



2022 UK greenhouse gas emissions, provisional figures

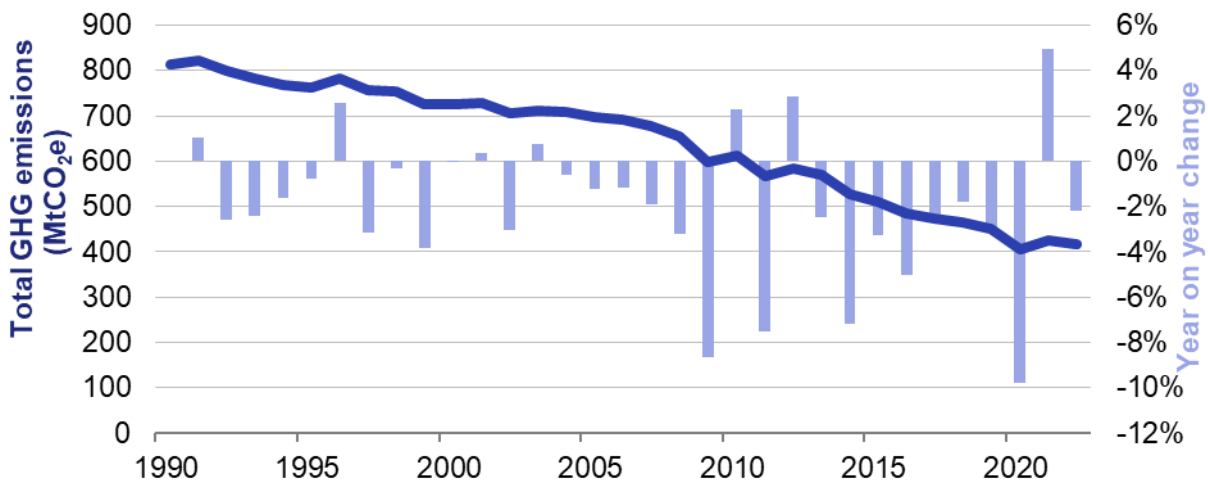
30 March 2023

National Statistics

Despite rises in some emissions as the UK continued to recover from the 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. This will largely be because 2022 was considerably warmer than 2021 and higher energy prices may also have been a factor, particularly towards the end of the year.

- Carbon dioxide (CO₂) emissions in the UK are provisionally estimated to have decreased by 2.4% in 2022 from 2021, to 331.5 million tonnes (Mt), and total greenhouse gas emissions by 2.2% to 417.1 million tonnes carbon dioxide equivalent (MtCO_{2e}). Compared to 2019, the most recent pre-pandemic year, 2022 CO₂ emissions are down 7.5% and total greenhouse gas emissions are down 7.4%. Total greenhouse gas emissions were 48.7% lower than they were in 1990.
- This decrease in 2022 is primarily due to the reduction in gas for heating buildings, as the weather was warmer than in 2021. Higher energy prices may have also caused people to reduce their energy use. CO₂ emissions from the residential sector fell 11.1 Mt (16.5%) in 2022. Comparatively, overall CO₂ emissions in the UK only fell 8.1 Mt, with a notable rise in emissions from transport (4.2 Mt). The rise in transport emissions came in the first half of the year, following reduced travel in the same period in 2021 due to COVID-19 restrictions.

UK territorial greenhouse gas emissions, 1990-2022



What you need to know about these statistics:

This publication provides provisional estimates of 2022 UK territorial greenhouse gas emissions, meaning emissions that occur within the UK's borders. Emissions are presented in carbon dioxide equivalent units (CO_{2e}) throughout this statistical release.

These estimates give an early indication of emissions in 2022 and are subject to revision when final estimates are published in February 2024. They also include estimates of quarterly emissions and the impact on emissions of external temperature changes.

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Introduction

This publication provides provisional annual and quarterly estimates of UK territorial greenhouse gas emissions for 2022, including estimates of carbon dioxide emissions by source sector. It also provides an estimate of temperature adjusted emissions, which give an idea of overall trends in emissions without fluctuations due to changes in external temperature. More information about the underlying methodology for the provisional emissions statistics can be found in the methodology summary published alongside this report.

Data for 1990-2021 are consistent with the annual emissions presented in the National Statistics publication [2021 final UK greenhouse gas emissions statistics](#). Data for 2022 emissions are provisional and do not follow the full methodology used for 1990-2021. The estimates of carbon dioxide (CO₂) emissions that are related to energy use are based on provisional inland energy consumption statistics, which are being published at the same time by the Department for Energy Security and Net Zero in the quarterly [Energy Trends](#) publication. These are the large majority of emissions in the UK.

CO₂ emissions that are not related to energy use are assumed to remain the same as in 2021 as we do not yet have data from which to produce estimates for them, while estimates of non-CO₂ gases are based on a simple approach which assumes that the change in emissions of non-CO₂ gases between 2021 and 2022 will be in line with the percentage change in non-CO₂ emissions from 2021 to 2022 in the [Energy and Emissions Projections: 2021 to 2040](#) published by the Department for Energy Security and Net Zero. These emissions are assumed to be spread evenly over the year.

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, trends over time are likely to be much more reliable. For more information on uncertainties in emissions estimates see the annex published alongside the [2021 final UK greenhouse gas emissions statistics](#).

The estimates present emissions on a “territorial” basis, so only include emissions which occur within the UK’s borders. 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). When emissions are measured on this basis, UK 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.

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 “residency” 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.

For the purposes of reporting, greenhouse gas emissions are allocated into sectors as follows:

Energy Supply	Emissions from electricity generation and other energy production activities such as mining, refining and manufacturing fuels.
Business	Emissions from fuel combustion and product use in industrial and commercial sectors, and F gas emissions from refrigeration and air conditioning in all sectors. Includes industrial off-road machinery but not business-related transport emissions, which are included in the <i>Transport</i> sector.
Transport	Emissions from road transport, domestic aviation, railways and domestic shipping. Only includes emissions from vehicles and not from transport related infrastructure or from air conditioning. International aviation and shipping emissions are not included in national totals.
Public	Emissions from the combustion of fuel in public sector buildings, e.g., hospitals and schools. Emissions from public transport are included in the <i>Transport</i> sector.
Residential	Emissions from residential properties, including from consumer product use. Primarily consists of fuel combustion for heating/cooking, garden machinery, and fluorinated gases released from aerosols and metered dose inhalers.
Agriculture	Emissions of greenhouse gases from livestock, agricultural soils (excluding carbon stock changes which are included in the <i>LULUCF</i> sector) and agricultural machinery.
Industrial processes	Emissions resulting from industrial processes, except for those associated with fuel combustion which are included in the <i>Business</i> sector.
Land use, land use change and forestry (LULUCF)	Emissions/removals of CO ₂ from changes in the carbon stock in forestland, cropland, grassland, wetlands, settlements and harvested wood products, and 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. Because the impact of biomass harvest on carbon stocks in ecosystems is included in this sector, any emissions of CO ₂ from burning biomass (regardless of the country of origin) are excluded from other sectors to avoid double counting them.
Waste management	Emissions resulting from the treatment and disposal of solid and liquid waste, for example from landfill, incineration and composting. Emissions from incineration with energy recovery are instead reported in the <i>Energy Supply</i> sector and emissions from residential composting are included in the <i>Residential</i> sector.

These high-level sectors are made up of several more detailed sectors, which largely follow the definitions set out by the Intergovernmental Panel on Climate Change (IPCC)¹ and which are used in international reporting tables which are submitted to the United Nations Framework Convention on Climate Change (UNFCCC)² every year. It is important to note that these figures are based on provisional energy data and are subject to change. The sectoral breakdown is given mainly for information, and is included in the publication for completeness, but sectoral estimates are more uncertain than the overall total.

Note that we are proposing to replace the NC sectors in next year's publication. Please see the separate document published alongside the [2021 final UK greenhouse gas emissions statistics](#) setting out the changes we are proposing and send us any feedback you have at GreenhouseGas.Statistics@beis.gov.uk by 30 April 2023.

These estimates cover the Kyoto "basket" of seven gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulphur hexafluoride (SF₆) and nitrogen trifluoride (NF₃). The last four gases are collectively referred to as fluorinated gases or F gases. In accordance with international reporting and carbon trading protocols, emissions from each of the gases is 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 relation to that of carbon dioxide over a 100-year period. Greenhouse gas emissions are then presented in carbon dioxide equivalent units (CO₂e).

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".

