Office for National Statistics

Article

Greenhouse gas emissions and trade, UK: 2024

Patterns of UK greenhouse gas emissions embedded in goods trade and structural change as a likely contributor to falling emissions

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1 . Main points

- UK trade leads to greenhouse gas emissions (GHG) abroad and measurements of consumption emissions show the carbon footprint of goods imports.
- Like the territorial and residence measures of UK GHG emissions, consumption emissions have also declined, though at a slower rate, partly because of a greater dependence on some goods for imports.
- Structural changes in the UK's economy towards services has likely contributed to a fall in important measures of UK greenhouse gas emissions because of higher emissions intensity in manufacturing industries.
- UK consumption of goods involved 1.2 million tonnes of carbon dioxide equivalent per billion pounds of those imports' value in 2021, the latest year for which we have consumption emissions estimates.
- EU countries were the largest source region for consumption emissions embedded in imports while also being the largest source of UK imports overall.
- Big trading partners may not be larger sources of embedded emissions as the composition of goods imported and emission intensities of different industries vary depending on the country.

2 . Emissions embedded in trade

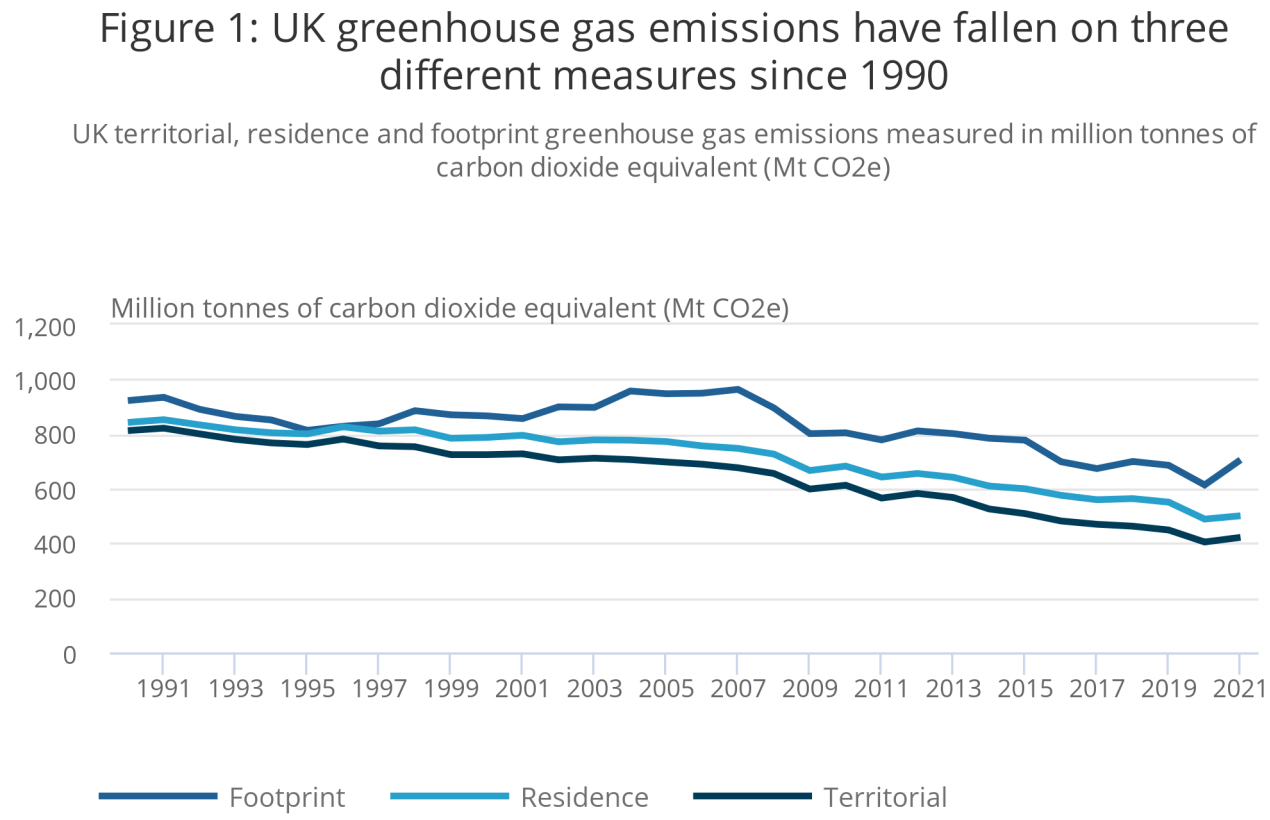
UK economy: industries and emissions

There are three measures of UK greenhouse gas (GHG) emissions: territorial, residence (or production) and footprint (or consumption). Each has its purpose and merits, and they complement each other to provide insights on emissions arising in the UK and abroad. For more detailed information on these measures, see our Measuring UK greenhouse gas emissions methodology.

