National Atmospheric Emissions Inventory

Air Pollutant Inventories for England, Scotland, Wales, and Northern Ireland: 1990-2017

Prepared by Ricardo Energy & Environment for the Department for Environment, Food & Rural Affairs, The Scottish Government, The Welsh Government and The Northern Ireland Department for Agriculture, Environment and Rural Affairs.

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Glossary

API	Air pollutant inventory
AQ	Air quality
AQEG	Air Quality Expert Group
NH_3	Ammonia
B[a]p	Benzo[a]pyrene
BAT	Best Available Techniques
BEIS	Department for Business, Energy & Industrial Strategy
BOFA	Boosted Over Fire Air
CO	Carbon monoxide
CCGT	Combined Cycle Gas Turbine
CLRTAP	Convention on Long-Range Transboundary Air Pollution
COMEAP	Committee on the Medical Effects of Air Pollutants
Defra	Department for Environment, Food & Rural Affairs
DA	Devolved Administration
DERV	Diesel engine road vehicle
DfT	Department for Transport
DUKES	Digest of UK Energy Statistics
DVLA	Driver and Vehicle Licensing Agency
EEA	European Environment Agency
EEMS	Environmental and Emissions Monitoring System
EMEP	European Monitoring and Evaluation Programme
EPR	Environmental Permitting Regulations
EU ETS	EU Emissions Trading System
EC	European Commission
EEA	European Environment Agency
EU	European Union
GHG	Greenhouse Gas
GDP	Gross Domestic Product
HCB	Hexachlorobenzene
HCH	Hexachlorocyclohexane
HFO	Heavy Fuel Oil

IED	Industrial Emissions Directive
IIR	Informative Inventory Report
IPPC	Integrated Pollution Prevention and Control
LCPD	Large Combustion Plant Directive
LDV	Light duty vehicles
LPG	Liquefied Petroleum Gas
LA	Local Authority
MDO	Marine Diesel Oil
MSW	Municipal solid waste
NAQS	National Air Quality Strategy
NAEI	National Atmospheric Emissions Inventory
NECD	National Emissions Ceiling Directive
NO_X	Nitrogen oxides
NFR	Nomenclature for Reporting
NMVOC	Non-methane volatile organic compounds
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
PAHs	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCDD/Fs	Dioxins and furans [polychlorobenzodioxins (PCDDs) and polychlorodibenzofurans (PCDFs)]
PCP	Pentachlorophenol
PI	Pollution Inventory
$PM_{2.5}$	Particulate matter less than 2.5 micrometres
PM_{10}	Particulate matter less than 10 micrometres
POPs	Persistent Organic Pollutants
SED	Solvent Emissions Directive
SI	Statutory instrument
SO_2	Sulphur dioxide
UK	United Kingdom
UKPIA	United Kingdom Petroleum Industry Association
UNECE	United Nations Economic Commission for Europe
WID	Waste Incineration Directive
WHO	World Health Organization

1 Introduction

This is the Air Pollutant Inventory Report for England, Scotland, Wales and Northern Ireland, presenting emissions inventories for each region for the period 1990 to 2017 for the following priority pollutants:

- Ammonia (NH_3)
- Carbon monoxide (CO)
- Nitrogen oxides (NO_X as NO_2)
- Non-methane volatile organic compounds (NMVOCs)
- Particulate matter less than 10 micrometres (PM_{10})
- Particulate matter less than 2.5 micrometres ($PM_{2.5}$)
- Sulphur dioxide (SO_2)
- Lead (Pb)

In addition to the above suite of air pollutants, for which source data and inventory methods are well-established, the report includes in **Appendix C** the first set of experimental inventory statistics for England, Scotland, Wales and Northern Ireland for emissions of: (i) dioxins and furans (PCDD/Fs), and (ii) benzo[a]pyrene (B[a]p). These are priority toxic pollutants, emission estimates for which are included within the scope of UK inventory submissions under the Convention on Long-Range Transboundary Air Pollution (CLRTAP). This is the first time that DA-level estimates have been developed for these two pollutants, and the data quality at sub-national level is such that the data are regarded as experimental statistics at this stage. Further work may be needed to improve the quality of DA estimates back the full time-series; see **Appendix C** for further details.

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 Agriculture, Environment and Rural Affairs for Northern Ireland, by the UK emission inventory teams at Ricardo Energy & Environment, Aether, Rothamsted Research, and the Centre for Ecology & Hydrology.

1.1 Background to Inventory Development

The development of air pollutant inventories (API) for England and each of the Devolved Administrations (DAs) has been commissioned by Defra to better inform policy-makers within the Devolved Administrations in their pursuit of objectives set by the Air Quality Strategy for England, Scotland, Wales and Northern Ireland. These objectives also contribute to the UK's targets in terms of meeting both national and international targets on both local and transboundary air pollution. Defra's Clean Air Strategy 2019 sets out how the UK intends to reduce pollutant emissions , making our air healthier to breathe, protecting nature and boosting the economy. The strategy is available here: https://www.gov.uk/government/publications/clean-air-strategy-2019.

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 policies could be pursued to achieve both Air Quality and Greenhouse Gas policy goals.

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

1.2 About the Air Pollutants

Each of the priority AQ pollutants for which DA inventories are calculated are briefly described below. Further information can be found on the NAEI website: http://naei.defra.gov.uk/overview/ap-overview, which includes an overview of the health impacts of these pollutants.

Ammonia (NH_3) emissions play an important role in several different environmental issues including acidification, eutrophication and changes in biodiversity. The atmospheric chemistry of NH_3 and ammonium (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. Agriculture is an important source of NH_3 within the UK, with the vast majority of emissions arising from this sector. Non-agricultural sources of NH_3 are diverse. Emission estimates for these sources are often highly uncertain since ammonia tends to originate from diffuse sources, leading to a lack of activity and emission factor data.

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

Nitrogen oxides (NO_x) arise primarily from combustion sources. The estimation of these emissions is complex since the nitrogen can be derived from either the fuel or atmospheric nitrogen. The emission is dependent on the conditions of combustion, in particular, temperature and excess in air-fuel ratio (this is the extent by which oxygen in the air is in excess of the minimum amount required for complete combustion of the fuel), which can vary considerably. Thus, combustion conditions, engine load and even state of maintenance are important. Studies into the effects of exposure on human health suggest NO_X has an exacerbating effect on respiratory illnesses and cardiovascular disease; however, due to NO_X often being co-emitted with several other pollutants, the quantification of health impacts from NO_X alone is complex (COMEAP, 2015).

Non-Methane Volatile Organic Compounds (NMVOCs) are emitted to air from a large, diverse range of sources from across many industrial sectors, transport, agriculture and the residential sector. They are emitted primarily as combustion by-products, as vapour arising from the transfer, storage and handling or use of petroleum distillates, or from the use of solvents or chemicals. The *Solvent and Other Product Use* sector comprises industrial and domestic solvent applications (such as cleaning, degreasing), as well as the manufacturing and processing of chemical products.

Particulate matter as PM_{10} and $PM_{2.5}$ is a measure of the size distribution of the particles emitted to air and represents the material with an aerodynamic diameter less than 10 and less than 2.5 micrometres respectively. Particulate matter 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 SO_2, NO_X and NH_3 to form solid sulphates and nitrates, as well as organic aerosols formed from the oxidation of NMVOCs. These are known as secondary sources. These inventories only consider primary sources. For further information on secondary particulates see the Air Quality Expert Group (AQEG) Report on particulate matter in the United Kingdom (AQEG, 2005) and on fine particulate matter ($PM_{2.5}$) in the United Kingdom (AQEG, 2012).

Sulphur dioxide (SO_2) emissions commonly arise from combustion and can be calculated from the sulphur content of the fuel and from information on the amount of sulphur retained in the ash. Inventory estimates are produced using UK energy statistics, together with information on the sulphur content of liquid fuels (UKPIA, 2018) and data on sulphur content of coal from coal suppliers.

Lead (Pb) emissions, prior to 1999 arose primarily from the combustion of leaded petrol. 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 catalytic converters which are incompatible with leaded petrol due to catalyst poisoning. Leaded petrol was then phased out from general sale at the end of 1999. These changes have caused a significant decline in total Pb emissions across the UK between 1990 and 2000. The UK-wide emissions of Pb are now dominated by combustion sources (mainly of solid fuels, biomass and lubricants in industrial and residential sectors), and from metal production processes at foundries and iron and steel works.

1.3 Data Sources and Inventory Methodology

The England and Devolved Administrations' inventories are compiled by disaggregating the UK emission totals presented within "UK Informative Inventory Report (1990 to 2017)" (Richmond, et al., 2019) derived from the National Atmospheric Emissions Inventory (NAEI). 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. Emission estimates at the national level are made using direct emission measurements (e.g. for industrial point sources) or by combining activity data with a mixture of country-specific and default emission factors (EMEP/EEA Guidebook, 2016). These are known as “bottom-up” and “top-down” approaches respectively.

The method for disaggregating UK emission totals across England and 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:

- BEIS 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.

Disaggregated emission estimates are only published when they can be directly attributed to the constituent countries, therefore emissions from offshore oil and gas installations and the vessels servicing them are excluded from the reported totals and accompanying dataset. In 2017, this ‘unallocated’ proportion of the UK inventory total was 6% of the UK total for NO_x and NMVOCs, 2% for CO and 1% SO_2, PM_{10} and $PM_{2.5}$. The proportion was zero or negligible for the other pollutants. For this reason, the sum of the DA total emissions for these pollutants will not match the published UK national totals. Further information on the data sources and inventory methodology can be found in **Appendix B**.

1.4 Uncertainties

Uncertainties in the UK inventory are associated with the availability and quality of activity data, emission factors, and the methodologies used in emissions calculations throughout the time-series. These uncertainties are quantified in assessments using both the Tier 1 uncertainty aggregation method and a Tier 2 method using a statistical Monte-Carlo technique. The Tier 1 methodology investigates the impact of the assumed uncertainty of individual parameters (such as emission factors and activity statistics) upon the uncertainty in the total emission of each pollutant. Results from both the Tier 1 methodology and the Monte-Carlo analysis are presented in Chapter 1.7 of the “UK Informative Inventory Report (1990 to 2017)” (Richmond, et al., 2019).

The air pollutant inventories for England, Scotland, Wales and Northern Ireland are derived by disaggregating UK emissions across the four countries and the unallocated region, and so the UK-wide uncertainty is compounded by further uncertainty introduced by the methods developed to split emissions on a source-activity scale. These uncertainties are not quantified within this report. Instead, an indicative and relative uncertainty rating is provided in **Appendix E** and summarised in **Table 1**. A ‘low’ rating implies a lower level of uncertainty in the emission estimates for the pollutant relative to the uncertainty in the estimates for a pollutant with a ‘high’ rating. Further information on the uncertainties for each pollutant can be found in **Appendix E**.

In general, the NAEI is regarded as an international leader in terms of quality and accuracy, e.g. through the application of higher Tier (more comprehensive) methodologies, particularly for key sources, and a continuous improvement process.

Further commentary on the levels of uncertainty in data used to estimate the emission inventories of B[a]p and PCDD/Fs is included in **Appendix C.3.2**.

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

Table 1 – Indicative uncertainty rating for each pollutant present in the UK API

Pollutant	Indicative Uncertainty Rating
Ammonia	Moderate
Carbon monoxide	Moderate
Nitrogen oxides	Low
Non-methane volatile organic compounds	Moderate
Particulate matter (PM_{10} and $PM_{2.5}$)	High
Sulphur dioxide	Low
Lead	High

2 Devolved Administrations' Air 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 pollutants.

These sections include the following:

Figures graphically presenting the inventory data, showing the annual trend from 1990 to 2017 for each pollutant. These graphs are also disaggregated by sector, and further information on these sectors can be found in **Appendix G**.

Summary information on trends is provided for each pollutant, highlighting the key reasons for the observed trend since 1990 and other notable aspects of the trend. This information is not guided by detailed statistical analysis, but through association of underlying trends in activity data with the visible emissions trends.

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 substantive areas for emissions and the patterns associated with that pollutant. For example, NO_x emissions are concentrated around the road networks of the countries.

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

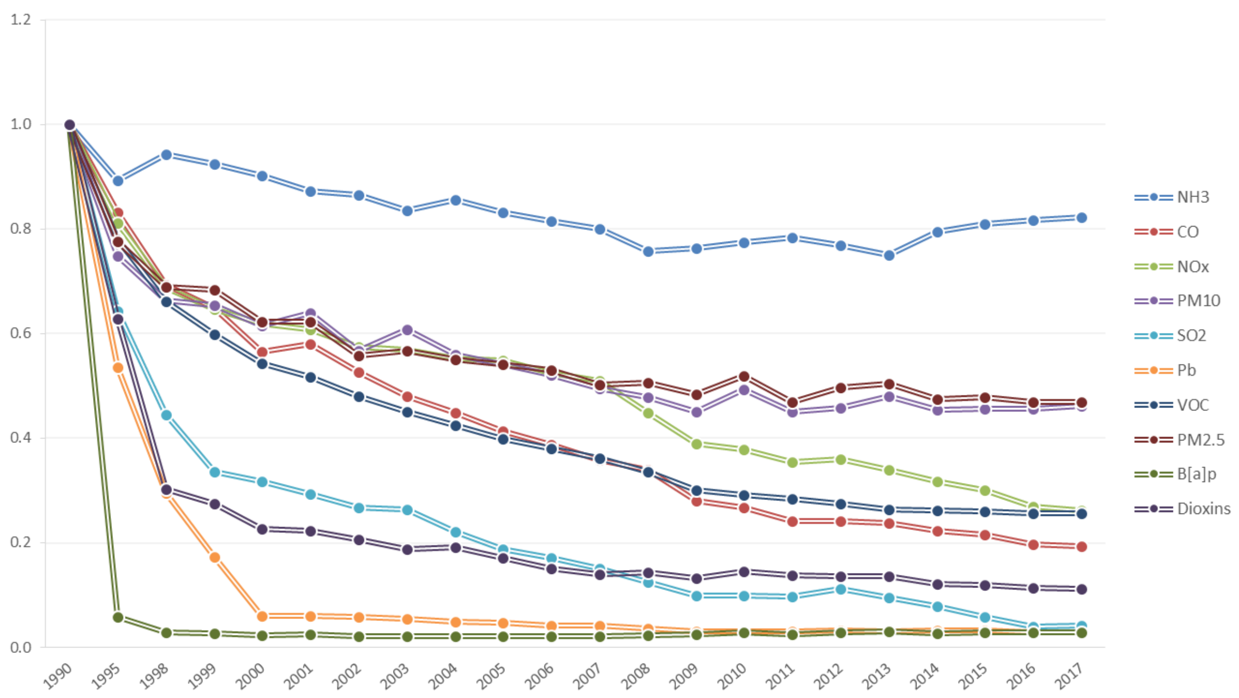
2.1 England

The following section provides a summary of emissions in England for the eight priority air pollutants: NH_3, CO, NO_x, NMVOCs, PM_{10}, $PM_{2.5}$, SO_2, and Pb whilst also providing a basic summary of PCDD/F and B[a]P emissions. A more detailed assessment for these two experimental pollutants is found in **Appendix C.2**.

Figure 1 shows emissions of all ten air pollutants normalised to provide the relative rate of decline since 1990. This graph shows that all pollutant emission levels are lower in 2017 than they were in 1990. The rate at which they have declined is similar for PM_{10}, $PM_{2.5}$, NO_x, NMVOC and CO. However, Pb and dioxins show a much higher rate of reduction from 1990 to 2000 which is coincident with the phase-out of leaded petrol and the closure of older MSW incinerators prior to 1996. . The most dramatic decline in emissions is exhibited by the B[a]p time-series due to the cessation of field burning activities from 1993, a practice that had contributed 92% to the overall inventory in 1990.

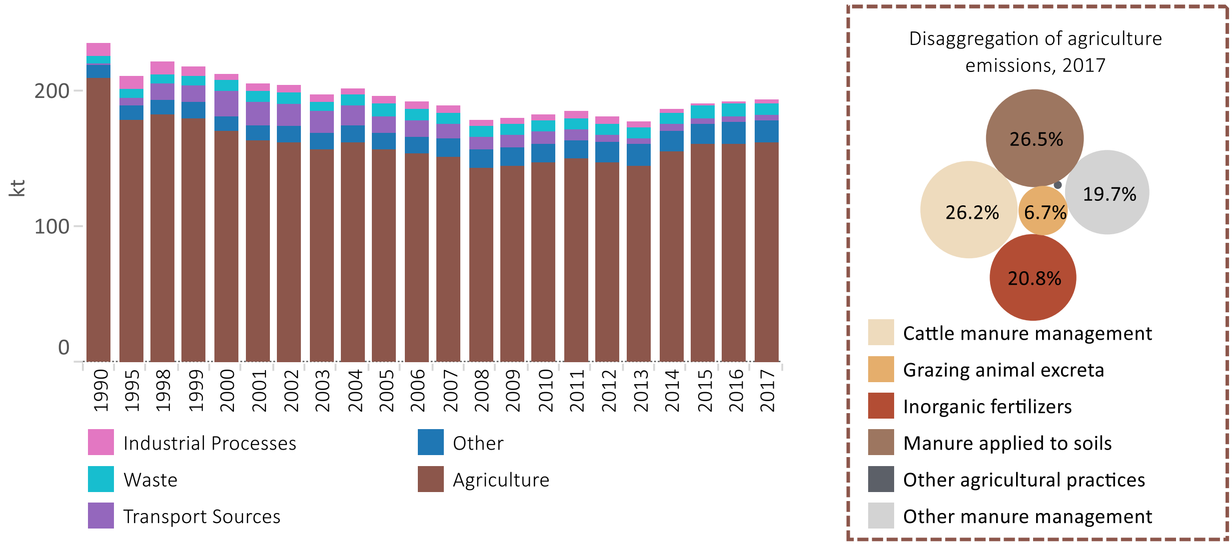
By contrast, NH_3 emissions have declined at a slower rate than other pollutants and have even risen in recent years due to increases in activity from several sources; urea-based fertiliser application; increases in housed cattle numbers and subsequent manure spreading on soils; and increases in digestate and other organic fertilisers which are applied to soils. SO_2 emissions declined rapidly between 1990 and 1999 due to reductions in the sulphur content of fuels and a shift in electricity production to use more natural gas and less coal and fuel oil. Emissions of NO_x have declined notably since 2007 primarily due to reductions in road transport emissions and the emissions from the power generation sector.

Figure 1 – England normalised trends for all pollutants



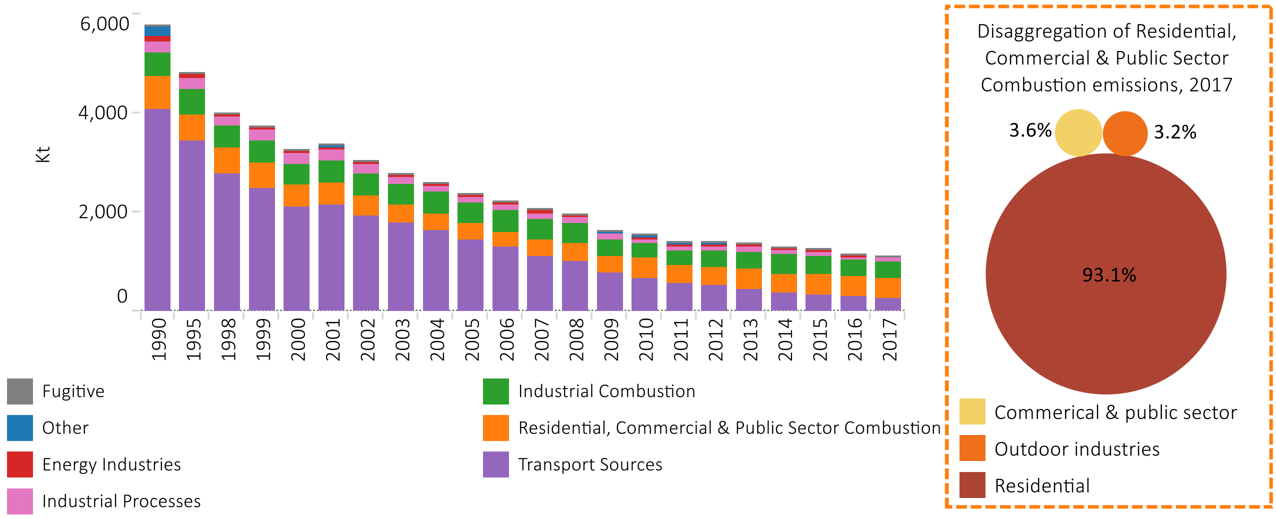
The following sections provide an overview of emissions from each of the eight main pollutants, explaining the trends and characteristics of the graphs. An overview of PCDD/Fs and B[a]p emissions is provided in **Appendix C.2** for the first time this year, although they should be considered as experimental statistics at this stage. **Appendix F** presents the DA inventory data summary tables, whilst **Appendix G** presents source category mapping used in the report**.**

Figure 2 – Ammonia Emissions in England



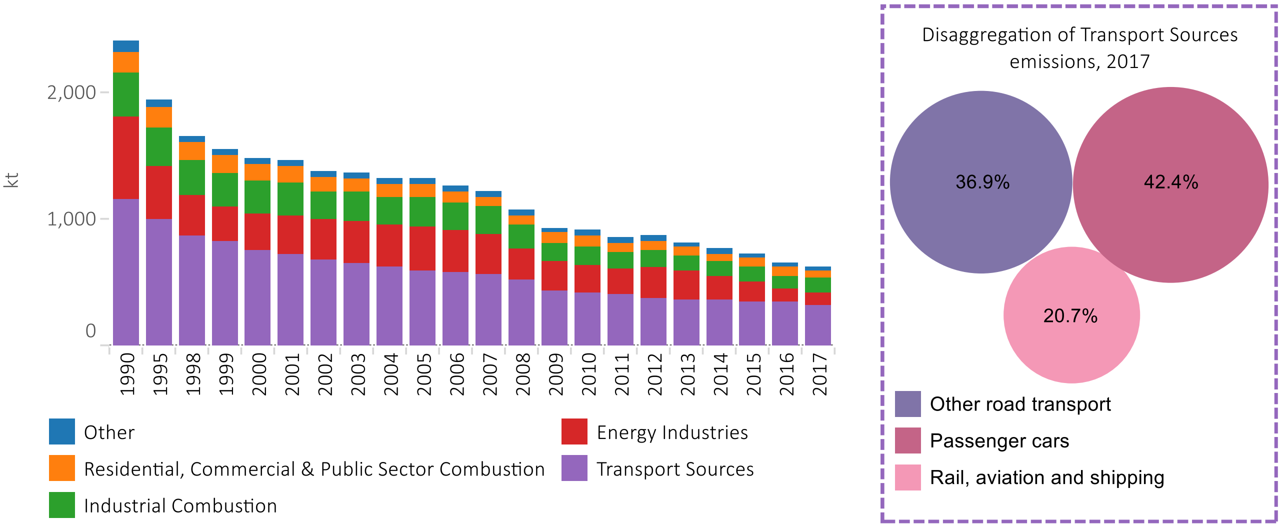
Emissions of **ammonia** were estimated to be 193kt in 2017 and have declined overall by 18% since 1990. Emissions in England account for 68% of the UK total in 2017. Agricultural sources make up by far the largest component in the inventory throughout the time-series, with cattle manure management, manure applied to soils and inorganic fertilizers each accounting for 20% or more of the emissions from this sector. In recent years, the trends in NH_3 emissions have been largely driven by increases in cattle numbers, which are often kept on slurry-based systems, and consequent emissions from spreading of cattle-manure slurry. In addition, increased application of urea-based and organic fertilisers such as digestate to agricultural soils contribute to an increase in emissions between 2013 and 2017.

Figure 3 – Carbon Monoxide Emissions in England



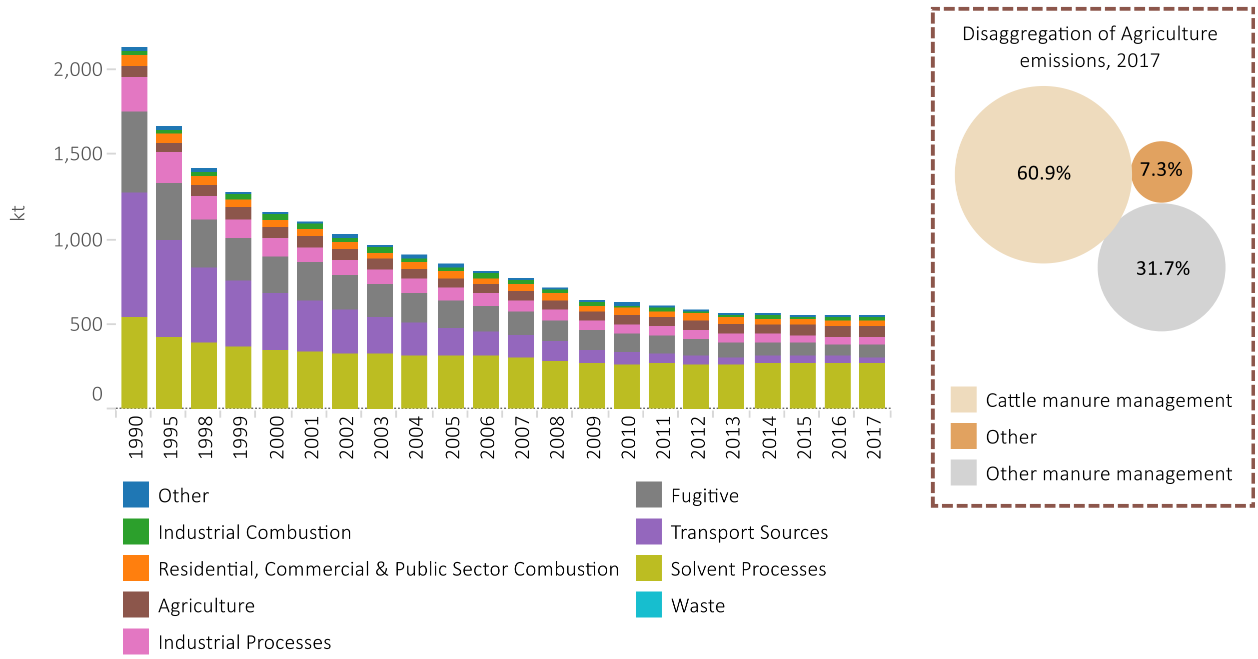
Emissions of **carbon monoxide** were estimated to be 1,118kt in 2017 and have declined by 81% since 1990. Emissions in England account for 73% of the UK total in 2017. This decline in emissions stems from changes in transport sources, particularly in road transport. The decline is driven by the introduction of Euro standards after 1992, which requires fitting of emission controls (e.g. three-way catalytic converters) in new petrol vehicles and in more recent years, the switch from petrol cars to diesel cars. Since 2008, emissions from passenger cars have further decreased, mainly driven by improvements in catalyst repair rates resulting from the introduction of regulations controlling the sale and installation of replacement catalytic converters and particle filters for light duty vehicles. In recent years, emissions from the residential and other combustion sector have increased, which corresponds with an increasing use of wood fuel, predominantly in the residential sector (BEIS, 2018a).

Figure 4 – Nitrogen Oxides Emissions in England



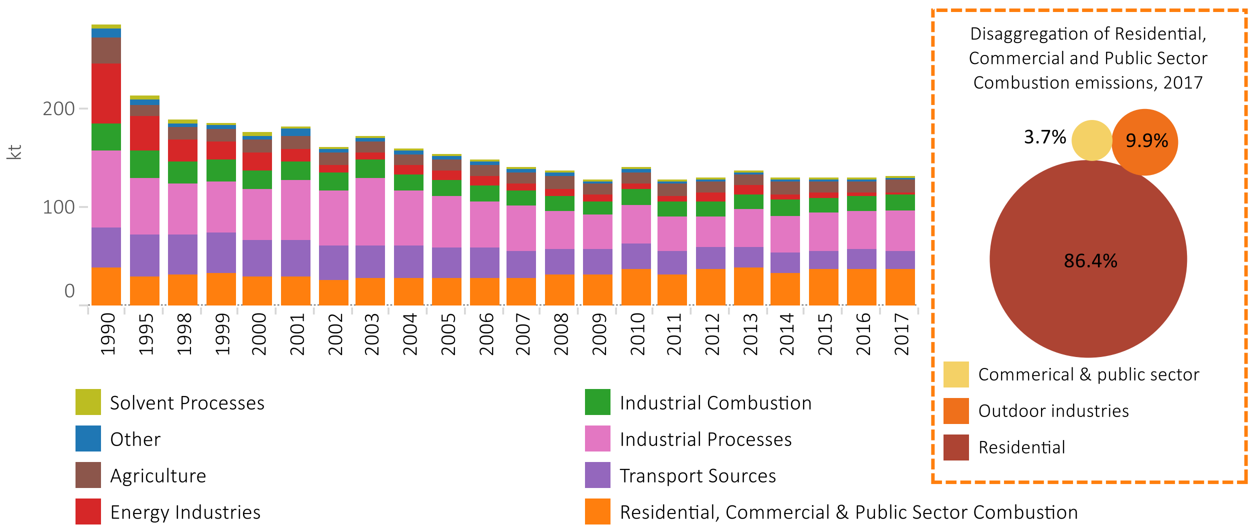
Emissions of **nitrogen oxides** were estimated to be 630kt in 2017, representing 72% of the UK total. Emissions have declined by 74% since 1990, mainly due to changes in transport sources, particularly in road transport. This decline is driven by the successive introduction of tighter emission standards for petrol cars and all types of new diesel vehicles over the last decade. Since 2008, emissions from passenger cars have further decreased, which is mainly driven by improvements in catalyst repair rates after the introduction of regulations controlling the sale and installation of replacement catalytic converters and particle filters for light duty vehicles. However, the increasing number of diesel cars offsets these emissions reductions, because diesel cars emit higher NO_x relative to their petrol counterparts. Emission reductions across the time-series from energy industries are mai due to shifts in the electricity generation fuel mix in the early 1990s from coal to natural gas (BEIS, 2018a) along with the installation of NO_X abatement at coal-fired power stations such as the installation of Boosted Over Fire Air (BOFA) systems since 2008. More recently, the accelerated phase-out of coal firing at power stations in favour of natural gas, and an increasing share of renewable energy generation (BEIS, 2018b) has contributed to a 13% decline in emissions since 2015.

Figure 5 – NMVOC Emissions in England



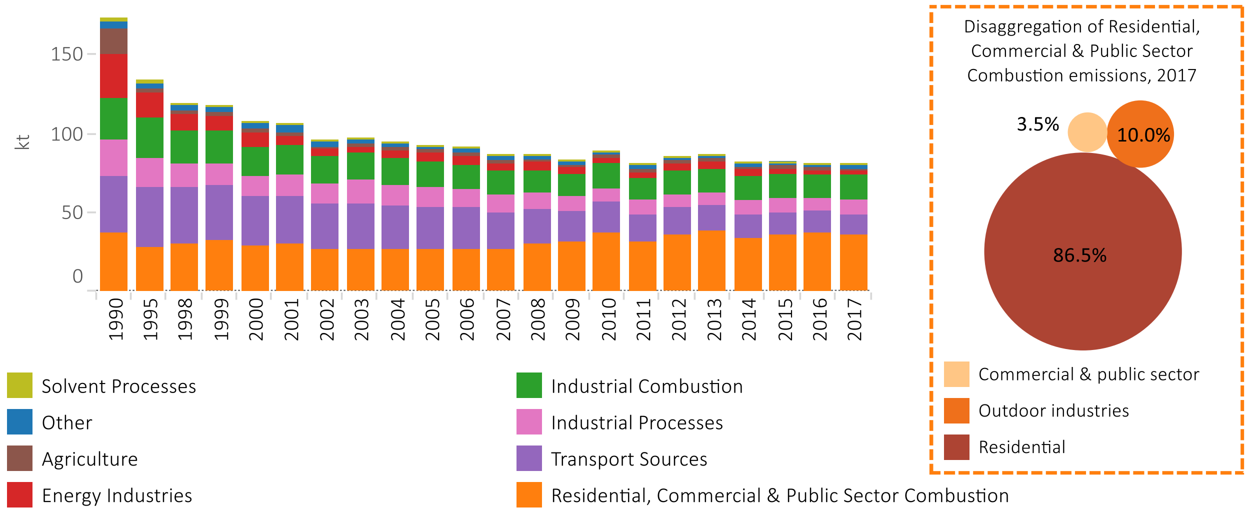
Emissions of **non-methane volatile organic compounds** were estimated to be 548kt in 2017, representing 68% of the UK total in 2017. Emissions have declined by 74% since 1990. Emissions from solvent processes reduced during the 1990s, but across the time-series the trend is dominated by reductions in emissions from transport sources and fugitive sources, including evaporative losses of fuel vapour from petrol vehicles. The decline is driven by emission control technologies introduced in new petrol vehicles since the early 1990s and in more recent years the switch from petrol cars to diesel cars. The reduction in emissions also occurs to a lesser extent due to the introduction of petrol vapour recovery systems at filling stations. With this large reduction in transport emissions, solvent processes are now the most important source of NMVOC emissions, with significant emissions in 2017 arising from both domestic and industrial solvent applications.

Figure 6 – PM_{10} Emissions in England



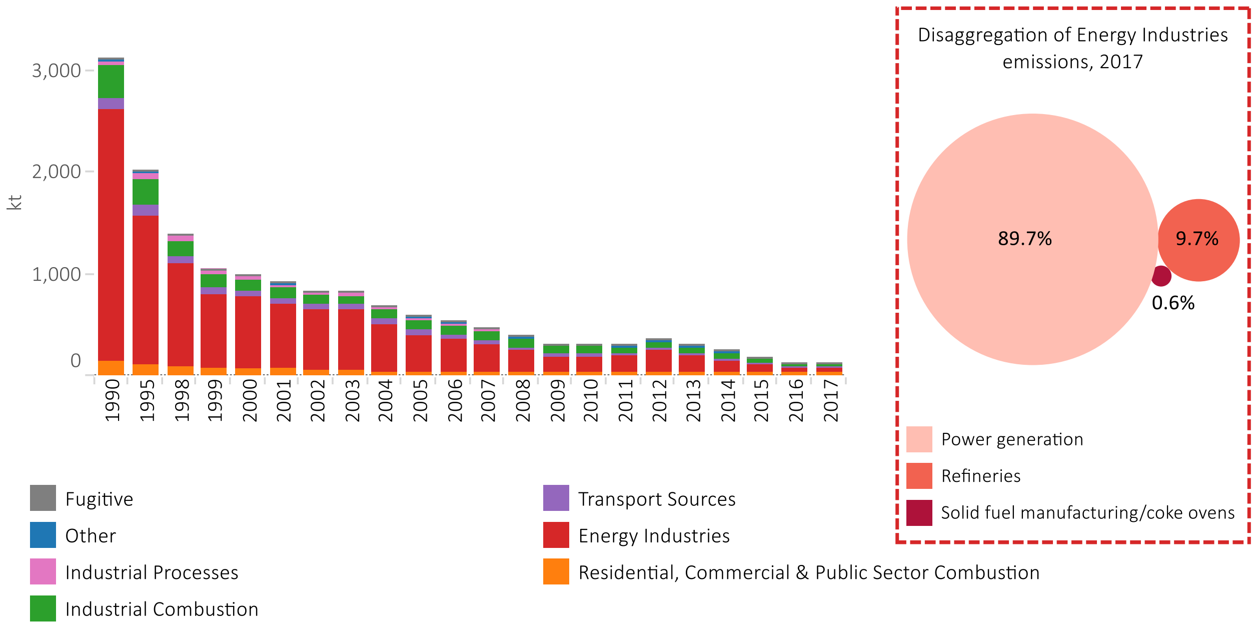
Emissions of **PM_{10}** were estimated to be 133kt in 2017 and have declined by 54% since 1990. They account for 79% of the UK total in 2017. Unlike most other pollutants, the emissions profile of PM_{10} is diverse: Transport sources, residential, commercial and public sector combustion, industrial combustion and industrial processes each accounted for over 10% of total emissions in 2017. Emissions from energy industries have had the most notable impact on the trend since 1990. The reduction in these emissions is primarily due to the reduction in coal-fired energy generation in place of natural gas, which has negligible PM_{10} emissions (BEIS, 2018a). Additionally, PM_{10} exhaust emissions from diesel vehicles have been decreasing due to the successive introduction of tighter emission standards over time. However, since 2007, emissions from the combustion of biomass in unclassified industries (i.e. NFR code 1A2gviii) and domestic wood combustion have caused the national trend to somewhat plateau.

Figure 7 – $PM_{2.5}$ Emissions in England



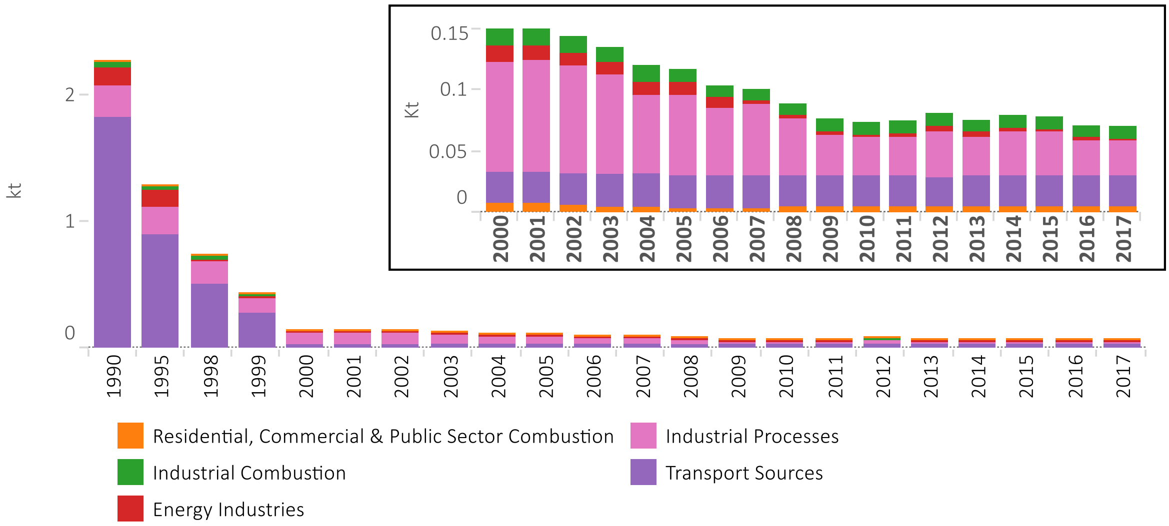
Emissions of **$PM_{2.5}$** were estimated to be 82kt in 2017 and have declined by 53% since 1990. Emissions in England account for 78% of the UK total in 2017. As with PM_{10}, $PM_{2.5}$ emissions have a large number of significant sources. Since combustion tends to produce finer particles, emissions from these sources (e.g. energy industries, industrial combustion) are of greater importance for this size fraction compared to PM_{10}. For $PM_{2.5}$, the residential, commercial and public sector combustion category accounts for 42% of 2017 emissions. The primary drivers for the decline in emissions since 1990 are the switch in the fuel mix used in electricity generation away from coal and towards natural gas, particularly in the early time-series, and later reductions in emissions from the transport sector due to the introduction of progressively more stringent emissions standards through time. Since 2005, declines in emissions have been offset by increases in emissions from the residential sector, and in particular, the combustion of wood.

Figure 8 - Sulphur Dioxide Emissions in England



Emissions of **sulphur dioxide** were estimated to be 131kt in 2017, representing 76% of the UK total. Emissions have declined by 96% since 1990, which has been dominated by the reduction in energy industries emissions, coincident with large changes in the power generation sector. These include the reduction in coal fired power generation since 1990; improved emission controls on large coal fired plants; co-firing of biomass in coal fired power stations; the introduction of CCGT (Combined Cycle Gas Turbine) plants which are more efficient than conventional coal and oil stations and have negligible SO_2 emissions; and, since 2007, the rapid expansion of the renewable share of electricity generation (BEIS, 2018b). The increase in emissions in 2012 was due to an increase in the use of coal in power generation relative to previous years (BEIS, 2018b). Transport sources emissions have declined, coincident with the reduced sulphur content of road fuels, both petrol and diesel. Emissions from industrial combustion, declined substantially during the 1990s, mainly due to a reduction in coal and fuel oil use in the chemicals sector and unclassified industry.

Figure 9 – Lead Emissions in England



Emissions of **lead** were estimated to be 71 tonnes in 2017, representing 75% of the UK total. Emissions have declined by 97% since 1990 almost entirely due to changes in transport sources. Petrol with lead additives was phased out from general sale by the end of 1999, which is the reason underlying a 99.9% decrease in transport emissions between 1990 and 2000. Also, during the 1990s, emissions from the waste sector declined as older waste incinerators were phased out. Since 2000, the predominant sources of emissions are linked to industry (industrial processes and industrial combustion) with the dominant subsector being the production of iron and steel.

Table 2 below provides a summary of the percentage contribution of each sector for each pollutant in 2017. The table is shaded according to the overall contribution of that sector to the pollutant total. The table below indicates that the Residential, Commercial & Public Sector Combustion category is important for CO, SO_2, PM_{10},$PM_{2.5}$, B[a]p and Dioxins, accounting for over 25% of emissions for each pollutant. Fuel combustion is a major source of emissions, whilst Industrial Processes are also important, especially for emissions of Pb from the iron and steel industry. This table also highlights that although emissions from the agriculture sector are not significant when considering all pollutants, it is of very high significance when considering emissions of NH_3; the same is true for NMVOC emissions from solvent processes.

Table 2 – Source Emission Contributions Ranked by Sector, England 2017

Sector	NH3	CO	NOx	NMVOC	PM10	PM2.5	SO2	Pb	B[a]p	Dioxins
Agriculture	92%	IE	IE	10%	18%	5%	IE	0%	0%	0%
Energy Industries	IE	4%	13%	IE	1%	2%	37%	6%	0%	1%
Fugitive	IE	1%	IE	14%	IE	IE	1%	IE	0%	0%
Industrial Combustion	IE	26%	13%	1%	8%	15%	10%	15%	1%	12%
Industrial Processes	0%	0%	IE	49%	26%	9%	5%	20%	2%	7%
Residential, Commercial & Public Sector Combustion	IE	42%	18%	3%	24%	42%	28%	9%	90%	41%
Solvent Processes	IE	0%	0%	19%	1%	0%	0%	0%	0%	1%
Transport Sources	1%	26%	51%	3%	17%	22%	18%	51%	3%	6%
Waste	3%	IE	IE	IE	IE	IE	IE	0%	5%	33%

Other	4%	2%	6%	1%	5%	6%	1%	0%	0%	0%

* The sector: "other" will include all "other" categories in the inventory and also a number of categories that are insignificant for a specific pollutant. These have been marked in the table as "IE" (used in inventory reporting for "Included Elsewhere"). A breakdown of what is included within this category in respect to each pollutant can be found in **Table 21**.

