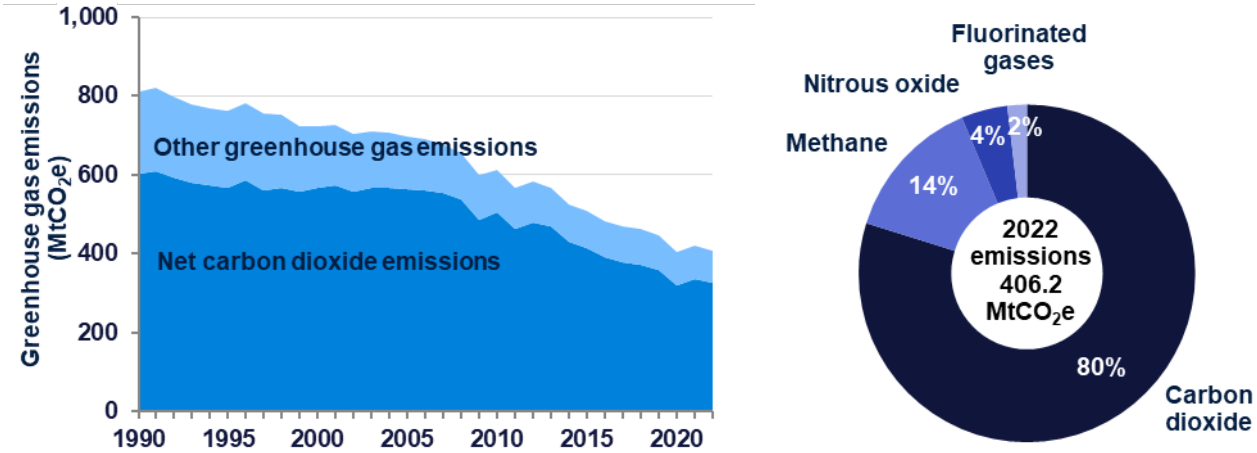
Department for Energy Security & Net Zero

2022 UK Greenhouse Gas Emissions, Final Figures

6 February 2024 **National Statistics**

Despite rises in some sectors as the UK continued to recover from the coronavirus (COVID-19) pandemic, 2022 saw a fall in greenhouse gas emissions in the UK, largely due to a reduction in fuel use to heat buildings. In 2022, net territorial greenhouse gas emissions in the UK were estimated to be 406.2 million tonnes carbon dioxide equivalent ($MtCO_2e$), a decrease of 3.5% from the 2021 figure of 421.1 million tonnes, and 9.3% lower when compared to 2019, the most recent pre-pandemic year. Total greenhouse gas emissions were 50.0% lower than they were in 1990. Carbon dioxide made up 80% of the 2022 total.

UK territorial greenhouse gas emissions, 1990-2022



- The fall in 2022 is primarily due to a reduction in gas use for heating buildings, as a result of warmer weather than in 2021. Emissions from the buildings and product uses sector fell 13.3%. Higher energy prices may have also caused people to reduce their energy use. Falls in emissions from industry and agriculture also contributed to the overall reduction.
- In comparison, emissions from the domestic transport sector rose 1.6%. This follows a period of reduced domestic travel in 2020 and 2021 due to COVID-19 restrictions. Domestic transport was the largest emitting sector, responsible for 28% of all greenhouse gas emissions in the UK. Emissions from electricity supply also rose by 0.6%.

What you need to know about these statistics:

This publication provides the latest estimates of 1990-2022 UK territorial greenhouse gas emissions, meaning emissions occurring within the UK's borders. Figures for all years since 1990 have been revised since the last publication to incorporate methodological improvements and new data, so the estimates presented here supersede previous ones. We have also introduced a new set of sectors to present emissions in this publication, see page 29 for more information.

Greenhouse gas emissions are presented in carbon dioxide equivalent units (CO_2e) throughout this statistical release and cover seven greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).

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Introduction

This publication provides the latest annual estimates of UK territorial greenhouse gas emissions from 1990-2022. The geographic coverage of this report is UK only unless stated otherwise. The figures in this statistical release are used as the basis for reporting against UK greenhouse gas emissions reduction targets and provide information for users on the drivers of emissions trends since 1990. Emissions are estimated following the guidance set out by the Intergovernmental Panel on Climate Change (IPCC)[1], as required for the UK's submissions to the United Nations Framework Convention on Climate Change (UNFCCC) each year.

The estimates present emissions on a "territorial" basis, so include emissions which occur within the UK's borders, including offshore areas over which the UK has jurisdiction. They therefore exclude emissions from UK businesses and residents that occur abroad, including from international aviation and shipping, and any emissions embedded within the supply chain of manufactured goods and services imported into the UK (while including emissions that occur in the UK resulting from exported goods and services).

Two additional approaches to estimating UK emissions are also published and the Office for National Statistics (ONS) has published an article that compares these different measures of the UK's greenhouse gas emissions in more detail. The alternative measures are:

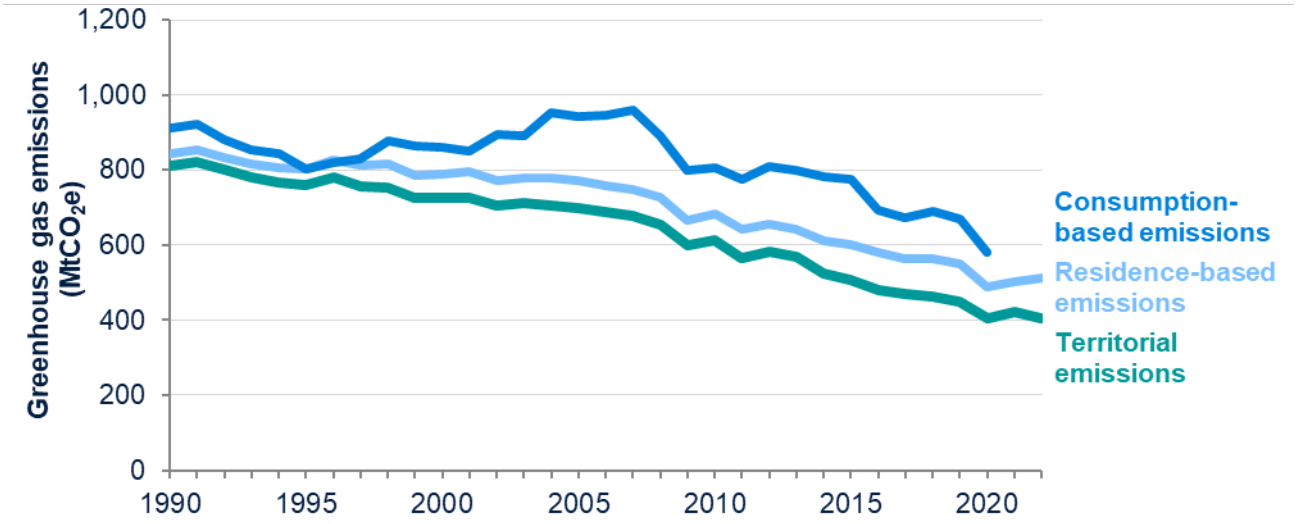
- ONS publishes emissions on a "residence" basis in the UK Environmental Accounts. The figures represent emissions caused by UK residents and businesses whether in the UK or abroad but exclude emissions within the UK which can be attributed to overseas residents and businesses.

- The Department for Environment, Food and Rural Affairs (Defra) publishes the UK's carbon footprint. This estimates emissions on a "consumption" basis, meaning it covers emissions associated with the consumption of goods and services by households in the UK. It includes estimates of emissions associated with each stage of the supply chain for those goods and services, regardless of where they occur, while excluding emissions occurring in the UK that are associated with the consumption of goods and services by households outside the UK.

Figure 1 shows how the estimates of UK territorial emissions in this publication compare to the most recent estimates of UK emissions on a residence and a consumption basis. The estimates are not directly comparable as there are differences in definitions and methodologies and both the consumption-based and residence-based estimates do not incorporate the latest methodology changes made to the territorial estimates. However, this does give a good indication of the relative sizes and trends in each of these estimates, for example the UK's consumption-based emissions are considerably higher than its territorial emissions and followed a different trend over this period, peaking in 2007 and not falling as far as the territorial and residence-based estimates have since 1990.

[1] 2006 IPCC Guidelines for National Greenhouse Gas Inventories: https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html; 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement): https://www.ipcc-nggip.iges.or.jp/public/wetlands/index.html; 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP Supplement): https://www.ipcc-nggip.iges.or.jp/public/kpsg/index.html

Figure 1: UK territorial, residence-based and consumption-based greenhouse gas emissions, 1990-2022



Sources: Table 1.1, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables
UK's carbon footprint, Defra: https://www.gov.uk/government/statistics/uks-carbon-footprint
Atmospheric emissions: greenhouse gases by industry and gas, ONS: https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsatmosphericemissionsgreenhousegasemissionsbyeconomicsectorandgasunitedkingdom

The estimates in this publication are based on the source of the emissions rather than where the end-user activity occurred, so for example emissions related to electricity generation are attributed to power stations, where the emissions occur, rather than homes and businesses where the electricity is used. A breakdown of UK territorial emissions with energy supply emissions presented on an end-user basis will be published as an annex to this publication on Thursday 28 March 2024[2].

These estimates cover seven gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). The last four gases are collectively referred to as fluorinated gases or F gases. In accordance with international reporting protocols, emissions of each gas are weighted by its global warming potential (GWP)[3], so that total greenhouse gas emissions can be reported on a consistent basis. The GWP for each gas is defined as its warming influence in relation to that of carbon dioxide over a 100-year period. Emissions are then presented in carbon dioxide equivalent units (CO_2e).

Carbon dioxide is reported in terms of net emissions, which means total emissions minus total removals of carbon dioxide from the atmosphere by carbon sinks. Carbon sinks are defined by the UNFCCC as “any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere”.

Note that as part of this release the 1990-2021 emissions figures have been revised since the previous publication in February 2023, to incorporate methodological improvements and new data, and the 2022 figures have been revised from the provisional estimates published in March 2023. Details of these revisions can be found later in this statistical release.

References to the ‘UK Greenhouse Gas Inventory’ refer to the consistent time series of emissions from 1990 to the most recent year which is updated annually and reported to the

[2] The Annex for 1990-2021 UK greenhouse gas emissions final figures by end-user published in March 2023 can be found here: https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2021
[3] The global warming potentials (GWPs) used are from Working Group 1 of the IPCC Fifth Assessment Report: Climate Change 2014 and summarised in table 6.4 in the data tables accompanying this publication.

UNFCCC. The figures in these statistics are consistent with the UK's Greenhouse Gas Inventory for 1990-2022, although the inventory reported to the UNFCCC includes emissions from the UK's Crown Dependencies and certain Overseas Territories which are excluded from these statistics except where specifically stated.

In a change from previous publications, greenhouse gas emissions are allocated into sectors known as Territorial Emissions Statistics (TES) sectors, which have replaced the National Communication (NC) sectors used in previous publications. More information about this change can be found on page 29. The TES sectors are as follows:

Electricity Supply	Emissions from power stations for electricity generation, including incinerators generating energy from waste. Excludes emissions from organisations generating their own electricity (autogeneration) even when exported to the electricity grid. These emissions are instead included in the sector in which they occur.
Fuel Supply	Emissions from the supply of fuels, e.g. oil, gas and coal. Includes activities such as extraction, production, venting, flaring, processing (e.g. oil refining) and distribution. Excludes emissions from coke production which are instead included in the *Industry* sector as coke is primarily used in the iron and steel industry.
Domestic Transport	Emissions from road vehicles, domestic aviation and shipping (including military), fishing vessels, and railways. Also includes emissions from transport related mobile machinery (e.g. at airports and ports) and F-gases from mobile air conditioning and refrigeration. International aviation and shipping emissions are not included in the national total, though are reported separately.
Buildings and Product Uses	Emissions from fuel combustion in residential, public, and commercial buildings, largely for heating. Also includes emissions from house and garden mobile machinery, anaesthetics, F-gases from air conditioning, refrigeration, heat pumps, aerosols as well as other product uses. Excludes emissions from industrial buildings which are instead included in the *Industry* sector.
Industry	Emissions from fuel combustion in the manufacturing and construction industries, industrial processes, and F-gases from industrial refrigeration. Emissions from coke production are included in this sector as coke is primarily used in the iron and steel industry. Includes emissions from organisations generating their own electricity and heat (autogeneration) even when exported to the electricity grid or used in heat networks.
Agriculture	Emissions from agricultural machinery and fuel combustion, livestock (enteric fermentation and manure management) and agricultural soils (excluding carbon stock changes which are included in the *LULUCF* sector).
Waste	Emissions from the treatment and disposal of waste, such as landfill, composting, incineration without energy recovery and wastewater handling. Excludes emissions from incinerators generating energy from waste as these are reported in the *Electricity Supply* sector.
Land Use, Land Use Change and Forestry (LULUCF)	Includes emissions and removals of CO_2 from changes in the carbon stock in forestland, cropland, grassland, wetlands, settlements and harvested wood products, and emissions of other greenhouse gases from drainage (excl. croplands and intensive grasslands) and rewetting of soils, nitrogen mineralisation associated with loss and gain of soil organic matter, and fires. As impacts of carbon stock changes are included in this sector, CO_2 emissions of biogenic origin (e.g. burning biomass for energy) are excluded from other sectors to avoid double counting.

2022 total greenhouse gas emissions

In the data tables accompanying this publication, table 1.1 shows UK greenhouse gas emissions since 1990 by gas and table 1.7 shows emissions by fuel type.

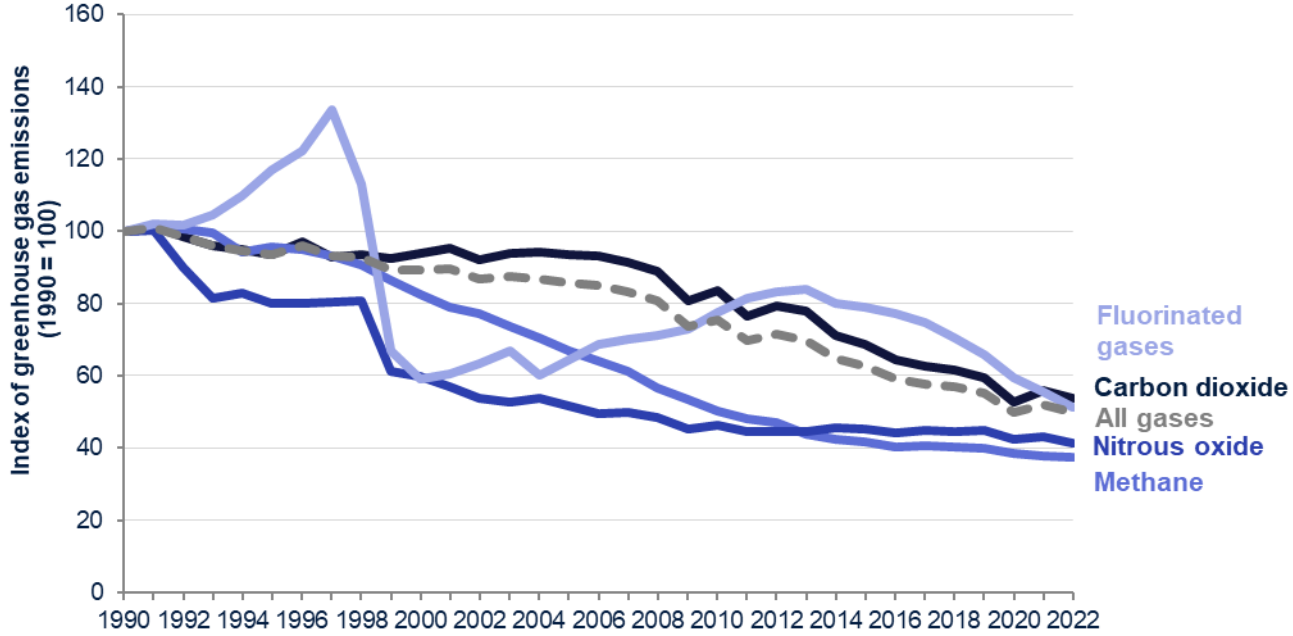
In 2022, emissions in the UK of the seven greenhouse gases that the UK reports internationally were estimated to be 406.2 million tonnes carbon dioxide equivalent ($MtCO_2e$), a decrease of 3.5% compared to the 2021 figure of 421.1 million tonnes. Greenhouse gas emissions in 2022 are estimated to be 9.3% lower than in 2019, the most recent pre-pandemic year, and 50.0% lower than they were in 1990.

