



UK Government

# Research on data quality of life cycle assessments of steel, cement and concrete products

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# Contents

|                                              |    |
|----------------------------------------------|----|
| List of figures                              | 6  |
| List of tables                               | 8  |
| 1 Executive summary                          | 9  |
| 1.1 Introduction                             | 9  |
| 1.2 Research approach                        | 9  |
| 1.3 Key findings                             | 10 |
| 1.4 Research gaps and limitations            | 13 |
| 1.5 Key conclusions                          | 14 |
| 1.6 Key recommendations                      | 16 |
| 2 Overview and purpose of research           | 17 |
| 2.1 Context                                  | 17 |
| 3 Approach to address objectives             | 19 |
| 4 Key findings                               | 22 |
| 4.1 Objective 1                              | 22 |
| 4.2 Objective 2                              | 31 |
| 4.3 Objective 3                              | 36 |
| 4.4 Objective 4                              | 39 |
| 4.5 Objective 5                              | 45 |
| 4.6 Objective 6                              | 48 |
| 5 Research gaps                              | 51 |
| 5.1 Limitations                              | 51 |
| 5.2 Where should future research be focused? | 51 |
| 6 Conclusions and recommendations            | 53 |
| 6.1 Data quality                             | 53 |
| 6.2 Methodological choice                    | 54 |
| 6.3 Enhancing methodologies                  | 56 |
| 6.4 Next steps                               | 57 |
| 7 Abbreviations and acronyms                 | 58 |
| 8 Definitions                                | 61 |
| 9 References                                 | 66 |

|                                                                                                |     |
|------------------------------------------------------------------------------------------------|-----|
| Appendix 1: Key concepts                                                                       | 69  |
| A1.1 Summary of steel, cement and concrete production                                          | 69  |
| A1.2 Summary of key standards                                                                  | 74  |
| A1.3 Industry standards, benchmarks and thresholds                                             | 79  |
| A1.4 ETS, EU and UK CBAM and EPD                                                               | 81  |
| A1.5 Life Cycle Assessment                                                                     | 83  |
| A1.6 Life cycle stages                                                                         | 84  |
| A1.7 Allocation in LCA                                                                         | 86  |
| A1.8 Differences in reporting                                                                  | 86  |
| A1.9 Data types                                                                                | 89  |
| Appendix 2: Comparing methodologies and standards                                              | 91  |
| A2.1 Methodological differences and system boundaries                                          | 91  |
| A2.2 Transparency of EPD and EU CBAM                                                           | 99  |
| A2.3 Robustness and comparability                                                              | 101 |
| A2.4 Financial and administrative costs                                                        | 103 |
| A2.5 Visualising results for consumer understanding                                            | 105 |
| A2.6 What is industry currently doing?                                                         | 107 |
| A2.7 Current industry practices                                                                | 109 |
| A2.8 International benchmarks and schemes                                                      | 111 |
| Appendix 3: Data quality and availability                                                      | 116 |
| A3.1 What defines “good data” for carbon assessments?                                          | 116 |
| A3.2 What are current practices and challenges in data collection?                             | 118 |
| A3.3 What challenges did industry identify regarding data?                                     | 120 |
| A3.4 What LCA databases and tools are used by industry?                                        | 122 |
| Annex 3                                                                                        | 132 |
| Appendix 4: Understanding carbon footprints of construction materials                          | 143 |
| A4.1 What is the carbon footprint for steel products?                                          | 144 |
| A4.2 What is the carbon footprint for cement and concrete products?                            | 147 |
| A4.3 What impact does utilising different methodologies have on A1 to A3 life cycle emissions? | 150 |
| A4.4 How does current data compare against future emission thresholds?                         | 152 |
| Annex 4                                                                                        | 154 |

---

|                                                                                                                            |     |
|----------------------------------------------------------------------------------------------------------------------------|-----|
| Appendix 5: Future landscape – policy and standard evolution                                                               | 157 |
| A5.1 What limitations were encountered in this study and where could future research be focused?                           | 157 |
| A5.2 How can greater consistency in LCA and emissions reporting be achieved across the steel, cement and concrete sectors? | 161 |
| Appendix 6: Technical methodological notes                                                                                 | 169 |
| A6.1 Data collection                                                                                                       | 169 |
| A6.2 Life cycle emission calculation methodologies                                                                         | 171 |
| A6.3 Key assumptions                                                                                                       | 172 |
| Appendix 7: Extracts from industry interviews                                                                              | 174 |
| Summary of key themes                                                                                                      | 174 |
| Appendix 8: Bibliography                                                                                                   | 180 |

