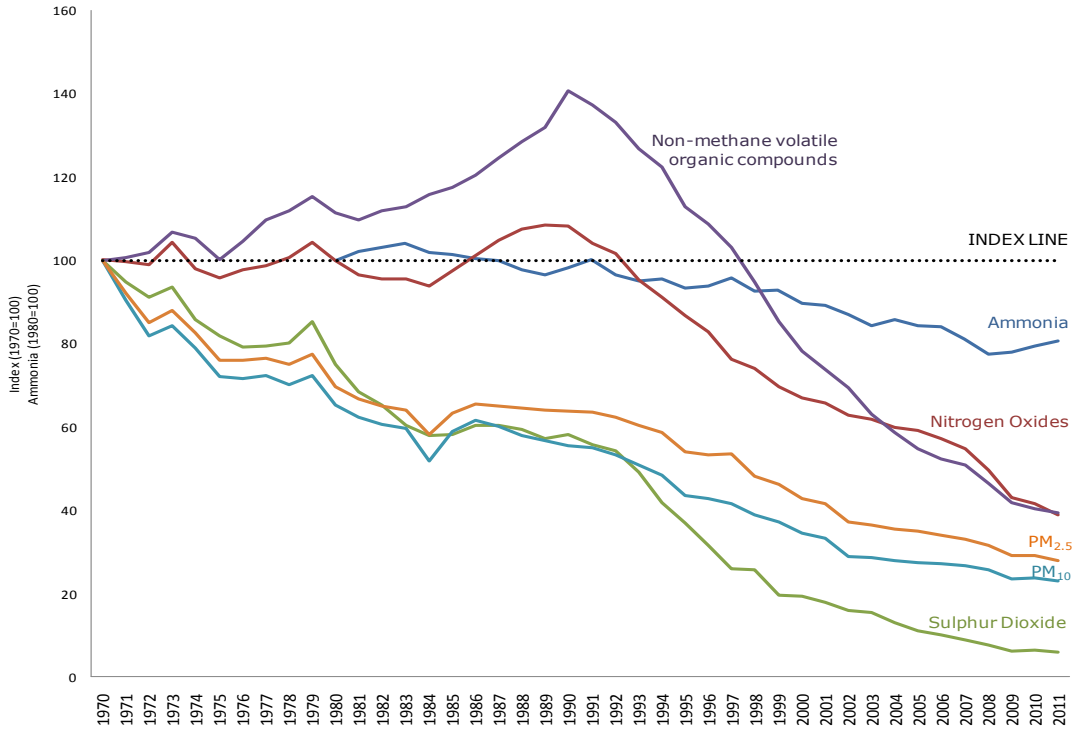
Department for Environment Food & Rural Affairs

STATISTICAL RELEASE: 18 DECEMBER 2012

EMISSIONS OF AIR POLLUTANTS IN THE UK, 1970 TO 2011

- There has been a long term decrease in the emissions of all of the pollutants covered (ammonia, nitrogen oxides, non-methane volatile organic compounds, particulate matter (PM_{10} $PM_{2.5}$) and sulphur dioxide). For sulphur dioxide and particulate matter, the rate of decline was most pronounced in the 1990s, and has slowed in recent years.
- Ammonia emissions have increased in each of the last three years by a total of four per cent, although this follows a relatively large fall between 2006 and 2008. The remaining air pollutants have seen decreases in 2011 compared to 2010, of between 2.5 and 6.6 per cent.
- The UK has continued to meet international obligations for emissions of the four pollutants for which it has legally binding commitments for 2010 onwards. The results are also presented alongside new commitments for emission reduction to 2020.

Figure 1: Trends in UK sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds, ammonia and particulate matter (PM_{10}, $PM_{2.5}$) emissions 1970 – 2011



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Why quantify UK emissions of air pollutants?

Air pollution is a local, regional and international problem caused by the emission of pollutants, which either directly or through chemical reactions in the atmosphere lead to negative impacts on human health and ecosystems.