The COVID-19 pandemic had a significant impact on UK greenhouse gas emissions in 2020 and 2021, and while it is not possible to identify the exact size of this effect, the restrictions in place led to large falls in emissions from transport and businesses. The last of these restrictions were lifted in the UK during 2022 and the sources of emissions most affected by the pandemic saw increases as a result, particularly transport. But 2022 was also a much warmer year than 2021, by 0.8 degrees Celsius on average across the year. These warmer temperatures led to a large drop in emissions from the use of fuels and electricity to heat buildings and are the main factor driving the fall in overall UK emissions. Higher energy prices may have also been a factor in reducing demand for fuels, particularly towards the end of the year.

When broken down by gas, UK emissions are dominated by carbon dioxide, which is estimated to have accounted for about 80% of greenhouse gas emissions in the UK in 2022. Weighted by global warming potential, methane accounted for about 14% and nitrous oxide for about 4% of UK emissions in 2022. Fluorinated gases accounted for the remainder, around 2%.

Carbon dioxide has always been the dominant greenhouse gas emitted in the UK. Emissions of carbon dioxide have reduced by 46.3% (around 279.5 $MtCO_2$) since 1990 to 324.2 $MtCO_2$ in 2022, mainly due to decreases in emissions from power stations. Emissions of methane have seen a larger proportional fall (62.5% since 1990) than those of carbon dioxide, and so have emissions of nitrous oxide (58.8% since 1990). Fluorinated gas (F gas) emissions are estimated to be 48.6% lower now than they were in 1990, with hydrofluorocarbons (HFCs) being the dominant F gas throughout this time period.

Figure 2: Index of territorial UK greenhouse gas emissions by gas, 1990-2022

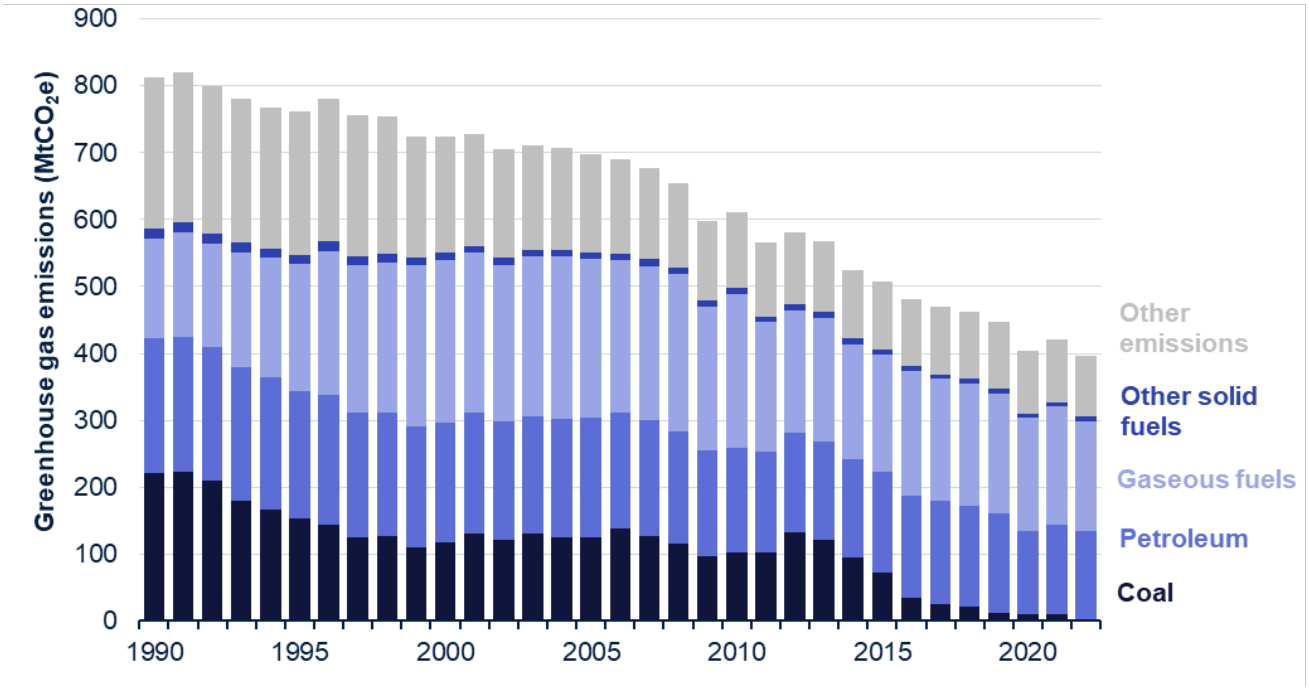


Source: Table 1.1, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables

In 2022, 77.6% of greenhouse gas emissions in the UK came from the use of fossil fuels. Emissions from fossil fuels decreased by 3.8% compared to 2021; they are down 9.4% compared to 2019 and 46.2% lower than in 1990. Fossil fuel emissions in 2022 predominantly came from the use of gaseous fuels and petroleum, which accounted for 40.4% and 33.3% of all UK emissions respectively. Gaseous fuel use in the UK is dominated by the use of natural gas for heating buildings and for electricity generation, while most petroleum use is in road vehicles.

Use of coal accounted for 2.3% of emissions in the UK in 2022. Emissions from the use of coal have fallen by 95.8% since 1990, at which point they were responsible for 27.2% of UK emissions as it was the main fuel used for electricity generation at that time.

Figure 3: Territorial UK greenhouse gas emissions by fuel type, 1990-2022 ($MtCO_2e$)



Source: Table 1.7, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables

UK performance against emissions reduction targets

In the data tables accompanying this publication, tables 2.1 and 2.2 show the UK's progress against domestic and international emissions reduction targets respectively.

Domestic Targets

The Climate Change Act 2008

The UK has domestic targets for reducing greenhouse gas emissions under the Climate Change Act 2008 (CCA)[4]. The CCA has established a long-term legally binding framework to reduce UK net greenhouse gas emissions by at least 100% below a 1990/95 baseline by 2050 (i.e. Net Zero). The CCA also introduced carbon budgets. These are legally binding limits on the total amount of greenhouse gas emissions the UK can emit over five-year periods and are required to be set 12 years in advance of the start of each period[5].

Compliance with carbon budgets is not assessed by directly comparing the budget level against UK net greenhouse gas emissions. Instead, the budget level is compared to the net UK carbon account, which can also take account of international emissions trading and is defined for each period in carbon accounting regulations[6]. Up until 2020, the net UK carbon account included adjustments for net trading of emissions allowances from UK operators participating in the EU Emissions Trading System (EU ETS)[7]. The UK left the EU ETS in 2020, and so adjustments for trading are not applicable from 2021. Further information on EU ETS adjustments can be found in Annual Statement of Emissions publications[8].

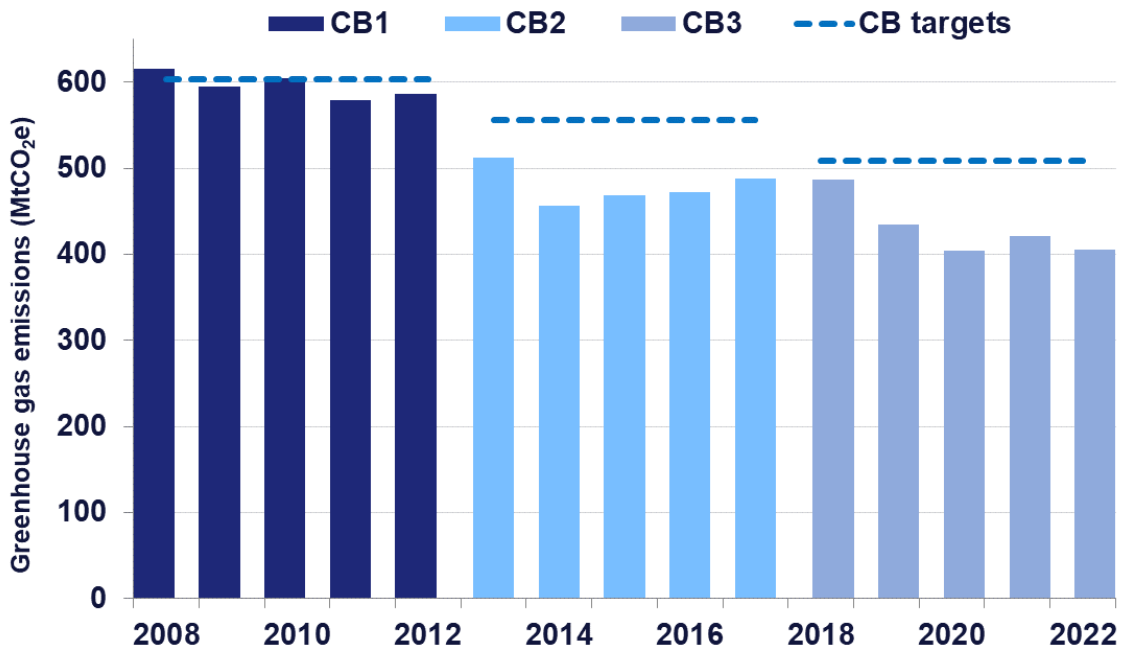
The first carbon budget ran from 2008-12. In 2014, it was confirmed the UK had met the budget with the net UK carbon account 36.5 $MtCO_2e$ (1%) below the limit of 3,018 $MtCO_2e$[9]. The second carbon budget ran from 2013-17. In 2019, it was confirmed the UK had met the budget with the net UK carbon account 383.9 $MtCO_2e$ (14%) below the limit of 2,782 $MtCO_2e$[10].

Figure 4 shows that the UK has met the third carbon budget, with the net UK carbon account 391.2 $MtCO_2e$ (15%) below the limit of 2,544 $MtCO_2e$. Further information will be published in the UK's Annual Statement of Emissions for 2022[11] and Final Statement for the Third Carbon Budget in March and May 2024 respectively.

Projected performance against current and future carbon budgets can be found in UK energy and emissions projections[12].

[4] Climate Change Act 2008: http://www.legislation.gov.uk/ukpga/2008/27/contents
[5] Carbon budgets: https://www.gov.uk/guidance/carbon-budgets
[6] Carbon Accounting Regulations: https://www.legislation.gov.uk/uksi/2009/1257/contents/made
[7] The EU Emissions Trading System (EU ETS): https://ec.europa.eu/clima/policies/ets_en
[8] Annual Statement of Emissions: https://www.gov.uk/government/collections/annual-statements-of-emissions
[9] Final statement for the first carbon budget period: https://www.gov.uk/government/statistics/final-statement-for-the-first-carbon-budget-period
[10] Final statement for the second carbon budget period: https://www.gov.uk/government/statistics/final-statement-for-the-second-carbon-budget-period
[11] Annual Statement of Emissions: https://www.gov.uk/government/collections/annual-statements-of-emissions
[12] Energy and emissions projections: https://www.gov.uk/government/collections/energy-and-emissions-projections

Figure 4: Progress towards UK Carbon Budget (CB) targets, 2008-2022 ($MtCO_2e$)



Source: Table 2.1, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables
Note: Up until 2020, UK net greenhouse gas emissions were adjusted for net trading of emissions allowances from UK operators participating in the EU ETS.

International Targets

The Kyoto Protocol

Up until 2020, the UK had emissions reduction targets under the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC)[13].

First Commitment Period (2008-2012)

Collectively with the EU, Iceland and Norway, the UK committed to reduce total greenhouse gas emissions by 8% on 1990 levels by 2012. As part of this, the UK committed to reduce its emissions by 12.5% below 1990 levels over 2008-12.

The UK met its commitment, reducing its emissions by around 23% below 1990 levels over 2008-12[14]. See table 2.2a from the data tables accompanying this publication for emission figures and further info on the UK's achievement of this target.

Second Commitment Period (2013-2020)

Collectively with the EU and Iceland, the UK committed to reduce total greenhouse gas emissions by 20% below 1990 levels over 2013-20. This target was separated into two parts:

[13] The Kyoto Protocol: https://unfccc.int/kyoto_protocol
[14] Final accounting report for the first commitment period of the Kyoto Protocol: https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-kyoto-protocol/second-commitment-period/final-compilation-and-accounting-reports

- Emissions in scope of the EU Emissions Trading System (ETS). Predominantly, power stations, heavy industry, and domestic aviation. The EU was responsible for this part and set an annually reducing system wide cap on emissions.
- Emissions outside the scope of the EU ETS. Each country was responsible for their share of these and given an emission allocation over the period represented by Assigned Amount Units.

UK target under the EU Effort Sharing Decision

To underpin implementation of the EU's Kyoto Protocol Second Commitment Period target, The EU Effort Sharing Decision (ESD) was agreed as part of the EU's Climate and Energy package. The EU ESD set out Annual Emission Allocations for each country's emissions outside the scope of the EU ETS. The UK's Annual Emissions Allocation over 2013-20 translates to an approximate 16% reduction in emissions from 2005 levels.

In June 2023, the European Commission updated the UK's performance against ESD for 2020 (so that emissions from Northern Ireland EU ETS installations could be accounted for correctly), confirming the UK's emissions outside the scope of the EU ETS were below the Annual Emission Allocation in 2020[15]. The UK has therefore now met all its annual targets under the EU ESD for 2013-20. See table 2.2c from the accompanying data tables for emission figures and further info on the UK's achievement of this target.

UK target under the Kyoto Protocol Second Commitment Period

As described above, the UK collectively committed to reduce total greenhouse gas emissions with the EU and Iceland. The UK share of this commitment is represented by Assigned Amount Units which gives a limit on emissions outside the scope of the EU ETS over the 2013-20 period. The UK complied with the target, by 'retiring' units corresponding to UK emissions outside the scope of the EU ETS over the period. The UK submitted its 'true-up' report to the UNFCCC in September 2023 detailing the 'retiring' of these units[16]. See table 2.2b from the accompanying data tables for emission figures and further information on the UK's achievement of this target.

The Paris Agreement

From 2021, the UK has emissions reduction targets under the Paris Agreement to the United Nations Framework Convention on Climate Change (UNFCCC). Under the Paris Agreement, the UK is required to set targets every five years known as Nationally Determined Contributions (NDCs)[17].

First NDC (2030)

The UK has committed to reduce total greenhouse gas emissions by at least 68% by 2030, compared to 1990 levels[18].

[15] European Commission Implementing Decision: http://data.europa.eu/eli/dec_impl/2022/1953/2023-06-29
[16] True up report for the second commitment period of the Kyoto Protocol https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review/reporting-and-review-under-the-kyoto-protocol/second-commitment-period/reporting-and-review-process-for-the-true-up-period-of-the-second-commitment-period-of-the-kyoto
[17] The Paris Agreement: https://unfccc.int/process-and-meetings/the-paris-agreement
[18] UK Nationally Determined Contribution under the Paris Agreement: https://www.gov.uk/government/publications/the-uks-nationally-determined-contribution-communication-to-the-unfccc

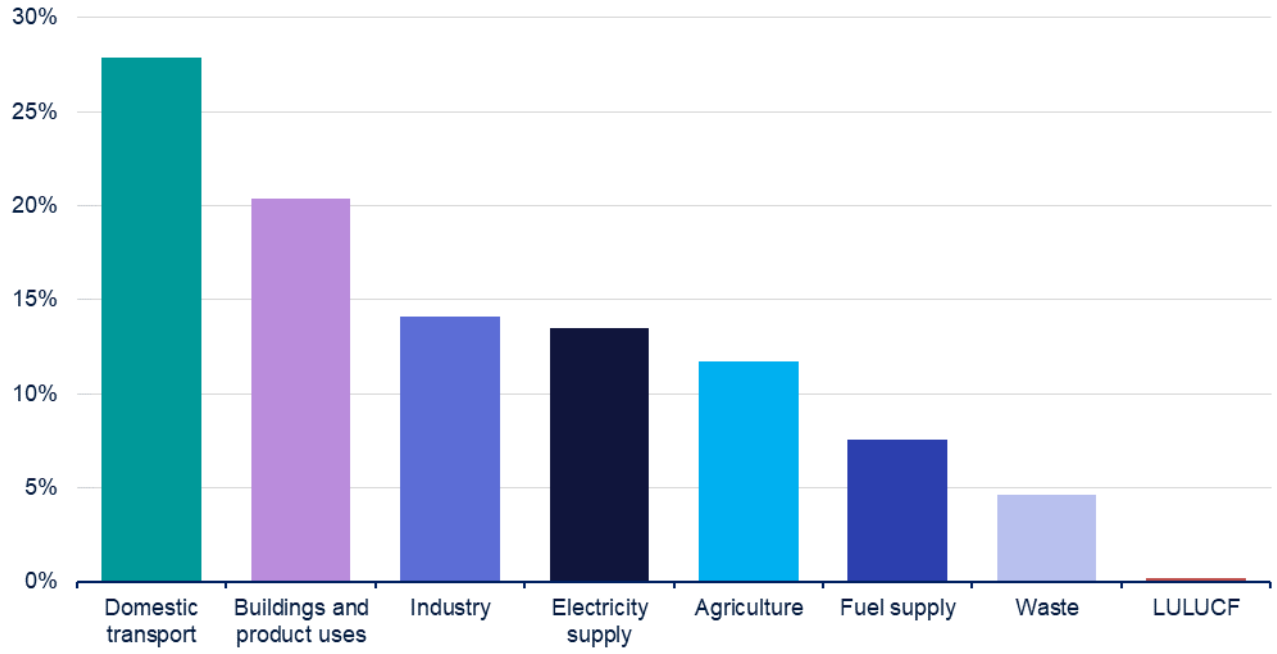
Emissions by sector

In the data tables accompanying this publication, table 1.2 shows overall UK greenhouse gas emissions since 1990 by sector and source, while tables 1.3 to 1.6 show this breakdown for each individual gas.

