ENERGY AND GREENHOUSE GASES IN TYNE & WEAR 2004

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By

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KEY POINTS

- Global greenhouse gas (GHG) emissions are estimated at 24,500 Mt[1] of CO_2-equivalent; or nearly 4 tonnes per person globally.[2]

- This report quotes carbon dioxide (CO_2) emissions *as 'tonnes of CO_2'*, whereas some sources quote them 'as tonnes of carbon' which reduces the numbers by a factor of 3.66.

- Other GHGs are measured by their 'Global Warming Potential' (GWP) relative to CO_2. For example, methane has a GWP of 20 times that of CO_2.

- The predominant UK GHG is CO_2, giving 85% of total UK emissions (giving the other GHGs higher weights).

- UK GHG emissions were 672 Mt in 2004[3] (about 2.7% of the world total). Emissions per head in the UK are nearly 12 tonnes, or three times the global average.

- CO_2 in the atmosphere has risen by about 1%p.a. in recent years, on top of a 30% rise since the Industrial Revolution.

- The main growing source of UK GHGs is transport (based on DEFRA data).

- TWRI estimates Tyne & Wear GHG emissions at about 10 Mt of CO_2-equivalent [from UK data].

- The National Air Emissions Inventory (NAEI) has [oddly] estimated GHG emissions in Tyne & Wear at only 4.1 Mt, which it says are dominated by:
  - Commercial & Residential 50%+
  - Road transport 36% (1.5 Mt)
  - Other transport 3% (121,000 tonnes)[4]

- Tyne & Wear has no power stations. These are one of the largest UK sources of emissions (58 Mt in 2002, Defra). If Tyne & Wear's consumers are responsible for 2% of the UK power station emissions, this is nearly 1.2 Mt CO_2-equivalent attributable to Tyne & Wear (but emitted elsewhere in the UK). [This adds about 12% to T&W GHGs].

- Burning of natural gas in Tyne & Wear creates 2.8 Mt (about 28 %)[5] [TWRI estimate from TRANSCO data].

- Methane (CH_4) is the second GHG, accounting for 6% of UK GHGs (where it has a weighting 20 times that of CO_2). These methane emissions come overwhelmingly from:
  - Agriculture – estimated to be very low (~6,000 tonnes or 0.05% of T&W GHGs) in T&W, due to its small area of farm land
  - Energy industries (a) notably as a by-product of coal-mining, and
  - (b) Leakage from the natural gas distribution system.
  - Waste-disposal – i.e. from landfill etc.
  - reduced by methane recovery systems (e.g. at Brenkley, in Newcastle)

Broadly, emissions of non-CO_2 GHGs have been reduced through improved control of processes; e.g. UK Landfill methane emissions are down about two-thirds from about 1.2 Mt (24 Mt CO_2-equivalent) in the late 1980s.

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[1] *1 Mt stands for '1 million tonnes.'*
[2] *Asia's GHG emissions have more than doubled 1980-2002.*
[3] *Provisional estimate, Netcen, DTI.*
[4] *Data is derived from NAEI (National Air Emissions Inventory) modelled data.*
[5] *TWRI estimate from TRANSCO data.*

1 INTRODUCTION

Why are we interested locally?

Greenhouse gas (GHG) emissions are self–evidently a global issue. Local Authorities (LAs) in Tyne & Wear, however, can make their contribution to reductions because their policies and practices can make a difference locally.

LA land use ('planning') policies, following national Planning Policy Statements[6], can encourage shorter travel (especially to work) by encouraging development at or near public transport nodes. Nevertheless traffic volumes continue to grow, although at a slower rate than in the past. Much development in the 1980s assumed extensive car use. Nationally, for example, over a third of all retail sales are at out-of-town sites.

Unfortunately, GHG emissions tend to rise with economic growth. This association means that they tend to rise with time and prosperity. Economic growth is also driving the rapid rise of emissions in Asia. China burns a billion tonnes of coal annually, ten times what the UK burnt even in the 1980s. Moreover, for oil, China also became the world's second-largest importer in 2003, overtaking Japan.

GHG emission reductions can be achieved through tackling them on many levels. The link between GHG emissions and economic growth can be broken in a number of ways. Eight broad ways are set out below, very roughly in order of difficulty (easier ones first);

1. **Choice of fuel: Already moved from coal to gas; but nuclear choices are ahead**
   - In terms of GHG emissions, oil is cleaner than coal and gas is cleaner than both. In the UK GHG emissions fell in 1989-95 as power station emissions fell due to the so-called 'dash-for-gas', as the coal burn was sharply reduced, replaced by natural gas - and higher output from nuclear stations. In the NE, the largest power station is Teesside Power's 1,875 MW gas-fired station.
   - Local Authorities can use cleaner fuels in their boilers. They might also make use of Combined Heat and Power (CHP) schemes at major sites.
   - Nationally, the government faces a major decision (well before 2010) on whether to replace aging nuclear power stations with modern nuclear capacity. This decision will affect the NE's only nuclear power station, British Energy's 1,200 MW AGR station at Hartlepool.

2. **Better regulation: Already achieved cuts in non-CO_2 emissions**
   - The Environment Agency has been successful in generally reducing the emissions of the 'other GHGs' besides CO_2. These are relatively powerful gases in terms of their 'Global Warming Potential' (GWP).
   - Nationally, methane emissions from landfill sites have fallen by over half. Waste management is a Local Government responsibility. Raising the recycling of waste could reduce landfill further.
   - Redundant coal-mines in the region are probably still emitting methane, an issue regulated by the Coal Authority.

3. **Energy conservation: A major potential route forward**
   - There are many opportunities for energy conservation in buildings and vehicles. The design of new housing might be influenced by Local Authorities.
   - The Eaga Partnership (based in Tyne & Wear) handles government grants top low-income households to improve energy conservation.

[6] *Planning Policy Statements (PPSs) replace Planning Policy Guidance (PPGs) and are issued, by subject, by ODPM (the Office of the Deputy Prime Minister)*

- Newcastle University's new (2003) Devonshire Building makes very extensive use of many of the latest techniques.
- Higher energy prices encourage lower consumption; this happened particularly after the 'oil price shocks' of the 1970s.

4. Emissions trading: A potentially very powerful control mechanism

- The EU has set ceilings for emissions by each member state – to implement the Kyoto treaty[7] - and set up (from January 2005) trading ('Cap and trade') of these allowances between companies. The beauty of this system is that it creates incentives to firms to collectively find the most cost-effective ways to cut emissions.
- The price of a tonne of CO_2 in early 2005 has been about €10[8]. This quite low price reflects the availability of opportunities to cut emissions which cost less than this. Lowering the ceilings will tend to raise the price, making more expensive investments financially viable. Wider emissions trading (e.g. global or with China) could reduce the price by opening up opportunities abroad where energy is more wastefully used and technology less advanced.
- Emissions trading could be expanded substantially. Perhaps large public bodies will be drawn into the emissions trading market. If aviation was brought into emissions trading (as UK operators have indicated) users could pay for the environmental damage they cause and finance offsetting cuts elsewhere.[9]
- The Kyoto regime runs until 2012; new arrangements need to be agreed globally to cover the period after this date.

5. Choice of mode of travel: National road charging could reduce emissions as well as congestion, but local measures can be taken

- Tyne & Wear still has relatively high use of public transport to go to work. About a quarter of people working in Newcastle, for example, use public transport (Census 2001). The ticket pricing decisions of the Passenger Transport Authority (PTA) can encourage or discourage use of public transport. Bus lanes can be used to try to tip the balance of advantage to public transport. Free public transport for pensioners was announced in the 2005 Budget.
- The introduction of national road-charging (not possible until at least 2014) would create a new incentive in congested urban areas to use public transport. By lowering motoring costs in un-congested locations, it could shift development pressures away from congested locations.
- For inter-city journeys, rail uses less energy than air travel. Oddly, the government is levying (from 2005) a large annual fee of well over £100m on GNER for the right to operate its trains (this amounts to a tax estimated by TWRI at about 20%).
- Air travel is a particular issue because its growth is so rapid, about 7% p.a. nationally. Growth at regional airports has been even faster with the arrival and expansion of low-cost airlines.

6. Technology: Renewables are helping to offset growing energy demand

- New technologies offer lower emissions. The University of Northumbria has pioneered advanced solar energy 'photo-voltaic cells'. NaREC, at Blyth, is exploring new renewable technologies. Local company SMD is developing wave energy devices. 'Renewables' contribute about 1% of the NE's electricity generating capacity[10]; more wind farms are expected to raise this towards the 10% target.

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[7] *Refer to Appendix C for the new US-led, six-country pact on developing clean technology to combat climate change.*

[8] *Article on the rise of price of carbon allowances to €30 (Economist 07/07/2005).*

[9] *Sustainable Aviation (a group which includes BA, the UK's 24 biggest airports and Airbus UK) says it will press for the inclusion of aviation in EU emissions trading by 2008 [Planning 24/06/2005]. Raising fuel efficiency by 50% by 2020 (from 2000), as they pledged, however, does not entail cuts in emissions because traffic is projected to grow even faster.*

[10] *North East State of the Region Report, 2003.*

- Use of electronic communications reduces the need for certain trips; to meetings and for shopping. Internet shopping has already reached 5% of retail sales and is growing rapidly.
- Conversely, digital TV seems set to raise domestic electricity consumption significantly.

7. New fuels: Fuel-cells and hydrogen look particularly promising

- Fuel-cell technology is already available in a few car models.
- Hydrogen-fuel is being tested in a small fleet of buses in London. The emissions are free of GHGs. Of course, the hydrogen has to be produced (probably from sea-water) using primary energy; use of nuclear and renewable sources would be free of GHGs at the point of production. Newcastle University has developed high-density hydrogen storage devices.
- The last hundred years' primary fuel use have seen a marked trend from carbon-rich fuels (coal), through hydro-carbons - first to oil then gas – towards hydrogen.
- The transition might take about twenty years. The shift from coal to oil took two decades, roughly from 1950 to 1970. Perhaps a new shift to a new fuel, such as hydrogen, would require a similar period.
- Special 'Quay Link' buses used to serve Newcastle and Gateshead Quaysides use hybrid energy systems. They have electric motors.

8. Sequester GHG gases (i.e. capture and store underground)

- This is one theoretical possibility, which has to be proven feasible.
- The DTI announced a grant scheme[11] to investigate this possibility. One idea is to pump the CO_2 into redundant North Sea oil-fields. Norway has managed to store carbon dioxide produced by a gas field under the North Sea since 1996, without any leakage[12].
- This would, perhaps, focus on large coal-fired power stations. Drax power station, for example, reportedly emits 17 Mt of CO_2 annually.
- The US-sponsored agreement (in Appendix C) focuses on technology including this one.

[11] *DTI (now DPEI), June 2005.*
[12] *Planning 08/07/2005.*

2. GREENHOUSE GASES (GHGs)

Increasing atmospheric concentrations of greenhouse gases originating from human activities are leading to enhanced warming of the atmosphere and global climate change. The major greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), all of which have both natural and human[13] sources. In contrast, the three industrial gases: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6), are potent greenhouse gases but do not occur in nature, and hence only originate from human sources.

These six greenhouse gases comprise the 'basket of emissions' against which reduction targets were agreed at Kyoto (the Third Conference of the Parties of the United Nations Framework Convention on Climate Change in Japan in December 1997). The Kyoto Treaty came into force in February 2005, following ratification by Russia.

Measuring greenhouse gases in terms of climate change (GWP)

The direct six greenhouse gases have different effectiveness in radiative forcing (global warming). The **global warming potential** (**GWP**) is a means of providing a simple measure of the relative radiative effects of the emissions of the various gases (Table 2.1). The time horizon is used as each gas has a different lifetime in the atmosphere and this effect must be taken into consideration for future climate conditions[14].

Table 2.1: Global warming potential* of greenhouse gases on a 100-year horizon

Main GHGs	GWP (100 years)
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Hydroflurocarbons (HFCs)	140 -11,700
Perfluorocarbons (PFCs)	6,500 - 9,200
Sulphur hexaflouride (SF_6)	23,900

**Global warming potential is GWP*

Source: IPCC 1996

Caution: The GWPs agreed by IPCC for a 100-year time horizon in 1996 were revised in 2001 (IPCC, 2001).

2.1 Carbon dioxide (CO_2)

In 2001, the IPCC[15] reported that the concentration of carbon dioxide in the atmosphere had increased from 280ppm, a pre-industrial estimate, to 368 ppm (parts per million), a rise of over 30%. This has increased to 376 ppm in 2003 (NOAA)[16]. The IPCC, through various scenarios, has estimated that due to human activities by 2100, concentrations could be as large as 540 – 979ppm.

[13] *Technically 'anthropogenic'.*

[14] *GWPs have been updated in IPCC 2001, but these do not apply to the Kyoto targets under the first commitment period.*

[15] *Intergovernmental Panel on Climate Change. The UN-appointed body of scientific advisers on the issue of climate change.*

[16] *US National Oceanographic and Atmosphere Administration*

Carbon dioxide is the major contributor to greenhouse gas emissions and arises predominately from the combustion of fossil fuels. Non-fossil fuel sources are more difficult to assess due to the importance of CO_2 within the global carbon cycle[17].

2.2 Methane (CH_4)

Methane, (natural gas) like carbon dioxide, is naturally occurring and is part of the global carbon cycle. Pre-industrial levels were at a level of 700 ppb[18], compared to 1,745 ppb in 1998 (IPCC, 2001). Thus, the atmospheric abundance of CH_4 has increased by a factor of 2.5 since the pre-industrial era. However, the magnitudes of sinks and sources of CH_4 are not well known. Methane in the atmosphere is eventually oxidised to CO_2 and the most recent IPCC estimates of its lifetime in the atmosphere is 12±3 years (IPCC, 2001). Methane has a much greater warming effect (GWP of 20) on the climate than carbon dioxide. The major human sources of methane are waste disposal, agriculture, coal mining and leakage from the gas distribution system. Due to the nature of these sources the estimation of methane emissions is very uncertain although the methodologies are continuously being improved.

2.3 Nitrous oxide (N_2O)

The third direct greenhouse gas, nitrous oxide (N_2O), is emitted from natural and human sources (agriculture, biomass burning, coal combustion and some industrial processes). As N_2O has a GWP (Global Warming Potential) of 296, it is a powerful greenhouse gas, despite lower human emissions. The globally averaged abundance of N_2O was 314 ppb in 1998, compared to 270 ppb for the pre-industrial era. As with methane, it remains difficult to assess global emission rates from individual sources that vary widely.

2.4 Hydrofluorocarbons (HFCs)

The IPCC guidelines separate HFC emissions into six source categories: aerosol propellants (including metered-dose inhalers), solvents, foam, mobile air conditioning, stationary refrigeration/air conditioning, and fire protection. The use of HFCs has increased since the early 1990s when CFCs and HCFCs began to be phased out under the Montreal Protocol. HFCs are normally considered to be industrially produced gases; however, these activities also take place within the homes of the general population. The IPCC provides a revised (2001) GWP factor of 12,000 for HFCs.

2.5 Perfluorocarbons (PFCs)

The main sources of PFCs are from stationary refrigeration and air-conditioning, halocarbon manufacture, aluminium production and the electronics industry. They have a global warming potential of up to 11,900, (IPCC).

2.6 Sulphur hexafluoride (SF_6)

The main sources of SF_6 are from electrical transmission & distribution equipment and the electronics industry. The global warming potential for SF_6 is the highest among all greenhouse gases, with a value of 22,200 GWP.