Figure 10 – Ammonia Emissions in England, 2017

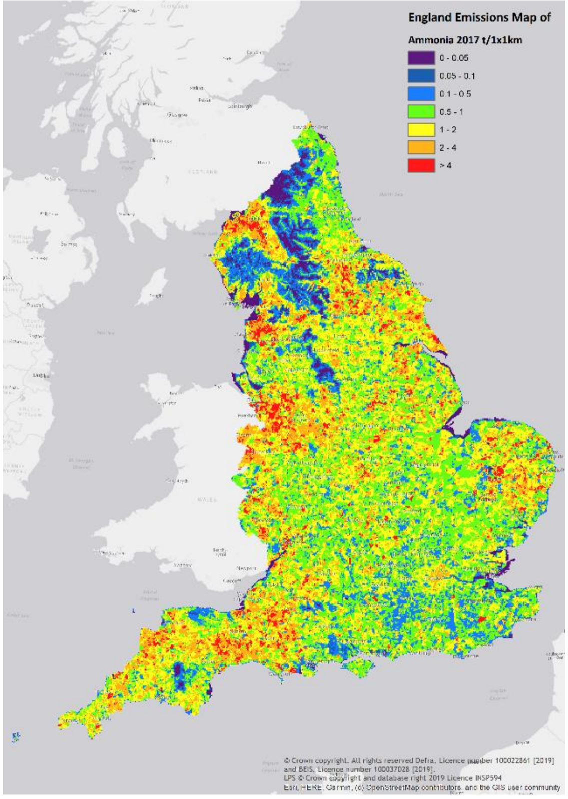


Figure 11 – Carbon Monoxide Emissions in England, 2017

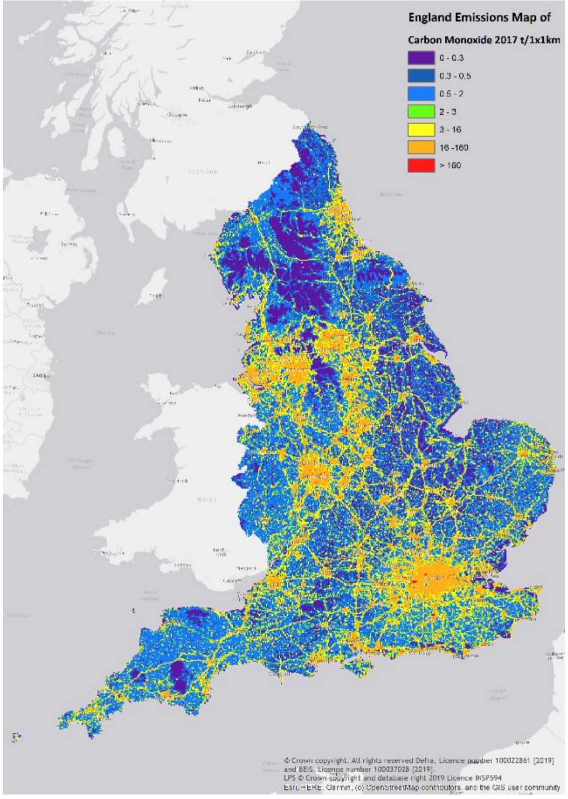


Figure 12 – Nitrogen Oxides Emissions in England, 2017

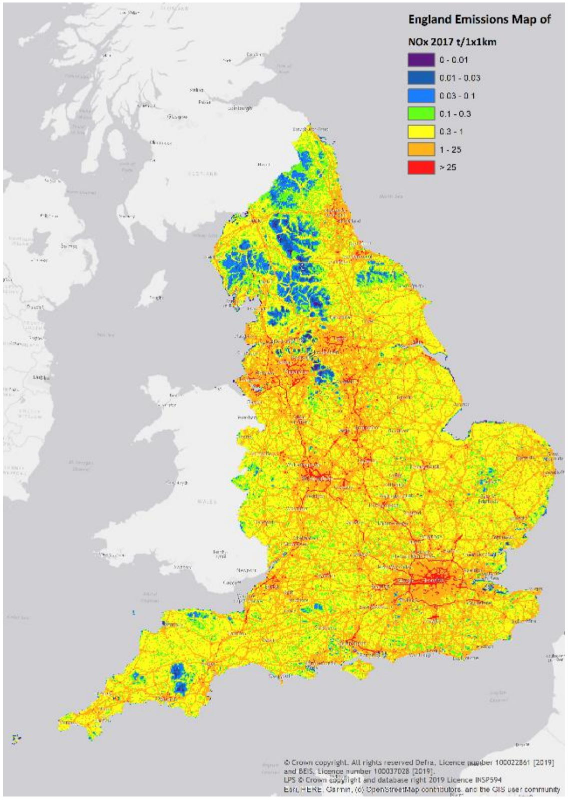


Figure 13 – NMVOC Emissions in England, 2017

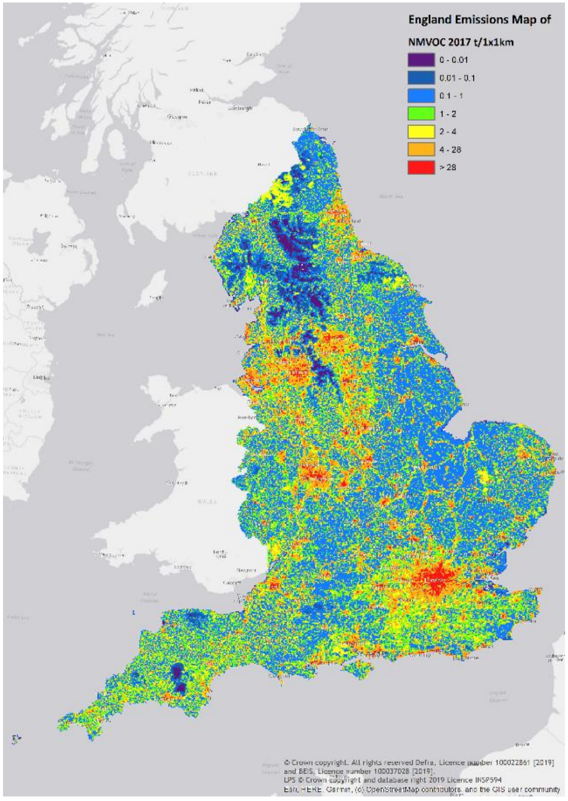


Figure 14 - PM_{10} Emissions in England, 2017

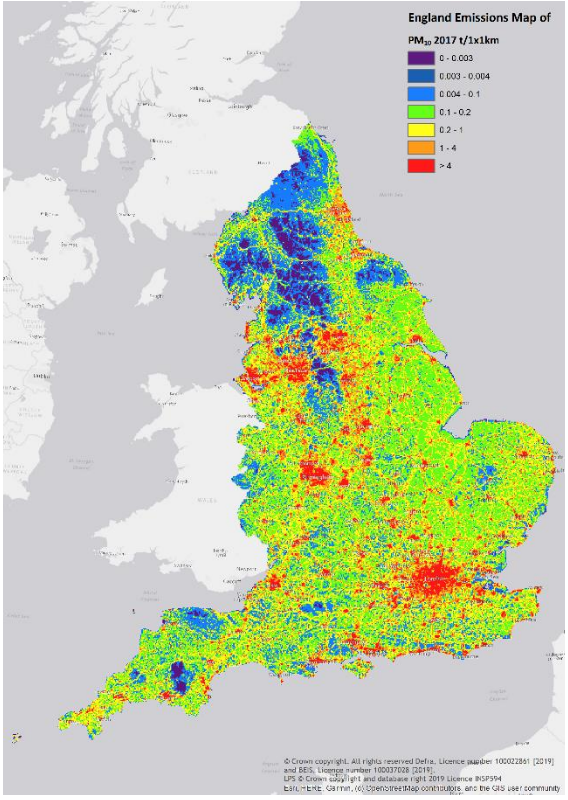


Figure 15 – $PM_{2.5}$ Emissions in England, 2017

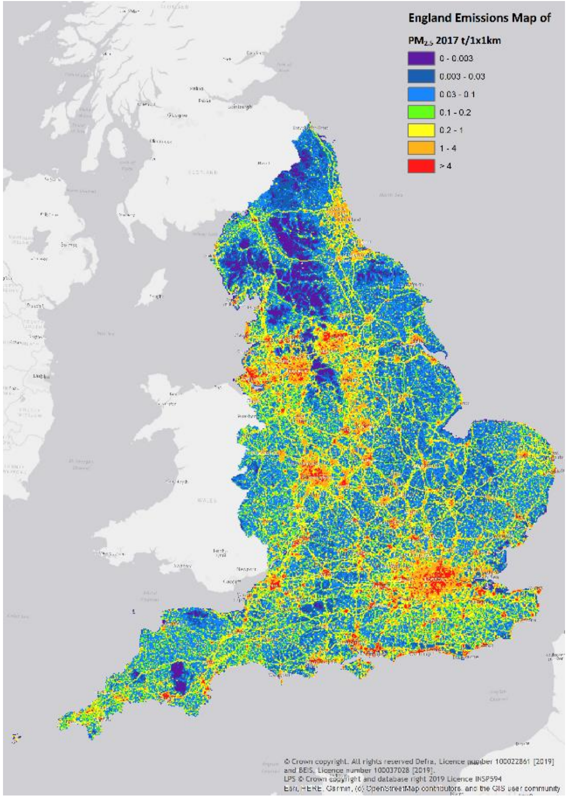


Figure 16 – Lead Emissions in England, 2017

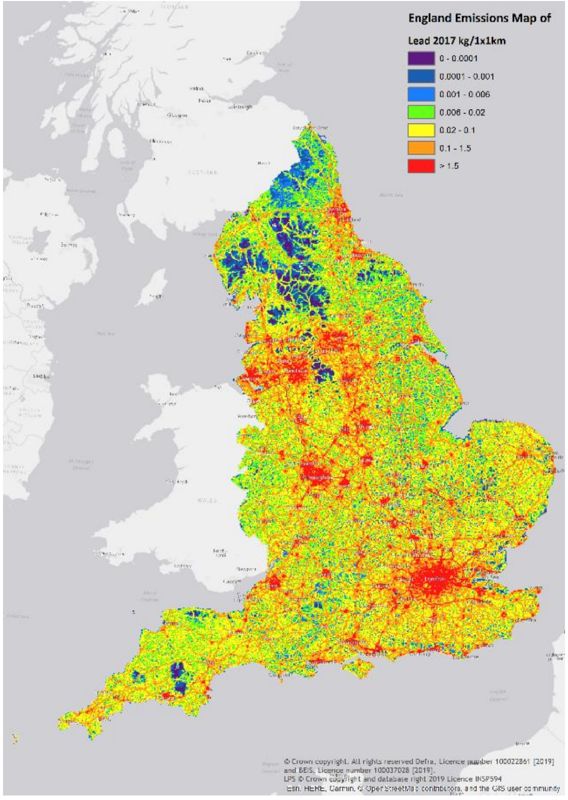
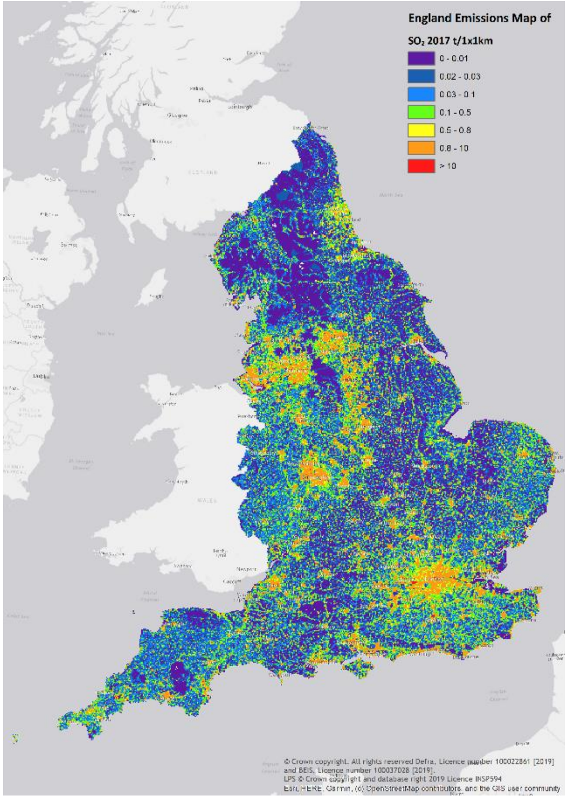


Figure 17 – Sulphur Dioxide Emissions in England, 2017



2.2 Scotland

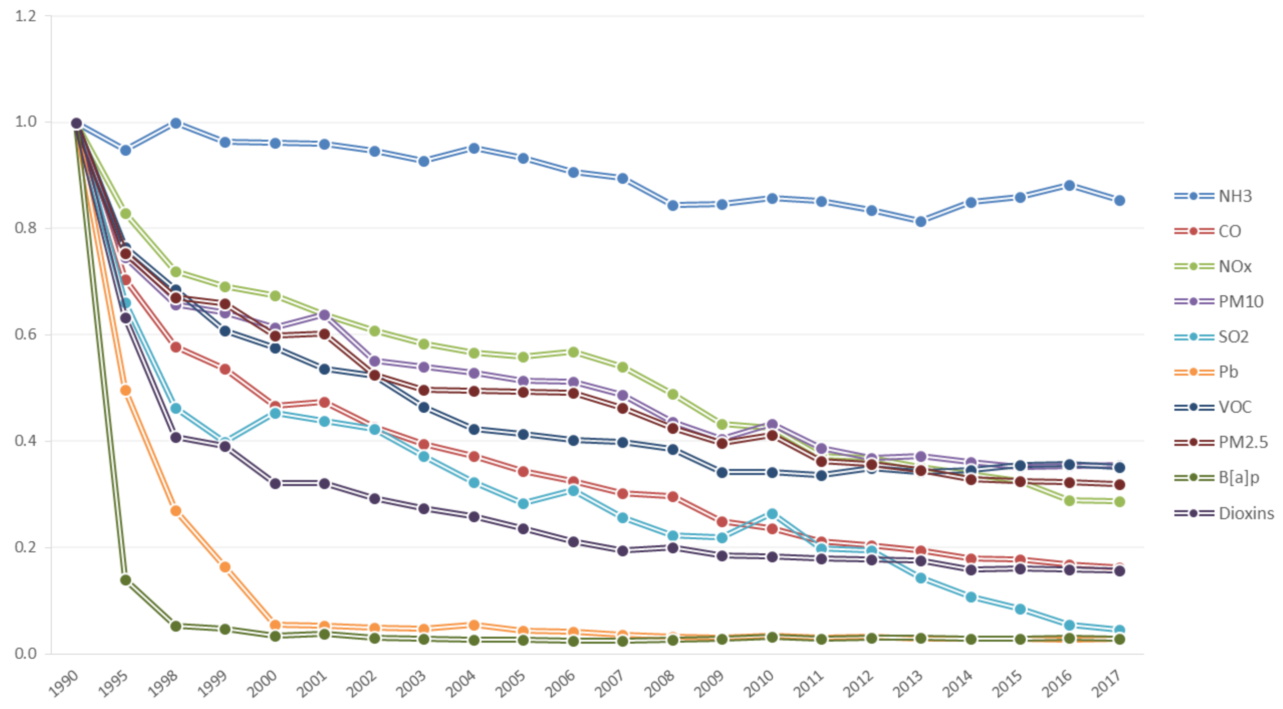
The following section provides a summary of emissions in Scotland for the eight priority air pollutants: NH_3, CO, NO_x, NMVOCs, PM_{10}, $PM_{2.5}$, SO_2, and Pb whilst also providing a basic summary of PCDD/F and B[a]p emissions. A more detailed assessment for these two experimental pollutants is found in **Appendix C.2**.

Figure 18 shows emissions of all ten air pollutants normalised to provide the relative rate of decline since 1990. This graph shows that all pollutant emission levels are lower in 2017 than they were in 1990. The decline is relatively similar for PM_{10}, $PM_{2.5}$, NO_x, NMVOC, PCDD/Fs, SO_2 and CO.

However, Pb shows a much higher rate of reduction from 1990 to 2000 which is coincident with the phase-out of leaded petrol by the end of 1999. B[a]p emissions similarly show a large decrease between 1990 and 2000, due primarily to the banning of field burning in 1994. 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 energy emissions, linked to changes in the consumption of coal in power stations.

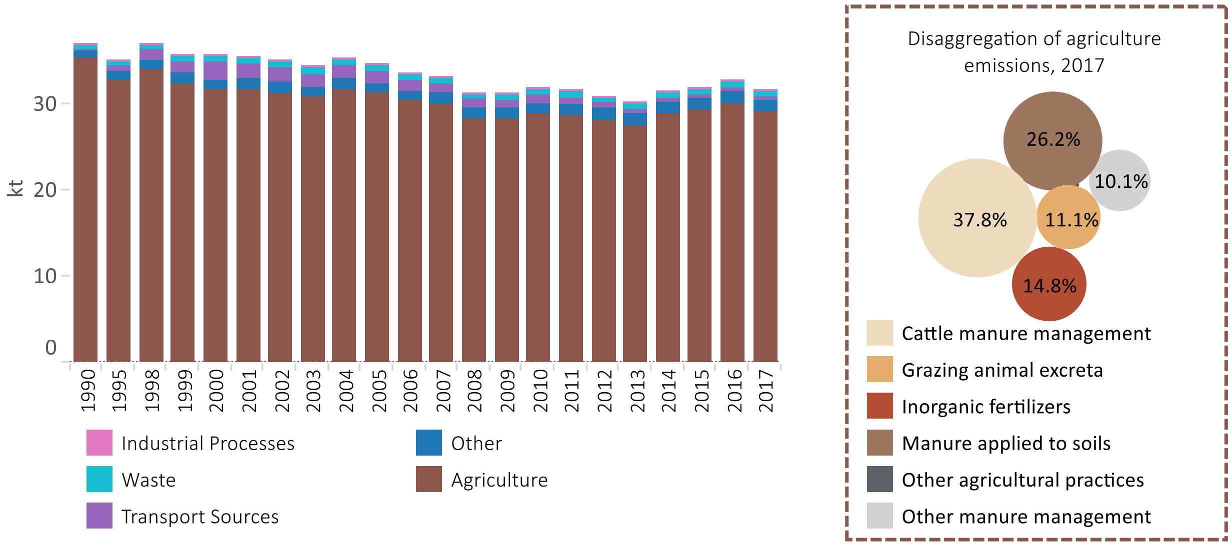
Emissions of NO_x have declined notably since 2007 primarily due to reductions in road transport emissions and the power generation sector. These are most likely linked to the installation of de-NO_x abatement systems (Boosted Over-Fire Air) on all four units at Longannet coal-fired power station (Scottish Power, Longannet Power Station, 2012) and also at Cockenzie power station (Scottish Power, 2011), which reduces NO_x emissions formed during coal combustion by up to 25%. Cockenzie power station has since ceased operation, in March 2013, and Longannet power station closed in March 2016.

Figure 18 - Scotland normalised trends for all pollutants



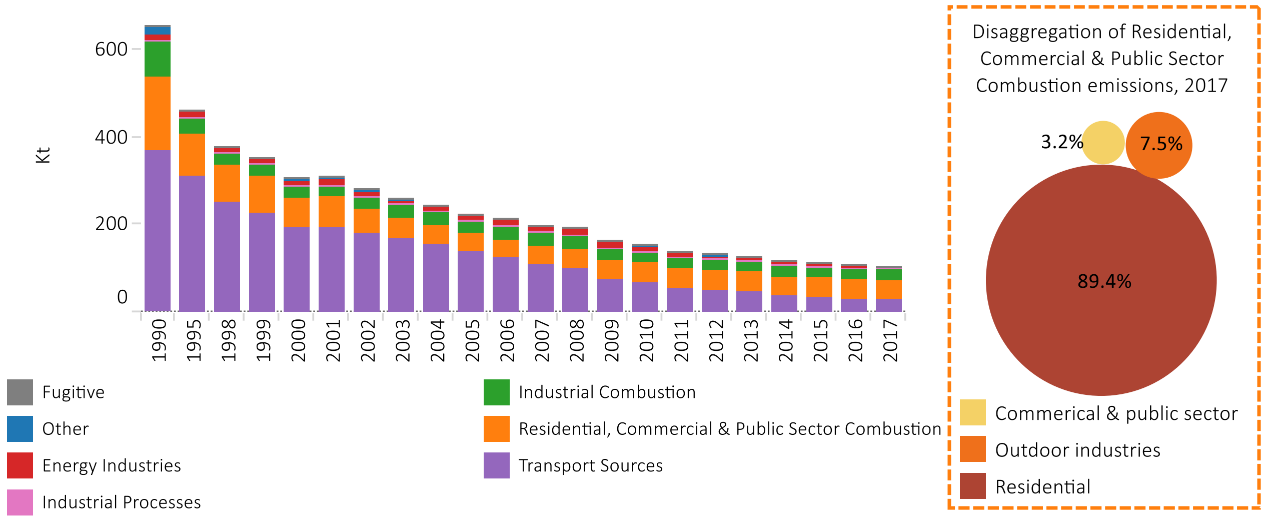
The following sections provide an overview of emissions from each of the eight main pollutants, explaining the trends and characteristics of the graphs. An overview of PCDD/Fs and B[a]p emissions is provided in **Appendix C.2** for the first time this year, although they should be considered as experimental statistics at this stage. **Appendix F** presents the DA inventory data summary tables, whilst **Appendix G** presents source category mapping used in the report**.**

Figure 19 – Ammonia Emissions in Scotland



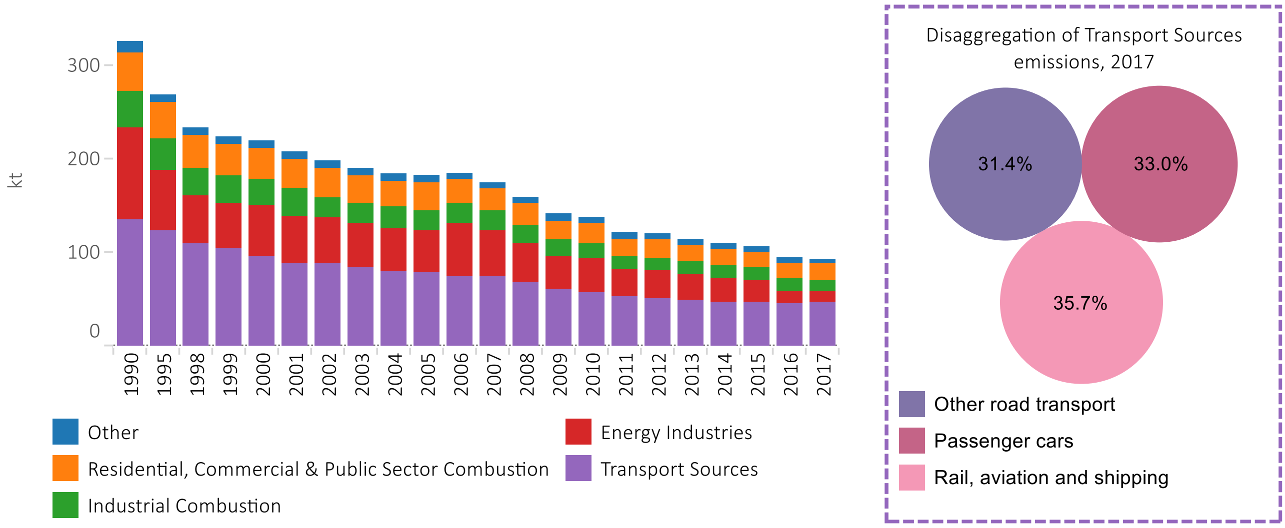
Emissions of **ammonia** were estimated to be 32kt in 2017. These emissions have declined by 15% since 1990 and accounted for 11% of the UK total in 2017. Agriculture sources have dominated the inventory throughout the time-series, with cattle manure management accounting for at least 30% of the emissions from this sector across the entire time-series. The trend in NH_3 emissions has been largely driven by decreasing animal numbers and a decline in fertiliser use, which have tended to decrease emissions across the time-series. However, an increased usage of urea-based fertilisers, which are associated with higher NH_3 emission factors, has had the opposite effect in recent years. The result is a plateauing of emissions since 2008, with an observed increase between 2013 and 2016. In addition to this, the land-spreading of non-manure digestates have caused additional increases over this period. Initial increases in the 1990s are linked to the introduction of three-ways catalytic converters, although subsequent technological advancements mean that emissions have been declining since 2000.

Figure 20 – Carbon Monoxide Emissions in Scotland



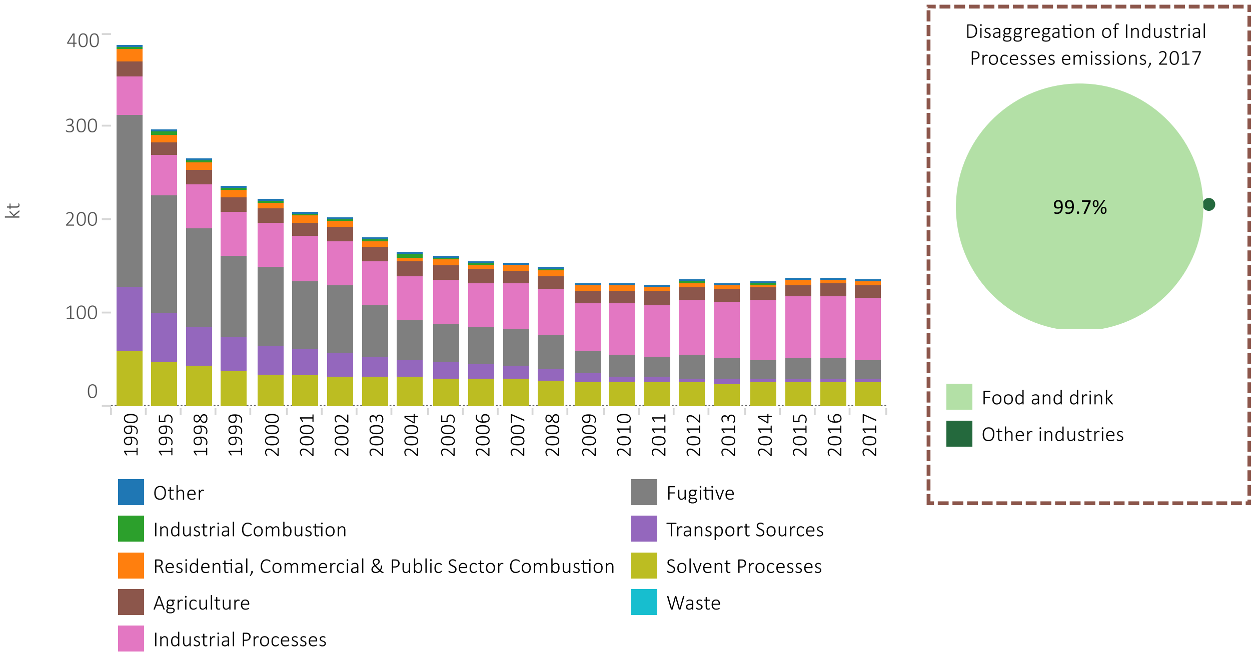
Emissions of **carbon monoxide** were estimated to be 107kt in 2017 and have declined by 84% since 1990. Emissions in Scotland accounted for 7% of the UK total in 2017. This decline in emissions stems from changes in transport sources, particularly in road transport. The decline is driven by the introduction of Euro standards after 1992 which required fitting of emission control (e.g. three-ways catalytic converters) in new petrol vehicles and in more recent years the switch from petrol cars to diesel cars. Since 2008, emissions from passenger cars have further decreased, which is mainly driven by improvements in catalyst repair rates resulting from the introduction of regulations controlling the sale and installation of replacement catalytic converters and particle filters for light duty vehicles. In recent years, emissions from the residential, commercial and public sector combustion have increased, which corresponds with an increasing use of wood fuel in the domestic sector (BEIS, 2018a).

Figure 21 – Nitrogen Oxides Emissions in Scotland



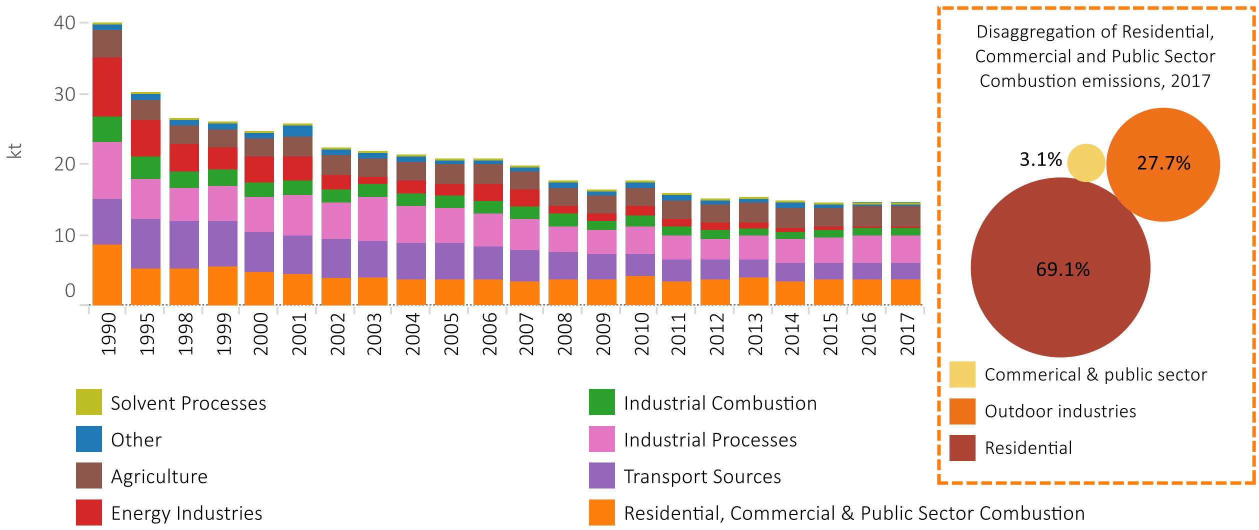
Emissions of **nitrogen oxides** were estimated to be 93kt in 2017, representing 11% of the UK total. Emissions have declined by 71% since 1990, mainly due to changes in transport sources, particularly in road transport (passenger cars and other road transport). This decline is driven by the successive introduction of tighter emission standards for petrol cars and all types of new diesel vehicles over the last decade. Since 2008, emissions from passenger cars have further decreased, which is mainly driven by improvements in catalyst repair rates resulting from the introduction of regulations controlling the sale and installation of replacement catalytic converters and particle filters for light duty vehicles. However, the increasing number of diesel cars partly offsets these emissions reductions, because diesel cars emit higher NO_x relative to their petrol counterparts (88% of 2017 passenger car emissions is due to diesel cars). The peak in NO_x emissions in 2006 is due to an increase in emissions linked to the increased use of coal at power stations that year. There was also a small increase in coal-fired generation in 2012 due to a UK-wide shift in power generation fuel mix from gas to coal in that year (BEIS, 2018a). The decline in NO_x emissions since 2007 is also linked to the power sector, as Boosted Over-Fire Air (BOFA) abatement systems were fitted to all four of Longannet's units, to reduce NO_x emissions from coal-fired generation by up to 25% (Scottish Power, Longannet Power Station, 2012). BOFA systems were also fitted on all four units at Cockenzie power station which then closed in 2013 (Scottish Power, 2011). Longannet power station closed in March 2016.

Figure 22 – NMVOC Emissions in Scotland



Emissions of **non-methane volatile organic compounds** were estimated to be 136kt in 2017, representing 17% of the UK total. Emissions have declined by 65% since 1990. This reduction has been dominated by the 90% decrease in fugitive emissions since 1990. This is primarily due to the decrease in emissions from the exploration, production and transport of oil, specifically emissions from the onshore loading of oil. The decrease between 2008 and 2009 was due to reductions in fugitive NMVOC emissions from oil loading at the Sullom Voe terminal in Shetland. Emissions from the food and drink industry (which accounts for more than 99% of industrial processes emissions in 2017) have consistently increased since 2008 due to the increased production and storage of whisky, now contributing approximately 45% of NMVOC emissions in Scotland. Emissions from road transport sources, including evaporative losses of fuel vapour from petrol vehicles have also declined over time due to emission control technologies introduced in new petrol vehicles since the early 1990s. The reduction in emissions also occurs to a lesser extent due to the introduction of petrol vapour recovery systems at filling stations.

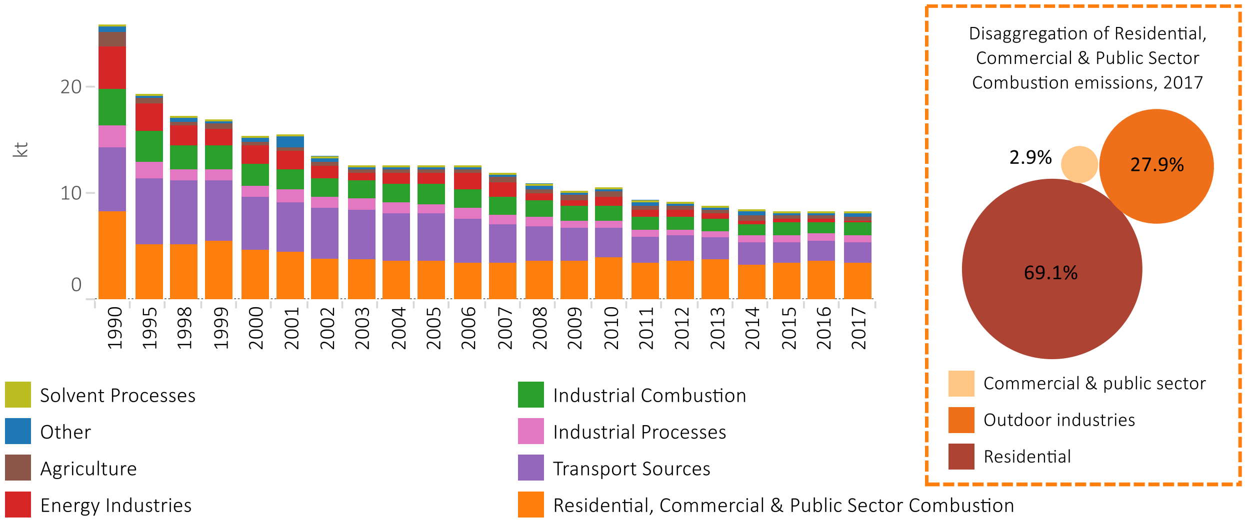
Figure 23 – PM_{10} Emissions in Scotland[2]



[2] 'Outdoor industries' presented in the bubble graph relate to combustion emissions from machinery in the agriculture, forestry and fishing industries.

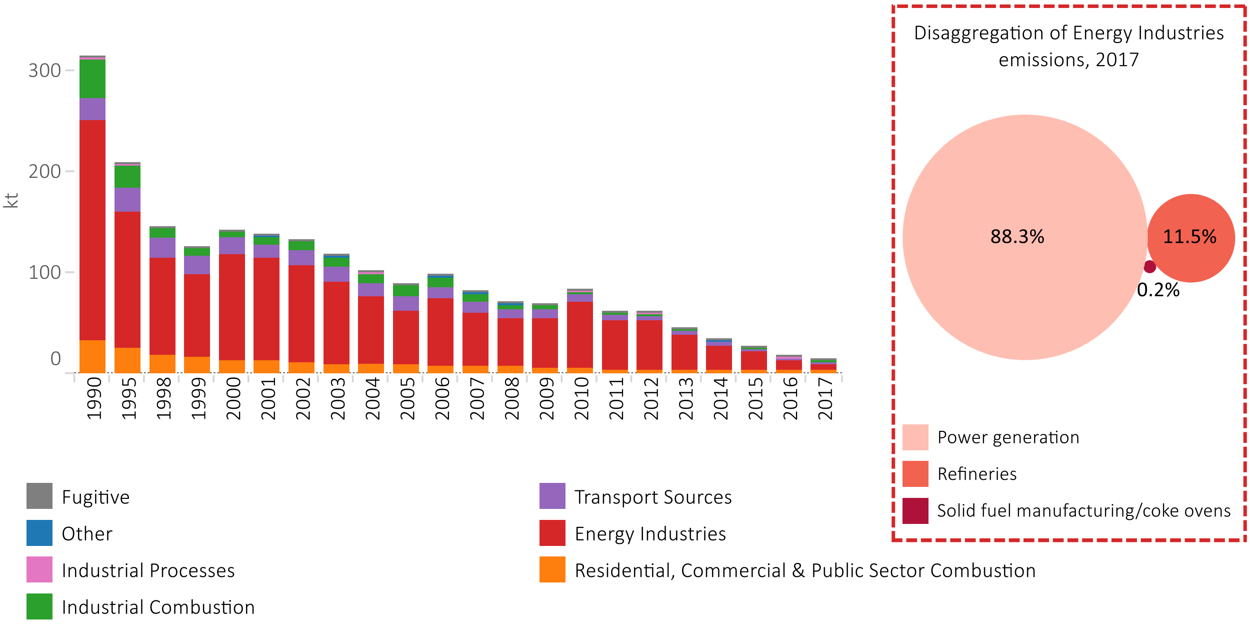
Emissions of **PM_{10}** were estimated to be 15kt in 2017, declining by 63% since 1990. These emissions account for 9% of the UK total. Unlike most other pollutants, the emissions profile of PM_{10} is diverse: transport sources, residential and industrial processes each accounted for over 10% of total emissions in 2017. Emissions from energy industries and transport sources have had the most notable impact on the trend. This reduction is primarily due to abatement at coal-fired stations, the increase in nuclear and renewable energy sources and the increase in the use of gas in energy generation (which has negligible PM_{10} emissions) in place of coal (BEIS, 2018a). PM_{10} exhaust emissions from diesel-fuelled vehicles have been decreasing due to the successive introduction of tighter emission standards over time. Increasingly non-exhaust sources of PM_{10} (for example tyre wear) have become more important to consider as exhaust PM_{10} has been reduced. In fact, in 2017, 75% of emissions from the road transport sector were related to non-exhaust sources. In recent years, emissions from the residential and other combustion sector have slightly increased, and this is due to an increasing quantity of wood fuel use, primarily in the residential sector (BEIS, 2018a).

Figure 24 – $PM_{2.5}$ Emissions in Scotland[2]



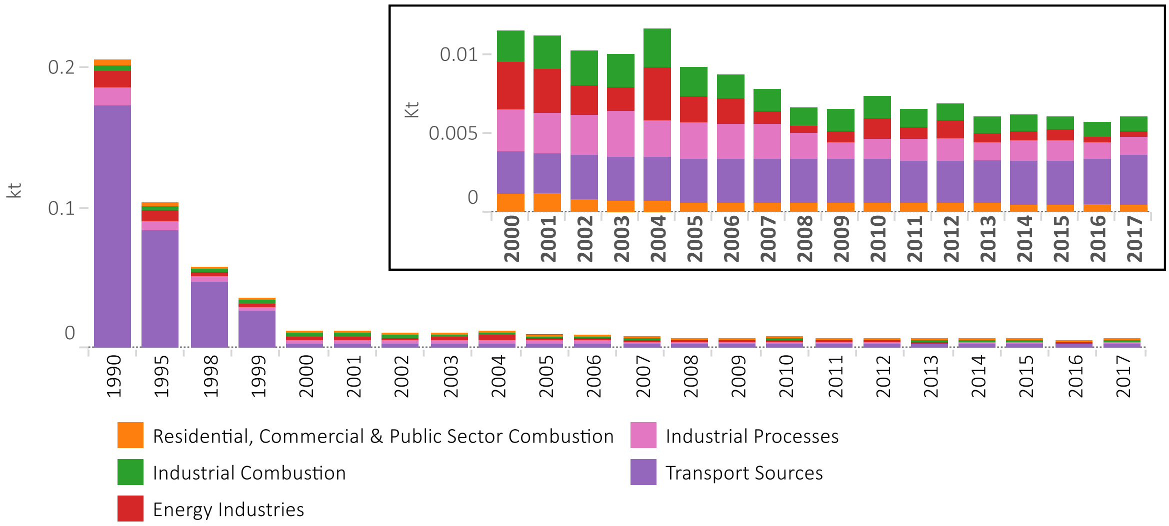
Emissions of **$PM_{2.5}$** were estimated to be 8kt in 2017, declining by 68% since 1990. These emissions account for 8% of the UK total in 2017. As with PM_{10}, $PM_{2.5}$ emissions have a large number of significant sources. However, process emissions tend to produce coarser PM fractions and as such, combustion emissions are of greater importance for $PM_{2.5}$ compared to PM_{10}. For $PM_{2.5}$, the residential, commercial and public sector combustion category (which includes agricultural combustion and fishing vessels – NFR code 1A4) accounts for 42% of 2017 emissions. The primary drivers for the decline in emissions since 1990 are the switch in the fuel mix used in electricity generation away from coal and towards natural gas, particularly in the early time-series, and later reductions in emissions from the transport sector due to the introduction of progressively more stringent emissions standards through time. Since 2005, declines in emissions have been offset by increases in emissions from the residential sector, and in particular, the combustion of wood.

Figure 25 – Sulphur Dioxide Emissions in Scotland



Emissions of **sulphur dioxide** were estimated to be 14kt in 2017, representing 8% of the UK total in 2017. Emissions have declined by 96% since 1990, dominated by the 98% reduction in energy industries emissions, coincident with large changes in the power generation sector. These include the reduction in coal fired power relative to other sources; improved emission controls on some large coal fired plants such as the installation of an FGD (flue-gas desulphurization) plant at Longannet power station; and also the use of coal of lower sulphur content in later years to Cockenzie (Scottish Power, 2011). Emissions from power generation fell between 2012 and 2013 due to the closure of Cockenzie power station in March 2013, and a UK-wide shift in power generation fuel mix back from coal to natural gas (BEIS, 2018a). The closure of Longannet in 2016 caused a large reduction in emissions in the latest reported year. SO2 emissions from transport sources have declined, coincident with the reduced sulphur content of road fuels, both petrol and diesel.

Figure 26 – Lead Emissions in Scotland



Emissions of **lead** were estimated to be 6.1 tonnes in 2017, representing 6% of the UK total. Emissions have declined by 97% since 1990 almost entirely due to changes in transport sources. Petrol with lead additives was phased out from general sale by the end of 1999, which is the reason for the 98.4% decrease in transport emissions between 1990 and 2000. The peak in 2004 was due to an increase in reported emissions from coal combustion in power generation. Transport sources accounted for 51% of total lead emissions in 2017, with industrial combustion accounting for a further 14%, and use of fireworks contributing a further 11%. The inventory agency has made note of a spurious trend in the raw data used to calculate road transport emissions in Scotland between 2016 and 2017. This will be interrogated when new data is received for the calculation of the 1990-2018 inventory and appropriate steps to ensure time-series consistency will be taken. Until then, the trend in transport emissions between 2016 and 2017 should be considered with high uncertainty.

Table 3 below provides a summary of the percentage contribution of each sector for each pollutant in 2017. The table is shaded according to the overall contribution of that sector to the pollutant total. The table below indicates that the Residential and Other Combustion sector is an important sector when considering emissions of CO, SO_2, PM_{10} and $PM_{2.5}$.

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

Table 3 – Source Emission Contributions Ranked by Sector, Scotland 2017

Sector	NH3	CO	NOx	NMVOC	PM10	PM2.5	SO2	Pb	B[a]p	Dioxins
Agriculture	92%	IE	IE	10%	18%	5%	IE	0%	0%	0%
Energy Industries	IE	4%	13%	IE	1%	2%	37%	6%	0%	1%
Fugitive	IE	1%	IE	14%	IE	IE	1%	IE	0%	0%
Industrial Combustion	IE	26%	13%	1%	8%	15%	10%	15%	1%	12%
Industrial Processes	0%	0%	IE	49%	26%	9%	5%	20%	2%	7%
Residential, Commercial & Public Sector Combustion	IE	42%	18%	3%	24%	42%	28%	9%	90%	41%
Solvent Processes	IE	0%	0%	19%	1%	0%	0%	0%	0%	1%
Transport Sources	1%	26%	51%	3%	17%	22%	18%	51%	3%	6%
Waste	3%	IE	IE	IE	IE	IE	IE	0%	5%	33%
Other	4%	2%	6%	1%	5%	6%	1%	0%	0%	0%

* The sector: “other” includes all “other” categories in the inventory and also a number of categories that are insignificant for a specific pollutant. These have been marked in the table as “IE” (used in inventory reporting for “Included Elsewhere”). A breakdown of what is included within this category in respect to each pollutant can be found in **Table 21**.

