

Updated Carbon Leakage Indicators for the UK Emissions Trading Scheme

Prepared for DESNZ

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1. Introduction

NERA was commissioned by the Department for Energy Security and Net Zero (DESNZ) to produce a set of updated Carbon Leakage Indicators (CLIs) and a Carbon Leakage List (CLL) for stationary installations in industries within the UK Emissions Trading Scheme (UK ETS).

This is intended to support the UK ETS Authority by developing updated CLIs based on UK data, building on a commitment in the the UK ETS Authority's 'Free Allocation Review' consultation, which closed in March 2024.¹ Results presented here are also detailed in the the Authority's publication outlining a preliminary updated CLL for UK industries.²

As part of the UK ETS, the UK ETS Authority provides some allowances to operators for free, known as free allocation (FA). FA aims to mitigate the risk of carbon leakage for UK businesses. Carbon leakage is considered the movement of production, and therefore associated emissions, from one country to another due to asymmetric levels of carbon pricing and climate regulation.

Within the current UK ETS Free Allocation Methodology, CLIs are calculated for each industry,³ based on their estimated trade intensity and emissions intensity. These CLIs are used to determine the CLL, defining eligibility for carbon leakage support through FA. Installations in industries which are on the CLL receive 100% (known as the Carbon Leakage Exposure Factor) of their entitlement of FA, set according to other elements of the FA Methodology;⁴ those off the CLL are not deemed a carbon leakage risk, and currently receive 30% of their benchmarked FA, set to reduce to zero by 2030. The 0.2 threshold is same as adopted in the EU ETS, initially informed from a bottom-up calculation of carbon leakage risk (see Section 5.2.2 for further discussion).

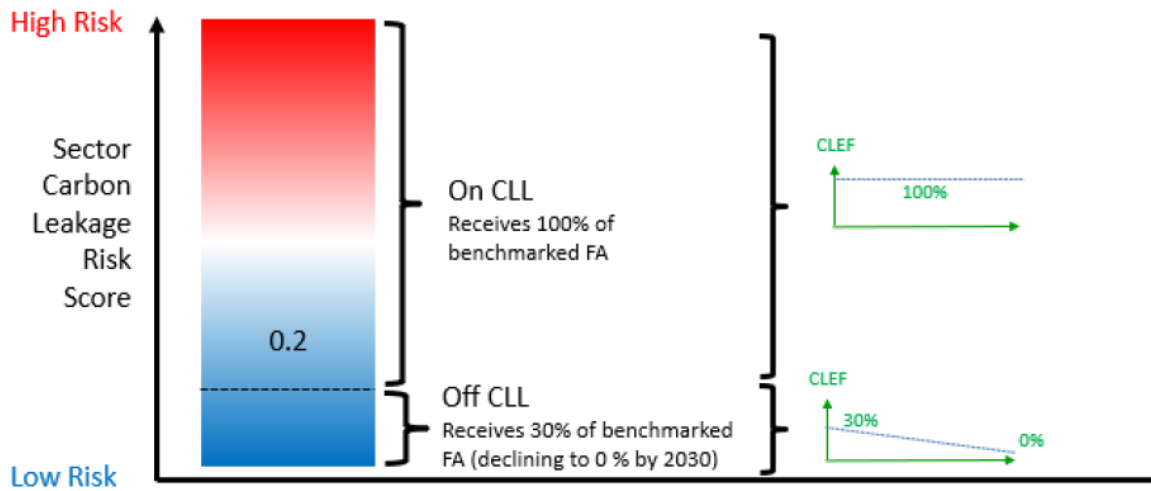
¹ DESNZ (December 2023) [UK Emissions Trading Scheme: free allocation review](#)

² UK ETS Authority Consultation (2024): www.gov.uk/government/consultations/uk-emissions-trading-scheme-free-allocation-review-carbon-leakage

³ Defined at 4-digit NACE level.

⁴ At their relevant 'Benchmark', and at their given activity level, typically Historic Activity Level

Figure 1.1: Carbon Leakage Indicator to Carbon Leakage Exposure Factor Conversion



Source: DESNZ.⁵

NERA’s work focusses on updating the CLI calculation with up-to-date and UK-specific data for the 2027-2030 period and potentially onwards. From launch, the UK ETS has had an adopted assessment of carbon leakage from the European Union (EU) ETS: the CLIs and CLL are therefore equivalent in both the UK and EU ETS. The calculation of industry CLIs is based on trade and emissions data at a European Union level.⁶

The current UK ETS CLIs and CLL are therefore based on EU-wide data relating to the years 2013-2015. While the UK was included within this estimation, such results may not be representative of the current characteristics of UK industries, in terms of trade intensity (based on EU to non-EU trade, and therefore excluding UK-EU trade), emissions intensity (based on EU average rather than UK-specific) and therefore be outdated (based on data from 2013-2015).

As a result, the UK ETS Authority outlined that updating the CLI using UK-focussed data may result in more representative, updated estimates of carbon leakage risk for UK industry. Therefore, the aim of this update is to ensure FA is better targeted at sectors most at risk of carbon leakage, in line with the objective of the free allocation review.⁷

The study provides a set of preliminary, updated CLIs, on which the UK ETS authority will be consulting. The UK ETS Authority may seek validation for the CLIs of some sectors over the consultation period.

The remainder of the report is structured as follows:

- Section 2 introduces the current form of the CLI formula and criteria we use in evaluating options for datasets used to update the CLI;

⁵ DESNZ (December 2023), Analytical Annex to the Free Allocation Review, Figure 14.

⁶ For a full methodology, see [European Commission Carbon Leakage](#), with the EU ETS CLL implemented in legislation in the [Commission Delegated Decision \(EU\) 2019/708](#), of 15 February 2019; implemented into UK Legislation.

⁷ See the UK ETS Authority Consultation (2024) www.gov.uk/government/consultations/uk-emissions-trading-scheme-free-allocation-review-carbon-leakage for further detail on the rationale for updated UK CLIs.

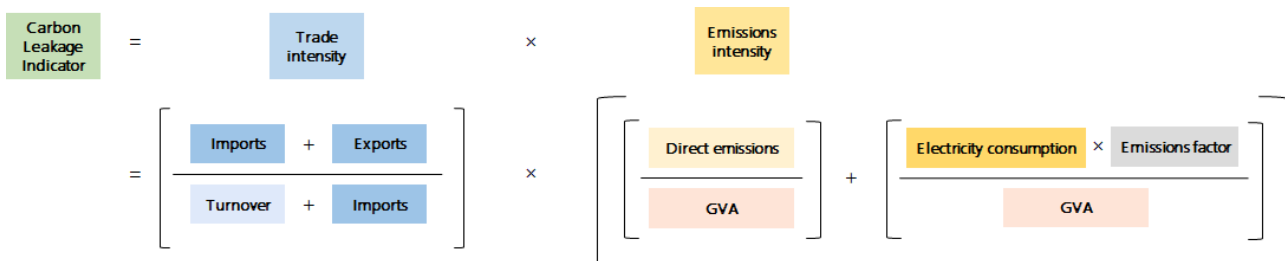
- Section 3 describes the data sources and the methodological approach to calculating Trade Intensity;
- Section 4 describes the data sources and the methodological approach to calculating Emissions Intensity;
- Section 5 presents the results: an updated preliminary set of CLIs, and a preliminary CLL, of UK industries deemed to be at risk of carbon leakage risks. It also outlines the next steps for further investigatory work suggested during the consultation phase.

2. The Carbon Leakage Indicator Formula and Criteria for Data Options to Update CLIs

2.1. The Carbon Leakage Indicator Formula

The current formula the UK ETS uses to calculate sectoral CLI values (see Figure 2.1 below) was adopted from the EU ETS. The key variables in the methodology to estimate carbon leakage risk – trade intensity and emissions intensity – are well established and were consulted on by the EU in 2009 with industry, academia, and Member States in the lead up to the creation of the Phase 3 CLL, and then again in 2018 in preparation for the Phase 4 CLL.^{8 9} As outlined in its Consultation, the UK ETS Authority intends to maintain this approach to estimating carbon leakage risk, with these two key variables. This enables continuity and clarity for operators within the UK ETS.

Figure 2.1: Carbon Leakage Indicator Formula



Source: European Commission.¹⁰

The CLI assesses a sector’s carbon leakage risk based on the trade intensity (TI) and emissions intensity (EI). Specifically,

- **Trade intensity:** This is calculated as imports plus exports (representing the total trade activity for the sector in the given jurisdiction(s)), divided by turnover plus imports (representing the market size of the sector in the given jurisdiction(s)). Trade intensity indicates the openness to international trade and competition for a given UK industry. This is a likely precondition for carbon leakage – if UK producers face greater costs (due to the UK ETS) than foreign competitors (with lower costs from climate regulation), they may be less competitive. Reduced competitiveness may lead to lower domestic production and greater imports in a sector (import substitution) or UK firms moving to areas with lower costs (industrial relocation). These risks are greater in highly traded industries.
- **Emissions intensity:** This aims to capture the rate of emissions for a given level of Gross Value Added (GVA) in each industry. Emissions intensity is the sum of two components: direct

⁸ European Commission, Energy, Climate change, Environment, Carbon Leakage, URL: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/carbon-leakage_en#:~:text=Carbon%20leakage%20lists%3A.

⁹ In 2018 the EU revised the criteria for the CLL. In essence the revision was to no longer require an estimate of EUA prices

¹⁰ European Commission (8 May 2018), Framework for Disaggregated Assessments, Figure 1, URL: https://climate.ec.europa.eu/document/download/0236312e-34de-4ddb-bc43-8b0829542e3b_en?filename=framework_for_disaggregated_assessments.pdf.

emissions intensity and indirect (electricity consumption) emissions intensity. Higher emissions intensity translates into a higher negative impact from carbon pricing on an industry's GVA relative to competitors in jurisdictions which face lower/no carbon prices. This is likely to affect competitiveness in the jurisdiction with higher carbon prices and increase the risk of carbon leakage. This risk is thought to be greatest in emissions-intensive industries which are yet to have significantly decarbonised production.