There are many sources of air pollution, including power stations, traffic, household heating, agriculture and industrial processes. The National Atmospheric Emissions Inventory (NAEI)[1] provides estimates of the amount of different pollutants that are emitted to the air each year from human activity in the UK. These are estimated to help to find ways of reducing the impact of human activities and the resulting air pollutants on the environment and our health.

This publication covers UK emissions of:

- sulphur dioxide (SO_2);
- nitrogen oxides (NO_x) [2];
- non-methane volatile organic compounds (NMVOCs);
- ammonia (NH_3);
- particulate matter (PM_{10} and $PM_{2.5}$) [3].

Data on emissions of other air pollutants will be available in February 2013 from the NAEI website referred to above.

The Effects of Air Pollution

Chronic exposure to PM contributes to the risk of developing cardiovascular diseases and lung cancer[4]. Particulate matter can have an either cooling or a warming effect on climate, and also has a key role in the ecosystem impacts of air pollution.

As well as being emitted directly, particulates can be formed in the atmosphere from reactions between other pollutants, of which SO_2, NO_x, NMVOCs and NH_3 are the most important. Health effects of PM are caused after their inhalation and penetration into the lungs. The smaller the particles, the deeper they penetrate into the lungs. PM's mortality effects are therefore strongly associated with the smaller $PM_{2.5}$ fraction, even though the coarser 2.5-10μm fraction known as PM_{10} also has clear health and mortality impacts. The recently revised UNECE Gothenburg Protocol which aims to abate

[1] //naei.defra.gov.uk/index.php
[2] NO_x are emitted during fuel combustion, such as by road transport and industrial facilities.
[3] PM_{10} refers to particles with a diameter smaller than 10μm and $PM_{2.5}$ to particles with a diameter smaller than 2.5μm. They may be produced directly from a source such as an engine or formed from reactions between other pollutants (e.g. NO_2, SO_2, NH_3) in the air (secondary PM).
[4] http://www.eea.europa.eu/publications/air-quality-in-europe-2012

acidification, eutrophication and ground-level ozone (Gothenburg Protocol[5]) now includes an emission reduction target for $PM_{2.5}$ to be met by 2020.

Emissions of NO_X, SO_2 or NMVOCs can react together to form low level ozone which at higher levels can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases. Several European studies have reported that current ozone concentrations in Europe have health effects, especially in the summer, and that daily mortality rises with increases in ozone exposure[6].

Air pollution also damages ecosystems through:

- **acidification** (SO_2, NO_x and NH_3) - where chemical reactions involving air pollutants create acidic compounds which can cause harm to vegetation and buildings (including as acid rain);
- **eutrophication** (NO_x and NH_3) - where nitrogen can be deposited in soils or in rivers and lakes through rain, affecting the nutrient levels and diversity of species in sensitive environments, for example encouraging algae growth in lakes and water courses.
- **ground-level ozone** (NO_x and NMVOCs) – where chemical reactions involving air pollutants create the toxic gas ozone (O_3) which can damage wild plants, crops, forests and some materials and is a green house gas contributing to the warming of the atmosphere.

Air pollutant emissions reductions do not always produce a corresponding drop in atmospheric concentrations in the UK. For example, emissions of the pollutants that lead to ozone formation have reduced substantially, but this is not reflected in the long-term trend in ozone concentrations. This is partly explained by a proportion of the ozone experienced in the UK originating from air pollutant emissions from mainland Europe and beyond."[7]

Factors affecting air pollutant emissions

Reductions in air pollutant emissions[8] are being achieved through regulatory controls and other means across industry, domestic and transport sectors. Examples include changes in fuel use (such as switching from coal to gas power stations), reducing fuel use, changes to industrial processes, pollutant capture or conversion (for example catalytic convertors on vehicles). Changes in behaviour such as making more sustainable transport choices

[5] http://www.unece.org/index.php?id=29858
[6] WHO, 2008, Air quality and health, Fact sheet no 313 (http://www.who.int/mediacentre/factsheets/fs313/en/).
[7] UNECE, 2010, Hemispheric Transport of Air Pollution 2010m Part D: Answers to Policy-Relevant Science Questions, Air Pollution Studies No. 20. ECE/EB.AIR/103, United Nations Economic Commission for Europe, Geneva.
[8] For Defra policy on air emissions see www.defra.gov.uk/environment/quality/air/air-quality/

also contribute to emissions reductions. Wider economic conditions also impact on pollutant emissions.

