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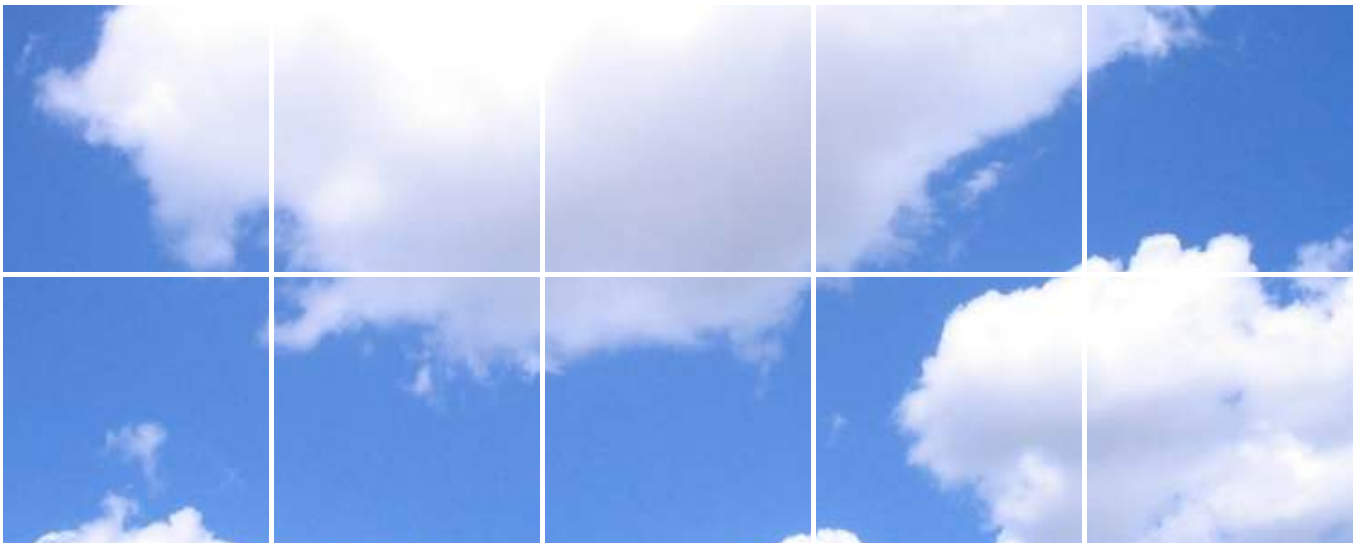

Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 - 2005

Report to Department for Environment, Food and Rural Affairs, The Scottish Executive, The Welsh Assembly Government and The Northern Ireland Department of Environment.

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Executive summary

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, 1998 to 2005. 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 2005 UK Greenhouse Gas Inventory (Baggott *et al.*, 2007) Issue 1. Emissions from offshore sources cannot be allocated to any country, so an unallocated category is used to report these. UK territorial coverage in this report includes the Crown Dependencies of Jersey, Guernsey and Isle of Man but excludes emissions for those Overseas Territories joining UK instruments of ratification for FCCC and the Kyoto Protocol namely, Cayman Islands, Falkland Islands, Bermuda, Montserrat and Gibraltar. Emissions from the Crown Dependencies are all allocated to England with the exception of domestic aircraft emissions which are presented separately in the unallocated sector.

All percentages quoted in this report are based on net emission estimates held at full precision and may therefore differ slightly from those that can be calculated from summary tables.

The study shows that the UK distribution of regional net greenhouse gas emissions in 2005, expressed in terms of global warming potentials (GWP), is[1]:

- England 78.0%
- Scotland 8.3%
- Wales 7.7%
- Northern Ireland 3.2%
- Unallocated 2.8%

Table ES1 (below) presents emissions of the six greenhouse gases in more detail for the base year and 2005. Tables ES2.1.1 to ES 2.5.3 present the time series of emissions for each constituent country, and for unallocated emissions.

[1] The percentages presented in these figures are rounded to one decimal place, but are calculated from emission estimates calculated at full precision.

UK trends in emissions of greenhouse gases over recent years[2] are as follows:

- **Carbon dioxide**: Overall UK emissions have fallen by 6.4% between 1990 and 2005, 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 52.3% between 1990 and 2005, due primarily to significant reductions in methane emissions from waste disposal and coal mining sources.

- **Nitrous oxide**: Overall UK emissions have fallen by 37.7% between 1990 and 2005, driven predominantly by a large reduction in emissions following the installation of abatement measures at an adipic acid plant in England. This overall downward trend is offset to a small degree by a rise across all constituent countries in nitrous oxide emissions from the transport sector over the period due to increased use of three-way catalytic converters.

- **HFCs**: Overall UK emissions have fallen by 40.6% between 1995 and 2005, mainly due to a big reduction in emissions following the installation of improved abatement equipment at a HCFC plant in England. However, there is 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.

- **PFCs**: Overall UK emissions have fallen by 25.5% between 1995 and 2005, 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 7.8% between 1995 and 2005. This is mostly due to decreases in emissions from the magnesium industry.

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. The 1990-2005 inventories have used for the first time a new series of regional energy statistics recently published by the Department for Business, Enterprise and Regulatory Reform (BERR, formerly the Department of Trade and Industry) for 2003 and 2004. These regional energy statistics have been developed to provide estimates of fuel use and CO_2 emissions data at Local Authority level across the UK. The data have been used in conjunction with other data sources to provide CO_2 emission estimates for unregulated sectors of small-scale combustion sources such as domestic, commercial, public administration and small-scale industry.

For other key emission sources (such as industrial processes, agriculture, land-use change and forestry, waste disposal) there are more reliable and complete country-level datasets available, although some of these are less detailed than data used for the UK Inventory.

2 Base years for UK Greenhouse Gas Emissions are: 1990 for carbon dioxide, methane and nitrous oxide, 1995 for the fluorinated gases.

As a result of these data availability issues, it should be noted that the emission estimates for the England, Scotland, Wales and Northern Ireland inventories are subject to greater uncertainty than the equivalent UK estimates. Chapter 7 of this report outlines significant changes to inventory methodology that have impacted upon the DA-level estimates for GHG emissions.

A number of sectors which were previously 'unallocated' were allocated to each of the four constituent countries for the first time in the compilation of the 1990 to 2004 inventories (published in 2006). These sectors are domestic aviation and shipping, and military aviation and shipping. The disaggregation methodologies used to allocate emissions from these sectors was experimental and has been reviewed this year, resulting in a change to the methodology used for disaggregating emissions from domestic flights. Emissions from this source are now allocated based on a detailed database of aircraft movement, which includes details of flight origin, destination, fuel type, aircraft and engine type. Emissions of all GHGs from take-off and landing and cruise cycles of domestic flights can therefore be calculated to much greater accuracy, and emissions from a given flight have been allocated to the country of flight origin. This new approach has significantly revised the emissions allocation for domestic flights across the four constituent countries of the UK.

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 October 2006) covered the years up to and including 2004, whilst this report gives emission estimates for the years up to and including 2005.

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 the DTI via 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 2003") 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, 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.

Notes on Table ES1 (Below)

#1995 is used as the Base Year 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.

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.

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	470,071	49,951	43,324	15,672	13,114	592,133
	1990 Percentage	%	79.4%	8.4%	7.3%	2.6%	2.2%	100.0%
	2005	kt CO_2e	436,571	43,698	41,722	15,113	17,090	554,193
	2005 Percentage	%	78.8%	7.9%	7.5%	2.7%	3.1%	100.0%
	Percentage change from BY	%	-7.1%	-12.5%	-3.7%	-3.6%	30.3%	-6.4%
CH_4	1990	kt CO_2e	82,610	8,185	7,692	3,139	1,808	103,434
	1990 Percentage	%	79.9%	7.9%	7.4%	3.0%	1.7%	100.0%
	2005	kt CO_2e	36,057	5,060	4,529	2,804	866	49,316
	2005 Percentage	%	73.1%	10.3%	9.2%	5.7%	1.8%	100.0%
	Percentage change from BY	%	-56.4%	-38.2%	-41.1%	-10.6%	-52.1%	-52.3%
N_2O	1990	kt CO_2e	50,572	6,169	3,670	3,066	111	63,588
	1990 Percentage	%	79.5%	9.7%	5.8%	4.8%	0.2%	100.0%
	2005	kt CO_2e	28,464	4,891	3,372	2,519	349	39,595
	2005 Percentage	%	71.9%	12.4%	8.5%	6.4%	0.9%	100.0%
	Percentage change from BY	%	-43.7%	-20.7%	-8.1%	-17.8%	212.7%	-37.7%
HFCs	1995	kt CO_2e	15,259	132	68	39	0	15,498
	1995 Percentage	%	98.5%	0.9%	0.4%	0.3%	0.0%	100.0%
	2005	kt CO_2e	7,855	734	384	233	0	9,206
	2005 Percentage	%	85.3%	8.0%	4.2%	2.5%	0.0%	100.0%
	Percentage change from BY	%	-48.5%	456.7%	467.2%	492.7%	NA	-40.6%
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%
	2005	kt CO_2e	231	70	50	0	0	351
	2005 Percentage	%	65.8%	20.0%	14.2%	0.0%	0.0%	100.0%
	Percentage change from BY	%	-1.7%	-19.8%	-66.3%	-100.0%	NA	-25.5%
SF_6	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%
	2005	kt CO_2e	991	69	69	13	0	1,143
	2005 Percentage	%	86.7%	6.1%	6.1%	1.1%	0.0%	100.0%
	Percentage change from BY	%	-11.8%	125.1%	-16.3%	566.0%	NA	-7.8%
Total	Base year	kt CO_2e	619,871	64,555	54,984	21,919	15,033	776,362
	Base year Percentage	%	79.8%	8.3%	7.1%	2.8%	1.9%	100.0%
	2005	kt CO_2e	510,169	54,522	50,126	20,682	18,304	653,803
	2005 Percentage	%	78.0%	8.3%	7.7%	3.2%	2.8%	100.0%
	Percentage change from BY	%	-17.7%	-15.5%	-8.8%	-5.6%	NA	-15.8%

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 (MtCO2 equivalent)

England	Mt CO_2 Equivalent										% change
	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	BY to 2005
CO_2	470.1	428.4	426.5	417.7	421.5	434.6	428.0	438.6	436.0	436.6	**-7%**
CH_4	82.6	70.9	60.2	56.0	52.1	47.1	44.9	39.7	37.9	36.1	**-56%**
N_2O	50.6	40.2	41.5	31.4	31.3	29.4	28.5	28.3	29.3	28.5	**-44%**
HFCs	11.4	15.3	16.5	10.0	8.1	8.6	8.7	9.0	7.6	7.9	**-49%**
PFCs	1.0	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	**-2%**
SF_6	0.9	1.1	1.1	1.3	1.6	1.3	1.4	1.2	1.0	1.0	**-12%**
Total (Net Emissions)	**616.5**	**556.0**	**546.1**	**516.5**	**515.0**	**521.2**	**511.6**	**516.9**	**512.1**	**510.2**	**-18%**
Net CO_2 Emissions from LULUCF	5.7	5.1	4.2	4.0	3.9	3.8	3.6	3.6	3.3	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	
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	

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	BY to 2005
CO_2	128.2	116.8	116.3	113.9	115.0	118.5	116.7	119.6	118.9	119.1	**-7%**
CH_4	22.5	19.3	16.4	15.3	14.2	12.8	12.2	10.8	10.3	9.8	**-56%**
N_2O	13.8	11.0	11.3	8.6	8.5	8.0	7.8	7.7	8.0	7.8	**-44%**
HFCs	3.1	4.2	4.5	2.7	2.2	2.3	2.4	2.4	2.1	2.1	**-49%**
PFCs	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	**-2%**
SF_6	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.3	0.3	0.3	**-12%**
Total (Net Emissions)	**168.1**	**151.6**	**148.9**	**140.9**	**140.5**	**142.2**	**139.5**	**141.0**	**139.7**	**139.1**	**-18%**
Net CO_2 Emissions from LULUCF	1.6	1.4	1.1	1.1	1.1	1.0	1.0	1.0	0.9	0.8	
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	
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	

Table ES2.1.3 Aggregated emission trends per source category for England (Mt CO2 Equivalent)

England	Aggregate Emission Trends by Source Category									
Source Category	**1990**	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1. Energy	481.4	435.7	432.0	422.4	425.5	438.9	433.1	441.1	438.3	437.8
2. Industrial Processes	49.0	42.2	44.2	27.7	26.2	25.0	23.1	23.7	23.2	22.7
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
4. Agriculture	34.0	32.0	31.7	31.5	30.4	28.0	28.4	27.8	28.0	27.5
5. LULUCF	5.7	5.1	4.2	4.0	3.9	3.9	3.6	3.6	3.3	3.1
6. Waste	46.5	41.0	34.0	30.9	29.0	25.5	23.4	20.7	19.4	19.1
Total	**616.5**	**556.0**	**546.1**	**516.5**	**515.0**	**521.2**	**511.6**	**516.9**	**512.1**	**510.2**

[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 (MtCO2 equivalent)

Scotland	**Mt CO_2 Equivalent**										**% change**
	1990	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**BY to 2005**
CO_2	50.0	48.6	49.1	46.2	49.0	49.0	46.0	46.4	44.4	43.7	**-13%**
CH_4	8.2	7.8	7.2	6.7	6.5	6.1	5.6	5.1	5.1	5.1	**-38%**
N_2O	6.2	5.6	5.5	5.3	5.2	5.2	5.2	5.1	5.0	4.9	**-21%**
HFCs	0.0	0.1	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.7	**457%**
PFCs	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**-20%**
SF_6	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	**125%**
Total (Net Emissions)	**64.4**	**62.2**	**62.4**	**58.8**	**61.4**	**61.0**	**57.6**	**57.5**	**55.3**	**54.5**	**-16%**
Net CO_2 Emissions from LULUCF	-2.5	-3.7	-3.9	-3.9	-3.9	-4.0	-4.2	-4.2	-4.6	-4.6	
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	
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	