- Each sub-component of emissions intensity is calculated in the following way:
 - The direct emissions intensity component is equal to direct emissions divided by the GVA of each industry. Direct emissions are emissions associated with a sector's own production process. This metric represents the amount of direct emissions produced per unit of value added to economic output.
 - The indirect emissions intensity component is equal to electricity consumption multiplied by the emissions factor (representing indirect emissions resulting from the electricity consumption associated with sectoral production) divided by the industry's GVA. Indirect emissions capture a sector's emissions from its electricity consumption. Similarly, this metric represents the amount of indirect emissions produced per unit of value added to economic output.

In this methodology, carbon leakage risk is considered to arise as a combination of these two factors: in short, carbon leakage is a risk in industries which are highly traded (open to international competition) and emissions intense (feel the effect of the carbon price). The calculation of the CLI as the product of TI and EI implies that both conditions are broadly necessary for carbon leakage to be a risk – if either is zero, there is no risk – and carbon leakage risks increase significantly when both factors increase.

It should also be noted that, while there may be significant variation within industries, this methodology considers only the average for a whole industry's emissions and trade intensity at a 4-digit NACE level: each industry code receives only one CLI value. The resulting CLI, and CLL is applied uniformly to all installations in an industry.

2.2. Criteria for Assessing Data Sources and Solutions

As discussed above, the main purpose of this assignment is to ensure that the CLI is a more accurate, representative, and updated estimation of carbon leakage risk for UK industries, to improve targeting of FA to appropriately mitigate carbon leakage risk. To assess the quality and applicability of different data sets for this calculation, the UK ETS Authority and NERA assesses the data according to the following criteria:

- Longevity: Whether there is high confidence that the data will be produced in future ETS phases.
- Transparency: Whether the data is easily accessible, transparent, and available for scheme participants.
- Data quality: Whether the data is accurate and produced to robust standards.
- Data coverage: Whether the data has enough coverage for the relevant ETS sectors.

- UK focus: Whether the data is based on UK firms and representative to the scheme participants.

In addition to the above criteria that are applicable to the entire data sources, there are other considerations of the characteristics and coverage within each data set, for example any sector-specific data gaps or anomalies (e.g., missing entries, non-intuitive values, large fluctuations) that are identified and resolved as part of developing the final results.

Within the scope of this assignment, we have prioritised a list of key sectors with sector-specific data issues to deal with. To aid prioritisation, the existing CLI values set was used to inform key industries of interest. To prioritise sectors, we identify industries which see significant changes in CLI value, and those particularly close to the CLL threshold. For the prioritised sectors with data issues, we carry out sector-specific data analysis to mitigate the issues and generate options. The prioritisation process is summarised below and in Figure 2.2:

- Start with a full list of 331 sectors at 4-digit NACE code¹¹ as initially identified by DESNZ.
- Narrowing the scope to sectors with issues, by only focusing on industries with missing or anomalous data.
- Excluding sectors that are not currently in the UK ETS leading to a further reduction in the number of sectors. This is because there are only 86 active sectors in the UK ETS.¹²
- Focusing on the borderline sectors by limiting attention to sectors with an existing CLI between 0.15 and 1.¹³ This also excludes sectors in the UK ETS that have no existing CLI values calculated from the EU ETS. In its Phase 4 CLI assessment, the EU only publishes CLI values for 245 sectors, (i.e., from Sector 0510 Mining of hard coal to Sector 3320 Installation of industrial machinery and equipment). As a result, out of the 86 sectors in the UK ETS, there are only 69 sectors that have an existing CLI value.

¹¹ Statistical classification of economic activities in the European Community, abbreviated as NACE, is the classification of economic activities in the European Union (EU).

Source: Eurostat website, Glossary: Statistical classification of economic activities in the European Community (NACE), URL: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Statistical_classification_of_economic_activities_in_the_European_Community_\(NACE\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Statistical_classification_of_economic_activities_in_the_European_Community_(NACE)). Assessed on 28 May 2024.

¹² GOV.UK website, UK ETS Public Reports, Compliance Report - Emissions and Surrenders, URL: <https://reports.view-emissions-trading-registry.service.gov.uk/ets-reports.html>. Assessed on 28 May 2024.

We note that there are 2 additional sectors (1812 and 2550) which appeared in the compliance report but are excluded in the analysis. These sectors each appear to relate to 1 installation, and both installations are closed. We have therefore excluded the two sectors in our prioritisation list.

¹³ EU ETS phase 4 Preliminary Carbon Leakage List, Carbon Leakage Indicator underlying data, URL: https://climate.ec.europa.eu/document/download/de7b6d7e-a152-4796-901d-133e5bdadeafc_en?filename=6_cii-eiti_results_en.pdf.

Figure 2.2: Prioritisation Criteria for Key Sectors



Source: NERA.

Regarding the temporal coverage of our assessment, we have agreed with DESNZ to update the CLI values using data covering three years between 2019 and 2021. The rationale for covering the period from 2019 to 2021 are i) similarity to the method used by the EU, which strikes a balance between smoothing annual fluctuations by using several years of data and only using recent observations; and ii) consistent availability of observations in these periods for all variables. The years 2019-2021 are, therefore, the three years of most recent activity for which we have complete data for all variables. When investigating sector specific data for prioritised sectors, we also consider whether variation caused by the COVID-19 pandemic over this period requires specific treatment.

3. Trade Intensity

As discussed in Section 2.1, the trade intensity is calculated as the ratio of a sector’s value of trade to its total domestic consumption. Figure 3.1 shows the formula to calculate the trade intensity.

Figure 3.1: Trade Intensity Formula

$$\text{Trade intensity} = \frac{\text{Imports} + \text{Exports}}{\text{Turnover} + \text{Imports}}$$

Source: European Commission.

The remainder of this section describes the approach and data sources to update the trade intensity using up-to-date, and UK specific data.

3.1. Approach to Calculating the Trade Intensity

Under the current CLIs, trade intensity is calculated as the ratio between imports plus exports and the total market size for the European Economic Area (EEA). As this is calculated relative to the EEA trading bloc, rather than the UK, only trade between the EEA and third countries (Rest of World) is captured, and not UK-EU trade. Therefore, updating the CLIs with UK specific data suggests the revised CLIs should include trade with the EU within the variable, considered in the box below:

Box 3.1: Consideration of UK-EU trade in the Trade Intensity Variable

There are two opposing considerations on whether trade between UK and the EU should be included in the CLI calculation.

The presence of similar ETSs in both the UK and the EU suggests that there may not be significant risks of carbon leakage between these jurisdictions. Therefore, it may not be sensible to include trade with the EU, on a like for like basis, to trade with the rest of the world in the calculations of CLIs. Treating trade with the EU comparably with the rest of the world may also lead to a step change in CLIs for those sectors which have a relatively high share of trade with the EU.

On the other hand, although the design of the UK and EU ETSs are similar, they may diverge going forward, and they are also subject to different fundamentals which could drive significantly different prices. Therefore, it may be reflective of UK carbon leakage risks to give trade with the EU the same treatment as trade with the rest of the world in the CLI formula.

Based on discussions with DESNZ, the approach to updating the CLI in this study includes UK sectors' trade with the EU in the trade intensity calculation. The trade intensity aims to capture the extent to which tightening of domestic carbon policy would result in operations moving abroad. While the EU has a similar ETS to that in the UK, the potential divergence between the UK and EU ETSs would affect the degree of competition UK ETS participants face from their EU competitors. Consequently, even for sectors that predominantly trade with the EU but not the rest of the world, tightening of UK carbon policy relative to that in the EU would also create incentives for businesses within these sectors to move abroad. Therefore, the exclusion of EU trade in the CLI calculation may not be appropriate as it will likely underestimate the carbon leakage risks of these sectors and create potential carbon leakage.

On balance, in order to maintain the methodological approach of the current CLIs, and enable a simple approach which does not differentiate between jurisdictions, we include EU trade within the Trade Intensity variable. This approach also aims to align with the intent of this study to reflect UK sectors' specific carbon leakage risks, including exposure of trade with the EU.

3.2. Data Sources for Each Component of Trade Intensity

3.2.1. Trade data

The draft updated CLIs use trade data as published by HM Revenue & Customs (HMRC).¹⁴ The data includes monthly trade value by products and reports UK's trade with EU and non-EU countries separately. The trade data classifies product type using different systems of product codes,

¹⁴ HMRC website, Build an Overseas Trade Data Table, URL: <https://www.uktradeinfo.com/trade-data/ots-custom-table/>. Assessed on 28 May 2024.

including the Standard International Trade Classification (SITC),¹⁵ Harmonised System (HS),¹⁶ and Combined Nomenclature (CN)¹⁷.

Trade product-industry Mapping

The ETS classifies sectors using 4-digit UK Standard Industrial Classification (SIC) code, the national version of the Statistical Classification of Economic Activities in the European Community (NACE) code. Constructing variables for trade intensity requires combining the value of trade for an industry (in trade codes, such as HS) and economic output (industry codes: SIC/NACE). Therefore, developing CLI values reported on the same basis requires mapping of the product codes on to industry NACE codes.

The mapping relies on the concordance tables published by Eurostat,¹⁸ using the statistical classification of products by activity (CPA) code as a bridge. The CPA code is an extension of NACE code and is identical to NACE up to 4 digits. Eurostat publishes the CN code – CPA code concordance table on an annual basis. The mapping from trade data to ETS sectors hence involves the following steps:

1. Mapping the CPA code to NACE code by matching the first 4 digits of the CPA code to the corresponding NACE code; and
2. Combining the CN – CPA concordance table and the CPA – NACE mapping, to obtain the mapping from CN code to NACE code. The CN code and the CN – CPA concordance table is updated annually, so the mapping between each year's trade data and the ETS sectors relies on the concordance table of the corresponding year. For example, this mapping uses the 2019 concordance table to map the 2019 trade data, the 2020 concordance table to map the 2020 trade data and so on, to avoid inconsistent classification of CN code across different years.

Table 3.1 below shows the assessment of the trade product-industry mapping approach against the pre-defined criteria and identifies the key sector(s) with sector-specific issues. The approach to addressing the sector-specific issue is discussed in Section 3.3 below. The assessment suggests that the trade mapping approach used in this study meets the high-level criteria for data quality.

