National Atmospheric Emissions Inventory

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Air Quality Pollutant Inventories for England, Scotland, Wales and Northern Ireland: 1990-2012

A report of the National Atmospheric Emissions Inventory

October 2014

Aether

RICARDO-AEA

Air Quality Pollutant Inventories for England, Scotland, Wales and Northern Ireland: 1990-2012

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October 2014

Title		Air Quality Pollutant Inventories, for England, Scotland, Wales and Northern Ireland: 1990-2012
Customers		Department for Environment, Food and Rural Affairs, The Scottish Government, The Welsh Government, The Northern Ireland Department of the Environment.
Confidentiality, copyright and reproduction		Crown Copyright
Report Number		Aether-ES1014-01
NAEI Reference		ED59799/2012/CD8403/GT
ISBN		978-0-9573549-6-8
Authors		E Salisbury, G Thistlethwaite, Y Pang, R Bailey
Version		Version 2 –Corrections to report text on emission share and trends for PM10 emissions in Wales. Minor revisions to text and rounding of information on emission trends and the main drivers of reported trends. *Version 1 – released September, 2014*
Approved by	***Name***	Justin Goodwin
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This work forms part of the Atmosphere & Local Environment (ALE) Programme of the Department for Environment, Food and Rural Affairs. Ricardo-AEA and Aether compile emission estimates for the energy, industrial process, solvents and waste sectors. Rothamsted Research provides the estimates of agricultural emissions.

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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
NOx	Nitrogen oxides
NFR	Nomenclature for Reporting
NMVOC	Non-methane volatile organic compounds
SED	Solvent Emissions Directive
PM_{10}	Sub-10 micron particulate matter
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 2012, 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.

Further information on each of the pollutants listed above can be found in Appendix A.

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 B.

1.2. Data Sources and Inventory Methodology

The Devolved Administrations' inventories are compiled by disaggregating the UK emission totals presented within "UK Informative Inventory Report 1980 to 2012" (NR Passant *et al.*, 2014) 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 C.

[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.

1.3. 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.

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

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

Further information on the uncertainties for each pollutant can be found in Appendix E.

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.

Please note that the numbers quoted in the text of this report are rounded. As such, the sum of data may not equal the aggregated values quoted. For data at the full level of detail, please refer to the dataset: "DA_AQPI_1990-2012_Issue1.xlsx".

These sections include the following:

Figures graphically presenting the inventory data that can be found in the dataset: "DA_AQPI_1990-2012_Issue1.xlsx", which shows the annual trend from 1990 to 2012 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 are 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 prevalent areas for emissions and the patterns associated with that pollutant. For example, NOx emissions are concentrated around the road networks of the countries.

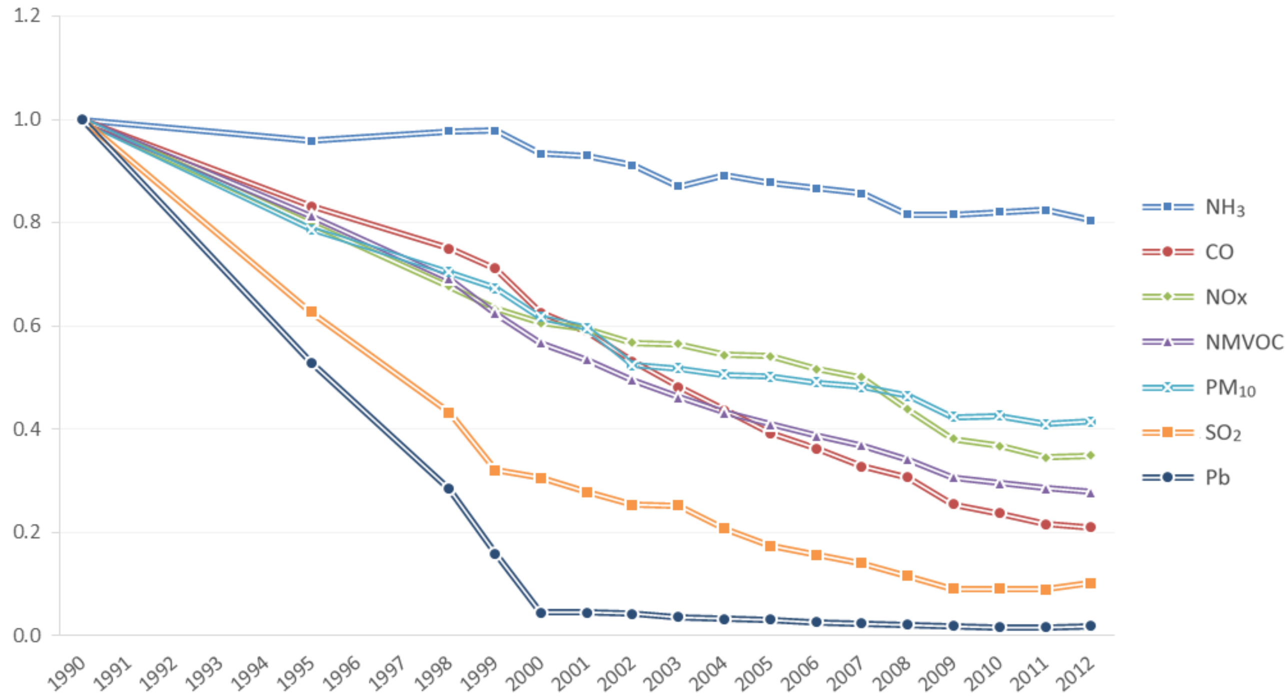
Source emission contributions matrix ranked by sector, which provides a simple indicative ranking of the sectors. This ranking is calculated using the sector's significance for each pollutant and averaging across all pollutants to produce an overall ranking of that sector. The table presents the sectors in order of their ranking, i.e. the highest ranking sector is presented at the top of the list.

2.1. England

Figure 1 shows that emissions of all seven air quality pollutants have declined since 1990. The rate at which they have declined is relatively similar for PM_{10}, NOx, NMVOC, CO and SO_2. Lead, however, shows a much higher rate of reduction from 1990 to 2000 due to the phase-out of leaded petrol. NH_3 emissions, by contrast, have declined at a slower rate than other pollutants, and have risen, for example, between 2008 and 2011 due to higher emissions from fertiliser application and increasing emissions from composting and biogas production via anaerobic digestion.

Figures 2 – 8 provide data on the trends of each pollutant split by sector. Table 2 summarises the percentage contribution of each sector for each pollutant. Figures 9 – 15 provide a geographical representation of the emissions for each pollutant.

Figure 1 Normalised trends for all pollutants, England (1990-2012)



The following information provides a summary of emissions in England for each pollutant. Figures 2 – 8 support this information.

Emissions of **ammonia** were estimated to be 190kt in 2012 and have declined by 20% since 1990. England's emissions account for 68% of the UK total in 2012. Agricultural sources dominate the inventory with manure management representing 55% of total ammonia emissions in 2012 and 33% coming from cattle manure management alone. Ammonia emissions in England have increased in recent years, with a 1.0% increase between 2008 and 2011 driven by higher emissions from fertiliser application. Emissions have subsequently declined between 2011 and 2012 by 2.4%, which is also driven by emissions from fertiliser application.

Emissions of **carbon monoxide** were estimated to be 1,508kt in 2012 and have declined by 79% since 1990. England's emissions account for 76% of the UK total in 2012. In 2012, 36% of England's emissions stemmed from road transport combustion sources. These sources are also the main reason for the decline across the time series. This is due to a number of reasons 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, there has been a reduction in the emissions from passenger cars, mainly driven by improvement in catalyst repair rates.

Emissions of **nitrogen oxides** were estimated to be 796kt in 2012, representing 75% of the UK total in 2012. Emissions have declined by 65% since 1990, with 35% of emissions in 2012 stemming from road transport combustion sources and 27% from power generation. The main source of the decline in emissions is the road transport sector, which is due to a number of reasons including the requirement for new petrol cars to be fitted with three-way catalysts since 1989. In more recent years, "Euro standards" for new cars have driven a reduction in emissions, although studies show that the diesel Euro 5 cars have not performed as well as expected. Since 2008, there has been a general reduction in the emissions from passenger cars, mainly driven by improvement in catalyst repair rates.

Emissions of **non-methane volatile organic compounds** were estimated to be 573kt in 2012, representing 69% of the UK total in 2012. Emissions have declined by 72% since 1990. This reduction has been dominated by the 96% decrease since 1990 in road transport sources, including evaporative losses. This is due to a number of reasons 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.

Emissions of **PM_{10}** were estimated to be 86kt in 2012 and have declined by 58% since 1990. They account for 76% of the UK total. 22% of emissions come from road transport sources. Power generation accounted for 28% in 1990 but have been significantly reduced to 8% of England's total in 2012. This is primarily due to the reduction in coal fired energy generation, which has been replaced by gas, which has negligible particulate matter.

Emissions of **sulphur dioxide** were estimated to be 314kt in 2012, representing 74% of the UK total in 2012. Emissions have declined by 90% since 1990, which has been dominated by the 93% reduction in power generation due to the growth in nuclear powered generation, the installation of FGD (flue-gas desulphurization) plant at a number of 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.

Emissions of **lead** were estimated to be 46 tonnes in 2012. Emissions have declined by 98% since 1990 and accounted for 75% of the UK total in 2012. The decline is dominated by the 1,927 tonnes reduction in transport sources due to the phase-out of leaded petrol. 35% of 2012 emissions arise due to the production in iron and steel industries.

Table 2 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 transport sector is the most significant sector when considering emissions from all pollutants. This sector accounts for over 25% of emissions for three pollutants: CO, NOx and PM_{10}. The majority of the important sectors are to do with the combustion of fuel, whilst Industrial Processes is also significant, especially for emissions of lead.

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).

Table 2 Source Emission Contributions Ranked by Sector, England 2012

Overall Rank	Sector	NH_3	CO	NO_X	NMVOC	PM_{10}	SO_2	Pb
1	Transport Sources	3.48%	38.91%	43.24%	7.49%	25.01%	2.36%	3.62%
2	Industrial Processes	2.42%	11.11%	0.71%	6.44%	15.50%	3.82%	56.70%
3	Commercial, domestic and agricultural combustion	0.67%	19.70%	7.84%	4.15%	20.94%	7.18%	7.48%
4	Industrial Combustion	0.00%	23.29%	16.14%	2.83%	9.17%	15.49%	17.19%
5	Energy Industries	0.00%	4.90%	29.34%	0.00%	9.27%	67.76%	9.22%
6	Agriculture	78.81%	0.00%	0.00%	8.06%	10.33%	0.00%	0.00%
7	Other *	9.60%	1.80%	2.74%	0.92%	5.16%	1.65%	2.28%
8	Fugitive	0.00%	0.28%	0.00%	13.83%	0.40%	1.73%	3.50%
9	Solvent Processes	0.00%	0.00%	0.00%	50.64%	4.22%	0.00%	0.00%
10	Waste	5.01%	0.00%	0.00%	5.64%	0.00%	0.00%	0.00%
	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.

Figures 2 – 8 provide the trend of each pollutant disaggregated by sector. The most recent year (2012) is also presented as a bubble diagram for pollutants with a considerable declining trend since 1990. This enables the user to identify the sectors present in the inventory in 2012. These graphs support the descriptive text provided above.

Legend for all graphs

- Energy Industries
- Industrial Combustion
- Transport Sources
- Commercial, domestic and agricultural combustion
- Fugitive
- Industrial Processes
- Agriculture
- Solvent Processes
- Waste
- Other

Figure 2 England Ammonia Emissions by Sector, 1990-2012

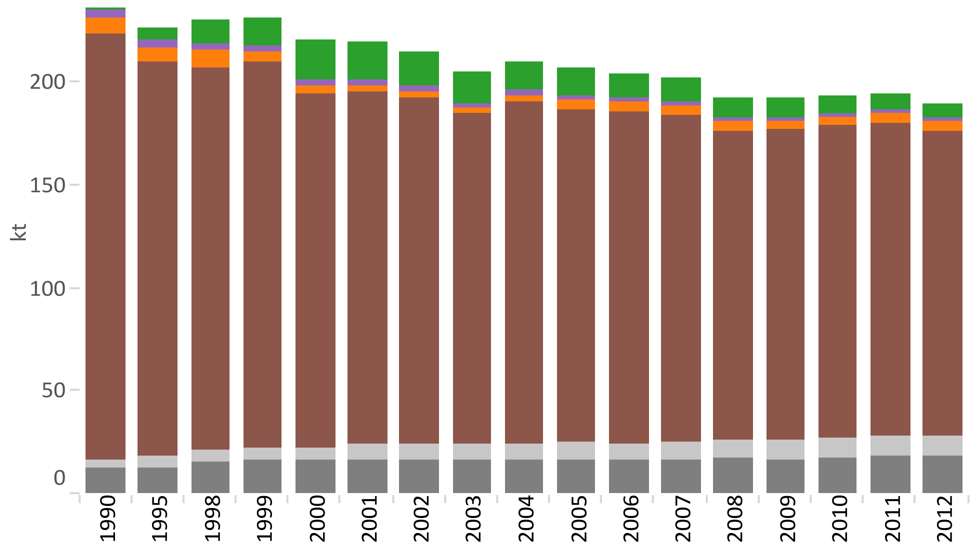


Figure 3 England Carbon Monoxide Emissions by Sector, 1990-2012

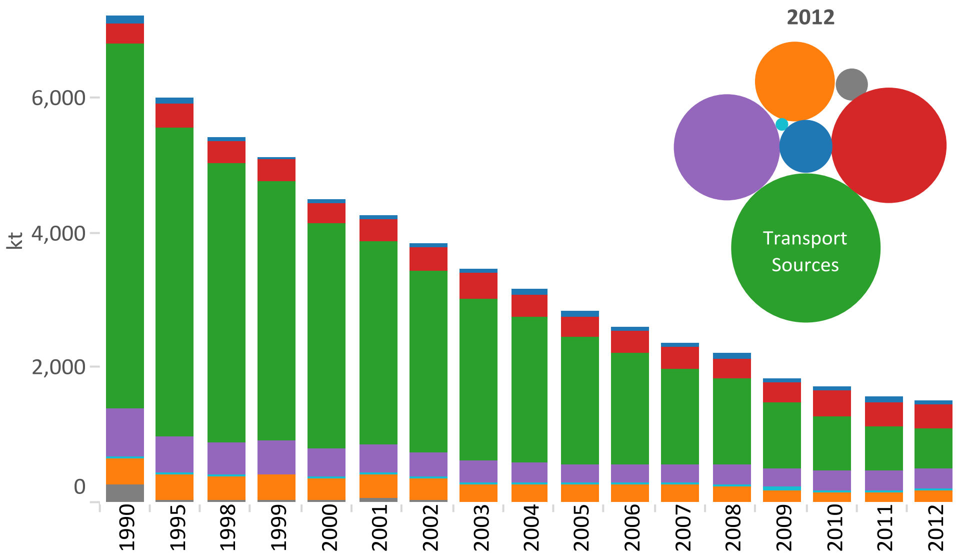


Figure 4 England Nitrogen Oxides Emissions by Sector, 1990-2012

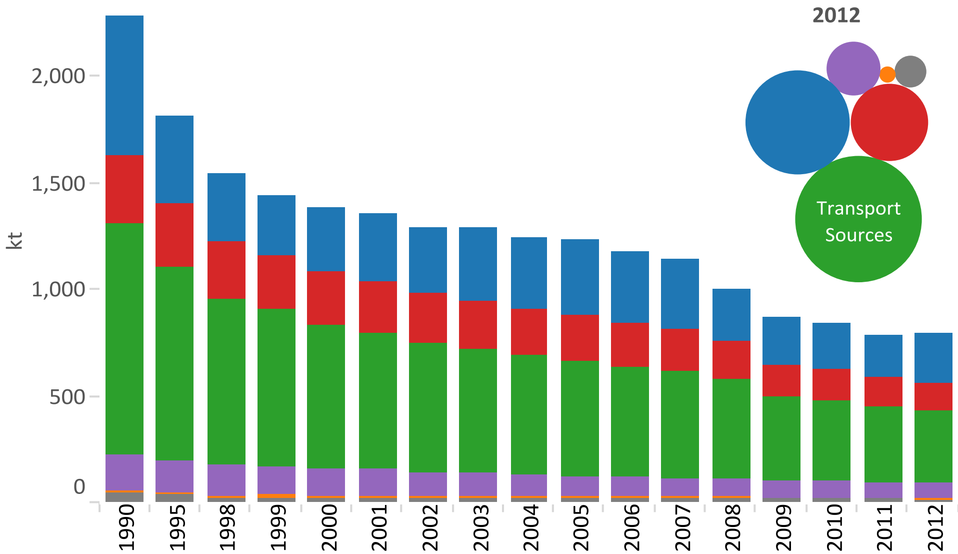


Figure 5 England NMVOC Emissions by Sector, 1990-2012

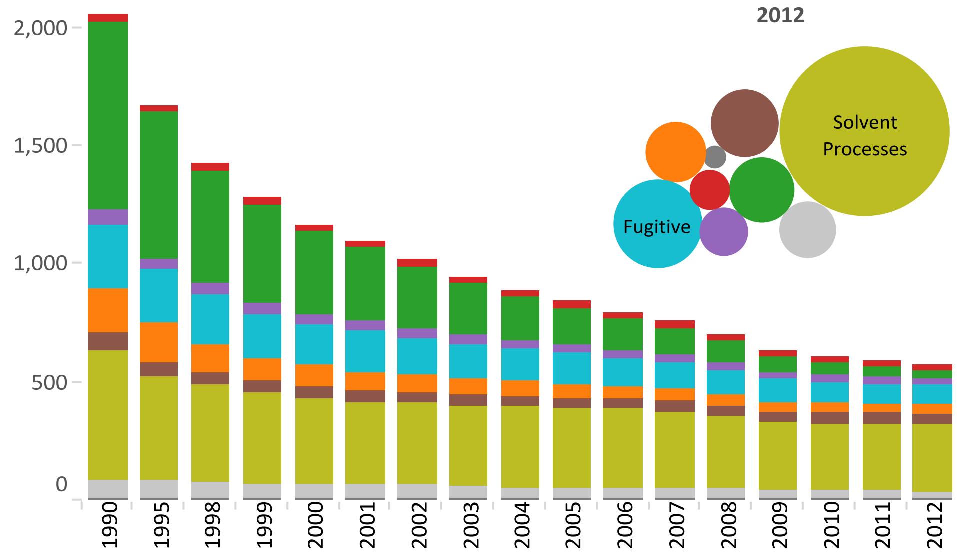


Figure 6 England PM_{10} Emissions by Sector, 1990-2012

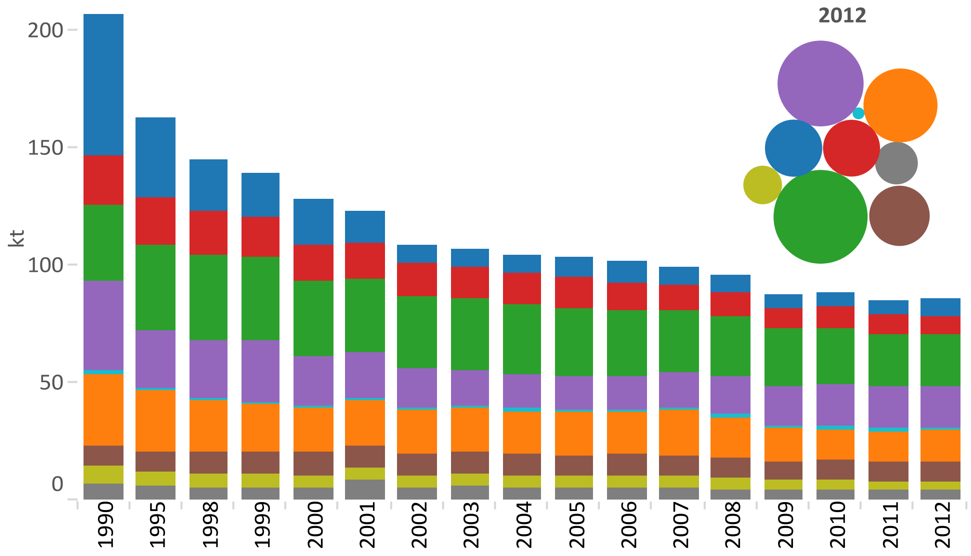


Figure 7 England Sulphur Dioxide Emissions by Sector, 1990-2012

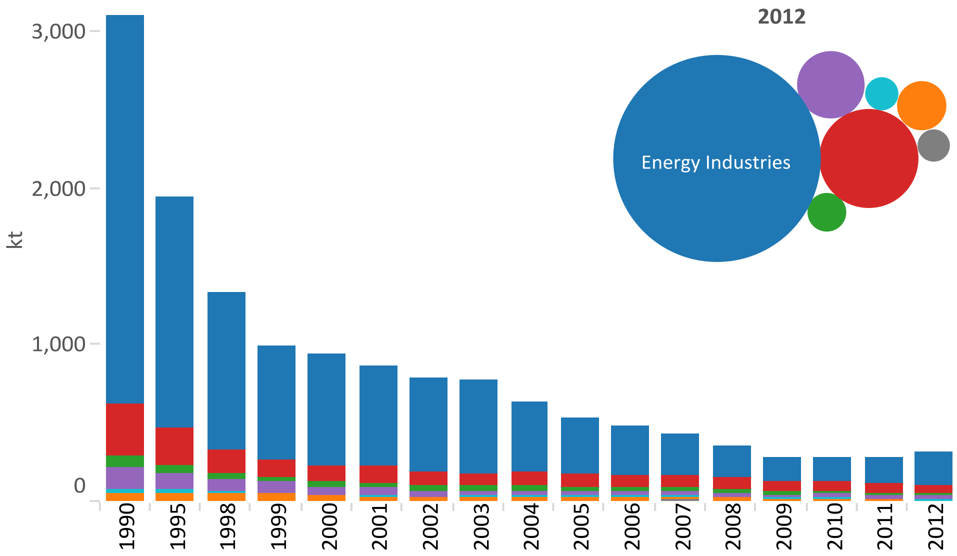
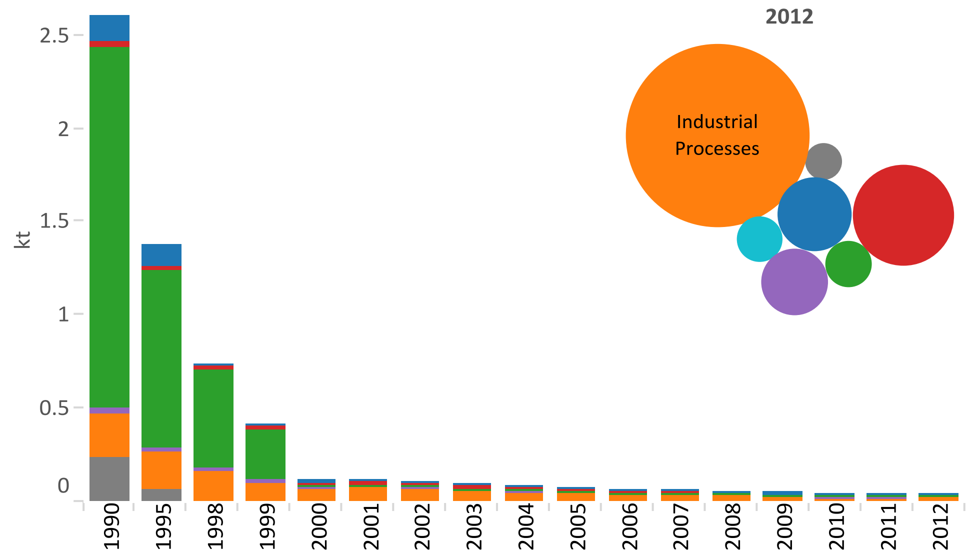


Figure 8 England Lead Emissions by Sector, 1990-2012



The following figures provide a graphical visualisation of emissions for all seven pollutants.

