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Air Emissions and Energy Accounts for Wales: Methodology and Results

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Air Emissions and Energy Accounts for Wales: Methodology and Results

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Overview

Main points:

- Overall, greenhouse gas emissions in Wales have been trending downwards since 1998, with an accelerated decline from 2016 onwards.
- The steeper decline in recent years is in large part due to the decarbonisation of electricity production, in particular the closure of coal fired power stations.
- Manufacturing has the highest total emissions of any sector, accounting for a third of total emissions in 2020.
- Travel related emissions increased between 2011 and 2019 but fell sharply in 2020 due to changes in behaviour related to the Covid-19 pandemic.
- Methane from landfill was of particular concern early in the timeseries but emissions reduced by 75% between 1998 and 2020 due to improvements in the standards of landfilling, reducing the quantity of biodegradable waste going to landfill, and improved capture of landfill gas which has been used as a substitute for fossil fuels in energy production.

Summary of methodology

An inventory of atmospheric emissions and energy use within the territory of Wales, funded by government and maintained by Ricardo, is the foundation of the Air and Energy Accounts for Wales. The residence principle is applied to include Welsh activities occurring overseas and exclude foreign activities within Wales, however the data available in the UK means it is only possible to apply the principle to cross-border travel activity (more detail available in full methodology section). Emissions and energy use are then allocated to industries based on which Standard Industrial Classification (SIC) is the primary emitter and which industry owns the unit creating the emissions.

Site-specific ‘point source’ emissions data is compiled using a variety of datasets and allocated to SICs based on the primary economic activity of each installation. Where emissions from point sources do not comprise the total emissions from a source in the Welsh Greenhouse Gas Inventory (GHGI), the residual ‘non-point’ emissions are calculated and allocated using one of the following methodologies:

Road transport: The proportion of car use for domestic purposes and taxi operation is estimated using Welsh statistics, then the remaining activity is split between all other SICs based on fuel purchase data. A similar method is used for vans but using UK statistics on domestic van use.

Off-road Machinery: Background data for the National Atmospheric Emissions Inventory (NAEI) details the types of machinery used and each one has been assigned to one or more SICs, leading to accurate splitting of emissions from this source.

Manufacture of metals and metal products: Residual emissions for natural gas use in this sector are expected to have come from sites that are too small to report accurately

and are likely involved in the casting of metals and manufacture of metal products. Employment data is used to split emissions between these two SICs.

Aviation: NAEI and Civil Aviation Authority (CAA) data is used to identify activity by Welsh airlines and activity that cannot be associated with a specific airline, which is split among multiple SICs.

Coastal shipping: Fishing and water transport vessels were identified through the NAEI shipping emissions model and allocated to SICs.

Power stations: Emissions reporting or information from permits was used to identify the primary fuel used at each power station and assign them to one of five subcategories of SIC07 subsection 35.1.

Other sources: For remaining sources, a hybrid approach is followed whereby emissions at Local Authority level, sourced from the NAEI emission maps, are split among SIC07 sectors using proportions from the UK Environmental Accounts, and then adjusted by employment at the Local Authority level to best represent the local economy. Emissions for all sectors from all Local Authorities are then recombined and reconciled to Welsh GHGI totals for each source, activity and pollutant.

Background

Air Emissions and Energy Accounts for Wales have been produced covering the period 1998 to 2020. The air emissions estimated are for the seven major greenhouse gases, carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). The energy accounts estimate the emission-relevant use of energy by combustion of renewable, waste and fossil fuels.

The Welsh Greenhouse Gas Inventory is a key data source for understanding the origins of emissions in Wales and is the foundation of this work. The inventory is compiled in line with international guidance from the Intergovernmental Panel on Climate Change (IPCC) and emissions and activity data are therefore reported using IPCC definitions.

However, economic data for businesses and industries in the UK is reported by Standard Industrial Classification (SIC). Air Emissions and Energy Accounts allocate sources in the national inventory to industrial classifications, for the purpose of linking environmental information about an industry to economic activity.

The accounts report historical air emissions and energy use for each industry with the intention of informing future decisions in the Welsh Government's progress towards net zero by 2050. By facilitating direct comparison of emissions and energy use with economic indicators such as Gross Value Added (GVA), employment and turnover, the accounts may enable more accurate tracking of emissions intensity and energy productivity, as well as improve estimation of the impacts of economic events on the environment. The accounts are reported on the same basis as the Office of National Statistics' Environmental Accounts and comparable to accounts of other UK nations, meaning analysis of Wales's decarbonisation relative to the UK and other devolved administrations may be possible.

This document sets out the methodologies and key findings of the Air Emissions and Energy Accounts for Wales. There are two appendices providing supplementary information to support the main text of the document.

1. Standards, concepts and definitions

1.1 UN System of Environmental Economic Accounts

The United Nations (UN) System of Environmental Economic Accounts (SEEA) was adopted by the UN Statistical Commission as the first international standard for environmental-economic accounting in 2012, following a comprehensive global consultation process. The SEEA sits alongside the UN System of National Accounts (SNA) to provide a framework for producing internationally comparable statistics on the environment and its relationship with the economy.

The SEEA framework follows a similar accounting structure to the SNA and uses consistent concepts, definitions and classifications in order to facilitate the integration of environmental and economic statistics.