¹⁵ SITC is a product classification of the United Nations (UN) used for external trade statistics (export and import values and volumes of goods). Source: Eurostat website, Glossary: Standard international trade classification (SITC). URL: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Standard_international_trade_classification_\(SITC\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Standard_international_trade_classification_(SITC)). Assessed on 28 May 2024.

¹⁶ HS an international system to classify goods developed by the World Customs Organisation (WCO). Source: European Commission website, Harmonised System, URL: <https://trade.ec.europa.eu/access-to-markets/en/content/harmonised-system-0>. Assessed on 28 May 2024.

¹⁷ CN is the EU's eight-digit coding system, comprising the Harmonised System (HS) codes with further EU subdivisions. Source: European Commission website, Combined Nomenclature, URL: [https://trade.ec.europa.eu/access-to-markets/en/content/combined-nomenclature-0#:~:text=The%20Combined%20Nomenclature%20\(CN\)%20is,the%20rest%20of%20the%20world](https://trade.ec.europa.eu/access-to-markets/en/content/combined-nomenclature-0#:~:text=The%20Combined%20Nomenclature%20(CN)%20is,the%20rest%20of%20the%20world). Assessed on 28 May 2024.

¹⁸ Eurostat website, ESTAT_Statistical_classification_of_products_by_activity_2.1_(CPA_2.1), URL: https://showvoc.op.europa.eu/#/datasets/ESTAT_Statistical_classification_of_products_by_activity_2.1_%28CPA_2.1%29/metadata. Assessed on 28 May 2024.

Table 3.1: Assessment of the Approach to Mapping the Trade Product Data to NACE Industry Code

Trade Mapping Approach	
Methodology	Using concordance tables published by Eurostat, ¹⁹ to map CN code to CPA code and then shorten to 4-digit NACE codes as CPA codes are identical to NACE at 4-digit level.
Assessment	
Longevity	● Annual publication
Transparency	● Uses a published concordance table
Data quality	● Unique mappings from CN to NACE code
Data coverage	● 90 sectors (1 key sector) with no mapped trade, however, trade could be zero for the corresponding sectors
UK focus	● The CN8 classification may differ across countries but is less of a concern for this study
Key sectors with issues	
Missing values (EU CLI)	13.3 Finishing of textiles (0.18)

Note: Severity of the data issues – ● denotes high; ● denotes medium; ● denotes low.

This analysis was carried out on data which did not include sub-installations.

Source: NERA.

3.2.2. Turnover data

Given the lack of comprehensive data sources on the sector turnover data, this study has relied on two UK-specific data sources for the turnover variable.

The primary data source is the Annual Business Survey (ABS) data as published by the Office for National Statistics (ONS).²⁰ As part of its ABS, ONS publishes the sector turnover at 4-digit SIC level, identical to the NACE code. However, there are 23 sectors in the UK ETS that are missing from the ABS data source (either the data is missing or reported as confidential for some years; or the sector is not included in the ABS at all).

In the case of missing data, fallback estimation is required. The main alternatives to estimating turnover are estimates from the Inter-Departmental Business Registry (IDBR) data.²¹ The IDBR reports number of businesses within each turnover band on 4-digit SIC code. The sector turnover

¹⁹ Eurostat website, ESTAT_Statistical_classification_of_products_by_activity_2.1_(CPA_2.1), URL: https://showvoc.op.europa.eu/#/datasets/ESTAT_Statistical_classification_of_products_by_activity_2.1_%28CPA_2.1%29/metadata. Assessed on 28 May 2024.

²⁰ ONS (18 May 2023), Non-financial business economy, UK: Sections A to S, URL: <https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseseconomyannualbusinesssurveysectionsas>. Assessed on 28 May 2028.

²¹ Nomis: UK Business Counts - enterprises by industry and turnover size band, from IDBR, URL: <https://www.nomisweb.co.uk/query/construct/summary.asp?mode=construct&version=0&dataset=199>. Assessed on 28 May 2028.

for each sector is estimated by first multiplying the number of businesses by the mid-point turnover value for each band; and then summing the product across the turnover bands.

While the supplemented turnover data has values for all the sectors, there could be considerable inconsistencies between turnover data in ABS and that estimated from IDBR for some sectors. In addition, the IDBR estimated turnover produces a value of zero for several sectors though it reports a positive total number of businesses.²²

Given these potential limitations and anomalies, the following checks were implemented to detect potential data issues:

- Check for abnormal annual variation in turnover in absolute terms (i.e., identify sectors with annual absolute variation in turnover greater than 50 per cent);
- Check for non-intuitive GVA to turnover ratio. The ABS dataset also includes sector GVA data, therefore, we also identify sectors with a GVA:turnover ratio above 1; and
- Check for zero turnover values.

The above criteria identified 20 sectors in the UK ETS with turnover data issues. Since data problems associated with these sectors are different from each other, different measures are required to address issues. For example:

- For sectors where there is only one year of data available in the ABS dataset, and there are large differences between the ABS and IDBR estimated turnover, we
 - Calculate the ratio of the ABS turnover to IDBR estimated turnover of the sector in the available year; and
 - Apply the ratio to scale up / down the IDBR estimated turnover, assuming the upward / downward bias of the IDBR estimates is consistent across the year.
- For sectors where the turnover data is missing for one year in the ABS dataset, but there is a significant difference between the ABS and IDBR estimated turnover observed in other years, the historic or parent level annual growth rate is applied to extrapolate data for the missing year or interpolate to 'fill in' the missing annual value.
- For sectors where the turnover data exhibits high annual variation, we check if the trend is consistent with GVA values, and if so, continue to use the turnover data.

After the sector-specific assessment, there are 3 ETS sectors with existing CLI values that have unresolved turnover issues.²³ All of them are key sectors as identified using the prioritisation process set out in Section 2.2. There is no turnover data for these sectors available in the ABS dataset and the turnover estimated from the IDBR data is zero. In addition, there is limited information in the public domain that would allow a proper estimation of their turnover sizes. The

²² This happens when the IDBR data reports a positive number of total businesses in a sector but fails to show the number of businesses within each turnover band.

²³ These are 08.91 Mining of chemical and fertiliser minerals; 10.81 Manufacture of sugar; and 24.46 Processing of nuclear fuel.

trade intensity calculation for these sectors therefore relies on the fallback option, as further discussed in Section 3.3 below.

Given the limited scope, this study has not conducted case-by-case assessments for sectors with turnover data issues that do not currently appear in the UK ETS.

3.3. Trade Intensity Calculation and Fallback Options

As discussed in the previous section, we calculate the trade intensity of the UK ETS sectors, at the 4-digit SIC level, primarily using trade data from HMRC, output data from the ONS Annual Business Survey, and using product-industry mapping to analyse industries consistently. The trade intensity variable covers the average for the years 2019-2021, the latest three years with full data. Fallbacks are used in cases of gaps or anomalous results for the following data:

- Trade data: HMRC data that reports value of trade by CN code, which is then mapped to NACE/SIC code using the concordance table published by Eurostat; and
- Turnover data: ONS ABS data, supplemented by estimated turnover using IDBR data, with sector-specific assessment for ETS sectors with turnover data issue.

The fallback option is to use the underlying trade intensity calculated from the EU ETS when a sector has data issues with either the trade mapping or turnover data. There are a total of 3 UK ETS sectors that use the fallback options, all of which are key sectors based on the prioritisation criteria outlined in Section 2.2 above.

Given the limited data availability, we consider the current EU-calculated trade intensity is a reasonable proxy of the trade intensity for UK firms within these sectors. However, there are certain limitations of this fallback option, specifically:

- The underlying assumption is that the trade intensity of these sectors in the UK is similar to the sectors in the EU, which may not always hold; and
- While the EU calculated the trade intensity for these sectors with UK data included, the assumption may i) ignore the trend in trade in these sectors over time; and ii) does not treat trade with the EU as imports/exports.

3.3.1. Consideration of Carbon Border Adjustment Mechanisms

In addition, it is necessary to note that this update does not consider the implication on the carbon leakage risks of the sectors covered under the Carbon Border Adjustment Mechanism (CBAM).

Separate to free allowances, the UK government announced its intention to introduce the CBAM by 2027. The CBAM would cover the aluminium, cement, fertiliser, hydrogen, iron, and steel sectors, and would apply a UK CBAM price to imports in these sectors to reflect the effective carbon price that UK installations pay. In effect, the CBAM would ensure that imports are priced at a level equivalent to if other countries were subject to the UK ETS price. Therefore, the CBAM aims to mitigate carbon leakage by applying comparable carbon prices to covered products, thus levelling the playing field and lowering risks of carbon leakage via import substitution or industrial relocation. Any interaction between FA and the UK CBAM policy is still under consideration, and

this report does not attempt to address risks to the CLI assessment associated with the introduction of CBAM.

4. Emissions Intensity

As discussed in Section 2.1, the emissions intensity variable used in the CLI is the sum of two components, the direct emissions intensity and the indirect emissions intensity of production by industry. Figure 4.1 shows the formula to calculate the emissions intensity.

Figure 4.1: Emissions Intensity Formula

$$\text{Emissions intensity} = \left[\frac{\text{Direct emissions}}{\text{GVA}} \right] + \left[\frac{\text{Electricity consumption} \times \text{Emissions factor}}{\text{GVA}} \right]$$

Source: European Commission.

The remainder of this section describes the approach and data sources to update the emissions intensity using up-to-date, UK specific data. As above, the aim is to produce updated, accurate, and representative estimates of the emissions intensity of production for each of the industries (at 4-digit SIC level) within the UK ETS. A higher emissions intensity signifies greater exposure to the carbon price (UK Allowances) as a proportion of value produced.

4.1. Calculation of Emissions Intensity

As throughout this analysis, we aim to maintain the current approach to calculating CLIs. As such, emissions intensity is treated as the sum of both direct and indirect emissions. While there are considerations as to the applicability of indirect emissions intensity as a factor (Box 4.1), this variable is included in the final calculation.²⁴

Box 4.1: Consideration of indirect emissions intensity

The current (EU and UK) CLIs include both direct and indirect emissions intensity of the sectors. However, whether indirect emissions should be included within the CLI formula depends on the extent to which carbon leakage risks from indirect emissions are assumed to be mitigated by other UK policies.

