Department for Environment Food & Rural Affairs

STATISTICAL RELEASE: 21 DECEMBER 2016

EMISSIONS OF AIR POLLUTANTS IN THE UK, 1970 TO 2015

- There has been a long term decrease in the emissions of all of the air pollutants covered by this statistical release (ammonia, nitrogen oxides, non-methane volatile organic compounds, particulate matter (PM_{10}, $PM_{2.5}$) and sulphur dioxide).

- Emissions of sulphur dioxide decreased by 23 per cent from 2014 to 2015, dropping to the lowest level in the time series.

- Emissions of nitrogen oxides decreased in 2015 compared to 2014 by 4.0 per cent, dropping to the lowest level in the time series.

- Emissions of non-methane volatile organic compounds are continuing to decline, by 0.6 per cent between 2014 and 2015. The rate of decline was most pronounced in the 1990s and early 2000s and has slowed in recent years.

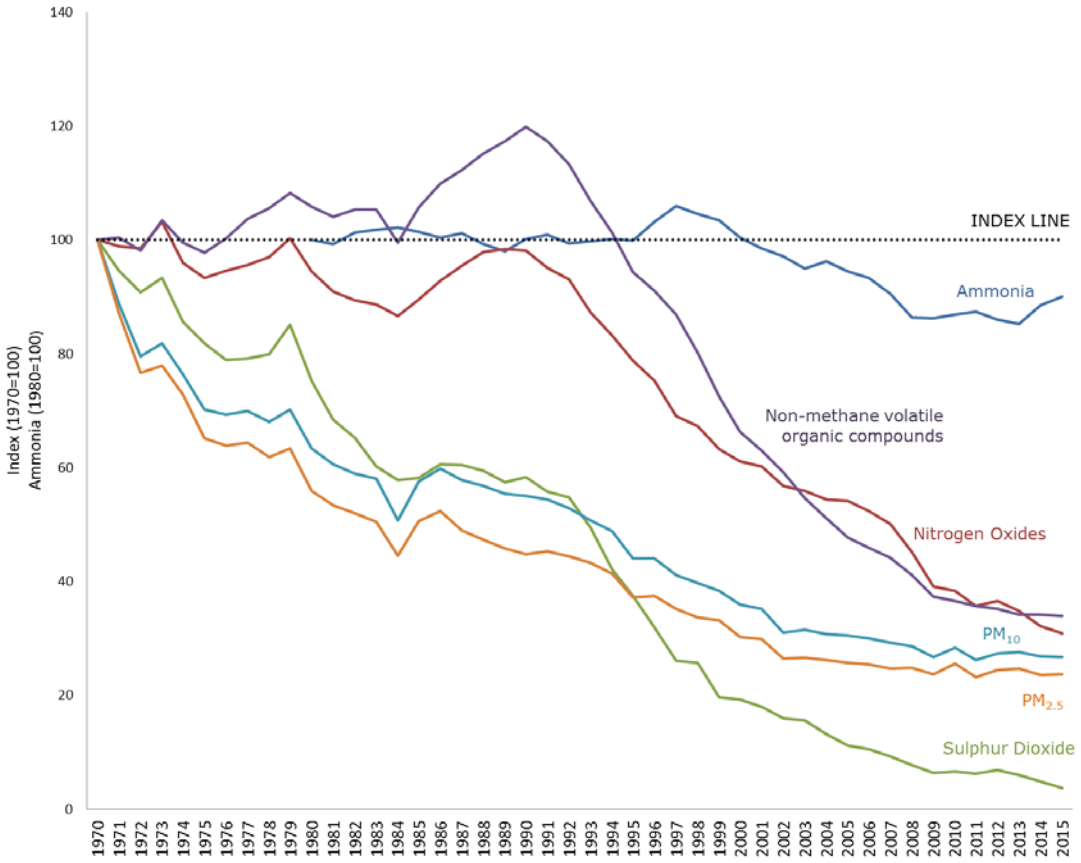
- PM_{10} emissions have remained relatively static over the past five years decreasing by less than 0.1 kilotonnes from 2014 to 2015.

- $PM_{2.5}$ emissions increased slightly by 0.9 per cent between 2014 and 2015. 2015 emissions are below the peak value of the last ten years, observed in 2010.

- There was an increase of 1.7 per cent in emissions of ammonia between 2014 and 2015. Increases in the past two years go against the trend of steady reduction observed from 1997 to 2013.