[17] *The total amount of carbon in the ocean is ~50 times greater than the amount in the atmosphere. Dissolution of CO_2 in the oceans provides a large sink for anthropogenic CO_2. The capacity of surface waters to take up anthropogenic CO_2 is decreasing as CO_2 levels increase. This decrease in uptake capacity of the oceans makes atmospheric CO_2 more sensitive to anthropogenic emissions and other changes in the natural cycling of carbon (IPCC, 2001).*

[18] *Parts per billion.*

3. GLOBAL CO_2 EMISSIONS

Global CO_2 emissions in 2002 were 24,500 Mt (24.5 bn tonnes), or nearly 4 tonnes per person on the planet (Table 3.1). Global emissions of carbon dioxide [only], from the consumption and flaring of fossil fuels, rose 32% between 1980-2002. The fastest rises in CO_2 emissions, by region, were Asia (up 119%), and the Middle East (up 136%).

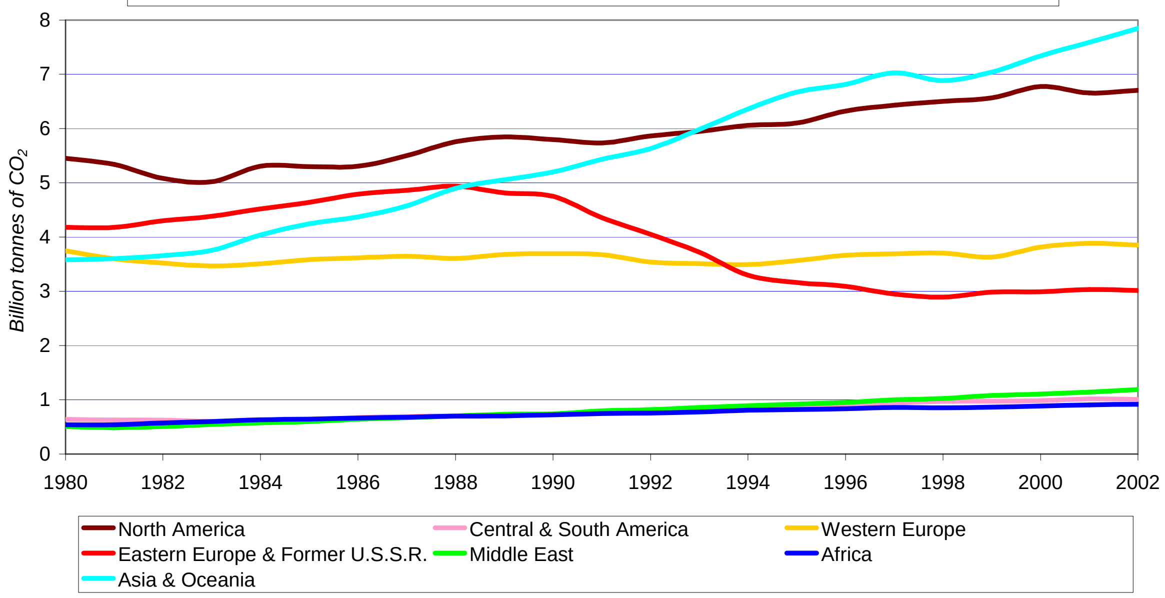
Table 3.1: World Carbon Dioxide Emissions from the Consumption & Flaring of Fossil Fules, 1980-2002 (Billions of tonnes of CO_2)

Region	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
North America	5.5	5.3	5.1	5.0	5.3	5.3	5.3	5.5	5.8	5.8	5.8	5.7	5.9	5.9	6.1	6.1	6.3	6.4	6.5	6.6	6.8	6.7	6.7
Central & South America	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0
Western Europe	3.7	3.6	3.5	3.5	3.5	3.6	3.6	3.6	3.6	3.7	3.7	3.7	3.5	3.5	3.5	3.6	3.7	3.7	3.7	3.6	3.8	3.9	3.9
Eastern Europe & Former U.S.S.R.	4.2	4.2	4.3	4.4	4.5	4.6	4.8	4.9	4.9	4.8	4.7	4.4	4.1	3.7	3.3	3.2	3.1	2.9	2.9	3.0	3.0	3.0	3.0
Middle East	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.2
Africa	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9
Asia & Oceania	3.6	3.6	3.7	3.8	4.0	4.2	4.4	4.6	4.9	5.1	5.2	5.4	5.6	6.0	6.4	6.7	6.8	7.0	6.9	7.0	7.3	7.6	7.8
World Total	**18.6**	**18.4**	**18.3**	**18.4**	**19.2**	**19.6**	**20.1**	**20.6**	**21.3**	**21.5**	**21.6**	**21.5**	**21.4**	**21.6**	**21.7**	**22.1**	**22.6**	**22.9**	**22.8**	**23.1**	**23.9**	**24.2**	**24.5**

Source: Energy Information Administration (EIA)

In 1980, North America was the region with the highest CO_2 emissions from fossil fuels; but since the early 1990s, Asia has been higher (Figure 3.1). The only region to cut its CO_2 emissions was Eastern Europe & Former U.S.S.R, down 28%. Western Europe was the only region to practically maintain its CO_2 emissions from fossil fuels (up 3%).

Fig. 3.1: World Carbon Dioxide Emissions from the Consumption & Flaring of Fossil Fuels 1980-2002



Source: Energy Information Administration (EIA)

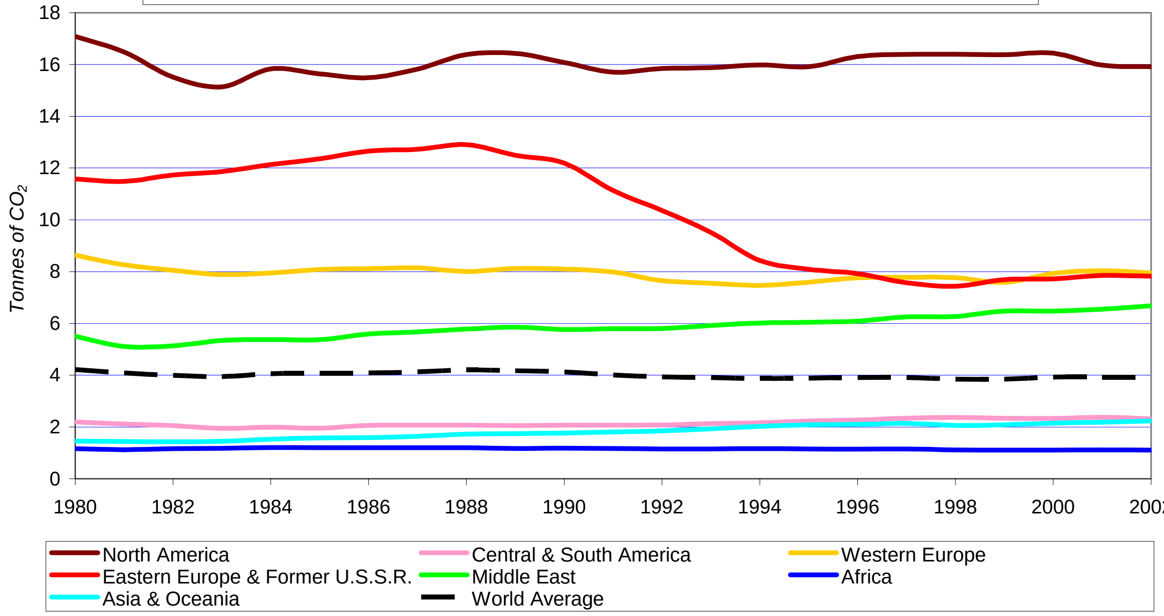
Table 3.2: World per Capita Carbon Dioxide Emissions from the Consumption & Flaring of Fossil Fuels, 1980-2002

Region	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
North America	17.08	16.48	15.51	15.14	15.83	15.63	15.49	15.82	16.38	16.43	16.08	15.70	15.85	15.88	15.99	15.92	16.31	16.39	16.40	16.38	16.44	15.98	15.91
Central & South America	2.20	2.12	2.05	1.95	2.00	1.95	2.06	2.07	2.07	2.06	2.07	2.07	2.08	2.13	2.16	2.23	2.27	2.34	2.37	2.34	2.33	2.38	2.32
Western Europe	8.64	8.26	8.05	7.89	7.95	8.08	8.12	8.15	8.01	8.12	8.10	7.99	7.65	7.55	7.47	7.59	7.76	7.78	7.77	7.58	7.93	8.04	7.94
Eastern Europe & Former U.S.S.R.	11.58	11.49	11.73	11.86	12.13	12.36	12.66	12.73	12.90	12.50	12.19	11.13	10.36	9.51	8.43	8.09	7.92	7.57	7.44	7.69	7.73	7.85	7.82
Middle East	5.51	5.11	5.13	5.34	5.38	5.37	5.59	5.67	5.78	5.86	5.77	5.79	5.81	5.92	6.01	6.04	6.09	6.25	6.27	6.47	6.48	6.55	6.68
Africa	1.16	1.13	1.17	1.18	1.21	1.20	1.20	1.20	1.20	1.17	1.18	1.17	1.15	1.15	1.17	1.15	1.15	1.16	1.12	1.11	1.11	1.11	1.10
Asia & Oceania	1.46	1.44	1.43	1.45	1.53	1.58	1.59	1.64	1.72	1.75	1.76	1.81	1.84	1.93	2.02	2.09	2.10	2.14	2.07	2.08	2.14	2.19	2.24
World Average	**4.22**	**4.09**	**3.99**	**3.95**	**4.06**	**4.08**	**4.09**	**4.13**	**4.20**	**4.17**	**4.12**	**4.01**	**3.94**	**3.91**	**3.88**	**3.89**	**3.91**	**3.91**	**3.85**	**3.85**	**3.92**	**3.93**	**3.93**

Source: Energy Information Administration (EIA)

The average world per capita carbon dioxide emissions (from fossil fuel consumption and flaring) were 3.93 tonnes for 2002 (Table 3.2). North America has the highest per capita CO_2 emissions, at 15.91 tonnes (almost twice the W. European) average. The largest falls in per capita CO_2 emissions were in Eastern Europe & Former U.S.S.R, down 33% from 1980. Per capita emissions also fell in Western Europe (down 8% on 1980), North America (down 7%), and Africa, respectively (down 5%).

Figure 3.2: World per Capita Carbon Dioxide Emissions from the Consumption & Flaring of Fossil Fuels, 1980-2002



Source: Energy Information Administration (EIA)

3.1 CO_2 Values of Energy Uses

- 1 kWh electricity = 0.43 $kgCO_2$
- 1 kWh natural gas = 0.19 $kgCO_2$
- 1 litre gas oil/diesel = 2.68 $kgCO_2$

- 1 litre petrol = 2.31 $kgCO_2$
- 1 litre LPG = 1.51 $kgCO_2$
- 1 tonne coal = 2,419 $kgCO_2$
- 1 mile in a petrol car = 0.36 $kgCO_2$
- 1 mile in a train/bus = 0.10 $kgCO_2$
- 1 mile in an aeroplane = 0.29 $kgCO_2$
- 1 litre kerosene = 2.52 $kgCO_2$

Source: National Energy Foundation and www.resurgence.org

The energy values ready-reckoner (above), allows rough estimates of emissions from different activities.

Caution: Actual emissions will depend on other factors besides distance such as; number of passengers on a train or plane or in a car. Short-flights will tend to consume more fuel, relative to distance – due to the high fuel use in take-off.

Global oil consumption is currently about 85mbd (million barrels/day), which equates to 4,400 Mt of oil annually. Burning this quantity of oil could thus generate about 11,000 Mt of CO_2 globally (nearly half the total).

If the UK's oil burn is about 100 Mt, this would generate about 250 Mt of CO_2, or about two-fifths of total UK GHGs.

A petrol car doing 10,000 miles in a year will emit 3.6 tonnes of CO_2.
A diesel car will emit 16% more CO_2 for each litre, but its better fuel economy (mpg) will tend to offset this.

Burning 100,000 litres of kerosene (aviation fuel) will create 252,000 tonnes of CO_2.
A flight of 1,000 miles (return) would be responsible for 580kg of CO_2.

A return train journey to London would create about 60kg of CO_2, whereas a car journey is reckoned to create over 200 kg (3.6 times as much) according to this ready-reckoner.

A household burning 12,000 kWh of gas (an annual gas bill of about £240 p.a., at 2p/kWh) would create about 2.4 tonnes of CO_2.

A household consuming about 3,000 kWh of electricity (costing about £240 p.a., at 8p/kWh) would be responsible for producing about 1.29 tonnes of CO_2.

4. EU EMISSIONS

Western Europe's total CO_2 emissions were about 3,900 Mt (in 2002)[19] (Table 4.1).

Under the Kyoto Protocol, the European Union (EU) has a target to reduce emissions by 8% from the 1990 base line, by 2008-2012 (EU-15 only[20]).

Total EU-15 emissions have fallen, so far, by 2.9% between 1990-2002. This means the EU-15 was little more than a third of the way towards achieving the 8% Kyoto target required by 2008–12 (Figure 4.1).

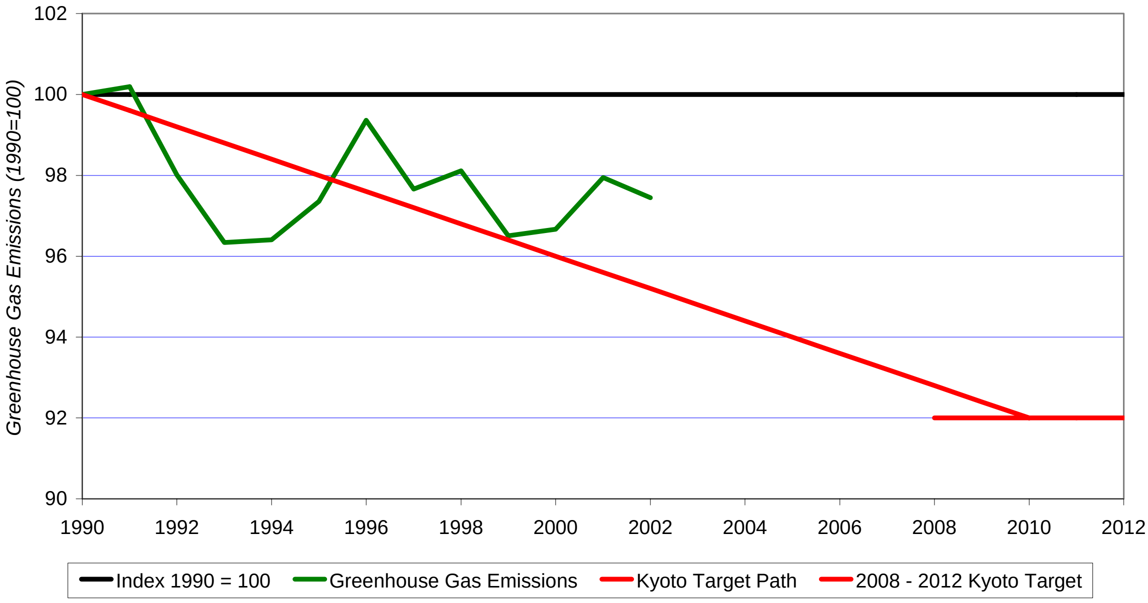
The fall between 1990-2002 was largely due to reductions in emissions of 19% in Germany and 15% in the UK. These two countries generate more emissions than any other country in the EU-15 with Germany generating 25% and UK 15% of the EU-15 total in 2002.

Nearly 50% of the reductions in both Germany and the UK were due to one-off factors. These were due to:

- Economic restructuring following reunification in Germany and;
- Energy liberalisation leading to increased use of gas [in place of coal] for electricity generation in the UK.

Emissions *increased* in nine Member States between 1990 and 2002.

