Department for Energy Security & Net Zero

2024 UK Greenhouse Gas Emissions, Provisional Figures

Methodology Summary

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Introduction

This document summarises how the provisional 2024 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 GHG emissions that occur within the UK's borders, and are presented on a "by source" basis, meaning that emissions are attributed to the sector that emits them directly. The annual GHG emissions estimates for years up to 2023 in this publication match those in the 2023 final UK greenhouse gas emissions statistics and information about how those estimates were produced can be found in that publication.

The Department for Energy Security and Net Zero (DESNZ) currently publishes final UK GHG emissions estimates 13 months after the end of the reference year. However, a more timely provisional estimate of UK GHG emissions is made at the end of March, 3 months after the end of the reference year. The provisional estimates are based on provisional energy use statistics published in Energy Trends (for energy use GHG emissions), and the latest published Energy and Emissions Projections (EEP, for other GHG emissions).

For the purposes of reporting, we allocate GHG emissions into Territorial Emissions Statistics (TES) sectors[1]. The provisional statistics include breakdowns by these high-level TES sectors and type of fuel. In addition, the buildings and product uses TES sector is disaggregated into residential buildings, commercial buildings, public buildings, and other buildings and product uses TES subsectors. Further breakdowns are not available in the provisional statistics.

The provisional UK GHG emissions statistics publication also includes:

- Quarterly GHG emissions estimates for the years 2008 onwards
- Temperature adjusted GHG emissions for the years 2008 onwards
- Provisional estimates of GHG emissions from UK-based international aviation and shipping that are not included in the UK GHG emissions totals.

Only UK GHG 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.

[1] The TES sectors are electricity supply, fuel supply, domestic transport, buildings and product uses, industry, agriculture, waste, and land use land use change and forestry (LULUCF). Full sector definitions can be found in the statistical release that this methodology summary accompanies: https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-statistics-2024

Provisional UK GHG emissions estimates

For the provisional estimates, GHG emissions are classified into four categories:

1. Energy use GHG emissions estimated through use of energy use data
2. Energy use GHG emissions estimated to remain constant
3. Non-energy use GHG emissions estimated to follow projections
4. Non-energy use GHG emissions estimated to remain constant.

The approach taken to estimate annual and quarterly GHG emissions for each of these four categories is summarised in Table 1.

Table 1: Approaches for estimating provisional annual and quarterly UK GHG emissions

	Annual estimates	**Quarterly estimates**
Energy use GHG emissions derived from energy use data	For individual activities/fuel types, year-on-year growth factors are applied to the latest final GHG emissions estimates to derive provisional estimates for the following year. These are based on year-on-year changes in energy use for the closest corresponding sector and fuel type included in the Energy Trends publication.	For individual activities and fuel types, annual GHG emissions are allocated to individual quarters within each year in proportion to quarterly energy statistics, using the same sector and fuel data series used to derive the provisional annual estimate for the latest year.
Energy use GHG emissions held constant	For these activities and fuel types, provisional estimates are taken to be the same as the final estimates for the previous year, so no change is assumed between the two years.	For each year in the series these GHG emissions are allocated equally between the four quarters.
Non-energy use GHG emissions derived from projections	For each category and gas, a growth factor is applied to the final GHG emissions total for the previous year. This growth factor is based on the year-on-year change in GHG emissions forecast for that category and gas in the latest published EEP.	For each year in the series these GHG emissions are allocated equally between the four quarters.
Non-energy use GHG emissions held constant	For these activities and fuel types, provisional estimates are taken to be the same as the final estimates for the previous year, so no change is assumed between the two years.	For each year in the series these GHG emissions are allocated equally between the four quarters.

Table 2 shows the percentage shares of GHG emissions for each methodological approach by the TES sectors presented in the provisional statistics.

Table 2: Percentage of GHG emissions for each methodological approach in the provisional estimates by TES sector, based on the final 2023 UK GHG emissions

TES sector	Energy use GHG emissions derived from energy use data	Energy use GHG emissions held constant	Non-energy use GHG emissions derived from projections	Non-energy use GHG emissions held constant
Electricity supply	84%	16%	0%	0%
Fuel supply	76%	~0%	0%	24%
Domestic transport	98%	~0%	1%	~0%
Buildings and product uses	92%	2%	7%	~0%
Residential buildings	99%	1%	0%	0%
Commercial buildings	98%	2%	0%	0%
Public sector buildings	98%	2%	0%	0%
Other buildings and product uses	0%	7%	93%	~0%
Industry	84%	3%	12%	1%
Agriculture	11%	~0%	88%	0%
Waste	0%	0%	100%	0%
LULUCF	0%	0%	100%	0%
Total GHG emissions	**76%**	**3%**	**20%**	**2%**

Notes: 1. LULUCF is land use, land use change and forestry

2. ~0% indicates where a value is non-zero but is less than 0.5% in magnitude. 0% indicates a zero value.