- The UK continues to meet current international and EU ceilings for emissions of ammonia, nitrogen oxides, non-methane volatile organic compounds and sulphur dioxide. The Gothenburg Protocol under the UNECE Convention on Long-range Trans-boundary Air Pollution was revised in 2012 to set new emission ceilings to apply from 2020. These ceilings are indicated in the charts of the results.

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 – 2015



The index line is a comparator that shows the level of emissions if they had remained constant from the beginning of the time series.

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, but not limited to, power stations, transport, 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. Knowledge of the sources of pollution aids the development of strategies to reduce air pollution from human activities and thereby reduce the impact of pollution 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); and
- particulate matter (PM_{10} and $PM_{2.5}$) [3].

This is consistent with the reporting under the EU National Emissions Ceiling Directive. Data on emissions of other air pollutants will be available in April 2017 from the NAEI website[1].

The Effects of Air Pollution

Air pollution has negative impacts on human health and the environment. Long term exposure to particulate matter contributes to the risk of developing cardiovascular diseases and lung cancer[4]. Particles can be inhaled and penetrate into the lungs. The smaller the particles, the deeper they can penetrate into the lungs and therefore health impacts are more strongly associated with the smaller $PM_{2.5}$ fraction. As well as being emitted directly, particulate matter 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.

Low level ozone also has an impact on health. This is formed when emissions of NO_x and NMVOCs react together in the atmosphere and, at higher

[1] http://naei.defra.gov.uk/index.php
[2] NO_x are emitted during fuel combustion, such as from road transport and industrial facility activities.
[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 (primary PM) or formed from reactions between other pollutants (e.g. NO_2, SO_2, NH_3) in the air (secondary PM). The NAEI only considers the emissions of primary PM.
[4] http://www.eea.europa.eu/publications/air-quality-in-europe-2016

concentrations, can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases[5].

Air pollution also damages ecosystems through:

- **acidification** (SO_2, NO_x and NH_3) - where chemical reactions involving air pollutants create acidic compounds which when deposited on land and aquatic systems can cause harm to soils, vegetation and buildings
- **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 NO_x and NMVOCs produce the toxic gas ozone (O_3) which can damage wild plants, crops, forests and some materials and is a greenhouse gas contributing to the warming of the atmosphere.

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

Reducing air pollutant emissions

Reductions in air pollutant emissions[6] 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, flue gas desulphurisation on coal power stations). Changes in behaviour such as individuals making more sustainable transport choices as well as wider economic conditions also impact on pollutant emissions.

Transboundary air pollution

While reducing UK emissions of air pollutants helps reduce atmospheric concentrations in the UK, the level of reduction in atmospheric concentrations is not always proportionate to the reduction in emissions. This is in part because of the transboundary nature of air pollution. 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 due to an increase in emissions of ozone precursors outside Europe. Ozone concentrations are also affected by complex chemical reactions between nitric oxide and ozone in the atmosphere.

There are two main sources of controls on trans-boundary air pollution:

- the **Gothenburg Protocol to the UNECE Convention on Long Range Trans-boundary Air Pollution (CLRTAP)** - sets 2010

[5] WHO, 2008, Air quality and health, Fact sheet no 313 (http://www.who.int/mediacentre/factsheets/fs313/en/).
[6] For Defra policy on air emissions see www.defra.gov.uk/environment/quality/air/air-quality/

emissions ceilings for the same pollutants and includes countries outside the EU. This Protocol was revised in May 2012 to set stricter emission reduction obligations from 2020. The Protocol has also been extended to set emission reductions for $PM_{2.5}$.

- the EU **National Emission Ceilings Directive (NECD)** – sets annual ceilings for emissions of sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds, and ammonia from each Member State. A revised Directive which sets ceilings for 2020 (in line with Gothenburg Protocol ceilings) and 2030 for these four air pollutants as well as $PM_{2.5}$ is expected to enter into force by 31 December 2016. The revised NECD will implement the 2020 Gothenburg Protocol Ceilings in the EU.

The NAEI is used to monitor emissions against these ceilings, and the UK figures are reported annually to the European Commission[7] and to the UNECE. The statistics presented below compare UK emissions against 2010 emission ceilings under the Gothenburg Protocol and the National Emission Ceilings Directive, and 2020 emission ceilings under the amended Gothenburg Protocol and revised National Emission Ceilings Directive.

