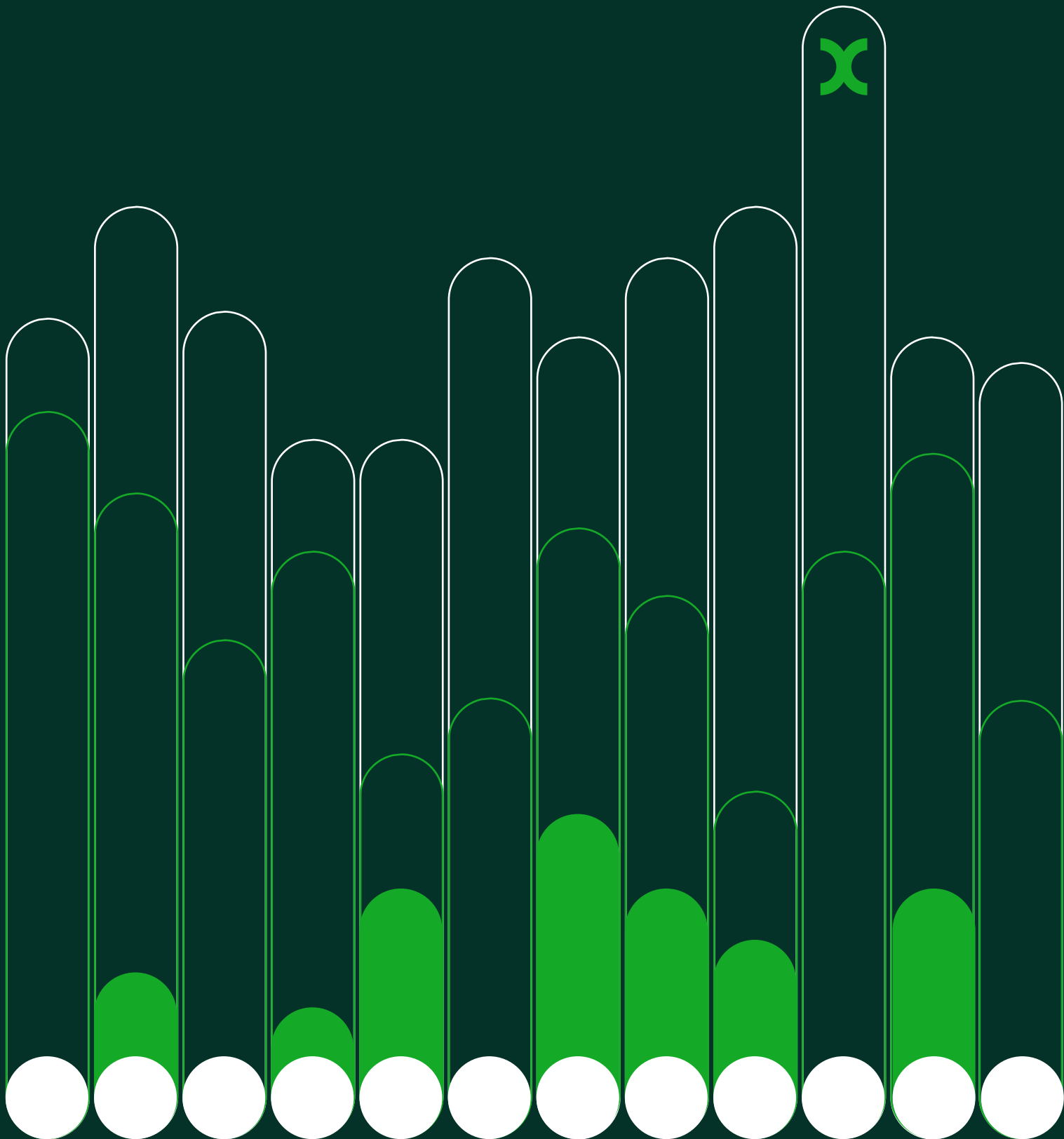




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1 Introduction

Future Energy Networks ('FEN') commissioned Oxera to examine the role of carbon reduction as a result of industrial offshoring in the UK's transition to net zero. This technical annex, which accompanies the Oxera policy note,¹ expands on the economic analysis undertaken and provides a detailed account of the key findings. This study aims to contribute to the evidence base informing the policy debate on decarbonisation via industrial offshoring and its implications for the UK's climate strategy.

The UK has committed to reaching net zero greenhouse gas ('GHG') emissions by 2050, with interim carbon budgets setting the path towards that goal.² This target reflects the UK's ambition to lead on climate action and decouple economic growth from environmental harm. Achieving net zero will require deep and sustained emissions reductions across all sectors of the economy, supported by a robust policy framework that accurately captures the sources of emissions and the impact of decarbonisation efforts.

The UK's carbon accounting framework is based on territorial emissions, capturing only those emissions released within the country's geographic boundaries. While this approach is internationally standardised and aligned with the UK's legal commitments under the Climate Change Act 2008,³ it may not fully capture the comprehensive climate impact associated with UK consumption. Specifically, observed reductions in domestic emissions could partly result from the relocation of carbon-intensive industrial activities abroad. As the UK continues to decarbonise its domestic production, a growing proportion of emissions may become 'embedded' in imported goods, presenting significant challenges for policymakers in assessing the scope and effectiveness of existing carbon targets. Policymakers should be mindful that, to the extent that industrial offshoring has driven reductions in territorial emissions, further reductions may be more challenging to achieve as the scope for import-substitution declines. This is often referred to as carbon offshoring, or

¹ Oxera (2025), 'The impact of carbon offshoring in the UK', August.

² HM Government (2021), '[Net Zero Strategy: Build Back Greener](#)', October, pp. 14–35.

³ The Climate Change Act 2008 provides that its provisions on GHG emissions apply to sources within the UK, UK coastal waters, and the UK sector of the continental shelf. HM Government (2008), '[Climate Change Act 2008](#)', Section 89: Territorial scope of provisions relating to greenhouse gas emissions.

emissions displacement, and has become an increasingly urgent concern in climate policy discussions.

As global supply chains become more complex, the risk that emissions are simply displaced abroad rather than reduced at a global level threatens to undermine the UK's climate ambitions. Moreover, from a global perspective, the carbon footprint of displaced production can even increase—both because of the emissions generated by transporting goods to the UK and because production in other countries may potentially be more carbon-intensive than in the UK. Understanding the scale and geographic distribution of offshored emissions is therefore critical for ensuring that carbon targets remain effective and credible as well as the design of policy measures to meet those ambitions.