Fig. 4.1: EU-15 Greenhouse Gas Emissions compared with Kyoto targets 2008-2012



Source: European Environment Agency (EEA)

On the basis of their emissions in 2002, nine of the EU-15 were not on track (Austria, Belgium, Denmark, Finland, Greece, Ireland, Italy, Portugal and Spain) to meet their individual greenhouse gas limitation or reduction targets in 2010 (Tables 4.1 & 4.2).

[19] *According to US (Energy Information Administration) estimates (quoted in section 1). W. Europe would appear to mean effectively the EU15 plus Norway and Switzerland.*

[20] *EU 15 means the EU before enlargement in 2004; Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the UK.*

From 1990 to 2002 EU-15 GHG emissions fell from most sectors (energy supply, industry, agriculture, waste management); however emissions from transport increased by nearly 22 % in the same period (Tables 4.3 & 4.4).

The latest projections for 2010 show that neither existing domestic policies and measures by Member States to reduce emissions, nor planned additional domestic policies and measures, will be sufficient for the EU-15 to reach its Kyoto target.

When the additional domestic policies and measures being planned by Member States are taken into account, an EU-15 emissions reduction of 7.7 % is projected. However, this relies on several Member States cutting emissions by more than is required to meet their national targets, which cannot be taken for granted. If no over-delivery by these Member States is included, the EU-15 will achieve a 5.4 % reduction with additional policies and measures.

The use of 'Kyoto mechanisms'[21], which are in a stage of implementation by Austria, Belgium, Denmark, Ireland, Luxembourg and the Netherlands, will reduce the gap between projected emissions (with planned domestic policies and measures by 2010) and the EU-15 target by 1.1 % additionally. This would bring the total reduction to –8.8 % and thus the Kyoto target for EU-15 would be achieved.

Six countries (Austria, Belgium, Denmark, Finland, the Netherlands and Sweden) have allocated financial resources for using the Kyoto mechanisms with a total amount of about €1,300m over the whole 5-year Kyoto Protocol commitment period. The same countries and Spain have started to prepare legal and operational frameworks and bilateral agreements for using the Kyoto mechanisms.

Domestic policies and measures in EU-15 Member States that are projected to help most in achieving the targets include promotion of electricity from renewable energy, promotion of combined heat and power (CHP), improvements in energy performance of buildings and energy efficiency in large industrial installations, and promotion of the use of energy-efficient appliances. However, the EU (2010) renewable energy target (22 % of gross electricity consumption) and the indicative EU target for CHP (18 % share in total electricity production) for 2010 are unlikely to be met with current trends.

Other key policies and measures include promotion of biofuels in transport and reducing the average CO_2 emissions of new cars, recovery of gases from landfills and reduction of fluorinated gases. The adopted emissions **trading** directive has created a market for CO_2 allowances (which started in early 2005) and aims to ensure that [at least industrial and power stations] emissions reductions can be made where it is most economically efficient.

[21] *The Kyoto Protocol creates three market-based mechanisms that have the potential to help countries reduce the cost of meeting their emissions reduction targets. These mechanisms are Joint Implementation, the Clean Development Mechanisms, and Emissions Trading.*

Table 4.1: Overview of Member States' contributions to EC GHG emissions (excl. LUCF*), 1990-2002 (Mt)**

Member State	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Austria	78	82	75	75	76	79	83	82	82	80	81	84	85
Belgium	146	149	148	147	152	155	159	150	155	148	150	149	150
Denmark	69	79	73	76	80	77	90	81	76	73	68	69	68
Finland	77	75	72	72	79	76	82	81	78	77	75	81	82
France	565	589	579	556	552	560	576	568	583	564	558	562	554
Germany	1,249	1,196	1,146	1,131	1,108	1,101	1,119	1,082	1,056	1,020	1,016	1,027	1,016
Greece	105	105	106	107	109	110	114	120	124	124	130	135	135
Ireland	53	54	55	55	57	58	59	62	64	66	68	70	69
Italy	509	511	506	500	493	525	517	523	535	540	544	554	554
Luxembourg	13	13	13	13	13	10	10	9	8	9	10	10	11
Netherlands	211	218	218	221	222	225	234	218	224	213	213	216	214
Portugal	58	60	64	62	63	67	65	68	72	80	78	78	82
Spain	285	291	300	289	304	316	310	331	341	370	385	383	400
Sweden	72	72	72	72	75	74	77	73	73	70	68	68	70
United Kingdom	743	744	721	701	696	686	708	684	679	648	648	656	635
EU-15	**4,231**	**4,239**	**4,147**	**4,076**	**4,079**	**4,119**	**4,204**	**4,132**	**4,151**	**4,083**	**4,090**	**4,144**	**4,123**

** LUCF means Land Use and Forestry Change*

** * In CO_2 equivalents*

Source: European Environment Agency

4.1 Emissions Trading

Emissions' trading is emerging as a key instrument in the drive to reduce greenhouse gas emissions. The rationale behind emission trading is to ensure that the emission reductions take place where the cost of the reduction is lowest thus lowering the overall costs of combating climate change[22].

Emissions trading is particularly suited to the emissions of greenhouse gases, which have the same effect wherever they are emitted. This allows the Government (or EU) to regulate the amount of emissions produced in aggregate by setting the overall cap for the scheme but gives companies the flexibility of determining how and where the emissions reductions will be achieved. By allowing participants the flexibility to trade allowances, the overall emissions reductions are achieved in the most cost-effective way possible.

Participating companies are allocated allowances, each allowance representing a tonne of the relevant emission, in this case CO_2-equivalent. Emissions trading allows companies to emit in excess of their allocation of allowances by purchasing allowances from the market. Similarly, a company that emits less than its allocation of allowances can sell its surplus allowances. In contrast to regulation, which imposes emission limit values on particular facilities, emissions trading gives companies the flexibility to meet emission reduction targets according to their own strategy; for example by reducing emissions on site or by buying allowances from other companies who have excess allowances. The environmental outcome is not affected because the amount of allowances allocated is fixed.

4.1.1 UK Emissions Trading Scheme

The UK emissions trading scheme is the world's first economy-wide greenhouse gas emissions trading scheme, which began in March 2002.

[22] *http://www.defra.gov.uk/environment/climatechange/trading/*

Thirty-one organisations ('direct participants' in the scheme) have voluntarily taken on emission reduction targets to reduce their emissions against 1998-2000 levels, delivering 11.88 Mt of additional CO_2-equivalent emission reductions over the life of the scheme (2002-2006).

The scheme is also open to the 6,000 companies with Climate Change Agreements. These negotiated agreements between business and Government set energy-related targets. Companies meeting their targets will receive an 80% discount from the Climate Change Levy, a tax on the business use of energy. These companies can use the scheme either to buy allowances to meet their targets, or to sell any over-achievement of these targets. Anyone can open an account on the registry to buy and sell allowances.

In the first year (2002), the Direct Participants achieved emission reductions of 4.64 Mt CO_2-equivalent against their baselines and in the second year (2003) they achieved emission reductions of nearly 5.2 Mt CO_2-equivalent against their baselines.

4.1.2 European Union Emissions Trading Scheme (ETS)

The EU ETS is one of the policies being introduced across Europe to tackle emissions of carbon dioxide and other greenhouse gases. The scheme commenced on 1 January 2005.

The first phase runs from 2005-2007 and the second phase will run from 2008-2012 to coincide with the first Kyoto Commitment Period. Further five-year periods are expected subsequently.

The scheme will work on a "Cap and Trade" basis. EU Member State governments are required to set an emission cap for all installations covered by the Scheme.

Each installation will then be allocated allowances for the particular commitment period in question. The number of allowances allocated to each installation for any given period, (the number of tradable allowances each installation will receive), will be set down in the National Allocation Plan.

For the EU ETS, selected industries will be given an emissions cap. Companies which emit less than their cap will be able to trade the surplus amount. Similarly those who emit more than their cap must buy more from the market. At the end of each year all companies must demonstrate that they are in compliance by surrendering the relevant number of allowances.

The EU ETS will, in its second phase (2008-2012), amount to International Emissions Trading under the Kyoto Protocol between participants across the EU Member States.

Table 4.2: Greenhouse gas emissions in CO_2 equivalents (excl. LUCF) and Kyoto Protocol targets for 2008–2012

Member State	Base year [1] (million tonnes)	2002 (million tonnes)	Change 2001–2002 (%)	Change base year - 2002 (%)	Targets 2008–12 under Kyoto Protocol and 'EU burden sharing' (%)
Austria	78.0	84.6	0.3	8.5	– 13.0
Belgium	146.8	150.0	0.5	2.1	– 7.5
Denmark (2)	69.0	68.5	– 1.2	– 0.8 (– 9.1)	– 21.0
Finland	76.8	82.0	1.7	6.8	0.0
France	564.7	553.9	– 1.4	– 1.9	0.0
Germany	1,253.3	1,016.0	– 1.1	– 18.9	– 21.0
Greece	107.0	135.4	0.3	26.5	25.0
Ireland	53.4	68.9	– 1.6	28.9	13.0
Italy	508.0	553.8	– 0.1	9.0	– 6.5
Luxembourg	12.7	10.8	10.4	– 15.1	– 28.0
Netherlands	212.5	213.8	– 1.1	0.6	– 6.0
Portugal	57.9	81.6	4.1	41.0	27.0
Spain	286.8	399.7	4.2	39.4	15.0
Sweden	72.3	69.6	2.0	– 3.7	4.0
United Kingdom	746.0	634.8	– 3.3	– 14.9	– 12.5
EU-15	**4,245.2**	**4,123.3**	**– 0.5**	**– 2.9**	**– 8.0**

[1] The base year for CO_2, CH_4 and N_2O is 1990; for the fluorinated gases 13 Member States have chosen to select 1995 as the base year, whereas Finland and France have chosen 1990. As the EC inventory is the sum of Member States' inventories, the EC base year estimates for fluorinated gas emissions are the sum of 1995 emissions for 13 Member States and 1990 emissions for Finland and France.

[2] For Denmark, data that reflect adjustments for electricity trade (import and export) in 1990 are given in brackets. This method is used by Denmark to monitor progress towards its national target under the EC 'burden sharing' agreement. For the EC emissions, total non-adjusted Danish data have been used.

Source: European Environment Agency

Table 4.3: Overview of EU-15 GHG emissions & removals in CO_2 equivalents, 1990-2002 (Mt)

Greenhouse gas emissions	Base Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Net CO_2 emissions/removals	3,234	3,234	3,310	3,167	3,096	3,111	3,158	3,222	3,153	3,212	3,174	3,211	3,251	3,224
CO_2 emissions (without LUCF)	3,335	3,335	3,358	3,285	3,228	3,232	3,270	3,347	3,281	3,333	3,306	3,328	3,392	3,382
CH_4	451	451	441	433	426	416	410	405	394	385	375	364	356	349
N_2O	392	392	388	378	369	374	375	383	383	361	338	336	335	328
HFCs	41	27	27	28	30	34	40	45	52	53	46	47	46	50
PFCs	12	16	14	12	11	10	9	9	8	8	7	6	6	5
SF_6	15	10	11	12	12	13	15	15	13	12	10	10	9	9
Total (with net CO_2 emissions/removals)	4,145	4,130	4,191	4,031	3,945	3,959	4,007	4,079	404	4,030	3,950	3,974	4,003	3,965
Total (without CO_2 from LUCF)	4,246	4,231	4,240	4,148	4,077	4,080	4,119	4,204	4,132	4,152	4,083	4,091	4,144	4,124
Total (without LUCF)	4,245	4,231	4,239	4,147	4,076	4,079	4,119	4,204	4,132	4,151	4,083	4,090	4,144	4,123

Source: European Environment Agency

Table 4.4: Overview of EU-15 GHG emissions of main source & sink categories in CO_2 equivalents, 1990-2002 (Mt)

GHG source & sink	Base Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Energy	3,322	3,322	3,353	3,282	3,227	3,218	3,250	3,331	3,259	3,309	3,278	3,293	3,358	3,349
Industrial processes	318	303	294	286	276	290	300	302	308	286	255	256	252	248
Solvent & other product use	9	9	9	9	8	8	8	8	8	9	8	9	8	8
Agriculture	456	456	443	432	426	428	428	431	432	430	428	424	421	416
Land-use change & forestry (LUCF)	-100	-100	-81	-117	-131	-121	-112	-125	-128	-121	-132	-117	-141	-158
Waste	138	138	138	137	136	133	131	129	122	116	111	106	103	100
Other	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Source: European Environment Agency

5. EVIDENCE OF CLIMATE CHANGE:

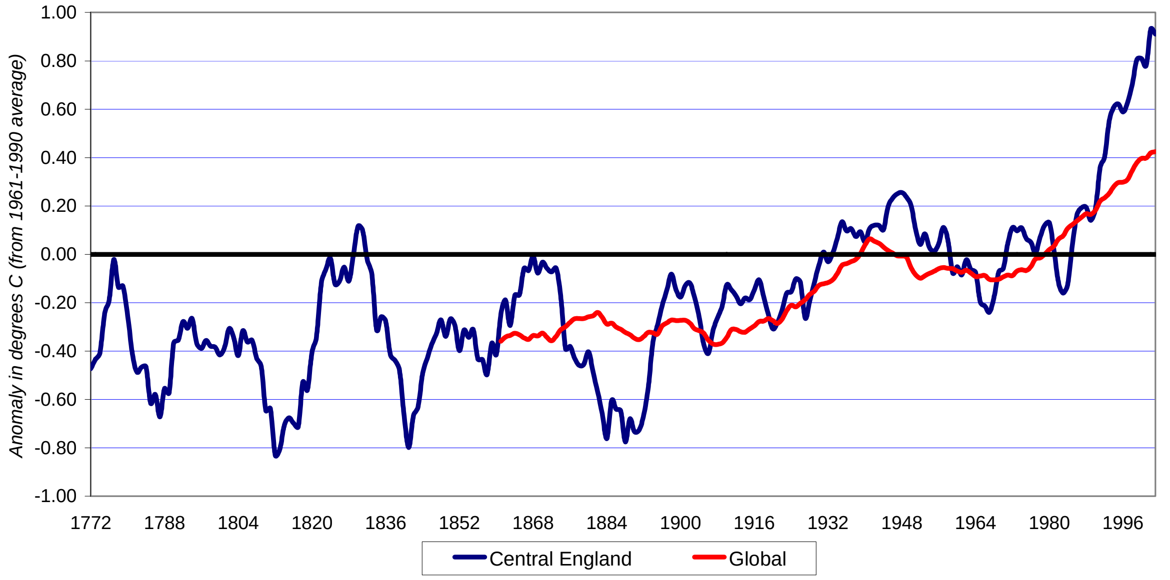
5.1 UK & Global temperatures

Average global surface temperatures have increased by 0.4 - 0.8° C since the late 19th century. 1998 was the hottest year since global records began in 1860, 2003 was the third warmest, and all ten of the hottest years on record have been during the period 1990-2003. Studies of this trend show that it is statistically significant and is unlikely to be entirely natural in origin. Current climate models predict that global temperatures will rise by a further 1.4 - 5.8° C by the end of the 21st century.

[UK temperatures have risen sharply since the 1980s.] During the 20th century, the annual mean central England temperature warmed by about 1°C (Figure 5.1). The 1990s were exceptionally warm in central England by historical standards, about 0.6°C warmer than the 1961-1990 average. Four of the five warmest years since 1772 have been since 1990.

In 2003, the UK experienced a ‘heat wave’, with daily temperatures in August in excess above the August average. This heat wave had an impact on mortality of certain regions and ages groups. With 17% more deaths and 1% more emergency hospital admissions than the expected average for the same period in the previous 5 years, (an excess of 2,100 deaths). The excess in mortality was greater than previously recorded for the heat waves of 1976 and 1995[23].

Figure 5.1: Global & Central England surface temperature anomalies: 1772-2003



These are smoothed figures based on 10 year moving averages.
Source: Met Office, Hadley Centre for Climate Prediction & Research.