Understanding air pollutant emissions figures

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

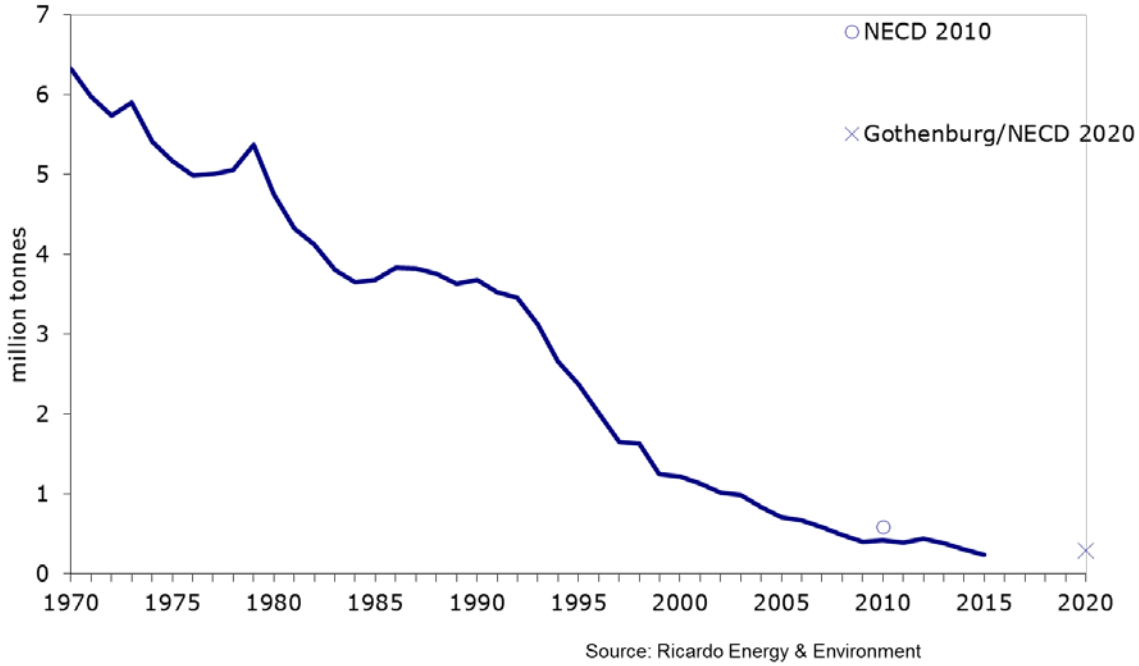
It is not practical, except for a limited number of large industrial processes, to measure emissions from all sources directly, so the NAEI is based on highly detailed calculation methods, assumptions and representative measurements on the amount of each air pollutant generated from different activities and the level of that activity in the UK. Refer to the NAEI[8] 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 totals, trends over time are likely to be more reliable. The breakdown of emissions by source sector is more uncertain than the national totals.