This study undertakes a high-level analysis of the production and trade dynamics of key industrial commodities in the UK. In doing so, it aims to identify which sectors may have been most affected by industrial offshoring in carbon-intensive sectors—that is, where carbon-intensive production activities have shifted overseas. We estimate the emissions that would have occurred if offshored goods had been produced in the UK, allowing us to relate reductions in the UK's territorial emissions to the emissions embedded in imports. This approach enables us to quantify both the potential scale of industrial offshoring and the associated emissions (based on the level of emissions that were produced when production was UK-based).

The analysis in this report seeks to provide a perspective that is closer to a consumption basis of emissions,⁴ offering a high-level aggregate assessment of where UK demand is being met through foreign production. It is designed to capture broad patterns across sectors rather than trace detailed supply chain interactions. The analysis relies on aggregate changes in production and trade data, and does not examine individual production bases—meaning it may not capture cases where commodities are imported, transformed into different commodity groups through processing or manufacturing, and then re-exported. As such, while the results presented should be interpreted with appropriate caution, they provide an informative high-level view of the scale and nature of the impact of industrial offshoring on UK carbon emissions.

⁴ A consumption-based approach to carbon accounting captures the emissions associated with goods and services consumed within a country's borders regardless of where they are produced (this is explored further in section 2.1).

The remainder of this document is structured as follows.

- Section 2 provides an overview of the policy debate surrounding carbon offshoring and its broader implications.
- Section 3 outlines the methodology used to identify offshored commodities and presents the associated findings.
- Section 4 describes the approach for quantifying emissions linked to the production of offshored commodities and presents key results, including an analysis of the countries to which the UK has offshored this production.
- Section 5 sets out the limitations of the study as well as areas of potential future analysis.

2 Policy context

In 2019, the UK introduced a legally binding commitment to achieve net zero GHG emissions by 2050.⁵ This target reflects the country's aspiration to lead global climate action and transition toward a sustainable, low-carbon economy.⁶

To support this goal, the UK government has implemented a broad suite of policies aimed at reducing emissions across all sectors, including energy, transport, buildings, industry, and agriculture. These policies include economy-wide strategies to guide the transition to a low-carbon economy, legally binding carbon budgets, and market-based mechanisms—such as emissions trading—to incentivise reductions in the most carbon-intensive sectors. In addition, a range of sector-specific initiatives, such as those targeting industrial decarbonisation, clean energy investment, and green innovation, seek to address the particular challenges of high-emitting industries while stimulating low-carbon growth.⁷

These efforts have contributed to a substantial decline in the UK's territorial emissions since 1990, particularly in the power generation sector and heavy industry (such as mining of coal and ignite, manufacture of petrochemicals or of basic iron and steel).⁸

However, as domestic emissions fall, it is also important to understand the full global impact of these reductions. If reductions in the UK's territorial emissions are partly achieved by the shift of carbon-intensive production overseas—particularly to countries with higher emissions intensity—the net benefit to the global climate may be substantially reduced. This practice, known as carbon offshoring, presents a significant policy challenge and raises important questions about how

⁵ In June 2019, with the Climate Change Act 2008 (2050 Target Amendment) Order 2019, the UK government committed to a 100% reduction of GHG emissions by 2050 compared with 1990 levels. This is referred to as the net zero target. HM Government (2019), '[The Climate Change Act 2008 \(2050 Target Amendment\) Order 2019](#)', SI 2019/1056. HM Government (2022), '[Policy paper: Why Net Zero](#)', April.

⁶ Ibid.

⁷ These include the UK Net Zero Strategy (2021), the Climate Change Act 2008 (which introduced the carbon budgets framework), the UK Emissions Trading Scheme (launched in 2021 following the UK's departure from the EU ETS), and other targeted programmes such as the Industrial Decarbonisation Strategy (2021), and the Clean Growth Strategy (2017). For further information, see HM Government (2021), '[Net Zero Strategy: Build Back Greener](#)', October; HM Government (2019), '[The Climate Change Act 2008 \(2050 Target Amendment\) Order 2019](#)', SI 2019/1056; HM Government (2021), '[Industrial Decarbonisation Strategy](#)', March; and HM Government (2017), '[The Clean Growth Strategy](#)', October.

⁸ HM Government (2021), '[Net Zero Strategy: Build Back Greener](#)', October, pp. 14–35.

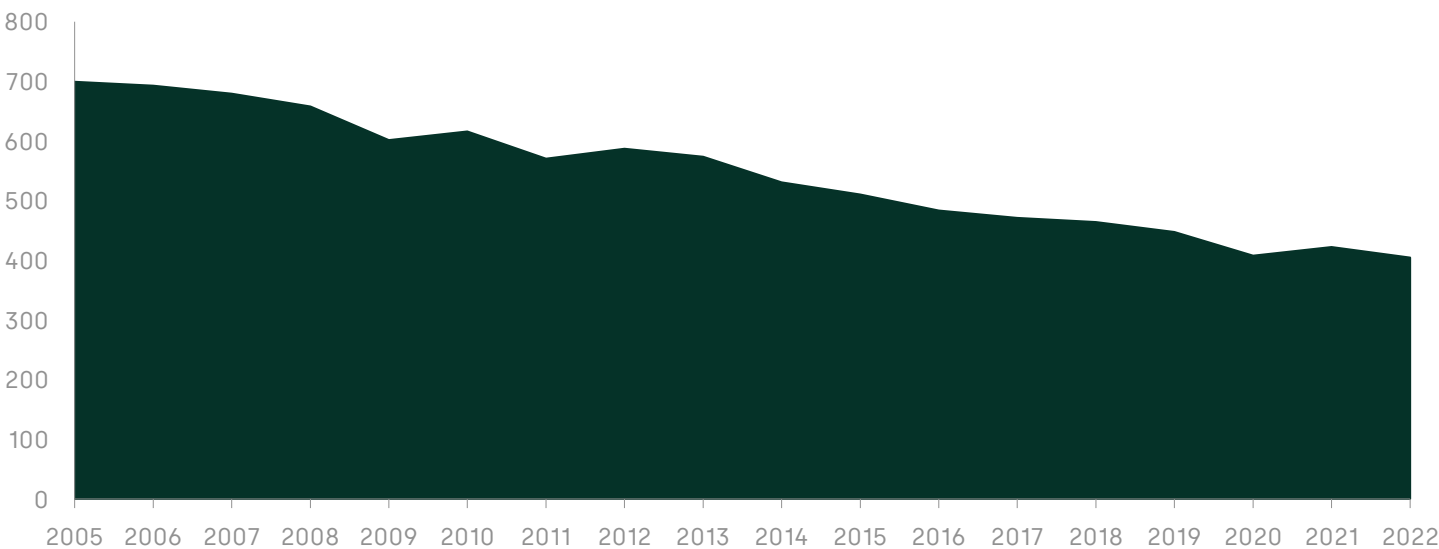
progress toward net zero should be measured and interpreted and future policies aimed at meeting the overall target.