‘The intent in physical flow accounting is to record the physical flows underpinning the transactions recorded in the monetary supply and use tables, primarily with respect to goods, and to then extend the monetary supply and use table to record physical flows from the environment to the economy (such as flows of natural resources) and physical flows from the economy to the environment (such as emissions to air and water).’

UN SEEA 2012 Central Framework, Chapter 3

Air emissions accounts are concerned with the physical flows of emissions from the economy to air. These flows from the economy to the environment can be termed residuals.

Air emissions are defined in the SEEA as ‘gaseous and particulate substances released to the atmosphere by establishments and households as a result of production, consumption and accumulation processes’. The aim of the account is to record ‘the generation of air emissions by resident economic units, by type of substance’ in line with ‘the scope and boundaries used in the compilation of the economic accounts’.

1.2 European Environmental Economic Accounts Regulation

The UK has been recording air emissions accounts and submitting them to Eurostat (European Statistical Agency) for a number of years, initially on a voluntary basis, and more recently under the mandatory requirements. During 2011, a European Regulation on Environmental Economic Accounts was adopted by the European Parliament and European Council. The Regulation includes a module on Air Emissions Accounts, mandating delivery to Eurostat annually from September 2013.

The concepts and definitions in the Regulation align with SEEA exactly, and the breakdown of emissions is very similar, although there is not the requirement for the distinction between those emissions released direct to the environment and those

captured and transferred to other economic units or stored. Neither is the separate identification of emissions from landfill sites.

However, in addition there is a requirement for ‘bridging items’ to be reported. These are the items which make transparent the differences between the environmental accounts measure and the United Nations Framework Convention on Climate Change (UNFCCC) and Convention on Long Range Transboundary Air Pollution (CLRTAP) measures.

1.3 Economic Boundary With Respect To Air Emissions - The Residence Principle

The residence principle is applied to the accounts in accordance with SEEA, to align with the scope of Welsh business, economy and labour market statistics. In theory, estimates compiled on a residency basis include only data relating to Welsh residents and businesses registered in Wales, regardless of whether they are physically in the Wales or overseas. Data relating to foreign visitors and foreign businesses would be excluded.

However, in practice, data limitations mean that residence principle adjustments for many sources of emissions are not possible or too uncertain to be worthwhile. In these accounts, it was possible to adjust for two of the largest cross-boundary emissions sources and the methodology for this is detailed in section 2.2.

Other boundary issues

Inclusions and exclusions of specific sources are applied in line with SEEA, for example:

Exclusions

- Emissions which are released in one country and travel through the atmosphere to another – flow within the environment
- Emissions from land use, land use change and forestry (LULUCF), for example CO_2 captured by the environment in forests
- Respiratory emissions made by humans and animals, and from cultivated plants to the atmosphere.

Included

- CH_4 emissions from cultivated livestock due to digestion
- Flaring and venting from oil and gas extraction
- Emissions from manure collected and spread on agricultural land.

1.4 Greenhouse Gas Emissions

Greenhouse gases are gaseous constituents of the atmosphere, both natural and produced by human activity, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth’s surface, the atmosphere and clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the earth’s atmosphere. Moreover, there are a multitude of entirely human-made greenhouse gases in the atmosphere, such as halocarbons and other chlorine and bromine-containing substances, covered by the Montreal Protocol. Besides carbon

dioxide, nitrous oxide and methane, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride, hydrofluorocarbons, and perfluorocarbons.

Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. There is consensus in the scientific community that this rise in greenhouse gas emissions has led to changes in the global atmosphere, termed climate change.

The greenhouse gases included in the atmospheric emissions accounts are those covered by the Kyoto Protocol. These are carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).

Further information on Greenhouse Gases can be found in Appendix 1 of this report and the glossary of the IPCC fourth Assessment Report.

1.5 Energy Use

The definition of 'energy use' in the context of these accounts is the total use of fuels for energy production, such as electricity or heat production, converted to energy units. Non-energy use of fuel is therefore excluded, meaning use of fuels as a feedstock for chemical processes is not reported.

Similarly, fuel transformed into a different fuel is not reported. Taking coal transformed into coke in the iron and steel industry as an example, since the coke is combusted for energy production and reported under Other fuels, reporting the coal use as well would lead to double counting.

2. Methodologies

2.1 The NAEI

The National Atmospheric Emissions Inventory[1] (NAEI) compiles estimates of emissions to the atmosphere by UK sources such as cars, trucks, power stations and industrial sites. It is funded by the UK's Department for Business, Energy & Industrial Strategy, the Department for Environment, Food & Rural Affairs, and the governments of the devolved administrations. Ricardo Energy & Environment maintains the NAEI and the inventories for each of the devolved administrations, including the Welsh Greenhouse Gas Inventory (GHGI).

The NAEI uses many data sources to estimate the activity data and emission factors of all relevant sources in the UK, which are then combined to calculate air emissions. The emissions and information about the sources of emissions is the foundation of the air emissions and energy accounts for Wales.

[1] National Atmospheric Emissions Inventory (2024): UK Emissions Interactive Map

2.2 Applying The Residence Principle

The NAEI reports emissions on a territorial basis, i.e. all emissions that occur within UK territories and from travel between UK territories are reported. Environmental Accounts are prepared on a residence basis, meaning only emissions and energy use relating to Welsh residents and businesses registered in Wales should be included, regardless of whether they occurred within the territory of Wales or overseas.

