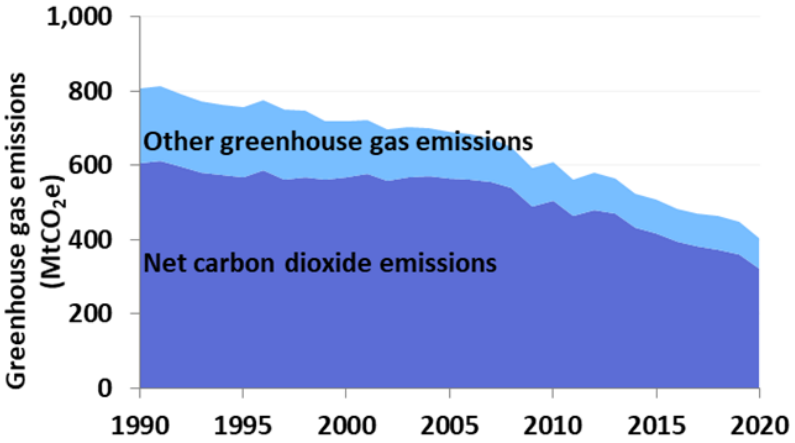
Department for Business, Energy & Industrial Strategy

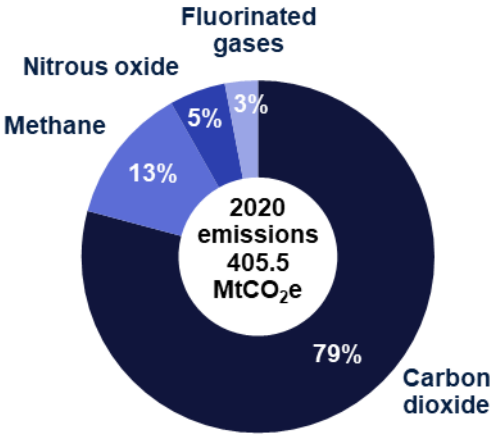
2020 UK Greenhouse Gas Emissions, Final Figures

1 February 2022 **National Statistics**

The coronavirus (COVID-19) pandemic and the resulting restrictions introduced in 2020 across the UK had major impacts on various aspects of society and the economy, which led to a significant impact on greenhouse gas emissions in the UK. In 2020, net territorial greenhouse gas emissions in the UK were estimated to be 405.5 million tonnes carbon dioxide equivalent ($MtCO_2e$), a decrease of 9.5% compared to the 2019 figure of 447.9 million tonnes and 49.7% lower than they were in 1990. Carbon dioxide made up around 79% of the 2020 total.

UK territorial greenhouse gas emissions, 1990-2020





- Over half of the decrease in greenhouse gas emissions between 2019 and 2020 was from the reduction in emissions from transport, which were down 19.2% (23.5 $MtCO_2e$) due to the large reduction in the use of road transport during the nationwide lockdowns. Despite this decrease, transport remained the largest emitting sector, responsible for 24% of all greenhouse gas emissions in the UK.

- Emissions from energy supply fell by 12.2% (11.6 $MtCO_2e$) in 2020 from 2019 following lower energy demand during the pandemic and the continued reduction in fossil fuel use in power stations. Emissions from energy supply are now 70.0% lower than in 1990.

- There were also notable falls from 2019 in emissions from industrial processes (8.5%), waste management (6.7%), the business sector (4.8%) and agriculture (3.5%). Conversely, emissions from the residential sector increased by 1.0% as more people stayed at home.

What you need to know about these statistics:
This publication provides the latest estimates of 1990-2020 UK territorial greenhouse gas emissions, meaning emissions that occur within the UK's borders. They are presented in carbon dioxide equivalent units (CO_2e) throughout this statistical release and cover the Kyoto "basket" of seven greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).

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Contents

Introduction

This publication provides the latest annual estimates of UK territorial greenhouse gas emissions from 1990-2020. The geographic coverage of this report is UK only unless stated otherwise. The figures in this statistical release are used as the basis for reporting against UK greenhouse gas emissions reduction targets and provide information for users on the drivers of emissions trends since 1990. Emissions are estimated following the guidance set out by the Intergovernmental Panel on Climate Change (IPCC)[1], as required for the UK's submissions to the United Nations Framework Convention on Climate Change (UNFCCC) each year.

The estimates present emissions on a "territorial" basis, so 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).

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:

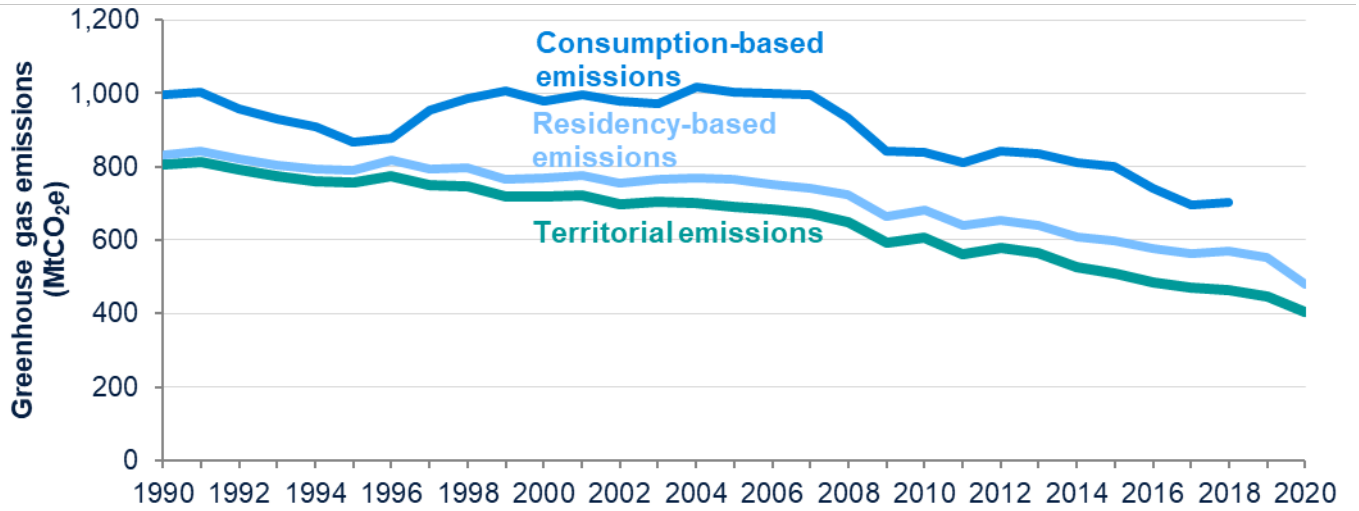
- ONS publishes emissions on a "residency" basis in the UK Environmental Accounts. The figures represent emissions caused by UK residents and businesses whether in the UK or abroad, but exclude emissions within the UK which can be attributed to overseas residents and businesses.

- 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.

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

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

Figure 1: UK territorial, residency-based and consumption-based greenhouse gas emissions, 1990-2020



Sources: Table 1.1, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables
UK's carbon footprint, Defra: https://www.gov.uk/government/statistics/uks-carbon-footprint
Atmospheric emissions: greenhouse gases by industry and gas, ONS: https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsatmosphericemissionsgreenhousegasemissionsbyeconomicsectorandgasunitedkingdom

The estimates in this publication are based on the source of the emissions rather than where the end-user activity occurred, so for example emissions related to electricity generation are attributed to power stations, where the emissions occur, rather than homes and businesses where the electricity is used. A breakdown of UK territorial emissions by end-user sector will be published as an annex to this publication on Thursday 31 March 2022[2].

These estimates cover the Kyoto "basket" of seven gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). The last four gases are collectively referred to as fluorinated gases or F gases. In accordance with international reporting 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 (CO_2e).

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

References to the 'UK Greenhouse Gas Inventory' refer to the consistent time series of emissions from 1990 to the most recent year which is updated annually and reported to the UN and the EU. The figures in these statistics are consistent with the UK's Greenhouse Gas Inventory for 1990-2020, although the inventory reported to the UN includes emissions from the UK's Crown Dependencies and certain Overseas Territories which are excluded from these statistics except where specifically stated.

[2] The Annex for 1990-2019 UK greenhouse gas emissions final figures by end-user published in March 2020 can be found here: https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2019
[3] The global warming potentials (GWPs) used are from Working Group 1 of the IPCC Fourth Assessment Report: Climate Change 2007 and summarised in a table published on the following page:
https://www.gov.uk/government/publications/uk-greenhouse-gas-emissions-explanatory-notes

Note that as part of this release the 1990-2019 emissions figures have been revised since the previous publication in February 2021, to incorporate methodological improvements and new data, and the 2020 figures have been revised from the provisional estimates published in March 2021. Details of these revisions can be found later in this statistical release.

For the purposes of reporting, greenhouse gas emissions are allocated into sectors known as National Communication (NC) sectors as follows:

Energy Supply	Emissions from electricity generation and other energy production activities such as mining, refining and manufacturing fuels. In the end-user estimates these emissions are instead assigned between the other sectors based on where the electricity/fuel is used, or to the *Exports* sector where they are used abroad.
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 *Transport* 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 *Transport* 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 *LULUCF* sector) and agricultural machinery.
Industrial processes	Emissions resulting from industrial processes, except for those associated with fuel combustion which are included in the *Business* 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 *Energy Supply* sector and emissions from residential composting are included in the *Residential* sector.

2020 total greenhouse gas emissions

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

In 2020, emissions in the UK of the basket of seven greenhouse gases covered by the Kyoto Protocol were estimated to be 405.5 million tonnes carbon dioxide equivalent ($MtCO_2e$), a decrease of 9.5% compared to the 2019 figure of 447.9 million tonnes. This is the largest proportional fall in UK greenhouse gas emissions in a single year since the start of the data series in 1990, slightly larger than the 8.6% fall seen in 2009 during the recession, although in absolute terms there were larger emission reductions in 2009 (of 56.2 $MtCO_2e$) and 2011 (of 45.7 $MtCO_2e$). Greenhouse gas emissions in 2020 are estimated to be 49.7% lower than they were in 1990.

The coronavirus (COVID-19) pandemic and the resulting restrictions brought in across the UK had a major impact on various aspects of UK society and the economy in 2020. There are a range of statistics available from across the UK government and the devolved administrations showing the impact it had, including profound changes to travel and economic activity[4,5]. As a result, COVID-19 will have had a significant impact on greenhouse gas emissions in the UK, in particular from transport and from businesses, although it is not possible to identify the exact size of this effect as other factors will have also played a part in the changes seen during 2020.

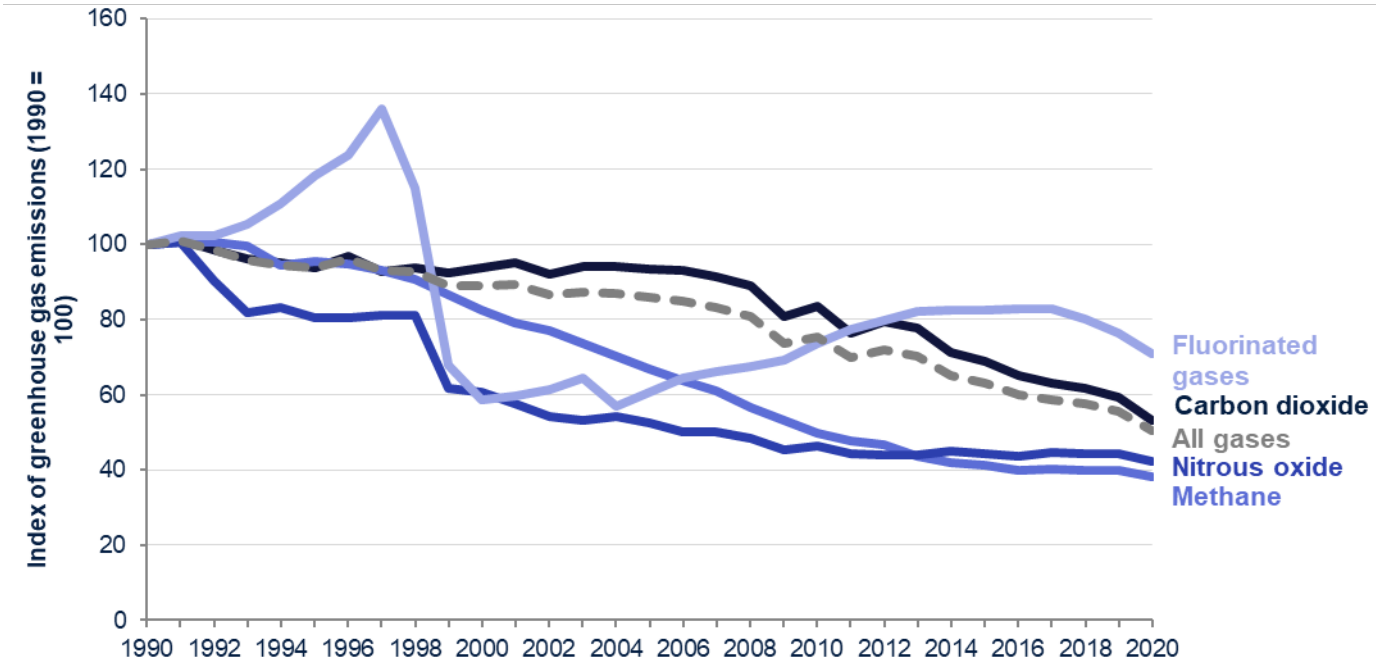
When broken down by gas, UK emissions are dominated by carbon dioxide, which is estimated to have accounted for about 79% of greenhouse gas emissions in the UK in 2020. Weighted by global warming potential, methane accounted for about 13% of UK emissions and nitrous oxide for about 5% of emissions in 2020. Fluorinated gases accounted for the remainder, around 3%.

Carbon dioxide has always been the dominant greenhouse gas emitted in the UK. Emissions of CO_2 have reduced by 47.0% (around 284.3 $MtCO_2$) since 1990 to 321.1 $MtCO_2$ in 2020, mainly due to decreases in emissions from power stations. There have been larger proportional falls in emissions from methane (61.8% since 1990) and nitrous oxide (57.8%). Fluorinated gas (F gas) emissions are estimated to be 29.0% lower now than they were in 1990, with hydrofluorocarbons (HFCs) being the dominant F gas.

[4] Coronavirus (COVID-19): 2020 in charts, Office for National Statistics (ONS): https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/articles/coronaviruscovid192020incharts/2020-12-18

[5] Coronavirus (COVID-19) roundup, Office for National Statistics: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/articles/coronaviruscovid19roundup/2020-03-26

Figure 2: Index of territorial UK greenhouse gas emissions by gas, 1990-2020

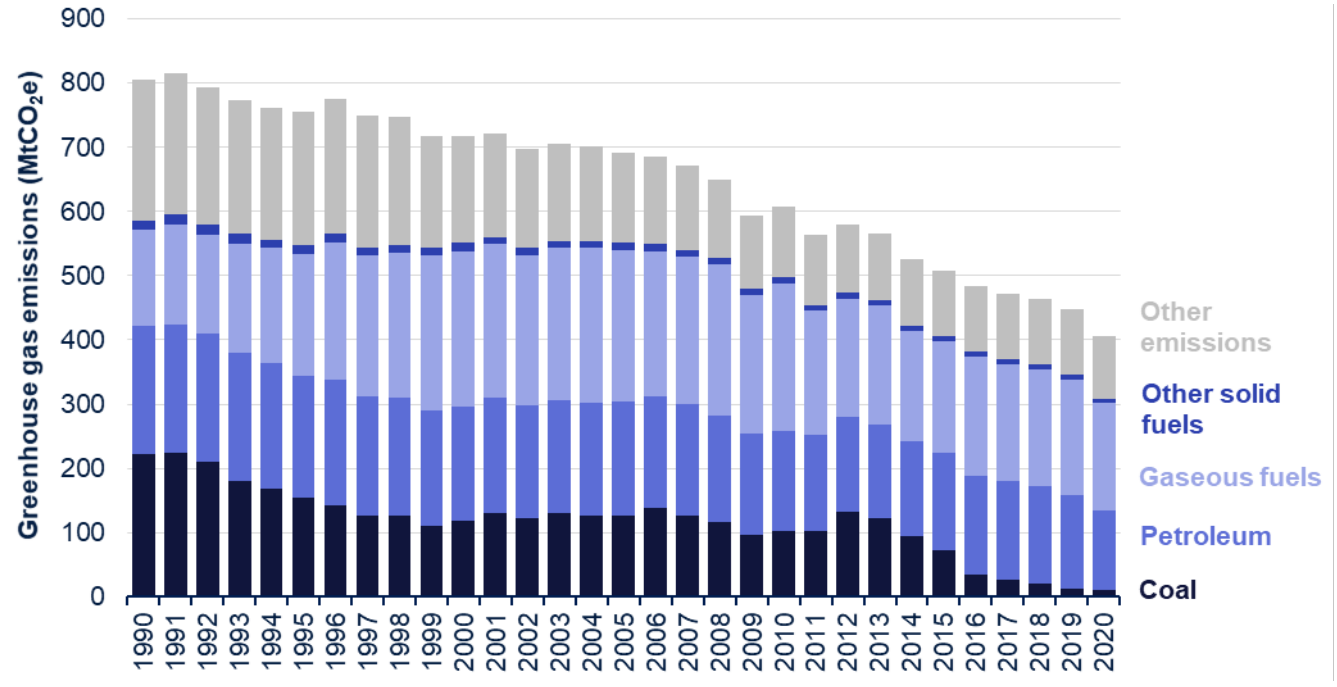


Source: Table 1.1, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

In 2020, 76.2% of greenhouse gas emissions in the UK came from the use of fossil fuels. Emissions from fossil fuels fell 10.5% compared to 2019 and were 47.2% lower than in 1990. Fossil fuel emissions in 2020 predominantly came from the use of gaseous fuels and petroleum, which accounted for 42% and 30% of all UK emissions respectively. Gaseous fuel use in the UK is dominated by the use of natural gas for heating buildings and for electricity generation, while most petroleum use is in road vehicles.