2.1 The UK’s carbon accounting approach

The UK’s climate policy framework is underpinned by a carbon accounting methodology based on territorial emissions—that is, emissions produced within the UK’s geographic borders. This approach aligns with the scope of GHG emissions considered within the Climate Change Act 2008, as well as international standards that aim to ensure consistency and comparability in emissions reporting across countries.

The UK has recorded a sustained decline in territorial GHG emissions since the early 2000s. As shown in Figure 2.1, emissions fell from 700 million tonnes of carbon dioxide equivalent ('MtCO₂e') in 2005 to 405 MtCO₂e in 2022—a reduction of around 295 MtCO₂e, or 42%, over 17 years.

Figure 2.1 UK territorial GHG emissions, in MtCO₂e

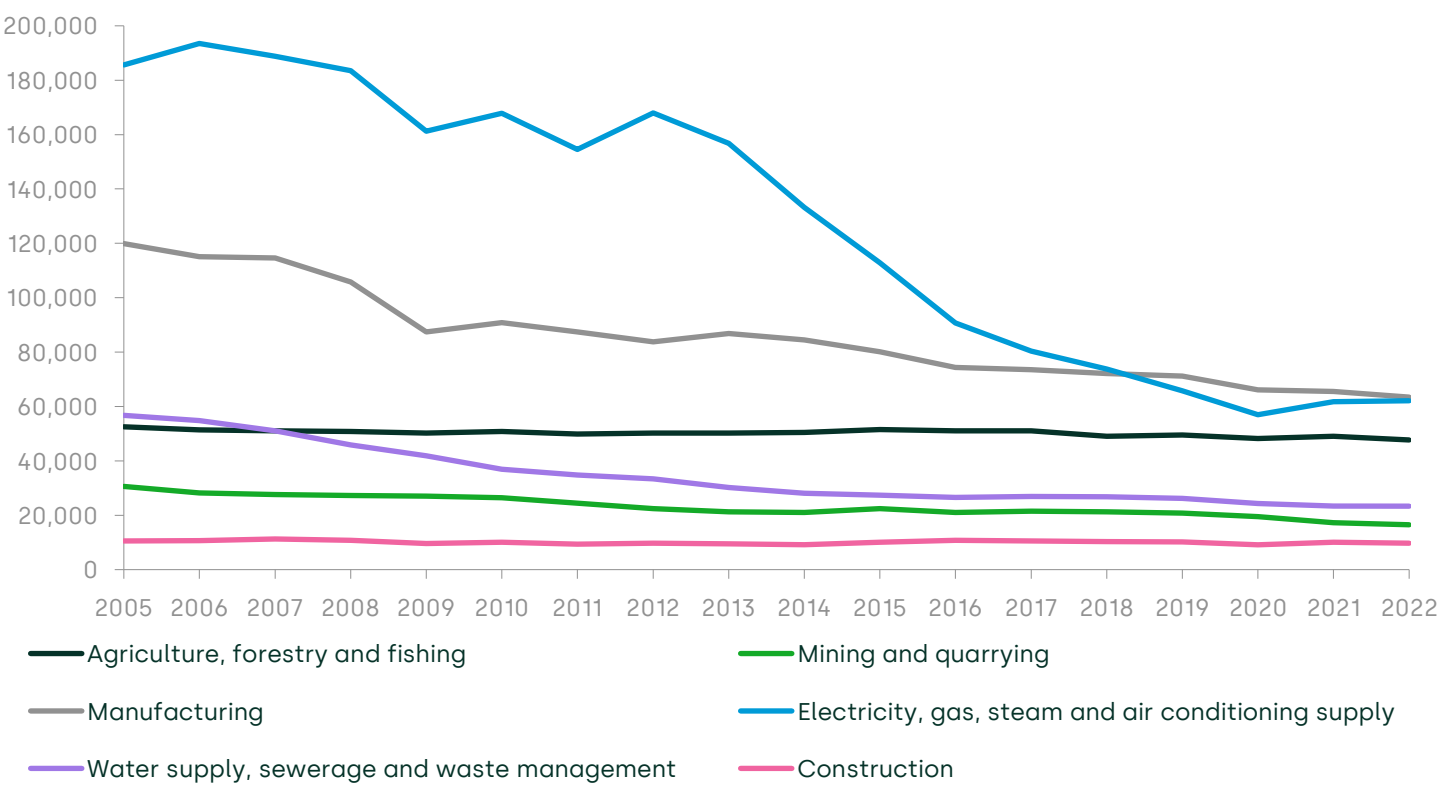


Note: The category ‘other’ includes other sources of GHG emissions, including hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride.
Source: DESNZ (2025), ‘Final UK territorial greenhouse gas emissions statistics by Standard Industrial Classification (SIC), 1990-2023’, June.

Figure 2.2 presents the trajectory of UK GHG emissions from 2005 to 2022 across energy-intensive sectors. Although territorial emissions from industry—such as manufacturing and mining and quarrying—have declined, the majority of the overall reduction is attributable to the

decarbonisation of the power sector, where renewable generation has progressively displaced coal and, more recently, gas.

Figure 2.2 Territorial GHG emissions by energy-intensive sector, in MtCO₂e



Source: DESNZ (2025), 'Final UK territorial greenhouse gas emissions statistics by Standard Industrial Classification (SIC), 1990-2023', June.

However, when examining specific production industries, it is important to recognise the inherent limitations of territorial accounting. While this approach offers clarity and international comparability, it does not capture the carbon embodied in imported goods and services, nor does it reflect the emissions associated with UK consumption patterns. Consequently, some of the observed reductions in reported domestic emissions may be the result of offshoring carbon-intensive production, rather than representing absolute reductions in emissions on a global scale.

An alternative is consumption-based accounting, which attributes emissions to the end consumer regardless of where the emissions physically occur. This approach provides a more comprehensive picture of the UK's true carbon footprint, capturing the emissions embedded in

goods and services consumed domestically, including imports. This method is not currently incorporated into the UK's formal targets or reporting frameworks, which remain focused on territorial emissions.⁹

Understanding these different accounting approaches is essential for contextualising the challenges posed by carbon offshoring and for developing effective policies that ensure the UK's net zero commitments translate into global emissions reductions.