The sector breakdowns in this publication and accompanying tables are based on TES sectors and present emissions by source, where emissions and removals are typically allocated to the sector in which they are emitted or removed from the atmosphere. E.g. emissions from power stations are included in the electricity supply sector rather than being recorded against the sectors where the electricity is used. An alternative breakdown where energy supply[19] emissions are presented on an end user basis rather than a by source basis will be published in an annex to this publication on 28th March 2024, in which emissions related to electricity and fuel supply, e.g. from power stations and refineries, will be reallocated to other sectors based on where the energy was used.

In 2022, 28% of net greenhouse gas emissions in the UK were estimated to be from the domestic transport sector, 20% from buildings and product uses, 14% from industry, 14% from electricity supply and 12% from agriculture. The other 12% was attributable to the remaining sectors: fuel supply, waste and the land use, land use change and forestry (LULUCF) sector. The LULUCF sector includes both sinks and sources of emissions.

Figure 5: Net territorial UK greenhouse gas emissions by TES sector, 2022 (%)



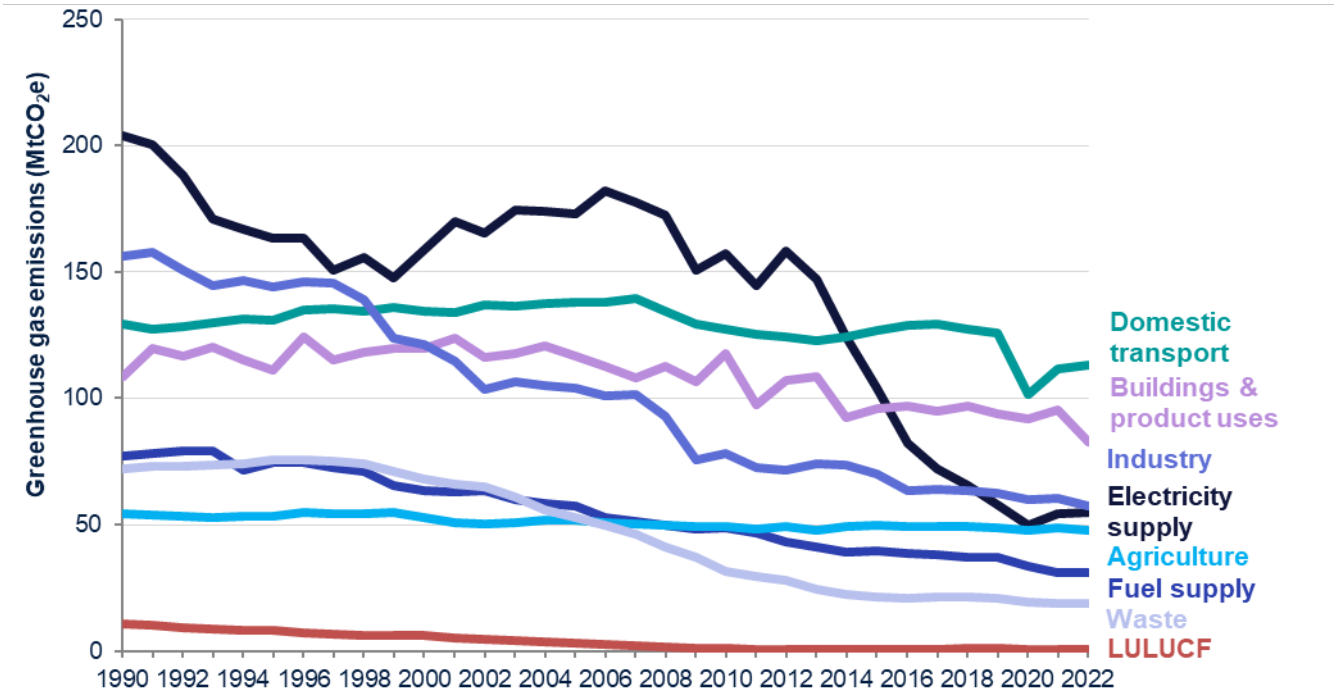
Source: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables

Note: LULUCF is land use, land use change and forestry.

[19] Energy supply emissions consist of those in the electricity supply and fuel supply TES sectors, along with a small number of sources in the industry sector (in particular from coke production and the autogeneration of electricity).

Historically, the electricity supply sector had the highest greenhouse gas emissions, but the large reductions over the last decade in emissions from power stations mean that since 2014 the domestic transport sector has had the highest emissions.

Figure 6: Territorial UK greenhouse gas emissions by NC sector, 1990-2022 ($MtCO_2e$)



Source: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables
Note: LULUCF is land use, land use change and forestry.

Domestic transport

The domestic transport sector consists of emissions from road vehicles, domestic aviation and shipping (including military), fishing vessels, and railways. It does not include emissions from international aviation or shipping. It is estimated to have been responsible for around 28% of greenhouse gas emissions in the UK in 2022, almost entirely through carbon dioxide emissions. The main source of emissions from this sector is the use of petrol and diesel in road vehicles.

In 2020 transport was significantly impacted by COVID-19, as people were instructed to stay at home as much as possible. COVID-19 restrictions were eased in 2021 and the last restrictions removed in 2022, resulting in consecutive years of increasing greenhouse gas emissions from domestic transport to 113.2 $MtCO_2e$ in 2022, a 2% rise from 2021 and 12% higher than in 2020, although this was still 10% lower than in 2019, the last full year before the pandemic. For most of the period since 1990 domestic transport was the second most emitting sector; however, reductions over time in what was the largest sector (electricity supply) mean that since 2014 domestic transport has been the sector with the highest emissions and remains so in 2022, despite the lower level of emissions in the last three years.

Before 2020 there had been relatively little overall change in the level of greenhouse gas emissions from domestic transport over the previous three decades, with emissions only 3% lower in 2019 than they were in 1990. Between 1990 and 2007 (when emissions peaked) there was a general increasing trend, with some fluctuations year to year. After this peak, emissions declined most years apart from a period of increase between 2013 and 2017. The impact of

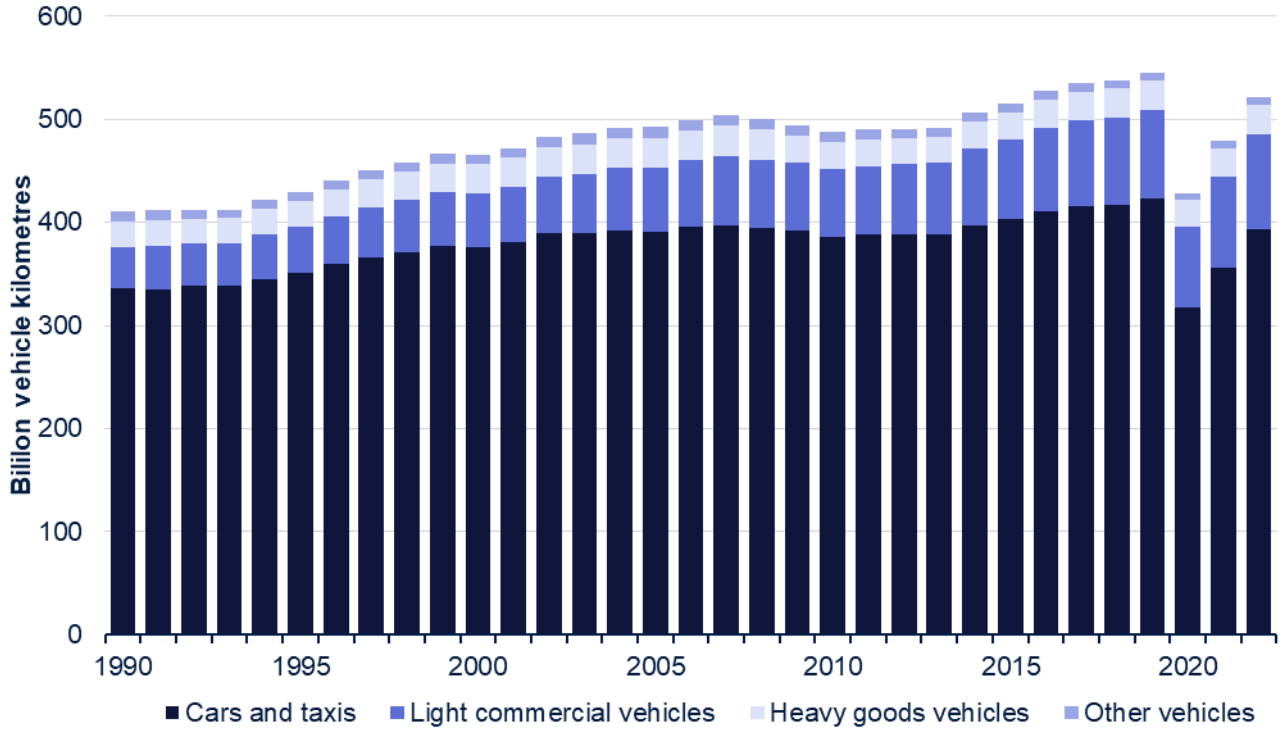
the COVID-19 pandemic means emissions are estimated to have been around 12% lower in 2022 than in 1990.

Road vehicles are the most significant source of emissions in this sector, in particular passenger cars; and the changes which have been seen over the period were heavily influenced by this category. Figure 7 shows how the volume of traffic on the roads has changed over time in Great Britain, which reflects the trend seen for the UK as a whole. Motor vehicle traffic volumes have generally increased throughout this period, other than a fall seen between 2007 and 2010 following the recession and a large 21% fall in 2020 as a result of the COVID-19 pandemic, since when motor vehicle traffic has largely recovered but was still 4% lower in 2022 than in 2019.

With lower petrol consumption outweighing an increase in diesel consumption[20] and improvements in fuel efficiency of both petrol and diesel cars, the volume of emissions from passenger cars has generally decreased since the mid-2000s. Although (pre-pandemic) this was partially offset by an increase in emissions from light commercial vehicles. Emissions of carbon dioxide are closely related to the amount of fuel used, whilst nitrous oxide and methane emissions are influenced more by the vehicle type and age.

Civil aviation emissions fell by more than half in 2020 compared to 2019, the largest proportional fall of any mode of transport, and in 2022 were still 20% lower than in 2019. Emissions from waterborne transport were 11% lower in 2022 than in 2019, having remained at a similar level to where they fell to in 2020, and emissions from railways were 19% lower than in 2019, having seen a partial recovery in 2021 from their 2020 level but a small fall in 2022.

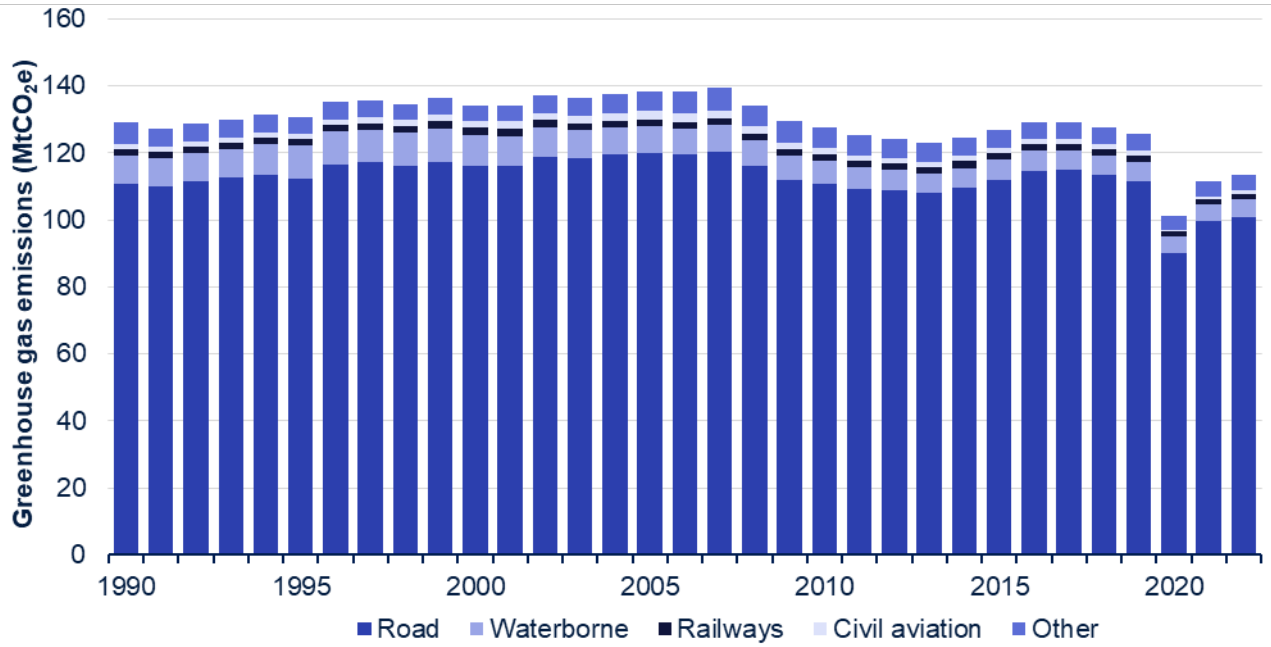
Figure 7: Motor vehicle traffic, Great Britain 1990-2022 (Billion vehicle kilometres)



Source: Transport Statistics Great Britain, Roads and traffic (TSGB07), Table TSGB0702 (TRA0201) Road traffic by vehicle type in Great Britain, annual from 1949: https://www.gov.uk/government/statistical-data-sets/tsgb07

[20] Transport Statistics Great Britain, Energy and environment (TSGB03), Table TSGB0301 (ENV0101) Petroleum consumption by transport mode and fuel type: United Kingdom from 2000: https://www.gov.uk/government/statistical-data-sets/tsgb03

Figure 8: Greenhouse gas emissions from domestic transport, UK 1990-2022 ($MtCO_2e$)



Source: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables

Electricity supply

The electricity supply sector consists of emissions from the combustion of fuels in electricity generation from power stations. It is estimated to have been responsible for 14% of UK greenhouse gas emissions in 2022, with carbon dioxide accounting for almost all emissions for this sector.

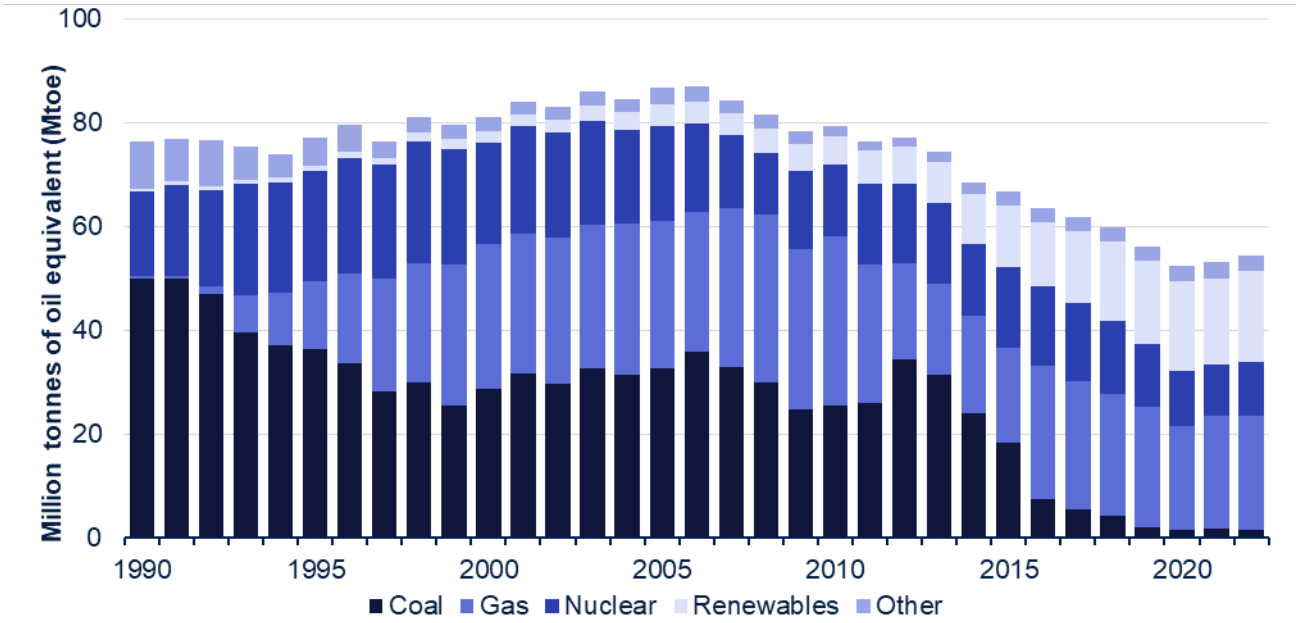
There was a 1% increase in emissions from the electricity supply sector between 2021 and 2022, although this was still 5% lower than in 2019. In 2020 and 2021 there was lower demand for electricity as a result of the COVID-19 pandemic and the increase in 2022 was driven by an increase in demand for electricity as COVID-19 restrictions were eased.