# List of figures

|                                                                                                                                                                                                                                                                                                            |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Figure 1: Analysis of data quality, accuracy and confidence. ....                                                                                                                                                                                                                                          | 24  |
| Figure 2: Calculated A1–A3 life cycle emissions data for selected steel products, in comparison to benchmark data. ....                                                                                                                                                                                    | 25  |
| Figure 3: Calculated A1–A3 life cycle emission data for selected cement and concrete products, in comparison to benchmark data. ....                                                                                                                                                                       | 26  |
| Figure 4: A comparison of A1–A3 net and gross emissions for cement clinker, cement and concrete. ....                                                                                                                                                                                                      | 28  |
| Figure 5: A buyer’s guide to using EPD to compare steel, cement and concrete products. ....                                                                                                                                                                                                                | 29  |
| Figure 6: Simplified scopes (GHG Protocol) plotted with EU CBAM boundaries and A1-A4 from BS EN 15804+A2:2019. ....                                                                                                                                                                                        | 30  |
| Figure 7: Comparison of EU CBAM and EPD methodological boundaries. ....                                                                                                                                                                                                                                    | 37  |
| Figure 8: The percentage difference in A1-A3 emissions for selected cement and steel products when using BS EN 15804+A2:2019 methodology in comparison to aligning to EU CBAM. ....                                                                                                                        | 38  |
| Figure 9: A1-A3 emissions for HS 7216 10 steel products produced via EAF and blast furnace routes in comparison to the GSCC Future Emission Thresholds. ....                                                                                                                                               | 46  |
| Figure 10: A1-A3 emissions for cement products in comparison to the IDDI Future Emission Threshold target (calculated using the global average clinker-to-cement ratio of 0.7). ....                                                                                                                       | 47  |
| Figure 11: Percentage contribution of each life cycle module to the total A1-A3 emissions for selected steel products with European (including UK) origins. ....                                                                                                                                           | 48  |
| Figure 12: Percentage contribution of each life cycle module to the total A1-A3 emissions for cement clinker, cement and concrete products with European (including UK) origins. ....                                                                                                                      | 49  |
| Figure 13: Steel production schematic via BF-BOS. ....                                                                                                                                                                                                                                                     | 70  |
| Figure 14: Steel production schematic via EAF. ....                                                                                                                                                                                                                                                        | 70  |
| Figure 15: Finished and near-finished steel products following casting. ....                                                                                                                                                                                                                               | 71  |
| Figure 16: Cement types as per BS EN 197-1:2000 Part 1 section 4. ....                                                                                                                                                                                                                                     | 72  |
| Figure 17: Concrete production process schematic. ....                                                                                                                                                                                                                                                     | 73  |
| Figure 18: Data tags required by ISO 14044+A2:2020 for LCA and BS EN 15941:2024 to assess data quality. ....                                                                                                                                                                                               | 76  |
| Figure 19: Life cycle stages as defined by ISO 14010+A1:2020 (blue boxes) plotted against BS EN 15804+A2:2019 modules (A, B, C and D) (white boxes). ....                                                                                                                                                  | 84  |
| Figure 20: Concrete CO <sub>2</sub> sensitivity to slag allocation method, from worldsteel 2014. ....                                                                                                                                                                                                      | 93  |
| Figure 21: Screenshot of Heidelberg Materials UK EPD for Portland Cement (CEM I 52.5N), reporting net emissions with gross values noted in the accompanying text. ....                                                                                                                                     | 94  |
| Figure 22: Process boundaries for Portland Cement / CEM I under the transitional phase of EU CBAM. Grey boxes indicate precursor products, and all inputs according to this diagram are to be included. Direct and indirect emissions for the product are highlighted in red and purple respectively. .... | 96  |
| Figure 23: Boundaries of different EPD and required modules across life cycle stages. ....                                                                                                                                                                                                                 | 97  |
| Figure 24: Concrete reporting modules based on BS EN 16757:2022. ....                                                                                                                                                                                                                                      | 98  |
| Figure 25: Relationship between ETS, EU CBAM and LCA data. ....                                                                                                                                                                                                                                            | 102 |

