National Atmospheric Emissions Inventory

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Air Quality Pollutant Inventories for England, Scotland, Wales and Northern Ireland: 1990-2013

A report of the National Atmospheric Emissions Inventory

September 2015

Aether

RICARDO-AEA

Air Quality Pollutant Inventories for England, Scotland, Wales and Northern Ireland: 1990-2013

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A copy of this report and related data may be found on the Defra NAEI website: http://naei.defra.gov.uk/

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Glossary

AQ	Air quality
AQPI	Air quality pollutant inventory
AQS for ESWNI	Air Quality Strategy for England, Scotland, Wales and Northern Ireland
NH_3	Ammonia
BAT	Best Available Techniques
BOFA	Boosted Over Fire Air
CO	Carbon monoxide
CCGT	Combined Cycle Gas Turbine
Defra	Department for Environment, Food & Rural Affairs
DECC	Department of Energy and Climate Change
DA	Devolved Administration
DERV	Diesel engine road vehicle
DUKES	Digest of UK Energy Statistics
DVLA	Driver and Vehicle Licensing Agency
EEMS	Environmental and Emissions Monitoring System
EPR	Environmental Permitting Regulations
EU ETS	EU Emissions Trading System
EC	European Commission
EEA	European Environment Agency
EMEP	European Monitoring and Evaluation Programme
EU	European Union
EPAQS	Expert Panel on Air Quality Standards
FGD	Flue-gas desulphurization
GHG	Greenhouse Gas
GDP	Gross Domestic Product
IED	Industrial Emissions Directive
IIR	Informative Inventory Report
IPPC	Integrated Pollution Prevention and Control
IPPCD	Integrated Pollution Prevention and Control Directive
LCPD	Large Combustion Plant Directive
LDV	Light duty vehicles
Pb	Lead
LPG	Liquefied Petroleum Gas
LA	Local Authority
MSW	Municipal solid waste
NAQS	National Air Quality Strategy
NAEI	National Atmospheric Emissions Inventory
NECD	National Emissions Ceiling Direction
NO_X	Nitrogen oxides
NFR	Nomenclature for Reporting
NMVOC	Non-methane volatile organic compounds
PM_{10}	Sub-10 micron particulate matter
SED	Solvent Emissions Directive
SO_2	Sulphur dioxide
UK	United Kingdom
UNECE	United Nations Economic Commission for Europe
WID	Waste Incineration Directive
WHO	World Health Organization

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1. Introduction

This is the Air Quality Pollutant Inventory Report for England, Scotland, Wales and Northern Ireland. The report presents emission inventories for the Devolved Administrations of the UK for the period 1990 to 2013, for the following priority Air Quality (AQ) pollutants:

- Ammonia (NH_3)
- Carbon monoxide (CO)
- Nitrogen oxides (NO_X as NO_2)
- Non-methane volatile organic compounds (NMVOCs)
- Sub-10 micron particulate matter (PM_{10})
- Sulphur dioxide (SO_2)
- Lead (Pb)

These inventories are compiled on behalf of the UK Department for Environment, Food & Rural Affairs (Defra), the Scottish Government, the Welsh Government and the Department of Environment for Northern Ireland, by the UK emission inventory teams at Ricardo-AEA, Aether and Rothamsted Research.

1.1. Background to Inventory Development

The development of Air Quality pollutant inventories (AQPI) for each of the Devolved Administrations (DAs) has been commissioned by Defra in order to better inform energy and environmental policy-makers within the Devolved Administrations in their pursuit of objectives set by the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS for ESWNI). These objectives also contribute to the UK's targets as a whole in terms of meeting both national and international targets on both local and transboundary air pollution.

The provision of DA-level datasets and subsequent identification of key sources at more regional and local levels is a key step to enable prioritisation of local action and to highlight the potential impacts of specific policies and measures. The time-series of AQ pollutant emissions provides an insight into the effects of environmental policies, and may help to identify where win-win policies could be pursued to achieve both Air Quality and Greenhouse Gas policy goals.

Further information on the background of the inventory development can be found in Appendix A.

1.2. About the Air Quality Pollutants

This report includes information on the seven pollutants in the Devolved Administrations' air quality pollutant inventory. Below is a brief description of each of these pollutants. Further information can be found on the NAEI website: http://naei.defra.gov.uk/overview/ap-overview, which includes the health impacts of these pollutants.

Ammonia (NH_3) emissions play an important role in a number of different environmental issues including acidification, eutrophication and changes in biodiversity. The atmospheric chemistry of NH_3 and NH_4^+ is such that transport of the pollutants can vary greatly, and that as a result, NH_3 emissions can exert impacts on a highly localised level, as well as contributing to the effects of long-range pollutant transport. Non-agricultural sources of ammonia comprise a number of diverse sources. Emission estimates for these sources are often highly uncertain due to a lack of activity and emission factor data.

Carbon monoxide (CO) arises from incomplete fuel-combustion and is of concern mainly due to its toxicity and its role in tropospheric ozone formation. In terms of human health, carbon monoxide combines with haemoglobin in blood, decreasing the uptake of oxygen by the lungs, with symptoms varying from nausea to asphyxiation depending upon the level of exposure.

Nitrogen oxides (NO_X) arise primarily from combustion sources. The estimation of these emissions is complex since the nitrogen can be derived from either the fuel or atmospheric nitrogen. The emission is dependent on the conditions of combustion, in particular temperature and excess air ratio, which can vary considerably. Thus combustion conditions, load and even state of maintenance are important.

Non-Methane Volatile Organic Compounds (NMVOCs) are emitted to air as combustion products, as vapour arising from handling or use of petroleum distillates, solvents or chemicals, and from numerous other sources. The diversity of

processes which emit NMVOCs is huge, covering not only many branches of industry, but also transport, agriculture and domestic sources. The Solvent and other product use sector comprises industrial and domestic solvent applications (cleaning, degreasing), as well as the manufacturing and processing of chemical products.

Particulate matter as PM_{10} is a measure of the size distribution of the particles emitted to air and represents the material with an aerodynamic diameter less than 10 micro meters. PM_{10} in the atmosphere arises from primary and secondary sources. Primary sources are direct emissions of particulate matter into the atmosphere, and arise from a wide range of sources such as fuel combustion, surface erosion and wind-blown dusts and mechanical break-up in, for example, quarrying and construction sites.

Particulate matter may be formed in the atmosphere through reactions of other pollutants such as sulphur dioxide, nitrogen oxides and ammonia to form solid sulphates and nitrates, as well as organic aerosols formed from the oxidation of NMVOCs. These are known as secondary sources. These inventories only consider primary sources. For further information on secondary particulates see the Air Quality Expert Group's Report on particulate matter in the United Kingdom (AQEG, 2005) and on fine particulate matter ($PM_{2.5}$) in the United Kingdom (AQEG, 2012).

Sulphur dioxide (SO_2) emissions can be calculated from knowledge of the sulphur content of the fuel and from information on the amount of sulphur retained in the ash. Published fuel consumption data (DECC, 2014a), sulphur contents of liquid fuels (UKPIA, 2014) and data from coal producers regarding sulphur contents of coals enable reliable estimates to be produced.

Lead emissions to air have declined significantly since 1990, with reductions occurring in most sectors. However, the decline has been mainly driven by the progressive phasing out of leaded petrol in the UK. The lead content of petrol was reduced from around 0.34 g/l to 0.143 g/l in 1986. From 1987, sales of unleaded petrol increased, particularly as a result of the increased use of cars fitted with three-way catalyst and leaded petrol was then phased out from general sale at the end of 1999.

1.3. Data Sources and Inventory Methodology

The Devolved Administrations' inventories are compiled by disaggregating the UK emission totals presented within "UK Informative Inventory Report 1990 to 2013" (A. Misra et al., 2015) derived from the National Atmospheric Emissions Inventory (NAEI) database. The emission estimates for each pollutant are presented in Nomenclature for Reporting (NFR) format, to be consistent with the UK inventory submissions to the United Nations Economic Commission for Europe (UNECE), which follow international inventory reporting guidelines.

The method for disaggregating UK emission totals across the Devolved Administrations (DAs) draws on a combination of point source data (e.g. Pollution Inventory[1] data for industrial emissions) and sub-national and local datasets such as:

- DECC sub-national statistics on energy use;
- Other regional energy use data for specific industries or regional data on raw material consumption or sector-specific production;
- Major road traffic count data;
- Domestic and international flight data for all major UK airports;
- Regional housing, employment, population and consumption data;
- Agricultural surveys (livestock numbers, crop production, fertiliser application);
- Land use survey data.

Further information on the data sources and inventory methodology can be found in Appendix B.

[1] The term "Pollution Inventory" is used here to represent the industrial emissions databases of the UK environmental regulators: the Environment Agency of England & Wales, the Scottish Environment Protection Agency and the Northern Ireland Department of Environment, which comprise annual emission estimates from all EPR/IPPC-regulated processes under their authority.

1.4. Uncertainties

The air quality pollutant inventories for England, Scotland, Wales and Northern Ireland are derived using a "top-down" approach whereby the UK inventory totals are disaggregated across the four countries. For most sources there is insufficient regional data to enable a comprehensive "bottom-up" calculation to be made, and hence available proxy data are used to estimate the country-specific share of UK activity for each emission source.

Further to the uncertainties in the UK datasets, there is an additional uncertainty inherent in the methodologies of disaggregating the UK emissions across the four countries. Further to this, there is greater uncertainty for emission estimates in the early years of the time-series, as these estimates are frequently based on very limited historic data. The air quality pollutant inventories for England, Scotland, Wales and Northern Ireland are therefore subject to greater uncertainty than the equivalent UK estimates.

Table 1 below provides an indication of the uncertainty associated with each pollutant. Further information on the uncertainties for each pollutant can be found in Appendix D.

Table 1 - Indicative uncertainty rating for each pollutant present in the DA AQPI

Pollutant	Indicative Uncertainty Rating
Ammonia	Moderate
Carbon monoxide	Moderate
Nitrogen oxides	Low
Non-methane volatile organic compounds	Low
Particulate matter (<10um)	High
Sulphur dioxide	Low
Lead	High

2. Devolved Administrations' Air Quality Pollutant Estimates

The following sections outline the findings of the inventory for each Devolved Administration, providing information on the trends and emission estimates for each of the seven air quality pollutants.

These sections include the following:

Figures graphically presenting the inventory data that can be found in the dataset: "DA_AQPI_1990-2013_Issue1.xlsx", which shows the annual trend from 1990 to 2013 for each pollutant. These graphs are also disaggregated by sector, and further information on these sectors can be found in Appendix F.

Summary information on trends is provided for each pollutant, highlighting the key reasons for the observed trend since 1990 and other significant aspects of the trend.

Normalised trends for all pollutants are graphically presented to enable pollutant comparison. This normalised graph provides information on the relative rate at which all pollutants have declined across the time-series, with 1990 emissions as the base value (equal to 1).

Mapped emissions for all pollutants are also provided to show the geographical disaggregation of each pollutant. This helps the reader to identify the more significant areas for emissions and the patterns associated with that pollutant. For example, NO_X emissions are concentrated around the road networks of the countries.

Sector contribution matrix provides an overview of the importance of each sector for each pollutant. For example, the transport sector accounts for a considerable proportion of CO, NO_X and PM_{10} emissions in some regions. This is another way in which the pollutants can be compared.

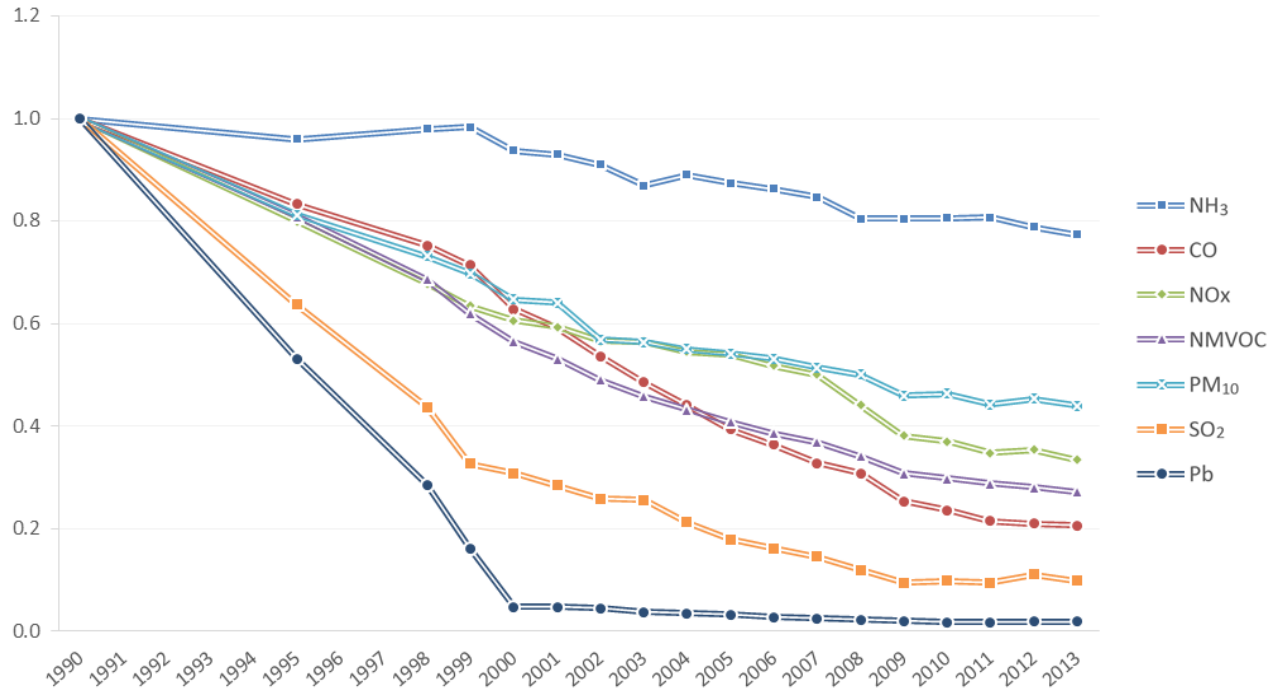
2.1. England

The following section provides a summary of emissions in England for the seven air quality pollutants: ammonia (NH_3), carbon monoxide (CO), nitrogen oxides (NO_X as NO_2), non-methane volatile organic compounds (NMVOCs), sub-10 micron particulate matter (PM_{10}), sulphur dioxide (SO_2) and lead (Pb).

Figure 1 shows emissions of all seven air quality pollutants normalised to provide the relative rate of decline since 1990. This graph shows that all pollutant emission levels are lower in 2013 than they were in 1990. The rate at which they have declined is relatively similar for PM_{10}, NO_X, NMVOC and CO. However, lead (Pb) shows a much higher rate of reduction from 1990 to 2000 due to the phase-out of leaded petrol.

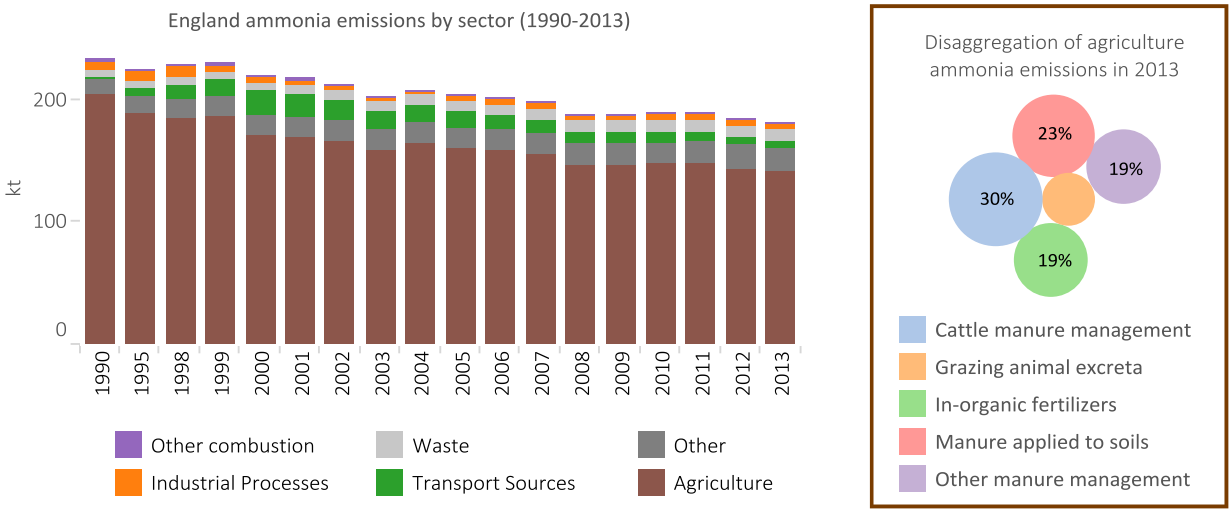
By contrast, ammonia (NH_3) emissions have declined at a slower rate than other pollutants, and have even slightly risen between 2008 and 2011 due to higher emissions from fertiliser application and increasing emissions from composting and biogas production via anaerobic digestion. Sulphur dioxide (SO_2) emissions declined rapidly between 1990 and 1999 due to the implementation of limits of the sulphur content of certain liquid fuels (Directive 1999/32/EC). Emissions of NO_X have declined notably since 2007 partly due to fitting de-NO_X abatement (Boosted Over-Fire Air) at several large coal-fired power stations, but mainly due to reductions in road transport.

Figure 1 - England normalised trends for all pollutants



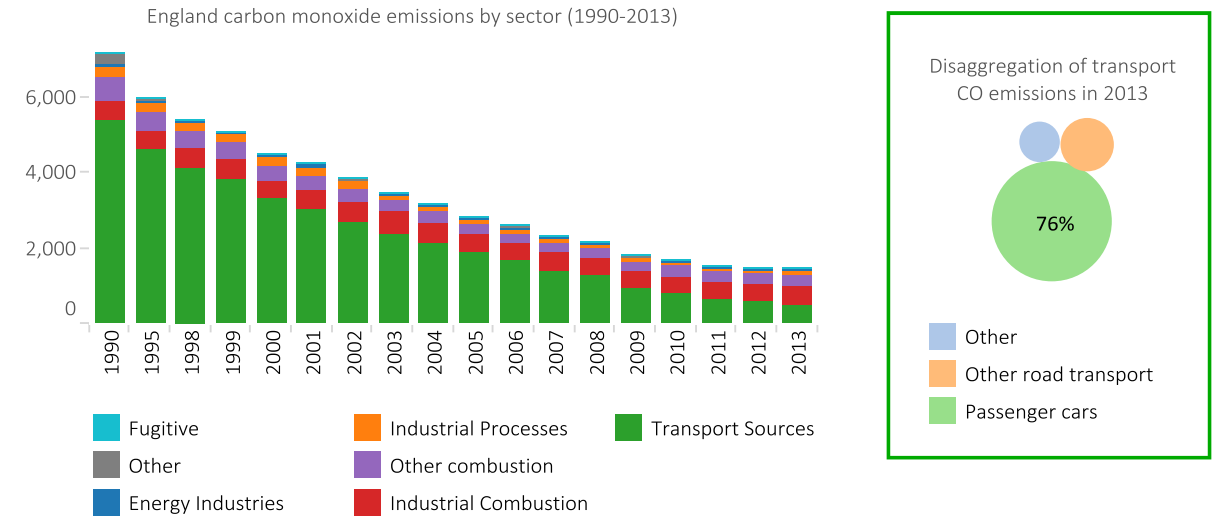
The following sections provide an overview of emissions from each of the seven pollutants giving explanations for the trends and characteristics of the graphs. Data summary tables for these emission estimates can be found in Appendix E. Mapping of the categories used in the graphs can be found in Appendix F.

Figure 2 - England Ammonia Emissions



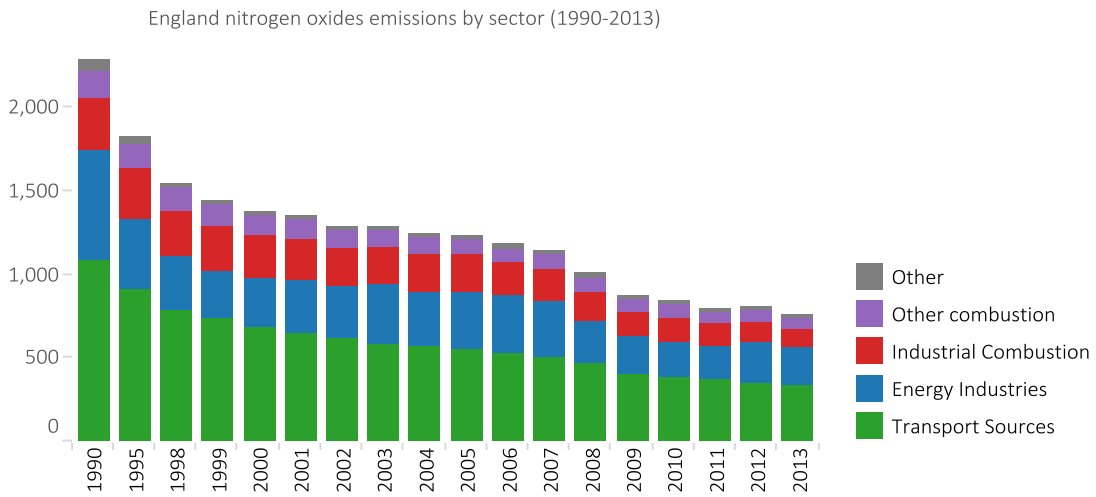
Emissions of **ammonia** were estimated to be 181kt in 2013 and have declined by 23% since 1990. England's emissions account for 67% of the UK total in 2013. Agricultural sources have dominated the inventory throughout the time series, and cattle manure management accounted for 30% of agricultural ammonia emissions in 2013. The trend in ammonia emissions has been driven by decreasing animal numbers. In addition, there has been a decline in fertiliser use, which also caused a decrease in emissions (although the decline in emissions has levelled out to some extent in recent years due to increased usage of urea-based fertilisers which are associated with much higher ammonia emission factors).

Figure 3 - England Carbon Monoxide Emissions



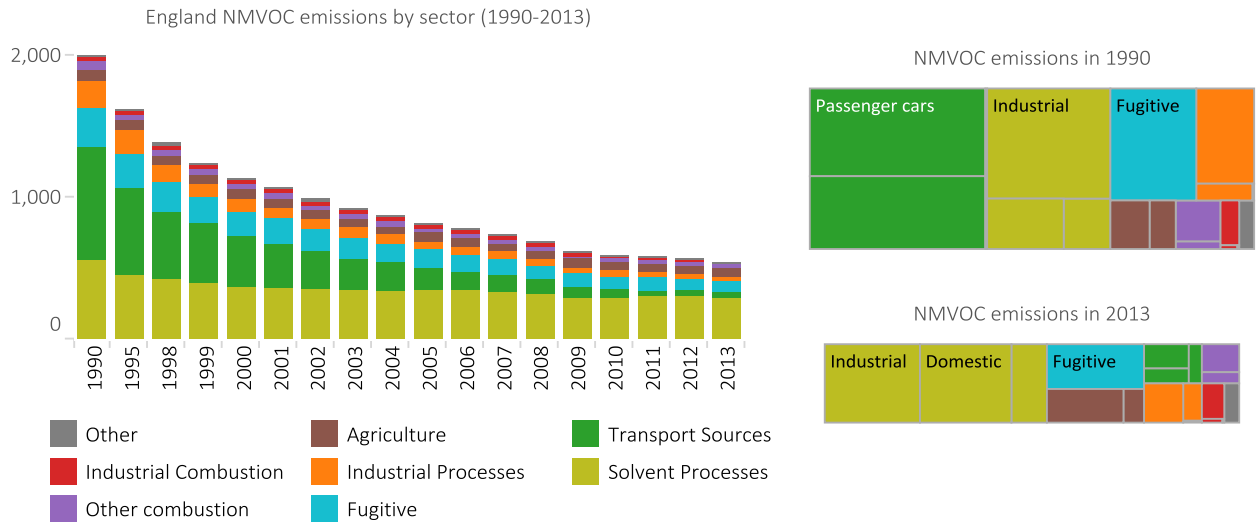
Emissions of **carbon monoxide** were estimated to be 1,474kt in 2013 and have declined by 79% since 1990. England's emissions account for 75% of the UK total in 2013. This decline in emissions stems from changes in the transport sector, more specifically, in road transport. There are a number of reasons for this decline including the requirement for new petrol cars to be fitted with three-way catalysts since 1989 and, in more recent years, the switch from petrol cars to diesel cars. Since 2008, emissions from passenger cars have decreased, which is mainly driven by improvements in catalyst repair rates. In recent years, emissions from the other combustion sector have increased, and this is due to an increasing quantity of wood combusted in the domestic sector.

Figure 4 - England Nitrogen Oxides Emissions



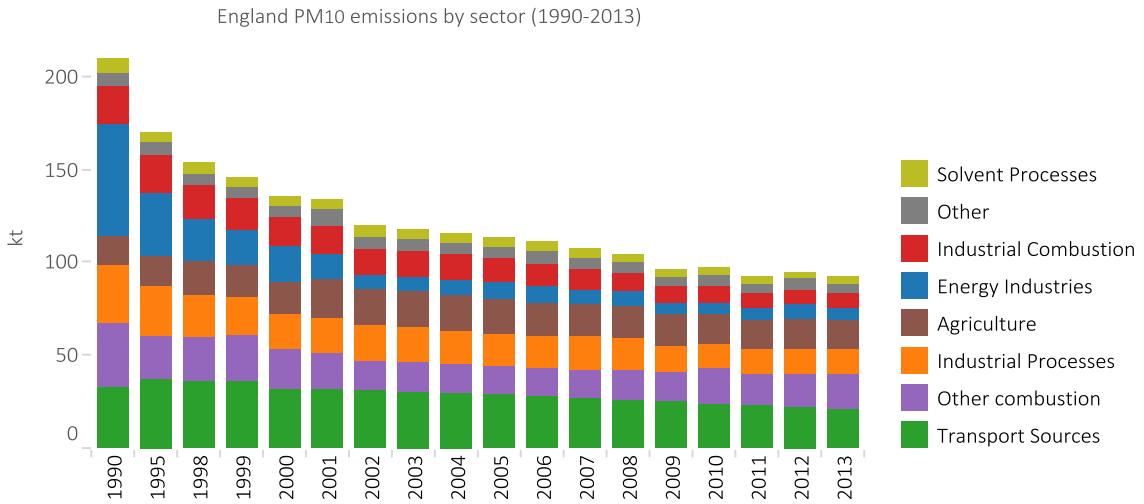
Emissions of **nitrogen oxides** were estimated to be 761kt in 2013, representing 75% of the UK total in 2013. Emissions have declined by 67% since 1990, mainly due to the changes in the road transport sector as described above for carbon monoxide regarding the fitted of three-way catalysts in road transport vehicles. Since 2008, the reduction was mainly driven by improvements in catalyst repair rates. Emission reductions across the time series from the Energy sector are primarily due to changes in the electricity generation fuel mix and the installation of NOx abatement at coal-fired power stations. Shifts in the electricity generation fuel mix in the early 1990s from coal to natural gas led to notable reductions. Since 2008, the installation of Boosted Over Fire Air (BOFA) systems across coal power stations to reduce NO_X formation and ensure compliance with the Large Combustion Plant Directive (LCPD) has led to further reductions.

Figure 5 - England NMVOC Emissions



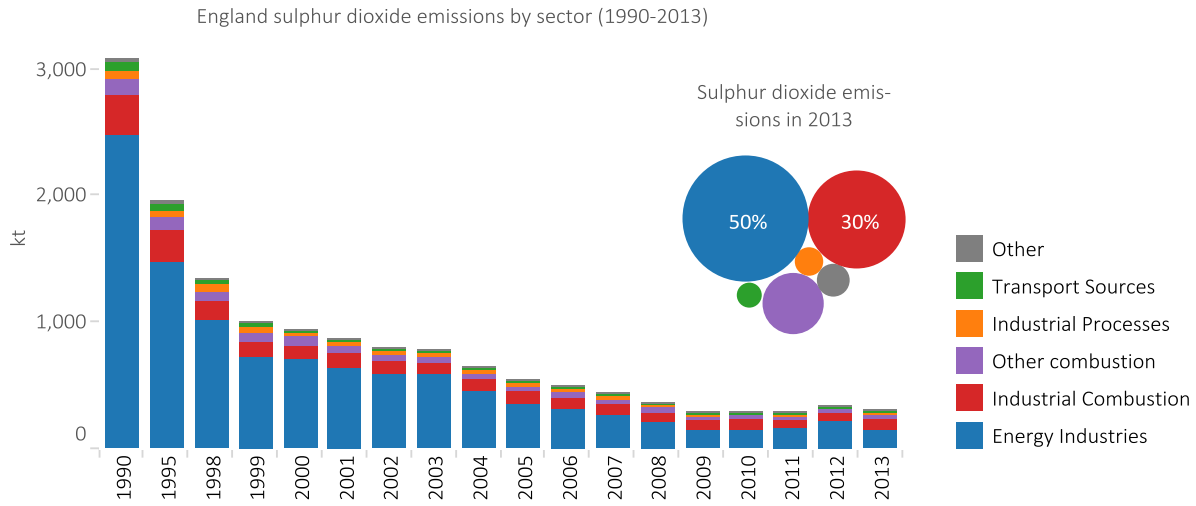
Emissions of **non-methane volatile organic compounds** were estimated to be 545kt in 2013, representing 68% of the UK total in 2013. Emissions have declined by 73% since 1990. Emissions from the chemical industry reduced during the 1990s as tighter emission controls were introduced, but the trend has been dominated by the decrease in road transport sources, including evaporative losses. Similarly to carbon monoxide and nitrogen oxides, this is mainly due to the requirement for new petrol cars to be fitted with three-way catalysts since 1989 and, in more recent years, the switch from petrol cars to diesel cars. With this large reduction in transport emissions, solvent processes is now the most significant source of NMVOC emissions.

Figure 6 - England PM_{10} Emissions



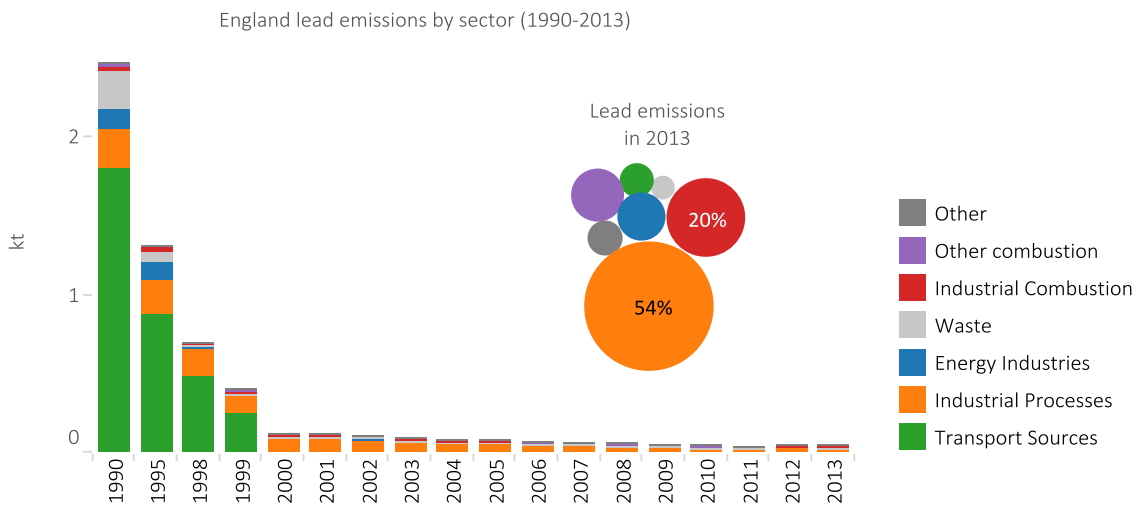
Emissions of **PM_{10}** were estimated to be 92kt in 2013 and have declined by 56% since 1990. They account for 74% of the UK total. Unlike most other pollutants, PM_{10} emissions have a large number of significant sources. Transport, other combustion, agriculture and industrial processes each accounted for over 10% of total emissions in 2013. Emissions from energy industries have had the most significant impact on the trend. The reduction in these emissions is primarily due to abatement at coal fired stations, such as flue gas desulphurisation (FGD), and the reduction in coal-fired energy generation in place of natural gas, which has negligible PM_{10} emissions. The main source of road transport emissions is exhaust gases from diesel engines, which have been decreasing due to the penetration of new vehicles meeting tighter PM_{10} emission regulations. In recent years, emissions from the other combustion sector have increased, and this is due to an increasing quantity of wood combusted in the domestic sector.

Figure 7 - England Sulphur Dioxide Emissions



Emissions of **sulphur dioxide** were estimated to be 303kt in 2013, representing 77% of the UK total in 2013. Emissions have declined by 90% since 1990, which has been dominated by the reduction in energy industries emissions due to the growth in nuclear powered generation, the installation of FGD (flue-gas desulphurization) plant at most of the larger coal-fired power stations, co-firing of biomass in coal fired power stations reducing the consumption of coal, and the introduction of CCGT (Combined Cycle Gas Turbine) plant, which are more efficient than conventional coal and oil stations and have negligible SO_2 emissions. The increase in emissions in 2012 was due to an increased use of coal in power generation. Road transport emissions have declined due to tightening of fuel standards during the 1990s and more recently due to the EU Fuel Quality Directive and its amendments leading to a reduction in the sulphur content of diesel. Emissions from waste incinerators reduced significantly during the 1990s due to the introduction of stricter emission standards forcing the closure of old-design incinerators and replacement with more modern plant.

Figure 8 - England Lead Emissions



Emissions of **lead** were estimated to be 44 tonnes in 2013, representing 70% of the UK total in 2013. Emissions have declined by 98% since 1990 almost entirely due to changes in the transport sector. Leaded petrol was phased out from general sale at the end of 1999, which is the reason for the 99.9% decrease in transport emissions between 1990 and 2000. The most significant source of emissions is now industry (industrial processes and industrial combustion) and more specifically the iron and steel industry. Improved combustion and flue gas controls, and abatement technology in modern incinerator design has resulted in a significant decline in emissions from waste incineration. Municipal Solid Waste (MSW) incinerators not meeting regulatory standards were closed in the period leading up to December 1996.

Table 2 below provides a summary of the percentage contribution of each sector for each pollutant in 2013. Using the ranking of these percentage contributions, the sectors have been ordered to provide its indicative significance across all pollutants. As such, the table below indicates that the transport sector is the most significant sector when considering emissions from all pollutants. This sector accounts for over 20% of emissions for three pollutants: CO, NO_X and PM_{10}. The majority of the important sectors are related to the combustion of fuel, whilst Industrial Processes is also significant, especially for emissions of lead from the iron and steel industry. This table also highlights that although emissions from the agriculture sector are not significant when considering all pollutants, it is of very high significance when considering emissions of ammonia (NH_3); the same is true for NMVOC emissions from solvent processes.

