

Statistical bulletin

# Experimental estimates of quarterly greenhouse gas emissions (residence basis), UK: Quarter 1 (Jan to Mar) 2023

Experimental estimates of UK quarterly greenhouse gas emissions on a residence basis using the Chow-Lin regression-based temporal disaggregation method.

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# 1 . Main points

- UK greenhouse gas emissions on a residence basis were estimated to be 151 million tonnes of carbon dioxide equivalent (Mt Co2e) in Quarter 1 (Jan to Mar) 2023, 1.4% lower than in Quarter 1 2022.
- These are experimental estimates of quarterly UK greenhouse gas emissions on a residence basis using modelling techniques.
- Residence-based emissions are directly comparable with a range of important economic statistics, including gross domestic product (GDP), and are different to territorial measures used to monitor UK emissions targets.
- These residence-based experimental quarterly estimates increase alignment with the timeliness and frequency of UK GDP estimates.

## 2 . Quarterly greenhouse gas emission estimates

Using modelling techniques, we have produced estimates of total quarterly UK greenhouse gas (GHG) and carbon dioxide (CO<sub>2</sub>) emissions on a residence basis up to Quarter 1 (Jan to Mar) 2023. We have developed this method by building on our previous [Developing quarterly greenhouse gas emissions accounts, UK: December 2022 article](#). Annual estimates of GHG emissions on a territorial basis (emissions that occur within the UK's borders) are produced by the Department for Energy Security and Net Zero.

As these modelled estimates are timelier than our annual estimates, they can be used to extend the GHG emissions series, therefore providing estimates for time periods beyond what is currently available. The first provisional annual GHG emissions on a residence basis for 2022 suggest an increase of 2.9% or 15 million tonnes of carbon dioxide equivalent (Mt Co<sub>2</sub>e) compared with 2021. These estimates are expected since the residence-based measure includes emissions from international shipping and aviation, which partially recovered from coronavirus (COVID-19) pandemic declines in 2022. For more information on these emission increases in 2022, please see [GOV.UK's provisional UK greenhouse gas emissions 2022 statistical release \(XLS 198KB\)](#).

UK GHG emissions are estimated to have been 151 Mt Co<sub>2</sub>e in Quarter 1 (Jan to Mar) 2023, which is a 1.4% decrease compared with estimates for the same quarter in 2022 (Figure 1). This change reflects the reduction in industrial energy consumption seen in some of the predictor indicators (for example, Energy and Manufacture of Basic Metals) used to derive these modelled estimates. For more information on the trends of all major aspects of energy in the UK, please see [GOV.UK's Energy Trends: June 2023 statistical release](#).

The Quarter 1 2023 figure (151 Mt Co<sub>2</sub>e) is the first year-on-year fall since Quarter 1 2021. It follows seven quarters of increases in GHG emissions on this measure, when compared with the same period in the previous year. This is likely because of the impact of the coronavirus pandemic, where emissions fell in 2020 following restrictions, before gradually increasing again from Quarter 2 (Apr to June) 2021 until Quarter 4 (Oct to Dec) 2022.

It is important to note that these experimental estimates are subject to uncertainty and should be interpreted with caution. For example, the underlying input data and estimates informing the model, as well as the modelling itself, introduce some uncertainty that affect the level of accuracy of these estimates. The level of uncertainty will be higher for the periods 2022 and Quarter 1 2023 as there is no annual estimate of GHG emissions (on a residence basis) to constrain these estimates to. More information can be found in Section 6 of the associated Experimental estimates of quarterly greenhouse gas emissions (residence basis), UK Quality and Methodology Information report.

Table 1 shows the change in quarterly totals from the same quarter the previous year in the non-seasonally adjusted estimates.

Table 1: Recent quarterly UK greenhouse gas (GHG) emissions  
 Change in non-seasonally adjusted estimates, Quarter 1 (Jan to Mar) 2020 to Quarter 1 (Jan to Mar) 2023

<b>Time period</b>	<b>Change in quarterly totals from same quarter the previous year (%)</b>
<b>Quarter 1 2020</b>	-3.0%
<b>Quarter 2 2020</b>	-23.6%
<b>Quarter 3 2020</b>	-13.5%
<b>Quarter 4 2020</b>	-8.5%
<b>Quarter 1 2021</b>	-5.7%
<b>Quarter 2 2021</b>	20.8%
<b>Quarter 3 2021</b>	2.0%
<b>Quarter 4 2021</b>	1.0%
<b>Quarter 1 2022</b>	2.4%
<b>Quarter 2 2022</b>	2.1%
<b>Quarter 3 2022</b>	8.9%
<b>Quarter 4 2022</b>	0.1%
<b>Quarter 1 2023</b>	-1.4%