The provisional estimates are not used for any formal reporting of how the UK is performing against its emissions reduction targets, as this requires final estimates based on the UK's greenhouse gas inventory. However, these statistics give policy makers and other users an initial steer as to the trend in emissions between 2021 and 2022, which helps them to form an initial assessment of the extent to which the UK is on track to meet targets. For information on UK emissions targets and progress towards them, see the [2021 final UK greenhouse gas emissions statistics](#).

¹ <https://www.ipcc-nggip.iges.or.jp/>

² <https://unfccc.int/>

³ The global warming potentials (GWPs) used are from table 8.A.1 (without climate-carbon feedback) of Working Group 1 of the IPCC Fifth Assessment Report: Climate Change 2013 and summarised in table 6.4 in the Excel tables in the [2021 final UK greenhouse gas emissions statistics](#).

2022 UK provisional emissions results

In the [data tables](#) accompanying this publication, table 1 shows UK annual territorial greenhouse gas emissions, including a breakdown by source sector for carbon dioxide emissions. Table 3 shows quarterly moving annual totals for these emissions and table 5 the totals for individual quarters, with tables 4 and 6 respectively showing the equivalent temperature adjusted estimates.

Territorial carbon dioxide emissions are provisionally estimated to have decreased by 2.4% (8.1 Mt) in 2022 from 2021, and total greenhouse gas emissions by 2.2% (9.4 MtCO_{2e}). Total greenhouse gas emissions are estimated to be 7.4% lower than those in 2019, which is a decrease of 33.4 MtCO_{2e}. At 417.1 MtCO_{2e}, greenhouse gas emissions in the UK in 2022 were 48.7% lower than in 1990. Because these provisional estimates are based on energy data it is only possible to make estimates of carbon dioxide emissions from different source sectors and not estimates of other gases, so the rest of this section presents the trends in carbon dioxide emissions.

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 it is clear that 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, and this led to a large drop in emissions from the use of fuels and electricity to heat buildings, which led to emissions across the UK falling overall. Higher energy prices may have also been a factor in reducing demand for fuels, particularly towards the end of the year.

After the increase in emissions in 2021 from 2020, there was a fall in every quarter of 2022 compared to the year before. The first quarter (Q1) of 2022, from January to March, saw carbon dioxide emissions fall 0.6% compared to the same period in 2021. This can largely be attributed to the fall in residential carbon dioxide emissions in Q1, down 15.2% (4.3Mt), due to warmer temperatures and people spending less time at home due to the easing of COVID-19 restrictions.

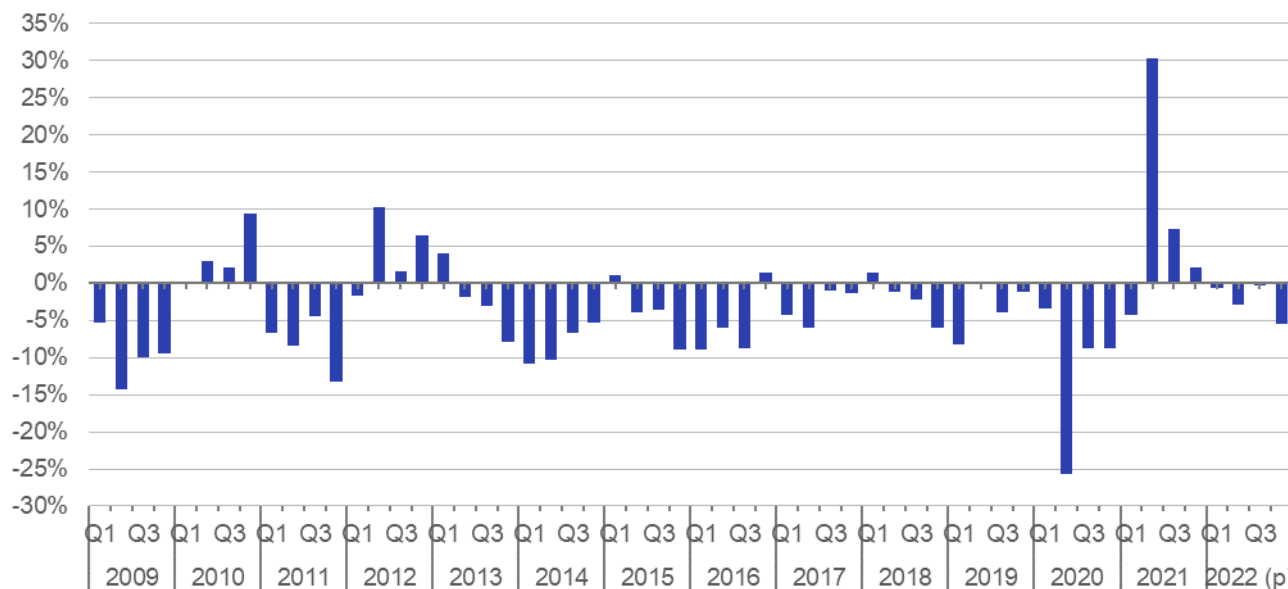
Transport, differing from most other sectors in Q1 2022, saw a stark increase, with carbon dioxide emissions rising by 23.2% (5.1Mt) from the same quarter the year before, largely as a result of the greater use of road transport⁴. Q2, April to June, of 2022 saw a 2.9% drop in CO₂ emissions, compared to Q2 2021, which was largely due to a significant fall in residential sector emissions (29.5%). This is mainly due to higher temperatures in 2022, as on a temperature adjusted basis, residential carbon dioxide emissions increased 3% in Q2 2022 compared to Q2 2021. Comparatively, transport, energy supply, and public emissions were up 7.3%, 4.4%, and 2.4% respectively from Q2 2021 to Q2 2022.

Q3, from July to September, saw the smallest decrease in carbon dioxide emissions of 0.2% from 2022 compared to 2021, with all sectors apart from transport and energy supply showing a decrease. Carbon dioxide emissions in Q4, October to December, of 2022 had the greatest quarterly fall of 5.4% (5.0 Mt) compared to the same period in 2021. With residential and

⁴ Transport use during the coronavirus (COVID-19) pandemic, Department for Transport (DfT): <https://www.gov.uk/government/statistics/transport-use-during-the-coronavirus-covid-19-pandemic>

transport sectors contributing the biggest carbon dioxide emissions falls, 2.6 Mt and 1.7 Mt respectively.

Figure 1: Percentage change in quarterly UK carbon dioxide emissions from previous year, Q1 2009 - Q4 2022



Source: Table 5, Provisional UK territorial greenhouse gas emissions national statistics 1990-2022 Excel data tables

Note: (p) 2022 estimates are provisional.

The residential sector saw a decrease in carbon dioxide emissions in 2022, of 16.5% (11.1 Mt) compared to 2021. These emissions are predominantly from the use of fuels for heating and cooking, but do not include emissions associated with electricity use as these are included in the energy supply sector. This decrease was likely largely due to the warmer weather conditions and people returning to the office after working from home for much of 2021, and higher energy prices may have also been a factor.

Overall, across 2022, carbon dioxide emissions in the transport sector increased by an estimated 3.8% (4.2 Mt) from 2021, with it remaining the largest emitting sector in the UK, accounting for 34.0% of carbon dioxide emissions in 2022. Transport emissions were still 7.7% (9.4 Mt) lower than in 2019. A further 24.8% of carbon dioxide emissions were from energy supply, 18.7% from business and 17.0% from the residential sector.