2.2 Offshoring carbon emissions

By focusing on territorial emissions, the carbon accounting framework may obscure whether reductions result from structural changes in the UK economy or from the relocation of emissions-intensive activity abroad. This dynamic is particularly relevant in energy-intensive sectors—such as oil and gas, or the production of materials like cement and concrete—where production processes are highly emissions-intensive, but where consumption of the final goods continues regardless of where they are produced.

Achieving carbon reductions as a result of industrial offshoring presents two main policy challenges.

- **Displacement rather than reduction:** If the UK continues to consume broadly the same volume of carbon-intensive goods, but increasingly sources them from overseas, emissions are not eliminated—they are simply relocated. These emissions no longer appear in the UK's official figures but still contribute to global GHG concentrations.
- **Higher global emissions:** When production shifts to countries with higher carbon intensity or less stringent environmental regulation, the result may be an overall increase in global emissions. This undermines the environmental effectiveness of UK climate policy and risks compromising global decarbonisation efforts.

Understanding the scale and nature of the carbon reductions associated to industrial offshoring is therefore critical—not because it

⁹ It is important to recognise that consumption-based accounting only captures emissions associated with goods and services consumed within the UK. As such, it does not account for instances where production is offshored from the UK but the resulting goods are exported to third countries. This means that some offshored emissions—particularly those linked to industries that serve global rather than domestic demand—may not be reflected in either territorial or consumption-based accounts.

implies a failure of current policy, but because it reveals the limitations of relying solely on territorial emissions as a measure of climate progress. For policymakers, this has important implications for the design of future carbon reduction strategies.

It is also important to recognise that not all emissions are equally mobile. While emissions associated with the production of tradable industrial goods are more susceptible to offshoring (since these goods can often be imported instead of produced domestically), a large share of emissions, such as those arising from domestic transport, household energy use, and service-based activities, are inherently tied to the UK and cannot be easily relocated abroad. This makes the risk of decarbonisation via industrial offshoring more relevant in specific sectors, especially energy-intensive industries, where shifts in trade patterns can significantly alter the location of emissions without reducing their global total.

Our analysis focuses on the first of the above policy challenges (emissions displacement) rather than the emissions intensity of foreign production. Our primary objective is to identify where UK consumption of key industrial commodities is increasingly met through imports rather than domestic production, and to estimate the emissions that would have been generated had those goods been produced within the UK.

3 Identifying offshored commodities

As outlined above in section 2, understanding the extent of carbon emission reductions as a result of industrial offshoring is essential for assessing the true global impact of the UK's progress towards its net zero target. If observed reductions in domestic emissions are partly achieved by shifting production overseas, particularly in emissions-intensive sectors, this may undermine the impact of current climate policies and influence how future policies are designed and implemented.

In this section, we outline our methodology for identifying which industrial commodities have experienced offshoring over time. This involves examining cases where UK consumption has become increasingly reliant on imports rather than domestic production.

We begin by outlining the theoretical framework underpinning the analysis, followed by a description of the methodology and data sources used. We then present our results.

3.1 Conceptual approach

To identify which commodities may have been offshored, we start with an identity in economics that links three fundamental elements of an economy: production, imports, and exports.

For any good in the economy, it must be true that the total amount consumed domestically must equal:

- 1 what is made in the UK (domestic production), together with;
- 2 what is brought in from other countries (imports), but excluding;
- 3 what is made in the UK but sent abroad (exports).

Put simply, for any particular commodity, the amount consumed in the UK must be equal to domestic production, plus imports, less exports. This gives us the equation:

$$\text{UK Consumption} = \text{UK Production} + \text{Imports} - \text{Exports}$$

This relationship helps us understand how demand for UK consumption is being met: to what extent it comes from production in the UK or from imports. By looking at how this balance changes over time, we can assess whether:

- (i) goods that were once produced domestically are now being imported to maintain stable levels of consumption;
- (ii) rising consumption is being met through imports, without a corresponding increase in domestic production; or,
- (iii) overall consumption declines slightly, but a growing share of the remaining demand is met through imports.

Such trends may indicate that production, and the associated emissions, have been relocated overseas or 'offshored'.¹⁰

3.2 Identifying offshored commodities

As discussed above, we identify offshoring when UK consumption of a particular good becomes increasingly met through imports rather than domestic production. To identify which commodities have been subject to this shift, we examine the evolution of the relationship between domestic production and trade flows over time.

Our analysis covers the period from 2005 to 2022 and draws on two main data sources.¹¹ Trade data is sourced from HM Revenue & Customs ('HMRC'), which provides detailed information on the volume and value of goods imported into and exported from the UK, broken down by commodity type.¹² To complement this, we use domestic production data published by the Office for National Statistics ('ONS'), which reports the volume of manufacturing output across a wide range of product categories.¹³ By bringing these datasets together, we are able to trace how the balance between domestic production and trade has shifted over time.¹⁴

To assess offshoring, we construct an 'offshoring ratio', defined as the ratio of net imports (i.e. imports minus exports) to domestic production. This allows us to track whether consumption of a given commodity is

¹⁰ This theoretical approach is intended to provide a proxy for offshoring, capturing broad sectoral patterns rather than tracing detailed supply chain dynamics. It relies on aggregate changes in production and trade data, without examining individual production sites.

¹¹ We select the period 2005 to 2022 due to the availability of consistent, disaggregated data on both trade and production across this timeframe.

¹² HMRC (2025), '[Overseas trade statistics](#)', accessed 10 July 2025.

¹³ ONS (2025), '[UK input-output analytical tables: product by product](#)', February.

¹⁴ Aligning the trade and production data required mapping between three different commodity classification systems used across the HMRC trade data, ONS production data, and emissions datasets. This process required aligning classifications across datasets in a consistent and comparable way. While we aimed for accuracy throughout, some approximations were necessary due to differences in the level of detail and structure between classification systems.

becoming more reliant on imports relative to what is produced within the UK.¹⁵

We identify commodities as 'offshored' where:

- the offshoring ratio has increased significantly over the period; and
- neither domestic output nor import volumes have declined in absolute terms, suggesting that underlying consumption levels have remained stable or increased.

Due to data availability, our identification of commodities where we think offshoring is taking place relies on monetary values rather than physical volumes (e.g. tonnes). This introduces important caveats; prices can vary between imports and exports, so changes in the offshoring ratio may reflect shifts in value rather than actual physical quantities traded. As a result, the volume of goods moving in or out may be higher or lower than the value-based data suggests. To quantify offshored volumes, however, we use absolute changes in import volume (in tonnes).