Figure 27 – Ammonia Emissions in Scotland, 2017

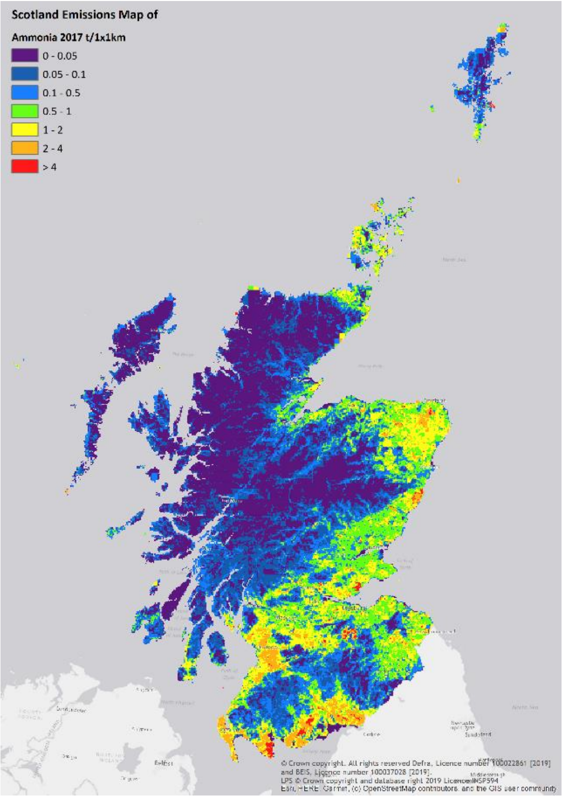


Figure 28 – Carbon Monoxide Emissions in Scotland, 2017

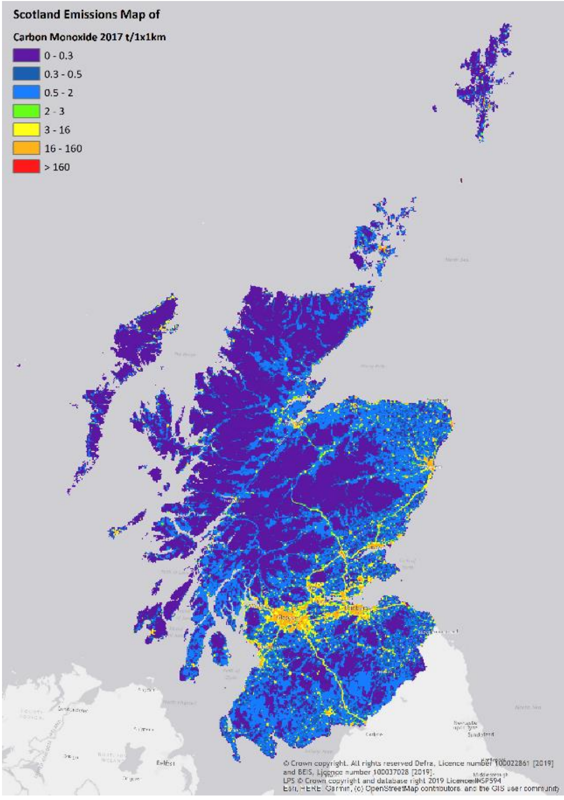


Figure 29 – Nitrogen Oxides Emissions in Scotland, 2017

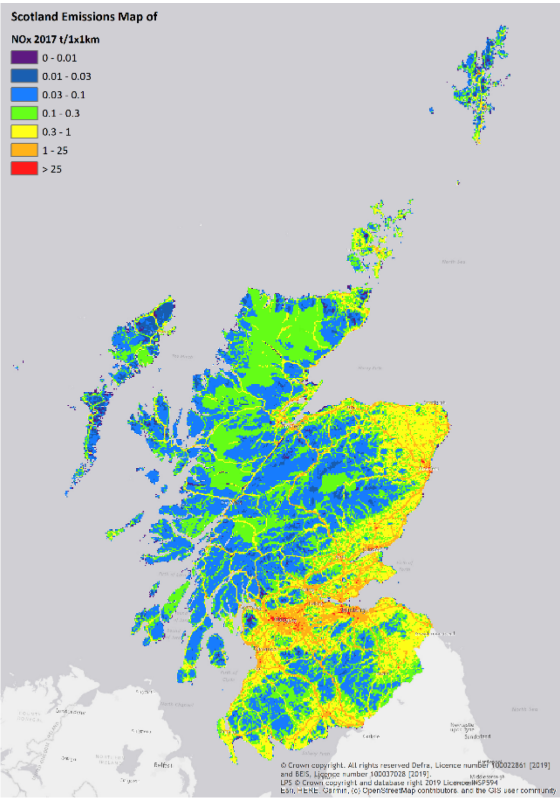


Figure 30 – NMVOC Emissions in Scotland, 2017

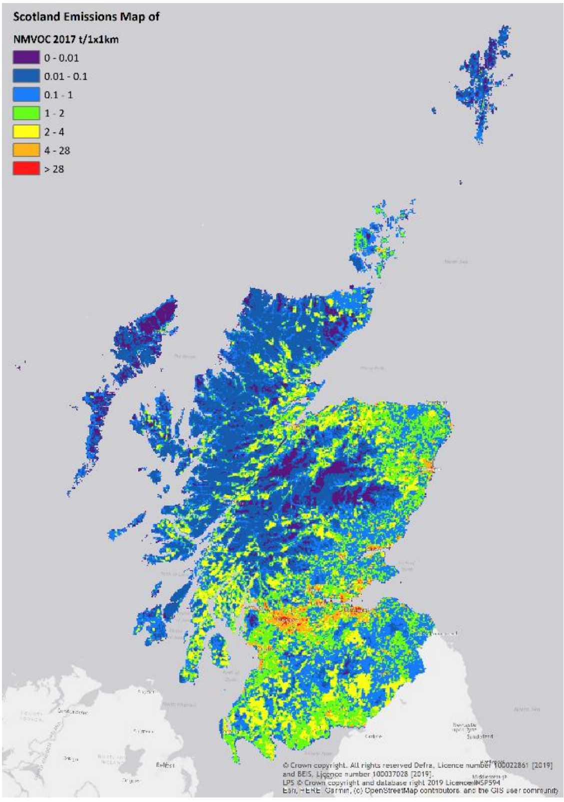


Figure 31 – PM_{10} Emissions in Scotland, 2017

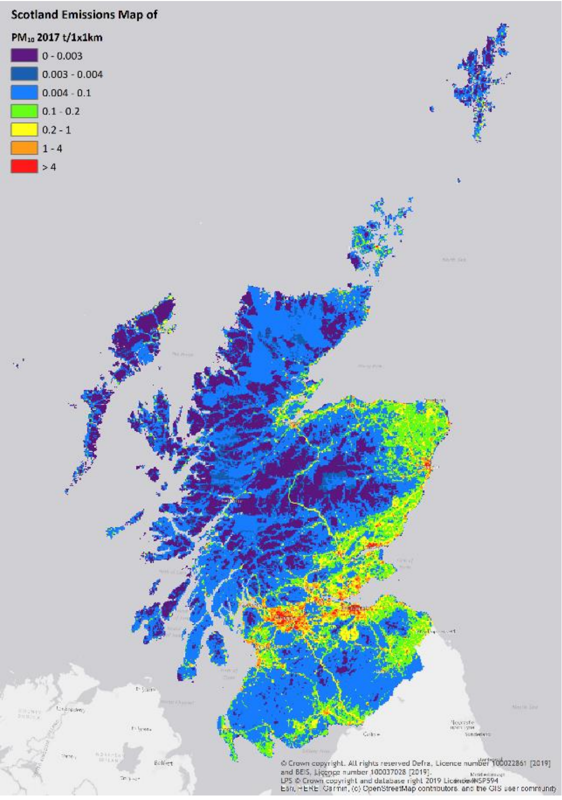


Figure 32 – $PM_{2.5}$ Emissions in Scotland, 2017

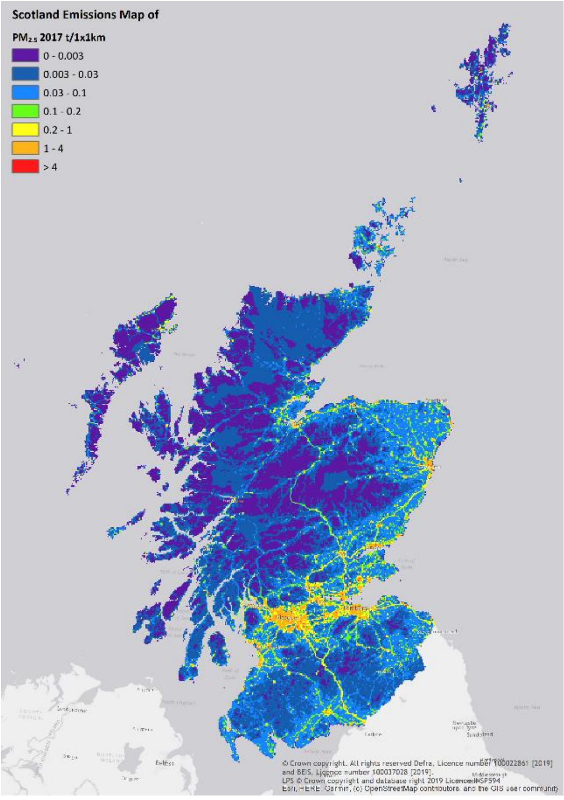


Figure 33 – Lead Emissions in Scotland, 2017

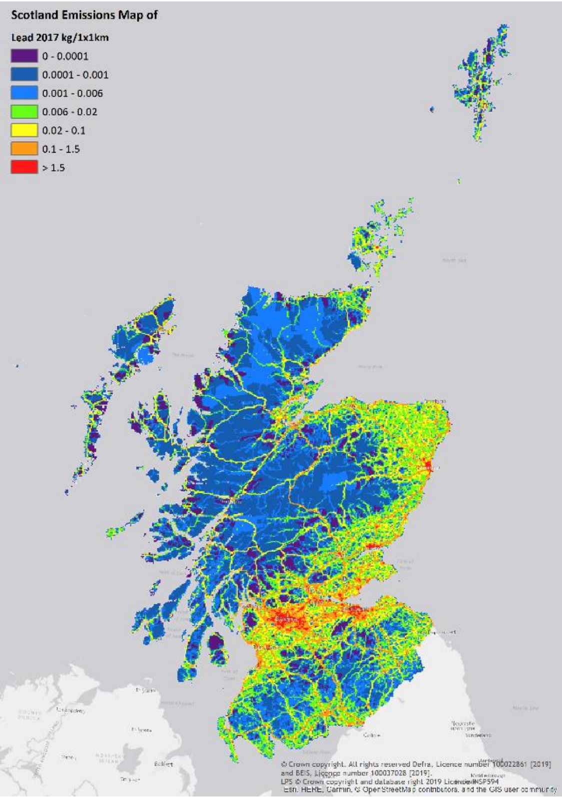
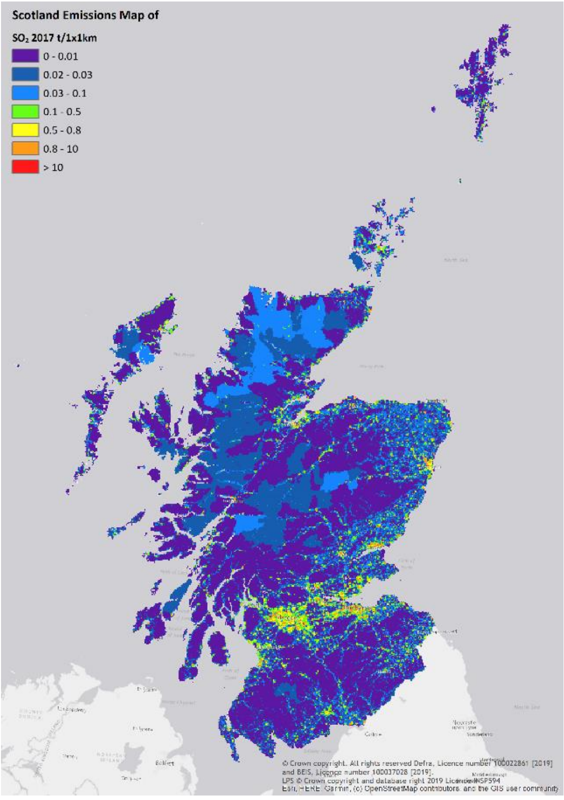


Figure 34 – Sulphur Dioxide Emissions in Scotland, 2017



2.3 Wales

The following section provides a summary of emissions in Wales for the eight priority air pollutants: NH_3, CO, NO_x, NMVOCs, PM_{10}, $PM_{2.5}$, SO_2, and Pb whilst also providing a basic summary of PCDD/F and B[a]p emissions. A more detailed assessment for these two experimental pollutants is found in **Appendix C.2**.

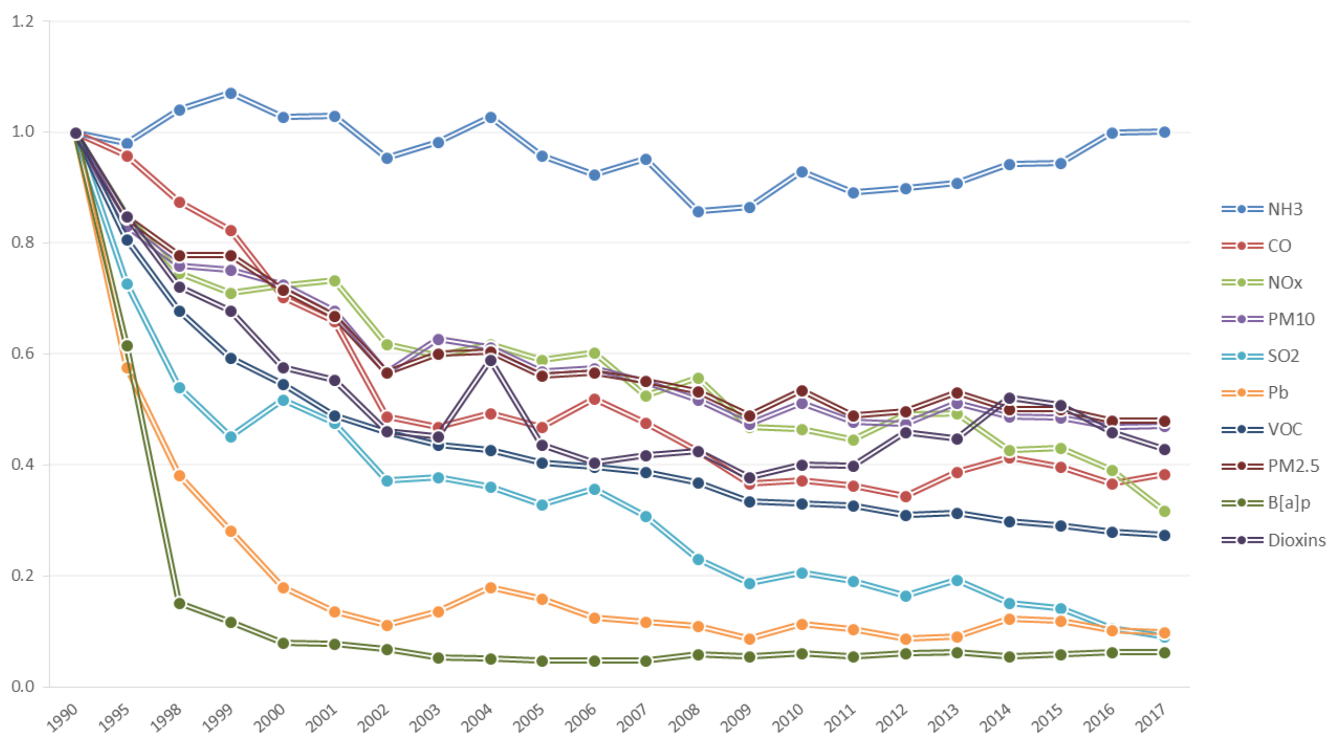
Figure 35 shows emissions of all ten air pollutants normalised to provide the relative rate of decline since 1990. This graph shows that the majority of pollutant emission levels are lower in 2017 than they were in 1990. The decline is relatively similar for PM_{10}, $PM_{2.5}$, NO_x, dioxins, NMVOC and CO.

However, Pb shows a higher rate of reduction from 1990 to 2000 coincident with the phase-out of leaded petrol by the end of 1999. B[a]p emissions similarly show a large decrease between 1990 and 2000 due to the ban on field burning. NH_3 emissions, by contrast, have declined at a much slower rate than other pollutants, and have exhibited a slight increase in emissions in recent years due to increases in application of organic and inorganic nitrogen-based fertilisers, and also due to increases in cattle livestock and subsequent waste management.

Reductions in SO_2 since 2006 are due, primarily, to the retro-fitting of flue gas desulphurisation and the co-firing of biomass at power stations, with the increase in 2013 due in part to increases in generation and hence the amount of fuel consumed.

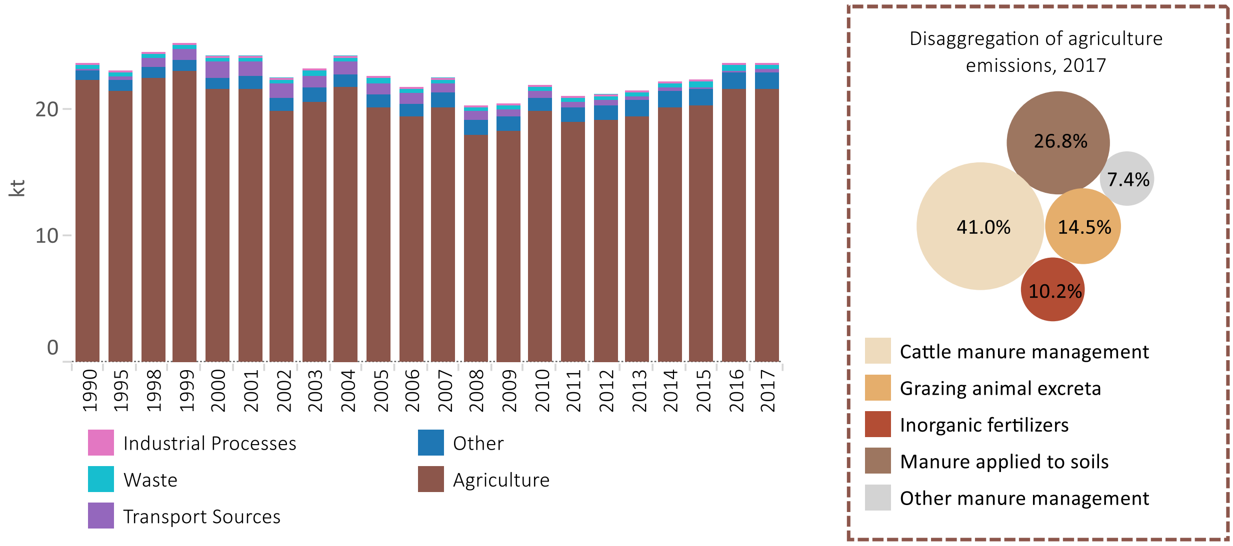
Many pollutant trends in Wales are also influenced substantially by the combustion and process emission sources linked to the iron and steel industry, and in particular changes in activity at Port Talbot steelworks. For example, between 2012 and 2013 an upturn in production at the plant led to increases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

Figure 35 – Wales normalised trends for all pollutants



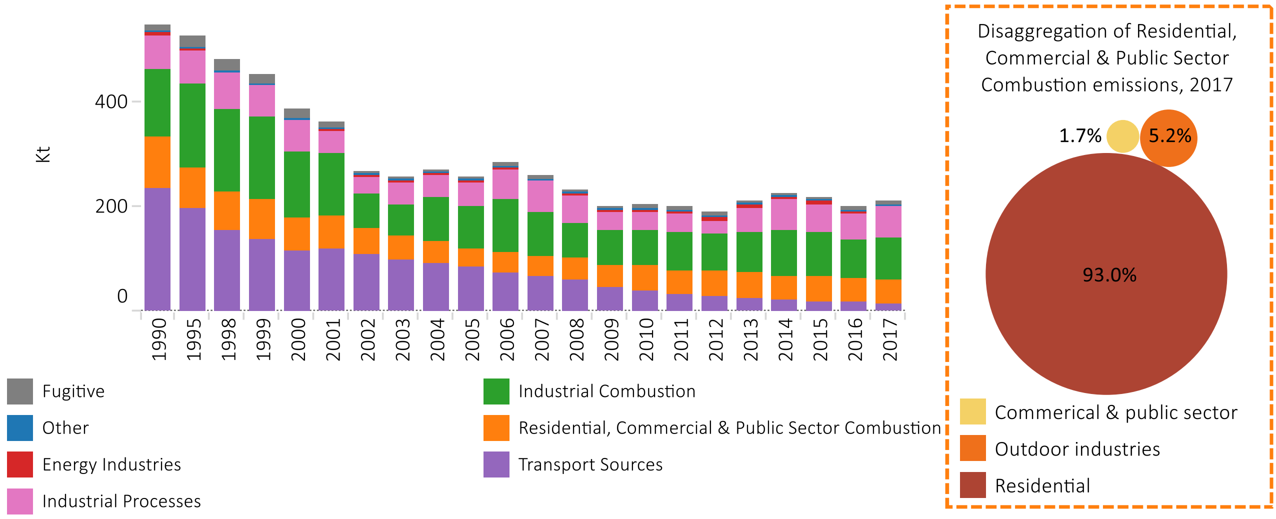
The following sections provide an overview of emissions from each of the eight main pollutants, explaining the trends and characteristics of the graphs. An overview of PCDD/Fs and B[a]p emissions is provided in **Appendix C.2** for the first time this year, although they should be considered as experimental statistics at this stage. **Appendix F** presents the DA inventory data summary tables, whilst **Appendix G** presents source category mapping used in the report**.**

Figure 36 – Ammonia Emissions in Wales



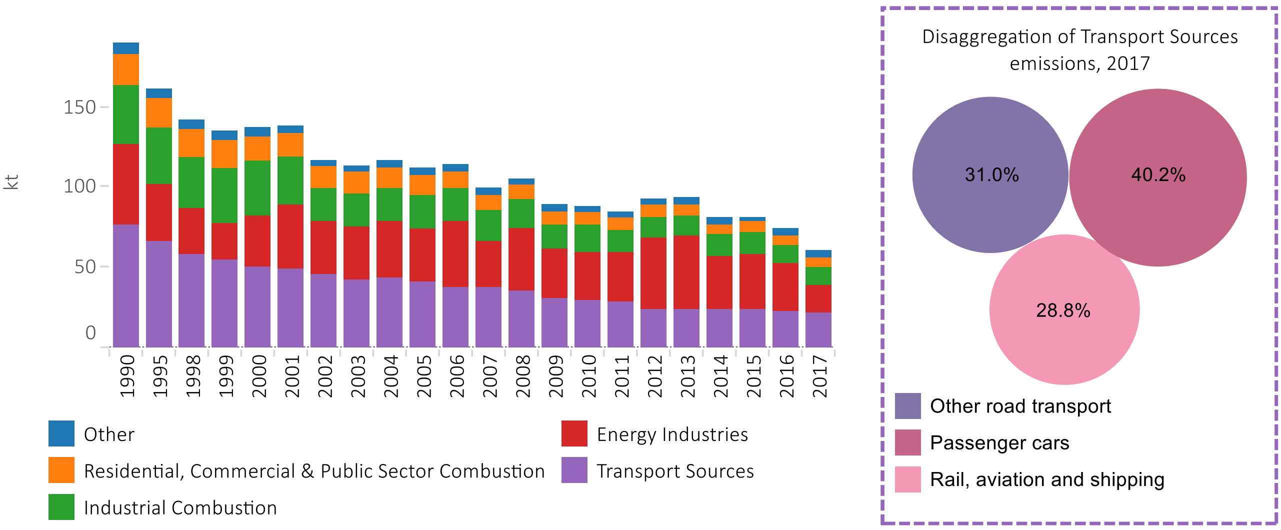
Emissions of **ammonia** were estimated to be 24kt in 2017. These emissions are at a similar level in 2017 to 1990 and account for 8% of the UK total. Agriculture sources have dominated the time-series, with cattle manure management alone accounting for over 35% of emissions throughout. The trend in NH_3 emissions has been largely driven by decreasing animal numbers and a decline in fertiliser use, which have tended to decrease emissions across the time-series. However, increased emission from manure management practices, particularly for dairy cattle, and from the application of ammonium nitrate and digestate fertilisers to soils have seen emissions increase since reaching a minimum in 2007.

Figure 37 – Carbon Monoxide Emissions in Wales



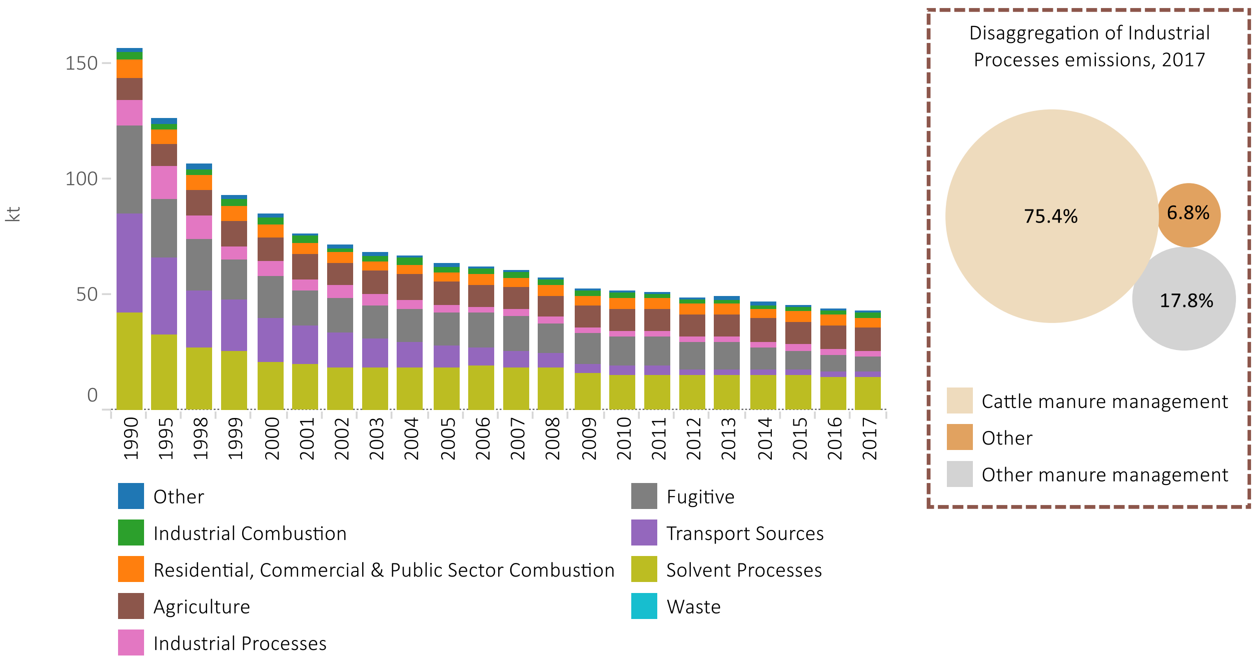
Emissions of **carbon monoxide** were estimated to be 211kt in 2017 and have declined by 62% since 1990. Emissions in Wales accounted for 14% of the UK total in 2017. This decline in emissions stems from changes in transport sources, particularly road transport. The decline is driven by the introduction of Euro standards after 1992 which requires fitting of emission control (e.g. three-ways catalytic converters) in new petrol vehicles and in more recent years the switch from petrol cars to diesel cars. Since 2008, emissions from passenger cars have further decreased, which is mainly driven by improvements in catalyst repair rates resulting from the introduction of regulations controlling the sale and installation of replacement catalytic converters and particle filters for light duty vehicles. In more recent years, the most important sector has been industrial combustion and, more specifically, the iron and steel industry.

Figure 38 – Nitrogen Oxides Emissions in Wales



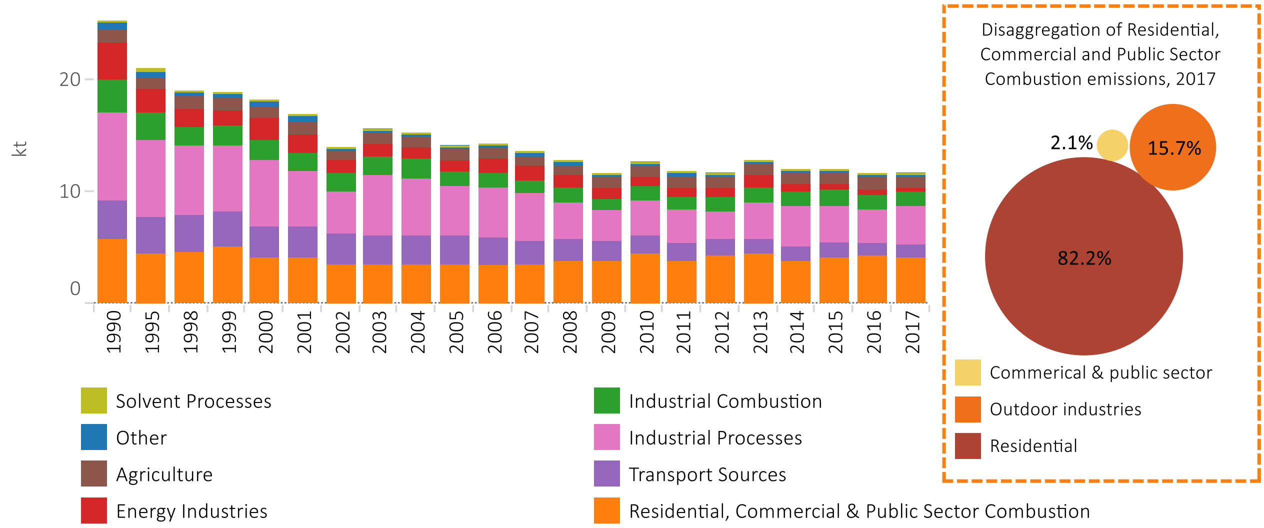
Emissions of **nitrogen oxides** were estimated to be 60kt in 2017, representing 7% of the UK total. Emissions have declined by 68% since 1990, mainly due to changes in transport sources, particularly in road transport. This decline is driven by the successive introduction of tighter emission standards for petrol cars and all types of new diesel vehicles over the last decade. Since 2008, emissions from passenger cars have further decreased, which is mainly driven by improvements in catalyst repair rates resulting from the introduction of regulations controlling the sale and installation of replacement catalytic converters and particle filters for light duty vehicles. However, the increasing number of diesel cars offsets these emissions reductions, because diesel cars emit higher NO_x relative to their petrol counterparts. The reduction in emissions more recently corresponds to the reduction in coal use at Aberthaw power station since 2013.

Figure 39 – NMVOC Emissions in Wales



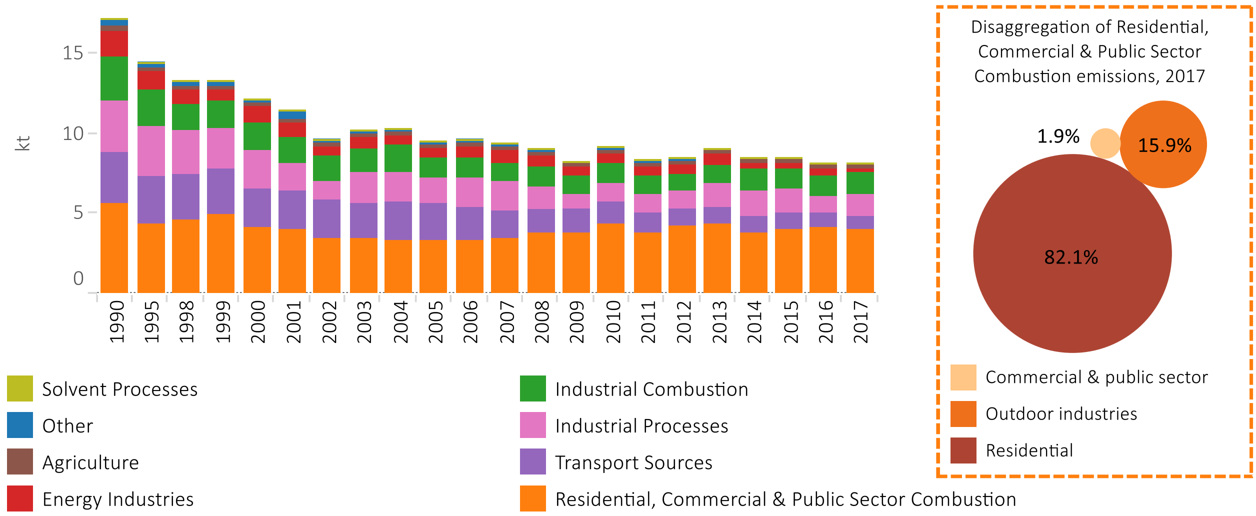
Emissions of **non-methane volatile organic compounds** were estimated to be 43kt in 2017, representing 5% of the UK total. Emissions have declined by 73% since 1990. This reduction is mainly due to the decrease in emissions from transport and fugitive sources, including evaporative losses of fuel vapour from petrol vehicles. This decline is coincident with emission control technologies introduced in new petrol vehicles since the early 1990s and, in more recent years, the increasing proportion of diesel fuelled vehicles in the passenger fleet. The reduction in emissions also occurs to a lesser extent due to the introduction of petrol vapour recovery systems at filling stations. Due to this large reduction in transport emissions, solvent processes are now the most important source of NMVOC emissions, with the largest amount of emissions arising from domestic solvent applications.

Figure 40 – PM_{10} Emissions in Wales[3]



Emissions of **PM_{10}** were estimated to be 12kt in 2017 and have declined by 54% since 1990. These emissions account for 7% of the UK total in 2017. Unlike most other pollutants, the emissions profile of PM_{10} is diverse: transport sources, industrial combustion and industrial processes each account for significant fractions of the total, although the largest individual source is residential combustion, which accounts for 33% of the 2017 total. Iron and steel process sources such as sinter plants, basic oxygen furnaces and blast furnaces, and combustion sources, account for a further 14%. As a result, recent trends are influenced by the use of solid fuels in the residential sector as well as iron and steel production trends, but there is no strong trend in overall emissions evident in the last 9 years. In recent years, emissions from residential, commercial and public sector combustion have increased, and this is primarily due to increasing wood fuel use in the residential sector (BEIS, 2018a).

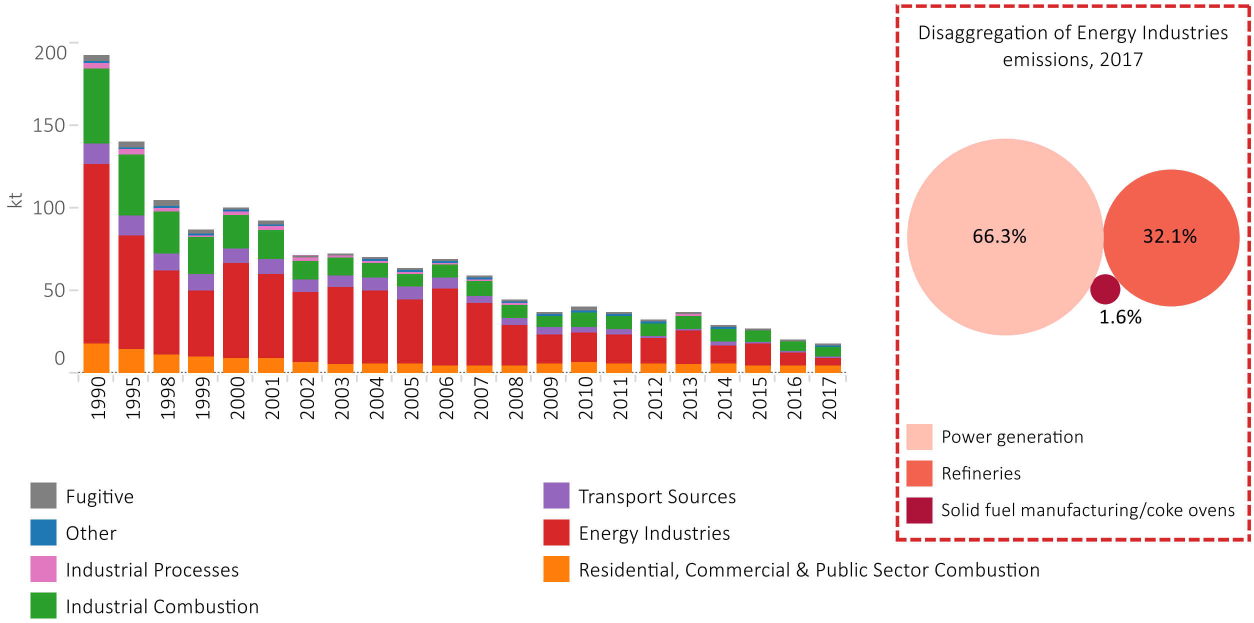
Figure 41 – $PM_{2.5}$ Emissions in Wales[3]



[3] 'Outdoor industries' presented in the bubble graph relate to combustion emissions from machinery in the agriculture, forestry and fishing industries.

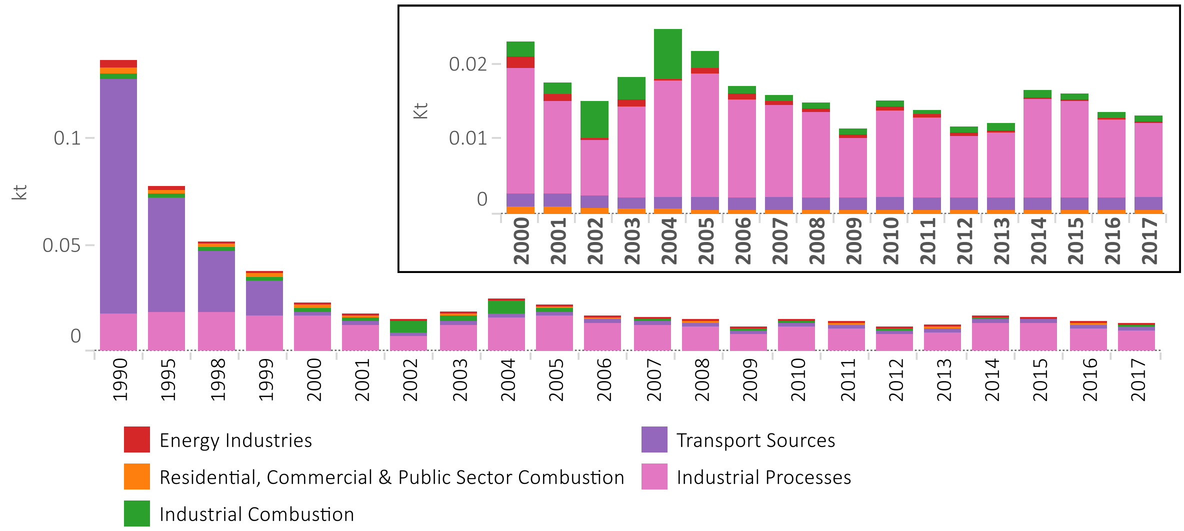
Emissions of **$PM_{2.5}$** were estimated to be 8kt in 2017 and have declined by 52% since 1990. These emissions account for 8% of the UK total in 2017. As with PM_{10}, $PM_{2.5}$ emissions have a large number of significant sources. However, process emissions tend to produce coarser PM fractions and as such, combustion emissions are of greater importance for $PM_{2.5}$ compared to PM_{10}. For $PM_{2.5}$, the residential, commercial and public sector combustion category (NFR 1A4, which also includes agricultural combustion and fishing vessels) accounts for 48% of 2017 emissions. The primary drivers for the decline in emissions since 1990 are the switch in the fuel mix used in electricity generation away from coal and towards natural gas, particularly in the early time-series, and later reductions in emissions from the transport sector due to the introduction of progressively more stringent emissions standards through time. Since 2005, declines in emissions have been offset by increases in emissions from the residential sector, and in particular, the combustion of wood.

Figure 42 – Sulphur Dioxide Emissions in Wales



Emissions of **sulphur dioxide** were estimated to be 17kt in 2017, representing 10% of the UK total. Emissions have declined by 91% since 1990, which has been dominated by the 96% reduction in energy industries emissions. This reduction is coincident with the UK-wide shift in power generation fuel mix away from coal to natural gas, nuclear and renewable sources. Trends in recent years are influenced by emissions from a range of energy industries (power generation, oil refining) as well as the use of solid fuels in the residential sector and production trends (and related coal use) in the iron and steel industry.

Figure 43 – Lead Emissions in Wales



Emissions of **lead** were estimated to be 14 tonnes in 2017, representing 14% of the UK total. Emissions have declined by 90% since 1990 almost entirely due to changes in transport sources. Petrol with lead additives was phased out from general sale by the end of 1999, which is the reason for the 98.96 decrease in transport emissions between 1990 and 2000. The most substantive sources of emissions are now industrial processes in the iron and steel industry.

Table 4 below provides a summary of the percentage contribution of each sector for each pollutant in 2017. The table is shaded according to the overall contribution of that sector to the pollutant total. The majority of the top five sectors are related to the combustion of fuel, whilst Industrial Processes is also significant, 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 important when considering all pollutants, it is of very high significance when considering emissions of NH_3.