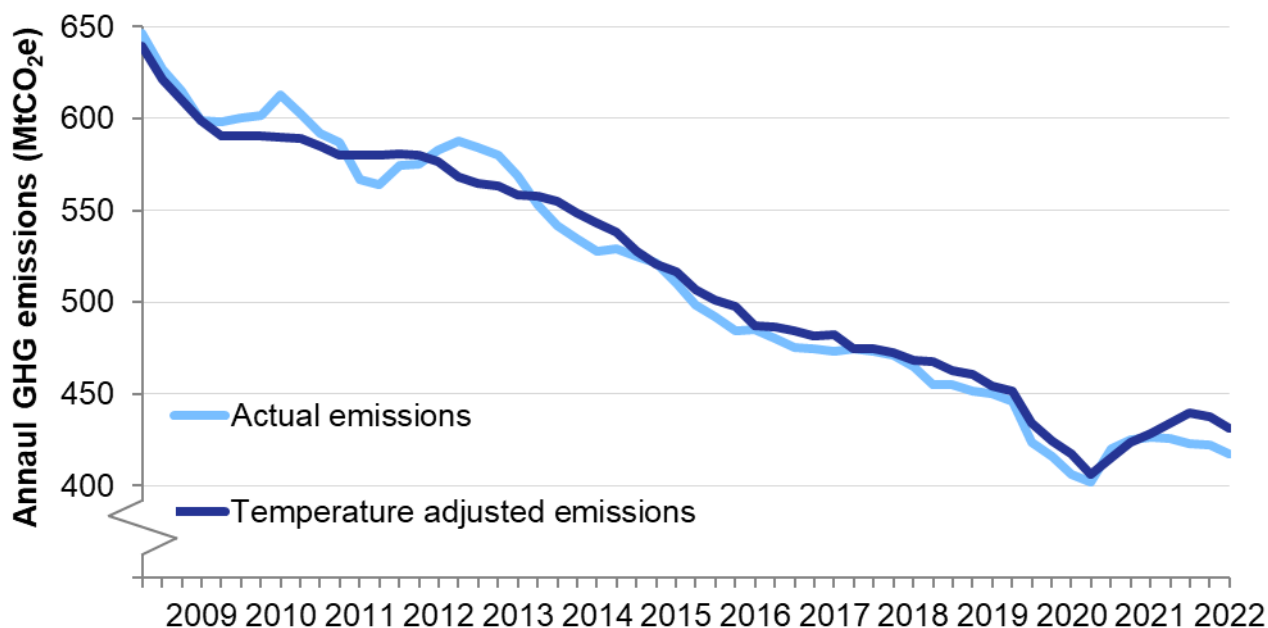
Carbon dioxide emissions in the energy supply sector increased by 1.7% (1.4 Mt), between 2021 and 2022. This will have been affected by the lifting of pandemic restrictions, with greater demand for some fuels leading to an increase in emissions from their production and supply. This increase in carbon dioxide emissions from fossil fuel use in the energy supply sector is contrary to long term trends, with emissions down 70.6% and 8.2% since 1990 and 2019 respectively.

Business sector territorial carbon dioxide emissions decreased by 4.1% (2.7 Mt) from 2021 to 2022, likely seeing decreased emissions due to the warmer temperatures in 2022 compared to 2021, which will have decreased the use of heating in buildings. Public sector emissions increased by 1.4% (0.1 Mt) between 2021 and 2022. This will have been affected by the ending of COVID-19 restrictions.

Between 1990 and 2022, UK territorial carbon dioxide emissions decreased by 45.1%. While the pandemic led to a notable fall in emissions in 2020, the largest factor behind this long-

term decrease was the change in the mix of fuels being used for electricity generation, with a shift away first from coal to gas in the 1990s, and more recently to renewable energy sources. This was combined with lower electricity demand, owing to greater efficiency resulting from improvements in technology and a decline in the relative importance of energy intensive industries. Overall inland energy consumption is provisionally estimated to have decreased by 21.9% since 1990^{5,6}, and if this figure is adjusted to allow for the effect of temperature, there was a 22.9%⁷ decrease over this period.

Figure 2: Actual and temperature adjusted annual territorial greenhouse gas emissions, UK, Year to Q1 2009 - Year to Q4 2022 (MtCO₂e)



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

Note: 1. Figures are annual totals including the preceding 4 quarters.
2. From year ending Q1 2022 onwards, figures include provisional data.

As shown in Figure 2 above, temperature adjusted territorial greenhouse gas emissions show a similar overall trend to non-temperature adjusted emissions. Over the most recent ten-year period, temperature adjusted UK territorial greenhouse gas emissions decreased by 25.2%, similar to the fall in actual emissions over this period (28.5%). When adjusted for temperatures, greenhouse gas emissions in 2022 were 0.7% higher than in 2021, although still 5.0% lower than they were in 2019.

⁵ Digest of UK Energy Statistics (DUKES), Availability and consumption of primary fuels and equivalents (energy supplied basis), 1970 to 2022 (DUKES1.1.2), Department for Business, Energy & Industrial Strategy: <https://www.gov.uk/government/statistics/energy-chapter-1-digest-of-united-kingdom-energy-statistics-dukes>

⁶ Energy Trends: UK total energy, Inland energy consumption: primary fuel input basis (ET 1.2 – monthly), Department for Business, Energy & Industrial Strategy: <https://www.gov.uk/government/statistics/total-energy-section-1-energy-trends>

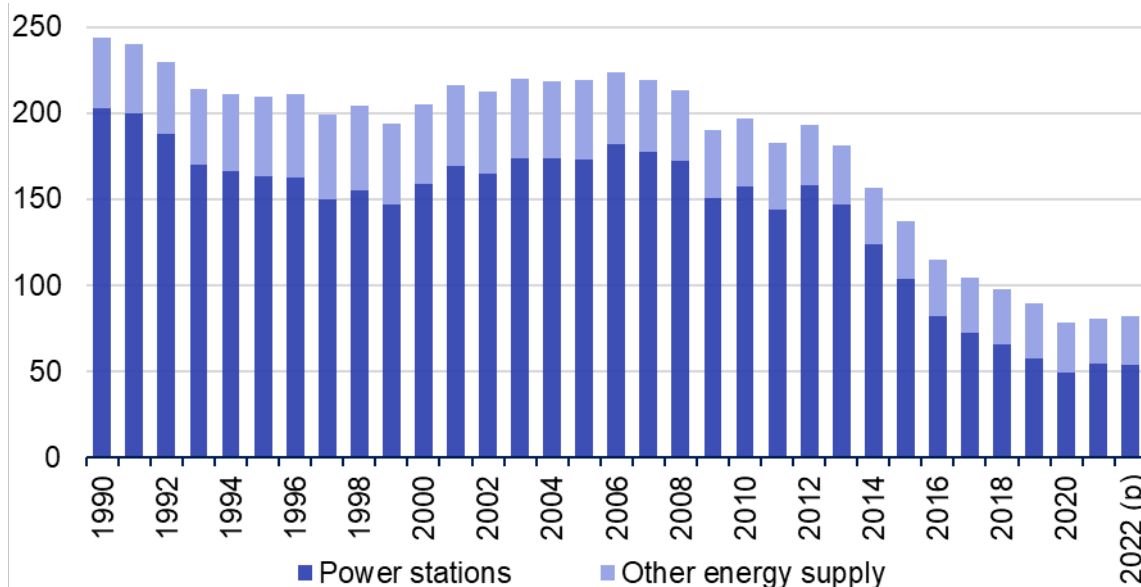
⁷ Digest of UK Energy Statistics (DUKES), Primary energy consumption, gross domestic product, and the energy ration, 1970 to 2022 (DUKES1.1.4), Department for Business, Energy & Industrial Strategy: <https://www.gov.uk/government/statistics/energy-chapter-1-digest-of-united-kingdom-energy-statistics-dukes>

Energy Supply

Carbon dioxide emissions from this sector are provisionally estimated to be 82.2 Mt in 2022, an increase of 1.7% (1.4 Mt) compared to 2021 and a decrease of 8.0% (7.2 Mt) compared to 2019, the last full pre-pandemic year.

This increase was the result of a 7.8% (2.1 Mt) increase in carbon dioxide emissions from energy supply that didn't come from power stations. In 2022, carbon dioxide emissions from power stations, at 53.7 Mt, accounted for 16.0% of all carbon dioxide emissions. Carbon dioxide emissions from power stations were 73.6% lower in 2022 than in 1990. This is despite consumption of electricity being provisionally estimated to be only 5.7% lower in 2022 than in 1990.