5.2 UK rainfall

Figures 5.2 & 5.3 are scatter plots of departures (‘anomalies’) from the average rainfall and average temperatures for the summer and winter periods since 1915. The plots for each of the last 30 years (1975 - 2004) are highlighted as blue diamonds.

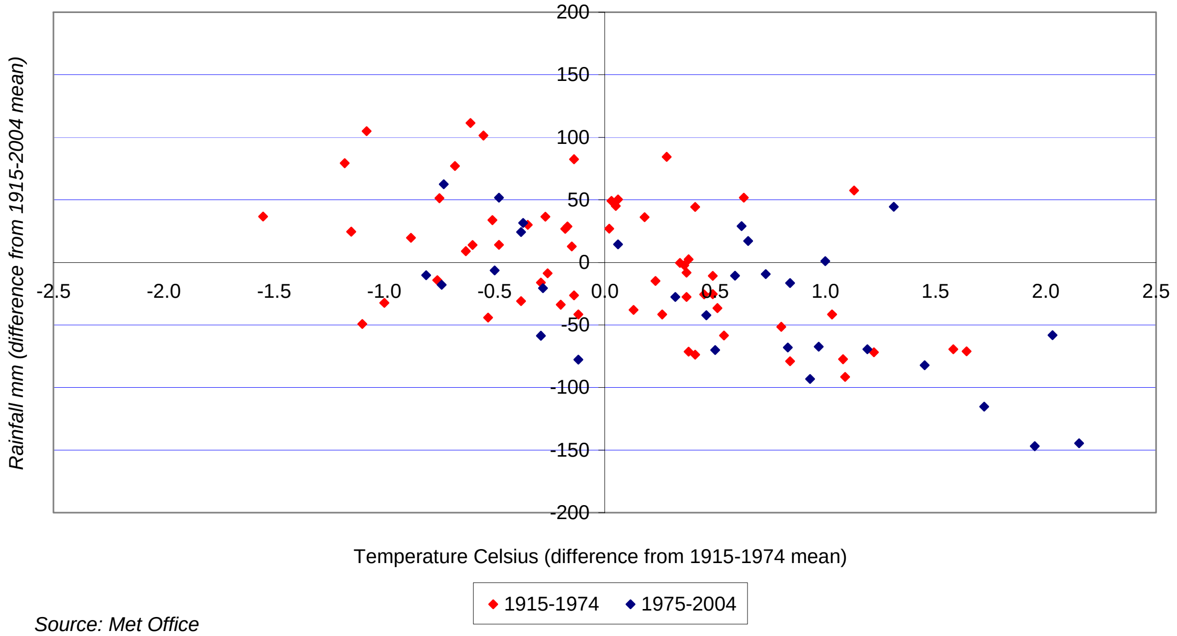
UK winters have become warmer and wetter; on the winter chart, the recent years tend to fall more in the top right quarter.

[23] *www.statistics.gov.uk/downloads/theme_health/HSQ25.pdf*

UK summers have become hotter and drier; on the summer chart recent years tend to fall more in the bottom right quarter. Both these tendencies (summer and winter changes) are consistent with recent climate change scenarios, but the climate is naturally variable and any apparent short-term trends should be treated with caution. In the dry summer of 2003, the UK had the lowest February - October rainfall total since 1921.

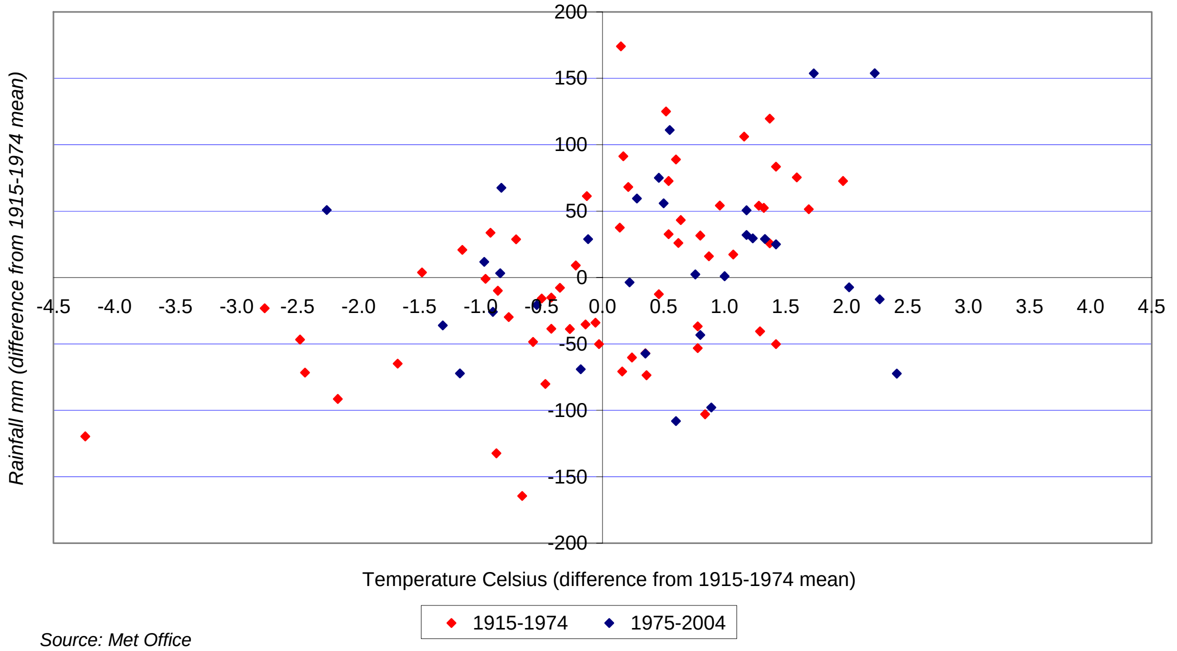
Changes in seasonal weather patterns have important implications for the frequency and magnitude of flooding and for water resources.

Figure 5.2: Rainfall & temperature in England & Wales (Summer) 1915-2004



Source: Met Office

Figure 5.3: Rainfall & temperature in England & Wales (Winter) 1915-2004



Source: Met Office

6. UK EMISSIONS

The 1990-2003 (provisional 2004 CO_2) emissions for each of these six greenhouse gases are summarised below (Table 6.1). The total global warming potential of UK greenhouse gas emissions has been calculated using their global warming potentials (GWPs),

In 2003, the UK greenhouse gas emissions were 666 Mt CO_2-equivalent. This was a fall of 13.4% from base year emissions, with an estimated reduction of 12.6% for 2004.

Table 6.1: Estimated total emissions of UK 'basket' greenhouse gases on an IPCC basis[1] weighted by global warming potential: 1990-2004

United Kingdom — **Million tonnes**

		Base Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 [4] (provisional)	% change Base Year - 2003
Carbon dioxide equivalent	2																	
CO_2		606.3	606.3	613.1	597.5	582.9	575.7	567.1	588.7	564.5	566.6	556.4	560.3	577.1	559.8	572.2	580.8	-5.6%
CH_4		77.5	77.5	76.7	75.6	73.0	66.3	66.0	64.1	61.0	57.6	53.7	49.9	47.0	45.0	40.6	..	-47.6%
N_2O		67.9	67.9	66.0	59.1	55.4	58.6	57.1	59.1	60.8	58.1	45.0	44.9	42.6	41.0	40.4	..	-40.5%
HFC		15.49	11.38	11.85	12.32	13.00	14.01	15.49	16.72	19.18	17.27	10.83	9.08	9.73	10.42	10.70	..	-30.9%
PFC		0.46	1.39	1.16	0.57	0.49	0.48	0.46	0.50	0.45	0.44	0.45	0.54	0.44	0.38	0.38	..	-17.6%
SF_6		1.29	1.08	1.13	1.18	1.22	1.24	1.29	1.32	1.28	1.31	1.47	1.85	1.46	1.59	1.56	..	20.8%
Basket total	3	769	766	770	746	726	716	707	730	707	701	668	667	678	658	666	672	-13.4%
Percentage change from **baseline**				0.1	-2.9	-5.6	-6.8	-8.0	-5.0	-8.0	-8.8	-13.1	-13.3	-11.8	-14.4	-13.4	-12.6	
Carbon equivalent	2																	
CO_2		165.4	165.4	167.2	162.9	159.0	157.0	154.7	160.6	153.9	154.5	151.7	152.8	157.4	152.7	156.1	158.4	-5.6%
CH_4		21.1	21.1	20.9	20.6	19.9	18.1	18.0	17.5	16.6	15.7	14.7	13.6	12.8	12.3	11.1	..	-47.6%
N_2O		18.5	18.5	18.0	16.1	15.1	16.0	15.6	16.1	16.6	15.8	12.3	12.2	11.6	11.2	11.0	..	-40.5%
HFC		4.22	3.10	3.23	3.36	3.55	3.82	4.22	4.56	5.23	4.71	2.95	2.48	2.65	2.84	2.92	..	-30.9%
PFC		0.12	0.38	0.32	0.16	0.13	0.13	0.12	0.14	0.12	0.12	0.12	0.15	0.12	0.10	0.10	..	-17.6%
SF_6		0.35	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.35	0.36	0.40	0.51	0.40	0.43	0.43	..	20.8%
Basket total	3	210	209	210	204	198	195	193	199	193	191	182	182	185	180	182	183	-13.4%
Percentage change from **baseline**				0.1	-2.9	-5.6	-6.8	-8.0	-5.0	-8.0	-8.8	-13.1	-13.3	-11.8	-14.4	-13.4	-12.6	

[1] Emissions inventories based on the methodology developed by the Intergovernmental Panel on Climate Change (IPCC) are used to report UK' emissions to the Climate Change Convention.

[2] 12 tonnes of C is equivalent to 44 tonnes of CO_2

[3] The 1990 baseline year, used for comparison with the Kyoto target, is the sum of 1990 totals for CO_2, CH_4 and N_2O and 1995 totals for HFC, PFC and SF_6.

[4] Provisional estimates will be subject to revision when final estimates are published in 2006, but they provide an indication of the emissions in the most recent full year.

UK national emission estimates are updated annually and any developments in methodology are applied retrospectively to earlier years.

Source publication: e-Digest of Environmental Statistics, Published March 2005

Department for Environment, Food and Rural Affairs

http://www.defra.gov.uk/environment/statistics/index.htm

Source: netcen (1990 to 2003), DTI (2004)

In the UK, emissions arise from the following sectors:

- Energy
- Industrial processes
- Solvents
- Agriculture
- Land-use change and forestry (LUCF)
- Waste

Table 6.2: Aggregated emission trends per source category, 1990-2003 (Mt CO_2 equivalent)

GREENHOUSE GAS SOURCE & SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy	610.4	619.6	604.7	589.7	575.6	567.7	588.3	564.1	565.5	554.2	557.8	576.0	559.7	567.3
Industrial Processes	56.5	52.9	46.9	44.1	48.4	48.4	51.5	54.5	50.2	30.9	29.8	27.9	25.7	26.8
Solvent & Other Product Use*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agriculture	53.4	52.9	51.3	50.6	51.5	51.4	51.8	52.5	51.6	51.0	49.1	46.1	46.4	45.8
Land-Use Change & Forestry (emissions)	17.6	17.7	17.4	16.5	16.6	16.8	16.5	16.0	15.5	15.4	15.1	14.9	14.5	14.7
Land-Use Change & Forestry (removals)	-14.9	-15.1	-15.3	-15.6	-15.9	-15.9	-15.9	-15.8	-15.8	-15.9	-15.8	-15.9	-16.0	-16.3
Waste	27.8	26.9	26.0	25.0	24.1	23.1	22.2	20.2	18.6	16.3	14.8	13.4	11.9	11.1
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total (with LUCF)	765.6	769.9	746.3	726.1	716.3	707.3	730.4	707.3	701.4	667.8	666.6	678.3	658.2	665.8
Total (without LUCF)	750.6	754.9	731.0	710.4	700.4	691.4	714.6	691.4	685.5	651.9	650.8	662.5	642.2	649.6

** Solvents & other product use emissions occur as NMVOC and so do not appear in this table which covers direct greenhouse gases.*

Source: Defra, 2004

The predominant contribution to greenhouse gas emissions arises from the energy sector, (85% of total emissions in 2003).[24] Emissions of CO_2, CH_4 and N_2O arise from this sector. Since 1990, emissions from the energy sector have declined by 7% (Table 6.2).

The second-largest source of greenhouse gases in the UK is the agricultural sector (7%). Emissions from this sector arise for both CH_4 and N_2O. Since 1990, emissions from this sector have fallen 14%, due to the decline in emissions from enteric fermentation, agricultural waste disposal and agricultural soils.

Industrial processes sector makes up the third-largest source of greenhouse gases in the UK, contributing 4% to the national total in 2003. Emissions from all six direct greenhouse gases occur from this sector.

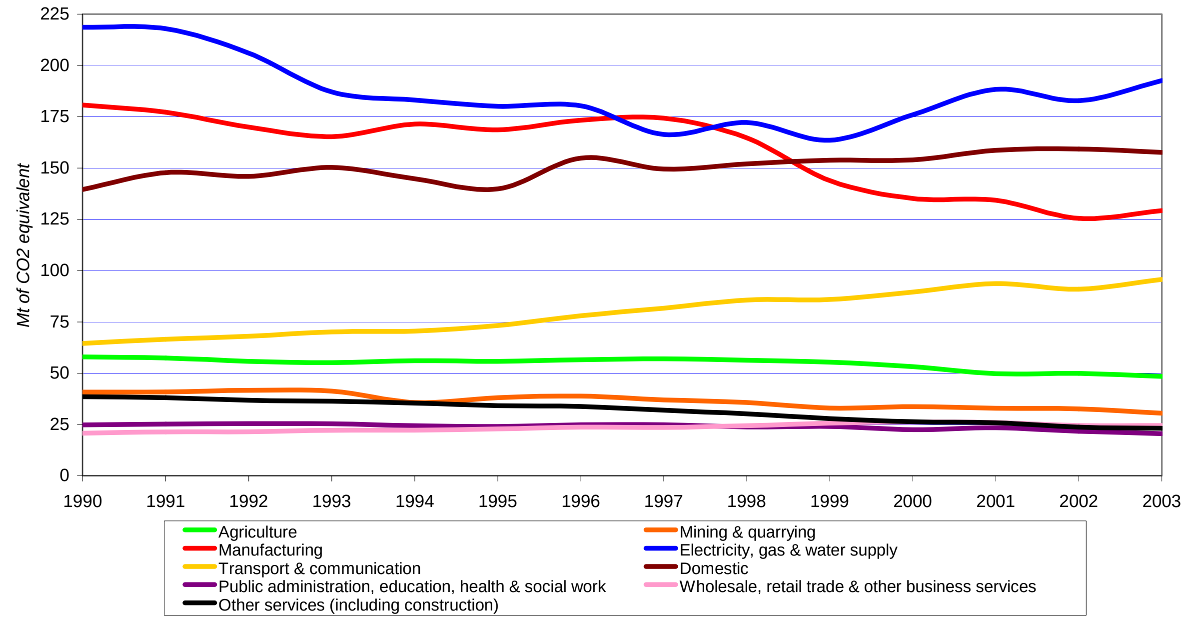
Land-use change and forestry (LUCF) contributed 2% to the national total in 2003. Emissions from this sector occur for CO_2, N_2O and CH_4. LUCF contains 'sinks'[25] as well as sources of CO_2 emissions.

Waste contributed less than 2% to the national total in 2003. Emissions arise for CO_2, CH_4 and N_2O, with emissions occurring in incineration and solid waste disposal. Emissions from this sector have fallen steadily, and are down to 40% of those in 1990.