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**	**BY to 2005**
CO_2	13.6	13.3	13.4	12.6	13.4	13.4	12.5	12.6	12.1	11.9	**-13%**
CH_4	2.2	2.1	2.0	1.8	1.8	1.7	1.5	1.4	1.4	1.4	**-38%**
N_2O	1.7	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.3	**-21%**
HFCs	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	**457%**
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-20%**
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**125%**
Total (Net Emissions)	**17.6**	**17.0**	**17.0**	**16.0**	**16.8**	**16.6**	**15.7**	**15.7**	**15.1**	**14.9**	**-16%**
Net CO_2 Emissions from LULUCF	-0.7	-1.0	-1.1	-1.1	-1.1	-1.1	-1.1	-1.2	-1.3	-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	
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	

Table ES2.2.3 Aggregated emission trends per source category for Scotland (Mt CO2 Equivalent)

Scotland	Aggregate Emission Trends by Source Category									
Source Category	**1990**	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1. Energy	53.7	53.9	54.4	51.2	54.1	54.2	51.1	51.2	49.7	49.0
2. Industrial Processes	1.7	0.9	1.3	1.3	1.4	1.4	1.5	1.5	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
4. Agriculture	8.6	8.3	8.2	8.0	7.7	7.5	7.5	7.4	7.3	7.1
5. LULUCF	-2.5	-3.7	-3.9	-3.9	-3.9	-4.0	-4.2	-4.2	-4.6	-4.6
6. Waste	3.0	2.8	2.4	2.2	2.2	1.9	1.7	1.5	1.4	1.4
Total	**64.4**	**62.2**	**62.4**	**58.8**	**61.4**	**61.0**	**57.6**	**57.5**	**55.3**	**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**	**BY to 2005**
CO_2	43.3	40.7	42.9	44.4	46.5	43.9	37.5	38.7	42.4	41.7	**-4%**
CH_4	7.7	6.6	6.0	5.8	5.6	5.1	4.9	4.7	4.7	4.5	**-41%**
N_2O	3.7	3.6	3.9	3.7	3.5	3.4	3.3	3.3	3.3	3.4	**-8%**
HFCs	0.0	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	**467%**
PFCs	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	**-66%**
SF_6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**-16%**
Total (Net Emissions)	**55.1**	**51.3**	**53.2**	**54.4**	**56.1**	**52.9**	**46.2**	**47.3**	**50.8**	**50.1**	**-9%**
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	
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	
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	

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**	**BY to 2005**
CO_2	11.8	11.1	11.7	12.1	12.7	12.0	10.2	10.6	11.6	11.4	**-4%**
CH_4	2.1	1.8	1.6	1.6	1.5	1.4	1.3	1.3	1.3	1.2	**-41%**
N_2O	1.0	1.0	1.1	1.0	1.0	0.9	0.9	0.9	0.9	0.9	**-8%**
HFCs	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**467%**
PFCs	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-66%**
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-16%**
Total (Net Emissions)	**15.0**	**14.0**	**14.5**	**14.8**	**15.3**	**14.4**	**12.6**	**12.9**	**13.9**	**13.7**	**-9%**
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	
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	
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	

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

Wales	Aggregate Emission Trends by Source Category									
Source Category	**1990**	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1. Energy	44.3	40.8	42.7	44.0	46.1	43.9	38.0	38.7	42.3	41.6
2. Industrial Processes	2.2	2.2	2.3	2.4	2.5	2.0	1.6	2.0	2.1	2.2
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
4. Agriculture	6.1	6.1	6.3	6.2	5.9	5.6	5.5	5.5	5.5	5.5
5. LULUCF	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2
6. Waste	2.7	2.4	2.0	1.8	1.7	1.5	1.4	1.2	1.2	1.1
Total	**55.1**	**51.3**	**53.2**	**54.4**	**56.1**	**52.9**	**46.2**	**47.3**	**50.8**	**50.1**

[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**	**BY to 2005**
CO_2	15.7	16.3	15.4	15.7	15.6	15.9	14.4	14.5	14.3	15.1	**-4%**
CH_4	3.1	3.2	3.2	3.1	3.0	3.0	3.0	2.9	2.9	2.8	**-11%**
N_2O	3.1	3.2	3.4	3.4	3.2	3.2	2.8	2.7	2.6	2.5	**-18%**
HFCs	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	**493%**
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-100%**
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**566%**
Total (Net Emissions)	**21.9**	**22.8**	**22.2**	**22.4**	**22.0**	**22.2**	**20.3**	**20.3**	**20.1**	**20.7**	**-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	
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	
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	

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**	**BY to 2005**
CO_2	4.3	4.4	4.2	4.3	4.2	4.3	3.9	3.9	3.9	4.1	**-4%**
CH_4	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	**-11%**
N_2O	0.8	0.9	0.9	0.9	0.9	0.9	0.8	0.7	0.7	0.7	**-18%**
HFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	**493%**
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-100%**
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**566%**
Total (Net Emissions)	**6.0**	**6.2**	**6.0**	**6.1**	**6.0**	**6.1**	**5.5**	**5.5**	**5.5**	**5.6**	**-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	
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	
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	

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

Northern Ireland	Aggregate Emission Trends by Source Category									
Source Category	**1990**	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1. Energy	15.7	16.5	15.5	15.9	16.0	16.3	14.8	14.9	14.7	15.4
2. Industrial Processes	0.8	0.8	1.0	1.1	0.9	0.9	0.5	0.5	0.5	0.7
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
4. Agriculture	4.8	4.9	5.2	5.1	4.8	4.9	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
6. Waste	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.4	0.4	0.4
Total	**21.9**	**22.8**	**22.2**	**22.4**	**22.0**	**22.2**	**20.3**	**20.3**	**20.1**	**20.7**

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

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**	**BY to 2005**
CO_2	13.1	15.6	16.2	16.9	16.2	16.3	17.4	16.9	17.4	17.1	**30%**
CH_4	1.8	1.7	1.5	1.3	1.1	1.1	1.0	1.0	1.0	0.9	**-52%**
N_2O	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.3	**213%**
HFCs	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	**NA**
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**NA**
Total (Net Emissions)	**15.0**	**17.4**	**17.8**	**18.3**	**17.5**	**17.6**	**18.6**	**18.1**	**18.6**	**18.3**	**22%**
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	
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	
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	

Table ES2.5.2 Unallocated GHG emissions (MtC equivalent)

Unallocated	**Mt Carbon Equivalent**										**% change**
	1990	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**BY to 2005**
CO_2	3.6	4.2	4.4	4.6	4.4	4.4	4.7	4.6	4.8	4.7	**30%**
CH_4	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.2	**-52%**
N_2O	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	**213%**
HFCs	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	**NA**
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**NA**
Total (Net Emissions)	**4.1**	**4.7**	**4.9**	**5.0**	**4.8**	**4.8**	**5.1**	**4.9**	**5.1**	**5.0**	**22%**
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	
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	
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	

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

Unallocated	Aggregate Emission Trends by Source Category									
Source Category	**1990**	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1. Energy	15.0	17.4	17.8	18.3	17.5	17.6	18.6	18.1	18.6	18.3
2. Industrial Processes	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
4. Agriculture	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
6. Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**15.0**	**17.4**	**17.8**	**18.3**	**17.5**	**17.6**	**18.6**	**18.1**	**18.6**	**18.3**

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

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Document Revision History

Document Revision History	
Version	Comment
Draft A	Tables of emissions issued for comment to the DAs. Comments received and revisions made. Draft Report prepared and submitted for comment, 20th August 2007.
Draft Final	Revisions made to address DA feedback, issued 31st August 2007.

1 Introduction

1.1 Background to Inventory Development for the Devolved Administrations

The United Nations Framework Convention on Climate Change (FCCC) was ratified by the United Kingdom in December 1993 and came into force in March 1994. Parties to the Convention are committed to develop, publish and regularly update national emission inventories of greenhouse gases (GHG).

Following devolution, a national UK inventory continues to be necessary to ensure the UK fulfils its reporting requirements under the FCCC and to monitor the legally binding commitments under the Kyoto Protocol to reduce greenhouse gas emissions. However, some of the measures to deliver GHG emission reductions are devolved and information on the emissions from the four individual countries is needed to support action in each country.

Therefore, Defra agreed with the Scottish Executive (SE), the Welsh Assembly Government and in Northern Ireland, the Department of the Environment, to carry out a joint research project to provide first estimates of GHG emissions inventories for England, Scotland, Wales and Northern Ireland. The results of this study were published in *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 and 1995: A Scoping Study, AG Salway et al (1999).* Subsequently these studies have been updated for 1998 to 2005.

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 2005. 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)

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 are consistent with the UK Greenhouse Gas Inventory (Baggott *et al*, 2007), submitted in April 2007. This report follows the convention used in Baggott *et al* (2007) of reporting carbon dioxide emissions and removals as net totals.

Certain emissions cannot be allocated to a country and are reported in a table for unallocated emissions. Unallocated emissions for these inventories are limited to emissions from the offshore oil and gas industry and domestic aviation emissions for flights originating from the Crown Dependencies (Channel Islands, Isle of Man).

1.2 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 2005. The reasons for any significant trends in emissions, issues regarding data availability and uncertainty estimates are provided for each inventory. Tables 9.1 to 9.6 present the summary data for these years as global warming potential (GWP) weighted emissions. This section of the report has been restructured this year to discuss trends in emissions by sector, rather than by gas.

Appendix 1: This appendix describes in detail the methodology of the estimates and how the Devolved Administration inventories relate to the UK Greenhouse Gas Inventory.

Appendix 2: This appendix provides IPCC Sectoral Tables for 1990 and 2005 for England, Scotland, Wales and Northern Ireland. Summary tables (IPCC Sectoral Table 7A) are provided for 1995 and 2004 for England, Scotland, Wales and Northern Ireland. UK summary tables are also reported. Table 3 of the Sectoral Tables are omitted because this reports Volatile Organic Compounds (VOCs) which are not relevant to this study. In IPCC Tables, emissions are reported in Gigagrammes (Gg).[3]

1.3 Global Warming Potential

Greenhouse gases all have different degrees of effectiveness in global warming. The Global Warming Potential (GWP) is an attempt to provide a simple measure of the relative radiative effects of the emissions of the various gases. The index is defined as the cumulative radiative forcing between the present and some chosen time horizon caused by a unit mass of gas emitted now, expressed relative to that of CO_2. It is necessary to define a time horizon because the gases have different lifetimes in the atmosphere. Table 1.1 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 FCCC 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 estimate the total contribution to global warming of UK greenhouse gas emissions.

Table 1.1 GWP of Greenhouse Gases on a 100-year Horizon (t CO_2 equiv/ t gas)

GWP	
Greenhouse Gas	Global Warming Potential (t CO_2 equiv / t gas)
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310
HFCs	140-11700
PFCs	6500-9200
SF_6	23900

1.4 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 report covered the years up to and including 2004, whilst this report gives emission estimates for the years up to and including 2005.

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 the DTI via 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 2003") 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, 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

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

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.

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.

2 Emissions in England

2.1 Summary of Main Emission Sources

The main emission sources for England in 2005 are summarised in Table 2.1 below, expressed as a percentage of the total English GHG emissions in 2005 of 510.2 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 7%
- CH_4 emissions have reduced by 56%
- N_2O emissions have reduced by 44%
- HFC emissions have reduced by 49%
- PFC emissions have reduced by 2%
- SF_6 emissions have reduced by 12%
- Total GHG emissions (as CO_2-equivalents) have reduced by 18%

The largest emissions source is CO_2 from power stations, which accounted for 27% of total English greenhouse gas emissions in 2005. 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 2005 English GHG emissions.

Table 2.1 Emissions Summary for England, 2005 (kt CO_2e)

Summary of Main Emission Sources, England 2005 (kt CO_2e)				
Gas	Sector Name	IPCC code	Emission	Percentage of total GWP Weighted Emissions
CO_2	Power stations	1A1a	138911	27%
CO_2	Road Transport	1A3b	99322	19%
CO_2	Residential Combustion	1A4b	68617	13%
CO_2	Other Industrial Combustion	1A2f	56157	11%
CO_2	Commercial and Institutional Combustion	1A4a	20197	4%
CH_4	Landfill	6A1	16970	3%
N_2O	Agricultural Soils	4D	16691	3%
CO_2	Refineries	1A1b	12431	2%
CO_2	Iron and Steel	1A2a	11477	2%
CH_4	Enteric fermentation - Cattle	4A1	6614	1%

Note that in the sector discussion text below, the percentages quoted are derived from the pivot table inventory data (on the attached cd-rom) and 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. 96% of energy sector emissions are CO_2.

Energy Industries (IPCC Sector 1A1) is the largest source of CO_2 in England and in 2005 this contributed 35.4% of the total CO_2 for the country, down from 39.7% of the England total of CO_2 emissions in 1990. This sector includes power generation, refineries, solid fuel transformation processes and the oil and gas industry. Power generation in England contributed 31.8% of the total English CO_2 emission, which is slightly higher than the UK proportion of 31.1%.

The mix of generation capacity is different in England from the rest of the UK: there is 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. Emissions from Energy Industries in England have decreased by 17.2% since 1990. At the UK level, the reduction in CO_2 emissions from Energy industries over 1990-2005 is only 11.6%. This difference can be explained, in part, by the installation of CCGTs in England and increased nuclear capacity and utilisation in England over the period. The CCGTs have higher efficiency than conventional thermal stations and produce lower emissions per GWh electricity generated.