Following a consultation in 2021, the UK Government deems there to be a continued risk of carbon leakage due to indirect emissions. Therefore, the UK Government will continue to provide compensation for indirect emissions costs until March 2025. However, there is currently no indication regarding whether such scheme would continue to be in place after March 2025.

Based on discussions with DESNZ, the approach to updating the CLI in this study includes indirect emissions intensity in the CLI updates. The updated CLI values will inform DESNZ's decision on the FA allowances to the ETS sectors over the period 2027-2030. However, there is lack of certainty beyond 2025 whether EII compensation and exemption schemes will continue. In the event the EII compensation scheme ceases to continue from 2025 onwards, the exclusion of indirect emissions intensity in the CLI calculation will underestimate the carbon leakage risks to the UK ETS sectors, especially for sectors with relatively high electricity consumption.

Therefore, on balance, NERA and DESNZ chose to include indirect emissions intensity in the CLI calculations in this update, to maintain approach and avoid risks of underestimating the carbon leakage risks of an industry.

²⁴ Discussion of the cost compensation policy in Box 4.1 relates to: GOV.UK website: [Compensation for the indirect costs of the UK ETS and the CPS mechanism](#)

4.2. Data Sources for Each Component of the Emissions Intensity

4.2.1. Direct emissions

The main source for direct emissions data for ETS sectors is obtained from the UK ETS compliance report.²⁵ This data is reliable, verified, and included in published reports covering the recorded annual emissions (surrendered allowances) of all installations participating in the UK Emissions Trading Scheme (UK ETS).

The UK ETS launched in 2021, so emissions data relating to years prior to 2021 are not published in this dataset. However, through linking operator account details to compliance under the EU ETS – also published data – DESNZ has provided the emissions data by participants and NACE code in years 2019 and 2020 based on mapping UK sectors with EU ETS published data for this update.

Table 4.1 below shows the assessment of the ETS emissions data against the pre-defined criteria and identifies the key sector(s) with sector-specific issues. The assessment finds that the ETS emissions data meets the high-level criteria and covers the full list of ETS sectors.

Table 4.1: Assessment of the Direct Emissions Data from ETS Compliance Report

	ETS Emissions Data
Methodology	Use direct emissions for ETS sectors using ETS compliance report
Assessment	
Longevity	● Data is published annually
Transparency	● Publicly available data
Data quality	● Bottom-up data for ETS sectors
Data coverage	● Full coverage of key sectors, although only covers emissions from sites that are eligible for UK ETS participation
UK focus	● UK-specific
Key sectors with issues	
Missing values (EU CLI)	N/A

Note: Severity of the data issues – ● denotes high; ● denotes medium; ● denotes low.

Source: NERA.

This analysis was carried out on data which did not include sub-installations.

While this approach follows the approach used by the EU to estimate direct EI, using the ETS emissions and sector GVA to calculate the direct emissions intensity may underestimate the direct emissions intensity of a sector. This is because the ETS recorded emissions may only cover the emissions of the sector in part, whereas the GVA data considers the whole sector.²⁶ Therefore,

²⁵ GOV.UK website, UK ETS Public Reports, Compliance Report - Emissions and Surrenders, URL: <https://reports.view-emissions-trading-registry.service.gov.uk/ets-reports.html>. Assessed on 24 May 2024.

²⁶ Omission of non UK ETS emissions for ETS sectors, when used as the numerator in the EI formula which takes the GVA of the whole sector as the denominator, may reduce EIs by thresholds to achieve the same distribution of firms on and off the list as current, if the bias caused by partial coverage of sector emissions is systematic across sectors, it would not impact the sectors on the CLL.

there may be a need to further examine the direct emissions intensity, for the sectors leaving the CLL based on the draft updated CLI values with particularly low direct emissions intensity as compared to that calculated from the EU ETS.

An alternative option for the direct emissions that we considered in this study was replacing the entire EI component with emissions intensity calculated directly by ONS.²⁷ While this alternative approach relies on annually published public data, results are produced at varying levels of sector disaggregation, varying from 2- to 4-digit SIC code level. As a result, there are several industries for which only an aggregated estimate is available. This option therefore has limited 'data coverage' and lacks the granularity as desired by the ETS to be the primary data source. Therefore, this dataset was not the preferred option, but is considered as a fallback option in cases where data is lacking. NACE codes which only appear at sub-installation activity level within the UK ETS, but not in the published *installation-level* Emissions and Surrenders Compliance data,²⁸ do not have ETS recorded emissions. Therefore, these sectors, as well as some others, use the ONS 'fallback' estimate for direct emissions intensity.

4.2.2. GVA data

The data source for sector GVA is the ONS ABS dataset.²⁹ This includes variables for approximate Gross Value Added (aGVA), a measure of economic value produced by industry.³⁰

However, as noted above, there are some industries for which output variables are missing in the ABS. We identify 25 sectors in the UK ETS for which the ABS dataset does not report GVA values. Unlike for the turnover data where a supplementary data source is available, there are limited available public data sources on sector GVA.

For sectors with missing entries, we estimate GVA values using parent level GVA to turnover ratios. The approach involves the following steps:

- Aggregate the respective GVA and turnover values by parent NACE codes (i.e., NACE 2-digit). We use adjusted turnover values using the turnover data adjustment as discussed in Section 3.2.2 above. We exclude the turnover data for sectors where the GVA value is not available at 4-digit NACE level, to avoid distorting the GVA to turnover ratio at parent level.
- We then calculate the GVA to turnover ratio for each parent sector.
- Finally, we estimate the GVA for sectors with missing entries by multiplying their turnover by the corresponding parent level GVA to turnover ratio.

As shown in Table 4.2 below, the assessment of the above approach suggests that it is broadly in line with the pre-defined criteria.

²⁷ ONS (9 October 2023), Atmospheric emissions: greenhouse gas emissions intensity by industry, URL: <https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsatmosphericemissionsgreenhousegasemissionsintensitybyeconomicsectorunitedkingdom>. Assessed on 28 May 2024.

²⁸ See UK Emissions Trading Registry (2024) <https://reports.view-emissions-trading-registry.service.gov.uk/ets-reports.html>

²⁹ See ONS (2024) *Non-financial business economy, UK: Sections A to S*

³⁰ aGVA is constructed as the income generated by the surveyed businesses (and the industry or sector they represent) less their intermediate consumption of goods and services used up in order to produce their output.

Table 4.2: Assessment of Approach to Addressing Missing GVA Issues

Approach to Addressing Missing GVA Issues	
Methodology	Use ONS ABS data for GVA, and calculate GVA / Turnover ratio at parent SIC code level for missing key sectors
Assessment	
Longevity	● Annual publication
Transparency	● Publicly available data
Data quality	● Represents an approximation of the GVA values
Data coverage	● GVA data issue not resolved for 6 ETS sectors
UK focus	● UK-specific
Key sectors with issues	
Missing values (EU CLI)	08.91 Mining of chemical and fertiliser minerals (0.26) 10.81 Manufacture of sugar (0.63) 24.46 Processing of nuclear fuel (0.22)

Note: Severity of the data issues – ● denotes high; ● denotes medium; ● denotes low.

Source: NERA.

This analysis was carried out on data which did not include sub-installations.

There are 3 ETS sectors with existing CLI values that have unresolved GVA issues, which are all key sectors.³¹ These sectors correspond to the sectors with unresolved turnover issues as described in Section 3.2.2 above. For these sectors, the corresponding fallback option applies, as further discussed in Section 4.3 below.

As discussed in section 4.2.1 for direct emissions, an alternative option that also would have removed the need for GVA estimates that we considered in this study was replacing the entire EI component with emissions intensity calculated directly by ONS.³² While this alternative approach relies on annually published public data, it is calculated at a 2-digit NACE code level and so lacks the granularity as desired by the ETS. Therefore, it was not the preferred option.

4.2.3. Indirect emissions data

There is no published dataset which produces reliable estimates of indirect emissions at the required 4-digit SIC level. Therefore, this study seeks to estimate the indirect emissions of each industry based on estimates of expenditure on electricity and emissions of purchased electricity compared to output (GVA) for a sector.

³¹ These include: Sector 08.91 Mining of chemical and fertiliser minerals; Sector 10.81 Manufacture of sugar; and Sector 24.46 Processing of nuclear fuel.

³² ONS (9 October 2023), Atmospheric emissions: greenhouse gas emissions intensity by industry, URL: <https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsatmosphericemissionsgreenhousegasemissionsintensitybyeconomicsectorunitedkingdom>. Assessed on 28 May 2024.

We utilise the ONS's Annual Purchases Survey (APS) data,³³ and data from HM Treasury Green Book to estimate the indirect emissions for the ETS sectors.

The ONS does not publish the relevant data from the APS on a regular basis. The only published dataset prior to this study is data on the average business expenditure on energy (including electricity as a separately reported item). The average business expenditure on energy is expressed as a proportion of total purchases of energy, goods, materials, and services in 2018.³⁴ Therefore, an ad-hoc publication is used to establish expenditure data in the years covered, based on a specific request data request to the ONS. Following our data request to the ONS, it has subsequently published the same data for 2021.³⁵

The steps to estimate the indirect emissions intensity by sectors involve the following:

- A. For both 2018 and 2021, estimate the sectors' spending on energy, goods, materials, and services (referred to as "intermediate spending" in what follows) by taking the difference between the sector turnover and GVA.
- B. Then, for both 2018 and 2021, approximate the sector's electricity spending using the sector's share of electricity spending as reported in the ONS data, multiplied by its intermediate spending obtained in step (A) above.
- C. Next, for both 2018 and 2021, calculate the sector's electricity consumption volume by using its electricity spending (step B), divided by the average industrial electricity price of the corresponding years as estimated in the HM Treasury Green Book.³⁶
- D. Estimate each sector's electricity consumption volume in 2019 and 2020 as follows:
 1. For sectors where the ONS data is available in both 2018 and 2021, we use the electricity consumption volume in 2018 and 2021 (step C) and assume constant annual growth rate to estimate the sector's electricity consumption volume in 2019 and 2020; and

³³ ONS (25 May 2022), Estimates of business energy expenditure from the Annual Purchases Survey, by energy type and 2, 3 and 4 digit Standard Industrial Classification (SIC), URL: <https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/adhocs/14688estimatesofbusinessenergyexpenditurefromtheannualpurchasessurveybyenergytypeand23and4digitstandardindustrialclassificationsic>. Assessed on 28 May 2024.