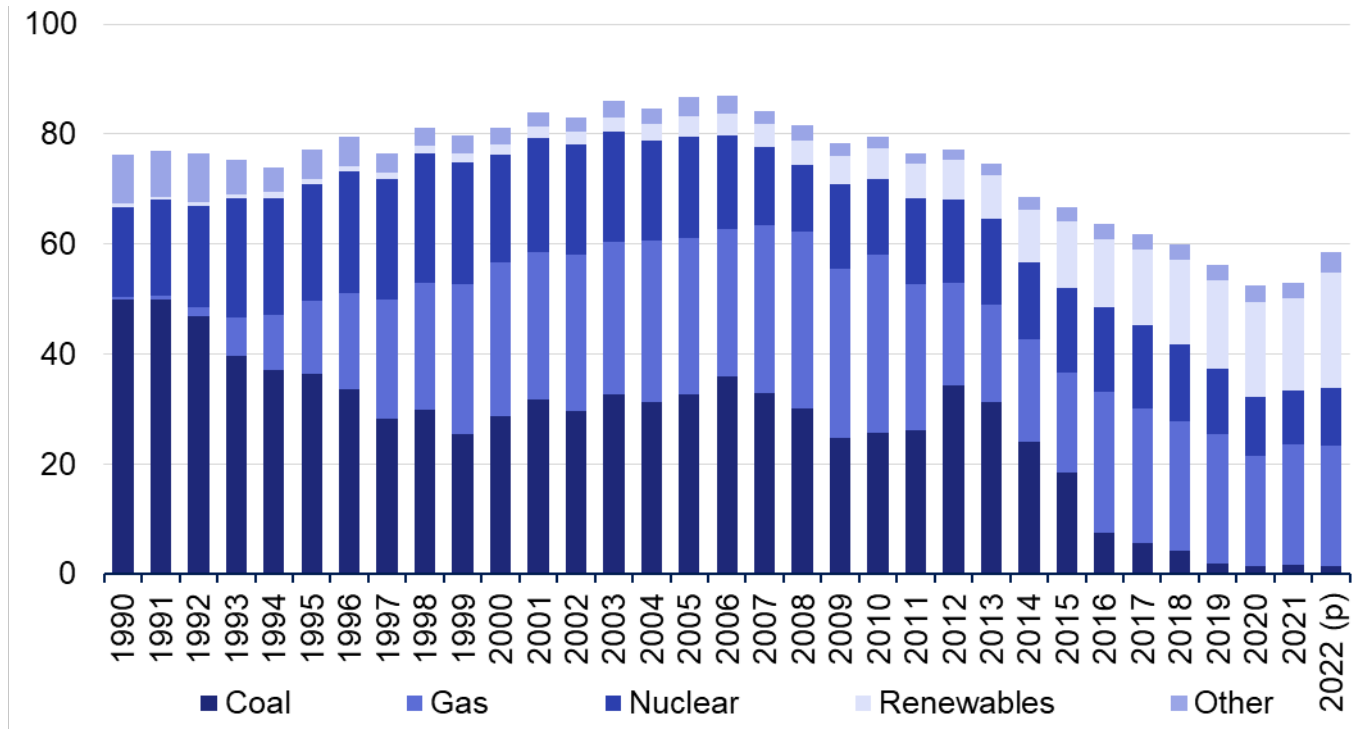
Figure 3: Territorial carbon dioxide emissions from energy supply, UK, 1990-2022 (MtCO₂)



Source: Table 1, Provisional UK territorial greenhouse gas emissions national statistics 1990-2022 Excel data tables
 Note: (p) 2022 estimates are provisional.

This long-term decrease has mainly resulted from changes in the mix of fuels being used for electricity generation with a switch from coal to natural gas and growth in the use of renewable energy sources, combined with greater efficiency resulting from improvements in technology and a decline in the relative importance of energy intensive industries. In 2022 coal made up 2.4% of fuel used for electricity generation, compared to 65.3% in 1990. Nuclear and renewables, which are low carbon energy sources, accounted for 54.0% of fuel used for electricity generation in 2022, up from 22.2% in 1990.

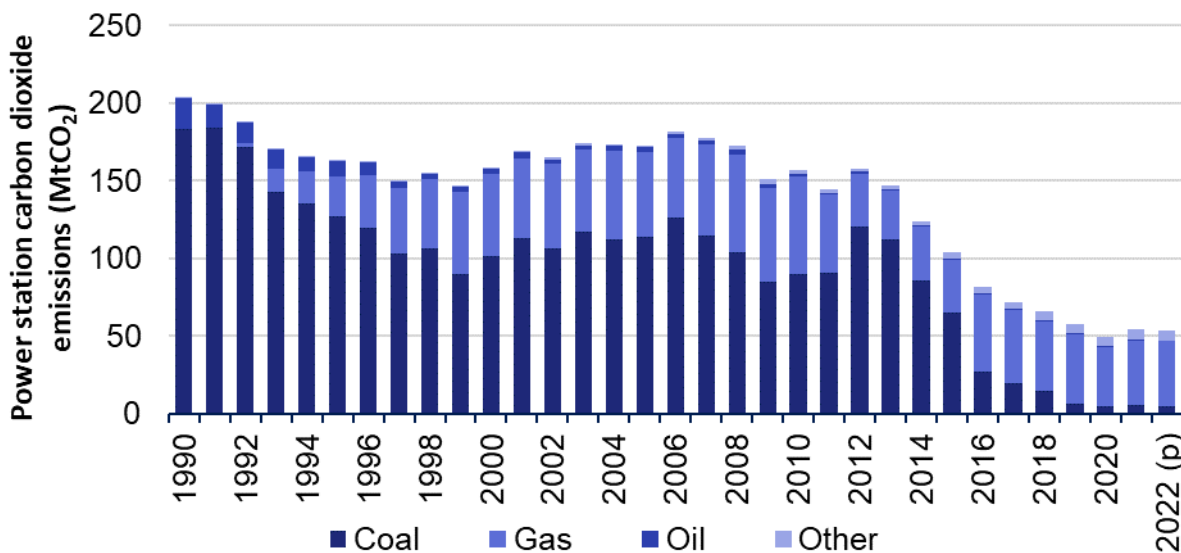
Figure 4: Fuel mix for UK electricity generation, 1990-2022 (Million tonnes of oil equivalent)



Source: Table 5.1.1, Digest of UK Energy Statistics (DUKES) 1970-2021 and Table 5.1 Energy Trends: March 2022 Excel data tables

Note: (p) 2022 estimates are provisional.

Figure 5: Territorial carbon dioxide emissions from power stations, UK, 1990-2022 (MtCO₂)

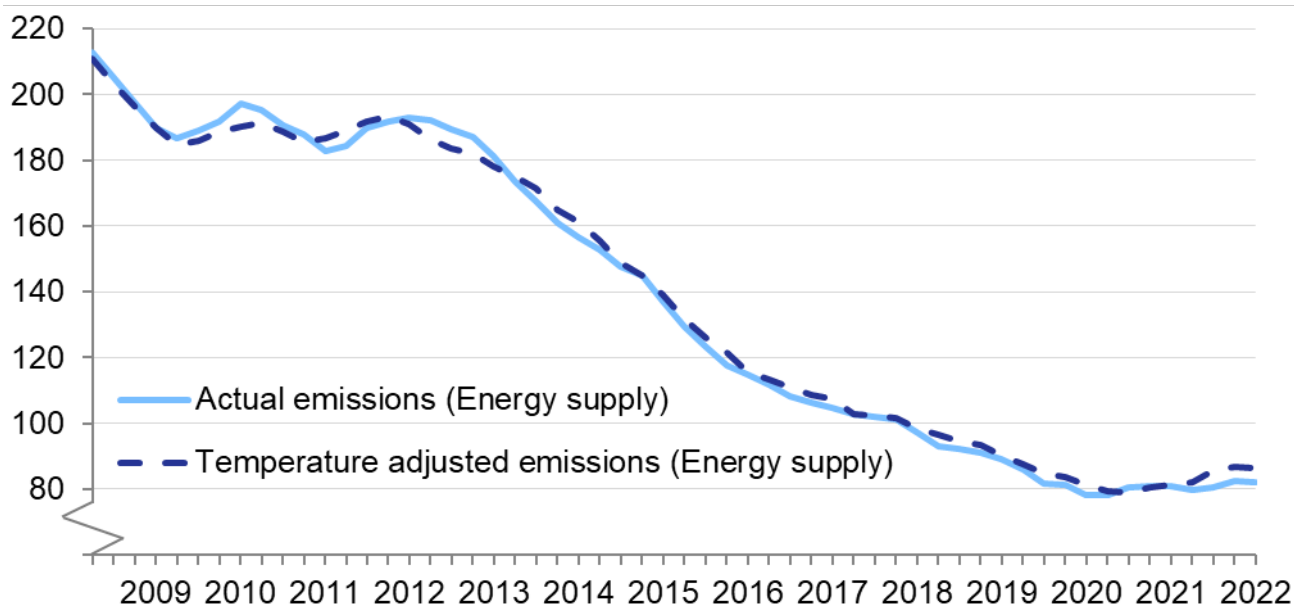


Source: Tables 1 & 2, Provisional UK territorial greenhouse gas emissions national statistics 1990-2022 Excel data tables

Note: (p) 2022 estimates are provisional.

The overall trend in temperature adjusted energy supply emissions is similar to the unadjusted trend, as the majority of electricity generated is used for other purposes rather than heating.