Figure 9 England Ammonia Emissions, 2012

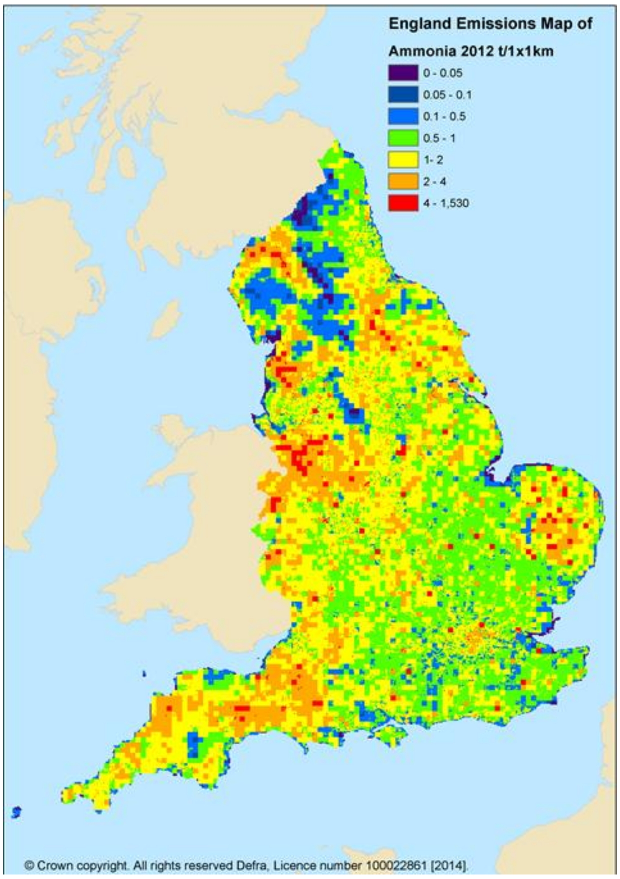


Figure 10 England Carbon Monoxide Emissions, 2012

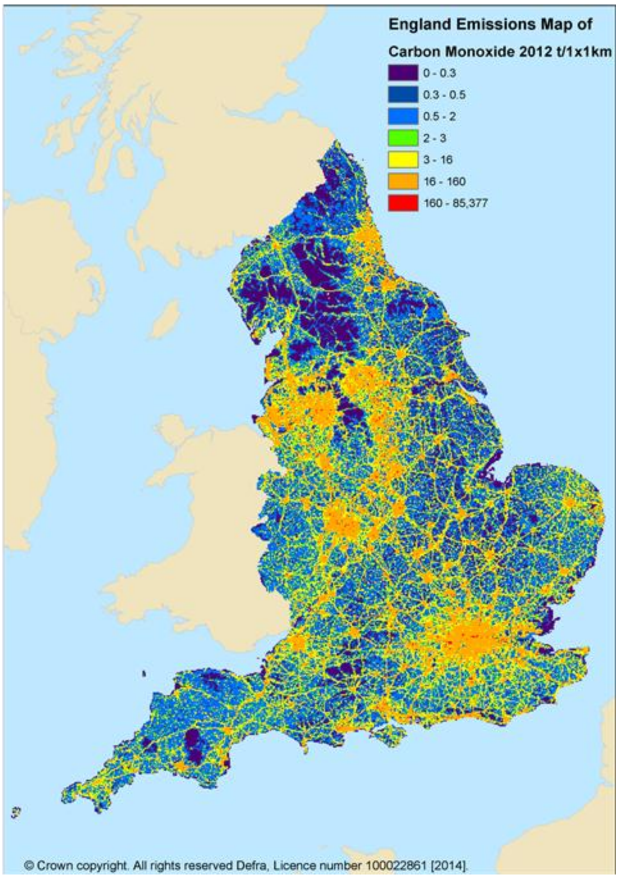


Figure 11 England Nitrogen Oxides Emissions, 2012

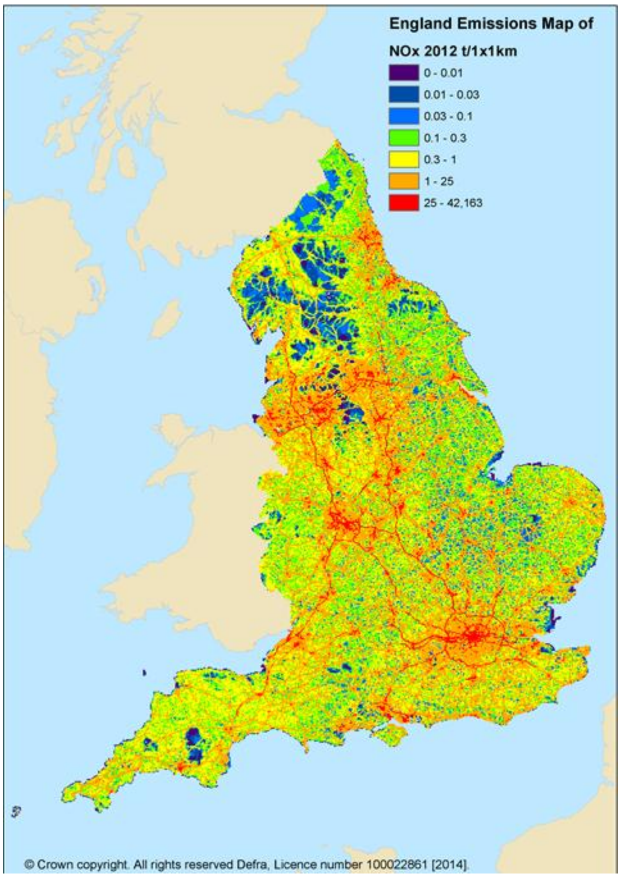


Figure 12 England NMVOC Emissions, 2012

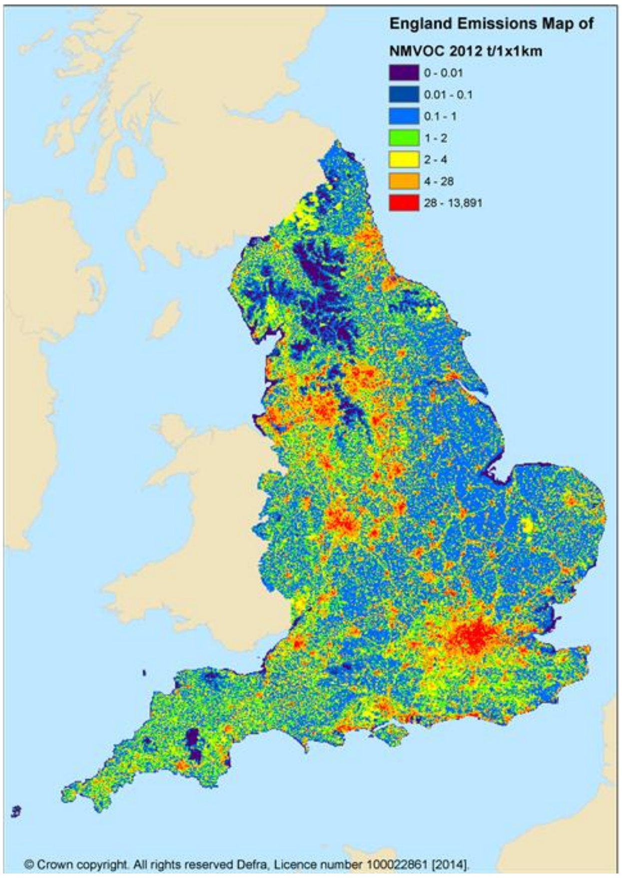


Figure 13 England PM_{10} Emissions, 2012

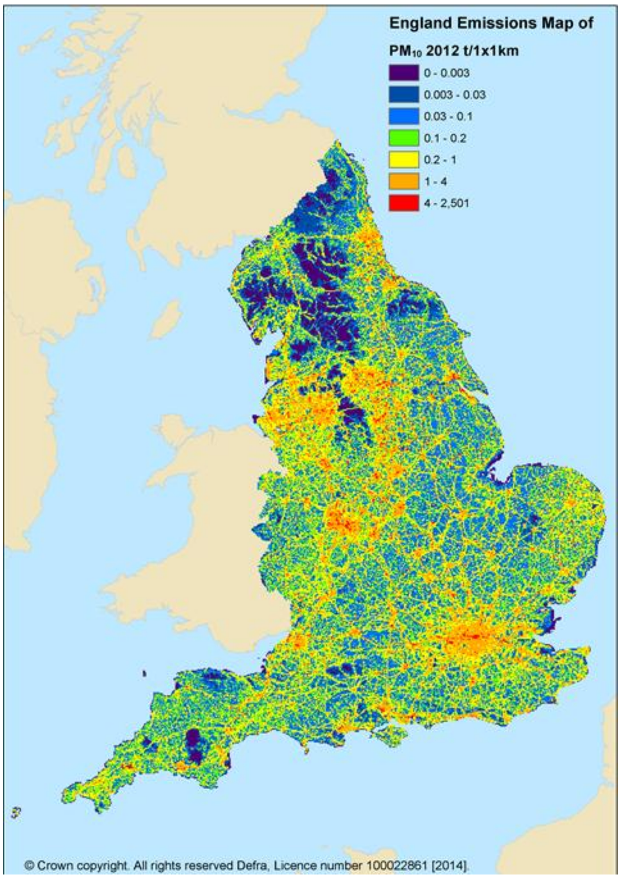


Figure 14 England Sulphur Dioxide Emissions, 2012

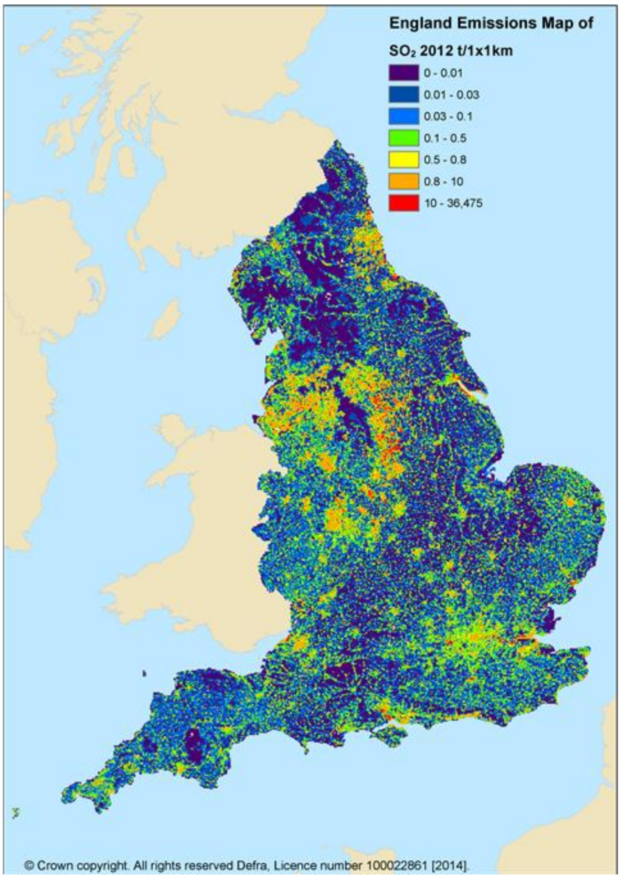
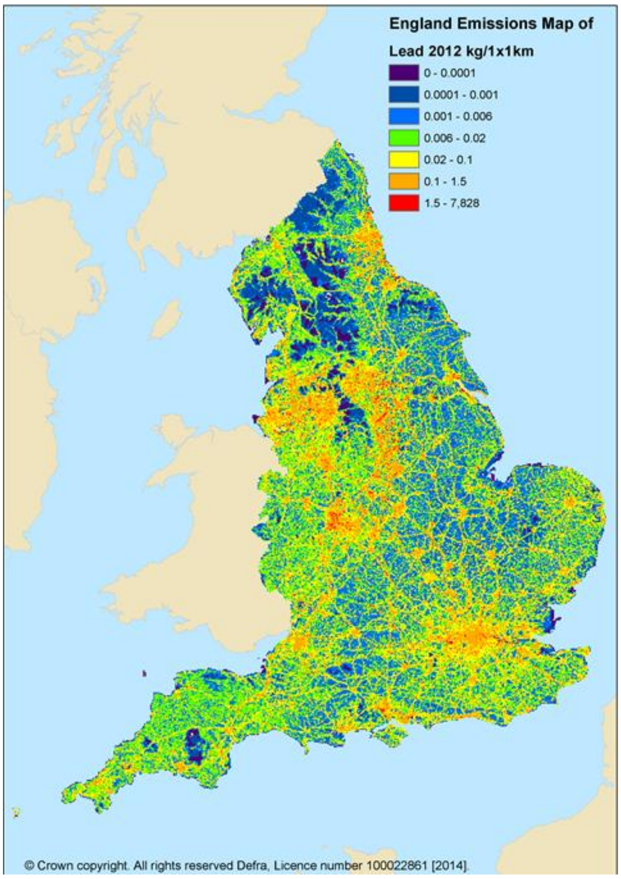


Figure 15 England Lead Emissions, 2012

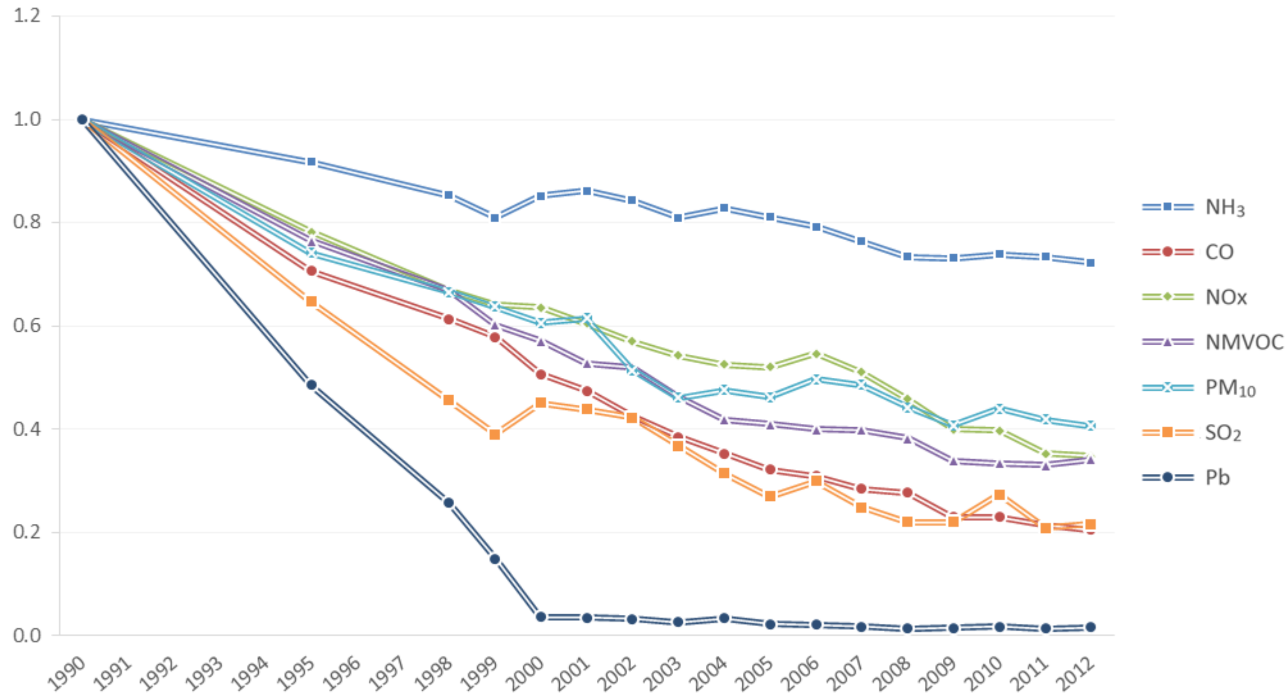


2.2. Scotland

Figure 16 shows that the emissions of all seven air quality pollutants have declined since 1990. The rate at which they have declined is relatively similar for PM_{10}, NOx, 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. 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.

Figures 17 – 23 provide data on the trends of each pollutant split by sector, Table 3 summarises the percentage contribution of each sector for each pollutant. Figures 24 – 30 provide a geographical representation of the emissions for each pollutant.

Figure 16 Normalised trends for all pollutants, Scotland (1990-2012)



The following information provides a summary of emissions in Scotland for each pollutant. Figures 17 – 23 support this information.

Emissions of **ammonia** were estimated to be 33kt in 2012. These emissions have declined by 28% since 1990 and account for 12% of the UK total in 2012. Agricultural sources dominate the inventory with manure management representing 66% of total ammonia emissions in 2012, and 53% coming from cattle manure management alone. Ammonia emissions have remained relatively stable in recent years.

Emissions of **carbon monoxide** were estimated to be 169kt in 2012 and have declined by 80% since 1990. Scotland's emissions account for 9% of the UK total. In 2012, 28% of emissions stemmed from road transport combustion sources. These sources are also the main reason for the decline across the time series. This is due to a number of reasons 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, there has been a reduction in the emissions from passenger cars, mainly driven by improvement in catalyst repair rates.

Emissions of **nitrogen oxides** were estimated to be 98kt in 2012, representing 9% of the UK total in 2012. Emissions have declined by 65% since 1990, with 29% of emissions in 2012 stemming from road transport combustion sources and 27% from power generation. The main sources of the decline in emissions are the road transport sector and the energy sector. Transport emissions have declined due to a number of reasons including the requirement for new petrol cars to be fitted with three-way catalysts since 1989 and, in more recent years, "Euro standards" for new cars have driven a reduction in emissions, although studies show that the diesel Euro 5 cars have not performed as well as expected. Since 2008, there has been a general reduction in the emissions from passenger cars, mainly driven by improvement in catalyst repair rates. Power generation emissions have declined due to the introduction of abatement technology and the increasing use of renewables.

Emissions of **non-methane volatile organic compounds** were estimated to be 141kt in 2012, representing 17% of the UK total in 2012. Emissions have declined by 66% since 1990. This reduction is partly due to the transport sector where emissions have decreased due to a number of reasons 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. The most significant factor in the trend is the 87% reduction in emissions from fugitive sources, which is mainly due to improvements in gas handling systems at oil and gas terminals to minimise fugitive releases from sources such as oil loading and unloading operations.

Emissions of **PM_{10}** were estimated to be 12kt in 2012 and have declined by 59% since 1990. They account for 10% of the UK total. 37% of emissions came from commercial, domestic and agricultural combustion in 2012. Emissions from power generation accounted for 25% of total emissions in 1990 but have reduced to only 8% of the total in 2012. This is primarily due to the reduction in coal-fired energy generation, which has been replaced by gas, which has negligible particulate matter emissions.

Emissions of **sulphur dioxide** were estimated to be 65kt in 2012, representing 15% of the UK total in 2012. Emissions have declined by 78% since 1990, due primarily to a shift in power generation fuel mix away from oil- and coal-fired power stations, with a greater contribution now from gas-fired power stations, nuclear and renewables.

Emissions of **lead** were estimated to be 3.4 tonnes in 2012. Emissions have declined by 98% since 1990 and accounted for 6% of the UK total in 2012. The decline is dominated by the 183 tonnes reduction in transport sources due to the phase-out of leaded petrol. The industrial combustion sector accounted for 24% of 2012 emissions.

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 commercial, domestic and agricultural combustion sector is the most significant sector when considering emissions from all pollutants. This sector accounts for nearly 25% or over of emissions for three pollutants: CO, Pb and PM_{10}.

The majority of the top five sectors are to do with the combustion of fuel, whilst Industrial Processes is also significant, especially for NMVOC, which is due to the significant food and drinks industry present 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 2012

Overall Rank	Sector	NH_3	CO	NO_X	NMVOC	PM_{10}	SO_2	Pb
1	Commercial, domestic and agricultural combustion	1.05%	38.98%	11.78%	3.81%	36.94%	13.63%	24.63%
2	Transport Sources	2.09%	30.11%	37.79%	2.53%	19.59%	2.18%	5.42%
3	Energy Industries	0.00%	5.72%	33.25%	0.00%	9.16%	74.74%	33.35%
4	Industrial Processes	0.22%	2.81%	0.02%	44.42%	9.74%	1.16%	9.34%
5	Industrial Combustion	0.00%	20.23%	14.51%	1.14%	6.90%	7.35%	24.14%
6	Agriculture	86.51%	0.00%	0.00%	7.11%	10.77%	0.00%	0.00%
7	Other *	5.51%	1.75%	2.65%	0.49%	3.96%	0.74%	3.12%
8	Fugitive	0.00%	0.42%	0.00%	16.73%	0.97%	0.20%	0.00%
8	Solvent Processes	0.00%	0.00%	0.00%	19.82%	1.96%	0.00%	0.00%
10	Waste	4.62%	0.00%	0.00%	3.96%	0.00%	0.00%	0.00%
	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.

Figures 24 – 30 provide the trend of each pollutant disaggregated by sector. The most recent year (2012) is also presented as a bubble diagram for pollutants with a considerable declining trend since 1990. This enables the user to identify the sectors present in the inventory in 2012. These graphs support the descriptive text provided above.

Legend for all graphs

- Energy Industries
- Industrial Combustion
- Transport Sources
- Commercial, domestic and agricultural combustion
- Fugitive
- Industrial Processes
- Agriculture
- Solvent Processes
- Waste
- Other

Figure 17 Scotland Ammonia Emissions by Sector, 1990-2012

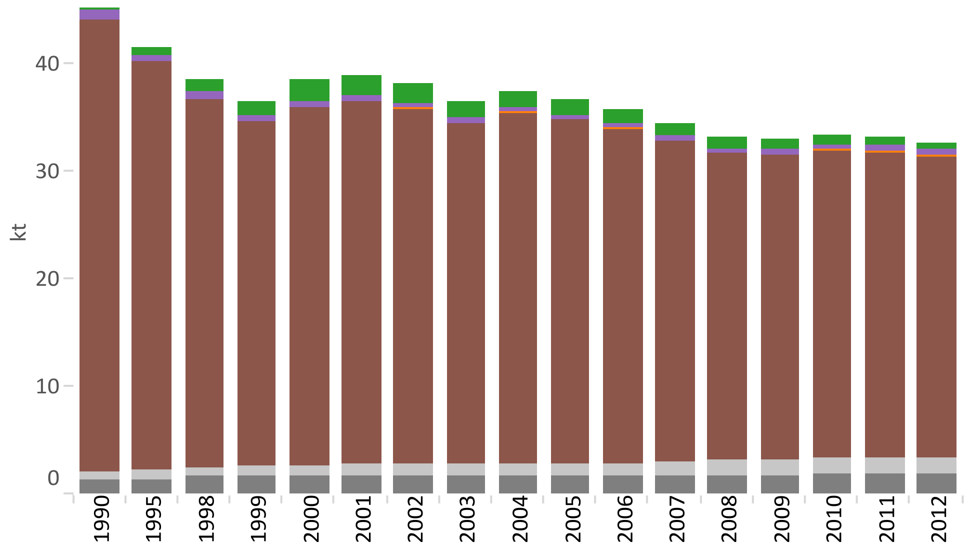


Figure 18 Scotland Carbon Monoxide Emissions by Sector, 1990-2012

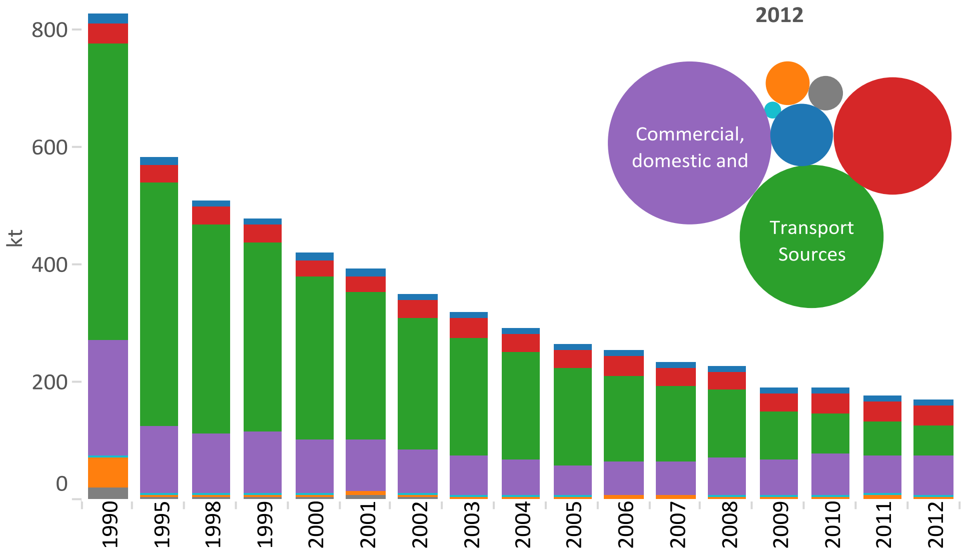


Figure 19 Scotland Nitrogen Oxides Emissions by Sector, 1990-2012

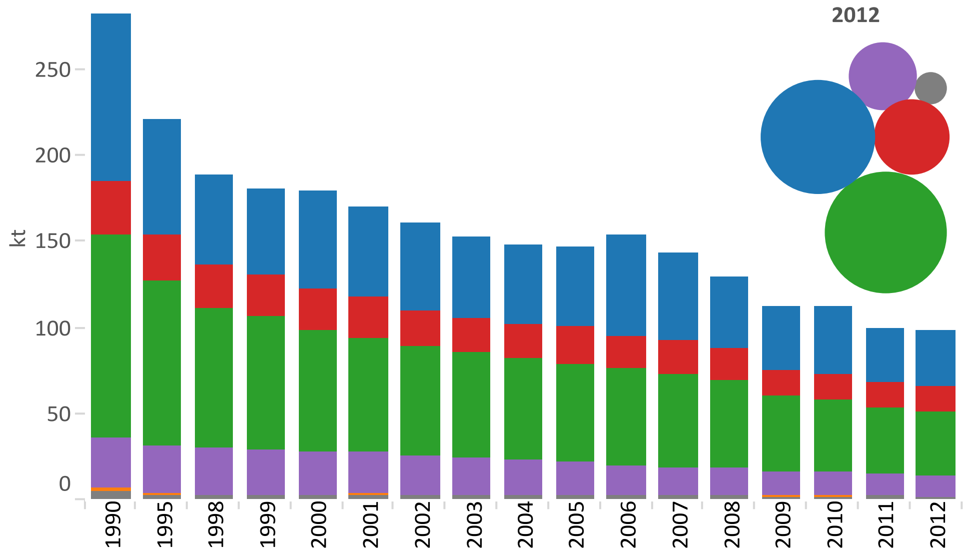


Figure 20 Scotland NMVOC Emissions by Sector, 1990-2012

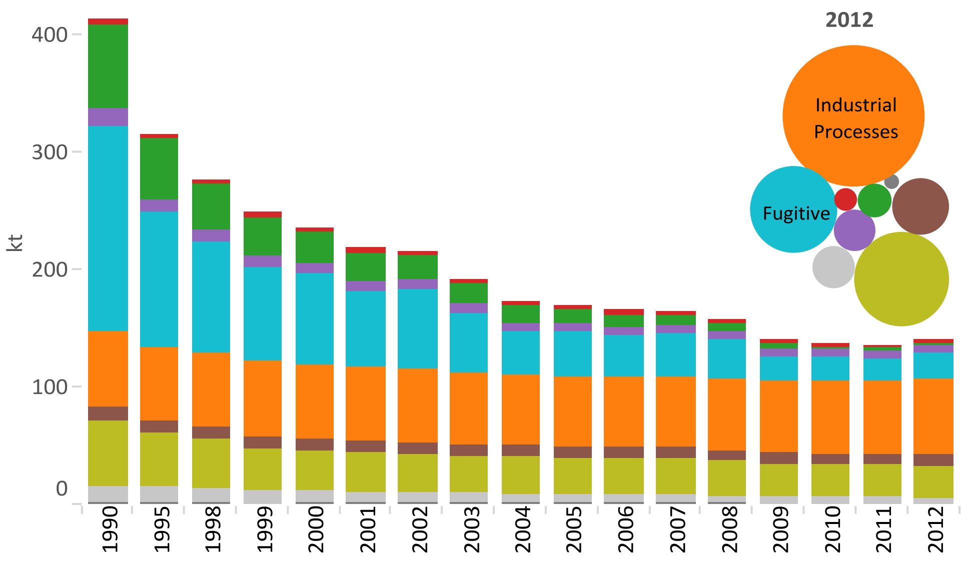


Figure 21 Scotland PM_{10} Emissions by Sector, 1990-2012

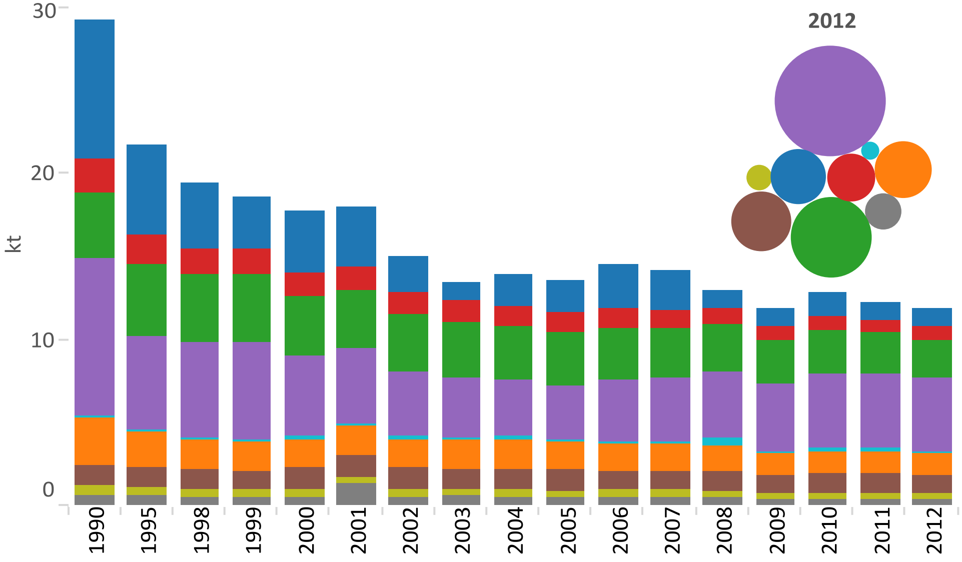


Figure 22 Scotland Sulphur Dioxide Emissions by Sector, 1990-2012

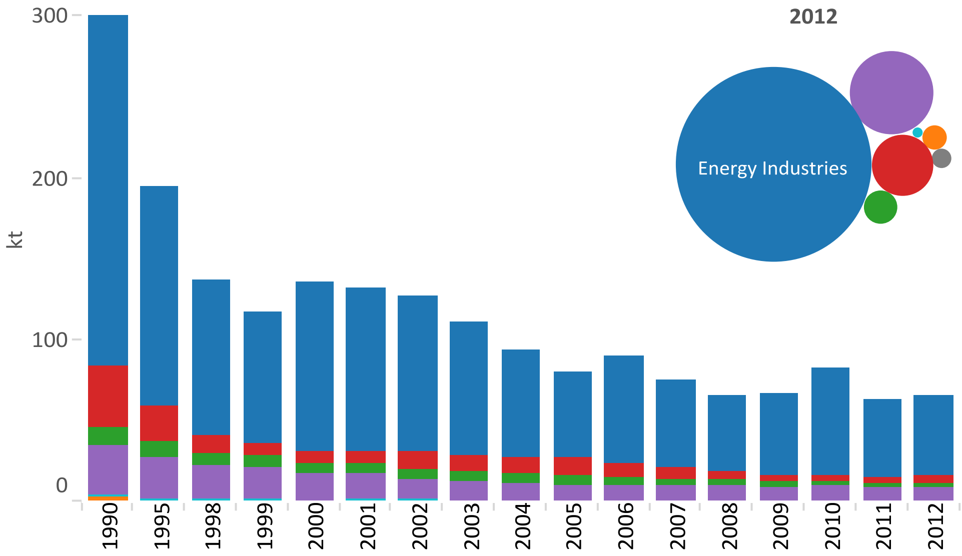
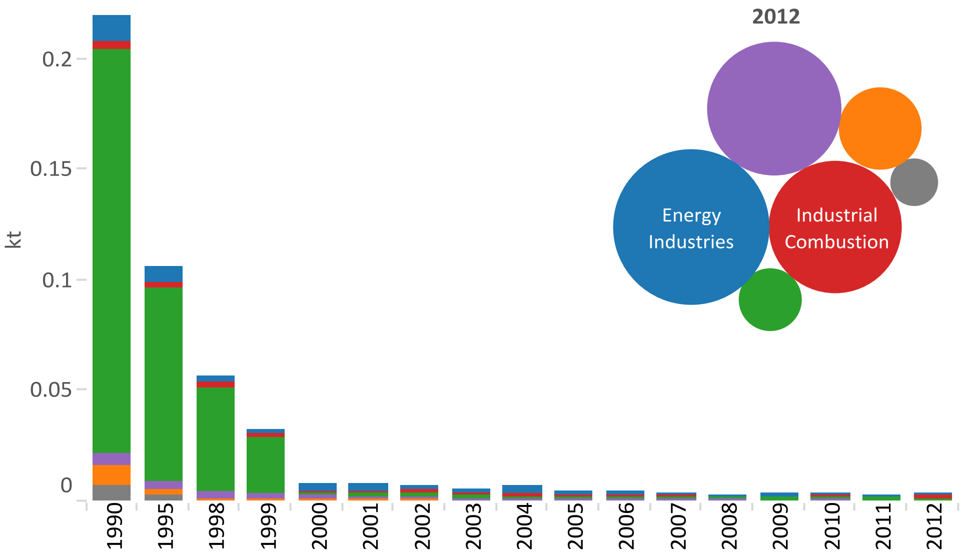


Figure 23 Scotland Lead Emissions by Sector, 1990-2012



The following figures provide a graphical visualisation of emissions for all seven pollutants.