Between 1990 and 2022 emissions have reduced by 73%. This decrease has resulted mainly from changes in the mix of fuels being used for electricity generation, including the growth of renewables; together with greater efficiency resulting from improvements in technology. The electricity supply sector historically had the largest emissions of the sectors presented in these statistics. However, these reductions mean that since 2014 this has no longer been the case and there are now several sectors with higher emissions (the largest being transport).

Since 1990 there has been a decline in the use of coal at power stations and an increase in the use of gas, which has a lower carbon content so results in fewer emissions. Coal use in generation reduced by 97% between 1990 and 2022, and now makes up only 3% of the fuel used for UK electricity generation compared to 65% in 1990[21]. Electricity supplied was 4% higher in 2022 than in 1990, having grown to a peak in 2005 and decreased since then[22]. In 2022 the use of gas for electricity generation increased 1% from 2021 and the use of renewables and nuclear both by 5%, whereas coal saw a 16% decrease.

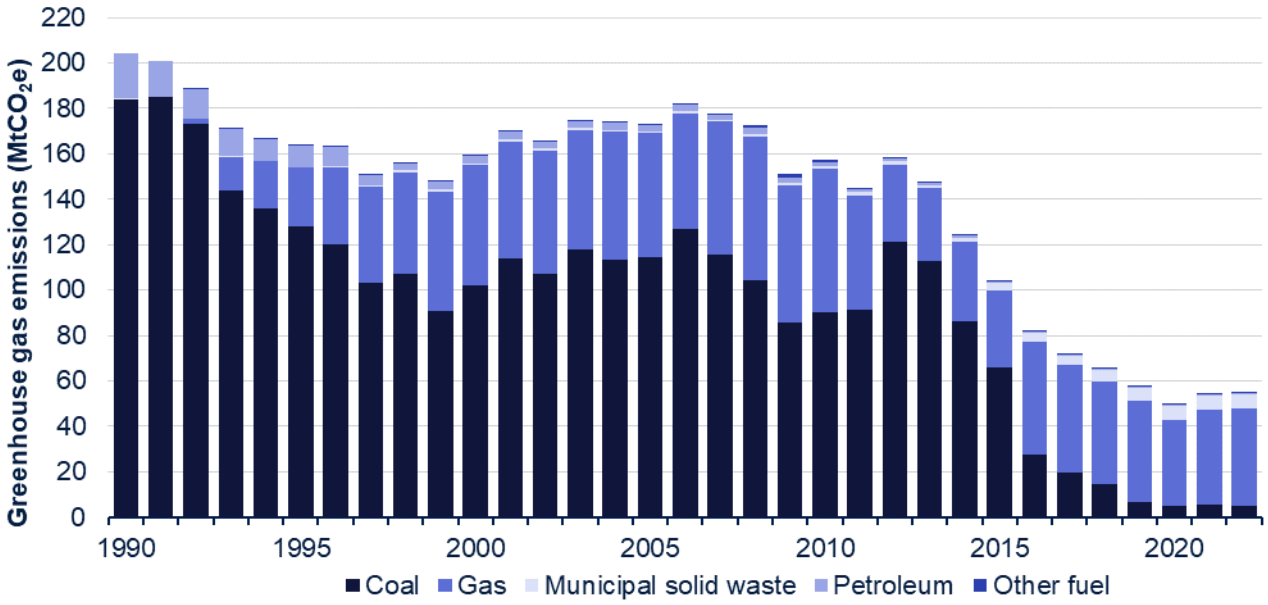
[21] Digest of United Kingdom Energy Statistics, Table 5.1.1 Fuel input for electricity generation, 1970 to 2022
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904820/DUKES_5.1.1.xls
[22] Digest of United Kingdom Energy Statistics, Table 5.1.3 Electricity generated and supplied, 1970 to 2022
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904822/DUKES_5.1.3.xls

Figure 9: Fuel used for UK electricity generation, UK 1990-2022 (Million tonnes of oil equivalent (Mtoe))



Source: Digest of United Kingdom Energy Statistics, Table 5.1.1 Fuel input for electricity generation, 1970 to 2022
https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes

Figure 10: Greenhouse gas emissions from electricity supply, 1990-2022 ($MtCO_2e$)



Source: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables
Note: Figures 9 and 10 show different fuel groupings as not all fuels produce direct emissions, e.g. nuclear and most renewables. The use of municipal solid waste is included in the renewables category in figure 9 and the use of petroleum in the 'other' category.

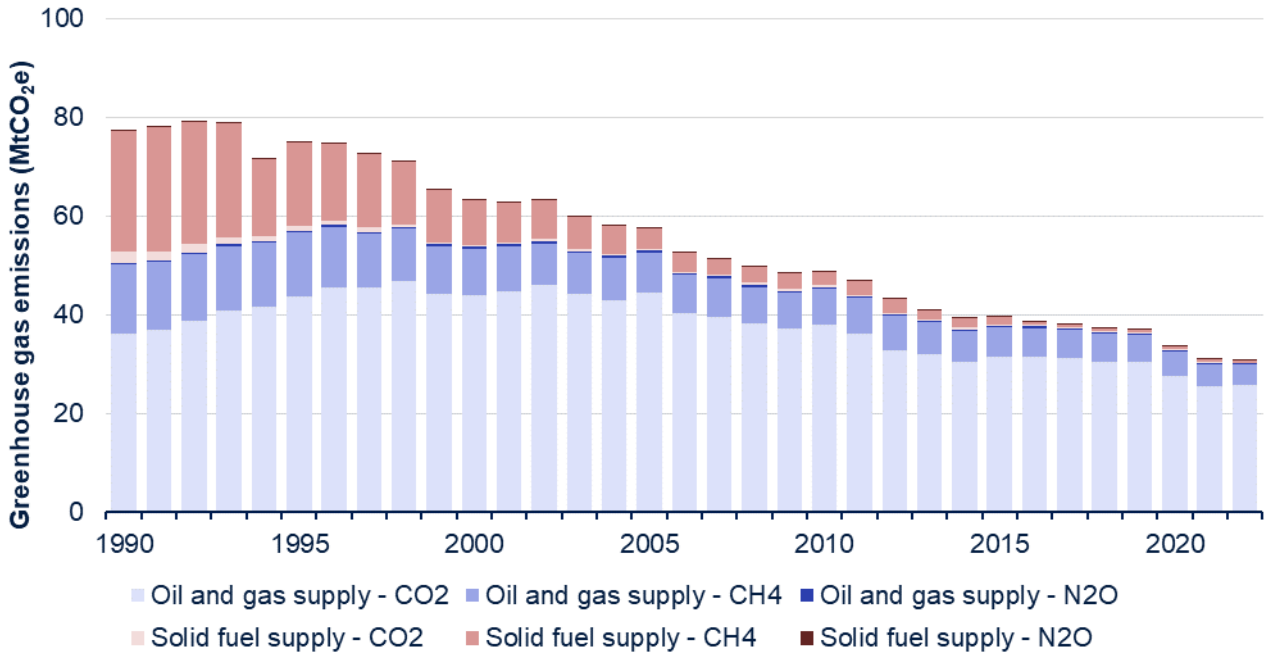
Fuel supply

The fuel supply sector consists of emissions that arise during the production and supply of fuels, for example from the combustion of fuels in oil refineries and at oil and gas platforms, the flaring and venting of gas from oil and gas facilities, leakages from the gas network and methane emissions from coal mining. It accounted for 8% of greenhouse gas emissions in the UK in 2022, 98% of which were from oil and gas supply.

Fuel supply emissions fell by 1% between 2021 and 2022, largely due to reductions in emissions from oil platforms and from flaring at upstream oil facilities, and despite a rise in emissions from oil refineries. Since 1990 fuel supply emissions have fallen by 60%.

The main factor in the long-term decline in emissions in the fuel supply sector has been related to coal mining. The production of deep-mined coal in particular has declined steadily over the period, with the last three large deep mines all closing in 2015. Emissions from coal mining and handling have fallen from 26.5 $MtCO_2e$ in 1990 to only 0.6 $MtCO_2e$ in 2022. Oil and gas supply emissions rose to a peak in 1996 at 58.2 $MtCO_2e$, since when they have fallen by 48%.

Figure 11: Greenhouse gas emissions from fuel supply, UK 1990-2022 ($MtCO_2e$)



Source: Tables 1.3-1.5, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables

Buildings and product uses

The buildings and product uses sector consists primarily of emissions from fuel combustion in buildings, largely from the use of natural gas and other fuels for heating and cooking, as well as emissions that directly arise from the use of products such as refrigeration & air conditioning, garden machinery, anaesthetics, metered dose inhalers and aerosols. In 2022 it is estimated to have been responsible for 20% of greenhouse gas emissions in the UK. Of these emissions, 67% were from fuel combustion in residential buildings, 15% in commercial buildings, 10% in public sector buildings and 7% were other buildings and product use emissions.

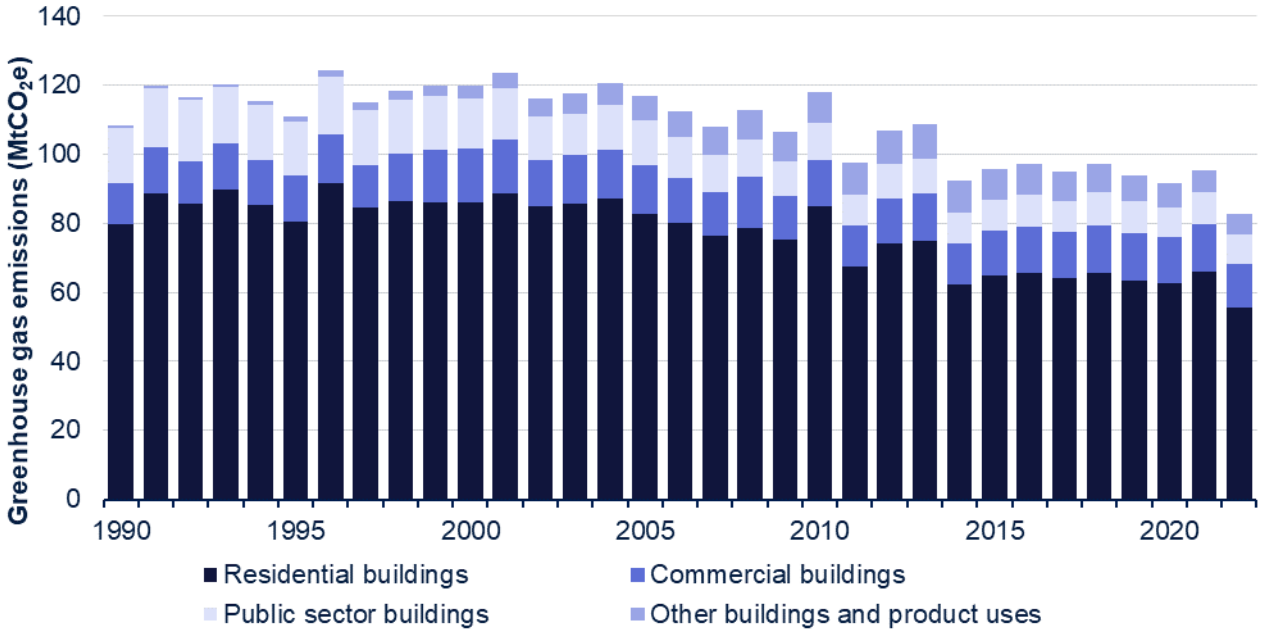
It should be noted that since these figures are estimates of emissions by source, emissions related to electricity use in buildings – including electricity use for heating – are attributed to power stations and are therefore included in the electricity supply sector rather than the buildings and product uses sector.

There was a 13% decrease in emissions in this sector between 2021 and 2022. The warmer temperatures in 2022 are likely to be one of the main factors, resulting in less energy being used to heat buildings, and it may have also been affected by higher energy prices, particularly towards the end of the year. The average temperature across the year was 0.8 degrees

Celsius warmer in 2022 than in 2021[23]. Emissions from this sector are particularly influenced by external temperatures, with colder temperatures driving higher emissions due to increased use of heating. Between 1990 and 2022 there has been considerable variation in emissions from year to year as a result. Further information on the impact of external temperatures on emissions can be found later in this statistical release.

Since the emissions largely relate to fuel combustion, carbon dioxide is the most prominent gas in the buildings and product uses sector, accounting for 92% of emissions in 2022. Fluorinated gases (F gases) made up 6% of emissions. Emissions from F gases increased significantly in the 1990s and 2000s, mainly due to an increase in emissions from refrigeration & air-conditioning as HFCs replaced ozone depleting substances which were previously used as refrigerants. This increasing trend has reversed in recent years following the introduction of the HFC phase down as part of the EU's 2014 F-Gas Regulation, and F gas emissions in this sector have fallen by 44% since their peak in 2012.

Figure 12: Greenhouse gas emissions from the buildings and product uses sector, UK 1990-2022 ($MtCO_2e$)



Source: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables

Emissions from residential buildings fell by 16% between 2021 and 2022. Changes in emissions from residential buildings from year to year are heavily influenced by external temperatures but there has been a reduction in the long term, and they were 30% lower in 2022 than they were in 1990. This is despite the UK population rising over this period[24] and a rise in the number of households in the UK[25]. This fall is partly related to a large fall in use of coal and other solid fuels for heating homes, which have a higher carbon content than the other fuels commonly used.

Between 1990 and 2022 there has been a general downward trend in greenhouse gas emissions from public sector buildings such as schools, hospitals and offices, which have

[23] Energy Trends: Weather Table ET 7.1 Average temperatures, heating degree days and deviations from the long-term mean https://www.gov.uk/government/statistics/energy-trends-section-7-weather
[24] Office for National Statistics: Population estimates time series dataset https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatestimeseriesdataset
[25] Office for National Statistics: Families and households dataset https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/datasets/familiesandhouseholdsfamiliesandhouseholds

fallen by 47% over this period. Emissions from commercial buildings on the other hand have remained at a similar level and were 6% higher in 2022 than in 1990. But in both cases there has been a change in the fuel mix, with less use of coal and oil, and more use of natural gas. Both public sector and commercial buildings saw a 9% fall in greenhouse gas emissions between 2021 and 2022.

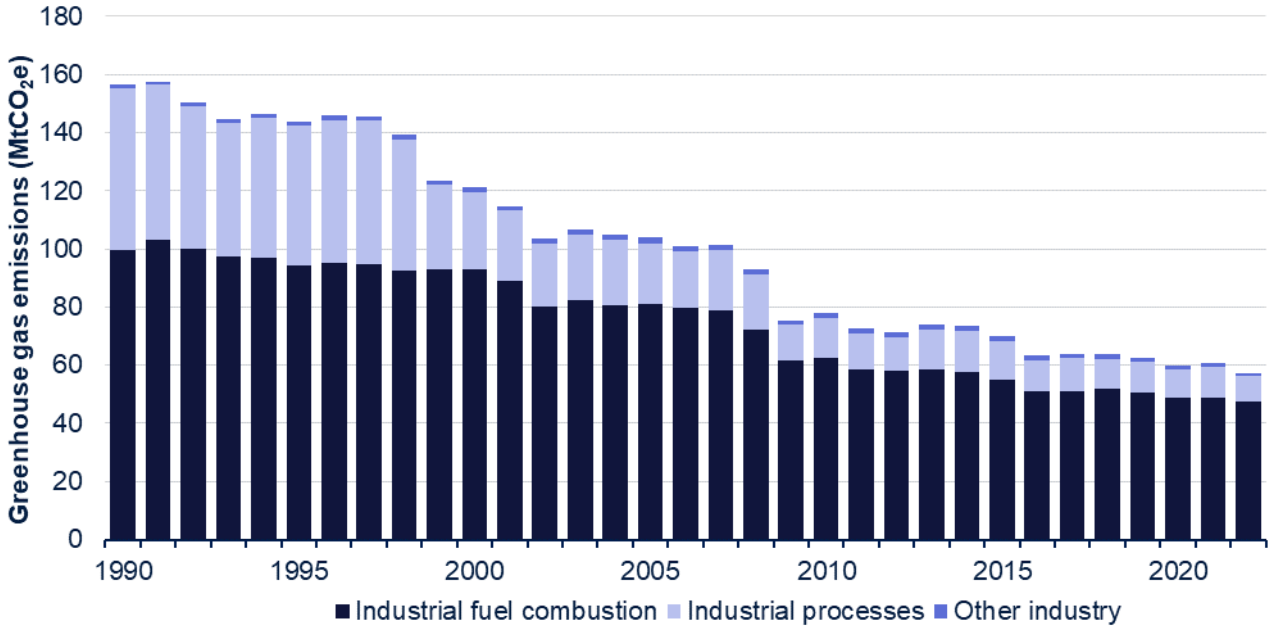
Industry

The industry sector includes emissions from fuel combustion at industrial sites and in industrial machinery, emissions resulting from industrial processes and emissions of fluorinated gases from industrial uses such as in refrigeration systems. Between 2021 and 2022 there was a 5% decrease in greenhouse gas emissions from industry, largely because of a reduction in emissions from industrial combustion and from iron and steel production. The industry sector is estimated to have been responsible for 14% of greenhouse gas emissions in the UK in 2022, with carbon dioxide being the most prominent gas.

