



Department for
Energy Security
& Net Zero



UK GREENHOUSE GAS EMISSIONS: PROVISIONAL ESTIMATES

Methodology Summary

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Any enquiries regarding this publication should be sent to us at: GreenhouseGas.Statistics@beis.gov.uk

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Introduction

This document summarises how the provisional 2022 UK greenhouse gas (GHG) emissions estimates were derived, including the quarterly and temperature adjusted estimates that are included in this publication. The estimates show UK territorial GHG emissions, meaning emissions that occur within the UK's borders. The annual emissions estimates for years up to 2021 in this publication match those in the [final UK greenhouse gas emissions national statistics: 1990 to 2021](#), and information about how those estimates were produced can be found in that publication.

The Department for Energy Security and Net Zero currently publishes the final UK GHG emissions estimates 13 months after the end of the reference year. However, we are able to provide more timely provisional UK GHG emissions estimates, which are usually published at the end of March, 3 months after the end of the reference year. These are based on the energy use statistics published in [Energy Trends](#) (for carbon dioxide (CO₂) emissions), and the latest published [Energy & Emissions Projections](#) (EEP, for non-CO₂ GHG emissions).

While the provisional figures for CO₂ emissions include breakdowns by sector and fuel type, only overall totals for non-CO₂ emissions are included in the provisional estimates.

The provisional UK greenhouse gas emissions publication also includes:

- Quarterly greenhouse gas emissions estimates for the years 2008 onwards
- Temperature adjusted greenhouse gas emissions for the years 2008 onwards

Provisional estimates are also made for emissions from UK-based international aviation and shipping bunkers, which are not included in the UK GHG emissions totals. These are also based on energy use statistics from Energy Trends, with the same method used to estimate CO₂ and non-CO₂ gases.

Only UK emissions are included in the provisional estimates. The Crown Dependencies and Overseas Territories for which estimates are made in the final GHG emissions publication are not included.

Provisional UK greenhouse gas emissions estimates

For the purpose of producing the provisional UK estimates, GHG emissions are classified into three categories:

1. Carbon dioxide (CO₂) emissions based on energy use data
2. CO₂ emissions not based on energy use data
3. Other greenhouse gas emissions (non-CO₂).

When deriving the provisional annual UK GHG emissions estimates and the quarterly estimates a different approach is taken for each of these three categories of emissions, as summarised in Table A.

Table A: The approaches taken for estimating provisional annual UK GHG emissions and quarterly emissions

	Provisional annual estimates	Quarterly estimates
CO₂ emissions based on energy use data	For individual activities/fuel types, year on year growth factors are applied to the latest final emissions figures to derive provisional estimates for the following year. These are based on looking at year on year changes in energy use for the closest corresponding sector/fuel type included in the <i>Energy Trends</i> publication.	For a given activity/ fuel type, annual emissions are allocated to individual quarters within each year in proportion to the quarterly energy use. This is based on the looking at same sector/fuel types in <i>Energy Trends</i> as for the provisional annual estimates.
CO₂ emissions not based on energy use data	For these activities/fuel types, the provisional figures are taken to be the same as the final figures for the previous year, so no change is assumed between the two years.	For each year in the series these emissions are allocated equally between the four quarters.
Non-CO₂ greenhouse gas emissions	A growth factor is applied to the final non-CO ₂ emissions for the previous year. This growth factor is based on the year on year growth in total non-CO ₂ GHG emissions forecast in the latest published <i>Energy and Emissions Projections</i> .	For each year in the series these emissions are allocated equally between the four quarters.

Carbon dioxide emissions derived from energy use

For the vast majority of net CO₂ emissions (95% in the 2021 final UK figures), the provisional emissions estimates are based on energy use data published in Energy Trends on the same day that the provisional GHG emissions estimates are published. To produce the estimates it is assumed that the percentage change in CO₂ emissions between the latest two years is the same as the change in energy use for a particular activity and fuel between the latest two years. E.g. if the volume of gas used in power stations has reduced by 5% in the energy data we assume that CO₂ emissions from the use of gas in power stations reduced by 5%.

The emissions that are scaled this way are put into 28 groups based on the source sectors and fuels shown in Table B, and a scaling factor is calculated for each one from the energy use data. For a small number of sources, emissions from energy use are kept flat if there is no suitable data available in Energy Trends to scale it by. All agriculture CO₂ emissions are also kept flat, since energy use only makes up a small proportion of emissions in this sector.