Petroleum refining constitutes 2.8% of CO_2 emissions in England in 2005, lower than the UK mean contribution of 3.3% of total CO_2 emissions from refineries in 2005. Refinery CO_2 emissions in England have increased by 5.5% since 1990. The other energy emissions are relatively small and are mostly gas consumption at oil and gas terminals, gas separation plant, coking and solid fuel production. Only emissions arising from on-shore installations in England have been included. Other energy emissions have however increased by 26.4% from 1990 to 2005 as a result of an increase in gas consumption by the oil and gas industry, although the 1990 figures are highly uncertain.

Combustion emissions from Manufacturing Industry and Construction (IPCC Sector 1A2) account for 15.5% of the English CO_2 total. The iron and steel industry in England accounts for 64.2% of the UK Iron and Steel combustion emissions. The 'Other industry' category (IPCC sector 1A2f) for England contributes 83.6% towards the UK 'Other industry' CO_2 total.

Road Transport is the largest single source of CO_2 after power generation, contributing 22.8% to the English total CO_2 emission. The contribution of English road transport to UK road transport CO_2 emissions is 82.8%, which is slightly less than that which would be expected from England's population (83.8% of UK[4]). The emission has risen by 8.4% from 1990 to 2005 compared with a 9.6% rise for the UK. (See also the discussion regarding road transport emission estimation methodology in Appendix 1.)

Other combustion emissions arise from the domestic (residential), commercial and public sectors. 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, although the methodology for these sectors has been improved for the 1990 – 2005 inventories (see Section 7). CO_2 emissions from domestic combustion sources are estimated to account for 15.7% of the English total. As a proportion of UK domestic emissions they are estimated to represent 82.3%, which is slightly less than would be expected from England's population (83.8%).

N_2O emissions from combustion sources account for 25% of the English total. These arise mainly from road transport, amounting to 14.8% of England's total N_2O emissions having increased by almost 400% since 1990, due to the increase in the number of vehicles using three way catalysts. Fuel combustion emissions only account for 2.2% 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 is around 20.9% of the English total methane emission compared with the UK average of 19.1%. The higher English emission is due to the greater contribution of coal mining and leakage from the gas transmission system in England than elsewhere in the UK. Of these fugitive methane emissions, coal mining contributes 9.1%, natural gas distribution 11.4% and oil and gas terminals 0.2% of the English total. Coal mining emissions have declined by 79.6% from 1990 to 2005 due to the decline in the coal industry. Gas leakage from the gas transmission system is reducing as the mains and services are renewed. The reduction in leakage between 1990 and 2005 is around 41.5%.

2.3 Industrial Processes

Industrial processes produce emissions from non-combustion sources such as the use of limestone in cement and glass making. Almost half of the emissions from this sector in England are CO_2 (47%),

[4] Where population percentages are quoted throughout this report, they are taken from ONS data for 2005.

with HFCs contributing a further 35%, although total greenhouse gas emissions from this sector only contribute 4.4% 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, constituting 1.0% of English total CO_2 emissions, with smaller emissions from glass, ammonia, aluminium, iron and steel production contributing a further 0.8% of the English total in 2005. England emits all of the UK's emissions from lime production and ammonia production, 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 75% of HFC emissions (as CO_2 equivalent) in England and 71% of total UK HFC emissions (as CO_2 equivalent). Over recent years, HFC emissions from the manufacture of HCFCs and HFCs have been reduced through the installation of improved abatement systems on HCFC production plant. In 2005, HCFC and HFC production in England contributed only 4.3% of total English HFC emissions (as CO_2 equivalent) and 3.7% of total UK HFC emissions (as CO_2 equivalent).

In 2005, the largest sources of HFC emissions are refrigeration, air conditioning, and aerosols and metered dose inhalers. These sources account for 85% of English HFC emissions in 2005, and for 29% of total GHG emissions in the industrial processes sector. Emissions from refrigeration arise from losses from refrigeration and air conditioning equipment during its manufacture and lifetime, and 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.

N_2O emissions account for 12.4% of total GHG emissions from the industrial processes sector in England, and 10% of the total English N_2O emission occurs here. Up until 1998, a more substantial proportion of England's nitrous oxide emissions were produced by chemical processes, namely adipic acid production and to a lesser extent nitric acid production. In 1998, these processes constituted around 36% of England's total N_2O emissions and 97% 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 emissions from this source were significantly reduced. In 2005, the sum of the English emissions from the nitric acid and adipic acid production is around 9.0 kt N_2O, equivalent to 9.8% of the total English N_2O emission, 7.1% of the UK total.

4% of total GHG emissions from the industrial processes sector in England are sulphur hexafluoride (SF_6). The main sources of SF_6 emissions are from use as electrical insulation, which accounts for 46% of SF_6 emissions in England in 2005 and as a cover gas in magnesium production which accounted for around 27%. Magnesium production is largely concentrated in England; English emissions account for 93% of the UK magnesium production emission. Sulphur hexafluoride is also emitted from other sources: electrical switchgear used in power transmission, electronics applications and leakage from the soles of certain brands of training shoes. The sum of these emissions accounts for around 27% of total English SF_6 emissions in 2005. Emissions of SF_6 have decreased by 12% since 1995.

PFC emissions only account for 1% of emissions in the industrial processes sector in England, and for around 0.05% of total English GHG emissions. The largest sources in England in 2005 were by-product emissions from primary aluminium production (43%) and fugitive emissions from PFC manufacture (48%). English PFC emissions account for 65.8% of total UK PFC emissions, and have declined by 1.7% since 1995.

Emissions of methane from this sector are not significant.

2.4 Agriculture

GHG emissions from agriculture comprise entirely of methane and N_2O. English emissions represent 56% 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[5]. This contributes 28% to the overall CH_4 emissions in England in 2005, with cattle responsible for 77% of the agricultural methane emissions. Emissions from agriculture are largely dependent on the numbers of livestock and have fallen by 21% from 1990 to 2005 resulting from a decline in cattle and sheep numbers. Of the total emission from agriculture in England, 84% is due to enteric fermentation.

Of the total English emission of 91.8 kt N_2O in 2005, 56.4 kt N_2O of this was from agriculture, representing 61% of the total. Most of these were emissions arising from the agricultural soils category as a result of processes in the soil arising from, in order of magnitude:

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

- synthetic fertiliser application (28%)
- leaching of fertiliser nitrogen and applied animal manures to ground and surface water (27%)
- wastes from grazing animals (14%)
- ploughing in crop residues (14%)
- manure used as fertiliser (9%)
- atmospheric deposition of ammonia (NH_3) and oxides of nitrogen (NOx) (6%)
- cultivation of legumes (1.3%)
- cultivation of histosols (i.e. high organic content soils) (0.8%)
- biological fixation in improved grass (0.5%)

A relatively small proportion (2.5kt N_2O) is emitted from the management of animal manure (emissions related to handling of manure before it is added to the soil). English agricultural nitrous oxide emissions have decreased by 17% in the period 1990-2005 and in 2005 represent around 66% of UK agricultural emissions.

2.5 Land Use, Land Use Change and Forestry

Data are calculated and presented in this report for net emissions of carbon dioxide from Land Use Change and Forestry. England is a net source of greenhouse gases from LULUCF activities, representing 0.6% of total GHG emissions.

The LULUCF sector contains both sources and sinks of carbon dioxide, as well as small sources of methane and nitrous oxide. England is a net source of carbon dioxide from LULUCF activities although the size of this source has diminished by 46% between 1990 and 2005 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 Forestland and Grassland categories are increasing. The Cropland category is the largest overall.

Net emissions in 1990 are estimated here to be 5.712 Mt CO_2 compared to 5.736 Mt CO_2 in the 2004 DA inventory report. For 2004 a net source of 3.259 Mt CO_2 is estimated here compared to 3.231 Mt CO_2 in the 2004 inventory. Differences between the inventories are due to revision of the 1990-2004 data on conversion of Forestland to Settlement, which also affected the land use transition matrix, and some minor revisions of the data used for allocating liming to Grassland or Cropland. Activity data was updated with 2005 estimates. There were no changes in methods this year. Appendix 1 contains details of the methods and data sources used.

Methane and nitrous oxide emissions from the conversion of Forestland to Grassland or Settlement are not significant.

2.6 Waste

The waste sector contributes 4% to total GHG emissions in England, and is the largest source sector for methane emissions, representing 49% of total methane emissions.

5 Data pertaining to agriculture emissions are provided by the Institute of Grassland and Environmental Research.

This is dominated by landfill methane with a small contribution from wastewater treatment. The landfill emission is around 87% of the UK landfill emission, which is slightly higher than would be expected from England's population (83.8%). Estimates are based on data on disposal of municipal solid waste and sewage sludge in England, using UK data for waste composition and the percentage of MSW disposed to landfill. Also it has been assumed that the proportion of methane recovered in England reflects that recovered in the UK. Since 1990, landfill emissions in England have declined by 61.2% due to the increasing use of methane recovery systems. This is the same trend as is observed for the UK as a whole. Emissions from wastewater treatment are around 2% of the English total methane emissions and comprise 83.8% of UK wastewater emissions.

3 Emissions in Scotland

3.1 Summary of Main Emission Sources

The main emission sources for Scotland in 2005 are summarised in Table 3.1 below, expressed as a percentage of the total Scottish GHG emissions in 2005 of 54.5 Mt CO_2-equivalent. 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 13%
- CH_4 emissions have reduced by 38%
- N_2O emissions have reduced by 21%
- HFC emissions have increased by 457%
- PFC emissions have reduced by 20%
- SF_6 emissions have increased by 125%
- Total GHG emissions (as CO_2-equivalents) have reduced by 16%

The largest emissions source in Scotland is CO_2 from power stations, which accounted for 26% of net Scottish emissions in 2005. The largest methane source is from enteric fermentation in cattle, 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 amount to a removal of 13 $MtCO_2$ in 2005.

Table 3.1 Emissions Summary for Scotland, 2005 (kt CO_2e)

Summary of Main Emission Sources, Scotland 2005 (kt CO_2e)				
Gas	Sector Name	IPCC code	Emission	Percentage of total GWP Weighted Emissions
CO_2	Power stations	1A1a	14057	26%
CO_2	Road Transport	1A3b	9903	18%
CO_2	Residential Combustion	1A4b	7551	14%
CO_2	Land Converted to Cropland	5B2	6561	12%
CO_2	Other Industrial Combustion	1A2f	6026	11%
N_2O	Agricultural Soils	4D	3769	7%
CO_2	Refineries	1A1b	2399	4%
CO_2	Commercial and Institutional Combustion	1A4a	2120	4%
CH_4	Enteric fermentation - Cattle	4A1	2021	4%
CO_2	Other Energy Industries	1A1c	1994	4%

Note that in the sector discussion text below, the percentages quoted are derived from the pivot table inventory data (on the attached cd-rom) and 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).

3.2 Energy

The energy sector accounts for 90% of total greenhouse gas emissions in Scotland, and CO_2 emissions contribute 97% of the emissions in this sector. This sector includes all emissions from fuel combustion, and also fugitive emissions from fuels.

Energy Industries is 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 2005, power generation (IPCC category 1A1a) contributed around 32.2% of the total Scottish CO_2 emission, which is slightly higher than the UK average of 31.1%. Scottish emissions from 1A1a have decreased by 5.3% since 1990 in contrast with a fall of 15.6% in UK emissions.

These observations may be due to Scotland generating electricity that is subsequently exported and used elsewhere in the UK. The mix of generation capacity in Scotland is different from the rest of the UK, with a higher proportion of nuclear and hydro-electricity plant, and hence a lower carbon dioxide emission may be expected. On the other hand, the fossil fuel generation in Scotland is 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) over the period that have higher generation efficiencies than conventional thermal plant.

CO_2 emissions from petroleum refining constitute a larger proportion of national emissions in Scotland at 5.5% of the CO_2 total, compared with 3.3% for the UK due to the greater incidence of oil and gas landings in Scotland from offshore facilities compared to the UK average. The other energy emissions account for around 4.6% of Scottish emissions, mostly from gas consumption at oil and gas terminals and gas separation plant. Only those emissions arising from on-shore installations in Scotland have been included.

CO_2 emissions from Manufacturing Industry and Construction (IPCC Sector 1A2) account for 13.9% of the Scottish CO_2 total compared with 15.3% for the UK. Between 1990 and 2005, CO_2 emissions have declined over the period by 34%, mainly due to the closure of the Ravenscraig steel plant.

Road transport is the largest single source of CO_2 after power generation and comprises around 22.7% of the Scottish total. Scotland's contribution to UK road transport emissions is 8.3%, which is slightly lower than would be expected from Scotland's population (8.5%). The emission has risen by 9.7% over the period (1990-2005) compared with a 9.6% rise for the UK. (See also the discussion regarding road transport emission estimation methodology in Appendix 1.) Road transport is also the most significant source of N_2O emissions in the energy sector, accounting for 8.6% of total N_2O emissions in Scotland. Emissions of N_2O from this source have increased by several hundred per cent as a result of the increasing use of three way catalysts.

Other combustion emissions arise from the domestic, commercial and public sectors. 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. CO_2 emissions from domestic combustion sources are estimated to account for around 17.3% of the Scottish total. As a proportion of UK domestic emissions they are 9.1% which slightly higher than would be expected from Scotland's population (8.5%). Domestic combustion is also the largest combustion related source of methane, contributing 1% 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 is 9.3% of the Scottish methane total. This is a lower proportion compared with the UK as a whole, where fugitives are around 19.1% 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 2%, oil and gas terminals 0.5% and natural gas distribution 6.5% of the Scottish methane total. Coal mining emissions have declined by 83.7% over the period due to the decline in the coal industry. Emissions from the oil & gas industry have fallen by 76.7% over the same period due to tighter regulation of environmental emissions. Gas leakage from the gas transmission system was reduced by 42.3% over 1990-2005 as the mains and services are renewed. The estimate of gas leakage from the gas transmission system is based on UK National Grid data.

