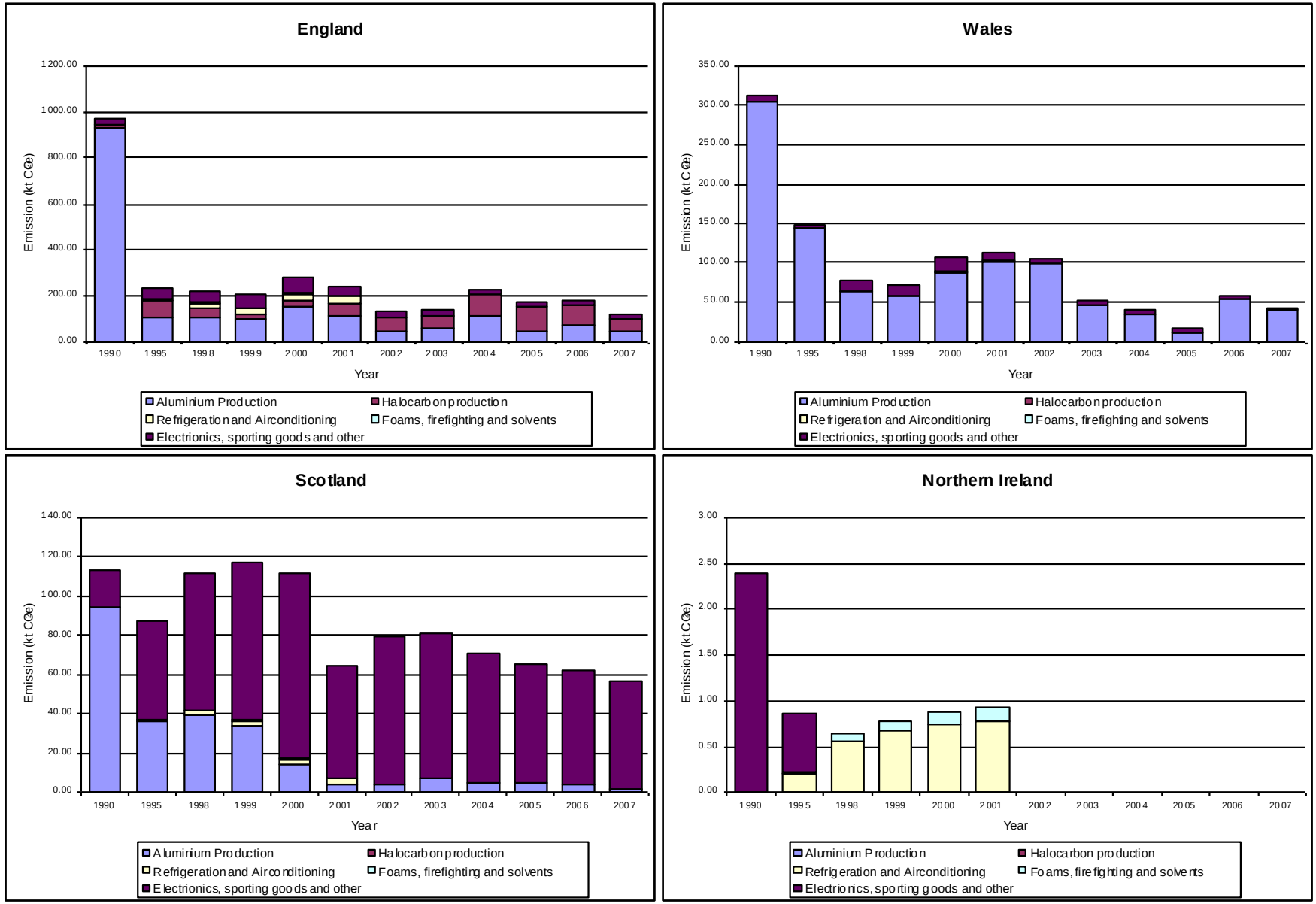
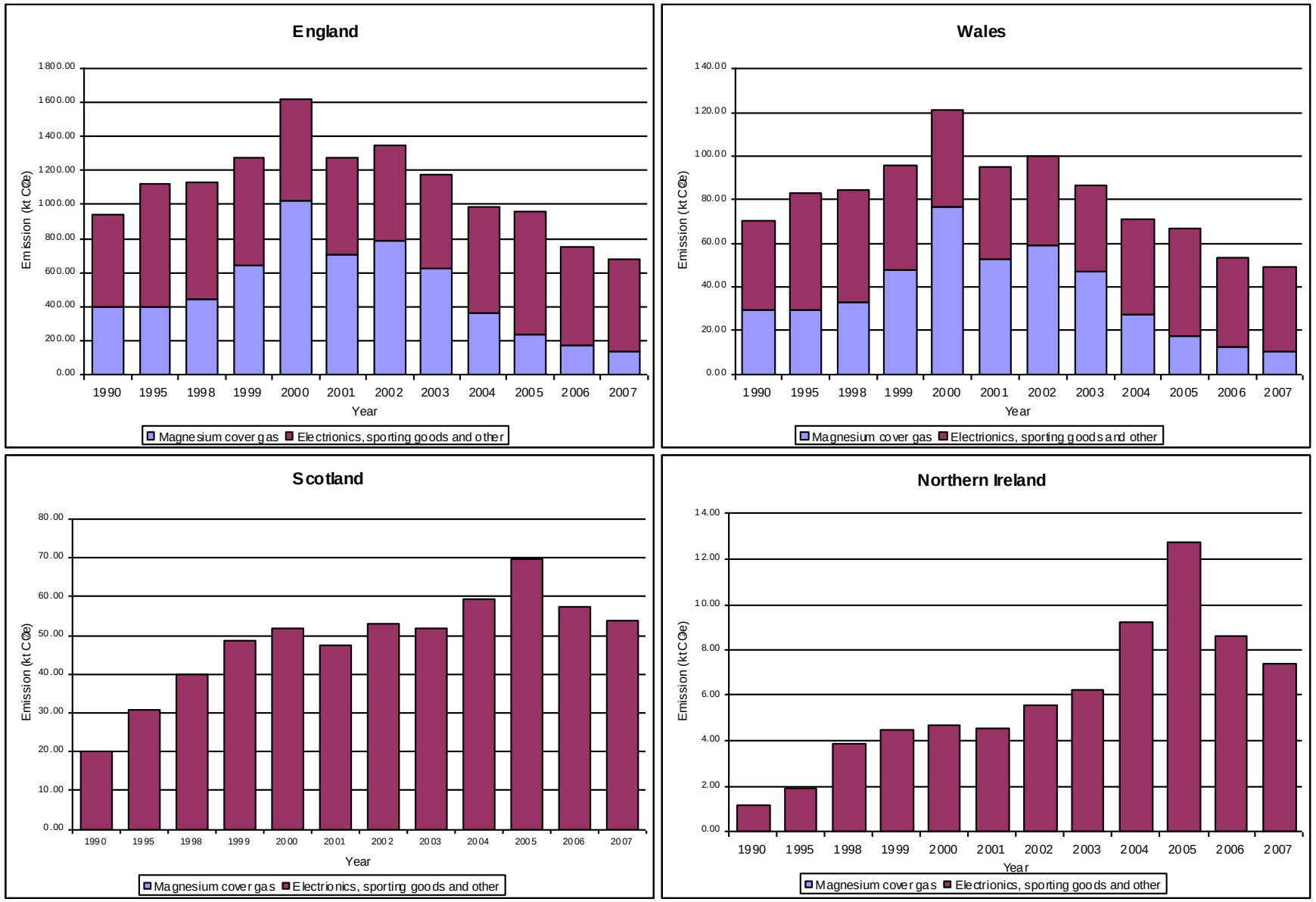


Figure 9.7: Graphs of SF_6 Emission Inventory Estimates for England, Scotland, Wales and Northern Ireland, 1990-2007



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