As with emissions of other air pollutants, CO_2 estimates are calculated by applying emission factors to statistical information on mainly fuel consumption data, as opposed to measurements at the point of emission. Fossil fuel combustion is the major source of UK CO_2 emissions and so fuel consumption statistics, combined with appropriate emission factors for each source and type of fuel, are used to estimate the majority of CO_2 emissions. Emission factors reflect the carbon contents of fuels. An uncertainty distribution was allocated to each emission factor and activity rate. The parameters of the distributions were set by analysing the available data on emission factors and activity data or by expert judgement. Based on the 2002 inventory, total CO_2 emission estimates for any given year are thought to be accurate to within ±2 per cent [about ±13 Mt], although the trend is likely to be more reliable than this.

[24] *Excluding removals.*
[25] *'Sinks' are places where CO_2 is taken from the atmosphere.*

Figure 6.1: UK Greenhouse Gases by Sector, 1990-2003, by sector



Source: Netcen, ONS

Caution: there are differences between Figure 6.1 and all other figures presented in this section, due to different categorisation and allocation of GHGs to particular sectors.

Figure 6.1 shows that UK GHGs due to manufacturing have fallen substantially since 1990 (notably since 1997) from about 175 Mt to close to 125 Mt. Emissions from energy industries [power stations] also fell by about 50 Mt from 1990-99 but have since risen by about 25 Mt. Conversely, transport emissions have risen the fastest, from under 70 Mt to over 95 Mt.

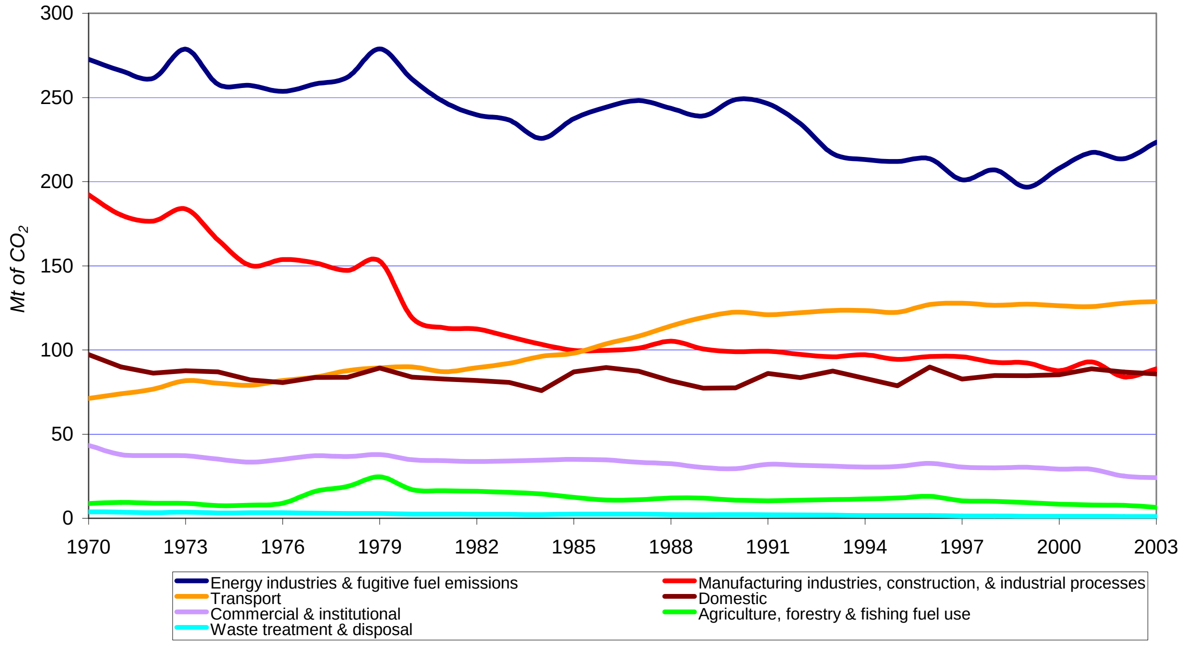
6.1 UK Carbon dioxide

Carbon dioxide emissions account for 86% (572 Mt CO_2-equivalent in 2003) of weighted GHG emissions, the dominant UK contributor to global warming (Defra, 2004). However, emissions of CO_2 rose in the transport sector, (1970 – 2003), compared to all other sectors (Figure 6.2). However, emissions from transport are less than those emitted from the energy industries (Figure 6.3).

The DTI has announced plans to capture and store carbon dioxide emissions from power plants under the North Sea. This could reduce emissions by 85%, with the storage of CO_2 in depleted oil and gas fields. This scheme is part of a £25m strategy to improve power plant efficiency through low-carbon alternatives[26].

[26] *This scheme is called 'A Strategy for Developing Carbon Abatement Technologies for Fossil Fuel Use.' Report can be found at: http://www.dti.gov.uk/energy/coal/cfft/cct/pub/catreportlinked.pdf*

Figure 6.2: UK CO_2 emissions by source, 1970-2003

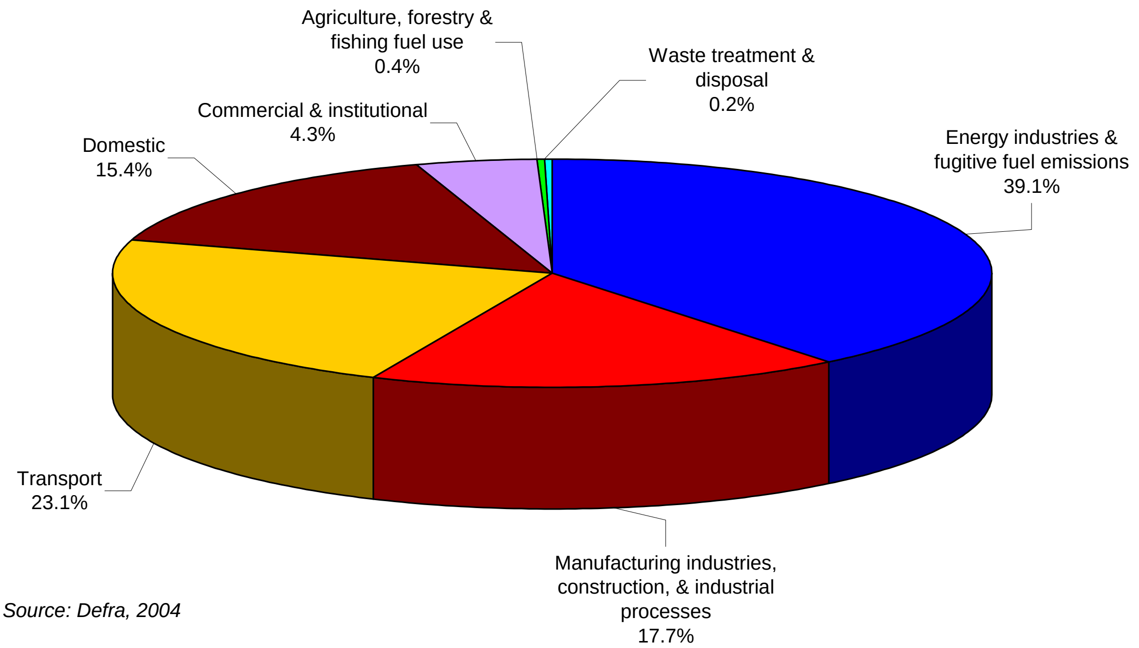


Source: Defra, 2004

The fall in CO_2 emissions in the first half of the 1990s is associated mainly with greater use of gas in electricity generation and increased use of nuclear-generated electricity. Both displaced coal use.

In 2002, food transport accounted for 10 Mt of carbon dioxide, 1.8% of UK emissions – Defra. The quantity of food transported by lorries has more than doubled since 1974, and in 2005, accounts for 25% of all heavy goods traffic[27].

Figure 6.3: UK CO_2 emissions by source, 2003

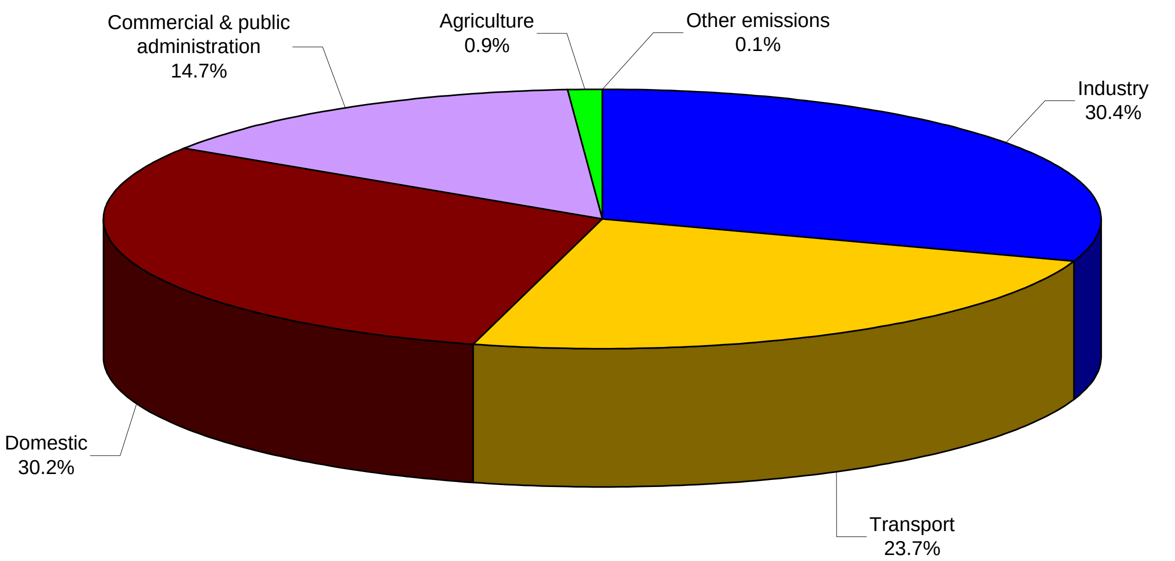


Source: Defra, 2004

27 *'The Validity of Food Miles as an Indicator of Sustainable Development.' Report can be found at: http://statistics.defra.gov.uk/esg/reports/foodmiles/execsumm.pdf*

For estimates of CO_2 emissions by **end-user**, a simple pro rata method is used to re-allocate estimated emissions from power stations and other fuel processing industries to final users of delivered energy. This method, for example, does not take into account higher emissions from increased coal and oil-fired generation used to meet peak domestic demand for electricity. Emissions by end-user are therefore subject to more uncertainty than those by source and should only be used to give a broad indication by sector (Figure 6.4).

Figure 6.4: UK CO_2 emissions by end user, 2002



Source: Defra, 2004

Caution: Economic output, trends in energy efficiency and outside temperatures also affect the differences in emissions from year to year.

6.2 UK Methane

Methane is the second most significant greenhouse gas in the UK and contributed 6% of UK GHGs in 2003 (at 40.6 Mt CO_2-equivalent). The major sources of methane are agriculture, waste disposal, leakage from gas distribution system, and coal mining (Figure 6.5).

Global methane (CH_4) concentrations in the atmosphere have been rising at a rate of 7 ppb (parts per billion) per annum in the last few decades although there has been a slowdown in the rate of increase in recent years (Defra, 2004). The global release of CH_4 emissions to the atmosphere is estimated to range between 410 and 660 Mt per annum including those from natural sources. Man-made emissions are estimated to range between 300 and 450 Mt per annum. The UK contributed just under 2 Mt in 2003 (about ½% of global methane).

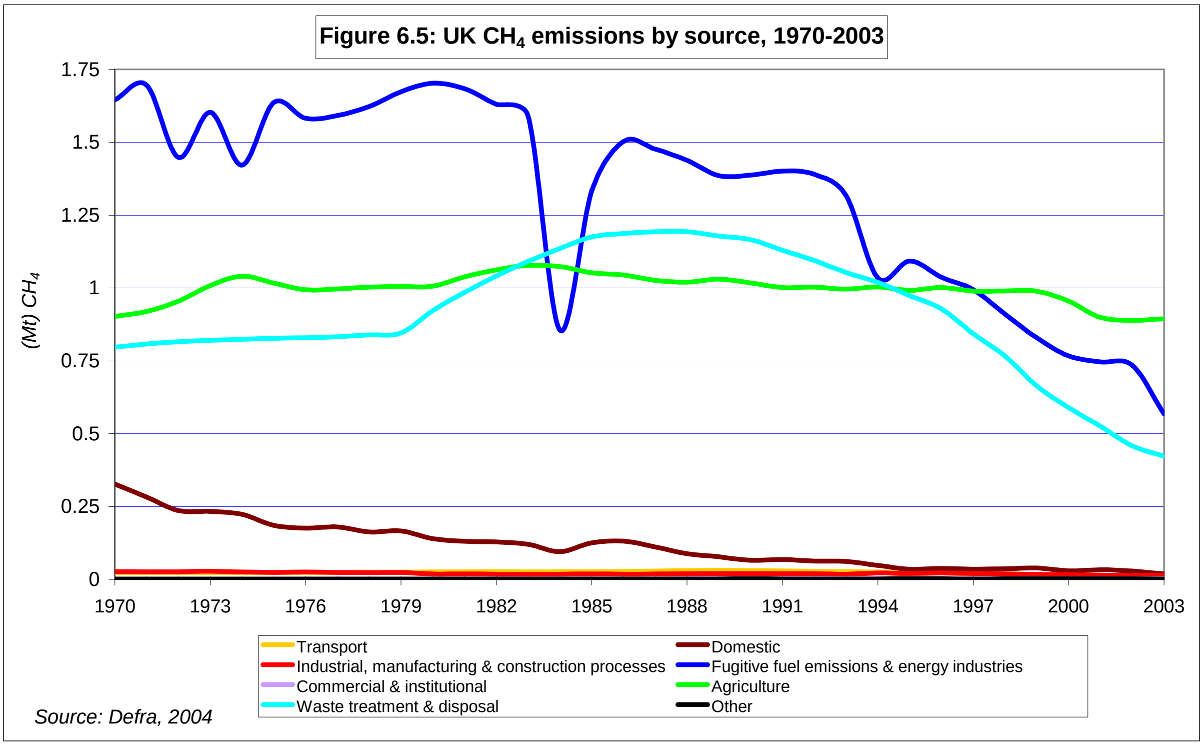
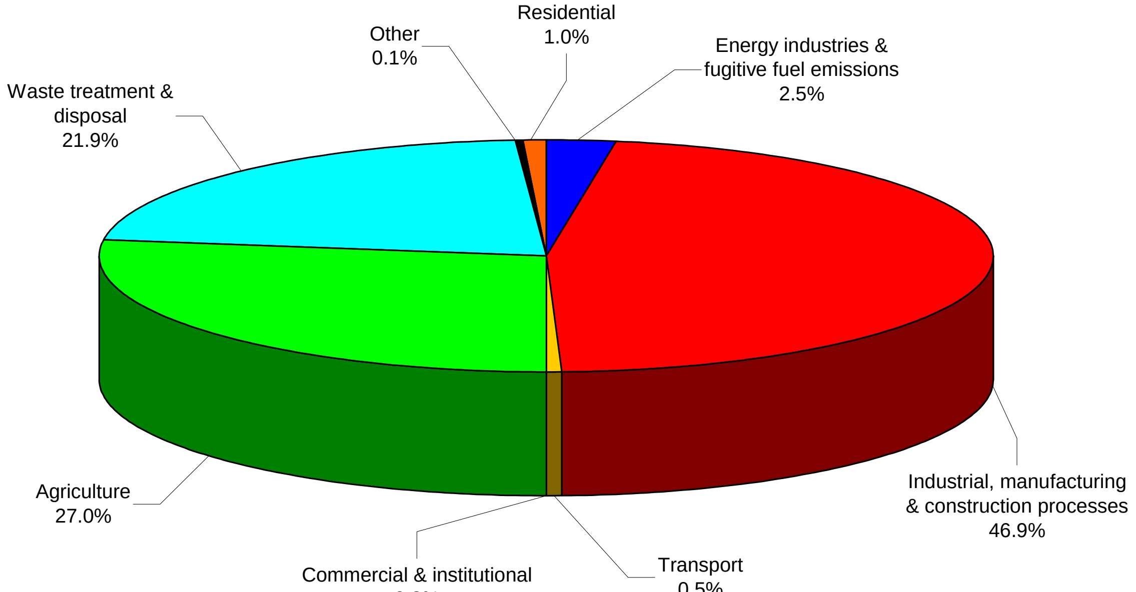


Figure 6.5 shows annual UK estimated emissions of CH_4 since 1970 with the largest sources now (since 1997) being agriculture (nearly 1 Mt), energy industries (about 0.6 Mt), and landfill sites (0.4 Mt). Emissions have fallen by 48% since 1990, largely as a result of the implementation of methane recovery systems at landfill sites and reduced emissions from coal mines. Note: Estimates are given to the nearest thousand tonnes, which helps indicate the trends, but does not reflect the accuracy of the estimates, which, based on the 2002 inventory, is probably ±13% overall, although the trend is likely to be more reliable than this. [The sharp fall in 1984 in energy industry methane emissions reflects much-reduced coal-mining in the year of the coal strike – Ed].