Figure 24 Scotland Ammonia Emissions, 2012

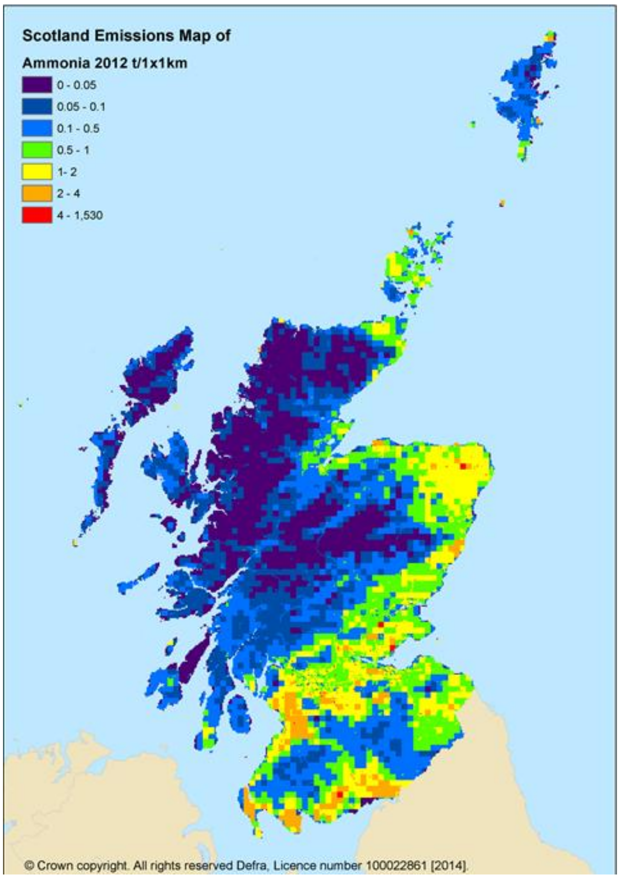


Figure 25 Scotland Carbon Monoxide Emissions, 2012

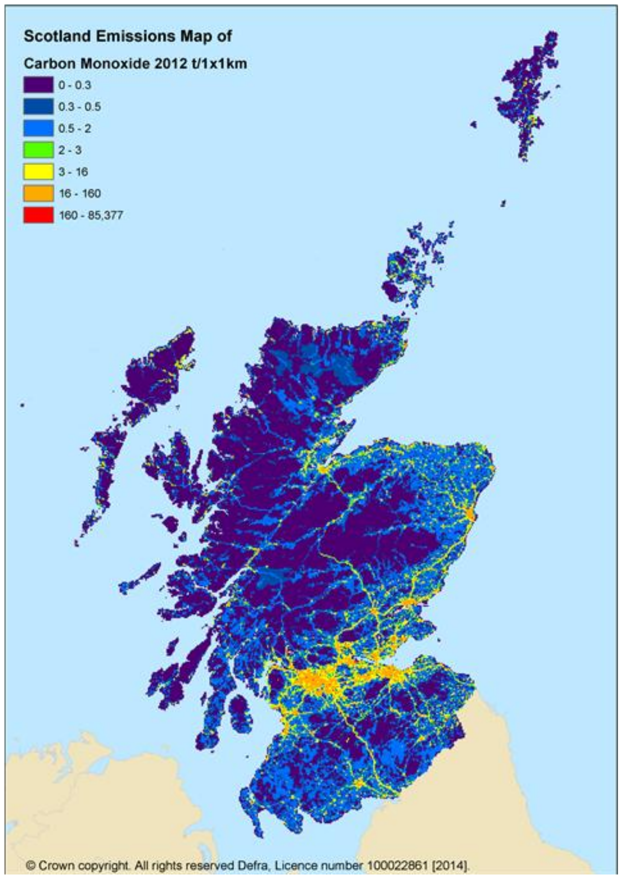


Figure 26 Scotland Nitrogen Oxides Emissions, 2012

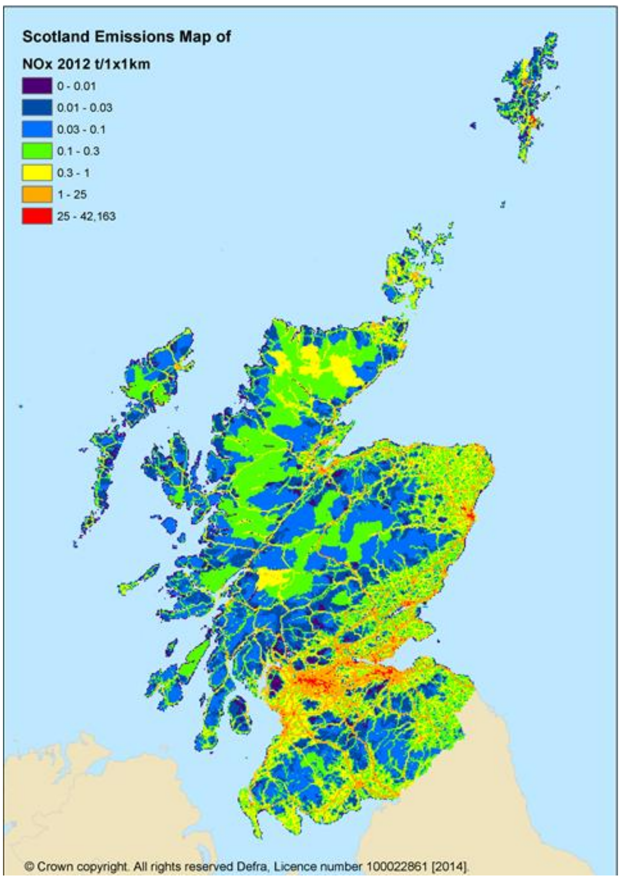


Figure 27 Scotland NMVOC Emissions, 2012

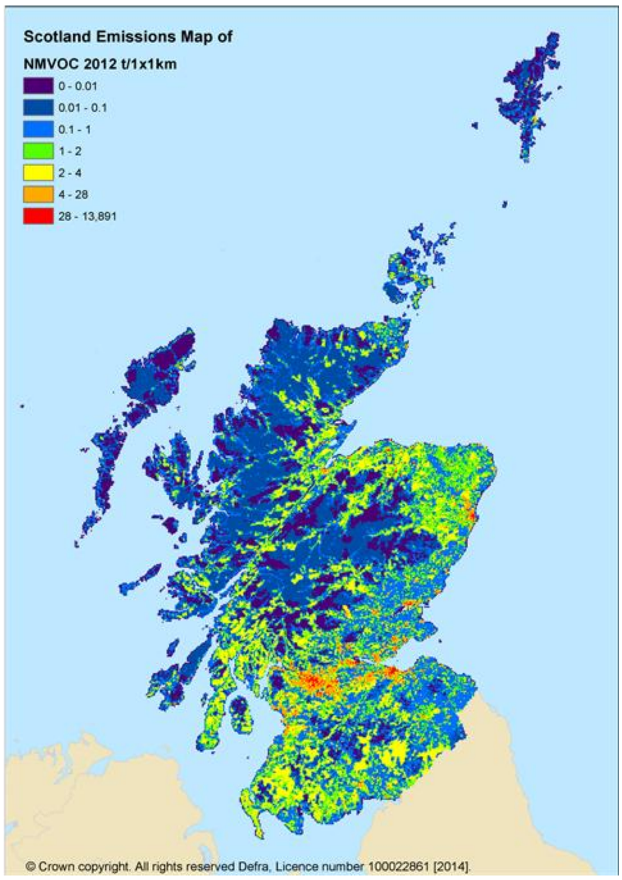


Figure 28 Scotland PM_{10} Emissions, 2012

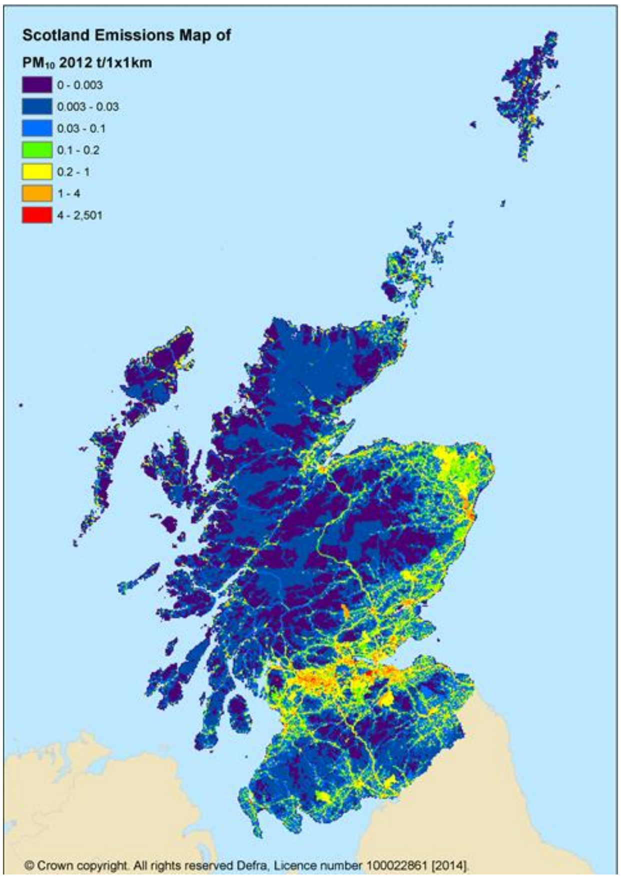


Figure 29 Scotland Sulphur Dioxide Emissions, 2012

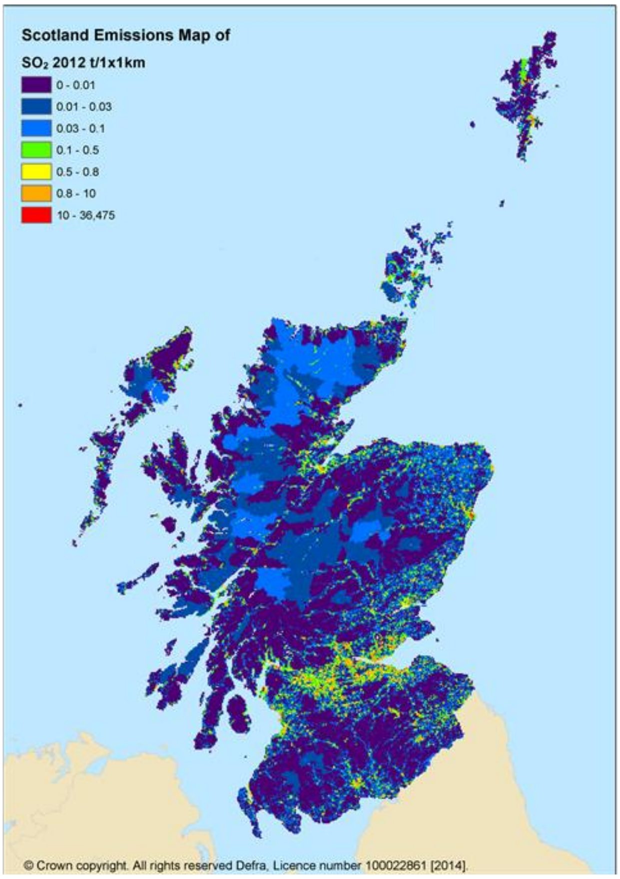
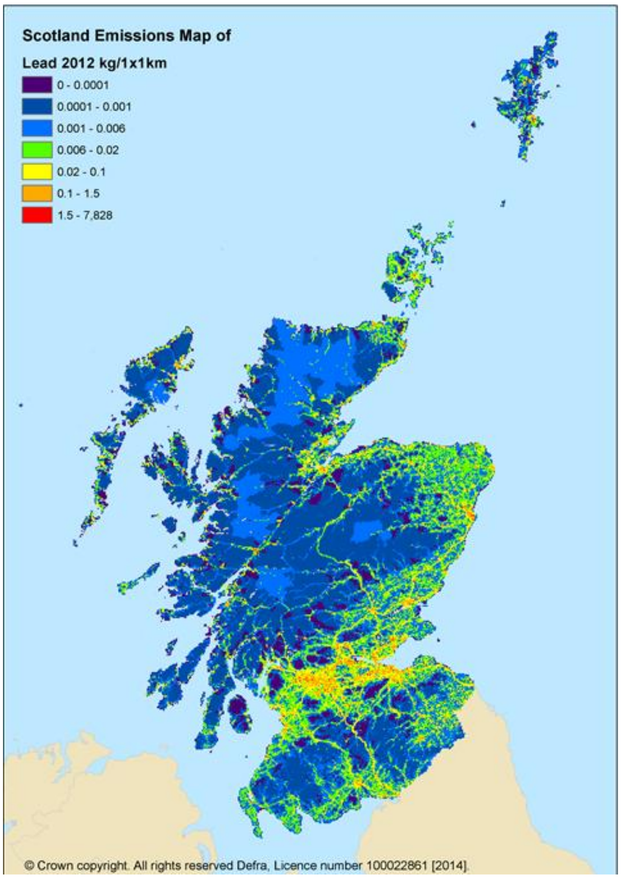


Figure 30 Scotland Lead Emissions, 2012

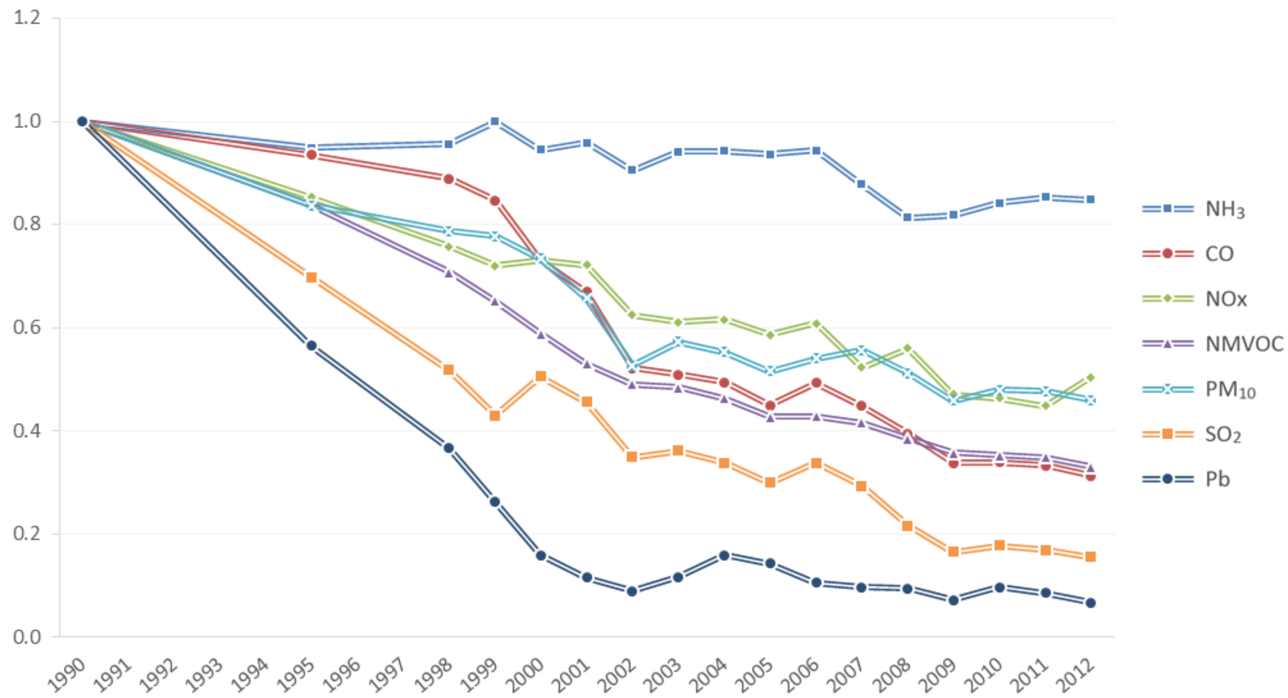


2.3. Wales

Figure 31 shows that emissions of all seven air quality pollutants have declined since 1990. The rate at which they have declined is relatively similar for PM_{10}, NOx, 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. Ammonia (NH_3) emissions, by contrast, have declined at a slower rate than other pollutants.

Figures 32 – 38 provide data on the trends of each pollutant split by sector, Table 4 summarises the percentage contribution of each sector for each pollutant. Figures 39 – 45 provide a geographical representation of the emissions for each pollutant.

Figure 31 Normalised trends for all pollutants, Wales (1990-2012)



The following information provides a summary of emissions in Wales for each pollutant. Figures 32 – 38 support this information.

Emissions of **ammonia** were estimated to be 25kt in 2012. These emissions have declined by 15% since 1990 and account for 9% of the UK total in 2012. Agricultural sources dominate the inventory with manure management representing 62% of total ammonia emissions in 2012, and 52% coming from cattle manure management alone. Ammonia emissions have increased in recent years, with a 4.8% increase between 2008 and 2011 driven primarily by increasing emissions from fertiliser application, composting and biogas production via anaerobic digestion.

Emissions of **carbon monoxide** were estimated to be 205kt in 2012 and have declined by 69% since 1990. Wales' emissions account for 10% of the UK total. In 2012, 16% of emissions stemmed from road transport combustion sources, whilst in 1990 this sector accounted for 48% of total emissions. This is the most significant factor in the 69% decline and is due to a number of reasons 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. Industrial process emissions from the iron and steel sector are now the most significant contributor to total emissions, accounting for 39% in 2012. Since 2008, there has been a reduction in the emissions from passenger cars, mainly driven by improvement in catalyst repair rates.

Emissions of **nitrogen oxides** were estimated to be 88kt in 2012, representing 8% of the UK total in 2012. Emissions have declined by 50% since 1990, with 20% of emissions in 2012 stemming from road transport combustion sources and 42% from power generation. The main source of the decline in emissions is the road transport sector, which has declined due to a number of reasons including the requirement for new petrol cars to be fitted with three-way catalysts since 1989.In more recent years, "EURO standards" for new cars have driven a reduction in emissions. Since 2008, there has been a general reduction in the emissions from passenger cars, mainly driven by improvement in catalyst repair rates. Energy sector emissions have varied across the time series and recent trends have followed the consumption levels of coal, which increased in 2006, 2008 and 2012.

Emissions of **non-methane volatile organic compounds** were estimated to be 47kt in 2012, representing 6% of the UK total in 2012. Emissions have declined by 67% since 1990. This reduction is dominated by the 96% reduction in road transport emissions since 1990. This is due to a number of reasons 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.

Emissions of **PM_{10}** were estimated to be 9kt in 2012 and have declined by 54% since 1990. They account for 8% of the UK total. 35% of emissions came from commercial, domestic and agricultural combustion in 2012. Emissions from power generation accounted for 14% of total emissions in 1990 but have reduced to 7% of the total in 2012. This is primarily due to the reduction in coal fired energy generation, which has been replaced by gas, which has negligible particulate matter emissions. Other factors include a reduction in emissions from the residential sector due to the restriction of the use of coal for domestic combustion through the Clean Air Act.

Emissions of **sulphur dioxide** were estimated to be 29kt in 2012, representing 7% of the UK total in 2012. Emissions have declined by 84% since 1990, which has been dominated by the 94% reduction in power generation due to the installation of FGD (flue-gas desulphurization) plant at a coal-fired power station 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.

Emissions of **lead** were estimated to be 9.7 tonnes in 2012. Emissions have declined by 93% since 1990 and accounted for 16% of the UK total in 2012. The decline is dominated by the 118 tonnes reduction in transport sources due to the phase-out of leaded petrol. The Industrial Processes sector accounted for 73% of 2012 emissions with the iron and steel sector accounting for 68% alone.

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 commercial, domestic and agricultural combustion sector is the most significant sector when considering emissions from all pollutants. This sector accounts for nearly 25% or over of emissions for two pollutants: CO and PM_{10}.

The majority of the top five sectors are to do with 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 2012

Overall Rank	Sector	NH_3	CO	NO_X	NMVOC	PM_{10}	SO_2	Pb
1	Commercial, domestic and agricultural combustion	1.30%	22.56%	7.55%	7.96%	35.25%	12.32%	6.66%
2	Industrial Processes	0.24%	38.80%	2.22%	4.30%	19.22%	12.76%	73.10%
3	Transport Sources	1.60%	17.05%	25.76%	5.29%	15.99%	3.30%	1.10%
4	Industrial Combustion	0.00%	13.78%	13.20%	3.13%	5.84%	15.18%	8.42%
5	Energy Industries	0.00%	4.28%	50.25%	0.00%	10.23%	52.75%	4.31%
6	Agriculture	85.73%	0.00%	0.00%	15.91%	8.57%	0.00%	0.00%
7	Fugitive	0.00%	2.90%	0.00%	21.65%	0.47%	2.94%	5.82%
8	Other *	6.74%	0.63%	1.02%	1.33%	2.52%	0.74%	0.59%
9	Solvent Processes	0.00%	0.00%	0.00%	35.88%	1.90%	0.00%	0.00%
10	Waste	4.39%	0.00%	0.00%	4.55%	0.00%	0.00%	0.00%
	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.

Figures 39 – 45 provide the trend of each pollutant disaggregated by sector. The most recent year (2012) is also presented as a bubble diagram for pollutants with a considerable declining trend since 1990. This enables the user to identify the sectors present in the inventory in 2012. These graphs support the descriptive text provided above.

Legend for all graphs

- Energy Industries
- Industrial Combustion
- Transport Sources
- Commercial, domestic and agricultural combustion
- Fugitive
- Industrial Processes
- Agriculture
- Solvent Processes
- Waste
- Other