In 2022, greenhouse gas emissions from industry were 63% lower than in 1990. Between 1990 and 2022 there was a large reduction in emissions from industrial processes of 84%. There was also a 53% decrease in emissions from industrial fuel combustion over this period, most of which came between 2001 and 2009, with a significant drop in 2009 likely driven by economic factors. There has been a gradual decline in emissions from industry in more recent years.

The fall in industrial process emissions over time was most notably due to a large reduction in nitrous oxide emissions from adipic acid production and HFC emissions from halocarbon production between 1998 and 1999 following the fitting of abatement equipment at production facilities. In 2022, the largest source of industrial process emissions was cement production, with other processes such as sinter, lime, iron and steel, and ammonia production also contributing significantly.

Figure 13: Greenhouse gas emissions from industry by subsector, UK 1990-2022 ($MtCO_2e$)



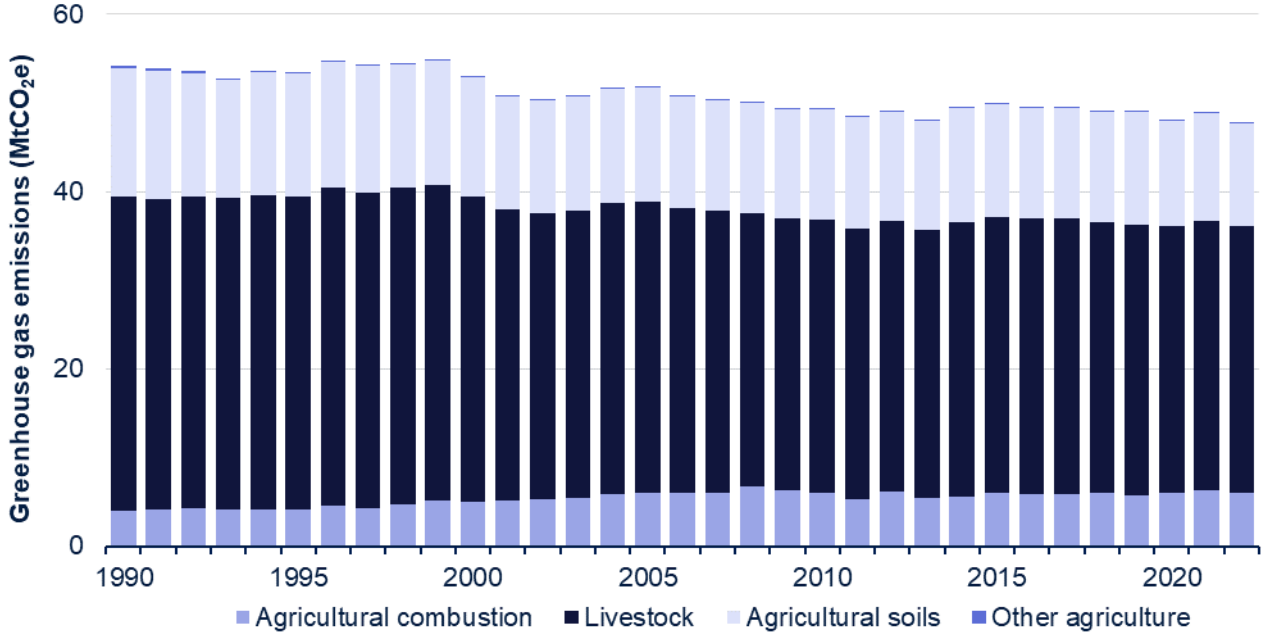
Source: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables

Agriculture

The agriculture sector consists of emissions from livestock, agricultural soils, stationary combustion sources and off-road machinery. It is estimated to have been responsible for 12% of greenhouse gas emissions in the UK in 2022. Emissions of methane (58%) and nitrous oxide (26%) dominate this sector. The most significant sources are emissions of methane due to enteric fermentation (digestion processes) from livestock, particularly cattle; and nitrous oxide emissions related to the use of fertilisers on agricultural soils.

Between 2021 and 2022 there was a 2% fall in emissions from the agriculture sector, largely due to a reduction in fertiliser use and a decrease in emissions from agricultural machinery. Between 1990 and 2022, greenhouse gas emissions from agriculture decreased by around 12%. Most of this fall happened during the 2000s, since when emissions have remained at a similar level. The reduction in emissions was driven by a fall in animal numbers over the period, together with a decrease in synthetic fertiliser use.

Figure 14: Greenhouse gas emissions from agriculture by subsector, UK 1990-2022 ($MtCO_2e$)



Source: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables

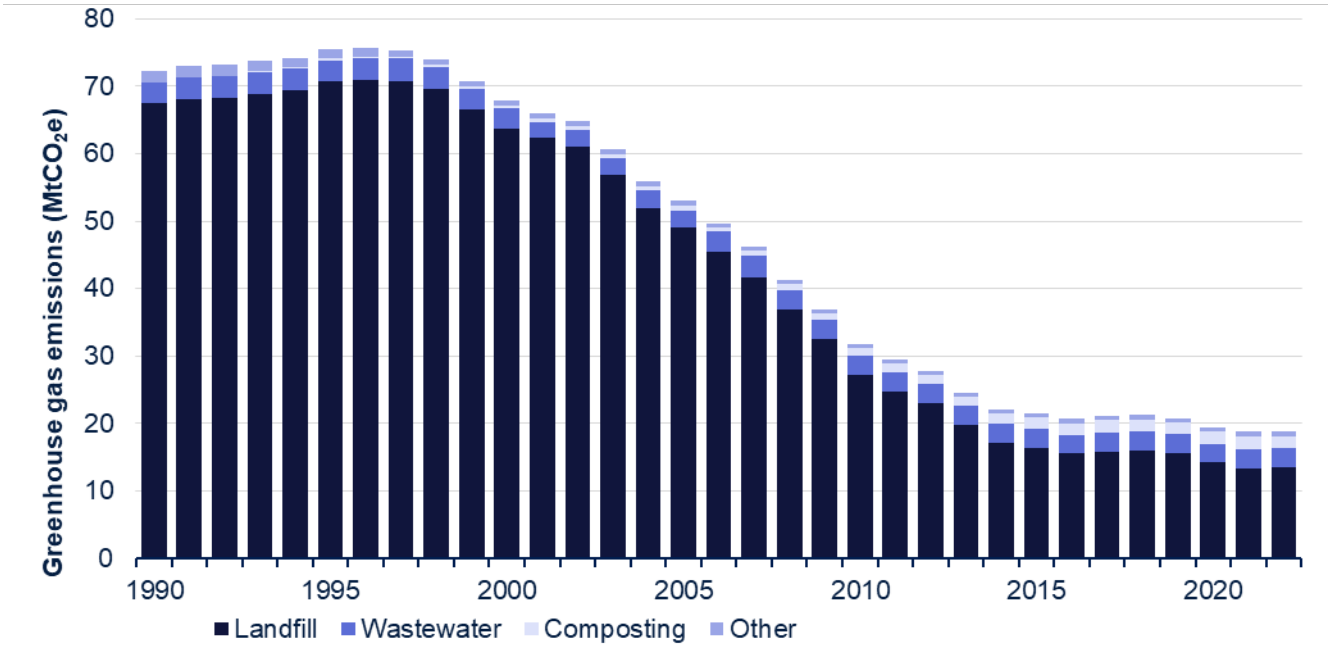
Waste

The waste sector consists of emissions from the treatment and disposal of solid and liquid waste, including from waste disposed of to landfill sites, composting, waste incineration (except when energy is recovered), and the treatment of wastewater. It is estimated to have been responsible for around 5% of greenhouse gas emissions in the UK in 2022, with methane being by far the most prominent gas (accounting for 90% of emissions). Most of these emissions are from landfill sites.

Emissions in the waste sector remained at around the same level in 2022 as they were in 2021. Between 1990 and 2022, greenhouse gas emissions from the waste sector decreased by 74%. This was due to a combination of factors, including improvements in the standards of

landfilling, changes to the types of waste going to landfill (such as reducing the amount of biodegradable waste), and an increase in the amount of landfill gas being used for energy.

Figure 15: Greenhouse gas emissions from waste, UK 1990-2022 ($MtCO_2e$)



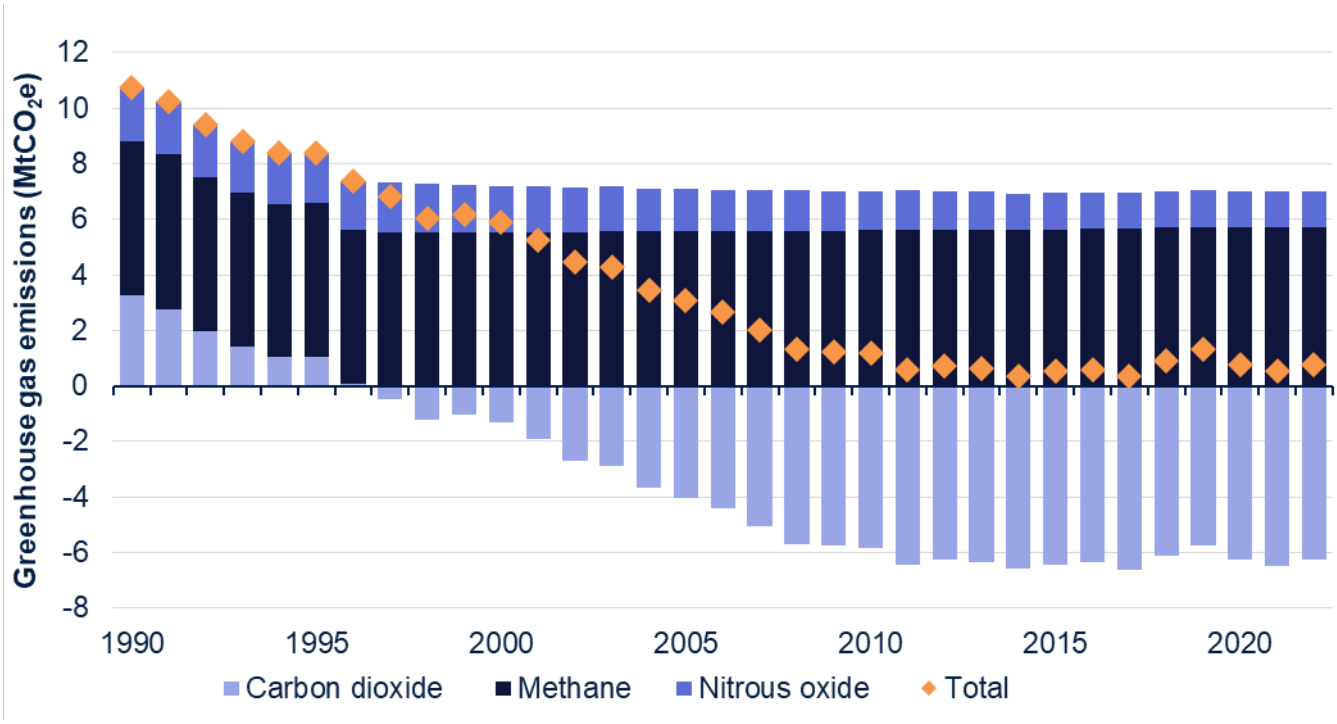
Source: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables

Land use, land use change and forestry (LULUCF)

The LULUCF sector consists of emissions and removals from forests, cropland, grassland, peatland, and settlements. This sector includes emission removals, although we estimate the sector as a whole to be a net source of greenhouse gas emissions in each year from the start of the data series in 1990. In general, peatland is the largest source of greenhouse gas emissions, while forestry is the dominant sink. Grassland mineral soils changes are estimated to be an emissions sink throughout the data series, while cropland mineral soils changes and settlements are estimated to have been net sources of emissions.

The LULUCF sector is estimated to have had net emissions of 0.8 $MtCO_2e$ in 2022. This is a slight increase from 0.5 $MtCO_2e$ in 2021 but down from a total of 10.7 $MtCO_2e$ in 1990. The largest factor in this long-term fall has been a reduction in emissions from peatlands associated with ongoing management practices such as re-wetting. There has also been a reduction in net emissions from settlements and cropland mineral soils changes, and an increase in the net sink from grassland mineral soils changes and forestry.

Figure 16: Greenhouse gas emissions from the LULUCF sector, UK 1990-2022 ($MtCO_2e$)



Source: Tables 1.2 to 1.6, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables

International comparison

UK territorial greenhouse gas emissions account for around 1% of the global total, based on a range of estimates produced by the UN, the International Energy Agency, and the World Resources Institute amongst others. Under the United Nations Framework Convention on Climate Change (UNFCCC), the UK and a number of other countries (known as the Annex I Parties to the Convention[26]) report their territorial emissions each year to the UNFCCC, while other countries report theirs every few years. This allows for comparisons to be made between different countries' emission estimates following consistent approaches in line with the guidance set out by the Intergovernmental Panel on Climate Change (IPCC)[27].

Figure 17 shows the most recent territorial greenhouse gas emissions estimates for the UK and other members of the G20. This year's comparison now includes the African Union following its admission into the G20 as a permanent member in 2023. Emissions estimates are derived from individual countries' reports submitted to the UNFCCC, apart from for the African Union for which there is limited data coverage within the UNFCCC reports for several of its members. Instead, an aggregate total for the African Union has been compiled using World Resources Institute emissions estimates[28]. Figure 18 shows this in terms of annual emissions per person in the population. To be consistent with other countries the UK emissions shown are the 2021 estimates submitted to the UNFCCC last year, so do not include the revisions to the estimates shown elsewhere in this publication. The members of the G20 account for around 85% of world GDP and about two thirds of the world's population[29].

The year the data relates to for each country is shown in the charts, for Annex I countries this is 2021. As these are territorial emissions, they only include emissions within a country's borders, so do not reflect any emissions resulting from the production of goods imported into a country or any international travel by its residents. The estimates shown include emissions and removals from the LULUCF sector. The coronavirus (COVID-19) pandemic and the resulting worldwide restrictions have had different impacts on different countries since 2020. In general, 2021 greenhouse gas emissions estimates are still lower than pre-pandemic levels in 2019, although less so compared to 2020 as many restrictions were eased throughout the year.

Countries' emissions tend to reflect their size, with the highest emissions coming from the countries with the largest populations and land areas. China is the country with the highest greenhouse gas emissions, of around 11,200 $MtCO_2e$ in 2014 (the latest year of data available), followed by the United States, which had emissions of around 5,600 $MtCO_2e$ in 2021. The African Union had emissions of around 4,400 $MtCO_2e$ in 2020, whilst the European Union (EU 27) had emissions in 2021 of 3,200 $MtCO_2e$.

When adjusted for population, Saudi Arabia has the highest emissions of G20 countries with 21 tonnes of CO_2e per person in 2016, while Australia, Canada, and the United States also each had emissions of over 15 tCO_2e per person in their latest available data. India has the lowest emissions per person in the G20, at around 2 tCO_2e per person in its latest data from 2016, followed by the African Union with emissions per person at around 3 tCO_2e in 2020. The UK had emissions of around 6 tCO_2e per person in 2021. Higher emission rates can be

[26] Annex I Parties' submissions in 2023 showing greenhouse gas emissions in 2021 are available here: https://unfccc.int/ghg-inventories-annex-i-parties/2023
[27] 2006 IPCC Guidelines for National Greenhouse Gas Inventories: https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html
[28] A description of the methodology used by Climate Watch and a comparison with the UNFCCC data are available here: https://www.climatewatchdata.org/about/faq/ghg
[29] https://www.g20.org/en/about-the-g20

associated with several factors, such as significant heavy industry, a large manufacturing sector, or the use of more carbon intensive fuels such as coal for electricity generation.

