FEATURE

# UK environmental accounts: air emissions and energy use

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SUMMARY

The Office for National Statistics' air emissions data show that between 1990 and 2005, total UK greenhouse gas emissions on a UK residents basis fell 9.3 per cent from 808.3 million tonnes of carbon dioxide equivalent to 733.4 million tonnes. However, much of this reduction took place in the period between 1990 and 1999. Since 1999, emissions have remained broadly stable although there has been 20.5 per cent growth in economic activity. In contrast, the rate that energy consumption has increased over the whole period is relatively stable: between 1990 and 1999 it was up 5.1 per cent and between 1999 and 2005 up 5.5 per cent.

This article is divided into three parts: the first sets out various definitions used in the compilation of the air emissions and energy use accounts; the second part moves on to an analysis of the latest data set (consistent with data published in July 2007); and in the third part, some conclusions are offered regarding the trends that have emerged.

Climate change and sustainable development attract global interest. There is a growing consensus that the rise in concentrations of greenhouse gases in the atmosphere has led to changes in the global climate system. Therefore, the level and source of these emissions are of interest to policy makers and analysts. Emissions of other pollutants, such as those that lead to acid rain, may affect air quality, health or other general environment factors, are also of interest to policy makers.

The Office for National Statistics' (ONS) air emissions accounts provide a breakdown of emissions of atmospheric pollutants and greenhouse gases by 93 industries, starting from 1990. These estimates are largely determined indirectly by using scientifically agreed factors to extrapolate from known fuel use information. The factors are derived from measurements made regarding the particular content of an emissions source, for instance the carbon content of fossil fuels. ONS energy accounts provide information regarding the volume and mix of fuels that are used in the economy. The result is a set of tables that provide information on which industries are producing which pollutants. It is then possible to compare these data with economic data to establish links between production and emissions.

Air emissions and energy use accounts form part of a suite of accounts known as Environmental Accounts. The Environmental Accounts are a tool to analyse the links between the environment and the economy at European Union, national, regional and industry level. They help to assess the extent our current production and consumption patterns are degrading natural resources and the effects of economic policy measures. As a complement to environmental statistics, Environmental Accounts allow an analysis in more depth of environmental concerns as the different modules are broken down by industry (in the form of a National Accounting Matrix including Environmental Accounts (NAMEA) at country level. The NAMEA is a framework in which different types of statistical data are consistently organised, bringing together economic and environmental information that come from different parts of the statistical system.

This article is divided into three parts: the first part sets out various definitions used in the compilation of the air emissions and energy use accounts; the second part moves on to an analysis of the latest data set (consistent with data published in July 2007); and in the third part, some conclusions are offered regarding trends that have emerged in the data.

## What are air emissions?

When fuel is converted into energy, different gases and materials are produced which disperse into the atmosphere: these are known as air emissions. Such emissions include greenhouse gases and substances that are directly toxic, such as heavy metals. These pollutants can be grouped according to their contribution to environmental themes such as climate change and acid rain. Each year the Environmental Accounts present estimates of pollutants directly emitted into the atmosphere by industry under four different themes: greenhouse gas

emissions, emissions leading to acid rain, heavy metals and other pollutants.

## Methods

### Units of measurement

To aggregate the greenhouse gases covered in the accounts, a weighting based on the relative global warming potential of each gas is applied, using the effect of carbon dioxide over a 100-year period as reference. A similar process is used to aggregate emissions that lead to acid rain, according to their acidification potential. Energy use is measured in tonnes of oil equivalent (toe), which enables different fuels to be compared and aggregated. A tonne of oil equivalent should be regarded as a measure of energy content rather than a physical quantity.

### Atmospheric emissions and energy use data sources

The industry breakdown of atmospheric emissions is supplied to ONS by AEA Energy & Environment (formerly Netcen) and is primarily based on information compiled for their National Atmospheric Emissions Inventory (NAEI) and their Greenhouse Gas Inventory. AEA Energy & Environment compiles the NAEI and the Greenhouse Gas Inventory, on behalf of the Department for Environment, Food and Rural Affairs (Defra) and the devolved administrations.

Atmospheric emissions are estimated by multiplying detailed information on fuel consumption by emissions factors and then adding releases unrelated to fuel use, such as methane arising from landfill. Therefore, there is a clear link between the energy used in the economy and the emissions produced by that economy. The NAEI data are used to identify the main processes and industries responsible for the atmospheric emissions. These are then allocated to individual industries using information from a variety of sources. For example, emissions from diesel combustion by heavy goods vehicles are allocated to industries using vehicle mileage information from the Department for Transport. The allocation process also uses expenditure data, for example, emissions arising from the use of various industrial coatings are allocated to relevant industries in proportion to each sector's expenditure on paints, varnishes and similar coatings, printing ink and mastics, based on ONS National Accounts Input-Output Supply and Use Tables.

Data for estimating fuel consumption by industrial sectors are collected by the Department for Business, Enterprise & Regulatory Reform and underlie the figures given in the *Digest of UK Energy Statistics*.

## Concepts

### National accounts consistent emissions

There are a number of formats for the reporting and recording of atmospheric emissions data. These include those used by Defra for reporting greenhouse gases under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, and for reporting air pollutant emissions to the United Nations Economic Commission for Europe (UNECE). Differences between the National Accounts measure, published by ONS, and those used for reporting under the UNFCCC and the Kyoto Protocol, following the guidance of the Intergovernmental Panel on Climate Change (IPCC), are described below.

The ONS Environmental Accounts measure greenhouse gas emissions on a UK residents basis – they include all emissions generated by UK households' and companies' transport and travel at home and abroad. They exclude emissions generated by non-residents' travel and transport in the UK. National Accounts define the economy in terms of institutional units that have a centre of economic interest in the UK. National Accounts adjustments are made for the following vehicles: aircraft, ships, cars, lorries and coaches. The methodology for deriving these adjustments is explained in more detail in *Adjustments to the UK's atmospheric emissions and energy accounts to bring them on to a National Accounts "residents" basis*[1] (ONS 2002) and the *Greenhouse gas emissions from transport Report*[2] (ONS 2004).