2.5% of emissions in the UK in 2020 came from the use of coal. Emissions from the use of coal have fallen by 95.4% since 1990, at which point they were responsible for 27.4% of UK emissions as it was the main fuel used for electricity generation.

Figure 3: Territorial UK greenhouse gas emissions by fuel type, 1990-2020 ($MtCO_2e$)



Source: Table 1.7, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

UK performance against emissions reduction targets

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

Domestic Targets

The Climate Change Act 2008

The UK has domestic targets for reducing greenhouse gas emissions under the Climate Change Act 2008 (CCA)[6]. The CCA established a long-term legally binding framework to reduce emissions, initially by at least 80% below a 1990/95 baseline by 2050. In June 2019, following the IPCC's Special Report on Global Warming of 1.5°C and advice from the UK Climate Change Committee, the CCA was amended to commit the UK to achieving at least a 100% reduction in net emissions by 2050 (Net Zero).

The CCA also introduced carbon budgets. These are legally binding limits on the total amount of greenhouse gas emissions the UK can emit over five-year periods and are required to be set 12 years in advance of the start of each period[7]. The first carbon budget ran from 2008-12. In 2014, it was confirmed the UK had met the budget with emissions 36 $MtCO_2e$ below the cap of 3,018 $MtCO_2e$[8]. The second carbon budget ran from 2013-17. In 2019, it was confirmed the UK had met the budget with emissions 384 $MtCO_2e$ below the cap of 2,782 $MtCO_2e$[9]. A final statement for the third carbon budget, covering the period 2018-22, will be published in May 2024.

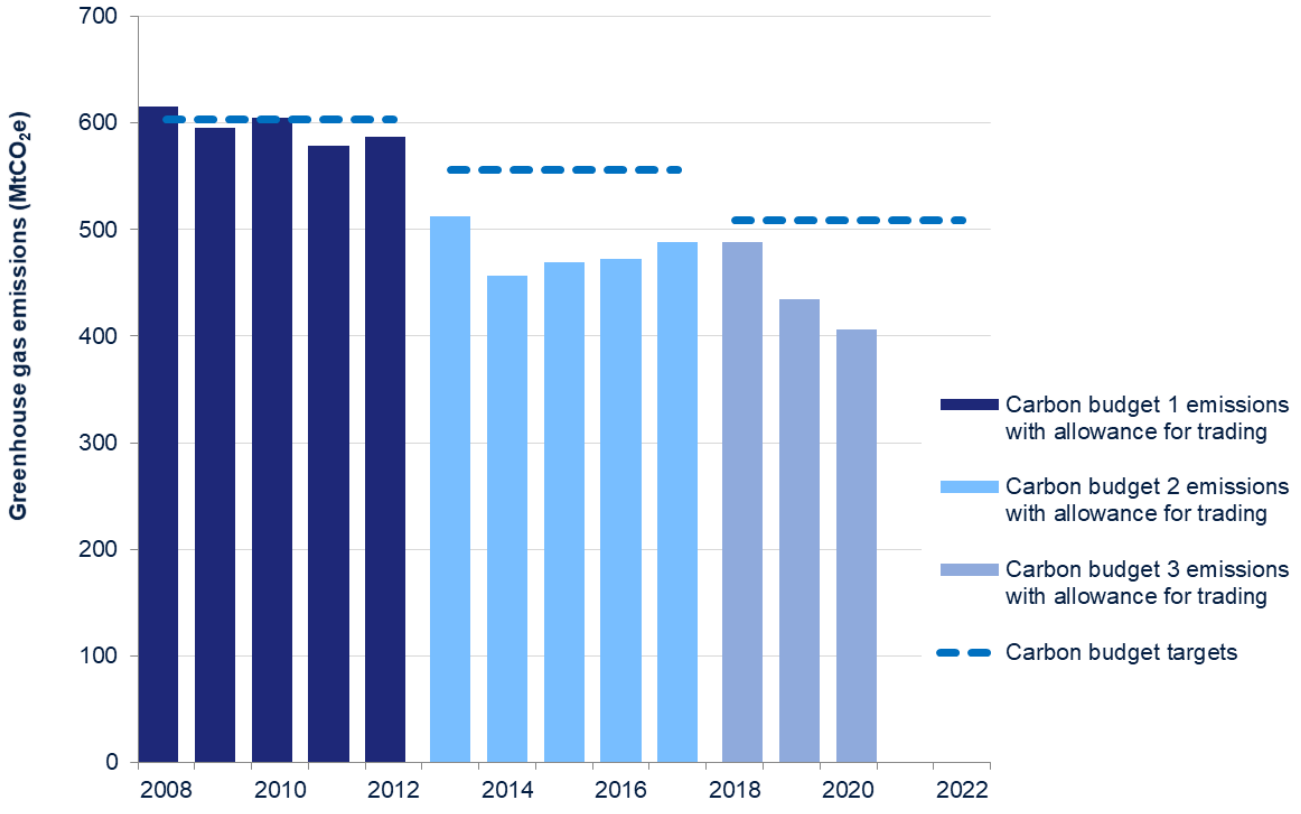
Compliance with carbon budgets is not assessed by directly comparing the budget level against UK greenhouse gas emissions. Instead, the budget level is compared to the net UK carbon account, which takes account of international emissions trading and is defined for each period in carbon accounting regulations[10]. The net UK carbon account up to 2020 is defined as the sum of three components:

- Emissions allowances allocated to the UK under the EU Emissions Trading System (EU ETS)[11]. These cover the power sector, heavy industry, and domestic aviation.
- Emissions not covered by the EU ETS.
- Credits/debits from other international trading systems

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

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

Figure 4: UK's progress towards meeting carbon budgets



The latest figures show:

- After taking account of units debited to the net UK carbon account as a result of treatment of the EU Emissions Trading System (ETS) emissions, the 2020 net UK carbon account was 405.8 $MtCO_2e$.

- 2020 represents the third year of the third carbon budget. The net UK carbon account must be on average lower than 508.8 $MtCO_2e$ each year for the UK to meet the third carbon budget.

Detailed information on how the 2020 net UK carbon account is calculated will be published in the Annual Statement of Emissions for 2020, due to be published by BEIS by the end of March 2022[13].

International Targets

Pre-2020: targets under the Kyoto Protocol

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) is an international agreement.[14]

[13] Annual Statement of Emissions: https://www.gov.uk/government/collections/annual-statements-of-emissions
[14] UNFCCC page on the Kyoto Protocol: https://unfccc.int/kyoto_protocol

First Commitment Period (2008-2012)

The UK met its emissions reductions target for the first commitment period of the Kyoto Protocol. Under the first commitment period of the Kyoto Protocol (2008-12), the EU and its Member States, Iceland and Norway collectively made a commitment to reduce greenhouse gas emissions across the EU by 8% on 1990 levels by 2012. As part of this, the UK undertook to reduce total greenhouse gas emissions by 12.5% below base year levels over the five-year period 2008-12[15].

UK emissions of the basket of greenhouse gases covered by the Kyoto Protocol were an average 600.6 $MtCO_2e$ per year (exclusive of emissions trading) over the first commitment period (2008-12), 23% lower than base year emissions[16]. The UK's total emissions over the period were 372.5 $MtCO_2e$ lower than the Assigned Amount allocation (see table 2.2(a) in excel data tables).

Second Commitment Period (2013-2020)

Emission targets under the second commitment period of the Kyoto Protocol (2013-2020) are set out in the Doha Amendment.[17] These targets are translated into emission allocations called Assigned Amount Units (AAUs), as set out in each Party's 'initial report'.[18]

Joint Fulfilment with the EU

The EU had a target to reduce emissions by 20% relative to the reference year (1990) over the second commitment period. This is being fulfilled jointly with Member States and other participating countries (UK and Iceland) in accordance with Article 4 of the Kyoto Protocol. In line with this target, emissions are split into (i) 'traded sector' emissions, covered by the EU Emissions Trading System (EU ETS) which gives an overall EU-wide 'cap' on emissions from participating sectors; and (ii) 'non-traded sector' emissions, which are covered by country-level targets. Countries' emissions from the traded sector are managed centrally by the Union and are not counted towards individual targets under the Kyoto Protocol. Only emissions outside the scope of the EU ETS are counted towards individual country-level targets.

Under the terms of the Withdrawal Agreement, the UK remains committed to its shared target with the EU under the Kyoto Protocol as part of the Joint Fulfilment Agreement.

UK targets under the EU Effort Sharing Decision

The EU Effort Sharing Decision (ESD) was agreed as part of the EU's 2020 Climate and Energy package, which came into force from January 2013. Under the terms of the Withdrawal Agreement, the UK remains committed to its targets under the EU ESD due to its shared target with the EU under the Kyoto Protocol.

The ESD sets out targets for participating countries to either reduce or limit emissions by a certain percentage in the non-traded sector (i.e. covering most sectors not included in the EU ETS[19]), by 2020 from a 2005 baseline. Each country's national emission target has been translated into binding quantified Annual Emission Allocations (AEAs) for the period 2013–2020. The UK's 2020 target, based on relative GDP per capita, was to reduce emissions by

[15] Council Decision (2002/358/EC) of 25 April 2002: http://www.eea.europa.eu/policy-documents/council-decision-2002-358-ec
[16] A record of UK base year emissions is published on the following page: https://www.gov.uk/government/publications/uk-greenhouse-gas-emissions-explanatory-notes
[17] https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment
[18] Parties' initial reports for the second commitment period of the Kyoto Protocol: https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-kyoto-protocol/second-commitment-period/initial-reports
[19] ESD targets do not include emissions from LULUCF sectors.

16% from 2005 levels, to be achieved through a declining limit for emissions for each year from 2013-2020[20].

In October 2021 the European Commission confirmed for each participating country their performance against ESD for 2019[21]. UK greenhouse gas emissions for 2019 under the ESD were confirmed to be 329.1 $MtCO_2e$[22], 24.9 $MtCO_2e$ below the UK's annual limit for 2019 of 354.1 $MtCO_2e$, meaning that the UK met its seventh annual target in the period. Provisional estimates indicate that greenhouse gas emissions for 2020 under the Effort Sharing Decision will also be below the annual emissions limit, by around 54.1 $MtCO_2e$. The UK is therefore on track to meet all its annual targets under the EU ESD for 2013-2020, as shown in Table 1 below and in table 2.2(c) of the excel data tables.

Table 1: Progress towards the EU Effort Sharing Decision

UK and Gibraltar, 2013-2020								$MtCO_2e$
	2013	2014	2015	2016	2017	2018	2019	2020 (p)
Total greenhouse gas emissions excl. LULUCF and NF_3 (A)	566.5	524.0	503.5	482.8	470.5	460.3	449.2	402.1
Total verified emissions from stationary installations under the EU ETS (B)	225.3	197.9	175.9	147.4	136.8	128.9	118.6	104.6
CO_2 emissions from civil aviation (C)	1.7	1.6	1.6	1.5	1.6	1.5	1.5	0.6
Total ESD emissions (D = A - B - C)	339.5	324.4	326.0	333.9	332.1	329.9	329.1	296.9
Annual emissions allocation (E)	358.7	354.2	349.7	345.2	360.4	357.2	354.1	350.9
Difference (E - D)	**19.3**	**29.8**	**23.7**	**11.3**	**28.4**	**27.4**	**24.9**	**54.1**

Source: Table 2.2(c), Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables.

Note: ESD emissions for 2020 are provisional and subject to change, pending completion of the EU review and compliance process in 2022.

UK target under the Doha Amendment

Parties submitted 'initial reports' to facilitate the calculation of their allocated emission units permitted under their Kyoto targets.[23] The UK's initial report translates the UK's targets for the

[20] Annual emission allocations, European Commission: https://ec.europa.eu/clima/eu-action/effort-sharing-member-states-emission-targets/annual-emission-allocations-2013-2020-and-flexibilities_en
[21] Commission Implementing Decision (EU) 2021/1876 of 20 October 2021 on greenhouse gas emissions covered by Decision No 406/2009/EC of the European Parliament and of the Council for the year 2018 for each Member State: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021D1876&qid=1642152861255
[22] ESD dataset 2021, EEA website: https://www.eea.europa.eu/data-and-maps/data/esd-3
[23] 'Initial Reports' for the second commitment period of the Kyoto Protocol: https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-kyoto-protocol/second-commitment-period/initial-reports

non-traded sectors into Assigned Amount Units (AAUs). [24] Particular rules for the accounting of the LULUCF sectors are used (KP-LULUCF), and some minor LULUCF sources are also excluded from accounting.[25]

As of 28 October 2020, 147 Parties have deposited their instrument of acceptance (including the UK), therefore the threshold for entry into force of the Doha Amendment has been met[26]. These statistics contain indicative figures for the UK's progress against its targets under the Doha Amendment (see table 2.2(b) in excel data tables) which show the UK is on track to meet its target. The second commitment period of the Kyoto Protocol concluded in December 2020, but progress against the Kyoto target will not be finalised until the 'true-up' process, after final reporting of all emissions over the commitment period has taken place.

Beyond 2020: targets under the Paris Agreement

Following the 21st Conference of the Parties (COP21) of the UNFCCC in Paris in December 2015, 195 countries committed to adopt a global climate change Agreement. The Paris Agreement entered into force on 4 November 2016 and was ratified by the UK on 18 November 2016. Parties to the Paris Agreement are required to prepare, communicate and maintain successive Nationally Determined Contributions (NDCs).

On 12 December 2020, the UK communicated its Nationally Determined Contribution (NDC) under the Paris Agreement. The NDC commits the UK to reducing economy-wide greenhouse gas emissions by at least 68% by 2030, compared to 1990 levels.[27]

Emissions Trading

Under the UNFCCC and Kyoto Protocol, three flexible mechanisms were established to provide for trading of national allowances and project-based credits by Governments and emitters. These are International Emissions Trading, the Clean Development Mechanism (CDM) and Joint Implementation (JI). In reporting emissions reductions against all its targets, the UK needs to take account of emissions trading through these flexible mechanisms. Up until 31 December 2020, the UK participated in the EU ETS. The other mechanisms for trading of national allowances were not in operation in the UK, although it should be noted that EU ETS participants may also use credits generated under CDM and JI projects, subject to certain limits, in order to comply with their obligations.

European Union Emissions Trading System (EU ETS)

The EU ETS covers around 40% of EU greenhouse gas emissions and limits emissions from around 10,000 installations in the power sector and manufacturing industry, as well as airlines operating between member states.

[24] UK Initial Report for the second commitment period of the Kyoto Protocol: https://unfccc.int/files/national_reports/initial_reports_under_the_kyoto_protocol/second_commitment_period_2013-2020/application/zip/gbk-cp2-ir-29aug2017.zip

[25] Kyoto Protocol https://unfccc.int/sites/default/files/resource/docs/cop3/l07a01.pdf ; Decision 2/CMP.7 https://unfccc.int/resource/docs/2011/cmp7/eng/10a01.pdf; IPCC 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol https://www.ipcc-nggip.iges.or.jp/public/kpsg/index.html

[26] UNFCCC Doha Amendment: https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment. Information on the acceptance and entry into force of the Doha Amendment: https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-c&chapter=27&clang=_en

[27] UK Nationally Determined Contribution under the Paris Agreement: https://www.gov.uk/government/publications/the-uks-nationally-determined-contribution-communication-to-the-unfccc

The EU ETS works on the 'cap and trade' principle. A cap is set on the total amount of certain greenhouse gases that can be emitted by the installations covered by the system. The cap is reduced over time so that total emissions fall. Within the cap, installations buy or receive emissions allowances, which they can trade with one another as needed. The limit on the total number of allowances available ensures that they have a value. After each year, an installation must surrender enough allowances to cover its emissions. If an installation reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another installation that is short of allowances. Trading brings flexibility that ensures emissions are cut where it costs least to do so. A robust carbon price also promotes investment in innovative, low-carbon technologies.