As discussed in Section 1.3, in practice full adherence to the residence principle is not possible with the data available in the UK. Specifically, adjustments are not made for the emissions of non-residents within the territory or the emissions of residents released outside the territory that come from public transport use, electricity use or are released by vehicles that do not cross the territorial border (such as those that are rented at their destination). Emissions embedded in the import and export of goods are also not accounted for. This follows the methodology approach set out in UN System of Environmental Economic Accounts guidelines.

However, it can be possible to make adjustments for cross-border travel by residents and non-residents using information about the activity of road transport vehicles, boats, ships and the aviation industry. For Wales, it has been possible for aircraft, for which flights by airlines economically resident in Wales have been separately estimated. In addition, heavy goods vehicles (HGV) emissions have been allocated based on the proportion of HGVs registered in Wales rather than the proportion of vkm driven by HGVs, on the basis that the long trip profile of HGVs means vkm driven in Wales are unlikely to be a good proxy for activity of Welsh residents. All emissions and energy use by non-residents airlines and HGVs registered outside Wales are excluded from these accounts.

A method for making cross-boundary adjustments for other sources (such as cars, coaches, boats and ships) has not been clear from the data available. In these cases, the cross-boundary adjustments for the UK are scaled down by comparing the emissions for the source in the Welsh GHGI to the UK GHGI.

2.3 Industrial Classifications

Once adjustments for the residence principle have been applied to the NAEI datasets, emissions and energy use can be allocated to industries.

The industrial classification system used is the UK Standard Industrial Classification of Economic Activities 2007[2] (SIC07). This classification was chosen to create environmental accounts that are aligned with the classifications used in Welsh business, economic and labour market statistics.

2.4 Allocation To Industrial Classifications

[2] Office for National Statistics (2007): UK SIC 2007

The sources in the NAEI are not based on a coding structure such as SIC07 and thus a mapping procedure is required to allocate a source to an SIC.

The definitions are such that many of the NAEI sources can be mapped directly to a SIC07 classification through a one-to-one relationship, where a single NAEI source is judged as being equivalent to a single SIC07 classification. An example of this is the source activity combination that relates to gas oil used in freight trains, which can be fully attributed to the SIC07 code corresponding to the rail transport industry.

In some other cases NAEI sources can be linked to several SIC classifications through one-to-many relationships. Here, the activity and consequent emissions from that source must be split across each of the relevant SIC07 codes either directly, according to their proportionate level of activity, or indirectly. A significant part of the air emissions and energy accounts work carried out by Ricardo is in determining what proportions the emissions and fuel use by these sources should be split across the SIC divisions that span the economy. The methodology to do this is sometimes necessarily complex and varies depending on the source category.

In principle, estimates for the emissions of each industry are made on the basis of which industry is the primary emitter and which industry owns the unit creating the emissions. For example, if a retailer owns a fleet of trucks that deliver stock to its stores, the emissions from those trucks would go to the retail industry. However, if the retailer hires a separate freight company to deliver its goods, the emissions are allocated to the road freight industry.

2.4.1 Point source emissions

For many sources, site-specific emissions data are compiled for the UK inventory from various datasets such as the UK Pollutant Release and Transfer Register[3] (PRTR), EU Emissions Trading Scheme[4] (EU ETS) and Environmental and Emissions Monitoring System[5] (EEMS). The compiled point source emissions dataset includes emissions for 204 sites in Wales from 2005 onwards. These installations have been individually allocated to SIC07 categories based on the primary economic activity of each installation.

Where emissions from point sources do not comprise the total emissions from a source in the Welsh GHGI, the residual ‘non-points’ emissions are calculated and allocated to SIC07 using the source-specific methodologies outlined below.

2.4.2 Road transport

Road transport is a common activity throughout the economy, and the emissions calculated for this source are thus split over many of the SIC07 sectors that represent industry, commerce and public administration, as well as households. The levels of

[3] UK Government (2012): UK Pollutant Release and Transfer (PRTR) data sets
[4] European Environment Agency (2023) European Union Emissions Trading System (EU ETS) data from EUTL
[5] UK Government (2013) Oil and Gas EEMS database

activity, and therefore emissions the activity is responsible for, vary significantly between these SIC07 sectors and so data is required to estimate the proportion that should be attributed to each sector.

In order to split road transport emissions from cars, the Personal Travel in Wales[6] report was used to indicate the proportion of car use that is for domestic purposes. These emissions and fuel use are allocated to supplementary subsection 101 'Consumer expenditure – travel'.

The fuel use of subsection 49.32: 'Taxi operation' has been estimated using the number of licenced taxis & private hire vehicles according to Welsh Government statistics[7], and average annual mileage for Taxis across the UK originally calculated by the Department for Transport.

The remaining activity is split between all other SIC07 sectors using an adjusted version of the ONS Annual Purchase Survey (APS) data, which presents fuel purchases by different industries on a monetary basis. This is adjusted to better reflect the Welsh economy using employment statistics for each SIC07 sector in Wales relative to employment in the UK as a whole.

For example, across the UK in 2019, APS indicates near 0.18% of industrial diesel purchases are by businesses classed in SIC07 as 01: Products of agriculture, hunting and related services. UK employment in this sector represents 1.5% of total employment in 2019, however in Wales this figure is 3%. The APS proportion for the UK is therefore scaled up to represent the increased significance of this sector in Wales. Following renormalisation across all sectors, this industry is calculated to account for 0.35% of diesel purchases by business in Wales.