Table 4 – Source Emission Contributions Ranked by Sector, Wales 2017

Sector	NH3	CO	NOx	NMVOC	PM10	PM2.5	SO2	Pb	B[a]p	Dioxins
Agriculture	91%	IE	IE	24%	9%	3%	IE	0%	0%	0%
Energy Industries	IE	2%	27%	IE	3%	3%	25%	1%	0%	1%
Fugitive	IE	3%	IE	15%	IE	IE	5%	IE	12%	1%
Industrial Combustion	IE	38%	20%	4%	12%	16%	36%	6%	0%	5%
Industrial Processes	0%	28%	IE	5%	29%	17%	3%	73%	2%	57%
Residential, Commercial & Public Sector Combustion	IE	22%	10%	10%	35%	49%	26%	4%	82%	24%
Solvent Processes	IE	0%	0%	34%	1%	0%	0%	0%	0%	0%
Transport Sources	1%	7%	37%	5%	10%	10%	6%	12%	1%	2%
Waste	2%	IE	IE	IE	IE	IE	IE	0%	2%	11%
Other	6%	1%	6%	2%	3%	3%	1%	4%	0%	0%

* The sector: "other" will include all "other" categories in the inventory and also a number of categories that are insignificant for a specific pollutant. These have been marked in the table as "IE" (used in inventory reporting for "Included Elsewhere"). A breakdown of what is included within this category in respect to each pollutant can be found in **Table 21**

Figure 44 – Ammonia Emissions in Wales, 2017

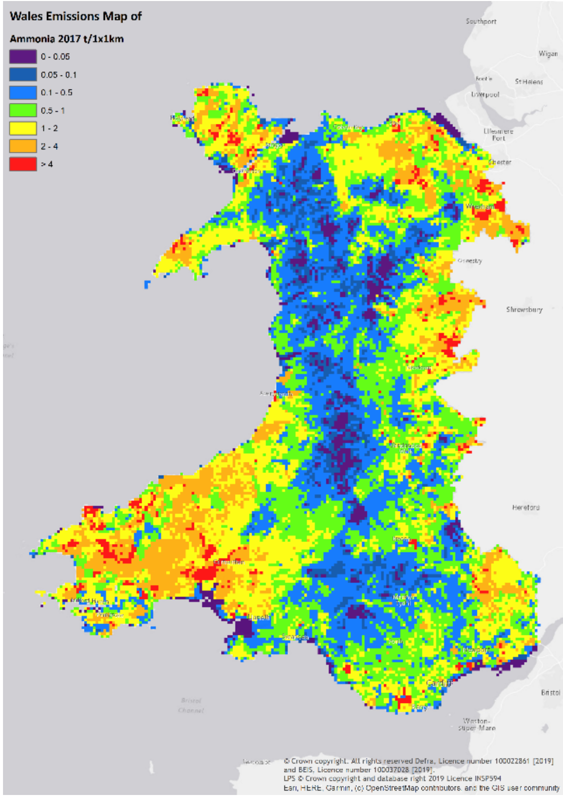


Figure 45 – Carbon Monoxide Emissions in Wales, 2017

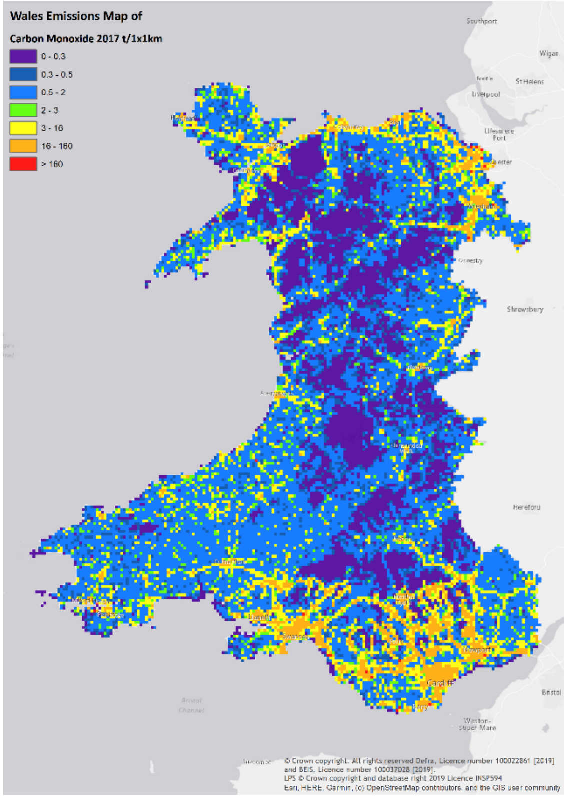


Figure 46 – Nitrogen Oxides Emissions in Wales, 2017

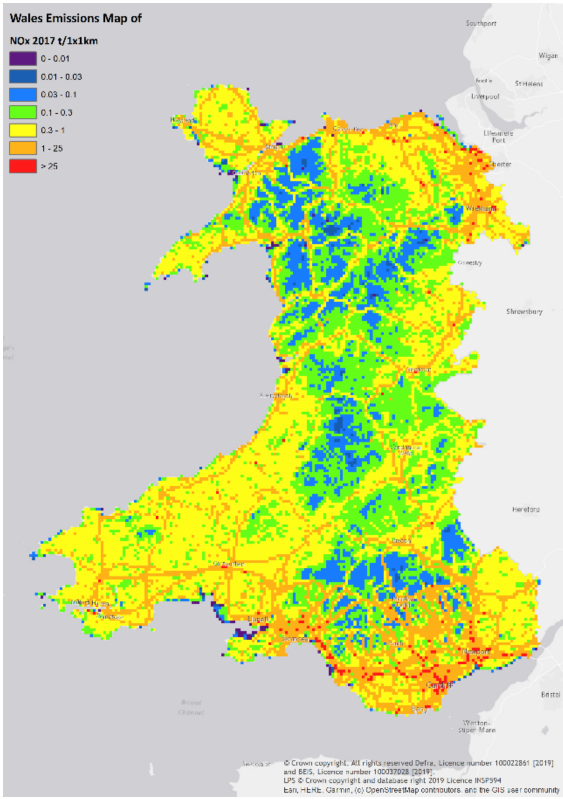


Figure 47 – NMVOC Emissions in Wales, 2017

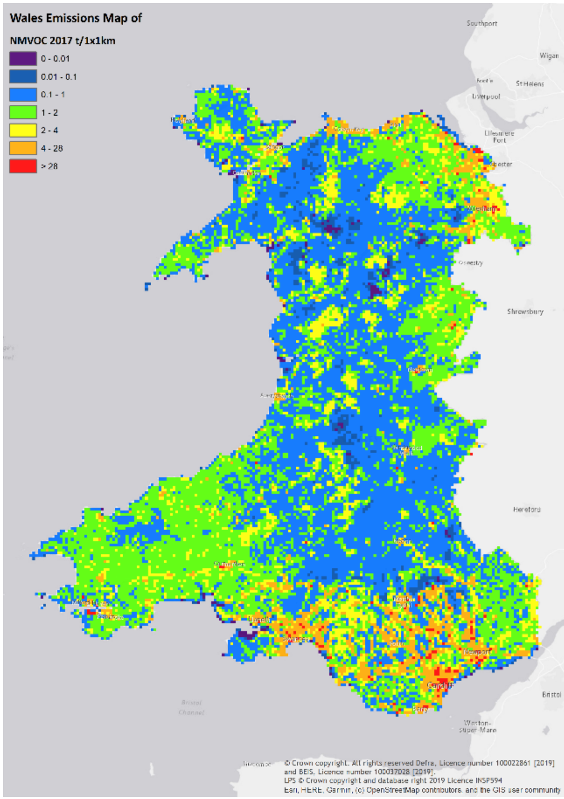


Figure 48– PM_{10} Emissions in Wales, 2017

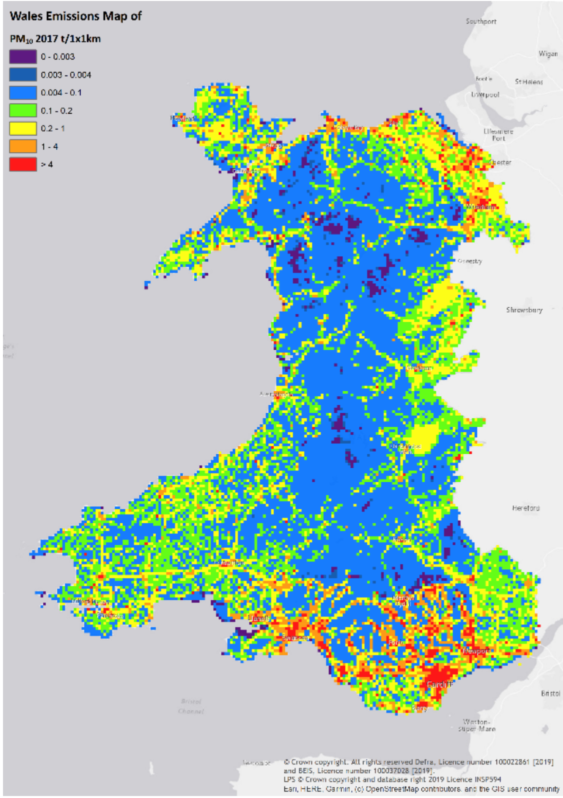


Figure 49 – $PM_{2.5}$ Emissions in Wales, 2017

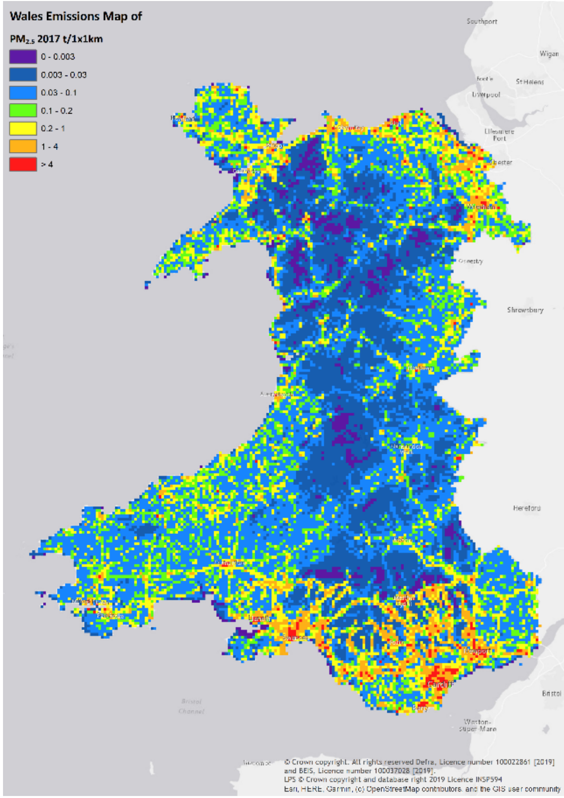


Figure 50 – Lead Emissions in Wales, 2017

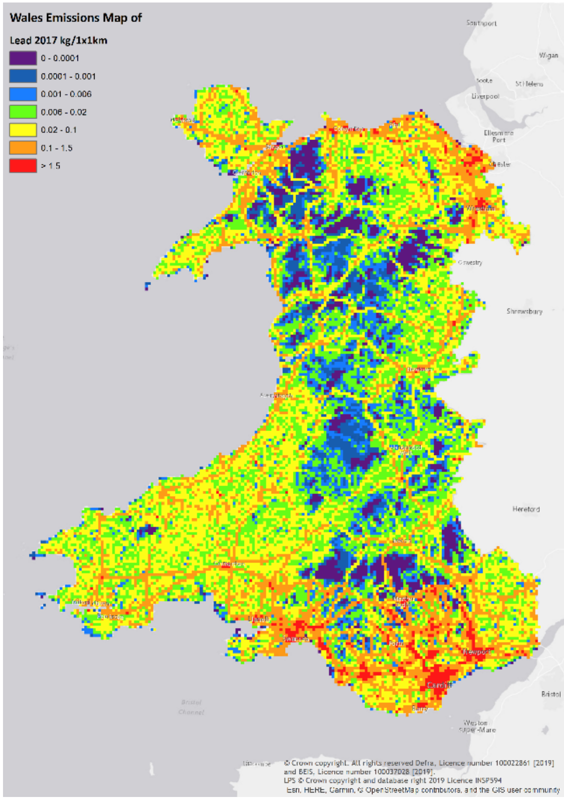
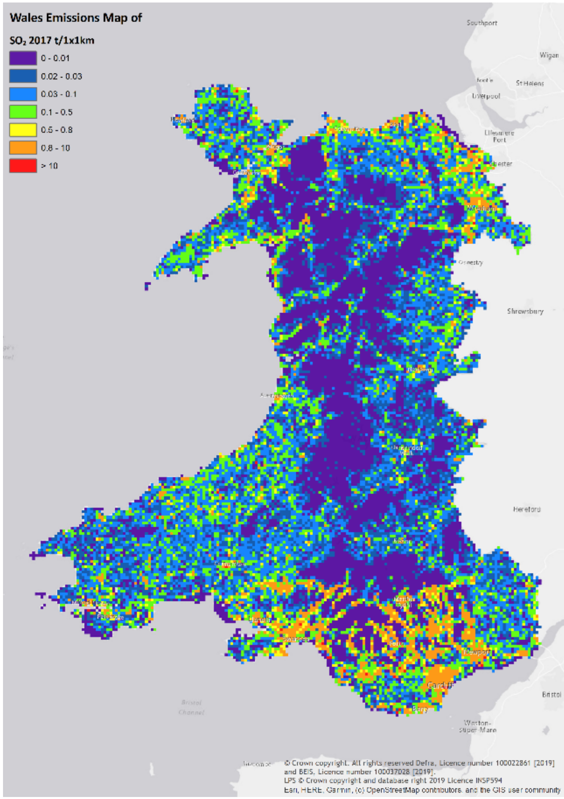


Figure 51 – Sulphur Dioxide Emissions in Wales, 2017



2.4 Northern Ireland

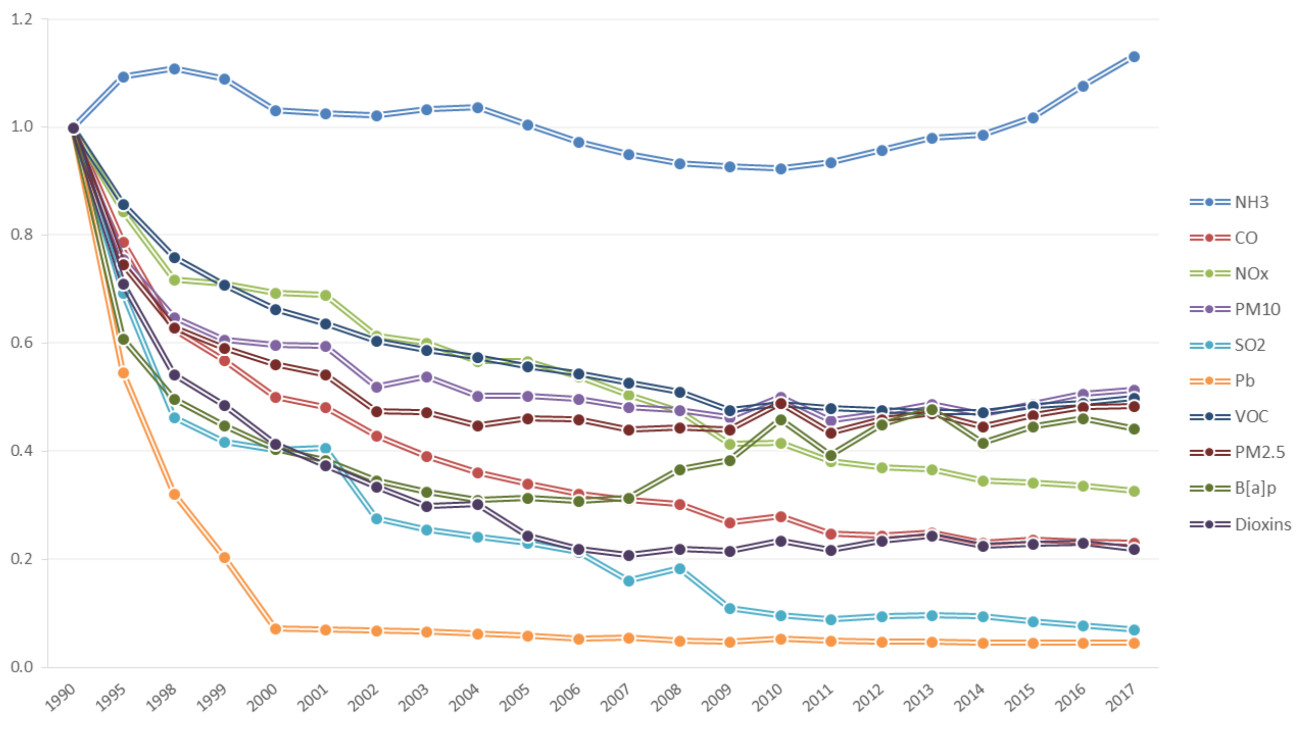
The following section provides a summary of emissions in Northern Ireland for the eight priority air pollutants: NH_3, CO, NO_x, NMVOCs, PM_{10}, $PM_{2.5}$, SO_2, and Pb whilst also providing a basic summary of PCDD/F and B[a]p emissions. A more detailed assessment for these two experimental pollutants is found in **Appendix C.2**.

Figure 52 shows emissions of all ten air pollutants normalised to provide the relative rate of decline since 1990. This graph shows that all pollutant emission levels except ammonia are lower in 2017 than they were in 1990. The decline is relatively similar for PM_{10}, $PM_{2.5}$, NO_x and NMVOC.

However, Pb shows a much higher rate of reduction from 1990 to 2000 due to the phase-out of leaded petrol by the end of 1999. NH_3 emissions, by contrast, only reached levels that were lower than 1990 estimates from 2007 onwards but has increased again since 2010 due to rising dairy cattle numbers, and hence emissions from manure management practices for these animals, and also from the spreading of cattle manure to agricultural soils. In addition, an increase in other nitrogen-based fertiliser use, primarily urea-based and digestate fertilisers. The trend for B[a]p is dominated by residential combustion, as is the long-term trend for dioxins.

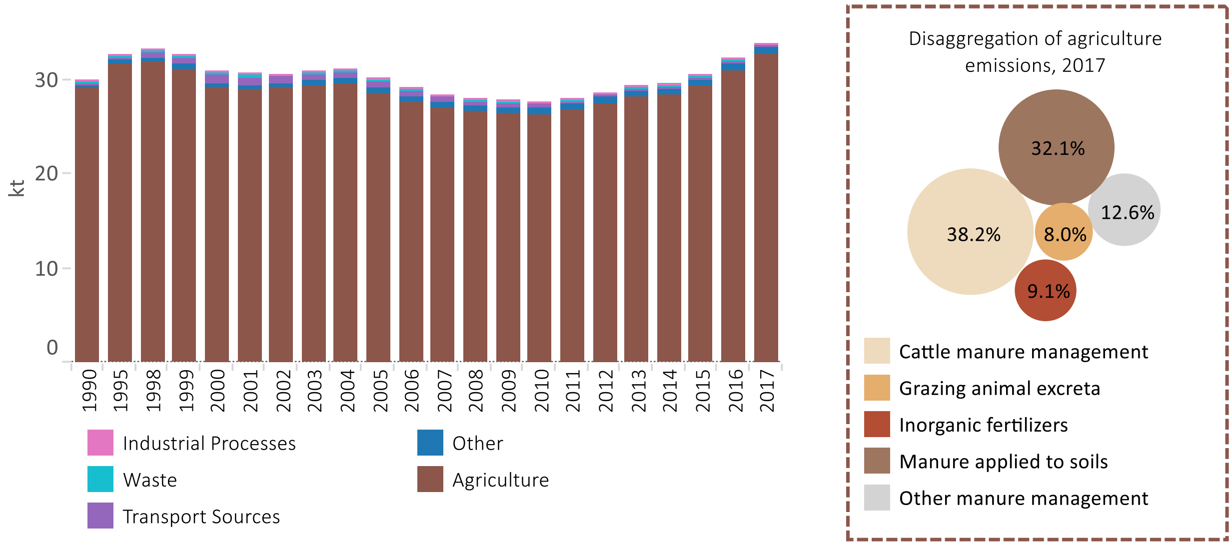
The reductions in SO_2 after 2001 are due to a reduction in use of coal in several industries but predominantly in power generation, linked to the development of the natural gas pipeline to Northern Ireland that enabled fuel switching away from coal and oil-fired generation (BEIS, 2018b).

Figure 52 – Northern Ireland normalised trends for all pollutants



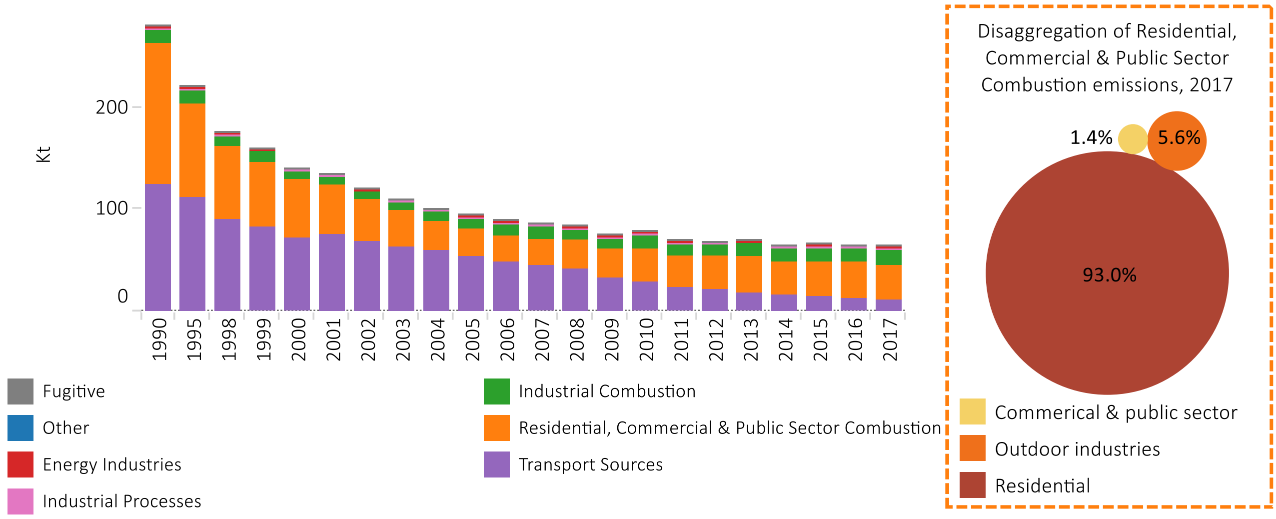
The following sections provide an overview of emissions from each of the eight main pollutants, explaining the trends and characteristics of the graphs. An overview of PCDD/Fs and B[a]p emissions is provided in **Appendix C.2** for the first time this year, although they should be considered as experimental statistics at this stage. **Appendix F** presents the DA inventory data summary tables, whilst **Appendix G** presents source category mapping used in the report.

Figure 53 – Ammonia Emissions in Northern Ireland



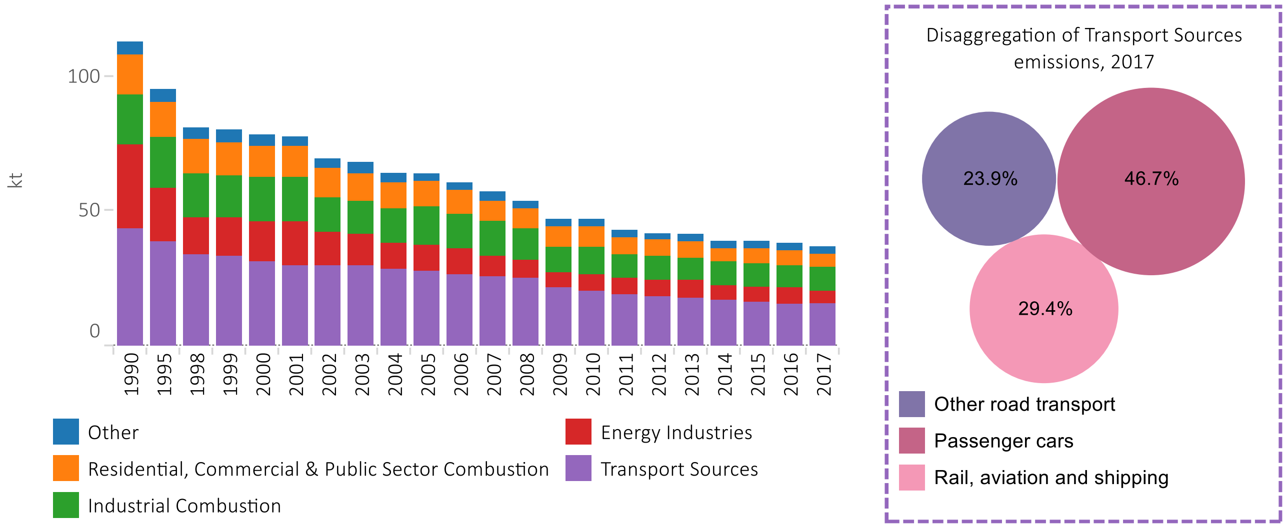
Emissions of **ammonia** were estimated to be 34kt in 2017. Emissions have increased overall by 13% since 1990 and account for 12% of the UK total in 2017. Agriculture sources have dominated the inventory throughout the time-series, with cattle manure management accounting for 38% of the emissions from this sector. NH_3 emissions have increased since 2011 largely due to increased emissions from the storage of dairy cattle waste in animal waste management systems (AWMS) such as slurry lagoons, and the subsequent spreading of dairy slurry to soils. In addition, the increased use of other organic fertilisers, such as digestate, and urea-based fertilisers contributes to the recent trend.

Figure 54 – Carbon Monoxide Emissions in Northern Ireland



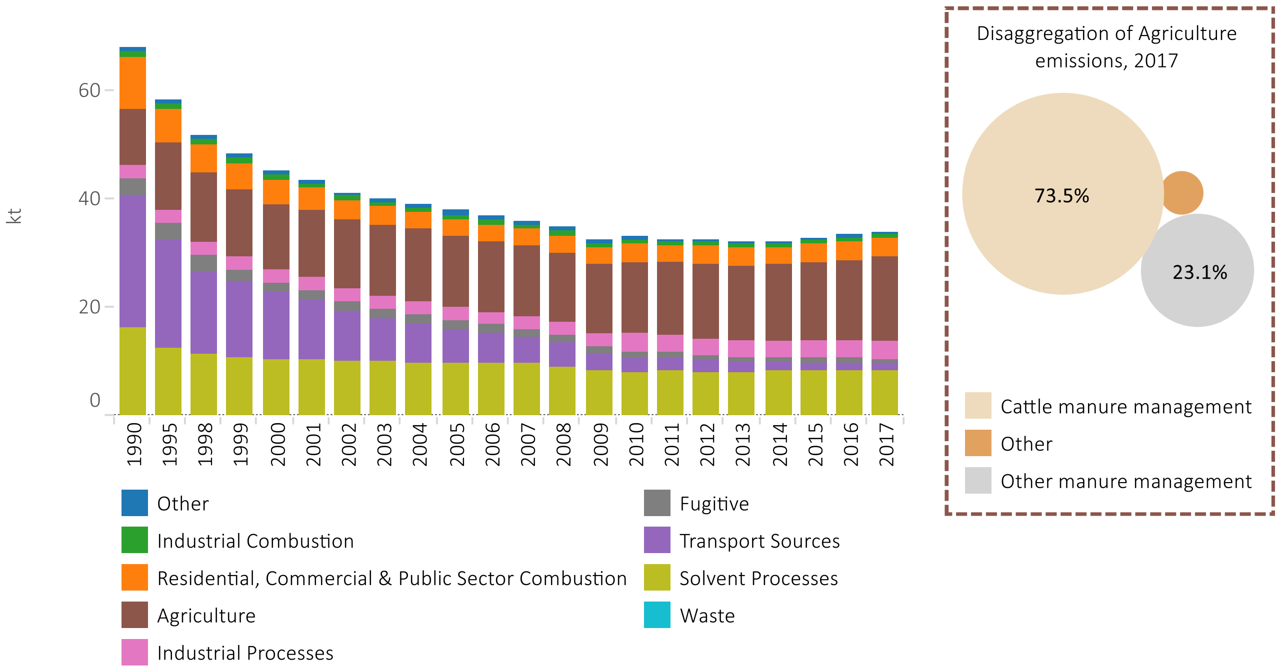
Emissions of **carbon monoxide** were estimated to be 65kt in 2017 and have declined by 77% since 1990. Emissions in Northern Ireland accounted for 4% of the UK total in 2017. The decline in emissions stems largely from the residential, commercial and public sector combustion category (dominated by residential combustion) and transport sources, particularly road transport. The decline is driven by the introduction of Euro standards after 1992 which requires fitting of emission controls (e.g. three-way catalytic converters) in new petrol vehicles and in more recent years the switch from petrol cars to diesel cars. Since 2008, emissions from passenger cars have further decreased, which is mainly driven by improvements in catalyst repair rates resulting from the introduction of regulations controlling the sale and installation of replacement catalytic converters and particle filters for light duty vehicles. The decrease in residential, commercial and public sector combustion in the earlier part of the time-series is mainly due to the expansion of the gas network leading to reductions in the consumption of solid and liquid fuels; the increase in more recent years is due to an increasing quantity of wood burned in the residential sector (BEIS, 2018a).

Figure 55 - Nitrogen Oxides Emissions in Northern Ireland



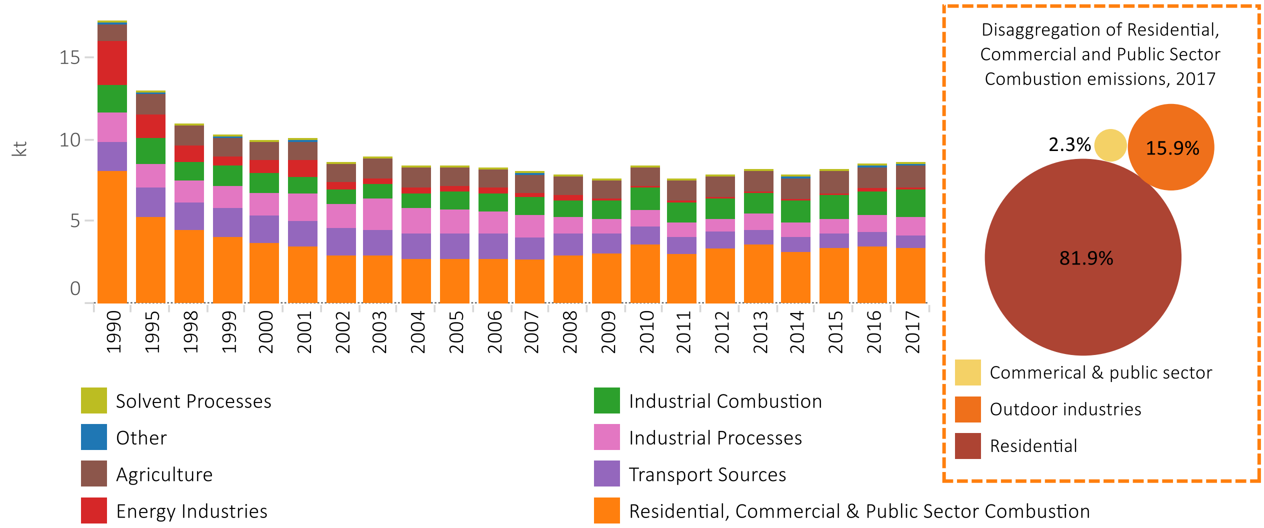
Emissions of **nitrogen oxides** were estimated to be 37kt in 2017, representing 4% of the UK total. Emissions have declined by 67% since 1990, partly due to changes in transport sources, particularly in road transport. This decline is driven by the successive introduction of tighter emission standards for petrol cars and all types of new diesel vehicles over the last decade. Since 2008, emissions from passenger cars have further decreased, which is mainly driven by improvements in catalyst repair rates resulting from the introduction of regulations controlling the sale and installation of replacement catalytic converters and particle filters for light duty vehicles. However, the increasing number of diesel cars offsets these emissions reductions, because diesel cars have higher NO_X emissions relative to their petrol counterparts. Energy industries have also had a notable impact on the trend with implementation of abatement technology and reductions in the amount of coal used.

Figure 56 – NMVOC Emissions in Northern Ireland



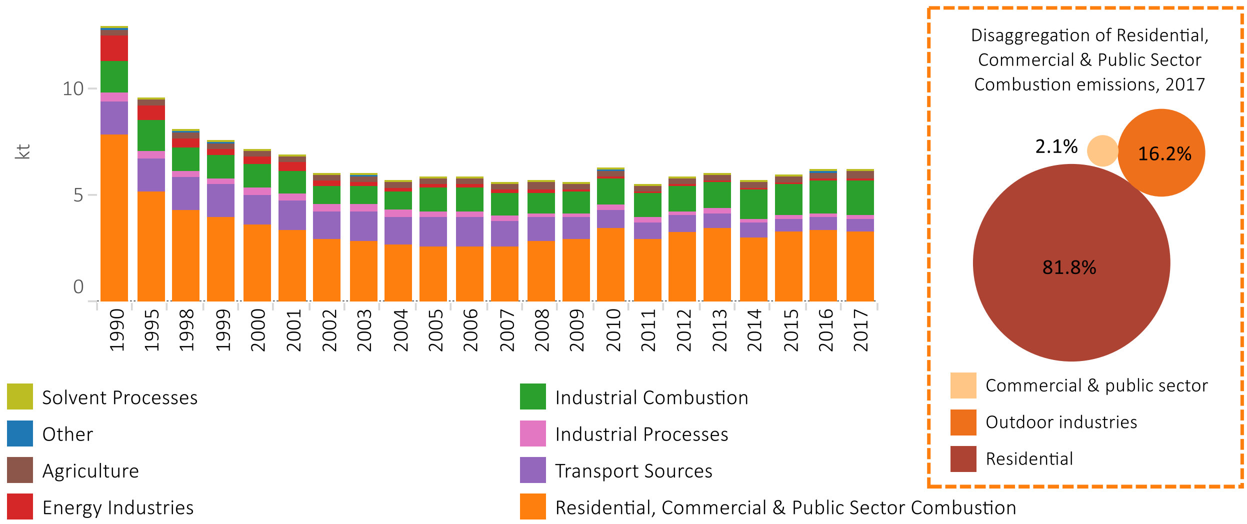
Emissions of **non-methane volatile organic compounds** were estimated to be 34kt in 2017, representing 4% of the UK total. Emissions have declined by 50% since 1990 mainly due to the decrease in transport sources, including evaporative losses. This decline is coincident with emission control technologies introduced in new petrol vehicles since the early 1990s and, in more recent years, the increasing proportion of diesel fuelled vehicles in the passenger fleet. The reduction in emissions also occurs to a lesser extent due to the introduction of petrol vapour recovery systems at filling stations. With this large reduction in emissions from transport sources, agriculture is now the most important source of NMVOC emissions, more specifically emissions from cattle manure management. Emissions from agriculture have increased across the time-series and accounted for 15% of total NMVOC emissions in 2017.

Figure 57 – PM_{10} Emissions in Northern Ireland



Emissions of **PM_{10}** were estimated to be 9kt in 2017 and accounted for 5% of the UK total. Emissions have declined by 50% since 1990, with the major decrease observed between 1990 and 2004. The decreasing trend was defined by emissions from residential, commercial and public sector combustion, with a reduction in the use of peat and coal and fuel switching across many economic sectors from coal and oil to natural gas. PM_{10} exhaust emissions from vehicles have been decreasing due to the successive introduction of tighter emission standards over time, while non-exhaust PM_{10} emissions from vehicles have been increasing due to increasing traffic activity. In recent years, emissions from residential, commercial and public sector combustion have primarily increased coincident with increasing wood fuel use in the residential sector (BEIS, 2018a).

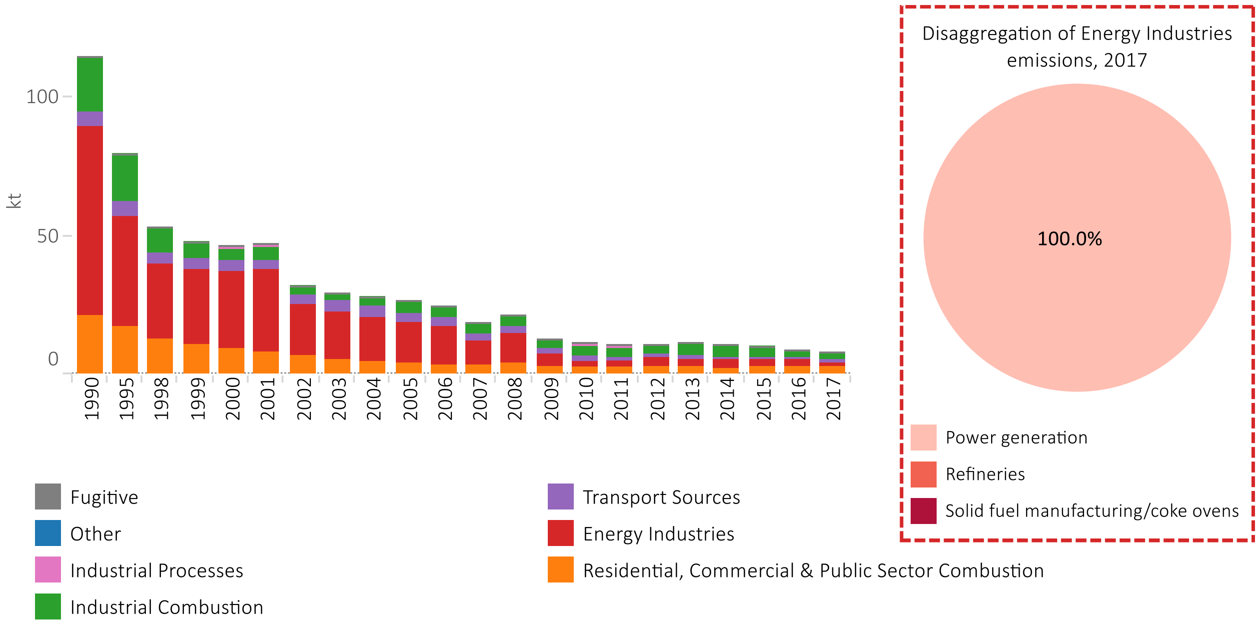
Figure 58 - $PM_{2.5}$ Emissions in Northern Ireland



Emissions of **$PM_{2.5}$** were estimated to be 6kt in 2017 and accounted for 6% of the UK total. Emissions have declined by 52% since 1990, with the major decrease observed between 1990 and 2004. As with PM_{10}, $PM_{2.5}$ emissions have a large number of significant sources. However, process emissions tend to produce coarser PM fractions and as such, combustion emissions are of greater importance for $PM_{2.5}$ compared to PM_{10}. For $PM_{2.5}$, the residential, commercial and public sector combustion category accounts for 52% of

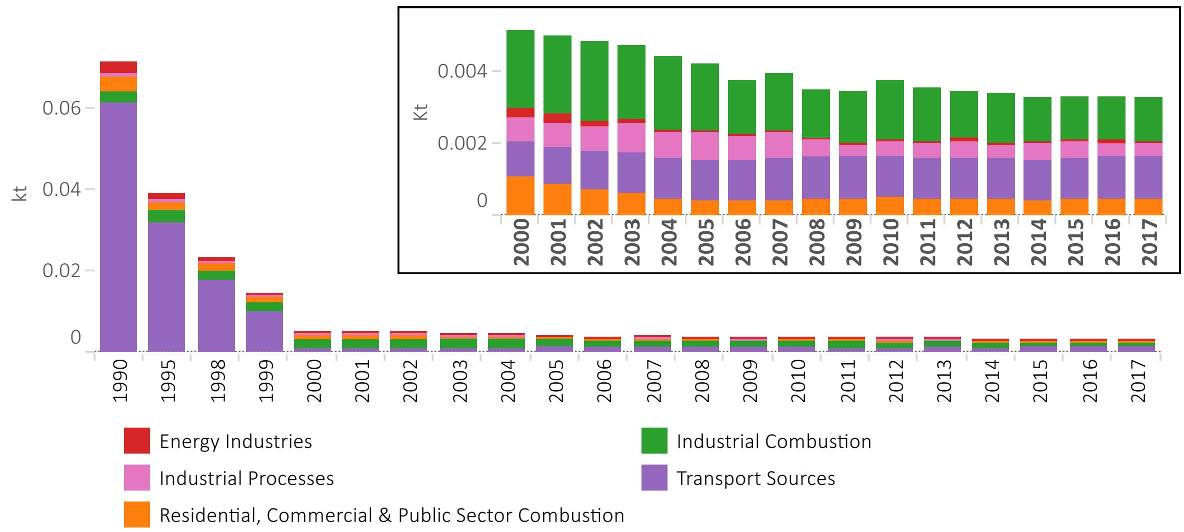
2017 emissions, dominated by emissions from residential combustion. The primary drivers for the decline in emissions since 1990 are the switch in the fuel mix used in electricity generation away from coal and towards natural gas, particularly in the early time-series, and later reductions in emissions from the transport sector due to the introduction of progressively more stringent emissions standards through time. Since 2005, declines in emissions have been offset by increases in emissions from the residential sector, and in particular, the combustion of wood.

Figure 59 – Sulphur Dioxide Emissions in Northern Ireland



Emissions of **sulphur dioxide** were estimated to be 8kt in 2017, representing 5% of the UK total. Emissions have declined by 93% since 1990, which has been dominated by the 98% reduction in energy industries emissions due to the introduction of CCGT (Combined Cycle Gas Turbine) plants, which are more efficient than conventional coal and oil power stations and have negligible SO_2 emissions. In addition, as the natural gas network has expanded to different parts of Northern Ireland, other sectors have also shown step-changes in emissions as fuel switching away from coal and oil has been made possible. SO_2 emissions from road transport have also declined, coincident with the reduced sulphur content of road fuels, both petrol and diesel.

Figure 60 – Lead Emissions in Northern Ireland



Emissions of **lead** were estimated to be 3.3 tonnes in 2017, representing 3% of the UK total. Emissions have declined by 95% since 1990 almost entirely due to changes in transport sources. Leaded petrol was phased out from general sale by the end of 1999, which is the reason for the 98.4% decrease in transport emissions between 1990 and 2000. The most significant source of emissions is now the use of lubricants in industry.

Table 5 below provides a summary of the percentage contribution of each sector for each pollutant in 2017. The table is shaded according to the overall contribution of that sector to the pollutant total. The table below indicates that the Residential and Other Combustion sector is a significant sector when considering emissions for CO, B[a]p, Dioxins, PM_{10}, $PM_{2.5}$ and SO_2, accounting for at least 20% of emissions for each pollutant.

The majority of the top five sectors are related to the combustion of fuel, except for agriculture, which is an important sector in Northern Ireland when considering 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 2017

Sector	NH3	CO	NOx	NMVOC	PM10	PM2.5	SO2	Pb	B[a]p	Dioxins
Agriculture	96%	IE	IE	46%	17%	5%	IE	0%	0%	0%
Energy Industries	IE	4%	15%	IE	1%	2%	19%	1%	0%	0%
Fugitive	IE	0%	IE	2%	IE	IE	0%	IE	0%	0%
Industrial Combustion	IE	24%	23%	2%	20%	26%	36%	37%	0%	20%
Industrial Processes	0%	0%	IE	10%	12%	3%	0%	12%	0%	0%
Residential, Commercial & Public Sector Combustion	IE	54%	14%	10%	39%	52%	34%	14%	97%	61%
Solvent Processes	IE	0%	0%	24%	0%	0%	0%	0%	0%	0%
Transport Sources	1%	17%	42%	4%	10%	9%	10%	36%	1%	3%
Waste	1%	IE	IE	IE	IE	IE	IE	0%	2%	15%
Other	3%	1%	7%	1%	2%	2%	1%	0%	0%	0%

* The sector: “other” will include all “other” categories in the inventory and also a number of categories that are insignificant for a specific pollutant. These have been marked in the table as “IE” (used in inventory reporting for “Included Elsewhere”). A breakdown of what is included within this category in respect to each pollutant can be found in **Table 21**.