Figure 6: Actual and temperature adjusted energy supply carbon dioxide territorial emissions, UK, Year to Q1 2009 - Year to Q4 2022 (MtCO₂)



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

Transport sector

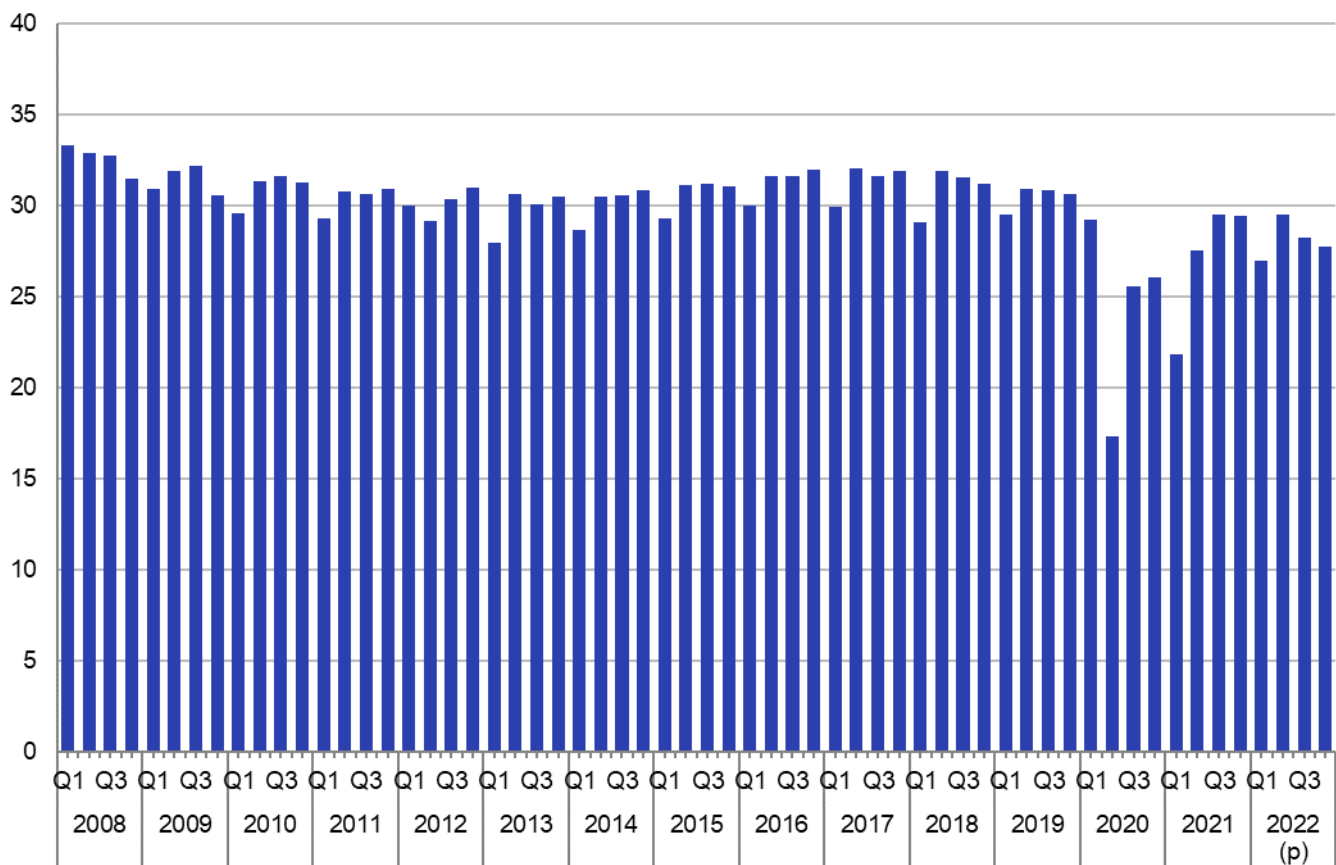
In 2020 transport was significantly impacted by COVID-19, as people were instructed to stay at home as much as possible. In 2021, COVID-19 restrictions were eased, and people were able to travel more freely. Following on from this, in 2022, all restrictions were removed, resulting in consecutive years of increasing territorial carbon dioxide emissions from the transport sector to 112.5 Mt, a 3.8% (4.2 Mt) rise from 2021, yet 7.7% (9.4 Mt) lower than in 2019. In 2022 transport accounted for 34.0% of all territorial carbon dioxide emissions, compared to 30.9% in 2020 and 34.0% in 2019 (pre-pandemic). The large majority of emissions from transport are from road transport.

Primarily as a result of a continual growth in vehicle kilometres travelled on roads⁸, transport carbon dioxide grew to a peak in 2007, 7.8% higher than in 1990. Since then, emissions from this sector had fallen back to around 1990 levels up until 2019, driven mainly by improvements in new car fuel efficiency⁹, as well lower traffic growth than in previous years as a result of a dip following the 2008/2009 recession.

It should be noted that these estimates do not include emissions from international aviation and shipping. Domestic aviation (i.e. flights taking off and landing within the UK) and shipping, however, are included.

⁸ Transport Statistics Great Britain, Roads and traffic (TSGB07), Table TSGB0702 (TRA0201) Road traffic (vehicle kilometres) by vehicle type in Great Britain, annual from 1949 <https://www.gov.uk/government/statistical-data-sets/tsqb07>

⁹ Transport Statistics Great Britain, Energy and environment (TSGB03), Table TSGB0303 (ENV0103) Average new car fuel consumption: Great Britain from 1997 <https://www.gov.uk/government/statistical-data-sets/tsqb03>

Figure 7: Quarterly territorial carbon dioxide emissions from transport, UK, 2008-2022 (MtCO₂)

Source: Table 5, Provisional UK territorial greenhouse gas emissions national statistics 1990-2022 Excel data tables

Note: (p) 2022 estimates are provisional.

Business sector

Territorial carbon dioxide emissions from the business sector were estimated to be 61.9 Mt in 2022 and accounted for around 18.7% of all carbon dioxide emissions. There has been a 43.8% decrease in business sector emissions since 1990. Most of this decrease came between 2001 and 2009, with a significant drop in 2009 likely to have been driven by economic recession.

Between 2021 and 2022 carbon dioxide emissions from this sector decreased by 4.1% (2.7 Mt), also meaning 2022 carbon dioxide emissions were 5.0% (3.3 Mt) lower compared to 2019. This decrease in 2022 is likely to have been influenced by the warmer temperatures, resulting in less heating used in buildings, and may have also been affected by higher energy prices. Trading volumes, the number of businesses trading, saw little change over the course of 2022¹⁰, along with UK GDP also plateauing over the time period¹¹.

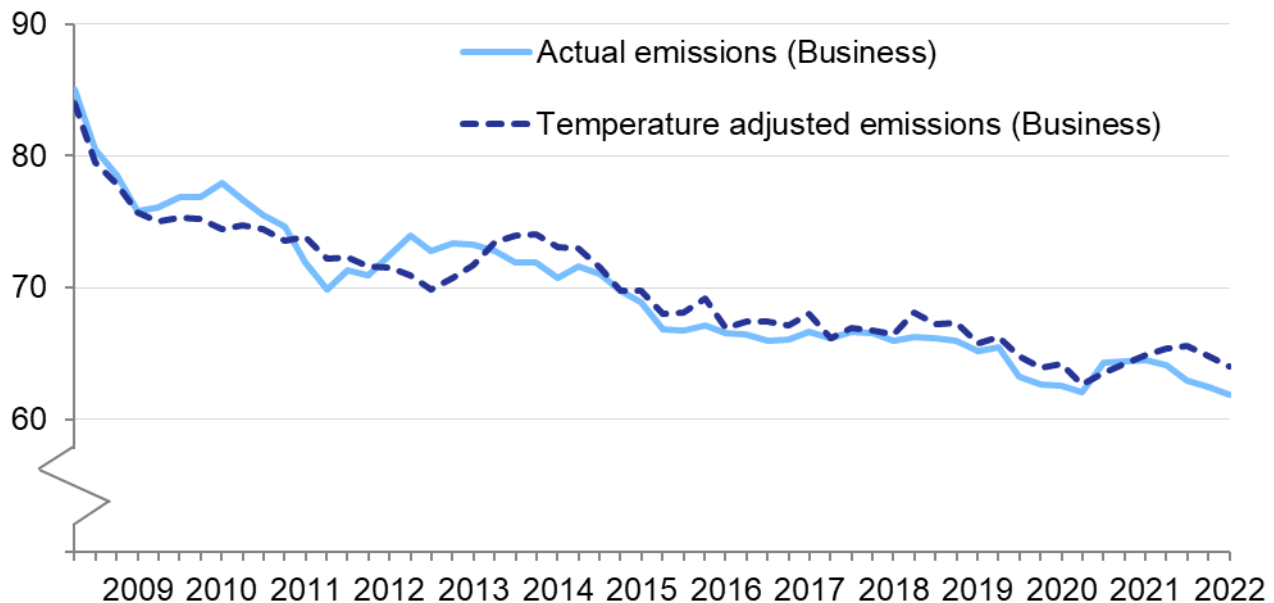
¹⁰ Business insights and impact on the UK economy, Office for National Statistics:

<https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/bulletins/businessinsightsandimpactontheukeconomy/23march2023>

¹¹ GDP monthly estimate, UK, Office for National Statistics:

<https://www.ons.gov.uk/economy/grossdomesticproductgdp/bulletins/gdpmonthlyestimateuk/january2023>

Figure 10: Actual and temperature adjusted annual business sector carbon dioxide territorial emissions, UK, Year to Q1 2009 - Year to Q4 2022 (MtCO₂)



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

- Note:
1. Figures are annual totals including the preceding 4 quarters.
 2. From year ending Q1 2022 onwards, figures include provisional data.