Only around 3% of CO_2 emissions arise from oil and gas fugitives, mainly from processes at oil and gas terminals (1.5%), as well as oil and gas flaring (0.8%). Between 1990 and 2005, oil and gas process emissions increased by 86.5%, while emissions from flaring have decreased by 64.5%.

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 27% of total Scottish emissions from the industrial processes sector.

In 2005, refrigeration and air conditioning contributed 56.6% 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 31.7% to the total Scottish HFC emission in 2005, the main sources being industrial aerosols and medical use of metered dose inhalers. The remaining emission sources (foams, fire-fighting and solvents) contributed 11.7% of total Scottish HFC emissions.

Total emissions of HFCs have increased significantly since the 1995 base year, in contrast to a large decrease in emissions for England (which has the largest effect on the UK total). This is because English emissions before 1998 were dominated by fugitive and by-product emissions from HFC and HCFC manufacture, which have now decreased significantly due to the installation of abatement equipment, offsetting the increases from other sources; there is no manufacture of fluorinated gases in Scotland.

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 1.4% of the Scottish total in 2005 and have decreased by 52% over 1990-2005.

In 1990, nitric acid manufacture and iron and steel were both important sources of greenhouse gases in the Scottish industrial processes sector. However, emissions from these sources in 2005 are negligible since the closure of the Ravenscraig iron and steel plant, and the relocation of the only Scottish nitric acid plant to Dublin in 1995. In 1990 around 394kt CO_2e of nitrous oxide were emitted from a nitric acid plant in Leith, and 466kt CO_2 were emitted from iron and steel processes. These plant closures have made a significant contribution to the decrease in Scottish emissions since the 1990 base year.

Emissions of PFCs represent 4.6% of Scottish GHG emissions in the industrial processes sector. The largest source of perfluorocarbons in Scotland is consumption by the electronics industry. In 2005, this contributed around 86% to the total Scottish PFC emission (as CO_2 equivalent). The other main source of PFCs in Scotland is aluminium production and this contributes 14% to the total emissions of PFCs from Scotland. Overall, Scottish PFC emissions account for 20% of the UK total (as CO_2 equivalent) and have decreased by 19.8% over 1995-2005 as the decreases in emissions from the aluminium production have out-weighed the increase from the electronics industry.

SF_6 emissions represent 4.6% of Scottish industrial process 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 2005 are 6.1% of the UK total and in Scotland the emissions of SF_6 have increased by 125% over 1995-2004.

3.4 Agriculture

Emissions from the agriculture sector contribute 13% to total greenhouse gas emissions in Scotland. These emissions arise 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.

Enteric fermentation from cattle is the largest single source of methane emissions in Scotland, contributing almost 40% of Scottish methane emissions. Total emissions from cattle (including both waste management and enteric fermentation) are 72% of total methane emissions from agriculture in Scotland, with sheep responsible for a further 26%. Emissions are largely dependent on the numbers of livestock and have fallen by 8.5% over the period 1990-2005, due to a decline in cattle and sheep

numbers. Scotland accounts for around 17% of UK agricultural methane emissions. In addition to the methane emissions from livestock, N_2O emissions also arise from waste management, although this is only a small proportion of total agricultural greenhouse gas emissions (3%).

The agriculture sector also includes the largest source of N_2O emissions; emissions from agricultural soils contribute 77% of total N_2O emissions, and 53% of GHG emissions from the agriculture sector. Of the total Scottish emission of 15.7kt N_2O in 2005, around 13kt N_2O of this was from agriculture, representing 81% of the total. Emissions from the agricultural soils sector are broken down below.

[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%)
- synthetic fertiliser application (26%)
- wastes from grazing animals (22%)
- manure used as fertiliser (9%)
- ploughing in crop residues (7%)
- atmospheric deposition of ammonia (NH_3) and oxides of nitrogen (NO_x) (7%)
- biological fixation in improved grass (0.8%)
- cultivation of histosols (i.e. high organic content soils) (0.2%)
- cultivation of legumes (<0.1%)

3.5 Land Use, Land Use Change and Forestry

Data are calculated and presented in this report for net emissions of carbon dioxide from Land Use Change and Forestry. LULUCF activities are also a 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. The size of this sink has increased by 80%, from -2.5 to - 4.6 Mt CO_2, between 1990 and 2005 although this trend is projected to level off or reverse in the future. Net emissions/removals in Scotland are dominated by the large Forestland sink (-10.1 Mt CO_2 in 2005) although the Cropland source is also significant (6.5 Mt CO_2 in 2005).

Net removals in 1990 are estimated here to be -2.541 Mt CO_2 compared to -2.535 Mt CO_2 in the 2004 DA inventory report. For 2004 a net sink of -4.649 Mt CO_2 is estimated here compared to -4.617 Mt CO_2 in the 2004 inventory. Differences between the inventories are due to revision of the 1990-2004 data on conversion of Forestland to Settlement, which also affected the land use transition matrix, and some minor revisions of the data used for allocating liming to Grassland or Cropland. Activity data was updated with 2005 estimates. There were no changes in methods this year. Appendix 1 contains details of the methods and data sources used.

Methane and nitrous oxide emissions from the conversion of Forestland to Grassland or Settlement are not significant.

3.6 Waste

Waste emissions in Scotland are dominated by methane emissions from landfills. This accounts for 86% of total greenhouse gas emissions from the waste sector. Scottish landfill emissions represent 6.3% of total UK landfill methane emissions, which is less than would be expected from the Scottish proportion of the population (8.5%). The estimates are based on data on arisings of municipal solid waste and sewage sludge in Scotland but using UK data for their composition and the proportion of Municipal Solid Waste disposed of to landfill. It has been assumed that the degree of methane recovery from Scottish landfills reflects that of the UK. Landfill emissions 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 12% of total greenhouse gas emissions in the waste sector. These

emissions are estimated to be around 8.4% of UK wastewater treatment emissions, which is consistent with the Scottish share of the UK population. Emissions have increased since 1998 when sea dumping ended and other disposal routes were adopted.

4 Emissions in Wales

4.1 Summary of Main Emission Sources

The main emission sources for Wales in 2005 are summarised in Table 4.1 below, expressed as a percentage of the total Welsh GHG emissions in 2005 of 50.1 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 4%
- CH_4 emissions have reduced by 41%
- N_2O emissions have reduced by 8%
- HFC emissions have increased by 467%
- PFC emissions have reduced by 66%
- SF_6 emissions have reduced by 16%
- Total GHG emissions (as CO_2-equivalents) have reduced by 9%

In Wales, 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, these ten categories account for more than 81% of the Welsh total net emissions in 2005.

Table 4.1 Emissions Summary for Wales, 2005 (kt CO_2e)

Summary of Main Emission Sources, Wales 2005 (kt CO_2e)				
Gas	Sector Name	IPCC code	Emission	Percentage of total GWP Weighted Emissions
CO_2	Power stations	1A1a	14047	28%
CO_2	Iron and Steel	1A2a	6332	13%
CO_2	Road Transport	1A3b	6027	12%
CO_2	Residential Combustion	1A4b	4488	9%
CO_2	Other Industrial Combustion	1A2f	3719	7%
CO_2	Refineries	1A1b	3344	7%
N_2O	Agricultural Soils	4D	2648	5%
CH_4	Enteric fermentation - Cattle	4A1	1468	3%
CO_2	Land Converted to Cropland	5B2	1046	2%
CH_4	Landfill	6A1	994	2%

Note that in the sector discussion text below, the percentages quoted are derived from the pivot table inventory data (on the attached cd-rom) and 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 96.8% of total GHGs in this sector. Emissions of methane and N_2O from fuel combustion are much smaller, amounting to only 1.6% of the sector. Fugitive emissions from fuels are an important source of methane, accounting for 14.5% of the Welsh methane total, although they only account for 1.6% of total energy sector emissions. The energy sector accounts for 82.9% of total Welsh GHG emissions.

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 around 33.7% of the total Welsh carbon dioxide emissions in 2005, which is slightly higher

than the UK proportion of 31.1%. Emissions from electricity generation in Wales have increased by 24.8% compared with a fall of 15.6% in UK emissions over 1990 to 2005.

There is now only one nuclear power station 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. One power station (oil-fired) at Pembroke has closed. 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.

Petroleum refining constitutes 8% of Welsh CO_2 emissions in 2005 compared with 3.3% for the UK. The other energy emissions are mostly combustion emissions from coke ovens and solid fuel plant and account for 0.7% of the 2005 Welsh carbon dioxide total emission. There are no significant emissions from oil and gas production.

Combustion emissions from Manufacturing Industries and Construction (IPCC Sector 1A2) account for 24.1% of the Welsh CO_2 total compared with 15.3% 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 35.4% of UK Iron and Steel combustion emissions of CO_2 in 2005. The sintering process in the iron and steel sector is also the most significant combustion source of methane in Wales, accounting for 1.2% of total Welsh methane emissions. Welsh CO_2 emissions from the 'other industry' category are 5.5% of the UK CO_2 total for this sector.

Road transport is the largest single source of CO_2 after power generation and iron and steel, and comprises 14.4% of the total Welsh carbon dioxide emission in 2005, which is 12% of all Welsh GHG emissions. The contribution of Welsh Road Transport to UK Road Transport CO_2 emissions is 5.0%, which is consistent with Wales' population (4.9% of UK population). The emission has risen by 9.3% from 1990 to 2005 compared with a 9.6% rise for the UK. (See also the discussion regarding road transport emission estimation methodology in Appendix 1.). Road transport is also the most significant source of N_2O emissions in the energy sector, accounting for 7.9% of total Welsh N_2O emissions. These emissions have increased significantly since 1990 due to a higher prevalence of vehicles fitted with three way catalysts in the UK fleet.

Other combustion emissions arise from the domestic, commercial and public 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. CO_2 emissions from domestic combustion sources are estimated to account for 10.8% of the Welsh total in 2005. As a proportion of UK domestic emissions they are estimated to represent 5.4%, 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 a much smaller contribution from N_2O and CO_2. The largest methane source in this category is coal mining, which represents 9% of total Welsh methane emissions, and 10.8% of total UK emissions from this sector. Emissions from this source have decreased by 72.9% since 1990 due to the decline in the mining industry in Wales. The other major source is leakage from the gas distribution network, which amounts to 5.4% of the Welsh methane total. This emission has decreased by 27.5% since 1990, due to the renewal of the gas supply network.

4.3 Industrial Processes

The industrial processes sector includes emissions from all non-fuel combustion sources in the industrial sector. In Wales, the largest emission in this 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. This accounts for 29% of Welsh total greenhouse gas emissions from this sector. 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 are not significant in this sector.

CO_2 emissions from cement and glass production amount to 1.6% of total CO_2 emissions in Wales; Welsh process emissions from the glass industry represents 24% of total UK emissions in this sector. Aluminium production in Wales is a significant source of both CO_2 and PFC emissions, which together account for 14% of total greenhouse gas emissions from the industrial processes sector.

In 2005 the total HFC emission in Wales was 4.2% of the UK HFC total (as CO_2 equivalent). Refrigeration is the largest source and contributes 51.8% to the total Welsh HFC emission (as CO_2 equivalent) due to losses from refrigeration and air conditioning equipment during its manufacture and lifetime. Aerosols contribute 35.2% to the total Welsh HFC emission (as CO_2 equivalent), the main sources being industrial aerosols and medical use of metered dose inhalers. The remaining emission sources (foams, fire-fighting and solvents) contributed 13% to the total Welsh HFC emission (as CO_2 equivalent) in 2005. Emissions of HFCs in Wales have increased significantly since the 1995 base year, compared to a 48.5% decrease for England, and 40.6% for the UK. This is because there is no manufacture of these gases in Wales, and reductions in this sector have helped to offset the increases in HFC use in England.

Welsh emissions of sulphur hexafluoride are estimated at 6.1 % of the UK total in 2005. The largest source of emissions is from IPCC category 2F8 and this accounts for 71% of emissions. 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 industry use as a cover gas in magnesium production. This accounts for around 29% of total Welsh SF_6 emissions and comprises 7% of the UK magnesium production emission.

4.4 Agriculture

Agriculture accounts for 11% of total greenhouse gases in Wales, and is the most significant source sector for methane and N_2O, accounting for 60% and 82% of total Welsh emissions of these two gases, respectively.

The largest single source of methane emissions in Wales is enteric fermentation from cattle. This accounts for 32% of total Welsh methane emissions and 54% of methane emissions from the agriculture sector, with enteric fermentation in sheep accounting for a further 36% of these emissions. Total emissions arising from enteric fermentation amount to 90% of methane emissions from agriculture, with the remaining 10% of emissions coming from animal wastes. Animal waste is also a relatively significant source of N_2O emissions, representing 3.7% of the Welsh N_2O total. Emissions from livestock are largely dependent on livestock numbers, and have declined by 7% since 1990 in line with a decrease in sheep and cattle numbers, although this is much less than the average UK decline in these emissions, which was 14% over the same period.

The other major source of emissions in the agriculture sector is agricultural soils, which constitutes a significant emission of N_2O (78.5% of the Welsh N_2O total). A further breakdown of these emissions is shown below.

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

- wastes from grazing animals (33%)
- leaching of fertiliser nitrogen and applied animal manures to ground and surface water (29%)
- synthetic fertiliser application (19%)
- manure used as fertiliser (9%)
- atmospheric deposition of ammonia (NH_3) and oxides of nitrogen (NOx) (8%)
- ploughing in crop residues (1%)
- biological fixation in improved grass (1%)
- cultivation of histosols (i.e. high organic content soils) (0.5%)
- cultivation of legumes (<0.1%)

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 increased from -0.24 to -0.25 Mt CO_2 from 1990 to 2005. The Forestland net sink (-1.5 Mt CO_2 in 2005) and the Cropland net source (1.0 Mt CO_2 in 2005) are the largest contributors to the LULUCF sector in Wales.