Road transport emissions and fuel use associated with light goods vehicles was split across SICs using a similar method to cars, except using surveys such as the UK Department or Transport's Van Survey 2019-20 to inform the proportion of vehicle use that is for domestic purposes. Splits for all other road transport vehicles are taken from the UK Environmental Accounts and influenced by employment as described in section 2.4.8.

2.4.3 Off-road machinery

The source 'Other industry off-road machinery' in the NAEI aggregates emissions for many types of machinery and these must be split across the responsible industries for the purposes of these accounts. Background data for the NAEI details the types of machinery used and each one has been assigned to one or more SICs, leading to accurate splitting of emissions from this source across the UK economy.

To make the splits more representative of the Welsh economy, analysis prepared as part of the forthcoming improvements to the NAEI's non-road machinery model has been used.

[6] Welsh Government (2013) Personal Travel: 2012

[7] Welsh Government (2023) Public Service Vehicles (Buses and Taxis)

Sites using machinery in 2017 were identified and categorised into nine sectors, such as construction, mining & quarrying and agriculture. This allowed the proportion of the UK's emissions that occur in Wales to be calculated for each sector, which has been used to scale up or scale down the splits for each SIC that were based on the UK economy.

2.4.4 Manufacture of metals & metal products

Given the historical importance of the iron and steel industry to Wales, additional attention was paid to this sector. Many of the sources in the Welsh GHGI can be allocated an SIC immediately, however natural gas usage at metal manufacturing sites was identified as a source that needed to be split across multiple SICs.

Major metal manufacturing sites were identified from EU ETS and assessed as to whether their economic activity came from the manufacture of iron & steel (SIC07 24.1-24.3) or the manufacture of other basic metals & casting (SIC07 24.4-5, excluding 24.42 nor 24.46). This process allocated 58% of emissions across the timeseries.

The residual emissions are expected to have come from sites that are below the reporting threshold for EU ETS and are likely involved in the casting of metals and manufacture of metal products. The residual was split between these industries using employment data, with a 1.5 times uplift applied to the casting proportion to account for increased natural gas usage that would be expected at these sites relative to sites manufacturing metal products. Despite the uplift, approximately 86% of residual emissions were allocated to industries involved in the manufacture of metal products (SIC07 25.1-3 and 25.5-9).

2.4.5 Aviation

Emissions from flights to and from all Welsh airports have been estimated from NAEI and CAA data, and aggregated by the fuel used, the route and airline operator.

For UK airlines, publicly available data for UK airports was used to assign routes to airlines. Routes operated by non-UK airlines were assigned to non-UK. In some cases, it was not possible to assign a route to a single UK airline or entirely to non-UK airlines, for example if more than one UK airline operated the same route or if both UK and non-UK airlines operated the same route. In these instances, the types of aircraft used on the routes were first assessed in order to match them to those operated by UK airlines. If this was not possible, the assumption was made that the flights are shared evenly between airlines that operate the route. Finally, a renormalisation was applied to ensure that the number of flights by UK airlines tally with the published CAA statistics of UK airline data.

Research revealed that only Air Wales was economically resident in Wales. It operated between 2003 and 2006 and so its activity has been allocated to SIC 51: Air transport services for those years.

Flights using aviation spirit and that could not be associated with an airline have been splits among Air Transport Services, Public administration, Human health services and

Consumer expenditure – travel SICs in the same proportions as used in the UK Environmental Accounts.

2.4.6 Coastal shipping

Data from the UK Inventory shipping emissions model[8] has been used to identify fishing and water transport vessels in Wales. Vessel types and their associated emissions were allocated to SIC07 as follows:

Table 1 Vessel Type Allocation

SIC07 Subsection	Vessel type
03: Fishing and aquaculture	Miscellaneous - fishing
06: Extraction of crude petroleum and natural gas	Liquefied gas tanker
	Offshore
	Oil tanker
50: Water transport	Bulk carrier
	Chemical tanker
	Container
	Cruise
	Ferry-pax only
	General cargo
	Miscellaneous - other
	Refrigerated bulk
	Ro-Ro
	Service - other
	Service - tug

Source: NAEI 2017

2.4.7 Power stations

Point source emissions comprise over 99% of emissions from power stations in Wales. Installations are allocated to one of five subcategories of SIC07 subsection 35.1 based on their primary fuel, identified using IPCC and ETS reported data or permit information.

[8] National Atmospheric Emissions Inventory (2017): A review of NAEI shipping methodology

Table 2 Electricity Production Allocation

Subsection	Name
35.1/1	Electricity production – gas
35.1/2	Electricity production – coal
35.1/3	Electricity production – nuclear
35.1/4	Electricity production – oil
35.1/5	Electricity production – other

Source: NAEI 2017

Residual emissions are allocated based on the 'other sources' methodology outlined in section 2.4.8.

2.4.8 Other sources

For all remaining sources, a hybrid approach is followed whereby emissions at Local Authority (LA) level, sourced from the NAEI emission maps[9], are split to SIC07 sectors using proportions from the UK Environmental Accounts, and then adjusted by employment at the Local Authority level to best represent the local economy. Emissions for all sectors from all Local Authorities are then recombined and reconciled to Welsh GHGI totals for each source, activity and pollutant.