[7] www.eea.europa.eu/
[8] http://naei.defra.gov.uk/index.php

Sulphur dioxide

Figure 2: UK Sulphur dioxide emissions and targets: 1970 – 2015

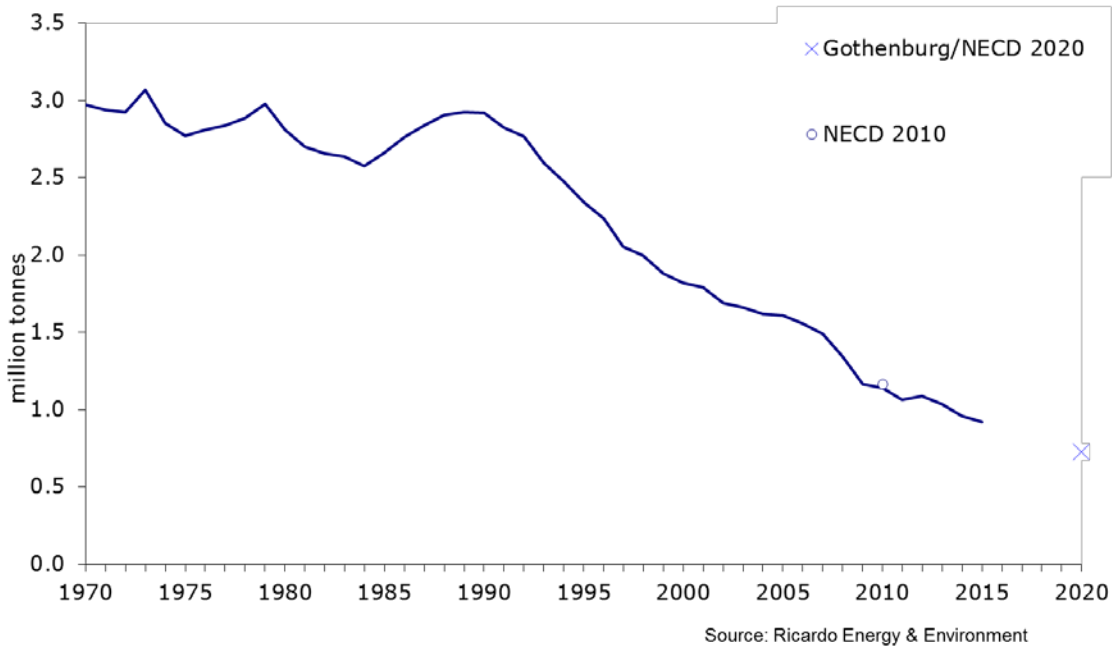


- Emissions of sulphur dioxide in 2015 have fallen by 96 per cent since 1970, to 0.24 million tonnes.
- Emissions decreased by 23 per cent from 2014 to 2015, dropping to the lowest level in the time series.
- The UK meets the 2010 ceilings for emissions in EU and international legislation. The revised Gothenburg Protocol requires the UK to reduce sulphur dioxide emissions by 2020 by 59 per cent compared to 2005 emissions.

The main source of sulphur dioxide (SO_2) emissions in 2015 was from combustion in energy production and transformation (54 per cent), followed by combustion in manufacturing industries (21 per cent). It is reductions from these sources that have been the strongest drivers for the long term trend of decreasing 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. The decrease in SO_2 emissions in recent years, with UK emissions falling by 46 per cent between 2012 and 2015, was largely due to the closure of a number of coal-fired power stations that had reached the end of their working lifetime. These closures, together with the conversion of a few other coal-fired units to burn biomass instead, have significantly reduced the overall coal-burning capacity.

Nitrogen oxides

Figure 3: UK Nitrogen oxides emissions and targets: 1970 - 2015



- Emissions of nitrogen oxides in 2015 have fallen by 69 per cent since 1970, to 0.92 million tonnes.

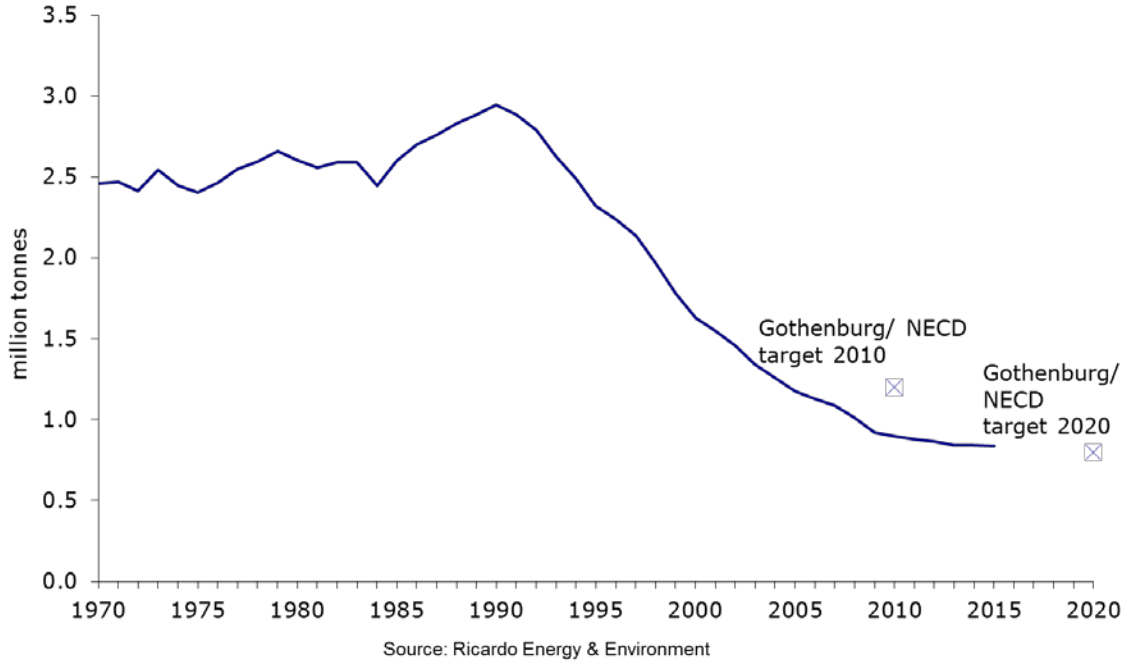
- There was a decrease in emissions in 2015 by 4.0 per cent compared to 2014. This is slightly below the long-term trend, since emissions have fallen by an average of 4.5 per cent per year between 1990 and 2015.