Table 2 - Source Emission Contributions Ranked by Sector, England 2013

Overall Rank	Sector	NH_3	CO	NO_X	NMVOC	PM_{10}	SO_2	Pb
1	Transport Sources	3.3%	35.0%	44.1%	7.0%	22.4%	2.0%	3.7%
2	Other combustion	0.8%	21.1%	8.6%	4.5%	21.7%	11.8%	9.1%
3	Industrial Combustion	0.0%	32.0%	15.3%	2.7%	8.1%	30.2%	19.9%
4	Industrial Processes	1.8%	5.3%	0.0%	6.9%	13.6%	2.5%	54.0%
5	Energy Industries	0.0%	4.6%	29.5%	0.0%	7.0%	50.1%	7.5%
6	Agriculture	78.4%	0.0%	0.0%	10.2%	17.4%	0.0%	0.0%
7	Other *	10.5%	1.7%	2.5%	1.8%	5.6%	3.4%	4.0%
8	Solvent Processes	0.0%	0.0%	0.0%	53.8%	4.2%	0.0%	0.0%
9	Fugitive	0.0%	0.3%	0.0%	13.1%	0.0%	0.0%	0.0%
10	Waste	5.2%	0.0%	0.0%	0.0%	0.0%	0.0%	1.8%
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

* The sector: "other" will include all "other" categories in the inventory and also a number of categories that are insignificant for a specific pollutant.

Emission maps for all seven pollutants are shown below.

Figure 9 - England Ammonia Emissions, 2013

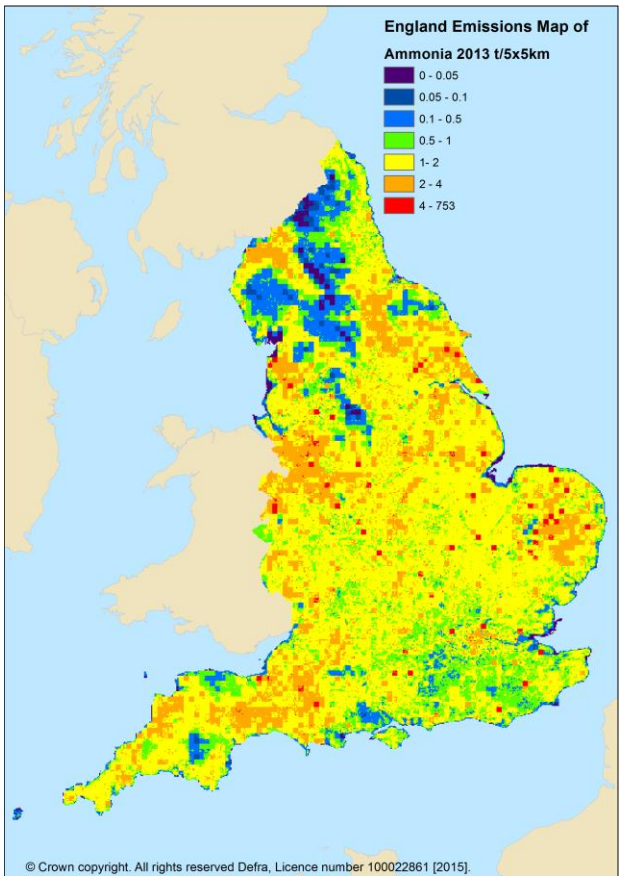


Figure 10 - England Carbon Monoxide Emissions, 2013

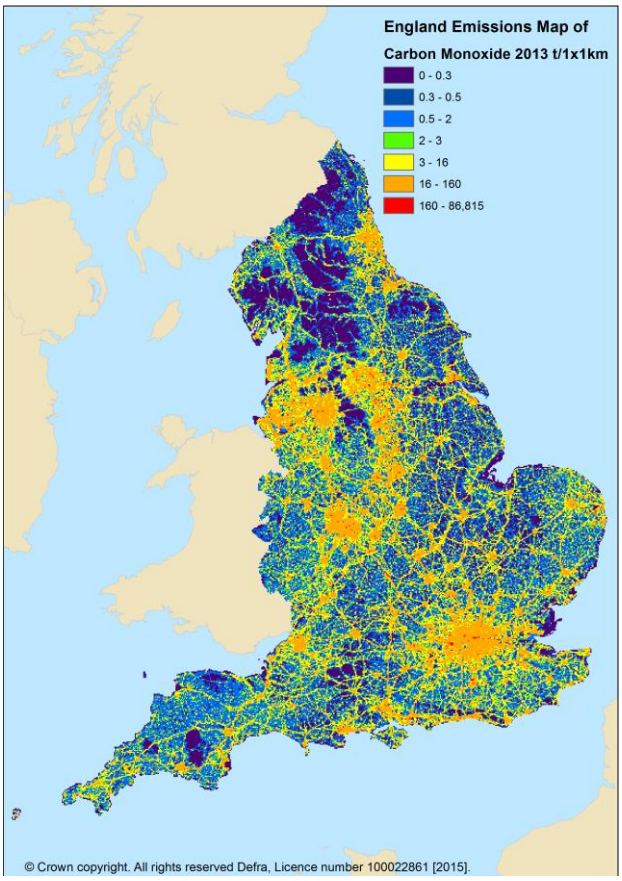


Figure 11 - England Nitrogen Oxides Emissions, 2013

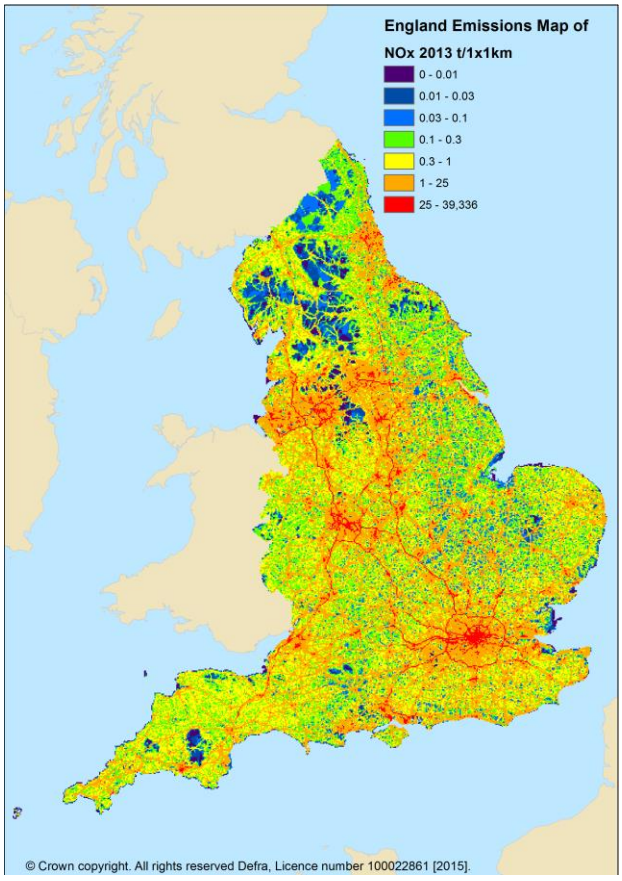


Figure 12 - England NMVOC Emissions, 2013

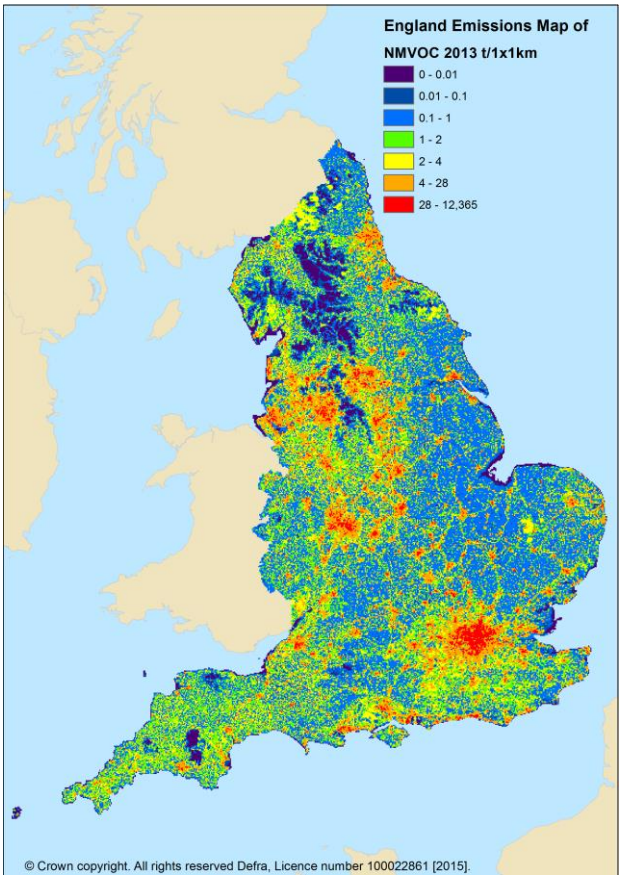


Figure 13 - England PM_{10} Emissions, 2013

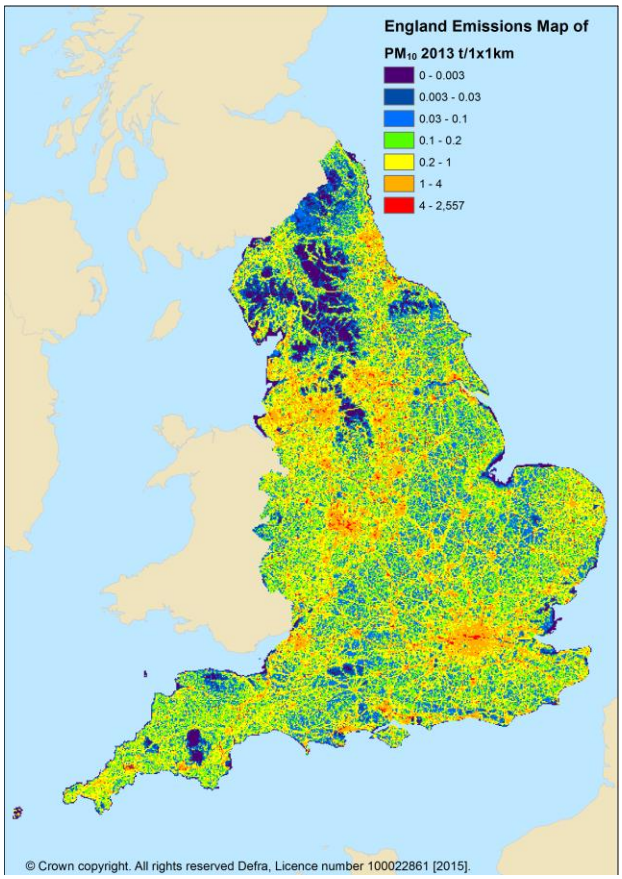


Figure 14 - England Sulphur Dioxide Emissions, 2013

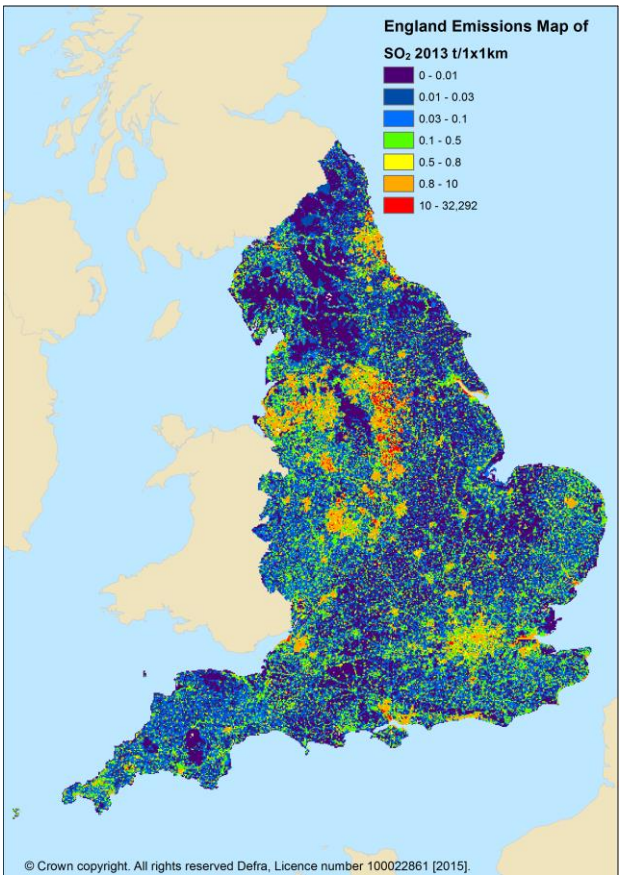
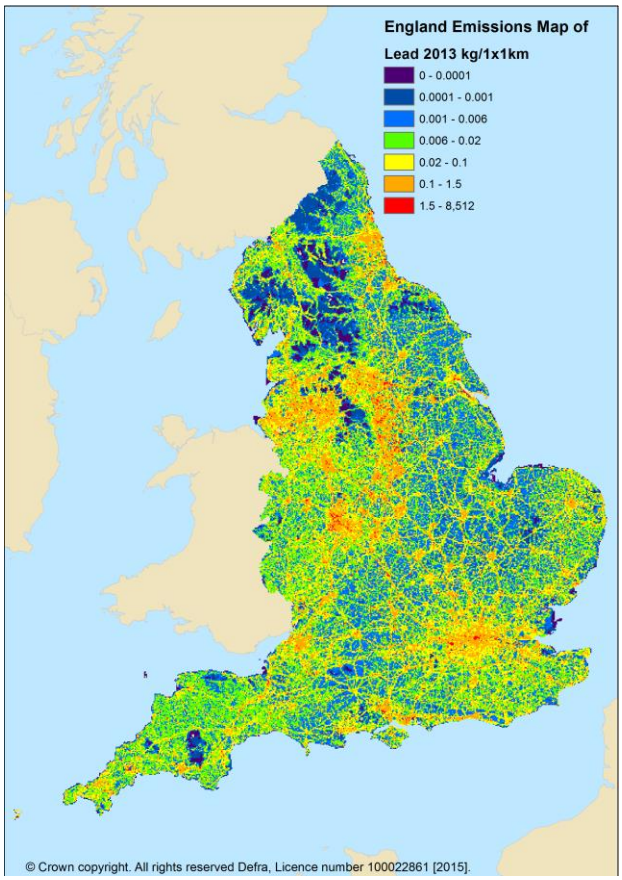


Figure 15 - England Lead Emissions, 2013



2.2. Scotland

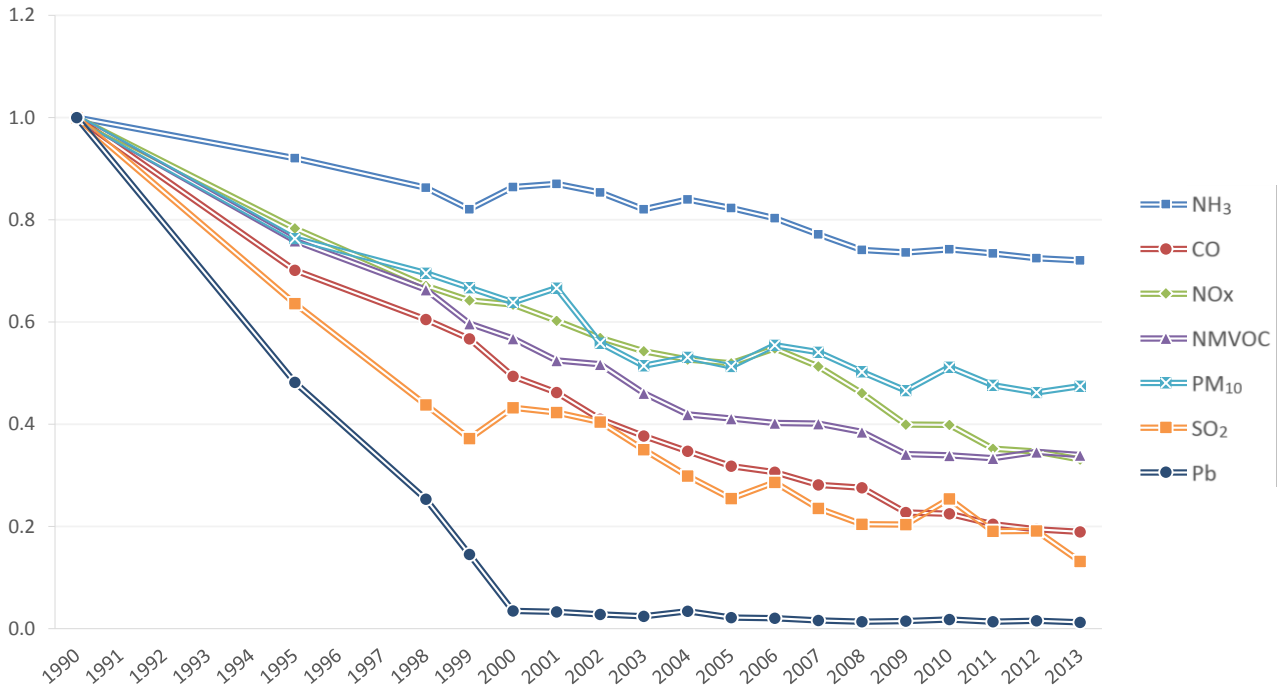
The following section provides a summary of emissions in Scotland for the seven air quality pollutants: ammonia (NH_3), carbon monoxide (CO), nitrogen oxides (NO_X as NO_2), non-methane volatile organic compounds (NMVOCs), sub-10 micron particulate matter (PM_{10}), sulphur dioxide (SO_2) and lead (Pb).

Figure 16 shows emissions of all seven air quality pollutants normalised to provide the relative rate of decline since 1990. This graph shows that all pollutant emission levels are lower in 2013 than they were in 1990. The decline is relatively similar for PM_{10}, NO_X, NMVOC, SO_2 and CO.

Lead (Pb), however, shows a much higher rate of reduction from 1990 to 2000 due to the phase-out of leaded petrol by the end of 1999. Ammonia (NH_3) emissions, by contrast, have declined at a slower rate than other pollutants. The peaks in SO_2 emissions for 2006 and 2010 were due to an increase in the consumption of coal in power stations. The spike in PM_{10} emissions in 2001 is due to the outbreak of foot-and-mouth disease and the resultant emissions from animal carcass pyres.

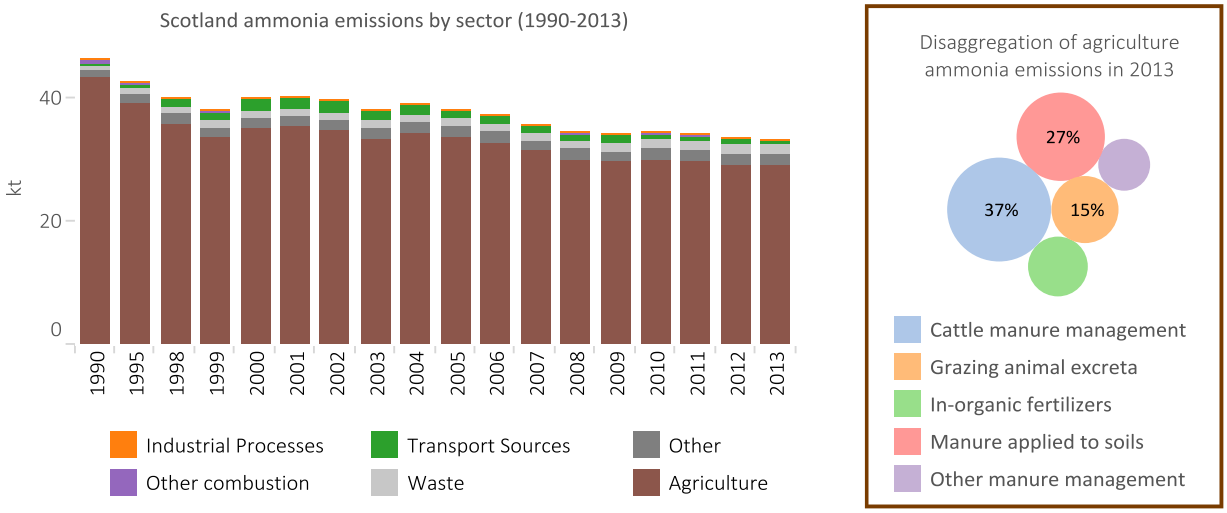
Emissions of NO_X have declined notably since 2007 due, primarily, to the installation of de-NO_X abatement systems (Boosted Over-Fire Air) on all four units at Longannet coal-fired power station and also at Cockenzie power station (which then closed in 2013), which reduces NO_X emissions formed during coal combustion by up to 25%.

Figure 16 - Scotland normalised trends for all pollutants



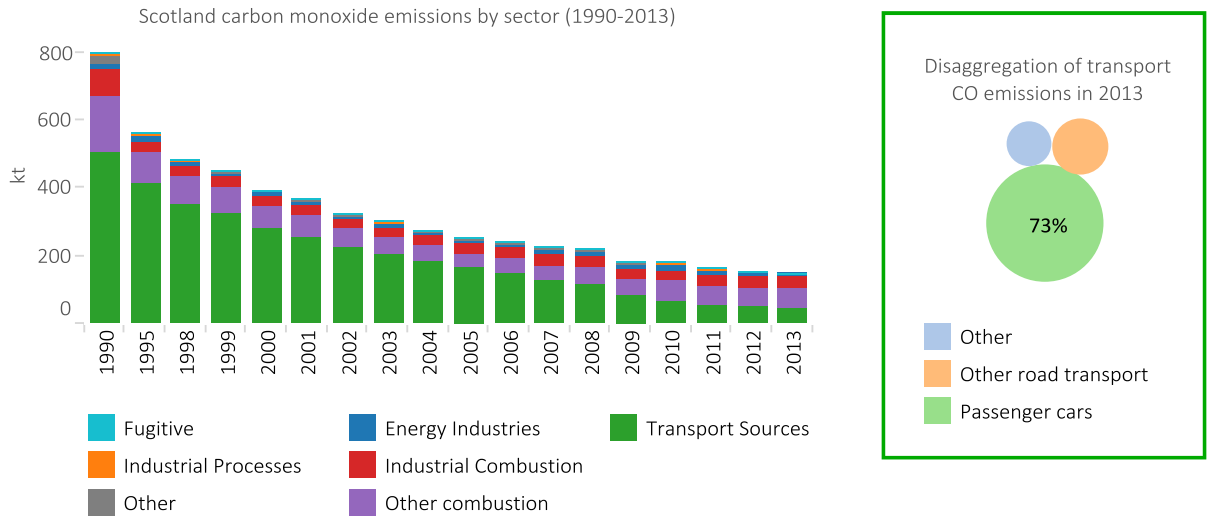
The following sections provide an overview of emissions from each of the seven pollutants giving explanations for the trends and characteristics of the graphs. Data summary tables for these emission estimates can be found in Appendix E. Mapping of the categories used in the graphs can be found in Appendix F.

Figure 17 - Scotland Ammonia Emissions



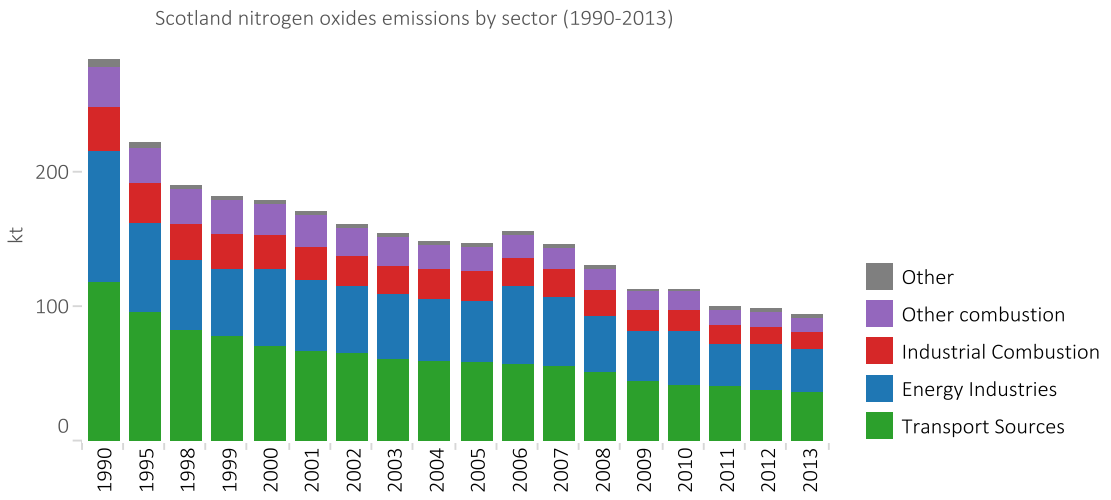
Emissions of **ammonia** were estimated to be 33kt in 2013. These emissions have declined by 28% since 1990 and account for 12% of the UK total in 2013. Agricultural sources have dominated the inventory throughout the time series, and cattle manure management accounted for 37% of agricultural ammonia emissions in 2013. The trend in ammonia emissions has been driven by decreasing animal numbers and a decline in fertiliser use, although the decline in emissions has levelled out to some extent in recent years due to increased usage of urea-based fertilisers, which are associated with much higher ammonia emission factors.

Figure 18 - Scotland Carbon Monoxide Emissions



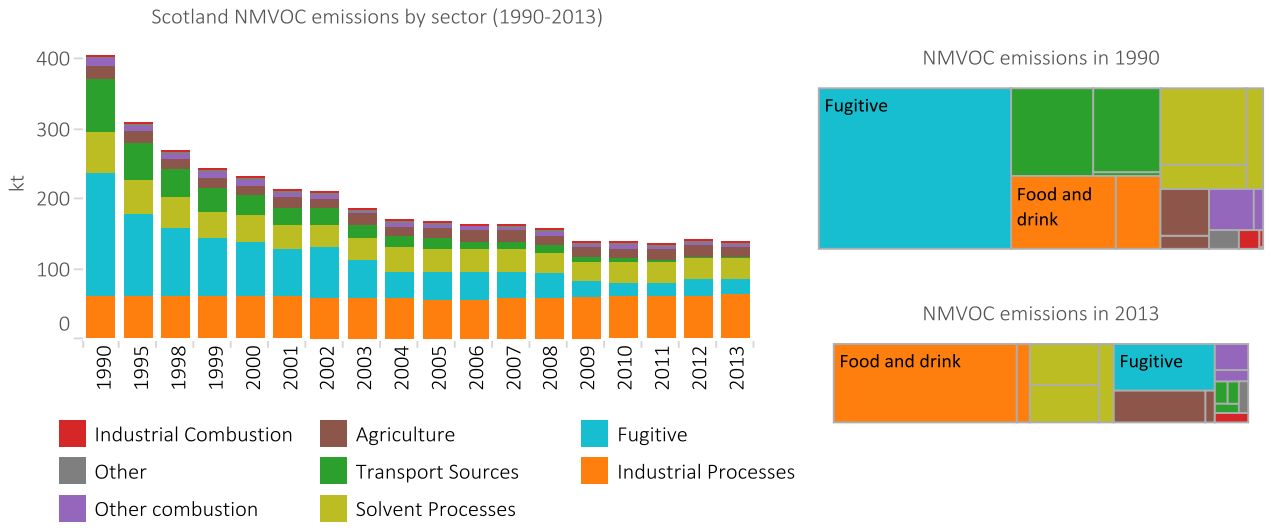
Emissions of **carbon monoxide** were estimated to be 151kt in 2013 and have declined by 81% since 1990. Scotland's emissions accounted for 8% of the UK total in 2013. This decline in emissions stems from changes in the transport sector, more specifically, in road transport. There are a number of reasons for this decline including the requirement for new petrol cars to be fitted with three-way catalysts since 1989 and, in more recent years, the switch from petrol cars to diesel cars. Since 2008, emissions from passenger cars have decreased, which is mainly driven by improvements in catalyst repair rates. In recent years, emissions from the other combustion sector have increased, and this is due to an increasing quantity of wood combusted in the domestic sector.

Figure 19 - Scotland Nitrogen Oxides Emissions



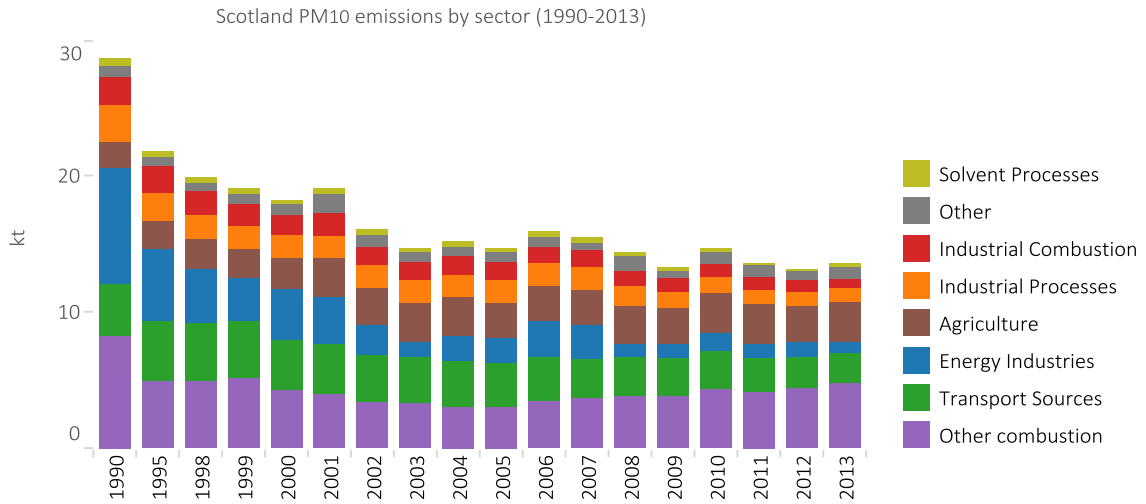
Emissions of **nitrogen oxides** were estimated to be 94kt in 2013, representing 9% of the UK total in 2013. Emissions have declined by 67% since 1990, mainly due to the changes in the road transport sector as described above for carbon monoxide regarding the fitting of three-way catalysts in road transport vehicles. Between 2008 and 2009, the reduction was mainly driven by improvements in catalyst repair rates. The peak in NO_X emissions in 2006 is due to a significant increase in coal-fired power generation at Longannet in that year. There was a smaller peak in coal-fired generation in 2012 as global coal and gas prices fluctuations led to a UK-wide shift in power generation fuel mix from gas to coal in that year. The decline in NO_X emissions since 2007 is also linked to the power sector, as Boosted Over-Fire Air (BOFA) abatement systems were fitted to all four of Longannet's units, to reduce NO_X emissions from coal-fired generation by up to 25%. BOFA systems were also fitted at Cockenzie power station which then closed in 2013.

Figure 20 - Scotland NMVOC Emissions



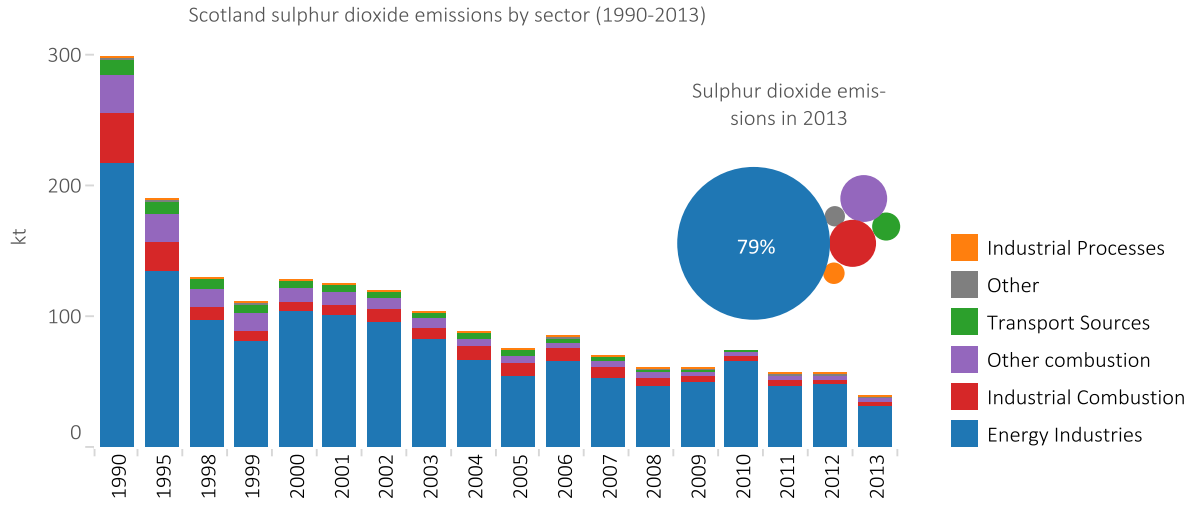
Emissions of **non-methane volatile organic compounds** were estimated to be 138kt in 2013, representing 17% of the UK total in 2013. Emissions have declined by 66% since 1990. This reduction has been dominated by the 89% decrease in fugitive emissions since 1990. This is primarily due to the decrease in emissions from the exploration, production and transport of oil because of a reduction in refinery capacity and tighter emission regulations during the 1990s. The decrease between 2008 and 2009 was due to reductions in fugitive NMVOC emissions from oil loading at the Sullom Voe terminal in Shetland. Emissions from the food and drink industry have consistently increased since 2008 due to the increased production and storage of whisky.

Figure 21 - Scotland PM_{10} Emissions



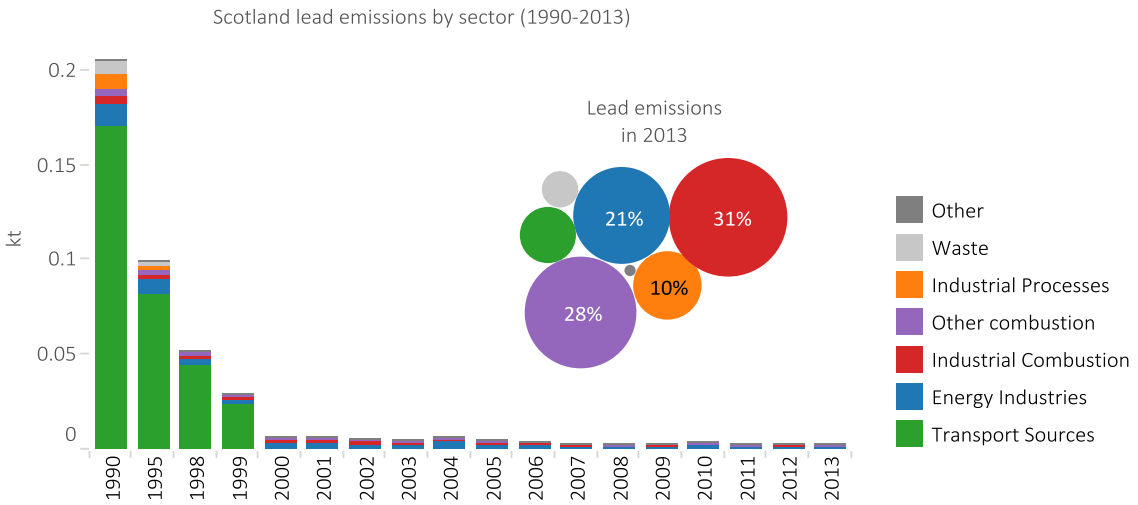
Emissions of **PM_{10}** were estimated to be 14kt in 2013 and have declined by 53% since 1990. They account for 11% of the UK total. Unlike most other pollutants, PM_{10} emissions have a large number of significant sources. Transport, other combustion and agriculture all accounted for over 10% of emissions across most of the time-series. Emissions from energy industries have had the most significant impact on the trend. This reduction is primarily due to abatement at coal fired stations, and the reduction in coal fired energy generation in place of natural gas (which has negligible PM_{10} emissions), nuclear and renewable sources. The main source of road transport emissions is exhaust gases from diesel engines, which have been decreasing due to the penetration of new vehicles meeting tighter PM_{10} emission regulations. In recent years, emissions from the other combustion sector have increased, and this is due to an increasing quantity of wood combusted in the domestic sector.