By applying the principle of residency, it is possible to focus attention on those responsible for emissions rather than the physical source of the emissions. Furthermore, this approach allows for comparisons of emissions and material flows against mainstream National Accounts measures such as gross domestic product (GDP) and gross value added. Eurostat also requires National Accounts consistent atmospheric emissions for inclusion in their NAMEA tables. The National Accounts measure also includes emissions of $CO_2$ from biomass.

Greenhouse gas emissions reported following IPCC guidance for UNFCCC and Kyoto Protocol purposes are reported on a territory basis. They therefore include emissions from within an individual country but exclude emissions from international transport. 'Net' greenhouse gas emissions reported under the UNFCCC include the total of all emissions and then net off removals from changes in land use and forestry.[3] Reporting of air pollutant emissions to the UNECE is also on a 'territorial' basis.

The measurement of greenhouse gas emissions used to monitor progress against the UK's Kyoto Protocol target of a 12.5 per cent reduction by the period 2008–2012 differs slightly from the UNFCCC net greenhouse gases total because it uses a

Table 1
**Reconciliation of UK greenhouse gas emissions between UK residents and territory basis**

Million tonnes of $CO_2$ equivalent

| | 1990 | 1995 | 2000 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| **UK residents basis** | **808.3** | **753.7** | **732.5** | **721.1** | **730.1** | **734.8** | **733.4** |
| *less* | | | | | | | |
| Bunker emissions[1] | 22.6 | 27.1 | 36.3 | 34.6 | 35.1 | 39.4 | 41.3 |
| $CO_2$ from biomass[2] | 3.0 | 5.2 | 6.6 | 7.5 | 8.4 | 9.4 | 9.2 |
| Cross-boundary adjustment[3] | 13.0 | 12.9 | 17.4 | 23.8 | 25.7 | 27.5 | 27.3 |
| *plus* | | | | | | | |
| Crown dependencies | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 |
| Land use change and forestry[4] | 2.9 | 1.0 | –0.4 | –1.1 | –1.2 | –1.9 | –2.0 |
| Intergovernmental Panel on Climate Change (including net $CO_2$ emissions/removals) | 773.0 | 709.7 | 672.0 | 654.3 | 660.0 | 657.0 | 653.8 |
| Adjustment for 'Kyoto' total | –2.7 | –1.0 | –0.5 | –0.1 | –0.2 | 0.4 | 0.3 |
| **Kyoto basket total reported** | **770.3** | **708.7** | **671.6** | **654.2** | **659.8** | **657.3** | **654.1** |
| **Kyoto base year** | **775.2** | | | | | | |

**Notes:**

1 IPCC memo item, emissions from international aviation and shipping bunkers.
2 Emissions arising from from wood, straw, biogases and poultry litter combustion for energy production.
3 Emissions by UK residents abroad less emissions made by foreign residents in the UK.
4 Emissions from deforestation, soils and changes in forest and other woody biomass.

*Source: Office for National Statistics; Department for Environment, Food and Rural Affairs*

narrower definition of land use change and forestry, and in addition includes emissions from a number of Overseas Territories. This measure is used in the UK's climate change sustainable development indicator published by Defra.

Therefore, Environmental Accounts emissions data differ from estimates published by Defra under the UK's Kyoto Protocol obligations, although it is possible to reconcile the two data sets. **Table 1** reconciles data on both bases, consistent with latest published data.

### Greenhouse gas emissions by industry and by activity

Greenhouse gas emissions shown in the Environmental Accounts cover all the emissions associated with a particular industry and not solely the emissions from the primary economic activity of that industry. For example, greenhouse gas emissions from the road freight industry not only comprise emissions from the primary source, heavy goods vehicles used for road haulage, but also include emissions from light goods vehicles, cars and other equipment used by that particular industry. Identifying emissions on an industry basis produces different levels of emissions and different rates of change when compared with greenhouse gas estimates compiled on an activity basis. For instance, freight activity is undertaken by a number of industries, such as retail and wholesale trade, in addition to the road freight industry. The different sectors of the economy are broken down by 93 industries, each with a specific Environmental Accounts (EA) code (see Appendix **Table A1**).

## Trends in greenhouse gas emissions, 1990–2005

The greenhouse gases included in the atmospheric emissions accounts are those covered by the Kyoto Protocol:

- carbon dioxide ($CO_2$) comes mainly from the combustion of fossil fuels
- methane ($CH_4$) is produced when organic matter is broken down in the absence of oxygen and comes from sources such as animals and organic waste
- nitrous Oxide ($N_2O$) is released in some industrial processes and from agricultural fertilisers, and
- hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$) are artificial fluids that were widely used as refrigerants, in aerosols and in solvents.

Between 1990 and 2005, total UK greenhouse gas emissions on a UK residents basis fell 9.3 per cent from 808.3 million tonnes of carbon dioxide equivalent to 733.4 million tonnes (**Figure 1**). However, much of this reduction took place in the period between 1990 and 1999. Since 1999, emissions have remained broadly stable, although there has been 20.5 per cent growth in economic activity. Levels of emissions are related to the type and quantity of fuels used in the economy. Year-on-year changes in the levels of emissions are subject to a broad range of short-term factors, including fuel prices and the weather, and should be interpreted with caution.

Between 2004 and 2005, greenhouse gas emissions from the non-household sector increased by 0.6 per cent. This recent rise is due to a 3.0 per cent increase in emissions from the transport and communications sector and a 1.5 per cent increase in emissions from the electricity, gas and water supply industries.

However, these increases have been offset by decreases in emissions from other sectors, in particular the household sector, which in 2005 accounted for 21.3 per cent of all emissions and saw a year-on-year fall of 2.9 per cent. This fall was largely driven by a reduction in emissions related to household heating and cooking fuels. Since 1999, there has been a period of relative stability in greenhouse gas emissions, up slightly by 0.8 per cent compared with a 10.0 per cent fall between 1990 and 1999. Emissions of greenhouse gases have remained stable in recent years despite rising economic growth and energy use. **Figure 2** illustrates these trends.

A list of links to published data sets of breakdowns of emissions by sector is shown under Note 4.

### Electricity, gas and water supply

Greenhouse gas emissions from the electricity, gas and water supply companies (EA 51–57) fell 13.2 per cent from 216.9 million tonnes in 1990 to 188.2 million tonnes in 2005 as electricity generators increased their use of natural gas as opposed to coal (**Figure 3**). Greenhouse gas emissions from electricity generation (EA codes 51–55) constituted 24.5 per cent of all greenhouse gas emissions in 2005, lower than the 25.6 per cent share in 1990, but higher than the lowest recorded figure of 20.2 per cent in 1997. The level of emissions depends to a large extent on the variety of fuel being used to generate electricity. Recent rises in emissions reflect increasing use of coal for electricity generation.