This approach provides a consumption-based perspective on industrial offshoring and, as such, does not capture instances where production shifts overseas but the resulting goods are re-exported to third countries rather than consumed in the UK. Taken together, these considerations highlight the need to interpret the results with caution and view them as high-level, indicative estimates rather than precise measurements.

Table 3.1 presents the list of commodities for which we find the strongest evidence of offshoring (i.e. those for which the offshoring ratio at least doubles), along with the absolute change in import volumes between 2005 and 2022, used here as an indicator for the scale of offshored volumes.¹⁶ For commodity categories where exports have also risen significantly over the period, we report changes in net imports (i.e. imports minus exports) to avoid overstating offshored volumes in cases where imported goods may be re-exported rather than consumed

¹⁵ We focus on net imports rather than gross imports to better capture the share of production destined for domestic consumption, and to minimise distortions from re-exports or trade that is not consumption-driven.

¹⁶ While the table highlights selected commodities whose offshoring ratios have doubled or more, the total offshored volume includes all commodities that have seen an increase in their offshoring ratio.

within the UK. These are indicated by an asterisk (*) in the table below.¹⁷

Table 3.1 Selected commodities with evidence of offshoring and associated offshoring volumes, thousand tonnes

Commodity group	Total offshored volumes between 2005–2022 (thousand tonnes)
Total offshored commodities	64,000
<i>Selected commodities with evidence of offshoring</i>	
Crude petroleum and natural gas	34,380
Products of forestry, logging and related services	7,420
Other mining and quarrying products	7,310
Manufacture of glass, refractory, clay, other porcelain and ceramic products, stone, and abrasive products	2,490
Manufacture of other chemical products and man-made fibres	1,050
Manufacture of refined petroleum products	890
Manufacture of coke oven products	720
Manufacture of cleaning and toilet preparations	650
Fabricated metal products, except machinery and equipment, excluding weapons and ammunition	630
Plastic products	580
Manufacture of bakery and farinaceous products	510
Manufacture of articles of concrete, cement and plaster	360
Electrical equipment	280
Manufacture of grain mill products, starches and starch products	250*
Fertilisers	150*

¹⁷ This adjustment for re-exporting provides a logical, high-level method to account for re-exporting within the same commodity category. As this is made at the aggregate commodity group level, it does not capture supply chain interactions—such as where imported goods are transformed into different products before being exported. As such, our approach may not fully account for intra-industry trade or vertical specialisation.

Commodity group	Total offshored volumes between 2005–2022 (thousand tonnes)
Aluminium production	140
Manufacture of vegetable and animal oils and fats	120*
Rubber products	30

Note: The change in offshored volumes represents the change in UK imports of each commodity between 2005 and 2022, as a proxy for the change in the volume of domestic consumption now met through imports. For commodity categories where exports have also increased significantly over the period, the figures reflect the change in net imports (imports minus exports) to avoid overstating offshored volumes in cases where imported goods may be re-exported rather than consumed domestically. These are marked with a (*) symbol. Offshored volumes for each commodity have been rounded to the nearest 10 thousand tonnes. The total offshored volumes have been rounded to the nearest 1,000 thousand tonnes. The commodities shown in the table have experienced a 200% or greater increase in their offshoring ratio, whereas the total offshored volume reflects all commodities with any increase in the ratio.

Source: Oxera analysis based on HMRC (2025), '[Overseas trade statistics](#)', accessed 10 July 2025, and ONS (2025), '[UK input-output analytical tables: product by product](#)', February.

The most pronounced shifts appear in sectors such as crude petroleum and natural gas or certain mining and quarrying products where the trade and domestic production patterns indicate that production has moved overseas. By comparing this list of commodities with UK output and production emissions data, we find that several are among the most emissions-intensive in the UK economy, generating the highest levels of GHG emissions per million pounds of output. This is explored further in section 4.1 (see Figure 4.1, in particular).¹⁸

In the following section, we estimate the associated volume of GHG emissions embedded in the production of the above offshored commodities.

4 Quantifying offshored emissions

Having identified the commodities for which consumption increasingly relies on imports rather than domestic production, the next step is to quantify the associated emissions.

For simplicity and consistency, we focus on the emissions that would be generated if these goods were produced within the UK under current production conditions and levels of carbon intensity—effectively, a counterfactual scenario without offshoring. This approach enables us to directly compare the emissions embodied in offshore production with the reported reductions in UK territorial carbon emissions by industry, offering valuable insight into the net climate effect of shifting production overseas. That said, we do not account for variation in the emissions intensity of production across countries, i.e. that goods imported to meet UK demand may be produced under more or less energy-intensive methods than they would be domestically.

4.1 Total offshored emissions by commodity

In this subsection, we estimate the GHG emissions associated with the offshored commodity volumes identified in section 3.23.2. Our aim is to quantify the climate implications of these shifts in production by linking changes in trade patterns with the emissions that would have occurred had the goods been produced in the UK.