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|                                                                                                                                                                                                                                                            |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Figure 26: Steel emission thresholds from selected initiatives. Please note the dotted lines do not correlate to the % of scrap steel (unlike the other benchmarks) and has been provided purely for a visual comparison against the other benchmarks..... | 113 |
| Figure 27: Cement emissions thresholds from select initiatives. Please note the dotted line represents a fixed clinker ratio (unlike the other benchmarks) and has been provided purely for a visual comparison against the other benchmarks. ....         | 114 |
| Figure 28: Concrete emissions thresholds from selected initiatives.....                                                                                                                                                                                    | 115 |
| Figure 29: Calculated A1-A3 life cycle emission data for selected steel products, in comparison to benchmark data. ....                                                                                                                                    | 144 |
| Figure 30: Percentage contribution of each life cycle module to the total A1-A3 emissions for steel products.....                                                                                                                                          | 145 |
| Figure 31: A1-A3 emissions for a selected steel product (HS 7216 10) produced via different manufacturing processes. ....                                                                                                                                  | 146 |
| Figure 32: Calculated A1-A3 life cycle emission data for selected cement and concrete products, in comparison to benchmark data.....                                                                                                                       | 148 |
| Figure 33: Percentage contribution of each life cycle module to the total A1-A3 emissions for cement clinker (1), cement (2) and concrete (3) products.....                                                                                                | 148 |
| Figure 34: A comparison of A1- A3 net and gross emissions for cement clinker, cement and concrete. ....                                                                                                                                                    | 149 |
| Figure 35: The percentage difference in A1-A3 emissions for selected cement and steel products when using BS EN 15804+A2:2019 methodology in comparison to aligning to EU CBAM.....                                                                        | 150 |
| Figure 36: Percentage contribution of emissions associated with WTT for A1-A3 emissions for a selected cement and steel product.....                                                                                                                       | 151 |
| Figure 37: A1-A3 emissions for cement products in comparison to the IDDI Future Emission Threshold target (calculated using the global average clinker-to-cement ratio of 0.7). ....                                                                       | 152 |
| Figure 38: A1-A3 emissions for HS 7216 10 steel products produced via EAF and blast furnace routes in comparison to the GSCC Future Emission Thresholds. ....                                                                                              | 153 |
| Figure 39: Summary of the sourced publicly available data used within this research project. ....                                                                                                                                                          | 170 |
| Figure 40: Data processing undertaken for all collected data.....                                                                                                                                                                                          | 171 |

---

# List of tables

|                                                                                                                                                          |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Table 1: Count of emissions data points collected during the research, after data quality checks.....                                                    | 32  |
| Table 2: Cost of EU CBAM and EPD gathered from literature review and interviews (Further details presented in Appendix 7). .....                         | 35  |
| Table 3: Standards evaluated for definitions of data quality.....                                                                                        | 76  |
| Table 4: Comparison of data required for each PCR studied.....                                                                                           | 77  |
| Table 5: Comparison of requirements within BS EN 15804+A2:2019 and EU CBAM. An 'X' represents the criteria is covered by the applicable methodology..... | 85  |
| Table 6: Summarises the cost of EU CBAM and EPD gathered from literature review and interviews. ....                                                     | 104 |
| Table 7: Assessment of secondary databases used by respondents.....                                                                                      | 123 |
| Table 8: Summary of data collected and methods and tools used by stakeholders.....                                                                       | 133 |
| Table 9: Overview of secondary databases used by respondents. ....                                                                                       | 137 |
| Table 10: Approximate percentage of carbon emissions across A1 to A5 for blast furnace steel production (Arup, 2023). ....                               | 147 |
| Table 11: Source data and descriptions of data presented in Appendix 4. ....                                                                             | 154 |
| Table 12: Environmental Impact Indicators described on BS EN 15804+A2:2019.....                                                                          | 160 |
| Table 13: Overview of interviews. ....                                                                                                                   | 175 |

# 1 Executive summary

## 1.1 Introduction

To support policy aims to grow the market for low-carbon industrial products, the Department for Energy Security and Net Zero (DESNZ) is developing an Embodied Emissions Reporting Framework (EERF). It is proposed that this will consist of guidance and an IT system to increase standardisation and comparability in measuring and reporting embodied emissions of industrial products using existing standards and methodologies.

The research project has been undertaken to increase understanding and trust of the data used to calculate embodied emissions, which is essential for an effective reporting framework needed to drive decarbonisation in the market. The standards and methodologies considered in this research focus on steel, cement and concrete products in the UK and include:

- BS EN 15804+A2:2019, the main standard for producing Environmental Product Declarations (EPDs) for construction products such as steel, cement and concrete.
- Three accompanying product category rules (PCR) compliant with BS EN 15804+A2:2019: for steel (EN 17662 - which is still in development at the time of writing), cement (BS EN 16908:2017+A1:2022) and concrete (BS EN 16757:2022).
- Transitional EU Carbon Border Adjustment Mechanism (CBAM) scheme as of December 2024.

## 1.2 Research approach

This project was undertaken by Frazer-Nash Consultancy Ltd, with support from ConstructionLCA Ltd and the University of Surrey between July 2024 and October 2025. A Project Advisory Board consisting of industry bodies, and cement and steel manufacturers were regularly consulted throughout.

The research consisted of:

- Review of existing literature.
- Collection of activity and intensity data for certain UK steel, cement and concrete products.
- Interviewing manufacturers to understand how they collect data and conduct Life Cycle Analysis (LCAs), produce EPDs and their plans for EU CBAM declarations.
- Analysing the results through the creation of a bespoke tool.
- Drawing conclusions, keeping in mind the limitations encountered during the research.
- Developing recommendations and avenues for further research.