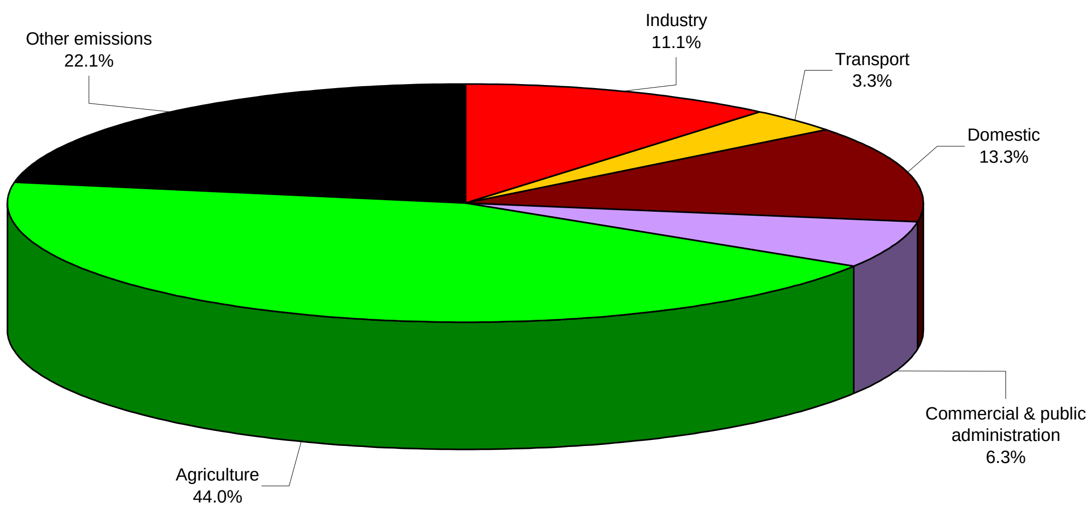
Figure 6.6: UK CH_4 emissions by source, 2003



Source: Defra, 2004

The UK's largest emissions by source of CH_4 were from the industrial sector, followed by agriculture and waste disposal. However, these change markedly when compared to emissions by end-user, in which agricultural, other, domestic and industrial emissions account for the majority of emissions (Figures 6.6 & 6.7). Despite the difference, agricultural emissions are a predominant source in general emissions of CH_4.

Figure 6.7: UK CH_4 emissions by end user, 2002



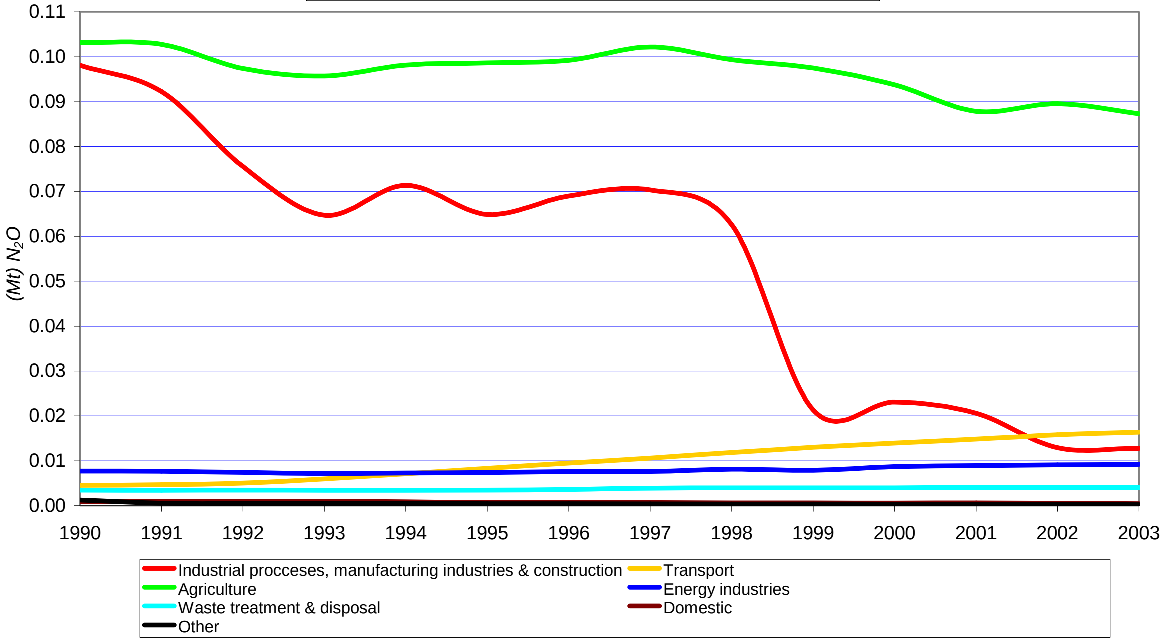
Source: Defra, 2004

6.3 UK Nitrous Oxide

Emissions from nitrous oxide contributed 6% (40.4 Mt CO_2-equivalent) to the UK greenhouse gas inventory (Defra, 2004). The emissions from nitrous oxide are uncertain as there are many small sources, both natural and human. The main human sources are agriculture, transport, industry, industrial processes and coal combustion. Emissions have declined 41% since 1990 due to falls in both agricultural and industrial emissions.

The graphic below (Figure 6.8) shows that estimates of man-made nitrous oxide (N_2O) emissions in the UK (including farming) fell by 40% between 1990 and 2003. Agriculture is now the largest single source accounting for about two-thirds of emissions, the majority from agricultural soils where the most significant sources are fertiliser application and leaching. Decreases in emissions from agriculture are as a result of a fall in the number of agricultural animals and a fall in synthetic fertiliser application. Another significant source up to 1998 was industrial processes [including on Teesside] - the production of adipic acid used in nylon manufacture and nitric acid production. Emissions from this source fell by 96% in 1999 following the installation of emission abatement technology in the nylon industry.

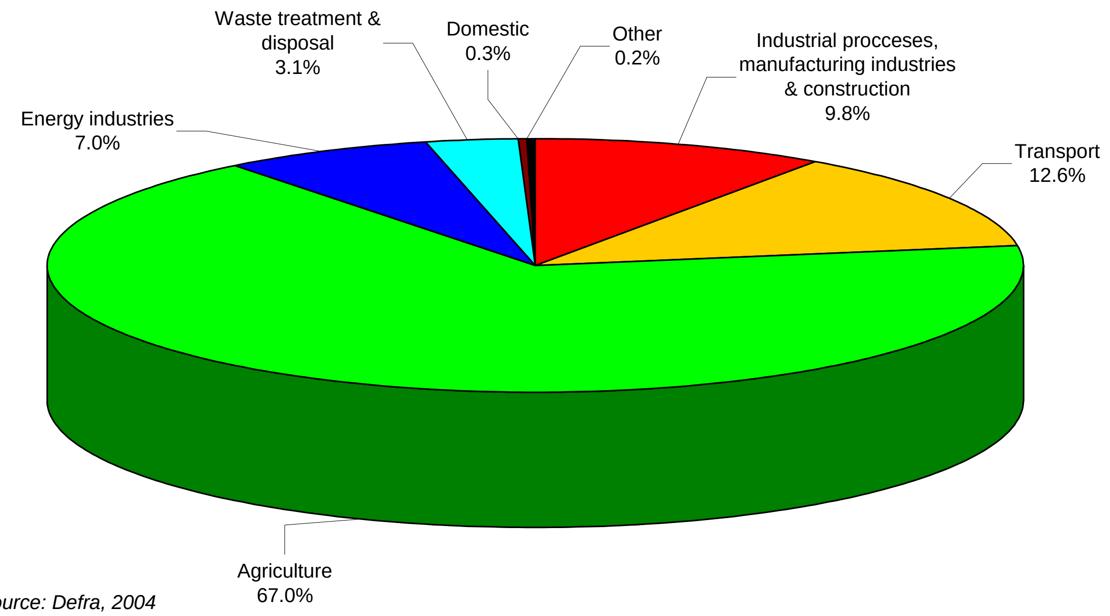
Figure 6.8: UK N_2O emissions by source, 1990-2003



Source: Defra, 2004

The analysis of the uncertainties in the N_2O emissions is particularly difficult because emissions arise from a diverse collection of sources and few data are available to form an assessment of uncertainties in each source.

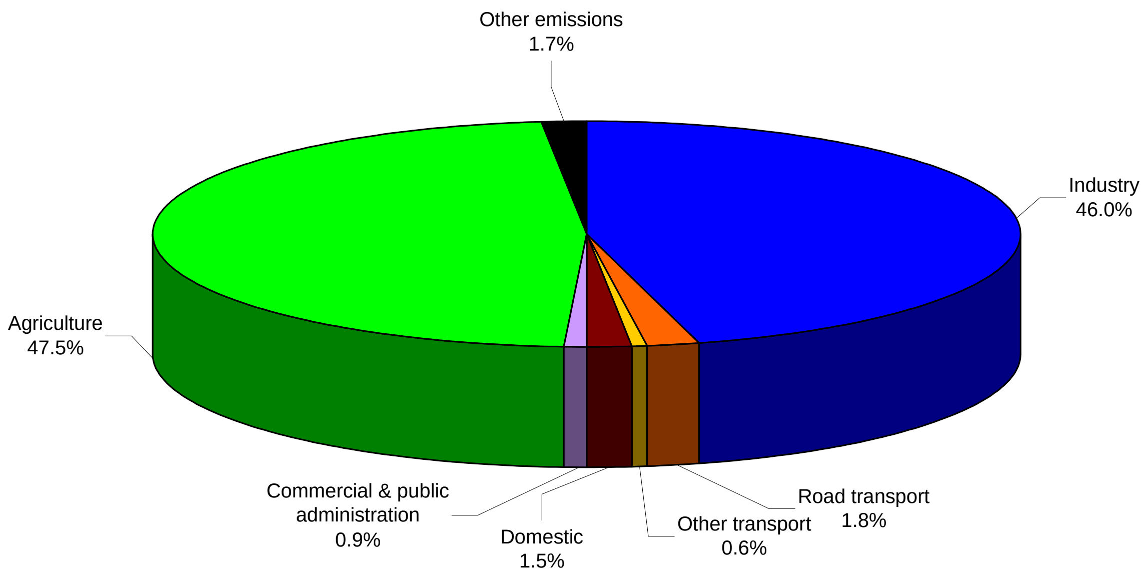
Figure 6.9: UK N_2O emissions by source, 2003



Source: Defra, 2004

Agricultural emissions of N_2O are predominant in both source and end-user sectoring of emissions (Figures 6.9 & 6.10). However, industrial processes are of similar value to agricultural in end-user sectoring.

Figure 6.10: UK N_2O emissions by end user, 2002



Source: Defra, 2004

6.4 UK Fluorinated Gases:

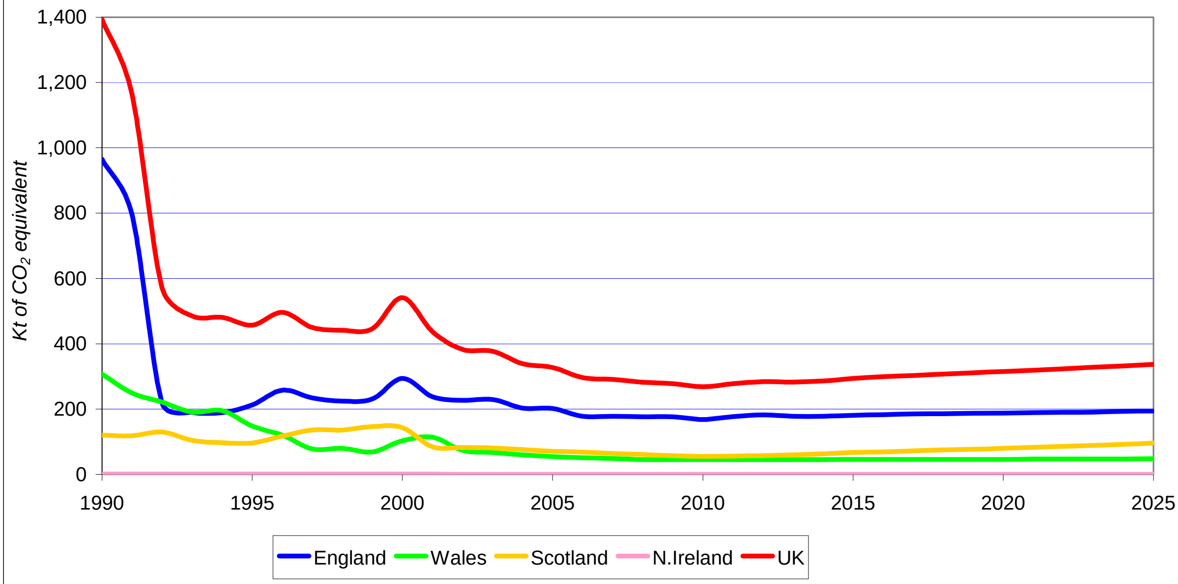
Emissions of the F-gases totalled 12.6 Mt CO_2-equivalent in 2003 (about 2% of the UK GHGs). Since 1990 the overall fall has been 9%, although individually SF_6 emissions have risen 44%. Sources of F-gases within the UK are from refrigeration and air conditioning, halocarbon and aerosol production, aluminium production and electronics.

Global emissions of HFC (Hydrofluorocarbon), PFC (Perfluorocarbon) and SF_6 (Sulphur hexafluoride) are small at present but they are significant for climate change due to their very large global warming potentials and the anticipated growth in emissions in the near future e.g. SF_6 emissions are expected to remain above 1 Mt (CO_2-equivalent). Emissions and projections are based on the information obtained from Defra.

6.4.1 UK PFC

UK PFC emissions are predicted to fall from 1.4 Mt to less than 0.3 Mt (CO_2-equivalent) by 2025 (Figure 6.11). The largest reduction has been seen in England, which is also the largest emitter of PFCs within the UK.