Figure 22 - Scotland Sulphur Dioxide Emissions



Emissions of **sulphur dioxide** were estimated to be 39kt in 2013, representing 10% of the UK total in 2013. Emissions have declined by 87% since 1990, which has been dominated by the 86% reduction in energy industries emissions due to the growth in nuclear powered generation, the installation of a FGD (flue-gas desulphurization) plant at Longannet power station, co-firing of biomass in coal fired power stations reducing the consumption of coal, and also the supply of lower-sulphur coal in later years to Cockenzie. Emissions from power generation fell between 2012 and 2013 due to the closure of Cockenzie power station in March 2013, and a UK-wide shift in power generation fuel mix back from coal to natural gas in response to global fuel prices. Road transport emissions have declined due to tightening of fuel standards during the 1990s and more recently due to the EU Fuel Quality Directive and its amendments leading to a reduction in the sulphur content of diesel.

Figure 23 - Scotland Lead Emissions



Emissions of **lead** were estimated to be 2.7 tonnes in 2013, representing 4% of the UK total in 2013. Emissions have declined by 99% since 1990 almost entirely due to changes in the transport sector. Leaded petrol was phased out from general sale at the end of 1999, which is the reason for the 99.9% decrease in transport emissions between 1990 and 2000. The most significant sources of emissions are now combustion of coal in all sectors and the use of lubricants in transport. The peak in 2004 was due to an increase in reported emissions from coal combustion in power generation.

Table 3 below provides a summary of the percentage contribution of each sector for each pollutant. Using the ranking of these percentage contributions, the sectors have been ordered to provide its indicative significance across all pollutants. As such, the table below indicates that the other combustion sector is the most significant sector when considering emissions from all pollutants. This sector accounts for at least 25% of emissions for three pollutants: carbon monoxide (CO), lead (Pb) and PM_{10}.

The top four sectors encompass all fuel combustion. Industrial Processes is also significant, especially for NMVOC, which is due to the significance of the food and drink industry in Scotland. This table also highlights that although emissions from the Agriculture sector are not as significant when considering all pollutants, it is of very high significance when considering emissions of ammonia (NH_3).

Table 3 - Source Emission Contributions Ranked by Sector, Scotland 2013

Overall Rank	Sector	NH_3	CO	NO_x	NMVOC	PM_{10}	SO_2	Pb
1	Other combustion	1.3%	38.3%	11.6%	3.8%	35.2%	7.5%	27.6%
2	Transport Sources	1.8%	30.2%	38.5%	2.4%	16.4%	2.7%	7.0%
3	Industrial Combustion	0.0%	22.6%	13.0%	1.0%	5.0%	7.5%	31.1%
4	Energy Industries	0.0%	6.5%	34.6%	0.0%	5.7%	79.4%	20.8%
5	Industrial Processes	0.2%	0.0%	0.0%	47.1%	8.7%	1.6%	10.4%
6	Agriculture	86.6%	0.0%	0.0%	9.8%	21.1%	0.0%	0.0%
7	Other *	5.6%	1.7%	2.3%	1.0%	6.0%	1.4%	0.3%
8	Solvent Processes	0.0%	0.0%	0.0%	20.5%	1.8%	0.0%	0.0%
8	Fugitive	0.0%	0.6%	0.0%	14.5%	0.0%	0.0%	0.0%
10	Waste	4.5%	0.0%	0.0%	0.0%	0.0%	0.0%	2.9%
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

* The sector: “other” will include all “other” categories in the inventory and also a number of categories that are insignificant for a specific pollutant.

Emission maps for all seven pollutants are shown below.

Figure 24 - Scotland Ammonia Emissions, 2013

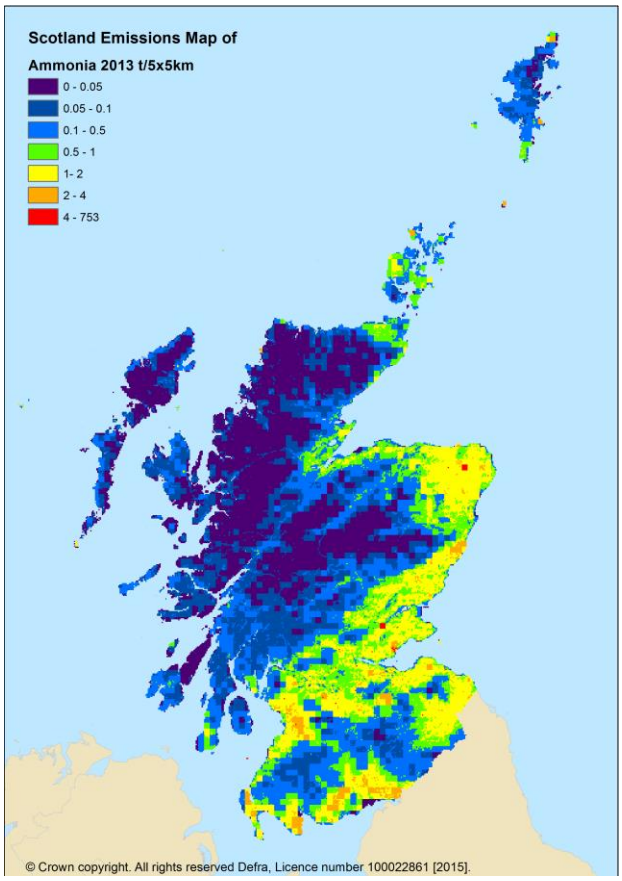


Figure 25 - Scotland Carbon Monoxide Emissions, 2013

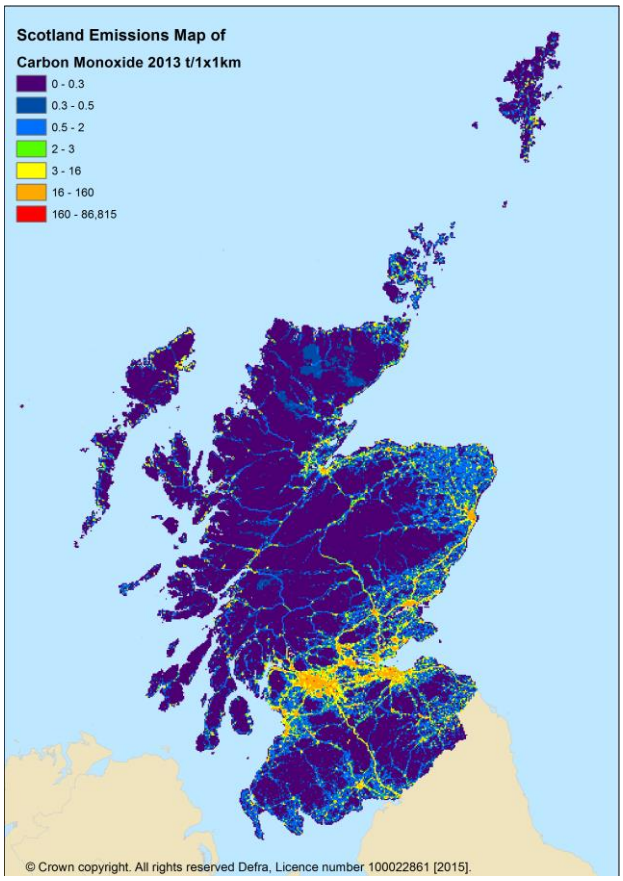


Figure 26 - Scotland Nitrogen Oxides Emissions, 2013

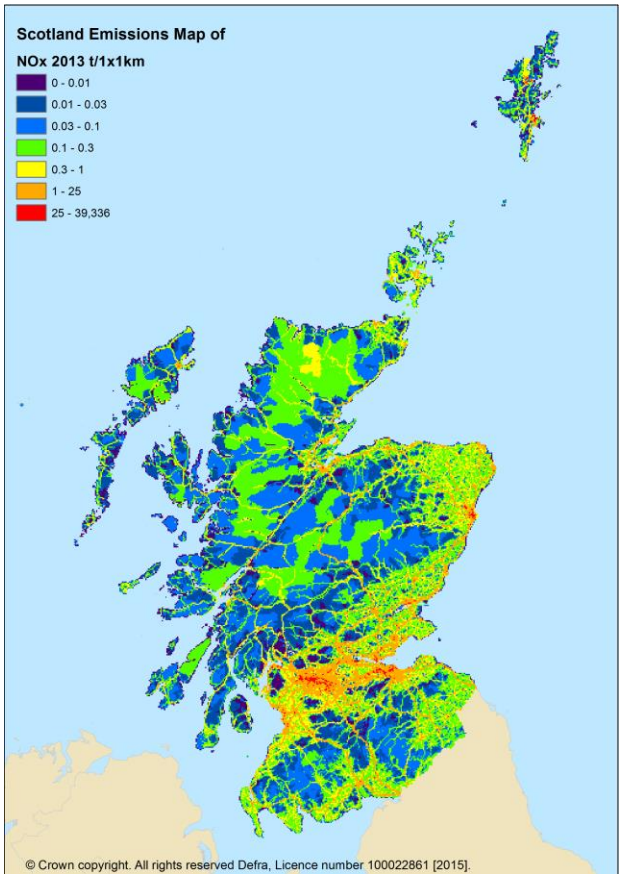


Figure 27 - Scotland NMVOC Emissions, 2013

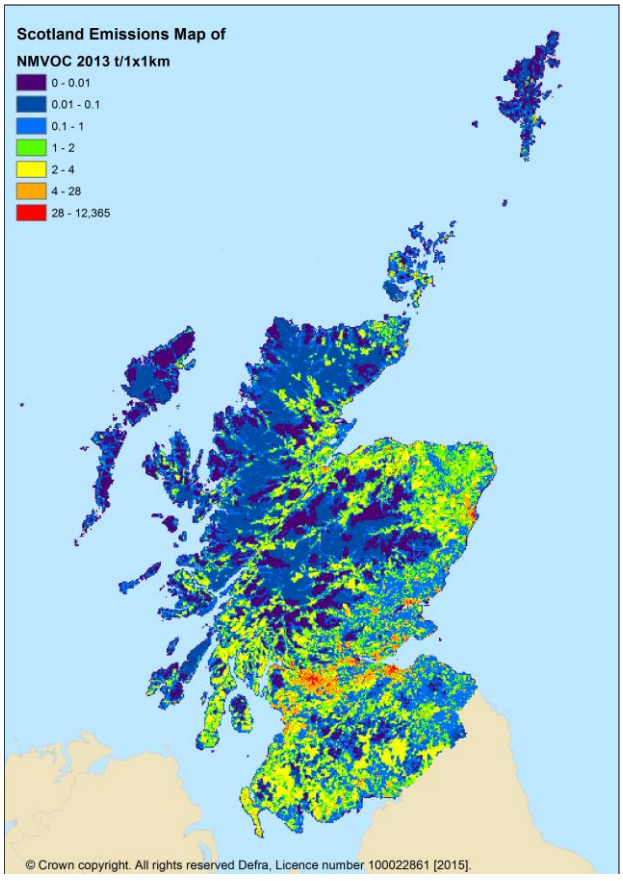


Figure 28 - Scotland PM_{10} Emissions, 2013

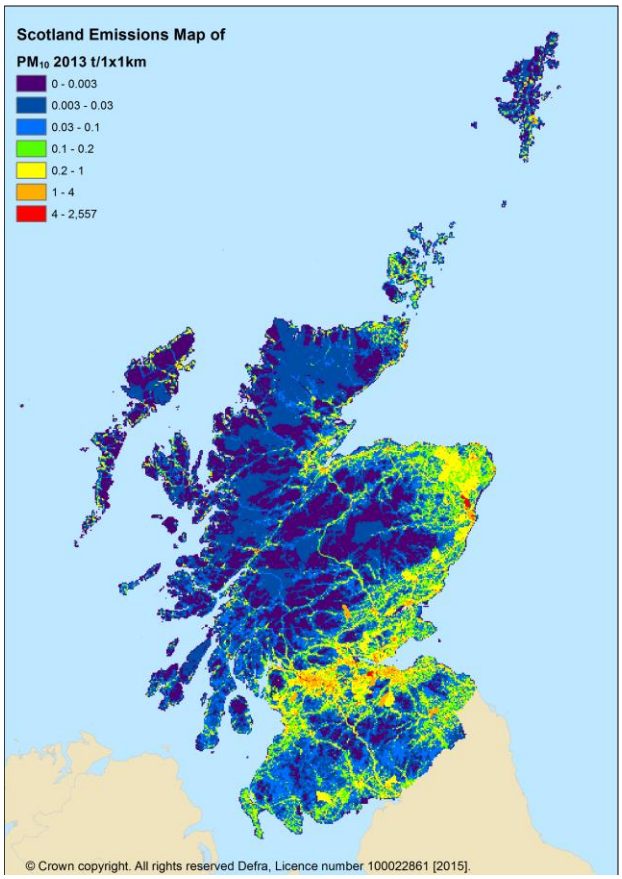


Figure 29 - Scotland Sulphur Dioxide Emissions, 2013

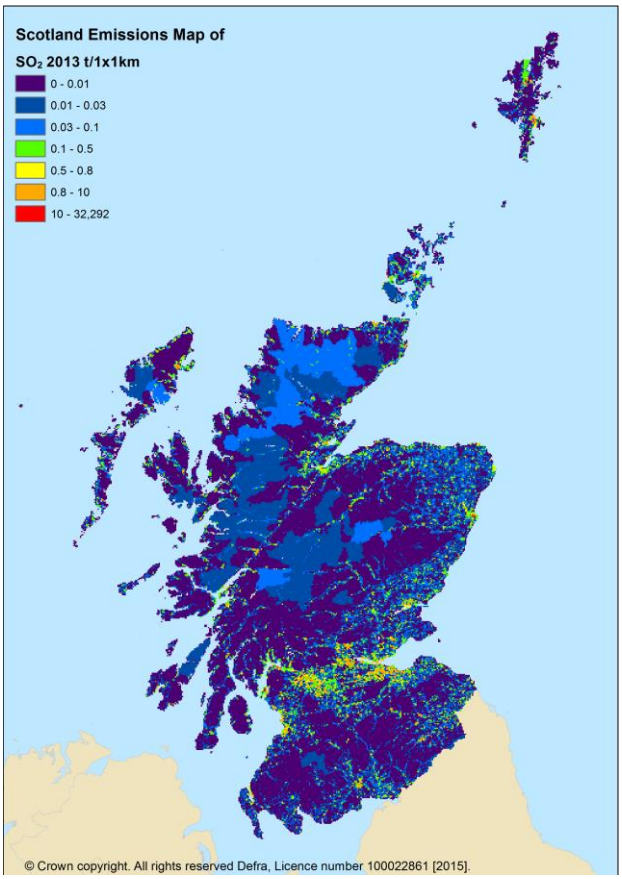
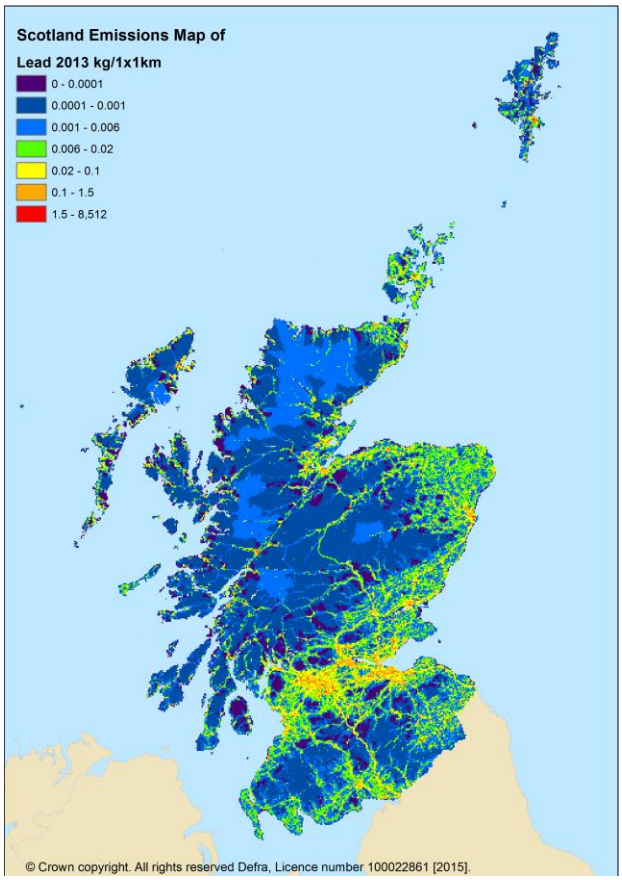


Figure 30 - Scotland Lead Emissions, 2013



2.3. Wales

The following section provides a summary of emissions in Wales for the seven air quality pollutants: ammonia (NH_3), carbon monoxide (CO), nitrogen oxides (NO_X as NO_2), non-methane volatile organic compounds (NMVOCs), sub-10 micron particulate matter (PM_{10}), sulphur dioxide (SO_2) and lead (Pb).

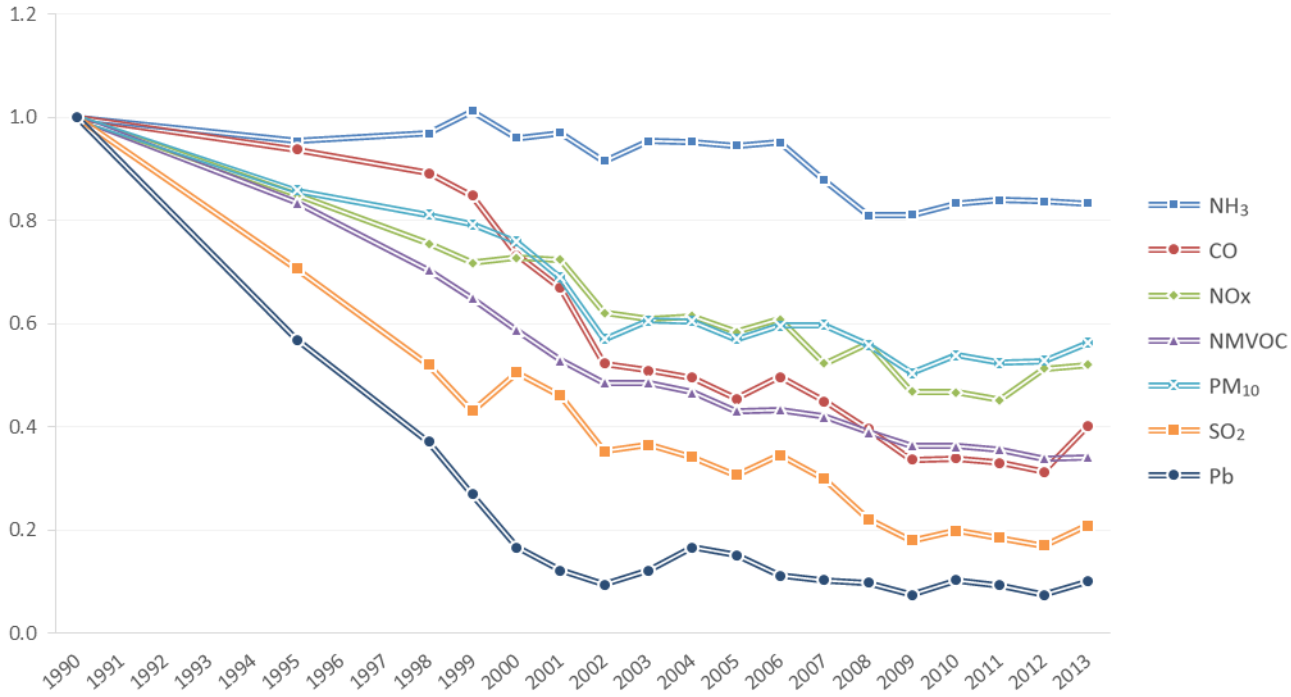
Figure 31 shows emissions of all seven air quality pollutants normalised to provide the relative rate of decline since 1990. This graph shows that all pollutant emission levels are lower in 2013 than they were in 1990. The decline is relatively similar for PM_{10}, NO_X, NMVOC and CO.

Lead (Pb), however, shows a higher rate of reduction from 1990 to 2000 due to the phase-out of leaded petrol by the end of 1999. Ammonia (NH_3) emissions, by contrast, have declined at a much slower rate than other pollutants.

Reductions in SO_2 since 2006 are due, primarily, to the retro-fitting of Flue Gas Desulphurisation abatement at Aberthaw coal-fired power station, with the increase in 2013 due in part to increases in generation at the plant.

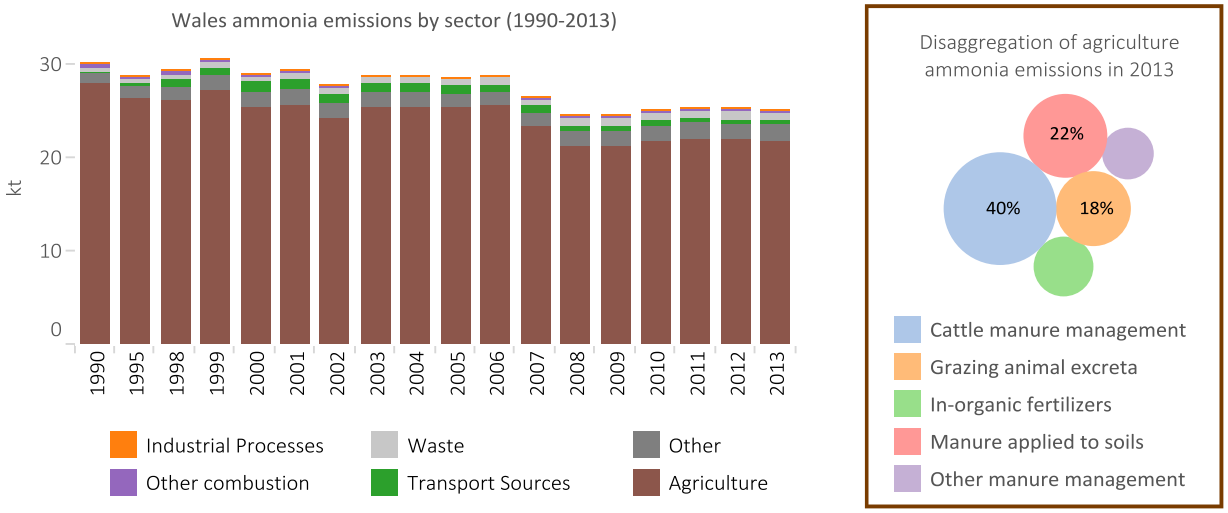
Many pollutant trends in Wales are also influenced significantly by the combustion and process emission sources linked to the iron and steel industry, and in particular the production trends at Port Talbot steelworks. For example, between 2012 and 2013 an upturn in iron and steel production led to increases in emissions from the sector across the priority air quality pollutants reported here, influencing the national trends most notably for carbon monoxide (CO), lead (Pb), and sulphur dioxide (SO_2).

Figure 31 - Wales normalised trends for all pollutants



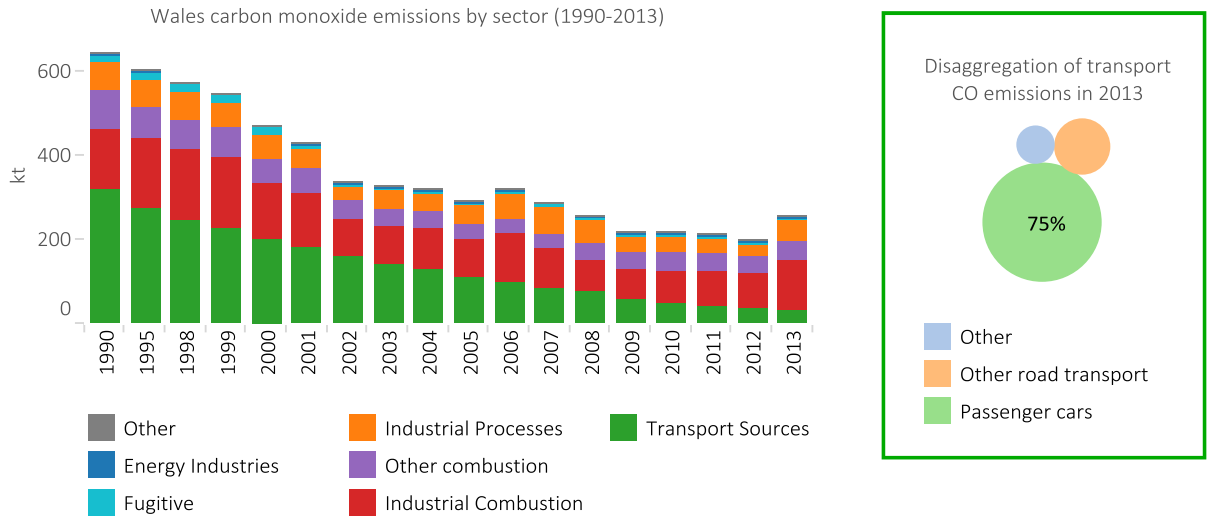
The following sections provide an overview of emissions from each of the seven pollutants giving explanations for the trends and characteristics of the graphs. Data summary tables for these emission estimates can be found in Appendix E. Mapping of the categories used in the graphs can be found in Appendix F.

Figure 32 - Wales Ammonia Emissions



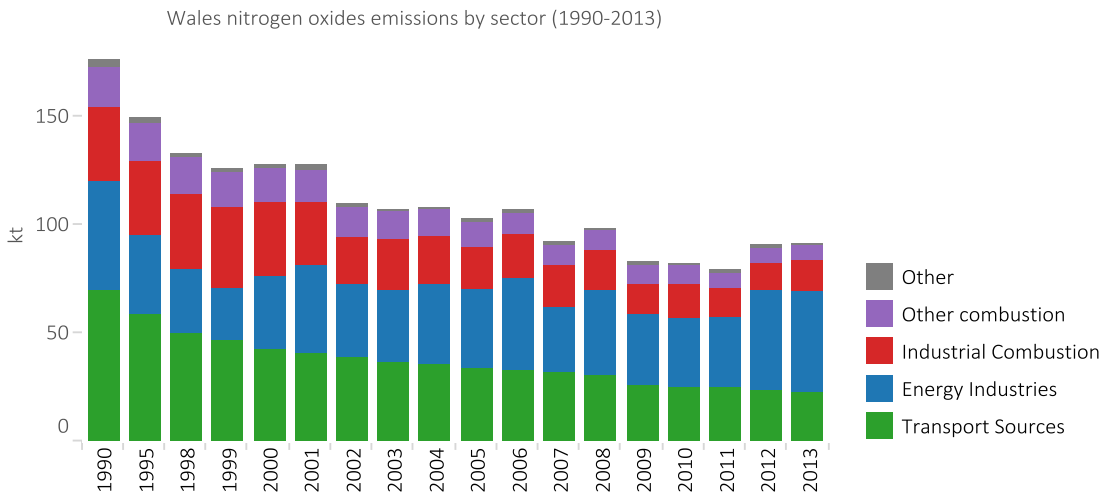
Emissions of **ammonia** were estimated to be 25kt in 2013. These emissions have declined by 17% since 1990 and account for 9% of the UK total in 2013. Agricultural sources have dominated the inventory throughout the time series, and cattle manure management accounted for 40% of agricultural ammonia emissions in 2013. The trend in ammonia emissions has been driven by decreasing animal numbers and a decline in fertiliser use, although the decline in emissions has levelled out to some extent in recent years due to increased usage of urea-based fertilisers which are associated with much higher ammonia emission factors.

Figure 33 - Wales Carbon Monoxide Emissions



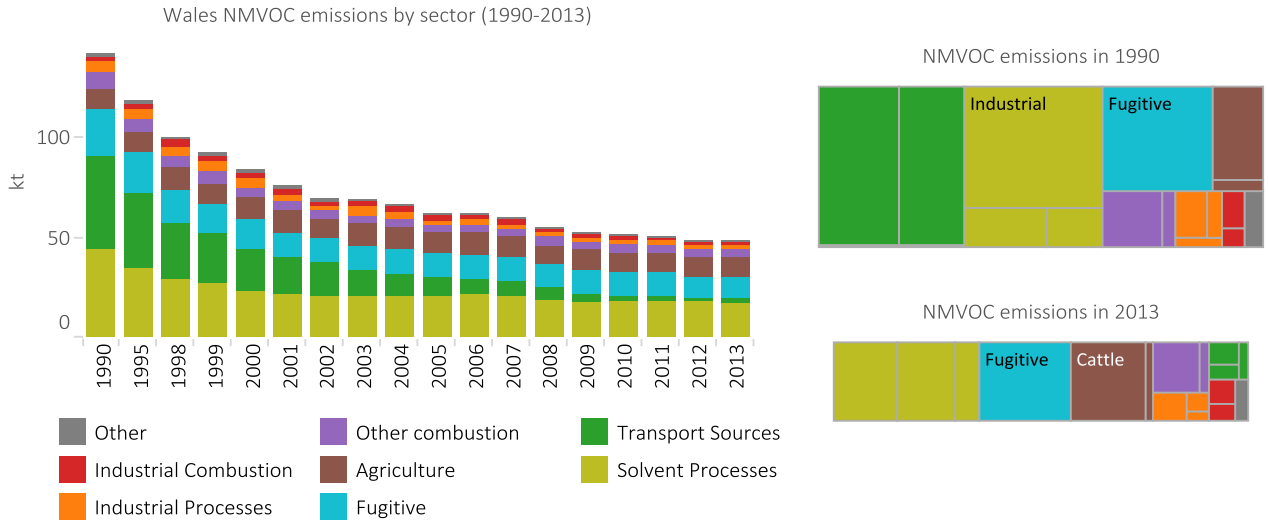
Emissions of **carbon monoxide** were estimated to be 260kt in 2013 and have declined by 60% since 1990. Wales' emissions accounted for 13% of the UK total in 2013. This decline in emissions stems from changes in the transport sector, more specifically, in road transport. There are a number of reasons for this decline including the requirement for new petrol cars to be fitted with three-way catalysts since 1989 and, in more recent years, the switch from petrol cars to diesel cars. Since 2008, emissions from passenger cars have decreased, which is mainly driven by improvements in catalyst repair rates. In more recent years, the most significant sector has been industrial combustion and, more specifically, the iron and steel industry. Emissions from this industry explain the significant increase in emissions in 2013 due to production at Port Talbot steelworks.

Figure 34 - Wales Nitrogen Oxides Emissions



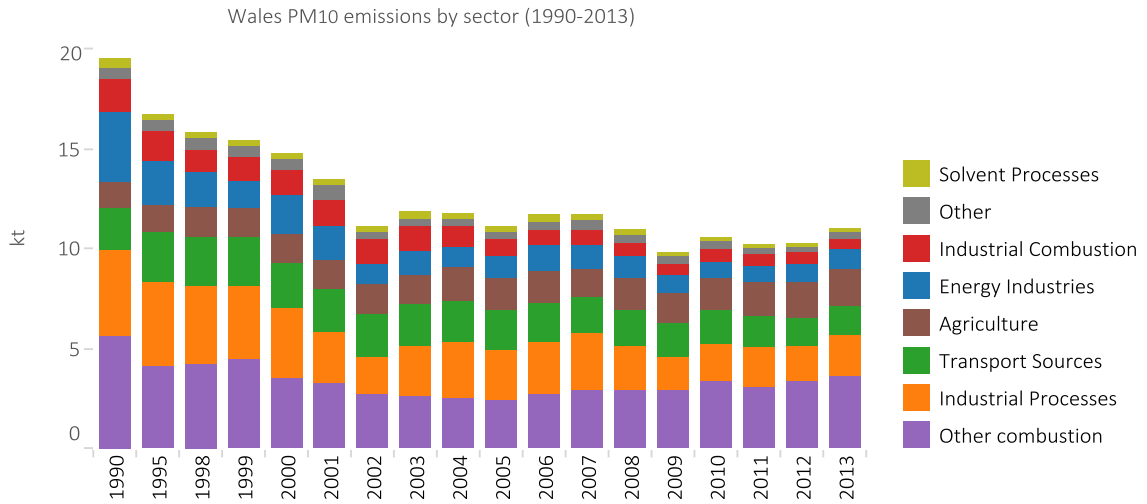
Emissions of **nitrogen oxides** were estimated to be 91kt in 2013, representing 9% of the UK total in 2013. Emissions have declined by 48% since 1990, mainly due to the changes in the road transport sector as described above for carbon monoxide regarding the fitted of three-way catalysts in road transport vehicles. Between 2008 and 2009, the reduction was mainly driven by improvements in catalyst repair rates. The recent trends in Wales NO_X emissions differ from elsewhere in the UK primarily as the design of the Aberthaw coal-fired power station does not enable Boosted Over-Fire Air abatement to be fitted, unlike in most other UK coal-fired stations. Therefore, the Wales trend does not show the same recent decline as other Devolved Administrations. The recent upturn (2012, 2013) reflects the increase in coal-fired power generation at Aberthaw.

Figure 35 - Wales NMVOC Emissions



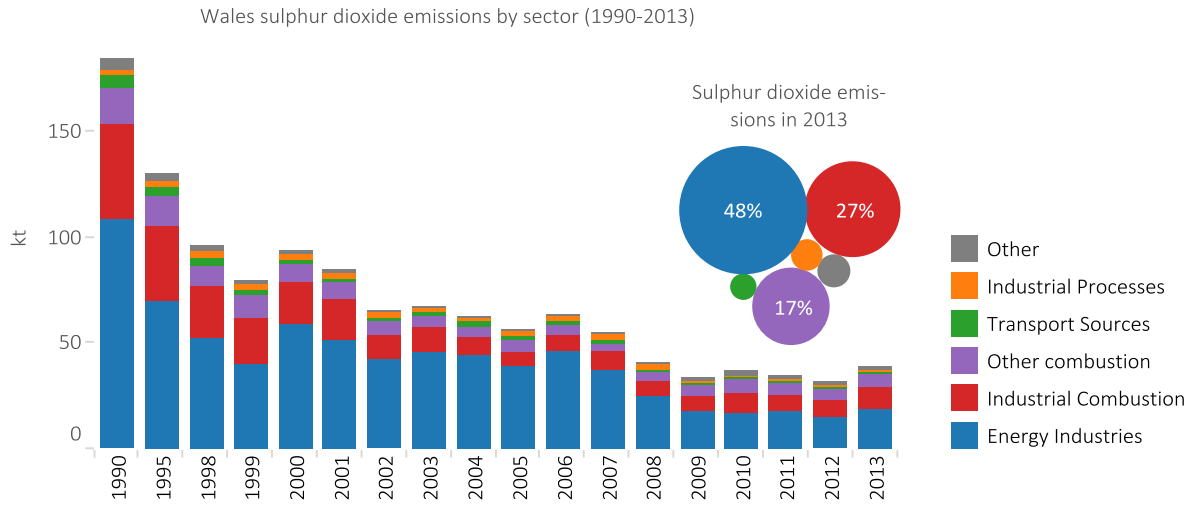
Emissions of **non-methane volatile organic compounds** were estimated to be 49kt in 2013, representing 6% of the UK total in 2013. Emissions have declined by 66% since 1990. This reduction is mainly due to the decrease in emissions from road transport sources, including evaporative losses. Similarly to carbon monoxide and nitrogen oxides, this is mainly due to the requirement for new petrol cars to be fitted with three-way catalysts since 1989 and, in more recent years, the switch from petrol cars to diesel cars. With this large reduction in transport emissions, solvent processes are now the most significant source of NMVOC emissions.