Emissions on all three measures are available since 1990, and all have decreased since then, though at different rates.

Figure 1: UK greenhouse gas emissions have fallen on three different measures since 1990

UK territorial, residence and footprint greenhouse gas emissions measured in million tonnes of carbon dioxide equivalent (Mt CO2e)



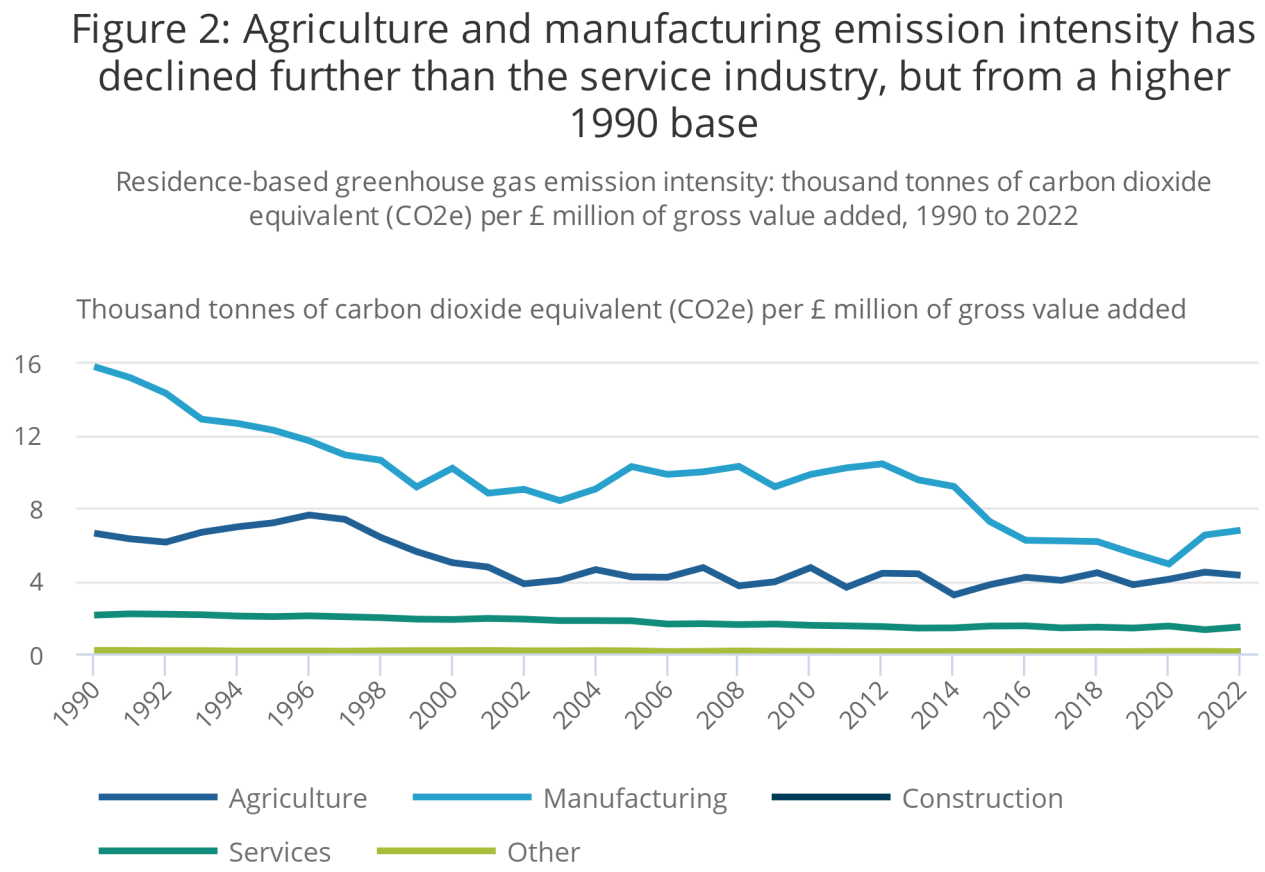
Source: Environmental accounts from the Office for National Statistics, Department for Energy Security and Net Zero, Department for Environment, Food and Rural Affairs