Phase II of the EU ETS coincided with the first Carbon budget period and Kyoto Protocol first commitment period (2008-12). During this period each member state held a specific quantity of allowances based on their EU-approved National Allocation Plan (NAP). This then resulted in net "sales" or "purchases" of emissions allowances reported from UK installations depending on whether total emissions were below or above the UK's allocation23.

The EU ETS was revised for phase III (2013-20) to make a greater contribution to tackling climate change. The system shifted away from NAPs in favour of an EU-wide cap on the number of available allowances. In the absence of a UK-specific allocation, a notional UK cap has been estimated so that carbon budget performance can take account of emissions trading through the EU ETS. Further details of this methodology are laid out in Annual Statements of Emissions[28].

In 2012, aviation was included in the EU ETS for the first time, and aircraft operators were required to report their annual emissions and surrender an equivalent number of allowances for all flights within the European Economic Area (EEA). However, as UK carbon budgets only cover domestic aviation (aviation within the UK) a separate notional cap for UK domestic aviation has been estimated, so that carbon budget performance only takes account of domestic aviation emissions trading through the EU ETS.

The UK needs to take account of emissions trading through the EU ETS when reporting against carbon budgets. Net adjustments to the net UK carbon account from UK installations and aviation operators trading in the EU ETS (up until 2020) are provided in table 2.1 of the tables accompanying this publication.

[28] Note that a negative net value indicates that the reported emissions from UK installations in the EU ETS were below the cap, i.e. there was a net selling or withholding of units by UK installations. This means that emissions are either emitted elsewhere or emitted at a later stage, so they may not be used to offset UK emissions. The opposite occurs when reported emissions from EU ETS installations exceed the cap

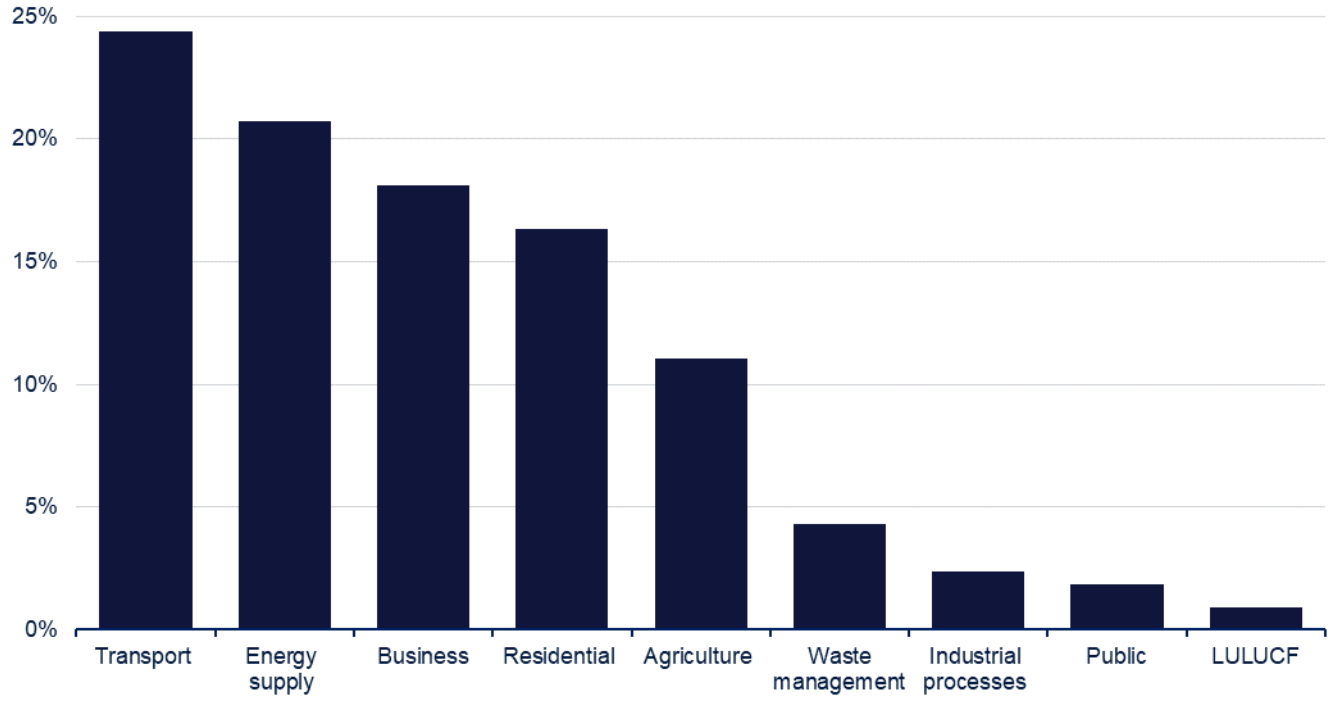
Emissions by sector

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

All the sectoral breakdowns below show emissions by source, meaning emissions are attributed to the sector that emits them directly, as opposed to where the end-user activity occurred. E.g. emissions from power stations are included in the energy supply sector rather than being recorded against the sectors that use the electricity. A breakdown of 1990-2020 UK territorial emissions by end-user sector will be published as an annex to this publication on Thursday 31 March 2022, in which emissions from energy supply will be reallocated to the sectors that use the energy.

In 2020, 24% of net greenhouse gas emissions in the UK were estimated to be from the transport sector, 21% from energy supply, 18% from business, 16% from the residential sector and 11% from agriculture. The other 9% was attributable to the remaining sectors: waste management, industrial processes, the public sector and the land use, land use change and forestry (LULUCF) sector. The LULUCF sector includes both sinks and sources of emissions.

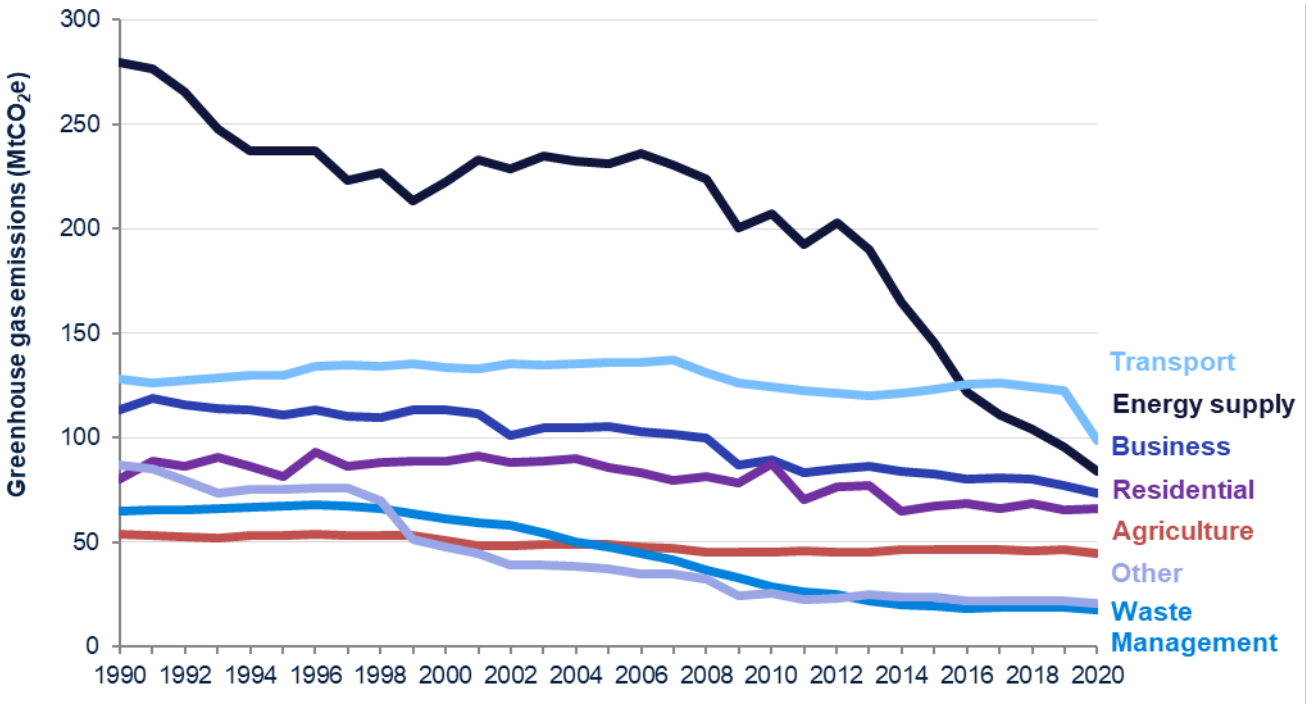
Figure 5: Net territorial UK greenhouse gas emissions by NC sector, 2020 (%)



Source: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables
Note: LULUCF is land use, land use change and forestry.

Historically, the energy supply sector had the highest greenhouse gas emissions, but the large reductions over the last decade in emissions from power stations in particular mean that since 2016 the transport sector has had the highest emissions.

Figure 6: Territorial UK greenhouse gas emissions by NC sector, 1990-2020 ($MtCO_2e$)



Source: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

Note: Other includes Public, Industrial Processes and the Land Use, Land Use Change and Forestry (LULUCF) sectors.

Transport

The transport sector consists of emissions from road transport, railways, domestic aviation, shipping, fishing and aircraft support vehicles. It is estimated to have been responsible for around 24% of greenhouse gas emissions in the UK in 2020, almost entirely through carbon dioxide emissions. The main source of emissions from this sector is the use of petrol and diesel in road transport. Transport emissions fell by 19% between 2019 and 2020, attributable to the impact of the COVID-19 pandemic as people were instructed to stay at home as much as possible for large periods of 2020. The transport sector had historically been the second most emitting sector; however, reductions over time in what was the largest sector (energy supply) mean that since 2016 transport has been the sector with the highest emissions and remains so in 2020, despite the unusually large fall in emissions.

Before 2020 there had been relatively little overall change in the level of greenhouse gas emissions from the transport sector in the last three decades, with emissions only 5% lower in 2019 than they were in 1990. Between 1990 and 2007 (when emissions peaked) there was a general increasing trend, with some fluctuations year to year. After this peak, emissions declined each year until 2013, at which point this trend reversed to show small increases most years. The impact of the COVID-19 pandemic means emissions are estimated to have been around 23% lower in 2020 than in 1990.

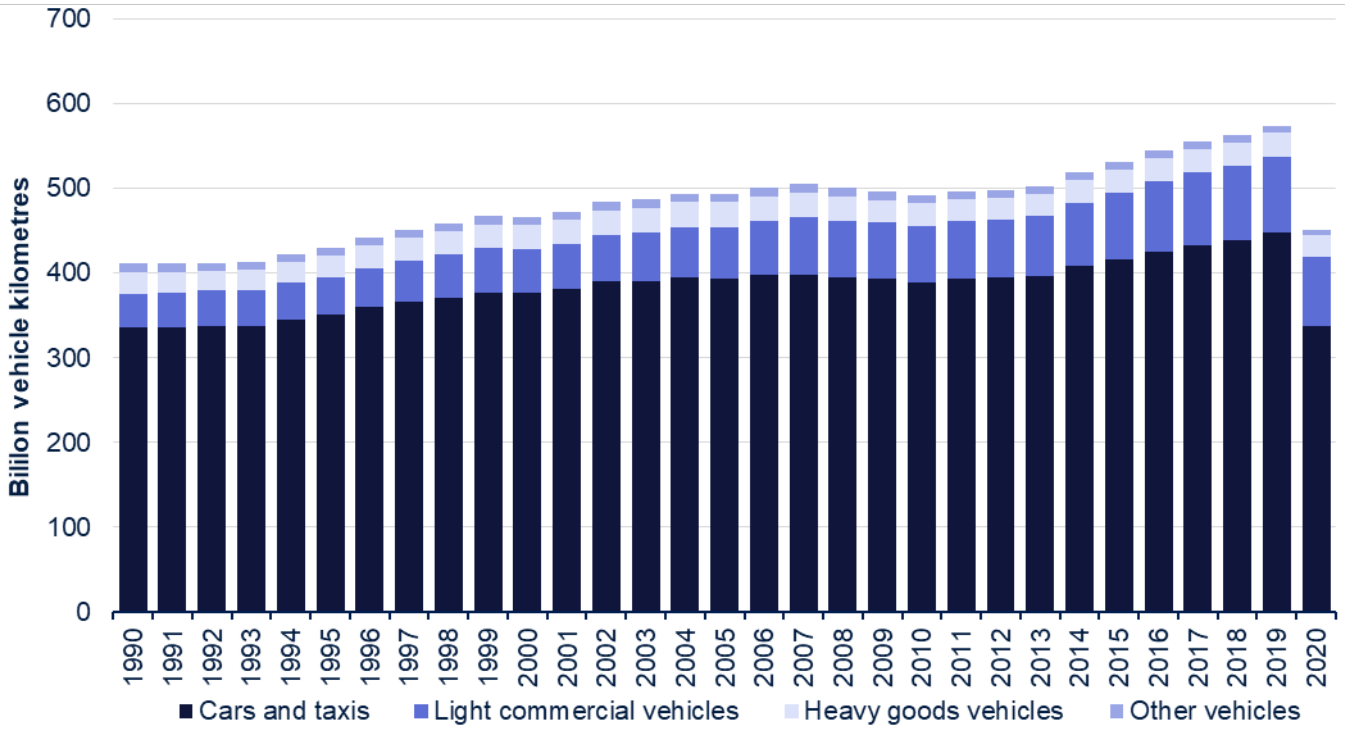
Road transport is the most significant source of emissions in this sector, in particular passenger cars; and the changes which have been seen over the period were heavily influenced by this category. Figure 7 shows how the volume of traffic on the roads has changed over time in Great Britain, which reflects the trend seen for the UK as a whole. Motor vehicle traffic volumes have generally increased throughout this period, other than a fall seen between 2007 and 2010 following the recession. Again, the COVID-19 pandemic has had a

dramatic impact on the level of road transport occurring in 2020, with cars & taxis and other vehicles seeing falls in total vehicle kilometres of around 25%.

With lower petrol consumption outweighing an increase in diesel consumption[29] and improvements in fuel efficiency of both petrol and diesel cars[30], the volume of emissions from passenger cars has generally decreased since the mid-2000s. Although (pre-pandemic) this has been partially offset by an increase in emissions from light commercial vehicles. Emissions of carbon dioxide are closely related to the amount of fuel used, whilst nitrous oxide and methane emissions are influenced more by the vehicle type and age.

Domestic aviation emissions fell by 60% in 2020 compared to 2019, the largest proportional fall of any mode of transport, due to the large fall in air traffic that occurred following the start of the pandemic. Emissions from railways fell 22% and from domestic shipping by 13%.

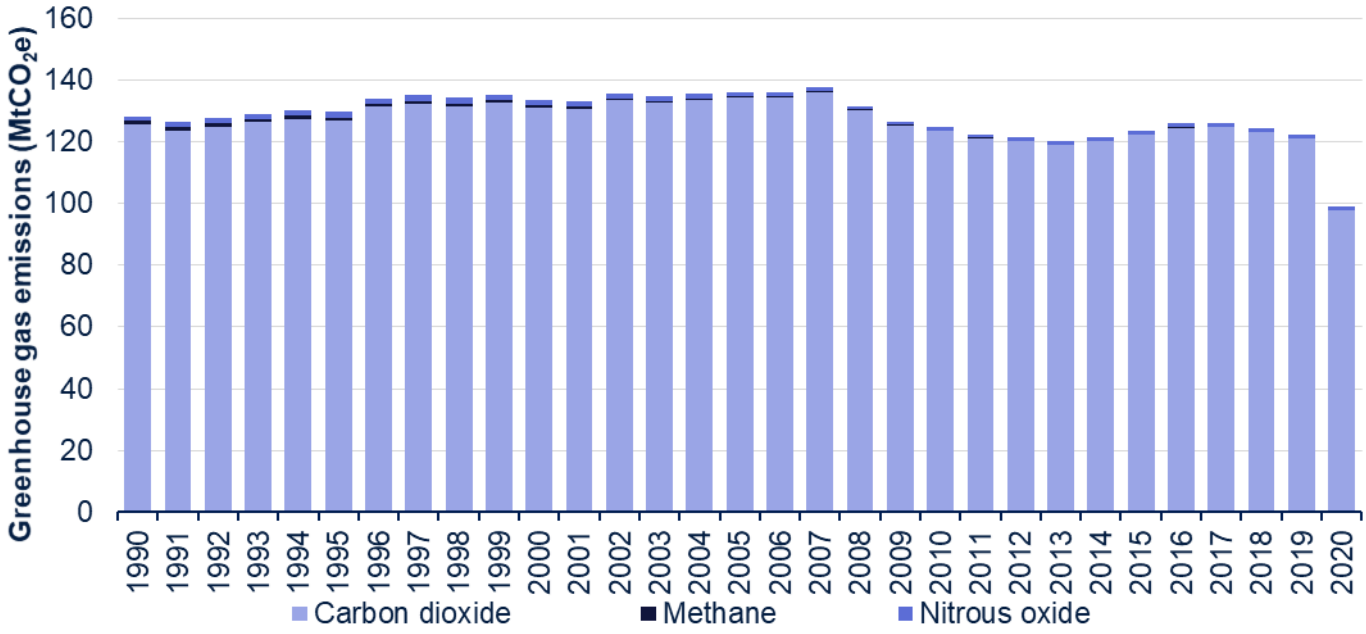
Figure 7: Motor vehicle traffic, Great Britain 1990-2020 (Billion vehicle kilometres)



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

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

Figure 8: Greenhouse gas emissions from transport, UK 1990-2020 ($MtCO_2e$)



Source: Tables 1.2 to 1.6, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

Energy supply

The energy supply sector consists of emissions from fuel combustion for electricity generation and other energy production sources. It is estimated to have been responsible for 21% of UK greenhouse gas emissions in 2020, with carbon dioxide being by far the most prominent gas for this sector (93%). The main source of emissions from this sector is the combustion of fuels in electricity generation from power stations.