Figure 61 – Ammonia Emissions in Northern Ireland, 2017

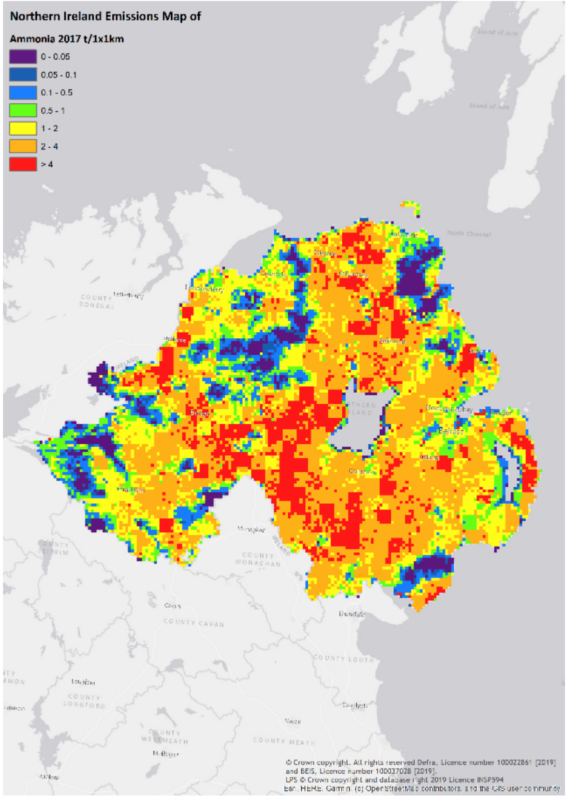


Figure 62 – Carbon Monoxide Emissions in Northern Ireland, 2017

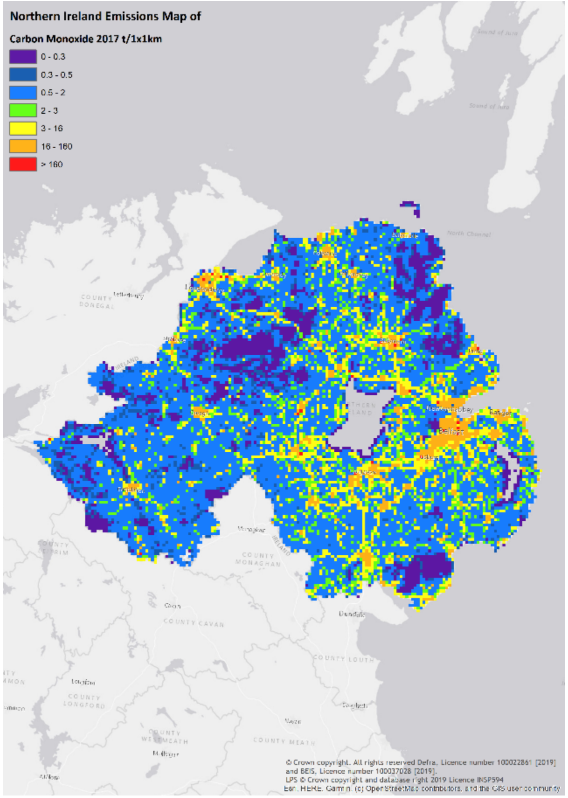


Figure 63 – Nitrogen Oxides Emissions in Northern Ireland, 2017

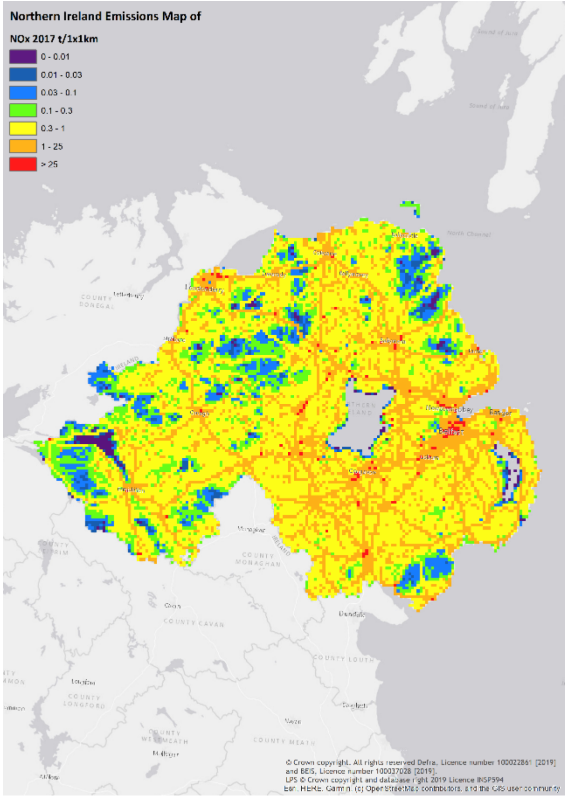


Figure 64 – NMVOC Emissions in Northern Ireland, 2017

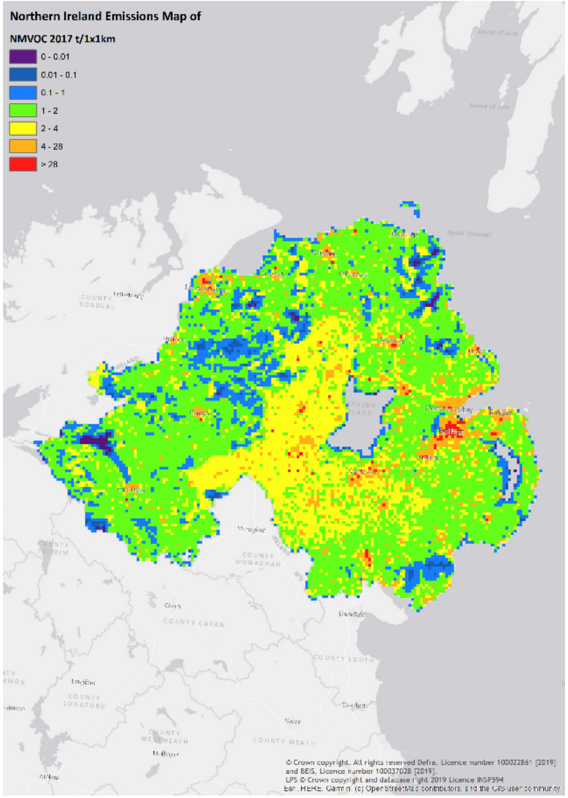


Figure 65 – PM_{10} Emissions in Northern Ireland, 2017

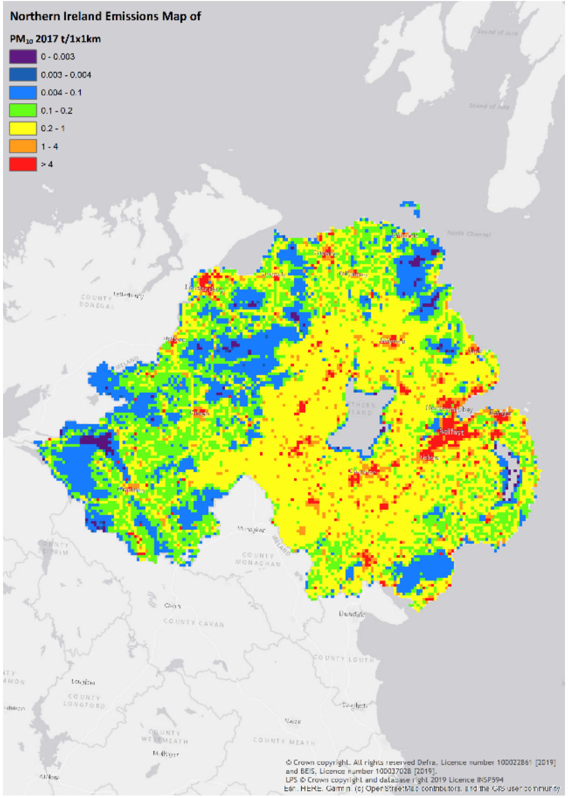


Figure 66 – $PM_{2.5}$ Emissions in Northern Ireland, 2017

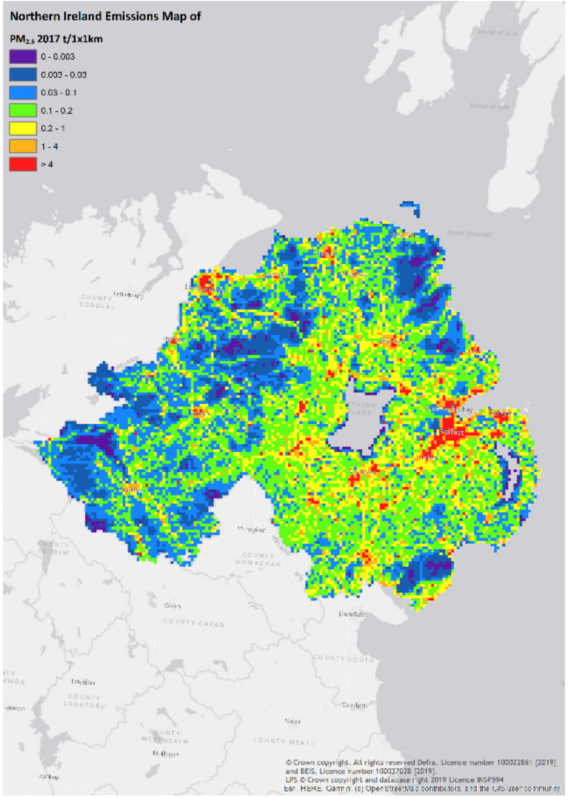


Figure 67 – Lead Emissions in Northern Ireland, 2017

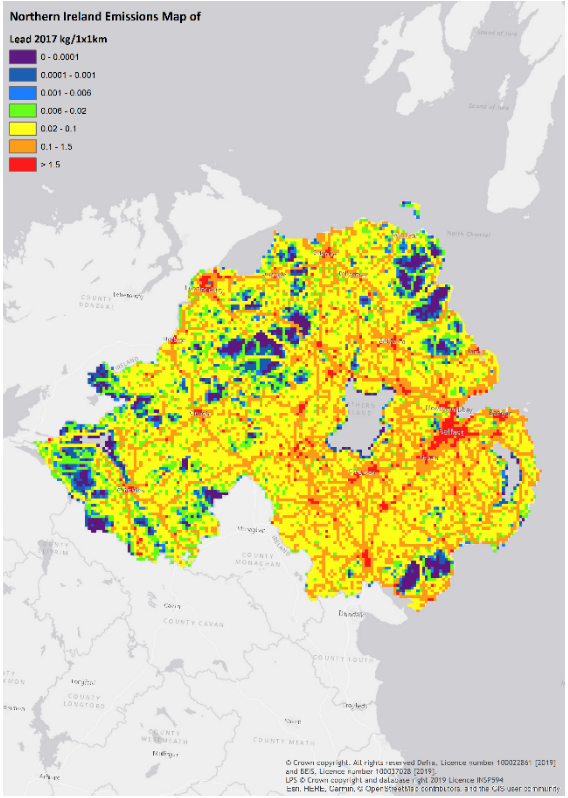
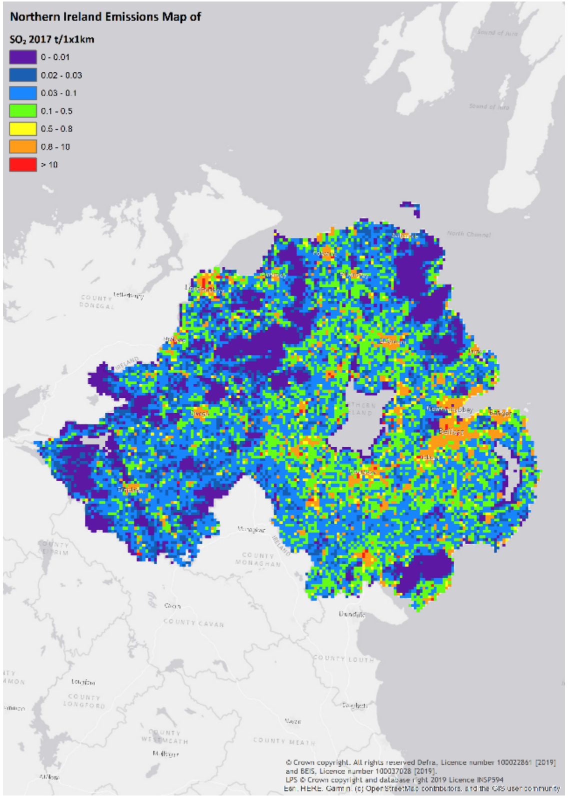


Figure 68 – Sulphur Dioxide Emissions in Northern Ireland, 2017



Appendix A Background to Inventory Development

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

The latest inventory data shows that the UK continues to meet international and EU ceilings for emissions of nitrogen oxides, ammonia, non-methane volatile organic compounds and sulphur dioxide. Further information on UK emissions trends can be found in the Defra National Statistics Release: Emissions of air pollutants in the UK, 1970 to 2017, see:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/778483/Emissions_of_air_pollutants_1990_2017.pdf?_ga=2.251130502.1250178570.1566899990-287603479.1544120160

In 2019, the UK Government published its Clean Air Strategy[4], which sets out how it will work towards achieving the 2020 and 2030 emission reduction commitments that are established through the regulations and mechanisms outlined below.

A.1 National Emissions Ceilings Directive

Within the EU, the National Emission Ceilings Directive (NECD) was agreed in 2001. This Directive set emission ceilings to be achieved from 2010 onwards for each Member State for the same four pollutants in the original Gothenburg Protocol, sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds and ammonia.

The European Commission has since revised the NECD, repealing the original Directive and replacing it with a new legislative instrument (Directive 2016/2284/EU) which ensures the emissions ceilings originally set continue until 2020. In addition, new national emission reduction commitments (ERCs) are applicable from 2020 and 2030 onwards for SO_2, NO_x, NMVOC, NH_3, and $PM_{2.5}$ in order to cut the health impact attributed to air pollution by approximately half when compared to 2005. The UK has published its National Air Pollution Control Programme (NAPCP) in 2019 describing the potential policies and measures to meet the 2020 and 2030 ERCs under the NECD.

A.2 Gothenburg Protocol

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

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

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

[4] https://www.gov.uk/government/publications/clean-air-strategy-2019

A.3 Industrial Emissions Directive

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

A.4 Heavy Metals Protocol

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

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

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

A.5 Persistent Organic Pollutants (POPs) Protocol

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

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

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

A.6 Sulphur Content of Liquid Fuels Directive

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

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

The UK Government leads on the UK's input to International and European legislation relating to Air Quality, with input from the Scottish Government, Welsh Government and Northern Ireland Government. Linked to the requirements of the EU Directives, the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Defra, 2007) sets out a framework of standards and objectives for the air pollutants of most concern at the time (sulphur dioxide, particulate matter, nitrogen oxides, polycyclic aromatic hydrocarbons, benzene, 1, 3-butadiene, carbon monoxide, lead, ammonia and ozone).

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

A.8 Air quality plan for nitrogen dioxide (NO_2) in UK

The Air quality plans for nitrogen dioxide (NO_2) form the government's plan for reducing NO_2 emissions in the UK's towns and cities as part of its commitment for cleaner air.

The air quality plans set out targeted local, regional and national measures to ensure that UK air will be cleaner than ever before. This will build on significant improvements in air quality in recent decades and fulfil the UK's environmental responsibilities, benefiting health and making cities better places to live and work.

As a result of the Government's NO_2 Plans, Government is working closely with 61 English local authorities, and has placed legal duties on them, underpinned by £495 million in funding, to tackle their nitrogen dioxide exceedances and achieve compliance with NO2 legal limits in the shortest possible time.

The Government published a Supplement to the 2017 NO_2 Plan on 5 October 2018 setting out work with a further 33 local authorities. This including setting out that a further 8 local authorities will be developing local plans. It also sets out 10 local authorities that are implementing measures to bring forward compliance including bus retrofit and signal optimisation.

Due to the highly localised nature of the problem, local knowledge is crucial in solving pollution problems in these hotspots. The Government is taking a strong national leadership role and is providing financial and expert support to local authorities to develop innovative plans.

Measures include retrofitting of buses, traffic management measures and other measures as behavioural change. The documents include 37 zone plans, a UK overview document, a list of national measures and a technical report. The plans must show how they achieve compliance with NO_2 limits in the shortest possible time.

The Directive on Ambient Air Quality and Cleaner Air for Europe (2008/50/EC) sets concentration limit values for seven pollutants, including NO_X, SO_2, PM_{10} and CO and an exposure reduction target for $PM_{2.5}$. The Fourth Daughter Directive (2004/107/EC), under the now repealed Air Quality Framework Directive, set target values for a further five substances (heavy metals and polycyclic aromatic hydrocarbons). Member States are required to submit annual reports to the European Commission on whether the concentration limits have been achieved within their respective areas and to develop management plans where they are not. This legislative framework was established to manage air quality and to avoid exceeding the air pollutant concentration limits known to be harmful to human health and the environment. The 2008 Directive was transposed into UK law by the Air Quality Standards Regulations (2010) and their equivalents for Scotland, Wales and Northern Ireland.

Appendix B Inventory Methodology

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

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

B.1 Data Availability

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

In particular, energy-balance data (i.e. fuel production, transformation and sector-specific consumption data) are not available across the time-series for England, Scotland, Wales and Northern Ireland. Sub-national energy statistics are published annually by the Department for Business, Energy & Industrial Strategy (BEIS) within the quarterly Energy Trends publication (BEIS, 2018b). These sub-national statistics are limited in their detail when compared to UK-level energy statistics, but do provide estimated fuel use data for England, Scotland, Wales and Northern Ireland for the following combustion source sectors: industry, commercial, agriculture (combustion sources) and residential.

These BEIS sub-national energy statistics are based on local electricity and gas consumption patterns, as part of a project to develop Local Authority carbon dioxide emissions data. These statistics use local electricity and gas use data from the National Grid and the gas supply network operators (formerly Transco). Solid and liquid fuel use is calculated using point source consumption data for major industrial sites, and a complex modelling process to distribute remaining UK fuel allocations that uses employment and population data and takes account of smoke control areas and the patterns of gas and electricity consumption. The latest available data include Local Authority fuel use estimates available for solid, liquid, gas, and electricity use are available from 2005 for Great Britain, and since 2008 for Northern Ireland.

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

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

For other important 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 Industrial Emissions Directive (IED). Major sources include power stations, cement and lime kilns, iron & steel works, aluminium and other non-ferrous metal plant, chemical industries. These data are not available across the full time-series from 1990, as the regulatory reporting regimes were developed in the late 1990s (in England, Wales and Northern Ireland) and early 2000s (in Scotland).

- Emissions from **oil and gas terminals** and offshore platforms and rigs, are based on operator estimates reported to the BEIS OPRED team (BEIS OPRED, 2018) through the Environmental Emissions Monitoring System (EEMS). Emissions from the offshore oil & gas exploration and production sector are not attributed to a specific country inventory, but are reported within an "unallocated" category, whilst emissions from onshore oil & gas terminals are assigned to the appropriate country inventories.

- **Agricultural emissions** are based on official livestock datasets, annual fertiliser use surveys, farm management practice surveys and detailed emission factors from recent literature sources. The methodology for compiling the inventory of NH_3 emissions from agriculture follows that of (Misselbrook & Gilhespy, 2019). Emissions are affected by a large number of factors, including animal species, age, weight, diet, housing and manure management systems, and environmental conditions. As such, the interpretation and extrapolation of experimental data is problematic, making emission estimates uncertain.

- Emissions from **waste disposal activities** are estimated based on modelled emissions from the UK pollutant emissions inventory (Defra, 2019) 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.

- Emissions from **shipping activities** are based on a bottom-up inventory introduced into the inventory estimates for the first time in 2018 for the 1990-2016 dataset. High-resolution terrestrial Automatic Identification System (AIS) vessel movement data supplied by the UK Maritime and Coastguard Agency for 2014 is used to calculate emissions specific to each vessel at each point of the vessel's voyage around the UK's coastline. This method captures a number of smaller vessels and voyages that were not captured by the previous approach, such as movement to and from offshore oil and gas installations. Country-specific proxies based predominantly on port movement statistics (DfT Maritime Statistics, 2018) are used to estimate fuel use and emissions back to 1990, and to forecast to 2017. Emissions from shipping were split between the DAs using the methodology described in the 1990-2016 DA Air Pollutant Inventory report, published in 2018.

For some sources where, regional data are not available, current NAEI mapping grids have been used. These mapping grids are commonly based on census and other survey data that are periodically updated and used within UK emissions mapping and modelling work (Tsagatakis, et al., 2018).

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

B.2 Key Compilation Resources

As a result of the more limited DA-specific activity and emission factor data, the emission estimates for the England, Scotland, Wales and Northern Ireland inventories are subject to greater uncertainty than the equivalent UK estimates. There are step-changes in data availability during the time-series, such as installation-specific fuel use data from major industrial plant under EU ETS (from 2005 onwards) and sites regulated under Environmental Permitting Regulations / Industrial Emissions Directive (EPR/IED) (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 the back-casting of emission estimates, but there remains a greater level of uncertainty in emission estimates from the earlier part of the time-series compared to more recent years. Furthermore, the data quality from these environmental regulatory systems has evolved over the years as monitoring, reporting and quality checking methods and protocols have developed. This also impacts upon the accuracy of the reported emissions of air pollutants which are used within inventory compilation, such that more recent data are likely to be more accurate. The uncertainties in the Devolved Administrations' inventories are discussed in more detail in **Appendix D**.

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

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

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

B.2.1 NAEI Point Source Database

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

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

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

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

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

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

B.2.2 NAEI Emission Mapping Grids

Emission maps for the whole of the UK are routinely produced as part of the NAEI for 25 pollutants, including all of the pollutants considered in the Devolved Administrations' Air Pollutant Inventory. The maps are compiled at a 1km resolution and are produced annually. The mapped emissions data are available on the NAEI website 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., 2018).

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

The geographical distribution of emissions across the UK is built up from distributions of emissions in each source sector. These source sector distributions are developed using a set of statistics appropriate to that sector.

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

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

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

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

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

NFR Sector	Source	Disaggregation Method
1A1a	Public electricity and heat production (all fuels)	All emissions from major fuels are derived from the point source database, which is based on annual emissions estimates reported to UK environmental regulators by IPC/IED-regulated industry and (since 2005) fuel use data available from the EU ETS. Environment Agency (2018a,b), SEPA (2018a,b), Natural Resources Wales (2018a,b) NIEA (2018a,b). Exceptions are minor fuels: sewage gas use is estimated based on UK-wide estimates disaggregated using DA share of UK population (ONS, 2018); landfill gas use is based on the elution of methane from landfills from the MELMod model (Ricardo, 2018).
1A1b	Petroleum refining (all fuels)	Point source data provided by plant operators to IPC/IED pollution inventories (see 1A1a). Further detail on combustion and process emissions provided by UKPIA (2018).
1A1c	Coke & SSF production (all fuels)	Point source data provided by plant operators (see 1A1a). Regional iron & steel production and fuel use data (ISSB, 2018). UK fuel use data from BEIS (2018a).
	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 (2018).
	Gas production, downstream network (all fuels)	EU ETS installation data for natural gas use from 2005-2017. All other years estimated based on the DA share from the 2005 EU ETS data. Environment Agency (2018b), SEPA (2018b), Natural Resources Wales (2018b), NIEA (2018b) Colliery methane use based on deep-mined coal production, data from the Coal Authority (2018).
	Upstream oil & gas, including gas separation plant (all fuels)	BEIS OPRED (2018) 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 by source from Tata Steel (2018).

NFR Sector	Source	Disaggregation Method
	Iron & steel combustion plant (all fuels)	Regional iron & steel production and fuel use data (ISSB, 2018) used to inform estimates to 2004. Data to disaggregate emissions from 2005 onwards is proved by the operators of integrated steelworks themselves.
1A2b	Combustion in non-ferrous metals manufacturing industry	Pollution Inventory (EA 2018a, SEPA 2018a, NRW 2018a, NIEA 2018a), EU ETS (EA 2018b, SEPA 2018b, NRW 2018b, NIEA 2018b) IDBR and employment data (ONS, 2018). Overall analysis of the 1A2b,c,d,e and g sectors used to constrain the DA totals to previous 1A2 DA estimates, using 1A2g Other Industry as residual. Detailed analysis conducted for 2008-2017; 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. Coal use in autogeneration derived from Energy Trends publications (BEIS, 2018b) Exceptions: All NH_3 production and methanol production (both 1A2c) is located in England.
1A2c	Combustion in chemical manufacturing industry, NH_3 production	
1A2d	Combustion in paper, pulp and print manufacturing industry	
1A2e	Combustion in food processing, beverages and tobacco manufacturing industry	
1A2f	Combustion in minerals industries: cement and lime	Cement: Point source data from plant operators (see 1A1a). All lime production is in England.
1A2g	Refractory & ceramic production	Regional GDP data (ONS, 2018).
	Other industrial combustion (oils)	Sub-national energy statistics, BEIS (2018b), and analysis of point source data derived from EU ETS and IED data. Environment Agency (2018a,b), SEPA (2018a,b), NRW (2018a, b) NIEA (2018a,b). Overall analysis of the 1A2b,c,d,e and g sectors used to constrain the DA totals to previous 1A2 DA estimates, using 1A2g Other Industry as residual.
	Other industrial combustion (SSF, coke)	
	Other industrial combustion (coal)	
	Other industrial combustion & auto-generators (gas)	Natural gas consumption data from gas network operators: National Grid (2018), Northern Gas Networks (2018), Scotia Gas Networks (2018), Wales & West Utilities (2018), Airtricity (2018), Firmus Energy (2018), Vayu (2018). Sub-national energy statistics, BEIS (2018b), and analysis of point source data derived from EU ETS and IED data. Environment Agency (2018a,b), SEPA (2018a,b), NRW (2018a,b), NIEA (2018a,b).
	Industrial off-road machinery (all fuels)	Mapping grids are used, interpolated between 2007 and 2010, with the 2011 grid used for later years
1A3ai (i)	Aircraft – international take-off and landing (all fuels)	CAA (2018), UK airport statistics. All take-off and landing cycle emissions for each flight assigned to DA of origin and destination airport.
1A3aii (i)	Aircraft – domestic take-off and landing (all fuels)	
1A3bi to 1a3bvii	Road Transport	Vehicle km, DfT (for GB), NI Department for Regional Development (DRD) up until 2015 (for later years, GB growth factors are then applied as data no longer available). Emission factors: Boulter et al. (2009) COPERT 4 (EEA, 2018) Fuel efficiency: Road Freight Statistics, DfT (2018) Composition of fleet: GB - Vehicle Licensing Statistics Report, DfT (2018) NI - Dept. of Regional Development (2018) Traffic data: National Traffic Statistics, DfT (England, Scotland, Wales: 1990-2017) 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- 2015) Fuel consumption: Digest of UK Energy Statistics (1990-2017) (BEIS, 2018a)
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

NFR Sector	Source	Disaggregation Method
		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 (1990-2017) (BEIS, 2018a)
1A3dii	Coastal shipping (all fuels)	UK Maritime and Coastguard Agency, DfT Maritime Statistics (2018). MMO Fishing statistics (MMO, 2016). Scarbrough et al., (2017), IMO (2015) Estimates for all inland waterways are based on population (ONS, 2018).
1A3eii	Aircraft support vehicles (gas oil)	Regional aircraft movements, DfT (2018d)
1A4a	Railways – stationary combustion	Sub-national energy statistics, BEIS (2018b). Natural gas use all in England.
	Industrial & commercial combustion	Sub-national energy statistics, BEIS (2018b), and analysis of point source data and public and commercial mapping grids from regional employment data by sector. Gas use data supplemented by data from gas network operators (same references as 1A2g). PSEC data (DFPNI 2015) used to inform the N Ireland estimates.
	Public sector combustion	
1A4bi	Domestic combustion	For coal, anthracite, petroleum fuels, natural gas, analysis is from sub-national energy statistics, BEIS (2018b) and Housing Condition Survey data. Domestic peat combustion data from CEH (Personal communication, 2017). Northern Ireland gas use in the residential sector is based on estimates from all energy suppliers in Northern Ireland (Airtricity, Firmus Energy, Vayu; all 2018). Domestic wood combustion mapping grids based on a BEIS domestic wood survey (BEIS, 2016)
1A4bii	Household and gardening mobile machinery (all fuels)	Population data (ONS, 2018)
1A4ci	Agriculture – Stationary combustion	Agricultural employment data, Defra (2018a) used for allocation of solid and gaseous fuels. Regional energy statistics, BEIS (2018b) 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 BEIS sub-national energy data (BEIS, 2018b)
1A4ciii	Fishing vessels	UK Maritime and Coastguard Agency, DfT Maritime Statistics (2018). MMO Fishing statistics (MMO, 2016). Scarbrough et al., (2017), IMO (2015)
1A5b	Military aircraft and naval shipping	Regional GDP data (ONS, 2018).
1B1a	Deep-mined coal	Regional deep mine production, Coal Authority (2018). Emissions from closed coal mines derived from WSP report (Fernando, 2011), updated to account for deviations from the projected closure dates assumed in the original study.
1B1b	Charcoal, Coke & SSF production	Charcoal production estimates based on regional GDP data (ONS, 2018). Coal feed to coke ovens, ISSB, WS, BEIS and (1999-2004) PI. 2005 onwards: EU ETS (EA 2018b, SEPA 2018b, NRW 2018b, NIEA 2018b)
	Iron & steel flaring	Coal feed to coke ovens, ISSB, WS, BEIS and (1999-2004) PI. Data to disaggregate emissions from 2005 onwards is proved by the operators of integrated steelworks themselves.
1B2ai	Upstream oil & gas: offshore oil loading, well testing.	All emissions unallocated.
	Upstream oil & gas: process emissions, onshore oil loading, oil terminal storage	Emissions derived from BEIS OPRED (2018) EEMS point source dataset, with extrapolations back to cover 1990, 1995 where data gaps are evident.

NFR Sector	Source	Disaggregation Method
1B2aiv	Refinery process emissions (drainage, tankage, general)	Point source data provided by plant operators (see 1A1a), UKPIA (2018) and analysed using the NAEI point source database.
1B2av	Petrol terminal storage and loading, Refinery road and rail haulage emissions	Point source data provided by plant operators (see 1A1a), supplemented by refinery road/rail loading estimates from UKPIA (2018).
	Petrol station emissions from delivery, vehicle refuelling, storage tanks and spillages	Regional road transport distribution based on analysis of vehicle km data for different vehicle types and the resultant fuel use distributions. Hence, references as 1A3b.
1B2b	Gasification processes	Regional GDP data (ONS, 2018)
	Upstream gas production: terminal storage, well testing, process emissions	All well testing emissions offshore (therefore all Unallocated). Process and storage emissions based on operator-reported data from EEMS (BEIS OPRED, 2018) and PI/SPRI (Environment Agency 2018a; SEPA 2018a; NRW 2018a)
	Gas leakage from supply infrastructure	Leakage data provided by gas network operators: National Grid (2018), Northern Gas Networks (2018), Scotia Gas Networks (2018), Wales & West Utilities (2018), Airtricity (2018).
1B2c	Upstream oil & gas: flaring & venting	Emissions derived from the EEMS dataset (BEIS OPRED, 2018), with extrapolations back to cover 1990, 1995 where data gaps are evident.
	Refinery flaring	Point source data provided by plant operators (see 1A1a) supplemented by data from the trade association (UKPIA, 2018)
2A1	Slag cement production	Point source data provided by plant operators (see 1A1a).
2A3	Glass industry process emissions	Point source data provided by plant operators (see 1A1a). Exceptions are emissions from production of flat glass, frits and lead crystal, all of which only occur in England. Glass ballotini emissions are not reported by operators, and so emissions are assumed equal across all known operating plants in England and Scotland (it is believed that there is no production in Wales and Northern Ireland).
2A5	Construction, asphalt manufacture	Regional GDP data (ONS, 2018).
	Quarrying (aggregates)	Quarries mapping grid.
	Lead mining	All emissions in England.
2A6	Bricks and ceramics	All fletton brick production in England. Non-fletton brick estimates based on point source data provided by plant operators (see 1A1a). Process emissions from concrete batching plants and ceramics manufacture based on regional GDP statistics (ONS, 2018).
2B2	Nitric acid production	Point source data provided by plant operators (see 1A1a). Now all England.
2B6	Chemical industry – titanium dioxide	All emissions in England
2B7	Chemical industry – soda ash manufacture	All emissions in England
2B10	Ship purging	All emissions unallocated (i.e. offshore)
	Chemical industry process emissions	Mapping grids for chromium, magnesia, nitric acid use, phosphate based fertilizers, pigment manufacture, and reforming. Coal tar and bitumen processes, and ammonia use in the chemical industry based on point source data provided by plant operators (see 1A1a).

NFR Sector	Source	Disaggregation Method
		Other chemical industry sources (i.e. alkyl lead, ammonia based fertilizer, carbon black, sulphuric acid use, solvent and oil recovery, and sulphuric acid production) are based on population statistics (ONS, 2018)
2C1	Industrial process emissions from SMEs, hot & cold steel rolling emissions, lead battery manufacture, zinc alloy and semis production, and zinc oxide production	Regional GDP data (ONS, 2018).
	Alumina production	All emissions in Scotland.
	Process emissions from: blast furnaces, EAFs, BOFs, primary aluminium production & anode baking, non-ferrous metal processes	Point source data provided by plant operators (see 1A1a), plus supplementary data provided by Tata Steel (2018), SSI (2014) and the ISSB (2018)
	Flaring & stockpile emissions at iron & steelworks	Regional iron & steel production and fuel use data (ISSB, 2018).
	Non-ferrous metal processes	All emissions in England
	Foundries	Foundries mapping grid
2D3a	Aerosol and non-aerosol products (cosmetics & toiletries, household products, paint thinners),	Population data, ONS (2018).
	Agrochemical use	Arable mapping distribution grid
2D3b	Road dressings and bitumen use	Road dressing mapping grid.
	Asphalt manufacture	Regional GDP data (ONS, 2018).
2D3d	Trade & retail decorative paints,	Population data, ONS (2018).
	Industrial coatings: Aircraft, agricultural and construction vehicles, coil coating, leather coating	Regional GDP data (ONS, 2018).
	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: film, metal packaging, automotive, drum, textile, paper	Point source data provided by plant operators (see 1A1a).
2D3e	Domestic surface cleaning.	Population data, ONS (2018).
	Industrial surface cleaning	Industrial employment mapping distribution grid.
	Leather coating and degreasing	Regional GDP data (ONS, 2018).
2D3f	Dry cleaning (solvent use)	Dry cleaning mapping grid
2D3g	Rubber & plastic products	Population data, ONS (2018).
	Industrial coating manufacture: adhesives, inks, solvents and pigments, tyre manufacture	Various industry-specific coatings mapping distribution grids

NFR Sector	Source	Disaggregation Method
2D3h	Printing – flexible packaging, publication gravure	Point source data provided by plant operators (see 1A1a).
	Other printing sources	Population data, ONS (2018).
2D3i	Seed oil extraction	All emissions in England
	Wood impregnation – creosote, LOSP	Wood impregnation mapping grid
	Solvent Use	Population data, ONS (2018).
2G	Cigarette smoking and fireworks	Population data, ONS (2018).
2H1	Paper production	GDP data, ONS (2018)
2H2	Cider & wine manufacture, sugar beet processing and sugar manufacture	All emissions are in England.
	Spirit manufacture	Point source data provided by plant operators (see 1A1a).
	Brewery emissions	Brewing mapping grid and point source database.
	Food & drink process industries: meat & fish, margarine, cakes & biscuits, animal feed, coffee roasting	Population used to disaggregate emissions.
	Other food & drink processes: bread baking, malting.	Point source data provided by plant operators (see 1A1a).
2H3	Other industry Part B process emissions	Regional GDP data (ONS, 2018).
2I	Wood product process emissions	Wood coating mapping grid.
3A	Manure management	DA splits for manure management based on regional pollutant-specific emissions data provided by Rothamsted Research (2018)
3B	Inorganic N fertilizers	DA splits for fertilizers based on regional pollutant-specific emissions data provided by Rothamsted Research (2018)
3D	Agricultural soil emissions	DA splits for agricultural soils based on regional pollutant-specific emissions data provided by Rothamsted Research (2018)
3F	Field burning of agricultural wastes	Field burning estimates from Rothamsted Research (2018)
5A	Landfills	DA-specific models based on country-specific waste landfilling data published by the Environment Agency, Scottish Environmental Protection Agency, Natural Resources Wales, and Northern Ireland Environment Agency (2018)
5B	Composting	Population data, ONS (2018).
5C1	Incineration: MSW, crematoria, chemical waste	Point source data provided by plant operators (see 1A1a).
5C1 5C2	Incineration: Clinical waste, sewage sludge	Population data, ONS (2018).
	Incineration: animal carcases	Agriculture mapping grid.
	Foot & mouth pyres	Data on livestock disposal, NAO (2002).

NFR Sector	Source	Disaggregation Method
	Open-burning of waste	Population data, ONS (2018).
5D1	Small scale waste burning	Population data, ONS (2018)
6A	Sewage sludge decomposition	Population data, ONS (2018).
6A	Other sources: accidental fires, bonfires, cigarettes, fireworks, infant emissions from nappies, domestic pets	Population data, ONS (2018).
	Non-agricultural horses, professional horses	Driver for non-agricultural horses based on activity data time-series from Rothamsted Research and CEH (2018)
	Parks, gardens and golf courses	Data on non-fuel fertiliser use, Rothamsted (2018)

B.2.3 Other Regional Data

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

- **Sub-national fuel use data** for natural gas, solid fuel and petroleum-based fuels, from National Grid (National Grid, 2018), other gas network operators, the Coal Authority (Coal Authority, 2018) and the Department for Business, Energy & Industrial Strategy (BEIS, 2018a). The UK energy mapping team has been involved in the on-going development of the BEIS sub-national energy statistics which provide limited data from 2004 to 2017. These data are used to underpin many of the AQ pollutant emission estimates from small-scale (non-regulated) combustion sources such as residential, 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, 2018) database of flight movements, fuel use data (BEIS, 2018a), aircraft fleet information (CAA, 2018) 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, 2018).
- **Regional iron and steel production data**, and regional fuel use data in the iron and steel industry (Tata Steel, 2018), (ISSB, 2018).
- Site-specific emissions data split by combustion and process sources for all **UK refineries**, and refinery production capacities (UKPIA, 2018).
- Site-specific cement production capacities and UK-wide **cement industry** fuel use data (MPA, 2018).
- The **rail sector** uses information from the UK's Department for Transport Rail Emissions Model (REM).
- **Regional housing and population data** (Department for Communities and Local Government).
- **Regional economic activity and industrial production indices** (Office of National Statistics, 2018).

Appendix C Development of Emission Inventories for PCDD/Fs and Benzo[a]pyrene

C.1 Background

In addition to the core suite of air pollutants that have been reported in inventories for England, Scotland, Wales and Northern Ireland for many years, for which source data and inventory methods are well-established, this publication includes an experimental set of inventory statistics of: (i) dioxins and furans (PCDD/Fs), and (ii) benzo[a]pyrene (B[a]p). These are priority toxic pollutants, emission estimates for which are included within the scope of UK inventory submissions under the Convention on Long-Range Transboundary Air Pollution (CLRTAP).

This is the first time that DA-level estimates have been developed for these two pollutants, and the data quality at sub-national level is such that the data are regarded as **experimental statistics only**. These inventories have the potential to enhance the evidence-base for decision-making processes and identify priorities for action, both on a national and local scale. However, without further work to assess the completeness, interrogate outliers, and apply good practice gap-filling techniques to installation-level data, or to study regional variations of unregulated combustion (such as residential burning) to consider country-specific trends, then the inventory estimates will remain highly uncertain and can only be used for indicative purposes. They are not yet suitable for use as a tool to prioritise policies and measures.

Benzo[a]pyrene, B[a]p, is a toxic polycyclic aromatic hydrocarbon (PAH), one of a group of persistent organic pollutants (POPs) that contain two or more benzene rings. The International Agency for Research on Cancer (IARC) has determined that B[a]p is a carcinogen. Its primary mechanism for formation is incomplete combustion, predominantly from vehicle exhausts, domestic wood and coal fires, whilst trace amounts are also found in cigarette smoke.

Like other POPs, B[a]p accumulates in organisms that are exposed to it; it binds strongly to sediments, soils and other solid matter, and it is stable and can remain in the environment making it a concern at a local and a global scale. Industrial emissions in the UK are controlled through the UK Pollution, Prevention and Control (PPC) Regulations and the subsequent Industrial Emissions Directive (IED).

Dioxins and furans are toxic which are not intentionally manufactured but are released to the atmosphere as by-products from a number of processes including waste incineration, fuel combustion (industrial, domestic and transport), and metal processing. As with B[a]p, trace amounts are found in cigarette smoke. Dioxins released to the air are deposited to ground, and water-courses, where livestock and fish may ingest them; dioxins bio-accumulate and concentrate through food chains, are stable and persistent in the environment, and hence can be transported long distances and even re-suspended to the atmosphere, again making them a local and global concern. Humans may ingest or inhale dioxins, and whilst health effects depend on the precise composition, several dioxin substances are determined to be carcinogenic. Industrial emissions of dioxins are controlled through the Pollution, Prevention and Control (PPC) Regulations, Industrial Emissions Directive (IED) and Waste Incineration Directive (WID) and associated UK regulations.

C.2 Key Sources and Emission Trends

C.2.1 Dioxins and Furans

PCDD/Fs are primarily formed during incomplete combustion. In the UK, for example, the key source categories for PCDD/Fs are primarily in the energy industries (NFR 1A1), road transport (1A3b), small-scale combustion (NFR 1A4) and waste management (NFR 5) sectors, and in particular, the combustion processes within each sector. Since the combustion of solid and liquid fuels are more complex and often heterogeneous, the PCDD/F emissions from their combustion is greater than those from gaseous fuels. Emissions of PCDD/Fs have declined significantly since 1990. Sector-specific trends are;

- **Energy Industries**: Emissions have decreased significantly across the time-series, tracking the decline in power generation at coal-fired power stations combined with increasingly stringent regulatory controls since the base year.
- **Road transport**: Emissions of dioxins are associated with compounds previously added to leaded petrol, and hence PCDD/F emissions have decreased substantially, in line with lead emissions from road vehicles.

- **Small Stationary Combustion**: Dioxin emissions in this sector are dominated by residential burning of coal and wood. Coal use has declined significantly over the time-series, whilst wood burning in the residential sector has increased substantially in the last 10-15 years across the UK and this remains a key source category for dioxin emissions in recent years.
- **Waste management**: Dioxin emissions from waste management sources have been substantially reduced across the time-series in the UK, primarily driven by the introduction of more stringent regulatory controls for incineration of wastes through: technical guidance for waste incineration processes regulated under the integrated process control (IPC) regime (Environment Agency, 1996); the EU Waste Incineration Directive (2000/76/EC); and subsequent UK regulations such as the Environmental Permitting (England and Wales) Regulations 2010 SI 2010 No.675.
    - Municipal Solid Waste (MSW) incinerators that did not meet the new standards were closed in the period leading up to December 1996; improved combustion and flue gas controls at the remaining Energy from Waste plant, and developments in abatement technology has resulted in significantly lower levels of PCDD/F emissions in the later part of the time-series;
    - The relatively low emissions from chemical incinerators reflects the much lower quantities of waste burnt, and the use of different technologies and/or the use of more advanced abatement equipment;
    - Clinical waste incineration remains a significant source;
    - Burning of household waste on domestic open fires has declined, also resulting in decreased emissions across the time-series.

C.2.2 Benzo[a]pyrene

Similar to dioxins, UK emissions of benzo[a]pyrene are formed principally in non-optimal combustion conditions, in particular in the combustion of solid and liquid fuels. Emissions have also declined significantly since 1990, and whilst notable reductions have been achieved in many key source sectors, the emissions from small-scale combustion persist as the dominant emission source in recent years. The key source categories and drivers of UK trends since 1990 include sources in agriculture (NFR 3), industrial processes (NFR 2) and small-scale combustion (NFR 1A4):

- **Small Stationary Combustion**: As emissions from other sources have declined significantly since 1990, emissions from small-scale combustion, especially residential combustion from fireplaces and stoves, have become increasingly important across the UK. Similar to dioxins, coal burning in the residential sector has declined notably since 1990, whilst wood use and B[a]p emissions from wood burning has increased considerably over the last 10-15 years and this is now the largest emission source in the UK.
- **Industrial Processes**: Emissions from industrial processes in the early part of the time-series were dominated by aluminium production and the process of anode baking. Emissions from this source have substantially declined since the mid-1990s, and with the gradual decline of the primary aluminium production sector across the UK, anode baking no longer takes place in the UK.
- **Agriculture:** The large emissions of B[a]p from the agriculture sector in the first few years of the time-series are emissions from field burning. Following a ban on the practice of field burning, emissions are estimated to fall to zero from 1994 onwards.

C.3 Development of DA POPs Inventories

The DA inventories for PCDD/Fs and B[a]p have been derived using the same methodology as for the other air pollution inventories, that is to derive the best available ‘driver’ data to disaggregate the reported UK emissions totals from the latest Informative Inventory Report (Richmond et al, 2019). To maximise the use of resources available to develop these initial POPs inventories, the inventory agency has sought to prioritise analysis to derive accurate DA estimates as far as practicable for Key Categories and for the time-series from 2005 to the latest year. Future work may be needed, if warranted, to further refine the data, methods and extend the analysis to further improve the evidence base for inventory stakeholders.

C.3.1 Key Category Emission Sources for POPs

For **B[a]**p, the IIR describes the UK inventory Key Category Analysis for the latest year of emissions data, 2017, indicating that the only key category is residential combustion (NFR sector 1A4bi), due to the very high emissions reported for residential fuel combustion, driven in recent years by the burning of wood in residential fireplaces, stoves and boilers.

In addition to 1A4bi, and considering the impact of other source categories on the reported inventory trends, the inventory agency considers that qualitative key categories for B[a]p also include the following sources, in approximate order of significance:

- NFR 5E: Accidental fires. The most significant sources here are the emissions from fires in dwellings and other buildings;
- NFR 5C2: Waste burning. This is dominated in the early years by agricultural waste burning and has a large impact on the UK trend. However, this is not considered to be a very significant source in recent years, and note that the emission factors and country-specific activity data for this source are subject to high uncertainty;
- NFR 1A2gvii: Industrial off-road machinery. Note that (even at UK level) the activity data for this source, which is predominantly the gas oil used in off-road mobile machinery, are subject to moderate uncertainty across the time-series, due to the limited information available from energy statistics and other data sources to model fuel use within the UK fleet of off-road mobile machinery;
- NFR 1A4cii: Agricultural off-road mobile machinery. The same limitation on activity data accuracy at UK level applies as described for NFR 1A2gvii above;
- NFR 2B10a: Chemical industry emissions including from coal tar distillation. UK emissions have declined by 99% since 1990, due to plant closures and changes in industry practice. Whilst this source notably impacts the overall reported trend, this is not a significant source in recent years;
- NFR 2I: Creosote use. Similar to NFR 2B10a, this source has almost disappeared from UK emissions since 1990, affects the reported trend but is not a significant emission source for recent years.