The UK economy has structurally shifted away from manufacturing towards services. The Information Technology revolution (How has growth changed over time? Bank of England article), from 1950 until present, has likely contributed to falling UK greenhouse emissions in recent years. This is because service industries generally have both lower overall emissions and lower emissions intensity (emissions per unit of output) compared with manufacturing. However, manufacturing industries have seen emission intensity fall further compared with services industries. The emission intensity of manufacturing, not including construction, has fallen from 15,750 tonnes of CO2e per million British pounds (GBP) of gross value added in 1990 to 6,760 tonnes in 2022. The figure for services was 1,450 thousand tonnes in 2022.

Where territorial and residence measurements of emissions follow a similar trend, consumption emissions show more volatility. This is partly because consumption emissions follow more closely the wider consumer expenditure in the economy. This can be seen in the drop of consumption versus territorial and residence emissions during the Great Recession in 2008.

Figure 2: Agriculture and manufacturing emission intensity has declined further than the service industry, but from a higher 1990 base

Residence-based greenhouse gas emission intensity: thousand tonnes of carbon dioxide equivalent (CO2e) per £ million of gross value added, 1990 to 2022

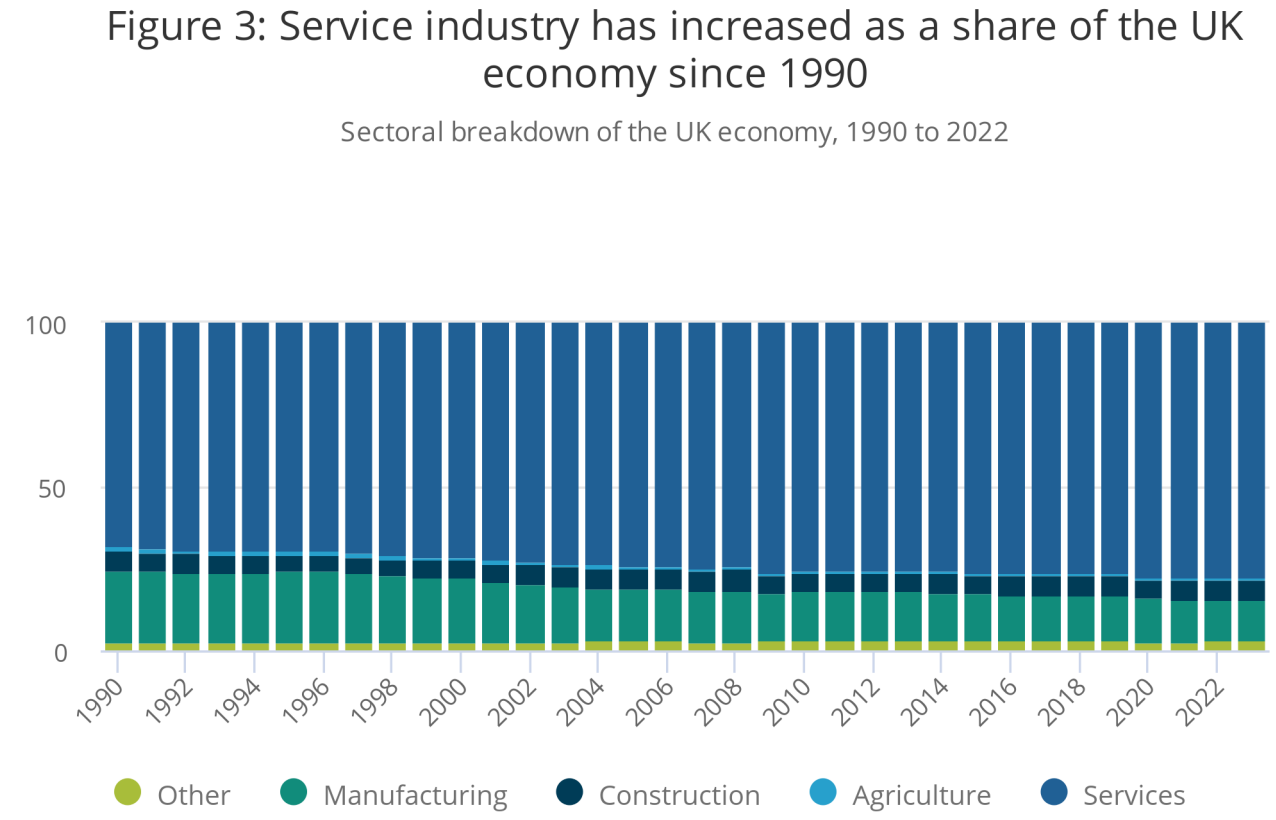


Source: Environmental accounts from the Office for National Statistics

While emissions intensity has generally fallen across sectors, the share of total UK gross value added (GVA) from services increased from 67.8% in 1990 to 77.3% in 2022, while manufacturing (including construction) fell from 28.4% to 18.6% in the same period.

Figure 3: Service industry has increased as a share of the UK economy since 1990

Sectoral breakdown of the UK economy, 1990 to 2022



Source: Gross Value Added from the Office for National Statistics

UK trading partners