Source: Office for National Statistics – Environmental Accounts, Department for Energy Security and Net Zero – Energy Trends

Notes

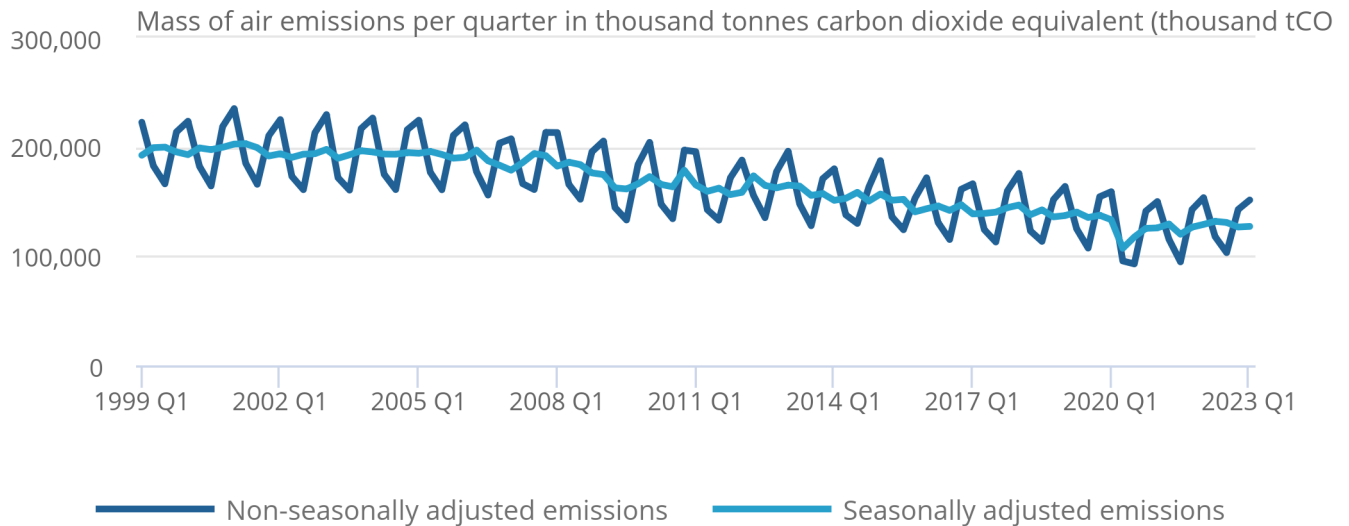
1. Percentage change in quarterly totals from same quarter the previous year.
2. Q1 refers to Quarter 1 (Jan to Mar), Q2 refers to Quarter 2 (Apr to June), Q3 refers to Quarter 3 (July to Sept) and Q4 refers to Quarter 4 (Oct to Dec)., These data are sourced from the Office for National Statistics and the Department for Energy Security and Net Zero's Environmental Accounts and Energy Trends

## Figure 1: UK emissions on a residence basis have generally declined since 1999

Experimental estimates of quarterly greenhouse gas emissions on a residence basis, UK, Quarter 1 (Jan to Mar) 1999 to Quarter 1 (Jan to Mar) 2023

### Figure 1: UK emissions on a residence basis have generally declined since 1999

Experimental estimates of quarterly greenhouse gas emissions on a residence basis, UK, Quarter 1 (Jan to Mar) 1999 to Quarter 1 (Jan to Mar) 2023



Source: Office for National Statistics, Department for Energy Security and Net Zero

#### Notes:

1. Q1 refers to Quarter 1 (Jan to Mar), Q2 refers to Quarter 2 (Apr to June), Q3 refers to Quarter 3 (July to Sept) and Q4 refers to Quarter 4 (Oct to Dec). 2. These estimates have been modelled using the Chow-lin regression based temporal disaggregation method. 3. For seasonal adjusted estimates, the predictor indicators used within the modelling were seasonally adjusted using X-13ARIMA-SEATS. 4. These data are sourced from the Office for National Statistics and the Department for Energy Security and Net Zero's Environmental Accounts and Energy Trends.

### **3 . Intensity of quarterly greenhouse gas emissions**

Our residence basis emissions estimates are compiled in accordance with the UN System of Environmental Economic Accounting (SEEA), which closely follows the UK System of National Accounts (SNA). This means they are broadly comparable with important economic indicators, such as gross domestic product (GDP), and so enables the calculation of emissions intensity (that is, emissions per unit of economic output).