Figure 17: Most recent annual territorial greenhouse gas emissions: G20 countries ($MtCO_2e$)

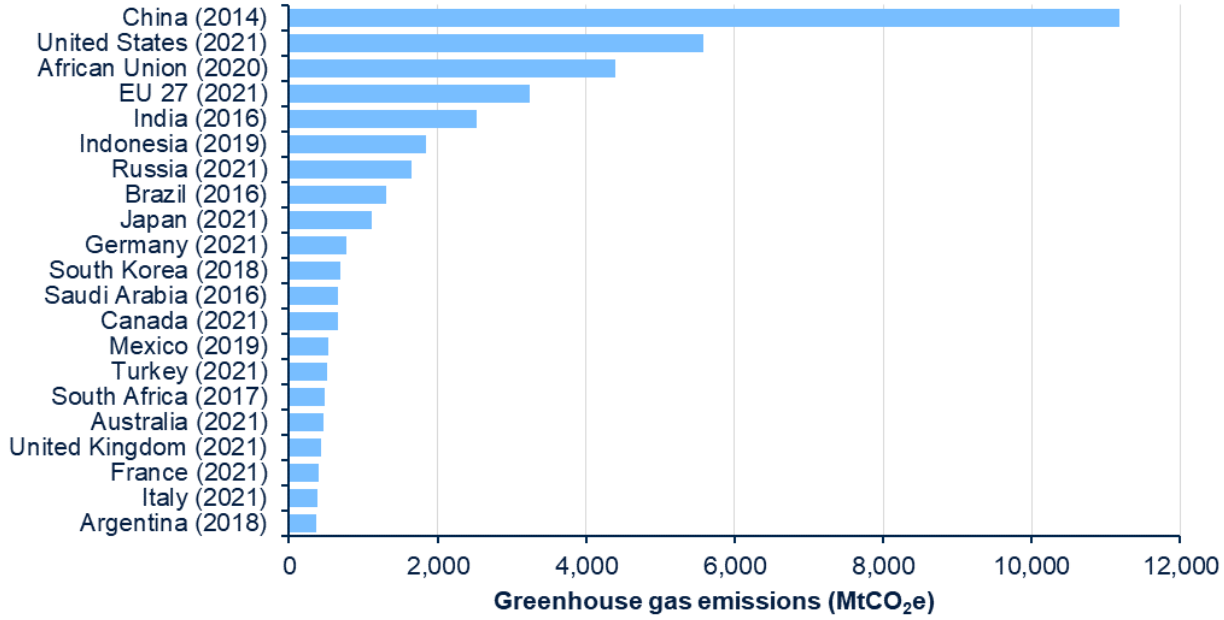
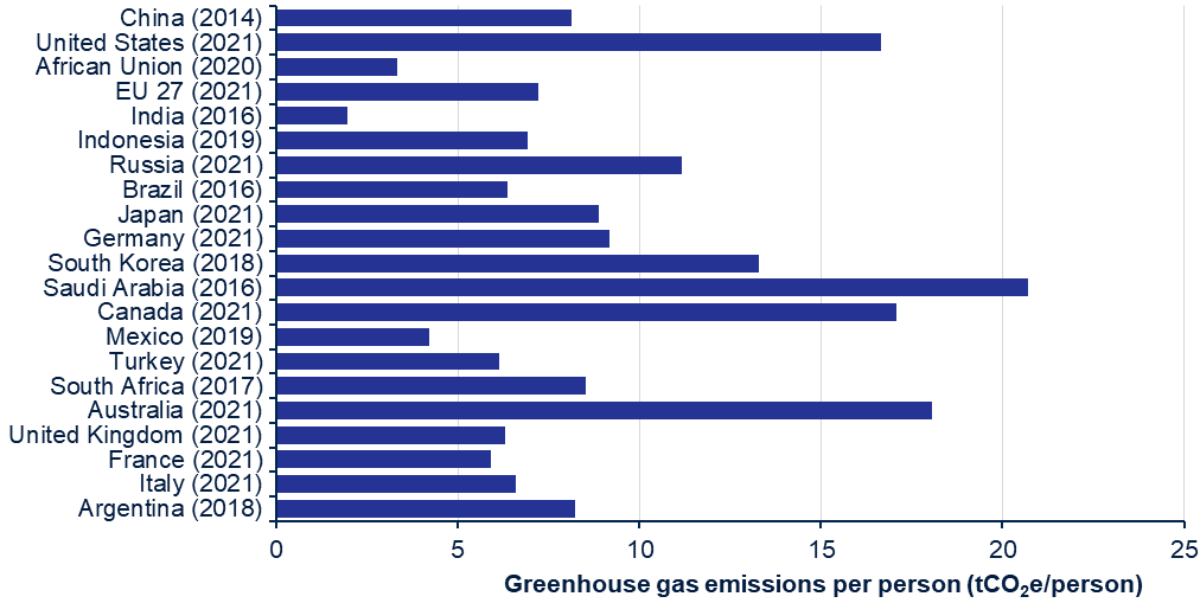


Figure 18: Annual territorial greenhouse gas emissions per person: G20 countries (tCO_2e per person)



Sources: Countries' submissions to the UNFCCC
Climate Watch Global Historical Emissions for the African Union

Notes:

1. The year the data relates to for each country is shown next to their name in the charts.
2. All emissions totals include emissions and removals from the LULUCF sector.
3. The UK figures include Crown Dependencies and certain Overseas Territories in line with its international reporting requirements, although they only make up around 1% of the UK emissions total.
4. The UK figures are from the 2021 emissions estimates submitted to the UNFCCC in 2023 so do not incorporate the data updates and methodology changes made to the 2021 estimates in this publication.
5. The EU total includes France, Germany, and Italy despite them also being shown separately.
6. In its last submission, Saudi Arabia reported its emissions for each gas separately in absolute terms. These figures have been converted to CO_2e using the same Global Warming Potentials as used for the UK figure to produce a combined total for this comparison.

International aviation and shipping

In the data tables accompanying this publication, table 5.1 shows greenhouse gas emissions arising from use of fuels from UK international aviation and shipping bunkers since 1990.

Emissions from international aviation and shipping can be estimated from refuelling from bunkers[30] at UK airports and ports, whether by UK or non-UK operators. Under the reporting guidelines agreed by the UNFCCC, these emissions are not included in the UK's emissions total that is submitted to the UNFCCC but are reported as 'memo' items in national greenhouse gas inventories. However, it is important to note that whether emissions from refuelling at UK-based international aviation and shipping can be used as an accurate estimate of UK international aviation and shipping emissions will depend on what assumptions are being made about how to allocate international aviation and shipping emissions to different countries.

In line with international reporting requirements, the UK's 2030 emissions reduction target under the Paris Agreement (known as the UK's Nationally Determined Contribution) does not include emissions from international aviation and shipping. Instead, Parties to the UNFCCC are required to act to limit or reduce emissions from international services working through the International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO), the international organisations responsible for formulating policies and setting targets for reducing emissions from international aviation and shipping respectively[31,32].

However, in 2021 the UK government set the Sixth Carbon Budget (covering 2033-37) to include the UK's share of international aviation and shipping emissions, as recommended by the Climate Change Committee. This is the first time emissions from international aviation and shipping will be included in the UK's domestic carbon budget targets.

In 2022, emissions from international aviation fuel use from UK bunkers were estimated to be 28.5 $MtCO_2e$. This was around double the 2021 emissions, when it was 14.0 $MtCO_2e$, but still 22.5% lower than in 2019, when it was 36.7 $MtCO_2e$. As a result of COVID-19 pandemic restrictions, 2020 and 2021 saw international aviation emissions fall to their lowest annual figures since these estimates began. Following these easing, 2022 saw an increase in air traffic towards pre-pandemic levels. In 2022, the number of international flights landing or taking off from UK airports was more than double the number in 2021 but remained 21.9% lower than in 2019[33]. Between 1990 and 2006, emissions more than doubled from 15.5 $MtCO_2e$ to 35.6 $MtCO_2e$. After 2006, emissions dipped slightly, then increased again above the 2006 peak between 2017 and 2019, before the fall in 2020.

High altitude aviation has a greater greenhouse effect due to the formation of persistent condensation trails (contrails) over and above that of carbon dioxide emissions from fuel alone, but this is not reflected in these estimates.

Emissions from UK international shipping bunkers were estimated to be 6.3 $MtCO_2e$ in 2022, an increase of 1.3% from the 2021 level, but still 14.2% below the 2019 figure. Although not as

[30] A large container or compartment that stores fuel for ships or aircraft.
[31] More information on ICAO strategies for reducing international aviation emissions: https://www.icao.int/environmental-protection/Pages/default.aspx
[32] More information on IMO strategies for reducing international shipping emissions: https://www.imo.org/en/OurWork/Environment/Pages/2023-IMO-Strategy-on-Reduction-of-GHG-Emissions-from-Ships.aspx
[33] AVI0102: Air traffic by type of service, operator and airport https://www.gov.uk/government/statistical-data-sets/aviation-statistics-data-tables-avi

pronounced a drop as aviation, these emissions remain at lower levels following the fall in shipping traffic that occurred following the start of the COVID-19 pandemic. Since 1990, emissions from UK shipping bunkers have fluctuated, as can be seen in the chart below, but in recent years before the reduction in 2020 had been at around the same level that they were in 1990.

Figure 19: Greenhouse gas emissions from UK-based international aviation and shipping bunkers, 1990-2022 ($MtCO_2e$)

Source: Table 5.1, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables

Revisions from provisional estimates of greenhouse gas emissions

Provisional estimates of 2022 UK greenhouse gas and carbon dioxide emissions were published in March 2023, based on early estimates of energy consumption for the year. Differences between the provisional and final estimates arise primarily due to revisions to other statistics on which these estimates were based, use of actual data to estimate non-CO_2 emissions which are only estimated in a simplistic way in the provisional estimates, and methodological changes to the way emissions are calculated.

Typically, the provisional estimates provide a better indication of emissions trends than of absolute emissions, as they do not take account of any methodological improvements that may be made to the way emissions are calculated and which can lead to revisions to the whole emissions time series from 1990 onwards. More information on revisions to the time series can be found in the next section.

It was provisionally estimated that total greenhouse gas emissions in 2022 for the UK would be 417.1 $MtCO_2e$, representing a 2.2% decrease on 2021 emissions. The final estimates show that 2022 emissions were 406.2 $MtCO_2e$, representing a 3.5% decrease on 2021 emissions. Therefore, the provisional greenhouse gas emissions estimates overestimated total greenhouse gas emissions in 2022 (by 2.7%) and underestimated the percentage decrease in emissions from 2021 to 2022 (by 1.3 percentage points). The difference in the total is largely explained by methodology changes made this year and revisions to the energy data used in producing the estimates.

The provisional estimates are focused on carbon dioxide emissions from the energy sector, and only provide a simplistic estimate of non-CO_2 gases which assumed that the 2022 emissions for non-CO_2 gases changed from the 2021 total in line with the percentage difference between the estimates for 2021 and 2022 of total non-CO_2 emissions in the 2019 Energy and Emissions Projections[34] published by DESNZ. Focusing on carbon dioxide emissions, it was provisionally estimated that net UK carbon dioxide emissions in 2022 were 331.5 million tonnes. The final 2022 figure of 324.2 million tonnes indicates that the provisional estimate overestimated CO_2 emissions by 2.3%. Again, this was largely due to methodology changes in the final estimates and revisions to the energy data used in producing the estimates.

The provisional estimate for emissions of non-CO_2 gases in 2022 was 85.6 $MtCO_2e$ and the final estimate is 82.0 $MtCO_2e$, so these emissions were overestimated by 4.4% in the provisional estimates.

[34] Energy and emissions projections: https://www.gov.uk/government/collections/energy-and-emissions-projections

Table 1: Comparison of 2022 provisional and final estimates

UK, 2021-2022 $MtCO_2e$

	2022 Provisional estimates	2022 Final estimates	Difference between final and provisional	Provisional 2021 to 2022 % change	Final 2021 to 2022 % change
Total CO_2	331.5	324.2	-7.3	-2.4%	-3.8%
Non-CO_2 gases	85.6	82.0	-3.6	-1.6%	-2.4%
All greenhouse gases	417.1	406.2	-10.9	-2.2%	-3.5%

Source: Table 1.1, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables
Table 1, Provisional UK greenhouse gas emissions national statistics 2022 Excel data tables

Revisions to the UK's Greenhouse Gas Inventory

In the data tables accompanying this publication, table 4.3 shows how our estimates of greenhouse gas emissions in the UK since 1990 have been revised from year to year.

The UK Greenhouse Gas Inventory (the time series of emissions from 1990 onwards which is the basis for these statistics), is reviewed every year internally and externally (including a review by the UNFCCC), and the whole historical data series is revised where necessary to incorporate methodological improvements, changes to international reporting guidelines or new data. This takes into account revisions to the datasets which have been used in its compilation, most notably the UK energy statistics published in the Digest of UK Energy Statistics (DUKES). The methodological changes to the UK Greenhouse Gas Inventory can also impact future emissions projections. Full details of the methods used to produce the latest greenhouse gas emissions estimates will be published in the UK's National Inventory Document (NID)[35].

These changes are applied back through the time series to 1990 to ensure that the trend in emissions from 1990 to the latest year is based on a consistent method. Therefore, it is not appropriate to compare the emissions time series from one year with that from another. However, the latest inventory represents a single consistent data series going back to 1990, and this therefore allows year-on-year comparisons to be made. Estimates of carbon dioxide emissions between 1970 and 1989 are also published in these statistics, but these no longer get updated each year and do not include estimates of some of the emission sources included in the data from 1990 onwards as earlier data are not available.

This section sets out the main methodology changes made this year and describes changes we have made to the sectors we group emissions into in the statistics.

[35] Under the Paris Agreement countries established an enhanced transparency framework. Starting from 2024, countries will now submit an annual NID instead of the previously required National Inventory Report (NIR). The latest NID covering 1990-2022 emissions will be submitted to the UNFCCC later in 2024. To enable the use of new reporting tools, the UNFCCC has moved its usual submission deadline of 15th April to 31st December for 2024. Previous UK NIRs can be found here: https://naei.beis.gov.uk/reports/reports?section_id=3

Replacement of NC sectors with TES sectors

Background

In previous iterations of the UK's official territorial emissions statistics, greenhouse gas emissions estimates were categorised into 'National Communication' (NC) sectors. However, feedback has shown that these NC sectors were misaligned with the needs of many users.

To ensure that UK territorial greenhouse gas emissions statistics best meet users' needs, the Department for Energy Security & Net Zero (DESNZ) has changed the way UK emissions sources are categorised, replacing the NC sectors with new 'Territorial Emissions Statistics' (TES) sectors.

User feedback and rationale for replacing the NC sectors

Alongside their role in meeting the UK's international reporting requirements, territorial emissions estimates have a variety of other uses. Central government departments, devolved administrations and local authorities use territorial greenhouse gas emissions estimates to develop policies to reduce emissions, set targets, and serve a variety of users including policymakers, academics, companies, and the public.

To ensure that UK territorial greenhouse gas emissions statistics best meet users' needs, DENSZ sought feedback from key stakeholders ahead of proposed adjustments to the sector categorisation of UK emissions sources[36]. Both internal stakeholder feedback and public feedback found that the NC sectors were not best suited for users; they misaligned with policy responsibilities and limited users' ability to identify key emissions sources such as heating buildings, producing energy from waste, non-road mobile machinery, and upstream oil and gas production. It was also found that the coverage of the NC sectors was sometimes misunderstood, in particular the 'business' sector given that many of the emissions in other sectors were the result of activities of businesses, while some sectors did not include certain emissions that some users would have expected them to, such as emissions from public transport not being included in the 'public' sector and emissions from industrial combustion not being in the 'industrial processes' sector.

In response to these limitations, internal and external users of these statistics have developed alternative sector categorisations. For instance, DESNZ and the Devolved Administrations (DAs) use separate sectors for decarbonisation strategies[37], whilst the Climate Change Committee (CCC) has developed its own sector categorisation for reporting advice to Parliament[38].