Like any economic activity, trade causes emissions. Greenhouse gas emissions (GHG) are associated with UK trade, particularly imports goods for consumption with the production of these goods occurring in other countries. As high-income economies tend to be net importers of emissions, consuming through goods and services more emissions than they emit, trade plays an important role for global emissions.

Emissions being exported abroad are also known as carbon leakage; this is the movement of production and associated emissions from one country to another because of different levels of decarbonisation efforts through carbon pricing and climate regulation. Many countries have or are planning to implement carbon boarder adjustments. HM Treasury and the Department for Energy Security and Net Zero explain this in their Factsheet: UK Carbon Border Adjustment Mechanism.

The UK emitted 1.2 million tonnes of carbon dioxide equivalent per billion British pounds (GBP) of goods imported in 2021, which is the latest year for which we have consumption emissions estimates.

For the same year, the total value of UK goods imports was £495 billion with the UK total goods exports valued at £331 billion, making the UK a net importer of goods. The value of imports and exports when measured in current prices have both increased since 1997.

China was the country with the highest value of goods imported to the UK in 2021, closely followed by Germany. The top five are completed by the United States, the Netherlands and Norway.

Correspondingly, the UK's largest export market in 2021 was the United States, followed by Germany, the Netherlands, Ireland and France.

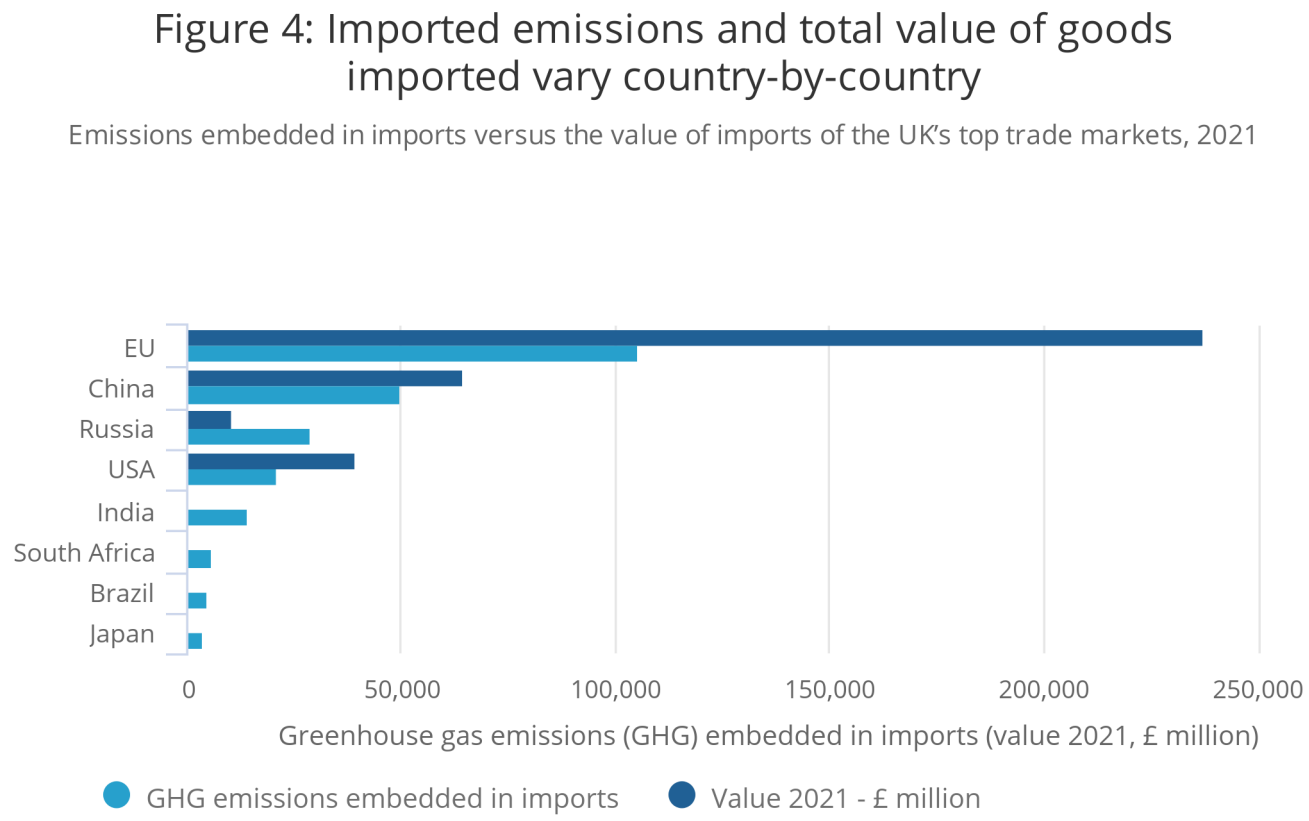
These countries' sources of imports broadly overlap with the countries. For example, EU countries taken together make up the largest group of imported emissions, followed by China. However, both Russia and rest of Africa (excluding South Africa), Asia and Middle East make up a larger share of imported emissions than the United States. Yet, the United States is one of the top countries for both imports and exports to and from the UK: one reason for this is that GHG emissions related to production vary across economies as well as differences in the composition of the goods imported.