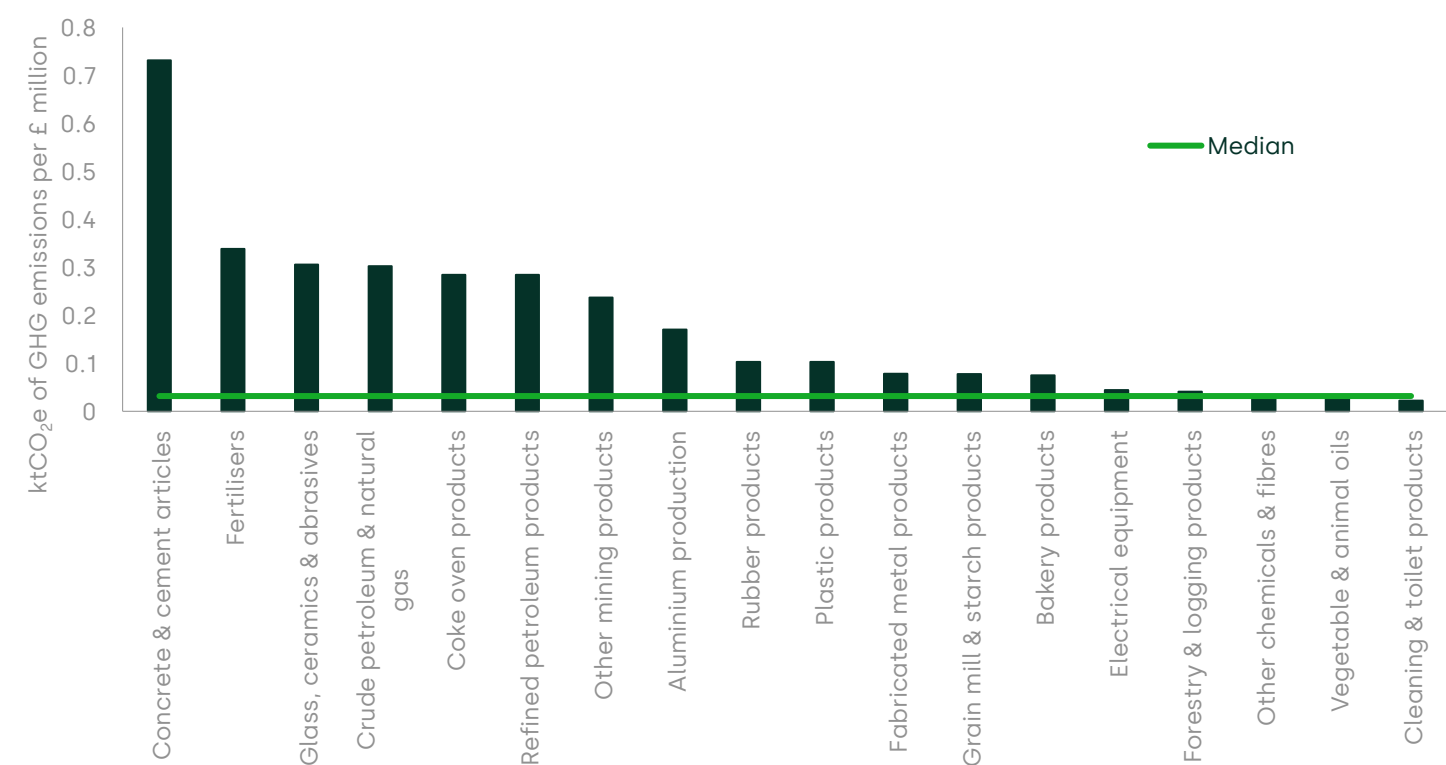
We begin by estimating UK-specific GHG conversion factors—i.e. the emissions produced per unit of output for each relevant commodity. These are derived using data from the Department for Energy Security and Net Zero ('DESNZ') on territorial emissions by industrial sector, combined with domestic production data from the ONS.¹⁹ This allows us to establish average emissions intensities by commodity group, based on actual UK production conditions.

Figure 4.1 below presents these results for the list of commodities presented in Table 3.1, as kilotonnes of CO₂ equivalent ('ktCO₂e') of GHG emissions per million pounds of production value.²⁰

¹⁹ DESNZ (2025), 'Final UK territorial greenhouse gas emissions statistics by Standard Industrial Classification (SIC), 1990-2023', June; and ONS (2025), '[UK input-output analytical tables: product by product](#)', February.

²⁰ We measure emissions in ktCO₂e per unit of value rather than per unit of volume, due to limited availability of output data in volume terms.

Figure 4.1 Estimated GHG conversion factors based on UK-specific territorial emissions by industrial sector in 2022, ktCO₂e per £ million



Note: GHG conversion factors are rounded to two decimal places.
Source: Oxera analysis based on DESNZ (2025), 'Final UK territorial greenhouse gas emissions statistics by Standard Industrial Classification (SIC), 1990-2023', June and ONS (2025), ['UK input-output analytical tables: product by product'](#), February.

We then apply these conversion factors to the offshored volumes identified in section 3.2 to estimate the emissions that would have been generated had these goods been produced within the UK.

Table 4.1 below presents the results, showing the estimated total emissions associated with the offshore production of key commodities between 2005 and 2022 (specifically, those for which the offshoring ratio has at least doubled), expressed in ktCO₂e.²¹ Offshored

²¹ While the table lists selected commodities where the offshoring ratios have at least doubled, the total offshored emissions figure includes all commodities where the offshoring ratio has increased. As noted above, the change in offshored volumes represents the change in UK imports of each commodity between 2005 and 2022, as a proxy for the change in the volume of domestic consumption now met through imports. For commodity categories where exports have also increased significantly over the period, the figures reflect the change in net imports (imports minus

commodities are defined as those showing an increase in the value-based offshoring ratio between 2005 (the base year) and 2022, provided that their overall consumption volumes (both domestic production as well as imports) did not experience a sharp decline. The corresponding emissions estimates are calculated by applying 2022 commodity-specific carbon intensity values to the change in offshored volume observed over this period.

Table 4.1 Estimated emissions associated with offshore production increases (2005–2022), ktCO₂e

Commodity group	Total associated emissions from offshoring (ktCO ₂ e)
Total offshored commodities	14,900
<i>Selected commodities with evidence of offshoring</i>	
Crude petroleum and natural gas	8660
Manufacture of glass, refractory, clay, other porcelain and ceramic products, stone, and abrasive products	680
Manufacture of refined petroleum products	210
Fabricated metal products, except machinery and equipment, excluding weapons and ammunition	210
Plastic products	170
Electrical equipment	140
Other mining and quarrying products	110
Manufacture of other chemical products and man-made fibres	100*
Aluminium production	90
Manufacture of coke oven products	90
Manufacture of bakery and farinaceous products	90
Manufacture of cleaning and toilet preparations	60
Products of forestry, logging and related services	50
Manufacture of articles of concrete, cement and plaster	50
Manufacture of grain mill products, starches and starch products	40*

exports) to avoid overstating offshored volumes in cases where imported goods may be re-exported rather than consumed domestically. These are marked with the (*) symbol in the table.

Commodity group	Total associated emissions from offshoring (ktCO ₂ e)
Fertilisers	30*
Manufacture of vegetable and animal oils and fats	10*
Rubber products	10

Note: Offshored emissions for each commodity have been rounded to the nearest 10 ktCO₂e. The total offshored emissions have been rounded to the nearest 100 ktCO₂e. Commodities presented in the table have an offshoring ratio of 200% or more, while the total offshored emissions figure includes all commodities with an increasing ratio. Source: Oxera analysis based on DESNZ (2025), 'Final UK territorial greenhouse gas emissions statistics by Standard Industrial Classification (SIC), 1990-2023', June; HMRC (2025), '[Overseas trade statistics](#)', accessed 10 July 2025 and ONS (2025), '[UK input-output analytical tables: product by product](#)', February.