Transboundary air pollution

Air pollutants released in one country may be transported in the atmosphere, contributing to harmful impacts elsewhere.

There are two main international agreements that aim to reduce transboundary air pollution:

- the **National Emission Ceilings Directive (NECD)** - sets ceilings for each EU Member State for emissions of sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds (NMVOCs), and ammonia to be met by 2010 and thereafter.
- the **Gothenburg Protocol under the UNECE Convention on Long Range Transboundary Air Pollution (CLRTAP)** - sets similar or identical UK emissions ceilings for the same pollutants for 2010 and thereafter. This Protocol was revised in May 2012 and now sets emission reduction commitments for the same four pollutants and for $PM_{2.5}$ for 2020.

The NAEI is used to monitor emissions against the international targets, and the UK figures are reported annually to the European Commission via the European Environment Agency[9] and the CLRTAP. The statistics presented below compare the UK emissions against the international targets.

[9] www.eea.europa.eu/

Understanding air pollutant emissions figures

It should be noted that the amount of emissions for the different pollutants should not be compared as their effects on health and the environment are very different.

Reductions in air pollutant emissions[10] are being achieved through regulatory controls and other means across industry, domestic and transport sectors. Examples include changes in fuel use (such as switching from coal to gas power stations), reducing fuel use, changes to industrial processes, pollutant capture or conversion (for example catalytic convertors on vehicles). Changes in behaviour such as making more sustainable transport choices also contribute to emissions reductions. Wider economic conditions also impact on pollutant emissions.

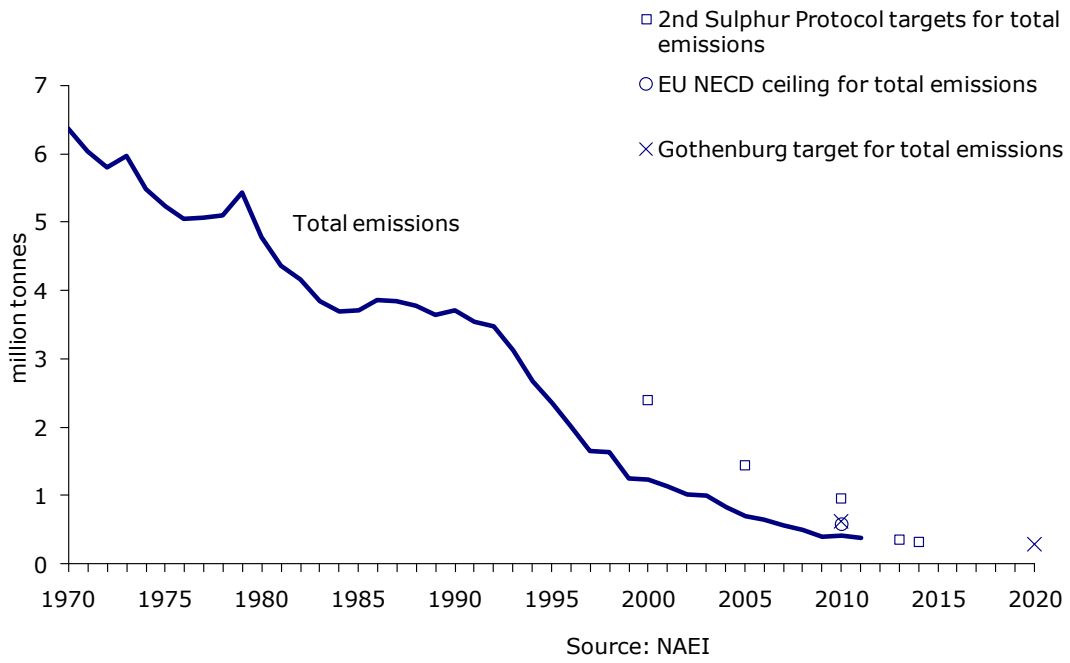
It is not practical, except for a limited number of large industrial processes, to measure emissions directly, so the NAEI is based on highly detailed assumptions on the amount of each air pollutant generated from different activities and the level of that activity in the UK. Refer to the NAEI[11] for more details.