³⁴ ONS (25 May 2022), Estimates of business energy expenditure from the Annual Purchases Survey, by energy type and 2, 3 and 4 digit Standard Industrial Classification (SIC), URL: <https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/adhocs/14688estimatesofbusinessenergyexpenditurefromtheannualpurchasessurveybyenergytypeand23and4digitstandardindustrialclassificationsic>. Assessed on 28 May 2024.

³⁵ We have reached out to ONS to request the data for 2019 and 2020. We were informed by ONS that data in 2019 and 2020 are not available since the data processing work was impacted by the outbreak of Covid-19. The ONS has subsequently provided us with the same data in 2021 and 2022.

Source: ONS (25 June 2024), Estimates of business electricity expenditure from the Annual Purchases Survey, by 2, 3 and 4 digit Standard Industrial Classification (SIC): 2021 and 2022, URL: <https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/adhocs/2158estimatesofbusinessselectricityexpenditurefromtheannualpurchasessurveyby23and4digitstandardindustrialclassificationsic2021and2022>. Assessed on 25 June 2024.

³⁶ HM Treasury Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, URL: <https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal>.

2. For sectors where only 1 year of ONS data is available, we note that ONS’s 2018 data has better data coverage than the 2021 data. There are 16 ETS sectors where the ONS data is available in the 2018 dataset, but not in the 2021 dataset. For these sectors, we estimate their electricity consumption volumes in 2019 and 2020 using the 2018 data and applying the annual growth rate of the corresponding parent code (i.e., 2-digit SIC level).
- E. Finally, for each sector and for each year, calculate the indirect emissions intensity, using the formula as specified in Section 4 above. To do so, we multiply the sector’s electricity consumption (as detailed in step D) by the average grid emissions factor as estimated in the HM Treasury Green Book³⁷ to give the indirect emissions in kg CO₂e. We then divide the indirect emissions by the sector’s GVA value to calculate their indirect emissions intensity.

As shown in Table 4.3 below, the above approach to estimating the indirect emissions intensity is broadly in line with the pre-defined criteria.

Table 4.3: Assessment of the Approach to Estimating Indirect Emissions Intensity of ETS Sectors

Approach to Estimating Indirect Emissions Intensity	
Methodology	ONS data on electricity spending by 4-digit NACE code + HM Treasury Green Book data on electricity prices and grid emissions factor
Assessment	
Longevity	● Data updated regularly (APS data published upon request)
Transparency	● Publicly available data; Straightforward calculation
Data quality	● Data publication by UK authorities
Data coverage	● Missing sectors / confidential data
UK focus	● UK-specific
Key sectors with issues	
Missing values (EU CLI)	10.81 Manufacture of sugar (0.63) 23.13 Manufacture of hollow glass (0.63) 10.62 Manufacture of starches and starch products (0.52) 23.14 Manufacture of glass fibres (0.42) 08.91 Mining of chemical and fertiliser minerals (0.26) 23.99 Manufacture of other non-metallic mineral products n.e.c (0.22) 24.46 Processing of nuclear fuel (0.21)

Note: Severity of the data issues – ● denotes high; ● denotes medium; ● denotes low.

Source: NERA.

This analysis was carried out on data which did not include sub-installations.

However, the electricity spending data for 12 ETS sectors with existing CLI values is missing in the ONS dataset, out of which 7 are identified as key sectors. As discussed above, there are unresolved

³⁷ HM Treasury Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, URL: <https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal>.

GVA data issues for 3 key sectors. For these issue sectors, the corresponding fallback option applies when calculating their indirect emissions intensity (see further discussion in Section 4.3 below).

An alternative option for indirect emissions intensity considered was to utilise the Digest of UK Energy Statistics (DUKES) electricity consumption data. DUKES reports annual electricity consumption by highly aggregated industrial sectors annually.³⁸ Therefore, the approach to use DUKES data for indirect emissions intensity calculation for ETS sectors involves subjective mappings of the sector classifications between DUKES data and the ETS sectors. It would also be a high-level approximation, hence may suffer concerns over representativeness. Therefore, the alternative approach is not preferable to the selected approach described above.

³⁸ Digest of UK Energy Statistics: Electricity, URL: <https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes>.

4.3. Emissions Intensity Calculation and Fallback Options

We calculate the emissions intensity for the ETS sectors over the three-year period from 2019-2021 using direct emissions data, sector GVA, and indirect emissions intensity as discussed in Section 4.2.

To facilitate the comparison between the revised emissions intensity values and the existing emissions intensity values, and to identify the key drivers of the changes in the CLI values for each sector, the following adjustment is applied to the monetary values:

- Deflate the monetary values in UK-specific data to 2014 values using the GDP deflator index as provided in the HM Treasury Green Book.³⁹ The aim of this adjustment is to align the price basis with that in the EU CLI calculation, based on the period over which the EU collected underlying data for the calculation of the CLIs;⁴⁰
- Adjust the emissions intensity data underpinning the existing CLI (expressed on a kgCO₂/€ basis) to kgCO₂/£ basis. This aims to ensure the comparability between the updated emissions intensity data in this study and that reported by the EU Phase 4 assessment. The adjustment uses the annual average EUR/GBP exchange rate in 2014.⁴¹

However, as noted above, there are some sectors where there are issues with the underlying data. For these sectors, the following fallback options apply:

- Direct emissions intensity: For sectors with unresolved GVA data issues, we use ONS emissions intensity data at the less granular 2-digit parent NACE code level to the 4-digit NACE code ETS sector:
 - As discussed in Section 4.2.1, the ONS publishes direct emissions intensity by sectors on an annual basis, and at a varying level of granularity.⁴² There are 23 ETS sectors with existing

³⁹ HM Treasury Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, URL: <https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal>.

⁴⁰ The underlying data covers the period 2013 to 2015, we have taken the mid-point of this period (i.e., 2014) to deflate the UK values.

⁴¹ Band of England website, Annual Average Exchange Rate at 31 December 2014; URL: <https://www.bankofengland.co.uk/boeapps/database/Rates.asp?TD=31&TM=Dec&TY=2014&into=EUR&rateview=A>.

⁴² ONS calculates emissions intensity with the sector GVA expressed in constant 2019 prices. We adjust ONS emissions intensity using the UK GDP deflator reported in the HM Treasury Green Book, to ensure consistency between the ONS data and the GVA data this study uses (i.e., 2014 prices).

Sources: (1) ONS (9 October 2023), Atmospheric emissions: greenhouse gas emissions intensity by industry, URL: <https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsatmosphericemissionsgreenhousegasemissionsintensitybyeconomicsectorunitedkingdom>. Assessed on 28 May 2024; (2) Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, URL: <https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouseand-gas-emissions-for-appraisal>.

CLI values that use the fallback option for direct emissions intensity.⁴³ Of those sectors using fallback options, 6 of them are identified as key sectors.

- Indirect emissions intensity: For sectors with unresolved GVA issues and / or with missing data on electricity consumption, we use a fallback option of indirect emissions intensity calculated at parent NACE code level for sectors using the same ONS APS data:
 - There are 12 ETS sectors with existing CLI values that use the fallback option for indirect emissions intensity, 7 of which are identified as key sectors.⁴⁴

Given the limited data availability, we consider the parent level direct / indirect emissions intensity to be reasonable proxies for UK participants within sectors with data issues. The fallback options calculate direct/indirect emission intensity at a less granular level, which may not be perfectly representative of the EI of the specific subsectors, and the bias could be either upward / downward. Therefore, where a fallback option is in use and the sector the draft updated CLI results in the sector joining/leaving the CLL, the Authority may wish to seek further validation over the consultation period. We provide more details on such sectors in section 5.3.1.

⁴³ These include: Sector 08.91 Mining of chemical and fertiliser minerals; Sector 10.81 Manufacture of sugar; and Sector 24.46 processing of nuclear fuel.

The option for direct emissions intensity is also in use for Sector 06.20 Extraction of natural gas, after a further assessment on the reported GVA data for the sector in the ABS dataset. See further discussion in Section 5.3.1 below.

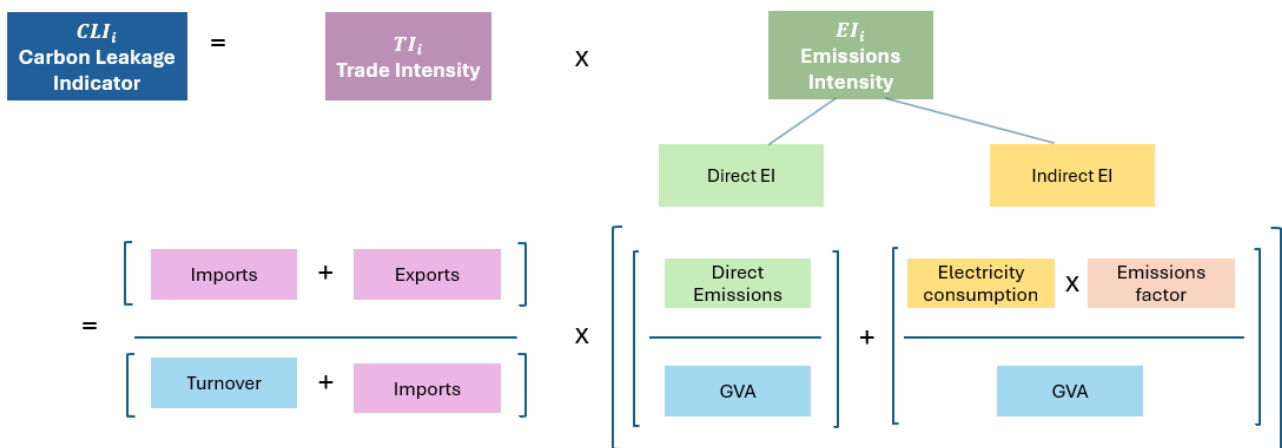
⁴⁴ These include: Sector 06.20 Extraction of natural gas; Sector 23.52 Manufacture of lime and plaster; Sector 23.31 Manufacture of ceramic tiles and flags; Sector 10.62 Manufacture of starches and starch products; Sector 23.11 Manufacture of flat glass; Sector 23.13 Manufacture of hollow glass; Sector 23.99 Manufacture of other non-metallic mineral products n.e.c.; Sector 08.91 Mining of chemical and fertiliser minerals; Sector 23.14 Manufacture of glass fibres; Sector 24.46 Processing of nuclear fuel; Sector 10.81 Manufacture of sugar; and Sector 23.32 Manufacture of bricks, tiles and construction products, in baked clay.