We estimate that emissions associated with the offshoring of production between 2005 and 2022 amounted to approximately 14.9 MtCO₂e. This figure reflects emissions not captured by the UK's territorial accounting framework, instead aligning with a consumption-based approach, which attributes emissions to the end user, regardless of where they are generated.²² To put this figure into perspective, the estimated emissions associated with offshoring production between 2005 and 2022 are equivalent to the annual emissions of approximately 10 million UK cars, based on the latest 2023 emissions data from the Department for Transport,²³ or to 8.8 million return flights from London to New York.²⁴

For comparison, territorial emissions from the industrial sector fell by 76 MtCO₂e over the same period, while total UK territorial emissions across all sectors decreased by 295 MtCO₂e. The emissions associated with production of these goods is therefore equivalent to approximately 20% of the industrial emissions reduction and 5% of the total UK emissions reduction. Emissions associated with displaced production therefore

²² As noted earlier, it is important to recognise that consumption-based accounting only captures emissions associated with goods and services consumed within the UK. As such, it does not account for instances where production is offshored from the UK but the resulting goods are exported to third countries. This means that some offshored emissions—particularly those linked to industries that serve global rather than domestic demand—may not be reflected in either territorial or consumption-based accounts.

²³ Department for Transport (2025), 'Vehicle licensing statistics data tables', August; and Department for Transport (2025), 'Annual mileage of cars by ownership, fuel type and trip purpose: England, 2002 onwards', August.

²⁴ Figure was calculated using average passenger conversion factors from DESNZ and a distance of 5,570km. DESNZ, '[Greenhouse gas reporting: conversion factors 2025](#)', 10 June 2025.

constitute a significant share of the observed decline in territorial industrial emissions.

As the table illustrates, some of the largest estimated offshored emissions are associated with commodities such as crude petroleum and natural gas, glass, ceramics, stone and abrasive products, and refined petroleum products. While many of the above commodities are energy-intensive, fossil fuels account for over half of the estimated decarbonisation due to industrial offshoring.

To better understand the significance of these findings, we compare the estimated offshored emissions with the reductions in UK territorial emissions as reported by the national carbon accounting framework. Table 4.2 below presents this comparison for the six commodity groups with the highest emissions associated with offshoring.

Table 4.2 The relationship between estimated offshoring and observed reductions in UK territorial emissions for selected commodities

Selected commodities	Total decrease in Associated emissions		Proportion of reduction in sectoral emissions linked to industrial offshoring (%)
	territorial emissions (ktCO ₂ e)	from offshoring (ktCO ₂ e)	
Crude petroleum and natural gas	10,560	8660	82
Manufacture of glass, refractory, clay, other porcelain and ceramic products, stone, and abrasive products	1,000	680	68
Manufacture of refined petroleum products	7,910	210	3
Fabricated metal products, except machinery and equipment, excluding weapons and ammunition	460	210	47
Plastic products	720	170	24
Electrical equipment	260	140	55

Note: The estimated proportions reflect a high-level assessment of the link between offshored emissions and reductions in UK territorial emissions. The analysis is based on aggregate changes in production and trade, and does not track individual production sites or supply chains. While the results should be interpreted with appropriate caution, they offer a useful indication of broad offshoring patterns and their potential contribution to reported territorial emission reductions.

Source: Oxera analysis based on DESNZ (2025), 'Final UK territorial greenhouse gas emissions statistics by Standard Industrial Classification (SIC), 1990-2023', June; HMRC

This comparison reveals that in four of the six cases presented, the estimated offshored emissions account for more than 40% of the observed domestic reductions, suggesting that the shift in production location may be a major factor behind the decline in reported emissions.

This analysis is based on aggregate changes in production and trade, aiming to capture broad patterns of offshoring rather than trace individual supply chains or production locations. As a result, it does not fully reflect the complexity of global trade flows or account for potential reshoring or new domestic production. The estimates should therefore be seen as indicative, not exact. While this analysis does not suggest that all territorial reductions are attributable to offshoring, it does highlight the importance of considering trade-adjusted emissions in evaluating the true effectiveness of decarbonisation efforts.

4.2 Total offshored emissions by country of origin

Having quantified the emissions associated with offshore production, we now explore where these emissions are likely to originate. Using detailed trade data, we identify the countries from which the UK increasingly imports the relevant commodities.²⁵ This allows us to understand the geographical distribution of offshored emissions.

By linking the increase in import volumes (see section 3.2) with country-level trade shares and UK-based emissions intensity factors, we approximate the proportion of emissions that can be attributed to trade with each source country. While this does not capture variations in carbon intensity across different countries' production processes, it provides a first-order estimate of where the emissions embodied in UK consumption of offshored production are being generated.

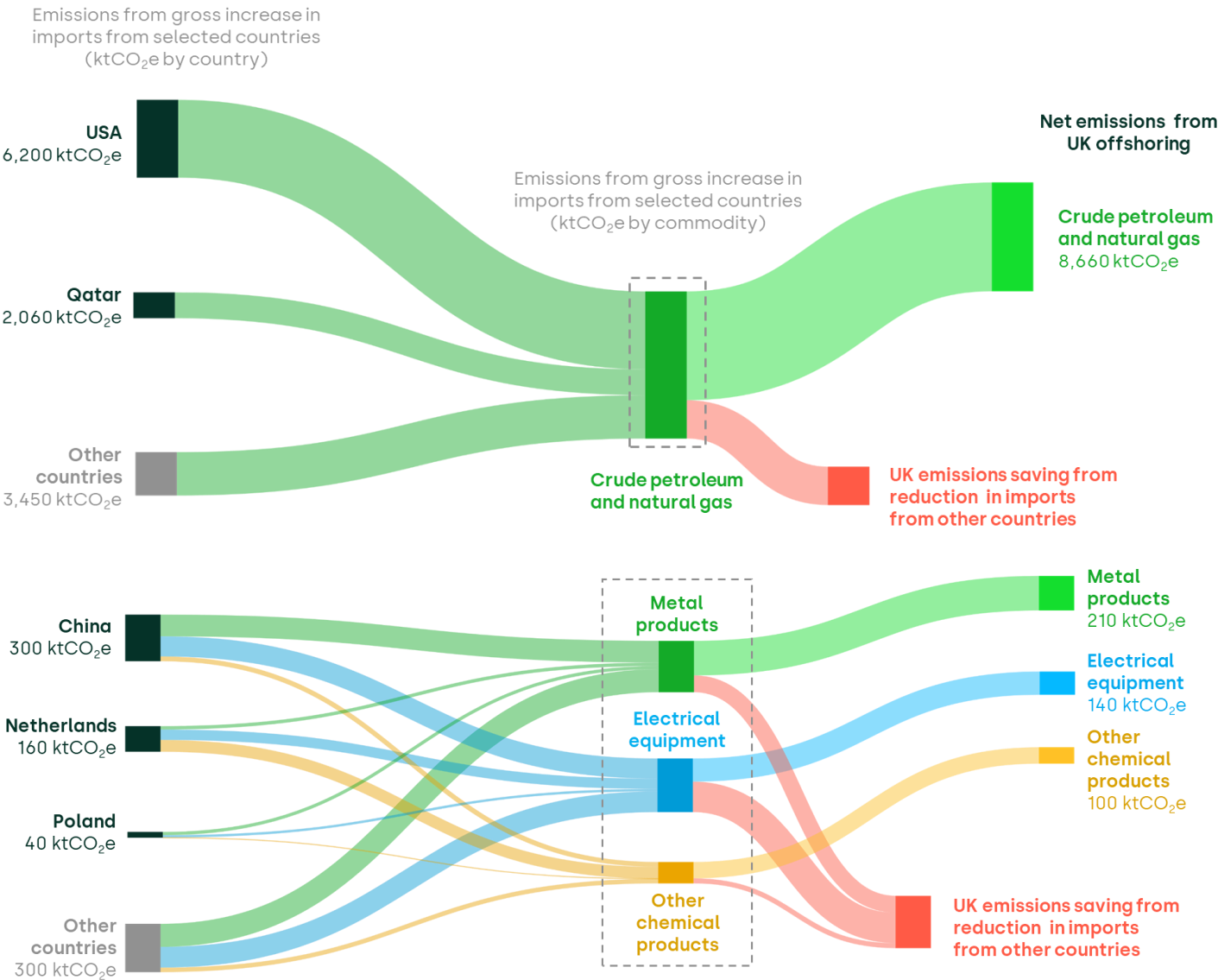
Figure 4.2 below presents this information for selected commodity groups. It illustrates the estimated GHG emissions linked to the offshored production of goods consumed in the UK, highlighting the relative contributions of key countries of origin.