For example, if the UK primarily imports goods from an economy that is associated with a high emission intense industry, such as oil or gas, but not many other goods, the economy may stand out more in the carbon footprint, but not in the trade data.

The UK's trade in services are not considered in this article but more information is available in our International trade in services, UK: 2018 bulletin.

Figure 4: Imported emissions and total value of goods imported vary country-by-country

Emissions embedded in imports versus the value of imports of the UK's top trade markets, 2021



Source: Carbon footprint data from the Office for National Statistics, Department for Environment, Food and Rural Affairs

Trade in 2021 was affected by the gradual easing of coronavirus (COVID-19) restrictions and the end of the EU exit transition period (see our UK trade in goods, year in review: 2021 article). Although the goods imported and exported have remained broadly the same, there are some differences between 2021 and the latest yearly estimates in 2023 (see our UK trade in goods, year in review: 2023 article). UK trade in goods country-by-commodity data can be explored in our UK trade: April 2024 bulletin.

UK emissions from consumption

Among the three UK emission measures, carbon footprint includes emissions associated with consumption of UK residents on goods and services from abroad. As this accounts for these emissions wherever in the world they arise along supply chains, it takes account of emissions associated with trade.

Emissions relating to imports to the UK produced overseas are often referred to as "embedded emissions". These are more difficult to measure than emissions generated within UK borders (territorial) or by the UK economy (residence). There are general conventions on how to do this, but the results cannot be viewed as being as robust as the estimates of emissions generated for the National Atmospheric Emissions Inventory.

The UK's carbon footprint fell 24% from 922 Million tonnes of carbon dioxide equivalent (Mt CO2e) in 1990 to 705 Mt CO2e in 2021 with the peak of emissions happening in 2007. By comparison, territorial emissions, the measure used to track the UK's net zero emissions by 2050 target, have fallen 53%, and residence emissions have fallen 40%, over the same period.

The smaller percentage reduction in consumption emissions since 1990 may reflect the shift towards service industry outlined previously, away from manufacturing industry, leading to a greater UK dependence on some imports.

Consumption emissions increased 15% between 2020 and 2021, reflecting increases in emissions from all activities, but especially in emissions from imported goods, such that 2021 consumption emissions were the highest since 2015. Consumption emissions are influenced by changes in patterns of UK imports, supply chain patterns and differences in emission intensity of production across the countries involved.