Net removals in 1990 are estimated here to be -0.244 Mt CO_2 compared to -0.241 Mt CO_2 in the 2004 DA inventory report. For 2004 a net sink of -0.244 Mt CO_2 is estimated here compared to -0.249 Mt CO_2 in the 2004 inventory. Differences between the inventories are due to revision of the 1990-2004 data on conversion of Forestland to Settlement (which also affected the land use transition matrix), some minor revisions of the data used for allocating liming to Grassland or Cropland and the correction of an error in the non-forest biomass estimate (change of -0.084 Gg CO_2 per year). Activity data was updated with 2005 estimates. There were no changes in methods this year. Appendix 1 contains details of the methods and data sources used.

Methane and nitrous oxide emissions from the conversion of Forestland to Grassland or Settlement are not significant.

4.6 Waste

Greenhouse gas emissions in the waste sector are dominated by methane emissions from landfills, which represent 89% 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 21.9% of total Welsh methane emissions, and have decreased by 61.6% since 1990, due to increasing use of methane recovery systems. Estimates were based on data on arisings of municipal solid waste and sewage sludge in Wales but using UK data for their composition and the proportion of MSW disposed of to landfill. The degree of methane recovery on Welsh landfills was assumed to reflect that of the rest of the UK.

Emissions from wastewater treatment are 1.8% of total Welsh N_2O emissions, and these emissions account for 4.9% of UK wastewater treatment N_2O emissions and are dependent on the data on sewage disposals and disposal routes used.

5 Emissions in Northern Ireland

5.1 Summary of Main Emission Sources

The main emission sources for Northern Ireland in 2005 are summarised in Table 5.1 below, expressed as a percentage of the total Northern Irish GHG emissions in 2005 of 20.7 Mt CO_2-equivalent. 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 4%
- CH_4 emissions have reduced by 11%
- N_2O emissions have reduced by 18%
- HFC emissions have increased by 493%
- PFC emissions have reduced by 100%
- SF_6 emissions have increased by 566%
- Total GHG emissions (as CO_2-equivalents) have reduced by 6%

Emissions in Northern Ireland are dominated by CO_2 from power stations, road transport and residential combustion, which together account for 61% of the total net emissions. Agricultural sources, including N_2O from soils, CH_4 from enteric fermentation, and CO_2 from stationary combustion in this sector all appear in the list of the ten largest sources. Emissions of CO_2 from the cement industry are also significant for Northern Ireland.

Table 5.1 Emissions Summary for Northern Ireland, 2005 (kt CO_2e)

Summary of Main Emission Sources, Northern Ireland 2005 (kt CO_2e)				
Gas	Sector Name	IPCC code	Emission	Percentage of total GWP Weighted Emissions
CO_2	Power stations	1A1a	5264	25%
CO_2	Road Transport	1A3b	4641	22%
CO_2	Residential Combustion	1A4b	2686	13%
N_2O	Agricultural Soils	4D	2002	10%
CH_4	Enteric fermentation - Cattle	4A1	1872	9%
CO_2	Other Industrial Combustion	1A2f	1291	6%
CO_2	Land Converted to Cropland	5B2	1138	6%
CO_2	Land Converted to Settlements	5E2	569	3%
CO_2	Agriculture - Stationary Combustion	1A4c	382	2%
CO_2	Cement - Decarbonising	2A1	343	2%

Note that in the sector discussion text below, the percentages quoted are derived from the pivot table inventory data (on the attached cd-rom) and 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 74% of total greenhouse gas emissions. This is much lower than the UK average contribution from this sector, which in 2005 was 86%. This is because, unlike the other DAs, Northern Ireland does not have any refineries, iron and steel industry, oil and gas terminals, coal mining, and because leakage from the gas supply network is minimal due to the relatively young age of the network.

In the 1990 to 2004 inventory report, road transport was the largest single source of CO_2 in Northern Ireland. Following revisions to the data supplied by DRDNI, this is no longer the case and in 2005 the largest source was power generation with road transport now the second largest source. Greenhouse

gas emissions from power generation (mostly CO_2) represent 34% of total emissions from the energy sector, and 26% of total emissions.

The mix of generation capacity is quite different 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 high emission from electricity generation. 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.

CO_2 emissions from electricity generation decreased by 3.6% between 1990 and 2005, largely due to the conversion to natural gas. However, the emissions have shown an 11.2% increase from 2004 to 2005, due to significant increases in emissions from Kilroot and Ballylumford.

Emissions from road transport represent 30.7% of the 2005 Northern Ireland CO_2 total, and this emission has risen by 44% since 1990, compared with a 9.6% increase for the UK over the same period (See also the discussion regarding road transport emission estimation methodology in Appendix 1.) Road transport is also becoming an increasingly significant source of N_2O emissions, with emissions rising by several hundred per cent since 1990, to represent 7.3% of total N_2O emissions, and the largest combustion related source of N_2O in Northern Ireland

Combustion emissions from Manufacturing Industry and Construction (IPCC Sector 1A2) account for 8.5% of the total Northern Ireland carbon dioxide emission compared with 15.3% 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 1.9% towards the UK Other Industry total, and has decreased by approximately 31.6% over the period 1990-2005, compared with a UK average 11% decrease for this sector. The calculation methodology for this sector has been revised significantly in the compilation of this latest inventory to use regional energy statistics that have been published for recent years by BERR. Despite the use of these new regional energy data, the emission estimates for this source are still subject to significant uncertainty. Further information regarding the estimation method and source data can be found in Appendix 1.

Other combustion emissions arise from the domestic, commercial and public sectors. The methodology for estimating emissions from solid and liquid fuel use in these sectors has also been revised this year to use the DBERR regional energy statistics, and for domestic sources, HECA data to ascertain trends in fuel switching. CO_2 emissions from domestic combustion sources are estimated to account for 17.8% of the Northern Irish CO_2 total. As a proportion of UK domestic emissions they are estimated to represent 3.2%, 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 18.5% 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 the Industrial Processes sector in Northern Ireland contribute 3.2% to the over all emissions total, and more than half of these emissions (52%) are CO_2 from the cement industry. There are no sources of methane, N_2O or PFCs in this sector in Northern Ireland in 2005, 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 Northern Irish emissions of HFCs in 2005 were 2.5% of the UK Total (as CO_2 equivalent), and represent 36% of total greenhouse gas emissions in the Northern Ireland industrial processes sector. The largest source was refrigeration (including air conditioning) contributing 53.7% of the Northern Ireland HFC total due to losses from refrigeration and air conditioning equipment during its manufacture and lifetime. Aerosols contributed 33.8% to the total Northern Irish HFC emission in 2005, the main sources being industrial aerosols and medical use of metered dose inhalers. The remaining emission sources (foams, fire-fighting and solvents) contributed 12.5% of total Northern Irish HFC emissions. The total emission has increased from virtually zero in 1990 to 233kt CO_2 equivalent in 2005.

Northern Ireland SF_6 emissions accounted for 1.1% of the UK total in 2005. The main sources of sulphur hexafluoride 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 22% of total greenhouse gas emissions in Northern Ireland in 2005, which is a much higher proportion than the UK average (7%). This is because there are fewer industry 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 (86%) and the management of animal wastes (14%). The largest single source of methane emissions in Northern Ireland is enteric fermentation from cattle. This source alone accounts for 67% of total methane emissions in Northern Ireland, and for 41% of total greenhouse gas emissions in the agriculture sector. These emissions are dependent on livestock numbers, and have increased by 4.5% since 1990, mainly influenced by an increase in cattle numbers. This is in contrast to the over all trend for the UK, which shows a decrease in emissions of methane from this source. Emissions from Northern Ireland represent 13% of total UK agricultural methane.

The largest source of N_2O emissions is also in the agriculture sector. Emissions in the agricultural soils sector account for 79% of the total Northern Irish N_2O emission in 2005. A further breakdown of this emissions source is shown below.

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

- leaching of fertiliser nitrogen and applied animal manures to ground and surface water (30%)
- wastes from grazing animals (24%)
- synthetic fertiliser application (21%)
- manure used as fertiliser (15%)
- atmospheric deposition of ammonia (NH_3) and oxides of nitrogen (NOx) (8%)
- ploughing in crop residues (1%)
- improved grass (1%)
- histosols (i.e. high organic content soils) (0.2%)
- cultivation of legumes (<0.1%)

A relatively small emission (0.6 kt N_2O) comes from the treatment of animal wastes (Manure Management). Northern Irish agricultural nitrous oxide emissions have fallen by 12.5% between 1990 and 2005, and in 2005 represent around 8% of UK agricultural N_2O emissions.

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 -0.05 to -0.31 Mt CO_2 from 1990 to 2005. The Cropland net source (1.1 Mt CO_2 in 2005) and the Grassland net sink (-1.2 Mt CO_2 in 2005) 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 -0.045 Mt CO_2 here and in the 2004 DA inventory report. For 2004 a net sink of -0.300 Mt CO_2 is estimated here compared to a net source of -0.307 Mt CO_2 in the 2004 inventory. Differences between the inventories are due to a minor revision of the 1999-2004 forest planting data and some minor revisions of the data used for allocating liming to Grassland or Cropland. Activity data was updated with 2005 estimates. There were no changes in methods this year. Appendix 1 contains details of the methods and data sources used.

Methane and nitrous oxide emissions from the conversion of Forestland to Grassland or Settlement are not estimated for Northern Ireland due to a lack of data.

5.6 Waste

Emissions from the waste sector represent 2% of total greenhouse gas emissions in Northern Ireland, and 1.6% of total UK waste emissions.

These emissions are dominated by methane emissions from landfills, which comprise 81% 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 UK data for waste composition, percentage of MSW disposed to landfill, and proportion of methane recovery. On this basis, landfill emissions have fallen by 52% due to increasing use of methane recovery systems, reflecting the UK trend.

Emissions from wastewater treatment represent 2.9% of UK emissions from this source, which is consistent with the relative populations. Wastewater treatment is a relatively important source of N_2O emissions, representing 1.4% of total N_2O emissions in Northern Ireland.

6 Unallocated Emissions

Emissions from offshore oil and gas installations and domestic aviation emissions from flights originating in the Crown Dependencies (Channel Islands, Isle of Man) are accounted as “unallocated” emissions. As a proportion of the 2005 UK totals they account for the following:

Carbon dioxide	3.1%	(up 30% since 1990)
Methane	1.8%	(down 52% since 1990)
Nitrous oxide	0.9%	(up 213% since 1990)

There are no unallocated emissions of halocarbons and sulphur hexafluoride.

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7 Availability of Data & Changes to Inventory Methodologies

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. A complete set of such 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). In 2005, the EUETS 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.

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 Availability of Data by Sector

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

- **Agriculture** (Defra)
- **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 EPER inventory and the Northern Ireland Department of Environment's ISR inventory.)
- **Road Transport** (DfT. 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 (a UK average fleet is assumed).

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* (DTI, 2006), and this publication does include 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 & Wales combined. This regional data is of limited use, since it provides no sectoral 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 statistics disaggregated by region and consumer size and Phoenix Gas provides data for natural gas consumption in NI disaggregated by type of consumer. Therefore for each constituent country the overall gas consumption data is of good quality, but there may be some mis-allocations between source sectors. For example, many of the smaller consumers may be either domestic or small commercial operations.

Fuel consumption within the iron & steel industry is well documented by *Iron and Steel Industry Statistics* (ISSB, 2007). 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 & 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, DTI fuel use data (e.g. for power stations) and plant production data from trade associations (e.g. cement industry data from the BCA). Data are now also available through the EU Emissions Trading Scheme for power generation and other large combustion sources. 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 EUETS 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.

Detailed data are available for the offshore industry from the UKOOA EEMS database which includes installation and process-specific data for 1995, and 1998 to 2005 of varying coverage; earlier years in the UKOOA dataset are more sparsely populated and appear to be less consistent across the industry. All 1990 sector splits have been based on extrapolating back the 1995 sector splits. There are some data inconsistencies evident across the time-series of the EEMS data, and hence the trends in emissions from the oil & gas extraction sector are quite uncertain.

Northern Ireland produces an annual set of fuel statistics which includes 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 coal & oil
- Miscellaneous/Commercial and public sector coal & oil
- Agriculture sector coal & oil
- All fuel use within the “Other Manufacturing Industry” sector (excluding cement and autogeneration)

Various surrogates are used to estimate these sources:

- The regional disaggregation of agricultural sector fuel combustion emissions and oil consumption in the commercial and public service sectors are based on employment statistics.
- BERR (formerly DTI) Regional Energy Statistics have been used for solid and liquid fuels in the commercial, public, small industrial and domestic sectors.
- Domestic sector estimates are based on BERR 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.

7.2 Significant Changes to Inventory Methodology

A number of changes have been made to the estimates since the last study (Baggott *et al* 2006) due to revisions to:

- Carbon dioxide, methane and nitrous oxide emission estimates in the UK inventory; and
- disaggregation methodologies to derive DA inventories from the UK data.

The most significant changes are described below.

7.2.1 Changes to the UK Greenhouse Gas Inventory

The National Inventory is updated each year to reflect changes in statistics for earlier years (for example, fuel statistics in DUKES may be revised from one year to the next), or changes to emission factors or methodologies. These changes are explained in the National Inventory Report (Baggott *et al* 2007), and a short summary of the most significant changes to this year's inventory is included below:

- Revisions to fuel oil statistics in the energy sector. This effects emissions from power generation from 2000 to 2004.
- Revisions to fuel use statistics in the rail sector. These are supplied to AEA by ATOC (the Association of Train Operating Industries), and were revised significantly between the 2004 and 2005 inventories. This has affected emissions in the rail sector, in addition to emissions in other sectors where gas oil is used, since the over all fuel use totals for the UK must agree with the National Statistics published in DUKES (DTI, 2006).
- Nitric and Adipic acid manufacture. One of the UK site operators has revised their N2O emission estimates following a review of their data management systems and assumptions, as part of an Improvement Condition under their IPPC authorisation regulated by the EA. This has led to a decrease in the estimated emissions of N_2O across the full time series.