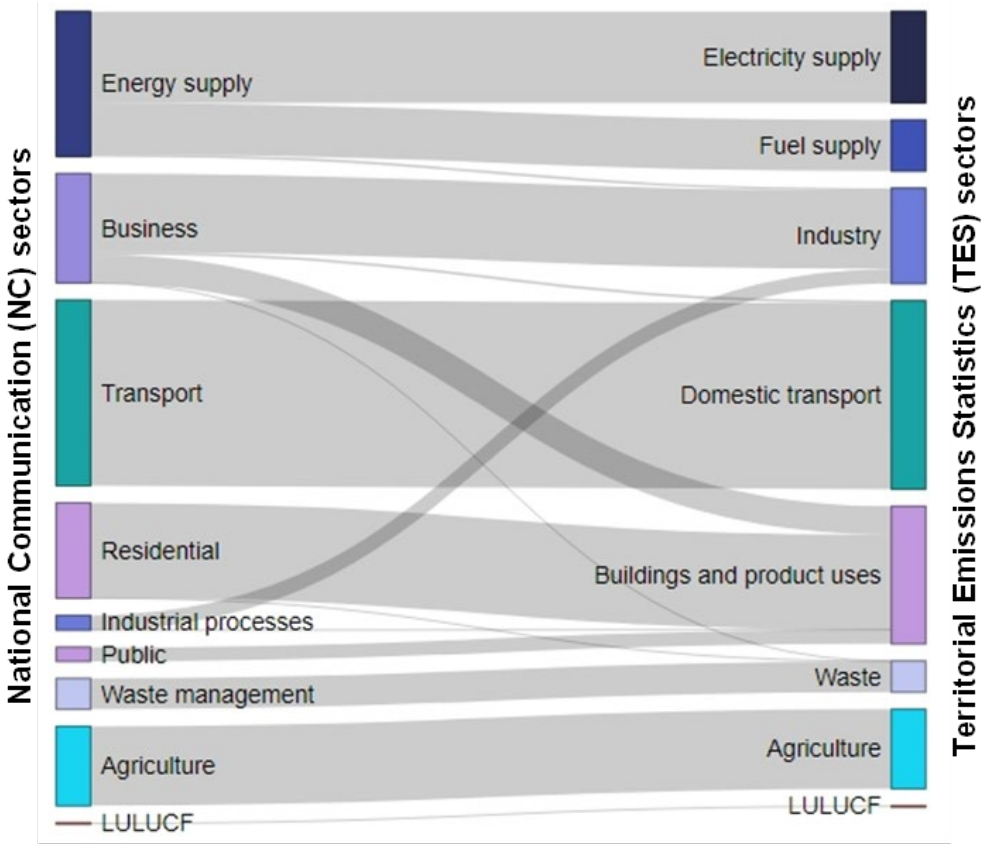
Building on this feedback, we have developed the TES sectors to make it easier for users to understand what the main emissions sources in the UK are and to be better aligned with policy responsibilities within government. We have also introduced subsectors to provide a slightly more detailed breakdown within every TES sector, as only some NC sectors had them before, and made some revisions to the categories presented in the statistics within each sector.

[36] National Communication sector replacement proposal: https://assets.publishing.service.gov.uk/media/63e145ac8fa8f50e805a3e52/national-communication-sector-replacement-proposal-user-feedback.pdf
[37] Net Zero Strategy: https://www.gov.uk/government/publications/net-zero-strategy
[38] 2023 Progress Report to Parliament: https://www.theccc.org.uk/publication/2023-progress-report-to-parliament/

Changes to the sector categorisation of UK emissions sources

Figure 20 illustrates the scale of emissions being reallocated between the NC and TES sectors. Whilst there have been adjustments to the category names within the agriculture and LULUCF sectors, the overall emissions estimates for these sectors remains unchanged.

Figure 20: Greenhouse gas emissions by sector, UK 2022



Source: Table 1, Mapping table comparing the National Communication (NC) and Territorial Emissions Statistics (TES) sectors
2022 UK greenhouse gas emissions: final figures – dataset of emissions by source
Note: LULUCF is land use, land use change and forestry.

Table 2 provides a more detailed breakdown of how emissions sources from the NC sectors have been reallocated across the new TES sectors. Like the hierarchical NC sectors, the TES sectors provide a breakdown of emissions at three levels.

For complete information on how each emissions source in the UK 1990-2022 GHG Inventory maps between NC and TES sectors see the supplementary mapping document published alongside this publication. Table NC_1.2 in the data tables accompanying this publication also shows what the 1990-2022 UK greenhouse gas emissions estimates would have been using the NC sectors and categories.

Table 2: Comparison of National Communication and Territorial Emissions Statistics sectors

TES sector	Emissions sources in scope according to their NC sector allocation
Electricity Supply	**Energy Supply** – Includes emissions from power stations previously allocated to the *Energy Supply* sector.
Fuel Supply	**Energy Supply** – Includes emissions from fuel production and fuel supply activities such as mining, refining, manufacturing, and distributing fuels previously allocated to the *Energy Supply* sector.
Domestic Transport	**Transport** – Includes all emissions previously allocated to the *Transport* sector. **Business** – Includes F-gas emissions from mobile air conditioning and transport refrigeration previously categorised as part of the *Business* sector.
Buildings and Product Uses	**Business** – Includes emissions from combustion on commercial sites previously allocated to the *Business* sector. Also includes emissions from product uses in *Business* such as nitrous oxide (N_2O) use as an anaesthetic, or stationary refrigeration and air conditioning. **Public** – Includes all emissions previously allocated to the *Public* sector. **Residential** – Includes emissions from residential fuel combustion and product uses such as recreational N_2O use, aerosols, and metered dose inhalers previously allocated to the *Residential* sector. **Industrial Processes** – Includes emissions from the use of N_2O in industry previously allocated to the *Industrial Processes* sector.
Industry	**Business** – Most *Industry* sector emissions carry over from the *Business* sector. These comprise of emissions from manufacturing and construction, as well as industrial refrigeration and air conditioning. **Industrial Processes** – Most emissions previously categorised as part of the *Industrial processes* sector have been reallocated to the *Industry* sector. **Energy Supply** – Emissions from coke production previously categorised as part of the *Energy Supply* sector are now included in the *Industry* sector as energy from coke production is primarily used in the iron and steel industry.
Waste	**Waste Management** – Includes all emissions previously allocated to the *Waste Management* sector. **Business** – Includes emissions from accidental fires previously allocated to the *Business* sector. **Residential** – Includes emissions from household composting, small-scale waste burning, and accidental fires previously allocated to the *Residential* sector.
Agriculture	**Agriculture –** The coverage of the *Agriculture* sector is unchanged. However, there have been some changes to the categories within the *Agriculture* sector.
Land Use, Land Use Change and Forestry (LULUCF)	**Land Use, Land Use Change and Forestry (LULUCF)** – The coverage of the *LULUCF* sector is unchanged. However, there have been some substantial changes to the categories within the *LULUCF* sector to align better with land use policy. Key changes include the separation of forestry and peatlands related emissions into their own sub-sectors, as well as the creation of new categories within forestry and peatlands that better describe the emissions and removals.

Methodology and data revisions

Alongside the changes to the sectors used to categorise emissions estimates in our statistics publications, there have been other methodology and data revisions. Unlike the changes to sector categorisation that have no impact on overall UK emissions totals, these revisions can lead to revisions to the historical figures.

The most notable methodological change to the historical series since the 1990-2021 Greenhouse Gas Inventory was published are the changes to burning oil emissions estimates following the use of more detailed DUKES data. This additional detail has allowed for more appropriate sectoral allocation of burning oil emissions, leading to increased emissions estimates from burning oil in the buildings and product uses and agriculture sector and decreased emissions estimates in the industry sector for all years in the time series from 1998. Other key methodological changes include a more detailed breakdown of non-road mobile machinery (NRMM) emissions by machinery type allowing for allocation to more suitable sectors, as well as changes to the HFC Outlook model that have generally reduced F-gas emissions estimates across the domestic transport, buildings and product uses, and industry sectors. Revisions to road transport activity data has also led to changes to emissions sources estimates within the domestic transport sector across the time series. Details of the changes made to estimates of 1990 and 2021 emissions are given in Table 3. Revisions to other years of the time series are generally of a similar scale.

Table 3: Revisions in the 1990-2022 Greenhouse Gas Inventory, by sector

UK, 1990 and 2021 — $MtCO_2e$

	1990 emissions			2021 emissions		
	1990-2021 inventory	1990-2022 inventory	Change	1990-2021 inventory	1990-2022 inventory	Change
Electricity supply	204.0	204.0	0.0	54.2	54.6	0.3
Fuel supply	77.2	77.2	~0.0	31.1	31.0	-0.1
Domestic transport	128.6	129.3	0.7	112.0	111.4	-0.6
Buildings and product uses	108.5	108.4	-0.1	94.2	95.4	1.2
Industry	157.3	156.4	-0.9	67.1	60.5	-6.6
Agriculture	54.4	54.1	-0.3	47.9	48.8	0.9
Waste	72.3	72.3	~0.0	18.9	18.8	-0.1
LULUCF	11.1	10.7	-0.4	1.1	0.5	-0.6
Total	**813.4**	**812.4**	**-1.0**	**426.5**	**421.1**	**-5.5**

~0.0 indicates where a value is non-zero but is less than 0.05 $MtCO_2e$ in magnitude.

Sources: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2022 Data tables
Table 1, Mapping table comparing the National Communication (NC) and Territorial Emissions Statistics (TES) sectors
2021 UK greenhouse gas emissions: final figures – dataset of emissions by source

Non-domestic burning oil

The allocation of burning oil to end use sectors has been updated to be more closely aligned to DUKES allocations. In 2022, this has led to around 4 $MtCO_2e$ being reallocated from the industry sector to the buildings and product uses, and agriculture sectors. This only applies to post-1998; older data are based on paper copies of DUKES that were not expanded to include this resolution.

Non-road mobile machinery

Following improvements to the non-road mobile machinery (NRMM) model, NRMM emissions are now better disaggregated by machinery type. Prior to this change, a large share of NRMM emissions were reported as 'industrial off-road machinery' as there was insufficient data resolution to report them against more appropriate sectors. Now, NRMM emissions can be allocated to more appropriate sectors. Emissions from refrigerated transport and seaport machinery (0.7 $MtCO_2e$ in 2022) which would have previously been reported in the industry sector can now be reported in the domestic transport sector, consistent with the allocation of emissions from aircraft support vehicles.

This change has no impact on the overall estimate of UK territorial greenhouse gas emissions. Instead, improvements to the NRMM model allow for a more appropriate and detailed sector allocation of NRMM emissions.

HFC-sensitivity

Hydrofluorocarbon (HFC) emissions are estimated through bottom-up modelling of all UK equipment and products that use HFCs. Key sources of HFC emissions include refrigeration, air-conditioning, and heat pumps (RACHP), insulating foams, technical aerosols, and metered dose inhalers. To verify the HFC emissions estimates included in the UK greenhouse gas inventory, DESNZ also funds external HFC emissions modelling carried out by the UK Met Office and Bristol University. These alternative estimates are derived from atmospheric measurements of HFC concentrations. Previously, there have been significant discrepancies between the estimates obtained from the two approaches[39].

To support Defra's work on the upcoming revisions of the Great Britain F-Gas Regulation, several model parameters were reviewed and updated to address the discrepancies with external model estimates. Overall, these revisions reduce total HFC emissions estimates throughout the time series. Key changes include:

- A change in the leakage deterioration factor for most RACHP equipment. This factor is applied to increase the leakage from RACHP equipment after it reaches two thirds of its life expectancy. Previously, lack of good data necessitated the use of a conservatively high factor. There have also been modifications to the in-life leakage and end-of-life emission assumptions for mobile air-conditioning, as well as retail and industrial refrigeration.

- Modifications to stock assumptions to reflect the rapid growth expected by DESNZ in the heat pump market.

Semiconductor F-gas use

The models used to estimate semiconductor F-gas use now use real data from industry. Previously, estimates of semiconductor F-gas use were based on qualitative data. Overall, the inclusion of new data from industry has minimal impacts on industry sector emissions estimates across the series.

[39] Annual Report 2021: Verification of UK greenhouse gas emissions using atmospheric observations: https://www.gov.uk/government/publications/uk-greenhouse-gas-emissions-monitoring-and-verification#:~:text=The%20atmospheric%20observations%20derive%20baseline,Atmospheric%20Gases%20Experiment%20(AGAGE).

Recreational N_2O use

There have been several updates to the assumptions included in the recreational N_2O use model in response to new research indicating that the previous assumptions used were inaccurate[40]. The assumption changes are:

- An increase in the mass of N_2O in a 10mL cartridge from 1.2g to 7.5g.
- An increase in the number of N_2O canisters consumed per session from 1 to 5.

These assumptions are considered more evidence-based than the previous ones and sum to an increase in N_2O emissions estimates from recreational use.

Industrial liquid biofuels

The 2023 publication of DUKES introduced data on the quantities of liquid biofuels used in unclassified industries together with autogenerators. These data have been incorporated into the greenhouse gas inventory to include estimates of emissions from these fuels for the first time, with appropriate emission factors obtained from the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines, Volume 2.

Sustainable aviation fuel

The 2023 publication of DUKES introduced data on the quantities of aviation biofuel use. These data have been used to produce estimates of emissions from these fuels for the greenhouse gas inventory for the first time, calculating them using the DUKES activity data and the IPCC Tier 3 methodology for aviation.

Land use, land use change and forestry changes

There have been several methodological updates to the LULUCF sector. These include:

- Several updates to the carbon accounting models that change the estimates of Forest Land Carbon Stock Change. Notable changes include revisions to the soil model and the inclusion of urban trees across the whole time series. There are other minor changes resulting from the estimation of Northern Ireland wood production in private woodland for the first time. Combined, these changes to carbon accounting models have the largest impact to emissions estimates amongst the methodological changes to the LULUCF sector this year.
- Several updates to peatlands emissions estimates. The inclusion of new peat extraction volume data for Northern Ireland sums to the largest change to organic soils this year. Peat map revisions for England and Northern Ireland have also affected estimates of emissions and removals from the LULUCF sector. For Northern Ireland, revisions have led to a decrease in organic soil areas of 137 hectares. For England, peat map revisions have led to the inclusion of 2,674 hectares of rewetted bog. There have also been slight changes to peatland restoration areas in Scotland, including the addition of restoration areas for domestic peat extraction. Peat map revisions for have also led to minor changes in cropland areas and estimates of greenhouse gas emissions from cropland.

[40] Reassessment of N_2O model assumptions: https://pubs.rsc.org/en/content/articlehtml/2023/ea/d3ea00025g#cit20

- New data for estimating forest, grassland, settlement, and cropland areas in the Isle of Man. The methodology for calculating these areas in the Isle of Man was updated to use the Land Cover Map (LCM) 2019 dataset that was commissioned by the Isle of Man Government in 2021. This has resulted in a larger forest area, a smaller grassland area, and a smaller settlement area. These changes have all led to lower emissions estimates in the Isle of Man across the time series in these sub-sectors. In contrast, the new data set now results in a larger cropland area, and therefore higher emissions for cropland. The overall effect of these changes is lower emissions estimates for the Isle of Man.

- Minor changes to forest land, grassland, settlement, and cropland area estimates for Guernsey resulting from consistency updates and error corrections.

- Minor LULUCF changes resulting from updated deforestation data and woodland loss estimates in England. In Scotland, updates to estimates of rewetting have impacted the split between forest to wetland and forest to grassland areas from 2000 onwards.

Accompanying tables

The following tables are available in Excel and ODS format on the department's statistics website, alongside a dataset of UK territorial greenhouse gas emissions and a table showing how each source in the UK GHG Inventory maps between NC and TES sectors.