There are uncertainties associated with all estimates of pollutant emissions which vary between pollutants and emission sources. Although for a given year there may be considerable uncertainties in the national emissions total, trends over time are likely to be more reliable. The breakdown of emissions by source sector is more uncertain than the national totals.

[10] For Defra policy on air emissions see www.defra.gov.uk/environment/quality/air/air-quality/
[11] //naei.defra.gov.uk/index.php

Sulphur dioxide

Figure 2: UK Sulphur dioxide emissions and targets: 1970 – 2011



- Emissions of sulphur dioxide have fallen by 94 per cent since 1970, to 0.37 million tonnes in 2011.

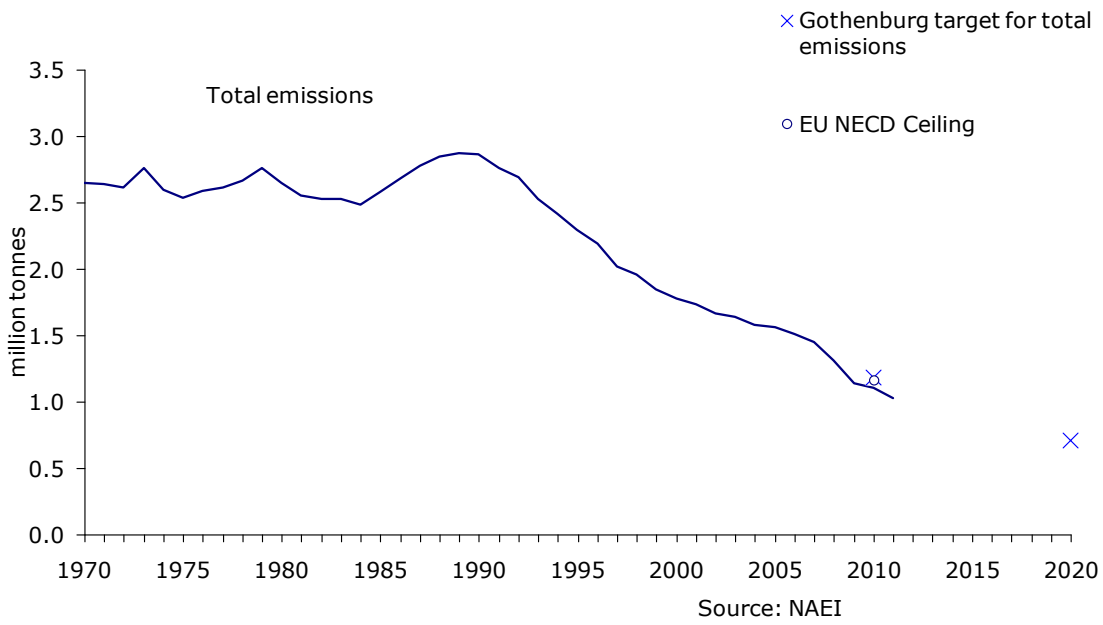
- Emissions decreased by 6.9 per cent between 2010 and 2011, following a small increase in the previous year. The rate of reduction has slowed since the large decreases seen in the 1990s.

- The UK remains within 2010 international targets for emissions, and the UK has signed the revised Gothenburg protocol agreeing to reduce emissions by 2020 from the 2005 level by 59 per cent.

The main source of sulphur dioxide (SO_2) emissions is from combustion in energy production and transformation (61 per cent in 2011), followed by combustion in manufacturing industries (16 per cent in 2011). It is these sources that have been the strongest drivers for the long term trend of falling emissions, by switching fuel use from coal to gas and the fitting of flue gas desulphurisation in the remaining coal fired plants in the power sector.

Nitrogen oxides

Figure 3: UK Nitrogen oxides emissions and targets: 1970 - 2011



- Emissions of nitrogen oxides have fallen by 61 per cent since 1970, to 1.03 million tonnes in 2011.