Figure 32 Wales Ammonia Emissions by Sector, 1990-2012

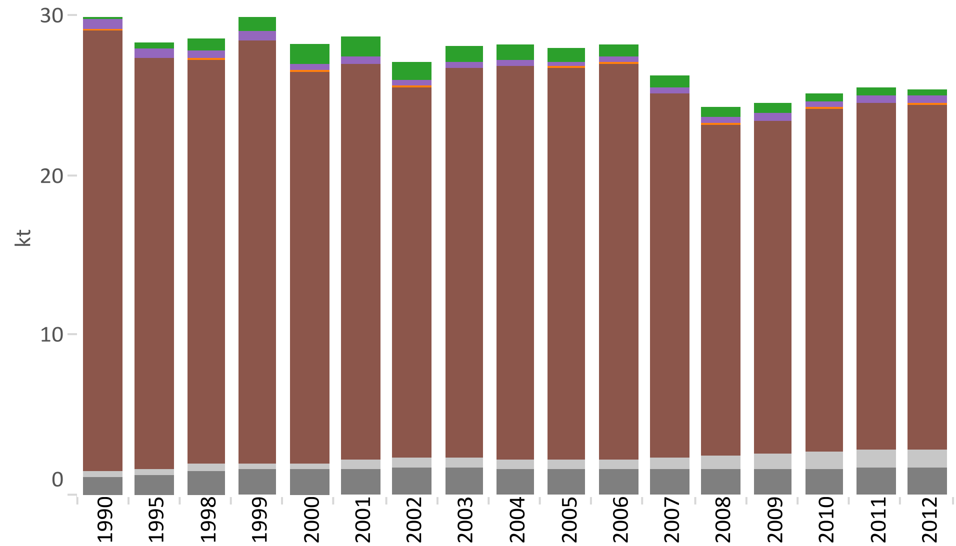


Figure 33 Wales Carbon Monoxide Emissions by Sector, 1990-2012

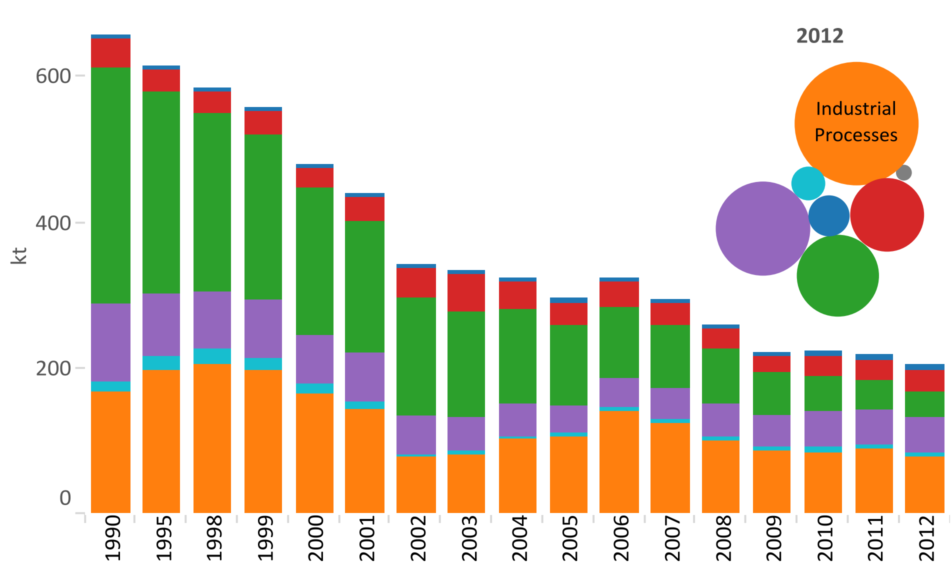


Figure 34 Wales Nitrogen Oxides Emissions by Sector, 1990-2012

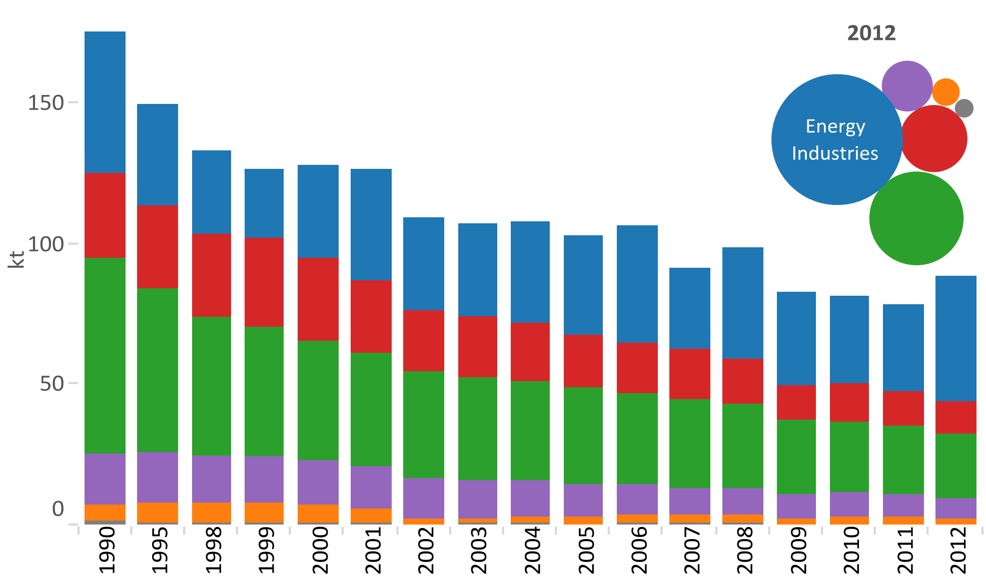


Figure 35 Wales NMVOC Emissions by Sector, 1990-2012

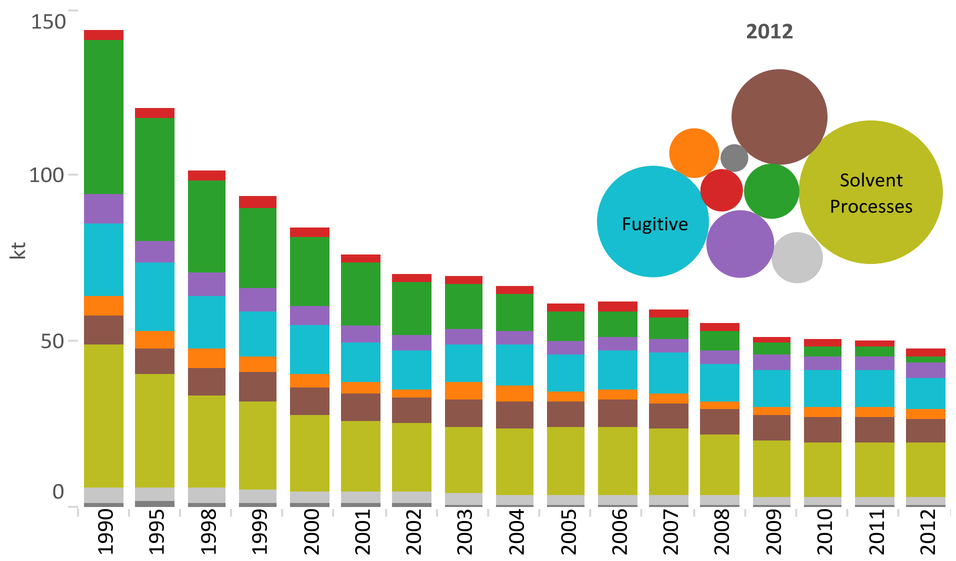


Figure 36 Wales PM_{10} Emissions by Sector, 1990-2012

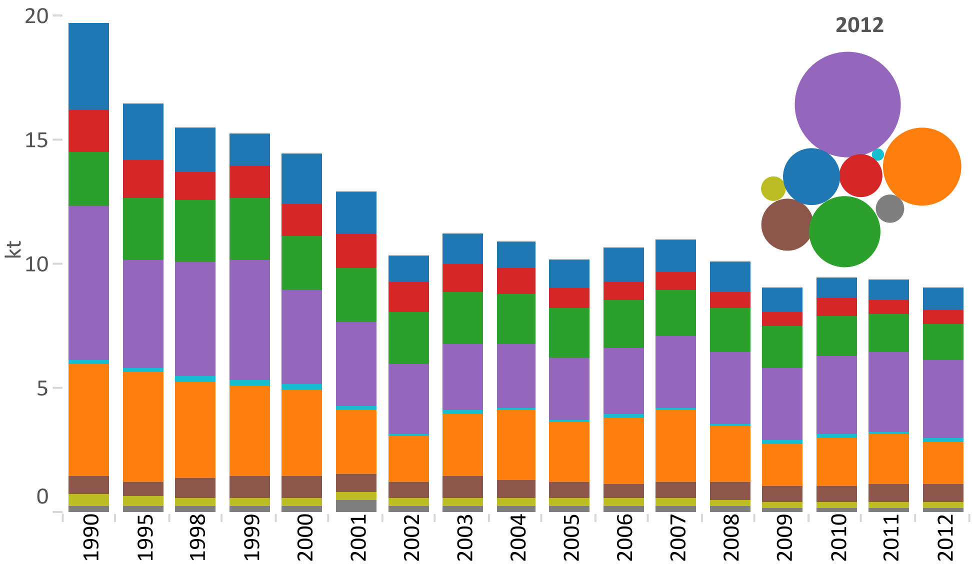


Figure 37 Wales Sulphur Dioxide Emissions by Sector, 1990-2012

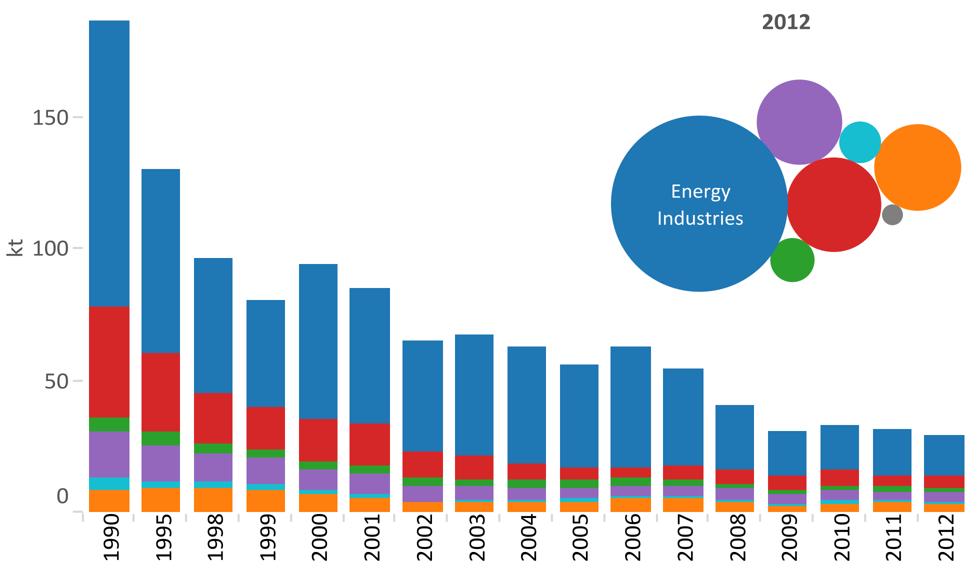
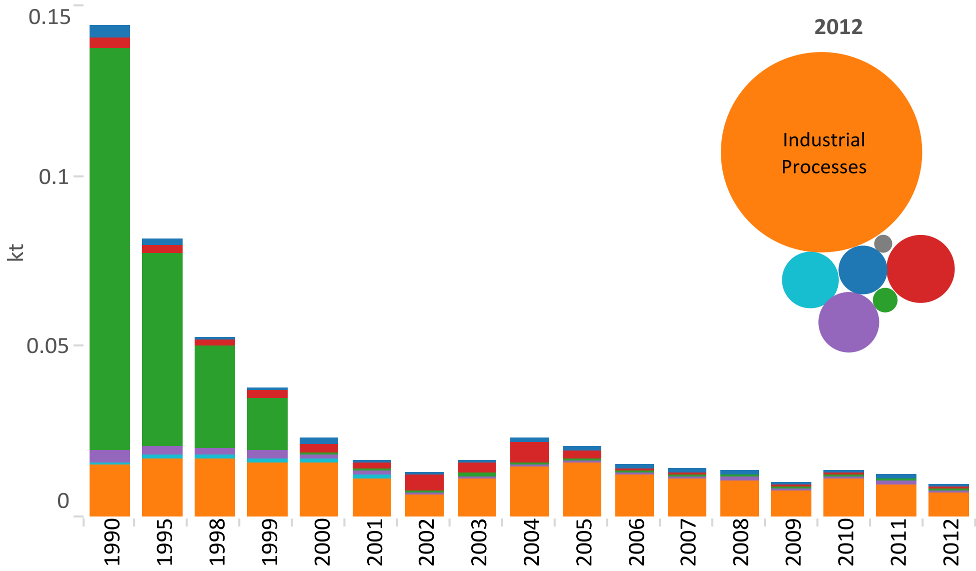


Figure 38 Wales Lead Emissions by Sector, 1990-2012



The following figures provide a graphical visualisation of emissions for all seven pollutants.

Figure 39 Wales Ammonia Emissions, 2012

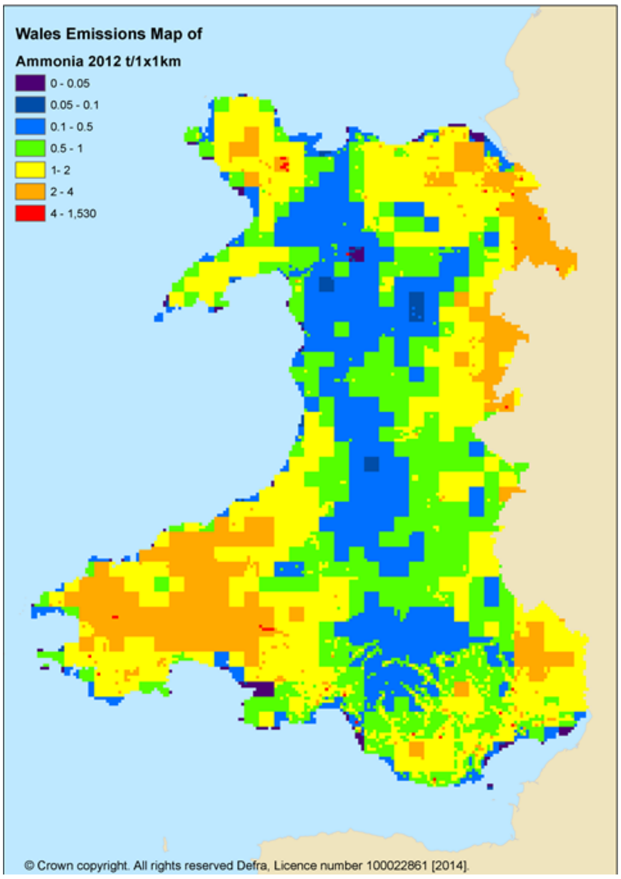


Figure 40 Wales Carbon Monoxide Emissions, 2012

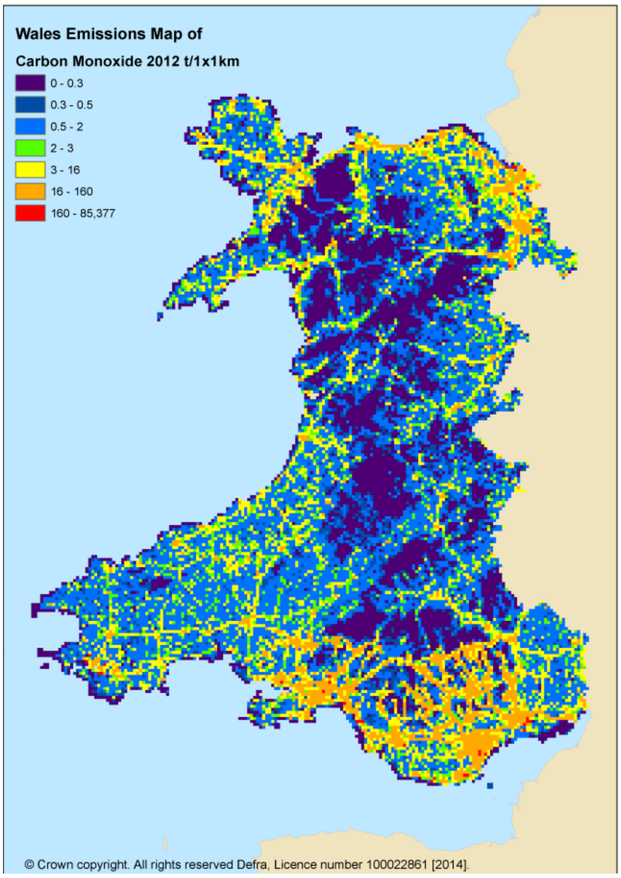


Figure 41 Wales Nitrogen Oxides Emissions, 2012

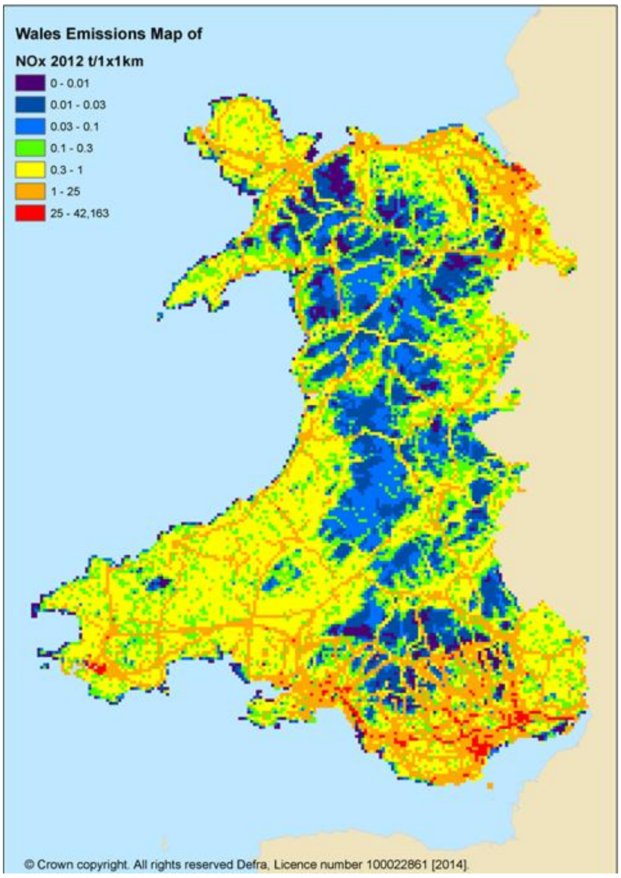


Figure 42 Wales NMVOC Emissions, 2012

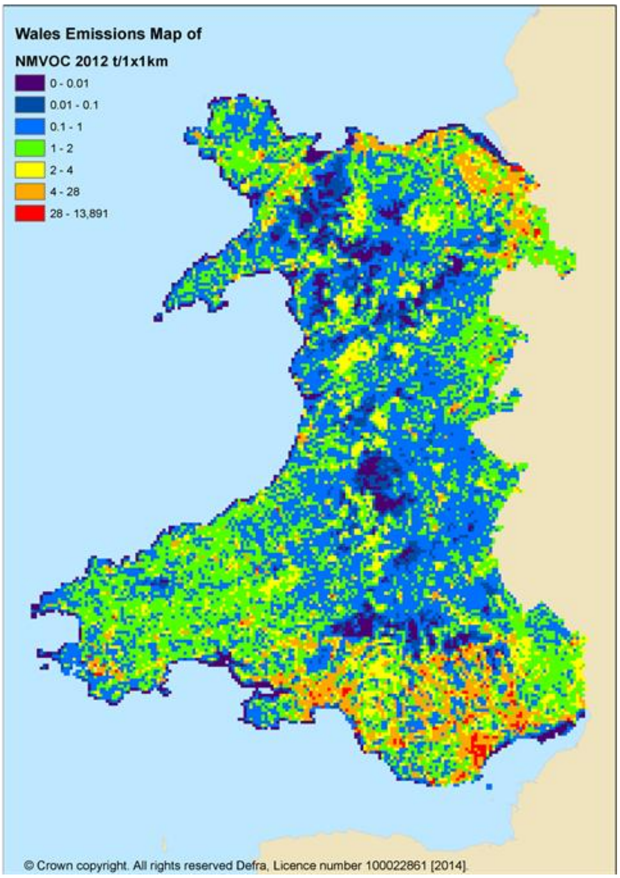


Figure 43 Wales PM_{10} Emissions, 2012

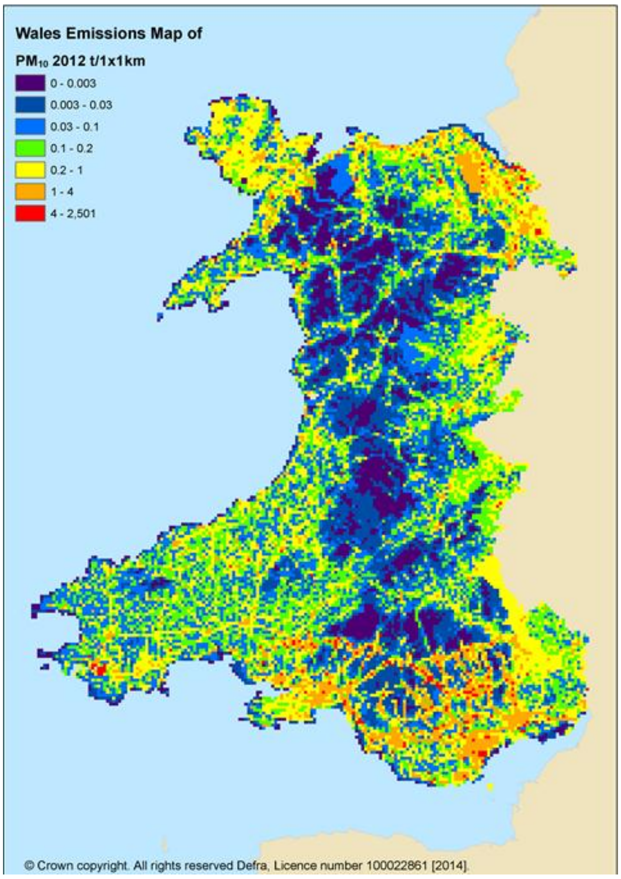


Figure 44 Wales Sulphur Dioxide Emissions, 2012

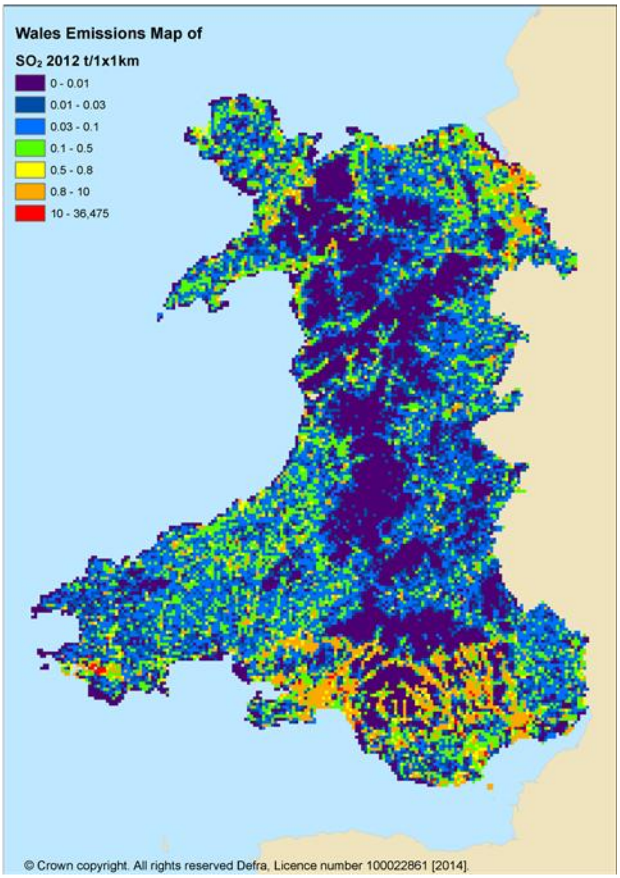
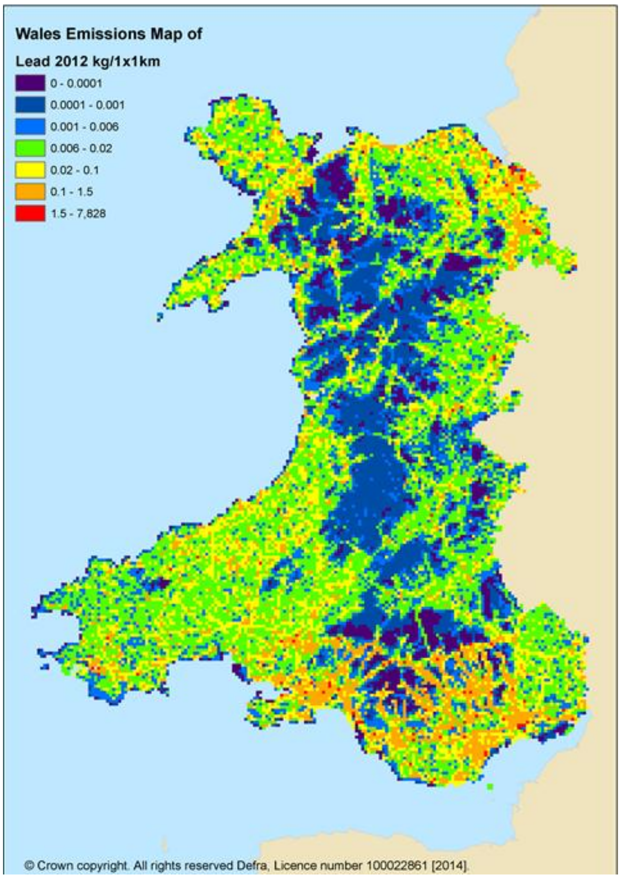


Figure 45 Wales Lead Emissions, 2012

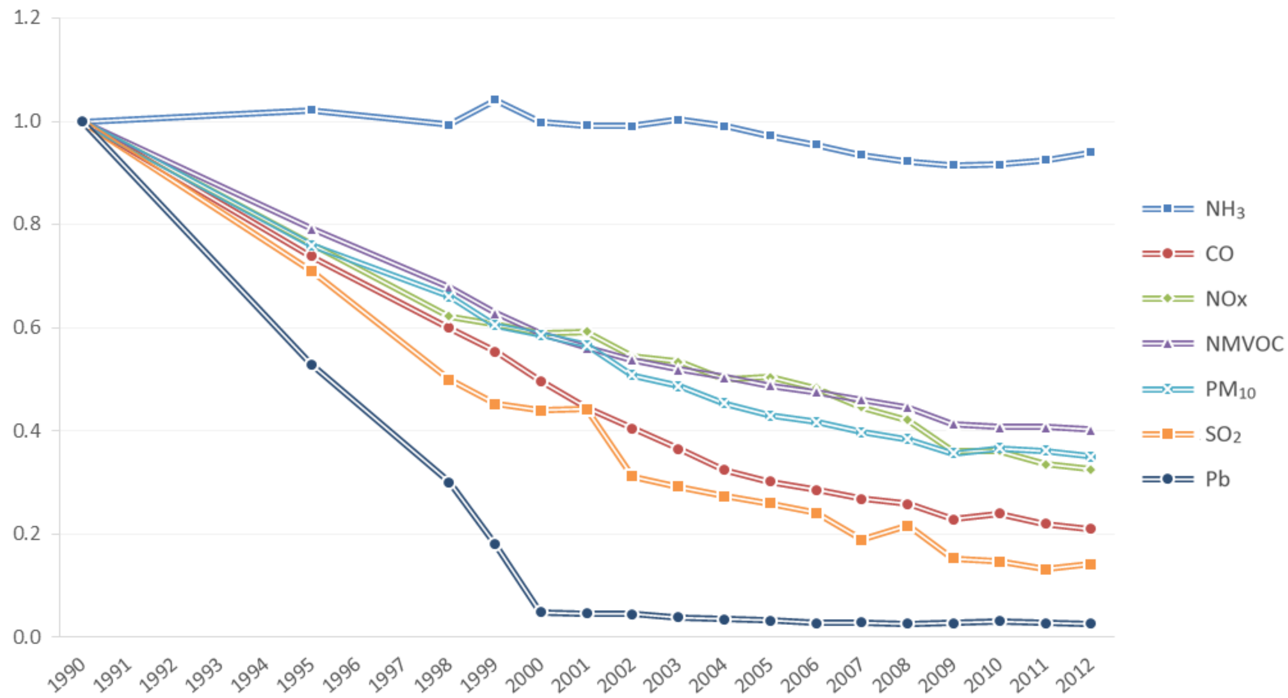


2.4. Northern Ireland

Figure 46 shows that emissions of all seven air quality pollutants have declined since 1990. The rate at which they have declined is relatively similar for PM_{10}, NOx, 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. Ammonia (NH_3) emissions, by contrast, only reached levels that were consistently lower than 1990 estimates in 2004.

Figures 47 – 53 provide data on the trends of each pollutant split by sector. Table 5 summarises the percentage contribution of each sector for each pollutant. Figures 54 – 60 provide a geographical representation of the emissions for each pollutant.

Figure 46 Normalised trends for all pollutants, Northern Ireland (1990-2012)



The following information provides a summary of emissions in Northern Ireland for each pollutant. Figures 47 – 53 support this information.

Emissions of **ammonia** were estimated to be 29kt in 2012. These emissions have declined by 6% since 1990 and account for 11% of the UK total in 2012. Agricultural sources dominate the inventory with manure management representing 79% of total ammonia emissions in 2012, and 62% coming from cattle manure management alone. Ammonia emissions have increased in recent years, with a 2.7% increase between 2009 and 2012 driven, primarily, by increasing emissions from manure management of cattle farming, but also by emissions from composting and biogas production via anaerobic digestion.

Emissions of **carbon monoxide** were estimated to be 75kt in 2012 and have declined by 79% since 1990. Northern Ireland’s emissions account for 4% of the UK total. In 2012, 26% of emissions stemmed from road transport combustion sources, whilst in 1990 this sector accounted for 48% of total emissions. This is the most significant factor in the overall decline and is due to a number of reasons 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, there has been a reduction in the emissions from passenger cars, mainly driven by improvement in catalyst repair rates.

Emissions of **nitrogen oxides** were estimated to be 32kt in 2012, representing 3% of the UK total in 2012. Emissions have declined by 67% since 1990, with 35% of emissions in 2012 stemming from road transport combustion sources and 18% from power generation. These are the two main sources of the decline in emissions since 1990. Transport emissions have declined due to a number of reasons including the requirement for new petrol cars to be fitted with three-way catalysts since 1989.In more recent years, “Euro standards” for new cars have driven a reduction in emissions, although studies show that the diesel Euro 5 cars have not performed as well as expected. Since 2008, there has been a general reduction in the emissions from passenger cars, mainly driven by improvement in catalyst repair rates. Energy sector emissions have declined due to the introduction of abatement technology and, in more recent years, the increasing use of renewables.

Emissions of **non-methane volatile organic compounds** were estimated to be 30kt in 2012, representing 4% of the UK total in 2012. Emissions have declined by 60% since 1990. This reduction is dominated by the 97% reduction in road transport emissions since 1990. This is due to a number of reasons 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.

Emissions of **PM_{10}** were estimated to be 5kt in 2012 and have declined by 65% since 1990. They account for 5% of the UK total. 35% of emissions came from commercial, domestic and agricultural combustion in 2012, and this sector is the main reason for the decline. Emissions from this sector have reduced by 77% since 1990 due to a reduction in emissions from the residential sector because of the restriction of the use of coal for domestic combustion through the Clean Air Act.

Emissions of **sulphur dioxide** were estimated to be 16kt in 2012, representing 4% of the UK total in 2012. Emissions have declined by 86% since 1990, which has been dominated by the 96% reduction in power generation due to the installation of FGD (flue-gas desulphurization) at coal-fired power stations 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.

Emissions of **lead** were estimated to be 2.0 tonnes in 2012. Emissions have declined by 97% since 1990 and accounted for 3% of the UK total in 2012. The decline is dominated by the 67 tonnes reduction in transport sources due to the phase-out of leaded petrol. The Industrial combustion sector accounted for 55% of 2012 emissions.

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 commercial, domestic and agricultural combustion sector is the most significant sector when considering emissions from all pollutants. This sector accounts for over 25% of emissions for four pollutants: CO, Pb, PM_{10} and SO_2.