Figure 1
**Greenhouse gas emissions, energy use and economic growth**

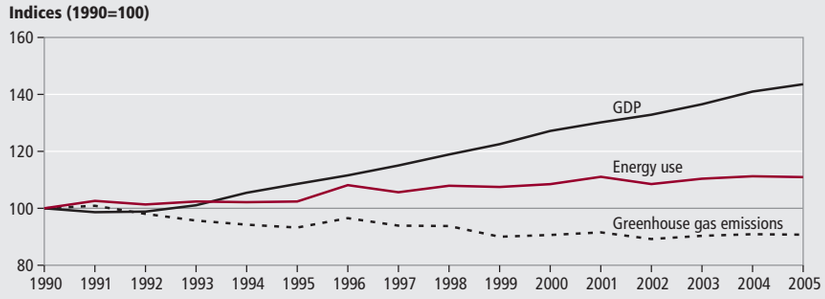



Figure 2
**Greenhouse gas emissions: by sector**

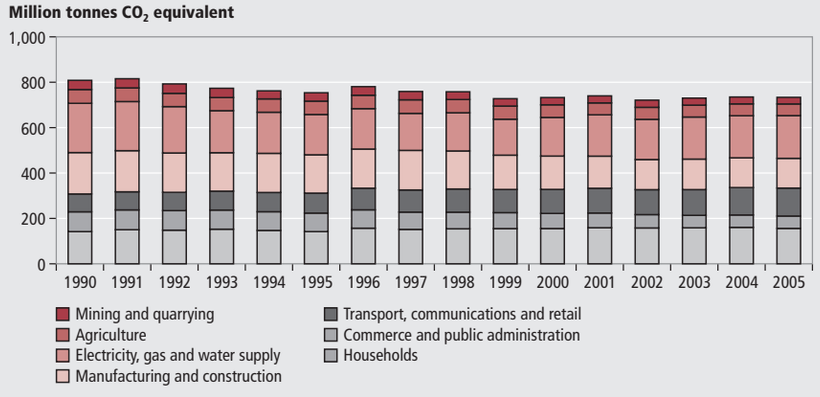


Figure 3
**Greenhouse gas emissions: by electricity generation source**

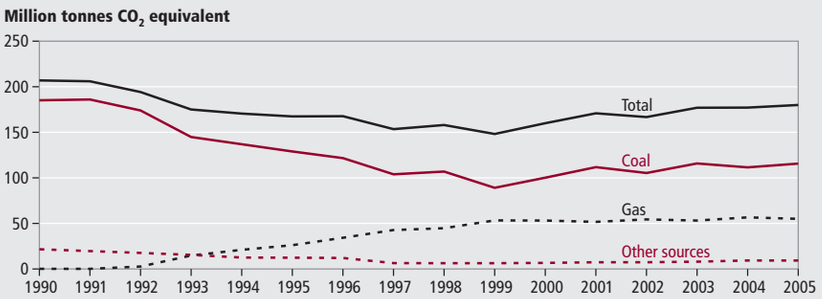



Figure 4
**Greenhouse gas emissions – other sectors**

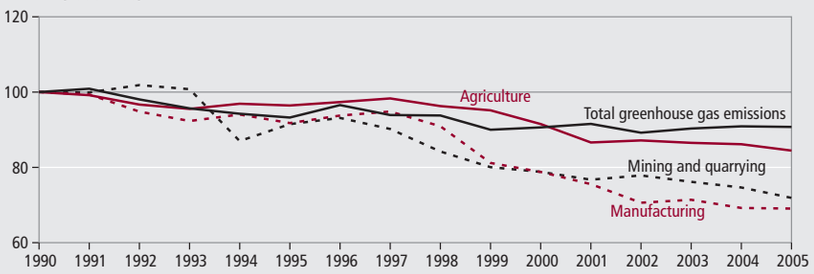



Figure 5
**Greenhouse gas emissions – UK households sector**

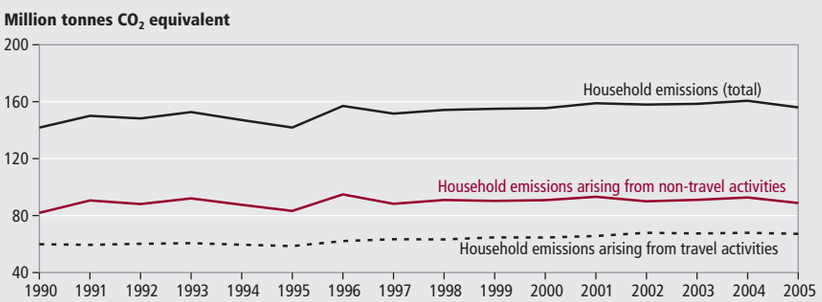
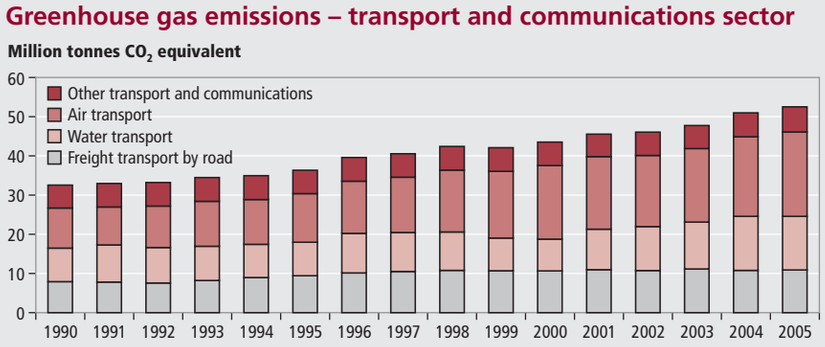



Figure 6
**Greenhouse gas emissions – transport and communications sector**




## Other sectors

Greenhouse gas emissions from the manufacturing industries (EA 8–49) fell from 173.4 million tonnes in 1990 to 119.8 million tonnes in 2005, a fall of 30.9 per cent (**Figure 4**). Emissions from agriculture (EA 1–3), mining and quarrying (EA 4–7) and construction (EA 58) show falls over the same period, reflecting a shift from coal and oil use to more energy-efficient fuels such as natural gas.