Figure 36 - Wales PM_{10} Emissions



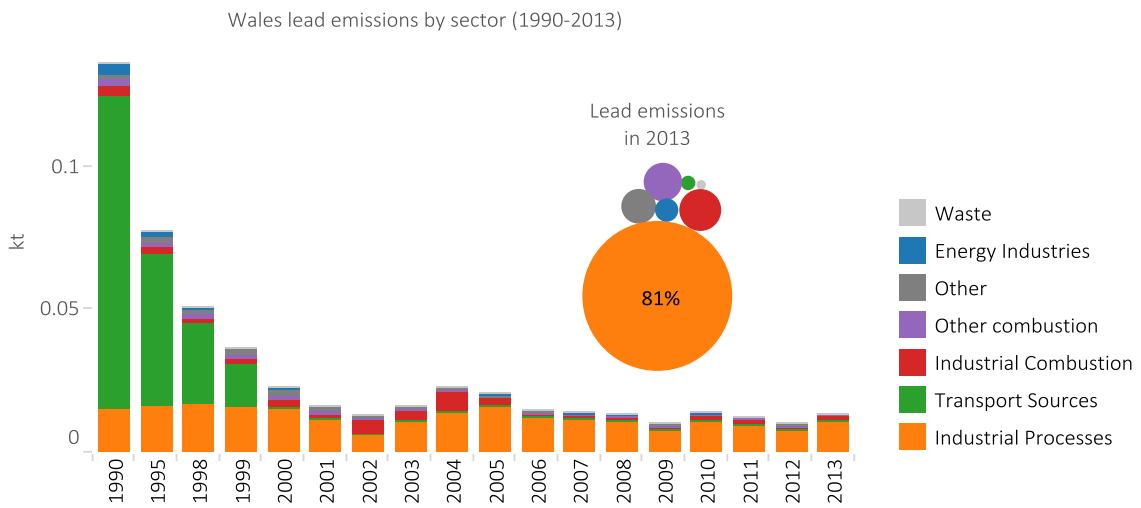
Emissions of **PM_{10}** were estimated to be 11kt in 2013 and have declined by 44% since 1990. They account for 9% of the UK total. Unlike most other pollutants, PM_{10} emissions have a large number of significant sources. Transport, other combustion, industrial processes and agriculture all accounted for over 10% of emissions across most of the time-series. In 2013 the most significant sources were from residential combustion, and from iron and steel process sources such as from sinter plant, basic oxygen furnaces and blast furnaces at the Port Talbot steelworks. As a result, recent trends are influenced by the use of solid fuels in the domestic sector as well as iron and steel production trends, but there is no strong trend in overall emissions evident in the last 5 years. In recent years, emissions from the other combustion sector have increased, and this is due to an increasing quantity of wood combusted in the domestic sector.

Figure 37 - Wales Sulphur Dioxide Emissions



Emissions of **sulphur dioxide** were estimated to be 39kt in 2013, representing 10% of the UK total in 2013. Emissions have declined by 79% since 1990, which has been dominated by the 83% reduction in energy industries emissions. This reduction is due to the UK-wide shift in power generation fuel mix away from coal to natural gas, nuclear and renewable sources, combined with the installation of flue-gas desulphurization (FGD) abatement plant at Aberthaw B power station in the late 2000s. Trends in recent years are influenced by emissions from a range of energy industries (power generation, oil refining) as well as the use of solid fuels in the domestic sector and production trends (and related coal use) in the iron and steel industry. For example, the increase between 2012 and 2013 is the combined impact of increased coal-fired power generation, oil refining output, iron and steel production and estimated solid fuel use in residential homes.

Figure 38 - Wales Lead Emissions



Emissions of **lead** were estimated to be 14 tonnes in 2013, representing 22% of the UK total in 2013. Emissions have declined by 90% since 1990 almost entirely due to changes in the transport sector. Leaded petrol was phased out from general sale at the end of 1999, which is the reason for the 99.9% decrease in transport emissions between 1990 and 2000. The most significant sources of emissions are now industrial processes in the iron and steel industry, which accounts for all of the increase in estimated emissions in Wales between 2012 and 2013.

Table 4 below provides a summary of the percentage contribution of each sector for each pollutant. Using the ranking of these percentage contributions, the sectors have been ordered to provide its indicative significance across all pollutants. As such, the table below indicates that the other combustion sector is the most significant sector when considering emissions from all pollutants. This sector accounts for over 15% of emissions for three pollutants: CO and PM_{10} and SO_2.

The majority of the top five sectors are related to the combustion of fuel, whilst Industrial Processes is also significant, especially for lead, which is due to the iron and steel industry present in Wales. This table also highlights that although emissions from the agriculture sector are not as significant when considering all pollutants, it is of very high significance when considering emissions of ammonia (NH_3).

Table 4 - Source Emission Contributions Ranked by Sector, Wales 2013

Overall Rank	Sector	NH_3	CO	NO_x	NMVOC	PM_{10}	SO_2	Pb
1	Other combustion	1.6%	18.1%	7.1%	8.3%	32.9%	17.4%	5.3%
2	Industrial Combustion	0.0%	46.2%	15.8%	3.3%	4.5%	26.7%	6.3%
2	Industrial Processes	0.2%	17.4%	0.0%	4.8%	18.9%	2.9%	81.0%
4	Transport Sources	1.5%	12.0%	24.4%	4.6%	12.5%	2.0%	0.8%
4	Energy Industries	0.0%	3.5%	51.3%	0.0%	9.6%	47.8%	2.0%
6	Agriculture	86.4%	0.0%	0.0%	19.8%	17.1%	0.0%	0.0%
7	Other *	6.9%	0.5%	1.4%	1.7%	2.7%	3.2%	4.3%
8	Solvent Processes	0.0%	0.0%	0.0%	35.1%	1.6%	0.0%	0.0%
8	Fugitive	0.0%	2.4%	0.0%	22.3%	0.0%	0.0%	0.0%
10	Waste	3.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

* The sector: "other" will include all "other" categories in the inventory and also a number of categories that are insignificant for a specific pollutant.

Emission maps for all seven pollutants are shown below.

Figure 39 - Wales Ammonia Emissions, 2013

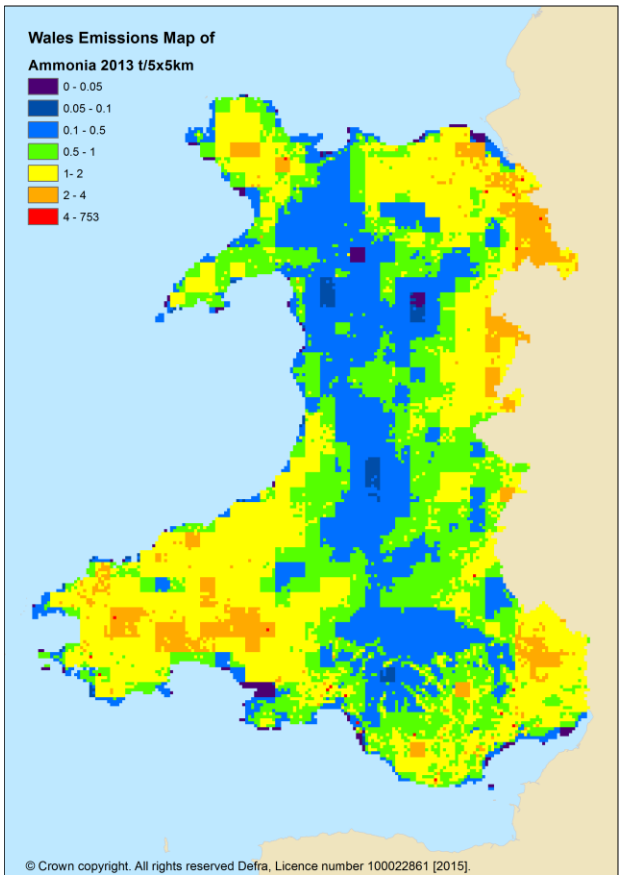


Figure 40 - Wales Carbon Monoxide Emissions, 2013

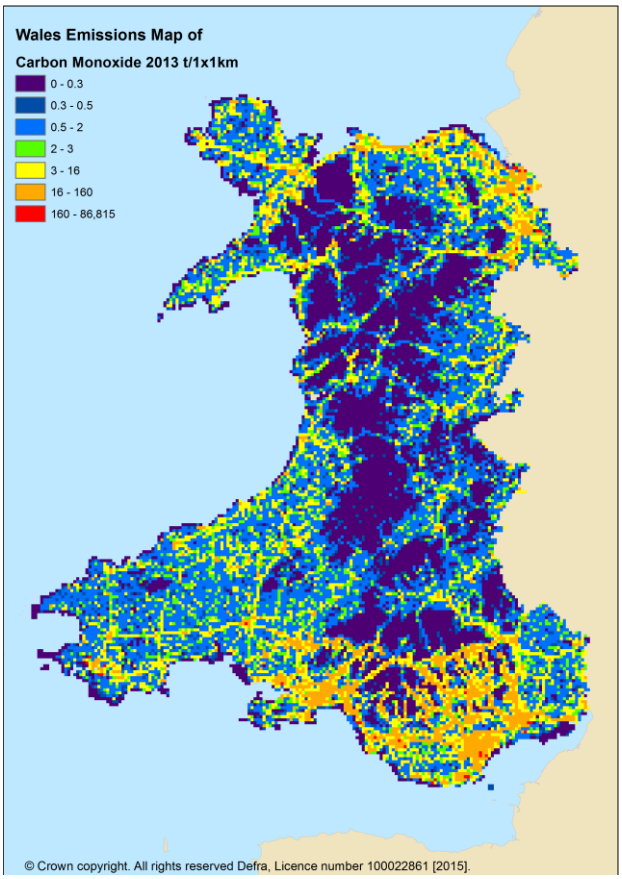


Figure 41 - Wales Nitrogen Oxides Emissions, 2013

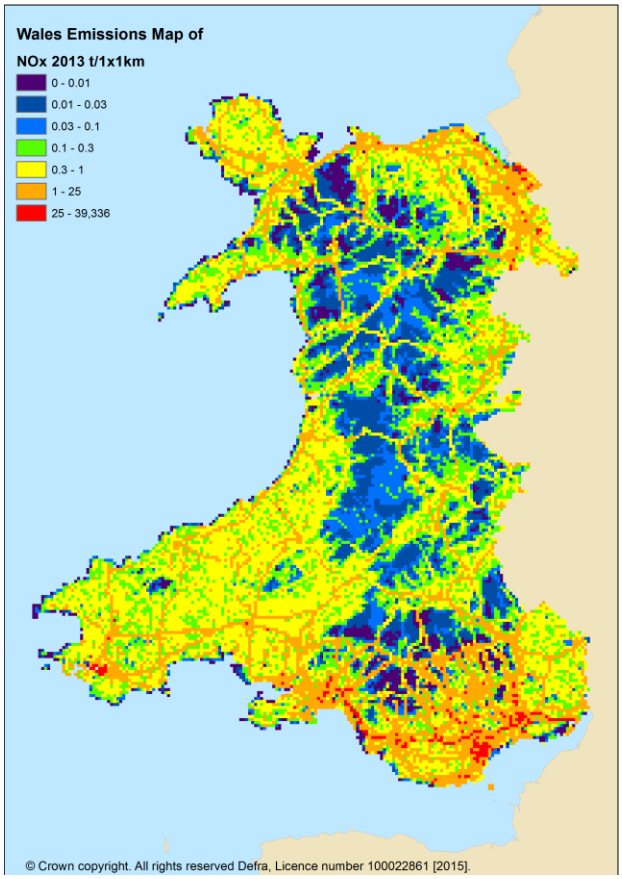


Figure 42 - Wales NMVOC Emissions, 2013

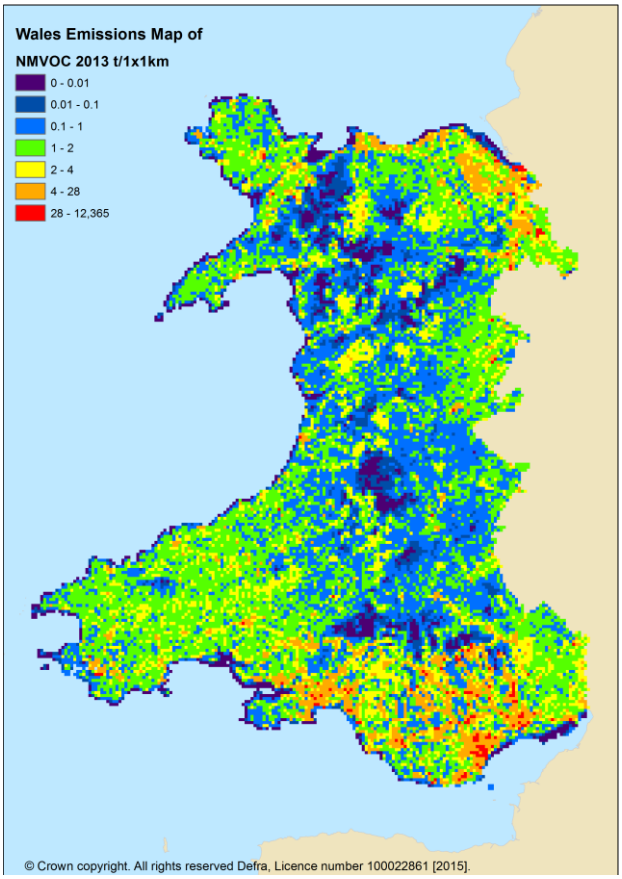


Figure 43 - Wales PM_{10} Emissions, 2013

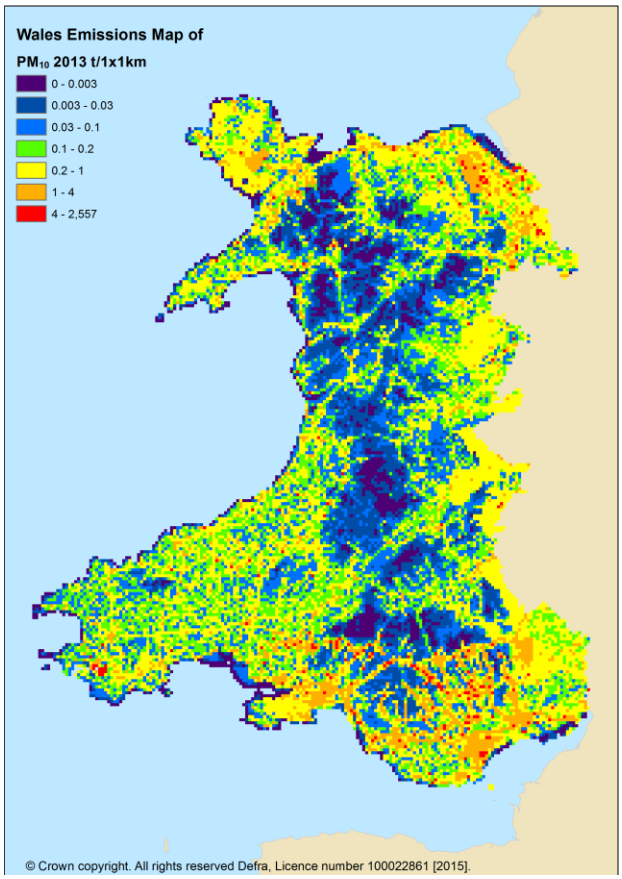


Figure 44 - Wales Sulphur Dioxide Emissions, 2013

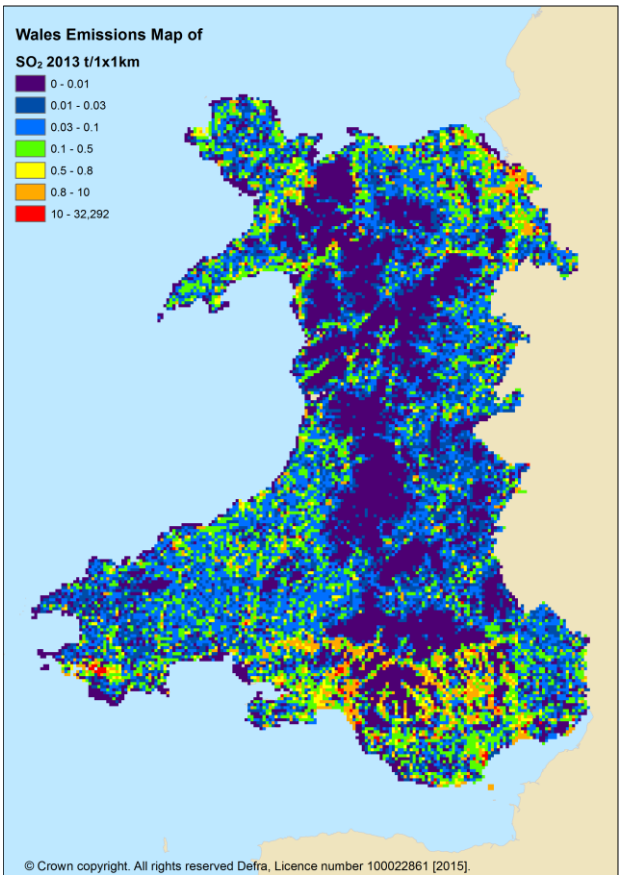
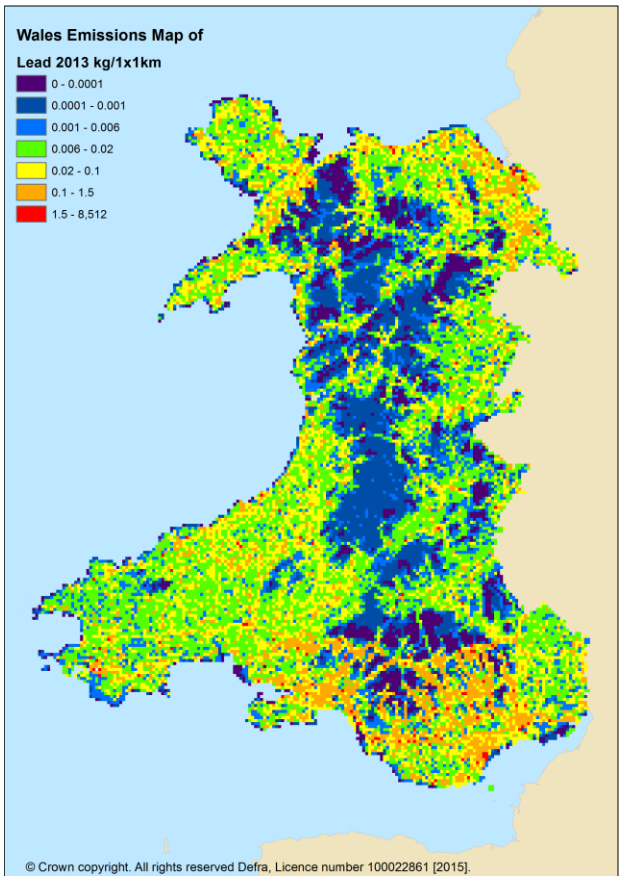


Figure 45 - Wales Lead Emissions, 2013



2.4. Northern Ireland

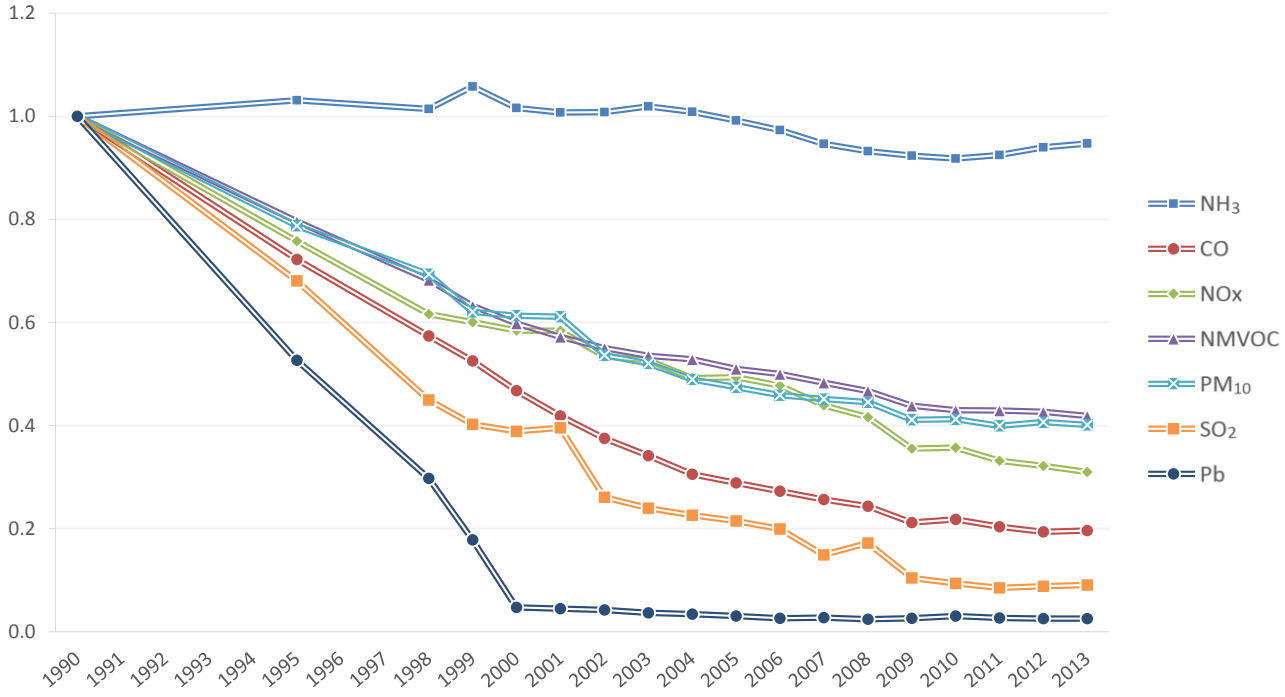
The following section provides a summary of emissions in Northern Ireland for the seven air quality pollutants: ammonia (NH_3), carbon monoxide (CO), nitrogen oxides (NO_X as NO_2), non-methane volatile organic compounds (NMVOCs), sub-10 micron particulate matter (PM_{10}), sulphur dioxide (SO_2) and lead (Pb).

Figure 46 shows emissions of all seven air quality pollutants normalised to provide the relative rate of decline since 1990. This graph shows that all pollutant emission levels are lower in 2013 than they were in 1990. The decline is relatively similar for PM_{10}, NO_X, NMVOC and CO.

Lead (Pb), however, shows a much higher rate of reduction from 1990 to 2000 due to the phase-out of leaded petrol by the end of 1999. Ammonia (NH_3) emissions, by contrast, only reached levels that were lower than 1990 estimates in 2005.

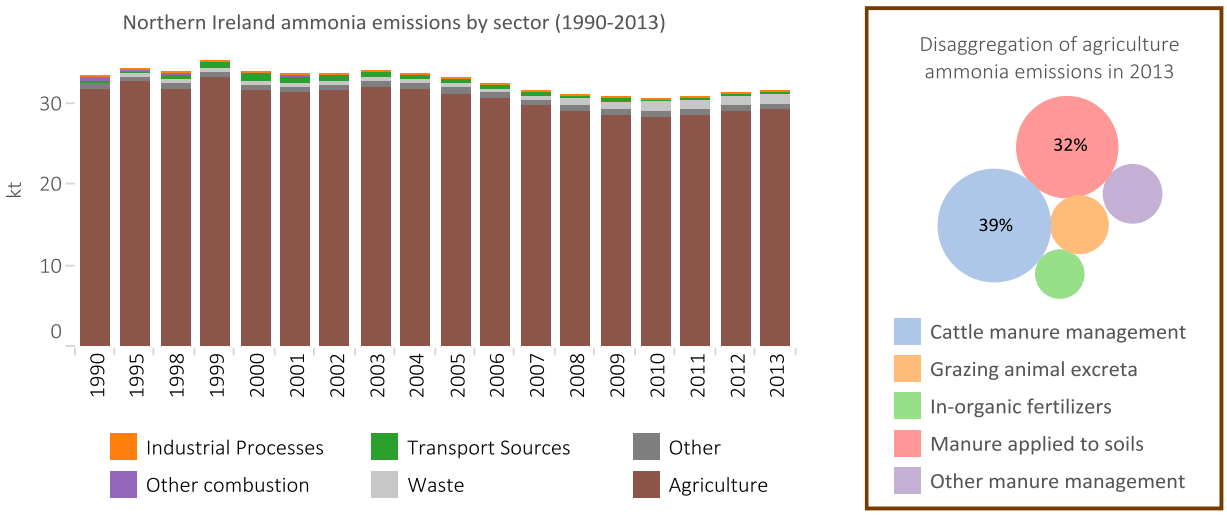
The reductions in PM_{10} and SO_2 after 2001 are due to a reduction in use of coal in several industries but predominantly in power generation, linked to the development of the natural gas pipeline to Northern Ireland which enabled fuel-switching away from coal and oil-fired generation.

Figure 46 - Northern Ireland normalised trends for all pollutants



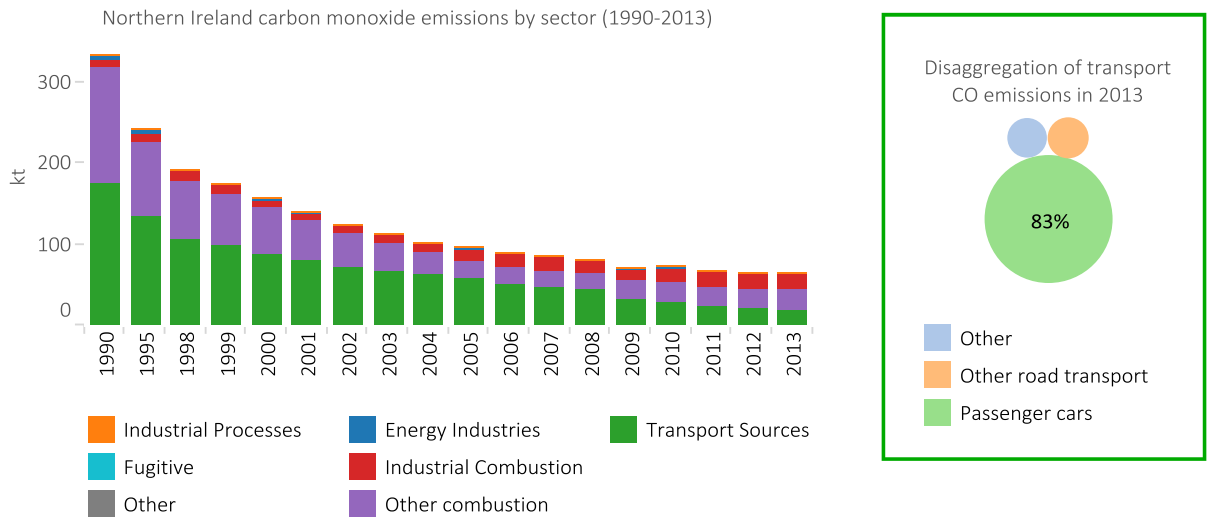
The following sections provide an overview of emissions from each of the seven pollutants giving explanations for the trends and characteristics of the graphs. Data summary tables for these emission estimates can be found in Appendix E. Mapping of the categories used in the graphs can be found in Appendix F.

Figure 47 - Northern Ireland Ammonia Emissions



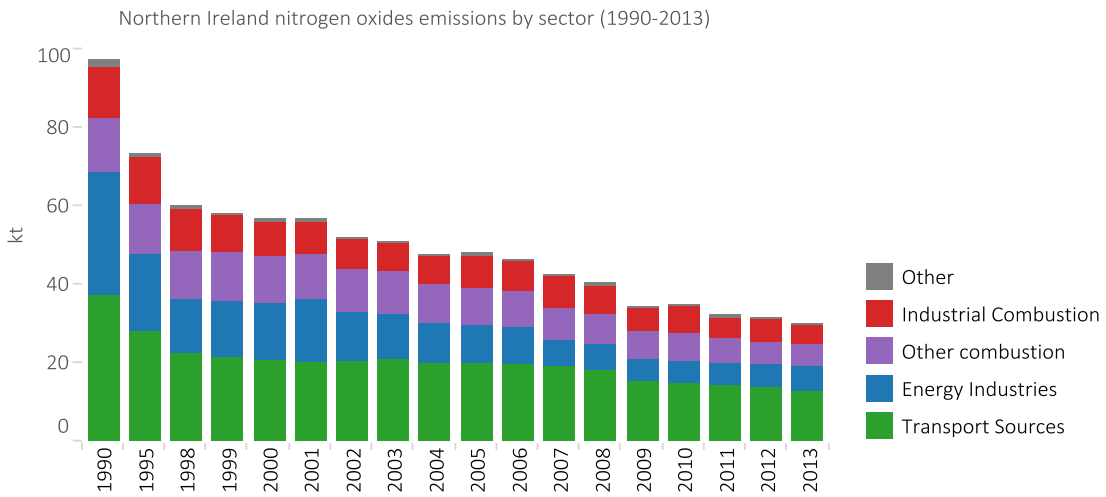
Emissions of **ammonia** were estimated to be 32kt in 2013. These emissions have declined by 5% since 1990 and account for 12% of the UK total in 2013. Agricultural sources have dominated the inventory throughout the time series, and cattle manure management accounted for 39% of agricultural ammonia emissions in 2013. Ammonia emissions have increased in recent years and this mainly due to increased emissions from manure applied to the soil, and the manure management processes for pigs.

Figure 48 - Northern Ireland Carbon Monoxide Emissions



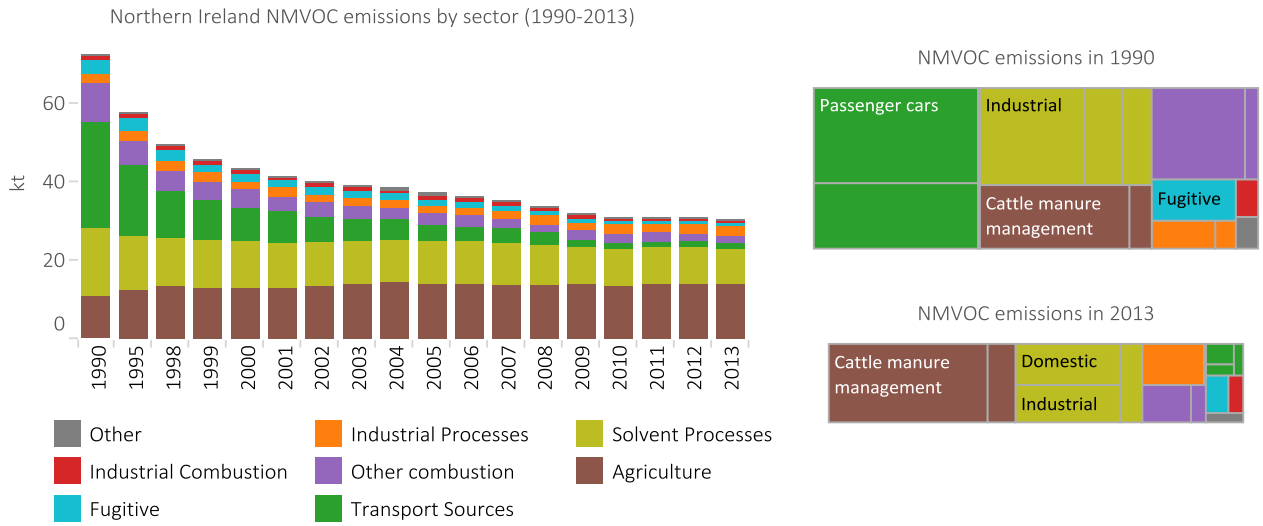
Emissions of **carbon monoxide** were estimated to be 65kt in 2013 and have declined by 80% since 1990. Northern Ireland's emissions accounted for 3% of the UK total in 2013. This decline in emissions stems from changes in the other combustion sector, and the transport sector, more specifically, in road transport. There are a number of reasons for the road transport emissions decline including the requirement for new petrol cars to be fitted with three-way catalysts since 1989 and, in more recent years, the switch from petrol cars to diesel cars. Since 2008, emissions from passenger cars have decreased, which is mainly driven by improvements in catalyst repair rates. The decrease in other combustion in the earlier part of the time series is mainly due to the expansion of the gas network leading to reductions in the consumption of solid and liquid fuels; the increase in more recent years is due to an increasing quantity of wood combusted in the domestic sector.

Figure 49 - Northern Ireland Nitrogen Oxides Emissions



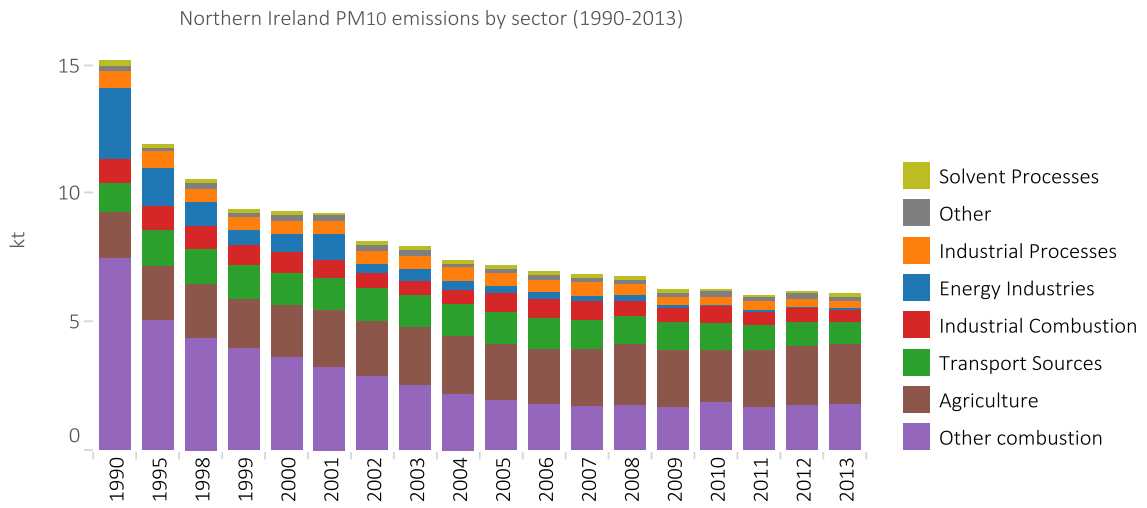
Emissions of **nitrogen oxides** were estimated to be 30kt in 2013, representing 3% of the UK total in 2013. Emissions have declined by 69% since 1990, partly due to the changes in the road transport sector as described above for carbon monoxide regarding the fitted of three-way catalysts in road transport vehicles. Since 2009, the reduction was mainly driven by improvements in catalyst repair rates. Energy industries have also had a significant impact on the trend due to emissions from the combustion of coal. Both implementation of abatement technology and the change in the amount of coal used are reasons for this trend.