## 1.3 Key findings

### 1.3.1 Objective 1: Understand the issues and impact of using generic or specific data, and variability in methodological choices and choice of standards.

- Primary, product-specific data provides the most accurate results but is resource-intensive and can be technically complex to obtain.
- Secondary data is widely used by manufacturers, but datasets are often outdated and inconsistent.
- Secondary data is often intensity based<sup>1</sup>, which limits transparency by concealing underlying process and assumptions. Carbon intensity is the result of the calculation of a carbon assessment. It cannot be “reverse engineered” to reveal the components that went into the product and therefore is more readily shared.
- Literature review suggests that use of different allocation methods to attribute emissions to co-products can affect reported emissions of products by up to 40%.
- There is inconsistency in reporting net or gross emissions<sup>2</sup>. This undermines transparency and comparability and risks misleading purchasers of these products. The use of net rather than gross emissions reporting accounts for an approximate 10% reduction in cradle-to-gate results.
- Methodological assumptions can reduce the comparability of EPDs, for example, differences in how renewable electricity is accounted for.
- Verification improves robustness but varies across different frameworks.
- Scope and reporting boundaries are defined differently across standards which affects comparability.
- A shift to lower cost self-serve EPD platforms risks weakening methodological rigour.

### 1.3.2 Objective 2: Develop policy understanding of using different emissions accounting standards, and prevalence for different types of products, both imported and produced in the UK.

- EPD are voluntary: steel, cement and concrete manufacturers may create EPD to enter their products into markets in which they are commonly used. Manufacturers interviewed during this research stated they have a good understanding of EPD requirements, and the steps needed to create an EPD.
- EU CBAM is required for certain products entering the EU market. It is a new requirement; it is therefore less well understood by manufacturers preparing to undertake carbon assessments using the EU CBAM methodology.
- Primary data is needed for EU CBAM declarations. UK and EU ETS data is often used as a starting point for this, however additional work is required to allocate emissions to specific products. Much of this primary data is also required for EPD development.

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<sup>1</sup> Data which provides carbon dioxide equivalent emissions associated with the product output per life cycle module (e.g.: kg CO<sub>2</sub>e/tonne).

<sup>2</sup> Reporting carbon emissions from the product can be done in two ways: including the carbon emissions from the incineration of waste during production (gross) or without carbon emissions from the incineration of waste during production (net).

- The financial and administrative costs of EU CBAM and EPD is closely linked to the quantity and complexity of data required for compliance. Both EPDs and EU CBAM draw on similar datasets, with some repeating data points. Due to this overlap, if a producer has already prepared an EU CBAM declaration, a large proportion of emissions data needed for the EPD is already covered and available. This can reduce the time and cost for producing an EPD by avoiding any duplication in data collection and repurposing EU CBAM data.
- EPDs require a broader set of life cycle data compared to EU CBAM, some of which have limited influence on the overall results or are associated with higher uncertainty due to limited data availability. Collecting these additional data points can be relatively resource intensive. As a result, while the initial overlap between EU CBAM and EPDs offer efficiency gains, particularly if supported by an EERF that harmonises data structures and methodological expectations, the remaining EPD-specific data will require additional effort. This does not suggest that EPD's are not valuable, but rather that the cost-efficiency of data collection decreases once the shared EU CBAM/ EPD data elements have been produced, as the residual data requires more detail and can be harder to obtain.
- The narrower scope of EU CBAM makes it effective for regulatory compliance and trade, where the priority is to capture the largest emissions sources and establish a carbon price signal. EPD, in contrast, provide a more comprehensive life cycle perspective, which is valuable for product-level benchmarking, procurement decisions, and tracking decarbonisation over time.

#### 1.3.3 Objective 3: Develop an analysis tool for DESNZ to compare EU CBAM methodology and other life cycle assessment standards for measuring the life cycle emissions of steel, iron, cement and concrete products.

- The LCA comparator tool showed that the EU CBAM methodology generates results typically 8-15% lower than EPD for the same product. This is because EU CBAM focuses on A3 (manufacturing emissions) and key A1 (raw material supply) precursors, whilst EPD cover additional modules A1 to D (production, distribution and storage, use and end of life) providing a broader assessment.

#### 1.3.4 Objective 4: Produce quantified evidence to evaluate challenges in LCA methodology to feed into international consensus-building exercises such as the International Energy Agency (IEA) Working Party for Industrial Decarbonisation (WPID), and the Industrial Deep Decarbonisation Initiative (IDDI).