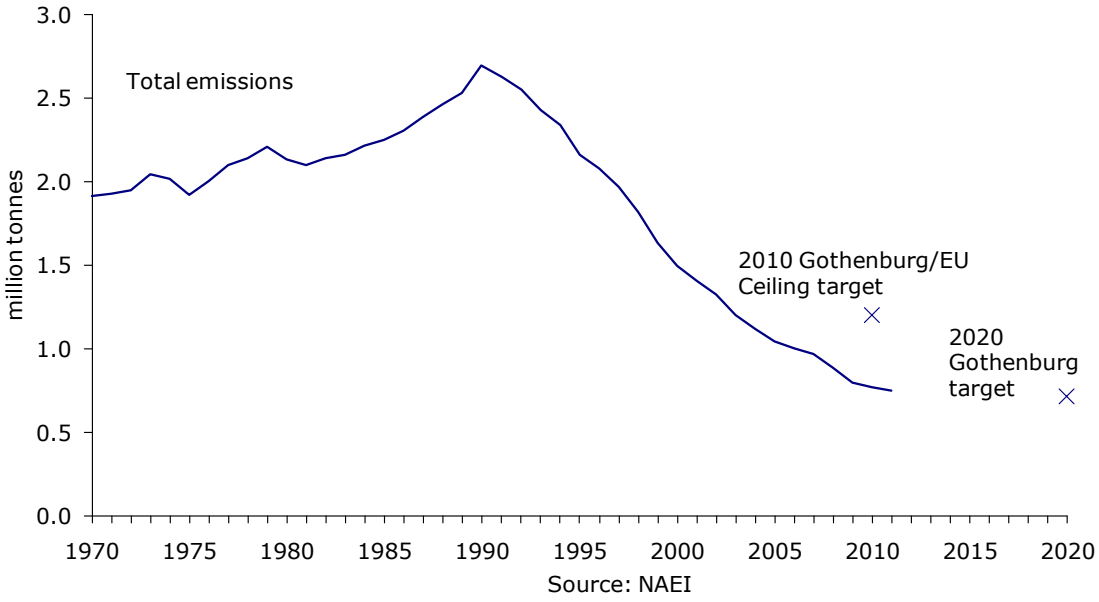
- There was a 6.6 per cent decrease in emissions of nitrogen oxides between 2010 and 2011. There has been a downward trend since the 1990s but the rate of reduction has slowed since the large decreases seen in the years 2008 and 2009.

- The UK has met current international targets to reduce emissions of nitrogen oxides and has agreed to reduce emissions in 2020 and thereafter by 55 per cent from the 2005 total.

Increases in road traffic account for the steep climb in nitrogen oxide (NO_x) emissions between 1984 and 1989, and road transport still accounts for around one third of total NO_x emissions. Catalytic converters and stricter emission regulations have resulted in a strong downward trend since 1990. Emissions from power stations have been also reduced significantly.

Non-methane volatile organic compounds

Figure 4: UK Non-methane volatile organic compounds emissions and targets: 1970-2011