7.2.2 Revisions to Regional Disaggregation Methodologies

A number of methods have been revised regarding the split of UK data to produce GHG inventories for England, Scotland, Wales and Northern Ireland. We have an ongoing process of improvement in this regard and increasingly are working towards harmonisation of our approach with other inventory products such as mapping grids and local inventory models.

The key changes in the latest inventory compilation are:

- The methodology for disaggregating emissions from domestic aviation has been improved. These emissions were disaggregated for the first time in the 1990 – 2004 DA Inventories, using a basic methodology based on total aircraft movements at UK airports. This method has been refined this year, to be consistent with the methodology used for the UK inventory. Estimates for take off and landing and cruise cycles of domestic flights are now calculated using a database of aircraft movements, which includes details of flight origin, destination, aircraft type, fuel type and engine type, enabling pollutant-specific estimates of GHGs to be determined. Emissions from a given flight are allocated to the country of flight origin. This change has led to an increase in the emissions from this sector in Scotland, as it has highlighted the major domestic routes (i.e. Glasgow-London, Edinburgh-London).

- A new data source has been identified for emissions of methane from closed coal mines. Defra commissioned a report on emissions from this source, which was completed in May 2005, and was used in the compilation of the 2004 UK Inventory. Previously, the regional split of these emissions was based on the amount of coal produced. This year, information on the total methane reserves by site has been identified within the UK report and therefore this has been used to provide a more representative estimate for each constituent country.

- Emission estimates from domestic sources have been revised. Good quality data is available for gas and electricity use at high spatial resolution for this sector from the DTI and UK National Grid. However, "bottom-up" information for liquid and solid fuel use is not available on a consistent basis across the time-series and the information from sales data from collieries and refineries is subject to significant uncertainty.

  For 2003 – 2004, BERR (formerly the DTI) have published regional energy statistics, which detail liquid and solid fuel use for this sector based on a modelled approach, which takes into account the availability of gas, smoke control areas and housing data to distribute the total UK fuel use to Local Authority areas. These data have been used to ascertain the distribution of these fuels in 2003 to 2005. The trend for Northern Ireland has been modelled on Housing Condition survey data from surveys in 1996, 2001 and 2004, which detail the fuel switching trends as the region's historic reliance on solid fuels has been replaced by a significant swing to oil and gas use. The trend in emissions from the other DAs follows the UK trend, which is based on DUKES fuel use data for the domestic sector.

- Emissions from liquid and solid fuels in small industrial and commercial combustion sources have been revised, based on the DTI regional energy statistics. Estimates for this sector are subject to significant uncertainty as a consistent time-series of fuel use at DA level is not available. It has therefore been assumed that the trend in all of the DAs follows the UK trend for these sources. This revision has had a disproportionately large effect on the Northern Ireland inventory, where the carbon dioxide inventory is more susceptible to revisions due to the smaller industrial economy evident in the region. It appears, however, from the DTI regional energy statistics dataset, that previous carbon dioxide inventories for Northern Ireland included over-estimates for these smaller-scale sources. It is anticipated that ongoing studies to research fuel use in the commercial sectors in Northern Ireland will provide further improvements to these estimates in future inventories.

- Emissions from peat use in combustion processes were distributed to the DAs based on the distribution of coal use in the 1990 to 2004 DA GHG Inventories. For this year, regional peat use data has been supplied by CEH. This has led to increased emissions in Northern Ireland, where much of the peat is used, although the total emission from this source is not very significant.

- Road traffic count data from DRDNI has been revised significantly this year, leading to a revision of road transport emissions in Northern Ireland.

- The methodology for disaggregating refinery emissions has been modified to incorporate plant specific data from UKPIA. This is a "fine tuning" of the previous method that used data from the PI, SPRI and ISR (EA, SEPA, NI DoE).

More information about the methodologies used is presented for each sector in Annex 1.

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 (Baggott *et al*, 2007) to account for data and methodological changes. Using the uncertainty method developed for the UK inventory, estimates of the uncertainty in the DA GHG inventories can also be calculated. These are presented in Table 8.1 below. The estimated uncertainty in the UK carbon dioxide has been revised significantly (as explained in Baggott *et al*, 2007). This reduced estimate for the UK inventory has therefore led to a reduction in the uncertainty estimates for the Devolved Administrations, in some cases.

As a result of the activity data gaps in the Devolved Administration inventories, the estimates will be more uncertain than for the UK inventory. The uncertainties in the emission totals have been estimated using a Monte Carlo simulation. In the calculations of uncertainties for the 1990-2005 DA GHG inventories, the assumptions under-pinning the additional uncertainty due to the use of proxy activity data for the DA inventories have been revised for all fuels and all sources. 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 BERR regional energy statistics with historic data. 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 uncertainty estimates for the 1990-2005 DA GHG inventories are reported in Table 8.1. The N_2O distribution is heavily skewed[6], so that 2.5% and 97.5% confidence limits are quoted.

Table 8.1 Estimated Uncertainties in the DA GHG Inventories in 2005

Uncertainties						
GHG	Units	England	Scotland	Wales	N Ireland	UK
CO_2	± %	2	6	2	5	1.6
Methane	± %	24	18	17	17	20.5
N_2O	Lower kt Upper kt	20.8 320.8	2.5 67.6	1.7 47.1	1.1 36.5	27.6 473.9
HFC	± %	23	19	19	19	19.1
PFC	± %	16	10	10	*NA*	10.1
SF_6	± %	23	20	20	20	20.0
Total	**± %**	**12**	**20**	**18**	**32**	**13.1**

Notes

1. Uncertainty is defined as ± 2×(standard deviation)/mean %, which closely approximates the 95% confidence interval
2. Emissions of PFC in Northern Ireland are zero.

The relatively high uncertainties in the Scottish CO_2 and GWP inventories reflect the large contribution made by Land Use, Land Use Change & Forestry (LULUCF) to the Scottish CO_2 inventory. The high uncertainty in the GWP inventory for Northern Ireland and Wales is a consequence of the relatively large contributions of methane and agricultural N_2O. The high uncertainty in the Northern Ireland CO_2 inventory reflects the relatively high contribution from the more uncertain, smaller combustion sources. The GWP inventory for England has lower uncertainty as a consequence of the relatively low contributions to the English inventories from high uncertainty sources such as LULUCF and agricultural N_2O.

[6] The upper and lower estimates do not lie at an equal distance from the mean and therefore these limits are given separately for N_2O as it is inappropriate to quote a single % figure.

9 Summary Graphs

Graphs illustrating the greenhouse gas emissions for the years 1990, 1995, and 1998 to 2005 for the Devolved Administration are shown in figures 9.1 to 9.6. All of the plots show net emissions as CO_2 equivalent.

The summary data and time-series trends illustrated by these graphs are also presented in more detailed country-specific tables in Appendix 2, including a breakdown of total greenhouse gas emissions by the following IPCC Source Categories:

- Energy
- Industrial Processes
- Agriculture
- Land Use, Land Use Change & Forestry
- Waste