- Primary data was sought but could not be obtained in sufficient quantities to enable quantified evidence.
- The IDDI stated using primary activity data (where available) for all upstream processes, which are likely to be significant within a product's overall footprint, will increase the accuracy of carbon footprints. Every stakeholder interviewed for this research stated

that they use primary data where possible in their carbon assessments, including EPD and EU CBAM, but suppliers were unlikely to share primary activity data, only intensity data. This makes this recommendation harder to implement.

- The IDDI found that reporting emissions at a common production step such as per 1 tonne of feedstock or precursor could help to compare the footprints of products more effectively. This project agreed that reporting emissions at this intermediate step, in addition to reporting final emissions would be beneficial, consistent with IDDI findings.
- The IDDI stated allocating emissions to co-products results in differences. This research found that EU CBAM and EPD have a hierarchy of allocation to be followed for each methodology. Each method of allocating emissions to co-products leads to a slightly different result because they each emphasise specific (but different) properties. Whilst it is recognised that reaching a consensus on application of allocation methods for co-products is essential to improve consistency, achieving this will be extremely challenging due to the vested interests of affected industries i.e. one allocation choice will favour an industry, and disfavour another.
- The IDDI's research highlights that the recycling of steel should be encouraged and somehow recognised in the carbon footprint of steel products. Key questions arose during this research on whether, and how, to assign emissions to scrap, to account for its future recyclability and emissions incurred in original production. This research found that allowing steel manufacturers to account for emissions reductions associated with the use of scrap steel within overall global warming potential (GWP) results will encourage recycling.
- The IDDI recommends that both gross and net emissions are clearly reported in EPD, satisfying Greenhouse Gas Protocol reporting principles whilst still encouraging the future use of non-fossil fuels in production processes. However, this research found that EPD summary tables only allow space for one result, and whether gross or net is chosen seems to be through industry body recommendation (the Global Cement and Concrete Association (GCCA) recommends reporting net) or country recommendation (the UK emphasises gross results are reported). Clarity is needed on accounting for the use of alternative fuels such as wastes which can be excluded from net emissions reporting.
- This project found that standards do not have consistent methodologies to allow manufacturers to claim emission reductions through the use of Carbon Capture Utilisation and Storage (CCUS). CCUS has been identified as one of the main technology levers for decarbonisation, especially of cement<sup>3</sup>, and the ability for manufacturers to incorporate this into carbon emissions reporting is important.

#### 1.3.5 Objective 5: Understand how UK steel, iron, cement and concrete products sit on different benchmarking thresholds.

- International emissions benchmarks are converging around International Energy Agency thresholds but differ by sector and scope.

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<sup>3</sup> DESNZ, 2025, UK carbon capture, usage and storage (CCUS) - GOV.UK, URL: [www.gov.uk/government/collections/uk-carbon-capture-usage-and-storage-ccus](https://www.gov.uk/government/collections/uk-carbon-capture-usage-and-storage-ccus)

- EPD provide product-level emissions values but rarely disclose results at the crude steel or cement stage, which are the basis of most benchmarks. This prevents a straightforward comparison of UK products to international thresholds.
- The LCA Comparator tool shows that for the UK steel and cement products assessed, the carbon footprints are above low and net zero emissions benchmarks.
  - Steel: Electric arc furnace (EAF) production using high scrap content is significantly closer to the Global Steel Climate Council and International Energy Agency targets than blast furnace–basic oxygen furnace (BF–BOF) routes.
  - Cement: Blended cements with lower clinker content (e.g. CEM III) are closer to the IDDI target than CEM I or II.
  - Concrete: Thresholds proposed by GCCA and the Low Carbon Concrete Group suggest that UK products are currently above future performance targets across common strength grades.
- Scrap content in steel products and clinker ratio in cement products are the primary drivers of progress towards emissions reductions at source.

### 1.3.6 Objective 6: Produce an initial assessment of the proportion of emissions across each life cycle stage, and how embodied emissions could be reduced across these stages.

The following quantified results were produced using secondary data (obtained through literature review), and calculated using the LCA Comparator Tool developed specifically for this research project. More detail on these key findings, including the parameters within which they were calculated, can be found in Section 4 of this report.

- For clinker production, manufacturing (A3) was the largest contributor to cradle-to-gate emissions, accounting for approximately 96%.
- Raw material extraction (A1) was the largest contributor to cradle-to-gate emissions for cement products (~98%) and ready to pour concrete products (~92%).
- Raw material extraction (A1) was the largest contributor to cradle-to-gate emissions for steel products, ranging from ~93% to ~99% across the steel products assessed.
- Reported embodied emissions can vary depending on the methodology used and choices made within those methodologies. This research shows that data quality and methodology choice can significantly impact the final GWP result.
- Reported embodied emissions could be reduced through the use of accounting methods that incentivise and account for low carbon practices, for example accounting for the use of recycled content (scrap) in steel manufacturing, carbon capture and utilisation in concrete products and more generally the use of biofuels as an energy source.