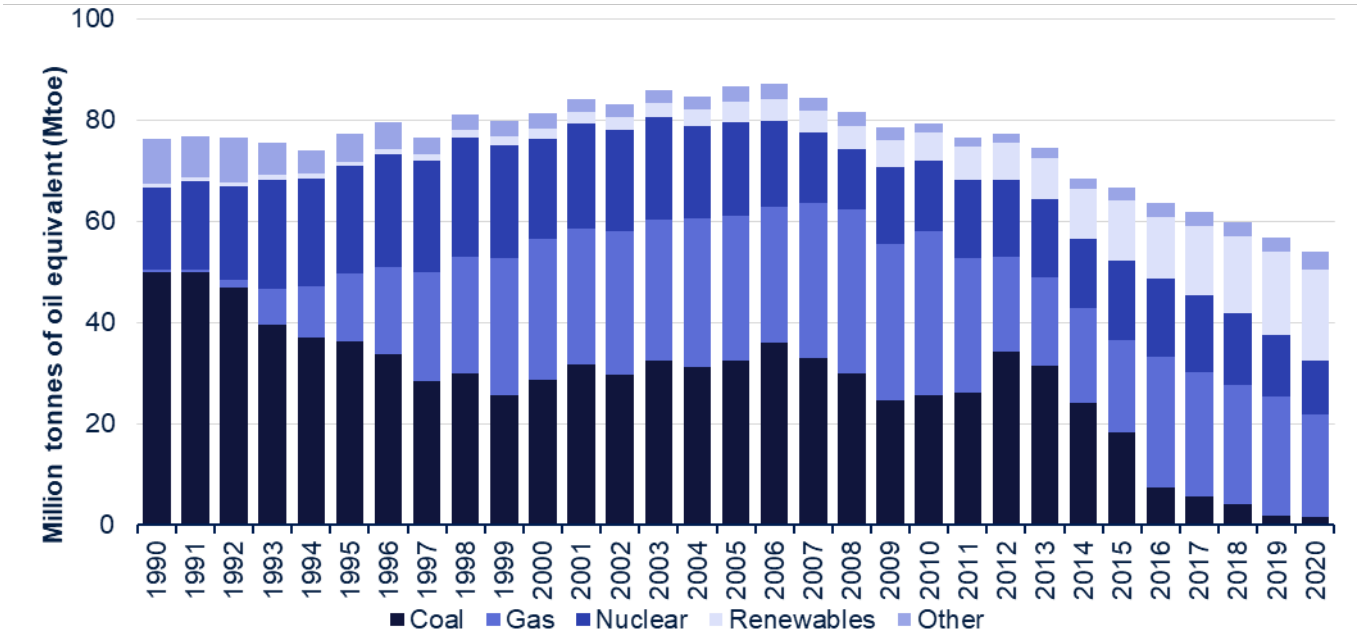
There was a 12% fall in emissions from the energy supply sector between 2019 and 2020, meaning that between 1990 and 2020 they have reduced by 70%. This decrease has resulted mainly from changes in the mix of fuels being used for electricity generation, including the growth of renewables; together with greater efficiency resulting from improvements in technology. In 2020 there was also lower demand for electricity and other fuels as a result of the COVID-19 pandemic. The energy supply sector had historically been the sector with the largest emissions. However, these reductions mean that since 2016 it has been the second largest sector presented in these statistics (the largest being transport).

Since 1990 there has been a decline in the use of coal at power stations and an increase in the use of gas, which has a lower carbon content so results in fewer emissions. Coal use in generation reduced by 97% between 1990 and 2020, and now makes up only 3% of the fuel used for UK electricity generation compared to 65% in 1990[31]. Electricity generation was 1% lower in 2020 than in 1990, having peaked in 2005 and decreased since then[32]. In 2020 the use of gas for electricity generation decreased 14% from 2019 and the use of coal by 21%, whereas renewables saw an 8% increase. In 2020, total greenhouse gas emissions from power stations, at 50.2 $MtCO_2e$, accounted for 12% of all greenhouse gas emissions in the UK.

[31] Digest of United Kingdom Energy Statistics, Table 5.1.1 Fuel input for electricity generation, 1970 to 2020
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904820/DUKES_5.1.1.xls
[32] Digest of United Kingdom Energy Statistics, Table 5.1.3 Electricity generated and supplied, 1970 to 2020
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904822/DUKES_5.1.3.xls

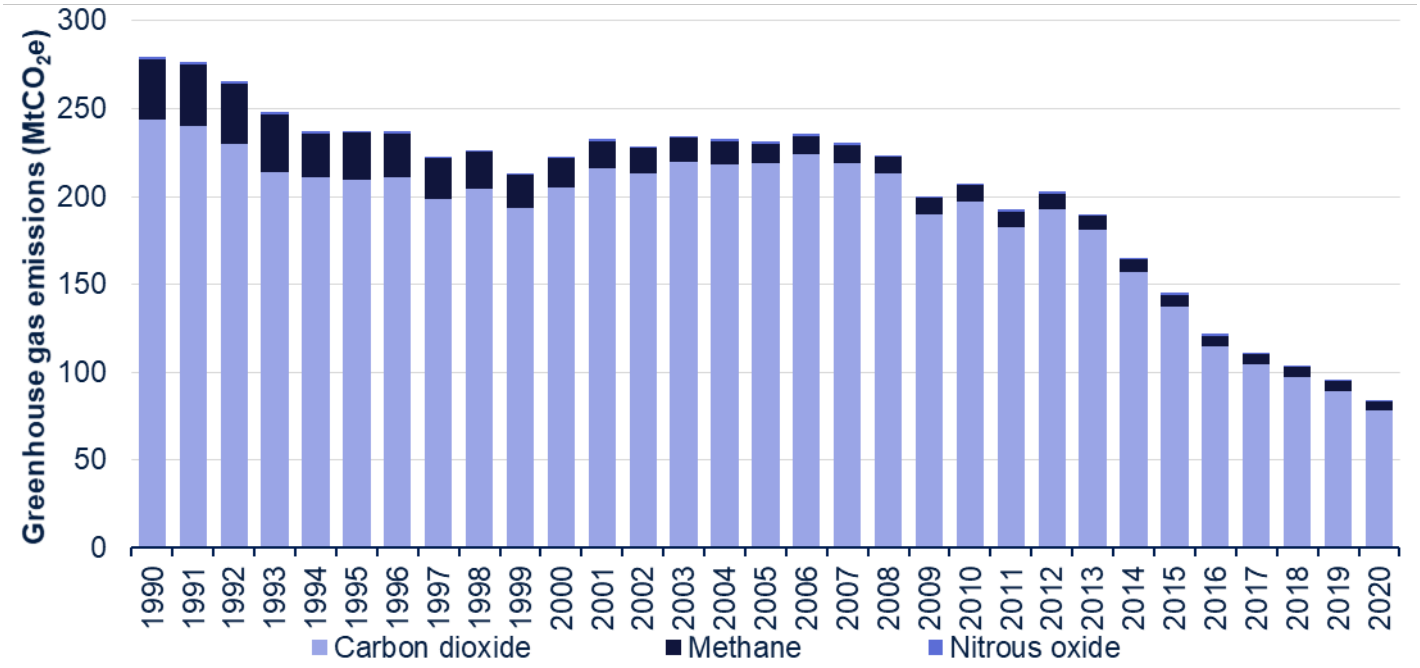
The other main factor which has noticeably contributed to the long-term decline in emissions in the energy sector has been in relation to coal mining. The production of deep-mined coal in particular has declined steadily over the period, with the last three large deep mines all closing in 2015. Emissions from coal mining and handling have fallen from 21.8 $MtCO_2e$ in 1990 to only 0.5 $MtCO_2e$ in 2020.

Figure 9: Fuel used for UK electricity generation, UK 1990-2020 (Million tonnes of oil equivalent (Mtoe))



Source: Digest of United Kingdom Energy Statistics, Table 5.1.1 Fuel input for electricity generation, 1970 to 2020
https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes

Figure 10: Greenhouse gas emissions from energy supply, 1990-2020 ($MtCO_2e$)



Source: Tables 1.2 to 1.6, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

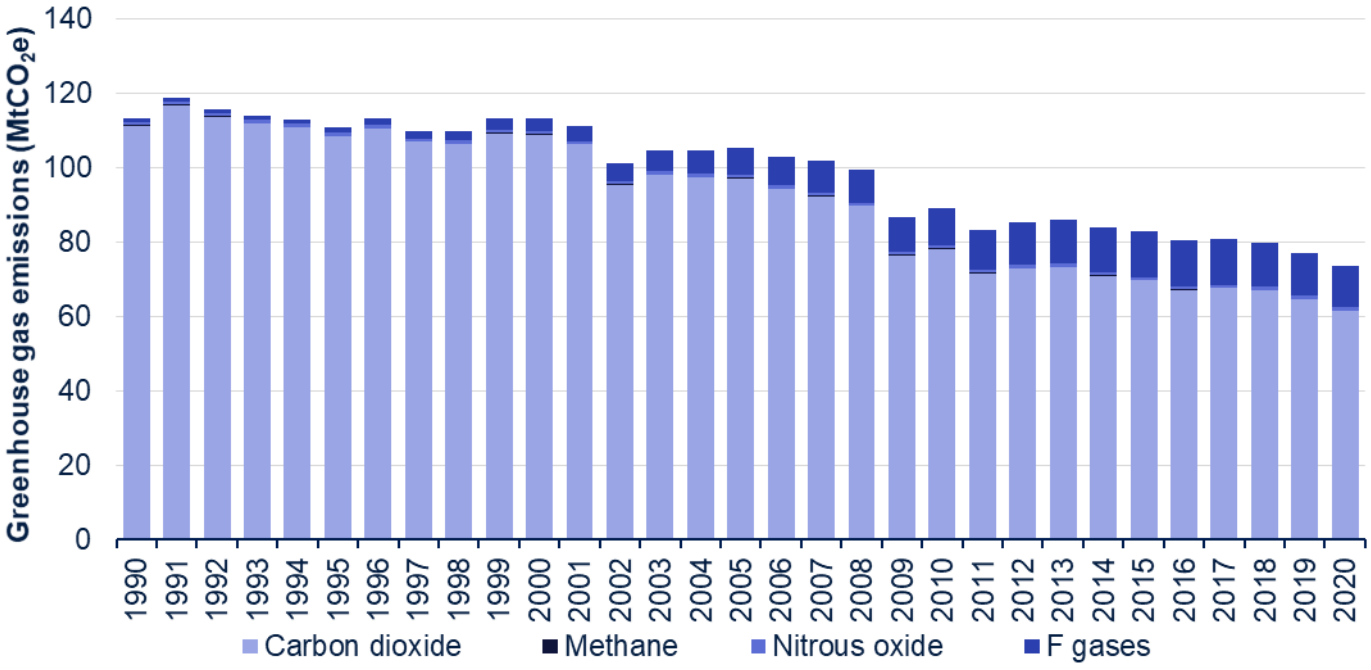
Business

The business sector consists of emissions from combustion in industrial/commercial sectors, industrial off-road machinery, and refrigeration and air conditioning. Between 2019 and 2020 there was a 5% decrease in emissions from the business sector, largely as a result of falls in emissions from industrial and commercial combustion as business activity reduced following the start of the COVID-19 pandemic. The business sector is estimated to have been responsible for 18% of greenhouse gas emissions in the UK in 2020, with carbon dioxide being the most prominent gas. Emissions from this sector primarily relate to fossil fuel combustion in industry and commerce, although emissions of F gases from the use of fluorinated compounds in certain applications, particularly refrigeration and air-conditioning, are also significant. The business sector is responsible for the large majority of emissions from F gases.

In 2020, emissions from the business sector were 35% lower than 1990 emissions. Most of this decrease came between 2001 and 2009, with a significant drop in 2009 likely driven by economic factors. There has been a gradual decline in emissions in recent years. The main driver of the decrease in emissions since 1990 is a reduction in emissions from industrial combustion (including iron and steel) which has led to a 45% reduction in carbon dioxide emissions since 1990.

However, emissions from F gases have increased significantly, mainly due to an increase in emissions from refrigeration and air-conditioning as HFCs replaced ozone depleting substances which were previously used as refrigerants. This increasing trend has reversed in recent years following the introduction of the HFC phase down as part of the EU's 2014 F-Gas Regulation, and F gas emissions have fallen by 11% since their peak in 2016.

Figure 11: Greenhouse gas emissions from business, UK 1990-2020 ($MtCO_2e$)



Source: Tables 1.2 to 1.6, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

Residential

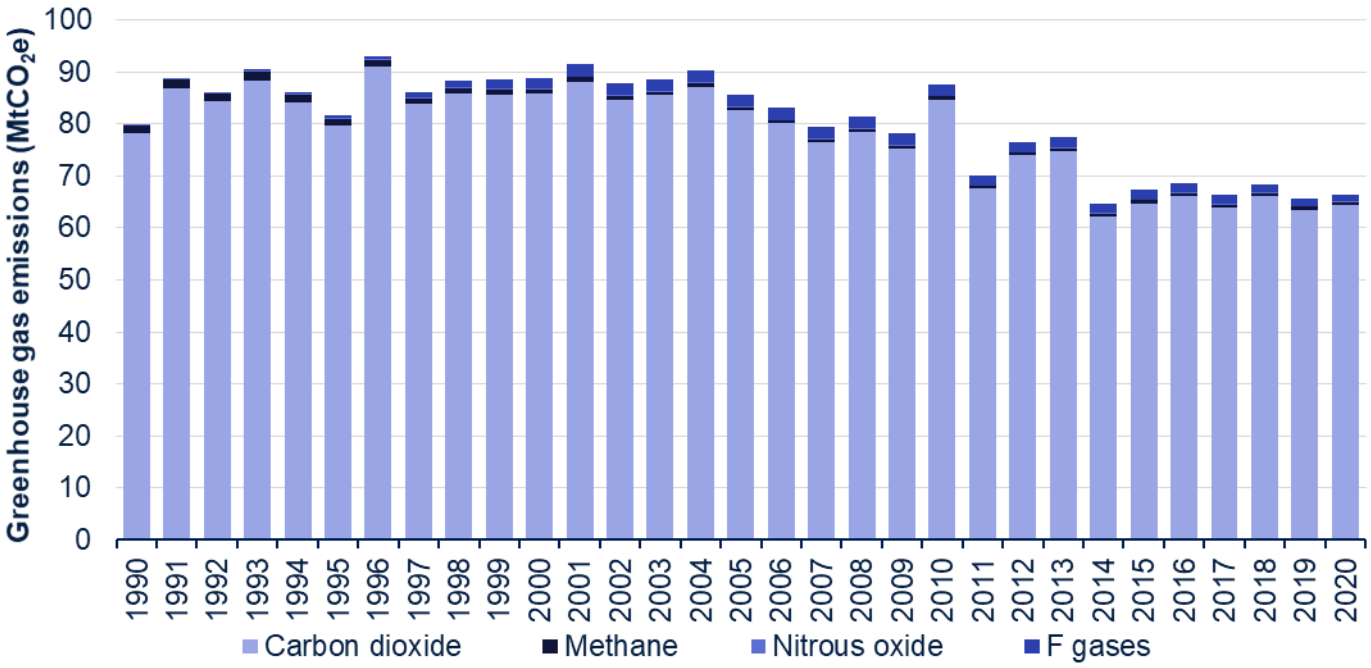
The residential sector consists of emissions from fuel combustion for heating and cooking, garden machinery, and fluorinated gases released from aerosols and metered dose inhalers. It is estimated to have been responsible for around 16% of greenhouse gas emissions in the UK in 2020, with carbon dioxide being the most prominent gas for this sector (97%). The main source of emissions from this sector is the use of natural gas for heating and cooking.