Emission intensity can be used to examine the relationship between economic growth and greenhouse gas (GHG) emissions on a residence basis. A reduction in overall UK GHG emissions intensity would indicate that the UK is moving towards a lower carbon economy. This could be driven by several factors, including changes in the structure of the economy and behavioural changes that may show the interaction between the economy and the environment.

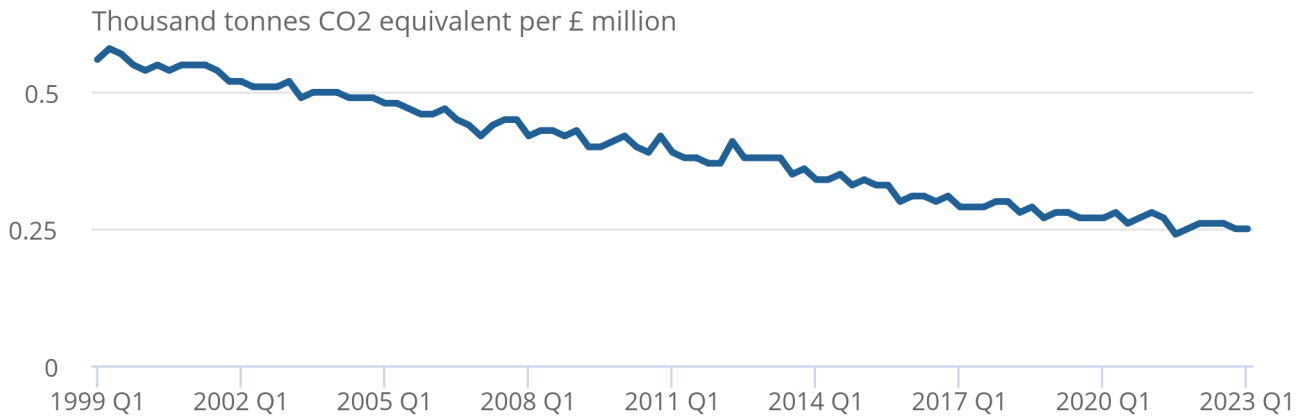
For example, it could be related to some industries becoming more efficient in their production processes through the adoption of lower emission technologies, or to changes in the composition of the economy where there is a growing shift from higher to lower emissions-emitting economic activities (such as, manufacturing to services activities), or a combination of these factors. Any of these factors could contribute to reduced emissions per unit of gross value added (GVA). As can be seen in Figure 2, quarterly GHG emissions intensity has fallen steadily since 1999.

## Figure 2: Emissions intensity on a residence basis has fallen since 1999

Experimental estimates of greenhouse gas emissions intensity (seasonally adjusted), UK (residency basis), Quarter 1 (Jan to Mar) 1999 to Quarter 1 (Jan to Mar) 2023

### Figure 2: Emissions intensity on a residence basis has fallen since 1999

Experimental estimates of greenhouse gas emissions intensity (seasonally adjusted), UK (residency basis), Quarter 1 (Jan to Mar) 1999 to Quarter 1 (Jan to Mar) 2023



Source: Office for National Statistics

#### Notes:

1. Q1 refers to Quarter 1 (Jan to Mar), Q2 refers to Quarter 2 (Apr to June), Q3 refers to Quarter 3 (July to Sept) and Q4 refers to Quarter 4 (Oct to Dec).
2. Greenhouse gas emissions intensity is calculated by dividing the level of greenhouse gas emissions by gross value added (GVA). GVA is the difference between output and intermediate consumption for any given industry. This means the difference between the value of goods and services produced (output) and the cost of raw materials and other inputs, which are used up in production (intermediate consumption). GVA are chained volume measures, in constant prices with 2019 as the base and reference year. All emissions intensity figures are calculated excluding consumer expenditure.
3. Intensity figures have been calculated on seasonally adjusted estimates of greenhouse gas emissions, excluding those from households that refer to consumer expenditure in the dataset accompanying this bulletin.
4. For seasonal adjusted estimates, the predictor indicators used within the modelling were seasonally adjusted using X-13ARIMA-SEATS.

## 4 . Experimental estimates of quarterly greenhouse gas emissions (residence basis), UK data

### [Experimental estimates of quarterly greenhouse gas emissions](#)

Dataset | Released 25 July 2023

Experimental estimates of UK quarterly greenhouse gas emissions (GHG) and carbon dioxide (CO<sub>2</sub>) emissions on a residence basis.