## UK households sector

UK households (EA 92–93) were responsible for the direct emission of 156.0 million tonnes of greenhouse gases in 2005, down 2.9 per cent on a year earlier (**Figure 5**). However, emissions from this sector are currently 10.0 per cent higher than in 1990. Greenhouse gas emissions from households' travel, largely emissions from private vehicles (EA 93), were 67.1 million tonnes in 2005 compared with 67.9 million tonnes in 2004, while emissions from other sources such as heating and cooking (EA 92) amounted to 88.8 million tonnes, 4.2 per cent lower than in the previous year. In 2005, greenhouse gas emissions from households constituted 21.3 per cent of all greenhouse gas emissions compared with 17.5 per cent in 1990.

## Transport sector

Year on year, greenhouse gas emissions from transport and communications (EA 63–72) increased 4.4 per cent between 2004 and 2005 (**Figure 6**). Greenhouse gas emissions from the transport and communications sector were 61.3 per cent higher in 2005 than in 1990. The transport and communications sector was responsible for emitting the equivalent of 104.5 million tonnes of greenhouse gases in 2005 compared with 64.8 million tonnes in 1990.

Emissions from the air transport industry rose 6.1 per cent between 2004 and 2005, following growth of the industry. Over the same period, the number of flight kilometres by UK operators increased by 7.4 per cent. Since 1990, emissions from the aviation industry have more than doubled, reflecting a 112.1 per cent rise in flight kilometres over the same period. As a proportion of total greenhouse gas emissions, their share has increased from 2.5 per cent to 5.8 per cent.

Over the same period, the proportion of greenhouse gas emissions attributed to the shipping industry has increased from 2.1 per cent in 1990 to 3.7 per cent in 2005 (**Figure 7**). This rise reflects increases in the number of UK-owned ships following the introduction of the UK tonnage tax in 2000. Shipping companies qualify for tonnage tax if they operate ships which are strategically and commercially managed in the UK and, as companies moved into tonnage tax, UK-owned ship tonnage increased. Between end-2000 and 2005, gross tonnage of UK-owned trading ships increased by 60.7 per cent.

Between 1999 and 2005, emissions from the road freight industry remained relatively stable at between 21.2 and 22.2

Figure 7
**Water transport emissions and ship tonnage**

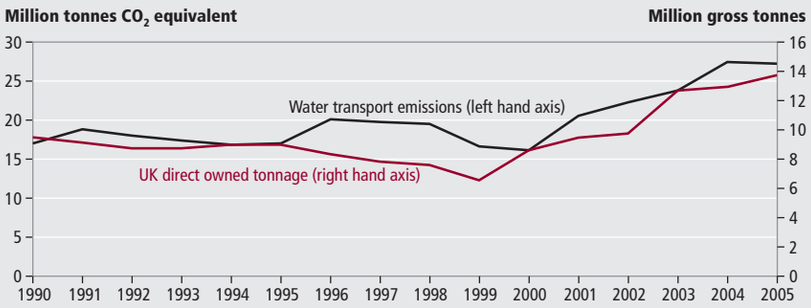



Table 2
**Greenhouse gas emissions from the UK transport industry**

Million tonnes of $CO_2$ equivalent

| | 1990 | 1995 | 1997 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|
| **EA code and industry** | | | | | | | | | | |
| 63 Railways | 1.8 | 1.7 | 1.9 | 2.0 | 2.0 | 2.1 | 2.1 | 2.1 | 2.2 | 2.4 |
| 64 Buses and coaches | 5.4 | 5.1 | 4.9 | 4.5 | 4.2 | 4.0 | 4.3 | 4.4 | 4.5 | 4.6 |
| 65 Tubes and trams | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.1 | 0.1 | 0.1 |
| 66 Taxis and minicabs | 1.2 | 1.6 | 1.7 | 1.8 | 1.9 | 1.9 | 1.9 | 1.9 | 2.1 | 2.3 |
| 67 Road freight | 15.8 | 18.8 | 20.9 | 21.3 | 21.2 | 21.8 | 21.4 | 22.2 | 21.5 | 21.7 |
| 68 Transport via pipeline | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 69 Water transport | 17.0 | 17.0 | 19.8 | 16.6 | 16.1 | 20.6 | 22.3 | 23.8 | 27.4 | 27.2 |
| 70 Air transport | 20.4 | 24.7 | 28.0 | 33.8 | 37.3 | 36.8 | 36.1 | 37.4 | 40.4 | 42.8 |
| Total transport industry | 62.0 | 69.4 | 77.7 | 80.7 | 83.4 | 87.8 | 88.6 | 92.0 | 98.3 | 101.1 |
| *Percentage of total UK emissions* | *7.7* | *9.2* | *10.2* | *11.1* | *11.4* | *11.9* | *12.3* | *12.6* | *13.4* | *13.8* |
| UK households' vehicles[1] | 59.9 | 58.6 | 63.4 | 64.7 | 64.6 | 65.7 | 67.9 | 67.4 | 67.9 | 67.1 |
| *Percentage of total UK emissions* | *7.4* | *7.8* | *8.4* | *8.9* | *8.8* | *8.9* | *9.4* | *9.2* | *9.2* | *9.2* |
| Other emission sources | 686.4 | 625.7 | 617.9 | 582.2 | 584.5 | 586.5 | 564.6 | 570.7 | 568.6 | 565.2 |
| *Percentage of total UK emissions* | *84.9* | *83.0* | *81.4* | *80.0* | *79.8* | *79.3* | *78.3* | *78.2* | *77.4* | *77.1* |
| **Total UK emissions *of which*** | **808.3** | **753.7** | **759.1** | **727.5** | **732.5** | **740.0** | **721.1** | **730.1** | **734.8** | **733.4** |
| Road transport[2] | 111.8 | 114.7 | 122.2 | 123.9 | 123.4 | 123.5 | 126.2 | 126.2 | 127.5 | 128.1 |
| *Percentage of total UK emissions* | *13.8* | *15.2* | *16.1* | *17.0* | *16.8* | *16.7* | *17.5* | *17.3* | *17.3* | *17.5* |

**Notes:**

1 Includes emissions from LGV vehicles attributed to the household sector.
2 Greenhouse house gas emissions from road transport comprise emissions from all road transport sources ie cars, heavy goods vehicles, light goods vehicles, motorcycles, buses, coaches, etc. across all 93 EA industries.