For example, CO_2 emissions from public sector natural gas combustion in the 'public administration' sector (subsection group 84 excluding 84.22) in Cardiff are calculated as follows:

- NAEI maps indicate 47 kt CO_2 emissions arise from public sector natural gas combustion in Cardiff
- Across the UK as whole 20% of this source is allocated to 'public administration' (84 excl. 84.22)
- Employment in the 'public administration' sector is 4.2% of total UK employment
- In Cardiff this sector accounts for 9.9% of employment
- The 20% UK split for this source is therefore scaled up by the ratio of employment (i.e. 0.099÷0.042) to be more representative of the local economy in Cardiff
- This approach is carried out for each source across all sectors and all Welsh LAs. The total of all Welsh LAs is then normalised to the Welsh GHGI total for CO_2 emissions from public sector natural gas combustion of 322 kt.

Following normalisation, CO_2 emissions in the public administration sector from public sector natural gas combustion in Cardiff are calculated to be 23 kt, as opposed to the 9 kt suggested by applying the UK SIC split directly to gridded emissions.

[9] National Atmospheric Emissions Inventory (2020): UK Emissions Interactive Map

Combining calculations for all Welsh Local Authorities, total CO_2 emissions in the public administration sector from public sector natural gas combustion are calculated to be 88 kt, as opposed to the 64 kt suggested by the UK split.

This approach assumes that average fuel consumption per employee is similar across the UK in each SIC. That is, that the best guide to expected fuel activity of an employee is provided by fuel consumption of employees in the same sector in other LAs, rather than by fuel consumption of employees in other sectors in the same LA.

2.4.9 Splits based on employment & improvements

As described at the beginning of this section, the majority of sources in the NAEI can be allocated directly to an SIC, leaving around 18% of emissions requiring a split across multiple SICs. The splits that are independent of employment data are those based on point sources and the aforementioned methods for off-road machinery, aviation, coastal shipping and power stations.

Due to its importance to Welsh emissions, information on the quantities of fuel used by industries for road transport in Wales could be used to significantly improve the accuracy of the accounts. Currently fuel usage is estimated by scaling the UK-wide Annual Purchase Survey using employment in Wales (further detail in section 2.4.2). The impact would be greatest for apportioning heavy goods vehicle usage to industries, as the foundation for this is currently a UK Department for Transport survey from more than a decade ago. Car and light goods vehicle splits could also be improved with this information.

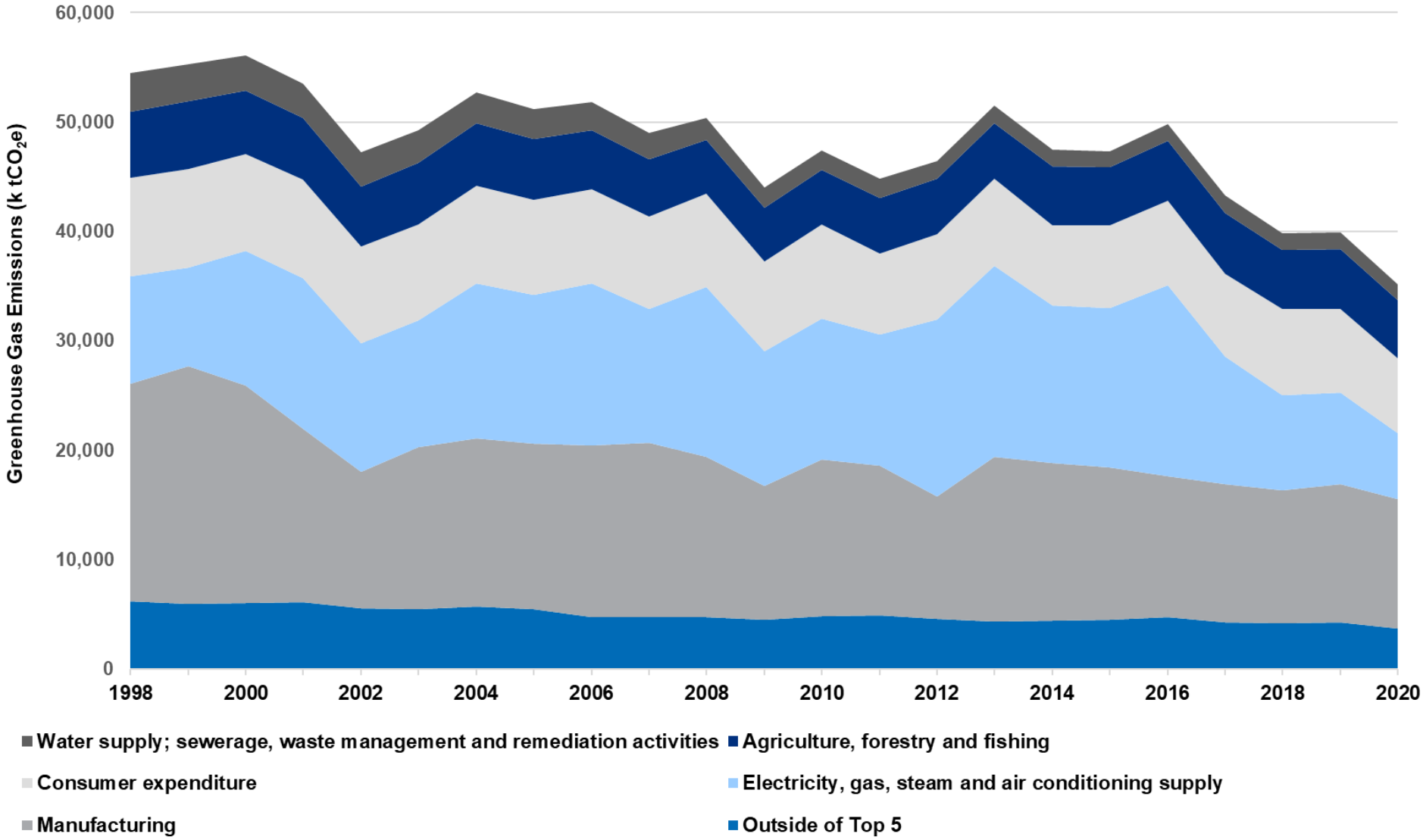
Allocations of emissions amongst industries within the manufacturing sector would also benefit from Wales-specific information on fuel consumption. For the UK Environmental Accounts, the Department for Business, Energy & Industrial Strategy's 'Energy consumption in the UK'[10] provides the fuel usage (such as oil, gas, coal etc.) of a number of heavy industries, reported by SIC. This is based on a fuel purchase enquiry from 2007, therefore a UK-wide update with regional disaggregation, or a survey solely for Wales, would improve the accuracy of emissions and energy allocations.