The majority of the top five sectors are to do with 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 2012

Overall Rank	Sector	NH_3	CO	NO_X	NMVOC	PM_{10}	SO_2	Pb
1	Commercial, domestic and agricultural combustion	0.41%	44.17%	19.71%	8.20%	35.34%	52.69%	30.43%
2	Transport Sources	1.07%	27.62%	42.45%	4.09%	16.92%	2.81%	3.34%
3	Industrial Combustion	0.00%	24.63%	17.56%	2.03%	8.91%	25.41%	55.14%
4	Agriculture	93.57%	0.00%	0.00%	39.31%	26.69%	0.00%	0.00%
5	Energy Industries	0.00%	2.39%	18.39%	0.00%	1.93%	18.19%	5.37%
6	Industrial Processes	0.01%	0.02%	0.00%	7.66%	5.91%	0.08%	3.98%
7	Other *	2.46%	1.14%	1.88%	0.60%	2.68%	0.82%	1.73%
8	Solvent Processes	0.00%	0.00%	0.00%	31.58%	1.62%	0.00%	0.00%
8	Waste	2.48%	0.00%	0.00%	3.69%	0.00%	0.00%	0.00%
10	Fugitive	0.00%	0.03%	0.00%	2.84%	0.00%	0.00%	0.00%
	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.

Figures 47 – 53 provide the trend of each pollutant disaggregated by sector. The most recent year (2012) is also presented as a bubble diagram for pollutants with a considerable declining trend since 1990. This enables the user to identify the sectors present in the inventory in 2012. These graphs support the descriptive text provided above.

Legend for all graphs

- Energy Industries
- Industrial Combustion
- Transport Sources
- Commercial, domestic and agricultural combustion
- Fugitive
- Industrial Processes
- Agriculture
- Solvent Processes
- Waste
- Other

Figure 47 Northern Ireland Ammonia Emissions by Sector, 1990-2012

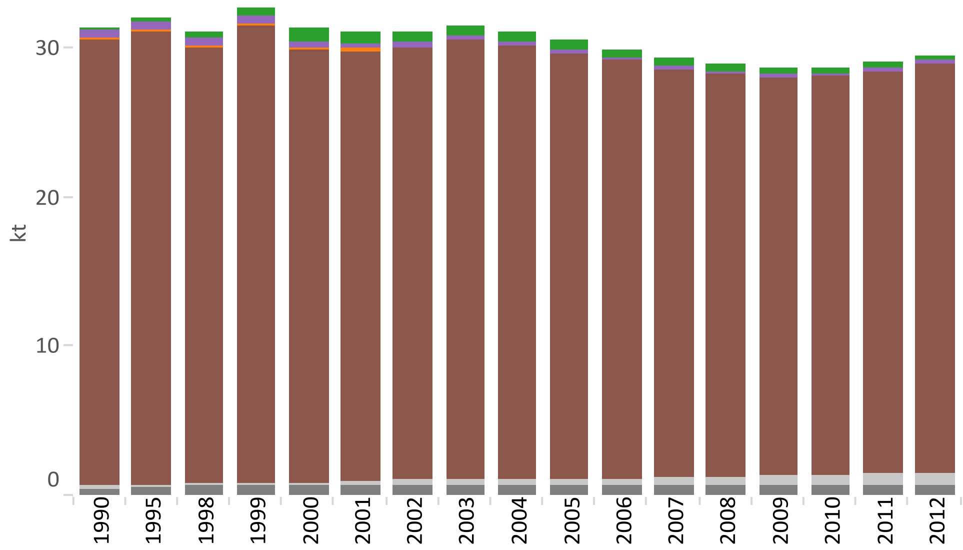


Figure 48 Northern Ireland Carbon Monoxide Emissions by Sector, 1990-2012

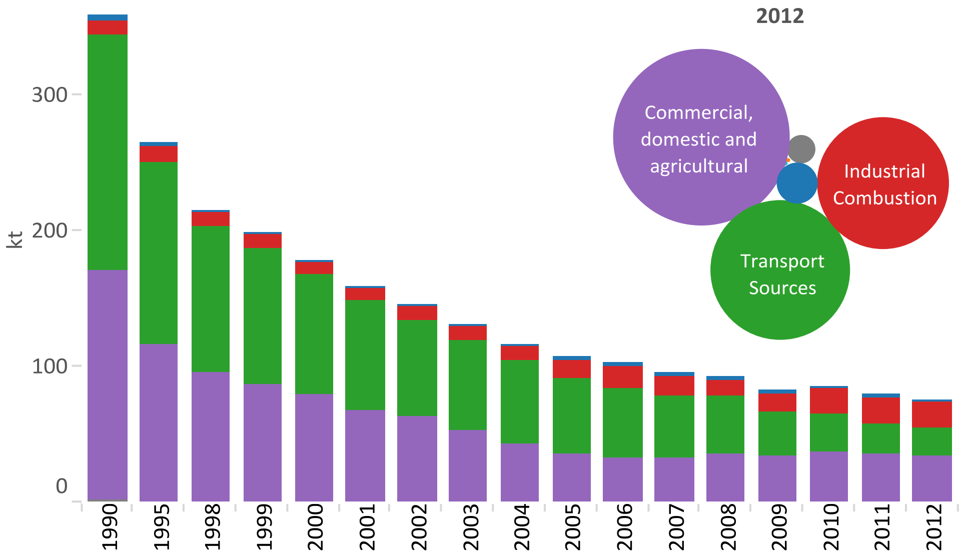


Figure 49 Northern Ireland Nitrogen Oxides Emissions by Sector, 1990-2012

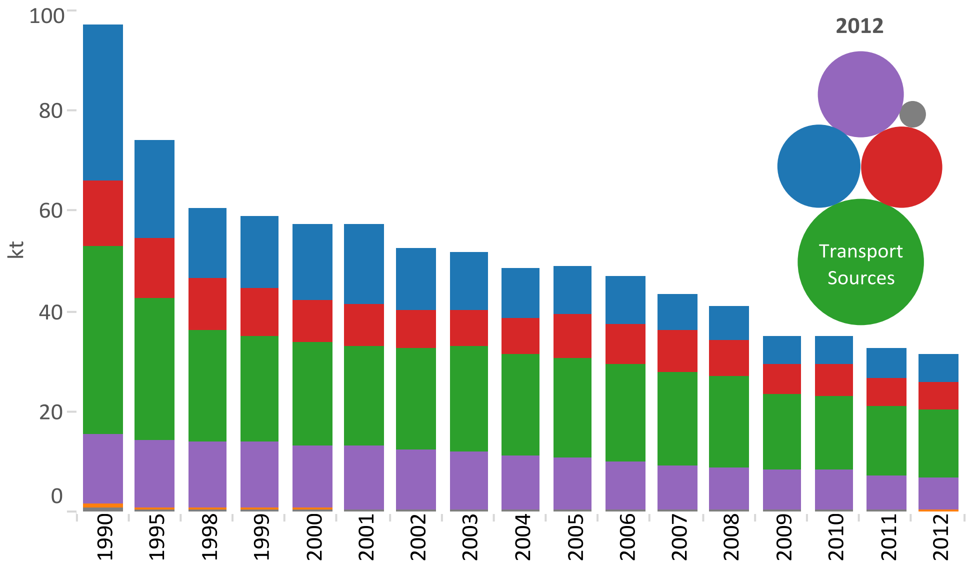


Figure 50 Northern Ireland NMVOC Emissions by Sector, 1990-2012

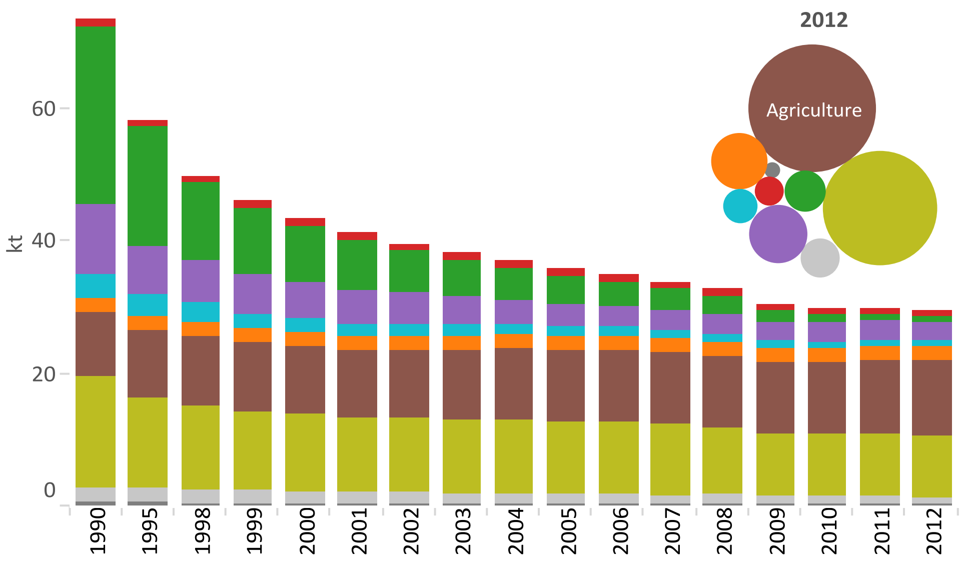


Figure 51 Northern Ireland PM_{10} Emissions by Sector, 1990-2012

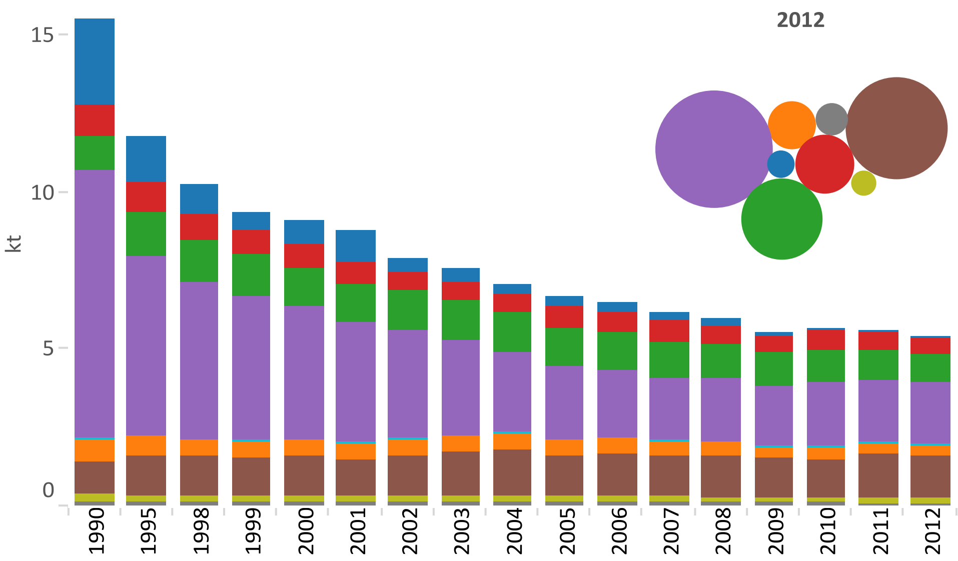


Figure 52 Northern Ireland Sulphur Dioxide Emissions by Sector, 1990-2012

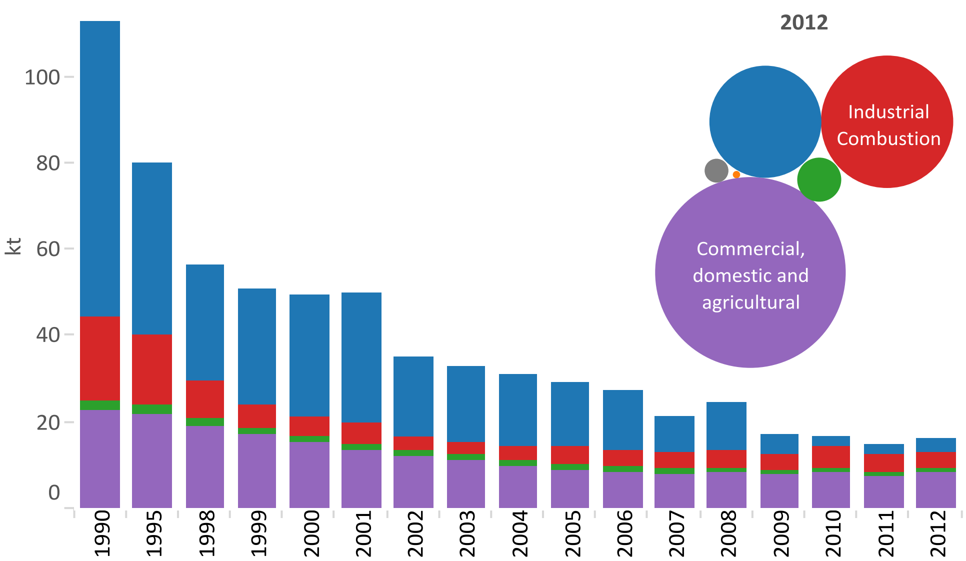
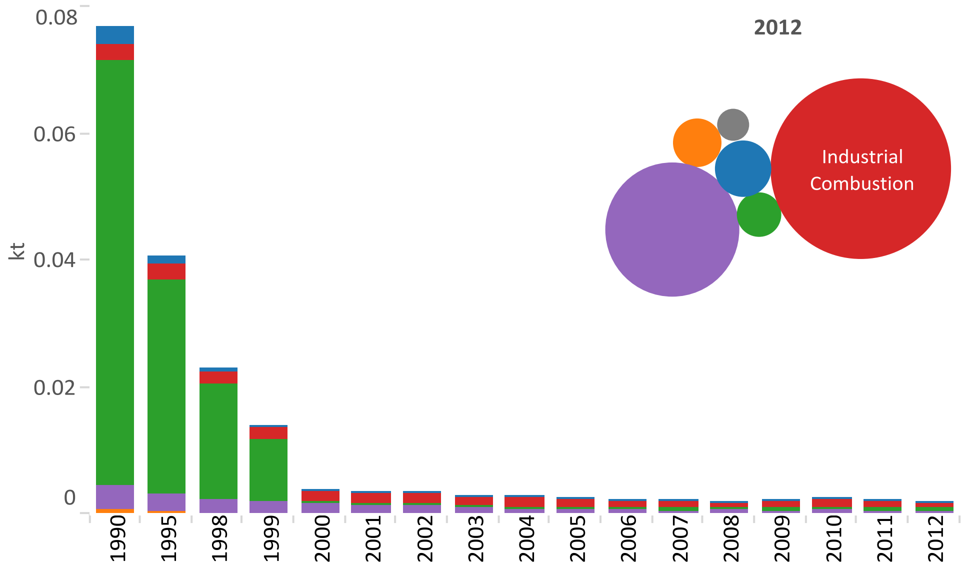


Figure 53 Northern Ireland Lead Emissions by Sector, 1990-2012



The following figures provide a graphical visualisation of emissions for all seven pollutants.

Figure 54 Northern Ireland Ammonia Emissions, 2012

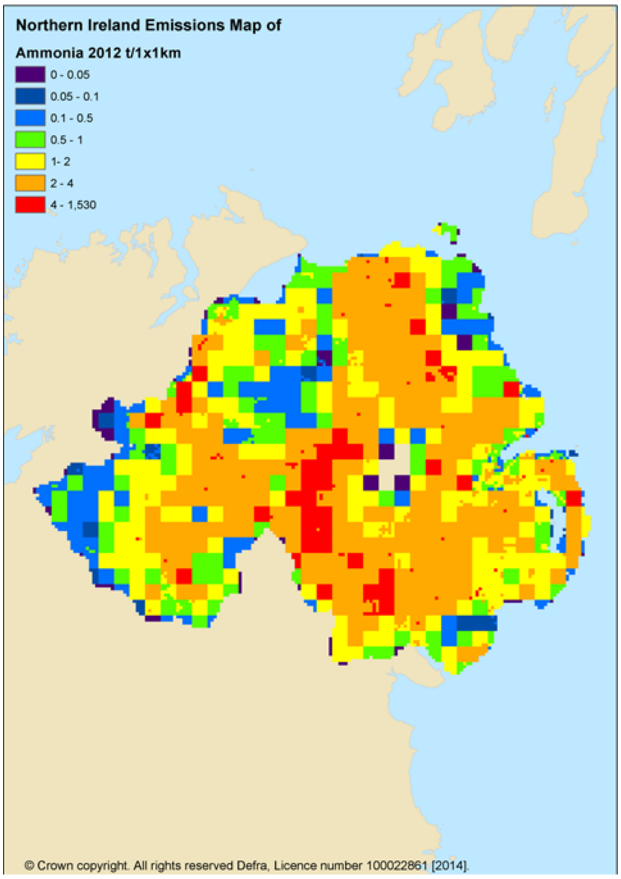


Figure 55 Northern Ireland Carbon Monoxide Emissions, 2012

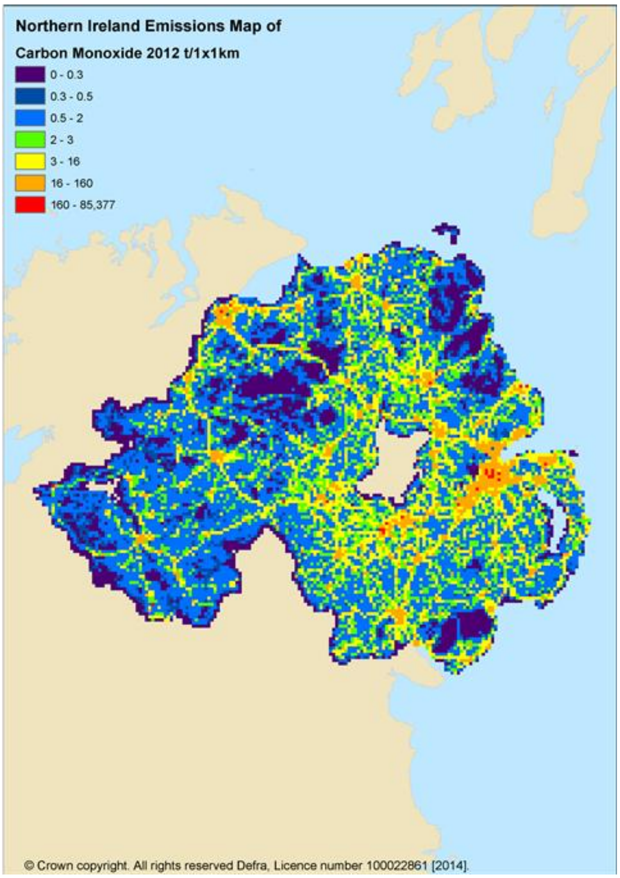


Figure 56 Northern Ireland Nitrogen Oxides Emissions, 2012

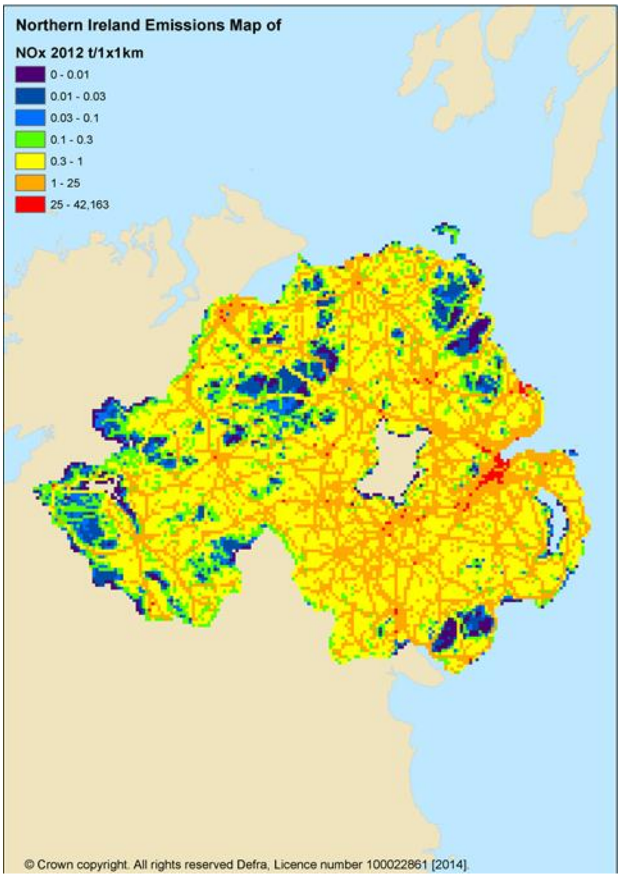


Figure 57 Northern Ireland NMVOC Emissions, 2012

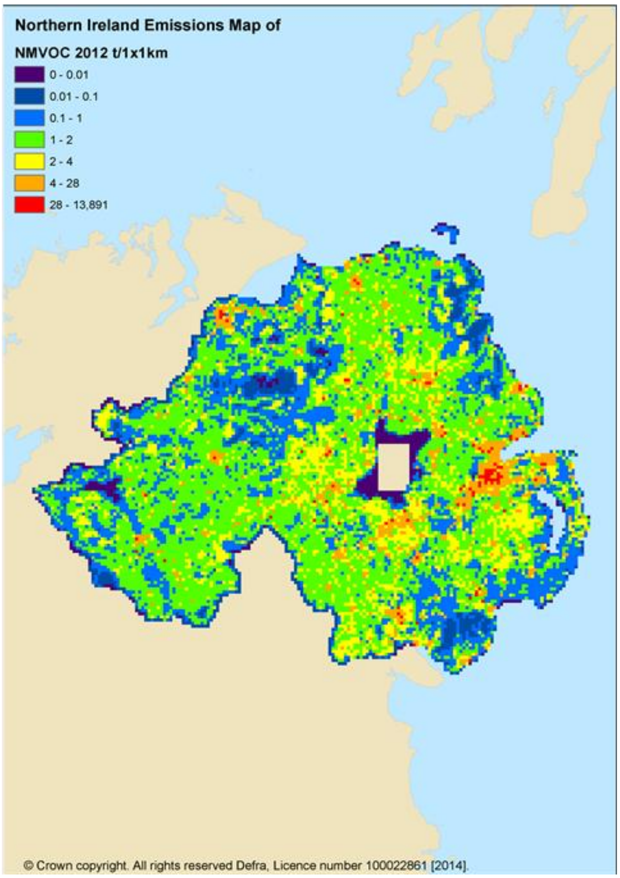


Figure 58 Northern Ireland PM_{10} Emissions, 2012

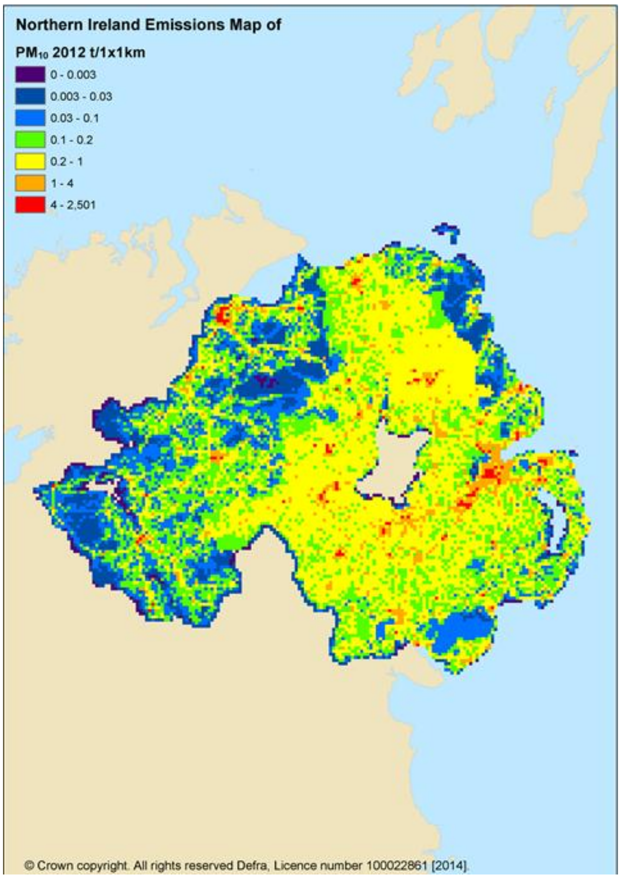


Figure 59 Northern Ireland Sulphur Dioxide Emissions, 2012

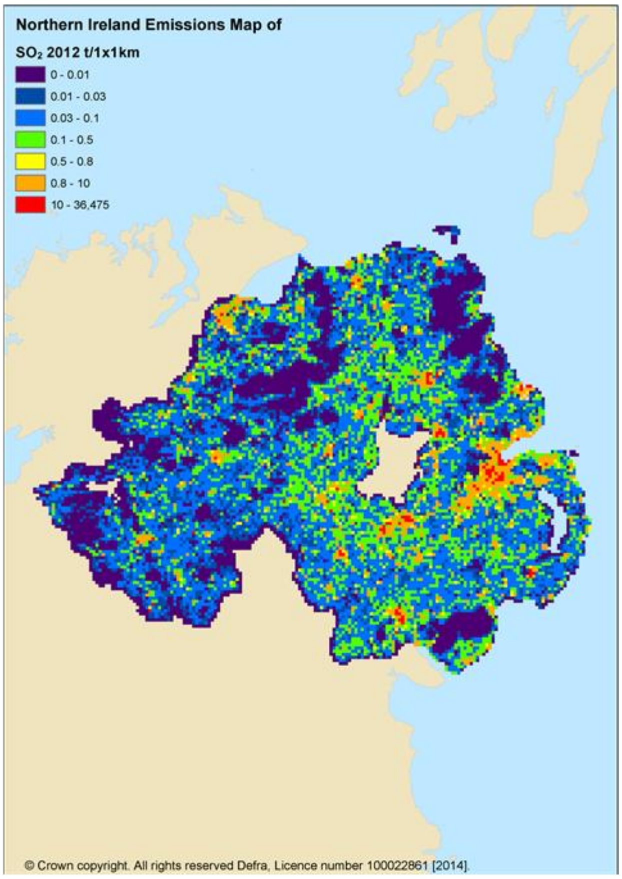
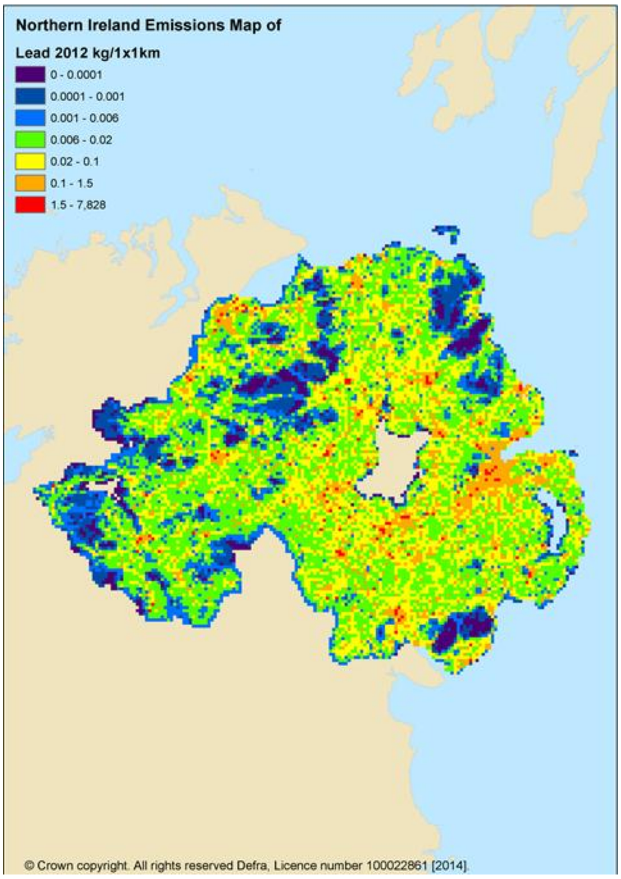


Figure 60 Northern Ireland Lead Emissions, 2012



2.5. Per Capita Emissions

Emissions per capita have been calculated for each of the Devolved Administrations and a brief summary of the findings is described below:

- Across all DAs, for all pollutants, per capita emissions have fallen between 1990 and 2012.
- The most notable decrease (in percentage terms) is for lead, with a decrease of more than 90% across all of the DAs.
- In England, per capita emissions are lower than the UK average for all pollutants in 2012.
- In Northern Ireland, ammonia emissions per capita are over three times the UK average in 2012. This is due to the very high contribution of emissions from agriculture, relative to the rest of the UK; Northern Ireland accounted for 11% of UK ammonia emissions, compared with just 3% of the UK population.
- Scottish NMVOC emissions per capita are approximately two times the UK average in 2012, mainly due to the high contribution of emissions from the food and drink industry.
- Welsh emissions are considerably higher than the UK average for NMVOC, NO_x, PM_{10}, SO_2, and most notably for Pb and CO. This is predominantly due to the contribution of iron and steel industry emissions to the Welsh total.