Figure 9.1 Emissions of CO_2

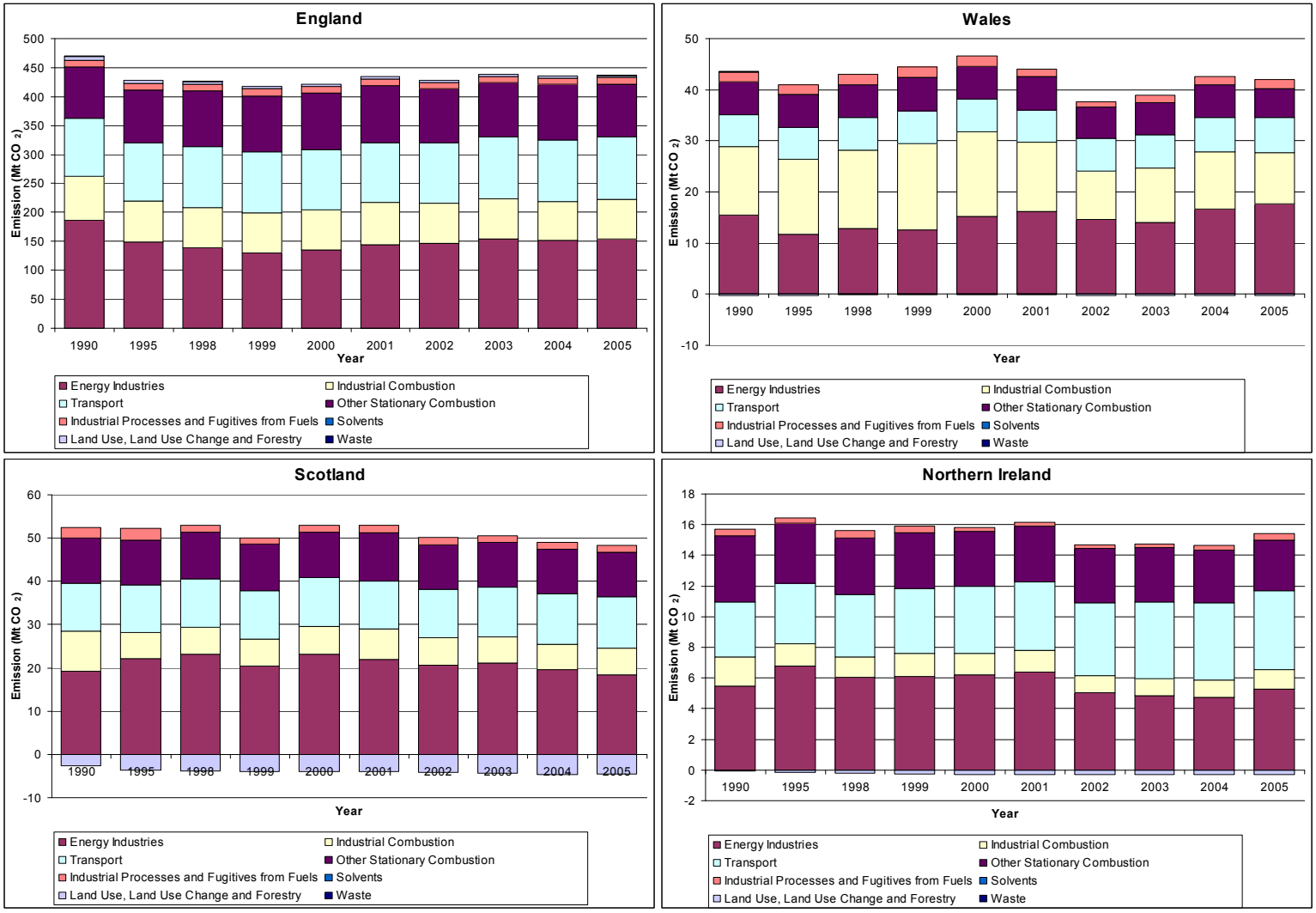


Figure 9.2 Emissions of Methane

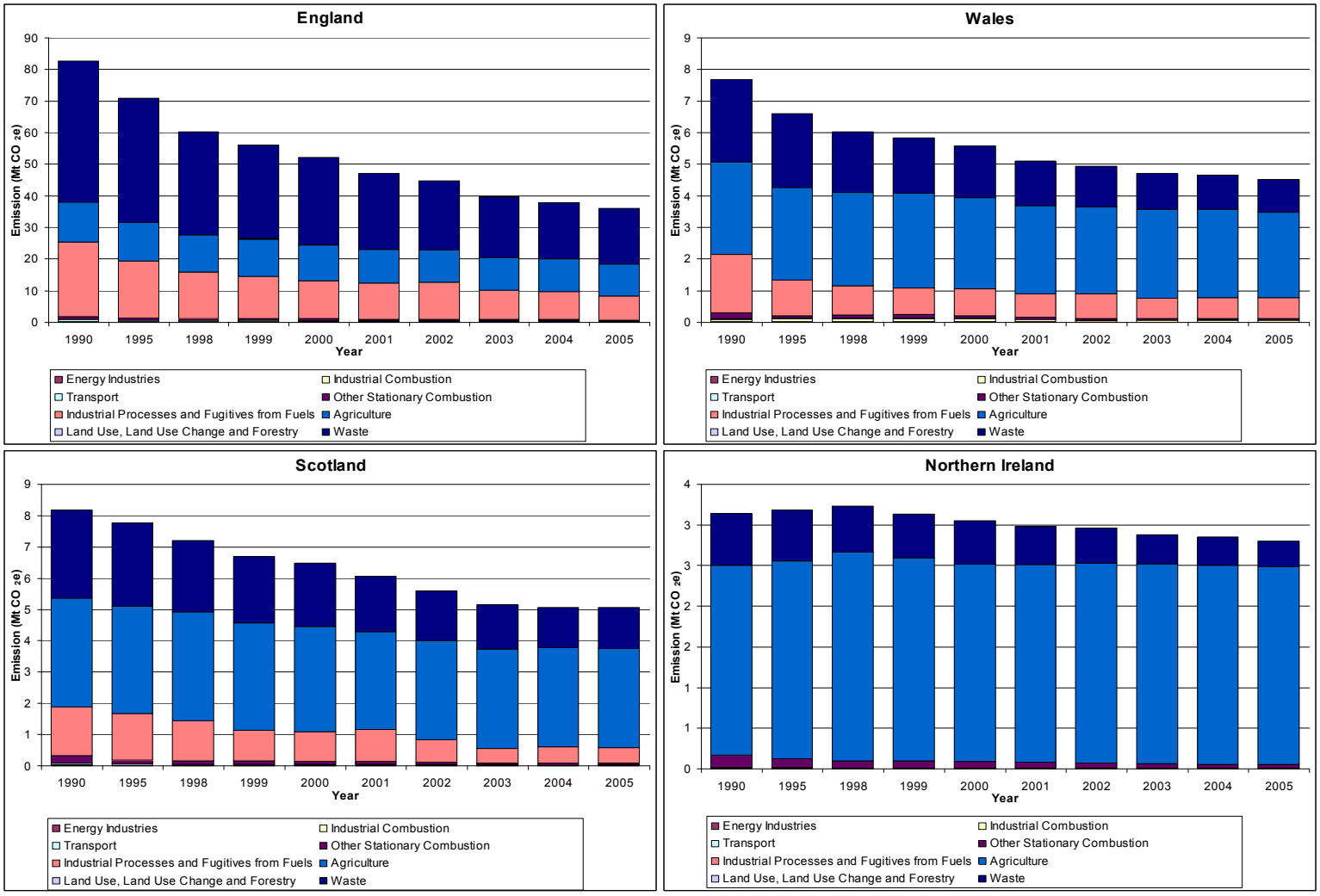


Figure 9.3 Emissions of Nitrous Oxide

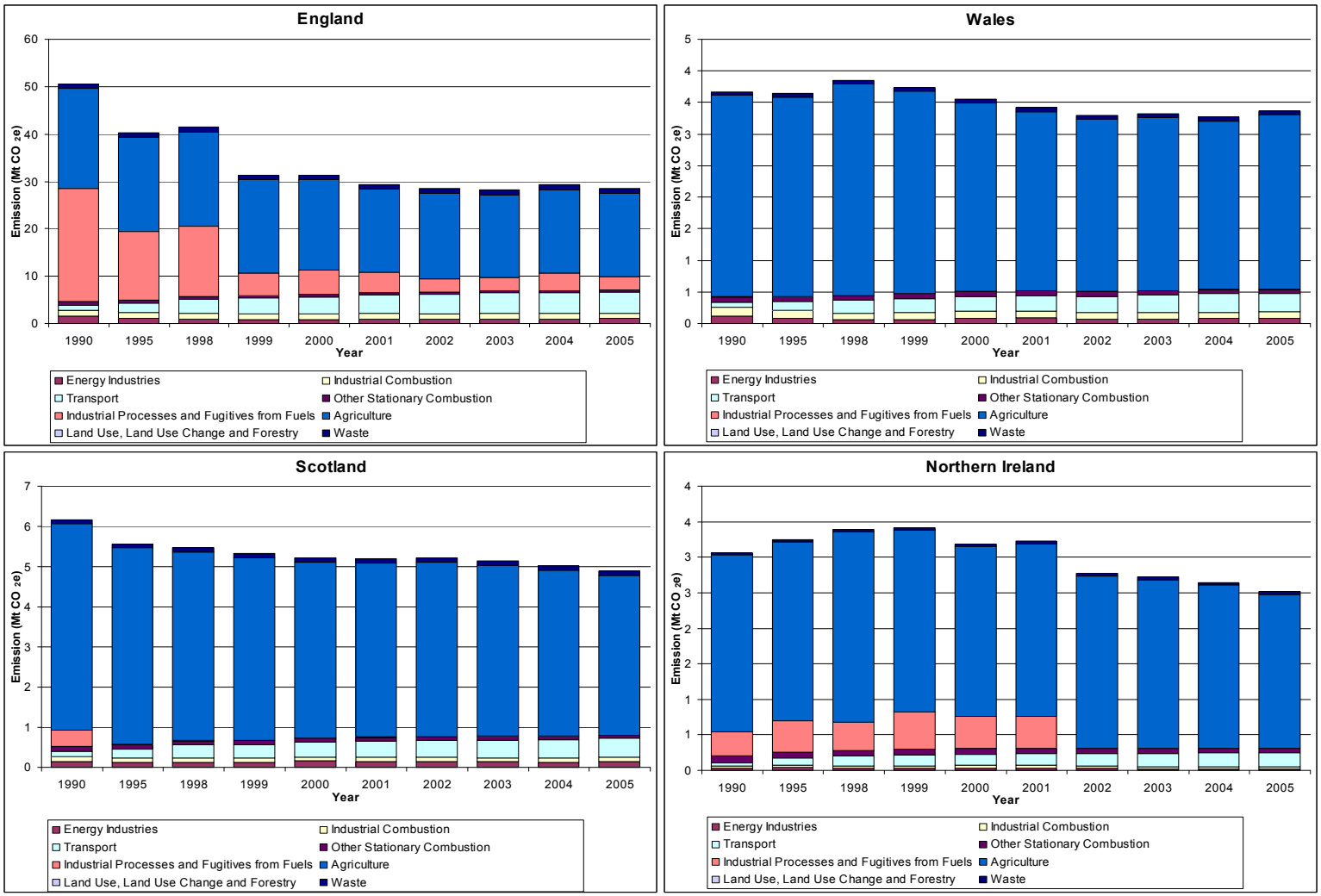


Figure 9.4 Emissions of HFCs

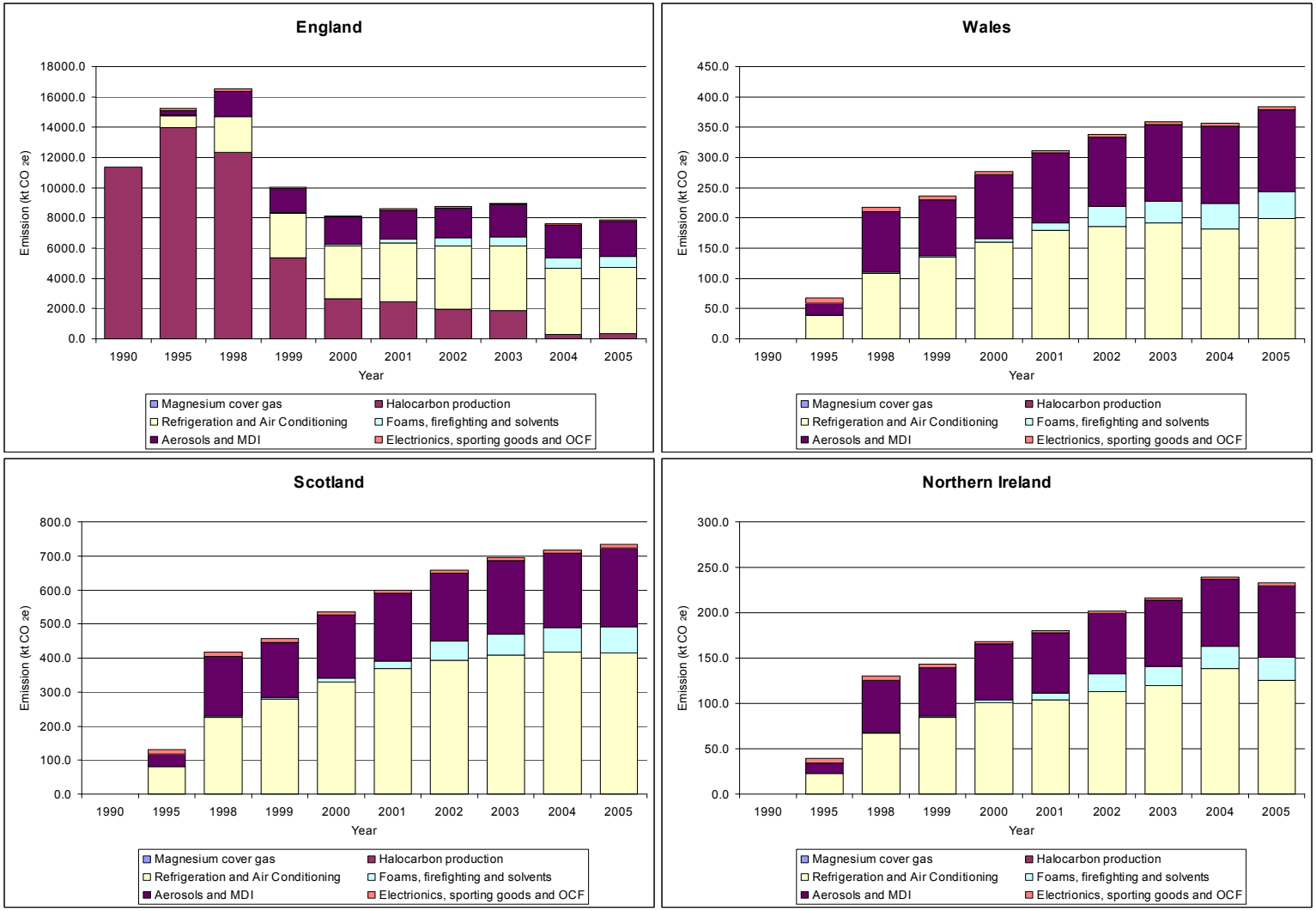


Figure 9.5 Emissions of PFCs

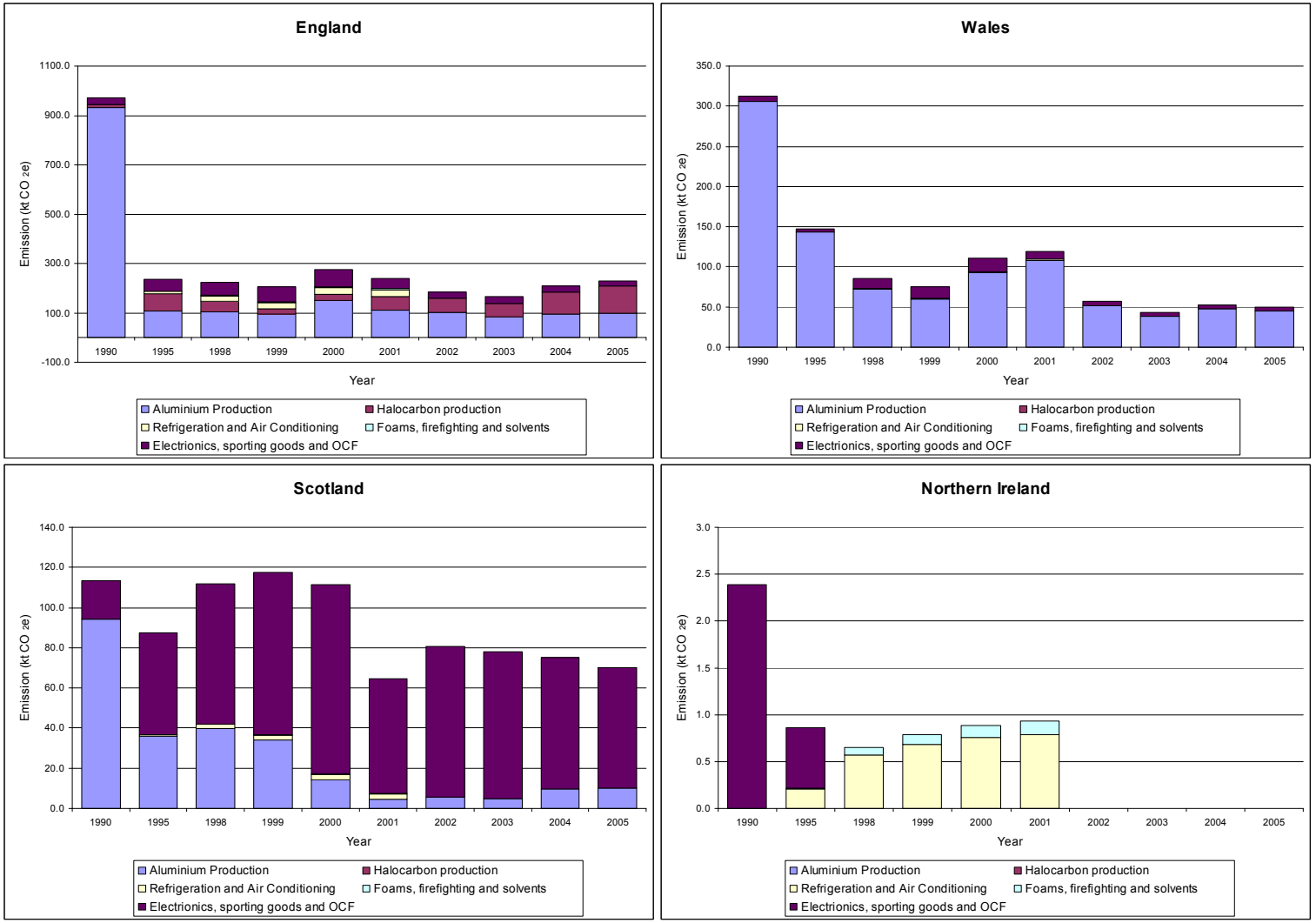
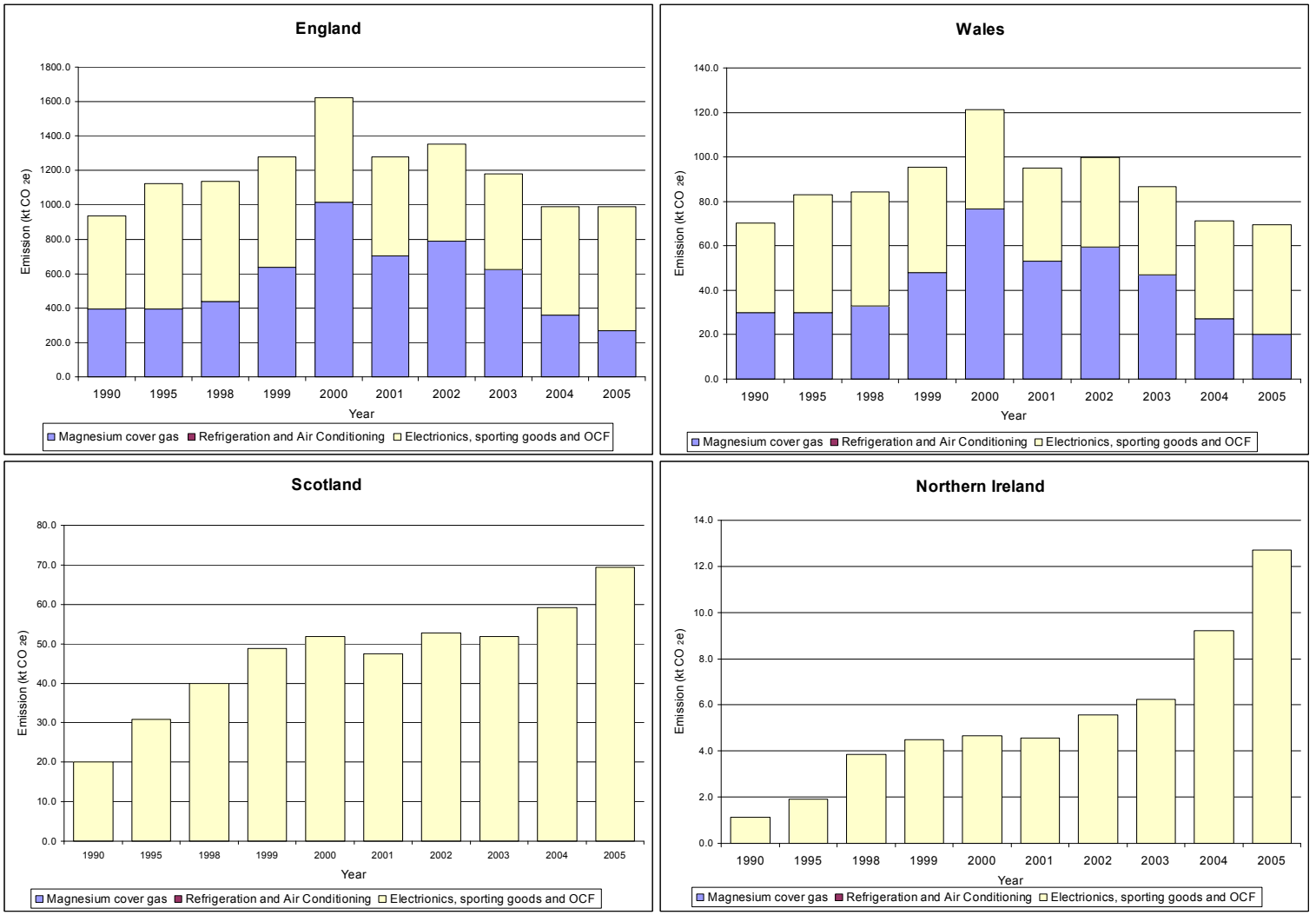