3. Results

Figure 1 shows the 5 sectors with the highest total greenhouse gas emissions over the time period. The emissions of different gases are made comparable by calculating their global warming potential, expressed in 'kilotonnes of carbon dioxide equivalent' (more information about the global warming potential of a gas compared to its weight can be found in Appendix 1).

[10] UK Government National Statistics (2021): Energy Consumption in the UK 2021

Figure 1: Top 5 Highest Emitting Sectors

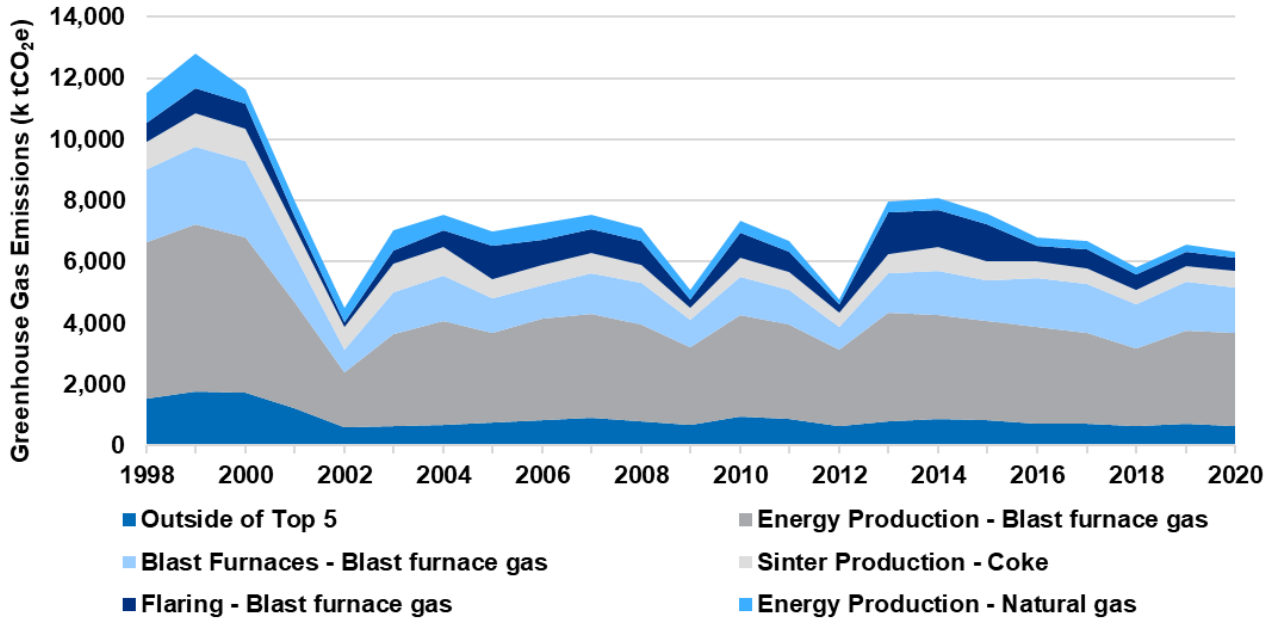


Source: Ricardo Energy & Environment

Overall, greenhouse gas emissions in Wales have been trending downwards since 1998, with an accelerated decline from 2016 onwards. The steeper decline in recent years is in large part due to the decarbonisation of electricity production, in particular the closure of coal fired power stations. Natural Gas usage for electricity production has also reduced from its peak in 2016, though the SIC (35.1/1) remains the third largest source of emissions in 2020.