For **PCDD/Fs**, the IIR describes 5 key categories in 2017 emissions:

- NFR 1A4bi: Residential fuel combustion. Similar to for B[a]p, the highest emission source in 2017 is emissions from residential fuel combustion, and wood burning in particular, following a decline in coal and anthracite burning over time, replaced in recent years by a growth in wood use. Whilst the level and trend of recent wood use is somewhat uncertain, with the UK energy statistics dependent on a small number of residential fuel use surveys, work continues within Defra and BEIS to further improve the data used to estimate emissions from domestic combustion.
- NFR 5E: Accidental fires. The most significant sources here are the emissions from fires in dwellings and other buildings, and also PCDD/F emissions on bonfire night;
- NFR 2C1: Iron and Steel Process emissions. Emissions of PCDD/Fs are primarily from sinter plant in integrated iron and steel works.
- NFR 1A2gviii: Other industrial combustion of fuels. These emissions are dominated by emissions from burning of solid fuels: wood, coal and biomass.
- NFR 5C2: Waste burning. PCDD/F emissions are derived from both agricultural waste burning, which has all but disappeared as an activity in recent years, but also from small-scale waste burning, which in 2017 accounts for around 8% of total emissions. As noted above for B[a]p, the availability of activity data and also emission factors to accurately estimate these emissions are scarce, and hence these emission estimates are associated with quite high uncertainty.

In addition to these key categories in 2017 for PCDD/Fs, analysis of the impact of individual source categories on the reported UK trend indicates a number of sources that were significant in 1990, but have declined significantly to be a minor source in 2017, and as such are regarded as qualitative key categories by the inventory agency, including:

- NFR 1A1a: Power generation. PCDD/F emissions from power stations accounted for around 10% of total emissions in 1990 but have declined to less than 1% in 2017 due primarily to the closure of many power stations that were burning MSW, and the impact of more stringent regulation that led to improvements in dioxin emissions abatement at remaining installations;
- NFR 1A3bi: Road transport, Cars. PCDD/F emissions are associated with the additives of lead in petrol, which has all but been removed from the UK fleet since the mid-1990s.
- NFR 2C7a: Production of copper alloy and semis, and secondary copper. These emissions have also declined through the closure of the main UK production plant in 1999, and hence are no longer a key source.
- NFR 5C1a: MSW Incineration. As above for power stations burning MSW, the practice of incinerating MSW without energy recovery was banned from 1996 and all such plant either closed or were retrofitted with boilers and abatement equipment to meet the new emission regulations for the sector.

C.3.2 Inventory Uncertainty

Inventories for persistent organic pollutants (POPs) are more uncertain than those for gaseous pollutants, PM_{10}, and metals. This is largely due to the paucity of emission factor measurements on which to base emission estimates and the complexity of dealing with POPs as families of congeners (PCDD/PCDFs, PAHs). The issue is further exacerbated by a lack of activity data for some important sources, for example small scale waste burning.

Where emissions in the DA and UK inventories are based on installation-level reported data by operators (which is the case for many high-emitting energy sector, industrial combustion, industrial process and waste management sources such as incineration), the emissions data reported for PCDD/Fs and B[a]p are typically less complete (than for other pollutants, e.g. NO_X, SO_2, PM_{10}) due to the reporting thresholds within the regulators' inventories: PI/SPRI/WEI/NIPI. Through analysis of the reported time-series by many installations the inventory agency further notes that reporting of POPs is typically more susceptible to reporting errors by operators, often by several orders of magnitude. In the compilation of the UK inventories for these species, therefore, the inventory agency makes every effort to (i) identify outliers in the reported data by installation operators, and (ii) apply inventory good practice gap-filling techniques (such as data interpolation and extrapolation, or use of year to year trends in other reported emissions as a proxy) to derive a more consistent, complete and accurate inventory time-series.

In the course of developing the DA inventories, further outliers in operator-reported datasets have been identified that will be added to the inventory issues log for further assessment in the 1990-2018 inventory cycle, to determine whether the outliers observed may be errors in operator reporting.

This susceptibility to operator reporting errors for high-emitting industrial sources exacerbates the limitations in activity data and research to inform accurate emission factors for many POPs emission sources, adding to the overall level of uncertainty in UK and DA reported levels and trends of POPs emissions.

Emissions from unregulated sectors, such as through the combustion of wood and coal domestically, are yet more uncertain. For the UK inventory, the Digest of UK Energy Statistics (DUKES) is used to inform the activity (or amount) of fuel that is consumed in a given year. Sub-national energy statistics and emission maps, based predominantly on periodic user surveys and available data from censuses and housing condition surveys, are used to estimate the DA share of this UK activity. The fuel use data at DA-level is least uncertain for metered fuels (i.e. natural gas and electricity), but more uncertain for those fuels that are the main source of POPs emissions, such as wood and coal.

C.3.3 POPs Inventory Source Data and Methods

The table below summarises the key data sources and methods for the inventory methods applied to derive the experimental POPs inventory estimates.

Table 7 – POPs Inventory Methods

NFR	Source Categories	PCDD/F inventory method	B[a]p Inventory method
1A1a	Power stations, Autogenerators	Operator-reported emissions data, gap-filled where required. Prior to 2005 the UK trends have been applied, as installation-level reporting and therefore allocation to DAs is less complete for the early years of the time-series.	
1A1b	Petroleum refining	Same as NFR 1A1a	
1A1c	[All source categories]	For all of the energy industry source categories under 1A1c, (which are combustion processes in gas production, collieries, nuclear fuel production, SSF production and upstream oil and gas production) there are very limited operator-reported POPs data across all installations and years, and hence activity-data DA drivers (i.e. pollutant-generic drivers) are applied.	
1A2a	Iron and steel combustion plant	Dominated by gas combustion and a very low emission source for POPs, therefore a pollutant-generic driver from the DA GHG inventory analysis is applied.	
1A2b-e	[Industrial combustion sources: stationary combustion in specific industries]	Same as NFR 1A2a	

NFR	Source Categories	PCDD/F inventory method	B[a]p Inventory method
1A2f	Lime production	Same as NFR 1A2a	
	Cement production	Same as NFR 1A1a.	
1A2g	Industrial combustion sources: stationary and mobile combustion in unclassified industry	The sector comprises minor emission sources from use of petrol and gas oil in NRMM, minor emission sources from gaseous and liquid fuels in stationary sources, and significant sources of PCDD/Fs from combustion of solid fuels including wood, coal and biomass. In all cases there is very little detailed DA-level or operator reporting, and therefore pollutant-generic drivers from GHGI analysis are applied.	
1A3b	Road transport	Road transport emissions from fuel combustion and from tyre and brake wear are a notable emission source for dioxins, less significant for B[a]p. Detailed analysis using the road-link level activity data by vehicle type and aggregated to DA-level has been used here for both pollutants.	
1A3 (other)	Transport (other sources: air, rail, shipping, other)	All non-road transport sources are minor sources of both POPs species. Pollutant-generic drivers from DA GHGI analysis applied.	
1A4bi	Residential combustion	The use of solid fuels in residential combustion (i.e. wood, coal, anthracite, charcoal) are very significant emission sources for both dioxins and B[a]p. However, there are no more suitable DA-level splits than those derived on an activity basis for the DA GHGI analysis, so these are used. We have no detailed insight into local variations in fuel quality (e.g. moisture levels) and/or performance of the combustion stock to generate more detailed DA estimates.	
1A4, 1A5 (other)	Commercial and institutional combustion; Public administration; Off-road mobile machinery (agriculture) All sources in 1A5.	All non-residential emission sources in 1A4 and 1A5 are minor sources of POPs emissions, dominated by gaseous and liquid fuel use and for which no local data are available. Hence DA GHGI analysis of activity data splits are applied.	
1B1b	Coke production (fugitives); SSF production	Same as NFR 1A1c, in that emissions estimates are derived from limited installation-level data, but this category refers to the fugitive emissions associated with coke and SSF production.	
2A3	Glass production (several sub-sectors)	All glass process sources are very insignificant sources of POPs. Several sub-sectors are all located in England, with all emissions therefore in England. Other sub-sectors are allocated to DAs on a pollutant-generic basis, using employment data.	
2A6	Bricks and ceramics production (Several sub-sectors)	All brick and ceramic production processes are very insignificant sources of POPs. Allocations to DAs are based on GDP data, similar to the method applied for the DA GHGI.	
2B10a	Chemical Industry	There are several minor chemical industry sources of POPs. The share of UK emissions are estimated for DAs based on GDP as a proxy.	
2C1	Sinter production	This is a significant source of dioxin emissions, with a high level of operator reporting from the UK's iron and steel works operators across the time-series. The DA allocations are based on a method similar to that for NFR 1A1a.	

NFR	Source Categories	PCDD/F inventory method	B[a]p Inventory method
	Electric arc furnaces	As above, but EAFs are only a moderate source of dioxins and a relatively insignificant source of B[a]p in all years.	
2C3	Primary aluminium	Now a minor source, primary aluminium impacts on the trend for dioxin and B[a]p emissions, and using operator reporting, the method here is similar to that for NFR 1A1a.	
	Secondary aluminium	A minor source for dioxins, insignificant for B[a]p. The dioxin method therefore is similar to that for NFR 1A1a.	
2C4	Magnesium alloying	Minor source. GDP used as a proxy.	*Not a source for B[a]p.*
2C5	Secondary lead production	One large installation in England dominates UK emissions in the early years, and in recent years, minor emissions at England and Wales sites. Point source data used to derive DA data.	*Not a source for B[a]p*
2C6	Primary lead and zinc manufacture	As above, one installation in England dominates with moderate emissions until closure in 2002.	*Not a source for B[a]p*
	Zinc alloy and semis production	Minor source across the time-series. No operator data available. GDP used as a proxy.	*Not a source for B[a]p*
2C7a	Secondary copper production	As above for NFR 2C5	*Not a source for B[a]p*
	Copper alloy and semis production	Point source data for particulate matter (PM_{10}) is used as the best available proxy, with one plant in England dominating UK emissions.	*Not a source for B[a]p*
2C7b	Nickel production	Minor source across the time-series. No operator data. GDP used as a proxy.	*Not a source for B[a]p*
2C7c	Foundries	Minor source across the time-series. No operator reporting, so an activity-data based emissions map used for other pollutants is applied here.	*Not a source for B[a]p*
	Tin production	Insignificant source. GDP used as a proxy.	*Not a source for B[a]p*
2D3b	Asphalt manufacture	Minor source. GDP used as a proxy.	*Not a source for B[a]p*
	Bitumen use	*Not a source for dioxins.*	Minor source. Population used as a proxy.
2G	Cigarette smoking	Minor source. Population used as a proxy.	

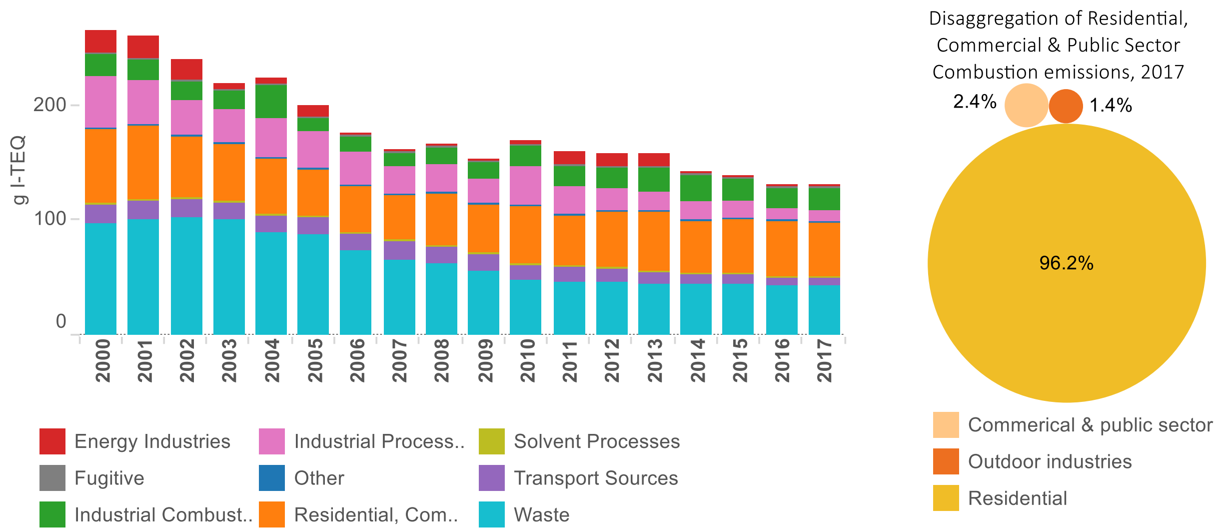
NFR	Source Categories	PCDD/F inventory method	B[a]p Inventory method
2I	Wood impregnation, PCP	Minor source, zero emissions after 1998. Population used as a proxy.	*Not a source for B[a]p*
	Creosote use	*Not a source for dioxins.*	Minor source. DA estimates based on a mapping grid used for other pollutants.
2K	Transformers, capacitors and fragmentisers	Minor source of dioxins. Population used as a proxy.	*Not a source for B[a]p*
3F	Field burning	Only a source in the very early part of the time-series until the practice was banned. No pollutant-specific information, so DA activity estimates are applied, as used for the DA GHGI and other air pollutants.	
5A	Landfill	Minor source. Same driver as that used for methane emissions.	*Not a source for B[a]p*
5C1	[All source categories]	The 5C1 sources comprise a range of incineration technologies, most of which are closely regulated and minor emission sources for POPs. However, there are notable dioxin emissions from chemical waste incineration and also from crematoria. The operator reporting for these sources is limited, however, and there are very scarce data on POPs. Emissions from MSW were very significant in the early 1990s and therefore notably affect the reported UK trends. Activity data drivers that are pollutant-generic are applied for MSW incineration, chemical waste incineration and crematoria, whilst a simple population driver is used for very minor sources such as clinical waste and sewage sludge incinerators.	
5C2	Small scale waste burning	A minor source of B[a]p emissions, but a significant source of dioxins. No available DA data, so population used as a proxy to estimate the DA share of UK emissions.	
	Agricultural waste burning	This is a moderate source of both dioxins and B[a]p, with a small impact on the UK and DA trends since 2005. There is limited DA-level data but activity has been estimated for DA GHGI and API reporting, and that is applied here also, but a mapping grid split applied to all years, i.e. assuming the same trend across UK.	
5E	[All source categories]	This sector includes accidental fires in dwellings, cars, other buildings and emissions on bonfire night. This is a significant source of dioxins and of B[a]p for which DA-level data are limited across the time-series. The method applied is to use population statistics as a proxy for all emissions.	

C.3.4 POPs Inventory Results for England, Scotland, Wales and Northern Ireland

The experimental POPs inventories for England, Scotland, Wales and Northern Ireland are summarised below. Graphs and charts focus on the trends since 2000, reflecting the greater confidence in data for later years.

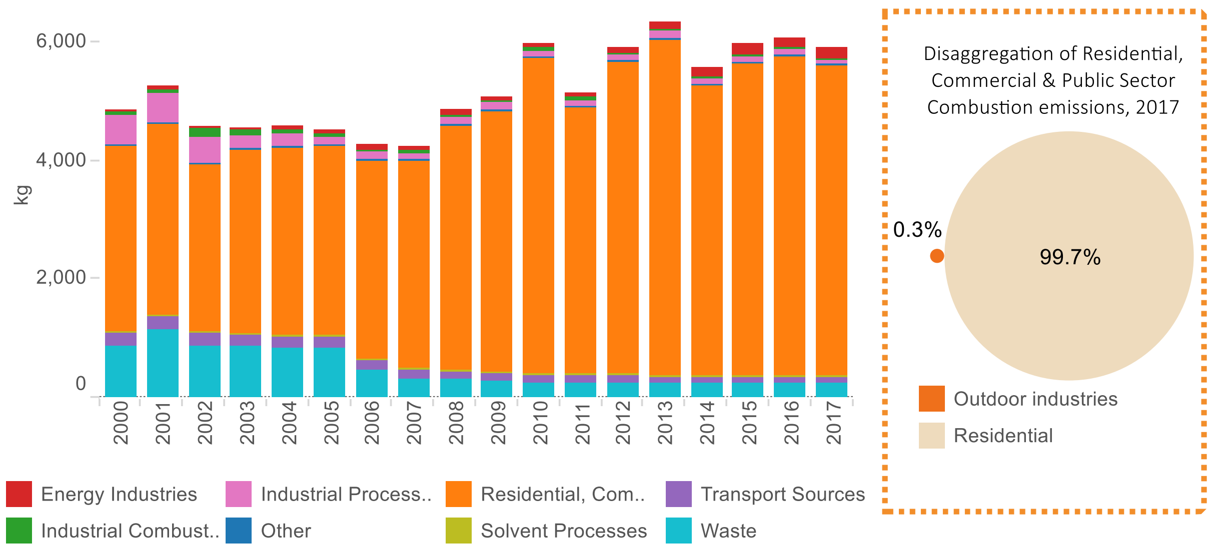
C.3.4.1 England POPs Inventories

Figure 69 Dioxins emissions in England



Emissions of **PCDD/Fs** were estimated to be 131g I-TEQ in 2017, representing 73% of the UK total. Emissions have declined by 89% since 1990. The early time-series trends are dominated by the cessation of field burning practices in 1993, the closure of waste incinerators that did not meet more stringent environmental criteria by 1996, and the phase-out of lead additives in petrol in the late 1990's. Since 2005, the inventory for PCCD/Fs has continued to decline, tracking trends in reducing coal-firing at power stations and the introduction of more stringent regulatory controls and the promotion of alternative waste disposal and recycling streams to reduce small-scale open waste burning of household and garden waste.

Figure 70 B[a]p emissions in England



Emissions of **benzo(a)pyrene** were estimated to be 5,931 kg in 2017, representing 77% of the UK total. Emissions have declined by 97% since 1990, but since 2000 have increased by 21%. The early time-series trends are driven by the cessation of field burning practices in 1993 and the gradual decline of anode-baking processes to produce aluminium. More recently, the increase in domestic wood combustion has caused a broad reversal in this trend since 2006.

Figure 71 Dioxin Emissions in England, 2017

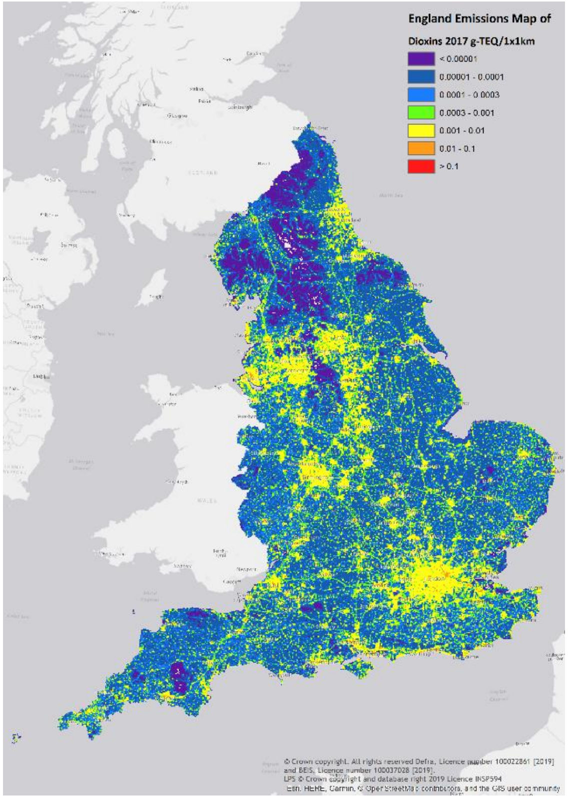
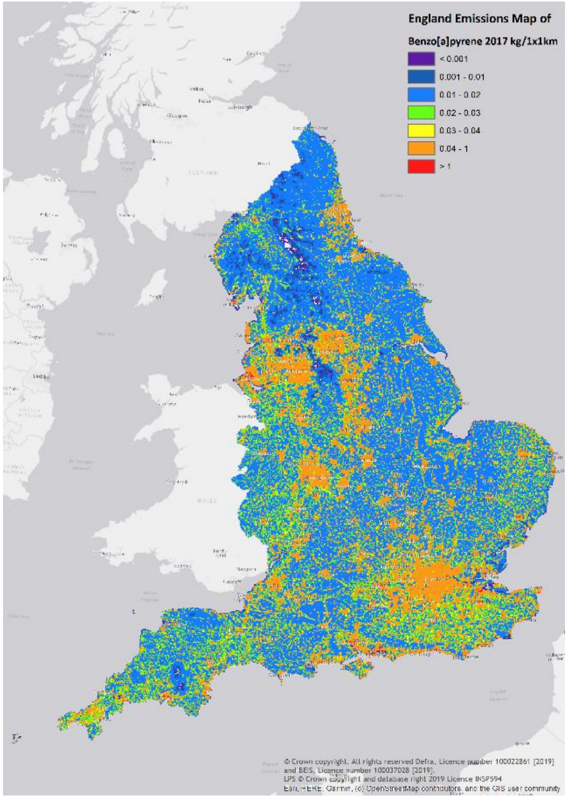
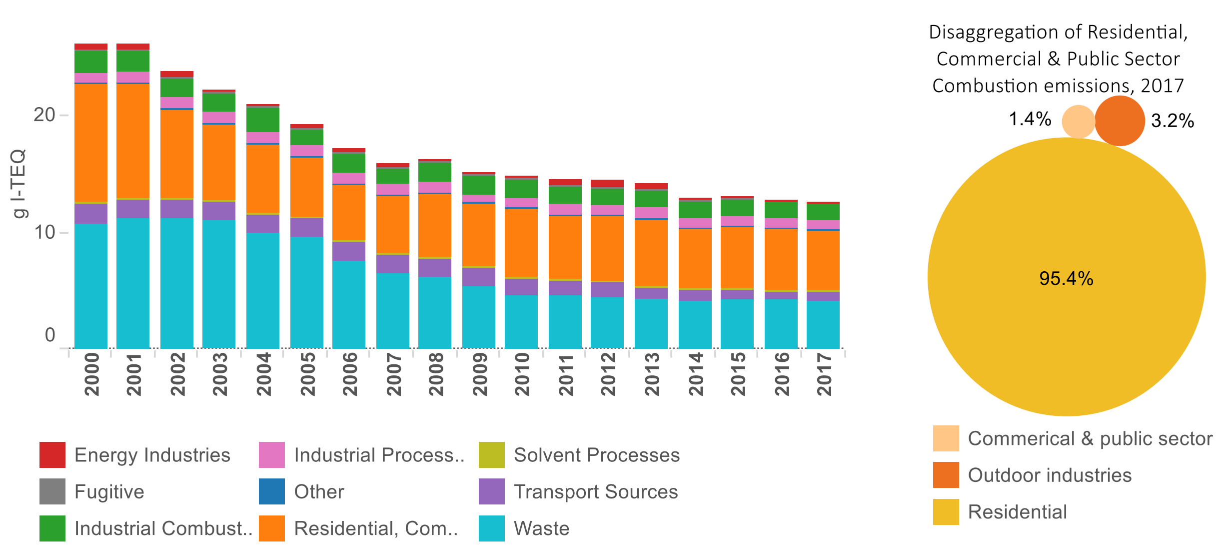


Figure 72 B[a]p Emissions in England, 2017



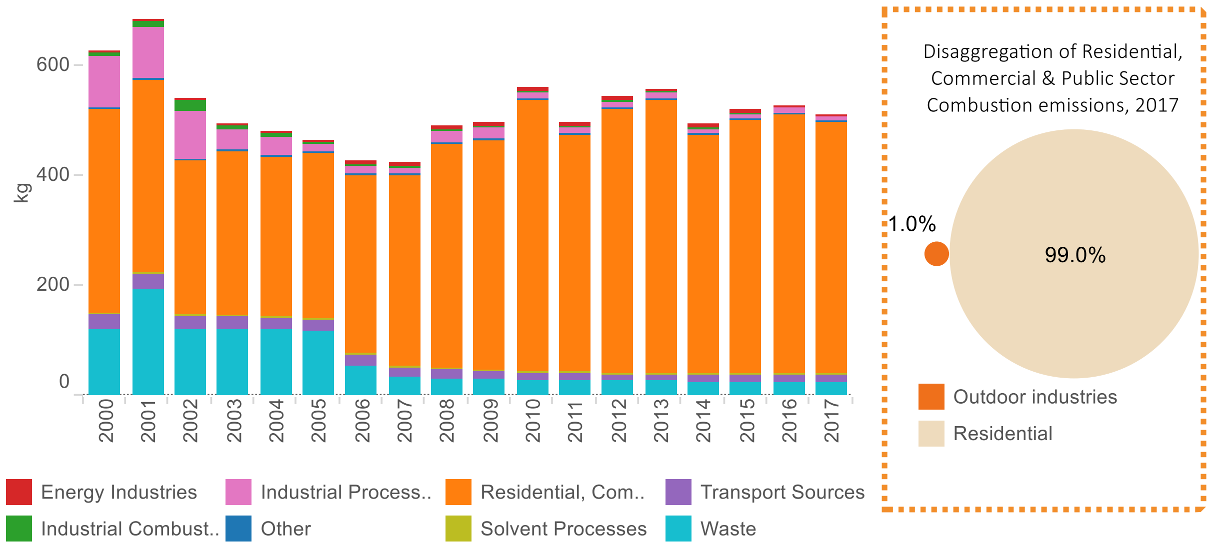
C.3.4.2 Scotland POPs Inventories

Figure 73 Dioxins Emissions in Scotland



Emissions of **dioxins** were estimated to be 12.7g I-TEQ in 2017, representing 7% of the UK total. Emissions have declined by 84% since 1990, mainly driven by a reduction in emissions from the waste sector. The early time-series trends are dominated by the cessation of field burning practices in 1993, the closure of waste incinerators that did not meet more stringent environmental criteria by 1996, and the phase-out of lead additives in petrol in the late 1990's. Since 2005, the inventory for PCCD/Fs has continued to decline, tracking trends in reducing coal-firing at power stations and the introduction of more stringent regulatory controls and the promotion of alternative waste disposal and recycling streams to reduce small-scale open waste burning of household and garden waste.

Figure 74 – B[a]p emissions in Scotland



Emissions of **benzo(a)pyrene** were estimated to be 511 kg in 2017, representing 7% of the UK total. Emissions have declined by 97% since 1990. The early time-series trends are driven by the cessation of field burning practices in 1993 and the gradual decline of anode-baking processes to produce aluminium. More recently, the increase in domestic wood combustion has caused a broad reversal in this trend since 2006.

Figure 75 Dioxin Emissions in Scotland, 2017

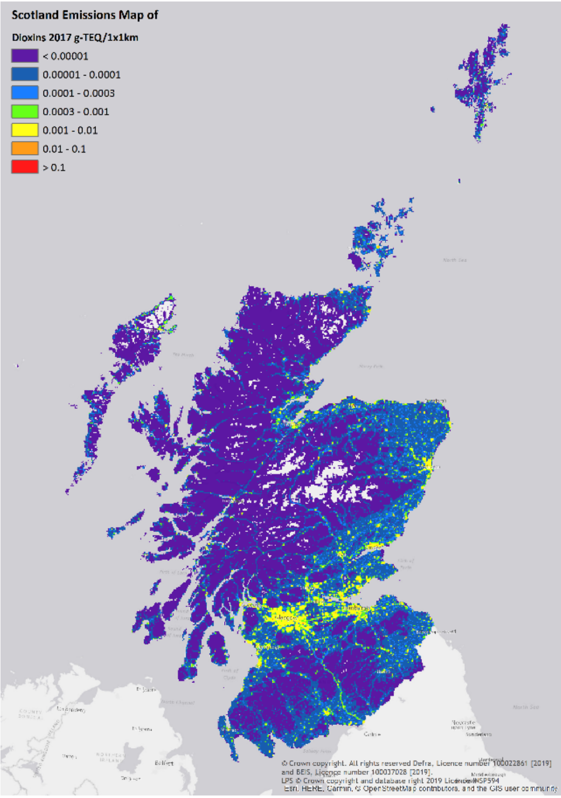
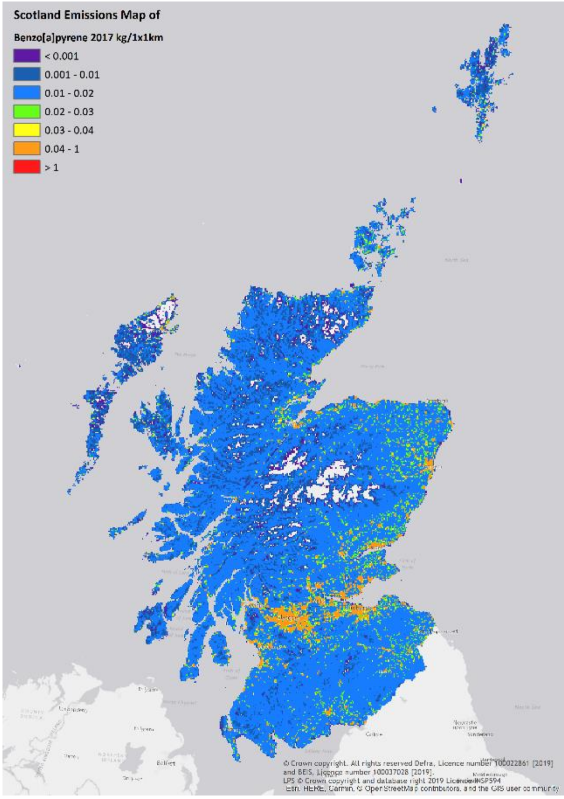
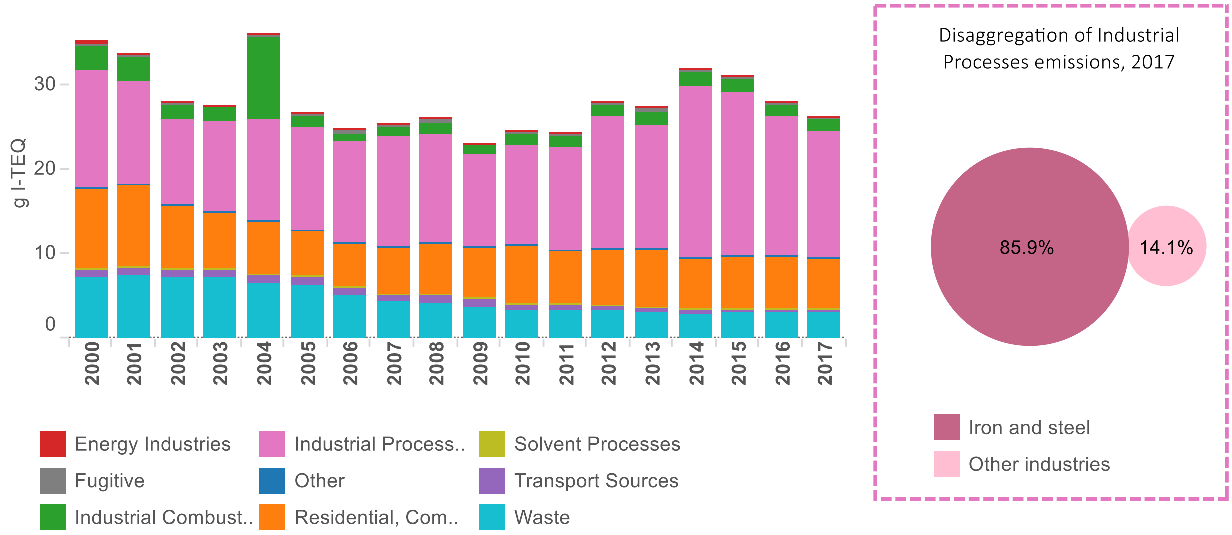


Figure 76 B[a]p Emissions in Scotland, 2017



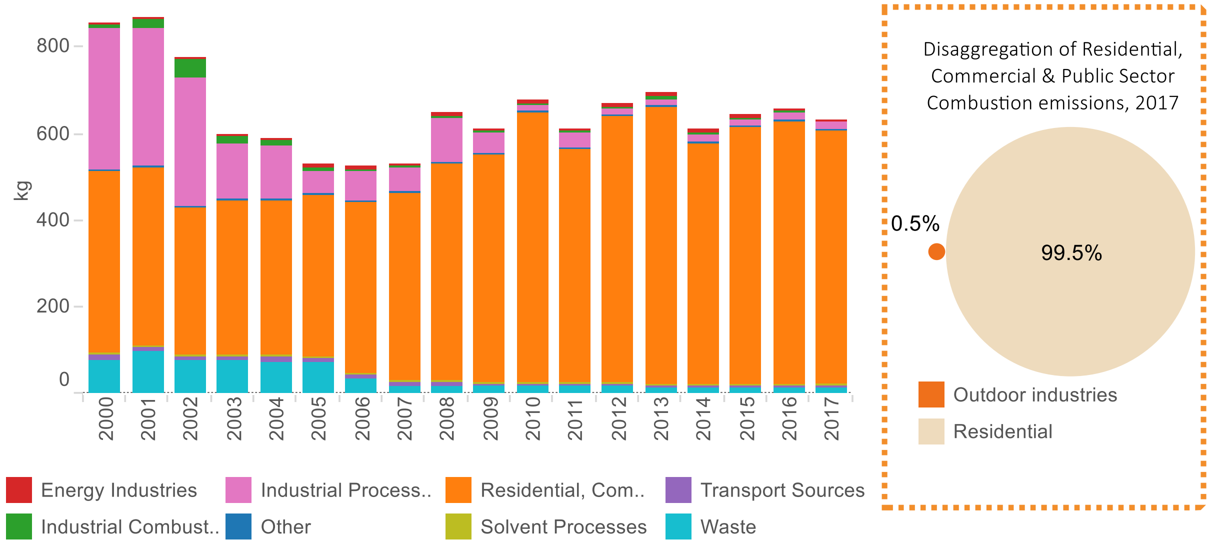
C.3.4.3 Wales POPs Inventories

Figure 77 Dioxins Emissions in Wales



Emissions of **dioxins** were estimated to be 26g I-TEQ in 2017, representing 15% of the UK total. Emissions have declined by 57% since 1990. The early time-series trends are dominated by the cessation of field burning practices in 1993, the closure of waste incinerators that did not meet more stringent environmental criteria by 1996, and the phase-out of lead additives in petrol in the late 1990's. However, the prominence of the iron and steel sector in Wales, particularly emissions from sinter production, dictates more recent trends has an overall increase since 2005. There is a notable outlier in 2004 for Industrial Combustion. This has been noted in the UK data, is reflected in the Welsh data and is indicative of the uncertainty in pre-2005 data.

Figure 78 B[a]p Emissions in Wales



Emissions of **benzo(a)pyrene** were estimated to be 718 kg in 2017, representing 9% of the UK total. Emissions have declined by 94% since 1990. The early time-series trends are driven by the cessation of field burning practices in 1993 and the gradual decline of anode-baking processes to produce aluminium. More recently, the increase in domestic wood combustion has caused a reversal in this trend since 2005.

Figure 79 Dioxin Emissions in Wales, 2017

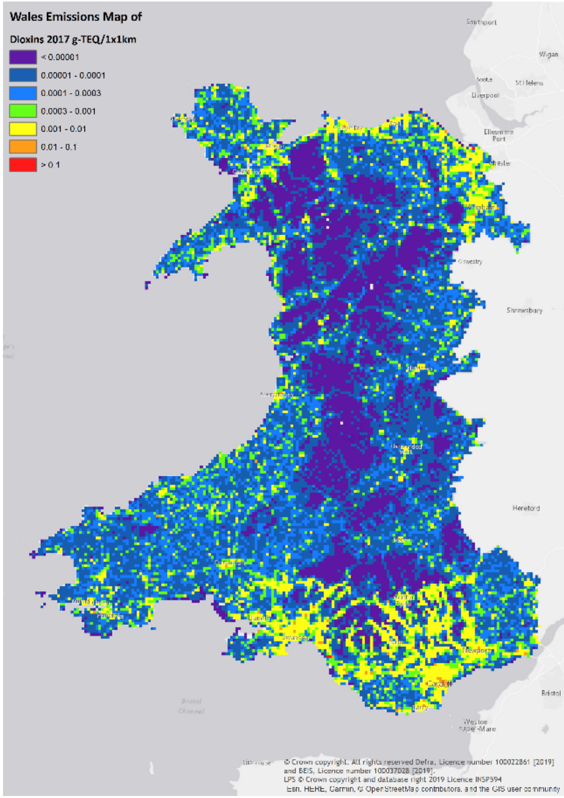
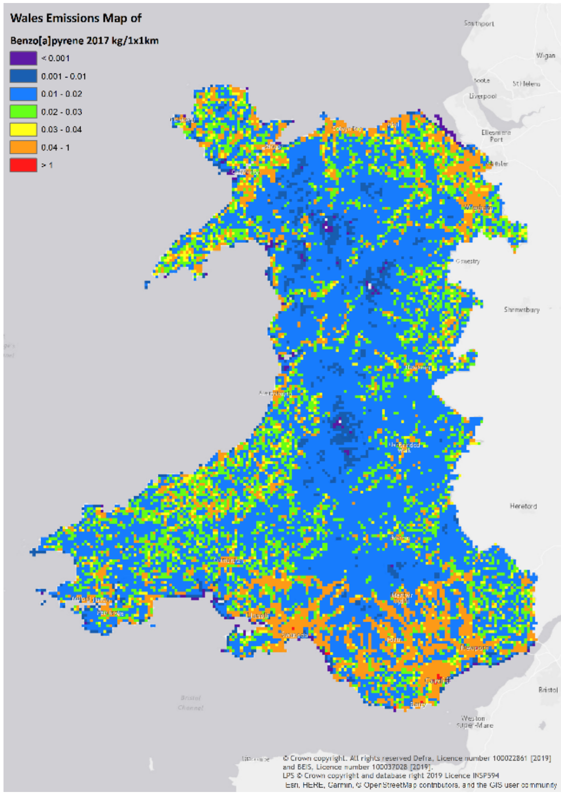
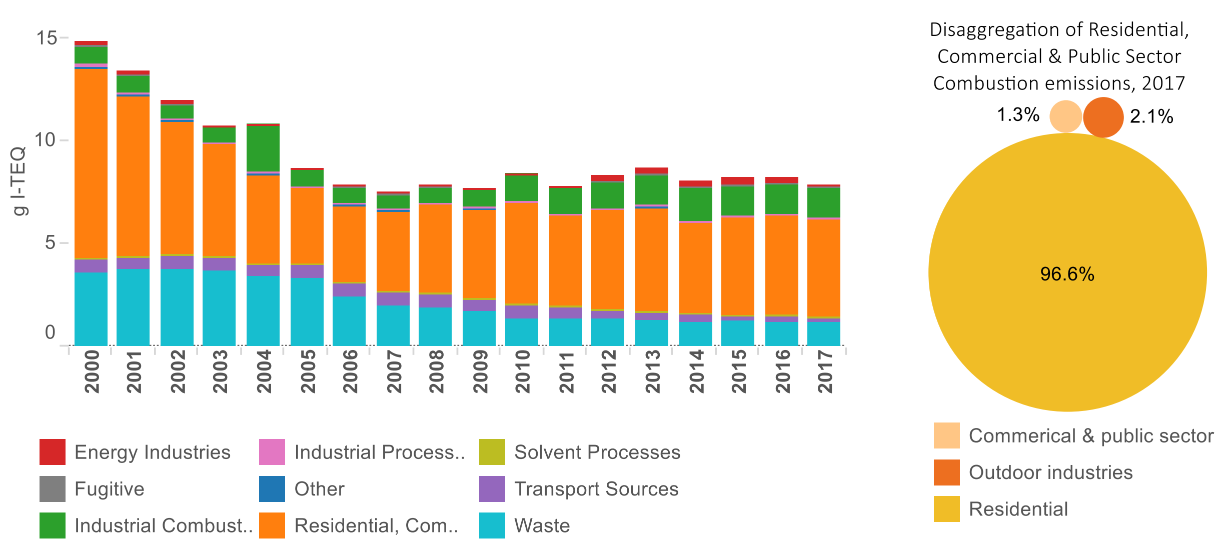


Figure 80 B[a]p Emissions in Wales, 2017



C.3.4.4 Northern Ireland POPs Inventories

Figure 81 Dioxins Emissions in Northern Ireland



Emissions of **dioxins** were estimated to be 7.8g I-TEQ in 2017, representing 4% of the UK total. Emissions have declined by 78% since 1990, largely driven by reductions in emissions from road transport after the phase-out of lead additives in petrol, and also reductions in emissions from residential combustion, as natural gas has penetrated the residential fuel market to displace oils and solid fuels. More recently, however, increased wood and other biomass combustion in residential and unallocated industries (1A4bi and 1A2gviii respectively) have opposed continued decline in emissions and held a fairly stable trend since 2008.

Figure 82 B[a]p Emissions in Northern Ireland

Emissions of **benzo(a)pyrene** were estimated to be 498 kg in 2017, representing 6% of the UK total. This trend is driven by residential combustion practices. The expansion of the natural gas network across Northern Ireland has reduced reliance on the combustion of solid fuels domestically, particularly coal and peat. However, over the time-series, increased use of wood for residential heating has offset this reduction and has caused a broad increase in emissions since 2004.

Figure 83 Dioxin Emissions in Northern Ireland, 2017

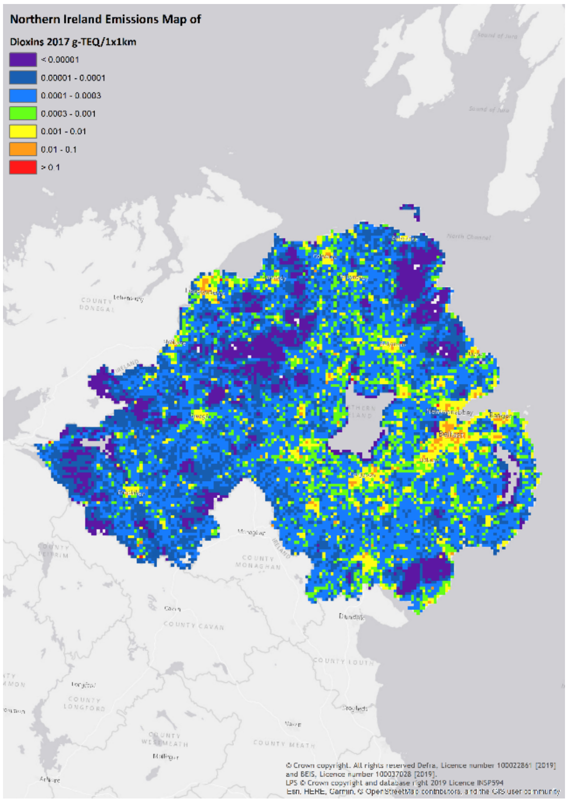
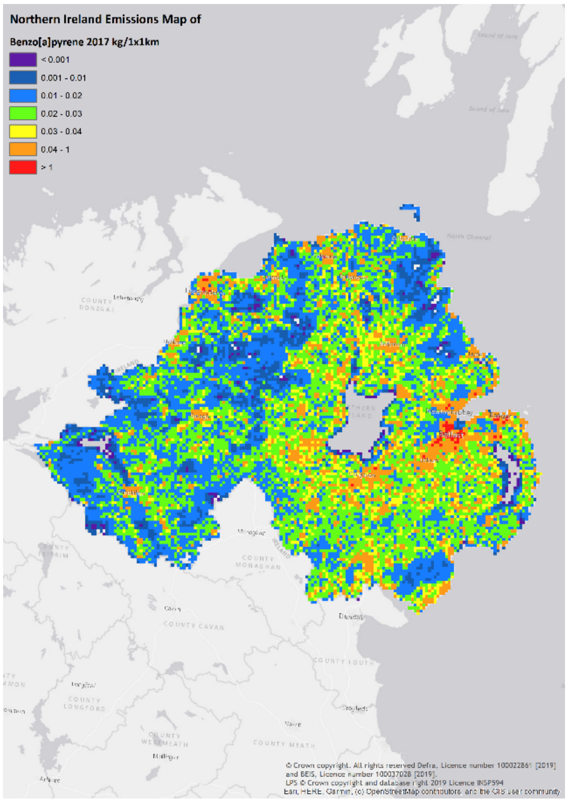


Figure 84 B[a]p Emissions in Northern Ireland, 2017



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 Devolved Administrations' inventories. For further details on recalculations and method changes affecting each NFR sector, see chapter 8 'Recalculations and Methodology Changes' of the UK Informative Inventory Report (IIR) (Richmond, et al., 2019). The most significant changes for each pollutant in the most recent inventory for 2016 are given in the tables below (note the shading within columns indicates magnitude of absolute emission recalculations). Recalculations to the B[a]p and Dioxins inventories are not included in this section as emissions from these pollutant groups are included for the first time this compilation cycle.