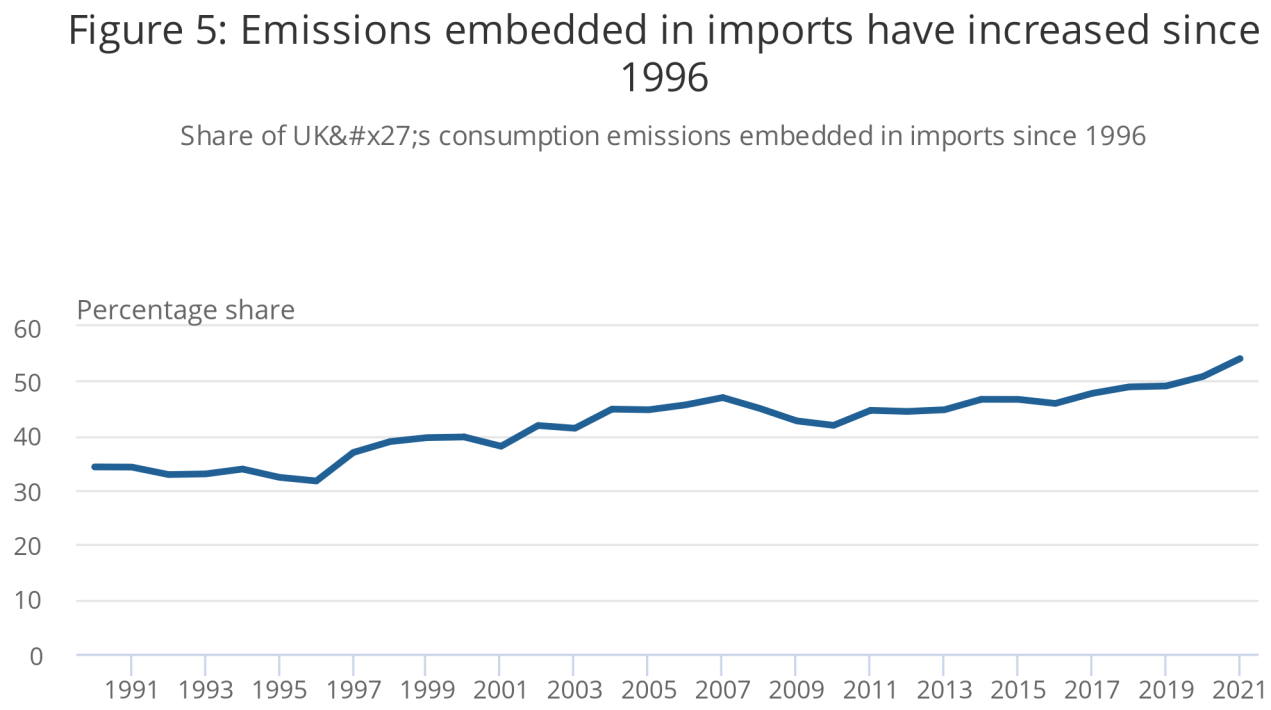
Emissions embedded in imports

Imported emissions are the part of the consumption footprint that occur abroad to support final UK demand for goods and services. Reflecting the shift of the economy, a growing population and rising incomes, imported emissions have increased since 1996, according to the Climate Change Committee's Reducing the UK's carbon footprint and managing competitiveness risks report. .

Embedded emissions from imports increased by 72% from 1996 to 2007 when they reached a peak of 452 Mt CO2e. In 2021, the proportion of the UK emissions footprint from imports was 54% or 381 Mt CO2e, with the other 44% generated in the UK. Although the percentage share of UK's consumption emissions embedded in imports is higher in 2021 compared with 2007, the estimated emissions are 16% lower than the peak in 2007.

Figure 5: Emissions embedded in imports have increased since 1996

Share of UK's consumption emissions embedded in imports since 1996



Source: Carbon footprint data from the Department for Environment, Food and Rural Affairs

The emissions embedded in imports are grouped by geographical or sectoral composition, showing what countries, regions or sectors make up the UK's imported emissions. Changes in the geographical pattern of where the UK import goods from affects the consumption emissions in various ways.

For example, increases in emissions associated with imports can be because of the UK importing more goods, the emissions intensity of these goods increasing as the emission intensity for certain industries can vary from country to country, or both. An example of this is the surge of coal-fired electricity generation in China during the 1990s and 2000s. Using coal for electricity generation is more emission intense than other fuel sources, which impacts the overall emissions even if the consumption of goods produced this way remains at similar levels.