Manufacturing has the highest total emissions of any sector across the timeseries. Emissions reduced between 1999 and 2002 but have not fallen significantly since, meaning the sector accounted for a third of total emissions in 2020. The dominant industrial group is SIC07 24.1-3: Manufacture of basic iron and steel, largely based at Port Talbot steelworks in West Glamorgan. **Error! Reference source not found.** shows the d etails of emission sources within the SIC group and the fuel responsible for the emissions. With the exception of flaring of blast furnace gas, emissions from each source and fuel combination have remained stable in recent years.

Figure 2: Manufacture of Basic Iron and Steel - Emission Sources and Fuel Used



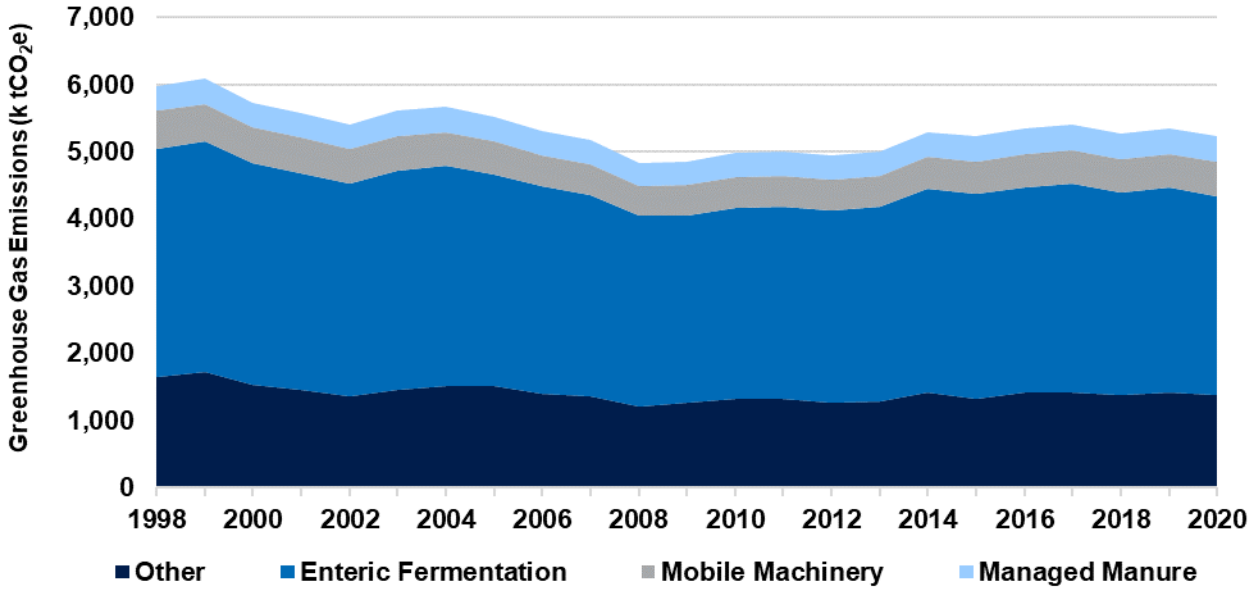
Source: Ricardo Energy & Environment

Consumer expenditure is the third highest emitting sector and reported in two parts, emissions and fuel use related to travel (SIC07 101) and not related to travel (SIC07 100). Since 1998, 95% of emissions related to travel have come from car usage. Travel related emissions increased between 2011 and 2019 but fell sharply in 2020 due to changes in behaviour related to the Covid-19 pandemic.

Conversely, 'Consumer expenditure – not travel' did not fall in 2020 and emissions totals have not changed significantly since 2014. The SIC's emissions are dominated by domestic combustion for purposes such as home and water heating, with natural gas combustion responsible for 61% of 2020 emissions and combustion of burning oil a distant second at 14% of emissions.

Agriculture, forestry and fishing is notable as a large sector whose emissions have increased in recent years. Emissions are almost entirely within SIC07 01: Products of agriculture, hunting and related services, and heavily dependent on methane emissions produced by enteric fermentation (a part of the food digestion process in ruminant animals). Enteric fermentation by beef and dairy cattle produced 37% of total greenhouse gas emissions from agriculture while sheep were responsible for 19%. Gas oil use in mobile machinery and manure management, particularly manure from cattle, complete the top three agricultural emissions sources.

Figure 3: Products of agriculture, hunting and related services – Top Three Emission Sources



Source: Ricardo Energy & Environment

Water supply and waste management was the fifth highest emitting sector across the timeseries and SIC07 38, 'Waste collection, treatment and disposal services; materials recovery services', is responsible for a significant proportion of these emissions. Methane from landfill was of particular concern early in the timeseries but emissions reduced by 75% between 1998 and 2020 due to improvements in the standards of landfilling, reducing the quantity of biodegradable waste going to landfill, and improved capture of landfill gas which has been used as a substitute for fossil fuels in energy production. Nonetheless, landfill was responsible for 70% of SIC 38's emissions in 2020 and so remains a significant source.

11% of greenhouse gas emissions in 2020 came from sectors outside of the five mentioned above.

Reference List

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UK Government National Statistics (2021): Energy Consumption in the UK 2021

Welsh Government (2013) Personal Travel: 2012

Welsh Government (2023) Public Service Vehicles (Buses And Taxis)

Appendices

Appendix 1: Description of Greenhouse Gases

Appendix 2: Glossary of terms and acronyms

Notes on the use of statistical articles

Appendix 1: Description of Greenhouse Gases

'Changes in the atmospheric abundance of greenhouse gases and aerosols, in solar radiation and in land surface properties alter the energy balance of the climate system. […] Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years.'