Figure 9.6 Emissions of SF_6



10 References

Adger, N, Subak, S. (1995) *"Carbon fluxes resulting from Land Use Change: Land Use Data and Policy."* In: Carbon Sequestration in Vegetation and Soils (Ed. by MGR Cannell), DOE/ITE Contract EPG 1/1/3. Interim Report March 1995. Department of Environment, London.

AES Drax (2004), Power station fuel consumption, Personal Communication.

Alcan (1998, 2000, 2002, 2004, 2006), Personal Communication.

Agricultural Industries Confederation (2006). Fertiliser Statistics 2006 Report www.agindustries.org.uk

ATOC (2006), Fuel use by train operating companies, 2005, personal communication.

Baggott S, Cardenas L, Garnett E, Jackson J, Mobbs DC, Murrells T, Passant N, Thomson A, Watterson J (2007) "*UK Greenhouse Gas Inventory, 1990 to 2005 Annual Report for submission under Framework Convention on Climate Change."* AEA Energy & Environment, AEA Technology, April 2007.

Baggott SL, Cardenas L, Downes M, Garnett E, Jackson J, Li Y, Passant N and Thomson A (2006), *"Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2004."*

Barlow, TJ, Hickman, AJ, Boulter, P, "Exhaust Emission Factors 2001: Database and Emission Factors", TRL Report PR/SE/230/00, September 2001

Bell, DM (2006), ISR and Power Station Fuel Consumption, Personal Communication, Northern Ireland Department of Environment.

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

BP (2004), Grangemouth Refinery, Personal Communication.

Bradley, I (1997) *"Carbon loss from drained lowland fens."* In: Carbon Sequestration in Vegetation and Soils (Ed. by MGR Cannell), DOE/ITE Contract EPG 1/1/3. Final Report March 1997. Department of Environment, London.

Bradley, R. I., Milne, R., Bell, J., et al. (2005). A soil carbon and land use database for the United Kingdom. *Soil Use and Management*, 21, 363-369.

British Cement Association (2005), Personal Communication.

British Glass (2001), Emissions from the UK Glass Industry. Report prepared for NETCEN.

British Glass (2006), Production Statistics for UK Glass Industry, Personal Communication.

Brown, KA, Smith, A, Burnley, SJ, Campbell, DJV, King, K, Milton, MJT (1999) *"Methane Emissions from UK Landfills"*, AEA Technology, AEAT-20624, Culham

BSFP (1991, 1996, 2005), British Survey of Fertiliser Practice for 1990, 1995, 1998-2005.

Cannell, MGR, Dewar, RC, Pyatt, DG, (1993) *"Conifer plantations on drained peatland in Britain: a net gain or loss of carbon?"* In: *Forestry 66*, 353-368.

Cannell, M. G. R. and Dewar, R. C. (1995). The Carbon Sink Provided by Plantation Forests and Their Products in Britain. *Forestry,* 68, 35-48

Cannell, MGR, Milne, R, Hargreaves, KJ, Brown, TAW, Cruickshank, MM, Bradley, RI, Spencer, T, Hope, D, Billett, MF, Adger, WN & Subak, S (1999) *"National inventories of terrestrial carbon sources and sinks: the UK experience."* In: *Climatic Change 42*, 505-530

Civil Aviation Authority (2006), database of UK flight information.

Coal Authority (2006), Regional Coal Production, Personal Communication.

Cooper, A. and McCann, T. (2002). Technical Report of the Northern Ireland Countryside Survey. University of Ulster.

Cruickshank, MM, Tomlinson, RW (1997) *"Carbon loss from UK peatlands for fuel and horticulture."* In: *Carbon Sequestration in Vegetation and Soils* (Ed. by MGR Cannell), DOE, Contract EPG 1/1/3. Final Report March 1997. Department of Environment, London.

Cruickshank, MM, and Tomlinson, RW, (2000) *"Change in soil carbon storage in Northern Ireland: estimated by the IPCC default and matrix methods."* In.: *Carbon Sequestration in Vegetation and Soils* (Ed. by R. Milne), DETR Contract EPG 1/1/39. Final Report April 2000. (Available at http://www.nbu.ac.uk/ukcarbon/)

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

DARDNI (2000, 2001), The Agricultural Census in Northern Ireland: Results for June 1999, 2000.

Department of Communities and Local Government (2006). Land use change in England to 2005. Additional tables LUCS-21A. UK Government, London

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

DEFRA (2001) June Agricultural Census for 2000. Department for Environment, Food and Rural Affairs.

DEFRA (2006a), Agricultural Census Statistics for UK, Annual Reference Tables, Labour Force. DEFRA Agricultural Statistics website.

DEFRA (2006b), 2005 EUETS emissions and fuel use data by site, personal communication.

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

Dewar, R. C. and Cannell, M. G. R. (1992). Carbon Sequestration in the Trees, Products and Soils of Forest Plantations - an Analysis Using UK Examples. *Tree Physiology*, 11, 49-71.

DfT (2006a) "Vehicle Licensing Statistics: 2005 data" Transport Statistics Bulletin

DfT (2006b) "Transport Statistics Great Britain: 2006 edition", The Stationary Office

DfT (2006c) "Road Traffic Statistics: 2005" Transport Statistics Bulletin

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

DOE, (1993), UK Sewage Sludge Survey, CES Limited, HMSO

DoRDNI (2006a) "Northern Ireland Transport Statistics 2005-2006", Central Statistics and Research Branch, Department of Regional Development in Northern Ireland. (Available at http://csrb.drdni.gov.uk/statistics/statistics.asp)

DoRDNI (2006b), "Traffic and Travel Information Report, 2005" and communication with David Compston, Department for Regional Development, Northern Ireland, Road Services Headquarters, October 2006

DTI (2006a), "*Digest of UK Energy Statistics*" Department of Trade and Industry, HMSO.

DTI (2006b), Regional Energy Statistics – Transport & Residual Fuels, *Energy Trends*.

DTI (2006c), Local gas use data by LDZ, personal communication.

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

Edwards, P. N. and Christie, J. M. (1981). Yield models for forest management. Forestry Commission Booklet. 48. Forestry Commission, Edinburgh.

EFW (2001), Energy for Waste, Current and Projected Energy for Waste Capacity in UK as at December 2000.

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

Electricity Association (2004), Electricity transmission data, Personal Communication.

Environment Agency (1999), UK Sewage Sludge Survey, Regional Presentation, WRc, R&D Project Record P2/065/1

Environment Agency (1999a, 2000-2007), database of emissions to atmosphere from authorised processes in England & Wales, as reported to the Pollution Inventory (data for 1998-2005).

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

Haines-Young, R. H., Barr, C. J., Black, H. I. J., et al. (2000). *Accounting for nature: assessing habitats in the UK countryside.* DETR Countryside Survey 2000, London.

Hargreaves, KJ, Milne, R and Cannell, MGR, (2003). *"Carbon balance of afforested peatland in Scotland"* In: *Forestry* 76, 299 - 317

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

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

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

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

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

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

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

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

ISSB, (2007) *Iron & Steel Industry Annual Statistics for the UK*, Consumption by Product by Region, personal communication.

Levy, P and Milne, R, (2003) Deforestation rates in the United Kingdom. In: *UK Emissions by Sources and Removals by Sinks due to Land Use, Land Use Change and Forestry Activities. Annual report (2003)* for DEFRA Contract EPG1/1/160 (Ed. by R. Milne). (Available at http://www.nbu.ac.uk/ukcarbon/)

Levy, P.E. and Milne, R. (2004) Estimation of deforestation rates in Great Britain. *Forestry,* 77, 9 –16.

LQM (2003) Methane emissions from landfill sites in the UK. Final report. January 2003. Report for the UK Department for Environment, Food and Rural Affairs. Authors: Gregory, R.G., Gillett, A.G., Bradley, D. LQM report 443/1. DEFRA contract EPG 1/1/145.

LRC (1999), Personal Communication from L Saddler, London Research Centre

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

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

Milne, R and Brown, TA (1997) Carbon in the vegetation and soils of Great Britain. *Journal of Environmental Management*, 49, 413 - 433.

Milne, R., Mobbs, D.C. and Thomson, A.M. (2006) Land Use Change and Forestry: The 2004 UK Greenhouse Gas Inventory and projections to 2020. In: UK Emissions by Sources and Removals by Sinks due to Land Use, Land Use Change and Forestry Activities. Annual report (2006) for DEFRA Contract CEPG1/GA01054 (Ed. by R. Milne & D.C. Mobbs). (Available at http://www.nbu.ac.uk/ukcarbon/)

Milne, R, Brown, TAW and Murray, TD (1998) The effect of geographical variation in planting rate on the uptake of carbon by new forests of Great Britain. *Forestry*, 71, 298 – 309.

MLC (1986). Monitoring Landscape Change. Report prepared by Hunting Surveys & Consultants Ltd for Department of the Environment and the Countryside Commission.

Mobbs, D (2006) Regional peat consumption data, 1990-2005, (CEH) personal communication.

National Grid (2006), natural gas leakage from high pressure, low pressure distribution systems and from Above Ground Installations, personal communcation.

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

Northern Gas Networks (2006) Natural Gas leakage from LDZ and AGIs, personal communication

ONS (2007), Datasets available pertaining to a wide range of industrial and population-related activities via the publications “Annual Abstract of Statistics” and “Regional Trends”, Office for National Statistics.

ONS (2000a), IDBR, Employment Database

Patel, NM (2000), Personal Communication, Strategic Consultancy, AEA Technology

Phoenix Natural Gas (2006), Gas consumption and leakage data, Personal Communication

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

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

Sage, PW, (2001), Methane from Abandoned Coal Mines in the UK, AEA Technology, Report AEAT/ENV/R/0500, Harwell

Scotia Gas Networks (2006) Natural Gas leakage from LDZ and AGIs, personal communication

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

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

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

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

SEPA (2002), Scottish Waste Data Digest 2001

SEPA (2006), Annual atmospheric emissions data for authorised processes in Scotland, from SEPA's Pollution Release Inventory, Personal Communication.

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

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

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

Sylvester-Bradley, R., Lunn, G., Foulkes, J., et al. (2002). Management strategies for high yields of cereals and oilseed rape. In HGCA R&D Conference - Agronomic Intelligence: The basis for profitable production, pp. 8.1-8.17. Home-Grown Cereals Authority.

Thomson, A.M. and van Oijen, M. (eds.) (2007). *Inventory and projections of UK emissions by sources and removals by sinks due to land use, land use change and forestry*. Annual contract report to Defra, June 2007. At http://www.edinburgh.ceh.ac.uk/ukcarbon/reports.htm.

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

Translink (2006), Annual fuel consumption, Personal Communication.

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

UKOOA (2006), Environmental Database for annual Emissions and Discharges from Offshore Installations, from the EEMS reporting inventory.

UKPIA (2006), Personal Communication, United Kingdom Petroleum Industry Association Ltd

Wales & West Utilities (2006) Natural Gas leakage from LDZ and AGIs, personal communication

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

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

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

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