- The UK meets the 2010 ceilings for emissions in EU and international legislation to reduce emissions of nitrogen oxides. The revised Gothenburg Protocol requires the UK to reduce nitrogen oxide emissions by 55 per cent compared to 2005 emissions by 2020.

Increases in road traffic account for the steep climb in nitrogen oxide (NO_x) emissions between 1984 and 1989. The introduction of catalytic converters and stricter emission regulations have resulted in a strong downward trend since 1990. However road transport still accounts for 34 per cent of UK NO_x emissions in 2015 and the rate of reduction from this sector has slowed down due to the increased contribution from diesel vehicles. Emissions from power stations and industrial combustion plant have also reduced significantly, reflecting a long-term trend away from the use of coal and oil in favour of natural gas and renewable energy sources. The recent 16 per cent decrease in total NO_x emissions between 2012 and 2015 occurred due to similar reasons to those detailed for SO_2: the closure of a number of coal-fired power stations meant that emissions from the energy industries fell by 27 per cent over that period which was the greatest change for any emissions source group. Road transport and industrial combustion emissions, in comparison, fell by 9 per cent and 12 per cent respectively.

Non-methane volatile organic compounds

Figure 4: UK Non-methane volatile organic compounds emissions and targets: 1970-2015



- Emissions of non-methane volatile organic compounds (NMVOCs) in 2015 have fallen by 66 per cent since 1970, to 0.84 million tonnes.

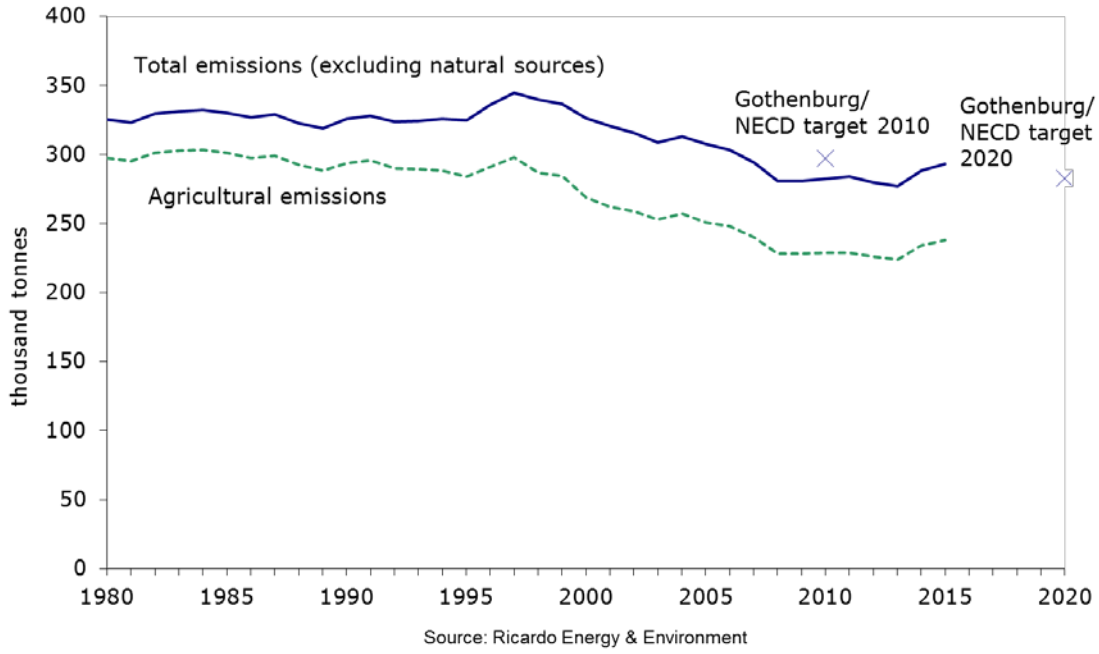
- There was a slight decrease in emissions of 0.6 per cent between 2014 and 2015. NMVOC emissions peaked in 1990 and then fell by an average of 6 per cent per year between 1990 & 2009. Since then, changes have been much smaller, averaging just 1.6 per cent lower each year.