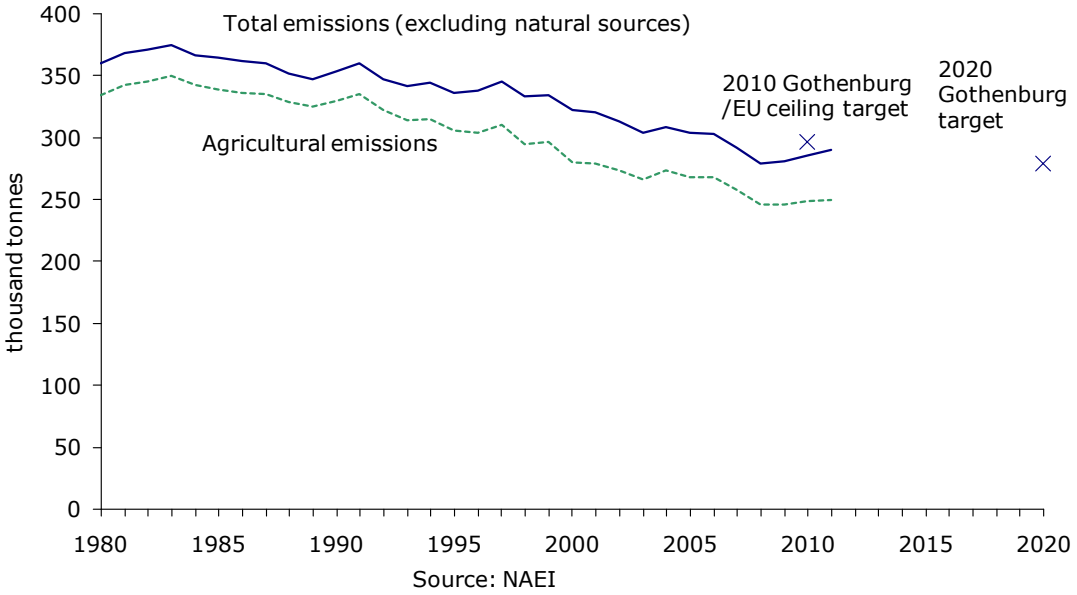


- Emissions of non-methane volatile organic compounds (NMVOCs) have fallen by 60.7 per cent since 1970, to 0.75 million tonnes in 2011.
- There was a 2.5 per cent decrease in emissions between 2010 and 2011 continuing the steady decrease since 1990.
- The UK has met current international targets to reduce emissions and has agreed to reduce emissions in 2020 and thereafter by 32 per cent from the 2005 total.

Solvents, production processes, and the extraction and distribution of fossil fuels are the primary sources of NMVOC emissions. The marked decrease in emissions since the early 1990s reflects stricter limits placed on emissions.

Ammonia

Figure 5: UK Ammonia emissions and targets: 1980-2011



- Emissions of ammonia have fallen by 19.5 per cent since 1980, to 290 thousand tonnes in 2011.

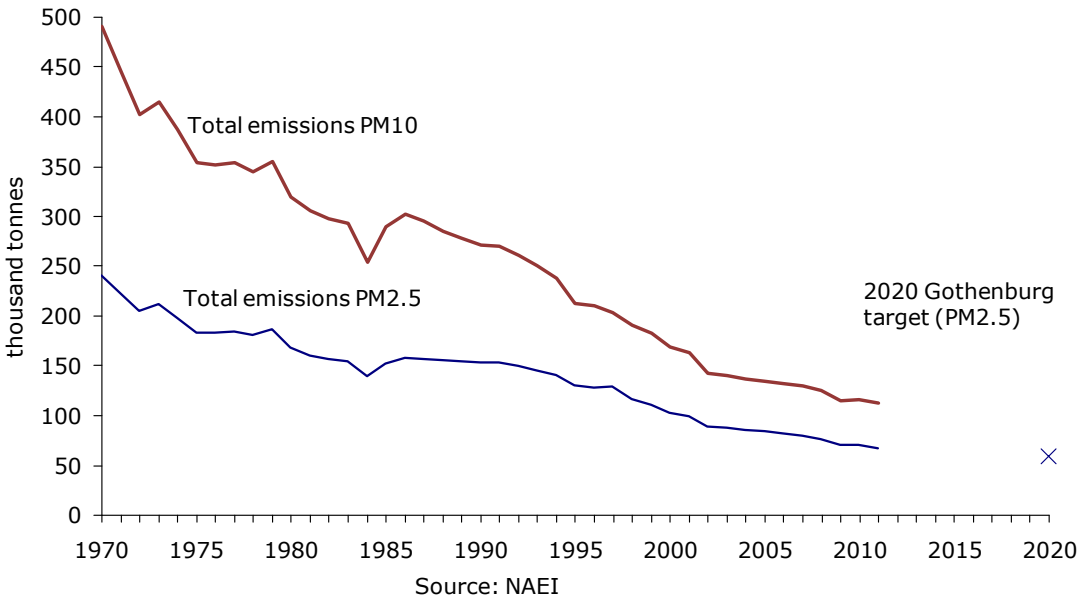
- There was a slight increase of 1.6 per cent in emissions of ammonia between 2010 and 2011. Ammonia emissions have increased in each of the last three years by a total of 4 per cent, although this follows a relatively large fall between 2006 and 2008.