Figure 50 - Northern Ireland NMVOC Emissions



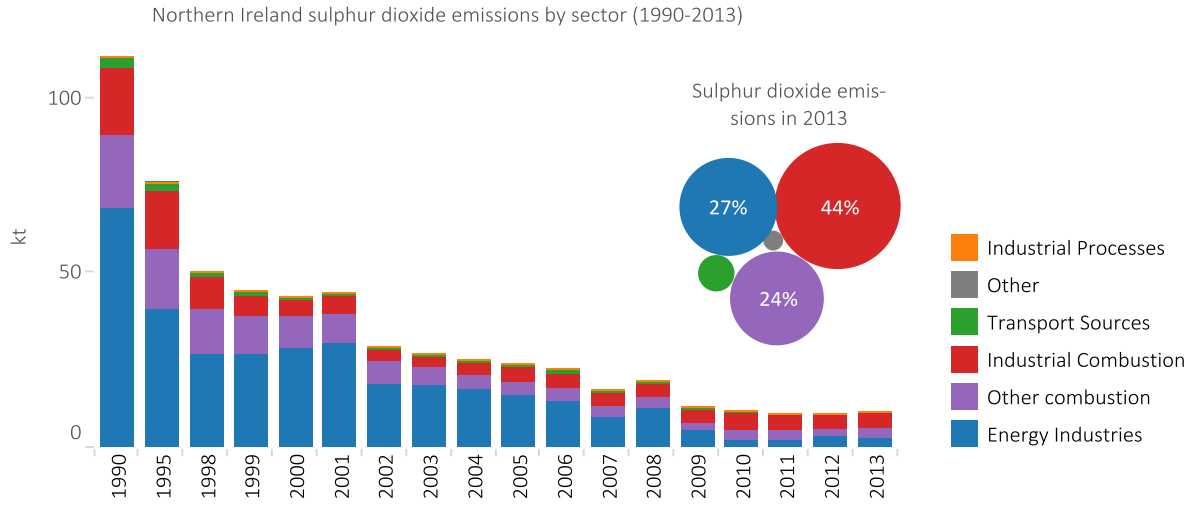
Emissions of **non-methane volatile organic compounds** were estimated to be 30kt in 2013, representing 4% of the UK total in 2013. Emissions have declined by 58% since 1990 mainly due to the decrease in road transport emission sources, including evaporative losses. Similarly to carbon monoxide and nitrogen oxides, this is mainly due to the requirement for new petrol cars to be fitted with three-way catalysts since 1989 and, in more recent years, the switch from petrol cars to diesel cars. With this large reduction in transport emissions, agriculture is now the most significant source of NMVOC emissions, more specifically emissions from cattle manure management.

Figure 51 - Northern Ireland PM_{10} Emissions



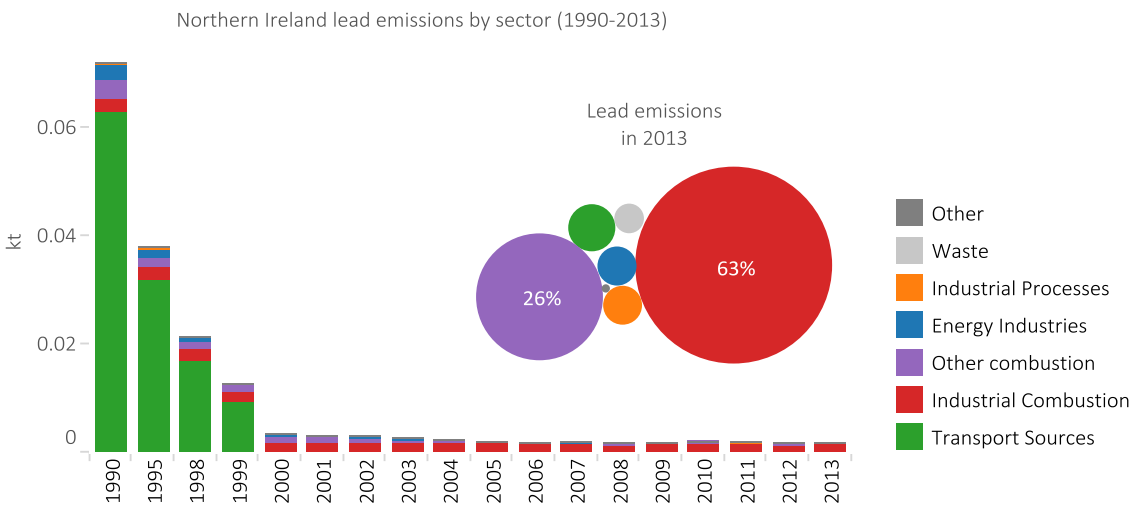
Emissions of **PM_{10}** were estimated to be 6kt in 2013 and accounted for 5% of the UK total. Emissions have declined by 60% since 1990 and this decreasing trend has been defined by emissions from the other combustion sector. There has been a reduction in the use of peat and coal in the domestic sector, which is partly due to the restriction of the use of coal for domestic combustion through the Clean Air Act. Across many economic sectors there has also been significant fuel-switching from coal and oil to natural gas, reducing PM_{10} emissions as the Northern Ireland gas supply network has expanded. The main source of road transport emissions is exhaust gases from diesel engines, which have been decreasing due to the penetration of new vehicles meeting tighter PM_{10} emission regulations. In recent years, emissions from the other combustion sector have increased, and this is due to an increasing quantity of wood combusted in the domestic sector.

Figure 52 - Northern Ireland Sulphur Dioxide Emissions



Emissions of **sulphur dioxide** were estimated to be 10kt in 2013, representing 3% of the UK total in 2013. Emissions have declined by 91% since 1990, which has been dominated by the 96% reduction in energy industries emissions due to the installation of flue-gas desulphurization (FGD) at Kilroot coal-fired power station in 2009, and the introduction of CCGT (Combined Cycle Gas Turbine) plant, which are more efficient than conventional coal and oil stations and have negligible SO_2 emissions. As the natural gas network has expanded to different parts of Northern Ireland, other sectors have also shown step-changes in emissions as fuel-switching away from coal has been made possible. Road transport emissions have declined due to tightening of fuel standards during the 1990s and more recently due to the EU Fuel Quality Directive and its amendments leading to a reduction in the sulphur content of diesel.

Figure 53 - Northern Ireland Lead Emissions



Emissions of **lead** were estimated to be 1.9 tonnes in 2013, representing 3% of the UK total in 2013. Emissions have declined by 97% since 1990 almost entirely due to changes in the transport sector. Leaded petrol was phased out from general sale at the end of 1999, which is the reason for the 99.9% decrease in transport emissions between 1990 and 2000. The most significant source of emissions is now the use of lubricants in industry.

Table 5 below provides a summary of the percentage contribution of each sector for each pollutant. Using the ranking of these percentage contributions, the sectors have been ordered to provide its indicative significance across all pollutants. As such, the table below indicates that the other combustion sector is the most significant sector when considering emissions from all pollutants. This sector accounts for at least 15% of emissions for five pollutants: CO, NO_X, Pb, PM_{10} and SO_2.

The majority of the top five sectors are related to the combustion of fuel, except for agriculture, which is a significant sector in Northern Ireland for ammonia (NH_3), PM_{10} and NMVOC. The table also highlights that whilst emissions from the solvent processes sector are not as significant when considering all pollutants, it is relatively significant when considering emissions of NMVOC.

Table 5 - Source Emission Contributions Ranked by Sector, Northern Ireland 2013

Overall Rank	Sector	NH_3	CO	NO_X	NMVOC	PM_{10}	SO_2	Pb
1	Other combustion	0.5%	38.5%	18.4%	7.0%	29.6%	24.4%	26.4%
2	Transport Sources	0.9%	28.8%	43.2%	3.6%	14.4%	3.7%	3.6%
3	Industrial Combustion	0.0%	29.7%	16.6%	1.7%	7.9%	44.2%	63.5%
4	Agriculture	92.4%	0.0%	0.0%	45.0%	38.1%	0.0%	0.0%
5	Energy Industries	0.0%	1.8%	20.4%	0.0%	0.7%	26.6%	2.5%
6	Industrial Processes	0.0%	0.0%	0.0%	8.0%	5.3%	0.0%	2.5%
7	Other *	2.4%	1.2%	1.5%	1.1%	2.5%	1.1%	0.1%
8	Solvent Processes	0.0%	0.0%	0.0%	30.9%	1.5%	0.0%	0.0%
9	Waste	3.7%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%
10	Fugitive	0.0%	0.0%	0.0%	2.7%	0.0%	0.0%	0.0%
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

* The sector: "other" will include all "other" categories in the inventory and also a number of categories that are insignificant for a specific pollutant.

Emission maps for all seven pollutants are shown below.

Figure 54 - Northern Ireland Ammonia Emissions, 2013

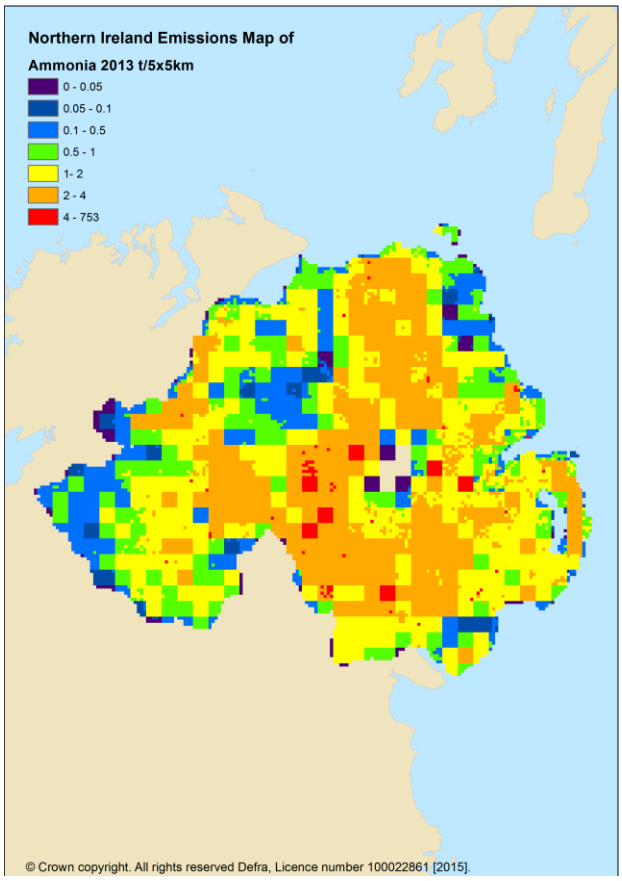


Figure 55 - Northern Ireland Carbon Monoxide Emissions, 2013

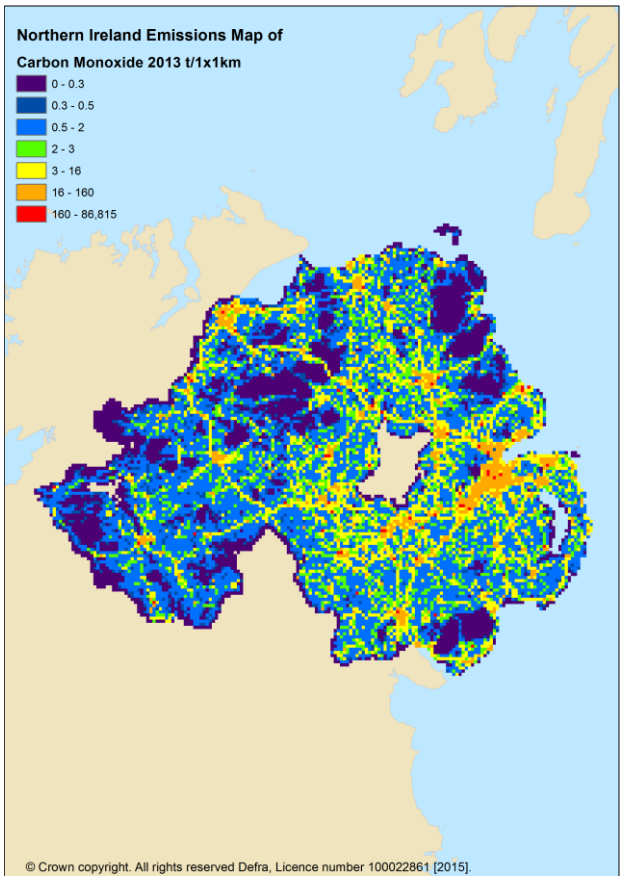


Figure 56 - Northern Ireland Nitrogen Oxides Emissions, 2013

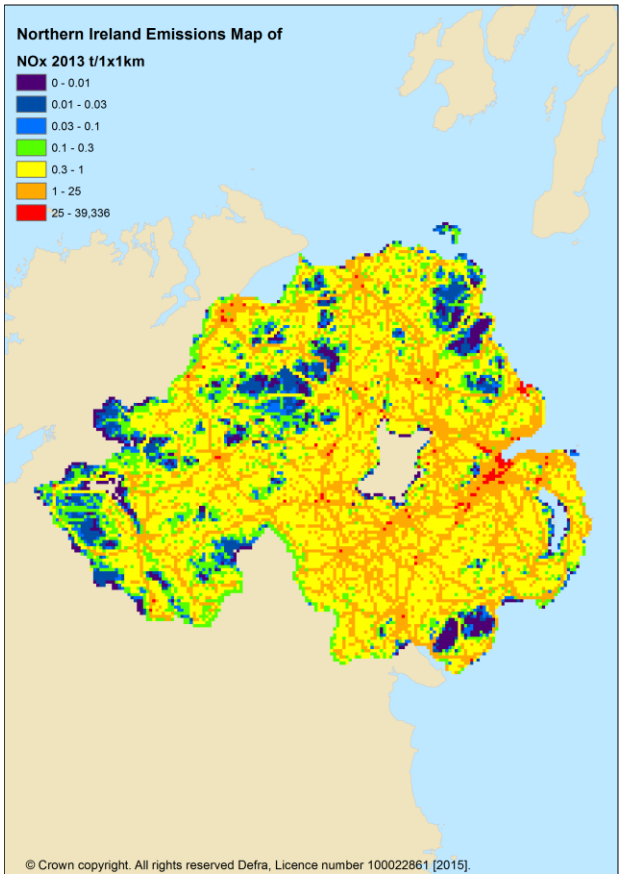


Figure 57 - Northern Ireland NMVOC Emissions, 2013

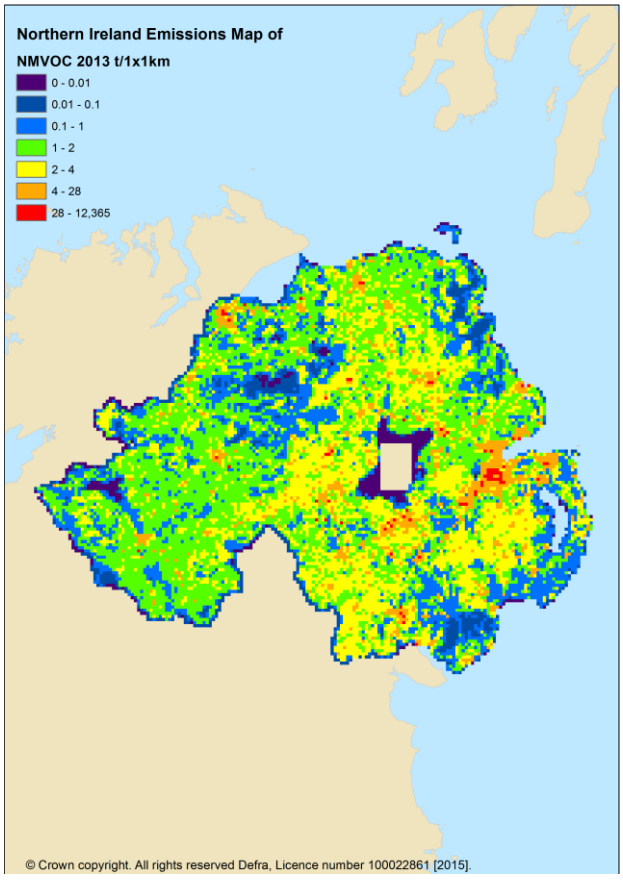


Figure 58 - Northern Ireland PM_{10} Emissions, 2013

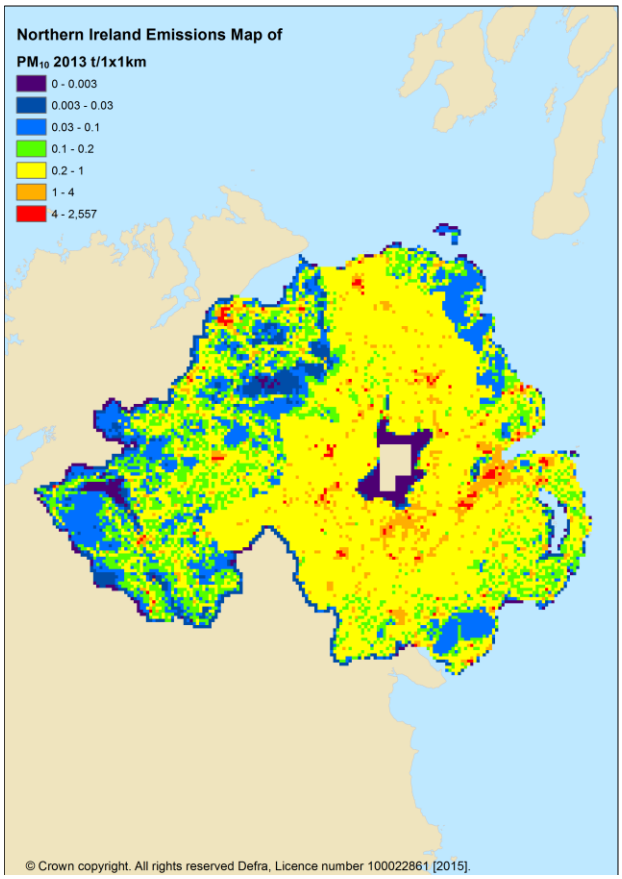


Figure 59 - Northern Ireland Sulphur Dioxide Emissions, 2013

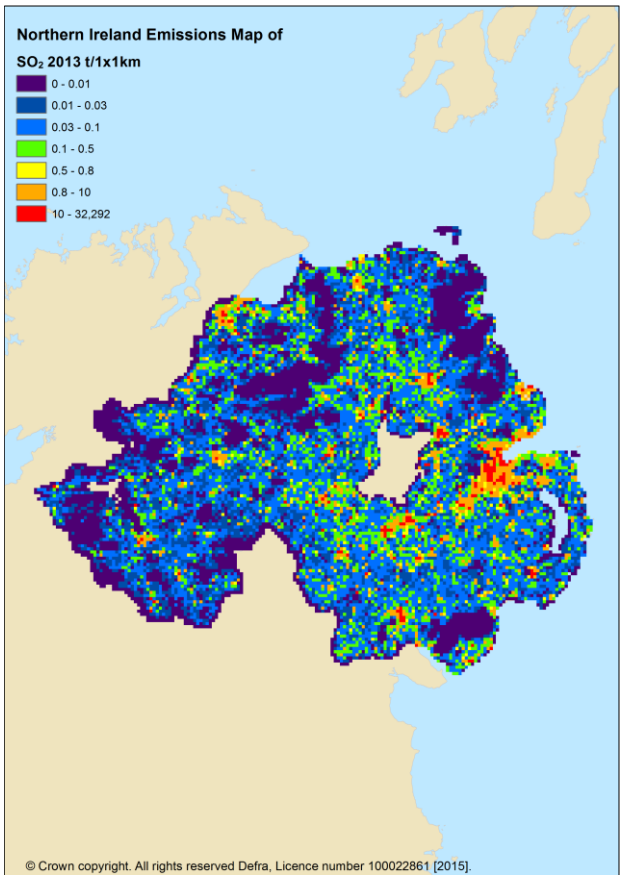
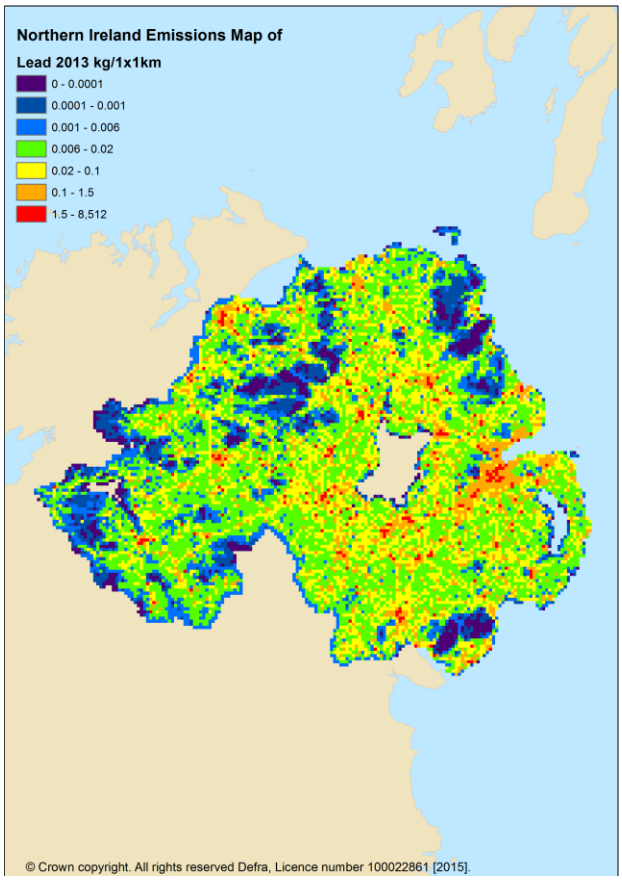


Figure 60 - Northern Ireland Lead Emissions, 2013



2.5. Per Capita Emissions

Using the Devolved Administrations emissions data and population statistics, emissions per capita can be calculated. A brief, qualitative summary of the key features is given below:

- Across all Devolved Administrations, for all pollutants, per capita emissions have fallen between 1990 and 2013;
- The most notable decrease (in percentage terms) is for lead, with a decrease of more than 90% across all of the Devolved Administrations;
- In England, per capita emissions were lower than the UK average for all pollutants in 2013;
- In Northern Ireland, ammonia emissions per capita were over four times the UK average in 2013. This is due to the very high contribution of emissions from agriculture, relative to the rest of the UK;
- Scottish NMVOC emissions per capita were two times the UK average in 2013, mainly due to the high contribution of emissions from the food and drink industry.
- Welsh emissions were considerably higher than the UK average for all pollutants in 2013, most notably for lead and carbon monoxide. This is predominantly due to the contribution of emissions from the iron and steel industry.

Appendix A Background to Inventory Development

The following sections provide further detail on the background of the air quality pollutant inventory development for the Devolved Administrations. This is supporting information for Section 1.1 of the main report.

Overall air quality in the UK is currently estimated to be better than at any time since the industrial revolution. However air pollution is still estimated to reduce the life expectancy of every person in the UK. The estimated burden in the UK of anthropogenic particulate matter air pollution in 2010 as a loss of life expectancy from birth is approximately six months. The burden as an effect on mortality in 2010 was equivalent to nearly 29,000 deaths in the UK at typical ages and an associated loss of total population life of 300,000 life-years (PHE, 2014). The policies described below, which aim to improve air quality, are currently in place in the UK.

A.1 National Emissions Ceilings Directive

Within the EU, the National Emission Ceilings Directive (NECD) was agreed in 2001. It sets emission ceilings to be achieved from 2010 onwards for each Member State for the same four pollutants in the original Gothenburg Protocol, which cause harm to people's health and to the natural environment: sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds and ammonia. The UK met all four of its emissions ceilings by 2010, and continues to do so.

The European Commission has prepared a revision to the NECD. The Directive is not yet in force, but it will ensure that the emission ceilings set in the original directive for SO_2, NO_X, NMVOC and NH_3 shall apply until 2020. In addition, new national emission reduction commitments will be applicable from 2020 and 2030 onwards for SO_2, NO_X, NMVOC, NH_3, $PM_{2.5}$ and CH_4.

A.2 Gothenburg Protocol

The EU Member States, Central and Eastern European countries, the United States and Canada negotiated the 'multi-pollutant' protocol under the Convention on Long-Range Transboundary Air Pollution (CLRTAP) aimed at addressing photochemical pollution, acidification and eutrophication. The Protocol to Abate Acidification, Eutrophication and Ground-level Ozone was adopted in Gothenburg in December 2000 (Gothenburg Protocol). It incorporates several measures to facilitate the reduction of emissions:

- Emission ceilings are specified for sulphur, nitrogen oxides, ammonia and NMVOCs, which were to be attained by 2010 and all subsequent years;
- Emission limits are specified for sulphur, nitrogen oxides and NMVOCs from stationary sources;
- Emission limits are indicated for carbon monoxide, hydrocarbons, nitrogen oxides and particulates from new mobile sources;
- Environmental specifications for petrol and diesel fuels are given;
- Several measures to reduce ammonia emissions from the agriculture sector are required.

The Gothenburg Protocol was amended in 2012 to include national emission reduction commitments (expressed as percentage reduction from emission levels in 2005) to be achieved in 2020 and beyond. Several of the Protocol's technical annexes were also revised with updated sets of emission limit values for both key stationary sources and mobile sources, as well as the addition of emission reduction commitments for $PM_{2.5}$.

A.3 Industrial Emissions Directive

The Industrial Emissions Directive (2010/75/EU) entered into force in 2011 and aims to minimise pollution from applicable industrial sources throughout the EU. This Directive integrated seven existing pieces of legislation. Operators of particular industrial installations are required to obtain an integrated permit from the Environment Agency (England and Wales), Scottish Environment Protection Agency or the Northern Ireland Department of the Environment.

A.4 Heavy Metals Protocol

The LRTAP Convention has been extended by a number of protocols, including the 1998 Protocol on Heavy Metals, to which the UK is a signatory. The Heavy Metals Protocol targets three particularly harmful substances: lead, cadmium and mercury.

Countries are obliged to reduce their emissions of these three metals below their levels in 1990 (or an alternative year between 1985 and 1995). The protocol aims to cut emissions from industrial sources (iron and steel industry, non-ferrous metal industry), combustion processes (power generation, road transport) and waste incineration. The protocol specifies limit values for emissions from stationary sources and requires the use of Best Available Technology (BAT) to minimise emissions from these sources, through the application of special filters or scrubbers for combustion sources, or mercury-free processes. The protocol also requires countries to phase out leaded petrol. Under the protocol, measures are introduced to lower heavy metal emissions from other products (such as mercury in batteries) and examples are given of management measures for other mercury containing products, such as electrical components (thermostats, switches), measuring devices (thermometers, manometers, barometers), fluorescent lamps, dental amalgam, pesticides and paint.

The protocol was amended in 2012 to introduce more stringent emission limit values for emissions of particulate matter and of the specific heavy metals cadmium, lead and mercury applicable for certain combustion and other industrial emission sources releasing them into the atmosphere. The emission source categories for the three heavy metals were also extended to the production of silico- and ferromanganese alloys.

A.5 Persistent Organic Pollutants (POPs) Protocol

The UNECE adopted the Protocol on Persistent Organic Pollutants (POPs) in 1998, which focuses on a list of 16 substances that have been singled out according to agreed risk criteria. The substances comprise eleven pesticides, two industrial chemicals and three by-products/contaminants.

The objective of the Protocol is to eliminate any discharges, emissions and losses of POPs. The Protocol bans the production and use of some products, whilst others are scheduled for elimination at a later stage. The Protocol includes provisions for dealing with the wastes of products that will be banned. It also obliges Parties to reduce their emissions of dioxins, furans, polycyclic aromatic hydrocarbons (PAHs) and hexachlorobenzene (HCB) below their levels in 1990 (or an alternative year between 1985 and 1995). For the incineration of municipal, hazardous and medical waste, it lays down specific limit values.

The Protocol was amended in 2009 to include seven new substances and implement revised obligations for some substances as well as emission limit values (ELVs) for waste incineration.

A.6 Sulphur Content of Liquid Fuels Directive

The EC's Directive to limit sulphur content in gas oil and fuel oil has been transposed into UK regulations which were initially established in 2000 but were updated with Statutory Instruments brought into force across the DAs via the Sulphur Content of Liquid Fuel Regulations 2007 (England and Wales: SI79/2007; Scotland: SI 27/2007; Northern Ireland: SI 272/2007). The main impact of these regulations has been to gradually drive down the maximum sulphur content of refinery products, with the 2007 Regulations requiring that gas oil has a maximum 0.1% content Sulphur by mass from January 2008 onwards. The impacts of this change are evident within the recent emission trends of the UK and DA inventories as SO_2 emissions have declined significantly between 2007 and 2008 from road transport (1A3b) and other sources where petroleum-based fuels are dominant.

A.7 Air Quality Strategy for England, Scotland, Wales and Northern Ireland

The UK Government leads on the UK's input to International and European legislation relating to Air Quality, with input from the Scottish Government, Welsh Government and Northern Ireland Government. Linked to the requirements of the EU Directives, the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Defra, 2007) sets out a framework of standards and objectives for the air pollutants of most concern at the time (sulphur dioxide, particulate

matter, nitrogen oxides, polycyclic aromatic hydrocarbons, benzene, 1, 3-butadiene, carbon monoxide, lead, ammonia and ozone).

These standards relate to the quality of air, whilst the objectives are policy targets for the restriction of levels at which particular substances are present in the air. The aim of the strategy is to reduce concentrations of air pollutants to avoid unacceptably higher impacts on human health and ecosystems.

A.8 EU Air Quality Framework Directive

Under and the 4th Daughter Directive of the EU Air Quality Framework Directive (2008/50/EC), concentration limit values are set for twelve pollutants, including NO_x, SO_2, PM and CO. Member States are required to submit annual reports to the European Commission on whether the concentration limits have been achieved within their respective areas. This framework was established to set limit values on air pollutant concentrations and manage air quality more generally to avoid exceeding the air pollutant concentration limits known to be harmful to human health and the environment.

The 2008 directive replaced most of the earlier EU air quality legislation and was made law in Scotland through the Air Quality Standards (Scotland) Regulations 2010. The Regulations also incorporates the 4th air quality daughter directive (2004/107/EC) that sets targets for levels in ambient air of specific heavy metals and polycyclic aromatic hydrocarbons.

Appendix B Inventory Methodology

This Appendix provides further detail on how the inventory is compiled, and the data sources that are used during compilation. This information supports Section 1.3 of the main report.

The disaggregation of air quality (AQ) pollutant emissions across the four Devolved Administrations (DAs) of the UK is part of a programme of on-going data and methodology improvement, to provide emission inventories for the Devolved Administrations. This programme spans both greenhouse gas and air quality emission inventories, and is driven by the developing requirements for sub-national reporting against emission targets and Devolved Administration policy development.

B.1 Data Availability

For many emission sources of air quality pollutants, the data available for Devolved Administration emissions are less detailed than for the UK as a whole, and for some sources country-level data are not available at all.

In particular, energy balance data (i.e. fuel production, transformation and sector-specific consumption data) are not available across the time-series for England, Scotland, Wales and Northern Ireland. Sub-national energy statistics are published annually by the Department for Energy and Climate Change (DECC) within the quarterly Energy Trends publication (DECC 2014b). These sub-national statistics are limited in their detail when compared to UK-level energy statistics, but do provide estimated fuel use data for England, Scotland, Wales and Northern Ireland for the following combustion source sectors: industry, commercial, agriculture (combustion sources) and domestic.

These DECC sub-national energy statistics are based on local electricity and gas consumption patterns, as part of a project to develop Local Authority carbon dioxide emissions data. These statistics use local electricity and gas use data from the National Grid and the gas supply network operators (formerly Transco). Solid and liquid fuel use is calculated using point source consumption data for major industrial sites, and a complex modelling process to distribute remaining UK fuel allocations that uses employment and population data and takes account of smoke control zones and the patterns of gas and electricity consumption. The latest available data include Local Authority solid and liquid fuel use estimates for 2005 to 2012, with gas and electricity data also being available up to 2013.

The DECC sub-national energy statistics are National Statistics and are revised and improved each year through targeted sector research aimed at reducing uncertainties in the modelling approach. The lack of consistent and comprehensive fuel use data from across the Devolved Administrations (especially for solid and liquid fuels) leads to significant potential errors in the distribution of UK fuel use across the regions. Expert judgement and proxy data are used to address data gaps and inconsistencies in energy use data over the time-series. The Devolved Administrations' emission estimates for earlier years in the inventory time-series and the reported inventory trends are associated with higher uncertainty than the data and trends reported in the UK emissions inventory.

The DECC sub-national energy statistics are used to derive estimates for industry sector combustion of fuels such as fuel oil, gas oil and coal. These data are based predominantly on analysis of available point source data, supplemented by production and employment surveys, and in several sectors new data on building Display Energy Certificates and Energy Performance Certificates have been used to provide a better indicator of the Devolved Administrations' energy use than the production or employment indices.

For other significant emission sources there are complete country-level datasets available, although some of these are less detailed than data used for the UK Inventory:

- Industrial process emissions are based on plant operator estimates reported to environmental agencies under regulatory systems such as Integrated Pollution Prevention and Control (IPPC). Major sources include power stations, cement and lime kilns, iron & steel works, aluminium and other non-ferrous metal plant, chemical industries. These data are not available across the full time-series from 1990, as the regulatory reporting regimes were developed in the late 1990s (in England, Wales and Northern Ireland) and early 2000s (in Scotland).

- Emissions from **oil and gas terminals** and offshore platforms and rigs, are based on operator estimates reported to the DECC Offshore Inspectorate team (DECC Offshore Inspectorate, 2014) in Aberdeen through the Environmental Emissions Monitoring System (EEMS). Emissions from the offshore oil & gas exploration and production sector are not attributed to a specific country inventory, but are reported within an "unallocated" category, whilst emissions from onshore oil & gas terminals are assigned to the appropriate country inventories.
- **Agricultural emissions** are based on official livestock datasets, annual fertiliser use surveys, farm management practice surveys and detailed emission factors from recent literature sources. The methodology for compiling the inventory of ammonia emissions from agriculture follows that of Misselbrook, T.H. et al., (2013). Emissions are affected by a large number of factors, including animal species, age, weight, diet, housing and manure management systems, and environmental conditions. As such, the interpretation and extrapolation of experimental data is problematic, making emission estimates uncertain.
- Emissions from **waste disposal activities** are estimated based on modelled emissions from the UK air quality inventory (Defra, 2014) split out across the DAs based on local authority waste disposal activity reporting (www.wastedataflow.org) which provides an insight into the local shares of UK activity for recycling, landfilling, incineration and other treatment and disposal options. Waste incineration emissions are based on point source emissions data.

For some sources where regional data are not available, current NAEI mapping grids have been used. These mapping grids are commonly based on census and other survey data that are periodically updated and used within UK emissions mapping and modelling work (Tsagatakis *et al.*, 2015).

In many source sectors, there are insufficient local data available back to 1990 or earlier, and assumptions and extrapolations of available datasets have frequently been used to present a time-series of air quality pollution emissions.

B.2 Key Compilation Resources

As a result of the more limited DA-specific activity and emission factor data, the emission estimates for the England, Scotland, Wales and Northern Ireland inventories are subject to greater uncertainty than the equivalent UK estimates. There are step-changes in data availability during the time-series, such as installation-specific fuel use data from major industrial plant under EU ETS (from 2005 onwards) and sites regulated under Environmental Permitting Regulations / Integrated Pollution Prevention and Control (EPR/IPPC) (1998 onwards for England and Wales, 1999 onwards for Northern Ireland, and in 2002 and from 2004 onwards for Scotland).