- The UK meets the 2010 ceilings for emissions in EU and international legislation to reduce emissions of NMVOCs. The revised Gothenburg Protocol requires the UK to reduce non-methane volatile organic compound emissions by 32 per cent compared to 2005 emissions by 2020.

Road transport, chemical processes, industrial solvent use, coal mining, and the production, refining and distribution of petroleum fuels were the primary sources of NMVOC emissions in the early 1990s, contributing 80 per cent of the total emission in 1990. The marked decrease in NMVOC emissions since the early 1990s largely reflects the decline of coal mining in the UK and stricter limits placed on emissions from the rest of these sources. Emissions from these sources are now much lower and only a minor component – 37 per cent - of the UK total in 2015. Emissions from residential combustion, agriculture, food and drink manufacture, and use of solvents in consumer products have not significantly reduced and these sources now contribute a higher proportion of emissions than previously (13 per cent in 1990, and 47 per cent in 2015). As a result, the rate of decrease in NMVOC emissions has slowed.

Ammonia

Figure 5: UK Ammonia emissions and targets: 1980-2015



- Emissions of ammonia in 2015 have fallen by 9.9 per cent since 1980, to just over 290 thousand tonnes.

- There was an increase of 1.7 per cent in emissions of ammonia between 2014 and 2015. Increases in the past two years go against the trend of the steady reduction observed from 1997 to 2013.

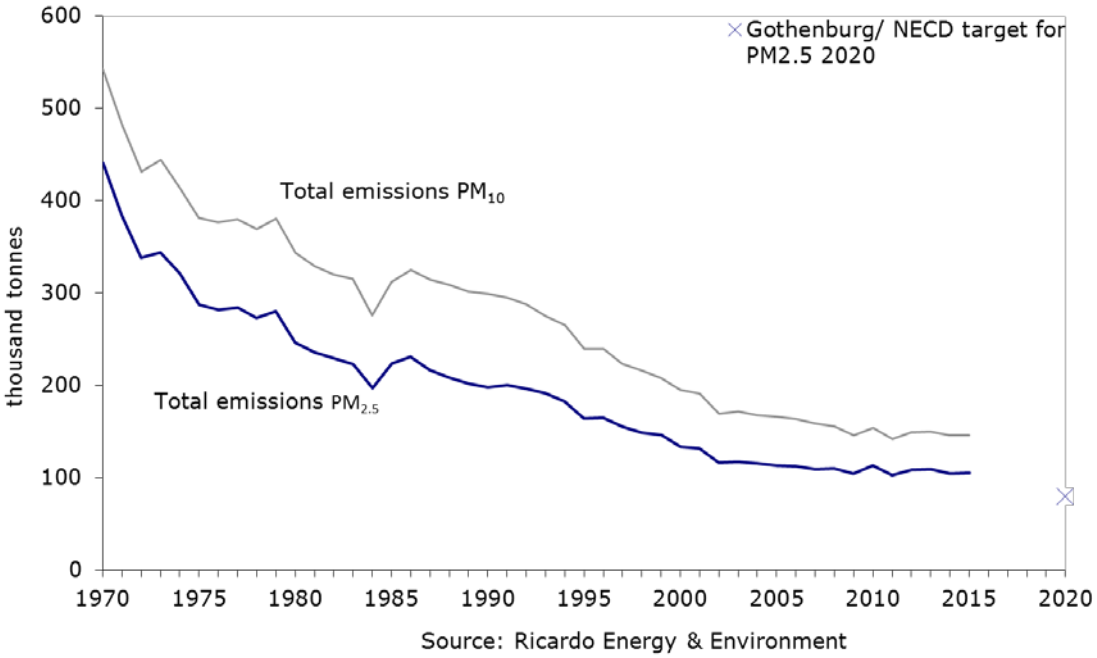
- The UK meets the 2010 ceilings for emissions in EU and international legislation to reduce emissions of ammonia. The revised Gothenburg Protocol requires the UK to reduce ammonia emissions by 8 per cent compared to 2005 emissions by 2020.