*Source: ONS Environmental Accounts*

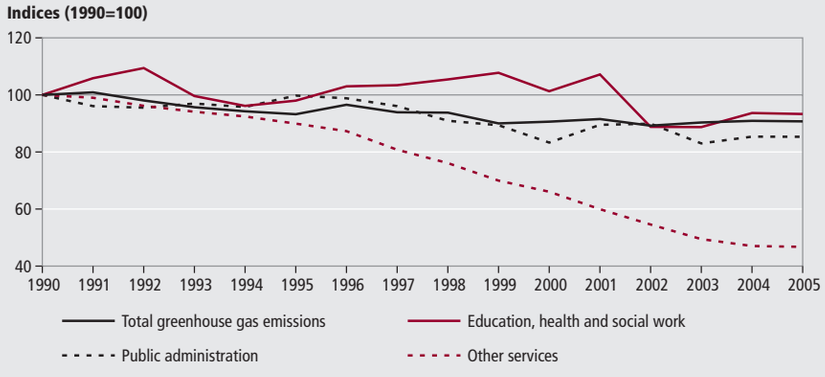
million tonnes of $CO_2$ equivalent, although in the period between 1990 and 1999 there was a 35.0 per cent rise in emissions from this industry.

There have also been smaller, less significant increases in emissions from other industries within the transport sector, including railways and taxis.

Emissions from tubes and trams have fallen by approximately 85 per cent since the 1990s.

**Table 2** shows emissions from the transport industry broken down into different transport types.

Figure 8
**Greenhouse gas emissions – services and public sector**




### Services and public sector

Overall, emissions of greenhouse gases from public administration (EA 81–82) have fallen 14.7 per cent since 1990 (**Figure 8**). Fewer emissions associated with the activities of military aircraft and the navy led to a 22.4 per drop in emissions from defence activities. Emissions related to non-defence activities in the public sector remained broadly stable over the same period.

Emissions from education, health and social work (EA 83–84) fell by 6.7 per cent between 1990 and 2005, largely because of fewer emissions from education.

There was a decline in emissions attributed to other services (EA 85–91), from 58.1 million tonnes of oil equivalent (mtoes) to 27.2 mtoes between 1990 and 2005. This was driven by a 60.0 per cent fall in emissions related to the incineration activities of the solid waste industry (EA 86).

## Trends in emissions of gases that lead to acid rain, 1990–2005

The term 'acid rain' describes the various chemical reactions that acidic gases and particles undergo in the atmosphere. The gases may be transported long distances before being deposited. When deposited, hydrogen ions may be released, forming dilute acids, which damage ecosystems and buildings. The gases covered are:

- sulphur dioxide ($SO_2$), produced when coal and some petroleum products are burnt. $SO_2$ is an acid gas that can cause respiratory irritation, damage ecosystems and buildings and contribute to acid rain
- nitrogen oxides ($NO_X$), arising when fossil fuels are burnt under certain conditions. High concentrations are harmful to health and reduce plant growth
- ammonia ($NH_3$), largely emitted from spreading animal manure and some fertilisers. It can lead to acidification, nitrification and eutrophication in the environment

Emissions of chemicals that can cause acid rain fell by 53.8 per cent between 1990 and 2005, from 6.9 million tonnes to 3.2 million tonnes (**Figure 9**). Between 2004 and 2005, most sectors of the economy saw falls in their emissions, resulting in an overall decrease of 5.1 per cent. However, the rate of decline in emissions from acid rain chemicals was

Figure 9
**Emissions of acid rain precursors**

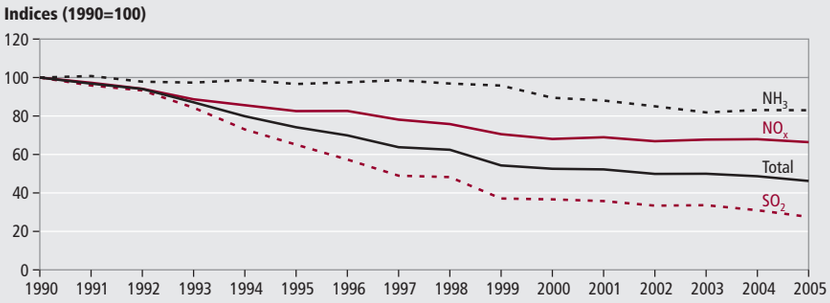



Figure 10
**Emissions of acid rain per unit of output**

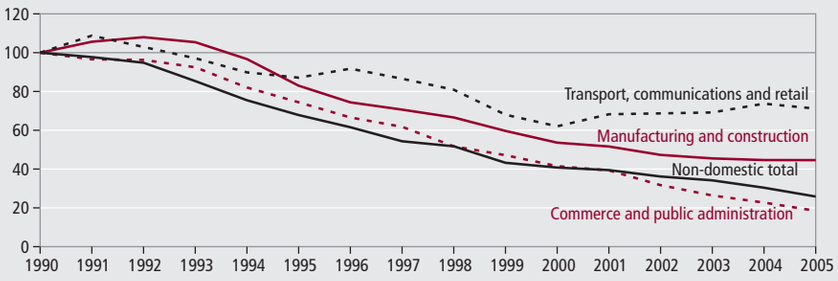
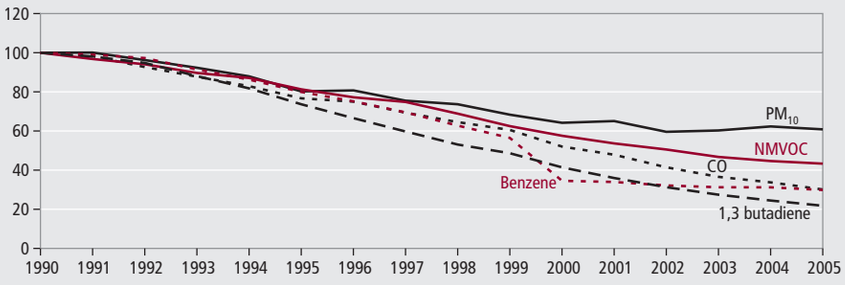



Figure 11
**Emissions of other pollutants**




slower in the period between 1999 and 2005 (14.9 per cent) than in the earlier period between 1990 and 1998 (45.7 per cent). The non-domestic sector (EA 1–90) is responsible for the majority of acid rain emissions in the UK. Since 1990, emissions from these industries have fallen by 52.9 per cent, from 6.3 million tonnes to 2.9 million tonnes (**Figure 10**). The largest fall was in the electricity, gas and water industry (EA 51–57) where emissions fell by 80.5 per cent over the same period, from 3.3 million tonnes to 0.7 million tonnes largely as a result of the adoption of cleaner technology.