- The UK has met current international targets to reduce emissions of ammonia and has agreed to reduce emissions in 2020 and thereafter by 8 per cent from the 2005 total.

Emissions from agriculture accounted for 86 per cent of total ammonia emissions in 2011. Agriculture's contribution to the total has decreased slightly since 1980, largely due to reductions in cattle numbers and more efficient fertiliser use. However, more recently there has been increased use of urea as a nitrogen-containing fertiliser and a resulting slight increase in emissions from agriculture. The increased use of anaerobic digestion for waste management has also led to additional ammonia emissions.

Particulate Matter

Figure 6: UK PM_{10} and $PM_{2.5}$ emissions and targets: 1970-2011



- Emissions of PM_{10} have fallen by 77 per cent since 1970, to 113 thousand tonnes in 2011.
- Emissions of $PM_{2.5}$ have fallen by 72 per cent since 1970, to 67 thousand tonnes in 2011.
- Both PM_{10} and $PM_{2.5}$ decreased slightly by 3 and 4.5 per cent respectively between 2010 and 2011.
- The UK has agreed to reduce $PM_{2.5}$ emissions in 2020 and thereafter by thirty per cent from the 2005 total.

Emissions from road transport accounted for around a quarter of the total $PM_{2.5}$ emissions and just over one fifth of the total PM_{10} emissions in 2011.

A Defra National Statistics publication

National Statistics are produced to high professional standards set out in the National Statistics Code of Practice. They undergo regular quality assurance reviews to ensure they meet customer needs.

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Main notes

1. Table 1 below shows the emissions figures for the five pollutants, from 1970 to 2011. Table 2 below shows the emissions by source for 2009 and 2010.

2. The figures in this Defra National Statistics Release are from the National Atmospheric Emissions Inventory for 1970 to 2011, produced for Defra and the Devolved Administrations by Ricardo-AEA. For further information on the Inventory see the NAEI website.

3. There are uncertainties associated with all estimates of pollutant emissions, which vary between pollutants and emission sources. Although and for any given year there may be considerable uncertainties in the national emissions total. However, trends over time are likely to be more reliable.

4. Results for other pollutants, including other pollutants covered by the UK Air Quality Strategy, will be released in February 2012. This data can be accessed on the NAEI website.

5. The methodology and assumptions in the NAEI are continually refined as better scientific information and input data become available for example on different fuel use and activities. For each inventory compilation, data for earlier years is revised based on these new assumptions to give a consistent time series.

6. Results for greenhouse gases, also covered in the NAEI, are published by Department of Energy and Climate Change (DECC) in a separate National Statistics release. For further details visit the DECC website.

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Table 1: Emissions of air pollutants in the UK, 1970 to 2011

Year	Sulphur dioxide (Million tonnes)	Nitrogen oxides (Million tonnes)	Non-methane volatile organic compound (Million tonnes)	Ammonia (excluding natural sources) (Thousand tonnes)	PM10 (Thousand tonnes)	PM2.5 (Thousand tonnes)
1970	6.37	2.65	1.91	no data	491	240
1971	6.04	2.64	1.93	no data	445	222
1972	5.80	2.62	1.95	no data	403	205
1973	5.97	2.76	2.05	no data	415	212
1974	5.47	2.60	2.02	no data	388	198
1975	5.22	2.54	1.92	no data	355	183
1976	5.05	2.59	2.00	no data	352	183
1977	5.06	2.62	2.10	no data	355	184
1978	5.10	2.66	2.14	no data	345	181
1979	5.43	2.76	2.21	no data	355	186
1980	4.78	2.65	2.14	361	320	168
1981	4.36	2.56	2.10	369	306	161
1982	4.16	2.53	2.14	372	298	156
1983	3.84	2.53	2.16	375	293	154
1984	3.69	2.49	2.22	367	254	140
1985	3.72	2.58	2.25	365	290	152
1986	3.86	2.68	2.31	362	303	158
1987	3.84	2.78	2.38	360	295	156
1988	3.78	2.84	2.46	352	285	155
1989	3.65	2.87	2.53	348	278	154
1990	3.71	2.87	2.70	354	272	153
1991	3.55	2.76	2.63	361	270	153
1992	3.47	2.70	2.55	348	261	150
1993	3.13	2.53	2.43	342	250	146
1994	2.66	2.42	2.34	345	238	141
1995	2.36	2.30	2.16	337	214	130
1996	2.01	2.19	2.08	338	210	128
1997	1.65	2.02	1.97	345	204	129
1998	1.63	1.96	1.82	333	191	116
1999	1.25	1.85	1.63	334	183	111
2000	1.23	1.78	1.50	323	170	103
2001	1.13	1.74	1.41	321	164	100
2002	1.02	1.67	1.33	314	142	90
2003	0.99	1.64	1.21	304	140	88
2004	0.83	1.59	1.12	309	137	85
2005	0.70	1.57	1.05	304	134	84
2006	0.65	1.52	1.00	303	133	82
2007	0.57	1.45	0.97	292	130	80
2008	0.49	1.31	0.89	279	126	76
2009	0.39	1.14	0.80	281	115	70
2010	0.41	1.11	0.77	286	116	70
2011	0.38	1.03	0.75	290	113	67