Emissions from agriculture accounted for 81 per cent of total ammonia emissions in 2015 and are the main driver for the emissions increase observed in the past two years, with emissions from agriculture increasing from just over 220 kilotonnes in 2013 to just under 240 kilotonnes in 2015. The increase in agricultural emissions over this period is largely due to larger dairy herds, where emissions increase by 2.7 kilotonnes, and 11.5 kilotonnes greater emissions from organic and urea-based fertilisers. However, agriculture's contribution to the total has decreased slightly since 1980 (from 91 per cent in 1980 to 81 per cent in 2015). Other significant contributions to the total come from waste disposal, non-agricultural animals (horses & domestic pets), and road transport (8 per cent, 6 per cent and 2 per cent respectively in 2015). Emissions classed as "waste disposal" are growing, partly due to anaerobic digestion[9], emissions from which have increased by 70 per cent since 2013, reaching about 10 kilotonnes by 2015.

[9] Emissions from anaerobic digestion have been included in the time series for the first time as methodology is available from the latest 2016 EMEP/EEA air pollutant emission inventory guidebook.

Particulate Matter

Figure 6: UK PM_{10} and $PM_{2.5}$ emissions and targets: 1970-2015



- Emissions of PM_{10} in 2015 have fallen by 73 per cent since 1970, to just under 150 thousand tonnes.

- Emissions of $PM_{2.5}$ in 2015 have fallen by 76 per cent since 1970, to just over 100 thousand tonnes.

- PM_{10} emissions decreased by less than 0.1 kilotonnes from 2014 to 2015. $PM_{2.5}$ emissions increased slightly by 0.9 per cent between 2014 and 2015. The trend for both pollutants has been fairly static over the past 6 years with emissions of both pollutants only very marginally higher in 2015 than in 2009.

- The revised Gothenburg Protocol requires the UK to reduce emissions of $PM_{2.5}$ by 30 per cent compared to 2005 emissions by 2020.

Emissions from road transport accounted for 14 per cent of PM_{10} and 13 per cent of $PM_{2.5}$ in 2015 and is the third largest source after combustion in residential, public, commercial & agricultural sectors, and industrial processes. The contribution from the category covering combustion in the residential, public, commercial & agricultural sectors has increased over recent years and peaked in 2013 at 51 kilotonnes PM_{10} and 50 kilotonnes $PM_{2.5}$. In 2014 there was reduced fuel demand in the domestic sector but consumption increased again in 2015 and estimated emissions from residential, public, commercial combustion were 48 kilotonnes for PM_{10} and 47 kilotonnes for $PM_{2.5}$. Most of the emissions from residential, public, commercial combustion in these last 3 years – 79 per cent for both pollutants - are from the use of wood as a domestic fuel.

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.

Responsible Defra statisticians: Neil Ward

Main notes

1. The figures presented in the text of this release have been rounded to two significant figures where appropriate.

2. Table 1 below shows the emissions figures for the six pollutants, from 1970 to 2015. The figures from this table have been rounded to three significant figures.

3. Table 2 below shows the emissions by source for 2014 and 2015. The figures in this table have been rounded to one decimal place.

4. The figures in this Defra National Statistics Release are from the National Atmospheric Emissions Inventory for 1970 to 2015, produced for Defra and the Devolved Administrations by Ricardo Energy & Environment. For further information on the Inventory see the NAEI website.

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

6. Results for other air pollutants will be accessible on the NAEI website released in April 2017.

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

8. Results for greenhouse gases, also covered in the NAEI, are published by the Department for Business, Energy & Industrial Strategy (BEIS) in a separate National Statistics release. For further details visit the BEIS website.