Table 3 shows the percentage shares of GHG emissions for each methodological approach by gas.

Table 3: Percentage of GHG emissions for each methodological approach in the provisional estimates by gas, based on the final 2023 UK GHG emissions

Gas	Energy use GHG emissions derived from energy use data	Energy use GHG emissions held constant	Non-energy use GHG emissions derived from projections	Non-energy use GHG emissions held constant
Carbon dioxide (CO2)	96%	3%	~0%	1%
Methane (CH4)	1%	2%	89%	8%
Nitrous oxide (N2O)	7%	3%	90%	~0%
Hydrofluorocarbons (HFCs)	0%	0%	100%	0%
Perfluorocarbons (PFCs)	0%	0%	100%	0%
Sulphur hexafluoride (SF6)	0%	0%	100%	0%
Nitrogen trifluoride (NF3)	0%	0%	100%	0%
Total GHG emissions	**76%**	**3%**	**20%**	**2%**

Note: ~0% indicates where a value is non-zero but is less than 0.5% in magnitude. 0% indicates a zero value.

Energy use GHG emissions derived from energy use data

Provisional emissions estimates for the majority of GHG emissions (76% in the 2023 final UK statistics) are based on provisional energy statistics published in Energy Trends on the same day as the provisional GHG emissions estimates. To produce these estimates, it is assumed that the percentage change in GHG emissions between the latest two calendar years is the same as the percentage change in the corresponding energy use over the same period. For example, if the volume of gas used in power stations has reduced by 5% in the energy data, it is assumed that GHG emissions from the use of gas in power stations reduced by 5%.

The GHG emissions are scaled in proportion to energy use data that are categorised into 29 groups based on the GHG emissions categories and fuels shown in Table 4. For each group, a scaling factor is calculated from the energy use statistics. These scaling factors are then applied to the GHG emissions allocated to that group to derive the provisional estimates.

Table 4: GHG emissions categories and fuels for which scaling factors are produced from Energy Trends data to estimate provisional GHG emissions

GHG Emissions category	Fuel
Power stations	Coal
Power stations	Gas
Other energy industry	Coal
Other energy industry	Oil
Other energy industry	Gas
Road transport	Motor Spirit
Road transport	DERV
Road transport	LPG
Road transport	Gas
Rail	Coal
Rail	Oil
Aviation	Oil
Waterborne transport	Oil
Residential buildings	Coal
Residential buildings	Other solid fuels
Residential buildings	Oil
Residential buildings	Gas
Commercial buildings	Coal
Commercial buildings	Gas
Public sector buildings	Coal
Public sector buildings	Gas
Industry	Coal
Industry	Other solid fuels
Industry	Gas
Industry	Blast furnace gas
Industry	Coke oven gas
Agriculture	Coal
Agriculture	Oil
Non-residential	Oil

Energy use GHG emissions held constant

A small number of energy use GHG emissions are held constant from the previous year in the provisional estimates as there is no suitable data available in Energy Trends to scale it by. Whilst only 3% of total energy use GHG emissions (based on the 2023 final UK statistics) are assumed to remain constant in the provisional estimates, this method is particularly prominent for some activities and fuels. For example, all GHG emissions from biogenic fuel use and waste combustion for energy are assumed to remain constant in the provisional estimates.

Non-energy use GHG emissions derived from projections

Non-energy use GHG emissions make up 22% of total UK GHG emissions (based on the 2023 final UK statistics). The majority of these GHG emissions (90% in the 2023 final UK statistics), provisional estimates are derived through use of the projections in the latest EEP publication and contribute 20% of total UK GHG emissions (based on the 2023 final UK statistics). To produce these estimates, it is assumed that the percentage change in GHG emissions between the latest two years is the same as the projected percentage change in the corresponding category and gas over the same period. Projected percentage changes are derived from the reference scenario in the latest EEP publication. For example, if the latest EEP publication projects a 1% fall in methane emissions from agricultural soils for the year that provisional estimates are being produced, it is assumed that methane emissions from agriculture soils have fallen by 1%.