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

Between 1990 and 2020 there has been considerable variation in greenhouse gas emissions from year to year in the residential sector. In general, carbon dioxide emissions from this sector are particularly heavily influenced by external temperatures, with colder temperatures driving higher emissions due to increased use of heating.

The COVID-19 pandemic was likely the main driver of the 1% increase in residential emissions between 2019 and 2020, with increased demand for heating when people were instructed to stay at home for periods of the year and many more people were either working from home or unable to go to work due to the coronavirus restrictions. This increase was despite the warmer weather conditions in 2020 compared to 2019, as the average temperature across the year was 0.3 degrees Celsius higher[33]. This would usually be expected to result in a reduction in residential emissions due to reduced use of natural gas for heating. Further information on the impact of external temperatures on emissions can be found later in this statistical release.

Figure 12: Greenhouse gas emissions from the residential sector, UK 1990-2020 ($MtCO_2e$)



Source: Tables 1.2 to 1.6, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

[33] Energy Trends: Weather Table ET 7.1 Average temperatures, heating degree days and deviations from the long-term mean https://www.gov.uk/government/statistics/energy-trends-section-7-weather

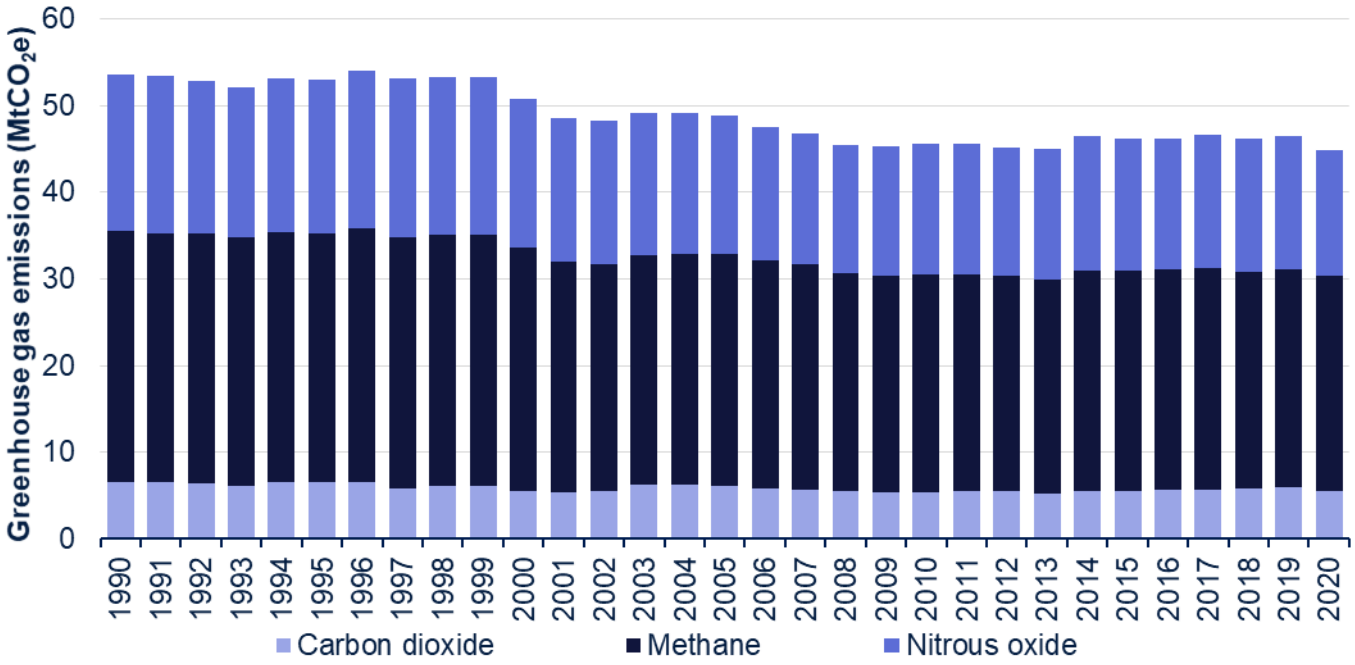
Agriculture

The agriculture sector consists of emissions from livestock, agricultural soils, stationary combustion sources and off-road machinery. It is estimated to have been responsible for 11% of greenhouse gas emissions in the UK in 2020. Emissions of methane (55%) and nitrous oxide (32%) dominate this sector. The most significant sources here are emissions of methane due to enteric fermentation (digestion processes) from livestock, particularly cattle; and nitrous oxide emissions related to the use of fertilisers on agricultural soils.

Between 2019 and 2020 there was a 3% decrease in emissions from the agriculture sector, largely due to decreases in carbon dioxide emissions from liming, and both direct and indirect soil emissions of nitrous oxide.

Between 1990 and 2020, greenhouse gas emissions from agriculture decreased by around 16%. Most of this fall happening during the 2000s, since when emissions have remained at a similar level. The reduction in emissions was driven by a fall in animal numbers over the period, together with a decrease in synthetic fertiliser use.

Figure 13: Greenhouse gas emissions from agriculture, UK 1990-2020 ($MtCO_2e$)



Source: Tables 1.2 to 1.6, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

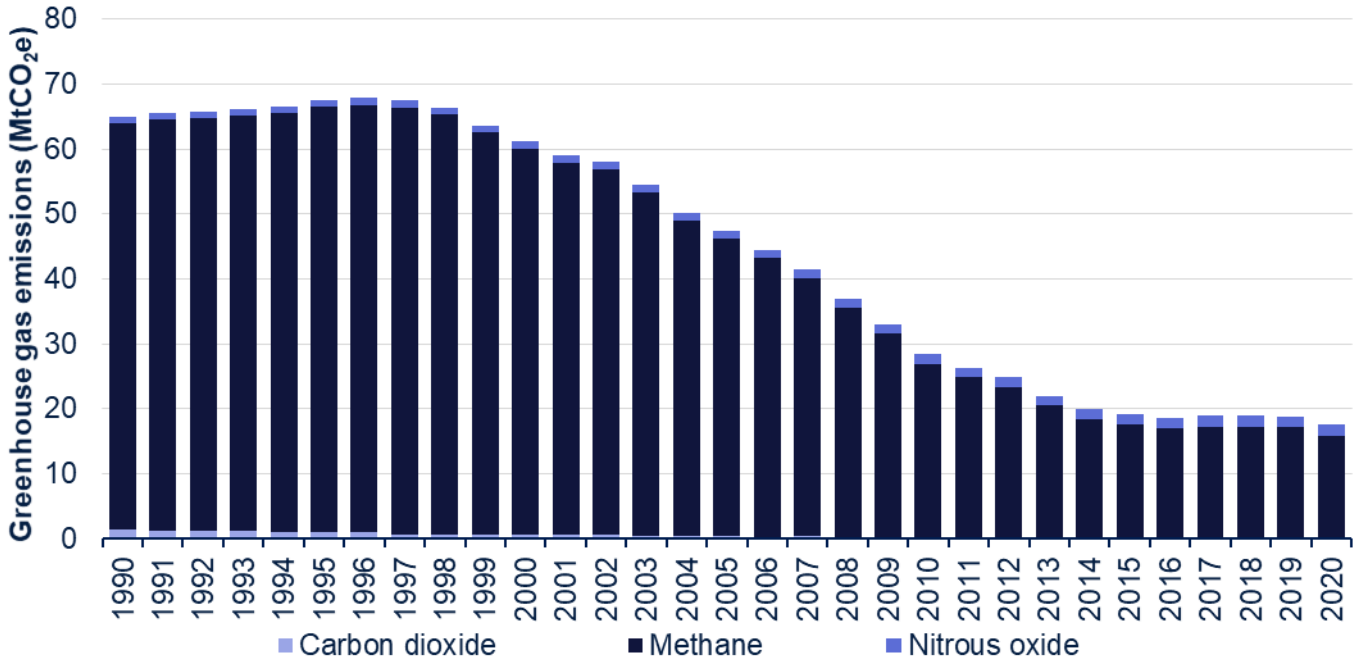
Waste management

The waste management sector consists of emissions from waste disposed of to landfill sites, waste incineration, and the treatment of waste-water. It is estimated to have been responsible for around 4% of greenhouse gas emissions in the UK in 2020, with methane being by far the most prominent gas (accounting for 89% of emissions). The vast majority of these emissions are from landfill sites.

Emissions in the waste management sector decreased by 7% between 2019 and 2020 due mainly to reduced emissions from landfill. Between 1990 and 2020, greenhouse gas emissions from the waste management sector decreased by 73%. This was due to a combination of

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

Figure 14: Greenhouse gas emissions from waste management, UK 1990-2020 ($MtCO_2e$)



Source: Tables 1.2 to 1.6, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

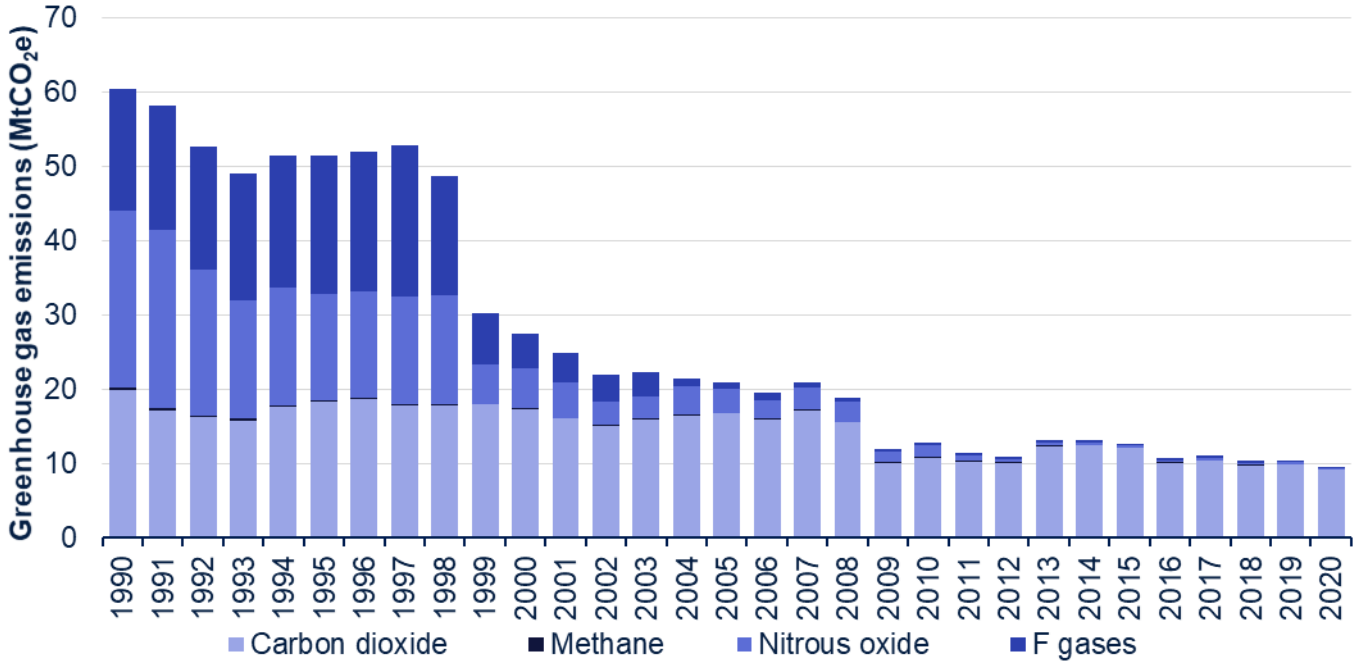
Industrial processes

The industrial processes sector consists of emissions from industry except for those associated with fuel combustion. It is estimated to have been responsible for 2% of greenhouse gas emissions in the UK in 2020, with carbon dioxide being the most prominent gas. The largest source of emissions was cement production, with other processes such as sinter, lime, and ammonia production also contributing significantly.

Between 1990 and 2020, there was a large reduction in greenhouse gas emissions from the industrial processes sector, with an overall decrease of 84%. This was most notably due to a large reduction in emissions from adipic acid production and halocarbon production between 1998 and 1999 following the fitting of abatement equipment at production facilities.

Emissions in the industrial processes sector decreased by 9% in 2020 compared to 2019. The largest factor in this fall was a decrease in emissions from the production of cement, but reductions were seen in emissions from most industrial processes in 2020 as businesses reduced activities during the pandemic.

Figure 15: Greenhouse gas emissions from industrial processes, UK 1990-2020 ($MtCO_2e$)



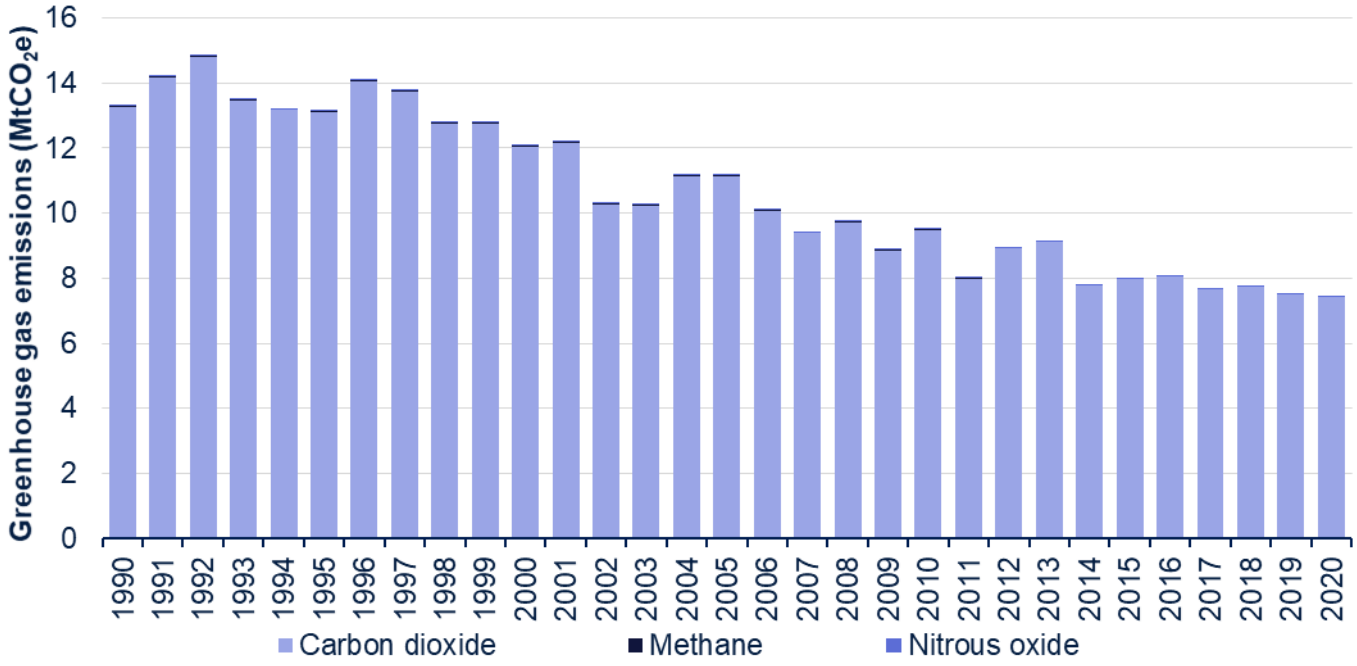
Source: Tables 1.2 to 1.6, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

Public

The public sector consists of emissions from combustion of fuel in public sector buildings, such as schools, hospitals and offices. It is estimated to have been responsible for around 2% of greenhouse gas emissions in the UK in 2020, with carbon dioxide making up almost all of these emissions. The main source of emissions from this sector is the use of natural gas for heating public buildings. It should be noted that these totals do not include emissions from the generation of electricity consumed by the public sector as these emissions are included in the energy supply sector, while emissions from public transport are included in the transport sector.

Between 1990 and 2020 there has been a general downward trend in greenhouse gas emissions from the public sector, which have fallen by 44% over this period. This has been driven by a change in the fuel mix, with less use of coal and oil, and more use of natural gas. Between 2019 and 2020 emissions decreased by 1% in the public sector. This sector did not see the significant falls that some other sectors saw due to the impact of the pandemic, remaining relatively stable. This is also despite the slightly warmer temperatures throughout much of the year compared to 2019, which will have likely reduced the demand for heating.