These data sources are used, where possible, to inform back-casting of emission estimates, but there remains a greater level of uncertainty in emission estimates from the earlier part of the time-series compared to more recent years. Furthermore, the data quality from these environmental regulatory systems has evolved over the years as monitoring, reporting and quality checking methods and protocols have developed. This also impacts upon the accuracy of the reported emissions of air quality pollutants which are used within inventory compilation, such that more recent data are likely to be more accurate. The uncertainties in the Devolved Administrations' air quality inventories are discussed in more detail in Appendix D.

There are a number of resources that have been used to analyse the Devolved Administrations' share of UK emissions for each emission source, including:

- NAEI point source database;
- NAEI emission mapping grid data;
- Local and regional data derived from analysis of activity data trends;
- Generic parameters and proxy data such as population or economic indicators such as GVA data.

These main resources used within the DA air quality pollutant inventory are outlined below.

B.2.1 NAEI Point Source Database

Operators of all EPR/IPPC-regulated industrial plant are required to submit annual emission estimates of a range of pollutants (including all of those pertinent to this report) to their local UK environmental regulatory agency, and these emission estimates are subject to established procedures of Quality Assurance and Quality Checking prior to publication.

These industrial point-source pollution inventories (held by the Environment Agency, the Scottish Environment Protection Agency, Natural Resources Wales and the Northern Ireland Environment Agency) are emission datasets that have been developing and improving since their inception in the mid-1990s. Robust and reliable data for installations in England and Wales have been widely available since around 1998, whilst the equivalent datasets in Scotland and Northern Ireland became available from the early 2000s.

NAEI point source data have been improved over recent years through the increasing quality and availability of these EPR/IPPC-regulated industrial pollution emission datasets, as well as through the availability of site-specific fuel use data for sites that operate within the EU Emissions Trading System (EU ETS), which has been running since 2005. Annual data requests are also made directly to plant operators or trade associations in key sectors such as power stations, refineries, cement & lime manufacture, iron & steel manufacture, chemical industry and waste treatment and disposal, in order to procure more detailed emissions data and other parameters (such as production data).

Through analysis of the time-series of data and review of the latest emission estimates, the point source data is amended as appropriate to fill in gaps and rectify any errors. These finalised data are then used as the basis for the NAEI industrial emissions estimates. The location of each site is known and therefore the point source database can be queried to extract all emissions information relevant to a given geographical area, and hence the DA-level inventories can partly be populated in this way.

The NAEI point source database is most useful for industries that are dominated by large EPR/IPPC-authorised plant, such as power stations, refineries, iron & steel manufacturing, cement and lime kilns and so on. For these sectors, the point source database covers nearly 100% of emissions, and is regarded to be the best available dataset for such sources, as it is largely based on energy use and emissions data derived from regulatory agency sources that are subject to quality checking and (in the case of EU ETS data) independent verification.

Annual revisions to the NAEI point source database are conducted when new data become available and/or when installation-level data are revised by operators, regulators or through enquiry by the UK inventory team to resolve data discrepancies which may be evident between reporting mechanisms.

B.2.2 NAEI Emission Mapping Grids

Emission maps for the whole of the UK are routinely produced as part of the NAEI for 25 pollutants, including all of the pollutants considered in the Devolved Administrations' Air Quality Pollutant Inventory. The maps are compiled at a 1km resolution and are produced annually for the most recent NAEI database. The mapped emissions data are available on the NAEI web site at: http://naei.defra.gov.uk/data/mapping. For a more detailed description of the integration of point source data analysis and the development of UK emission maps, see Tsagatakis et al. (2015).

The emission maps are used by the UK inventory team and other organisations for a variety of Government policy support work at the national scale. In particular, the maps are used as input into a programme of air pollution modelling studies.

The geographical distribution of emissions across the UK is built up from distributions of emissions in each source sector. These source sector distributions are developed using a set of statistics appropriate to that sector. For large industrial 'point' sources, emissions are compiled from a variety of official UK sources (Environment Agency, Scottish Environment Protection Agency, Natural Resources Wales, Northern Ireland Environment Agency, and Local Authority data). For sources that are distributed widely across the UK (known as 'area' sources), a distribution map is generated using appropriate surrogate statistics for that sector. The method used for each source varies according to the data available, but is commonly based on either local activity statistics such as raw material use, energy use, industrial production and employment data, housing and population data, road vehicle and fuel sales data, periodic census or socio-economic survey data.

Periodic surveys and censuses of industrial, commercial, domestic, and other economic sectors provide indicators regarding the location and scale of a wide variety of activity data that can be used to disaggregate emissions totals, and these are commonly utilised within the NAEI mapping grids.

The key limitation to the use of mapping grids within inventory development is the difficulty in obtaining an accurate time-series of emissions from a given sector, as the mapping grids are typically only updated every few years as more survey data becomes available. The data availability limitations inevitably impact upon the reliability of emission inventory estimates. In this study, the project team has focussed resources on ensuring that the most significant sources are assessed most accurately across the time-series, whilst less significant source sectors may be disaggregated using a mapping grid for all years in the time-series.

The table below provides a summary of the mapping grid data availability for each sector using the Nomenclature for Reporting (NFR) structure, which is the format currently required for the submission under the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP).

Table 6 - Disaggregation Methodologies for the Devolved Administrations Air Quality Pollutant Inventories

NFR Sector	Source	Disaggregation Method
1A1a	Public electricity and heat production (all fuels)	All emissions from major fuels are derived from the point source database, which is based on annual emissions estimates reported to UK environmental regulators by IPC/IPPC-regulated industry and (since 2005) fuel use data available from the EU ETS. Environment Agency (2014a,b), SEPA (2014a,b), NIEA (2014a,b). Exceptions are minor fuels: sewage gas use is estimated based on UK-wide estimates disaggregated using DA share of UK population (ONS, 2014); landfill gas use is based on the elution of methane from landfills from the MELMOD model (Ricardo-AEA, 2014).
1A1b	Petroleum refining (all fuels)	Point source data provided by plant operators to IPC/IPPC pollution inventories (see 1A1a). Further detail on combustion and process emissions provided by UKPIA (2014). In the 1990-2013 dataset there is an exception from this method, as DUKES estimates of naphtha use as a fuel in unclassified industry has been allocated to the refinery sector in the NAEI, and within the DA AQPIs. This leads to a slightly conservative estimate for some pollutants for the refinery sector, when compared against the operator-reported data. Further work is planned for the 1990-2014 inventory to review the sector allocation of the naphtha use and subsequent emissions.
1A1c	Coke & SSF production (all fuels)	Point source data provided by plant operators (see 1A1a). Regional iron & steel production and fuel use data (ISSB, 2014). UK fuel use data from DECC (2014a).
	Nuclear fuel production (all fuels)	All emissions are in England
	Colliery combustion and colliery methane production (all fuels)	Deep mined coal production, data from the Coal Authority (2014).
	Gas production, downstream network (all fuels)	EU ETS installation data for natural gas use from 2005-2013. All other years estimated based on the DA share from the 2005 EU ETS data. Environment Agency (2014a,b), SEPA (2014a,b), NIEA (2014a,b)
	Upstream oil & gas, including gas separation plant (all fuels)	DECC Offshore Inspectorate (2014) EEMS inventory. Point source data for NO_X, SO_2, VOC. (CO and PM_{10} assumed same as SO_2.)
1A2a	Blast furnaces & sinter plant	Point source data provided by plant operators (see 1A1a), supplemented by site-specific breakdown of emissions from Tata Steel (2014).
	Iron & steel combustion plant (all fuels)	Regional iron & steel production and fuel use data (ISSB, 2014) used to inform estimates to 2004. 2005 onwards derived from activity data from EU ETS.
1A2b	Combustion in non-ferrous metals manufacturing industry	Pollution Inventory (EA 2014a, SEPA 2014a, NIEA 2014a), EU ETS (EA 2014b, SEPA 2014b, NIEA 2014b) IDBR and employment data (ONS, 2014). Overall analysis of the 1A2b,c,d,e and g sectors used to constrain the DA totals to previous 1A2 DA estimates, using 1A2g Other Industry as residual.
1A2c	Combustion in chemical manufacturing industry, ammonia production	

NFR Sector	Source	Disaggregation Method
1A2d	Combustion in paper, pulp and print manufacturing industry	Detailed analysis conducted for 2008-2013; 1A2b,c,d,e 1990-2008 DA trends matched with UK trends due to data limitations for the detailed industry sub-sector activities at DA level. Exceptions: All ammonia production (1A2c) is located in England.
1A2e	Combustion in food processing, beverages and tobacco manufacturing industry	
1A2f	Combustion in minerals industries: cement and lime	Cement: Point source data from plant operators (see 1A1a). All lime production is in England.
1A2g	Refractory & ceramic production	Regional GDP data (ONS, 2014).
	Autogenerators (coal)	All emissions in England.
	Other industrial combustion (oils)	Sub-national energy statistics, DECC (2014b), and analysis of point source data derived from EU ETS and IPPC data. Environment Agency (2014a,b), SEPA (2014a,b), NIEA (2014a,b). Overall analysis of the 1A2b,c,d,e and g sectors used to constrain the DA totals to previous 1A2 DA estimates, using 1A2g Other Industry as residual.
	Other industrial combustion (SSF, coke)	
	Other industrial combustion (coal)	
	Other industrial combustion & auto-generators (gas)	Natural gas consumption data from gas network operators: National Grid (2014), Northern Gas Networks (2014), Scotia Gas Networks (2014), Wales & West Utilities (2014), Airtricity (2014), Firmus Energy (2014), Vayu (2014), Energia (2014). Sub-national energy statistics, DECC (2014b), and analysis of point source data derived from EU ETS and IPPC data. Environment Agency (2014a,b), SEPA (2014a,b), NIEA (2014a,b).
	Industrial off-road machinery (all fuels)	Sub-national energy statistics (DECC, 2014b) and DA GDP data (ONS, 2014).
1A3ai (i)	Aircraft – international take-off and landing (all fuels)	CAA (2014), UK airport statistics. All take-off and landing cycle emissions for each flight assigned to DA of origin airport.
1A3aii (i)	Aircraft – domestic take-off and landing (all fuels)	
1A3bi to 1a3bvii	Road Transport	Vehicle km, DfT, NI Department for Regional Development (DRD) Emission factors: Boulter et al. (2009) COPERT 4 (EEA, 2013b) Fuel efficiency: Road Freight Statistics, DfT (2014) Composition of fleet: Vehicle Licensing Statistics Report, DfT (GB) Dept. of Regional Development (NI). Traffic data: National Traffic Census, DfT (England, Scotland, Wales: 1990-2013) Dept. of Regional Development (NI: 1990-1999), Traffic Census Report (NI: 2000), Vehicle Kilometres of Travel Survey of Northern Ireland Annual Report (NI: 2001), Traffic and Travel Information, DRDNI (NI: 2002- 2013) Fuel consumption: Digest of UK Energy Statistics (1990-2013),
1A3c	Railways: intercity, regional and freight	UK specific emission factors in g/vehicle (train) km are taken from the Department for Transport's Rail Emissions Model (REM) for different rail engine classes based on factors provided by WS Atkins Rail. Data from UKPIA on sulphur content of gas oil. Gas oil consumption data from Office of Rail Regulation for passenger and freight trains for 2005-2009 combined with trends in train km to estimate consumption for other years. Train km data from REM are used to provide the breakdown between train classes. Fuel consumption: Digest of UK Energy Statistics (1990-2013)
1A3dii	Coastal shipping (gas oil, fuel oil)	Port movement data, DfT (2014b) Maritime Statistics. Estimates for all inland waterways are based on population (ONS, 2014).
1A3eii	Aircraft support vehicles (gas oil)	Regional aircraft movements, DfT (2014d)
1A4a	Railways – stationary combustion	Sub-national energy statistics, DECC (2014b)
	Industrial & commercial combustion	

NFR Sector	Source	Disaggregation Method
	Public sector combustion	Sub-national energy statistics, DECC (2014b), and analysis of point source data and public and commercial mapping grids from regional employment data by sector. Gas use data supplemented by data from gas network operators (same references as 1A2g). PSEC data (DFPNI 2014) used to inform the N Ireland estimates.
1A4bi	Domestic combustion	For coal, anthracite, petroleum fuels, natural gas, analysis is from sub-national energy statistics, DECC (2014b) and Housing Condition Survey data. Domestic peat combustion data from CEH (Personal communication, 2014). Northern Ireland gas use in the residential sector is based on estimates from all energy suppliers in Northern Ireland (Airtricity, Firmus Energy, Energia, Vayu; all 2014)
1A4bii	Household and gardening mobile machinery (all fuels)	Regional dwellings data, ONS (2014).
1A4ci	Agriculture – Stationary combustion	Agricultural employment data, Defra (2014a) used for allocation of solid and gaseous fuels. Regional energy statistics, DECC (2014b) used for petroleum-based fuels. N Ireland gas use data for agriculture sector based on 2005 estimate for the sector provided by Phoenix Natural Gas (2007).
1A4cii	Agriculture – mobile machinery	Agricultural off-road mapping grid, with overall petroleum fuel allocations constrained to the DECC sub-national energy data (DECC, 2014b)
1A4ciii	Fishing vessels	Port movement data, DfT (2014b) Maritime Statistics
1A5b	Military aircraft and naval shipping	Regional GDP data (ONS, 2014).
1B1a	Deep-mined coal	Regional deep mine production, Coal Authority (2014). Emissions from closed coal mines derived from WSP report (Fernando, 2011)
1B1b	Charcoal, Coke & SSF production	Charcoal production estimates based on regional GDP data (ONS, 2014). Coal feed to coke ovens, ISSB, WS, DECC and (1999-2004) PI. 2005 onwards: EU ETS (EA 2014b, SEPA 2014b, NIEA 2014b)
	Iron & steel flaring	Coal feed to coke ovens, ISSB, WS, DECC and (1999-2004) PI. 2005 onwards: EU ETS (EA 2014b, SEPA 2014b, NIEA 2014b)
1B2ai	Upstream oil & gas: offshore oil loading, well testing.	All emissions unallocated.
	Upstream oil & gas: process emissions, onshore oil loading, oil terminal storage	Emissions derived from the DECC Offshore Inspectorate (2014) EEMS point source dataset, with extrapolations back to cover 1990, 1995 where data gaps are evident.
1B2aiv	Refinery process emissions (drainage, tankage, general)	Point source data provided by plant operators (see 1A1a), UKPIA (2014) and analysed using the NAEI point source database.
1B2av	Petrol terminal storage and loading, Refinery road and rail haulage emissions	Point source data provided by plant operators (see 1A1a), supplemented by refinery road/rail loading estimates from UKPIA (2014).
	Petrol station emissions from delivery, vehicle refuelling, storage tanks and spillages	Regional road transport distribution based on analysis of vehicle km data for different vehicle types and the resultant fuel use distributions. Hence, references as 1A3b.
1B2b	Gasification processes	Regional GDP data (ONS, 2014)
	Upstream gas production: terminal storage, well testing, process emissions	All well testing emissions offshore (therefore all Unallocated). Process and storage emissions based on operator-reported data from EEMS (DECC Offshore Inspectorate, 2014) and PI/SPRI (Environment Agency 2014a,b; SEPA 2014 a,b)
	Gas leakage from supply infrastructure	Leakage data provided by gas network operators: National Grid (2014), Northern Gas Networks (2014), Scotia Gas Networks (2014), Wales & West Utilities (2014), Airtricity (2014).
1B2c	Upstream oil & gas: flaring & venting	Emissions derived from the EEMS dataset (DECC Offshore Inspectorate, 2014), with extrapolations back to cover 1990, 1995 where data gaps are evident.
	Refinery flaring	Point source data provided by plant operators (see 1A1a) supplemented by data from the trade association (UKPIA, 2014)

NFR Sector	Source	Disaggregation Method
2A1	Cement decarbonising	Point source data provided by plant operators (see 1A1a).
	Concrete batching	Regional GDP data (ONS, 2014).
	Slag cement production	Slag cement production mapping grid
2A2	Lime production decarbonising	All lime production in England.
2A3	Glass industry process emissions	Point source data provided by plant operators (see 1A1a). Exceptions are emissions from production of flat glass, frits and lead crystal, all of which only occur in England.
2A5	Construction, asphalt manufacture	Regional GDP data (ONS, 2013).
	Quarrying (aggregates)	Quarries mapping grid.
	Lead mining	All emissions in England.
2A6	Bricks and ceramics	All fletton brick production in England. Non-fletton brick estimates based on point source data provided by plant operators (see 1A1a). Process emissions from concrete batching plants and ceramics manufacture based on regional GDP statistics (ONS, 2014).
2B1	Ammonia production	All ammonia production now in England. Point source emissions data and plant capacity data used for earlier years.
2B2	Nitric acid production	Point source data provided by plant operators (see 1A1a). Now all England.
2B3	Adipic acid production	Point source data provided by plant operators (see 1A1a). All England.
2B6	Chemical industry – titanium dioxide	All emissions in England
2B7	Chemical industry – soda ash manufacture	All emissions in England
2B10	Ship purging	All emissions unallocated (i.e. offshore)
	Chemical industry process emissions	Point source data provided by plant operators (see 1A1a). Exceptions are sectors where all emissions are in England: acrylonitrile, alkyl lead, ammonia-based fertiliser, carbon black, ethylene oxide, methanol, sulphuric acid production/use, coal tar and bitumen processes.
2C	Industrial process emissions from SMEs, hot & cold steel rolling emissions, lead battery manufacture.	Regional GDP data (ONS, 2014).
	Process emissions from: blast furnaces, EAFs, BOFs, primary aluminium production & anode baking, alumina production, non-ferrous metal processes	Point source data provided by plant operators (see 1A1a), plus supplementary data provided by Tata Steel (2014), SSI (2014) and the ISSB (2014)
	Flaring & stockpile emissions at iron & steelworks	Regional iron & steel production and fuel use data (ISSB, 2014).
	Foundries	Foundries mapping grid
2D3a	Aerosol and non-aerosol products (cosmetics & toiletries, household products, paint thinners),	Population data, ONS (2013).
	Agrochemical use	Arable mapping distribution grid
2D3b	Road dressings and bitumen use	Road dressing mapping grid.

NFR Sector	Source	Disaggregation Method
	Asphalt manufacture	Regional GDP data (ONS, 2014).
2D3d	Trade & retail decorative paints,	Population data, ONS (2014).
	Industrial coatings: commercial vehicles, aircraft, agricultural and construction vehicles.	Regional GDP data (ONS, 2014).
	Industrial coatings: wood, metal, plastic, marine, vehicle refinishing.	Various coatings mapping distribution grids are used based on surveys of locations of such processes.
	Industrial coatings: coil, film, metal packaging, automotive, drum, textile, paper	Point source data provided by plant operators (see 1A1a).
2D3e	Domestic surface cleaning.	Population data, ONS (2014).
	Industrial surface cleaning	Industrial employment mapping distribution grid.
	Leather coating and degreasing	Regional GDP data (ONS, 2014).
2D3f	Dry cleaning (solvent use)	Dry cleaning mapping grid
2D3g	Rubber & plastic products	Population data, ONS (2014).
	Tyre manufacture	Point source data provided by plant operators (see 1A1a).
	Industrial coating manufacture: adhesives, inks, solvents and pigments	Various industry-specific coatings mapping distribution grids
2D3h	Printing – flexible packaging, publication gravure	Point source data provided by plant operators (see 1A1a).
	Other printing sources	Population data, ONS (2014).
2D3i	Solvent use	Population data, ONS (2014).
	Seed oil extraction	Point source data provided by plant operators (see 1A1a).
	Wood impregnation – creosote, LOSP	Wood impregnation mapping grid
2H1	Paper production process emissions	Regional GDP data (ONS, 2014).
2H2	Cider & wine manufacture, sugar beet processing and sugar manufacture	All emissions are in England.
	Spirit manufacture	Point source data provided by plant operators (see 1A1a).
	Brewery emissions	Brewing mapping grid
	Food & drink process industries: meat & fish, margarine, cakes & biscuits, animal feed, coffee roasting	Population used to disaggregate emissions.
	Other food & drink processes: bread baking, malting.	Point source data provided by plant operators (see 1A1a).
2H3	Other industry Part B process emissions	Regional GDP data (ONS, 2014).
2I	Wood product process emissions	Wood coating mapping grid.
3B	Manure management	Ammonia DA splits for manure management, based on regional emissions data for 1990, 1995, 2000-2013 provided by Rothamsted Research (2015), 2013 Mapping data from CEH (Dragosits U. et al., 2014) and population data, ONS (2014).
3D1	Inorganic N fertilizers	Ammonia DA splits for fertiliser use, based on regional emissions data for 1990, 1995, 2000-2013 provided by Rothamsted Research, population data, ONS (2014).

NFR Sector	Source	Disaggregation Method
	Agricultural soil emissions	Ammonia DA splits for agricultural soils, based on regional emissions data for 1990, 1995, 2000-2013 provided by Rothamsted Research (2015)
3F	Field burning of agricultural wastes	Field burning estimates from Rothamsted Research (2014)
5A	Landfills	Regional landfill MSW disposal data (www.wastedataflow.org), combined with DA-specific landfill model developed by the Defra Waste team (Defra, 2012b).
5B	Composting	Population data, ONS (2014).
5C1	Incineration: MSW, crematoria, chemical waste	Point source data provided by plant operators (see 1A1a).
	Incineration: Clinical waste, sewage sludge	Population data, ONS (2014).
	Incineration: animal carcases	Agriculture mapping grid.
	Foot & mouth pyres	Data on livestock disposal, NAO (2002).
5C2	Open-burning of waste	Population data, ONS (2014).
5D1	Sewage sludge decomposition	Population data, ONS (2014).
6A	Other sources: accidental fires, bonfires, cigarettes, fireworks, infant emissions from nappies, domestic pets	Population data, ONS (2014).
	Heather burning	Agriculture mapping grid
	Non-agricultural horses, professional horses	Driver for non-agricultural horses based on activity data time-series from Rothamsted Research and CEH (2014)
	Parks, gardens and golf courses	Data on non-fuel fertiliser use, Rothamsted (2014)

B.2.3 Other Regional Data

In recent years, the NAEI team has aimed to develop a consistent time-series of detailed datasets to inform DA and local emission inventories (back to 1990) and pollutant mapping campaigns. Examples of such datasets that have been used in this study include:

- **Sub-national fuel use data** for natural gas, solid fuel and petroleum-based fuels, from UK Transco (Transco, 2014), other gas network operators, the Coal Authority (Coal Authority, 2014) and the Department of Energy and Climate Change (DECC, 2014b). The UK energy mapping team has been involved in the on-going development of the DECC sub-national energy statistics which provide limited data from 2004 to 2013. These data are used to underpin many of the AQ pollutant emission estimates from small-scale (non-regulated) combustion sources such as domestic, commercial, public administration and small-scale industrial sectors. Back-casting the fuel use trends to 1990 has drawn upon available UK-level data and trends supplemented by analysis of additional data, such as Housing Condition Survey data, to ensure that significant changes are represented in the inventories (e.g. to reflect the development of the gas supply infrastructure in Northern Ireland since 1999).
- The **Road Transport** emissions database uses emission factors (g/km) for different types of vehicles, which depend on the fuel type (petrol or diesel) and are influenced by the drive cycle or average speeds on the different types of roads; traffic activity for each DA region, including distance and average speed travelled by each type of vehicle on each type of road; DA-specific fleet data on petrol/diesel car mix, car engine size and fleet composition (i.e. age distribution) for cars, light goods vehicles (LGVs) and rigid heavy goods vehicles (HGVs) based on data from the Driver and Vehicle Licensing Agency (DVLA); the age of the fleet determines the proportion of vehicles manufactured in conformity with different exhaust emission regulations;
- **Aircraft emissions** are derived from the Civil Aviation Authority's (CAA, 2014) database of flight movements, fuel use data (DECC), aircraft fleet information (CAA, 2014) and emission factors from international guidance

and research (Intergovernmental Panel on Climate Change, IPCC) to derive emission estimates for aircraft cruise, take-off and landing cycles.

- **Regional quarry production data** and quarry location information (British Geological Survey) (BGS, 2012).
- **Regional iron and steel production data**, and regional fuel use data in the iron and steel industry (Tata Steel, 2014), (ISSB, 2014).
- Site-specific emissions data split by combustion and process sources for all **UK refineries**, and refinery production capacities (UKPIA, 2014).
- Site-specific cement production capacities and UK-wide **cement industry** fuel use data (Mineral Products Association, 2014).
- The **rail sector** uses information from the UK's Department for Transport Rail Emissions Model (REM).
- **Regional housing and population data** (Department of Communities and Local Government).
- **Regional economic activity and industrial production indices** (Office of National Statistics) (ONS, 2014).

Appendix C Recalculations

Throughout the UK inventory, emission estimates are updated annually across the full time-series in response to new research and revisions to data sources. These changes also have an impact on the calculation of the Devolved Administrations' inventories. For further details on recalculations and method changes affecting each NFR sector, see chapter 13 'Recalculations and Methodology Changes' of the UK Informative Inventory Report (IIR) (NR Passant *et al.*, 2014). The most significant changes for each pollutant in the most recent inventory for 2012 are given in the tables below.

Table 7 - Recalculations to 2012 estimates for ammonia between the 2014 and 2015 inventory publications

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)
Overall change		**-3.42**	**-2%**	**1.07**	**3%**	**-0.03**	**0%**	**1.86**	**6%**
Energy Industries	No significant revisions.	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Industrial Combustion	Minor revisions to gas oil activity data within DUKES and across several NAEI combustion sources, mainly affecting estimates for industrial off-road machinery.	0.00	1%	0.00	5%	0.00	1%	0.00	4%
Transport Sources	Update to the petrol/diesel share for cars due to availability of ANPR data for 2013. Reallocation of aircraft support vehicle emissions from Other to Transport.	0.02	0%	0.00	0%	0.00	0%	0.00	0%
Other combustion	Changes to the activity data and emission factors used for small stationary combustion for fuels such as wood and petroleum coke.	0.07	5%	0.03	9%	0.03	11%	0.02	17%
Industrial Processes	Minor revisions to industrial process ammonia sources, including updates to chemical industry ammonia data, mainly affecting England.	1.89	70%	0.00	3%	0.02	36%	0.00	-2%
Agriculture	Updates to emissions from animal manure applied to soils and emissions from cattle wastes. Reallocation of emissions within this sector from manure management to manure application to soils.	-5.57	-4%	0.96	3%	0.16	1%	1.38	5%
Fugitive	Minor revisions to solid fuel and petroleum coke allocations, due to revisions in DUKES to activity data in SSF manufacture.	0.00	1%	0.00	0%	0.00	-1%	0.00	0%
Solvent Processes		0.00	0%	0.00	0%	0.00	0%	0.00	0%
Waste	Revision to the UK and DA estimates for emissions from sources such as composting.	-0.13	-1%	0.03	2%	-0.25	-22%	0.46	63%
Other	Minor revisions primarily due to re-allocation of Heather burning to "Other".	0.29	2%	0.04	3%	0.01	1%	0.01	1%

Table 8 - Recalculations to 2012 estimates for carbon monoxide between the 2014 and 2015 inventory publications

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)
Overall change		**-9.46**	**-1%**	**-13.70**	**-8%**	**-2.49**	**-1%**	**-10.33**	**-14%**
Energy Industries	Revisions to DUKES data for fuel use in power stations, combined with a correction to power station coal allocation due to re-classification of the Lynemouth plant (from autogenerator to power station).	-2.15	-3%	3.36	35%	-0.20	-2%	-0.37	-21%
Industrial Combustion	Revisions to DUKES fuel use allocations across several industries including chemicals and paper & pulp. Increased petroleum coke allocation to fuel combustion, and some re-allocation of activity data between combustion sources and industrial process sources such as sinter plant emissions.	89.26	25%	-1.63	-5%	55.20	195%	-0.53	-3%
Transport Sources	Update to the petrol/diesel share for cars due to availability of ANPR data for 2013. Reallocation of aircraft support vehicle emissions from Other to Transport.	4.94	1%	0.71	1%	0.21	1%	0.12	1%
Other combustion	Revisions to domestic sector fuel mapping distributions through integration of census data; revision to emission factors for domestic solid fuel combustion.	-6.50	-2%	-12.34	-19%	-2.26	-5%	-9.47	-29%
Industrial Processes	Revision to primary aluminium operator estimates, affecting Scotland and England. Also some re-allocation of activity data from combustion sources to industrial process sources such as sinter plant emissions and petroleum coke re-assigned to use as a reductant rather than as a fuel, mainly affecting England and Wales.	-93.57	-56%	-3.49	-74%	-55.43	-70%	-0.01	-87%
Agriculture		0.00		0.00		0.00		0.00	
Fugitive	Addition of emissions from charcoal manufacture.	0.00	0%	0.00	0%	0.00	0%	0.00	3%
Waste	Minor updates to estimates for small-scale waste burning.	0.06	0%	0.01	0%	0.00	0%	0.00	1%
Other	Reallocation of aircraft support vehicle emissions from Other to Transport.	-1.49	-9%	-0.31	-18%	-0.02	-3%	-0.07	-13%

Table 9 - Recalculations to 2012 estimates for nitrogen oxides between the 2014 and 2015 inventory publications

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)
Overall change		**9.97**	**1%**	**0.00**	**0%**	**1.69**	**2%**	**-0.32**	**-1%**
Energy Industries	Revisions to DUKES data for fuel use in power stations, combined with a correction to power station coal allocation due to re-classification of the Lynemouth plant (from autogenerator to power station). Estimates are also now included to reflect new DUKES allocations of naphtha use as a fuel, which are allocated to Energy Industries in the NAEI.	7.64	3%	1.25	4%	1.96	4%	0.09	2%
Industrial Combustion	Revisions to DUKES fuel use allocations across several industries including chemicals and paper & pulp. Increased petroleum coke allocation to fuel combustion, and some re-allocation of activity data between combustion sources and industrial process sources such as sinter plant emissions.	-0.67	-1%	-1.44	-10%	1.15	10%	-0.19	-3%
Transport Sources	Update to the petrol/diesel share for cars due to availability of ANPR data for 2013. Reallocation of aircraft support vehicle emissions from Other to Transport.	5.91	2%	0.88	2%	0.19	1%	0.25	2%
Other combustion	Revisions to domestic sector fuel mapping distributions through integration of census data; revision to emission factors for domestic solid fuel combustion.	4.14	7%	-0.16	-1%	0.16	2%	-0.36	-6%
Industrial Processes	Revision to primary aluminium operator estimates, affecting Scotland and England. Also some re-allocation of activity data from combustion sources to industrial process sources such as sinter plant emissions and petroleum coke re-assigned to use as a reductant rather than as a fuel, mainly affecting England and Wales.	-4.66	-83%	-0.01	-58%	-1.71	-87%	0.00	-34%
Agriculture		0.00		0.00		0.00		0.00	
Fugitive	Minor revisions to fugitive sources, mainly for iron and steel flaring sources affecting England and Wales.	0.00	-2%	0.00	0%	0.00	5%	0.00	3%
Waste	Minor revision to allocations for chemical waste incineration, using DA activity data.	0.02	2%	0.00	-1%	-0.03	-36%	0.00	-1%
Other	Reallocation of aircraft support vehicle emissions from Other to Transport.	-2.40	-12%	-0.52	-24%	-0.03	-4%	-0.10	-18%

Table 10 - Recalculations to 2012 estimates for NMVOCs between the 2014 and 2015 inventory publications

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)
Overall change		**-10.46**	**-2%**	**-0.34**	**0%**	**0.95**	**2%**	**1.57**	**5%**
Energy Industries	Minor revisions to estimates of emissions from refineries, upstream oil and gas production and power stations.	0.02	1%	0.00	0%	0.00	-1%	0.00	1%
Industrial Combustion	Minor revisions to gas oil activity data within DUKES and across several NAEI combustion sources, mainly affecting estimates for industrial off-road machinery.	0.49	3%	0.01	1%	0.11	7%	0.01	2%
Transport Sources	Reallocation of aircraft support vehicle emissions from Other to Transport. Update to the petrol/diesel share for cars due to availability of ANPR data for 2013.	0.93	2%	0.17	5%	0.03	1%	0.03	3%
Other combustion	Revisions to domestic sector fuel mapping distributions through integration of census data. Revisions in DUKES regarding petroleum coke fuel use in SSF manufacture and in domestic combustion.	0.42	2%	-0.27	-5%	0.26	7%	-0.25	-10%
Industrial Processes	Minor revisions to several industrial process estimates, including for the chemical industry, wood products manufacture and for petroleum coke use as a reductant.	0.71	2%	-0.04	0%	-0.03	-1%	0.08	3%
Agriculture	Revisions to the emission estimates for non-dairy cattle have led to increased emissions.	9.34	20%	3.99	40%	2.22	29%	2.42	21%
Fugitive	Revisions to data on fugitive releases from the natural gas distribution and transmission system due to new data from operators and a small revision to compositional analysis.	-1.59	-2%	-0.12	-1%	-0.10	-1%	0.00	0%
Solvent Processes	Minor revisions to estimates for cosmetics and industrial adhesives.	6.21	2%	0.75	3%	0.33	2%	0.21	2%
Waste	Revised estimates from landfill sites, using new data on commercial waste receipts, waste composition, waste degradation rates and landfill gas capture and utilisation in flares and engines.	-26.51	-82%	-4.74	-85%	-1.86	-86%	-0.92	-84%
Other	Reallocation of aircraft support vehicle emissions from Other to Transport.	-0.48	-22%	-0.10	-38%	-0.01	-7%	-0.02	-31%

Table 11 - Recalculations to 2012 estimates for PM_{10} between the 2014 and 2015 inventory publications

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)
Overall change		**8.87**	**10%**	**1.38**	**12%**	**1.27**	**14%**	**0.74**	**14%**
Energy Industries	Minor revisions due to updates to DUKES data for fuel use in power stations, and increases in refinery fuel allocations for naphtha and fuel oil.	0.13	2%	0.02	2%	0.02	3%	0.00	1%
Industrial Combustion	Revisions to DUKES fuel use allocations across several industries including chemicals and paper & pulp.	0.37	5%	-0.04	-5%	0.00	-1%	-0.01	-1%
Transport Sources	Update to the petrol/diesel share for cars due to availability of ANPR data for 2013. Reallocation of aircraft support vehicle emissions from Other to Transport.	0.23	1%	0.04	2%	0.00	0%	0.01	1%
Other combustion	Revisions to domestic sector fuel mapping distributions through integration of census data; revision to emission factors for domestic solid fuel combustion.	0.47	3%	-0.03	-1%	0.22	7%	-0.16	-8%
Industrial Processes	Minor revisions to a range of industrial process sources including PM10 emissions from construction, quarrying, secondary lead and a re-allocation of emissions from asphalt manufacture.	-0.13	-1%	-0.01	-1%	-0.02	-1%	0.00	0%
Agriculture	Upward revisions in PM emissions from agriculture (using emission factors from the EMEP/EEA Emission Inventory Guidebook). The most significant increase is seen in emissions from housed poultry.	7.15	81%	1.37	107%	1.02	132%	0.89	61%
Fugitive	Addition of emissions from charcoal manufacture.	0.67	196%	0.06	52%	0.03	63%	0.02	
Solvent Processes	Emissions from asphalt production have been reallocated from industrial processes	0.19	5%	0.02	7%	0.01	4%	0.01	6%
Waste	Minor updates to estimates for small-scale waste burning.	0.02	1%	0.00	1%	0.00	1%	0.00	1%
Other	Reallocation of aircraft support vehicle emissions from Other to Transport.	-0.23	-9%	-0.04	-16%	0.00	-3%	-0.01	-12%

Table 12 - Recalculations to 2012 estimates for sulphur dioxide between the 2014 and 2015 inventory publications

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)	Change in 2012 (kt)	Change in 2012 (%)
Overall change		**24.52**	**8%**	**-7.73**	**-12%**	**2.46**	**8%**	**-6.15**	**-38%**
Energy Industries	Minor revisions due to updates to DUKES data for fuel use in power stations, and increases in refinery fuel allocations for naphtha and fuel oil.	3.09	1%	0.74	2%	0.10	1%	0.05	2%
Industrial Combustion	Revisions to DUKES fuel use allocations across several industries including chemicals and paper & pulp. Increased petroleum coke allocation to fuel combustion, and some re-allocation of activity data between combustion sources and industrial process sources such as sinter plant emissions.	19.08	39%	-2.32	-49%	3.32	76%	-0.19	-5%
Transport Sources	Gas oil consumption from coastal shipping has revised upward slightly due to a change in the activity drivers used for passenger vessels.	-0.95	-13%	-0.21	-15%	-0.16	-17%	-0.07	-15%
Other combustion	Changes in the way that DUKES records use of petroleum coke resulting in reallocation of some emissions from the domestic combustion of petroleum coke to domestic combustion of solid smokeless fuels. Changes in assumptions about the level of consumption of petroleum coke as an industrial and domestic fuel. Revisions to domestic sector fuel mapping distributions through integration of census data.	9.29	41%	-5.91	-67%	1.87	52%	-5.92	-70%
Industrial Processes	Reallocation of the quantity of petroleum coke used for non-energy leading to an allocation of emissions from industrial processes to industrial combustion for England and Wales. Revised emission estimates from secondary lead and aluminium production.	-5.61	-47%	0.01	2%	-2.69	-73%	-0.01	-100%
Fugitive	Minor revisions to solid fuel and petroleum coke allocations, due to revisions in DUKES to activity data in SSF manufacture.	0.10	2%	0.00	0%	0.04	4%	0.00	
Waste	Minor revision to estimates of SO2 from clinical waste incineration.	0.00	-1%	0.00	-1%	0.00	-1%	0.00	-1%
Other	Gas oil consumption from naval shipping has been revised due to a change in the activity drivers used for passenger vessels.	-0.46	-10%	-0.04	-10%	-0.02	-11%	-0.01	-7%

Table 13 - Recalculations to 2012 estimates for lead between the 2014 and 2015 inventory publications

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2012 (t)	Change in 2012 (%)	Change in 2012 (t)	Change in 2012 (%)	Change in 2012 (t)	Change in 2012 (%)	Change in 2012 (t)	Change in 2012 (%)
Overall change		**-0.94**	**-2%**	**-0.19**	**-6%**	**0.53**	**5%**	**-0.20**	**-10%**
Energy Industries	Minor revisions to power station estimates.	0.07	2%	0.00	0%	0.00	0%	0.00	0%
Industrial Combustion	Revisions to DUKES fuel use allocations across several industries including chemicals and paper & pulp.	0.03	0%	-0.01	-1%	0.00	0%	-0.01	-1%
Transport Sources	Update to the petrol/diesel share for cars due to availability of ANPR data for 2013. Reallocation of aircraft support vehicle emissions from Other to Transport.	-0.01	0%	0.00	2%	0.00	-2%	0.00	1%
Other combustion	Revisions to domestic sector fuel mapping distributions through integration of census data.	0.30	9%	-0.14	-17%	0.05	8%	-0.15	-24%
Industrial Processes	Revisions to estimates for industrial process sources such as secondary lead and secondary aluminium production (especially in Wales and England), and foundries.	-1.19	-5%	-0.04	-12%	0.48	7%	-0.03	-42%
Fugitive	Minor revisions to estimates from coke production.	-0.08	-5%	0.00		0.00	0%	0.00	
Waste	Minor revision to allocations for chemical waste incineration, using DA activity data.	-0.03	-3%	0.00	-3%	0.00	-4%	0.00	-4%
Other	Reallocation of aircraft support vehicle emissions from Other to Transport.	-0.04	-29%	-0.01	-49%	0.00	-10%	0.00	-43%

Appendix D Uncertainties

The following sections provide information on the key characteristics of each pollutant, with an indicative "Uncertainty Rating" for each. This information supports Section 1.4 of the main report.