Source: National Atmospheric Emissions Inventory

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Table 2: Emissions of air pollutants by source in the UK, 2010 and 2011 (Thousand tonnes)

	Source	2010 SO_2	2010 NO_x	2010 NMVOC	2010 NH_3	2010 PM_{10}	2010 $PM_{2.5}$	**2011** SO_2	**2011** NO_x	**2011** NMVOC	**2011** NH_3	**2011** PM_{10}	**2011** $PM_{2.5}$
1	Energy industries (Combustion in power plants & Energy Production)	236.17	329.81	4.84	0.83	8.20	4.87	232.58	312.74	4.52	0.87	8.11	4.59
2	Manufacturing Industries and Construction	73.73	179.42	23.54	0.36	11.74	9.76	61.61	167.93	21.87	0.44	10.68	8.83
3	Road Transport	0.97	368.81	53.79	10.24	25.51	18.68	0.87	338.79	43.85	9.08	23.77	17.05
4	Non-road transport	11.74	88.06	10.70	NA	3.52	3.31	10.63	91.08	10.97	NA	3.61	3.40
5	Other sectors (Commercial, residential , agriculture and fishing stationary and mobile combustion)	42.44	101.23	38.11	1.93	27.06	16.72	38.38	84.94	36.18	2.02	27.04	16.58
6	Other, Mobile (Including military)	7.60	28.03	2.11	0.00	0.93	0.89	5.59	25.99	1.98	0.00	0.85	0.81
7	Fugitive emissions	13.01	2.61	153.15	0.15	1.56	1.19	8.17	2.46	143.71	0.45	1.35	1.09
8	Industrial Processes	20.52	7.21	107.13	3.97	16.36	7.94	20.22	7.72	105.82	4.61	16.02	7.84
9	Solvent and other product use;	NA	NA	343.10	1.21	4.01	1.40	NA	NA	349.42	1.21	4.08	1.43
10	Agriculture	NA	NA	NA	249.31	12.68	2.03	NA	NA	NA	250.08	12.63	2.02
11	Waste	0.75	1.13	33.55	17.42	2.19	2.19	0.72	1.16	32.36	21.11	2.19	2.19
12	Other* (included in national total for entire territory)	NA	0.27	1.41	0.28	2.65	1.44	NA	0.27	1.41	0.28	2.62	1.44
	NATIONAL TOTAL	**406.92**	**1106.58**	**771.44**	**285.69**	**116.40**	**70.42**	**378.77**	**1033.08**	**752.08**	**290.15**	**112.92**	**67.24**
	Memo items**	93.93	341.18	104.39	8.16	36.74	24.37	86.55	373.14	105.57	8.16	38.91	26.78

* Emissions from Gibraltar are included in national total

** Memo Items are reported but EXCLUDED from national totals. Memo items include: International & National Aircraft (cruise), International Shipping, VOC emissions from forest fires and NH3 emissions from wild animals and humans, Natural Emissions (Volcanoes)

Source: National Atmospheric Emissions Inventory

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