5. Draft Updated Carbon Leakage Indicator Values

5.1. Updating the Carbon Leakage Indicator Values

The updated CLI for each industry is calculated by multiplying its average trade intensity and average emissions intensity over the years 2019-2021, as in the CLI formula as specified in Figure 5.1. The primary data sources used within this calculation are summarised in Table 5.1.

Figure 5.1: Carbon Leakage Indicator Formula



Where CLI_i represents the Carbon Leakage Indicator for a given industry 'i'.

Table 5.1: Carbon Leakage Indicator Main Data Sources

Metric	Units	Source	Sector detail	Time period	Comment
Imports; exports	Million GBP	HMRC trade tables ⁴⁵	CN 8-digit code	2019-2021 (monthly)	Monthly aggregated to annual; Trade with all partner countries (including EU)
Trade product-industry mapping	N/A	Eurostat concordance table ⁴⁶	Maps CN code to NACE code	2019-2021	One key sector with no mapped trade code
Turnover	Million GBP	ONS Annual Business Survey ⁴⁷	4-digit SIC	2019-2021	Turnover estimate using IDBR data for missing sectors ⁴⁸
(Approximate) GVA	Million GBP	ONS Annual Business Survey ⁴⁹	4-digit SIC	2019-2021	aGVA used; no fallback dataset available so use estimates i.e., using parent code turnover to GVA ratios
Direct emissions	tCO ₂ e ⁵⁰ reported emissions by each installation	ETS compliance report ⁵¹	All installations; aggregated to 4-digit SIC	2019-2021	N/A
Direct emissions (<i>fallback</i>)	GHG emissions / GVA	ONS Atmospheric emissions – GHG intensity by industry ⁵²	Varies between 2-4 - digit SIC	2019-2021	Varied aggregation; some sectors receive 'parent' (2-digit) estimate
Electricity consumption A	Expenditure on electricity as proportion of total purchases (%)	Electricity spending – ONS Annual Purchases Survey ⁵³	4-digit SIC	2018 and 2021	Data in 2019 and 2020 is not available, so use estimates i.e., assuming constant annual growth rate in electricity consumption
Electricity expenditure B	p/kWh	Electricity prices – HMT Green Book; ⁵⁴	Aggregated industrial prices	2018 and 2021	N/A
Emissions factor	kgCO ₂ e/kWh	Grid average emission factor – HMT Green Book. ⁵⁵	Average emission factor of industrial sector	2019-2021	N/A

Source: NERA.

⁴⁵ HMRC website, Build an Overseas Trade Data Table, URL: <https://www.uktradeinfo.com/trade-data/ots-custom-table/>. Assessed on 28 May 2024.

⁴⁶ Eurostat website, ESTAT_Statistical_classification_of_products_by_activity_2.1_(CPA_2.1), URL: https://showvoc.op.europa.eu/#/datasets/ESTAT_Statistical_classification_of_products_by_activity_2.1_%28CPA_2.1%29/metadata. Assessed on 28 May 2024.

⁴⁸ Nomis: UK Business Counts - enterprises by industry and turnover size band, from IDBR, URL: <https://www.nomisweb.co.uk/query/construct/summary.asp?mode=construct&version=0&dataset=199>. Assessed on 28 May 2028.

The draft updated CLI values of UK ETS sectors are reported in Appendix A below.

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- ⁴⁸ Nomis: UK Business Counts - enterprises by industry and turnover size band, from IDBR, URL: <https://www.nomisweb.co.uk/query/construct/summary.asp?mode=construct&version=0&dataset=199>. Assessed on 28 May 2028.
- ⁴⁹ ONS (18 May 2023), Non-financial business economy, UK: Sections A to S, URL: <https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveysectionsas>. Assessed on 28 May 2028.
- ⁵⁰ Tonnes of carbon dioxide equivalent of greenhouse gas emissions
- ⁵¹ GOV.UK website, UK ETS Public Reports, Compliance Report - Emissions and Surrenders, URL: <https://reports.view-emissions-trading-registry.service.gov.uk/ets-reports.html>. Assessed on 24 May 2024.
- ⁵² ONS (2024) Atmospheric emissions: greenhouse gas emissions intensity by industry - <https://www.ons.gov.uk/economy/environmentalaccounts/datasets/ukenvironmentalaccountsatmosphericemissionsgreenhousegasemissionsintensitybyeconomicsectorunitedkingdom>. Accessed on 28 August 2024
- ⁵³ ONS (25 May 2022), Estimates of business energy expenditure from the Annual Purchases Survey, by energy type and 2, 3 and 4 digit Standard Industrial Classification (SIC), URL: <https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/adhocs/14688estimatesofbusinessenergyexpenditurefromtheannualpurchasesurveybyenergytypeand23and4digitstandardindustrialclassificationsic>. Assessed on 28 May 2024.
- ⁵⁴ HM Treasury Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, URL: <https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal>.
- ⁵⁵ HM Treasury Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, URL: <https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal>.

5.2. Determining the CLL: Updating the CLI Thresholds

The above analysis has focused on developing a set of CLIs for each industry in the UK ETS. To convert these values into a CLL, a decision on the threshold point or methodology must be made, to determine which CLIs are considered at risk of carbon leakage and on the CLL.

There are several potential approaches to this. In particular, we consider two approaches to setting the CLI threshold in this study:

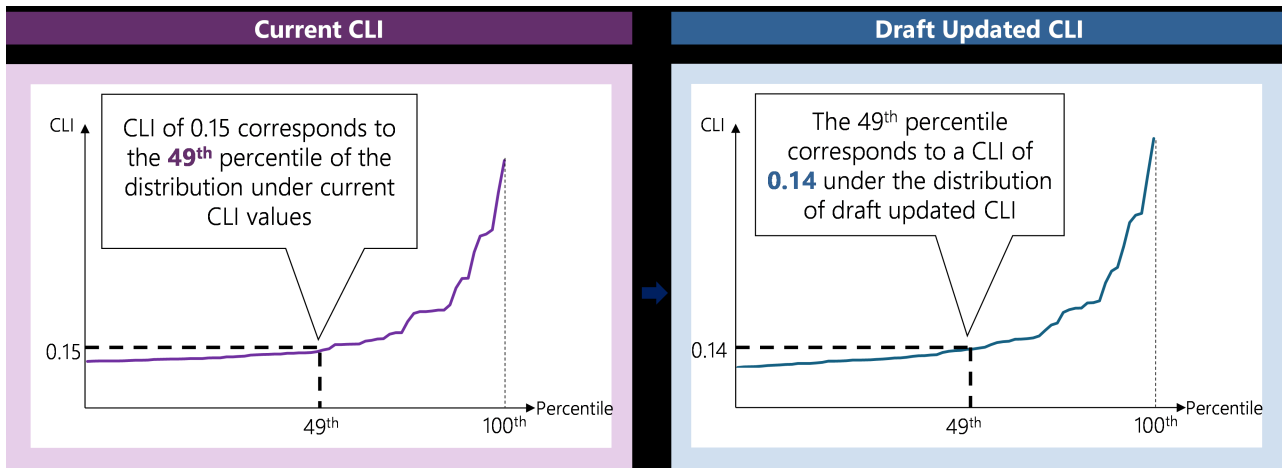
- **Option 1 – CLI distribution approach:** This approach aims to choose the same point on the distribution of all ordered CLI industry values as in the current CLI to CLL approach. In this case, the relative values and ranking determine the threshold value. As a result, this aims to keep a **similar proportion of industries on the CLL** as before.

The steps for this approach are as follows and shown in Figure 5.2:

- a. Rank the UK ETS industries by current CLI (i.e., the EU data), and calculate the percentile for each CLI value;
 - b. Find the corresponding point on the distribution (percentile) of the current CLI values, which determined which sectors were eligible for the second stage assessment (i.e., 0.15 threshold);
 - c. Rank the UK ETS industries by ordering the updated CLIs to produce an updated distribution;
 - d. Set the threshold at the same point on the distribution as before (as in Step B), using the updated CLIs. This approach produces a threshold for eligibility on the Carbon Leakage List of 0.14
 - e. Several industries sit at the threshold value to two decimal places (d.p.) but may be marginally below the exact value.⁵⁶ In order to allow a reasonable margin of error in the application of the threshold on the status of sectors, the threshold is set to 0.14 and applied at two decimal places. Therefore, every sector with a CLI *rounded to the second decimal place* are equal to or greater than 0.14 will join the CLL.
 - f. This results in 35 sectors on the updated CLL
- **Option 2 – Bottom-up approach:** This approach aims to independently estimate a CLI value which represents a significant level of carbon leakage risk for the given industry. This uses a bottom-up calculation to calculate an expected threshold CLI value (based on trade and emissions intensity per unit of GVA) beyond which an industry is considered to face significant carbon leakage risk and uses the resulting calculated CLI value as the CLL threshold. This mirrors the EU's initial approach to determining the threshold. In this case, the "absolute" threshold value is established independently, and all CLI values above which are considered to be exposed to significant carbon leakage risks – which may result in a larger or smaller number of UK industries on the CLL.

⁵⁶ Three industries with a CLI of 0.14 are Manufacture of cocoa, chocolate and sugar confectionery (above the threshold); Distilling, rectifying and blending of spirits; and Manufacture of other rubber products

Figure 5.2: Stylised Illustration of the Distribution Approach



Source: NERA.

On balance, we have calculated the draft updated CLIs using **Option 1, the distribution approach**, for setting the threshold as the primary means to determine the CLI threshold due to this approach being more transparent than Option 2 as result of not relying on a UKA price. This maintains a degree of consistency with the current approach by the EU, offers control of the size of the CLL and continuity to operators. However, we have also implemented a comparison to results from Option 2, using the ‘first principles’ approach, to check that the update threshold is robust to current UKA prices.