D.1 Ammonia

Ammonia emission estimates are more uncertain than those for SO_2, NO_x as NO_2 and NMVOC largely due to the nature of the major agricultural sources. Emissions depend on animal type, age, weight, diet, housing systems, waste management and storage techniques. This large number of impacting factors makes interpretation of experimental data difficult and emission estimates uncertain (DOE, 1994). Emission estimates for non-agricultural sources such as wild animals are also highly uncertain. Unlike the case of NO_x as NO_2 and NMVOC, a few uncertain sources dominate the inventory for NH_3 and there is limited potential for error compensation.

Uncertainty Rating: MODERATE

D.2 Carbon Monoxide

Carbon monoxide emissions occur almost exclusively from combustion of fuels, particularly by road transport. Emission estimates for road transport are moderately uncertain, as measurements are quite limited on some vehicle types and emissions highly variable between vehicles and for different traffic situations.

Emissions from stationary combustion processes are also variable and depend on the technology employed and the specific combustion conditions. Emission estimates from small and medium-sized installations are derived from emission factors based on relatively few measurements of emissions from different types of boiler. As a result of the high uncertainty in emission data for major sources, emission estimates for CO are much more uncertain than other pollutants such as NO_x (as NO_2) and SO_2 which are also emitted mainly from major combustion processes. Unlike the case of NO_x (as NO_2) and NMVOC, a few sources dominate the inventory and there is limited potential for error compensation.

Uncertainty Rating: MODERATE

D.3 Nitrogen Oxides

NO_x (as NO_2) emission estimates are less accurate than SO_2 because, although they are calculated using measured emission factors, these emission factors can vary much more with combustion conditions; emission factors given in the literature for combustion sources show large variations In the case of road transport (1A3b) emissions, while the inventory methodology takes into account variations in the amount of NO_x emitted as a function of speed and vehicle type, significant variations in measured emission factors have been found between vehicles of the same type even when keeping these parameters constant.

From the above, one might expect the NO_x inventory to be very uncertain, however the overall uncertainty is in fact lower than for any pollutant other than SO_2 for a number of reasons:

- While NO_x emission factors are somewhat uncertain, activity data used in the NO_x inventory is very much less uncertain. This contrasts with inventories for pollutants such as volatile organic compounds, PM_{10}, metals, and persistent organic pollutants, which contain a higher degree of uncertainty in source activity estimates.
- The NO_x inventory is made up of a large number of independent emission sources with many of similar size and with none dominating. This leads to a large potential for error compensation, where an underestimate in emissions in one sector is very likely to be compensated by an overestimate in emissions in another sector. The other extreme is shown by the inventories for PCP, HCH and HCB where one or two sources dominate and the inventories are highly uncertain.
- Many of the larger point-source emission sources make up the bulk of the UK estimates, and these are commonly derived from continuous emission measurement data and hence are regarded to be good quality.

Uncertainty Rating: LOW

D.4 Non-Methane Volatile Organic Compounds

The NMVOC inventory is more uncertain than those for SO_2 and NO_x. This is due in part to the difficulty in obtaining good emission factors or emission estimates for some sectors (e.g. fugitive sources of NMVOC emissions from industrial processes, and natural sources) and partly due to the absence of good activity data for some sources. Given the broad range of independent sources of NMVOCs, as with NO_x, there is a high potential for error compensation, and this is responsible for the relatively low level of uncertainty compared with most other pollutants in the NAEI.

Uncertainty Rating: LOW

D.5 Particulate Matter

The emission inventory for PM_{10} is subject to high uncertainty. This stems from uncertainties in the emission factors themselves, and the activity data with which they are combined to quantify the emissions. For many source categories, emissions data and/or emission factors are available for total particulate matter only and emissions of PM_{10} must be estimated based on assumptions about the size distribution of particle emissions from that source. This adds a further level of uncertainty for estimates of PM_{10} and, to an even greater extent, $PM_{2.5}$ and other fine particulate matter.

Many sources of particulate matter are diffuse or fugitive in nature e.g. emissions from coke ovens, metal processing, or quarries. These emissions are difficult to measure and in some cases it is likely that no entirely satisfactory measurements have ever been made, so emission estimates for these fugitive sources are particularly uncertain.

Emission estimates for combustion of fuels are generally considered more reliable than those for industrial processes, quarrying and construction. All parts of the inventory would need to be improved before the overall uncertainty in PM could be reduced to the levels seen in the inventories for SO_2, NO_x or NMVOC.

Uncertainty Rating: HIGH

D.6 Sulphur Dioxide

Sulphur dioxide emissions can be estimated with the most confidence as they depend largely on the level of sulphur in fuels. Hence, the inventory, which is based upon comprehensive analysis of coals and fuel oils consumed by power stations and the agriculture, industry and domestic sectors, contains accurate emission estimates for the most important sources.

Uncertainty Rating: LOW

D.7 Lead

The lead inventory is more uncertain than SO_2 and NO_X inventories, and the certainty of the emissions varies over the time-series as different source sectors dominate at different times due to the very significant reductions in emissions from the key sources in 1990, notably road transport. From the key sources in 1990, the lead emission estimates were based on measured concentrations of lead in the fuels, which were tightly regulated prior to being phased out in the late 1990s. This gives a high confidence in the estimates for those sources of fuel combustion, which dominated in the early 1990s, but are now much reduced.

In more recent years, the level of emissions is estimated to be very much lower, and derived from a smaller number of sources. The metal processing industries are mainly regulated under IPPC and the estimates provided by plant operators to the regulatory agencies and used in the national inventories are based on emission measurements or emission factors that have been researched for the specific process type. There is a moderate level of uncertainty associated with these annual emission estimates due to the discrete nature of the stack emissions monitoring techniques and determination of mass emission flow rates from point sources. Furthermore the variability of lead content of raw materials such as fuels (e.g. coal) is such that the discrete lead emission measurements provide a snap-shot of the process and plant performance, and there is some uncertainty as regards how representative that result may be for use in scaling up to provide annual emission estimates.

These uncertainties are inherent within the inventories from environmental regulators of EPR/IPPC industries and are unavoidable; the emissions data from IPPC regulated installations used in the compilation of these DA inventories are subject to a managed process of quality checking by the environmental regulatory agencies and are regarded as the best data available for inventory compilation.

The observed year-to-year variations in emission estimates are based on actual trends reported by plant operators and may reflect changes in lead content of raw materials. The uncertainty in emission monitoring applies to all pollutants to some degree, but more so for pollutants such as lead for which (i) no continuous emission monitoring systems are available, and (ii) where fuel composition is known to be highly variable depending on the fuel source. This is not the case for species such as NO_X and SO_2 where many regulated sites will use Continuous Emission Monitoring Systems and the fuel elemental composition is either not a significant factor in process emissions or does not vary as much as for heavy metals and other trace contaminants.

The emission estimates of lead from other smaller-scale combustion and process sources from industrial and commercial activities are less well documented and the estimates are based on emission factors that are less certain than those based on regulatory emissions monitoring and reporting.

Uncertainty Rating: HIGH

Appendix ESummary Tables

E.1 Summary Air Quality Pollutant Emission Estimates for England

Table 14 - Summary of air quality pollutant emission estimates for England (1990-2013) *

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Ammonia (kt)	Agriculture	205	189	184	187	171	170	167	159	165	160	159	156	147	147	147	148	144	142
	Transport Sources	0.71	5.8	11.5	13.3	19.2	17.9	16.7	15.3	14.2	13.1	12.2	11.2	9.94	9.47	8.45	7.5	6.63	5.91
	Other combustion	3.2	2.22	2.01	2.15	1.74	1.7	1.39	1.21	1.16	0.96	0.92	1.02	1.03	1.09	1.29	1.18	1.35	1.5
	Industrial Processes	7.1	7.2	8.83	4.76	3.54	3.58	3.47	3.19	3.13	5.28	5.02	4.78	4.22	3.96	4.25	4.92	4.59	3.32
	Waste	5.58	6.63	6.55	6.76	6.84	7.55	7.92	8.18	8.29	8.31	8.43	8.67	8.99	9.46	9.44	9.4	9.38	9.39
	Other	12.8	13.3	15.9	16.5	16.5	16.6	16.5	16.8	16.6	16.8	16.7	16.7	17.5	17.2	17.9	18.3	18.5	19
	Total	**234**	**225**	**229**	**230**	**219**	**217**	**213**	**203**	**208**	**205**	**202**	**198**	**188**	**188**	**189**	**189**	**185**	**181**
Carbon monoxide (kt)	Energy Industries	98.8	92.7	56.2	50.4	59.5	58.1	57.5	63.7	61.7	67	67	70	67.9	61.5	60.4	62.7	71.7	67.6
	Industrial Combustion	485	529	501	496	433	485	516	551	501	484	467	458	449	405	408	425	441	471
	Transport Sources	5398	4588	4130	3833	3337	3014	2687	2397	2151	1886	1663	1409	1265	963	808	667	592	516
	Other combustion	651	488	451	465	403	396	344	312	296	254	246	253	275	269	304	281	291	311
	Fugitive	22.5	13.1	13.1	10.7	10.7	6.48	5.04	7.19	4.82	4.74	5.06	4.94	4.72	4.01	4.09	3.61	4.21	4.3
	Industrial Processes	227	225	204	226	227	234	196	115	107	95.1	122	120	111	78.9	74.7	70.3	74	78
	Other	280	31.5	29.9	30.4	29.4	45.8	30.3	30.9	29.6	28.9	30.3	30.6	28.9	27.8	26.8	26.5	25.7	25.3
	Total	**7162**	**5968**	**5386**	**5111**	**4499**	**4238**	**3836**	**3477**	**3151**	**2820**	**2600**	**2345**	**2201**	**1809**	**1687**	**1537**	**1499**	**1474**
Nitrogen oxides (kt)	Energy Industries	654	420	319	282	298	319	314	350	332	352	341	330	246	228	213	205	241	224
	Industrial Combustion	316	301	273	262	250	238	225	225	221	217	204	200	174	141	147	130	128	117
	Transport Sources	1087	906	785	737	679	648	617	585	565	545	526	504	474	400	382	368	350	335
	Other combustion	161	147	139	135	126	122	110	105	98.8	92.7	85.4	78.7	83.3	74.4	77.7	66.8	66.6	65.4
	Other	60.3	46.6	28.1	29.6	27.8	25.9	23.2	24.8	25.7	23.1	23.8	27.1	25.4	23.9	24.2	22.3	20.4	18.9
	Total	**2279**	**1821**	**1544**	**1446**	**1381**	**1353**	**1289**	**1289**	**1242**	**1230**	**1181**	**1140**	**1003**	**868**	**844**	**792**	**806**	**761**
NMVOC (kt)	Agriculture	88.1	65.5	67.3	67.5	65.5	62.2	59.5	61	62.9	60.6	60.1	60.2	59.2	58.7	57	56.4	55.5	55.9
	Industrial Combustion	25.2	25.8	25.9	25.4	25.1	25.4	25.1	25.1	25.6	25.4	24.8	24.8	23.2	18.9	19.5	17.3	16.7	14.5
	Transport Sources	803	623	479	422	354	318	270	226	190	160	137	116	101	70.7	59.6	50.1	43.8	38.2
	Other combustion	58.4	43	43.9	45.6	38.9	36.6	33.4	32.2	30.9	28.5	27.1	26.5	26.9	25.1	26.5	23.7	24.2	24.3
	Fugitive	271	229	208	183	174	174	153	142	134	130	118	112	101	94.5	85.3	81.9	77.6	71.6
	Industrial Processes	184	167	120	89.8	85.8	74.6	73.4	70.4	61.9	59.1	53.4	51.6	45.4	40.2	41.6	37.6	37.6	37.4
	Solvent Processes	555	449	415	392	371	357	351	346	346	340	339	332	314	296	295	298	296	293
	Other	20.4	20.4	17.2	16.8	17.8	16.9	18.7	17	16	15.3	15.8	14.4	13.6	12.5	11.6	11	10.6	9.96
	Total	**2005**	**1623**	**1376**	**1242**	**1132**	**1065**	**983**	**919**	**867**	**819**	**775**	**738**	**684**	**616**	**596**	**576**	**562**	**545**

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
PM_{10} (kt)	Agriculture	16.3	16.7	18.4	18	17.9	20.8	19.7	19.6	19.5	18.7	18.5	17.1	17.4	16.6	16.5	16.2	16	16
	Energy Industries	60.2	34.3	22.7	18.4	19.1	13.5	7.45	7.63	7.88	8.8	9.07	7.41	7.65	6.08	5.52	5.96	8.08	6.4
	Industrial Combustion	20.2	19.8	18.3	16.9	15.3	15.3	14.4	14.2	13.6	12.9	11.9	11	10.3	8.94	9.65	8.4	8.22	7.48
	Transport Sources	32.8	37.1	36.3	35.9	32.5	32	31	30.4	29.9	29.4	28.6	27.2	26	24.8	24.1	22.7	21.7	20.6
	Other combustion	34.8	23.4	23.9	25	20.4	19.2	16.6	15.6	15.1	14.4	14.3	14.8	16.3	16.3	18.7	17.3	18.4	19.9
	Industrial Processes	30.5	26.4	21.7	20	18.9	19.1	18.5	18.8	18	17.8	17.3	18.6	16.9	14.1	13.2	12.7	13.1	12.5
	Solvent Processes	7.2	5.59	5.79	5.6	5.31	5.04	5.08	5.01	4.88	4.79	5.15	5.08	4.39	3.65	3.72	3.81	3.81	3.84
	Other	7.37	6.84	6.04	6.24	6.07	9.01	6.26	6.79	6.27	6.44	6.38	6.4	5.89	5.56	5.57	5.37	5.35	5.16
	Total	**209**	**170**	**153**	**146**	**135**	**134**	**119**	**118**	**115**	**113**	**111**	**108**	**105**	**96**	**97**	**92.5**	**94.7**	**91.9**
Sulphur dioxide (kt)	Energy Industries	2481	1470	1012	723	713	638	594	597	457	356	315	272	209	152	150	163	216	152
	Industrial Combustion	313	249	147	118	104	114	95.3	87	93.7	97.2	86.5	82.8	78	71.9	81	64.1	67.7	91.5
	Transport Sources	70.7	59	36.1	28.2	20.6	18.3	18.7	19.1	19.1	19.4	19.2	14.9	10.8	9.66	7.85	6.9	6.46	5.94
	Other combustion	134	104	81.5	76.4	62.8	62.6	49.2	43.7	41.5	36.9	34.1	32.6	34.7	30.6	35.6	32.1	31.8	35.7
	Industrial Processes	51.1	54.1	55.6	45.6	38.2	30.6	28.7	31.3	30.1	30	29.5	26.8	18.7	12.2	11.5	11.3	6.38	7.72
	Other	28.2	23.7	13.7	11	9.77	9.98	8.53	9.35	10.9	9.79	10.3	16.2	15.6	13.7	15.5	10.6	10.2	10.3
	Total	**3077**	**1960**	**1345**	**1002**	**948**	**874**	**794**	**787**	**652**	**549**	**495**	**445**	**366**	**290**	**301**	**288**	**338**	**303**
Lead **(tonnes)**	Energy Industries	138	117	17.8	14	13.9	11.3	10.3	10.1	10.1	9.15	9.02	2.69	2.8	2.65	2.58	3.08	4.32	3.31
	Industrial Combustion	29.7	23.9	18.5	15.6	12.8	13.3	13.1	13	13.4	11.3	9.22	9.77	9.22	11.3	10.1	9.16	7.96	8.8
	Transport Sources	1801	878	481	253	2.21	2.06	2.02	2.03	2.06	2.14	2.14	1.82	1.75	1.69	1.67	1.66	1.67	1.65
	Other combustion	22.9	13.5	10.6	9.93	7.02	6.82	5.31	4.59	4.2	3.54	3.31	3.39	3.63	3.7	3.97	3.76	3.75	4
	Industrial Processes	249	210	175	102	77.7	80	75.5	59	50.9	50.9	40.5	39.6	34.7	25.8	20.8	20.7	25	23.9
	Waste	230	68.7	0.37	0.55	0.53	0.18	1.42	1.3	1.07	0.61	0.56	0.58	0.58	0.96	1.11	1.05	0.9	0.81
	Other	2.99	2.1	2	1.88	1.78	1.86	2.19	1.86	2.07	2.09	2.12	2.13	2.01	1.65	2.62	1.77	1.63	1.75
	Total	**2473**	**1314**	**705**	**397**	**116**	**116**	**110**	**91.9**	**83.9**	**79.7**	**66.9**	**60**	**54.7**	**47.8**	**42.8**	**41.2**	**45.2**	**44.2**

* The uncertainties in the data are greater than the precision indicated by the table above. This higher level of resolution has been chosen to aid transparency.

E.2 Summary Air Quality Pollutant Emission Estimates for Scotland

Table 15 - Summary of air quality pollutant emission estimates for Scotland (1990-2013) *

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Ammonia (kt)	Agriculture	43.3	39.2	35.8	33.6	35	35.3	34.7	33.3	34.3	33.7	32.8	31.3	29.9	29.6	29.9	29.6	29.2	29
	Transport Sources	0.07	0.61	1.17	1.33	1.96	1.83	1.74	1.59	1.48	1.35	1.28	1.16	1.03	0.98	0.87	0.76	0.68	0.61
	Other combustion	0.79	0.43	0.38	0.41	0.33	0.32	0.26	0.22	0.22	0.2	0.25	0.28	0.28	0.3	0.36	0.33	0.38	0.42
	Industrial Processes	0.07	0.08	0.08	0.07	0.07	0.07	0.06	0.06	0.07	0.08	0.06	0.07	0.06	0.07	0.07	0.1	0.07	0.05
	Waste	0.87	1.04	1.01	1.02	1.04	1.11	1.14	1.15	1.16	1.18	1.19	1.27	1.35	1.49	1.51	1.52	1.53	1.5
	Other	1.35	1.39	1.64	1.69	1.7	1.72	1.72	1.74	1.72	1.72	1.68	1.69	1.76	1.75	1.81	1.81	1.84	1.88
	Total	**46.4**	**42.7**	**40.1**	**38.1**	**40.1**	**40.4**	**39.6**	**38.1**	**39**	**38.2**	**37.3**	**35.8**	**34.4**	**34.2**	**34.5**	**34.1**	**33.7**	**33.4**
Carbon monoxide (kt)	Energy Industries	14.9	15	10.3	9.65	11.4	11.2	10.7	9.93	10.4	10.3	12.3	11.8	15.6	15.4	15	12.4	13	9.84
	Industrial Combustion	78.7	31.8	30	31	27.2	27.7	29.9	32.6	30	32.6	32.8	31.7	33.2	28.9	32.7	34.7	32.5	34.2
	Transport Sources	507	412	355	323	280	251	225	203	184	163	148	127	115	81.7	68.6	57	51.6	45.7
	Other combustion	166	92.6	79.3	80.5	67.2	65.6	53.2	47.9	44.6	40.3	42.8	45.5	48.3	47.9	55.6	51.9	53.5	58
	Fugitive	5.14	1.11	0.99	1.18	1.09	1.75	1.16	0.86	0.87	0.97	0.82	0.96	0.86	0.9	0.91	0.98	0.7	0.88
	Industrial Processes	4.09	3.37	3.87	3.67	3.63	3.49	3.51	3.5	3.53	3.5	4.23	4.33	4.22	3.69	4.05	3.59	1.25	0.06
	Other	22.1	3.4	3.17	3.18	3.08	7.24	3.15	3.21	3.08	3	3.14	3.15	3	2.9	2.77	2.74	2.65	2.6
	Total	**797**	**559**	**482**	**452**	**394**	**368**	**327**	**301**	**277**	**254**	**244**	**224**	**220**	**181**	**180**	**163**	**155**	**151**
Nitrogen oxides (kt)	Energy Industries	97.6	66.4	52.9	50.5	57	52.2	50.9	48.2	46.7	46.8	59	51.9	41.5	38.2	40	31.8	33.9	32.5
	Industrial Combustion	33.3	28.6	26.8	25.9	25.2	24.9	21.7	21.1	21.3	21.6	20.8	20.8	19.2	15.2	15.2	13.9	12.8	12.2
	Transport Sources	118	96.4	81.9	77.4	70.8	67.2	64.7	61.5	59.6	58	56.5	55.1	52.1	43.9	41.9	39.7	38	36.1
	Other combustion	28.7	27.1	25.9	25.3	23.7	23.2	21.1	20.1	18.9	18	16.4	14.9	15.2	13.6	13.7	11.9	11.4	10.9
	Other	5.49	3.18	2.36	2.86	2.84	3.08	2.7	2.76	2.7	2.64	2.62	2.46	2.46	2.25	2.27	2.44	2.08	2.18
	Total	**283**	**222**	**190**	**182**	**180**	**171**	**161**	**154**	**149**	**147**	**155**	**145**	**131**	**113**	**113**	**99.8**	**98.1**	**93.8**
NMVOC (kt)	Agriculture	16.9	15	15.2	14.6	15	14.6	14.7	14.7	15.2	15.1	15	14.9	14.4	14.1	14.2	14.1	14	13.6
	Industrial Combustion	2.55	2.29	2.32	2.29	2.27	2.3	2.25	2.24	2.21	2.18	2.16	2.21	2.21	1.81	1.84	1.7	1.62	1.33
	Transport Sources	74.5	54.9	39.9	34.4	28.8	25.6	21.9	18.4	15.8	13.6	12.1	10.4	9.14	5.71	4.91	4.2	3.74	3.31
	Other combustion	12.7	7.87	7.76	8.03	6.66	6.22	5.44	5.28	4.98	4.83	5.09	5.13	5.19	5.03	5.46	4.98	5.11	5.27
	Fugitive	177	117	97.2	80.9	78.2	67.3	70.4	52.6	39.3	40.3	38.2	38	34.8	22.5	20.5	19.2	23.5	20.1
	Industrial Processes	61.5	61.3	60.9	62.7	62	60.8	60	59.2	58	56.9	56.9	58.8	58.7	59.4	60.7	61	62.7	65.2
	Solvent Processes	59	47.9	44.3	37.9	35.7	34.5	33.5	33	33	32.3	32.3	32	30.5	28.9	28.8	29.1	28.7	28.3
	Other	3.06	3.09	2.69	2.42	2.63	2.46	2.6	2.37	2.31	2.19	2.24	1.98	1.91	1.76	1.62	1.51	1.43	1.34
	Total	**407**	**309**	**270**	**243**	**231**	**214**	**211**	**188**	**171**	**167**	**164**	**163**	**157**	**139**	**138**	**136**	**141**	**138**

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
PM_{10} (kt)	Agriculture	1.99	1.99	2.26	2.16	2.32	2.79	2.67	2.81	2.81	2.58	2.6	2.62	2.78	2.69	2.91	2.89	2.64	2.86
	Energy Industries	8.42	5.36	3.94	3.16	3.67	3.56	2.22	1.17	1.87	1.83	2.67	2.39	1.04	1.09	1.43	1.09	1.11	0.78
	Industrial Combustion	2.08	1.91	1.69	1.64	1.53	1.55	1.39	1.36	1.36	1.31	1.27	1.23	1.12	0.96	0.97	0.84	0.78	0.68
	Transport Sources	3.94	4.35	4.21	4.16	3.72	3.6	3.53	3.41	3.34	3.29	3.2	3	2.87	2.74	2.65	2.47	2.36	2.23
	Other combustion	8.18	5	4.97	5.17	4.24	4.03	3.37	3.28	3.08	3.04	3.5	3.65	3.81	3.83	4.44	4.07	4.34	4.79
	Industrial Processes	2.75	2.16	1.83	1.74	1.69	1.72	1.68	1.64	1.68	1.64	1.63	1.61	1.43	1.17	1.19	1.2	1.14	1.18
	Solvent Processes	0.55	0.4	0.4	0.38	0.36	0.35	0.34	0.33	0.32	0.33	0.37	0.36	0.3	0.25	0.25	0.25	0.25	0.25
	Other	0.72	0.69	0.64	0.7	0.76	1.48	0.8	0.73	0.74	0.69	0.64	0.63	1.05	0.62	0.82	0.83	0.62	0.82
	Total	**28.6**	**21.9**	**19.9**	**19.1**	**18.3**	**19.1**	**16**	**14.7**	**15.2**	**14.7**	**15.9**	**15.5**	**14.4**	**13.3**	**14.7**	**13.7**	**13.2**	**13.6**
Sulphur dioxide (kt)	Energy Industries	217	135	96.5	81.4	104	101	96.3	82.3	67	53.8	66.2	53.1	46.9	49.7	65.6	47.8	49.2	31.2
	Industrial Combustion	39.2	22.5	10.4	7.64	6.93	7.52	9.92	9.63	10.3	11.2	9.13	7.92	5.53	4.23	4.2	3.53	2.45	2.96
	Transport Sources	11.5	9.91	7.08	6.49	5.41	4.87	5.05	4.61	4.5	4.47	4.09	3.11	2.22	2.04	1.58	1.29	1.21	1.05
	Other combustion	28.2	21	15.3	13.7	10.8	10.3	7.55	6.28	5.61	4.96	4.7	4.52	4.64	3.26	3.13	2.98	2.94	2.93
	Industrial Processes	0.8	0.71	0.76	0.75	0.69	0.65	0.57	0.83	0.77	0.77	0.76	0.67	0.65	0.76	0.58	0.73	0.77	0.62
	Other	1.39	0.62	0.55	0.87	0.72	1.84	1.24	0.83	0.84	0.75	0.55	0.89	1.02	0.72	0.74	0.61	0.57	0.55
	Total	**298**	**190**	**131**	**111**	**129**	**126**	**121**	**105**	**89**	**75.9**	**85.4**	**70.2**	**60.9**	**60.7**	**75.8**	**57**	**57.2**	**39.3**
Lead **(tonnes)**	Energy Industries	11.8	7.58	2.71	2.2	3	2.79	1.94	1.55	3.38	1.6	1.71	0.79	0.47	0.69	1.3	0.64	1.14	0.55
	Industrial Combustion	3.41	2.78	2.13	1.91	1.66	1.65	1.86	1.72	2.08	1.51	1.17	1.17	1.06	1.13	1.1	0.95	0.81	0.83
	Transport Sources	171	81.6	44.2	23.1	0.26	0.24	0.24	0.23	0.24	0.24	0.24	0.21	0.2	0.2	0.19	0.19	0.19	0.19
	Other combustion	4.27	2.23	1.74	1.65	1.21	1.16	0.88	0.75	0.68	0.6	0.63	0.65	0.68	0.68	0.74	0.68	0.7	0.74
	Industrial Processes	7.27	2.19	1.32	0.95	0.97	0.91	0.77	0.61	0.56	0.51	0.5	0.51	0.36	0.26	0.27	0.27	0.28	0.28
	Waste	7.33	2.53	0.03	0.04	0.04	0.01	0.14	0.13	0.1	0.06	0.05	0.06	0.06	0.09	0.11	0.1	0.09	0.08
	Other	0.49	0.01	0.01	0.01	0.01	0.01	0.009	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.009	0.008	0.007
	Total	**205**	**99**	**52.1**	**29.9**	**7.15**	**6.77**	**5.84**	**5.01**	**7.05**	**4.52**	**4.32**	**3.41**	**2.84**	**3.07**	**3.72**	**2.84**	**3.23**	**2.67**

* The uncertainties in the data are greater than the precision indicated by the table above. This higher level of resolution has been chosen to aid transparency.