The figure illustrates the estimated flow of offshored emissions by country of origin, highlighting where the production of selected

²⁵ HMRC (2025), '[Overseas trade statistics](#)', accessed 10 July 2025.

industrial commodities has relocated and the associated level of emissions (based on UK emissions factors). The flows represent emissions from offshoring in the USA, China, the Netherlands, Poland, and other countries, distributed across crude petroleum and natural gas, metal products, electrical equipment, and chemical products. On the right, the figure shows how these gross emissions translate into the net change in UK emissions from offshoring, with the red flow capturing the emissions savings from reduced imports.

Figure 4.2 Total offshored emissions from 2005-2022 by country of origin for crude petroleum and natural gas, metal products, electrical equipment and other chemical products



Note: Offshored emissions for each commodity have been rounded to the nearest 10 ktCO₂e. For each commodity, imports increased from some countries and decreased from others. To present net emissions from offshoring, the 'reduction in imports from

other countries' reflects reductions in imports that offset part of the gross increase in offshored emissions.

Source: Oxera analysis based on DESNZ (2025), 'Final UK territorial greenhouse gas emissions statistics by Standard Industrial Classification (SIC), 1990-2023', June; HMRC (2025), '[Overseas trade statistics](#)', accessed 10 July 2025 and ONS (2025), '[UK input-output analytical tables: product by product](#)', February.

As the figure shows, a significant share of offshored emissions is concentrated in a few countries. The United States of America, China, and the Netherlands emerge as major sources of emissions associated with UK consumption of several offshored industrial goods. In many cases, these countries are home to large-scale industrial sectors and have well-established trade relationships with the UK.

5 Limitations and potential future analysis

This report set out to explore the extent to which the UK's reductions in territorial GHG emissions may in part reflect a relocation of emissions-intensive production overseas rather than a contribution to global decarbonisation due to changes in UK demand. As the UK continues to pursue its net zero targets, understanding the scale and nature of carbon offshoring is critical for ensuring the environmental integrity and effectiveness of future climate policy.

By combining production and trade data from 2005 to 2022, we provide a high-level, aggregate assessment of the extent to which UK demand is being met through foreign production—an indication that offshoring of production has occurred. Linking these trends to production-based emissions data, we estimate that the associated emissions of these offshored volumes totalled **14.9 MtCO₂e** over the period. While territorial emissions from UK industry fell significantly during the same timeframe, our analysis suggests that for certain sectors, a meaningful share of this decline may reflect offshoring of production rather than reductions in global emissions.

Limitations

Our approach is designed to capture broad patterns across sectors rather than trace detailed supply chain interactions. As such, it has several limitations:

- **Aggregate data:** The analysis relies on changes in production and trade at an aggregate level, without examining individual production bases. This may overlook cases where commodities are imported, transformed through processing or manufacturing, and then re-exported, or where offshoring patterns differ significantly between products within the same commodity group.
- **Monetary rather than physical values:** Offshored commodities are identified using monetary values rather than physical volumes. Because prices can vary between imports and exports, changes in the offshoring ratio may reflect shifts in value rather than quantities traded.
- **Temporal constraints:** The study period is limited to 2005–2022 due to the availability of consistent, disaggregated data on both trade and production.

- **Global emission impact:** The carbon footprint of displaced production can be higher than if goods were produced domestically, both because of emissions from transporting imports to the UK and because production in other countries may be potentially more carbon-intensive than in the UK.

These limitations mean the results should be seen as high-level, but they still provide valuable insights into the scale and nature of industrial offshoring's impact on UK carbon emissions. These findings remain highly relevant: they underscore the importance of understanding that reductions in territorial emissions do not necessarily equate to reductions in global emissions. Recognising the role of offshoring is therefore critical—not as a critique of current policy, but to highlight the limitations of relying solely on territorial emissions as a measure of climate progress. For policymakers, this has important implications for the design of future carbon reduction strategies.

Future analysis

Building on this analysis, a next step would be to examine trade flows within specific commodity groups and the emissions associated with producing them in different countries. In particular, further work could:

- **Analyse specific commodities at a more disaggregated level,** distinguishing between individual products within broad commodity groups.
- **Compare emission intensities across producing countries,** to assess how relocation of production influences global emissions.
- **Quantify transport-related emissions,** capturing the carbon embedded in shipping, ferry, and road freight associated with bringing goods into the UK.

Such analysis would offer a more detailed understanding of the global consequences of offshoring and support the design of policy measures that ensure reductions in UK emissions correspond to actual decreases in global carbon output rather than transferring the carbon burden abroad.



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A photograph of the Oxera office interior, viewed through a glass wall. The image shows three modern, white, bowl-shaped pendant lights hanging from the ceiling. In the background, the word "oxera" is displayed in large, white, three-dimensional letters. The office has a wooden desk with some papers and a laptop, and a wooden slatted partition in the foreground. The overall atmosphere is bright and modern, with natural light coming from a window on the right showing greenery outside.

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