Table B: Source sector and fuel categories for which scaling factors are produced from Energy Trends data to estimate provisional CO₂ emissions

Source Sector	Fuel
Power stations	Coal
Power stations	Other solid fuels
Power stations	Oil
Power stations	Gas
Other energy supply	Coal
Other energy supply	Other solid fuels
Other energy supply	Oil
Other energy supply	Gas
Transport	Motor Spirit
Transport	DERV
Transport	Gas (road vehicles)
Transport	Aviation fuels
Transport	Other fuels
Public	Coal
Public	Oil
Public	Gas
Residential	Coal
Residential	Other solid fuels
Residential	Oil
Residential	Gas
Commercial and miscellaneous combustion and electricity	Coal
Commercial and miscellaneous combustion and electricity	Oil
Commercial and miscellaneous combustion and electricity	Gas
Others	Coal
Others	Oil
Others	Gas
Others	Coke oven gas
Others	Other solid fuels

Carbon dioxide emissions not derived from energy use

The remainder of CO₂ emissions are assumed to have remained unchanged from the previous year. While this is only the case for 5% of net CO₂ (based on the 2021 final UK figures) this is particularly relevant for some sectors. For the *agriculture, waste management, and land use, land use change and forestry* (LULUCF) sectors all CO₂ emissions are treated in this way, even if they relate to energy use. This is also the case for most emissions from the *industrial processes* sector. Based on the final 2021 UK emissions estimates, Table C shows for each sector the proportion of CO₂ emissions for which the provisional estimates are not derived from energy use, and are therefore taken to be unchanged from the previous year.

Table C: Percentage of CO₂ emissions for which the provisional emissions estimates are not derived from energy use data, based on the final 2021 UK emissions

Sector	Percentage of CO ₂ emissions not derived from energy use data
Energy supply	11%
<i>from power stations</i>	12%
<i>other Energy supply</i>	10%
Business	1%
Transport	0%
Public	0%
Residential	0%
Agriculture	100%
Industrial processes	68%
Waste management	100%
LULUCF	100%
Total CO₂ emissions	5%

Non-carbon dioxide emissions

Non-CO₂ GHG emissions make up around a fifth of total GHG emission in the UK when measured on a carbon dioxide equivalent basis. The provisional annual total for non-CO₂ emissions is derived from applying a year on year growth factor to the previous year's total, based on looking at the percentage change between the projections for non-CO₂ emissions for the two years in the latest published [Energy & Emissions Projections \(EEP\)](#).

This approach was first introduced for the 2018 provisional estimates. Previously the provisional estimates had assumed that the total non-CO₂ emissions remained unchanged from the previous year. But as they have been consistently falling in recent years, and this is projected to continue, this approach was found to be consistently overestimating non-CO₂ emissions and using the projections would have been more reliable.

The reliability of the provisional annual GHG emissions figures

Table D looks at the estimated year on year growth in GHG emissions (both total GHG emissions and total CO₂ emissions), comparing the results based on the provisional figures with those based on the final figures published almost a year later. Overall, the year-on-year percentage change indicated by the provisional figures has usually been within a percentage point of the change shown by the final figures.

Table D: Differences between provisional and final GHG emissions estimates

	Year on year percentage change					
	CO ₂ emissions			Total GHG emissions		
	Provisional estimate	Final estimate	Percentage point difference	Provisional estimate	Final estimate	Percentage point difference
2012	+4.5%	+4.4%	+0.1	+3.4%	+3.2%	+0.2
2013	-2.1%	-1.8%	-0.3	-1.9%	-2.4%	+0.5
2014	-9.7%	-8.9%	-0.8	-8.4%	-7.7%	-0.7
2015	-4.1%	-4.1%	0.0	-3.4%	-3.8%	+0.4
2016	-7.4%	-5.9%	-1.5	-6.0%	-5.0%	-1.0
2017	-3.2%	-3.3%	+0.1	-2.6%	-2.7%	+0.1
2018	-2.4%	-2.2%	-0.2	-2.5%	-2.1%	-0.4
2019	-3.9%	-3.3%	-0.6	-3.6%	-2.8%	-0.8
2020	-10.7%	-10.6%	-0.1	-8.9%	-9.5%	+0.6
2021	+6.3%	+6.6%	-0.3	+4.7%	+5.0%	-0.3