IPCC Fourth Assessment Report

The greenhouse gases included in the atmospheric emissions accounts are those covered by the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).

Definitions can be found in the glossary of the IPCC (2007): Synthesis Report of the IPCC Fourth Assessment.[11]

Carbon dioxide (CO_2) emissions come from a wide variety of natural and anthropogenic sources, however the global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change. It is also produced in some industrial processes such as the manufacture of cement. Carbon dioxide is a long-lived gas remaining in the atmosphere for between 50 and 200 years. It is the most important anthropogenic greenhouse gas.

Methane (CH_4) is mainly produced when organic matter is broken down in the absence of oxygen. Large quantities are produced by enteric fermentation in cattle and sheep, by the spreading of animal manure and from organic waste deposited in landfill sites. Methane is also emitted in coal mining, oil and gas extraction and gas distribution activities. Methane is a significant greenhouse gas.

Nitrous oxide (N_2O) is released in a few industrial processes and from the soil when nitrogenous fertilisers are applied in agriculture and horticulture. These are the main anthropogenic sources. It is a long-lived pollutant, lasting about 120 years in the atmosphere and is a potent greenhouse gas.

Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) are artificial fluids that contain chlorine and/or fluorine. Because of their low reactivity and non-toxicity, they were widely used as refrigerants, foam blowing agents, aerosol propellants and solvents.

Nitrogen trifluoride (NF_3) is the most recent addition to GHGs which are reported under the Kyoto protocol. It is most readily released through the production of LCDs and solar cells.

[11] Intergovernmental Panel on Climate Change (IPPC) (2007) AR4 Climate Change 2007: Synthesis Report — IPCC

To aggregate the greenhouse gases covered in the accounts, a weighting based on the relative global warming potential (GWP) of each of the gases is applied, using the effect of CO_2 over a 100 year period as a reference. The IPCC Fourth Assessment Report gives methane a weight of 25 relative to CO_2 and nitrous oxide a weight of 298 relative to CO_2. SF6 has a GWP of 23,900 relative to CO_2. The GWP of the other fluorinated compounds varies according to the individual gas.

Greenhouse gas emissions are sometimes shown in terms of carbon equivalent rather than CO_2 equivalent. To convert from CO_2 equivalent to carbon equivalent it is necessary to multiply by 12/44.

Appendix 2: Glossary of terms and acronyms

Term	Definition
Activity	A quantitative representation of the variable which explains the emissions in a source category. For example, measures such as the energy content in GJ of fuels used in combustion processes, kilotonnes of solvents used in painting or other coating processes, or the distance in km driven by cars.
Emission factor	Emissions per unit of activity, e.g. grams of CO_2 per kilotonne of petrol consumed
Kyoto Protocol	International agreement regarding reductions in greenhouse gas emissions
NAEI	National Atmospheric Emissions Inventory – Estimates of emissions to the atmosphere from anthropogenic and natural sources in the UK and Gibraltar, including inventories for each of the devolved administrations
GHGI	Greenhouse Gas Inventory – Emission estimates for the six greenhouse gases specified under the UNFCCC and Kyoto Protocol
SEEA	System of Environmental Economic Accounts – Internationally agreed system of measuring air emissions on a national accounts basis
SIC	Standard Industrial Classification
SNA	System of National Accounts
Source	Processes, equipment or substances that lead to emissions to the atmosphere
UNECE	United Nations Economic Convention for Europe
UNFCCC	United Nations Framework Convention on Climate Change

Notes on the use of statistical articles

Statistical articles generally relate to one-off analyses for which there are no updates planned, at least in the short-term, and serve to make such analyses available to a wider audience than might otherwise be the case. They are mainly used to publish analyses that are exploratory in some way, for example:

- introducing a new experimental series of data
- a partial analysis of an issue which provides a useful starting point for further research but that nevertheless is a useful analysis in its own right
- drawing attention to research undertaken by other organisations, either commissioned by the Welsh Government or otherwise, where it is useful to highlight the conclusions, or to build further upon the research
- an analysis where the results may not be of as high quality as those in our routine statistical releases and bulletins, but where meaningful conclusions can still be drawn from the results.

Where quality is an issue, this may arise in one or more of the following ways:

- being unable to accurately specify the timeframe used (as can be the case when using an administrative source)
- the quality of the data source or data used
- other specified reasons.

However, the level of quality will be such that it does not significantly impact upon the conclusions. For example, the exact timeframe may not be central to the conclusions that can be drawn, or it is the order of magnitude of the results, rather than the exact results, that are of interest to the audience.

The analysis presented does not constitute a National Statistic, but may be based on National Statistics outputs and will nevertheless have been subject to careful consideration and detailed checking before publication. An assessment of the strengths and weaknesses in the analysis will be included in the article, for example comparisons with other sources, along with guidance on how the analysis might be used, and a description of the methodology applied.

Articles are subject to the release practices as defined by the release practices protocol, and so, for example, are published on a pre-announced date in the same way as other statistical outputs.

Missing value symbols used in the article follow the standards used in other statistical outputs, as outlined below.

.. The data item is not available

. The data item is not applicable

- The data item is not exactly zero, but estimated as zero or less than half the final digit shown

* The data item is disclosive or not sufficiently robust for publication