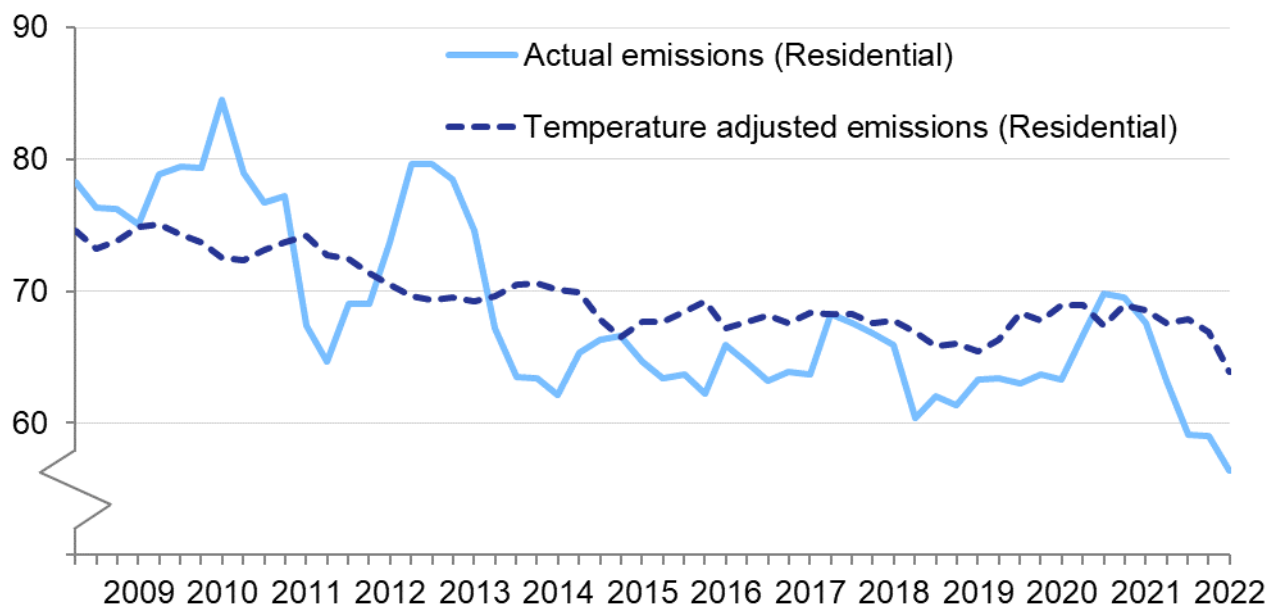
Residential

The main source of emissions in this sector is the use of natural gas for heating and cooking. It should be noted that emissions from this sector do not include emissions from the generation of electricity consumed, as these emissions are included in the energy supply sector.

In 2022, the residential sector emitted 56.4 MtCO₂, accounting for 17.0% of all carbon dioxide emissions in the UK. Between 2022 and 2021 territorial carbon dioxide emissions from the residential sector fell 16.5% (11.1 Mt), the third largest fall since the start of the series in 1990.

From 1990 to 2022 territorial carbon dioxide emissions from the residential sector have fallen by 27.9% (21.8 Mt). The decrease in carbon dioxide emissions between 2021 and 2022 was affected by the warmer weather in 2022, resulting in less energy being used to heat homes. It may have also been affected by higher energy prices, particularly in the final quarter of the year. The daily average temperature in 2022 was 0.9 degrees Celsius higher than the 30-year long-term mean (1991 – 2022) and 0.8 degrees higher than in 2021. If temperatures for both 2021 and 2022 had followed long-term trends then there would have still been a 6.8% (4.7 Mt) decrease. Residential emissions fluctuate owing to year-on-year variation in weather conditions, as seen in figure 8 below.

Figure 8: Actual and temperature adjusted annual residential carbon dioxide territorial emissions, UK, Year to Q1 2009 - Year to Q4 2022 (MtCO₂)



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

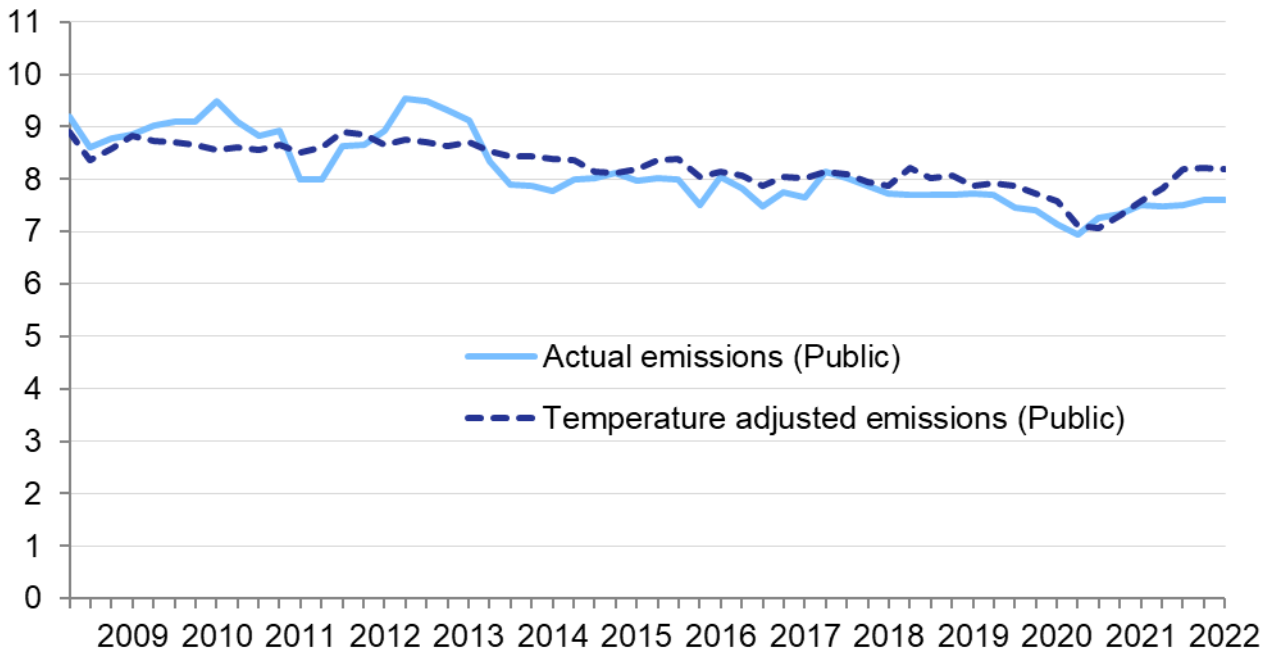
- Note:
1. Figures are annual totals including the preceding 4 quarters.
 2. From year ending Q1 2022 onwards, figures include provisional data.

Public sector

Natural gas for heating purposes is the main source of emissions in the public sector. Like the residential sector, emissions from the public sector do not include emissions from the generation of electricity consumed, as these emissions are included in the energy supply sector.

Emissions from the public sector were 7.6 MtCO₂ in 2022, a 1.4% (0.1 Mt) increase from 2021, and accounting for 2.3% of all territorial carbon dioxide emissions. These changes were affected by warmer weather in 2022. On a temperature adjusted basis between 2021 and 2022 we estimate there was a 8.0% (0.6 Mt) increase in emissions from the public sector. In the period from 1990 to 2022 territorial carbon dioxide emissions from the public sector decreased 52.4%.

Figure 9: Actual and temperature adjusted annual public sector carbon dioxide territorial emissions, UK, Year to Q1 2009 - Year to Q4 2022 (MtCO₂)



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

- Note:
1. Figures are annual totals including the preceding 4 quarters.
 2. From year ending Q1 2022 onwards, figures include provisional data.