Temperature adjusted emissions estimates

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. The temperature adjustment makes use of figures on the number of heating degree days, and how they deviate from the long-term average for the given time of year. This information is published in the *Weather* section of *Energy Trends*: www.gov.uk/government/statistics/energy-trends-section-7-weather

Emissions are only temperature adjusted for certain activities and fuel types, as not all emissions are affected by external temperatures. To decide whether emissions from a given activity/fuel type should be temperature adjusted or not, and if so by how much, the following procedure has been followed:

- A simple linear regression is established between the quarterly emissions for a given sector/fuel type and the quarterly average heating degree days, from 2002 to 2019 (later years are not currently included because of the behavioural changes seen during the COVID-19 pandemic).
- Identify the coefficient of determination (R^2), which measures how well the regression line approximates the data points. This takes a value between 0 and 1. The closer the R^2 is to 1, the stronger the correlation between the emissions from the given sector/fuel type and the number of heating degree days, while values closer to 0 indicate little to no correlation between them.
- Conduct a statistical test on the coefficient of each individual regression. If the coefficient is statistically significantly different from zero, and the R^2 is sufficiently high, then emissions for that given activity/fuel type are temperature adjusted. Otherwise, there is assumed to be no temperature effect, and therefore no adjustment required.

- CO₂ emissions are adjusted for each sector and fuel by using the gradient from the regression model as an estimate of the additional emissions per additional heating degree day. For a given quarter we look at the number of heating degree days by which it deviated from the typical amount of heating required in that quarter of the year (as given by the long-term average for the period 1991-2020).
- Multiplying this deviation by our estimate of the additional emissions per additional heating degree day for the given sector/fuel type gives the estimated temperature effect on CO₂ emissions. This temperature effect is then removed to give the temperature adjusted emissions for that quarter.

It should be noted that the temperature adjustment is intended to remove the effect of temperatures varying between years, and it does not adjust for the usual within-year seasonal variation in temperatures. So the temperature adjusted estimate for a particular quarter reflects what we estimate emissions would have been if the temperatures that quarter had been in line with the long-term average for that quarter.

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](#).

The non-CO₂ GHG emissions estimates and estimates of emissions from UK-based international aviation and shipping bunkers are not temperature adjusted.

Emissions from UK-based international aviation and shipping bunkers

Emissions from international aviation and shipping can be estimated from refuelling from bunkers¹ at UK airports and ports, whether by UK or non-UK operators. Under the reporting guidelines agreed by the United Nations Framework Convention on Climate Change (UNFCCC), these emissions are not included in the UK's emissions total that is submitted to the UNFCCC each year 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.

Provisional estimates of GHG emissions from UK-based international aviation and shipping bunkers were first included in the provisional 2022 UK GHG emission estimates. These estimates are made following the same approach used for carbon dioxide emissions derived from energy use in the UK provisional totals, using Energy Trends data. To produce the estimates it is assumed that the percentage change in emissions between the latest two years is the same as the change in the equivalent energy use between those two years. For emissions from international shipping the marine bunkers estimates from Energy Trends are used; and for emissions from international aviation bunkers we use the estimates for aviation fuels (the large majority of which are used for international aviation). This approach is used for all three greenhouse gases for which we produce estimates, not just carbon dioxide.

Quarterly and temperature adjusted emissions estimates are not made for these emissions.

¹ A large container or compartment that stores fuel for ships or aircraft.

The reporting of the greenhouse gas emissions

Emissions by source and end-user

The provisional, quarterly and temperature adjusted greenhouse gas (GHG) emissions figures are all presented on a “by source” basis only. This means that emissions are attributed to the sector that emits them directly.

This is different from emissions on a “by end-user” basis, where emissions from energy production are re-allocated to the final user of the energy. For example, all GHG emissions produced by a power station are allocated to the power station when reporting on a by source basis. However, when applying the end-user method, these emissions are re-allocated to the users of this electricity, e.g. households and businesses.

The final GHG emissions figures are published on both a “by source” and a “by end-user” basis.

National Communication sectors

For the purposes of reporting, greenhouse gas emissions are allocated to National Communication (NC) sectors. This small number of high-level sectors is listed in Table E.

These high-level sectors are made up of a number of more detailed categories, which largely follow the definitions set out by the [Intergovernmental Panel on Climate Change \(IPCC\)](#) and which are used in international reporting tables, submitted to the United Nations Framework Convention on Climate Change (UNFCCC) each year.

Table E: Emissions included in each National Communication sector

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.

This publication is available from: <https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-national-statistics-2022>

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