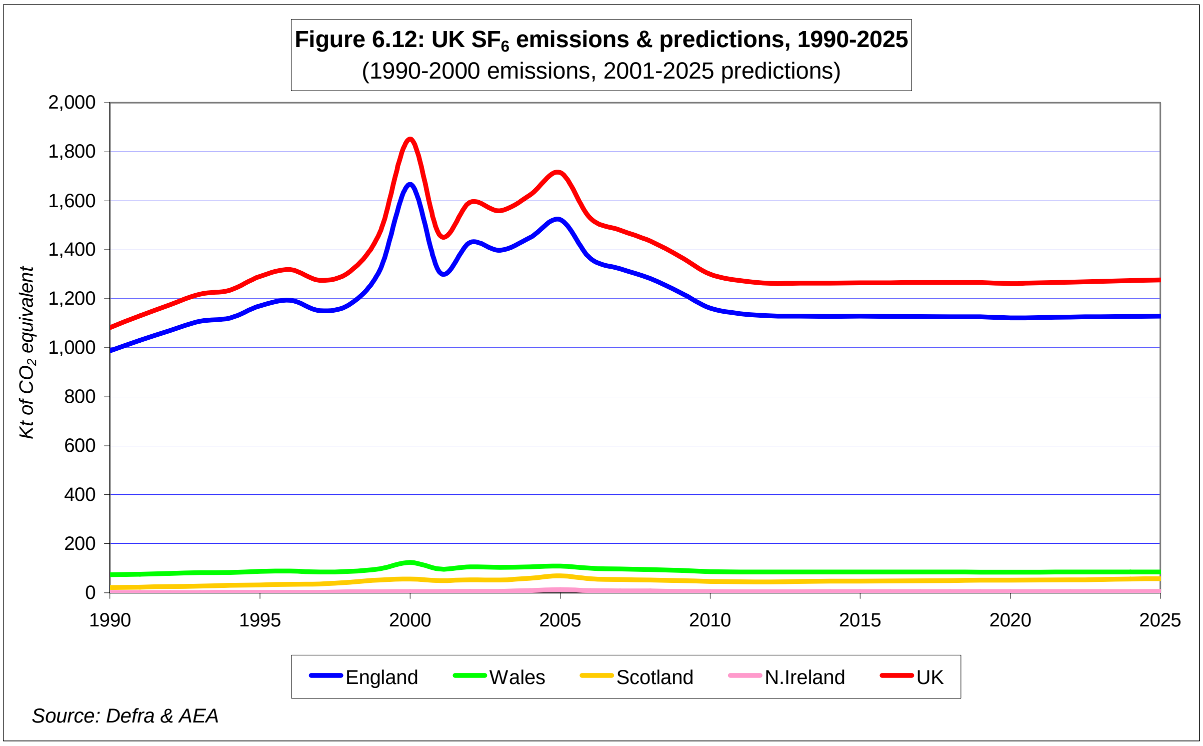
Figure 6.11: UK PFC emissions & predictions, 1990-2025
(1990-2000 Emissions, 2001-2025 Predictions)



Source: Defra & AEA Technology, 2004

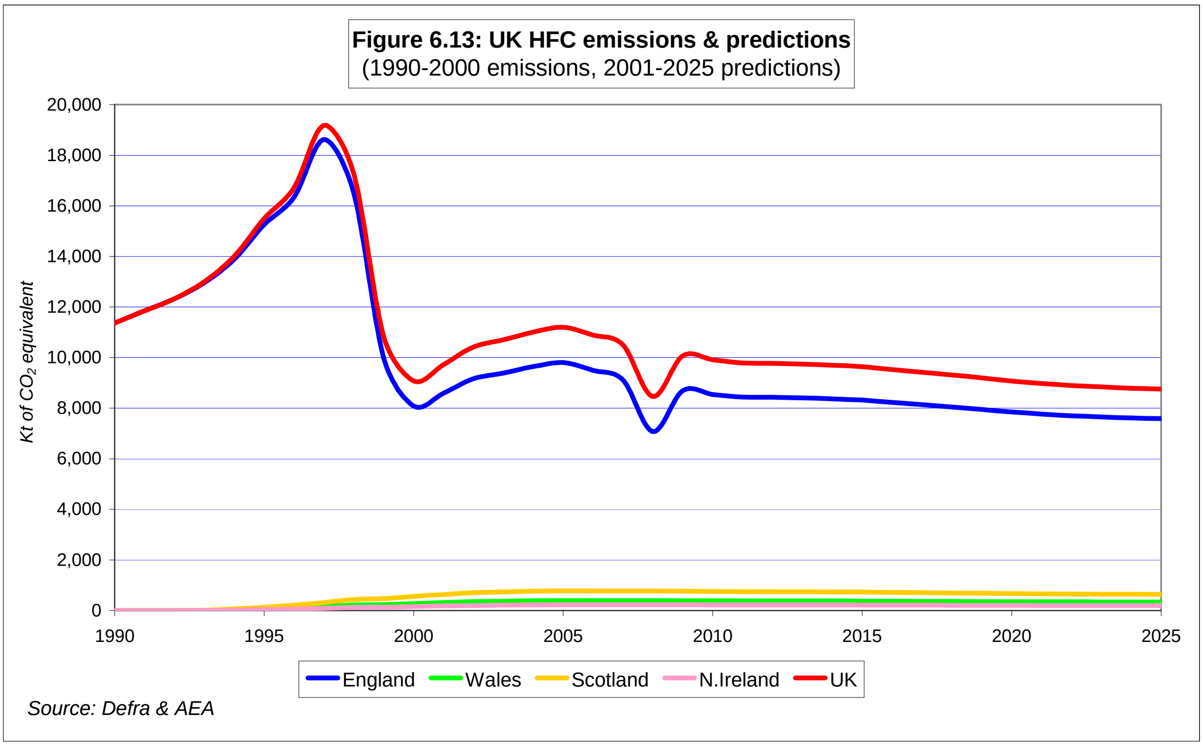
6.4.2 UK SF_6

Unlike the other fluorinated gases, it is expected that SF_6 emissions will not fall much below current levels of 1.4 Mt CO_2-equivalent, but will maintain 1990 levels (Figure 6.12). Levels of SF_6 emissions are expected to stabilise around 2010.



6.4.3 UK HFC

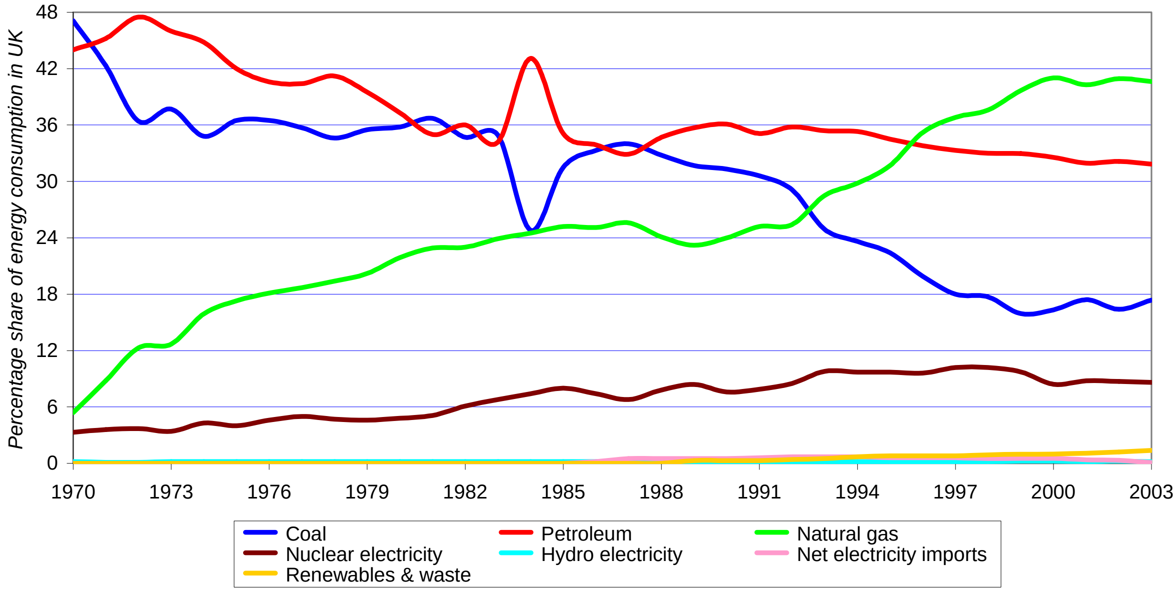
Large reductions are expected in the UK emissions of HFC, and will, like SF_6, stabilise by 2010 (Figure 6.13). Emissions are predicted to stabilise to 9 Mt (CO_2-equivalent), from a peak of 19 Mt in 1997.



6.5 UK Energy Emissions

Since the 1970s there have been large changes in the uses of particular fuels in the UK (Figure 6.14). In this period, as percentages of UK primary fuel consumption in the UK, use of natural gas has risen from 6% to over 40%; conversely coal has fallen from over 40% to about 18% and oil has fallen from over 40% to about 32%.

Figure 6.14: Inland consumption of primary fuels & equivalents for energy use,
1970-2003



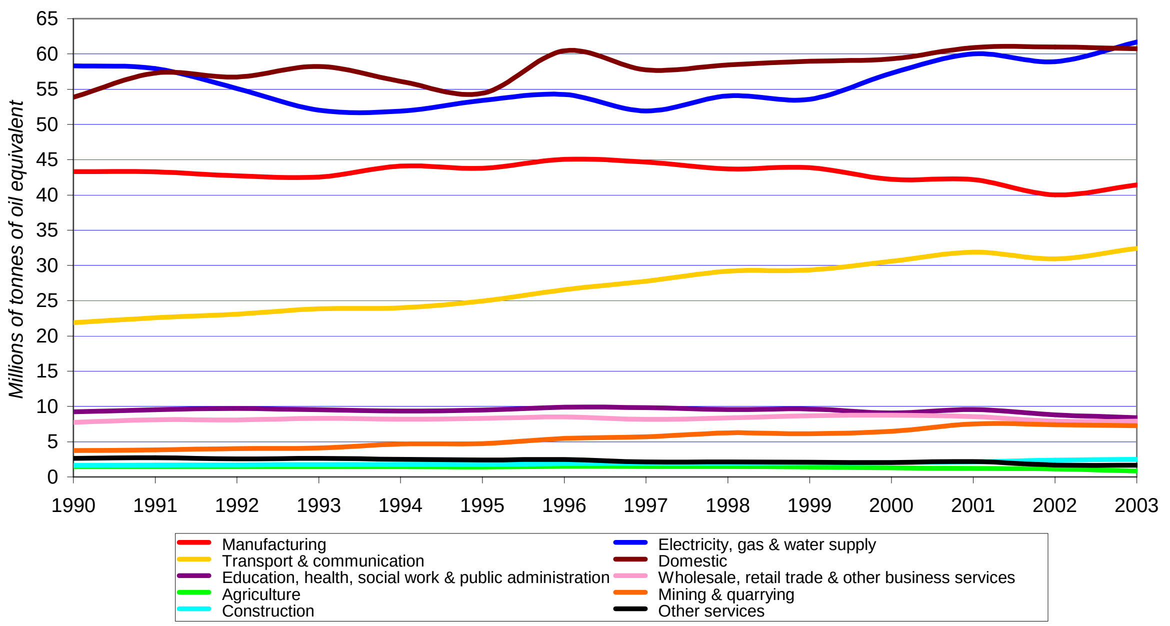
Source: DTI, 2004

The sectors with the largest energy use are 'electricity, gas & water supply', closely followed by 'domestic' usage (Figure 6.15). Both of these sectors have raised the amount of energy they use from carbon fuels since 1990. The sector with the largest rise in carbon fuel usage since 1990 is 'transport & communications'.

Slight falls in manufacturing usage of carbon fuels can be equated with the shrinking of the manufacturing sector in the UK.

There has also been a rise in energy usage for the mining & quarrying sector, with nearly a doubling in carbon fuel consumption since 1990 (from about 4 million tonnes of oil-equivalent to about 8 million tonnes).

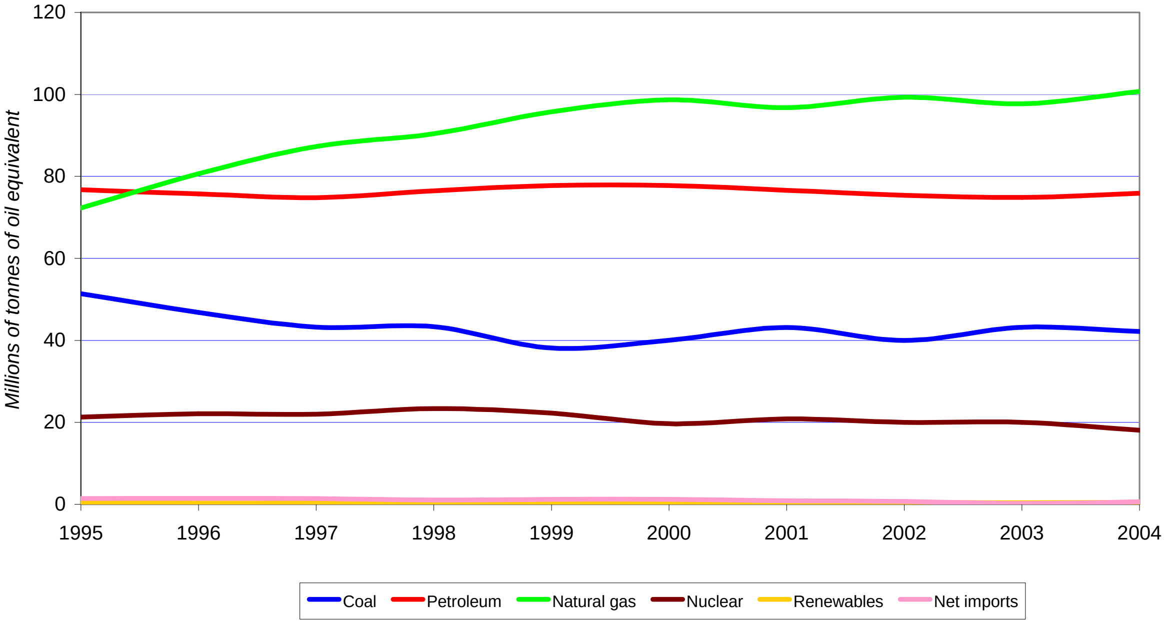
Figure 6.15: UK direct use of energy from carbon fuels, 1990-2003



Source: DTI, 2004

Since 1995, there have been changes in the type of fuel consumed, which can be seen in the increased use of natural gas compared to the fall in coal consumption (Figure 6.16[28]). There have been relatively small changes in the use of nuclear, petroleum and renewable energy in the UK between 1995 – 2004.

Figure 6.16: UK Energy Consumption, 1995-2004



Source: DUKES, 2004 [29]

[28] *DUKES is the Digest of UK Energy Statistics.*

7. TYNE & WEAR

7.1 Alternative routes to Local Estimates of GHG Emissions

GHG emissions in Tyne & Wear can be estimated by two broad routes:

a) **'Top down'**; Tyne & Wear has under 2 % of the UK's population (about 1.78 %) and about 2 % of its employment. 1.78% of UK emissions would imply a Tyne & Wear total of about 11.96 Mt. As no electricity power stations are in Tyne & Wear, the 1.2 Mt of their emissions attributable to Tyne & Wear do not actually occur in Tyne & Wear. More importantly, household incomes in Tyne & Wear are about 20 % lower than the national average (which translates into lower car ownership in particular), which will tend to mean less energy usage than the UK average[29]. Thus, on the above population and income basis, TWRI's first estimate of emissions in Tyne & Wear is about 10 Mt. On an 'attributable basis' (i.e. with the addition of about 1.2 Mt from power stations serving Tyne & Wear), Tyne & Wear's GHG emissions total could well be over 11 Mt.

b) **'Bottom up'**; this requires data on actual usage in Tyne & Wear such as for electricity, gas and the airport. Some of the data may have to be modelled, especially for road transport (as by NAEI, below). Data on many sources are required, some of which do not exist (like vehicle fuel use, commercial and industrial emissions) or for which data are insufficient for these purposes (such as emissions from major industrial sites). The NAEI modelled estimates for Tyne & Wear (Table 7.1), totalling only 4.1 Mt thus appear to be too low to be comparable with national totals.