Other sectors

For the *agriculture*, *waste management*, and *land use, land use change and forestry* (LULUCF) sectors provisional territorial carbon dioxide emissions cannot be derived based on energy statistics, so the carbon dioxide emissions from these sectors are assumed to be the same as they were in 2021. This is also the case for most of the emissions from the *industrial processes* sector.

Carbon dioxide emissions by fuel type

In the [data tables](#) accompanying this publication, table 2 shows UK territorial carbon dioxide emissions by sector and fuel type.

The combustion of fuel releases both energy and carbon dioxide. The amount of carbon dioxide released by the production of one unit of power depends on the type of fuel that is burned. For example, since coal has a higher carbon content than gas, more carbon dioxide emissions result from burning one tonne of coal to generate a unit of power than from one tonne of gas.

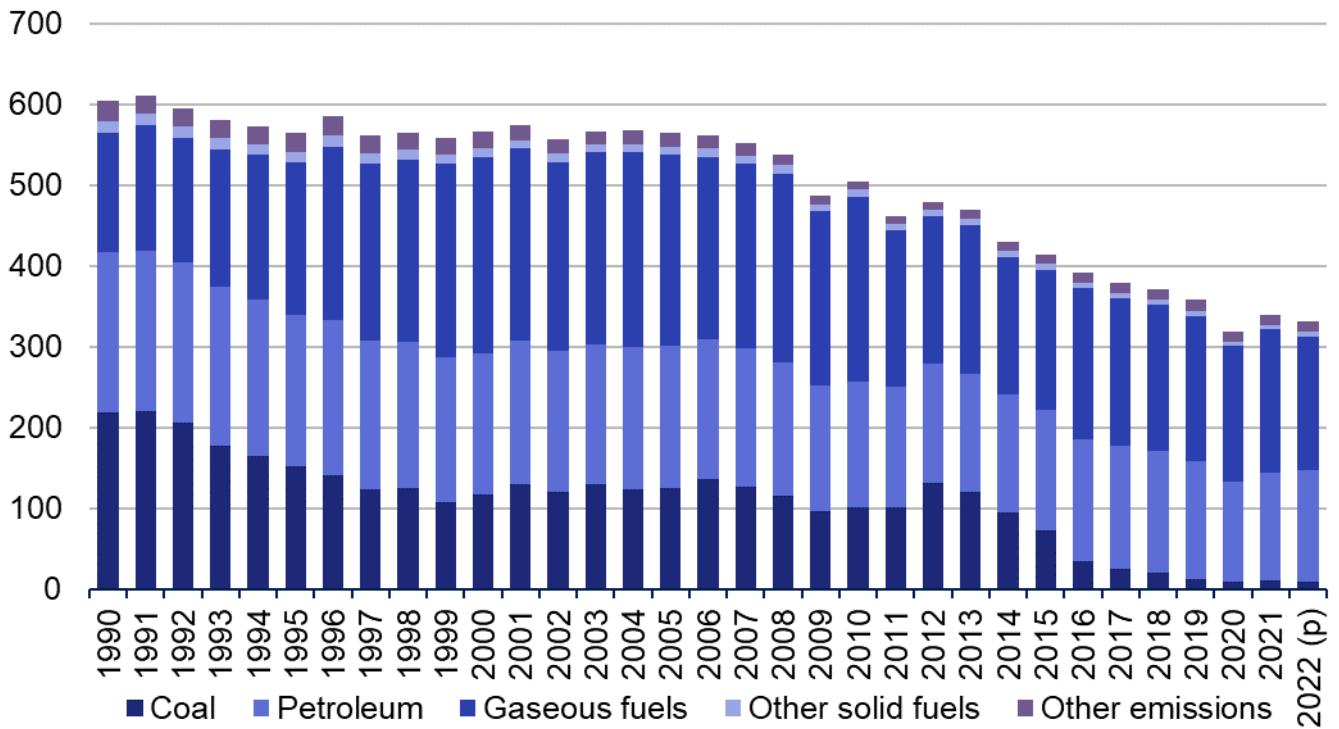
Emissions per unit of electricity supplied from fossil fuels are estimated to have been around 532 tonnes of carbon dioxide per gigawatt hour (GWh) overall in 2022 in the UK. Within this, emissions from electricity generated from coal (961 tonnes of carbon dioxide per GWh electricity supplied) were almost twice as high as for electricity supplied by gas (501 tonnes of carbon dioxide per GWh). For all sources of electricity (including nuclear, renewables and autogeneration), the average amount of carbon dioxide emitted in 2022 amounted to 269 tonnes per GWh of electricity supplied.

In 2022, total territorial carbon dioxide emissions from the use of fossil fuels, including fuel used for generating electricity, were estimated at 312.7 Mt. This was 2.7% less than the 2021 figure of 321.4 Mt and 7.4% lower than the 2019 figure of 337.6 Mt. The biggest absolute change in emissions was from the use of gas, down 10.9 Mt (6.2%) from 176.7 Mt in 2021 to 165.8 Mt in 2022. This largely resulted from the decrease in the use of heating in residential buildings due to, on average, 2022 being warmer than 2021 and possibly also due to higher energy prices. However, the largest percentage decrease in emissions came from the use of coal, down 13.9% (1.5 Mt) from 2021 to 2022, as a result of its decreased use in energy supply from power stations. Carbon dioxide emissions from the use of other solid fuels increased by 11.5% (0.6Mt) likely as a result of being an alternative to fossil fuels.

Over the period 1990 to 2022, carbon dioxide emissions from fossil fuels decreased by 44.7%. Over the same period, primary consumption of fossil fuels dropped by 27.9%. This relatively large decrease in emissions can be attributed to a large decrease in the use of coal accompanied by an increase in the use of gas.

Territorial carbon dioxide emissions from gas as a proportion of all carbon dioxide emissions from fossil fuels has increased from 26.2% in 1990 to 53.0% in 2022, whilst emissions from coal as a proportion of all fossil fuel carbon dioxide emissions has decreased from 38.7% to 3.0% over the same period. Oil was responsible for 35.1% of carbon dioxide emissions from fossil fuels in 1990 and this has increased to 44.0% in 2022.

Figure 11: UK Territorial carbon dioxide emissions by fuel type, 1990-2022 (MtCO₂)



Source: Table 2, Provisional UK territorial greenhouse gas emissions national statistics 1990-2022 Excel data tables

Note: (p) 2022 estimates are provisional.

2022 temperature adjusted provisional emissions results by sector

In the [data tables](#) accompanying this publication, table 3 shows quarterly moving annual totals for UK emissions and table 5 the totals for individual quarters, with tables 4 and 6 respectively showing the equivalent temperature adjusted estimates.

A temperature adjustment has been applied to the quarterly carbon dioxide emissions to estimate what the overall trend of territorial emissions would have been without the impact of differences in external temperatures. When temperatures are lower there is greater use of natural gas and electricity for heating buildings. Based on year-on-year percentage change, the sectors most affected by external temperatures are the residential sector and public sector.

Table 1 compares temperature adjusted and unadjusted carbon dioxide emissions by sector in 2022. The adjustments are based on the estimated historical impacts of temperatures on emissions, although as activity patterns were quite different to usual in 2020 and 2021 due to the coronavirus (COVID-19) pandemic, the adjustments may be less reliable in these years than in other years at reflecting what emissions might have been had temperatures followed the long-term average rather than the temperature pattern actually seen.

Table 1: Percentage changes in territorial carbon dioxide emissions by sector between 2021 and 2022 based on the temperature adjusted emissions and actual emissions

	Temperature adjusted emissions			Actual emissions		
	2021 (MtCO ₂)	2022 (MtCO ₂)	2021 - 2022 Percentage change	2021 (MtCO ₂)	2022 (MtCO ₂)	2021 - 2022 Percentage change
Energy supply	81.4	86.4	6.2%	80.8	82.2	1.7%
Business	64.9	64.1	-1.2%	64.6	61.9	-4.1%
Transport	108.4	112.5	3.8%	108.4	112.5	3.8%
Public	7.6	8.2	8.0%	7.5	7.6	1.4%
Residential	68.6	63.9	-6.8%	67.5	56.4	-16.5%
Other	10.8	10.9	1.0%	10.8	10.9	1.0%
Total CO₂	341.5	346.0	1.3%	339.5	331.5	-2.4%

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

Emissions from UK-based international aviation and shipping bunkers

In the [data tables](#) accompanying this publication, table 7 shows greenhouse gas emissions arising from use of fuels from UK international aviation and shipping bunkers since 1990. This is the first time that we have published a provisional estimate for these emissions.