Appendix A About the Air Quality Pollutants

The following sections provide further information on the seven pollutants in the Devolved Administrations' air quality pollutant inventory. This includes information on the main sources of the pollutant and an explanation of the general trends seen since 1990. This information supports Section 1 of the inventory. For further information, please refer to the UK Informative Inventory Report (IIR) (NR Passant et al., 2014).

A.1 Ammonia

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.

The main source of ammonia emissions in the UK is livestock manure management, and in particular cattle manure management. These emissions derive mainly from the decomposition of urea in animal wastes and uric acid in poultry wastes. Emissions from nitrogen fertiliser use on grassland and arable crops are also a significant source and included in the ammonia inventory.

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. Estimates 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 Webb and Misselbrook (2004) for manure management sources and Misselbrook et al. (2004) for fertiliser sources, with annual revisions to input data, emission factors and other parameters as described in the annual Informative Inventory Report.

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. Emissions from road transport (although relatively insignificant compared to agricultural emissions) increased in the 1990s as a result of the increasing number of three way catalysts in the vehicle fleet. However, emissions are now falling as the second generation of catalysts (which lead to lower ammonia emissions than first generation catalysts) penetrates the vehicle fleet.

A.2 Carbon Monoxide

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.

The decline in carbon monoxide emissions since 1990 has been driven by reductions in emissions from a number of sources, including road transport, agricultural field burning and the domestic sector. The decrease is dominated by the reduction in emissions from the road transport sector, caused by the increased use of three-way catalysts in cars; this trend is evident for all DAs.

Other sources of carbon monoxide emissions are small compared with transport and off-road sources. Industrial combustion emissions have decreased, reflecting fuel switching from solid fuels to gas, similar to the domestic sector. The increase between 2009 and 2010 reflects the cold weather experienced in 2010.

A.3 Nitrogen Oxides

Across the UK, emissions of oxides of nitrogen (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.

The main three combustion sources of NO_X are:

- **Transport sources** – since 1990 there has been a steady decline in emissions due to the introduction of catalytic converters on cars and stricter regulations on truck emissions. Since 2008 there has been a general reduction in the emissions from passenger cars which was mainly driven by improvement in catalyst repair rates[2]. This was due to the introduction of the Regulations Controlling Sale and Installation of Replacement Catalytic Converters and Particle Filters for Light Vehicles for Euro 3 (or above) LDVs after June 2009. Recent evidence has shown that diesel Euro 5 cars exceed their type approval limit for NO_x in real-world operation and this has been reflected in the emission factors provided in the 2013 EMEP/EEA Emission Inventory Guidebook (which has been incorporated into the UK 2012 inventory).

- **Power generation** (part of Energy Industries) – since 1988 the electricity generators have adopted a programme of progressively fitting low-NO_X burners to their 500 MWe (megawatt electric) or larger coal fired units. More recently the increased use of nuclear generation and the introduction of CCGT (Combined Cycle Gas Turbine) plant burning natural gas have further reduced NO_X emissions. The emissions from the low-NO_X turbines used are much lower than those of pulverised coal fired plant even when low-NO_X burners are fitted. An additional factor has been the recent retrofitting of Boosted Over Fire Air (BOFA) systems to reduce NO_X formation and ensure compliance with the Large Combustion Plant Directive.
- **Industrial combustion** – emissions from industrial combustion have declined since 1990, and this is primarily due to the decline in coal use in favour of gas and electricity.

A.4 Non-Methane Volatile Organic Compounds

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. During the 1990s, industrial NMVOC emissions fell as a result of emission controls, technological changes, and reduced manufacturing output in some sectors. Emissions from the chemical industry reduced during the 1990s as tighter emission controls were introduced. Domestic solvent emissions have also fallen due to a trend towards formulating products such as paints and aerosols with lower solvent contents.

The Transport sector emissions declined significantly during the 1990s due to the increased use of catalytic converters and fuel switching from petrol to diesel cars. Between 2008 and 2009, emissions from passenger cars fell due to the assumed improvements in catalyst repair rates.

A.5 Particulate Matter as PM_{10}

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.

[2] A sensitive parameter in the emission calculations for petrol cars is the assumption made about the proportion of the fleet with catalyst systems that have failed, for example due to mechanical damage or failure of the lambda sensor. Following discussions with DfT, it is assumed that the failure rate is 5% per annum for all Euro standards, and that up to 2008 only 20% of failed catalysts were rectified properly, but those that were rectified were done so within a year of failing. The revisions are based on evidence on fitting of replacement catalysts. According to DfT there is evidence that a high proportion of replacement catalysts were not Type Approved and do not restore the emission performance of the vehicle to its original level (DfT 2009). This is being addressed through the Regulations Controlling Sale and Installation of Replacement Catalytic Converters and Particle Filters for Light Vehicles for Euro 3 (or above) LDVs after June 2009. Therefore a change in the repair rate is taken into account for Euro 3 and above petrol LDVs from mid-2009, assuming all failed vehicles are rectified properly.

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).

The main sources of primary PM_{10} are briefly described below:

- **Road transport** – diesel engines typically emit a greater mass of particulates per vehicle kilometre than petrol engines. Particulate emissions also arise from all vehicles through brake and tyre wear as well as from the re-entrainment of dust from road surfaces caused by vehicle movements, but estimates of particulate emissions from re-suspension are not included within UK inventory PM_{10} totals.
- **Stationary combustion** – coal combustion has historically been the main source of particulate emissions in the UK, but restrictions in the use of coal for domestic combustion through the Clean Air Act has led to other sources becoming more important nationally. Domestic coal is still a significant source in Northern Ireland, some smaller towns and villages, and in areas associated with the coal industry. Other fossil fuels emit PM_{10} with combustion of wood, gas oil and fuel oil all contributing significantly to emissions. In general, particles emitted from fuel combustion are of a smaller size than from other sources.
- **Industrial processes** – particulates are emitted from a wide range of industrial processes including: the production of metals, cement, lime, coke and chemicals, bulk handling of dusty materials, construction, mining and quarrying. Whilst emission monitoring results are now widely available for stack and other point-source, emissions of particulates from regulated industrial processes, the quantification of diffuse and fugitive emissions from industrial sources is more difficult. Few UK measurements are available for these fugitive releases, but there have been substantial improvements in the estimation of PM_{10} emissions from industrial processes in recent years.

Emissions from road transport have varied across the time-series as a number of factors have combined. The main source of road transport emissions is exhaust gases from diesel engines. Emissions from diesel vehicles have been growing due to the growth in heavy-duty vehicle traffic and the move towards more diesel cars. Since around 1992, however, emissions from diesel vehicles have been decreasing due to the penetration of new vehicles meeting tighter PM_{10} emission regulations ("Euro standards" for diesel vehicles were first introduced in 1992), while non-exhaust emissions from tyre and brake wear and road abrasion are increasingly more important.

Emissions from power stations have declined despite a significant growth in electricity generation capacity, due to a shift in the fuel mix for power generation from coal to natural gas, nuclear and renewable generation, and also due to abatement being fitted at coal-fired power stations. For example, the installation of flue gas desulphurisation (FGD) at a number of plants has reduced particulate matter emissions substantially.

Among the non-combustion and non-transport sources, the major emissions are from industrial processes, the most important of which is quarrying, whose emission rates have remained fairly constant. Other industrial processes, including the manufacture of steel, cement, lime, coke, and primary and secondary non-ferrous metals, are collectively important sources of particulate matter although emissions from individual sectors are relatively insignificant.

A.6 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, 2013a), sulphur contents of liquid fuels (UKPIA, 2013) and data from coal producers regarding sulphur contents of coals enable reliable estimates to be produced.

Emissions from combustion of petroleum products have fallen significantly due to the decline in fuel oil use and the reduction in the sulphur content of gas oil and DERV (diesel fuel specifically used for road vehicles). The reduced sulphur content of gas oil is particularly significant in sectors such as domestic heating, commercial heating and off-road sources where gas oil is used extensively.

The main combustion sources are:

- **Power generation** – historically, coal-fired stations have been the most important source, but the gradual change in fuel mix of UK power stations (to more nuclear and gas-fired plant) , the increasing number of CCGT stations, coal-fired stations being closed and FGD fitted to remaining coal-fired power plant is resulting in decreasing emissions from this sector.

- **Industrial Combustion** – emissions of SO_2 from industry result from the combustion of coal and oil, some refinery processes and the production of sulphuric acid and other chemicals. Emissions have fallen, primarily due to the decline in energy-intensive heavy industries such as iron and steel manufacturing. In addition, industry has gradually switched from coal and oil-based fuels in favour of natural gas, as it provides a cleaner, cheaper energy source.

In recent years, road transport emissions have accounted for less than 1% of the total SO_2 emissions. Previously, this source was more significant, but a tightening of fuel standards during the 1990s and more recently due to the EU Fuel Quality Directive and its amendments has led to a significant decline in emissions due to the reduction in the sulphur content of DERV. The reduction in the sulphur content of gas oil (to 0.1% by mass from January 2008 onwards) has also reduced emissions from off-road vehicles.

Emissions from the domestic, commercial and agricultural sector have also declined since 1990, reflecting the major changes in fuel mix from oil and coal to gas. Emissions from waste incinerators have reduced significantly during the 1990s due to the introduction of stricter emission standards forcing the closure of old-design incinerators and their replacement with more modern plant with improved abatement.

A.7 Lead

Since 1990, emissions of lead to air have declined significantly, with reductions in emissions 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.

There has also been some reduction in emissions from iron and steel production processes due to improved abatement measures. Emissions have also declined as a result of the decreasing use of coal.

Reductions in lead emissions can also be seen in the waste sector. Municipal Solid Waste (MSW) incinerators not meeting regulatory standards were closed in the period leading up to December 1996. Improved combustion and flue gas controls, and developments in abatement technology in modern incinerator design has resulted in emissions from waste incineration significantly declining.

Appendix B 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.

B.1 Air Quality Emission Reduction Drivers

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. COMEAP (2010) estimated the burden in the UK of anthropogenic particulate matter air pollution in 2008 as a loss of life expectancy from birth of approximately six months. The burden was also calculated as an effect on mortality in 2008 equivalent to nearly 29,000 deaths in the UK at typical ages and an associated loss of total population life of 340,000 life-years. A number of policies are currently in place in the UK, which aims to improve air quality. This includes the National Air Quality Strategy for England, Scotland, Wales and Northern Ireland.

B.1.1 Air Quality Strategy for England, Scotland, Wales and Northern Ireland

The original National Air Quality Strategy (NAQS) published in 1997 (DOE 1997) set out a framework of standards and objectives for the air pollutants of most concern (SO_2, PM_{10}, NO_X, CO, lead, benzene, 1, 3-butadiene and tropospheric ozone). The aim of the strategy was to reduce the air pollutant impact on human health by reducing airborne concentrations.

The NAQS identified air quality standards for eight priority pollutants based on the recommendations of the Expert Panel on Air Quality Standards (EPAQS, 1995) or World Health Organisation (WHO) guidance where no EPAQS recommendation existed. The NAQS has been subject to periodic review, with consultation documents being published in 1998 and 2001 (DETR 1998a, Defra 2001), and has subsequently evolved into the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS for ESWNI), with the same goals. A second edition of the strategy was published in 2000 (DETR 2000), identifying further revisions and focused on the incorporation of air quality limit values in European Directives, and the impacts of devolution. On 17 July 2007 a new Air Quality Strategy was published by Defra and the Devolved Administrations. The details of this AQS can be found on the Defra website[3].

The new Air Quality Strategy supersedes previous versions and covers the whole of the UK, therefore including DA-specific objective values that were previously detailed in addenda to the previous AQS.

B.1.2 EU Air Quality Framework Directive

The EU air quality framework directive (96/62/EC) established a framework for setting limit values, assessing concentrations and managing air quality to avoid exceeding the limits for air pollutants known to be harmful to human health and the environment through a series of four Daughter Directives. However, in 2008, the Framework Directive and first three Daughter Directives were consolidated in a new EU Air Quality Directive (2008/50/EC). The 4th Daughter Directive (2004/107/EC) is expected to be merged with the Air Quality Directive in the future.

At present, under 2008/50/EC and the 4th Daughter Directive, limit values are set for twelve pollutants, including NO_X, SO_2, PM and CO, and member states are required to submit annual reports to the European Commission on whether the limits have been achieved within their respective areas.

B.1.3 UNECE Convention on Long-Range Transboundary Air Pollution

The UK is committed to reducing acidifying gas and ozone precursor emissions and is a Party to several protocols under the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP).

Under the Second Sulphur Protocol, the UK committed to reducing its total sulphur dioxide emissions by 50% by 2000, 70% by 2005 and 80% by 2010 (all from a 1980 baseline).

The NMVOC Protocol requires the UK to achieve a 30% reduction of anthropogenic NMVOC emissions by 1999 from a 1988 baseline. The emission estimates given in the 1999 version of the emissions inventory indicated that this was achieved.

[3] https://www.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-2

The NO_X Protocol required that the total emissions of NO_X in 1994 should be no higher than they were in 1987; UK emissions were 11% lower in 1994 than in 1987 and have fallen substantially since 1994.

In 1996, the UNECE started negotiating a new multi-effect, multi-pollutant protocol on nitrogen oxides and related substances. This was 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, where it was signed by the UK. It incorporates several measures to facilitate the reduction of emissions:

- Emission ceilings are specified for sulphur, nitrogen oxides, ammonia and NMVOCs;
- 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 2005 levels) 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 commitment for $PM_{2.5}$. More detailed information on both of the Gothenburg protocol and the Convention may be found at the UNECE web site: www.unece.org/env/lrtap/.

B.1.4 National Emissions Ceilings Directive

Within the EU, the National Emission Ceilings Directive was agreed in 2001. It sets emission ceilings to be achieved from 2010 onwards for each Member State for the same four pollutants as in the Gothenburg Protocol. The UK has met current international targets to reduce total emissions by 2010 of four air pollutants that cause harm to people's health and to the natural environment: sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds and ammonia. More information on these ceilings can be found in a statistical release from Defra (2013).

The European Commission is currently preparing for a revision of the NECD containing a ceiling for 2020 or even 2030 for the four already regulated substances and primary emissions of $PM_{2.5}$ as part of the implementation of the European Commission's Thematic Strategy on Air Pollution.

B.1.5 Industrial Emissions Directive

In November 2005 the European Commission launched a review of European legislation on industrial emissions in order to ensure clearer environmental benefits, remove ambiguities, promote cost-effectiveness, and to encourage technological innovation. The general objective of the review was stated as `to evaluate the scope to improve the functioning of the Directive and its interaction with other legislation, in particular related to industrial emissions, while not altering the main underlying principles and the level of ambition set in the Directive'.

The review led to the commission proposing, on 21 December 2007, a recast Directive on Industrial Emissions (IED). This proposal, which was accompanied by an impact assessment, involved the coalescing of seven existing directives into one namely:

- the Large Combustion Plant directive (LCPD);
- the Integrated Pollution Prevention and Control directive (IPPCD);
- the Waste Incineration directive (WID);
- the Solvent Emissions directive (SED); and
- the three existing directives on Titanium dioxide on (i) disposal (78/176/EEC), (ii) monitoring and surveillance (82/883/EEC) and (iii) programs for the reduction of pollution (92/112/EEC).

In June 2009, Member States reached political agreement on the draft proposal. In June 2010, following further discussions between the Council and the European Parliament, a final draft of the proposal was agreed which was subsequently ratified during a vote at the full session of the European Parliament.

On 8 November 2010, the European Council ratified the proposal. Following publication in the Official Journal of the European Union on 17 December 2010, the directive (2010/75/EU) came into force on 6 January 2011.

B.1.6 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.

B.1.7 UNECE Heavy Metals Protocol

The Convention on Long-range Transboundary Air Pollution was signed in 1979 and came into force in 1983. Since its entry into force, the Convention has been extended by a number of protocols, including the 1998 Protocol on Heavy Metals. This Protocol is given in outline below; more information may be found at the UN/ECE web site, located at: http://www.unece.org/env/lrtap/. The UK has signed this protocol.

The UNECE Protocol on Heavy Metals 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 required 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.

Appendix C 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 1.2 of the main report.

The disaggregation of air quality (AQ) pollutant emissions across the four Devolved Administrations of the UK has been conducted five times previously and this report presents the results from a programme of on-going data and methodology improvement, to provide emission inventories for the Devolved Administrations (DAs). This programme spans both GHG and AQ emission inventories, and is driven by the developing requirements for sub-national reporting against emission targets and DA policy development.

C.1 Data Availability

For many emission sources of AQ 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. For this reason, a "top-down" approach using UK inventory data as the core dataset has been adopted, and percentage splits of the UK total have been derived for each of the constituent countries using available regional data.

In particular, energy balance data (i.e. fuel production, transformation and sector-specific consumption data) are not available for England, Scotland and Wales. Sub-national energy statistics are published annually by the Department for Energy and Climate Change (DECC) within the quarterly Energy Trends publication (DECC 2013b). 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 and Wales as well as Northern Ireland for the following combustion source sectors: industry, commercial, agriculture (combustion sources) and domestic.

The DECC sub-national energy statistics have been developed in recent years to provide estimates of fuel use and CO_2 emissions data at Local Authority (LA) level across the UK. The latest available data include LA solid and liquid fuel use estimates for 2005 to 2011, with gas and electricity data also being available up to 2012.

The DECC data at local and regional level are derived from analysis of gas and electricity meter point data, supplemented by additional research to estimate the distribution of solid fuels and petroleum-based fuels across the UK. Since the initial study and presentation of experimental data for 2003 and 2004, each annual revision to the local and regional data has included data improvements through targeted sector research. These DECC sub-national energy statistics continue to evolve and improve, reducing data inaccuracies, and are the best data available to inform the patterns of fuel use across the Devolved Administrations. They are therefore used to underpin the pollutant emission estimates from fuel combustion sources within the inventories presented here, in conjunction with other data sources such as EU ETS fuel use data for large industrial sites and other DA-specific energy data.

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 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 (2013) in Aberdeen through the Environmental Emissions Monitoring System, EEMS. Note that 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 UK emission factors and annual survey data across each of the Devolved Administrations, including estimates of arable production and livestock numbers (Rothamsted Research, 2013).

- Emissions from **waste disposal activities** are estimated based on modelled emissions from the UK air quality inventory (Defra, 2012) 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 local 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.*, 2014).

In many source sectors, there is 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.

C.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 AQ pollutants which are used within inventory compilation, such that more recent data are likely to be more accurate. The uncertainties in the DA air quality inventories are discussed in more detail in Appendix E.

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

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

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

C.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 study) 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 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 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 (e.g. production data).

As part of the Devolved Administrations Inventory Improvement Programme, a research study was undertaken in early 2010 to source more detailed information on emissions sources at a number of petrochemical and industrial sites across the UK. The study included consultation with Environment Agencies responsible for each of the respective

Devolved Administrations and site visits to review further details of applications and reports submitted in relation to permitted activities.

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.

C.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. (2014).

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, Northern Ireland Environment Agency 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. For a more detailed description of the integration of point source data analysis and the development of UK emission maps, see the latest NAEI mapping methodology report available at the website given above (Tsagatakis et al., 2013).

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 we have endeavoured to focus 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 compiling the DA Air Quality Pollutant Inventories

NFR Sector	Source	Disaggregation Method
1A1a	Public electricity and heat production (all fuels)	All emissions 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 (2013a,b), SEPA (2013a,b), NIEA (2013a,b)
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 (2013).
1A1c	Coke & SSF production (all fuels)	Point source data provided by plant operators (see 1A1a). Regional iron & steel production and fuel use data (ISSB, 2013). UK fuel use data from DECC (2013a).
	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 (2013).
	Gas production, downstream network (all fuels)	EUETS installation data for natural gas use from 2005-2012. All other years estimated based on the DA share from the 2005 EUETS data. Environment Agency (2013a,b), SEPA (2013a,b), NIEA (2013a,b)
	Upstream oil & gas, including gas separation plant (all fuels)	DECC Offshore Inspectorate (2013) 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 (2013).
	Iron & steel combustion plant (all fuels)	Regional iron & steel production and fuel use data (ISSB, 2013) used to inform estimates to 2004. 2005 onwards derived from activity data from EU ETS.
1A2b	Combustion in non-ferrous metals manufacturing industry	Emissions analysis for 2012: Pollution Inventory (EA 2013a, SEPA 2013a, NIEA 2013a), EU ETS (EA 2013b, SEPA 2013b, NIEA 2013b) IDBR and employment data (ONS, 2013). Overall analysis of the 1A2b,c,d,e and f sectors used to constrain the DA totals to previous 1A2 DA estimates, using 1A2f Other Industry as residual. Detailed analysis conducted for 2008-2012; 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. (See above – method for 1A2b,c,d,e and f integrated.)
1A2c	Combustion in chemical manufacturing industry	
1A2d	Combustion in paper, pulp and print manufacturing industry	
1A2e	Combustion in food processing, beverages and tobacco manufacturing industry	
1A2f	Refractory & ceramic production	Regional GDP data (ONS, 2013).
	Autogenerators (coal)	All emissions in England.
	Lime, cement, brick and ammonia production (all fuels)	Point source data from plant operators (see 1A1a). All lime production and ammonia production in England.
	Other industrial combustion (oils)	Sub-national energy statistics, DECC (2013b), and analysis of point source data derived from EU ETS and IPPC data. Environment Agency (2013a,b), SEPA (2013a,b), NIEA (2013a,b). Overall analysis of the 1A2b,c,d,e and f sectors used to constrain the DA totals to previous 1A2 DA estimates, using 1A2f 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 (2013), Northern Gas Networks (2013), Scotia Gas Networks (2013), Wales & West Utilities (2013), Airtricity (2013), Firmus Energy (2013), Vayu (2013), Energia (2013). Sub-national energy statistics, DECC (2013b), and analysis of point source data derived from EU ETS and IPPC data. Environment Agency (2013a,b), SEPA (2013a,b), NIEA (2013a,b).
	Industrial off-road machinery (all fuels)	Sub-national energy statistics (DECC, 2013b) and DA GDP data (ONS, 2013).
1A3ai (i)	Aircraft – international take-off and	CAA (2013), UK airport statistics. All take-off and landing cycle emissions for each flight

NFR Sector	Source	Disaggregation Method
	landing (all fuels)	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 (2012) Composition of fleet: Vehicle Licensing Statistics Report, DfT (GB) Dept. of Regional Development (NI). Traffic data: National Traffic Census, DfT (England, Scotland, Wales: 1990-2012) 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- 2012) Fuel consumption: Digest of UK Energy Statistics (1990-2012),
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 (1990-2012)
1A3dii	Coastal shipping (gas oil, fuel oil)	Port movement data, DfT (2013b) Maritime Statistics.
1A3eii	Aircraft support vehicles (gas oil)	Regional aircraft movements, DfT (2013d)
1A4a	Railways – stationary combustion	Sub-national energy statistics, DECC (2013b)
	Industrial & commercial combustion	Sub-national energy statistics, DECC (2013b), 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 1A2f). PSEC data (DFPNI 2012) used to inform the N Ireland estimates.
	Public sector combustion	
1A4bi	Domestic combustion	For coal, anthracite, petroleum fuels, analysis is from sub-national energy statistics, DECC (2013b) and Housing Condition Survey data. Domestic peat combustion data from CEH (Personal communication, 2013). Gas use data provided by gas network operators (same references as 1A2f).
1A4bii	Household and gardening mobile machinery (all fuels)	Regional dwellings data, ONS (2013).
1A4ci	Agriculture – Stationary combustion	Agricultural employment data, Defra (2013a) used for allocation of solid and gaseous fuels. Regional energy statistics, DECC (2013b) 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, 2013b)
1A4ciii	Fishing vessels	Port movement data, DfT (2013b) Maritime Statistics
1A5b	Military aircraft and naval shipping	Regional GDP data (ONS, 2013).
1B1a	Deep-mined coal	Regional deep mine production, Coal Authority (2013). Emissions from closed coal mines derived from WSP report (Fernando, 2011)
1B1b	Coke & SSF production	Coal feed to coke ovens, ISSB, WS, DECC and (1999-2004) PI. 2005 onwards: EU ETS (EA 2013b, SEPA 2013b, NIEA 2013b)
	Iron & steel flaring	Coal feed to coke ovens, ISSB, WS, DECC and (1999-2004) PI. 2005 onwards: EUETS (EA

NFR Sector	Source	Disaggregation Method
		2013b, SEPA 2013b, NIEA 2013b)
1B2ai	Offshore oil & gas: offshore oil loading, well testing.	All emissions unallocated.
	Offshore oil & gas: process emissions, onshore oil loading, oil terminal storage	Emissions derived from the DECC Offshore Inspectorate (2013) 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 (2013) 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).
	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	Onshore gas production (gasification process emissions)	Point source data provided by plant operators (see 1A1a).
	Gas leakage from supply infrastructure	Leakage data provided by gas network operators: National Grid (2013), Northern Gas Networks (2013), Scotia Gas Networks (2013), Wales & West Utilities (2013), Airtricity (2013).
1B2c	Offshore oil & gas: flaring & venting	Emissions derived from the DECC Offshore Inspectorate (2013) EEMS point source dataset, with extrapolations back to cover 1990, 1995 where data gaps are evident.
	Refinery flaring	Point source data provided by plant operators (see 1A1a).
2A1	Cement decarbonising	Point source data provided by plant operators (see 1A1a).
	Concrete batching	Regional GDP data (ONS, 2013).
	Slag cement production	Slag cement production mapping grid
2A2	Lime production decarbonising	Point source data provided by plant operators (see 1A1a).
2A3	Limestone & dolomite use in: inter plant, glass production, and basic oxygen furnaces. FGD emissions from power stations.	Point source data provided by plant operators (see 1A1a).
2A4	Soda ash use in glass and chemical industries	Point source data provided by plant operators (see 1A1a).
2A7	Construction, asphalt manufacture	Regional GDP data (ONS, 2013).
	Quarrying (aggregates)	Quarries mapping grid.
	Glass industry process emissions	Point source data provided by plant operators and from EU ETS (see 1A1a).
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.
2B5	Ship purging	All emissions unallocated.
	Chemical industry process emissions	Point source data provided by plant operators (see 1A1a).
2C	Industrial process emissions from SMEs, hot & cold steel rolling emissions	Regional GDP data (ONS, 2013).
	Process emissions from: blast furnaces,	Point source data provided by plant operators (see 1A1a), plus supplementary data

NFR Sector	Source	Disaggregation Method
	EAFs, BOFs, primary aluminium production & anode baking, alumina production, non-ferrous metal processes	provided by Tata Steel (2013) and the ISSB (2013)
	Flaring & stockpile emissions at iron & steelworks	Regional iron & steel production and fuel use data (ISSB, 2013).
	Foundries	Foundries mapping grid
2D1	Paper production process emissions	Regional GDP data (ONS, 2013).
	Wood product process emissions	Wood coating mapping grid.
2D2	Cider & wine manufacture	All emissions are in England.
	Spirit manufacture	Spirits mapping grid
	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, sugar beet, malting.	Point source data provided by plant operators (see 1A1a).
3	Solvent use	Population data, ONS (2013).
3A	Trade & retail decorative paints,	Population data, ONS (2013).
	Industrial coatings: commercial vehicles, aircraft, agricultural and construction vehicles.	Regional GDP data (ONS, 2013).
	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, metal packaging, automotive, drum	Point source data provided by plant operators (see 1A1a).
3B	Domestic surface cleaning.	Population data, ONS (2013).
	Dry cleaning (solvent use)	Dry cleaning mapping grid
	Industrial surface cleaning	Industrial employment mapping distribution grid.
3C	Rubber & plastic products	Population data, ONS (2013).
	Leather coating and degreasing	Regional GDP data (ONS, 2013).
	Tyre manufacture and industrial coatings: textiles, film.	Point source data provided by plant operators (see 1A1a).
	Industrial coating manufacture: adhesives, inks, solvents and pigments	Various industry-specific coatings mapping distribution grids
3D	Industrial adhesives and solvent use, printing, aerosol and non-aerosol products (cosmetics & toiletries, household products, paint thinners),	Population data, ONS (2013).
	Printing – public gravure	Other printing mapping grid
	Road dressings	Road dressing mapping grid.
	Agrochemical use, wood impregnation	Various agricultural mapping distribution grids
	Seed oil extraction, paper coatings, and	Point source data provided by plant operators (see 1A1a).