As shown in Table 2, the provisional estimates for the agriculture, waste and LULUCF sectors, as well as for the other buildings and product uses subsector are largely derived from projections. Correspondingly, these sectors are marked as estimates in the published tables to denote that these totals are less reliable than the totals for the other sectors.

Non-energy use GHG emissions held constant

Like the energy use GHG emissions, a small number of non-energy use GHG emissions are held constant from the previous year in the provisional estimates. This is because these non-energy GHG emissions are not separated from energy use GHG emissions in the proxy projections. Overall, these GHG emissions account for 9% of total non-energy related GHG emissions and 2% of total GHG emissions (based on the 2023 final UK statistics). The most significant sources of GHG emissions in this category are fugitive GHG emissions in the fuel supply sector.

The reliability of the provisional GHG emissions estimates

Table 5 compares estimates of year-on-year growth in total GHG emissions from the provisional statistics with those from the final statistics published almost a year later. Overall, the year-on-year percentage change indicated in the provisional statistics has usually been within one percentage point of the change estimated in the final statistics.

Table 5: Percentage differences between provisional and final GHG emissions estimates

	Total GHG emissions		
	Provisional estimate	**Final estimate**	**Percentage point difference**
2012	+3.4%	+3.2%	**+0.2**
2013	-1.9%	-2.4%	**+0.5**
2014	-8.4%	-7.7%	**-0.7**
2015	-3.4%	-3.8%	**+0.4**
2016	-6.0%	-5.0%	**-1.0**
2017	-2.6%	-2.7%	**+0.1**
2018	-2.5%	-2.1%	**-0.4**
2019	-3.6%	-2.8%	**-0.8**
2020	-8.9%	-9.5%	**+0.6**
2021	+4.7%	+5.0%	**-0.3**
2022	-2.2%	-3.5%	**+1.3**
2023	-5.4%	-4.9%	**-0.5**

Temperature adjusted GHG emissions

Energy use GHG emissions are indirectly influenced by external temperatures. During the winter months, GHG 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 GHG emissions will be higher due to the additional fuel consumption.

Temperature adjusted GHG emissions estimates remove the effect of external temperatures. In a particularly cold winter quarter, for example, this will result in temperature adjusted GHG emissions that are lower than actual emissions, reflecting the lower fuel consumption that would have occurred if temperatures had been at average levels. The temperature adjustment makes use of statistics 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 Energy Trends.

Temperature adjustments are only applied to certain activities and fuel types, as not all GHG emissions are affected by external temperatures. The following procedure has been used to determine whether a GHG emissions source should receive a temperature adjustment:

- A simple linear regression is established between the GHG emissions for a given category and fuel type combination and the 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).

- Coefficients of determination (R^2) are calculated, measuring how well the regression line approximates the data points. The R^2 takes a value between 0 and 1; the closer it is to 1, the stronger the correlation between the GHG emissions from the given sector and fuel type combination and the number of heating degree days.

- If the coefficient from the regression model is statistically significantly different from zero, and the R^2 is sufficiently high, then GHG emissions for that given category and fuel type are temperature adjusted. Otherwise, there is assumed to be no temperature effect, and therefore no adjustment required.

- GHG emissions are adjusted for each category and fuel combination by using the coefficient from the regression model as an estimate of the additional GHG 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 the estimate of the additional GHG emissions per additional heating degree day for the given category and fuel combination gives the estimated temperature effect on GHG emissions. This temperature effect is then removed to give the temperature adjusted GHG emissions.

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. Therefore, quarterly temperature adjusted GHG emissions estimates provide an indication of what GHG emissions would have been if the temperatures that quarter had been in line with the long-term average for that quarter.

The long-term average used in the temperature adjustment is based on the 30-year period 1991-2020. The 30-year period used is usually updated every decade, with the most recent change being made in Energy Trends from June 2022. The period used will affect the absolute level of the temperature adjusted GHG emissions values, 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 the most recent change can be found in the article about long term mean temperatures in the March 2022 Energy Trends.

Provisional GHG emissions from international aviation and shipping

GHG emissions from international aviation and shipping can be estimated from refuelling from bunkers[2] 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 GHG emissions are not included in UK emissions totals that are submitted to the UNFCCC each year but are reported as memo items in national GHG 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 energy use GHG 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 GHG emissions from international shipping, the marine bunkers estimates from Energy Trends are used. For GHG emissions from international aviation, estimates for aviation fuels (the large majority of which are used for international aviation) are used. A small proportion of international aviation GHG emissions are related to lubricant use and cannot be estimated through energy statistics. Instead, these GHG emissions are held constant. This approach is consistent with provisional estimates of domestic transport sector GHG emissions from lubricant use.