In addition to the data above, in 2002, Newcastle City Council (NCC) commissioned a report on the amount of GHGs they contributed to Newcastle's total in 2000/2001. The summary of this report is below[30]:

ENERGY USE AND PRODUCTION

7.2 CO_2 Emissions in Tyne & Wear

Moreover, TWRI's calculations of CO_2 emissions due to burning natural gas are over 2.8 Mt and thus exceed NAEI's estimates[31] for all 'Commercial, Institutional and Residential' emissions (which should include oil and coal burnt, notably for heating) (Table 7.2).

[29] *Tyne & Wear's (TW) northerly location may mean slightly above average use of heating, but Tyne & Wear household's proportion with central heating is above the national average; thus probably making them cleaner than the (coal) alternatives.*

[30] *NCC GHG emissions are calculated at 0.16 Mt CO_2-equivalent in 2000/2001 (~1.6 % of TWRI's estimate of TW total GHGs). Of this, waste disposal accounted for 57 %, natural gas consumption 27 %, electricity consumption 13 %, with the remaining 3 % from council vehicles and gas oil consumption. The assessment excluded consumption from street lighting, business travel by public transport and employee vehicles, and refrigeration equipment. Waste disposal emissions were due to the inclusion of all council-owned landfill sites for the years 1999/2000.*

[31] *Table 7.1, from NAEI, illustrates the amount and sources of CO_2 emissions thought to be made within the county boundary. The table shows 'Commercial, Institutional and Domestic' emissions of 2.1 Mt (over half their total) and road transport emissions of nearly 1.5 Mt (over a third of their total). The National Air Emissions Inventory (NAEI) total of 4.1 Mt is, oddly, under half of what TWRI expected from simply apportioning UK CO_2 emissions.*

Table 7.1: CO_2 Emissions in Tyne & Wear Districts, 2002* (Kt CO_2)

UNECE Sectors	Gateshead	Newcastle	North Tyneside	South Tyneside	Sunderland	Tyne & Wear
Energy Production & Transformation	0.0	15.1	6.0	0.1	0.2	**21.4**
Commercial, Institutional & Residential	390.3	553.0	362.7	276.7	526.4	**2,109.1**
Industrial Combustion	103.5	60.8	53.7	32.9	97.9	**348.8**
Road Transport	295.6	361.1	245.7	173.5	397.6	**1,473.4**
Other Transport	11.1	67.4	11.4	22.3	8.8	**121.1**
Waste Treatment & Disposal	0.9	1.5	0.5	0.5	1.2	**4.7**
Agriculture	0.6	0.4	0.3	0.2	0.6	**2.2**
Nature	29.1	40.4	29.9	23.8	44.0	**167.2**
Other	0.0	0.0	0.0	0.0	27.5	**27.5**
Total	**801.5**	**1,059.1**	**680.3**	**506.0**	**1,059.6**	**4,106.5**

CO_2 figures have been collated from 1km^2 mapped NAEI data for 2002 [32]

Table 7.2: CO_2 emissions from the consumption of natural gas in Tyne & Wear, 2004 (Mt)*

	Domestic	Industrial & Commercial	Total
Gateshead	0.33	0.19	0.52
Newcastle	0.35	0.24	0.60
North Tyneside	0.41	0.20	0.61
South Tyneside	0.22	0.07	0.28
Sunderland	0.55	0.26	0.81
Tyne & Wear	1.86	0.96	2.82

**Gas consumption data converted by TWRI to CO_2 using 0.19 conversion factor from NAEI for natural gas in KWh.*

Source: TRANSCO, 2004.

The difference (by a factor of over 2) between the (low) NAEI total and the TWRI estimate, supported by the TRANSCO figures, cannot be explained by the difference of one year between results. NAEI's method appears to be not capturing major emissions within Tyne & Wear.

The experimental estimates (Tables 7.3 & 7.4) also appear very low, by a factor of about 4 for the natural gas and about 10 for the electricity consumed in Tyne & Wear.

Table 7.3: CO_2 emitted from the consumption of natural gas in Tyne & Wear, 2003 (experimental figures)

District	Domestic $MtCO_2$	Commercial & Industrial $MtCO_2$	Total
Gateshead	0.004	0.134	0.138
Newcastle upon Tyne	0.004	0.123	0.127
North Tyneside	0.004	0.150	0.154
South Tyneside	0.004	0.106	0.110
Sunderland	0.004	0.147	0.151
Tyne & Wear	0.020	0.660	0.680

Source: DTI, 2004

Table 7.4: CO_2 emissions from the consumption of electricity in Tyne & Wear, 2003 (experimental figures)

District	Domestic $MtCO_2$	Commercial & Industrial $MtCO_2$	Total
Gateshead	0.002	0.037	0.039
Newcastle upon Tyne	0.002	0.027	0.029
North Tyneside	0.002	0.030	0.031
South Tyneside	0.002	0.025	0.026
Sunderland	0.002	0.045	0.046
Tyne & Wear	0.008	0.163	0.172

Source: DTI, 2004

Only one industrial plant has been identified in Tyne & Wear emitting over 10,000 tonnes of CO_2; SRM in Sunderland, emitted over 60,000 tonnes (according to Environment Agency data). SRM is Solvent Resource Management.

7.3 Aviation CO_2 Emissions attributable to Tyne & Wear

TWRI's first estimate of emissions due to Newcastle International Airport is about 0.25 Mt CO_2, or about 2.5% of the [10 Mt] Tyne & Wear total.

Newcastle International Airport handled 4.7m passengers in 2004, about 2.2% of all passengers in the UK (216.6m)[32]. The Airport stated that its fuel depot handles more than 100m litres of fuel a year[33]. If we take 100m litres, this equates to 0.25 Mt CO_2 for Tyne & Wear[34]. This TWRI figure is about 4 times larger than that given in the NAEI table for 'other transport'[35] in Newcastle (about 0.07 Mt CO_2[36]).

Alternatively, the UK uses about 12 Mt of aviation fuel (in 2004). Newcastle International Airport handled 80,257 tonnes of aviation fuel[37], which is ~0.7% of the UK total. Newcastle International Airport's lower fuel consumption can be explained by its domestic and European flight focus, compared to worldwide flights from such airports as Heathrow, Gatwick, and Stansted.

The aviation industry has pledged to improve fuel efficiency by 50% by 2020 compared to levels in 2000. CO_2 emissions form new aircraft will be reduced by 50% and NO[38] by 80% over the period[39]. The programme was developed by Sustainable Aviation, a group which includes British Airways, Virgin Atlantic, Airbus UK, BAE Systems and the operators of the UK's 24 largest airports. The group is to press for the inclusion of aviation in the EU Emissions Trading Scheme (ETS) by 2008.

Note: Some sources claim that emissions from aircraft have a much more powerful greenhouse effect than ground-based emissions[40].

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[32] *Source: Civil Aviation Authority, UK Airport Statistics 2004.*

[33] *The Journal, March 13th 2005.*

[34] *A factor of 2.52 is used to calculate $kgCO_2$ for each litre of kerosene aviation fuel.*

[35] *The 'other transport' figure for Tyne & Wear should include emissions due to ferries (including international ferries to North Tyneside), and perhaps other shipping should be identified.*

Emissions due to electricity use by trains and the Metro will not be attributed to Tyne & Wear by the NAEI method.

[36] *Taken from NAEI mapped 1km x 1km data for 2002.*

[37] *1,246 litres of kerosene aviation fuel equates to 1 tonne.*

[38] *NOx (nitrogen oxides) do, however, affect global climate in their role as catalysts in the formation of tropospheric ozone (another GHG) and through interaction in CH_4 oxidation.*

[39] *www.foe.co.uk/resource/reports/aviation_tyndall_research.pdf*

[40] *IPCC Special Report: Aviation and the Global Atmosphere, 1999.*

7.4 Agricultural Emissions in Tyne & Wear

As Tyne & Wear is a largely urbanised county, there is only a small area of agricultural land which TWRI estimates very roughly at about 100km^2 (from about a fifth of the county area). The agricultural emissions *attributable* to Tyne & Wear's food consumption will be many times higher[41] (probably at least 25 times as high).

Around two-thirds of land in the North East is agricultural (about 5,800km^2), over 60% of which is grassland. Only about 30% of NE farmland is arable.

7.5 Methane CH_4

TWRI estimates agricultural methane (CH_4) emissions at of the order of 6,000 tonnes (in CO_2-equivalent) (below), or under 0.1 Mt of CO_2 (using GWP = 21). Thus agricultural methane accounts for only about 0.05% of Tyne & Wear's *direct* GHG emissions (the 10 Mt actually made in Tyne & Wear) but, on an *attributable* basis (x25), of the order of 1.5% (Table 7.5).

Table 7.5: Estimated CH_4 and N_2O emissions from Agriculture in Tyne & Wear, 1990 & 1998 - TWRI apportionment of UK (Defra) estimates (kt CO_2 equivalent)

	Total area in km^2	Area of agricultural land (km^2)*		Total CH_4	Apportioned agricultural CH_4**	Total CH_4	Apportioned agricultural CH_4**	Total N_2O	Apportioned agricultural N_2O**	Total N_2O	Apportioned agricultural N_2O**
		1990	1998	1990	1990	1998	1998	1990	1990	1998	1998
UK	242,514	107,847	107,684	21,131	5,832	15,714	5,673	18,516	8,721	15,847	8,399
T&W	538	108	108	21	6	16	**6**	18	9	16	**8**

** calculations used assume 1/5 of land in Tyne & Wear is agricultural.*

*** an exact proportion of agricultural emissions compared to other emission sectors (UK-based) is used for Tyne & Wear estimates. (Caution: using these two assumptions will give an estimate with larger errors.)*

Sources: ONS and TWRI calculations

Landfill sites in Tyne & Wear are probably also emitting methane. Indeed, estimates for Newcastle City Council put waste disposal as the authority's main source of emissions. Recycling in Tyne & Wear is relatively low, with only around 17 kg being recycled in 1998/99 in Tyne & Wear, compared to an England average of 45 kg per person[42].

7.6 Nitrous oxide N_2O from Agricultural land

Table 7.5 shows that the emissions of nitrous oxide (in CO_2-equivalent) are about 1.5 times those due to agricultural methane. Thus on an *attributable* basis, agricultural nitrous oxide could account for about 2.25 % of Tyne & Wear's emissions. These may be thought of as emissions from farmland in Northumberland used to feed the people of Tyne & Wear.

7.7 Fluorinated Gases

No data that Tyne & Wear produced any fluorinated gases. However, Tyne & Wear people and businesses use these products notably for refrigeration, air–conditioning and fire-fighting.

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41 About 2,500km^2 might be Tyne & Wear's share of UK agricultural land. Thus a factor of about 25 may need to be applied to the agricultural emissions in Tyne & Wear to arrive at an attributable figure (with more for imported food).

42 More details in the State of the Region Report, available from the North East Assembly (NEA).

If Tyne & Wear is responsible for 2 % of UK PFCs this would be the equivalent of about 6,000 tonnes of CO_2 (or 0.06 % of Tyne & Wear GHGs).

HFC emissions appear, however, to be much higher [if UK 9 Mt CO_2-equivalent is correct], with a 2% share being about 180,000 tonnes of CO_2-equivalent (or 1.8 % of total Tyne & Wear GHGs).

Appendix A: Unusual Weather Events

Caution: None of the below events can be individually attributed to climate change.
They provide an overview of the kind of whether events which *may* be becoming more common.

Autumn 2000; in North Yorkshire, the River Ouse floods so high that it forms a massive lake dubbed 'Lake Selby'. Floods in Ponteland, Northumberland.

January 2002; very high winds (gusting over 70mph) cause accidents on the A1 in Tyne & Wear, 2 die as vehicles over-turn.

Summer 2002; very extensive floods in central Europe (including Poland, Austria and Germany).

Summer 2003; very high temperatures in Western Europe. This event is outside the 95% confidence limit of historic variation.
Over 10,000 people die in France alone, attributed to the heat.
Reservoirs very low, including in Cumbria.

August 2004; flash-flood in Boscastle, Cornwall. Helicopter rescue prevents any deaths.

January 2005; very extensive flood in Carlisle, Cumbria. Two elderly people die.
Extensive damage at Corbridge, Northumberland, as river-retaining bank is breached.
Emergency water supplies installed to Hexham.

June 2005; flash-flood in North Yorkshire, at Helmsley and the base of Sutton Bank.
Flash flood in Newcastle (Walkergate); elderly couple rescued from a car engulfed by water.
Flash-flood in Newcastle (Fawdon area); flash-flood due to sudden heavy shower, 45 households had to be temporarily re-housed.

July 2005; tornado in Birmingham, which included the areas of King's Heath, Moseley, Quinton, Balsall Heath, and Sparkbrook (~200 homes rendered unsafe); and Peterborough, which included the areas of Gunthorpe and Newborough.

August 2005; (rare) category 5 hurricane (Katrina) hits US Gulf Coast. Wind speeds of 160mph for category 5. Storm surge of approximately 20 feet. New Orleans substantially evacuated. Very serious flooding in the city. About 800 people killed. Damage estimated at $200bn.

Appendix B: UK Schemes to reduce GHG emissions

- Regeneration of brownfield land to enable more people to live nearer where they work (i.e. reduce commuting).
- More efficient use of land through design, and (reasonably) higher residential densities.
- Design and layout of development and landscaping, to minimize wind chill, maximize solar benefits, and improve energy efficiency.
- Possible requirement for renewable energy equipment to be incorporated in larger housing and commercial developments.
- Conservation of buildings and embedded energy.
- A better distribution of convenience shopping to reduce trips.
- City centre parking policy which encourages short stay shoppers and discourages long stay commuting.
- Investment in facilities for public transport, cycling and a better environment for walkers.
- Environmental schemes to increase carbon sinks (e.g. Newcastle's Carbon Neutral tree planting project).

Appendix C: New Six-nation pact to develop clean energy technologies & combat global warming

On 28th July 2005, a US-led, six-nation pact to develop clean energy technologies and combat global warming was launched. The six members are: China, Australia, Japan, India, US, and South Korea. The pact was negotiated through APEC (the Asia-Pacific Economic Council). Japan is the only signatory which has also signed the Kyoto Treaty.

The aim of the group is to provide practical solutions to excess carbon emissions, such as technology to make coal combustion more efficient and to develop sustainable sources of energy, such as wind, solar and geothermal.

There are no targets and timetables for the delivery of any pledges, and no carbon dioxide reduction. This six-nation pact represents 45% of the world's population and nearly half of its energy consumption and greenhouse gas emissions. The US alone accounts for 25% of the world's emissions of greenhouse gases.

Useful Websites

Civil Aviation Authority: www.caa.co.uk

Department for Environment, Food and Rural Affairs: www.defra.gov.uk

Environment Agency: www.environment-agency.co.uk

Intergovernmental Panel on Climate Change: www.ipcc.ch

Meteorological Office's Hadley Centre for Climate Prediction and Research: www.met-office.gov.uk/research/hadleycentre

National Atmospheric Emissions Inventory: www.naei.org.uk

Carbon Neutral Newcastle: www.newcastle.gov.uk/cn/home.htm

National Academies' response to the G8 summit on climate change: www.nationalacademies.org/onpi/06072005.pdf

Resurgence: www.resurgence.org

Tyndall Centre for Climate Research: www.tyndall.ac.uk

Tyne & Wear Research and Information: www.tyne-wear-research.gov.uk

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