Figure 16: Greenhouse gas emissions from the public sector, UK 1990-2020 ($MtCO_2e$)



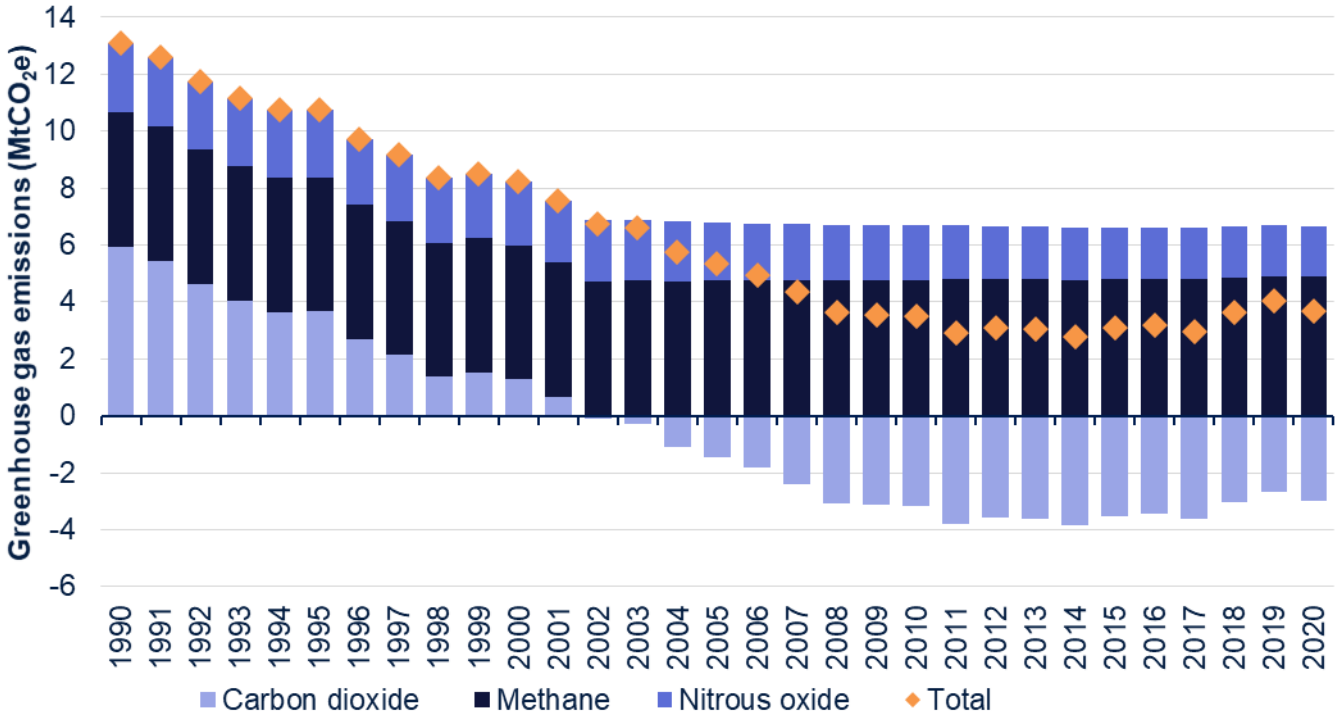
Source: Tables 1.2 to 1.6, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

Land use, land use change and forestry (LULUCF)

The LULUCF sector consists of emissions and removals from forest land, cropland, grassland, settlements and harvested wood products. It is the only sector that includes emission removals, although we estimate the sector as a whole to be a net source of greenhouse gas emissions in each year from the start of the data series in 1990. In general, cropland is the largest sources of carbon dioxide emissions, while forest land is the dominant sink. Settlements, wetlands and grasslands are estimated to have been net sources of emissions throughout the data series.

The LULUCF sector is estimated to have had net emissions of 3.7 $MtCO_2e$ in 2020. This is a slight decrease of 0.4 $MtCO_2e$ from 2019 and down from a total of 13.1 $MtCO_2e$ in 1990. This long-term fall has been driven by a reduction in emissions from grassland, cropland and settlements, and an increase in the sink provided by forest land, with an increasing uptake of carbon dioxide by trees as they reach maturity, in line with the historical planting pattern. There has also been some reduction in emissions since 1990 due to changes in agricultural practices.

Figure 17: Greenhouse gas emissions from the LULUCF sector, UK 1990-2020 ($MtCO_2e$)



Source: Tables 1.2 to 1.6, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

International comparison

UK territorial greenhouse gas emissions account for around 1% of the global total, based on a range of estimates produced by the UN, the International Energy Agency and the World Resources Institute amongst others. Under the United Nations Framework Convention on Climate Change (UNFCCC), the UK and a number of other countries (known as the Annex I parties to the Convention[34]) report their territorial emissions each year to the UNFCCC, while other countries report theirs every few years. This allows for comparisons to be made between different countries' emission estimates following consistent approaches in line with the guidance set out by the Intergovernmental Panel on Climate Change (IPCC)[35].

Figure 18 shows the most recent territorial greenhouse gas emissions estimates reported to the UNFCCC for the UK and other members of the G20, and figure 19 shows this in terms of annual emissions per person in the population. To be consistent with other countries the UK emissions shown are the 2019 estimates submitted to the UNFCCC last year, so do not include the revisions to the estimates shown elsewhere in this publication. The members of the G20 account for more than 80% of world GDP and 60% of the world's population[36]. The year the data relates to for each country is shown in the charts, for Annex I countries this is 2019. As these are territorial emissions they only include emissions within a country's borders, so do not reflect any emissions resulting from the production of goods imported into a country or any international travel by its residents. The estimates shown include emissions and removals from the LULUCF sector.

Countries' emissions tend to reflect their size, with the highest emissions coming from the countries with the largest populations and land areas. China is the country with the highest greenhouse gas emissions, of around 11,200 $MtCO_2e$ in 2014 (the latest year of data available), followed by the United States, which had emissions of 5,769 $MtCO_2e$ in 2019. The European Union as whole (excluding the UK) had emissions in 2019 of 3,359 $MtCO_2e$.

When adjusted for population, Australia has the highest emissions of G20 countries of around 20 tonnes of CO_2e per person in 2019, while Canada, Saudi Arabia and the United States also each had emissions of over 17 tCO_2e per person in their latest available data. India has the lowest emissions per person in the G20, at around 2 tCO_2e per person in its latest data from 2016, although this will have increased in the years since then. The UK had emissions of around 7 tCO_2e per person in 2019. Higher emission rates can be associated with a number of factors, such as significant heavy industry, a large manufacturing sector or the use of more carbon intensive fuels such as coal for electricity generation.

[34] Annex I parties' submissions in 2021 showing greenhouse gas emissions in 2019 are available here: https://unfccc.int/ghg-inventories-annex-i-parties/2021
[35] 2006 IPCC Guidelines for National Greenhouse Gas Inventories: https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html
[36] https://www.g20.org/en/il-g20.html

Figure 18: Most recent annual territorial greenhouse gas emissions reported to the UNFCCC: G20 countries ($MtCO_2e$)

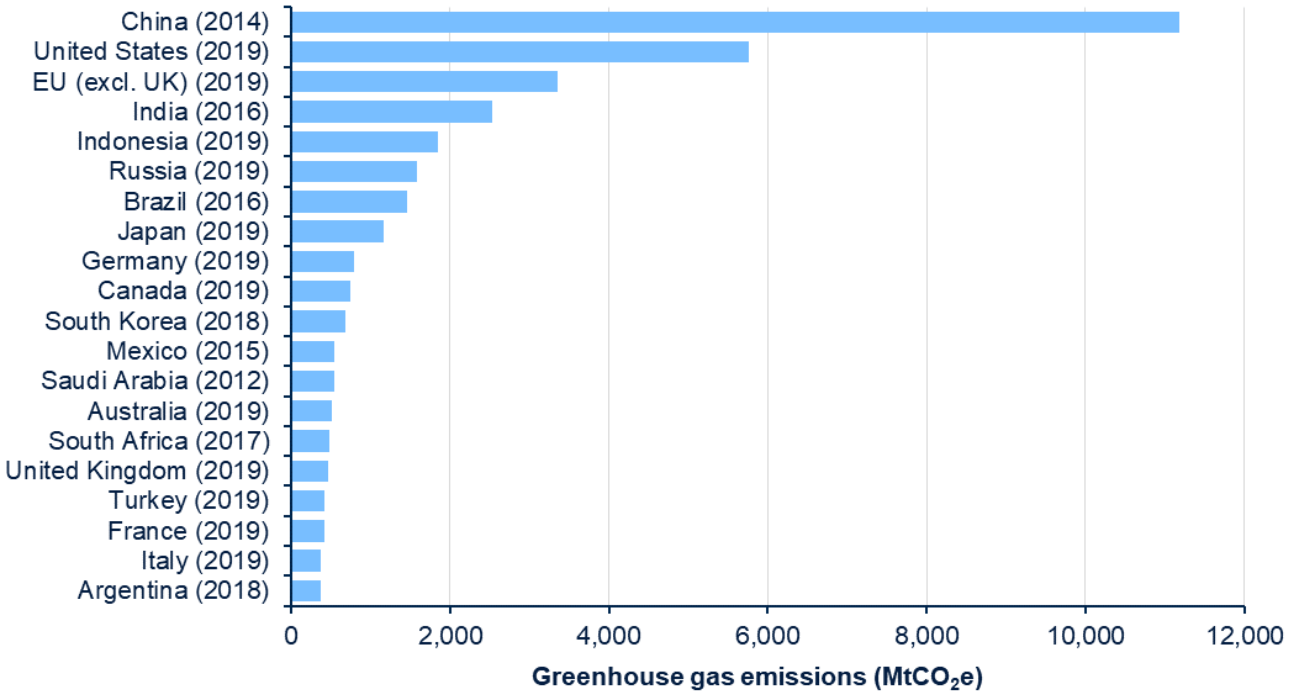
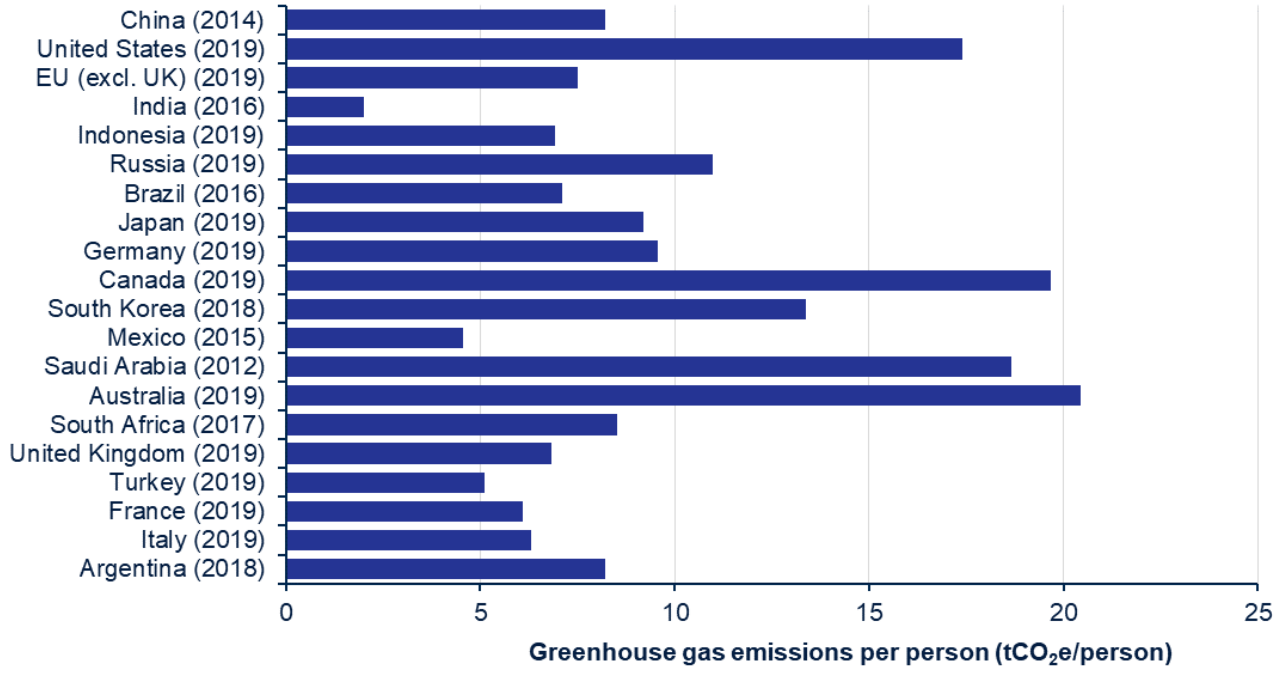


Figure 19: Annual territorial greenhouse gas emissions per person: G20 countries (tCO_2e per person)



Source: Countries' submissions to the UNFCCC

Notes:

1. The year the data relates to for each country is shown next to their name in the charts.
2. All emissions totals include emissions and removals from the LULUCF sector.
3. The UK figures include Crown Dependencies and certain Overseas Territories in line with its international reporting requirements, although they only make up around 1% of the UK emissions total.
4. The UK figures are the 2019 emissions estimates submitted to the UNFCCC in 2021 so do not incorporate the data updates and methodology changes made to the 2019 estimate in this publication.
5. The UK was a member of the EU in 2019 and included in the EU submission to the UNFCCC but has been removed from the EU figures for this comparison. The EU total includes France, Germany and Italy despite them also being shown separately.

Emissions from UK-based international aviation and shipping bunkers

In the data tables accompanying this publication, table 6.1 shows greenhouse gas emissions arising from use of fuels from UK international aviation and shipping bunkers since 1990.

Emissions from international aviation and shipping can be estimated from refuelling from bunkers[37] 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. 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).

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 the International Civil Aviation Organization, 193 states have agreed to implement a sectoral approach to tackling international aviation emissions, in the form of a "global market-based measure" known as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which does not allocate emissions to states. Under the scheme, airlines will offset their international aviation emissions covered by the scheme with reductions from other sectors, with the aim of delivering carbon-neutral growth of the sector from 2020[38].

In relation to the International Maritime Organization, the 2018 Initial Strategy on Reduction of GHG Emissions from Ships[39] commits Member States to peak greenhouse gas emissions from international shipping as soon as possible and to reduce the total annual greenhouse gas emissions by at least 50% by 2050 compared to 2008 while pursuing efforts towards phasing them out as soon as possible this century. The Initial Strategy is due to be revised in 2023.

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

In 2020, emissions from international aviation fuel use from UK bunkers were estimated to be 14.5 $MtCO_2e$. This was 60.7% lower than in 2019, when it was 36.8 $MtCO_2e$, and is the lowest annual figure since these estimates begin in 1990. This was due to the large fall in air traffic that occurred following the start of the COVID-19 pandemic, with the number of international

[37] A large container or compartment that stores fuel for ships or aircraft.
[38] https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx
[39] https://unfccc.int/sites/default/files/resource/250_IMO submission_Talanoa Dialogue_April 2018.pdf

flights landing or taking off from UK airports 64% lower in 2020 than 2019[40]. Between 1990 and 2006, emissions more than doubled from 15.5 $MtCO_2e$ to 35.7 $MtCO_2e$. After 2006, emissions dipped slightly, then increased again above the 2006 peak between 2017 and 2019, before the fall in 2020. High altitude aviation has a greater greenhouse effect due to the formation of persistent condensation trails (contrails) over and above that of carbon dioxide emissions from fuel alone, but this is not reflected in these estimates.

Emissions from UK international shipping bunkers were estimated to be 6.1 $MtCO_2e$ in 2020, a decrease of 17.8% from the 2019 level. This is the second lowest annual figure since these estimates begin in 1990 and was due to the large fall in shipping traffic that occurred following the start of the COVID-19 pandemic. Since 1990, emissions from UK shipping bunkers have fluctuated, as can be seen in the chart below, but in recent years before the reduction in 2020 had been at around the same level that they were in 1990.

Figure 20: Greenhouse gas emissions from UK-based international aviation and shipping bunkers, 1990-2020 ($MtCO_2e$)

Source: Table 6.1, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

Revisions from provisional estimates of greenhouse gas emissions

Provisional estimates of 2020 UK greenhouse gas and carbon dioxide emissions were published in March 2021, based on early estimates of energy consumption for the year. Differences between the provisional and final estimates arise primarily due to revisions to other statistics on which these estimates were based, use of actual data to estimate non-CO_2 emissions which are only estimated in a simplistic way in the provisional estimates, and methodological changes to the way emissions are calculated.

[40] AVI0102: Air traffic by type of service, operator and airport
https://www.gov.uk/government/statistical-data-sets/aviation-statistics-data-tables-avi

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

It was provisionally estimated that total greenhouse gas emissions in 2020 for the UK would be 414.1 $MtCO_2e$, representing an 8.9% decrease on 2019 emissions. The final estimates show that 2020 emissions were 405.5 $MtCO_2e$, representing a 9.5% decrease on 2019 emissions. The provisional greenhouse gas emissions estimates therefore overestimated the total greenhouse gas emissions in 2020 (by 2.1%) and underestimated the percentage decrease in emissions from 2019 to 2020 (by 0.5 percentage points). The difference in the total is largely explained by methodology changes made this year, combined with an underestimate of the reduction in non-CO_2 emissions between 2019 and 2020.