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

[2] A large container or compartment that stores fuel for ships or aircraft.

Methodology changes

Methodologies for calculating provisional estimates are periodically updated as our understanding of the factors affecting emissions trends improves and more detailed information becomes available. Methodological changes included in the provisional 2024 GHG emissions estimates improve the apportionment of energy use data for estimation of energy use GHG emissions. In addition, energy use non-CO2 emissions have been estimated through use of energy data for the first time. Previously, all non-CO2 emissions estimates were based on the latest EEP publication. Details of the methodology changes are given below.

Industrial manufactured fuel use

Estimates of GHG emissions from industrial and energy industry use of blast furnace gas, coke oven gas, and other manufactured solid fuels have been updated to use more appropriate provisional energy balance data. Previously, Energy Trends data on manufactured solid fuel use was applied in estimations of GHG emissions from use of blast furnace gas. More appropriate proxy Energy Trends data for blast furnace gas has now been identified and is applied to estimate the corresponding blast furnace gas use GHG emissions. In addition, more appropriate Energy Trends data for coke oven gas use has been introduced into models for estimating GHG emissions from coke oven gas use.

Rail and waterborne fuel use

Rail and waterborne oil and coal use GHG emissions are now estimated through use of separate trends in the Energy Trends data.

Previously, Energy Trends rail and waterborne oil use data were aggregated to produce an ‘other transport’ (i.e. non-road and non-aviation) scaling factor, and the resultant trend applied to estimate all rail and waterborne GHG emissions, as well as residual GHG emissions in the domestic transport sector such as those from stationary combustion and lubricant use. However, estimation of GHG emissions from rail coal use, rail oil use, and waterborne oil use separately, through use of the corresponding energy balance data, is deemed to provide more reliable GHG emissions estimates when compared to the previous use of an aggregate trend. Meanwhile, residual GHG emissions from the domestic transport sector are now held constant in the absence of appropriate Energy Trends proxy data.

Road gas use

Estimates of GHG emissions from road use of natural gas and liquid petroleum gas have been updated to use more appropriate provisional energy balance data. Previously, Energy Trends data for liquid petroleum gas use on roads was erroneously applied in estimations of GHG emissions road use of natural gas.

Non-residential oil use

Non-residential oil use GHG emissions are now estimated through use of the aggregate trend in non-residential oil use.

Previously, estimates of oil use GHG emissions were calculated at a sectoral level through use of sectoral oil consumption data in Energy Trends. However, reallocations of DUKES sectoral oil consumption data in UK GHG Inventory modelling mean that the sectoral consumption trends are unreliable for estimating oil use GHG emissions for most sectors. Instead, the aggregate trend in non-residential oil use is deemed to provide a more reliable estimate of total GHG emissions from oil use and is now used in place of individual estimates for commercial, public sector, and power station use of oil.

In addition, the aggregate non-domestic oil use data also includes agricultural use of oil. Correspondingly, the non-residential oil use trend is also employed to estimate GHG emissions from oil use in the agriculture sector for the first time. Prior to this change, GHG emissions from oil use in the agriculture sector were assumed to be constant in provisional estimates.

Agriculture coal and gas use

To align with use of energy data for estimating oil use GHG emissions in the agriculture sector for the first time, provisional estimates of GHG emissions from coal and gas use in the agricultural sector have also been updated to be based on data from Energy Trends. Previously, these GHG emissions were assumed to be constant in provisional estimates.

However, it is important to note that UK agricultural coal use has been zero since 2013. Therefore, this change leads to minor changes in natural gas use GHG emissions estimates only.

Energy use non-CO2

Models that employ Energy Trends data to calculate energy use CO2 emissions have been updated to also include the corresponding non-CO2 emissions. This is the first time that observed energy data has been used for non-CO2 emissions in the provisional UK GHG emissions estimates.

Previously, all provisional estimates of non-CO2 emissions were derived through use of year-on-year growth rates in GHG emissions anticipated in the latest EEP publication. Now, projections are only used for non-energy use emissions where there is an absence of appropriate observed data at the time of publication.

The new approach for energy use non-CO2 emissions incorporates all other methodology changes to the provisional statistics listed in this summary. Details of method apportionment by TES sector and gas are shown in Table 2 and Table 3.

This publication is available from: https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-statistics-2024

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