Emissions from international aviation and shipping can be estimated from refuelling from bunkers¹² 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. They are therefore shown in a separate table from the UK territorial GHG emissions estimates in the final and provisional UK GHG emissions publications.

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. 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). 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.

It is important to note that whether emissions from refuelling at UK-based international aviation and shipping bunkers 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 2022, emissions from international aviation fuel use from UK bunkers were estimated to be 26.0 MtCO_{2e}. This was nearly double the 2021 figure, when it was 13.3 MtCO_{2e}, but was still 29.3% lower than in 2019, when it was 36.7 MtCO_{2e}, which was the highest annual figure since these estimates begin in 1990. This rise in 2022 was due to the large increase in air traffic after the much lower levels seen in the previous two years due to the COVID-19 pandemic. 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 6.6 MtCO_{2e} in 2022, an increase of 5.5% from the 2021 level, but still a decrease of 10.7% from the 2019 figure. These emissions did not see as pronounced a drop as aviation following the start of the COVID-19 pandemic, but also remain at a lower level than before the pandemic following the fall in shipping traffic that occurred during it. 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.

¹² A large container or compartment that stores fuel for ships or aircraft.

Figure 20: Greenhouse gas emissions from UK-based international aviation and shipping bunkers, 1990-2022 (MtCO₂e)



Source: Table 7, Provisional UK territorial greenhouse gas emissions national statistics 1990-2022 Excel data tables

Note: (p) 2022 estimates are provisional.

Accompanying tables

The following tables are available in Excel and ODS format on the department’s statistics website <https://www.gov.uk/government/collections/uk-territorial-greenhouse-gas-emissions-national-statistics>:

Table 1	UK annual territorial greenhouse gas emissions, including a breakdown by source sector for carbon dioxide emissions
Table 2	UK territorial carbon dioxide emissions by sector and fuel type
Table 3	UK territorial greenhouse gas emissions, annual totals to the end of each quarter
Table 4	UK temperature adjusted territorial greenhouse gas emissions annual totals to the end of each quarter
Table 5	UK territorial greenhouse gas emissions for individual quarters
Table 6	UK temperature adjusted territorial greenhouse gas emissions for individual quarters
Table 7	Estimated greenhouse gas emissions, arising from the use of fuels from UK international aviation and shipping bunkers

Technical information

Basis of the provisional emissions estimates

The estimates of carbon dioxide emissions in 2022 have been produced based on provisional inland energy consumption statistics which are published in BEIS's quarterly [Energy Trends](#) publication.

Carbon dioxide accounts for the majority of UK greenhouse gas emissions (80% in 2021). However, in order to give an indication of what the latest provisional carbon dioxide emissions estimates imply for the total, we need to also produce an estimate of emissions of the remaining non-CO₂ gases. Estimates of non-CO₂ gases are based on a simple approach which assumes that emissions of non-CO₂ gases in 2022 will change from the 2021 total in line with the percentage difference between the estimates for the 2021 and 2022 non-CO₂ emissions in the [Energy and Emissions Projections: 2021 to 2040](#) published by BEIS.

Estimates of emissions of all greenhouse gases for 1990-2021 come from the latest UK greenhouse gas inventory. Information about the methodology behind these estimates can be found in the [2021 final UK greenhouse gas emissions statistics](#).

Quarterly totals

In order to remove the seasonality in the data so that a trend in emissions over time can be observed, quarterly emissions are reported as annual totals, covering the stated quarter plus the preceding three quarters. When data becomes available for each new quarter, the estimates for the latest quarter are added to the total, while at the same time the estimates for the same quarter from the previous year are removed from the series. This procedure serves to smooth out short-term fluctuations and highlights long term trends and can be used to show the underlying trend each quarter. Emissions estimates for each individual quarter are also reported in the data tables accompanying this publication.

Temperature adjustment

Carbon dioxide emissions are indirectly influenced by external temperatures. During the winter months, emissions are generally higher than in summer months, due to higher demand for fuel for space heating. During a particularly cold winter for example, it is likely that more fuel will be burnt for domestic or commercial use than during an average winter, and therefore emissions will be higher due to the additional fuel consumption.

Temperature adjusted quarterly emissions estimates therefore remove the effect of external temperatures. In a particularly cold winter quarter, for example, this will result in temperature adjusted emissions being lower than actual emissions, reflecting the lower fuel consumption which would have occurred if temperatures had been at average levels (based on the 30-year period 1991-2020). Temperature adjustment is determined by the average number of heating degree days in each quarter. This information can be found in [Energy Trends](#).

We have changed the long-term average used in the temperature adjustment this year to be based on the 30-year period 1991-2020 rather than 1981-2010. This is in line with the change made in Energy Trends from June 2022, in which the long-term average used is updated every decade. Temperatures were on average warmer in the UK over the period 1991-2020 than 1981-2010 and there were on average 5.3% fewer heating degree days, so the temperature adjusted emissions values are now lower than they were under the previous calculation as we assume that less heating is used in an average year. But this should not have a significant effect on the trends derived from the adjusted data since all years are adjusted based on the same long-term average. More information about this change can be found in the article about long term mean temperatures in the [March 2022 Energy Trends](#).

Further details of how quarterly emissions have been estimated and of the methodology underlying the temperature adjusted estimates can be found alongside this statistical release in a separate [methodology summary](#).

Further information

Future updates to these statistics

On Thursday 29th June 2023 the Department for Energy Security and Net Zero will publish estimates of greenhouse gas emissions by local authority for 2021. We will also publish estimates of 1990-2021 UK territorial greenhouse gas emissions by Standard Industrial Classification (SIC), to supplement the sector breakdown included in the final 2021 UK greenhouse gas emissions publication.

Final estimates of UK greenhouse gas emissions for 2022 will be published as National Statistics in February 2024. These estimates will be based on the UK's Greenhouse Gas Inventory for 1990-2022.

In March 2024, the 1990-2022 UK emissions estimates will be updated to include estimates by end user and uncertainty estimates, and provisional 2023 greenhouse gas emissions estimates will be published.

Related publications

- The UK's National Inventory Report (NIR) for 1990-2021 will be submitted to the United Nations Framework Convention on Climate Change (UNFCCC) on 15th April 2023. The report will contain national greenhouse gas emissions estimates for 1990-2021 and descriptions of the methods used to produce the estimates. Previous reports 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.
- The Department for Energy Security and Net Zero also publishes [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 can be found on the [UNFCCC's website](#).
- ONS publishes emissions on a “residential” 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](#) and the [Energy Trends](#) quarterly bulletin produced by the Department for Energy Security and Net Zero. Any enquiries about the UK energy statistics should be sent to energy.stats@beis.gov.uk.
- Detailed UK temperature data can be found on both the Met Office website and the weather statistics section of the [Gov.uk website](#).

Revisions policy

Our [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](#).

Emissions estimates for 2022 are provisional and are based on UK energy statistics. They will be revised when the final 2022 estimates are published in February 2024. The full time series going back to 1990 will also be revised at this time in line with any methodology changes made to the UK greenhouse gas inventory.

Uses of these statistics

The provisional estimates are not used for any formal reporting of how the UK is performing against its emissions reduction targets, as this requires final estimates based on the UK's greenhouse gas inventory. However, these statistics give policy makers and other users an initial steer as to the trend in emissions between 2021 and 2022, which helps them to form an initial assessment of the extent to which the UK is on track to meet targets. They also include estimates of quarterly emissions and the impact on emissions of external temperature changes.

For more detailed information about the sources of UK greenhouse gas emissions and information on UK emissions targets and progress towards them, see the [2021 final UK greenhouse gas emissions statistics](#).

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@beis.gov.uk

Our 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 status means that our statistics meet the highest standards of trustworthiness, quality and public value, and it is our responsibility to maintain compliance with these standards.

The continued designation of these statistics as National Statistics was confirmed in September 2018 following a [compliance check](#) by the Office for Statistics Regulation. The statistics last underwent a [full assessment](#) against the [Code of Practice for Statistics](#) in 2014.

Since the latest review by the Office for Statistics Regulation, we have continued to comply with the Code of Practice for Statistics, and have made the following improvements:

- Improved the accuracy of the historic emissions estimates by continuing to make [methodological changes](#) to the UK's Greenhouse Gas Inventory.
- Improved the accuracy of the provisional estimates by reviewing and changing the methodology for making provisional estimates of non-CO₂ emissions.
- Provided more methodological and background information about the statistics in the statistical releases.
- Started to publish provisional estimates of greenhouse gas emissions from UK-based international aviation and shipping bunkers.

Pre-release access to statistics

Some ministers and officials receive 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 our [statement of compliance](#) with the Pre-Release Access to Official Statistics Order 2008.

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