### [Atmospheric emissions: greenhouse gases by industry and gas](#)

Dataset | Released 10 June 2023

The emissions of carbon dioxide, methane, nitrous oxide hydro-fluorocarbons, perfluorocarbons, sulphur hexafluoride, nitrogen trifluoride and total greenhouse gas emissions, by industry (SIC 2007 group, around 130 categories), UK, 1990 to 2021.

### [Energy trends](#)

Dataset | Released 29 June 2023

Quarterly publication which presents data on the supply and demand of all the major fuels in the UK.

## 5 . Glossary

### Greenhouse gases

Greenhouse gases are defined by the Kyoto protocol. These include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF<sub>6</sub>) and nitrogen trifluoride (NF<sub>3</sub>).

### Residence basis

Estimates compiled on a residence basis include data relating to UK residents and UK-registered businesses, regardless of whether they are in the UK or overseas. Emissions released in the UK by tourists and foreign transport operations are excluded.

### Temporal disaggregation

Temporal disaggregation is the process of deriving high-frequency data (for example, quarterly) from low-frequency data (for example, annual).

## 6 . Measuring the data

### Quality

In terms of the accuracy of the estimates, the model for total greenhouse gas (GHG) emissions suggests that estimates for the latest year tend to be overestimated by 0.8% on average. Furthermore, the forecasts (in this case, estimates for 2023) tend to range between negative 1.9% to positive 1.9% of the final estimate. More quality and methodology information on strengths, limitations, appropriate uses, and how these quarterly estimates were created is available in our [Experimental estimates of UK quarterly greenhouse gas emissions \(residence basis\), QMI](#).



## Greenhouse gas emissions

The modelled quarterly greenhouse gas emissions (GHG) estimates reported in this bulletin are on a residence basis and complementary to the [annual GHG estimates](#), which are part of the UK Environmental Accounts.

Details on the methodology we use to calculate annual UK greenhouse gas estimates, including associated uncertainty, can be found in our [Environmental accounts on air emissions QMI](#).

## Energy Trends

The latest quarter of Energy Trends data used in the predictor indicators are provisional and subject to revision. Any revisions to these data will be reflected in the modelled estimates. More details on the methodology used to construct Energy Trends data can be found in the [Department for Energy and Net Zero's Energy Trends. UK statistical release](#).

## Revisions

This release contains revisions and estimates which differ from those published in our December 2022 [Experimental estimates of quarterly greenhouse gas emissions dataset](#). These revisions are driven by changes to both the source data and methodological development. More information on the revision is available in our [Experimental estimates of quarterly greenhouse gas emissions \(residence basis\), UK QMI](#).

## 7 . Strengths and limitations

These estimates are subject to uncertainty, both in the underlying estimates used with the model and because of uncertainty introduced by the modelling itself. For example, for periods where a base or reference year is unavailable, we now use casting measures to extend the series for five quarters. This implies that the estimates for those periods are less accurate compared with periods where a base or reference year is available

For information on the strengths and limitations of the estimates presented in this bulletin, please see Section 6 of our [Experimental estimates of UK quarterly greenhouse gas emissions \(residence basis\), QMI](#).

## 8 . Related links

### [Developing quarterly greenhouse gas emissions accounts, UK: December 2022](#)

Article | Released 16 December 2022

Update on work to develop a measure of quarterly UK greenhouse gas (GHG) emissions on residency basis, and future development and publications plans.

### [Greenhouse gas emissions, UK: provisional estimates: 2021](#)

Bulletin | Released 1 November 2022

Measuring the contribution of the environment to the economy, the impact of economic activity on the environment, and society's response to environmental issues.

### [Measuring UK greenhouse gas emissions](#)

Article | Released 1 November 2021

Article on the UK Climate Change Portal about the three official measures of UK greenhouse gas (GHG) emissions (territorial, residence and footprint). The UK is required to report its estimated GHG emissions on a range of different bases to fulfil a wide range of international agreements as well as for domestic policy-making purposes.

### [UK territorial greenhouse gas emissions national statistics](#)

Bulletins and data | Last updated 30 March 2023

Final and provisional estimates of UK territorial greenhouse gas emissions from 1990.

### [Energy Trends: June 2023](#)

Statistical release | Released 29 June 2023

Quarterly bulletin containing statistics on all major aspects of energy in the UK.

## 9 . Cite this statistical bulletin

Office for National Statistics (ONS), released 25 July 2023, ONS website, statistical bulletin, [Experimental estimates of quarterly greenhouse gas emissions \(residence basis\), UK: Quarter 1 \(Jan to Mar\) 2023](#)