5.2.1. Application of Option 1 – Two-threshold approach

In using the distribution approach, we aim to maintain a similar proportion of industries on the Carbon Leakage List. However, within the analysis, there is a marked difference between sectors which use different methods for calculating their Direct Emissions Intensity (DEI).

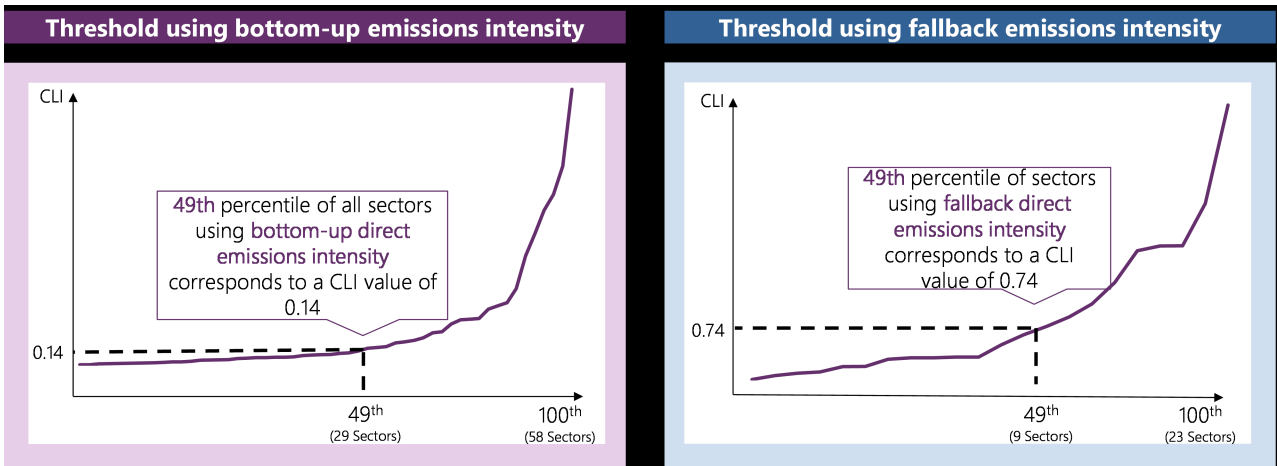
As in Table 5.1, there are two methods for calculating direct emission intensity of each sector. The primary method is a bottom-up calculation using reported UK ETS emissions and sector GVA; the ‘fallback’ method uses a calculated variable from the ONS Atmospheric emissions dataset. The primary method is preferred where possible due to using direct, reported data within the UK ETS for covered sectors, and due to more granular sectoral coverage. The fallback option has varied sector granularity and aggregation.

Of the 81 sectors in scope for this UK CLI calculation, 58 use the primary bottom-up calculation and 23 use the ‘fallback’ option. Importantly, as noted in 4.2.1, all sectors which only appear at sub-installations level in the UK ETS have no reported emissions data and therefore use the fallback variable. This affects a subset of sectors but is a potential source of bias since some fallback direct emissions intensities tend to be higher than primary, bottom-up estimates: this may arise as the bottom-up estimate divides ETS sectoral emissions by whole sectoral output (GVA).

We aim to produce the CLL by comparing sectors on an equivalent, like-for-like basis. Therefore, for the draft updated CLIs we calculate **one CLL threshold for sectors which use bottom-up direct emissions intensity** and **a separate threshold for sectors using fallback DEI**.

As above, this maintains the same proportion of industries on the CLL. However, this first splits sectors into one of two groups for DEI, and applies a different threshold for each. This ensures that a similar number of sectors in each group join the final CLL, and aims to address any risk of bias towards one group or another. This is presented as Option 1 – two threshold, illustrated below.

Figure 5.3: Stylised presented of Option 1 – two-threshold approach



Graphs are illustrative and exclude outliers.

This results in a Carbon Leakage List with the same proportion of industries on it currently, representing around 38 sectors. However, the threshold will be applied differently to sectors depending on their DEI variable.

5.2.2. Cross-checking of CLI threshold through Option 2

We also cross-check the above threshold following the same approach the EU has adopted to reach the threshold of 0.2. This is likely more relevant for the above threshold for bottom-up DEI sectors (of 0.14), rather than fallbacks, as the EU’s approach was comparable to the bottom-up estimate, using ETS emissions data. Nonetheless, it is useful to cross-check the value we apply, of 0.14, to the EU’s previous methodology.

In the European Commission’s 2015 Impact assessment for ETS Phase 4, one of the criteria it considered for a significant risk of carbon leakage was “the TI being above 10% and the costs resulting from the ETS amount to at least 5% of GVA”.⁵⁷ Later, the Commission decided to replace the ETS cost percentages of GVA with emissions intensity values so as to no longer rely on a carbon price assumption. The Commission then determined that ETS costs of 5 per cent of GVA corresponded to an emissions intensity of 2 kgCO₂/€. Multiplying the emissions intensity with 10 per cent trade intensity produces a CLI of 0.2, which is the threshold the EU currently uses.

We apply the same approach to the UK ETS to produce comparable values, ultimately producing a CLI threshold of 0.19 by applying the EU approach to the UK data. The approach uses the UK data gathered for this study and used the December 2024 UKA future price of around £35/tnCO₂ at the

⁵⁷ European Commission (15 July 2015), Impact Assessment – Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, p. 144.

time of producing this analysis.⁵⁸ This produces an emissions intensity of 1.9. Multiplying the emissions intensity with a trade intensity of 10 per cent, we obtain a CLI threshold of 0.19.

The bottom-up approach therefore produces a higher threshold than the distribution approach. Under the distribution approach, the 0.14 value corresponds to EU's threshold for the second stage assessment (i.e., 0.15), whereas the 0.19 value under the bottom-up approach corresponds to EU's threshold of 0.2. Both approaches produce a threshold that is close to the corresponding EU values. As such, we consider the results of the two approaches to be broadly consistent with each other.

Option 2 is not the preferred option, as results from Option 2 are highly sensitive to the carbon prices. The UKA price fluctuates, and the observed value is low compared to historic rates. If the UKA price were higher (e.g., the 2023 average price of £55.54), the same approach would produce a lower CLI threshold of 0.12.

5.3. The Updated Carbon Leakage List

The following preliminary List is based on analysis of all active NACE-4 industries listed for installations in the UK ETS. If deemed necessary by DESNZ, a wider set of industries could be included in this analysis, if following consultation it felt ETS participants' carbon leakage risk should be conducted at a more disaggregated level. In this case, the CLI distribution and threshold may have to be redrawn. This does not affect absolute CLI scores but may affect the threshold and size of eventual List. The results here should therefore be considered liable to change.

We outline a set of full CLIs for UK ETS industries, outlining Trade Intensity, Emissions Intensity, and CLI. We then apply the new CLL threshold to produce an updated, preliminary CLL.

Overall, the updated, preliminary CLL is not significantly different from the existing CLL. The existing CLL, of sectors also in the UK ETS, is 38, with one additional sector joining by 2 decimal places bringing the total number of sectors on the CLL to 39.

Most industries in the draft updated CLL (i.e., 31 of the 39 sectors on the CLL, or 79%) are the same as those in the existing CLL. Nonetheless, the remaining 8 industries are different and would 'join' the CLL. It should be noted that while a high degree of continuity is observed, difference in industries on the CLL is also expected, as a result of entirely updated data underpinning the CLIs.

However, we also note that there remain sector-specific issues and variation in data quality across the calculation. We aim to be clear where and why we have used fallback options in calculations, and some of these may merit further validation over the consultation period, as below.

⁵⁸ ICE website, UKA Futures, URL: <https://www.ice.com/products/80216150/UKA-Futures/data?marketId=6880837&span=2>. Assessed on 3 April 2024.

5.3.1. The use of fallback option for Sector 06.20 Extraction of Natural Gas

Certain fallback options are in use for sectors with unaddressed data issues as discussed in detail above, however, these are mostly in the case of missing data where the primary method of allocation is not possible. The one exception to this is when we have observed abnormalities in GVA data and thus conclude that a bottom-up Direct Emissions Intensity primary calculation would not be robust. There is only one sector within the UK ETS sectors that fall into this category, Sector 06.20 Extraction of Natural Gas.

The draft updated CLI for Sector 06.20 is 1.14 and the sector is in the draft updated CLL. This result uses the fallback for direct emissions intensity (i.e., 1.02 based on ONS emissions intensity data) and indirect emissions intensity (i.e., 0.02 based on the parent level indirect emissions intensity). The fallback option for direct emissions intensity results in an EI that is higher than the existing EU EI, which is one of the reasons why the sector would be included in the CLL based on the draft updated CLIs (the other reason being the updated trade intensity is considerably higher than the existing EU TI). However, we note that the sector would join the CLL regardless of the method chosen, if using the bottom-up or fallback data for emissions intensity. We use the fallback option for the direct emissions and indirect emissions because of the abnormal GVA data as reported in the ONS ABS dataset:

- The GVA for extraction of natural gas has many missing values, and is highly variable across the limited number of years with observations.
- The ABS reports very low absolute GVA for this sector. The production split between oil production and gas production is roughly 60 : 40 (or 1.5 : 1).⁵⁹ However, based on the ABS data, the GVA ratio between crude petroleum and natural gas is around 99 : 1 between 2019-2021; the same ratio applies to the turnover between the two sectors as well. Therefore, the data largely deviates from industry analysis.
- It is also likely that the GVA over the observation period was significantly impacted by COVID-19 and the Russia-Ukraine War.

We also note that this is a large sector, in terms of total emissions, and note significance of the sector joining the Carbon Leakage List if using UK Carbon Leakage Indicators. Additional consideration of data⁶⁰ on trade and emissions intensity for the sector similarly indicated that, if using the same methodology, the sector tends to have sufficiently high values for trade intensity and emissions intensity to be above the threshold for joining the List.

⁵⁹ UK Extractive Industries Transparency Initiative (EITI) website, Oil & Gas in the UK, URL: <https://www.ukeiti.org/oil-gas>. Assessed on 18 June 2024.

⁶⁰ Additional data we considered include production data from UK Extractive Industries Transparency Initiative (EITI) and emissions intensity estimates from North Sea Transition Authority to estimate an alternative EI for different years.