## 1.4 Research gaps and limitations

The main limitation of the research was having sufficient data to produce quantified supporting evidence for each research objective. To produce effective comparisons of life cycle emissions from steel, cement and concrete products, primary activity data was requested from

manufacturers for the production processes that they operate. Manufacturers and industry bodies were reluctant to share this information due to commercial confidentiality concerns. Where data was provided by manufacturers, it was typically intensity based, which does not allow for sensitivity analysis to be undertaken.

Data availability challenges could be overcome if UK Government was able to formally request activity data from manufacturers at a process equipment level and guarantee the safeguarding of commercial information. However, manufacturers will still face challenges in collecting this data as process equipment is often used to manufacture different products throughout the day, which would mean accurate product-level activity data could be difficult to isolate.

### 1.4.1 Future research priorities

Due to these challenges, other than a focus on improving data quality, benefit could be gained by focusing future research on the following:

- Assessing other LCA methodologies used outside of EPD and EU-CBAM. Research into the prevalence of other methodologies and what data manufacturers use to complete these assessments would provide policy makers with a picture of how manufacturers complete GWP assessments outside of EPD and EU CBAM.
- Assessing EPD methodologies and PCR of other products. Comparing the prevalence and requirements of the PCRs would assist policymakers in understanding the market and determine what impact different PCR approaches have on results.
- Assessing approaches used by different Programme Operators to develop PCRs. This would help determine what impact different operator approaches have on results and how variance could be minimised.

## 1.5 Key conclusions

This research shows that data quality and methodology choice can significantly impact the final GWP result, which underpins the key conclusions below.

### 1.5.1 Data quality

This research found that primary, product-specific data provides the most accurate results but is resource-intensive and can be technically complex to obtain. Using primary data (where available) for all upstream processes, which are likely to be significant within a product's overall footprint, will increase the accuracy of carbon footprints.

### 1.5.2 Methodologies

This research found that the methodologies for EU CBAM and EPD cover different parts of the product life cycle. They both cover A3 (manufacturing), with EU CBAM including parts of A1 (raw materials). Different EPD types (such as cradle to gate, cradle to cradle) require that different parts of the life cycle are included; a cradle to gate EPD covers all of A1 to A3. The LCA Comparator Tool showed that the EU CBAM methodology generates results typically 8-

15% lower than EPD for the same product; therefore, EU CBAM covers the majority of product emissions that EPD do.

The narrower scope of EU CBAM makes it effective for regulatory compliance and trade, where the priority is to capture the largest emissions sources and establish a carbon price signal. EPD, in contrast, provide a more comprehensive life cycle perspective, which is valuable for product-level benchmarking, procurement decisions, and tracking decarbonisation over time. Data requirements of the two schemes are similar, with some repeating data points, although EPD require additional data to be collected due to the larger boundary of assessment.

Different methodological choices within EPD creation and EU CBAM declaration impact results, with the most significant of these being the approach to allocation of co-products. Allocation choices can change the distribution of emissions between products and therefore have a greater effect on comparability than other methodological differences. Within EPD in particular, assumptions made during allocation can also reduce the comparability between EPDs developed by different manufacturers. While the use of secondary data sources can also introduce variation, especially where data quality differs, the influence is generally less pronounced than the impact of allocation choices.

The financial and administrative costs of EU CBAM and EPD to manufacturers is closely linked to the quantity and complexity of data required for compliance. Adhering to one methodology for each scheme which is independently verified and aligned with the UK's export markets would help reduce this burden. Providing clearer guidance on the preferred allocation approaches and methodological choices would help improve consistency and comparability.

Improvements could be made to relevant EPD standards or PCRs and to EU CBAM guidance to increase comparability of results and incentivise good environmental practices. These improvements include:

- Reporting emissions at a common production step such as per 1 tonne of feedstock or precursor could help to compare the footprints of products more effectively.
- Consistency on accounting for the use of alternative fuels such as wastes which can be excluded from net emissions reporting.
- Consistency across standards and methodologies to allow manufacturers to claim emissions reductions through the use of Carbon Capture and Storage or Utilisation.

Whilst EPD-related technical committees review standards and seek to address any identified shortfalls, this is likely to occur behind the pace of policy and technological advancements. Government will need to intervene if faster change is desired, through guidance on preferred data quality decisions and methods.

## 1.6 Key recommendations

To support the development of an effective EERF, this research has identified a range of actions for policymakers or for LCA practitioners and manufacturers. The actions could support the enhancement of standardisation and increase accuracy and comparability of life cycle emissions reporting of steel, cement and concrete products. These include:

Data used in assessments:

- Prioritising the use of primary activity data for raw materials. In circumstances where primary activity data cannot be obtained, secondary data should be sourced from recognised sources and clearly stated within EPD results.
- Creating a common set of industry benchmark values for the UK that manufacturers can use in circumstances where primary activity data is not available.