Between 2004 and 2005, the largest fall in emissions was again in the electricity, gas and water industry (15.1 per cent). Emissions from transport and communications industry fell by 1.2 per cent, the first time there has been a fall in emissions from this industry since 2000. In 2005, emissions from households (EA 91–92) were 61.3 per cent lower than in 1990 and 10.2 per cent down on 2004, mainly reflecting falling emissions from the use of vehicles because of cleaner technology such as catalytic converters.

## Trends in emissions of other atmospheric pollutants, 1990–2005

These pollutants affect the quality of the air we breathe and may have a negative impact on human health, for instance as carcinogens or causes of respiratory illness. Included in this category of atmospheric pollutants are:

- carbon monoxide (CO), formed by the incomplete combustion of fuel, particularly in transport and heating. CO can effect human health and lead to formation of ozone in the troposphere
- particulant matter ($PM_{10}$), fine particles produced mainly by road transport, coal fuel and various industrial processes, as a result of fuel combustion and surface erosion. Leading to poor air quality, it has been linked to premature mortality from respiratory diseases
- non-methane volatile organic compounds (NMVOCs), produced across a range of industries and having a role in the photochemical production of ozone
- benzene emissions, a result of evaporation and combustion of petroleum. The main source of benzene is road transport and it is a known carcinogen
- 1, 3 butadiene emissions, produced as a result of the combustion of petroleum and during the manufacture of synthetic rubber, nylon and latex paints. They are regarded as a cause of cancer in humans

Emissions of all these atmospheric pollutants have fallen since 1990, largely driven by the adoption of cleaner technologies (**Figure 11**). Fewer emissions of benzene and 1, 3 butadiene because of households' use of vehicles have led to falls of 70.1 per cent and 78.2 per cent, respectively. Emissions of CO, mainly from the production of electricity from coal and by road transport, fell by 69.9 per cent between 1990 and 2005. Emissions of NMVOCs, mainly produced by the chemical industries, fell by 56.7 per cent over the same period. Emissions of $PM_{10}$ fell 39.2 per cent following the introduction of cleaner technology for the burning of coal.

Households were significant contributors of emissions of these pollutants. However, emissions of $PM_{10}$, benzene and 1, 3 butadiene from the transport and communications sector are increasingly significant. The majority of emissions of NMVOCs are a result of the activities of the manufacturing sector. Emissions of CO arise mainly from the manufacturing and household sectors which, in 2005, accounted for 23.0 per cent and 50.4 per cent, respectively.

## Trends in emissions of heavy metals, 1990–2005

Heavy metals are natural constituents of the Earth's crust and many heavy metals in certain forms and appropriate

concentrations are essential to life. However, there is concern that some may cause damage to ecosystems of environmental and economic importance and may have harmful effects on human health. Combustion and industrial processes are the predominant anthropogenic sources of emissions of heavy metals into the atmosphere.[5]

Between 1990 and 2005, emissions of heavy metals have fallen, although the size of the reduction varies significantly (see **Table 3**).

Lead shows the largest fall, down 95.8 per cent between 1990 and 2005. This fall is driven by emissions from the household sector where the introduction of lead-free fuels for vehicles has resulted in a fall from 1,662,000 tonnes in 1990 to 5,000 tonnes in 2005. In 2005, the sector responsible for the most lead emissions (71.4 per cent) was manufacturing.

There were also large falls in mercury (79.5 per cent), chromium (75.6 per cent) and cadmium (72.5 per cent), driven mainly by lower levels of emissions from the manufacturing sector.

Arsenic, copper and zinc fell to a lesser extent by 66.1 per cent, 55.7 per cent and 53.9 per cent, respectively. The reduction in emissions from arsenic was driven by falls from the electricity, gas and water supply industries. The fall in emissions from copper followed lower emissions from the electricity, gas and water supply and manufacturing sectors. However, emissions of copper from the household sector rose between 1990 and 2005, largely due to households' use of vehicles. The fall in emissions from zinc was driven by lower emissions from the manufacturing sector. Although most sectors showed some reduction, the household sector was broadly stable.

Selenium and nickel showed the smallest drop in emissions between 1990 and 2005, falling 43.3 per cent and 35.5 per cent, respectively. Although most sectors showed falls, emissions of nickel from the transport and communications industries increased by 66.4 per cent, from 136,000 tonnes in 1990 to 227,000 tonnes in 2005, compared with an overall reduction from 465,000 tonnes to 300,000 tonnes. Manufacturing and the electricity, gas and water supply industries contributed 81.4 per cent of selenium emissions in 1990; in 2005, this proportion had fallen to 68.7 per cent. In 1990, the proportions of emissions from the transport and communications industries and households were 4.5 per cent and 8.9 per cent, respectively, while in 2005 these proportions stood at 11.4 per cent and 12.5 per cent.

Table 3
**Reductions in emissions of heavy metals, 1990 to 2005**

| Heavy metal | Percentage reduction in emissions since 1990 |
|---|---|
| Lead | *95.8* |
| Mercury | *79.5* |
| Chromium | *75.6* |
| Cadmium | *72.5* |
| Arsenic | *66.1* |
| Copper | *55.7* |
| Zinc | *53.9* |
| Selenium | *43.3* |
| Nickel | *35.5* |

## Trends in energy consumption, 1990–2005

In 2005, total energy consumption, including nuclear and hydroelectric power and imports of electricity, was slightly lower at 244.8 mtoes compared with 245.4 mtoes a year earlier. Since 1990, total energy consumption has risen 11.0 per cent.