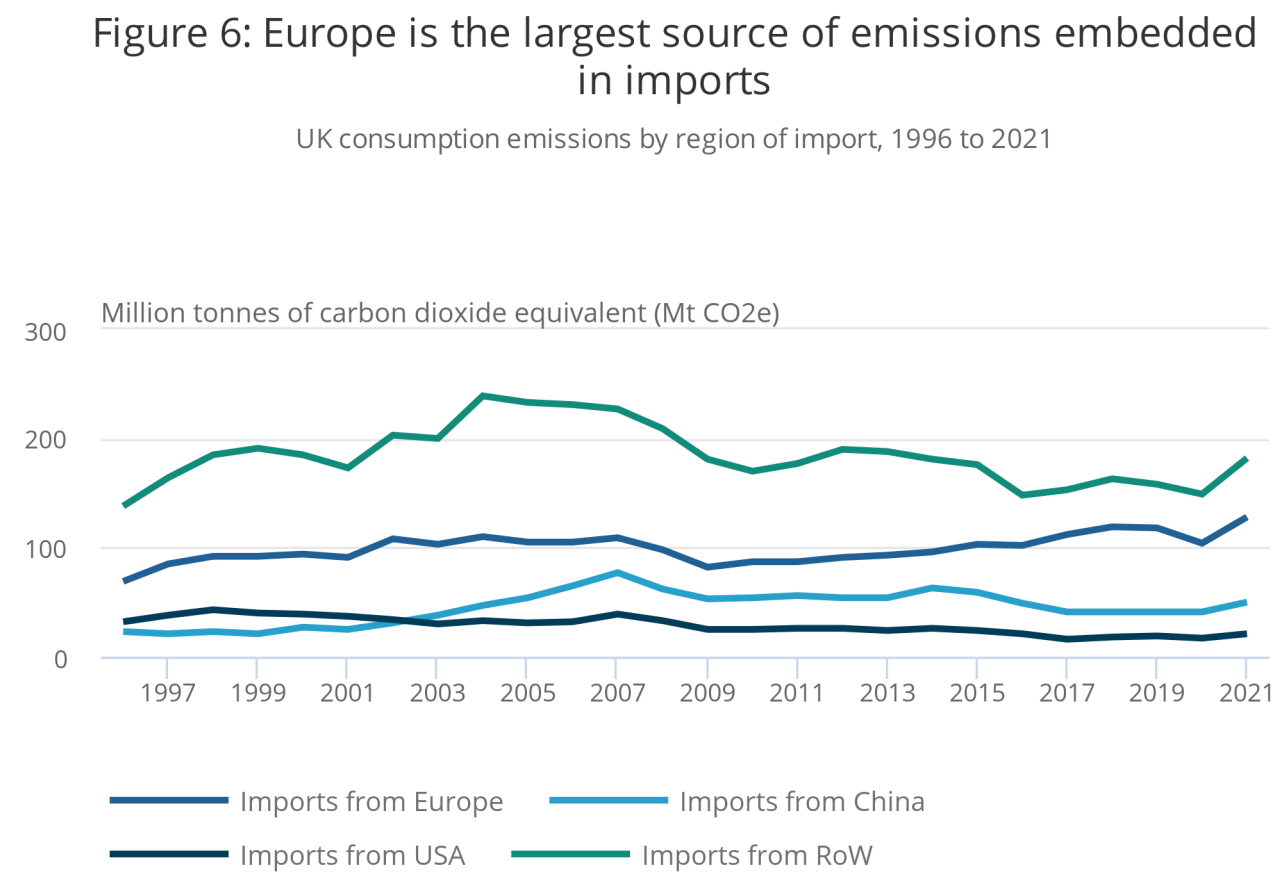
Emissions relating to imports from Europe accounted for 34% of imported emissions to the UK in 2021, equivalent to 128 Mt CO2e. Peaking at 128 Mt CO2e is the highest estimate since 1996.

Emissions associated with imports from China were 50 Mt CO2e, more than double the 1996 level of 23 Mt CO2e. They now account for 13% of the emissions associated with imports, compared with 9% in 1996. On the other hand, emissions embedded in imports from the United States accounted for 5% of imported emissions in 2021, down from 12% in 1996. They have decreased by 35% since 1996, from 32 Mt CO2e to 21 Mt CO2e.