The provisional estimates are focused on carbon dioxide emissions from the energy sector, and only provide a simplistic estimate of non-CO_2 gases which assumed that the 2020 emissions for non-CO_2 gases changed from the 2019 total in line with the percentage difference between the estimates for 2019 and 2020 of total non-CO_2 emissions in the 2019 Energy and Emissions Projections[41] published by BEIS. Focusing on carbon dioxide emissions, it was provisionally estimated that net UK carbon dioxide emissions in 2020 were 326.1 million tonnes. The final 2020 figure of 321.1 million tonnes indicates that the provisional estimate overestimated CO_2 emissions by 1.6%. This was largely due to methodology changes in the final estimates.

The provisional estimate for emissions of non-CO_2 gases in 2020 was 88.0 $MtCO_2e$ and the final estimate is 84.4 $MtCO_2e$, so these emissions were overestimated by 4.2% in the provisional estimates. This was largely due to the impact of the coronavirus (COVID-19) pandemic.

Table 2: Comparison of 2020 provisional and final estimates

UK, 2019-2020 — $MtCO_2e$

	2020 Provisional estimates	2020 Final estimates	Difference between final and provisional	Provisional 2019 to 2020 % change	Final 2019 to 2020 % change
Total CO_2	326.1	321.1	-5.0	-10.7%	-10.6%
Non-CO_2 gases	88.0	84.4	-3.6	-1.9%	-4.7%
All greenhouse gases	414.1	405.5	-8.6	-8.9%	-9.5%

Source: Table 1.1, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables
Table 1, Provisional UK greenhouse gas emissions national statistics 2020 Excel data tables

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

Revisions to the UK's Greenhouse Gas Inventory

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

The UK Greenhouse Gas Inventory (the time series of emissions from 1990 onwards which is the basis for these statistics), is reviewed every year internally and externally (including a review by the UNFCCC), and the whole historical data series is revised where necessary to incorporate methodological improvements, changes to international reporting guidelines or new data. This takes into account revisions to the datasets which have been used in its compilation, most notably the UK energy statistics published in the Digest of UK Energy Statistics (DUKES). The methodological changes to the UK Greenhouse Gas Inventory can also impact future emissions projections. Full details of the methods used to produce the latest greenhouse gas emissions estimates will be published in the UK's National Inventory Report[42] (NIR).

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

Table 3: Revisions in the 2021 Greenhouse Gas Inventory, by sector

UK, 1990 and 2019 — $MtCO_2e$

	1990 emissions			2019 emissions		
	1990-2019 inventory	1990-2020 inventory	Change	1990-2019 inventory	1990-2020 inventory	Change
Energy supply	278.0	279.5	1.6	95.8	95.6	-0.3
Transport	128.1	128.1	~0.0	122.2	122.3	0.1
Business	113.8	113.2	-0.5	77.9	77.1	-0.8
Residential	80.1	80.0	~0.0	69.2	65.7	-3.5
Agriculture	53.1	53.6	0.6	46.3	46.4	0.1
Waste management	64.7	64.9	0.1	19.0	18.8	-0.2
Industrial processes	59.9	60.4	0.5	10.4	10.4	~0.0
Public	13.5	13.3	-0.1	7.9	7.5	-0.4
LULUCF	18.0	13.1	-4.9	5.9	4.0	-1.9
Total	**809.1**	**806.3**	**-2.9**	**454.8**	**447.9**	**-6.9**

~0.0 indicates where a value is non-zero but is less than 0.05 $MtCO_2e$ in magnitude.
Source: Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2020 Data tables
Table 1.2, Final UK greenhouse gas emissions national statistics 1990-2019 Data tables

[42] Previous UK NIRs can be found here: http://naei.beis.gov.uk/reports/ and the latest NIR covering 1990-2020 emissions will be submitted to the UNFCCC on 15th April 2022.

The most notable methodological changes to the historical series since the 1990-2019 Greenhouse Gas Inventory was published are the revisions to the LULUCF sector as a result of the use of a wider range of sources to identify land-use changes over time. Revisions to the datasets used in producing these estimates have also led to changes across most sectors for more recent years. Details of the changes made to estimates of 1990 and 2019 emissions are given in Table 3. Revisions to other years of the time series are generally of a similar scale.

Within the sectors there have also been some changes made to the names of source categories this year to clarify their coverage, and two additional source categories have been added this year compared to the previous publication. These are summarised below.

NC category	**NC Sector**	**Reason for change**
Upstream oil and gas - flaring	Energy Supply	This is a renaming of the '*Offshore oil and gas – Flaring*' category from previous publications that has been made alongside methodology changes to how these emissions are estimated.
Upstream oil and gas - venting	Energy Supply	This is a renaming of the '*Offshore oil and gas – Venting*' category from previous publications that has been made alongside methodology changes to how these emissions are estimated.
Other ceramics	Industrial processes	This is a new category this year that includes carbon dioxide emissions from the manufacture of ceramics other than brick and roof tiles, which are being included in these statistics for the first time this year.
Biomass burning - Wetland	LULUCF	This is a new category this year that covers emissions from controlled burning on forest land converted to wetlands. These emissions were previously included in the '*Land converted to wetland'* category.
Drainage, rewetting and other management of organic and mineral soils - Forest land	LULUCF	This is a renaming of the '*Drainage of organic soils*' *– Forest land'* category from previous publications to make it clearer what it covers. The coverage is unchanged.
Drainage, rewetting and other management of organic and mineral soils - grassland	LULUCF	This is a renaming of the '*Drainage of organic soils – grassland'* category from previous publications to make it clearer what it covers. The coverage is unchanged.
Drainage, rewetting and other management of organic and mineral soils - wetland	LULUCF	This is a renaming of the '*Drainage of organic soils – wetlands*' category from previous publications to make it clearer what it covers. The coverage is unchanged.
Drainage, rewetting and other management of organic and mineral soils - settlements	LULUCF	This is a renaming of the '*Drainage of organic soils – settlements*' category from previous publications to make it clearer what it covers. The coverage is unchanged.

Details of the methodological changes made to the emissions estimates this year are given below.

Semiconductor manufacture

Several revisions have been made to the estimates of emissions from the manufacture of semiconductors following a general review of the model parameters and assumptions that was made in consultation with UK semiconductor manufacturers and with consideration for BEIS' Excel model QA guidance. In particular:

- A flatter trend in total CO_2e for 2001-10 following a review to the approach to modelling the phasing out of CF_4 and C_2F_6
- Removing the exponential growth previously assumed for 2010 onwards
- Some changes in the relative importance of each pollutant due to revisions in some parameters in the 2019 refinement compared to the 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines.

Airborne Warning And Control System (AWACS)

We have revised the estimates for sulphur hexafluoride (SF_6) emissions from AWACS using data providing a full time series of the number of active planes recently obtained from the Ministry of Defence. The previous estimate used an IPCC default emission factor, and a fixed number of planes for all years due to lack of better data. The default emission factor has been replaced by actual data for the years 2016-2020, a Ministry of Defence estimate for 2014 and 2015, and an average value based on all measured data (i.e. excluding the estimated data for 2014 and 2015) applied to all other years.

This marks a significant improvement to the accuracy and representativeness of the emissions estimates for this source and has led to a significant reduction in the estimates for all years.

Upstream/offshore oil and gas operations

We have developed new emission estimation models to make use of new and existing data sources, and to reflect some of the new IPCC methods for fugitive sources. The project has involved consultation with a number of industry, statistical and regulatory agencies, including: BEIS Offshore Petroleum Regulator for Environment and Decommissioning (OPRED), BEIS Energy Statistics, the Oil and Gas Authority (OGA), Oil and Gas UK, the Environment Agency and the Scottish Environmental Protection Agency (SEPA), and detailed analysis of:

- Environmental Emissions Monitoring System (EEMS) (fixed and mobile offshore operator-supplied data from BEIS OPRED);
- EU ETS (fixed offshore 3rd party verified operator-supplied data from BEIS OPRED, and onshore terminal data from the Environment Agency, SEPA and Natural Resources Wales);

- The Environment Agency's Pollution Inventory, SEPA's Scottish Pollutant Release Inventory, Welsh Emissions Inventory (onshore terminals operator-supplied data from environmental regulators);
- Petroleum Production Reporting System monthly returns per upstream oil and gas field (offshore and onshore operator-supplied data from OGA); this project is the first time the inventory method has been able to make use of these data.
- The first and second EU ETS National Allocation Plans, of CO_2 emissions per oil and gas installation, over 1998-2003.
- Historic editions of the Department of Trade and Industry (DTI) 'Brown Book' (Development of UK Oil and Gas Resources, available to 2004 then discontinued as a publication)
- UK oil and gas operator emissions inventory data for 1990-2003, provided by the UK Offshore Operators Association (UKOOA) to the inventory agency in February 2005.
- Digest of UK Energy Statistics (DUKES) (national energy statistics on own use of fuel, plus gas flaring and venting volume data for onshore and offshore production of oil and gas).

The project has sought to utilise the different datasets to track material production (e.g. from oil/gas field to top-side installation, to pipeline to terminal) and derive best estimates for emissions of greenhouse gases (and air quality pollutants) at each installation over the time series. Key changes have arisen from the comparisons of the National Allocation Plan data and the UKOOA 2005 dataset to revisit and overhaul the method for the early part of the time series, as well as to generate a new integrated model to automate the checking, allocations and calculation of "best" emission estimates from the combination of reporting mechanisms (notably EU ETS, EEMS and the onshore regulator Pollution Inventories). The project has also sought to address a number of minor sources for which new methodological guidance was presented in the 2019 Refinement of IPPC methods; these are generally minor fugitive emission sources from e.g. well drilling and well abandonment.

The approach to determining estimates for earlier years (i.e. in the pre-EEMS and pre-ETS period, 1990-1997) has been reviewed to improve time series consistency, drawing on the UKOOA 2005 dataset as the best available source, validated through comparison against the long-term production datasets, at the oil/gas field level, from the DTI Brown Book publications.

These revisions will have also had an indirect impact on public and business emissions in the early part of the time series where revisions to fuel use for this sector impacts fuel balance reconciliations, but it has not been possible to estimate the impact of this effect in the estimated impacts shown in this report.

Unconventional Gas (Shale gas)

A model has been produced to estimate the fugitive emissions resulting from shale gas exploration, which had not been estimated in previous inventories. With just a handful of wells drilled and completed since 2010, shale gas has been a very minor aspect of oil and gas sector activity in the UK and estimating fugitive emissions had been a lower priority than other areas of more significant uncertainty. However, to ensure the completeness of UK emissions reporting and so that the impacts of shale gas exploration and production can be better understood, research was commissioned to address this under-report and a model produced that can provide emission estimates, should the industry develop in the UK.

Electric Arc Furnaces

Through consultation with key industry operators and analysis of the EU ETS, a time series of detailed operator data has been developed allowing for more accurate emissions estimates.

Historically, emission estimates have relied on a simple method that combined annual data on total electric arc furnaces steel production with a UK industry standard emission factor per unit steel production.

In recent years the quality of greenhouse gas emissions reporting to the EU ETS has improved, and comparison between the EU ETS and greenhouse gas inventory estimates has indicated an under-report in the inventory method.

Ceramics other than bricks and roofing tiles

An estimate of CO_2 emissions from the manufacture of other ceramics has been made using British Geological Survey and EU ETS data. This is a source not previously included in the inventory, although this is a much smaller source than the brick and roof tile estimates which are currently included.

Introduction of use of natural gas as a road fuel

Natural gas use in transport has been identified separately in the Digest of UK Energy Statistics (DUKES) estimates for the first time, enabling it to be distinguished from other uses of natural gas. Therefore, we have introduced a new category in the emissions estimates for emissions from the use of natural gas in transport engines.

Note that this is a reallocation – total gas use in DUKES would have included this small component in earlier years and so CO_2 overall is likely to be unchanged. Emissions of N_2O and CH_4 will be different but as it is not possible to identify which category the gas has been reallocated from it is not possible to quantify this difference.

Revision to DUKES wood activity data, and review of time series consistency

There has been a large reduction to DUKES domestic wood activity estimates for 2008 onwards to reflect the findings of a Defra solid fuel combustion survey. Our approach to adjusting the historic time series for both domestic and industrial wood has been reviewed as a result to remove a time series adjustment to the level of activity data which is no longer necessary with the revision of the approach DUKES use.

The approach to adjusting for time series inconsistencies in energy densities of wood in DUKES has also been reviewed in consultation with Renewable Energy Statistics (RESTATS) for both domestic and industrial wood.

Nitrogen balance approach for sewage sludge removal from wastewater

We have reviewed our approach to accounting for nitrogen removed from wastewater in the form of sewage sludge. Previously to avoid double counting N_2O emissions between wastewater and emission from sewage sludge disposal we used a simple approach of deducting final emissions for other sources from wastewater emissions estimates. However, this approach did not account for the variable N_2O emission factors from these difference sources, and therefore did not well reflect actual reductions in nitrogen remaining that might result in N_2O emissions from effluent.

Now the implied nitrogen content of sewage sludge used as a fertiliser is applied to total sewage sludge removed from wastewater and incinerated, landfilled or used as a fertiliser. The total nitrogen calculated is deducted from the estimate of nitrogen in wastewater to determine the nitrogen remaining in wastewater effluent, and N_2O emission factors are applied to the remaining nitrogen.

This results in an increase in emissions for all years, particularly for later years where there is more sludge removed and less sludge disposed to waterways, and therefore more of an impact by changing the method for accounting for sludge removal.

Land use change activity data

There has been a methodological update to the land-use change activity data used in the LULUCF soils and non-forest biomass models. The new approach assimilates a wider range of land use and land-use change data sources to produce an annual time series, rather than the previous approach that used decadal rates of change based on the Countryside Survey. This has had a range of impacts to emissions across the different land types, including:

- Emissions from carbon stock change in the year of change show more annual variability and are lower than previously estimated.
- Estimates of land-use change from grassland to cropland before 2000, particularly in England, are lower than in the previous activity data set, resulting in lower carbon stock change emissions in mineral soils.
- The use of an annual time series results in a more gradual change in modelled carbon stock changes due to land-use change in mineral soil.
- Overall estimates of land-use change to grassland are lower than in the previous activity data set, resulting in smaller carbon stock change removals in mineral soils, but the direction of change varies between countries and land use transitions.
- Overall estimates of land-use change to settlement are lower than in the previous activity data set, resulting in smaller carbon stock change emissions in mineral soils.
- There are lower direct and indirect N_2O emissions from mineralisation corresponding to the lower emissions from land-use change transitions resulting in mineral soil carbon stock losses.

Forestry modelling

Small changes were made to the activity data for forest planting and wood production which included new data from the 2021 Forestry Statistics Publication. An improvement was made to the adjustment for open space within forests and estimation of forest planting data for Northern Ireland was updated to the same method as used for the rest of the UK. These changes resulted in minor changes to the forest carbon stock change and Harvested Wood Products modelled in CARBINE. A minor change was also made in the CARBINE model to improve drainage assumptions.

The deforestation activity data time series was also updated to improve consistency in assumptions for land use change following deforestation.

Minor LULUCF revisions

A number of other minor revisions were made to LULUCF models, including:

- Additional data reported by Growing Media Association was provided for peat extraction from 2014 onwards including data on volume of peat sold and sites which have ceased extraction. These new data replace interpolated values from 2014 onwards where there were data gaps due to the UK Minerals Yearbook no longer reporting peat volumes (the last year of data was 2014). This led to a small decrease in emissions from peat extraction.
- Additional peatland restoration area data supplied by Peatland Action for Scotland for 2016-2020 was used to update the activity dataset.
- Additional wildfire data for Scotland was supplied from the Fire and Rescue Service following a review of their data classification for large fires.
- Emissions from wetland drainage and rewetting of organic soils were included for the Isle of Man for the first time.