Between 1990 and 2005, the consumption of carbon fuels rose 10.9 per cent while greenhouse gas emissions fell 9.3 per cent, due to changes in fuel use – the combustion of natural gas rather than coal and the introduction of integrated pollution prevention and control measures (**Figure 12**).

In contrast to greenhouse gas emissions, the rate that energy consumption has increased over the whole period is relatively stable: between 1990 and 1999 it was up 5.1 per cent and between 1999 and 2005 up 5.5 per cent.

Energy consumption, including electricity, by non-household sectors of the UK economy increased by 10.6 per cent between 1990 and 2005, while output (GDP) rose by 43.6 per cent in real terms. As a result, energy intensity (energy consumed per unit of output) decreased by 22.9 percentage points over the same period.

The use of carbon fuels such as coal, oil and gas fell from 226.0 mtoes in 2004 to 225.0 mtoes in 2005, a decrease of 0.4 per cent. The largest direct users of carbon fuels were the electricity, gas and water supply industries which accounted for 27.0 per cent of carbon fuel consumption in 2005 and consumed 60.7 mtoes in 2005, up 0.7 per cent on 2004.

The next largest sector was UK households (26.4 per cent) which consumed 59.3 mtoes of carbon fuels in 2005. In 2005, the household sector accounted for 34.1 per cent of energy use (once electricity transformation and distribution losses are allocated to the final consumer). This was 3.4 per cent lower than in 2004 and broadly offset by a 3.2 per cent year-on-year increase in carbon fuel use by the transport and communications industry.

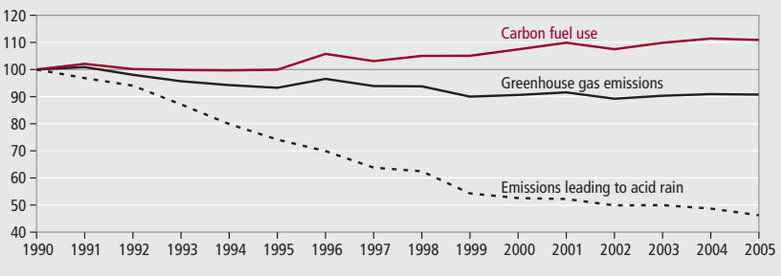
Energy from other sources such as nuclear, hydroelectricity, wind and imported electricity rose 2.1 per cent between 2004 and 2005, and is now 11.9 per cent higher than in 1990. Imports of electricity in 2005 were 11.0 per cent higher than in 2004, while energy derived from nuclear fuel and hydroelectricity remained broadly stable, up 1.2 per cent and 0.7 per cent, respectively. Between 2004 and 2005, energy from wind power increased by 50.3 per cent, from 0.2 to 0.3 million tonnes of oil equivalent.

The total amount of energy derived from renewable sources rose 12.2 per cent between 2004 and 2005. Energy from renewable sources such as biomass (for example, wood, manure and crops), hydro and wind power amounted to 4.6 mtoes in 2005 and accounted for 1.9 per cent of all energy used. Since 1990, the amount of energy from renewable sources has more than doubled from 1.9 mtoes to 4.6 mtoes.

## Conclusion

Generally, levels of atmospheric emissions have fallen during the period 1990 to 2005

Figure 12
**Air emissions and carbon fuel use**



while energy use and economic growth have continued to rise. This suggests that emissions and energy intensities of production are improving and policies to reduce the level and alter the mix of fuels used in the economy are resulting in fewer emissions. However, progress is mixed. Following an initial fall in the 1990s, emissions of greenhouse gases have remained stable since 1999. A similar if less marked pattern is evident in emissions of acid rain precursors, while emissions of other atmospheric pollutants show a steady falls throughout the period. Emissions of heavy metals provide a more mixed story: all are down on 1990 levels but emissions of nickel and selenium were higher in 2005 than in 1999.

## Notes

1 See www.statistics.gov.uk/about/methodology_by_theme/environmental_accounts/downloads/atmospheric_emissions_energy_use.pdf

2 See www.statistics.gov.uk/ downloads/theme_environment/transport_report.pdf

3 Defra publishes more detailed emissions data on this basis.

4 Published data sets are available as follows:

Greenhouse gas emissions (93 industries) at www.statistics.gov.uk/statbase/expodata/spreadsheets/d5695.xls

Acid rain precursors (93 industries) at www.statistics.gov.uk/statbase/expodata/spreadsheets/d5541.xls

Heavy metals (93 industries) at www.statistics.gov.uk/statbase/expodata/spreadsheets/d5696.xls

Other pollutants (93 industries) at www.statistics.gov.uk/statbase/expodata/spreadsheets/d5697.xls

Energy consumption at www.statistics.gov.uk/statbase/expodata/spreadsheets/d5542.xls