E.3 Summary Air Quality Pollutant Emission Estimates for Wales

Table 16 - Summary of air quality pollutant emission estimates for Wales (1990-2013) *

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Ammonia (kt)	Agriculture	28.1	26.3	26.1	27.3	25.4	25.6	24.1	25.3	25.4	25.3	25.5	23.3	21.2	21.2	21.8	22	21.9	21.8
	Transport Sources	0.05	0.39	0.73	0.83	1.23	1.14	1.08	0.99	0.93	0.84	0.79	0.72	0.64	0.6	0.53	0.47	0.41	0.37
	Other combustion	0.57	0.45	0.41	0.44	0.35	0.35	0.28	0.24	0.24	0.22	0.24	0.27	0.28	0.29	0.35	0.32	0.36	0.4
	Industrial Processes	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.07	0.07	0.06	0.05	0.06	0.07	0.06	0.05
	Waste	0.39	0.46	0.46	0.48	0.49	0.53	0.54	0.57	0.57	0.6	0.63	0.67	0.72	0.81	0.83	0.85	0.87	0.87
	Other	1.11	1.16	1.49	1.57	1.55	1.63	1.67	1.67	1.61	1.57	1.54	1.54	1.59	1.55	1.63	1.68	1.7	1.75
	Total	**30.2**	**28.9**	**29.3**	**30.6**	**29**	**29.3**	**27.7**	**28.8**	**28.8**	**28.6**	**28.8**	**26.6**	**24.5**	**24.5**	**25.2**	**25.4**	**25.3**	**25.2**
Carbon monoxide (kt)	Energy Industries	6.16	6.04	4.27	3.72	5.03	5.79	4.83	5.1	6.72	6.07	6.67	5.32	6.63	5.95	6.65	7.09	8.58	8.99
	Industrial Combustion	141	165	170	169	133	131	85.8	89.3	98.3	88.7	116	94.1	74.9	71.8	77	85.5	83.5	120
	Transport Sources	321	276	246	226	201	181	162	144	128	111	98.8	84.3	75.6	56.9	47.8	39.6	35.2	31.1
	Other combustion	96.4	75.7	68.4	71.6	58.4	58.3	46.2	40.7	38.8	34.5	34.4	37.9	39.3	38.7	45.1	42.2	44	46.9
	Fugitive	12.4	19.2	19.2	14.9	15.3	8.67	3.62	4.99	3.44	3.08	6.6	7.11	5.22	4.72	6.34	5.98	5.96	6.14
	Industrial Processes	64.4	62.3	66.5	61	60	45.2	33.4	43.6	42.8	48.8	56.9	60.6	53.3	38.2	34.7	32.3	24.2	45.3
	Other	3.79	1.67	1.55	1.57	1.52	2.7	1.55	1.59	1.53	1.49	1.55	1.55	1.46	1.41	1.34	1.32	1.28	1.26
	Total	**646**	**606**	**576**	**548**	**474**	**433**	**338**	**330**	**320**	**294**	**321**	**291**	**257**	**218**	**219**	**214**	**203**	**260**
Nitrogen oxides (kt)	Energy Industries	50.6	36.1	29.6	24.2	33.5	40.7	33.7	33.7	36.8	35.4	42.2	30	39.7	32.8	31.7	31.9	46.4	46.9
	Industrial Combustion	34.2	34.9	34.6	37.3	34.4	29.4	21.9	22.7	22.1	20.4	20.2	19.3	17.6	13.7	15.4	14.2	12.8	14.4
	Transport Sources	69.4	58.3	49.9	46.4	42.6	40.3	38.6	36.4	35.5	34	32.8	31.8	30.4	26.2	25.3	24.6	23	22.3
	Other combustion	18.1	17.2	16.5	16.1	15.1	14.7	13.5	12.8	12	11.2	10.2	9.18	9.06	8.24	8.31	7.13	6.84	6.49
	Other	3.2	2.72	2.24	2.23	2.24	2.01	1.32	1.37	1.55	1.57	1.51	1.63	1.64	1.48	1.4	1.51	1.1	1.31
	Total	**175**	**149**	**133**	**126**	**128**	**127**	**109**	**107**	**108**	**103**	**107**	**91.9**	**98.5**	**82.4**	**82**	**79.4**	**90.1**	**91.5**
NMVOC (kt)	Agriculture	10.6	10.4	10.8	11	10.8	10.7	9.81	10.9	10.9	10.5	11	9.87	9.78	9.73	9.74	9.84	9.77	9.66
	Industrial Combustion	2.51	2.74	2.9	2.92	3	2.64	2.34	2.6	2.43	2.18	2.28	2.32	2.22	1.72	1.89	1.77	1.59	1.63
	Transport Sources	46.8	37.2	28.2	24.6	21.1	18.9	16.2	13.5	11.2	9.31	8	6.78	5.91	4.07	3.45	2.92	2.54	2.24
	Other combustion	8.13	5.92	6.16	6.56	5.16	4.73	4.06	3.86	3.72	3.62	3.74	3.94	3.96	3.81	4.2	3.83	4.04	4.06
	Fugitive	22.8	20.8	16.9	13.8	14.9	12.2	12.3	11.7	12.5	11.6	12.3	12.9	11.4	12	11.7	11.9	10.2	10.9
	Industrial Processes	5.33	5.01	4.75	4.49	3.94	3.17	2.15	4.73	4.09	2.25	2.37	2.28	2.14	1.97	2.21	2.16	2.01	2.36
	Solvent Processes	44.3	34.7	29	27.6	23.2	21.6	20.9	20.6	20.7	21	21.1	20.8	19.1	17.8	17.6	17.6	17.4	17.1
	Other	2.01	2.14	1.74	1.55	1.74	1.5	1.61	1.43	1.19	1.07	1.11	1.05	1.05	0.93	0.94	0.91	0.92	0.83
	Total	**143**	**119**	**100**	**92.6**	**83.9**	**75.4**	**69.3**	**69.3**	**66.7**	**61.5**	**61.9**	**60**	**55.6**	**52**	**51.7**	**50.9**	**48.4**	**48.7**

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
PM_{10} (kt)	Agriculture	1.32	1.33	1.47	1.44	1.48	1.48	1.51	1.51	1.72	1.6	1.59	1.43	1.57	1.53	1.58	1.68	1.79	1.88
	Energy Industries	3.43	2.26	1.74	1.32	1.98	1.72	1.04	1.23	1.02	1.08	1.34	1.21	1.14	0.95	0.84	0.85	0.95	1.06
	Industrial Combustion	1.73	1.53	1.17	1.28	1.28	1.3	1.19	1.16	1.05	0.84	0.78	0.74	0.69	0.59	0.67	0.56	0.52	0.5
	Transport Sources	2.15	2.49	2.5	2.48	2.23	2.17	2.12	2.06	2.06	2	1.94	1.82	1.76	1.68	1.64	1.55	1.44	1.38
	Other combustion	5.62	4.11	4.24	4.49	3.53	3.29	2.75	2.58	2.51	2.48	2.67	2.91	2.94	2.9	3.39	3.08	3.4	3.62
	Industrial Processes	4.31	4.2	3.87	3.62	3.47	2.49	1.85	2.56	2.8	2.48	2.64	2.85	2.22	1.65	1.87	1.97	1.71	2.08
	Solvent Processes	0.45	0.32	0.33	0.32	0.31	0.29	0.29	0.28	0.28	0.27	0.3	0.28	0.23	0.19	0.18	0.18	0.18	0.18
	Other	0.49	0.52	0.5	0.51	0.53	0.71	0.39	0.46	0.38	0.38	0.4	0.42	0.38	0.36	0.37	0.35	0.31	0.3
	Total	**19.5**	**16.8**	**15.8**	**15.5**	**14.8**	**13.5**	**11.1**	**11.8**	**11.8**	**11.1**	**11.7**	**11.7**	**10.9**	**9.84**	**10.5**	**10.2**	**10.3**	**11**
Sulphur dioxide (kt)	Energy Industries	109	69.7	51.8	40.1	58.9	51.7	42.2	46.3	44.2	39.2	45.8	37.2	24.3	17.4	16.8	17.3	15.4	18.5
	Industrial Combustion	45	35.8	24.8	22	20.1	18.7	11.7	10.9	8.46	6.93	7.94	8.4	7.55	7.13	9.35	8.18	7.73	10.3
	Transport Sources	5.84	5.01	3.45	3.01	2.46	2.18	2.18	2.19	2.4	2.38	2.21	1.67	1.23	1.21	1.05	1	0.8	0.78
	Other combustion	17.2	13.5	10.5	9.96	8.13	8.11	6.01	5.2	5.06	4.76	4.37	4.34	4.3	5.65	6.98	5.77	5.44	6.73
	Industrial Processes	2.89	2.74	2.76	2.27	2.2	2.57	2.17	1.88	2.08	2.34	2.15	2.4	2.13	0.77	0.64	0.79	1.01	1.11
	Other	4.69	3.58	2.75	2.2	1.55	1.78	0.76	0.85	0.94	1.08	1.19	1.22	1.35	1.1	1.92	1.3	1.08	1.22
	Total	**184**	**130**	**96**	**79.6**	**93.3**	**85**	**65**	**67.3**	**63.1**	**56.7**	**63.6**	**55.2**	**40.9**	**33.3**	**36.7**	**34.3**	**31.5**	**38.6**
Lead **(tonnes)**	Energy Industries	3.71	1.79	0.83	0.58	1.46	1.01	0.5	0.83	0.38	0.7	0.83	0.41	0.47	0.49	0.5	0.43	0.42	0.27
	Industrial Combustion	2.76	2.22	1.71	2.33	2.21	1.59	4.53	3.19	6.53	2.54	0.86	0.91	0.82	0.91	1.04	0.9	0.82	0.87
	Transport Sources	110	52.8	27.9	14.5	0.14	0.13	0.13	0.13	0.13	0.14	0.14	0.12	0.11	0.11	0.11	0.11	0.1	0.1
	Other combustion	2.69	1.79	1.5	1.51	1.13	1.12	0.83	0.72	0.68	0.61	0.59	0.64	0.66	0.66	0.72	0.67	0.7	0.74
	Industrial Processes	14.8	16.5	16.8	15.8	15.8	11.4	6.26	10.8	14.5	16.2	12.2	11.4	10.7	7.5	11	9.97	7.57	11.2
	Waste	0.62	0.49	0.02	0.04	0.04	0.01	0.08	0.08	0.06	0.03	0.03	0.03	0.03	0.05	0.06	0.06	0.05	0.05
	Other	1.46	1.84	1.82	1.83	2	1.4	0.52	0.81	0.43	0.42	0.56	0.57	0.55	0.55	0.56	0.56	0.57	0.6
	Total	**136**	**77.4**	**50.7**	**36.7**	**22.8**	**16.6**	**12.9**	**16.6**	**22.7**	**20.6**	**15.2**	**14**	**13.4**	**10.3**	**14**	**12.7**	**10.2**	**13.8**

* The uncertainties in the data are greater than the precision indicated by the table above. This higher level of resolution has been chosen to aid transparency.

E.4 Summary Air Quality Pollutant Emission Estimates for Northern Ireland

Table 17 - Summary of air quality pollutant emission estimates for Northern Ireland (1990-2013) *

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Ammonia (kt)	Agriculture	31.8	32.7	31.9	33.3	31.6	31.4	31.6	32.1	31.8	31.2	30.6	29.6	29	28.5	28.3	28.5	29	29.2
	Transport Sources	0.03	0.27	0.5	0.58	0.89	0.82	0.74	0.67	0.64	0.59	0.54	0.51	0.46	0.45	0.4	0.36	0.32	0.29
	Other combustion	0.54	0.36	0.29	0.26	0.23	0.19	0.17	0.14	0.1	0.09	0.09	0.11	0.11	0.12	0.14	0.13	0.14	0.15
	Industrial Processes	0.16	0.16	0.16	0.16	0.16	0.16	0.03	0.001	0.001	0.002	0.001	0.001	0.002	0.003	0.004	0.004	0.004	0.003
	Waste	0.3	0.35	0.35	0.35	0.36	0.39	0.41	0.43	0.44	0.51	0.55	0.65	0.79	1	1.04	1.12	1.19	1.19
	Other	0.52	0.55	0.67	0.69	0.7	0.7	0.7	0.72	0.72	0.73	0.73	0.72	0.73	0.72	0.75	0.75	0.76	0.77
	Total	**33.4**	**34.4**	**33.9**	**35.3**	**33.9**	**33.6**	**33.6**	**34**	**33.7**	**33.1**	**32.5**	**31.6**	**31.1**	**30.8**	**30.7**	**30.9**	**31.4**	**31.6**
Carbon monoxide (kt)	Energy Industries	4.06	3.78	2.15	1.34	1.27	1.43	1.15	1.09	2	3.27	2.79	2.68	2.63	2.53	2.12	1.91	1.42	1.14
	Industrial Combustion	10	11.1	10.5	10.8	9.77	9.27	10.5	11.5	9.79	13.2	15.3	15.4	12.6	13	17.1	18.6	17.9	19.4
	Transport Sources	174	133	106	98.7	87.9	80.4	70.6	66.1	62.5	56.7	51.1	45.6	42.8	32.1	27.5	23	20.8	18.8
	Other combustion	143	91.6	71.1	63.3	56	47.5	41.7	34	26.6	22.2	20.8	20.9	22	22	25	23.5	23.6	25.2
	Fugitive	0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02
	Industrial Processes	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.008	0.004	0.003	0.002	0.002	0.002	0.002
	Other	2.23	0.95	0.92	0.94	0.92	0.93	0.94	0.97	0.92	0.9	0.94	0.96	0.9	0.87	0.83	0.81	0.79	0.77
	Total	**333**	**241**	**191**	**175**	**156**	**140**	**125**	**114**	**102**	**96.2**	**90.9**	**85.5**	**81.1**	**70.6**	**72.6**	**67.9**	**64.6**	**65.3**
Nitrogen oxides (kt)	Energy Industries	31.1	19.3	13.9	14.2	14.8	16	12.4	11.5	9.77	9.63	9.65	6.97	6.44	5.49	5.67	5.64	5.9	6.14
	Industrial Combustion	13.1	12.2	10.4	9.54	8.94	8.43	7.57	7.34	7.35	8.39	7.9	8.13	7.52	5.8	6.3	5.56	5.35	5.01
	Transport Sources	37.4	28.3	22.4	21.5	20.6	20.1	20.5	21.1	20.2	20	19.4	19	18.2	15.3	14.8	14.2	13.7	13
	Other combustion	14.1	12.7	12.4	12.2	11.7	11.4	11	10.6	9.87	9.46	8.85	7.9	7.64	7.31	7.4	6.26	5.86	5.55
	Other	1.62	1.04	0.8	0.86	0.82	0.71	0.53	0.59	0.61	0.55	0.59	0.68	0.62	0.6	0.59	0.54	0.49	0.44
	Total	**97.2**	**73.6**	**59.9**	**58.4**	**56.8**	**56.7**	**51.9**	**51.2**	**47.8**	**48**	**46.4**	**42.7**	**40.5**	**34.5**	**34.7**	**32.2**	**31.3**	**30.2**
NMVOC (kt)	Agriculture	11.2	12.6	13.4	13.1	13	13	13.5	13.8	14.4	14.1	14.1	13.8	13.7	13.7	13.4	13.9	14	13.7
	Industrial Combustion	0.87	0.88	0.9	0.88	0.82	0.81	0.81	0.82	0.82	0.87	0.92	0.92	0.81	0.7	0.73	0.65	0.61	0.53
	Transport Sources	27.2	18.1	11.8	10.2	8.72	7.89	6.58	5.79	5.1	4.42	3.88	3.43	3.12	1.87	1.63	1.39	1.24	1.11
	Other combustion	9.94	6.44	5.47	5.03	4.58	4.12	3.73	3.29	2.83	2.63	2.45	2.35	2.34	2.24	2.37	2.19	2.17	2.12
	Fugitive	3.43	3.24	2.87	2.16	2.06	1.94	1.81	1.76	1.67	1.53	1.44	1.36	1.13	1.07	0.87	0.87	0.84	0.81
	Industrial Processes	2.41	2.41	2.17	2.06	2	2.02	2.01	2.02	2.03	2.01	2.03	2.09	2.16	2.19	2.27	2.25	2.34	2.43
	Solvent Processes	17	13.5	12.5	12	11.7	11.4	11.2	11.1	11.1	10.9	10.9	10.8	10.3	9.68	9.59	9.66	9.53	9.41
	Other	0.76	0.78	0.59	0.58	0.63	0.44	0.44	0.43	0.58	0.69	0.67	0.42	0.51	0.49	0.46	0.41	0.33	0.34
	Total	**72.8**	**58**	**49.7**	**46.1**	**43.6**	**41.7**	**40.1**	**39**	**38.5**	**37.1**	**36.4**	**35.2**	**34**	**32**	**31.3**	**31.3**	**31.1**	**30.5**

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
PM_{10} (kt)	Agriculture	1.82	2.06	2.15	1.87	2.04	2.17	2.13	2.22	2.25	2.19	2.13	2.22	2.4	2.24	2.04	2.21	2.33	2.32
	Energy Industries	2.74	1.47	0.96	0.57	0.76	1.02	0.4	0.41	0.32	0.3	0.29	0.25	0.22	0.11	0.07	0.05	0.11	0.04
	Industrial Combustion	0.99	0.96	0.85	0.78	0.79	0.7	0.58	0.56	0.58	0.68	0.68	0.68	0.57	0.51	0.63	0.53	0.48	0.48
	Transport Sources	1.08	1.38	1.35	1.35	1.24	1.23	1.27	1.3	1.25	1.24	1.22	1.17	1.13	1.09	1.05	0.97	0.93	0.88
	Other combustion	7.46	5.11	4.34	3.98	3.62	3.28	2.92	2.55	2.19	1.98	1.82	1.73	1.74	1.69	1.87	1.7	1.75	1.8
	Industrial Processes	0.7	0.62	0.52	0.52	0.51	0.53	0.51	0.51	0.51	0.5	0.49	0.47	0.41	0.33	0.34	0.34	0.32	0.32
	Solvent Processes	0.2	0.15	0.15	0.15	0.14	0.13	0.13	0.13	0.13	0.12	0.14	0.14	0.11	0.1	0.09	0.09	0.09	0.09
	Other	0.17	0.19	0.18	0.19	0.19	0.19	0.19	0.21	0.19	0.19	0.19	0.19	0.17	0.17	0.16	0.16	0.16	0.15
	Total	**15.2**	**11.9**	**10.5**	**9.41**	**9.29**	**9.27**	**8.13**	**7.89**	**7.41**	**7.19**	**6.96**	**6.84**	**6.75**	**6.23**	**6.25**	**6.06**	**6.17**	**6.08**
Sulphur dioxide (kt)	Energy Industries	68.2	39.7	26.8	26.8	28.3	29.9	18.4	17.4	16.4	14.9	13.5	8.34	11	4.56	2.34	2.29	2.96	2.69
	Industrial Combustion	19.4	16.6	8.94	5.86	4.81	5.26	3.2	2.92	3.36	4.37	4.1	3.81	3.83	3.86	5.03	4.36	3.87	4.47
	Transport Sources	2.56	2.32	1.52	1.32	1.02	0.92	0.96	0.99	1.01	1.04	1.02	0.77	0.57	0.52	0.44	0.4	0.38	0.37
	Other combustion	21	17	12.7	10.7	8.99	7.89	6.42	5.25	4.23	3.54	3.46	3.45	3.53	2.47	2.48	2.33	2.5	2.47
	Industrial Processes	0.009	0.02	0.02	0.02	0.002	0.001	0.0006	0.002	0.0004	0.0009	0.0006	0.0005	0.0003	0	0	0	0	0
	Other	0.17	0.14	0.1	0.1	0.09	0.09	0.09	0.1	0.11	0.1	0.1	0.21	0.2	0.2	0.17	0.13	0.12	0.11
	Total	**111**	**75.8**	**50**	**44.8**	**43.2**	**44**	**29**	**26.7**	**25.1**	**23.9**	**22.2**	**16.6**	**19.2**	**11.6**	**10.5**	**9.5**	**9.84**	**10.1**
Lead (tonnes)	Energy Industries	2.77	1.31	0.68	0.21	0.24	0.22	0.18	0.15	0.05	0.05	0.06	0.03	0.02	0.02	0.05	0.03	0.11	0.05
	Industrial Combustion	2.39	2.35	2	1.87	1.68	1.69	1.71	1.57	1.59	1.48	1.19	1.28	1.09	1.25	1.47	1.26	1.1	1.18
	Transport Sources	62.8	31.7	17	9.18	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	Other combustion	3.38	2.01	1.53	1.35	1.13	0.97	0.83	0.68	0.54	0.44	0.41	0.43	0.45	0.46	0.5	0.47	0.47	0.49
	Industrial Processes	0.43	0.38	0.22	0.19	0.25	0.22	0.17	0.12	0.14	0.13	0.1	0.11	0.06	0.04	0.05	0.05	0.05	0.05
	Waste	0.23	0.2	0.008	0.01	0.01	0.004	0.05	0.04	0.03	0.02	0.02	0.02	0.02	0.03	0.04	0.04	0.03	0.03
	Other	0.004	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.002
	Total	**72**	**37.9**	**21.4**	**12.8**	**3.39**	**3.19**	**3.02**	**2.64**	**2.44**	**2.2**	**1.87**	**1.94**	**1.72**	**1.89**	**2.17**	**1.91**	**1.83**	**1.85**

* The uncertainties in the data are greater than the precision indicated by the table above. This higher level of resolution has been chosen to aid transparency.

Appendix F Definition of NFR Codes and Sector categories

Table 18 below provides a lookup table between the NFR codes and descriptions used to provide a high degree of detail in the inventory, and the categories used in the graphs within this report.

The Sector Category "Other" is applied to 1A5b and 6A across all pollutants, as shown in the table below. Additional Sector Categories are included under "Other" for each pollutant. If a Sector Category is insignificant for a pollutant, then it is included within the "Other" category in the tables and graphs of the report. See Table 19 below for further information.

Table 18 - Definition of NFR Codes and Sector Categories

NFR Code	NFR Source Description	Sector Category	Sub-sector Category
1A1a	Public Electricity and Heat Production	Energy Industries	Power generation
1A1b	Petroleum Refining	Energy Industries	Other
1A1c	Combustion in Manufacture of Solid Fuels and Other Energy Industries	Energy Industries	Other
1A2a	Combustion in Iron and Steel Manufacturing Industry	Industrial Combustion	Iron and steel
1A2b	Combustion in Non-ferrous Metals Manufacturing Industry	Industrial Combustion	Other
1A2c	Combustion in Chemical Manufacturing Industry	Industrial Combustion	Other
1A2d	Combustion in Pulp, Paper and Print Manufacturing Industry	Industrial Combustion	Other
1A2e	Combustion in Food Processing, Beverages and Tobacco Manufacturing Industry	Industrial Combustion	Food and drink
1A2f	Combustion in Non-metallic minerals Manufacturing Industry	Industrial Combustion	Other
1A2gvii	Mobile Combustion in manufacturing industries and construction	Industrial Combustion	Other
1A2gviii	Stationary combustion in other manufacturing industries and construction	Industrial Combustion	Other
1A3ai(i)	International aviation LTO (civil)	Transport Sources	Other
1A3aii(i)	Domestic aviation LTO (civil)	Transport Sources	Other
1A3bi	Road transport: Passenger cars	Transport Sources	Passenger cars
1A3bii	Road transport: Light duty vehicles	Transport Sources	Other road transport
1A3biii	Road transport: Heavy duty vehicles and buses	Transport Sources	Other road transport
1A3biv	Road transport: Mopeds & motorcycles	Transport Sources	Other road transport
1A3bv	Road transport: Gasoline evaporation	Transport Sources	Other road transport
1A3bvi	Road transport: Automobile tyre and brake wear	Transport Sources	Other road transport
1A3bvii	Road transport: Automobile road abrasion	Transport Sources	Other road transport
1A3c	Railways	Transport Sources	Other
1A3dii	National navigation (shipping)	Transport Sources	Other
1A3eii	Other	Transport Sources	Other
1A4ai	Commercial/institutional: Stationary	Other combustion	Other
1A4bi	Residential: Stationary	Other combustion	Residential
1A4bii	Residential: Household and gardening (mobile)	Other combustion	Residential
1A4ci	Agriculture/Forestry/Fishing: Stationary	Other combustion	Other
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Other combustion	Other
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Other combustion	Other

NFR Code	NFR Source Description	Sector Category	Sub-sector Category
1A5b	Other, Mobile (including military, land based and recreational boats)	Other	Other
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	Fugitive	Fugitive
1B2ai	Fugitive emissions oil: Exploration, production, transport	Fugitive	Fugitive
1B2aiv	Fugitive emissions oil: Refining / storage	Fugitive	Fugitive
1B2av	Distribution of oil products	Fugitive	Fugitive
1B2b	Fugitive emissions from natural gas	Fugitive	Fugitive
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Fugitive	Fugitive
2A1	Cement production	Industrial Processes	Cement production
2A3	Glass production	Industrial Processes	Other
2A5a	Quarrying and mining of minerals other than coal	Industrial Processes	Other
2A5b	Construction and demolition	Industrial Processes	Other
2A6	Other mineral products	Industrial Processes	Other
2B10a	Chemical industry: Other	Industrial Processes	Other
2B10b	Storage, handling and transport of chemical products	Industrial Processes	Other
2B2	Nitric acid production	Industrial Processes	Other
2B6	Titanium dioxide production	Industrial Processes	Other
2B7	Soda ash production	Industrial Processes	Other
2C1	Iron and steel production	Industrial Processes	Iron and steel
2C3	Aluminium production	Industrial Processes	Other
2C5	Lead production	Industrial Processes	Other
2C6	Zinc production	Industrial Processes	Other
2C7a	Copper production	Industrial Processes	Other
2C7c	Other metal production	Industrial Processes	Other
2D3a	Domestic solvent use including fungicides	Solvent Processes	Domestic
2D3b	Road paving with asphalt	Solvent Processes	Other
2D3d	Coating applications	Solvent Processes	Industrial
2D3e	Degreasing	Solvent Processes	Industrial
2D3f	Dry cleaning	Solvent Processes	Industrial
2D3g	Chemical products	Solvent Processes	Industrial
2D3h	Printing	Solvent Processes	Industrial
2D3i	Other solvent use	Solvent Processes	Other
2H1	Pulp and paper industry	Industrial Processes	Other
2H2	Food and beverages industry	Industrial Processes	Food and drink
2H3	Other industrial processes	Industrial Processes	Other
2I	Wood processing	Industrial Processes	Other
3B1a	Manure management - Dairy cattle	Agriculture	Cattle manure management
3B1b	Manure management - Non-dairy cattle	Agriculture	Cattle manure management
3B2	Manure management - Sheep	Agriculture	Other manure management
3B3	Manure management - Swine	Agriculture	Other manure management

NFR Code	NFR Source Description	Sector Category	Sub-sector Category
3B4d	Manure management - Goats	Agriculture	Other manure management
3B4e	Manure management - Horses	Agriculture	Other manure management
3B4gi	Manure management - Laying hens	Agriculture	Other manure management
3B4gii	Manure management - Broilers	Agriculture	Other manure management
3B4giii	Manure management - Turkeys	Agriculture	Other manure management
3B4giv	Manure management - Other poultry	Agriculture	Other manure management
3B4h	Manure management - Other animals	Agriculture	Other manure management
3Da1	Inorganic N-fertilizers (includes also urea application)	Agriculture	In-organic fertilizers
3Da2a	Animal manure applied to soils	Agriculture	Manure applied to soils
3Da3	Urine and dung deposited by grazing animals	Agriculture	Grazing animal excreta
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	Agriculture	Other
3F	Field burning of agricultural residues	Agriculture	Other
5A	Biological treatment of waste - Solid waste disposal on land	Waste	Waste
5B1	Biological treatment of waste - Composting	Waste	Waste
5C1a	Municipal waste incineration	Waste	Waste
5C1bii	Hazardous waste incineration	Waste	Waste
5C1biii	Clinical waste incineration	Waste	Waste
5C1biv	Sewage sludge incineration	Waste	Waste
5C1bv	Cremation	Waste	Waste
5C2	Open burning of waste	Waste	Waste
5D1	Domestic wastewater handling	Waste	Waste
6A	Other	Other	Other

Table 19 - Summary of the sector categories included in "Other" for each pollutant

Sector Category	CO	NH_3	NO_x	Pb	PM_{10}	SO_2	NMVOC
Agriculture	✓		✓				
Energy Industries		✓					✓
Fugitive		✓	✓	✓	✓	✓	
Industrial Combustion		✓					
Industrial Processes			✓				
Other (1A5b and 6A)	✓	✓	✓	✓	✓	✓	✓
Solvent Processes		✓					
Waste	✓		✓		✓	✓	✓

References

A Misra, NR Passant, TP Murrells, Y Pang, G Thistlethwaite, C Walker, M Broomfield, D Wakeling, S del Vento, B Pearson (Ricardo-AEA), M Hobson (Aether), T Misselbrook (Rothamsted Research), U Dragosits (CEH) "UK Informative Inventory Report (1990 to 2013): Annual Report for submission under the UNECE-Convention on Long-Range Transboundary Air Pollution", March 2015

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

Airtricity (2014), Gas consumption and gas leakage data for 2013 and breakdown of gas sales by customer sectors 2006-2013, Personal Communication

Alcan (2004, 2014), Personal Communication.

APEG (1999), Source Apportionment of Airborne Particulate Matter in the United Kingdom, report of the Airborne Particles Expert Group, ISBN 0-7058-1771-7

ATOC (2012), Fuel use by train operating companies, 2012, personal communication.

AQEG (2005), "Particulate Matter in the United Kingdom", Air Quality Expert Group

AQEG (2012) "Fine Particulate Matter ($PM_{2.5}$) in the United Kingdom", Air Quality Expert Group

Bell, DM (2014), ISR and Power Station Fuel Consumption, Personal Communication, Northern Ireland Department of Environment

BGS (2014), United Kingdom Minerals Yearbook 1990-2013, British Geological Survey

Boulter, P.G., Latham, S. (2009)." Emission Factors 2009: Report 4 – A Review of Methodologies for Estimating Cold Start Emissions", *TRL Project Report PPR 357*, June 2009

Boulter PG, TJ Barlow and IS McRae (2009). "Emission Factors 2009: Report 3 - Exhaust Emission Factors for Road Vehicles in the UK", *TRL Project Report PPR 356*, June 2009

British Glass (2014), Production Statistics for UK Glass Industry, Personal Communication

CAA (2014), "UK airport statistics 2013" – annual, Civil Aviation Authority

Carslaw, D., Beevers, S., Westmoreland, E., Wiliams, M., Tate, J., Murrells, T., Stedman, J., Li, Yvonne, Grice, S., Kent. A., and Tsagatakis, I (2011), "Trends in NO_X and NO_2 emissions and ambient measurements in the UK", *Report for Defra*

Coal Authority (2014), Regional Coal Production: open cast and deep mined, Personal Communication.

DECC (2014a), "Digest of UK Energy Statistics"*, Department of Energy & Climate Change,* HMSO

DECC (2015a), Local gas use data by LDZ, *personal communication*

DECC (2014b), "Energy Trends December 2014", Articles on DA electricity generation and consumption patterns and the regional energy statistics for 2005 to 2013

DECC (2014c), Oil & Gas flaring and venting volume data by installation and gas landings information, *personal communication*

DECC Offshore Inspectorate (2014), Environmental Database for annual Emissions and Discharges from Offshore Installations, from the EEMS reporting inventory reporting system of site operator annual returns to DECC for 2013

Defra (2007), "The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1)", *HMSO*

Defra (2012), Revised DA waste landfill model outputs, using available DA-specific data on NSW and C&I waste, Steve Nelson, Defra

DETR (1998a), "Review of the United Kingdom National Air Quality Strategy", a Consultation Document, 98EP0541/A, the Stationary Office, Norwich, Department of the Environment, Transport and the Regions

DETR (2000), "The Air Quality Strategy for England, Scotland, Wales and Northern Ireland - Working Together for Clean Air", the Stationary Office, Norwich, Department of the Environment, Transport and the Regions

DFPNI (2014) Public Sector Energy Campaign data, personal communication

DfT (2011), Road Freight Statistics 2010, October 2011 Release, Department for Transport.

DfT (2012b), personal communication, Network Analysis and Modelling, Department for Transport, 2012

DfT (2013), personal communication, Bus Service Operators Grant system, DfT, August 2013

DfT (2014a), personal communication, Road Traffic Statistics, DfT.

DfT (2014b), personal communication, Vehicle Licensing Statistics, Department for Transport, August 2014

DfT (2014c), Vehicle Licensing Statistics: 2013, Department for Transport, "Impacts of Nitrogen Deposition on Terrestrial Ecosystems", Report of the UK Review Group on Impacts of Atmospheric Nitrogen, ISBN 1-870393-22-8

DOE (1997), "The United Kingdom National Air Quality Strategy", March 1997, (Cm 3587)

Dragosits U., Mitchell R.F, Tang Y.S. and Sutton M.A. (2014), Modelling and mapping UK emissions of ammonia, methane and nitrous oxide from agriculture, nature, waste disposal and other miscellaneous sources for 2013, April 2014

DRDNI (2013) Northern Ireland Transport Statistics 2012-13. DRDNI – Department for Regional Development. http://www.drdni.gov.uk/ni_transport_statistics_annual_2012-13.pdf

DRDNI (2014) Vehicle licensing data. DRDNI – Department for Regional Development. Personal Communication.EEA (2009), EMEP/CORINAIR Emission Inventory Guidebook – 2009. Technical report No 9/2009.

EEA (2012), EMEP/EEA Emission Inventory Guidebook – 2009. Part B: sectoral guidance chapters, 1.A.3.b Road transport updated May 2012, European Environment Agency

EEA (2013), EMEP/EEA air pollutant emission inventory guidebook 2013 (updated).

Environment Agency (2014a), database of emissions to atmosphere from authorised processes in England & Wales, as reported to the Pollution Inventory (data for 1998-2013)

Environment Agency (2014b), database of EU ETS operator data including fuel use, process details and emissions totals, personal communication

EPAQS (1995), Expert Panel on Air Quality Standards – Particles, HMSO, London, Expert Panel on Air Quality Standards

Fernando, S. (2011), Update of Estimated Methane Emissions from UK Abandoned Coal Mines

Firmus Energy (2014), Gas sales in Northern Ireland in 2013: domestic and non-domestic data, Personal Communication

ISSB (2014), Iron & Steel Industry Annual Statistics for the UK, including regional fuel use data. Personal Communication, International Steel Statistics Bureau

MacCarthy J. Thomas J Choudrie S, Pearson B, S. Passant, N. Thistlethwaite, G. Murrells, T. Watterson J. Cardenas, Malcolm H (2011). UK Greenhouse Gas Inventory, 1990 to 2009. AEA ISBN 0-9554823-9-9

Mineral Products Association (2014), Cement industry fuel use data and plant capacity data, Personal Communication.

Misselbrook, T.H., Sutton, M.A., Scholefield, D., (2004), "A simple process-based model for estimating ammonia emissions from agricultural land after fertilizer applications", Soil Use and Management 20, 365-372

A Misra, NR Passant, TP Murrells, Y Pang, G Thistlethwaite, C Walker, M Broomfield, D Wakeling, S del Vento, B Pearson, M Hobson, T Misselbrook, U Dragosits (2015). "UK Informative Inventory Report (1990 to 2013)", March 2015

NAO (2002), The 2001 Outbreak of Foot and Mouth Diseases, National Audit Office, June 2002

National Grid (2014), natural gas leakage from high pressure, low pressure distribution systems and from Above Ground Installations, personal communication

NIEA (2014a), spreadsheet of emissions to atmosphere from authorised processes in Northern Ireland, as reported to the Inventory of Statutory Releases (data for 2005-2013), *Northern Ireland Environment Agency*

NIEA (2014b), spreadsheet of EU ETS operator data including fuel use, process details and emissions totals, personal communication, *Northern Ireland Environment Agency*

Northern Gas Networks (2014), Natural Gas leakage from LDZ and AGIs, personal communication

ONS (2014), Datasets available pertaining to a wide range of industrial and population-related activities via the publications "Annual Abstract of Statistics" and "Regional Trends", including regional GDP data, *Office for National Statistics*

Pang, Y., Walker, H., and Murrells, T (2011), "Improving the Greenhouse Gas Inventories for Road Transport in Scotland, Wales and Northern Ireland", Report for DECC, Welsh Assembly Government, the Scottish Government and the Department of the Environment for Northern Ireland, AEAT/ENV/R/3167, April 2011

Phoenix Natural Gas (2007), Gas consumption detailed by end-user sectors for 2005 and gas leakage data, Personal Communication

QUARG (1996), Airborne Particulate Matter in the United Kingdom, Third report of the Quality of Urban Air Review Group, Department of the Environment, ISBN 0-9520771-3-2

Rothamsted Research (2014), Ammonia emissions from agricultural sources and livestock data by region, personal communication (Tom Misselbrook)

Scotia Gas Networks (2014) Natural Gas leakage from LDZ and AGIs, personal communication

SEPA (2014a), Annual atmospheric emissions data for authorised processes in Scotland, from SEPA's Pollution Release Inventory, Personal Communication

SEPA (2014b), spreadsheet of EU ETS operator data including fuel use, process details and emissions totals, personal communication.

Tata Steel (2014). Site-specific breakdown of pollutant emissions by sub-source, for all UK integrated steelworks, *personal communication* (Peter Quinn)

Thistlethwaite, G., Goodwin, J., Salisbury, E., Young, K., Pang, Y., Thomson, A., Cardenas, L., (2015). "Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990 – 2013"

Thomson, A.M (2014) Peat use within Scotland and Northern Ireland: summary of research findings from CEH, personal communication, 2014

Transco (2014) Historic Gas Demands by Load Category, Personal Communication

Translink (2014), Annual fuel consumption, Personal Communication

Tsagatakis, I., Brace, S., Passant, N. and Jephcote, C. (2015), "UK Emission Mapping Methodology 2013". Report for Defra from the NAEI emissions mapping team (*unpublished as at September 2015*).

Tucker (2014), "Sulphur content of liquid fuels and petrol properties", *Personal Communication*

UKPIA (2014), Pollutant emissions for UK refineries, from combustion and process sources, Personal Communication, United Kingdom Petroleum Industry Association Ltd

UKPIA (2014), United Kingdom Petroleum Industry Association, Hugh Tucker communication on properties of UK fuels in 2013.

Vayu Ltd. (2014), Northern Ireland gas sales for domestic and commercial & industrial customers for 2013, Personal Communication

Wales & West Utilities (2014) Natural Gas leakage from LDZ and AGIs, personal communication

Webb, J., Misselbrook, T.H., (2004). "A mass-flow model of ammonia emissions from UK livestock production", *Atmospheric Environment*, 38, 2163-2176

www.wastedataflow.org, website providing regional waste disposal fate data, to inform regional estimates of landfill waste activities