Accompanying tables

The following tables are available in Excel and ODS format on the department's statistics website, alongside a CSV dataset of UK territorial greenhouse gas emissions:

UK territorial emissions

Table 1.1	Estimated territorial greenhouse gas emissions by gas, UK 1990-2020
Table 1.2	Estimated territorial greenhouse gas emissions by source category, UK 1990-2020
Table 1.3	Estimated territorial emissions of carbon dioxide (CO_2) by source category, UK 1990-2020
Table 1.4	Estimated territorial emissions of methane (CH_4) by source category, UK 1990-2020
Table 1.5	Estimated territorial emissions of nitrous oxide (N_2O) by source category, UK 1990-2020
Table 1.6	Estimated territorial emissions of fluorinated gases (F gases) by source category, UK 1990-2020
Table 1.7	Estimated territorial greenhouse gas emissions by type of fuel, UK 1990-2020
Table 1.8	Estimated territorial emissions of carbon dioxide (CO_2) by source category, UK 1970-1990

UK territorial emissions targets

Table 2.1	UK territorial greenhouse gas emissions: progress towards the UK Carbon Budget targets
Table 2.2	UK territorial greenhouse gas emissions: progress towards the Kyoto Protocol first commitment period, Kyoto Protocol second commitment period and EU Effort Sharing Decision

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

Table 3.1	Estimated territorial greenhouse gas emissions by geographical coverage and gas, UK, Crown Dependencies & Overseas Territories, 1990-2020
Table 3.2	Estimated territorial greenhouse gas emissions for the UK, Crown Dependencies and Overseas Territories by source category, 1990-2020
Table 3.3	Estimated territorial greenhouse gas emissions in the UK, Crown Dependencies & Overseas Territories, and totals reported to the UNFCCC and the EU, 1990-2020
Table 3.4	Estimated territorial greenhouse gas emissions for the UK, Crown Dependencies and Overseas Territories by type of fuel, 1990-2020

Uncertainty of territorial emission estimates and past revisions

Table 4.1	Uncertainty in estimates of territorial greenhouse gas emissions by gas, UK, Crown Dependencies and Overseas Territories: 1990/2019 *(will be updated on 31st March 2022 with 2020 estimates)*
Table 4.2	Uncertainty in estimates of territorial greenhouse gas emissions by source sector, UK, Crown Dependencies and Overseas Territories: 1990/2019 *(will be updated on 31st March 2022 with 2020 estimates)*
Table 4.3	Estimated territorial greenhouse gas emissions: changes over successive Greenhouse Gas Inventories from 1990-2008 to 1990-2020 for emissions within Carbon Budget coverage

UK territorial emissions on an end-user basis *(will be added on 31st March 2022)*

Table 5.1	Estimated territorial greenhouse gas emissions by end user category, UK 1990-2020
Table 5.2	Estimated territorial emissions of carbon dioxide (CO_2) by end user category, UK 1990-2020
Table 5.3	Estimated territorial emissions of methane (CH_4) by end user category, UK 1990-2020
Table 5.4	Estimated territorial emissions of nitrous oxide (N_2O) by end user category, UK 1990-2020
Table 5.5	Estimated territorial emissions of fluorinated gases (F gases) by end user category, UK 1990-2020
Table 5.6	Estimated territorial emissions of carbon dioxide (CO_2) by end user category, UK 1970-1990

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

Table 6.1	Estimated greenhouse gas emissions arising from the use of fuels from UK international aviation and shipping bunkers, 1990-2020

Reference tables

Table 7.1	Sectoral definitions and inclusions: relationships between source categories as defined by the IPCC and the categories used in this publication
Table 7.2	Sectoral details, methodologies and data sources
Table 7.3	Fuel categories used in greenhouse gas emissions statistics
Table 7.4	List of Global Warming Potentials (GWP) of greenhouse gases used in UK emissions estimates

UK territorial emissions using alternate global warming potentials from IPCC Fifth Assessment Report

Table AR5_1.1	Estimated territorial greenhouse gas emissions by gas, using global warming potentials from Working Group 1 of the IPCC Fifth Assessment Report, UK 1990-2020
Table AR5_6.1	Estimated greenhouse gas emissions arising from the use of fuels from UK international aviation and shipping bunkers, using global warming potentials from Working Group 1 of the IPCC Fifth Assessment Report, 1990-2020

UK territorial emissions by Standard Industrial Classification (SIC)
Tables showing emissions by Standard Industrial Classification (SIC) will be added to this publication in a separate file on 30th June 2022.

Technical information

Methodology for producing greenhouse gas emissions estimates

It is impractical to directly measure emissions from every exhaust, chimney and acre of land in the UK, so greenhouse gas emission estimates are based on a series of models that estimate emissions from different sources. The source data and methods used to derive UK greenhouse gas emission estimates have been developed to be consistent with methods defined within international guidance[43]. All countries that report to the UNFCCC are required to use these estimation methods to ensure that the emissions for each country are complete and comparable.

The basic equation for estimating most sources of emissions is:

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

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

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

[43] 2006 IPCC Guidelines for National Greenhouse Gas Inventories: https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html
2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement): https://www.ipcc-nggip.iges.or.jp/public/wetlands/index.html
2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP Supplement): https://www.ipcc-nggip.iges.or.jp/public/kpsg/index.html

derived from measurements on a number of representative sources and the resulting factor applied to all similar sources in the UK.

The UK Greenhouse Gas Inventory uses the best available data from UK and international research for each emission source. The approach used is largely defined by the availability of data and the significance of the emission source in the overall UK inventory: more detailed methods are used for the high-emitting sources, whilst simpler methods can be used for minor sources, consistent with international guidance.

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

Table 7.2 in the data tables accompanying this publication summarises the methods and data sources used to estimate emissions from each source, and there are factsheets published on the NAEI website[44] that summarise the main data sources and methods used for each sector. More detailed methodology information for each source can be found in the National Inventory Report submitted to the UNFCCC each year. The report for the 1990-2020 inventory will be published on 15 April 2022, so the report for the 1990-2019 inventory[45] is the most recently available at the time of this publication.

BEIS also runs a programme to monitor atmospheric concentrations of greenhouse gases, which is used to verify the emission estimates made in the Greenhouse Gas Inventory[46].

Estimating emissions on a temperature adjusted basis

BEIS publishes provisional estimates of temperature adjusted emissions[47], which give an idea of overall trends in emissions without fluctuations due to changes in external temperatures. The provisional emissions series is estimated based on UK provisional energy consumption data published by BEIS and is not as accurate as the estimates in this statistical release, which are derived from our annual Greenhouse Gas Inventory. We can compare the latest provisional unadjusted and temperature adjusted emissions with the final estimates now available.

On a temperature adjusted basis, net carbon dioxide emissions in 2019 and 2020 were estimated to be 375.3 Mt and 343.4 Mt respectively. The decrease in carbon dioxide emissions between 2019 and 2020 in the temperature adjusted figures is therefore 32.0 Mt, which is less than the decrease seen in the provisional non-temperature adjusted figures, as can be seen in the table below. This suggests that the underlying change between 2019 and 2020 when adjusted for temperature would be less than the 10.6% shown.

[44] Sector, Gas and Uncertainty Summary Factsheets: https://naei.beis.gov.uk/overview/ghg-overview
[45] UK National Inventory Report 1990-2019: https://naei.beis.gov.uk/reports/reports?report_id=1015
[46] Monitoring and verification of long term UK atmospheric measurement of greenhouse gas emissions: https://www.gov.uk/government/publications/uk-greenhouse-gas-emissions-monitoring-and-verification
[47] Provisional UK greenhouse gas emissions: https://www.gov.uk/government/collections/uk-territorial-greenhouse-gas-emissions-national-statistics

Table 4: Comparison of provisional UK carbon dioxide emissions estimates with final estimates, 2019-2020

UK 2019-2020 $MtCO_2$

	2019 CO_2 emissions (Mt)	2020 CO_2 emissions (Mt)	Absolute change (Mt)	Percentage change
Final estimates ➢ unadjusted emissions	359.3	321.1	-38.2	-10.6%
Provisional estimates ➢ unadjusted emissions	365.1	326.1	-39.0	-10.7%
Provisional estimates ➢ Temperature adjusted emissions	375.3	343.4	-32.0	-8.5%

Source: Table 1.1, Final UK greenhouse gas emissions national statistics 1990-2020 Data tables
Table 3 & 4, Provisional UK greenhouse gas emissions national statistics 2020 Excel data tables

Note: The provisional emissions estimates differ from the emissions estimates shown elsewhere in this publication because they were published before the 2020 figures presented were finalised.

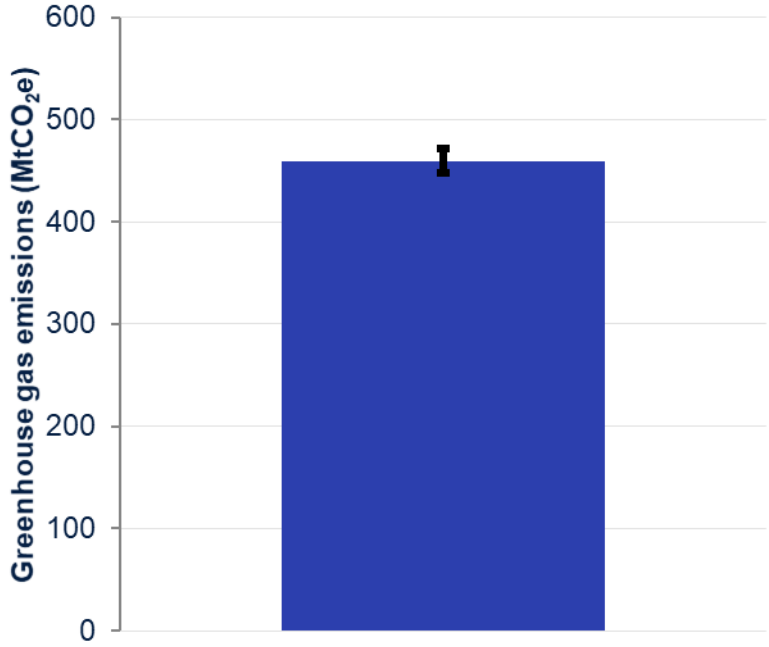
Uncertainties

In the data tables accompanying this publication, table 4.1 shows the uncertainty in the 2019 UK greenhouse gas emissions estimates by gas and table 4.2 shows it by NC sector. These will be updated to show the equivalent 2020 estimates on 31 March 2022.

Estimates of emissions have an inherent uncertainty due to uncertainty in the underlying data used to calculate the emissions, and due to uncertainty in the applicability, completeness, and application of that data. Uncertainty analysis is conducted by modelling the uncertainty in the underlying emission factors, activity data, and other variables within models; or in the overall model output. This suggests that the 95% confidence interval around the overall greenhouse gas emissions estimates is believed to be ±3%, as shown in Figure 21 (which is based on uncertainty analysis of 2019 emissions, as published in 2021). Estimates of 2020 uncertainties will be published on 31 March 2022.

The uncertainty of greenhouse gas emissions estimates varies considerably by sector. LULUCF emissions estimates are the most uncertain, followed by waste management and agriculture.

Figure 21: Illustration of uncertainty in UK greenhouse gas emissions, UK, Crown Dependencies and Overseas Territories, 2019 ($MtCO_2e$)



The error bar on this chart represents the uncertainty range (in this case, the 95% confidence interval) around the 2019 total greenhouse gas emissions central estimate.

Source: Table 4.1, Final UK greenhouse gas emissions national statistics 1990-2019 Excel data tables

Upcoming change to Global Warming Potentials

As detailed in the introduction section, emissions of each greenhouse gas (carbon dioxide, methane, nitrous oxide, fluorinated gases) are expressed in terms of carbon dioxide equivalent (CO_2e), recognising the different global warming potentials (GWP) of the different gases.

Figures for GWPs are set out in Intergovernmental Panel on Climate Change (IPCC) Assessment Reports (AR). In this publication, emissions estimates are primarily based on 100-year AR4 GWPs, consistent with international reporting and carbon trading protocols up to 2020.

In November 2021, it was agreed by the international community at COP26 that greenhouse gas emissions shall be reported under the Paris Agreement transparency framework using 100-year AR5 GWPs (without climate-carbon feedback)[48].Therefore, emissions estimates will primarily be based on 100-year AR5 GWPs in this publication next year.

Table 5, below, shows the total estimated emissions of each greenhouse gas based on AR4 and AR5 GWPs for 1990 and 2020:

[48] https://unfccc.int/documents/311138

Table 5: UK territorial emissions by greenhouse gas, 1990 & 2020

UK, 1990 and 2020 — $MtCO_2e$

Greenhouse Gas	1990			2020		
	AR4	AR5	Percentage difference	AR4	AR5	Percentage difference
Net CO_2 emissions (emissions minus removals)	605.4	605.4	0.0%	321.1	321.1	0.0%
Methane (CH_4)	134.1	150.2	12.0%	51.3	57.4	12.0%
Nitrous oxide (N_2O)	49.5	44.0	-11.1%	20.9	18.6	-11.1%
Hydrofluorocarbons (HFC)	14.4	12.1	-16.2%	11.7	11.1	-5.3%
Perfluorocarbons (PFC)	1.6	1.5	-10.0%	0.2	0.2	-5.4%
Sulphur hexafluoride (SF_6)	1.2	1.2	3.1%	0.4	0.4	3.1%
Nitrogen trifluoride (NF_3)	0.0	0.0	-6.4%	0.0	0.0	-6.4%
Total greenhouse gas emissions	**806.3**	**814.4**	**1.0%**	**405.5**	**408.7**	**0.8%**

Source: Table AR5_1.1, Final UK greenhouse gas emissions national statistics 1990-2020 Excel data tables

As carbon dioxide is the base against which other greenhouse gas emissions are weighted and reported ($MtCO_2e$), it's GWP always remains 1, so there is no change to carbon dioxide emissions estimates. Therefore, as most UK greenhouse gas emissions are from carbon dioxide (79.2% in 2020 using AR4 GWPs), the difference in total emissions when reported in AR5 instead of AR4 is small: a 1.0% increase in 1990 and a 0.8% increase in 2020.

The difference in AR4 and AR5 emissions for methane, nitrous oxide, sulphur hexafluoride, and nitrogen trifluoride remain the same in 1990 and 2020 (and all other years) because they are one greenhouse gas, with one GWP applied consistently to emissions estimates. Conversely, hydrofluorocarbons and perfluorocarbons are both collections of gases with a variety of associated GWPs, therefore the impact of moving from AR4 to AR5 can vary from year to year, as the amount of emissions these individual gases contribute to the total of hydrofluorocarbons and perfluorocarbons emissions changes.

For full details on the impact of moving to AR5 GWPs, see the dataset of greenhouse gas emissions by source published alongside this release, which presents emissions in both AR4 and AR5 GWPs.

Further information

Future updates to these statistics

On Thursday 31 March 2022 BEIS will publish a breakdown of 1990-2020 UK territorial emissions by end-user sector to supplement the source sector breakdown included in this publication, and estimates of the uncertainty in the 2020 emission estimates.

On Thursday 31 March 2022 BEIS will also publish provisional estimates of UK greenhouse gas emissions for 2021. This will coincide with the publication of Energy Trends statistics, which will include estimates of 2021 UK energy consumption.

On Thursday 30 June 2022 BEIS will publish estimates of 1990-2020 UK territorial emissions by Standard Industrial Classification (SIC), to supplement the sector breakdown included in this publication.

On Thursday 30 June 2022 BEIS will also publish estimates of greenhouse gas emissions by local authority for 2020.

Final estimates of UK greenhouse gas emissions for 2021 will be published in February 2023.

Related publications

- This statistical release and the related data tables are the first release of data from the National Atmospheric Emissions Inventory (NAEI) for 1970-2020, produced for BEIS and the Devolved Administrations by Ricardo Energy & Environment. Additional results will be released as they become available. For further information on the UK Greenhouse Gas Inventory, see the NAEI website.

- The UK's National Inventory Report (NIR) for 1990-2020 will be submitted to the United Nations Framework Convention on Climate Change (UNFCCC) on 15th April 2022. The report will contain national territorial greenhouse gas emissions estimates for 1990-2020 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.

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

- BEIS 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.

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

- Under the Climate Change Act, the Annual Statement of Emissions for 2020 must be laid before Parliament and published no later than 31st March 2022. This will give details of the net UK carbon account for 2020, which is used to determine compliance with the targets and budgets under the Act.

- 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.

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

- The latest UK energy statistics, including revisions to earlier years' data, can be found in the Digest of UK Energy Statistics.

- Detailed UK temperature data can be found on both the Met Office website and the Weather Statistics section of the gov.uk website.

- Similar results for non-greenhouse gas atmospheric pollutants are published by Defra in its statistics on Emissions of air pollutants in the UK.

Revisions policy

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

Uses of these statistics

The UK's territorial greenhouse gas emission estimates are used by central government departments, devolved governments and local authorities to understand emissions in the areas they are responsible for, to develop policies to reduce emissions and to set targets. They are the basis for the UK's domestic and international emissions targets and are required to be reported each year to the UNFCCC, and for the final time in 2022 to the EU.

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

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

User engagement

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

The BEIS 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.
- Providing more methodological and background information about the statistics in the statistical release and including international comparisons.
- Publishing more detailed datasets alongside the Excel tables that we publish and new tables showing territorial emissions by Standard Industrial Classification (SIC).

Pre-release access to statistics

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

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

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