UK territorial emissions

Table 1.1	Territorial greenhouse gas emissions by gas, UK 1990-2022
Table 1.2	Territorial greenhouse gas emissions by source category, UK 1990-2022
Table 1.3	Territorial emissions of carbon dioxide (CO_2) by source category, UK 1990-2022
Table 1.4	Territorial emissions of methane (CH_4) by source category, UK 1990-2022
Table 1.5	Territorial emissions of nitrous oxide (N_2O) by source category, UK 1990-2022
Table 1.6	Territorial emissions of fluorinated gases (F gases) by source category, UK 1990-2022
Table 1.7	Territorial greenhouse gas emissions by type of fuel, UK 1990-2022
Table 1.8	Territorial emissions of carbon dioxide (CO_2) by source category, UK 1970-1990

UK territorial emissions targets

Table 2.1	Progress against UK Carbon Budget targets
Table 2.2	Progress towards UK international greenhouse gas emissions reduction targets

UK territorial emissions for international reporting, including Crown Dependencies & Overseas Territories

Table 3.1	Territorial greenhouse gas emissions by geographical coverage and gas, UK, Crown Dependencies & Overseas Territories, 1990-2022
Table 3.2	Territorial greenhouse gas emissions for the UK, Crown Dependencies and Overseas Territories by source category, 1990-2022
Table 3.3	Territorial greenhouse gas emissions in the UK, Crown Dependencies & Overseas Territories, and totals reported to the UNFCCC and under the Paris Agreement, 1990-2022
Table 3.4	Territorial greenhouse gas emissions for the UK, Crown Dependencies and Overseas Territories by type of fuel, 1990-2022

Uncertainty of territorial emission estimates and past revisions

Table 4.1	Uncertainty in estimates of territorial greenhouse gas emissions by gas, UK, Crown Dependencies and Overseas Territories: 1990/2021 *(will be updated on 28th March 2024 with 2022 estimates)*
Table 4.2	Uncertainty in estimates of territorial greenhouse gas emissions by source sector, UK, Crown Dependencies and Overseas Territories: 1990/2021 *(will be updated on 28th March 2024 with 2022 estimates)*
Table 4.3	UK territorial greenhouse gas emissions: changes over successive Greenhouse Gas Inventories from 1990-2008 to 1990-2022

Emissions from the use of fuels from UK international aviation and shipping bunkers (not included in UK territorial emission totals)

Table 5.1	Greenhouse gas emissions arising from the use of fuels from UK international aviation and shipping bunkers, 1990-2022

Reference tables

Table 6.1	Sectoral definitions and inclusions: relationships between source categories as defined by the IPCC and the categories used in this publication
Table 6.2	Sectoral details, methodologies, and data sources
Table 6.3	Fuel categories used in greenhouse gas emissions statistics
Table 6.4	List of Global Warming Potentials (GWP) of greenhouse gases used in UK emissions estimates

UK territorial emissions by National Communication (NC) sector

Table NC_1.2	Territorial greenhouse gas emissions by National Communication (NC) source category, UK 1990-2022

UK territorial emissions on an end-user basis *(will be added in a separate file on 28th March 2024)*

Table 7.1	Territorial greenhouse gas emissions by end user category, UK 1990-2022
Table 7.2	Territorial emissions of carbon dioxide (CO_2) by end user category, UK 1990-2022
Table 7.3	Territorial emissions of methane (CH_4) by end user category, UK 1990-2022
Table 7.4	Territorial emissions of nitrous oxide (N_2O) by end user category, UK 1990-2022
Table 7.5	Territorial emissions of fluorinated gases (F gases) by end user category, UK 1990-2022
Table 7.6	Territorial emissions of carbon dioxide (CO_2) by end user category, UK 1970-1990

UK territorial emissions by Standard Industrial Classification (SIC)
Tables showing emissions by Standard Industrial Classification (SIC) will be added to this publication in a separate file on 27th June 2024.

Technical information

Methodology for producing greenhouse gas emissions estimates

It is impractical to directly measure emissions from every exhaust, chimney, and acre of land in the UK, so greenhouse gas emission estimates are based on a series of models that estimate emissions from different sources. The source data and methods used to derive UK greenhouse gas emission estimates have been developed to be consistent with methods defined within international guidance[41]. All countries that report to the UNFCCC are required to use these estimation methods to ensure that the emissions for each country are complete and comparable.

The basic equation for estimating most sources of emissions is:

$$Emission\ Factor\ \times Activity\ Data = Emission\ Estimate$$

For example, to estimate CO_2 emissions from vehicles the activity data might be the total number of kilometres travelled by that type of vehicle and the emission factor the amount of CO_2 emitted per kilometre.

The emission factor is the emission per unit of activity. Emission factors for energy sources are either dependent on the fuel characteristics (for emissions of CO_2) or how the fuel is burned, for example the size and efficiency of equipment used. For other sources, the emission factor can be dependent on a range of parameters, such as feed characteristics for livestock or the chemical reactions taking place for industrial process emissions. Emission factors are typically derived from measurements on a number of representative sources and the resulting factor applied to all similar sources in the UK.

The UK Greenhouse Gas Inventory uses the best available data from UK and international research for each emission source. The approach used is largely defined by the availability of data and the significance of the emission source in the overall UK inventory: more detailed

[41] 2006 IPCC Guidelines for National Greenhouse Gas Inventories: https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html
2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement): https://www.ipcc-nggip.iges.or.jp/public/wetlands/index.html
2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP Supplement): https://www.ipcc-nggip.iges.or.jp/public/kpsg/index.html

methods are used for the high-emitting sources, whilst simpler methods can be used for minor sources, consistent with international guidance.

For some sources, the calculation of emissions is more complicated, and therefore a more complex model is used to estimate emissions. For example, emissions of methane from waste disposed to landfills are estimated using a model that reflects the fact that the emissions occur over a long timeframe from the initial disposal of the waste, and that emissions are affected by the level of capture and utilisation of the landfill methane produced. The CO_2 emissions and removals from land use, land use change and forestry are also modelled.

Table 6.2 in the data tables accompanying this publication summarises the methods and data sources used to estimate emissions from each source, and there are factsheets published on the NAEI website[42] that summarise the main data sources and methods used for each sector. More detailed methodology information for each source can be found in the National Inventory Report submitted to the UNFCCC each year. The report for the 1990-2022 inventory (which will be known from this year as the National Inventory Document) will be published later in 2024, so the report for the 1990-2021 inventory[43] is the most recently available at the time of this publication.

DESNZ also runs a programme to monitor atmospheric concentrations of greenhouse gases, which is used to verify the emission estimates made in the Greenhouse Gas Inventory[44].

Estimating emissions on a temperature adjusted basis

In our provisional 2022 UK greenhouse gas emission statistics[45] we published estimates of temperature adjusted emissions, which give an idea of overall trends in emissions without fluctuations due to changes in external temperatures. The provisional emissions series is estimated based on UK provisional energy consumption data published by DESNZ and is not as accurate as the estimates in this statistical release, which are derived from our annual Greenhouse Gas Inventory. We can compare the latest provisional unadjusted and temperature adjusted emissions with the final estimates now available.

On a temperature adjusted basis, net carbon dioxide emissions in 2021 and 2022 were estimated to be 341.5 Mt and 346.0 Mt respectively. The increase in carbon dioxide emissions between 2021 and 2022 in the temperature adjusted figures was therefore 4.4 Mt, in contrast to the 8.1 Mt decrease seen in the provisional non-temperature adjusted figures, as shown in the table below. This suggests that the underlying change between 2021 and 2022 when adjusted for temperature would be less than the 3.8% decrease shown and could potentially have been an increase.

[42] Sector, Gas and Uncertainty Summary Factsheets: https://naei.beis.gov.uk/overview/ghg-overview
[43] UK National Inventory Report 1990-2021: https://naei.beis.gov.uk/reports/reports?report_id=1108
[44] Monitoring and verification of long term UK atmospheric measurement of greenhouse gas emissions: https://www.gov.uk/government/publications/uk-greenhouse-gas-emissions-monitoring-and-verification
[45] Provisional 2022 UK greenhouse gas emissions: https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-national-statistics-2022

Table 4: Comparison of provisional UK carbon dioxide emissions estimates with final estimates, 2021-2022

UK 2021-2022 $MtCO_2$

	2021 CO_2 emissions (Mt)	2022 CO_2 emissions (Mt)	Absolute change (Mt)	Percentage change
Final estimates ➢ unadjusted emissions	337.0	324.2	-12.9	-3.8%
Provisional estimates ➢ unadjusted emissions	339.5	331.5	-8.1	-2.4%
Provisional estimates ➢ Temperature adjusted emissions	341.5	346.0	4.4	1.3%

Source: Table 1.1, Final UK greenhouse gas emissions national statistics 1990-2022 Excel data tables
Tables 3 & 4, Provisional UK greenhouse gas emissions national statistics 2022 Excel data tables

Note: The provisional emissions estimates differ from the emissions estimates shown elsewhere in this publication because they were published before the 2022 figures presented were finalised.

Uncertainties

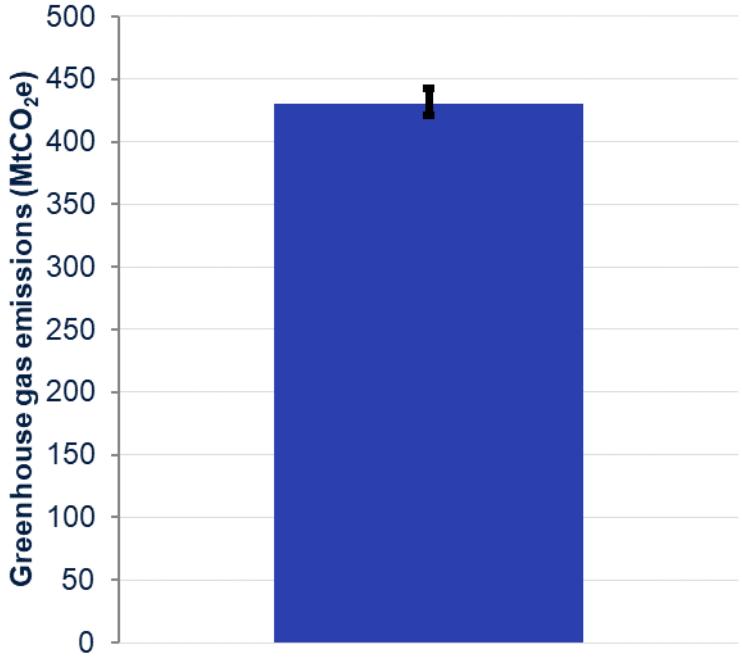
In the data tables accompanying this publication, table 4.1 shows the uncertainty in the 2021 UK greenhouse gas emissions estimates by gas and table 4.2 shows it by sector. These will be updated to show the equivalent 2022 estimates on 28 March 2024.

Estimates of greenhouse gas emissions have an inherent uncertainty due to uncertainty in the underlying data used to calculate the emissions, and due to uncertainty in the applicability, completeness, and application of that data. Uncertainty analysis is conducted by modelling the uncertainty in the underlying emission factors, activity data and other variables within models, or in the overall model output. The uncertainties are expressed as a 95% confidence interval. This means that in the uncertainty model 95% of the simulated values fell between the intervals shown. They are expressed as a single percentage value, which is calculated as 0.5*R/E where R is the difference between the 2.5 and 97.5 percentiles and E is the mean.

The overall uncertainty around total greenhouse gas emissions for 2021 is estimated to be around 2%, as shown in Figure 21 (which is based on uncertainty analysis of 2021 emissions, as published in 2023). The geographic coverage of the uncertainty estimates includes the UK, Crown Dependencies and Overseas Territories, but uncertainty estimates for the UK only would be expected to be very similar. Estimates of 2022 uncertainties will be published on 28 March 2024.

The uncertainty of greenhouse gas emissions estimates varies considerably by sector. LULUCF emissions estimates are the most uncertain, followed by waste and agriculture. Among the different greenhouse gases, carbon dioxide estimates have the lowest uncertainty associated with them while nitrogen trifluoride and perfluorocarbons estimates are the most uncertain.

Figure 21: Illustration of uncertainty in UK greenhouse gas emissions, UK, Crown Dependencies and Overseas Territories, 2021 ($MtCO_2e$)



The error bar on this chart represents the uncertainty range (in this case, the 95% confidence interval) around the 2021 total greenhouse gas emissions central estimate.

Source: Table 4.1, Final UK greenhouse gas emissions national statistics 1990-2021 Excel data tables

Further information

Future updates to these statistics

On Thursday 28 March 2024 DESNZ will publish a breakdown of 1990-2021 UK territorial emissions by end-user sector to supplement the source sector breakdown included in this publication and estimates of the uncertainty in the 2022 emission estimates.

On Thursday 28 March 2024 DESNZ will also publish provisional estimates of UK greenhouse gas emissions for 2023. This will coincide with the publication of Energy Trends statistics, which will include estimates of 2023 UK energy consumption.

On Thursday 27 June 2024 DESNZ will publish estimates of 1990-2022 UK territorial emissions by Standard Industrial Classification (SIC), to supplement the sector breakdown included in this publication.

On Thursday 27 June 2024 DESNZ will also publish estimates of greenhouse gas emissions by local authority for 2022.

Final estimates of UK greenhouse gas emissions for 2023 will be published in February 2025.

Related publications

- This statistical release and the related data tables are the first release of data from the National Atmospheric Emissions Inventory (NAEI) for 1970-2022, produced for DESNZ and the Devolved Administrations by Ricardo. Additional results will be released as they become available. For further information on the UK Greenhouse Gas Inventory, see the NAEI website.

- The UK's National Inventory Document (NID) for 1990-2022 will be submitted to the United Nations Framework Convention on Climate Change (UNFCCC) later in 2024. The report will contain national territorial greenhouse gas emissions estimates for 1990-2022 and descriptions of the methods used to produce the estimates. Starting in 2024, the NID replaces the previously required National Inventory Report (NIR). To enable the use of new reporting tools, the UNFCCC has moved its usual submission deadline of 15th April to 31st December for 2024. Previous UK NIRs can be found on the NAEI website.

- The background quality report provides a summary of quality issues relating to statistics on UK territorial greenhouse gas emissions.

- There are uncertainties associated with all estimates of greenhouse gas emissions. Although for any given year considerable uncertainties may surround the emissions estimates for a pollutant, it is important to note that trends over time are likely to be much more reliable. For more information on these uncertainties see the uncertainties factsheet on the NAEI website.

- Estimates of territorial greenhouse gas emissions in the four countries of the UK are published on the NAEI website and for local authority areas on gov.uk. In both cases estimates of emissions in 2022 will be published in June 2024.

- DESNZ also publishes UK territorial emissions projections based on assumptions of future emission reduction policies, economic growth, fossil fuel prices, electricity generation costs, UK population and other key variables.

- Further information about the Kyoto Protocol and the Paris Agreement can be found on the UNFCCC's website.

- Further details of the European Union Emissions Trading System can be found on the European Commission website.

- Under the Climate Change Act, the Annual Statement of Emissions for 2022 must be laid before Parliament and published no later than 31st March 2024. This will give details of the net UK carbon account for 2022, which is used to determine compliance with the targets and budgets under the Act.

- ONS publishes emissions on a "residence" basis in the UK Environmental Accounts. The figures represent emissions caused by UK residents and businesses whether in the UK or abroad but exclude emissions within the UK which can be attributed to overseas residents and businesses.

- Defra publishes the UK's carbon footprint. This estimates emissions on a "consumption" basis, meaning it covers emissions associated with the consumption of goods and services by households in the UK. It includes estimates of emissions associated with each stage of the supply chain for those goods and services, regardless of where they occur, while

excluding emissions occurring in the UK that are associated with the consumption of goods and services by households outside the UK.

- The latest UK energy statistics, including revisions to earlier years' data, can be found in the Digest of UK Energy Statistics.
- Detailed UK temperature data can be found on both the Met Office website and the Weather Statistics section of the gov.uk website.
- Similar results for non-greenhouse gas atmospheric pollutants are published by Defra in its statistics on Emissions of air pollutants in the UK.

Revisions policy

The DESNZ statistical revisions policy sets out the revisions policy for these statistics, which has been developed in accordance with the UK Statistics Authority Code of Practice for Statistics.

Uses of these statistics

The UK's territorial greenhouse gas emissions estimates are used by central government departments, devolved governments and local authorities to understand emissions in the areas they are responsible for, to develop policies to reduce emissions and to set targets. They are the basis for the UK's domestic and international emissions targets and are required to be reported each year to the UNFCCC.

Outside government the statistics are used by the media and the public to understand the level of greenhouse gas emissions in the UK and trends over time. They provide detailed emissions data on gases, sectors and sub-sectors that may of interest to users (particularly academics) with a focus on a particular area of emissions. The data are also the basis of emission conversion factors that are used by companies and other organisations to report their greenhouse gas emissions.

Information about user needs for greenhouse gas emissions statistics is published in our background quality report.

User engagement

Users are encouraged to provide comments and feedback on how these statistics are used and how well they meet user needs. Comments on any issues relating to this statistical release are welcomed and should be sent to: GreenhouseGas.Statistics@energysecurity.gov.uk

The DESNZ statement on statistical public engagement and data standards sets out the department's commitments on public engagement and data standards as outlined by the Code of Practice for Statistics.

National Statistics designation

National Statistics are accredited official statistics. Accredited official statistics are called National Statistics in the Statistics and Registration Service Act 2007.

These accredited official statistics were independently reviewed by the Office for Statistics Regulation (OSR) in June 2014 and had their accreditation reviewed in September 2018. They comply with the standards of trustworthiness, quality and value in the Code of Practice for Statistics and should be labelled 'accredited official statistics'.

Our statistical practice is regulated by the OSR.

OSR sets the standards of trustworthiness, quality and value in the Code of Practice for Statistics that all producers of official statistics should adhere to.

You are welcome to contact us by emailing greenhousegas.statistics@energysecurity.gov.uk with any comments about how we meet these standards.

Alternatively, you can contact OSR by emailing regulation@statistics.gov.uk or via the OSR website.

Pre-release access to statistics

Some ministers and officials receive pre-release access to these statistics up to 24 hours before release. Details of the arrangements for doing this and a list of the ministers and officials that receive pre-release access to these statistics can be found in the DESNZ statement of compliance with the Pre-Release Access to Official Statistics Order 2008.

Contact

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This publication is available from: https://www.gov.uk/government/collections/uk-territorial-greenhouse-gas-emissions-national-statistics

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