Table 8 - Recalculations to 2016 estimates for ammonia between previous and current inventory submissions

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)
Overall change		**-5.2**	**-3%**	**- 0.99**	**-3%**	**-0.7**	**-3%**	**0.5**	**2%**
Energy Industries	Some revisions to activity data, particular urea-based fertiliser use in 2016, which has had a significant impact on the overall NH3 trend. In other years that are minor adjustments to estimated nitrogen excretion due to changes to diet.	0.0	-5%	0.0	4%	0.0	4%	0.0	-64%
Industrial Combustion	Recalculations are not significant	0.2	14%	0.0	15%	0.0	13%	0.0	18%
Transport Sources	Recalculations are not significant	0.3	8%	0.0	9%	0.0	11%	0.0	8%
Residential, Commercial & Public Sector Combustion	Recalculations are not significant	0.1	5%	0.0	5%	0.0	5%	0.0	5%
Fugitive	Recalculations are not significant	0.0	-1%	0.0	477%	0.0	5%	0.0	53%
Industrial Processes	Inclusion of horse waste emissions under NFR code 6A in the 1990-2017 inventory.	0.0	0%	0.0	-23%	0.0	-2%	0.0	-27%
Solvent Processes	No change.	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Agriculture	Recalculations are not significant	-7.8	-5%	-0.9	-3%	-0.8	-4%	0.5	2%
Other	Minor revisions	1.4	15%	0.1	16%	0.2	30%	0.1	18%

"Change in 2016 (kt)" refers to the change in emission estimate for 2016 between the previous inventory and the current inventory.

Table 9 - Recalculations to 2016 estimates for carbon monoxide between previous and current inventory submissions

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)
Overall change		**30.1**	**3%**	**3.21**	**3%**	**2.4**	**1%**	**1.9**	**3%**
Energy Industries	Recalculations are not significant.	0.4	1%	0.3	6%	0.1	1%	0.1	3%
Industrial Combustion	Revisions to the inventory model for industrial off-road mobile machinery. DUKES recalculations also prominent in 2016, particularly gas use in unclassified industries.	12.5	4%	1.0	4%	0.8	1%	0.8	5%
Transport Sources	Updates to emission factors for a number of vehicle types, including Euro 4 and Euro 6 diesel cars, and petrol pre-Euro 1, Euro 5, and Euro 6 cars. Also revision to vehicle kilometres travelled in the latest years means there has been an overall increase in estimated CO emissions across all DAs.	13.6	5%	1.7	6%	1.0	6%	0.7	6%
Residential, Commercial & Public Sector Combustion	In 2016, changes are dominated by updates to annual publications such as DUKES and FAOstat. There have also been methodological changes to expand the number of fuels for which specific NCVs are utilised to account for variation in water content. This has a more noticeable impact in the early part of the time-series and so is not the dominant reason for change in 2016.	5.0	1%	0.3	1%	0.6	1%	0.4	1%
Fugitive	Recalculations are not significant.	-0.2	-15%	0.1	8%	-0.1	-1%	0.0	5%
Industrial Processes	Recalculations are not significant.	-1.2	-2%	0.0	-1%	0.0	0%	0.0	0%
Waste	Recalculations are not significant.	0.0	0%	-0.1	-3%	0.0	4%	0.0	-2%
Other	Recalculations are not significant.	0.0	0%	0.0	0%	0.0	2%	0.0	5%

Table 10 - Recalculations to 2016 estimates for nitrogen oxides between previous and current inventory submissions

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)
Overall change		**3.7**	**1%**	**3.60**	**4%**	**1.3**	**2%**	**2.2**	**6%**
Energy Industries	Minor revisions	0.2	0%	-0.1	0%	0.0	0%	0.1	1%
Industrial Combustion	Minor revisions	1.6	2%	0.2	2%	0.0	0%	0.3	3%
Transport Sources	Major revision to the emission factor for gas oil combustion on locomotive trains for all years after 1998. Additional revisions due to minor refinements to the shipping methodology which now produces uses pollutant-specific techniques to disaggregate UK emissions, but this is minor compared to changes to the 1A3c.	-11.2	-3%	-0.3	-1%	-0.7	-3%	0.2	1%
Residential, Commercial & Public Sector Combustion	Minor revisions	0.1	0%	0.8	5%	-0.1	-1%	0.0	0%
Fugitive	Minor revisions	0.0	-2%	0.0	24%	0.0	5%	0.0	5%
Industrial Processes	Minor revisions	0.3	31%	0.0	-9%	0.0	12%	0.0	25%
Agriculture	Minor revisions	12.4	248%	2.9	307%	1.9	257%	1.6	309%
Waste	Revision to country-specific emission factors for NOx emissions from soils (as NO-N) in response to international review to the 2018 submission. Minor changes due to corrections to nitrogen excretion estimates and some historical changes to urea-based fertiliser application rates.	0.1	6%	0.0	-3%	0.0	5%	0.0	-2%
Other	Minor revisions	0.2	2%	0.0	2%	0.0	7%	0.0	9%

Table 11 - Recalculations to 2016 estimates for NMVOCs between previous and current inventory submissions

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)
Overall change		**-13.1**	**-2%**	**- 3.21**	**-2%**	**-1.5**	**-3%**	**-1.0**	**-3%**
Energy Industries	Minor revisions	-0.08	-4%	- 0.0	-14%	0.1	28%	0.0	1%
Industrial Combustion	Minor revisions	0.77	5%	0.1	5%	0.0	3%	0.1	8%
Transport Sources	Minor revisions	0.49	1%	0.1	3%	0.0	2%	0.0	2%
Residential, Commercial & Public Sector Combustion	Minor revisions	0.79	2%	0.0	1%	0.1	3%	0.1	3%
Fugitive	Minor revisions	0.13	0%	0.3	1%	0.1	1%	- 0.0	0%
Industrial Processes	Changes to emissions factors for bread-baking and new activity data for foam blowing agents contribute to recalculations.	3.34	9%	1.7	2%	0.2	10%	0.5	17%
Solvent Processes	Improvement work to the emissions estimates from adhesives and sealants has revealed new data from the British Adhesives and Sealants Association which has been used to refine the time-series of activity data for various sources	-6.32	-2%	- 1.2	-5%	0.1	1%	- 0.2	-2%
Agriculture	Methodologies for the agriculture inventory now align with Tier 2 methodologies for estimating NMVOC emissions, causing recalculations across the time-series and all DAs.	-10.91	-15%	- 4.1	-23%	- 2.2	-18%	- 1.4	-9%
Waste	Minor revisions	0.04	1%	- 0.0	-5%	0.0	7%	- 0.0	-2%
Other	Minor revisions	-1.39	-43%	- 0.1	-36%	- 0.1	-39%	- 0.1	-44%

Table 12 - Recalculations to 2016 estimates for PM_{10} between previous and current inventory submissions

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)
Overall change		**-1.8**	**-1%**	**0.33**	**2%**	**-0.8**	**-6%**	**-0.4**	**-5%**
Energy Industries	Minor revisions	0.1	2%	-0.1	-18%	0.0	-8%	0.0	4%
Industrial Combustion	Revisions to DUKES activity data dominates reasons for change in 2016 for this sector.	1.1	7%	0.1	7%	0.1	7%	0.1	9%
Transport Sources	Minor revisions	0.1	1%	0.0	1%	0.0	-1%	0.0	-2%
Residential, Commercial & Public Sector Combustion	Revisions to DUKES activity data dominates reasons for change in 2016 for this sector.	0.9	2%	0.1	2%	0.1	3%	0.1	3%
Fugitive	Minor revisions	0.0	0%	0.0	16%	0.0	0%	0.0	5%
Industrial Processes	Revision to emission factors for spray painting and construction activities.	1.2	3%	0.1	3%	0.1	3%	0.1	6%
Solvent Processes	Improvement work to the emissions estimates from adhesives and sealants has revealed new data from the British Adhesives and Sealants Association which has been used to refine the time-series of activity data for various sources	-5.7		-0.5		-0.3		-0.2	
Agriculture	Reductions are due to manure management now only including emissions from housed livestock.	0.6	5%	0.6	28%	-0.8	-43%	-0.5	-28%
Waste	Minor revisions	0.0	0%	0.0	-1%	0.0	2%	0.0	-1%
Other	Minor revisions	-0.1	-26%	0.0	-20%	0.0	-32%	0.0	-31%

Table 13 - Recalculations to 2016 estimates for sulphur dioxide between previous and current inventory submissions

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)
Overall change		**6.9**	**1%**	**-9.2**	**-9%**	**1.7**	**3%**	**0.9**	**4%**
Energy Industries	Minor revisions	0.3	0%	-0.2	0%	0.0	0%	0.0	0%
Industrial Combustion	Minor revisions	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Transport Sources	Shipping emissions are now calculated using an approach which accounts for different vessel-fleet characteristics and engine types rather than simply an activity-based disaggregation. This means that there have been revisions to all pollutant estimates in the 1990-2017 inventory, but these changes are most apparent for SO_2 as this is an important source for this pollutant in the later years of the time-series.	6.7	15%	-9.0	-39%	1.7	28%	0.9	34%
Residential, Commercial & Public Sector Combustion	Minor revisions	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Fugitive	Minor revisions	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Industrial Processes	Minor revisions	-0.1	0%	0.0	0%	0.0	1%	0.0	0%
Waste	Minor revisions	0.0	-1%	0.0	-3%	0.0	4%	0.0	-2%
Other	Minor revisions	0.0	0%	0.0	0%	0.0	0%	0.0	0%

Table 14 - Recalculations to 2016 estimates for lead between previous and current inventory submissions

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)
Overall change		**25.7**	**28%**	**3.02**	**46%**	**1.7**	**8%**	**1.1**	**36%**
Energy Industries	Minor revisions	-0.1	-1%	0.0	0%	0.0	-2%	0.0	0%
Industrial Combustion	Minor revisions	0.1	1%	0.1	3%	0.0	0%	-0.1	-3%
Transport Sources	Estimates of lead emissions from tyre and brake wear from road transport are included under NFR code 1A3bvi for the first time in the UK air pollutant inventory. Disaggregation between DAs is based on estimated vehicle-kilometre data per vehicle type.	24.7	1156%	2.5	870%	1.5	1049%	1.0	1128%
Residential, Commercial & Public Sector Combustion	Minor revisions	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Fugitive	Minor revisions	-0.1	-3%	0.0	0%	0.0	-3%	0.0	0%
Industrial Processes	Minor revisions	1.1	2%	0.4	19%	0.2	1%	0.1	21%
Waste	Minor revisions	0.0	32%	0.0	2%	0.0	9%	0.0	2%

Table 15 - Recalculations to 2016 estimates for $PM_{2.5}$ between previous and current inventory submissions

Category	Reason for the change in emissions	England		Scotland		Wales		Northern Ireland	
		Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)	Change in 2016 (kt)	Change in 2016 (%)
Overall change		**-1.2**	**-1%**	**- 0.28**	**-3%**	**-0.3**	**-3%**	**-0.1**	**-1%**
Energy Industries	Minor revisions	0.0	2%	0.0	-14%	0.0	-7%	0.0	4%
Industrial Combustion	Revisions to DUKES activity data dominates reasons for change in 2016 for this sector.	1.0	8%	0.1	7%	0.1	7%	0.1	9%
Transport Sources	Minor revisions	0.1	1%	0.0	1%	0.0	-2%	0.0	-2%
Residential, Commercial & Public Sector Combustion	Revisions to DUKES activity data dominates reasons for change in 2016 for this sector.	0.9	2%	0.1	2%	0.1	3%	0.1	3%
Fugitive	Minor revisions	0.0	0%	0.0	14%	0.0	1%	0.0	5%
Industrial Processes	Revision to emission factors for spray painting and construction activities.	-0.3	-4%	0.0	0%	0.0	2%	0.0	2%
Solvent Processes	Improvement work to the emissions estimates from adhesives and sealants has revealed new data from the British Adhesives and Sealants Association which has been used to refine the time-series of activity data for various sources	-2.3	-83%	-0.2	-85%	-0.1	-80%	-0.1	-86%
Agriculture	Reductions are due to manure management now only including emissions from housed livestock.	-0.6	-24%	-0.2	-38%	-0.3	-61%	-0.2	-43%
Waste	Minor revisions	0.0	0%	0.0	-1%	0.0	2%	0.0	-1%
Other	Minor revisions	-0.1	-20%	0.0	-14%	0.0	-25%	0.0	-23%

Appendix E Uncertainties

The following sections provide information on the key characteristics of each pollutant based on the uncertainty assessments carried out for the UK NAEI, which uses both the Tier 1 uncertainty aggregation method and a Tier 2 statistical (Monte-Carlo) analysis. This information supports Section 1.4 of the main report. Further details are described in Chapter 1.7 of the "UK Informative Inventory Report 1990 to 2017" (Richmond, et al., 2019).

An indicative "Uncertainty Rating" is provided for each pollutant that reflects the relative magnitude in uncertainty estimates made for each pollutant at UK level across the full time-series. A 'low' rating implies a lower level of uncertainty in the emission estimates for the pollutant relative to the uncertainty in the estimates for a pollutant with a 'high' rating. A quantitative estimate of uncertainties in the inventories for each pollutant at UK level is given in the "UK Informative Inventory Report 1990 to 2016" (Richmond, et al., 2019). Quantitative estimates of uncertainties for each Devolved Administration have not been made but would be higher than the uncertainties at UK level and reflect uncertainties in the spatial distribution of emissions. These are higher for more diffuse sources than point sources. More details on the qualitative uncertainty estimates of the spatially resolved UK inventory are given in Section 5.1 of the 2016 NAEI mapping report (Tsagatakis, et al., 2018). The uncertainties in emission estimates may differ for each DA according to the relative mix of emissions from point sources and more diffuse sources in the DA and how this differs from the UK mix for a given pollutant. However, the overall uncertainty ranking of each pollutant at DA-level is not likely to be significantly different to the ranking at UK level given below for each pollutant and in Table 1 of the main body of the report.

The following sections refer to causes of uncertainties in emission estimates at UK level.

E.1 Ammonia

Ammonia emission estimates are more uncertain than those for SO_2, NO_X as NO_2 and NMVOC largely due to the nature of the major agricultural sources, which are more diffuse and therefore difficult to spatially model. Emissions depend on animal type, age, weight, diet, housing systems, waste management and storage techniques. This large number of impacting factors makes interpretation of experimental data difficult and emission estimates uncertain (DOE, 1994). Emission estimates for non-agricultural sources such as wild animals are also highly uncertain. Unlike the case of NO_X as NO_2 and NMVOC, a few uncertain sources dominate the inventory for NH_3 and there is limited potential for error compensation[5].

***Uncertainty Rating*: MODERATE**

E.2 Carbon Monoxide

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

Emissions from stationary combustion processes are also variable and depend on the technology employed and the specific combustion conditions. Emission estimates from small and medium-sized installations are derived from emission factors based on relatively few measurements of emissions from different types of boiler. Because of the high uncertainty in emission data for major sources, emission estimates for CO are much more uncertain than other pollutants such as NO_X (as NO_2) and SO_2 which are

[5] Error compensation refers to the theory that as more contributing sources are identified, there will logically be an increasing chance for lower or upper errors to be cancelled out, reducing the uncertainty in the aggregate total.

also emitted mainly from major combustion processes. Unlike the case of NO_X (as NO_2) and NMVOC, a few sources dominate the inventory and there is limited potential for error compensation.

***Uncertainty Rating*: MODERATE**

E.3 Nitrogen Oxides

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

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

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

***Uncertainty Rating*: LOW**

E.4 Non-Methane Volatile Organic Compounds

The NMVOC inventory is more uncertain than those for SO_2 and NO_X. This is due in part to the difficulty in obtaining robust emission factors or emission estimates for some sectors (e.g. fugitive sources of NMVOC emissions from industrial processes) and partly due to the absence of accurate activity data for some sources, such as for the use of cleaning products and domestic use of fuels for each specific Devolved Administration. Given the broad range of independent sources of NMVOCs, as with NO_X, there is a potential for error compensation, where an underestimate in emissions in one sector can be compensated by an overestimated of emissions in another sector when a large number of independent sources are utilised, with none dominating. A recent increase in the importance of solvent processes and agriculture sectors to the NMVOC inventory, which have higher uncertainty, means that the uncertainty rating of this inventory has been revised from low to moderate in this submission.

***Uncertainty Rating*: MODERATE**

E.5 Particulate Matter

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

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

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

Uncertainty Rating**:** **HIGH**

E.6 Sulphur Dioxide

SO_2 emissions can be estimated with the most confidence as they depend largely on the level of sulphur in fuels. Hence, the inventory, which is based upon comprehensive analysis on the sulphur content of coals and fuel oils consumed by power stations and the agriculture, industry and residential sectors, contains accurate emission estimates for the most important sources.

Uncertainty Rating**:** **LOW**

E.7 Lead

The Pb 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 Pb 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 the Industrial Emissions Directive (IED) 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 Pb emission measurements provide a snap-shot of the process and plant performance, and there is some uncertainty about 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/IED industries and are unavoidable; the emissions data from IED-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 Pb 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. In addition, the inventory agency has made note of a spurious trend in the raw data used to calculate road transport emissions in Scotland between 2016 and 2017. This will be interrogated when new data is received for the calculation of the 1990-2018 inventory and appropriate steps to ensure time-series consistency will be taken. Until then, the trend in transport emissions between 2016 and 2017 should be considered with high uncertainty.

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

***Uncertainty Rating*:** **HIGH**

Appendix F Summary Tables

In these tables, 'Other' is inclusive of categories which are considered to contribute negligible emissions for a given pollutant. For example, in the case of carbon monoxide, the 'Other' sector includes emissions from the agriculture, solvent processes, and other categories. The allocations of categories to the "Other" sector is presented in **Table 21**, Appendix G.

A full dataset is published alongside this report, available to download from the NAEI website.

F.1 Summary Air Pollutant Emission Estimates for England

Table 16 - Summary of air pollutant emission estimates for England (1990-2017)*

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
Ammonia (kt)	Agriculture	209	179	170	156	147	145	156	160	161	162
	Industrial Processes	9.8	8.6	4.9	5.5	4.4	3.5	3.0	2.2	2.5	3.0
	Transport Sources	0.7	5.8	19.2	13.1	8.4	5.3	4.7	4.2	4.0	3.8
	Waste	5.2	6.4	6.9	8.6	8.2	8.1	8.5	8.6	8.7	8.7
	Other	10	11	12	12	14	15	15	16	16	16
	Total	**235**	**210**	**212**	**196**	**182**	**177**	**187**	**191**	**192**	**193**
Carbon monoxide (kt)	Energy Industries	100	92	59	68	59	70	63	57	40	39
	Fugitive	23	13	11	5	4	4	4	3	1	1
	Industrial Combustion	490	498	389	432	318	353	375	370	329	338
	Industrial Processes	225	222	226	97	77	81	74	65	49	50
	Residential, Commercial & Public Sector Combustion	674	532	464	326	389	419	385	402	405	406
	Transport Sources	4,081	3,442	2,107	1,447	676	433	375	336	296	264
	Total	**5,804**	**4,827**	**3,283**	**2,401**	**1,548**	**1,383**	**1,297**	**1,254**	**1,141**	**1,118**
Nitrogen oxides (kt)	Energy Industries	651	417	292	346	212	224	188	155	102	101
	Industrial Combustion	340	312	256	231	157	121	116	119	110	112
	Residential, Commercial & Public Sector Combustion	168	153	130	102	78.1	70.4	61.9	63.5	63.9	61.6
	Transport Sources	1,160	998	758	598	420	365	361	354	341	323

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
	Other	81.6	68.4	49.2	42.3	42.5	37.3	36.1	32.6	31.1	32.0
	Total	**2,401**	**1,948**	**1,485**	**1,319**	**910**	**818**	**764**	**724**	**647**	**630**
NMVOC (kt)	Agriculture	66.3	62.7	63.6	59.3	57.0	57.7	59.4	59.4	60.1	61.6
	Fugitive	475	329	222	160	109	84.3	83.5	77.8	68.0	68.5
	Industrial Combustion	25.5	26.2	25.5	25.8	19.8	15.3	15.9	17.2	16.5	17.4
	Industrial Processes	209	180	106	76.2	54.1	48.0	46.1	45.0	45.6	47.1
	Residential, Commercial & Public Sector Combustion	59.1	46.1	45.0	37.5	40.5	40.2	35.7	38.2	38.9	38.4
	Solvent Processes	540	421	341	309	261	260	266	270	272	271
	Transport Sources	735	577	336	167	68.2	45.5	41.9	39.3	37.1	35.2
	Other	22.0	21.7	19.1	15.9	12.0	10.6	9.89	9.59	9.17	9.15
	Total	**2,131**	**1,663**	**1,158**	**850**	**622**	**562**	**558**	**556**	**547**	**548**
PM_{10} (kt)	Agriculture	27.2	11.9	12.6	11.9	11.7	11.4	11.8	11.6	11.8	12.0
	Energy Industries	59.9	33.8	18.8	8.49	5.47	7.52	6.19	4.90	3.38	3.30
	Industrial Combustion	29.1	27.7	19.7	17.1	16.2	15.3	16.5	16.0	15.3	16.7
	Industrial Processes	77.5	58.7	51.4	51.4	40.2	38.3	36.3	37.3	38.8	40.4
	Residential, Commercial & Public Sector Combustion	38.1	28.7	29.5	27.1	37.5	38.9	34.0	36.5	37.5	36.5
	Solvent Processes	4.29	3.73	2.47	1.28	1.06	1.19	1.32	1.37	1.37	1.39
	Transport Sources	40.8	42.7	36.6	32.8	24.8	21.1	20.5	19.9	19.3	18.7
	Other	11.1	8.40	6.64	6.15	5.34	4.91	4.79	4.50	4.24	4.24
	Total	**288**	**216**	**178**	**156**	**142**	**139**	**131**	**132**	**132**	**133**
Sulphur dioxide (kt)	Energy Industries	2,481	1,470	712	358	150	168	120	92.3	46.0	48.2
	Fugitive	16.1	16.1	6.09	6.18	7.11	5.80	5.74	3.35	0.89	0.87
	Industrial Combustion	316	253	106	100	79.6	68.0	61.5	36.6	26.7	28.0
	Industrial Processes	50.5	53.1	38.3	28.8	10.6	6.85	7.12	6.30	7.43	8.44
	Residential, Commercial & Public Sector Combustion	138	109	65.7	39.3	37.5	34.4	34.7	32.7	33.1	33.3

	Category	**1990**	**1995**	**2000**	**2005**	**2010**	**2013**	**2014**	**2015**	**2016**	**2017**
	Transport Sources	115	105	59.1	51.4	22.8	14.0	13.6	10.5	10.3	10.0
	Other	17.3	10.8	6.50	5.99	5.32	3.81	3.31	1.95	1.84	1.84
	Total	**3,134**	**2,017**	**994**	**590**	**313**	**301**	**246**	**184**	**126**	**131**
Lead (t)	Energy Industries	148	128	13.8	9.06	2.15	3.14	2.50	2.61	2.59	2.76
	Industrial Combustion	30.4	25.3	12.9	11.2	10.1	10.3	10.2	10.6	8.6	10.2
	Industrial Processes	257	219	90.3	66.3	31.5	32.7	36.6	35.6	28.6	27.6
	Residential, Commercial & Public Sector Combustion	23.4	13.7	7.12	3.71	4.16	4.43	4.22	3.81	3.87	3.91
	Transport Sources	1,825	901	26.0	26.8	25.5	25.2	25.9	26.2	26.5	26.5
	Waste	215	54.0	0.40	0.20	0.17	0.18	0.18	0.18	0.16	0.15
	Other	2.89	2.03	1.70	1.98	1.73	1.69	1.57	1.06	0.35	0.33
	Total	**2,503**	**1,344**	**152**	**119**	**75**	**78**	**81**	**80**	**71**	**71**
$PM_{2.5}$ (kt)	Agriculture	16.3	2.09	2.11	1.97	1.91	1.86	1.91	1.89	1.92	1.94
	Energy Industries	27.6	16.5	9.25	5.25	3.60	4.52	3.81	3.20	2.64	2.56
	Industrial Combustion	26.7	25.7	18.5	16.3	15.6	14.6	15.8	15.3	14.8	16.2
	Industrial Processes	22.9	18.7	13.1	12.4	9.06	9.07	9.11	9.01	8.36	8.57
	Residential, Commercial & Public Sector Combustion	37.2	28.1	28.9	26.5	36.6	38.0	33.2	35.6	36.6	35.6
	Solvent Processes	1.64	1.49	0.97	0.45	0.37	0.42	0.47	0.48	0.49	0.49
	Transport Sources	35.7	37.6	31.2	27.2	19.6	15.9	15.2	14.5	13.8	13.2
	Other	7.48	6.28	5.33	5.07	4.46	4.16	4.08	3.92	3.85	3.85
	Total	**175**	**136**	**109**	**95**	**91**	**89**	**84**	**84**	**83**	**82**
B[a]p (kg)	Agriculture	193,033	-	-	-	-	-	-	-	-	-
	Energy Industries	71.2	51.1	42.5	66.9	68.0	116	136	171	160	165
	Fugitive	76.9	52.8	47.1	64.3	78.7	78.6	73.4	85.3	32.2	39.1
	Industrial Combustion	142	121	59.2	44.3	41.3	39.6	37.6	40.1	40.7	38.7
	Industrial Processes	12,072	8,036	488	134	91.9	128	101	97.3	80.0	75.3

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
	Residential, Commercial & Public Sector Combustion	4,089	2,760	3,151	3,231	5,363	5,671	4,911	5,284	5,419	5,242
	Solvent Processes	11.5	11.2	9.13	8.82	6.35	6.31	6.55	6.81	6.23	6.68
	Transport Sources	315	326	256	188	142	126	126	124	123	122
	Waste	894	887	853	840	252	243	241	243	244	243
	Other	1.75	1.41	1.18	1.10	1.12	0.85	0.73	0.58	0.56	0.56
	Total	**210,706**	**12,247**	**4,909**	**4,580**	**6,045**	**6,411**	**5,633**	**6,051**	**6,105**	**5,931**
Dioxins (g I-TEQ)	Agriculture	41.3	-	-	-	-	-	-	-	-	-
	Energy Industries	194	219	18.8	9.08	2.83	10.40	1.61	1.52	1.56	1.41
	Fugitive	2.25	1.07	0.60	0.42	0.36	0.38	0.36	0.25	0.22	0.19
	Industrial Combustion	33.1	37.9	20.6	12.7	19.8	22.3	23.1	21.2	19.7	20.3
	Industrial Processes	91.7	89.7	43.9	32.2	33.1	15.9	15.9	13.7	9.70	9.47
	Residential, Commercial & Public Sector Combustion	99.4	75.1	64.9	41.3	51.1	53.1	46.7	48.7	48.7	48.5
	Solvent Processes	1.06	1.16	0.88	0.82	0.70	0.63	0.72	0.72	0.72	0.72
	Transport Sources	144	84.0	17.2	15.7	14.3	10.6	9.52	8.33	7.31	6.41
	Waste	556	223	97.5	87.2	47.1	44.0	44.1	45.0	43.8	43.6
	Other	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
	Total	**1,163**	**731**	**265**	**199**	**169**	**157**	**142**	**139**	**132**	**131**

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

F.2 Summary Air Pollutant Emission Estimates for Scotland

Table 17 - Summary of air pollutant emission estimates for Scotland (1990-2017)*

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
Ammonia (kt)	Agriculture	35.3	32.7	31.8	31.2	28.9	27.6	29.0	29.3	30.1	29.1
	Industrial Processes	0.09	0.09	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.04
	Transport Sources	0.08	0.62	1.97	1.36	0.86	0.55	0.48	0.43	0.41	0.37
	Waste	0.57	0.69	0.74	0.83	0.79	0.72	0.78	0.81	0.81	0.81
	Other	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.3	1.3	1.4
	Total	**37.1**	**35.2**	**35.7**	**34.7**	**31.8**	**30.2**	**31.6**	**31.9**	**32.7**	**31.7**
Carbon monoxide (kt)	Energy Industries	14.9	14.8	11.3	10.0	11.2	8.63	7.15	6.67	5.27	4.21
	Fugitive	5.15	1.11	1.09	0.97	0.91	0.88	0.97	1.17	0.82	0.60
	Industrial Combustion	79.9	32.0	25.4	29.4	25.9	24.1	25.9	27.0	26.3	27.5
	Industrial Processes	3.91	3.21	3.39	3.30	0.25	0.21	0.20	0.19	0.19	0.18
	Residential, Commercial & Public Sector Combustion	165	96.9	70.5	41.2	46.6	47.0	43.0	44.7	44.7	44.5
	Transport Sources	371	312	191	138	67.3	44.3	38.6	34.2	30.6	27.9
	Total	**657**	**463**	**306**	**225**	**155**	**127**	**118**	**116**	**110**	**107**
Nitrogen oxides (kt)	Energy Industries	96.6	65.0	54.8	44.5	37.1	28.0	26.2	23.9	14.3	11.6
	Industrial Combustion	40.0	32.8	28.5	22.5	16.5	13.3	12.9	12.4	12.0	11.9
	Residential, Commercial & Public Sector Combustion	41.1	39.4	32.0	28.6	21.4	17.8	17.8	16.8	17.3	16.7
	Transport Sources	136	123	95.3	78.4	56.1	48.2	46.9	46.8	45.2	47.4
	Other	10.4	8.77	7.92	6.96	6.30	6.28	5.73	5.35	5.12	5.12
	Total	**324**	**269**	**218**	**181**	**137**	**114**	**110**	**105**	**93.9**	**92.8**
NMVOC (kt)	Agriculture	15.6	15.4	15.2	15.0	14.3	13.7	13.8	13.6	13.7	13.6
	Fugitive	185	124	82.9	42.8	22.3	21.0	19.2	21.3	21.2	18.9
	Industrial Combustion	2.57	2.34	2.31	2.19	1.88	1.42	1.50	1.65	1.56	1.63

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
	Industrial Processes	41.2	43.1	47.7	47.1	55.4	61.2	64.2	66.0	67.3	67.2
	Residential, Commercial & Public Sector Combustion	12.6	7.97	6.90	5.25	5.15	4.62	4.20	4.34	4.38	4.30
	Solvent Processes	59.6	47.1	33.9	29.7	24.6	24.2	25.2	25.4	25.3	25.3
	Transport Sources	68.2	53.7	31.8	16.8	7.36	4.99	4.61	4.36	4.18	4.19
	Other	2.61	2.59	2.24	1.80	1.41	1.15	1.06	1.06	0.98	0.97
	Total	**388**	**297**	**223**	**161**	**133**	**132**	**134**	**138**	**139**	**136**
PM_{10} (kt)	Agriculture	3.97	2.78	2.74	2.70	2.70	2.67	2.70	2.62	2.66	2.69
	Energy Industries	8.23	5.12	3.56	1.69	1.35	0.72	0.60	0.45	0.29	0.21
	Industrial Combustion	3.65	3.19	2.08	1.81	1.49	1.16	1.18	1.21	1.17	1.24
	Industrial Processes	8.03	5.83	4.87	4.94	3.75	3.43	3.33	3.41	3.70	3.81
	Residential, Commercial & Public Sector Combustion	8.45	5.29	4.65	3.67	4.04	3.80	3.38	3.58	3.65	3.54
	Solvent Processes	0.37	0.32	0.18	0.10	0.08	0.09	0.10	0.10	0.10	0.10
	Transport Sources	6.61	6.84	5.76	5.07	3.32	2.64	2.54	2.49	2.45	2.48
	Other	1.05	0.98	1.09	0.99	1.05	0.90	1.11	0.73	0.68	0.72
	Total	**40.4**	**30.4**	**24.9**	**21.0**	**17.8**	**15.4**	**14.9**	**14.6**	**14.7**	**14.8**
Sulphur dioxide (kt)	Energy Industries	217	135	104	53.7	66.2	33.7	23.0	17.5	8.7	5.1
	Fugitive	0.59	0.06	0.40	0.41	0.15	0.15	0.31	0.11	0.08	0.10
	Industrial Combustion	39.7	24.0	7.09	11.2	4.42	2.90	2.57	1.99	1.55	1.41
	Industrial Processes	0.78	0.67	0.69	0.78	0.58	0.62	0.58	0.66	0.69	0.66
	Residential, Commercial & Public Sector Combustion	32.7	25.1	13.4	8.36	5.16	3.95	4.09	3.78	3.83	3.97
	Transport Sources	22.3	22.2	15.7	14.2	5.83	3.38	2.95	2.45	2.40	2.54
	Other	1.28	0.90	0.57	0.56	0.49	0.35	0.31	0.18	0.17	0.17
	Total	**314**	**208**	**142**	**89.2**	**82.9**	**45.0**	**33.8**	**26.6**	**17.4**	**14.0**
Lead (t)	Energy Industries	12.1	7.9	3.00	1.60	1.30	0.61	0.59	0.65	0.36	0.37
	Industrial Combustion	3.80	3.31	2.05	1.83	1.38	1.05	0.95	0.86	0.89	0.89

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
	Industrial Processes	12.6	5.96	2.71	2.38	1.33	1.15	1.35	1.32	1.12	1.21
	Residential, Commercial & Public Sector Combustion	4.50	2.26	1.18	0.57	0.58	0.55	0.51	0.52	0.52	0.52
	Transport Sources	173	84.4	2.68	2.81	2.76	2.69	2.75	2.78	2.84	3.06
	Waste	6.67	1.92	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Other	0.47	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
	Total	**213**	**106**	**12**	**9.2**	**7.4**	**6.1**	**6.2**	**6.1**	**5.7**	**6.1**
$PM_{2.5}$ (kt)	Agriculture	1.48	0.42	0.41	0.40	0.39	0.39	0.39	0.38	0.38	0.38
	Energy Industries	3.86	2.54	1.79	1.04	0.85	0.43	0.37	0.30	0.23	0.17
	Industrial Combustion	3.43	3.02	1.98	1.76	1.44	1.12	1.14	1.17	1.13	1.20
	Industrial Processes	2.10	1.47	0.99	0.99	0.70	0.65	0.69	0.66	0.72	0.72
	Residential, Commercial & Public Sector Combustion	8.27	5.18	4.57	3.60	3.96	3.71	3.31	3.50	3.57	3.47
	Solvent Processes	0.13	0.11	0.06	0.03	0.02	0.03	0.03	0.03	0.03	0.03
	Transport Sources	5.98	6.21	5.12	4.41	2.72	2.08	1.96	1.91	1.86	1.85
	Other	0.71	0.64	0.64	0.57	0.60	0.56	0.66	0.50	0.48	0.50
	Total	**26.0**	**19.6**	**15.6**	**12.8**	**10.7**	**8.97**	**8.55**	**8.47**	**8.40**	**8.32**
B[a]p (kg)	Agriculture	13,948	-	-	-	-	-	-	-	-	-
	Energy Industries	5.49	4.10	3.37	5.19	7.03	5.04	4.66	4.03	0.94	0.25
	Fugitive	12.9	-	-	-	-	-	-	-	-	-
	Industrial Combustion	15.5	12.8	5.81	4.07	4.81	3.96	4.00	3.89	4.08	3.76
	Industrial Processes	2,918	1,932	94.0	11.9	8.38	10.80	7.84	8.31	8.21	8.16
	Residential, Commercial & Public Sector Combustion	871	397	372	303	497	498	436	463	475	459
	Solvent Processes	1.22	1.18	0.94	0.89	0.63	0.62	0.64	0.67	0.61	0.65
	Transport Sources	35.1	37.6	29.7	22.1	17.1	14.6	14.4	14.4	14.4	14.6
	Waste	125	124	120	118	26.2	25.1	24.8	24.8	24.9	24.7
	Other	0.18	0.14	0.11	0.10	0.10	0.08	0.06	0.05	0.05	0.05

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
	Total	**17,931**	**2,509**	**626**	**465**	**561**	**558**	**492**	**519**	**528**	**511**
Dioxins (g I-TEQ)	Agriculture	2.99	-	-	-	-	-	-	-	-	-
	Energy Industries	5.52	6.71	0.49	0.27	0.24	0.51	0.21	0.18	0.12	0.11
	Fugitive	0.36	-	-	-	-	-	-	-	-	-
	Industrial Combustion	4.07	4.30	1.92	1.52	1.66	1.60	1.61	1.52	1.47	1.50
	Industrial Processes	1.90	1.71	0.93	0.95	0.79	0.86	0.81	0.89	0.89	0.87
	Residential, Commercial & Public Sector Combustion	26.0	14.5	10.1	5.13	6.02	5.86	5.15	5.34	5.29	5.24
	Solvent Processes	0.11	0.12	0.08	0.07	0.06	0.06	0.06	0.06	0.06	0.06
	Transport Sources	13.0	7.69	1.79	1.66	1.55	1.15	1.04	0.90	0.81	0.74
	Waste	27.4	16.5	10.8	9.67	4.58	4.22	4.11	4.21	4.20	4.18
	Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	**81.4**	**51.5**	**26.2**	**19.3**	**14.9**	**14.3**	**13.0**	**13.1**	**12.8**	**12.7**

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

F.3 Summary Air Pollutant Emission Estimates for Wales

Table 18 - Summary of air pollutant emission estimates for Wales (1990-2017) *

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
Ammonia (kt)	Agriculture	22.4	21.5	21.6	20.1	19.8	19.4	20.2	20.3	21.6	21.6
	Industrial Processes	0.07	0.07	0.06	0.06	0.06	0.05	0.06	0.05	0.05	0.05
	Transport Sources	0.05	0.40	1.23	0.84	0.53	0.33	0.29	0.26	0.24	0.23
	Waste	0.31	0.38	0.41	0.48	0.41	0.41	0.42	0.42	0.43	0.42
	Other	0.81	0.81	0.95	1.08	1.11	1.30	1.26	1.30	1.30	1.34
	Total	**23.6**	**23.1**	**24.2**	**22.6**	**21.9**	**21.5**	**22.2**	**22.3**	**23.6**	**23.6**
Carbon monoxide (kt)	Energy Industries	6.18	5.86	4.93	6.04	6.49	9.27	6.38	6.99	6.14	4.57
	Fugitive	12.4	19.2	15.3	3.10	6.38	5.99	5.62	4.63	9.54	6.21
	Industrial Combustion	131	161	126	77.7	69.5	75.6	88.5	84.7	73.7	79.7
	Industrial Processes	65.0	64.6	60.2	48.1	34.6	47.0	59.6	55.3	48.3	58.3
	Residential, Commercial & Public Sector Combustion	97	78.1	62.2	38.6	46.6	48.9	44.2	46.2	46.0	45.8
	Transport Sources	235	196	116	82.6	39.7	25.1	21.8	19.3	17.2	15.0
	Other	2.84	1.60	1.44	1.35	1.22	1.13	1.08	1.04	1.02	1.02
	Total	**550**	**527**	**386**	**258**	**204**	**213**	**227**	**218**	**202**	**211**
Nitrogen oxides (kt)	Energy Industries	49.9	35.2	32.2	33.6	30.3	44.9	32.4	35.2	29.6	16.4
	Industrial Combustion	37.2	35.3	34.2	20.5	16.2	13.2	13.6	13.2	11.2	11.9
	Residential, Commercial & Public Sector Combustion	19.0	18.2	15.5	12.3	8.36	7.16	6.36	6.22	6.18	6.05
	Transport Sources	76.3	66.2	49.8	40.7	29.4	24.3	24.4	23.6	23.2	22.0
	Other	6.86	6.16	5.33	4.40	3.76	3.67	3.98	3.12	3.67	3.72
	Total	**189**	**161**	**137**	**112**	**88.1**	**93.2**	**80.7**	**81.4**	**73.9**	**60.1**
NMVOC (kt)	Agriculture	9.49	10.1	10.6	9.94	9.67	9.86	10.2	10.0	10.2	10.3
	Fugitive	38.2	26.1	18.1	14.1	12.8	11.8	9.52	8.64	7.08	6.52

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
	Industrial Combustion	2.51	2.74	3.03	2.21	1.95	1.62	1.69	1.70	1.65	1.73
	Industrial Processes	11.4	13.5	6.65	3.35	2.45	2.54	2.53	2.47	2.37	2.29
	Residential, Commercial & Public Sector Combustion	8.04	6.04	5.57	4.25	4.91	4.74	4.24	4.47	4.54	4.45
	Solvent Processes	42.2	32.4	20.9	18.3	14.7	14.7	14.8	14.8	14.6	14.4
	Transport Sources	42.2	32.9	18.5	9.49	3.98	2.64	2.43	2.26	2.17	2.03
	Other	2.11	2.20	1.83	1.44	1.17	1.06	1.10	1.09	1.07	0.99
	Total	**156**	**126**	**85.2**	**63.0**	**51.7**	**48.9**	**46.6**	**45.5**	**43.7**	**42.7**
PM_{10} (kt)	Agriculture	1.07	0.99	1.05	0.94	0.95	0.99	1.01	0.95	1.03	1.04
	Energy Industries	3.32	2.12	1.93	1.04	0.81	1.11	0.60	0.57	0.50	0.32
	Industrial Combustion	3.04	2.52	1.79	1.23	1.32	1.22	1.38	1.37	1.30	1.38
	Industrial Processes	7.82	6.92	5.88	4.59	3.11	3.35	3.55	3.38	2.99	3.41
	Residential, Commercial & Public Sector Combustion	5.72	4.38	4.18	3.41	4.42	4.40	3.85	4.13	4.21	4.09
	Solvent Processes	0.27	0.24	0.14	0.07	0.05	0.06	0.07	0.07	0.07	0.07
	Transport Sources	3.52	3.36	2.78	2.61	1.70	1.37	1.33	1.28	1.25	1.19
	Other	0.80	0.68	0.62	0.42	0.42	0.36	0.37	0.35	0.38	0.30
	Total	**25.5**	**21.2**	**18.4**	**14.3**	**12.8**	**12.9**	**12.2**	**12.1**	**11.7**	**11.8**
Sulphur dioxide (kt)	Energy Industries	109	69.6	58.8	39.5	16.9	19.4	11.8	12.7	7.38	4.35
	Fugitive	4.12	3.08	1.38	0.97	1.58	0.88	1.17	0.91	0.81	0.84
	Industrial Combustion	45.3	37.0	20.1	7.14	9.99	8.36	8.66	7.18	5.71	6.26
	Industrial Processes	3.53	3.85	2.74	2.35	0.43	0.67	0.61	0.54	0.54	0.44
	Residential, Commercial & Public Sector Combustion	17.7	14.0	8.44	5.23	7.20	5.84	5.23	4.61	4.92	4.55
	Transport Sources	12.4	11.7	8.00	7.87	3.35	1.79	1.53	1.07	1.06	0.96
	Other	0.78	0.65	0.30	0.26	0.22	0.16	0.14	0.09	0.08	0.08
	Total	**193**	**140**	**100**	**63.3**	**39.7**	**37.1**	**29.1**	**27.1**	**20.5**	**17.5**
Lead (t)	Energy Industries	3.69	1.77	1.46	0.68	0.47	0.22	0.14	0.19	0.15	0.09