Emissions embedded in imports from countries other than from Europe, China and the United States accounted for the rest of imported emissions (48%). These imported emissions have increased by 32% from 138 Mt CO2e in 1996 to 182 Mt CO2e in 2021. More detailed breakdowns of imported emissions are available in this Defra article: UK and England's carbon footprint to 2021.

Figure 6:Europe is the largest source of emissions embedded in imports

UK consumption emissions by region of import, 1996 to 2021



Source: Carbon footprint data from the Department for Environment, Food and Rural Affairs

3 . Glossary

Greenhouse gases

- The greenhouse gases (GHG) included in the atmospheric emissions accounts are those covered by the Paris Agreement, which has superseded the Kyoto Protocol: carbon dioxide (CO2)
- methane (CH4)
- nitrous oxide (N2O)
- hydrofluorocarbons (HFCs)
- perfluorocarbons (PFCs)
- sulphur hexafluoride (SF6)
- nitrogen trifluoride (NF3)

These gases contribute directly to global warming and climate change, because of their positive radiative forcing effect. The potential of each GHG to cause global warming is assessed in relation to a given weight of CO2, so all greenhouse gas emissions are measured as carbon dioxide equivalents (CO2e).

Consumption emissions

Estimates associated with UK consumption include all GHG emissions through the supply chain of goods and services consumed in the UK, wherever they are produced in the world (see Carbon footprint for the UK and England to 2021). This includes emissions from UK imports of goods and services, though we focus on goods in this article, and excludes emissions arising from UK-produced goods that are exported. Consumption emissions are published by the Department of Environment, Food and Rural Affairs. See our Measuring greenhouse gas emissions methodology for a summary of the three measures of UK greenhouse gas (GHG) emissions: consumption (footprint), territorial and residence (production).

Residence emissions

Estimates compiled on a residence basis include data relating to UK residents and UK-registered businesses, regardless of whether they are in the UK or overseas. Data relating to foreign visitors and foreign businesses in the UK are excluded. Residence emissions are published by the Office for National Statistics.

Territorial emissions

Estimates compiled on a territory basis include emissions arising within the UK borders. UK air emissions statistics on a territory basis (UK greenhouse gas emissions statistics collection) are published by the Department for Energy Security and Net Zero.

4 . Data sources and quality

UK emissions

Data on UK consumption are published by the Department of Environment, Food and Rural Affairs. Despite there being general conventions on how to measure consumption emissions, the estimates are not considered as robust as estimates of emissions for the National Atmospheric Emissions Inventory (An introduction to the UK's greenhouse gas inventory). More information on the methodology for the consumption-based accounts and further details on residence and territorial emissions can be found in 2024 Data Release of Consumption-based Accounts for the UK: Summary of Methods from the University of Leeds.

UK trade statistics

Data on UK trade are published by the Office for National Statistics. Much of this data originates from HM Revenue and Customs (HMRC). HMRC implemented some data collection changes following the UK's exit from the EU. Additionally, the coronavirus (COVID-19) pandemic has affected statistics on UK trade in goods. More information is available in the Impact of the coronavirus and EU exit on the collection and compilation of UK trade statistics article and in the UK trade quality and methodology information report.

All trade figures exclude non-monetary gold (NMG) and other precious metals unless otherwise stated. This is because movements in NMG, an important component of precious metals, can be large and highly volatile, distorting underlying trends in goods exports and imports. These estimates are in value terms (current prices) not inflation-adjusted terms (chained volume measures) unless otherwise stated.

5 . Related links

UK trade: April 2024
Bulletin | Released 12 June 2024
Total value of UK exports and imports of goods and services in current prices, chained volume measures and implied deflators.

Carbon footprint for the UK and England to 2021
Statistical release | Released 15 May 2024
Annual greenhouse gas and carbon dioxide emissions relating to UK and England consumption.

UK Environmental Accounts: 2024
Bulletin | Released 5 June 2024
Measuring the contribution of the environment to the economy, impact of economic activity on the environment, and response to environmental issues.

UK territorial greenhouse gas emissions national statistics
Article | Released 28 March 2024
Final and provisional estimates of UK territorial greenhouse gas emissions from 1990.

Measuring UK greenhouse gas emissions
Methodology | Last revised 26 June 2024
Summary of the three measures of UK greenhouse gas (GHG) emissions: territorial, residence and footprint.

6 . Cite this article

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