NFR Sector	Source	Disaggregation Method
	some adhesive and printing processes.	
4B1	Manure management - cattle	Livestock data, via Rothamsted Research (2013) For NH_3, specific DA splits for manure management, based on regional emissions data for 1990, 1995, 2000-2012 provided by Rothamsted Research
4B3	Manure management – sheep and goats	Livestock data, via Rothamsted Research (2013) For NH_3, specific DA splits for manure management, based on regional emissions data for 1990, 1995, 2000-2012 provided by Rothamsted Research
4B6	Manure management – horses	Livestock data, via Rothamsted Research (2013)
4B8	Manure management – swine	Livestock data, via Rothamsted Research (2013) For NH_3, specific DA splits for manure management, based on regional emissions data for 1990, 1995, 2000-2012 provided by Rothamsted Research
4B9	Manure management – poultry	Livestock data, via Rothamsted Research (2013) For NH_3, specific DA splits for manure management, based on regional emissions data for 1990, 1995, 2000-2012 provided by Rothamsted Research
4B13	Manure management – domestic pets	2012 Mapping data from CEH (Dragosits U. et al., 2013) and population data, ONS (2013).
4D1	Use of domestic fertiliser & composting	Population data, ONS (2013). For NH_3, specific DA splits for fertiliser use, based on regional emissions data for 1990, 1995, 2000-2012 provided by Rothamsted Research
	Agricultural soil emissions	Rothamsted Research (2013), livestock data and fertiliser application data. For NH_3, specific DA splits for agricultural soils, based on regional emissions data for 1990, 1995, 2000-2012 provided by Rothamsted Research
4F	Field burning of agricultural wastes	Field burning estimates, via Rothamsted Research (2013)
6A	Landfills, benzoles & tars	Regional landfill MSW disposal data (www.wastedataflow.org), combined with DA-specific landfill model developed by the Defra Waste team (Defra, 2012b).
6B	Sewage sludge decomposition	Population data, ONS (2013).
6C	Clinical waste incineration, small-scale waste burning	Population data, ONS (2013).
	Incineration: MSW, crematoria, sewage sludge, chemical waste	Point source data provided by plant operators (see 1A1a).
	Foot & mouth pyres	Data on livestock disposal, NAO (2002).
6D	Other waste (including composting and biogas production)	Population data, ONS (2013).
7	Cigarettes, fireworks & bonfires	Population data, ONS (2013).

C.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, 2012), other gas network operators, the Coal Authority (Coal Authority, 2012) and the Department of Energy and Climate Change (DECC, 2012b). 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 2010. 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, 2012) database of flight movements, fuel use data (DECC), aircraft fleet information (CAA, 2012) 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, 2012), (ISSB, 2012).
- Site-specific emissions data split by combustion and process sources for all **UK refineries**, and refinery production capacities (UKPIA, 2012).
- Site-specific cement production capacities and UK-wide **cement industry** fuel use data (British Cement Association, 2012).
- 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, 2012).

Appendix D 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 DA inventories. For further detail 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 NFR sector in the most recent inventory are as follows:

D.1 Energy Industries

Revisions to the EMEP/EEA Inventory Guidebook emission factors used in the power stations methodology to allocate reported emissions to individual fuels. Note that these re-allocations will not have any significant effect on overall estimated emissions.

D.2 Industrial Combustion

Re-categorisation of some energy from renewable fuels as biogas rather than biomass with application of more appropriate emission factors has led to a reduction of 53kt of CO in 2011; updating of EMEP/EEA Guidebook factors leads to a 3kt decrease in estimates of NOx emissions for other industry use of lubricants; some other small revisions resulting from updates to UK energy statistics for coal and fuel oil.

D.3 Transport Sources

There were a number of changes made to the 2012 UK road transport inventory and thus affecting the DA inventories:

- DUKES data were revised for petrol and diesel sales (2005-2007), particularly for diesel sales in 2007 (2% higher compared to the value used in the 2011 inventory);
- The method for calculating emissions of air quality pollutants from transport has been changed by normalising the emissions to fuel sales. The difference in emissions calculated by the revised and previous methods varies by year and in some years normalising to fuel sales leads to a smaller estimate in emissions, whilst in others it leads to higher emission estimates;
- Minor revisions have been made to the 2011 vehicle km activity data for Northern Ireland as provided by the Department for Regional Development;
- Updated information from Transport for London on the composition of the bus and black cab taxi fleet operating in London has been incorporated into the UK inventory;
- Small revisions to the LGV fleet using LPG fuel have had a small effect on emissions from LPG consumption;
- Updated NOx assumptions for Euro 5 diesel LDVs;
- Correction to NMVOC cold start emissions from petrol cars and LGVs.

D.4 Commercial, Domestic and Agricultural Combustion

Use of updated emission factors from the EMEP/EEA Guidebook and updated energy data has resulted in revisions to domestic and public sector combustion; estimates of petroleum coke used as domestic fuel have been revised.

D.5 Fugitive

There were a number of changes made to the 2012 UK fugitive emissions inventory and thus affecting the DA inventories:

- Correction of a data processing error from the Pollution Inventory dataset for fugitive VOCs;
- Addition of VOC emission estimates from oil loading at one Scottish oil terminal, and revision of the VOC emission estimates from oil loading at a second oil terminal in England;
- Correction of a double-count in the estimates for Petroleum Processes;

- Revision to the estimates of leakage from the natural gas distribution system, following identification of an error in calculations completed by data providers.

D.6 Industrial Processes

Revision of emissions in the chemical industry sector has led to a reduction in NMVOC.

D.7 Solvent Processes

An error in the 2011 estimate for NMVOC emissions from industrial adhesives has been corrected.

D.8 Agriculture

NH_3 emission estimates between 1980 and 1989 were revised with updated livestock data; reallocation of emissions to NFR 7 – 'other' (non-agriculture horse wastes, and household fertiliser use).

D.9 Waste

A change to the way that landfill methane collection is calculated, with separate calculation of landfill gas combusted in engines and flares resulting in higher calculated quantities of landfill methane and associated pollutants assumed to be emitted to the atmosphere; ammonia estimates have been revised for landfill, sewage treatment and disposal, composting, and anaerobic digestion; emissions of some metals from sewage sludge incineration have been updated to the values given in the 2013 edition of the Emission Inventory Guidebook (EMEP/EEA, 2013). Ammonia emission estimates from anaerobic digestion are now reported as a memo item in the 2012 inventory.

D.10 Other

Introduction of time series emissions from small-scale waste burning (related to garden bonfires); revision of ammonia from domestic pets.

Appendix E Uncertainties

The following sections provide information on the key characteristics of each pollutant, with an indicative "Uncertainty Rating" for each. This information supports Section 1.3 of the main report.

E.1 Ammonia

Ammonia emission estimates are more uncertain than SO_2, NO_X and NMVOC inventories due largely to the nature of the major agricultural sources. Emissions depend on animal species, age, weight, diet, housing systems, waste management and storage techniques and environmental conditions. Hence emissions are affected by a large number of factors that make the 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 and NMVOC, a few sources dominate the inventory and there is limited potential for error compensation.

Uncertainty Rating: HIGH

E.2 Carbon Monoxide

In 2011, 34% of the UK total CO came from road transport sources (1A3b) alone, with 53% of UK carbon monoxide emissions derived from other sources of fuel combustion. Emission estimates for road transport are highly uncertain, as the available dataset of emission measurements is small and shows significant variability. 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 major sources, emission estimates for CO are much more uncertain than other pollutants such as NO_X, CO_2 and SO_2 which are also emitted mainly from combustion processes. Unlike the case of NO_X and NMVOC, a few sources dominate the inventory and there is limited potential for error compensation.

Uncertainty Rating: HIGH

E.3 Nitrogen Oxides

NO_X emission estimates are less accurate than SO_2 because they are calculated using measured emission factors, which can vary widely 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 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 any pollutant other than SO_2 for a number of reasons:

- While NO_X emission factors may be somewhat uncertain, activity data used in the NO_X inventory is very much more certain. This contrasts with inventories for pollutants such as volatile organic compounds and PM_{10}, which contain a higher degree of uncertainty in source activity estimates.
- The NO_X inventory is made up of a large number of 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.
- Many of the larger point-source emission sources make up the bulk of the regional estimates, and these are commonly derived from extrapolation of on-line measurement data and hence are regarded to be good quality.

Uncertainty Rating: LOW

E.4 Non-Methane Volatile Organic Compounds

The NMVOC inventory is more uncertain than SO_2 and NO_X inventories. 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. 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: MODERATE

E.5 PM_{10}

The UK emission inventory for PM_{10} has undergone considerable revision over recent years through specific research into key source sectors to improve the veracity of emission factors and improve the "bottom-up" activity data such as fuel use. Nonetheless, the uncertainties in the PM_{10} emission estimates must still be considered high, due to persisting uncertainties in some sectors regarding emission factors, activity data and particulate size distribution profiles.

Emission factors are generally based on a few measurements on an emitting source that is assumed to be representative of all similar sources. Emission estimates for PM_{10} are based whenever possible on source-specific measurements of PM_{10}, but frequently the available data is emission measurement of total particulate matter and hence conversion to PM_{10} is required based either on the size distribution of the sample collected or (more usually) on literature data on typical size distributions.

Many sources of particulate matter are diffuse or fugitive in nature, such as emissions from coke ovens, metal processing, raw material stockpiles, loading and unloading activities, construction or quarrying sites. These emissions are difficult to measure and are often dependent on conditions that vary over time and between localities such as meteorology and topography and hence are also difficult to model accurately. In many such cases it is likely that no satisfactory estimates or measurements have ever been made.

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 could be reduced to the levels seen in the inventories for SO_2, NO_X, or NMVOC.

Uncertainty Rating: HIGH

E.6 Sulphur Dioxide

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

Uncertainty Rating: LOW

E.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: MODERATE

Appendix F Summary Tables

F.1 Summary Air Quality Pollutant Emission Estimates for England

Table 7: Summary of air quality pollutant emission estimates for England (1990-2012) – data shown to 3 significant figures

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Ammonia (kt)	Agriculture	207	192	186	188	173	172	169	161	167	163	162	160	151	152	153	153	150
	Transport Sources	0.705	5.8	11.5	13.3	19.2	17.9	16.7	15.2	14.2	13.1	12.2	11.2	9.93	9.47	8.44	7.5	6.6
	Commercial, domestic and agricultural combustion	3.17	2.18	1.98	2.11	1.7	1.68	1.33	1.17	1.14	0.98	0.939	1.05	1.03	1.09	1.17	1.25	1.28
	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	3.97	4.26	4.93	4.6
	Waste	5.39	6.47	6.64	6.77	6.74	7.47	7.87	8.14	8.25	8.29	8.27	8.61	9.11	9.55	9.57	9.69	9.51
	Other	12.5	13	15.6	16.2	16.2	16.4	16.3	16.5	16.4	16.5	16.4	16.5	17.2	16.9	17.6	18	18.2
	Total	236	226	231	231	220	219	215	205	210	207	205	202	193	193	194	195	190
Carbon Monoxide (kt)	Energy Industries	98.8	92.7	56.2	50.3	59.5	58.1	57.4	63.7	61.7	67	66.7	69.2	71.9	65.7	63.4	65	73.9
	Industrial Combustion	319	339	324	319	302	308	347	390	342	319	328	325	311	302	361	362	351
	Transport Sources	5400	4590	4130	3830	3340	3020	2690	2400	2150	1890	1660	1410	1260	962	807	666	587
	Commercial, domestic and agricultural combustion	695	508	464	478	407	404	338	307	297	259	250	262	277	278	306	294	297
	Fugitive	22.5	13.1	13.1	10.7	10.7	6.47	5.03	7.19	4.82	4.74	5.06	4.95	4.72	4.01	4.12	3.64	4.21
	Industrial Processes	391	416	381	401	356	409	363	272	262	262	264	259	248	191	138	136	168
	Other	281	32.2	30.8	31.4	30.5	46.8	31.4	32.1	30.9	30.3	31.7	32.1	30.4	29.2	28.2	27.8	27.1
	Total	7210	5990	5400	5130	4500	4250	3830	3470	3150	2830	2610	2360	2210	1830	1710	1550	1510
Nitrogen Oxides (kt)	Energy Industries	653	419	317	281	297	316	311	347	330	350	339	328	244	228	208	202	234
	Industrial Combustion	320	299	271	260	251	239	229	225	219	220	201	201	176	144	149	132	128
	Transport Sources	1090	903	781	733	674	644	612	580	560	540	521	500	470	397	378	362	344
	Commercial, domestic and agricultural combustion	156	143	135	131	122	119	107	102	95.7	90.4	82.7	76.3	75.8	69.4	73.1	62.1	62.4
	Industrial Processes	17.1	13.1	12.1	12.7	10.6	11.2	8.04	8.65	8.61	8.47	8.11	8.1	7.54	6.2	4.55	4.94	5.64
	Other	51.5	43.6	27.3	28.7	27.2	26.4	25.3	26.7	27.7	25.3	26.2	29.1	27.2	25.7	25.8	23.9	21.8
	Total	2280	1820	1540	1450	1380	1350	1290	1290	1240	1230	1180	1140	1000	870	839	787	796
NMVOC (kt)	Agriculture	78	54	55.7	56.5	53.3	50.8	48.6	48.7	49.5	47.9	47.5	47	46.6	45.9	46.7	46.1	46.2
	Industrial Combustion	25.4	25.9	26.1	25.7	25.4	25.7	25.4	24.7	24.4	25.1	23.8	24.6	21.9	18	18.9	16.6	16.2
	Transport Sources	804	623	478	421	354	317	269	226	189	160	137	115	100	70.2	59.2	49.7	42.9
	Commercial, domestic and agricultural combustion	58	42.2	42.9	44.6	37.8	35.7	32.3	31.3	30	28.1	26.7	26.3	26.4	25.1	25.8	24.4	23.8
	Fugitive	271	229	208	183	174	175	153	142	134	130	118	112	101	94.7	85.6	82.2	79.2
	Industrial Processes	184	167	120	89.6	85.9	74.9	73.7	70.7	62.5	59.9	53.2	51.7	45.7	40.2	41.4	37.6	36.9
	Solvent Processes	557	450	416	393	371	357	351	345	345	340	338	331	312	290	288	291	290
	Waste	69.9	71.7	68.2	62.5	58.3	57	57.6	52.6	46.2	44.7	44.4	42.4	42	39.6	34.8	33.9	32.3
	Other	10.3	10	6.94	6.79	8.02	7.3	9.15	7.85	7.51	7.04	7.85	6.9	6.66	6.07	5.7	5.43	5.24
	Total	2060	1670	1420	1280	1170	1100	1020	949	889	842	797	758	702	629	606	587	573

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
PM10 (kt)	Agriculture	9.34	9.01	10.4	10.5	10.5	10.6	10.1	10.1	10.2	9.92	9.99	9.51	9.84	8.95	9.3	9.07	8.86
	Energy Industries	60.2	34.3	22.7	18.4	19.1	13.5	7.43	7.61	7.86	8.78	9.04	7.47	7.63	6.07	5.49	5.9	7.95
	Industrial Combustion	20.8	20	18.6	17.1	15.5	15.6	14.7	14.1	13.4	13.1	11.7	11.1	9.9	8.72	9.34	8.1	7.86
	Transport Sources	32.5	36.7	35.8	35.4	32.1	31.5	30.6	29.9	29.5	28.9	28.1	26.8	25.6	24.4	23.8	22.4	21.4
	Commercial, domestic and agricultural combustion	38.2	24.1	24.8	26.2	20.7	19.2	16.3	15.4	14.8	14.4	14.3	15.1	16.4	16.6	18.1	18	17.9
	Fugitive	0.377	0.242	0.265	0.254	0.207	0.166	0.333	0.38	0.401	0.617	0.591	0.619	0.461	0.349	0.46	0.326	0.341
	Industrial Processes	30.9	26.8	21.8	20	18.9	19.1	18.5	18.8	18	17.8	17.3	18.6	16.9	14.1	13.3	12.7	13.3
	Solvent Processes	6.89	5.26	5.52	5.34	5.06	4.77	4.81	4.74	4.66	4.55	4.9	4.84	4.16	3.45	3.52	3.58	3.62
	Other	7.19	6.32	5.37	5.58	5.47	8.42	5.51	5.99	5.44	5.39	5.36	5.33	4.95	4.69	4.55	4.44	4.42
	Total	206	163	145	139	127	123	108	107	104	103	101	99.3	95.8	87.5	87.8	84.6	85.7
Sulphur Dioxide (kt)	Energy Industries	2480	1470	1010	723	713	638	594	597	457	356	315	272	209	152	150	163	213
	Industrial Combustion	331	241	148	113	108	108	94	85.9	88	91.1	80.5	75.7	71.2	63.3	64.3	55.1	48.6
	Transport Sources	70.9	59.3	36.3	28.4	20.8	18.5	18.8	19.2	19.1	19.4	19.1	14.8	10.7	9.62	8.77	7.98	7.42
	Commercial, domestic and agricultural combustion	131	94.9	69.4	63.7	50.6	48.3	35.4	32	29.6	25.5	23.7	23.7	25	23.4	23.6	21.7	22.5
	Fugitive	16.1	8.87	7.44	6.08	6.09	6.56	5.23	6.58	8	7.27	6.8	8.97	7.66	6.36	10	5.73	5.44
	Industrial Processes	57	61.6	62.7	53	42.5	38.1	34.8	35.4	35.7	35.5	34.8	32.6	25.1	18.2	16.2	15.4	12
	Other	12.5	7.95	4.23	4.43	3.94	4.65	3.56	3.93	4.18	3.87	4.09	7.93	7.58	7.43	7.21	5.45	5.17
	Total	3100	1940	1340	992	944	862	786	780	641	539	484	435	356	281	280	274	314
Lead (tonnes)	Energy Industries	138	117	17.8	14	13.9	11.3	10.3	10.1	10.1	9.14	9.01	2.69	2.8	2.66	2.58	3.07	4.26
	Industrial Combustion	31.5	24.9	19.1	16	13.1	13.6	13.3	13	13.5	11.3	9.28	9.94	9.3	11.4	10.1	9.12	7.94
	Transport Sources	1930	941	515	271	2.28	2.11	2.07	2.07	2.1	2.18	2.17	1.85	1.75	1.7	1.67	1.68	1.67
	Commercial, domestic and agricultural combustion	23	13.2	10.1	9.35	6.35	6.26	4.67	4.03	3.74	3.23	3.01	3.12	3.28	3.46	3.56	3.56	3.45
	Fugitive	2.81	1.97	1.89	1.77	1.67	1.75	2.09	1.75	1.96	1.99	2.01	2.01	1.97	1.58	1.63	1.76	1.62
	Industrial Processes	247	209	174	101	77.2	79.4	74.6	59.5	50.9	50.9	40.4	39.7	34.9	26.2	21.3	21.4	26.2
	Other	230	68.9	0.498	0.689	0.665	0.304	1.54	1.43	1.21	0.739	0.696	0.73	0.714	1.09	1.24	1.17	1.05
	Total	2600	1380	739	414	115	115	109	92	83.5	79.5	66.6	60.1	54.7	48.1	42.1	41.8	46.2

F.2 Summary Air Quality Pollutant Emission Estimates for Scotland

Table 8: Summary of air quality pollutant emission estimates for Scotland (1990-2012) – data shown to 3 significant figures

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Ammonia (kt)	Agriculture	41.9	37.8	34.1	32	33.3	33.8	33.1	31.7	32.7	32	31.3	30	28.7	28.5	28.8	28.6	28.2
	Transport Sources	0.0716	0.613	1.17	1.33	1.96	1.83	1.74	1.59	1.48	1.35	1.28	1.16	1.03	0.977	0.864	0.762	0.68
	Commercial, domestic and agricultural combustion	0.804	0.445	0.397	0.422	0.349	0.331	0.286	0.246	0.226	0.193	0.244	0.273	0.27	0.286	0.309	0.333	0.343
	Industrial Processes	0.0725	0.08	0.0768	0.0682	0.0695	0.0681	0.0606	0.058	0.0737	0.0844	0.0631	0.0701	0.0573	0.0672	0.0761	0.103	0.0714
	Waste	0.876	1.06	1.05	1.06	1.05	1.12	1.15	1.16	1.16	1.18	1.19	1.25	1.34	1.47	1.48	1.52	1.51
	Other	1.32	1.36	1.6	1.66	1.67	1.69	1.68	1.7	1.68	1.68	1.63	1.64	1.71	1.7	1.76	1.77	1.8
	Total	45.1	41.4	38.4	36.5	38.4	38.8	38	36.5	37.3	36.5	35.7	34.4	33.1	33	33.3	33.1	32.6
Carbon Monoxide (kt)	Energy Industries	14.9	15	10.3	9.7	11.5	11.3	10.8	9.93	10.4	10.3	12.2	10.7	10.8	10.5	11.5	9.34	9.66
	Industrial Combustion	34.5	31.6	29.7	30.7	27	27.7	30.2	31.7	28.9	32.9	32.6	31.7	32.9	29.2	33.7	35.4	34.2
	Transport Sources	506	412	355	323	280	252	225	203	184	163	148	127	115	81.4	68.2	56.7	50.9
	Commercial, domestic and agricultural combustion	194	116	103	104	89.2	85.7	73.2	65.4	59.7	51.3	54.5	57.2	61.8	61.2	68.9	66.3	65.9
	Fugitive	5.14	1.11	0.987	1.18	1.09	1.75	1.16	0.858	0.876	0.974	0.824	0.966	0.856	0.899	0.908	0.983	0.705
	Industrial Processes	50.3	5.38	5.82	6.71	6.9	7	7.15	3.68	3.68	3.58	4.34	4.44	4.32	3.76	4.14	4.58	4.74
	Other	22.3	3.58	3.38	3.4	3.31	7.48	3.4	3.46	3.35	3.3	3.45	3.46	3.3	3.18	3.03	3.02	2.95
	Total	828	585	508	479	419	392	351	318	291	265	256	235	229	190	190	176	169
Nitrogen Oxides (kt)	Energy Industries	97.4	66.1	52.7	50.5	56.9	52.1	50.5	47.9	46.4	46.5	58.6	51.5	41.2	37.8	39.3	31.2	32.6
	Industrial Combustion	31	27.2	25.4	24.3	24.2	24.1	21	20	20.1	20.9	19.5	19.4	18.7	15.3	15.1	14.5	14.2
	Transport Sources	117	95.7	81	76.5	70	66.3	63.9	60.7	58.7	57.2	55.6	54.2	51.3	43.2	41.1	38.8	37.1
	Commercial, domestic and agricultural combustion	28.2	27.4	26.3	25.7	24.2	23.7	21.7	20.7	19.3	18.4	16.7	15.2	14.9	13.6	13.8	12	11.6
	Industrial Processes	2.9	0.156	0.0901	0.0811	0.0689	0.0698	0.0607	0.019	0.019	0.0166	0.0142	0.0158	0.0146	0.0141	0.0121	0.0158	0.017
	Other	5.27	3.89	3.2	3.7	3.69	3.95	3.6	3.68	3.64	3.58	3.56	3.33	3.23	2.87	2.85	2.93	2.6
	Total	282	220	189	181	179	170	161	153	148	147	154	144	129	113	112	99.5	98.1
NMVOC (kt)	Agriculture	12.7	10.8	10.9	10.5	10.6	10.2	10.2	10.2	10.4	10.4	10.3	10.3	10.1	9.84	10	10	10
	Industrial Combustion	2.53	2.32	2.35	2.33	2.31	2.34	2.29	2.22	2.15	2.21	2.09	2.21	2.11	1.75	1.79	1.67	1.61
	Transport Sources	74.2	54.7	39.6	34.2	28.6	25.4	21.7	18.3	15.6	13.4	11.9	10.2	8.97	5.56	4.76	4.05	3.57
	Commercial, domestic and agricultural combustion	13.1	8.42	8.4	8.69	7.33	6.81	6.12	5.89	5.45	5.2	5.38	5.41	5.52	5.39	5.66	5.52	5.38
	Fugitive	177	117	97.2	80.9	78.2	67.3	70.4	52.6	39.3	40.4	38.2	38	34.8	22.5	20.5	19.2	23.6
	Industrial Processes	61.6	61.4	60.8	62.6	61.9	60.8	60	59.2	58	57	56.7	58.7	58.8	59.5	60.7	61	62.7
	Solvent Processes	57.8	47	43.8	37.6	35.5	34.4	33.4	32.9	33	32.2	32.2	31.7	30	28	27.9	28.3	28
	Waste	13.2	13.3	12.3	11.2	10.3	9.97	10	9.08	7.95	7.66	7.55	7.2	7.12	6.74	5.94	5.83	5.59
	Other	1.39	1.38	1.04	0.835	1.09	0.96	1.12	0.971	1.01	0.952	1.09	0.879	0.901	0.835	0.781	0.723	0.687
	Total	413	316	276	249	236	218	215	191	173	169	165	165	158	140	138	136	141

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
PM10 (kt)	Agriculture	1.35	1.3	1.3	1.13	1.39	1.43	1.41	1.33	1.4	1.32	1.26	1.26	1.3	1.21	1.3	1.29	1.28
	Energy Industries	8.42	5.36	3.94	3.15	3.63	3.54	2.22	1.17	1.87	1.82	2.67	2.4	1.03	1.08	1.42	1.08	1.09
	Industrial Combustion	2.03	1.81	1.59	1.53	1.44	1.48	1.32	1.25	1.24	1.24	1.15	1.16	0.996	0.861	0.891	0.775	0.818
	Transport Sources	3.87	4.29	4.13	4.09	3.64	3.52	3.45	3.34	3.27	3.21	3.12	2.92	2.8	2.68	2.59	2.42	2.32
	Commercial, domestic and agricultural combustion	9.46	5.64	5.69	5.93	4.83	4.48	3.86	3.69	3.38	3.26	3.67	3.84	4.03	4.06	4.43	4.42	4.38
	Fugitive	0.0874	0.0394	0.0378	0.0849	0.161	0.126	0.197	0.0775	0.144	0.1	0.0498	0.0493	0.501	0.0905	0.31	0.326	0.115
	Industrial Processes	2.8	2.21	1.8	1.72	1.67	1.7	1.66	1.66	1.69	1.66	1.65	1.62	1.44	1.19	1.19	1.2	1.15
	Solvent Processes	0.522	0.369	0.373	0.358	0.34	0.321	0.317	0.31	0.304	0.305	0.345	0.338	0.276	0.232	0.233	0.234	0.232
	Other	0.691	0.659	0.604	0.621	0.606	1.36	0.613	0.656	0.602	0.594	0.59	0.581	0.539	0.507	0.486	0.475	0.469
	Total	29.2	21.7	19.5	18.6	17.7	18	15	13.5	13.9	13.5	14.5	14.2	12.9	11.9	12.9	12.2	11.8
Sulphur Dioxide (kt)	Energy Industries	217	135	96.5	81.5	104	101	96.3	82.3	67	53.8	66.2	53	46.9	49.7	65.6	47.8	48.5
	Industrial Combustion	37.6	22.2	10.4	7.39	7.07	7.37	10	9.57	10	11.3	9.15	7.96	5.55	4.22	4.03	3.46	4.77
	Transport Sources	11.5	9.95	7.11	6.52	5.45	4.91	5.09	4.62	4.51	4.47	4.06	3.08	2.2	2.03	1.8	1.51	1.41
	Commercial, domestic and agricultural combustion	29.5	25.2	21.1	19.6	16.7	15.6	13.1	12	10.8	9.43	8.93	8.79	9.45	8.68	9.07	8.16	8.85
	Fugitive	0.593	0.0562	0.19	0.527	0.396	1.25	0.921	0.485	0.475	0.409	0.181	0.178	0.314	0.0223	0.147	0.145	0.129
	Industrial Processes	3.24	1.04	1.07	0.978	0.886	0.823	0.69	0.92	0.836	0.843	0.828	0.728	0.707	0.608	0.604	0.753	0.753
	Other	0.857	0.601	0.408	0.394	0.373	0.644	0.373	0.41	0.44	0.413	0.441	0.785	0.746	0.735	0.685	0.513	0.481
	Total	300	194	137	117	135	132	126	110	94.1	80.7	89.7	74.6	65.8	66	82	62.4	64.9
Lead (tonnes)	Energy Industries	11.8	7.57	2.71	2.2	3	2.79	1.94	1.55	3.38	1.6	1.71	0.793	0.471	0.689	1.29	0.634	1.14
	Industrial Combustion	3.52	2.81	2.14	1.91	1.64	1.64	1.86	1.72	2.08	1.51	1.17	1.17	1.06	1.14	1.1	0.952	0.825
	Transport Sources	183	87.5	47.3	24.8	0.258	0.238	0.238	0.234	0.236	0.243	0.242	0.209	0.199	0.192	0.189	0.185	0.185
	Commercial, domestic and agricultural combustion	4.5	2.51	2.03	1.94	1.5	1.42	1.18	1.02	0.896	0.749	0.771	0.786	0.847	0.836	0.886	0.855	0.842
	Fugitive	0.468	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Industrial Processes	8.93	3.62	2.15	1.74	1.49	1.55	1.69	0.875	0.695	0.547	0.54	0.587	0.411	0.305	0.285	0.285	0.319
	Other	7.35	2.55	0.0408	0.0556	0.0559	0.0286	0.155	0.143	0.121	0.0739	0.072	0.075	0.0733	0.11	0.125	0.119	0.107
	Total	220	107	56.4	32.6	7.95	7.67	7.07	5.53	7.4	4.72	4.51	3.62	3.06	3.27	3.88	3.03	3.42