	Category	**1990**	**1995**	**2000**	**2005**	**2010**	**2013**	**2014**	**2015**	**2016**	**2017**
	Industrial Combustion	2.57	2.05	2.01	2.37	0.86	0.80	1.00	0.85	0.78	0.82
	Industrial Processes	17.3	18.4	16.8	16.4	11.5	8.76	13.1	12.8	10.4	9.98
	Residential, Commercial & Public Sector Combustion	2.70	1.76	1.09	0.57	0.61	0.60	0.55	0.57	0.57	0.57
	Transport Sources	111	53.8	1.57	1.66	1.61	1.59	1.63	1.65	1.69	1.66
	Waste	0.26	0.24	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Other	1.45	1.82	1.96	0.40	0.56	0.57	0.56	0.54	0.52	0.53
	Total	**139**	**79.9**	**24.9**	**22.1**	**15.7**	**12.5**	**17.0**	**16.6**	**14.1**	**13.7**
$PM_{2.5}$ (kt)	Agriculture	0.30	0.23	0.23	0.22	0.21	0.21	0.22	0.22	0.22	0.22
	Energy Industries	1.60	1.09	1.02	0.63	0.54	0.68	0.38	0.37	0.37	0.24
	Industrial Combustion	2.82	2.36	1.68	1.20	1.27	1.17	1.31	1.31	1.25	1.34
	Industrial Processes	3.20	3.07	2.37	1.68	1.18	1.46	1.67	1.48	1.08	1.36
	Residential, Commercial & Public Sector Combustion	5.61	4.30	4.11	3.34	4.33	4.30	3.76	4.04	4.12	4.00
	Solvent Processes	0.09	0.08	0.05	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Transport Sources	3.16	3.01	2.43	2.24	1.36	1.05	0.99	0.94	0.90	0.85
	Other	0.46	0.44	0.43	0.30	0.29	0.23	0.24	0.23	0.25	0.22
	Total	**17.2**	**14.6**	**12.3**	**9.63**	**9.20**	**9.13**	**8.60**	**8.61**	**8.23**	**8.25**
B[a]p (kg)	Agriculture	934	-	-	-	-	-	-	-	-	-
	Energy Industries	7.08	5.28	4.32	6.68	4.76	7.52	5.05	5.36	4.68	2.03
	Fugitive	39.9	50.1	58.4	13.3	26.8	27.6	27.2	46.3	66.5	86.0
	Industrial Combustion	26.0	20.5	8.60	8.81	3.36	7.53	4.14	3.51	3.48	2.88
	Industrial Processes	9,905	6,564	325.3	51.5	15.2	15.3	19.0	15.7	14.9	15.0
	Residential, Commercial & Public Sector Combustion	626	419	427	376	628	642	558	595	611	590
	Solvent Processes	0.69	0.67	0.54	0.52	0.37	0.36	0.37	0.39	0.35	0.38
	Transport Sources	20.0	21.0	16.6	12.3	9.38	8.22	8.18	8.06	8.05	7.89
	Waste	77.0	76.5	74.3	73.4	15.4	14.7	14.5	14.5	14.5	14.4

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
	Other	0.09	0.07	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02
	Total	**11,637**	**7,157**	**915**	**543**	**703**	**723**	**636**	**689**	**724**	**718**
Dioxins (g I-TEQ)	Agriculture	0.20	-	-	-	-	-	-	-	-	-
	Energy Industries	0.71	0.50	0.41	0.20	0.12	0.15	0.14	0.16	0.19	0.15
	Fugitive	1.14	0.55	0.29	0.24	0.32	0.34	0.31	0.23	0.20	0.18
	Industrial Combustion	5.91	5.17	2.65	1.19	1.34	1.52	1.63	1.51	1.41	1.40
	Industrial Processes	19.7	19.6	14.0	12.1	11.7	14.7	20.3	19.3	16.6	14.9
	Residential, Commercial & Public Sector Combustion	15.4	12.3	9.65	5.60	6.91	6.99	6.08	6.35	6.28	6.21
	Solvent Processes	0.05	0.06	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	Transport Sources	8.04	4.67	1.02	0.96	0.89	0.65	0.58	0.50	0.44	0.38
	Waste	10.1	9.15	7.23	6.33	3.23	3.00	2.94	3.02	2.99	2.98
	Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	**61.2**	**51.9**	**35.3**	**26.7**	**24.5**	**27.4**	**32.0**	**31.1**	**28.1**	**26.2**

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

F.4 Summary Air Pollutant Emission Estimates for Northern Ireland

Table 19 - Summary of air pollutant emission estimates for Northern Ireland (1990-2017) *

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
Ammonia (kt)	Agriculture	29.2	31.7	29.1	28.6	26.4	28.1	28.4	29.3	31.0	32.6
	Industrial Processes	0.17	0.17	0.16	0.01	0.01	0.00	0.00	0.00	0.00	0.00
	Transport Sources	0.03	0.27	0.88	0.59	0.39	0.26	0.22	0.20	0.19	0.18
	Waste	0.17	0.22	0.26	0.34	0.29	0.27	0.25	0.26	0.27	0.26
	Other	0.39	0.40	0.47	0.54	0.63	0.68	0.70	0.75	0.78	0.84
	Total	**30.0**	**32.8**	**30.9**	**30.1**	**27.7**	**29.4**	**29.5**	**30.5**	**32.3**	**33.9**
Carbon monoxide (kt)	Energy Industries	4.06	3.74	1.28	3.41	2.95	1.51	1.47	2.61	1.95	2.48
	Fugitive	-	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Industrial Combustion	14.4	13.4	10.0	11.3	13.0	13.0	14.3	14.6	14.9	15.7
	Industrial Processes	0.14	0.12	0.09	0.08	0.07	0.05	0.05	0.05	0.05	0.05
	Residential, Commercial & Public Sector Combustion	139	91.9	56.4	25.7	33.6	36.0	32.8	34.7	35.8	35.1
	Transport Sources	124	112	72.5	54.7	28.3	18.8	15.4	13.8	12.1	10.8
	Other	0.98	0.89	0.83	0.79	0.72	0.66	0.63	0.61	0.60	0.60
	Total	**282**	**222**	**141**	**96.0**	**78.6**	**70.0**	**64.7**	**66.4**	**65.3**	**64.7**
Nitrogen oxides (kt)	Energy Industries	31.1	19.3	14.8	9.86	6.07	6.82	5.71	5.74	5.93	5.36
	Industrial Combustion	18.7	18.8	16.3	14.1	10.3	8.23	8.59	8.81	8.46	8.38
	Residential, Commercial & Public Sector Combustion	15.0	13.4	11.9	9.27	6.98	5.71	5.26	5.26	5.22	5.07
	Transport Sources	43.3	38.9	31.0	27.6	20.5	17.7	16.7	16.1	15.7	15.3
	Other	4.38	4.52	3.91	3.07	2.83	2.86	2.61	2.47	2.48	2.58
	Total	**112**	**95.0**	**78.0**	**63.8**	**46.7**	**41.3**	**38.9**	**38.4**	**37.8**	**36.7**
NMVOC (kt)	Agriculture	10.1	12.3	12.1	13.2	13.0	13.7	14.0	14.3	14.8	15.5
	Fugitive	3.32	3.19	2.04	1.64	0.94	0.88	0.88	0.84	0.83	0.82

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
	Industrial Combustion	0.91	0.92	0.84	0.90	0.75	0.56	0.62	0.69	0.70	0.77
	Industrial Processes	2.48	2.51	2.38	2.39	3.48	2.98	3.04	3.32	3.22	3.38
	Residential, Commercial & Public Sector Combustion	9.91	6.28	4.50	3.10	3.65	3.63	3.28	3.49	3.59	3.49
	Solvent Processes	16.2	12.3	10.4	9.49	8.03	8.03	8.24	8.24	8.31	8.24
	Transport Sources	24.4	20.1	12.1	6.30	2.76	1.91	1.67	1.56	1.47	1.41
	Other	0.83	0.85	0.74	0.82	0.56	0.44	0.40	0.42	0.39	0.37
	Total	**68.1**	**58.4**	**45.2**	**37.9**	**33.2**	**32.1**	**32.2**	**32.9**	**33.3**	**33.9**
PM_{10} (kt)	Agriculture	1.04	1.22	1.13	1.18	1.15	1.24	1.27	1.32	1.36	1.44
	Energy Industries	2.74	1.47	0.75	0.30	0.08	0.07	0.06	0.08	0.12	0.11
	Industrial Combustion	1.61	1.56	1.23	1.13	1.33	1.31	1.48	1.51	1.56	1.71
	Industrial Processes	1.88	1.49	1.39	1.42	1.05	0.95	0.89	0.92	1.01	1.05
	Residential, Commercial & Public Sector Combustion	8.08	5.30	3.74	2.68	3.54	3.54	3.10	3.35	3.47	3.35
	Solvent Processes	0.10	0.08	0.05	0.03	0.02	0.03	0.03	0.03	0.03	0.03
	Transport Sources	1.74	1.76	1.60	1.61	1.14	0.95	0.89	0.87	0.85	0.83
	Other	0.18	0.18	0.18	0.16	0.14	0.13	0.13	0.13	0.13	0.13
	Total	**17.4**	**13.1**	**10.1**	**8.51**	**8.45**	**8.21**	**7.85**	**8.21**	**8.53**	**8.65**
Sulphur dioxide (kt)	Energy Industries	68.2	39.7	28.3	14.9	2.07	3.10	2.71	2.56	2.40	1.50
	Fugitive	-	-	-	-	-	-	-	-	-	-
	Industrial Combustion	19.7	17.3	4.94	4.20	4.48	4.39	4.72	4.03	3.07	2.90
	Industrial Processes	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Residential, Commercial & Public Sector Combustion	21.2	17.2	9.15	3.69	2.63	2.34	2.32	2.42	2.61	2.71
	Transport Sources	5.73	5.35	3.63	3.62	1.67	1.24	1.03	0.78	0.79	0.82
	Other	0.27	0.23	0.17	0.16	0.14	0.10	0.08	0.05	0.05	0.05
	Total	**115**	**79.8**	**46.2**	**26.6**	**11.0**	**11.2**	**10.9**	**9.85**	**8.92**	**7.98**
Lead (t)	Energy Industries	2.77	1.31	0.24	0.05	0.05	0.06	0.04	0.05	0.08	0.04

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
	Industrial Combustion	2.85	2.93	2.15	1.87	1.64	1.37	1.21	1.18	1.20	1.21
	Industrial Processes	0.95	0.79	0.69	0.77	0.43	0.37	0.46	0.46	0.37	0.38
	Residential, Commercial & Public Sector Combustion	3.67	2.03	1.06	0.41	0.50	0.47	0.43	0.45	0.47	0.46
	Transport Sources	60.9	31.8	0.99	1.14	1.15	1.13	1.13	1.14	1.16	1.18
	Waste	0.11	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	**71.3**	**38.9**	**5.14**	**4.23**	**3.76**	**3.40**	**3.26**	**3.28**	**3.28**	**3.28**
$PM_{2.5}$ (kt)	Agriculture	0.23	0.28	0.27	0.29	0.28	0.29	0.29	0.30	0.31	0.31
	Energy Industries	1.23	0.68	0.36	0.18	0.06	0.06	0.05	0.07	0.11	0.10
	Industrial Combustion	1.49	1.46	1.13	1.07	1.28	1.25	1.42	1.45	1.51	1.66
	Industrial Processes	0.42	0.35	0.28	0.29	0.22	0.19	0.19	0.19	0.20	0.20
	Residential, Commercial & Public Sector Combustion	7.90	5.19	3.68	2.63	3.46	3.47	3.03	3.28	3.39	3.27
	Solvent Processes	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Transport Sources	1.56	1.57	1.39	1.36	0.90	0.71	0.66	0.63	0.61	0.59
	Other	0.17	0.17	0.16	0.15	0.13	0.12	0.12	0.12	0.12	0.12
	Total	**13.0**	**9.72**	**7.28**	**5.99**	**6.34**	**6.10**	**5.77**	**6.05**	**6.25**	**6.26**
B[a]p (kg)	Agriculture	-	-	-	-	-	-	-	-	-	-
	Energy Industries	1.97	1.39	1.16	1.86	0.90	1.16	0.99	0.99	1.11	0.77
	Fugitive	-	-	-	-	-	-	-	-	-	-
	Industrial Combustion	19.9	17.3	6.73	2.11	1.85	1.68	1.77	1.86	1.88	1.63
	Industrial Processes	3.46	3.08	2.19	1.17	0.92	1.85	0.86	0.89	0.88	0.89
	Residential, Commercial & Public Sector Combustion	1,040	602	388	294	496	518	449	483	500	480
	Solvent Processes	0.38	0.38	0.31	0.30	0.22	0.21	0.22	0.23	0.21	0.22
	Transport Sources	10.9	11.7	10.1	7.84	6.21	5.48	5.29	5.19	5.17	5.15
	Waste	47.8	47.8	46.7	46.2	9.18	8.80	8.71	8.73	8.74	8.70

	Category	1990	1995	2000	2005	2010	2013	2014	2015	2016	2017
	Other	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.01
	Total	**1,125**	**683**	**455**	**353**	**515**	**537**	**467**	**501**	**518**	**498**
Dioxins (g I-TEQ)	Agriculture	-	-	-	-	-	-	-	-	-	-
	Energy Industries	0.21	0.15	0.12	0.05	0.03	0.33	0.29	0.30	0.30	0.03
	Fugitive	-	-	-	-	-	-	-	-	-	-
	Industrial Combustion	1.90	1.87	0.94	0.85	1.29	1.50	1.65	1.55	1.50	1.56
	Industrial Processes	0.40	0.47	0.14	0.05	0.03	0.03	0.03	0.03	0.03	0.02
	Residential, Commercial & Public Sector Combustion	24.2	15.9	9.31	3.77	5.04	5.15	4.50	4.76	4.91	4.77
	Solvent Processes	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Transport Sources	4.50	2.82	0.67	0.68	0.63	0.43	0.38	0.33	0.29	0.25
	Waste	4.58	4.20	3.62	3.29	1.37	1.24	1.19	1.21	1.21	1.20
	Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	**35.8**	**25.4**	**14.8**	**8.71**	**8.40**	**8.70**	**8.06**	**8.19**	**8.25**	**7.85**

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

Appendix G Definition of NFR Codes and Sector categories

Table 20 below provides a lookup table between the NFR codes and descriptions used to provide a high degree of detail in the inventory, and the categories used in the graphs within this report.

The Sector Category "Other" is applied to 1A5b and 6A across all pollutants, as shown in the table below. Additional Sector Categories are included under "Other" for each pollutant. If a Sector Category is insignificant for a pollutant, then it is included within the "Other" category in the tables and graphs of the report. See **Table 20** below for further information.

Table 20 - Definition of NFR Codes and Sector Categories

NFR Code	NFR Source Description	Sector Category	Sub-sector Category
1A1a	Public electricity and heat production	Energy Industries	Power generation
1A1b	Petroleum refining	Energy Industries	Refineries
1A1c	Manufacture of solid fuels and other energy industries	Energy Industries	Solid fuel manufacturing/coke ovens
1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	Industrial Combustion	Iron and steel
1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	Industrial Combustion	Other industries
1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	Industrial Combustion	Other industries
1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	Industrial Combustion	Other industries
1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	Industrial Combustion	Food and drink
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	Industrial Combustion	Other industries
1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)	Industrial Combustion	Other industries
1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	Industrial Combustion	Other industries
1A3ai(i)	International aviation LTO (civil)	Transport Sources	Rail, aviation and shipping
1A3aii(i)	Domestic aviation LTO (civil)	Transport Sources	Rail, aviation and shipping
1A3bi	Road transport: Passenger cars	Transport Sources	Passenger cars
1A3bii	Road transport: Light duty vehicles	Transport Sources	Other road transport
1A3biii	Road transport: Heavy duty vehicles and buses	Transport Sources	Other road transport
1A3biv	Road transport: Mopeds & motorcycles	Transport Sources	Other road transport
1A3bv	Road transport: Gasoline evaporation	Transport Sources	Other road transport
1A3bvi	Road transport: Automobile tyre and brake wear	Transport Sources	Other road transport
1A3bvii	Road transport: Automobile road abrasion	Transport Sources	Other road transport
1A3c	Railways	Transport Sources	Rail, aviation and shipping

NFR Code	NFR Source Description	Sector Category	Sub-sector Category
1A3dii	National navigation (shipping)	Transport Sources	Rail, aviation and shipping
1A3eii	Other (please specify in the IIR)	Transport Sources	Rail, aviation and shipping
1A4ai	Commercial/institutional: Stationary	Residential, Commercial & Public Sector Combustion	Commercial & public sector
1A4bi	Residential: Stationary	Residential, Commercial & Public Sector Combustion	Residential
1A4bii	Residential: Household and gardening (mobile)	Residential, Commercial & Public Sector Combustion	Residential
1A4ci	Agriculture/Forestry/Fishing: Stationary	Residential, Commercial & Public Sector Combustion	Outdoor industries
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Residential, Commercial & Public Sector Combustion	Outdoor industries
1A4ciii	Agriculture/Forestry/Fishing: National fishing	Residential, Commercial & Public Sector Combustion	Outdoor industries
1A5b	Other, Mobile (including military, land based and recreational boats)	Other	Other
1B1a	Fugitive emission from solid fuels: Coal mining and handling	Fugitive	Fugitive
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	Fugitive	Fugitive
1B2ai	Fugitive emissions oil: Exploration, production, transport	Fugitive	Fugitive
1B2aiv	Fugitive emissions oil: Refining / storage	Fugitive	Fugitive
1B2av	Distribution of oil products	Fugitive	Fugitive
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	Fugitive	Fugitive
1B2c	Venting and flaring (oil, gas, combined oil and gas)	Fugitive	Fugitive
2A1	Cement production	Industrial Processes	Cement production
2A3	Glass production	Industrial Processes	Other industries
2A5a	Quarrying and mining of minerals other than coal	Industrial Processes	Other industries
2A5b	Construction and demolition	Industrial Processes	Other industries
2A6	Other mineral products (please specify in the IIR)	Industrial Processes	Other industries
2B10a	Chemical industry: Other (please specify in the IIR)	Industrial Processes	Other industries

NFR Code	NFR Source Description	Sector Category	Sub-sector Category
2B10b	Storage, handling and transport of chemical products (please specify in the IIR)	Industrial Processes	Other industries
2B2	Nitric acid production	Industrial Processes	Other industries
2B3	Adipic acid production	Industrial Processes	Other industries
2B6	Titanium dioxide production	Industrial Processes	Other industries
2B7	Soda ash production	Industrial Processes	Other industries
2C1	Iron and steel production	Industrial Processes	Iron and steel
2C3	Aluminium production	Industrial Processes	Other industries
2C5	Lead production	Industrial Processes	Other industries
2C6	Zinc production	Industrial Processes	Other industries
2C7a	Copper production	Industrial Processes	Other industries
2C7c	Other metal production (please specify in the IIR)	Industrial Processes	Other industries
2D3a	Domestic solvent use including fungicides	Solvent Processes	Domestic
2D3b	Road paving with asphalt	Solvent Processes	Industrial
2D3d	Coating applications	Solvent Processes	Industrial
2D3e	Degreasing	Solvent Processes	Industrial
2D3f	Dry cleaning	Solvent Processes	Industrial
2D3g	Chemical products	Solvent Processes	Industrial
2D3h	Printing	Solvent Processes	Industrial
2D3i	Other solvent use (please specify in the IIR)	Solvent Processes	Other solvent uses
2G	Other product use (specified in the IIR)	Industrial Processes	Other industries
2H1	Pulp and paper industry	Industrial Processes	Other industries
2H2	Food and beverages industry	Industrial Processes	Food and drink
2H3	Other industrial processes (please specify in the IIR)	Industrial Processes	Other industries
2I	Wood processing	Industrial Processes	Other industries
3B1a	Manure management - Dairy cattle	Agriculture	Cattle manure management
3B1b	Manure management - Non-dairy cattle	Agriculture	Cattle manure management
3B2	Manure management - Sheep	Agriculture	Other manure management
3B3	Manure management - Swine	Agriculture	Other manure management
3B4d	Manure management - Goats	Agriculture	Other manure management
3B4e	Manure management - Horses	Agriculture	Other manure management

NFR Code	NFR Source Description	Sector Category	Sub-sector Category
3B4gi	Manure management - Laying hens	Agriculture	Other manure management
3B4gii	Manure management - Broilers	Agriculture	Other manure management
3B4giii	Manure management - Turkeys	Agriculture	Other manure management
3B4giv	Manure management - Other poultry	Agriculture	Other manure management
3B4h	Manure management - Other animals (please specify in IIR)	Agriculture	Other manure management
3Da1	Inorganic N-fertilizers (includes also urea application)	Agriculture	In-organic fertilizers
3Da2a	Animal manure applied to soils	Agriculture	Manure applied to soils
3Da2b	Sewage sludge applied to soils	Agriculture	Manure applied to soils
3Da2c	Other organic fertilizers applied to soils (including compost)	Agriculture	Manure applied to soils
3Da3	Urine and dung deposited by grazing animals	Agriculture	Grazing animal excreta
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products	Agriculture	Other agricultural practices
3De	Cultivated crops	Agriculture	Other agricultural practices
3F	Field burning of agricultural residues	Agriculture	Other agricultural practices
5A	Biological treatment of waste - Solid waste disposal on land	Waste	Waste
5B1	Biological treatment of waste - Composting	Waste	Waste
5B2	Anaerobic Digestion	Waste	Other waste practices
5C1a	Municipal waste incineration	Waste	Waste
5C1bii	Hazardous waste incineration	Waste	Waste
5C1biii	Clinical waste incineration	Waste	Waste
5C1biv	Sewage sludge incineration	Waste	Waste
5C1bv	Cremation	Waste	Waste
5C2	Open burning of waste	Waste	Waste
5D1	Domestic wastewater handling	Waste	Waste
5D2	Industrial wastewater handling	Waste	Waste
5E	Anaerobic Digestion - emissions from land spreading of non-manure digestates	Waste	Other waste practices
6A	Other (included in national total for entire territory) (please specify in IIR)	Other	Other

Table 21 - Summary of the sector categories included in "Other" for each pollutant

Sector Category	CO	NH_3	NO_x	Pb	PM_{10}	SO_2	VOC	PM2.5	B[a]p	Dioxins
Agriculture	✓	☐	✓	☐	☐	✓	☐	☐	☐	☐
Energy Industries	☐	✓	☐	☐	☐	☐	✓	☐	☐	☐
Fugitive	☐	✓	✓	✓	✓	☐	☐	✓	☐	☐
Industrial Combustion	☐	✓	☐	☐	☐	☐	☐	☐	☐	☐
Industrial Processes	☐	☐	✓	☐	☐	☐	☐	☐	☐	☐
Other	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Solvent Processes	☐	✓	☐	☐	☐	☐	☐	☐	☐	☐
Waste	✓	☐	✓	☐	✓	✓	✓	✓	☐	☐
Residential, Commercial & Public Sector Combustion	☐	✓	☐	☐	☐	☐	☐	☐	☐	☐

Appendix H Additional data tables

Appendix G contains an array of additional data tables regarding road transport, specifying the split in emissions of all pollutants according to both vehicle class and fuel type. Different sources of non-exhaust vehicle emissions (emissions not relating to the combustion of fuel in the vehicle's engine) are also displayed according to vehicles class[6].

Table 22- Emissions for England, road transport, split by vehicle class and fuel type.

Pollutant	Vehicle Classification	Fuel type	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
Carbon monoxide (t)	Light duty vehicles	DERV	15,799	25,016	25,797	23,765	18,771	16,094	14,167	12,348	10,532	8,692
	Light duty vehicles	Petrol	571,480	190,591	55,268	17,769	11,557	9,539	7,691	6,491	5,313	4,368
	Passenger cars	DERV	8,068	17,457	12,574	10,669	9,542	9,103	8,719	9,065	9,342	9,488
	Passenger cars	Petrol	3,288,055	1,678,754	1,169,755	499,705	349,067	290,364	239,228	212,114	178,981	155,075
Ammonia (t)	Light duty vehicles	DERV	11.4	35.0	48.2	52.9	61.8	69.5	79.8	91.5	140	192
	Light duty vehicles	Petrol	45.2	242	196	137	102	87.5	75.8	64.4	54.9	47.4
	Passenger cars	DERV	11.9	54.1	90.0	130	177	201	226	337	471	586
	Passenger cars	Petrol	551	18,769	12,678	7,904	5,687	4,757	4,086	3,488	3,064	2,713
Nitrogen oxides (t)	Light duty vehicles	DERV	18,902	46,449	54,393	50,124	56,754	63,048	69,699	76,552	81,002	82,501
	Light duty vehicles	Petrol	71,939	24,572	6,397	1,486	840	645	508	394	311	247
	Passenger cars	DERV	8,264	39,742	69,800	83,927	92,446	96,237	99,232	101,111	101,306	99,293
	Passenger cars	Petrol	700,179	298,004	157,678	51,652	34,229	27,148	23,004	19,624	16,693	14,554
Lead (t)	Light duty vehicles	DERV	0.06	0.16	0.20	0.21	0.21	0.22	0.23	0.24	0.25	0.26
	Light duty vehicles	Petrol	176	0.06	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Passenger cars	DERV	0.04	0.17	0.27	0.35	0.40	0.41	0.42	0.44	0.46	0.46

[6] Please note that estimates of diesel and petrol use in road transport are not considered official statistics. Country-specific energy balances are not available to reconcile against.

Pollutant	Vehicle Classification	Fuel type	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
	Passenger cars	Petrol	1,608.2	1.11	0.86	0.44	0.40	0.37	0.37	0.36	0.36	0.35
PM10 (t)	Light duty vehicles	DERV	4,755	5,940	4,845	3,335	2,574	2,186	1,880	1,656	1,411	1,165
	Light duty vehicles	Petrol	92.6	22.7	8.7	4.2	3.5	3.4	3.5	3.6	3.7	3.9
	Passenger cars	DERV	3,171	5,107	4,567	4,097	3,298	2,971	2,605	2,428	2,151	1,904
	Passenger cars	Petrol	1,587	644	425	266	237	225	225	228	233	236
PM2.5 (t)	Light duty vehicles	DERV	4,755	5,940	4,845	3,335	2,574	2,186	1,880	1,656	1,411	1,165
	Light duty vehicles	Petrol	92.6	22.7	8.7	4.2	3.5	3.4	3.5	3.6	3.7	3.9
	Passenger cars	DERV	3,171	5,107	4,567	4,097	3,298	2,971	2,605	2,428	2,151	1,904
	Passenger cars	Petrol	1,587	644	425	266	237	225	225	228	233	236
Sulphur Dioxide (t)	Light duty vehicles	DERV	4,330	239	236	58.8	59.8	58.1	60.3	66.2	74.3	73.7
	Light duty vehicles	Petrol	1,834	182	25.6	3.1	2.5	1.9	1.8	1.8	2.0	1.6
	Passenger cars	DERV	3,085	261	324	101	111	110	112	122	134	134
	Passenger cars	Petrol	523	599	633	624	622	623	641	652	664	673
NMVOC (t)	Light duty vehicles	DERV	1,712	4,737	5,075	3,397	2,821	2,624	2,489	2,462	2,382	2,260
	Light duty vehicles	Petrol	41,097	12,675	3,163	665	342	255	193	150	118	93.7
	Passenger cars	DERV	1,654	3,057	2,906	2,358	2,202	2,147	2,028	2,041	2,004	1,959
	Passenger cars	Petrol	428,832	186,427	98,757	30,386	18,580	14,321	11,405	9,640	7,896	6,658

Table 23 - Emissions for Scotland, road transport, split by vehicle class and fuel type.

Pollutant	Vehicle Classification	Fuel type	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
Carbon monoxide (t)	Light duty vehicles	DERV	1,557	2,502	2,585	2,520	2,002	1,724	1,519	1,331	1,157	1,013
	Light duty vehicles	Petrol	52,189	17,725	5,144	1,710	1,115	920	745	635	532	460
	Passenger cars	DERV	872	1,726	1,185	1,020	904	869	840	883	923	1,022
	Passenger cars	Petrol	297,658	150,037	109,574	48,082	34,037	28,333	23,154	20,352	17,268	14,937
Ammonia (t)	Light duty vehicles	DERV	1.2	3.7	5.1	5.9	6.9	7.8	8.9	10.3	15.9	22.6
	Light duty vehicles	Petrol	4.7	27.3	21.5	15.7	11.5	9.9	8.6	7.3	6.2	5.1
	Passenger cars	DERV	1.4	6.1	9.6	14	19.2	21.9	24.7	36.8	51.6	63.8
	Passenger cars	Petrol	55.4	1,916	1,306	805	581	484	409	344	302	251
Nitrogen oxides (t)	Light duty vehicles	DERV	1,734	4,572	5,472	5,331	6,028	6,706	7,435	8,208	8,826	9,445
	Light duty vehicles	Petrol	7,373	2,564	667	162	90.9	69.8	54.8	42.7	34.2	27.2
	Passenger cars	DERV	874	4,116	7,074	8,665	9,512	9,948	10,306	10,495	10,574	10,671
	Passenger cars	Petrol	69,647	28,676	15,537	5,086	3,374	2,664	2,229	1,881	1,604	1,429
Lead (t)	Light duty vehicles	DERV	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
	Light duty vehicles	Petrol	16.8	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Passenger cars	DERV	0.00	0.02	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05
	Passenger cars	Petrol	152.7	0.10	0.08	0.04	0.04	0.04	0.04	0.03	0.03	0.03
PM10 (t)	Light duty vehicles	DERV	479	605	492	359	278	238	204	181	157	136
	Light duty vehicles	Petrol	8.7	2.2	0.85	0.43	0.36	0.36	0.37	0.39	0.41	0.43
	Passenger cars	DERV	344	529	460	426	341	309	272	254	226	206
	Passenger cars	Petrol	146	57.9	39.5	25.0	22.5	21.5	21.3	21.5	22.1	23.0

Pollutant	Vehicle Classification	Fuel type	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
PM2.5 (t)	Light duty vehicles	DERV	479	605	492	359	278	238	204	181	157	136
	Light duty vehicles	Petrol	8.7	2.2	0.85	0.43	0.36	0.36	0.37	0.39	0.41	0.43
	Passenger cars	DERV	344	529	460	426	341	309	272	254	226	206
	Passenger cars	Petrol	146	57.9	39.5	25.0	22.5	21.5	21.3	21.5	22.1	23.0
Sulphur Dioxide (t)	Light duty vehicles	DERV	424	23.9	23.7	6.3	6.4	6.2	6.4	7.1	8.1	8.5
	Light duty vehicles	Petrol	175	17.9	2.5	0.33	0.26	0.19	0.19	0.19	0.21	0.18
	Passenger cars	DERV	335	27.4	32.8	10.5	11.5	11.4	11.7	12.7	14.1	14.4
	Passenger cars	Petrol	50	55.5	60.3	60.2	60.3	60.4	61.5	62.0	63.4	65.8
NMVOC (t)	Light duty vehicles	DERV	165	472	512	360	298	278	264	263	260	266
	Light duty vehicles	Petrol	3,543	1,128	288	63.0	32.4	24.1	18.3	14.3	11.6	10.0
	Passenger cars	DERV	177	304	278	233	216	213	202	205	202	212
	Passenger cars	Petrol	38,985	16,584	9,090	2,852	1,757	1,354	1,071	899	741	657

Table 24 - Emissions for Wales, road transport, split by vehicle class and fuel type.

Pollutant	Vehicle Classification	Fuel type	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
Carbon monoxide (t)	Light duty vehicles	DERV	1,008	1,599	1,657	1,569	1,237	1,070	942	829	713	598
	Light duty vehicles	Petrol	33,119	11,147	3,217	1,037	670	552	445	381	316	253
	Passenger cars	DERV	535	1,266	850	684	605	579	561	591	619	625
	Passenger cars	Petrol	190,661	92,561	67,270	29,338	20,444	17,130	14,199	12,565	10,667	8,902
Ammonia (t)	Light duty vehicles	DERV	0.8	2.4	3.3	3.8	4.4	4.9	5.6	6.5	9.9	13.7
	Light duty vehicles	Petrol	3.1	17.8	14.2	10.0	7.2	6.2	5.3	4.5	3.8	3.1
	Passenger cars	DERV	0.9	4.4	6.9	9.6	12.8	14.6	16.6	24.8	34.9	43.1
	Passenger cars	Petrol	35.4	1,201	811	495	348	291	250	210	183	156
Nitrogen oxides (t)	Light duty vehicles	DERV	1,103	2,907	3,509	3,342	3,732	4,146	4,579	5,073	5,396	5,549
	Light duty vehicles	Petrol	4,818	1,651	433	102	56.8	43.6	34.1	26.6	21.1	16.0
	Passenger cars	DERV	532	2,996	5,057	5,814	6,286	6,556	6,846	7,006	7,073	6,873
	Passenger cars	Petrol	44,365	17,678	9,583	3,129	2,048	1,626	1,379	1,171	1,002	838
Lead (t)	Light duty vehicles	DERV	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
	Light duty vehicles	Petrol	10.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Passenger cars	DERV	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03
	Passenger cars	Petrol	97.6	0.06	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.02
PM10 (t)	Light duty vehicles	DERV	312	388	317	224	172	148	127	113	96.9	81.1
	Light duty vehicles	Petrol	5.5	1.4	0.54	0.27	0.22	0.22	0.23	0.24	0.25	0.26
	Passenger cars	DERV	209	384	328	287	227	205	182	171	153	134
	Passenger cars	Petrol	93.3	35.7	24.2	15.2	13.6	13.0	13.1	13.3	13.7	13.4

Pollutant	Vehicle Classification	Fuel type	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
PM2.5 (t)	Light duty vehicles	DERV	312	388	317	224	172	148	127	113	96.9	81.1
	Light duty vehicles	Petrol	5.5	1.4	0.54	0.27	0.22	0.22	0.23	0.24	0.25	0.26
	Passenger cars	DERV	209	384	328	287	227	205	182	171	153	134
	Passenger cars	Petrol	93.3	35.7	24.2	15.2	13.6	13.0	13.1	13.3	13.7	13.4
Sulphur Dioxide (t)	Light duty vehicles	DERV	274	15.2	15.2	3.9	3.9	3.8	4.0	4.4	5.0	5.0
	Light duty vehicles	Petrol	113	11.3	1.6	0.20	0.16	0.12	0.12	0.12	0.13	0.10
	Passenger cars	DERV	204	20.0	23.5	7.1	7.7	7.6	7.8	8.5	9.4	9.4
	Passenger cars	Petrol	31.7	34.3	37.3	37.0	36.6	36.9	38.0	38.6	39.6	38.6
NMVOC (t)	Light duty vehicles	DERV	107	300	328	227	187	175	166	166	161	155
	Light duty vehicles	Petrol	2,220	696	178	38.6	19.8	14.8	11.2	8.7	7.0	5.4
	Passenger cars	DERV	108	223	200	157	145	142	135	138	137	132
	Passenger cars	Petrol	24,980	10,252	5,593	1,743	1,064	824	659	558	461	373

Table 25 - Emissions for Northern Ireland, road transport, split by vehicle class and fuel type.

Pollutant	Vehicle Classification	Fuel type	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
Carbon monoxide (t)	Light duty vehicles	DERV	641	432	454	461	354	319	269	237	205	172
	Light duty vehicles	Petrol	456	493	281	129	84.8	78.1	46.4	38.2	32.3	26.8
	Passenger cars	DERV	309	1,240	843	654	544	509	489	511	531	546
	Passenger cars	Petrol	118,141	65,312	47,539	22,874	16,282	14,567	11,404	10,178	8,539	7,360
Ammonia (t)	Light duty vehicles	DERV	0.49	0.64	0.93	1.1	1.3	1.5	1.6	1.9	2.8	3.9
	Light duty vehicles	Petrol	0.04	0.74	1.2	1.2	0.89	0.82	0.52	0.42	0.36	0.30
	Passenger cars	DERV	0.52	4.5	7.1	9.4	11.7	13.0	14.4	21.3	30.1	37.5
	Passenger cars	Petrol	23	875	576	374	269	240	197	169	146	127
Nitrogen oxides (t)	Light duty vehicles	DERV	696	791	970	982	1,052	1,207	1,271	1,400	1,490	1,526
	Light duty vehicles	Petrol	62.6	67.4	35.7	12.5	7.2	6.0	3.5	2.6	2.2	1.7
	Passenger cars	DERV	305	2,942	5,031	5,519	5,558	5,647	5,794	5,876	5,949	5,863
	Passenger cars	Petrol	28,400	12,574	6,672	2,321	1,540	1,298	1,039	884	747	649
Lead (t)	Light duty vehicles	DERV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Light duty vehicles	Petrol	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Passenger cars	DERV	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
	Passenger cars	Petrol	59.8	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
PM10 (t)	Light duty vehicles	DERV	200	105	86.9	66.2	49.5	44.1	36.1	32.1	27.7	23.2
	Light duty vehicles	Petrol	0.07	0.06	0.05	0.03	0.03	0.03	0.02	0.02	0.02	0.03
	Passenger cars	DERV	122	388	336	284	209	185	162	151	135	120
	Passenger cars	Petrol	55.7	23.6	15.6	10.6	9.7	10.0	9.5	9.7	10.0	10.2

Pollutant	Vehicle Classification	Fuel type	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
PM2.5 (t)	Light duty vehicles	DERV	200	105	86.9	66.2	49.5	44.1	36.1	32.1	27.7	23.2
	Light duty vehicles	Petrol	0.07	0.06	0.05	0.03	0.03	0.03	0.02	0.02	0.02	0.03
	Passenger cars	DERV	122	388	336	284	209	185	162	151	135	120
	Passenger cars	Petrol	55.7	23.6	15.6	10.6	9.7	10.0	9.5	9.7	10.0	10.2
Sulphur Dioxide (t)	Light duty vehicles	DERV	170	4.1	4.1	1.1	1.1	1.1	1.1	1.2	1.4	1.4
	Light duty vehicles	Petrol	1.5	0.48	0.14	0.02	0.02	0.02	0.01	0.01	0.01	0.01
	Passenger cars	DERV	115	19.5	23.2	6.7	6.8	6.5	6.6	7.1	7.9	7.9
	Passenger cars	Petrol	17.5	22.1	24.0	25.8	26.0	27.9	27.3	27.8	28.3	28.7
NMVOC (t)	Light duty vehicles	DERV	69.7	86.0	95.8	70.1	55.8	54.8	49.3	49.1	47.8	45.7
	Light duty vehicles	Petrol	31.6	33.3	16.5	5.0	2.6	2.2	1.2	0.92	0.75	0.60
	Passenger cars	DERV	62.5	222	204	154	133	127	120	122	120	119
	Passenger cars	Petrol	15,332	7,090	3,813	1,298	806	666	501	424	347	293

Table 26 – Non-exhaust $PM_{2.5}$ emissions for England from road vehicles (tonnes)

Emission Source	Vehicle classification	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
Brake Wear	Cars	879	961	979	945	945	939	957	964	973	976
	LGVs	161	199	233	246	245	251	265	274	286	287
	HGV	223	227	230	200	190	190	195	200	199	199
	Buses and coaches	59.1	70.1	71.3	69.6	60.6	62.1	62.1	59.2	55.1	51.6
	Motorcycles/moped	9.1	6.8	8.2	7.0	6.8	6.3	6.5	6.6	6.7	6.6
Road abrasion	Cars	1,186	1,330	1,383	1,356	1,359	1,356	1,384	1,400	1,421	1,436
	LGVs	140	183	217	230	232	239	252	263	275	281
	HGV	440	502	513	464	440	444	458	476	480	485
	Buses and coaches	78.3	87.5	86.6	84.4	73.0	74.9	74.9	71.4	66.4	63.3
	Motorcycles/moped	8.1	6.6	7.7	6.5	6.5	6.1	6.3	6.3	6.3	6.2
Tyre wear	Cars	1,541	1,717	1,775	1,733	1,735	1,730	1,765	1,782	1,806	1,821
	LGVs	287	369	435	461	463	476	504	524	548	557
	HGV	373	445	461	419	405	410	422	439	444	452
	Buses and coaches	51.5	58.7	58.4	56.9	49.4	50.6	50.6	48.3	44.9	42.5
	Motorcycles/moped	12.3	9.6	11.4	9.7	9.5	9.0	9.3	9.3	9.3	9.2

Table 27 – Non-exhaust $PM_{2.5}$ emissions for Scotland from road vehicles (tonnes)

Emission Source	Vehicle classification	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
Brake Wear	Cars	82.1	89.7	94.2	93.5	93.3	93.0	94.6	95.1	96.3	104
	LGVs	15.2	19.5	23.2	25.4	25.2	25.7	27.1	28.3	30.2	34.2
	HGV	24.8	24.8	26.7	25.3	23.6	23.7	23.6	23.9	24.1	25.2
	Buses and coaches	8.2	9.4	9.4	10.0	8.8	9.1	9.2	8.9	8.6	9.3
	Motorcycles/moped	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Road abrasion	Cars	116	129	138	138	139	139	141	142	145	149
	LGVs	14.1	18.8	22.4	25.0	25.1	25.9	27.4	28.6	30.5	32.8
	HGV	45.8	49.9	54.1	52.3	50.6	51.0	50.7	51.3	52.1	53.2
	Buses and coaches	11.3	12.3	12.0	13.3	12.0	12.4	12.5	12.1	11.5	11.9
	Motorcycles/moped	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Tyre wear	Cars	149	164	175	174	175	175	178	179	182	190
	LGVs	28.2	37.3	44.4	49.3	49.3	50.8	53.6	56.0	59.7	65.2
	HGV	39.7	44.1	47.1	45.8	44.4	44.8	44.7	45.5	46.3	48.2
	Buses and coaches	7.3	8.1	8.0	8.7	7.8	8.0	8.1	7.8	7.5	7.9
	Motorcycles/moped	0.6	0.6	0.7	0.6	0.6	0.6	0.7	0.6	0.6	0.7

Table 28 – Non-exhaust $PM_{2.5}$ emissions for Wales from road vehicles (tonnes)

Emission Source	Vehicle classification	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
Brake Wear	Cars	53.0	58.0	61.2	60.0	59.9	59.8	61.3	62.1	63.4	61.8
	LGVs	9.8	12.3	14.8	16.1	16.0	16.4	17.3	17.9	18.8	19.3
	HGV	13.8	13.4	13.3	11.8	10.9	10.9	11.0	10.9	11.2	11.3
	Buses and coaches	3.7	4.1	4.1	4.1	3.6	3.7	3.7	3.4	3.3	3.1
	Motorcycles/moped	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.4
Road abrasion	Cars	74.4	82.6	88.9	88.2	87.9	88.3	91.0	92.3	94.5	93.4
	LGVs	9.1	12.1	14.5	15.8	15.8	16.3	17.2	18.0	18.9	19.4
	HGV	25.4	26.2	26.3	23.5	21.9	22.1	22.2	22.4	22.9	23.2

	Buses and coaches	5.5	5.7	5.5	5.7	4.9	5.1	5.1	4.7	4.5	4.3
	Motorcycles/moped	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.4	0.4	0.4
Tyre wear	Cars	95.1	105	113	112	111	112	115	116	119	117
	LGVs	18.2	23.7	28.5	31.1	31.0	32.0	33.7	35.2	37.0	38.0
	HGV	20.4	22.0	22.4	20.1	19.0	19.2	19.5	19.8	20.1	20.5
	Buses and coaches	3.5	3.7	3.6	3.7	3.1	3.3	3.3	3.1	2.9	2.8
	Motorcycles/moped	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.6

Table 29 - Non-exhaust $PM_{2.5}$ emissions for Northern Ireland from road vehicles (tonnes)

Emission Source	Vehicle classification	1990	2000	2005	2010	2012	2013	2014	2015	2016	2017
Brake Wear	Cars	31.2	42.1	46.0	48.1	47.5	48.6	48.4	48.8	49.7	50.3
	LGVs	2.2	3.0	4.1	4.8	4.6	5.0	5.0	5.2	5.5	5.6
	HGV	6.9	9.4	13.0	11.8	10.6	10.2	10.1	10.4	10.4	10.5
	Buses and coaches	1.1	1.6	1.3	1.4	1.7	1.5	1.5	1.4	1.3	1.3
	Motorcycles/moped	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Road abrasion	Cars	46.2	62.3	69.1	72.3	71.0	72.9	72.7	73.7	75.3	76.4
	LGVs	2.0	2.7	3.8	4.5	4.4	4.7	4.8	5.0	5.2	5.4
	HGV	11.3	15.4	21.2	20.3	18.4	17.8	17.7	18.2	18.4	18.6
	Buses and coaches	1.4	2.0	1.8	2.0	2.4	2.3	2.3	2.2	2.0	2.0
	Motorcycles/moped	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Tyre wear	Cars	58.2	78.4	86.6	90.6	89.2	91.5	91.1	92.2	94.1	95.5
	LGVs	4.0	5.4	7.6	9.0	8.7	9.4	9.4	9.9	10.4	10.6
	HGV	9.9	13.7	19.7	18.0	16.2	15.6	15.5	16.0	16.3	16.6
	Buses and coaches	0.9	1.3	1.2	1.3	1.5	1.4	1.4	1.3	1.2	1.2
	Motorcycles/moped	0.1	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2