Table 1: Emissions of air pollutants in the UK, 1970 to 2015

Year	Sulphur dioxide (Million tonnes)	Nitrogen oxides (Million tonnes)	Non-methane volatile organic compounds (Million tonnes)	Ammonia (excluding natural sources) (Thousand tonnes)	PM_{10} (Thousand tonnes)	$PM_{2.5}$ (Thousand tonnes)
1970	6.32	2.97	2.46	no data	543	441
1971	5.98	2.94	2.47	no data	482	385
1972	5.74	2.93	2.41	no data	432	338
1973	5.90	3.07	2.54	no data	444	344
1974	5.42	2.85	2.45	no data	415	321
1975	5.17	2.77	2.40	no data	381	288
1976	4.99	2.81	2.47	no data	376	282
1977	5.01	2.84	2.55	no data	380	284
1978	5.06	2.88	2.60	no data	369	273
1979	5.38	2.98	2.66	no data	381	280
1980	4.76	2.81	2.60	325	344	246
1981	4.33	2.70	2.56	323	329	235
1982	4.13	2.66	2.59	330	320	230
1983	3.81	2.64	2.59	331	315	223
1984	3.66	2.57	2.45	332	275	197
1985	3.68	2.66	2.60	330	312	223
1986	3.83	2.76	2.70	327	325	231
1987	3.83	2.84	2.76	329	314	216
1988	3.76	2.91	2.83	323	309	209
1989	3.63	2.92	2.89	319	301	202
1990	3.69	2.92	2.95	326	299	198
1991	3.53	2.83	2.89	328	295	200
1992	3.46	2.76	2.79	323	288	196
1993	3.13	2.59	2.63	324	275	191
1994	2.66	2.47	2.49	326	265	183
1995	2.37	2.34	2.32	325	240	164
1996	2.02	2.24	2.24	336	239	165
1997	1.65	2.05	2.14	345	223	155
1998	1.63	2.00	1.97	340	216	149
1999	1.25	1.88	1.78	336	208	146
2000	1.22	1.82	1.63	326	195	134
2001	1.14	1.79	1.55	320	191	132
2002	1.01	1.69	1.46	316	169	117
2003	0.99	1.66	1.34	309	172	117
2004	0.83	1.62	1.26	313	167	116
2005	0.71	1.61	1.17	307	166	113
2006	0.67	1.56	1.13	303	163	112
2007	0.59	1.49	1.09	294	159	109
2008	0.49	1.34	1.01	281	155	110
2009	0.40	1.16	0.92	281	145	105
2010	0.42	1.14	0.90	282	154	113
2011	0.39	1.06	0.88	284	142	102
2012	0.44	1.09	0.87	280	149	108
2013	0.38	1.03	0.84	277	150	109
2014	0.31	0.96	0.84	288	146	104
2015	0.24	0.92	0.84	293	145	105

Source: National Atmospheric Emissions Inventory

Table 2: Emissions of air pollutants by source in the UK, 2014 and 2015 (Thousand tonnes)

	Source	2014						2015					
		SO_2	NO_x	NMVOC	NH_3	PM_{10}	$PM_{2.5}$	SO_2	NO_x	NMVOC	NH_3	PM_{10}	$PM_{2.5}$
1	Energy industries (Combustion in power plants & Energy Production)	158.9	291.3	4.6	0.1	7.5	4.6	126.4	262.8	4.3	0.1	5.9	3.8
2	Manufacturing Industries and Construction	75.5	149.9	19.0	1.7	19.0	18.0	50.2	151.2	19.6	1.9	18.4	17.4
3	Road Transport	1.2	321.1	28.7	5.7	21.0	14.4	1.2	311.4	26.0	5.1	20.6	13.9
4	Non-road transport	7.9	89.1	11.3	0.0	3.7	3.5	2.9	87.1	11.4	0.0	3.7	3.5
5	Other sectors (Commercial, residential , agriculture and fishing stationary and mobile combustion)	41.6	83.9	49.3	1.9	44.9	43.9	40.4	84.6	51.6	2.1	48.0	46.8
6	Other, Mobile (Including military)	3.9	16.3	1.0	0.0	0.4	0.4	1.1	16.0	1.0	0.0	0.4	0.4
7	Fugitive emissions	7.7	2.1	150.1	0.2	2.1	1.4	5.3	2.2	145.1	0.1	2.1	1.4
8	Industrial Processes	7.9	1.6	468.4	4.4	27.6	10.2	7.9	1.7	468.6	3.6	27.3	10.1
9	Agriculture	NA**	NE**	102.3	234.2	15.1	3.8	NA**	NE**	102.2	237.6	15.0	3.8
10	Waste	0.8	1.3	4.8	21.0	1.9	1.7	0.8	1.3	4.6	23.2	1.9	1.7
11	Other* (included in national total for entire territory)	NA**	0.1	1.0	18.8	2.1	1.9	NA**	0.1	1.0	18.9	2.1	2.0
	NATIONAL TOTAL	305.4	956.7	840.6	288.0	145.5	103.9	236.1	918.3	835.4	292.8	145.5	104.8
	Memo items	73.8	371.6	101.1	8.7	34.0	18.5	40.6	342.8	99.9	8.4	32.0	16.4

* Memo Items reported, but EXCLUDED from protocol totals. Includes: International&National Aircraft (cruise), International Shipping, forest fires, natural emissions, NH3 emissions from wild animals and humans.

**NE (Not estimated); NA (Not applicable - the source exists but relevant emissions are considered never to occur)

Source: National Atmospheric Emissions Inventory