F.3 Summary Air Quality Pollutant Emission Estimates for Wales

Table 9: Summary of air quality pollutant emission estimates for Wales (1990-2012) – data shown to 3 significant figures

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Ammonia (kt)	Agriculture	27.6	25.8	25.3	26.4	24.5	24.9	23.4	24.5	24.7	24.6	24.9	22.9	20.9	21	21.6	21.9	21.7
	Transport Sources	0.0451	0.395	0.734	0.829	1.23	1.14	1.08	0.988	0.925	0.841	0.788	0.721	0.64	0.602	0.531	0.465	0.406
	Commercial, domestic and agricultural combustion	0.573	0.455	0.414	0.442	0.353	0.352	0.275	0.241	0.238	0.205	0.23	0.262	0.264	0.278	0.3	0.321	0.329
	Industrial Processes	0.047	0.0521	0.0487	0.0458	0.0443	0.0428	0.0382	0.042	0.0465	0.0512	0.0681	0.0665	0.0615	0.0506	0.0638	0.0709	0.0608
	Waste	0.456	0.527	0.535	0.547	0.544	0.586	0.61	0.624	0.627	0.676	0.712	0.773	0.869	1	1.05	1.09	1.11
	Other	1.13	1.18	1.51	1.59	1.57	1.65	1.69	1.68	1.62	1.59	1.55	1.55	1.6	1.57	1.64	1.69	1.71
	Total	29.9	28.4	28.6	29.9	28.3	28.6	27.1	28.1	28.2	28	28.2	26.3	24.3	24.5	25.2	25.5	25.4
Carbon Monoxide (kt)	Energy Industries	6.16	6.04	4.27	3.71	5.03	5.78	4.82	5.09	6.71	6.06	6.64	5.26	7.01	6.27	6.86	7.25	8.78
	Industrial Combustion	40.5	29.3	30.3	32	28.4	33.1	40.9	52.2	38	30.1	33.2	31.4	26.8	23	27.8	27.8	28.3
	Transport Sources	321	276	246	226	201	181	162	144	129	112	98.9	84.4	75.7	57	47.9	39.6	35
	Commercial, domestic and agricultural combustion	107	84.3	76	79.5	64.7	64.7	50.7	44.8	42.9	35.3	36.4	40.6	42.3	42.3	47.1	46.3	46.3
	Fugitive	12.4	19.2	19.2	14.9	15.3	8.67	3.62	4.99	3.44	3.07	6.59	7.1	5.22	4.71	6.32	5.95	5.95
	Industrial Processes	166	198	207	199	165	144	78.7	81.1	103	108	140	124	101	87.5	85.2	90.1	79.6
	Other	3.78	1.66	1.56	1.58	1.54	2.71	1.57	1.61	1.55	1.5	1.56	1.57	1.48	1.42	1.35	1.34	1.3
	Total	657	615	584	557	480	440	343	334	325	295	324	294	260	222	222	218	205
Nitrogen Oxides (kt)	Energy Industries	50.4	35.8	29.3	23.9	33.2	39.3	33.3	33.3	36.4	34.8	41.6	29.2	39.3	32.5	30.6	30.9	44.4
	Industrial Combustion	30.2	29.8	29.1	31.6	29.2	26	21.2	21.5	20.6	19.1	18	17.5	15.8	12.7	13.6	12.4	11.7
	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	25.2	24.5	22.8
	Commercial, domestic and agricultural combustion	17.5	16.9	16.2	15.7	14.9	14.5	13.4	12.7	11.9	11.1	10.1	9.05	8.76	8.06	8.14	6.97	6.67
	Industrial Processes	5.71	7.08	7.08	7.24	6.99	5.13	1.83	2.11	2.46	2.51	2.96	2.84	2.8	1.92	2.58	2.69	1.96
	Other	2.01	1.57	1.17	1.17	1.17	1.11	1.01	1.07	1.12	1.01	1.07	1.17	1.11	1.02	1.02	0.99	0.901
	Total	175	149	133	126	128	126	109	107	108	103	106	91.6	98.1	82.4	81.2	78.4	88.4
NMVOC (kt)	Agriculture	8.45	8.12	8.44	8.69	8.3	8.25	7.58	8.29	8.32	8.05	8.44	7.52	7.38	7.31	7.48	7.55	7.55
	Industrial Combustion	2.43	2.62	2.77	2.81	2.92	2.58	2.33	2.52	2.3	2.12	2.13	2.2	2.01	1.57	1.73	1.61	1.49
	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	3.46	2.92	2.51
	Commercial, domestic and agricultural combustion	8.14	5.93	6.16	6.56	5.16	4.73	4.06	3.87	3.69	3.49	3.6	3.81	3.82	3.71	3.88	3.85	3.78
	Fugitive	22.8	20.8	16.9	13.8	14.9	12.2	12.3	11.8	12.5	11.6	12.3	12.9	11.4	12	11.7	11.8	10.3
	Industrial Processes	5.51	5.23	4.96	4.67	4.08	3.29	2.21	4.83	4.19	2.35	2.49	2.39	2.26	2.05	2.29	2.25	2.04
	Solvent Processes	43.6	34.1	28.6	27.3	23	21.6	20.9	20.6	20.6	21	21.1	20.7	19	17.5	17.2	17.2	17
	Waste	4.55	4.67	4.51	4.15	3.87	3.77	3.8	3.45	3.02	2.93	2.92	2.79	2.77	2.62	2.31	2.26	2.16
	Other	1.4	1.51	1.1	0.936	1.13	0.905	1.01	0.864	0.707	0.594	0.676	0.648	0.679	0.591	0.6	0.601	0.633
	Total	144	120	102	93.6	84.5	76.2	70.4	69.6	66.6	61.4	61.6	59.7	55.2	51.4	50.6	50.1	47.5

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
PM10 (kt)	Agriculture	0.742	0.702	0.856	0.921	0.94	0.867	0.692	0.921	0.827	0.728	0.682	0.728	0.779	0.741	0.763	0.787	0.774
	Energy Industries	3.43	2.26	1.74	1.32	1.98	1.71	1.03	1.22	1.01	1.07	1.33	1.24	1.14	0.949	0.825	0.839	0.923
	Industrial Combustion	1.72	1.54	1.18	1.29	1.29	1.32	1.21	1.16	1.04	0.868	0.765	0.757	0.665	0.576	0.659	0.554	0.527
	Transport Sources	2.15	2.49	2.51	2.49	2.24	2.17	2.12	2.06	2.06	2	1.94	1.82	1.76	1.68	1.64	1.55	1.44
	Commercial, domestic and agricultural combustion	6.18	4.31	4.52	4.83	3.7	3.38	2.8	2.63	2.52	2.4	2.62	2.89	2.93	2.9	3.14	3.18	3.18
	Fugitive	0.158	0.176	0.178	0.182	0.208	0.17	0.059	0.107	0.0532	0.0569	0.0807	0.104	0.086	0.0765	0.0934	0.0754	0.0421
	Industrial Processes	4.51	4.37	3.88	3.63	3.48	2.49	1.86	2.55	2.78	2.45	2.63	2.84	2.2	1.65	1.88	1.98	1.74
	Solvent Processes	0.439	0.305	0.322	0.309	0.296	0.281	0.281	0.272	0.268	0.26	0.287	0.272	0.219	0.182	0.171	0.172	0.172
	Other	0.31	0.304	0.282	0.292	0.285	0.5	0.288	0.316	0.285	0.281	0.28	0.276	0.255	0.242	0.233	0.228	0.228
	Total	19.6	16.4	15.5	15.3	14.4	12.9	10.3	11.2	10.8	10.1	10.6	10.9	10	9	9.41	9.36	9.03
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	15.3
	Industrial Combustion	41.9	30.3	19	16	16.1	16.1	10.3	8.73	6.13	4.61	4.3	5.26	5.06	4.79	5.96	4.54	4.4
	Transport Sources	5.87	5.05	3.49	3.04	2.5	2.22	2.22	2.23	2.44	2.42	2.24	1.69	1.24	1.23	1.23	1.2	0.957
	Commercial, domestic and agricultural combustion	17.2	13.4	10.4	9.84	8.02	7.54	5.57	5.1	4.78	3.93	3.74	3.94	4.04	3.76	3.76	3.32	3.57
	Fugitive	4.12	1.98	2.26	1.95	1.38	1.63	0.621	0.749	0.836	1.07	1	0.86	0.964	0.739	1.27	0.809	0.854
	Industrial Processes	8.66	9.64	9.63	9.05	7.35	5.69	4.1	4.21	4.41	4.6	5.72	5.45	4.43	2.63	3.7	4.06	3.7
	Other	0.342	0.266	0.168	0.168	0.157	0.227	0.148	0.162	0.174	0.159	0.168	0.326	0.306	0.301	0.288	0.225	0.214
	Total	187	130	96.7	80.2	94.3	85.1	65.2	67.4	62.9	56	62.9	54.7	40.4	30.9	33	31.4	29
Lead (tonnes)	Energy Industries	3.71	1.79	0.825	0.582	1.46	1.01	0.503	0.827	0.381	0.702	0.825	0.407	0.468	0.494	0.494	0.432	0.418
	Industrial Combustion	2.91	2.29	1.75	2.36	2.22	1.6	4.54	3.18	6.53	2.53	0.855	0.915	0.818	0.916	1.04	0.896	0.816
	Transport Sources	118	56.6	29.9	15.6	0.145	0.133	0.132	0.132	0.137	0.141	0.14	0.119	0.114	0.111	0.111	0.111	0.107
	Commercial, domestic and agricultural combustion	2.71	1.8	1.51	1.51	1.12	1.11	0.83	0.715	0.672	0.55	0.554	0.602	0.627	0.635	0.66	0.653	0.645
	Fugitive	1.45	1.83	1.81	1.82	1.99	1.4	0.511	0.804	0.43	0.412	0.551	0.562	0.565	0.558	0.559	0.551	0.564
	Industrial Processes	14.8	16.5	16.8	15.8	15.8	11.4	6.28	11	14.6	16.2	12.2	11.3	10.8	7.49	10.9	9.66	7.08
	Other	0.438	0.366	0.0241	0.0319	0.032	0.0131	0.0864	0.0796	0.0669	0.0389	0.0368	0.0385	0.0376	0.0596	0.0682	0.064	0.0569
	Total	144	81.2	52.7	37.7	22.8	16.7	12.9	16.7	22.8	20.6	15.1	13.9	13.4	10.3	13.8	12.4	9.69

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

Table 10: Summary of air quality pollutant emission estimates for Northern Ireland (1990-2012) – data shown to 3 significant figures

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Ammonia (kt)	Agriculture	29.9	30.4	29.2	30.7	29.1	28.9	29.1	29.6	29.3	28.7	28.2	27.6	27.1	26.8	26.8	27.1	27.6
	Transport Sources	0.0263	0.27	0.496	0.575	0.892	0.818	0.738	0.67	0.64	0.593	0.545	0.513	0.461	0.449	0.398	0.355	0.317
	Commercial, domestic and agricultural combustion	0.558	0.38	0.305	0.276	0.253	0.202	0.202	0.16	0.113	0.0937	0.0919	0.1	0.0995	0.104	0.111	0.118	0.119
	Industrial Processes	0.164	0.164	0.162	0.162	0.163	0.163	0.0254	0.00098	0.00133	0.00154	0.0013	0.00138	0.00183	0.00267	0.00383	0.0041	0.00367
	Waste	0.255	0.294	0.3	0.301	0.3	0.328	0.342	0.351	0.354	0.394	0.416	0.468	0.543	0.643	0.669	0.703	0.732
	Other	0.5	0.526	0.645	0.666	0.669	0.674	0.671	0.692	0.684	0.694	0.698	0.69	0.69	0.688	0.719	0.711	0.726
	Total	31.4	32.1	31.2	32.7	31.3	31.1	31.1	31.5	31.1	30.5	30	29.3	28.9	28.7	28.7	29	29.5
Carbon Monoxide (kt)	Energy Industries	4.06	3.78	2.15	1.34	1.27	1.43	1.15	1.09	2	3.27	2.78	2.65	2.81	2.73	2.25	2.33	1.79
	Industrial Combustion	10.1	11.1	10.5	10.8	9.74	9.24	10.4	11.2	9.55	13.1	15.4	15.8	12.2	13.4	18.6	18.6	18.5
	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	22.9	20.7
	Commercial, domestic and agricultural combustion	167	115	94.3	85.9	77.6	66.6	61.4	51.3	41	33.8	31.9	30.7	33.7	32.7	36.3	34	33.1
	Fugitive	0	0.0184	0.0232	0.0239	0.0243	0.0238	0.0233	0.0245	0.0241	0.024	0.0243	0.025	0.0241	0.0237	0.0233	0.0229	0.0228
	Industrial Processes	0.244	0.239	0.234	0.353	0.373	0.4	0.415	0.0513	0.0481	0.0314	0.0362	0.0299	0.0246	0.0185	0.0207	0.017	0.0163
	Other	2.26	1	0.969	0.988	0.969	0.978	0.991	1.02	0.979	0.964	1.01	1.03	0.975	0.933	0.892	0.877	0.854
	Total	358	265	215	198	178	159	145	131	116	108	102	95.8	92.5	81.9	85.6	78.7	74.9
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	5.81
	Industrial Combustion	13.2	12.2	10.3	9.37	8.7	8.46	7.7	7.32	7.33	8.57	7.88	8.23	7.48	5.81	6.32	5.6	5.55
	Transport Sources	37.3	28.2	22.2	21.4	20.4	20	20.3	21	20.1	19.8	19.3	18.8	18.1	15.2	14.6	14	13.4
	Commercial, domestic and agricultural combustion	13.8	13	12.9	12.8	12.3	12.1	11.7	11.3	10.5	10.1	9.37	8.34	8.08	7.72	7.77	6.66	6.23
	Industrial Processes	0.717	0.302	0.236	0.249	0.212	0.148	0.0023	0.0018	0.00213	0.00163	0.0015	0.00177	0.00139	0.00145	0.001	0.001	0.00105
	Other	1.06	0.941	0.786	0.816	0.812	0.77	0.747	0.791	0.811	0.754	0.782	0.884	0.811	0.739	0.717	0.652	0.593
	Total	97.1	74	60.4	58.9	57.3	57.5	52.8	51.9	48.4	48.9	46.9	43.3	40.9	34.9	35.1	32.5	31.6
NMVOC (kt)	Agriculture	9.63	10.3	11	10.8	10.5	10.5	10.7	10.9	11.3	11.2	11.2	11.1	11.1	11	11.1	11.5	11.6
	Industrial Combustion	0.885	0.896	0.91	0.889	0.83	0.82	0.819	0.807	0.798	0.883	0.889	0.92	0.768	0.669	0.714	0.621	0.599
	Transport Sources	27.1	18.1	11.7	10.2	8.7	7.86	6.56	5.77	5.07	4.4	3.85	3.4	3.1	1.85	1.61	1.36	1.21
	Commercial, domestic and agricultural combustion	10.3	6.98	6.12	5.69	5.25	4.72	4.41	3.91	3.33	3.04	2.8	2.63	2.67	2.55	2.64	2.51	2.42
	Fugitive	3.42	3.23	2.87	2.16	2.06	1.94	1.81	1.75	1.67	1.52	1.44	1.36	1.13	1.05	0.854	0.858	0.839
	Industrial Processes	2.42	2.41	2.18	2.07	2	2.02	2.02	2.02	2.03	2.02	2.04	2.09	2.17	2.2	2.26	2.26	2.26
	Solvent Processes	17.1	13.6	12.6	12	11.7	11.4	11.2	11.1	11	10.9	10.9	10.8	10.2	9.46	9.35	9.42	9.32
	Waste	2.18	2.27	2.18	2	1.87	1.84	1.86	1.7	1.5	1.45	1.45	1.39	1.38	1.31	1.16	1.14	1.09
	Other	0.47	0.483	0.294	0.283	0.344	0.156	0.158	0.158	0.327	0.447	0.444	0.207	0.316	0.308	0.296	0.247	0.176
	Total	73.5	58.3	49.8	46.1	43.3	41.3	39.5	38.2	37	35.8	35	33.8	32.7	30.4	30	29.9	29.5

	Category	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
PM10 (kt)	Agriculture	1.1	1.3	1.3	1.27	1.31	1.21	1.35	1.45	1.55	1.37	1.41	1.34	1.38	1.31	1.31	1.48	1.45
	Energy Industries	2.74	1.47	0.964	0.569	0.76	1.02	0.397	0.414	0.316	0.295	0.29	0.25	0.222	0.113	0.0686	0.0922	0.105
	Industrial Combustion	0.988	0.948	0.834	0.768	0.767	0.691	0.583	0.546	0.56	0.685	0.663	0.679	0.55	0.494	0.621	0.522	0.483
	Transport Sources	1.07	1.37	1.34	1.34	1.23	1.22	1.26	1.28	1.24	1.22	1.2	1.15	1.11	1.07	1.04	0.96	0.917
	Commercial, domestic and agricultural combustion	8.5	5.71	4.93	4.56	4.18	3.77	3.44	3.01	2.54	2.27	2.08	1.96	1.99	1.93	2.05	1.96	1.91
	Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Industrial Processes	0.71	0.632	0.53	0.521	0.509	0.535	0.517	0.509	0.51	0.497	0.487	0.471	0.41	0.333	0.336	0.337	0.32
	Solvent Processes	0.196	0.14	0.148	0.141	0.134	0.128	0.126	0.124	0.122	0.118	0.133	0.131	0.108	0.0918	0.0874	0.0878	0.0877
	Other	0.184	0.19	0.181	0.187	0.184	0.186	0.187	0.201	0.183	0.182	0.181	0.181	0.168	0.157	0.151	0.146	0.145
	Total	15.5	11.8	10.2	9.36	9.08	8.76	7.86	7.53	7.02	6.64	6.45	6.15	5.95	5.51	5.66	5.59	5.42
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	8.33	11	4.56	2.29	2.25	2.91
	Industrial Combustion	19.4	16.4	8.84	5.59	4.71	5.12	3.18	2.86	3.27	4.33	4.06	3.79	3.84	3.83	4.87	4.29	4.06
	Transport Sources	2.57	2.33	1.53	1.33	1.03	0.925	0.967	0.988	1.01	1.04	1.02	0.763	0.568	0.515	0.505	0.464	0.449
	Commercial, domestic and agricultural combustion	22.2	21.4	18.9	17	15.4	13.8	12.5	11.4	9.9	8.88	8.42	8.13	8.68	8.02	8.55	7.7	8.43
	Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Industrial Processes	0.109	0.0906	0.0782	0.0616	0.0425	0.0346	0.0209	0.0158	0.0107	0.0112	0.0111	0.00877	0.0104	0.012	0.0106	0.00827	0.0126
	Other	0.185	0.155	0.108	0.109	0.105	0.102	0.101	0.114	0.12	0.112	0.119	0.228	0.209	0.202	0.192	0.14	0.132
	Total	113	80	56.2	50.9	49.6	49.8	35.1	32.8	30.8	29.3	27.1	21.3	24.3	17.1	16.4	14.8	16
Lead (tonnes)	Energy Industries	2.77	1.31	0.681	0.208	0.238	0.224	0.181	0.15	0.0548	0.05	0.0554	0.029	0.0153	0.0246	0.0468	0.026	0.109
	Industrial Combustion	2.42	2.35	2	1.84	1.64	1.68	1.7	1.56	1.58	1.47	1.19	1.28	1.09	1.26	1.47	1.27	1.12
	Transport Sources	67.3	33.9	18.2	9.83	0.0847	0.0788	0.0792	0.0821	0.0826	0.0862	0.0862	0.0746	0.0714	0.0697	0.0689	0.0678	0.0677
	Commercial, domestic and agricultural combustion	3.59	2.29	1.85	1.67	1.45	1.26	1.16	0.974	0.781	0.647	0.608	0.589	0.646	0.629	0.683	0.636	0.616
	Fugitive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Industrial Processes	0.608	0.532	0.307	0.275	0.3	0.29	0.27	0.141	0.158	0.135	0.106	0.128	0.0908	0.0729	0.0776	0.074	0.0806
	Other	0.231	0.201	0.0123	0.0173	0.0177	0.0084	0.0508	0.0469	0.0395	0.0236	0.023	0.0244	0.0239	0.0367	0.0419	0.0393	0.0351
	Total	76.9	40.6	23	13.8	3.74	3.54	3.44	2.95	2.7	2.41	2.07	2.13	1.94	2.09	2.39	2.11	2.03

Appendix G Definition of NFR Codes and Sector categories

The Sector Category "Other" is applied to 1A5b and 7A 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.

Table 11 Definition of NFR Codes and Sector Categories

NFR Code	NFR Source Description	Sector Category
1A1a	Public Electricity and Heat Production	Energy Industries
1A1b	Petroleum Refining	Energy Industries
1A1c	Combustion in Manufacture of Solid Fuels and Other Energy Industries	Energy Industries
1A2a	Combustion in Iron and Steel Manufacturing Industry	Industrial Combustion
1A2b	Combustion in Non-ferrous Metals Manufacturing Industry	Industrial Combustion
1A2c	Combustion in Chemical Manufacturing Industry	Industrial Combustion
1A2d	Combustion in Pulp, Paper and Print Manufacturing Industry	Industrial Combustion
1A2e	Combustion in Food Processing, Beverages and Tobacco Manufacturing Industry	Industrial Combustion
1A2fi	Stationary combustion in manufacturing industries and construction: Other	Industrial Combustion
1A2fii	Mobile Combustion in manufacturing industries and construction	Industrial Combustion
1A3ai(i)	International Aviation -Take-Off and Landing	Transport Sources
1A3aii(i)	Civil Aviation - Domestic Take-Off and Landing	Transport Sources
1A3bi	Road Transport - Passenger Cars	Transport Sources
1A3bii	Road Transport - Light Duty Vehicles	Transport Sources
1A3biii	Road Transport - Heavy Duty Vehicles	Transport Sources
1A3biv	Road Transport - Mopeds & Motorcycles	Transport Sources
1A3bv	Road Transport - Gasoline Evaporation	Transport Sources
1A3bvi	Road Transport - Automobile Tyre and Brake Wear	Transport Sources
1A3bvii	Road Transport - Automobile Road Abrasion	Transport Sources
1A3c	Railways - Mobile Sources	Transport Sources
1A3dii	National Navigation (including Inland Waterways and Maritime Activities)	Transport Sources
1A4ai	Commercial / institutional: Stationary	Commercial, domestic and agricultural combustion
1A4bi	Residential Combustion Plants	Commercial, domestic and agricultural combustion
1A4bii	Household and Gardening (Mobile Machinery)	Commercial, domestic and agricultural combustion
1A4ci	Stationary Combustion Plants (Agriculture/Forestry/Fishing)	Commercial, domestic and agricultural combustion
1A4cii	Agricultural/Forestry Off-Road Vehicles and Other Machinery	Commercial, domestic and agricultural combustion
1A4ciii	National Fishing Activities	Commercial, domestic and agricultural combustion
1A5b	Other Mobile Sources (including Military)	Other
1B1b	Fugitive Emissions from Fuels - Solid Fuels/Transformation	Fugitive
1B2ai	Fugitive Emissions from Fuels, Oil - Exploration, Production, Transport	Fugitive
1B2aiv	Fugitive Emissions from Fuels, Refining/Storage	Fugitive

NFR Code	NFR Source Description	Sector Category
1B2av	Fugitive Emissions from Distribution of Oil Products	Fugitive
1B2b	Fugitive Emissions from Natural Gas Extraction	Fugitive
1B2c	Oil and Natural Gas/Venting and Flaring	Fugitive
2A1	Cement Production	Industrial Processes
2A4	Soda Ash Production and Use	Industrial Processes
2A6	Road Paving with Asphalt Production Processes	Industrial Processes
2A7a	Quarrying and mining of minerals other than coal	Industrial Processes
2A7b	Construction and demolition	Industrial Processes
2A7c	Storage, handling and transport of mineral products	Industrial Processes
2A7d	Other Mineral products	Industrial Processes
2B2	Nitric Acid Production	Industrial Processes
2B5a	Other chemical industry	Industrial Processes
2C1	Iron and steel production	Industrial Processes
2C3	Aluminium production	Industrial Processes
2C5a	Copper production	Industrial Processes
2C5b	Lead production	Industrial Processes
2C5d	Zinc production	Industrial Processes
2C5e	Other metal production	Industrial Processes
2D1	Pulp and Paper Production	Industrial Processes
2D2	Food and Drink Production	Industrial Processes
2D3	Wood processing	Industrial Processes
2G	Other Industrial Processes	Industrial Processes
3A1	Decorative coating application	Solvent Processes
3A2	Industrial coating application	Solvent Processes
3A3	Other coating application	Solvent Processes
3B1	Degreasing	Solvent Processes
3B2	Dry cleaning	Solvent Processes
3C	Chemical Products, Manufacture and Processing	Solvent Processes
3D1	Printing	Solvent Processes
3D2	Domestic solvent use including fungicides	Solvent Processes
3D3	Other product use	Solvent Processes
4B13	Manure Management - Other	Agriculture
4B1a	Manure Management - Dairy	Agriculture
4B1b	Manure Management - Non-Dairy	Agriculture
4B3	Manure Management - Sheep	Agriculture
4B6	Manure Management - Horses	Agriculture
4B8	Manure Management - Swine	Agriculture
4B9a	Laying hens	Agriculture

NFR Code	NFR Source Description	Sector Category
4B9b	Broilers	Agriculture
4B9c	Turkeys	Agriculture
4B9d	Other poultry	Agriculture
4D1a	Synthetic N-fertilizers	Agriculture
4D2c	N-excretion on pasture range and paddock unspecified	Agriculture
4F	Field Burning of Agricultural Wastes	Agriculture
4G	Other Agricultural (including use of pesticides)	Agriculture
6A	Solid Waste Disposal on Land	Waste
6B	Waste Water Handling	Waste
6Ca	Clinical waste incineration	Waste
6Cb	Industrial waste incineration	Waste
6Cc	Municipal waste incineration	Waste
6Cd	Cremation	Waste
6Ce	Small scale waste burning	Waste
6D	Other Waste (including Composting and Biogas Production)	Waste
7A	Other (included in total)	Other

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