5.4. Draft Updated CLI Limitations

This report aims to update the CLI values using up-to-date, UK-specific data. However, we note that there is limited data available in the public domain. Because of this, this study has relied on approaches to estimate missing data and fallback options to calculate the CLIs.

As discussed in the above sections, these approximations and use of fallback options face certain limitations, which may require further investigation during the consultation process, namely:

- The potential downward bias of the direct emissions intensity as calculated in this study: As we discuss in Section 4.3, the ETS recorded emissions may only cover the emissions of the sector in part, whereas the GVA data considers the whole sector. Therefore, there may be a need to further examine the direct emissions intensity for the sectors leaving the CLL based on the draft updated CLI values with particularly low direct emissions intensity as compared to that calculated from the EU ETS. Nonetheless, we attempt to mitigate the potential risk of bottom-up direct emissions intensity leading to sectors leaving the CLL through the application of the two-threshold option for the CLL as above.
- The sectors where a fallback option has been used: While we consider the fallback options adopted in this study to be reasonable proxies for the relevant sectors, there are certain limitations associated with each sector. Therefore, for sectors where the use of a fallback option produces considerable deviations between the draft updated and the existing CLIs, additional input from stakeholders may provide further insight.
- As discussed in Section 3.3, the introduction of CBAM would have implications on the carbon leakage risks of CBAM covered sectors and on the appropriate level of FA. Therefore, further work is required to understand the interactions between the FA and CBAM policies.

Appendix A. Draft Updated CLI Values

Table A.1: Draft Updated CLI Values for Sectors in the UK ETS.

Source: NERA & DESNZ Analysis Based on Data Outlined in Sections above. An '*' denotes where a fallback option is used, for example the fallback DEI threshold

Code	Industry	Trade intensity	Direct EI	Indirect EI	Updated CLIs (on CLL in bold)	EU CLI
23.51	Manufacture of cement	0.45	54.93	1.34	25.26	2.46
24.1	Manufacture of basic iron and steel and of ferro-alloys	0.55	16.00	0.30	8.99	2.12
20.14	Manufacture of other organic basic chemicals	1.33	4.25	0.13	5.82	1.05
19.1	Manufacture of coke oven products	1.07	4.65*	-0.14	4.83	20.12
23.52	Manufacture of lime and plaster	0.24	16.93	0.11*	4.08	1.02
24.42	Aluminium production	0.99	0.80	2.50	3.26	1.63
10.42	Manufacture of margarine and similar edible fats	1.16	2.58*	0.22	3.25	0.03
19.2	Manufacture of refined petroleum products	0.43	5.07	0.37	2.35	3.22
17.11	Manufacture of pulp	1.01	0.71*	1.35	2.08	0.99
23.31	Manufacture of ceramic tiles and flags	0.94	2.03	0.11*	2.02	1.05
20.15	Manufacture of fertilisers and nitrogen compounds	0.39	4.52	0.12	1.83	2.42
20.6	Manufacture of man-made fibres	0.72	2.11*	0.11	1.58	0.41
20.17	Manufacture of synthetic rubber in primary forms	0.55	2.11*	0.76	1.58	0.60
10.41	Manufacture of oils and fats	0.77	1.18	0.84	1.55	0.42
7.1	Mining of iron ores	1.00	0.91*	0.61	1.52	2.54
10.62	Manufacture of starches and starch products	0.26	4.77	0.25*	1.29	0.52
6.2	Extraction of natural gas	1.10	1.02*	0.02*	1.14	0.12

Code	Industry	Trade intensity	Direct EI	Indirect EI	Updated CLIs (on CLL in bold)	EU CLI
6.1	Extraction of crude petroleum	0.87	1.02	0.02	0.90	0.24
10.32	Manufacture of fruit and vegetable juice	0.89	0.38*	0.62	0.89	0.09
23.12	Shaping and processing of flat glass	0.42	1.38*	0.40	0.74	0.07
17.12	Manufacture of paper and paperboard	0.36	1.55	0.51	0.74	0.84
23.11	Manufacture of flat glass	0.22	3.04	0.11*	0.70	1.46
23.13	Manufacture of hollow glass	0.32	1.92	0.11*	0.66	0.63
8.99	Other mining and quarrying n.e.c.	0.93	0.59*	0.08	0.63	3.82
20.13	Manufacture of other inorganic basic chemicals	0.74	0.64	0.10	0.55	1.64
20.12	Manufacture of dyes and pigments	0.36	1.19	0.30	0.54	0.52
23.99	Manufacture of other non-metallic mineral products n.e.c.	0.64	0.71	0.11*	0.53	0.22
8.91	Mining of chemical and fertiliser minerals	0.62*	0.59*	0.26*	0.53	0.26
21.1	Manufacture of basic pharmaceutical products	0.97	0.36	0.14	0.48	0.19
16.1	Sawmilling and planing of wood	0.48	0.68*	0.17	0.41	0.07
22.11	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres	0.75	0.05	0.47	0.39	0.12
23.14	Manufacture of glass fibres	0.59	0.53	0.11*	0.38	0.42
24.45	Other non-ferrous metal production	1.55	0.11	0.10	0.32	0.28
20.16	Manufacture of plastics in primary forms	0.69	0.20	0.22	0.29	0.31
16.21	Manufacture of veneer sheets and wood-based panels	0.35	0.67	0.12	0.27	0.26
10.2	Processing and preserving of fish, crustaceans and molluscs	0.51	0.38*	0.14	0.26	0.07
17.29	Manufacture of other articles of paper and paperboard	0.29	0.71*	0.21	0.26	0.02
8.93	Extraction of salt	0.15	0.86	0.85	0.26	0.15
20.53	Manufacture of essential oils	0.91	0.27*	0.01	0.26	0.05

Code	Industry	Trade intensity	Direct EI	Indirect EI	Updated CLIs (on CLL in bold)	EU CLI
24.52	Casting of steel	0.23	0.24*	0.85	0.25	0.02
24.46	Processing of nuclear fuel	0.36*	0.24*	0.42*	0.24	0.22
11.06	Manufacture of malt	0.15	0.84	0.60	0.22	0.33
20.59	Manufacture of other chemical products n.e.c.	0.67	0.23	0.08	0.20	0.15
20.2	Manufacture of pesticides and other agrochemical products	0.87	0.17	0.06	0.20	0.09
24.2	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel	0.77	0.05	0.17*	0.16	0.23
17.21	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	0.18	0.71*	0.13	0.15	0.01
20.42	Manufacture of perfumes and toilet preparations	0.87	0.08*	0.10	0.15	0.04
10.82	Manufacture of cocoa, chocolate and sugar confectionery	0.53	0.04	0.23	0.14	0.03
11.01	Distilling, rectifying and blending of spirits	0.93	0.09	0.06	0.14	0.07
26.11	Manufacture of electronic components	0.80	0.04	0.11	0.12	0.15
10.39	Other processing and preserving of fruit and vegetables	0.37	0.03	0.30	0.12	0.08
10.61	Manufacture of grain mill products	0.26	0.07	0.37	0.12	0.04
20.11	Manufacture of industrial gases	0.10	0.51	0.57	0.11	1.02
10.51	Operation of dairies and cheese making	0.32	0.06	0.23	0.09	0.04
23.32	Manufacture of bricks, tiles and construction products, in baked clay	0.11	0.74	0.11*	0.09	0.14
30.3	Manufacture of air and spacecraft and related machinery	1.14	0.02	0.06	0.09	0.07
10.81	Manufacture of sugar	0.20*	0.20*	0.25*	0.09	0.63
10.83	Processing of tea and coffee	0.47	0.11	0.07	0.09	0.04
10.13	Production of meat and poultry meat products	0.22	0.01	0.37	0.09	0.01

Code	Industry	Trade intensity	Direct EI	Indirect EI	Updated CLIs (on CLL in bold)	EU CLI
13.3	Finishing of textiles	0.66*	0.02	0.10	0.08	0.18
22.21	Manufacture of plastic plates, sheets, tubes and profiles	0.27	0.05	0.22	0.07	0.08
10.85	Manufacture of prepared meals and dishes	0.23	0.20*	0.13	0.07	0.05
10.84	Manufacture of condiments and seasonings	0.42	0.02	0.13	0.06	0.02
11.05	Manufacture of beer	0.13	0.06	0.39	0.06	0.02
10.89	Manufacture of other food products n.e.c.	0.31	0.04	0.14	0.06	0.04
10.31	Processing and preserving of potatoes	0.23	0.14	0.10	0.05	0.08
10.12	Processing and preserving of poultry meat	0.19	0.18*	0.06	0.05	0.02
23.2	Manufacture of refractory products	0.33	0.01	0.11	0.04	0.41
8.12	Operation of gravel and sand pits; mining of clays and kaolin	0.14	0.05	0.20	0.04	0.01
10.92	Manufacture of prepared pet foods	0.35	0.01	0.09	0.03	0.02
11.03	Manufacture of cider and other fruit wines	0.19	0.02	0.13	0.03	0.01
29.1	Manufacture of motor vehicles	0.07	0.05	0.30	0.02	0.03
21.2	Manufacture of pharmaceutical preparations	0.45	0.00	0.05	0.02	0.05
25.4	Manufacture of weapons and ammunition	0.40	0.01	0.04	0.02	0.07
8.11	Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate	0.06	0.01	0.28	0.02	0.14
30.11	Building of ships and floating structures	0.26	0.01	0.06	0.02	0.08
11.07	Manufacture of soft drinks; production of mineral waters and other bottled waters	0.21	0.02	0.05	0.01	0.01
20.41	Manufacture of soap and detergents, cleaning and polishing preparations	0.23	0.03	0.04	0.01	0.03
23.62	Manufacture of plaster products for construction purposes	0.00	0.97	0.10	0.00	0.05

Code	Industry	Trade intensity	Direct EI	Indirect EI	Updated CLIs (on CLL in bold)	EU CLI
25.5	Forging, pressing, stamping and roll-forming of metal; powder metallurgy	0.00	0.22	0.05	0.00	0.11
33.16	Repair and maintenance of aircraft and spacecraft	0.00	0.01	0.03	0.00	0.00