5 See UNECE Protocol on Heavy Metals at www.unece.org/env/lrtap/full%20text/1998.Heavy.Metals.e.pdf

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## APPENDIX A

Table A1

### Environmental Accounts industry classifications

| Environmental accounts code | Industrial sector | SIC(92) | IO codes | Agg_ sectors | NACE |
|---|---|---|---|---|---|
| 1 | Agriculture, hunting and related service activities | 1 | 1 | AB | 1 |
| 2 | Forestry, logging and related service activities | 2 | 2 | AB | 2 |
| 3 | Fishing, operation of fish hatcheries and fish farms | 5 | 3 | AB | 5 |
| 4 | Mining of coal, lignite and peat | 10 | 4 | C | 10 |
| 5 | Extraction of crude petroleum and natural gas | 11 | 5 | C | 11 |
| 6 | Mining of metal ores | 13 | 6 | C | 13 |
| 7 | Other mining and quarrying | 14 | 7 | C | 14 |
| 8 | Manufacture of food products and beverages | 15 | 8–19 | D | 15 |
| 9 | Manufacture of tobacco products | 16 | 20 | D | 16 |
| 10 | Textiles | 17 | 21–27 | D | 17 |
| 11 | Manufacture of wearing apparel; dressing and dyeing of fur | 18 | 28 | D | 18 |
| 12 | Leather tanning, luggage and footwear | 19 | 29–30 | D | 19 |
| 13 | Timber, wood products excluding furniture; cork and straw | 20 | 31 | D | 20 |
| 14 | Pulp, paper and paper products | 21 | 32 | D | 21 |
| 15 | Publishing, printing and production of recorded material | 22 | 33–34 | D | 22 |
| 16 | Coke oven products | 23.1 | 35 | D | 23 |
| 17 | Refined petroleum products | 23.2 | | D | |
| 18 | Processing of nuclear fuel | 23.3 | | D | |
| 19 | Industrial gases, dyes, pigments | 24.11, 24.12 | 36 | D | 24 |
| 20 | Other inorganic chemicals | 24.13 | 37 | D | |
| 21 | Other organic basic chemicals | 24.14 | 38 | D | |
| 22 | Fertilisers and nitrogen compounds | 24.15 | 39 | D | |
| 23 | Plastics, synthetic rubber, primary form | 24.16, 24.17 | 40 | D | |
| 24 | Pesticides, agrochemicals | 24.2 | 41 | D | |
| 25 | Paints, varnishes, printing ink, etc. | 24.3 | 42 | D | |
| 26 | Pharmaceuticals and botanical products | 24.4 | 43 | D | |
| 27 | Soap and detergents, cleaning and toilet preparations | 24.5 | 44 | D | |
| 28 | Chemical products n.e.s. | 24.6 | 45 | D | |
| 29 | Man-made fibres | 24.7 | 46 | D | |
| 30 | Rubber products | 25.1 | 47 | D | 25 |
| 31 | Plastic products | 25.2 | 48 | D | |
| 32 | Glass and glass products | 26.1 | 49 | D | 26 |
| 33 | Ceramic goods | 26.2, 26.3 | 50 | D | |
| 34 | Structural clay products | 26.4 | 51 | D | |
| 35 | Cement, lime and plaster | 26.5 | 52 | D | |
| 36 | Articles of concrete, stone, other non-metallic mineral products | 26.6–26.8 | 53 | D | |
| 37 | Iron and steel | 27.1–27.3 | 54 | D | 27 |
| 38 | Non-ferrous metals excluding aluminium | 27.41, 27.43–27.45 | 55 | D | |
| 39 | Aluminium | 27.42 | | D | |
| 40 | Casting of metals | 27.5 | 56 | D | |
| 41 | Fabricated metal products, except machinery | 28 | 57–61 | D | 28 |
| 42 | Machinery and equipment | 29 | 62–68 | D | 29 |
| 43 | Office machinery and computers | 30 | 69 | D | 30 |
| 44 | Electrical machinery and apparatus | 31 | 70–72 | D | 31 |
| 45 | Radio, television and comms | 32 | 73–75 | D | 32 |
| 46 | Medical, precision and optical instruments, watches and clocks | 33 | 76 | D | 33 |
| 47 | Motor vehicles, trailers and semi-trailers | 34 | 77 | D | 34 |
| 48 | Other transport equipment | 35 | 78–80 | D | 35 |
| 49 | Manufacture of furniture, toys, sports equipment, other products | 36 | 81–83 | D | 36 |

Table A1 – *continued*

## Environmental Accounts industry classifications

| Environmental accounts code | Industrial sector | SIC(92) | IO codes | Agg_ sectors | NACE |
|---|---|---|---|---|---|
| 50 | Recycling | 37 | 84 | D | 37 |
| 51 | Electricity production – gas | 40.1 | 85 | E | 40 |
| 52 | Electricity production – coal | | | E | |
| 53 | Electricity production – nuclear | | | E | |
| 54 | Electricity production – oil | | | E | |
| 55 | Electricity production – other | | | E | |
| 56 | Gas distribution; steam and hot water supply | 40.2, 40.3 | 86 | E | |
| 57 | Water supply | 41 | 87 | E | 41 |
| 58 | Construction | 45 | 88 | F | 45 |
| 59 | Garages, car showrooms | 50 | 89 | GH | 50 |
| 60 | Wholesaler trade and commission trade except motor vehicles | 51 | 90 | GH | 51 |
| 61 | Retail and repair trade, except motor vehicles | 52 | 91 | GH | 52 |
| 62 | Hotels and restaurants | 55 | 92 | GH | 55 |
| 63 | Railways | 60.1 | 93 | I | 60 |
| 64 | Buses and coaches | 60.21/1, 60.23 | 94 | I | |
| 65 | Tubes and trams | 60.21/2 | | I | |
| 66 | Taxis operation | 60.22 | | I | |
| 67 | Freight transport by road | 60.24 | | I | |
| 68 | Transport via pipeline | 60.3 | | I | |
| 69 | Water transport | 61 | 95 | I | 61 |
| 70 | Air transport | 62 | 96 | I | 62 |
| 71 | Supporting and auxiliary transport activities, travel agencies | 63 | 97 | I | 63 |
| 72 | Post and telecommunications | 64 | 98–99 | I | 64 |
| 73 | Financial intermediation, except insurance and pension funds | 65 | 100 | JK | 65 |
| 74 | Insurance and pensions | 66 | 101 | JK | 66 |
| 75 | Activities auxiliary to financial intermediation | 67 | 102 | JK | 67 |
| 76 | Real estate activities | 70 | 103–105 | JK | 70 |
| 77 | Renting of machinery | 71 | 106 | JK | 71 |
| 78 | Computer and related actvities | 72 | 107 | JK | 72 |
| 79 | Research and development | 73 | 108 | JK | 73 |
| 80 | Other business actvities | 74 | 109–114 | JK | 74 |
| 81 | Public administration – not defence | 75 not 75.22 | 115 | L | 75 |
| 82 | Public administration – defence | 75.22 | | L | |
| 83 | Education | 80 | 116 | MN | 80 |
| 84 | Health and veterinary services, social work | 85 | 117–118 | MN | 85 |
| 85 | Sewage and treatment of liquid waste | 90 | 119 | O | 90 |
| 86 | Solid waste | | | O | |
| 87 | Other sanitary services | | | O | |
| 88 | Activities of membership organisations | 91 | 120 | O | 91 |
| 89 | Recreational, cultural and sporting actvities | 92 | 121 | O | 92 |
| 90 | Other service activities; dry cleaning, hair dressing, funeral parlours | 93 | 122 | O | 93 |
| 91 | Private households with employed persons | 95 | 123 | O | 95 |
| | Extra-territorial organisations and bodies | 99 | | O | |
| N | Natural world | | | | |
| 92 | Consumer expenditure – not travel | | 126 | Z | |
| 93 | Consumer expenditure – travel | | 126 | Z | |