Life cycle emissions methodologies and reporting requirements:

- Agreeing and implementing a preferred method for allocating emissions (and other environmental impacts) to products and co-products.
- Agreeing and implementing a preferred method for determining the emissions of steel products that utilise recycled content.
- Agreeing and implementing a consistent approach to account for the use of alternative fuels such as biofuels and wastes.
- Aligning CCS accounting approaches, with EPD adopting the approach implemented by EU CBAM.
- Calculating and reporting both net and gross emissions for EU CBAM and within EPD.
- Reporting GWP results at a common material level e.g. per 1 tonne of feedstock or precursor, in addition to reporting at a product level.

Verification activities:

- Including an independent plausibility check within verification schemes to ensure that the data used within assessments is relevant, appropriate, consistent, representative, and reproducible.
- Exploring how EPD verification schemes could align with existing monitoring, reporting and verification systems, particularly those used under UK ETS and CBAM.

The CEN committee is currently co-ordinating updates to BS EN 15804+A2 (2019) (the main standard for producing EPDs for construction products such as steel, cement and concrete) which presents an opportunity to implement the changes outlined above within EPDs. The UK Government could incorporate recommended measures into UK CBAM requirements and guidance to further improve standardisation, accuracy and comparability.

## 2 Overview and purpose of research

### 2.1 Context

The Industrial Decarbonisation Strategy, published in 2021, suggested using Life Cycle Assessments (LCAs) to enable the inclusion of embodied emissions in product labelling<sup>4</sup>. It also stated that the underpinning data that LCAs use for calculating embodied carbon emissions requires more exploration. After a 2023 consultation on voluntary standards and embodied emissions reporting<sup>5</sup>, Government proposed an Embodied Emissions Reporting Framework (EERF) that could support the development of future carbon leakage and decarbonisation policies for targeted industries.

At the time of writing, the embodied emissions policy framework is undergoing consultation, seeking views on policies to grow the market for low carbon industrial products, with an initial focus on steel, cement and concrete products used in construction<sup>6</sup>. This research project aims to support the proposed EERF consultation and the Department for Energy Security and Net Zero (DESNZ), by increasing understanding and trust in the data used to calculate embodied emissions, which is essential for an effective reporting framework to function.

#### 2.1.1 Purpose of research

DESNZ has an ambition to build a strong market for low carbon products to contribute to the UK's national decarbonisation goals. To support this, buyers must have reliable, appropriate information to inform decision making when choosing low carbon products. For DESNZ to facilitate successful change in this area, the risk associated with unreliable and poor-quality data must be mitigated, empowering the buyers and challenging producers to decarbonise.

Manufacturers of iron, steel, cement and concrete products can use a range of different methodologies to assess a product's whole life carbon footprint. This research project aims to compare the prevalence, methodology, outputs and data quality of different Life Cycle Assessment methodologies and standards widely used for construction products, particularly steel, cement and concrete. Focus is placed on international standards for Environmental Product Declarations (EPD) and the EU Carbon Border Adjustment Mechanism (EU CBAM).

This research project began in August 2024 and was completed in October 2025.

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<sup>4</sup> DESNZ, 2021, Industrial decarbonisation strategy, URL: [www.gov.uk/government/publications/industrial-decarbonisation-strategy](https://www.gov.uk/government/publications/industrial-decarbonisation-strategy)

<sup>5</sup> DESNZ, 2023, Factsheet: voluntary standards and embodied emissions reporting - GOV.UK, URL: [www.gov.uk/government/consultations/addressing-carbon-leakage-risk-to-support-decarbonisation/outcome/factsheet-voluntary-standards-and-embodied-emissions-reporting](https://www.gov.uk/government/consultations/addressing-carbon-leakage-risk-to-support-decarbonisation/outcome/factsheet-voluntary-standards-and-embodied-emissions-reporting)

<sup>6</sup> DESNZ, 2025, Technical consultation: A policy framework to grow the market for low carbon industrial products, URL: <https://assets.publishing.service.gov.uk/media/6863f18c08bf2f5376121ae9/policy-framework-to-grow-the-market-for-low-carbon-industrial-products-consultation.pdf>

## 2.1.2 Objectives of the research

The research project had six core objectives which have been explored and responded to within this report. The objectives of this research were to:

1. Understand the issues and impact of using generic (e.g. industry average, default values) or specific data (specifically related to the process), variability in methodological choices and choice of standards on the Life Cycle Assessments for steel, cement and concrete products.
2. Develop policy understanding of using different emissions accounting standards, their costs, and prevalence for different types of products, both imported and produced in the UK. In particular, focus on the methodological differences of EU CBAM and EPD, and develop understanding of the practicalities of implementing either methodology (e.g. on use of direct measurement, type of inputs and outputs).
3. Develop an analysis tool for DESNZ to compare EU CBAM methodology and other standards for measuring the life cycle emissions (focus on Global Warming Potential, GWP) of steel, iron, cement and concrete products.
4. Produce quantified evidence to evaluate challenges in LCA methodology to feed into international consensus-building exercises such as the International Energy Agency Working Party for Industrial Decarbonisation (WPID), and the Industrial Deep Decarbonisation Initiative (IDDI). As a minimum, examine the 7 methodological points raised by the IDDI Secretariat White paper<sup>7</sup> on driving consistency in the greenhouse gas accounting system.
5. Understand how UK steel, iron, cement and concrete products sit on different benchmarking thresholds, in particular the IEA near and low emission benchmarking system.
6. Produce an initial assessment of the proportion of emissions across each life cycle stage, and how embodied emissions of steel, iron, cement and concrete products could be reduced based on the breakdown by life cycle stage.

Section 3 sets out the approach of this research project to address these objectives.

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<sup>7</sup> IDDI, 2023, Driving consistency in the greenhouse gas accounting system, URL: [www.cleanenergyministerial.org/content/uploads/2024/12/driving-consistency-in-the-greenhouse-gas-accounting-system.pdf](https://www.cleanenergyministerial.org/content/uploads/2024/12/driving-consistency-in-the-greenhouse-gas-accounting-system.pdf)

## 3 Approach to address objectives

Frazer-Nash Consultancy Ltd. (Frazer-Nash) worked with DESNZ to develop a structured approach including stakeholder engagement and data gathering. The delivery team included specialist assistance from ConstructionLCA Ltd and support from the University of Surrey. In addition to this, a Project Advisory Board consisting of industry bodies and key manufacturers of cement and steel was formed and regularly consulted.

The approach consisted of the following key methodological stages:

### Literature review

A desktop literature review was undertaken to assess differences in carbon assessments. The review assessed the more prevalent carbon footprint standards for products, using sources such as the IDDI, British Standards, and academic literature. In particular, the literature review targeted information and sources relating to EU CBAM and EPD, identified as an area of focus for this research. EU CBAM was chosen because of how it affects UK manufacturers. EPD were selected because of their prevalence in the industry (for more information, see Section 3).

### Collation of data

A goal of the research was to calculate carbon footprints of products using different methodologies. To allow the most meaningful comparisons of life cycle emissions from steel, cement and concrete products:

- Primary activity data was requested from manufacturers for the production processes they operate. A spreadsheet was developed and disseminated to industry to populate, with engagement sessions to assist understanding the spreadsheet and its goals.
- EPD repositories were investigated, such as EC3<sup>8</sup> and ICE<sup>9</sup>.

### Stakeholder engagement and industry interviews

Following the initial collation of data, a number of data gaps were present. To mitigate the impact of this on the findings of this research project, Frazer-Nash undertook additional supporting interviews to supplement the evidence base of the research. Interviews were conducted with manufacturers of cement, concrete and steel products.

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<sup>8</sup> The EC3 tool, created and maintained by Building Transparency, URL: [www.buildingtransparency.org/tools/ec3/](http://www.buildingtransparency.org/tools/ec3/)

<sup>9</sup> The ICE database, created and maintained by Circular Ecology, URL: <https://circularecology.com/embodied-carbon-footprint-database.html>

## Tool development

The LCA Comparator Tool produced for this research combines data from multiple sources, including BREF notes, EPD databases, academic studies and industry data, and applies them to cradle-to-gate stages (A1 to A3). It was designed to test the sensitivity of results to different methodological frameworks, allowing EU CBAM and BS EN 15804+A2:2019 (EPD) approaches to be compared on a consistent basis. Where available, activity data was prioritised to allow for sensitivity testing. Where only intensity data was available, this was used with clear labelling of data gaps.

## Reporting outcomes

This research project, its approach, key findings and recommendations are summarised in the main body of this report. Section 2 and 3 introduce the research objectives and approach. The subsequent sections of this report are as follows:

- **Section 4:** Key findings are presented against each of the research objectives, alongside associated recommendations arising from the findings.
- **Section 5:** Describes the limitations of this research project, identifies research gaps, and sets recommendations for further work to supplement or strengthen the findings where barriers were encountered.
- **Section 6:** Key conclusions from the research are presented.
- **Section 7:** A summary of the recommendations presented in Section 4, categorised into key themes.
- **Section 8, 9 and 10:** Abbreviation and acronyms, definitions and references used within the report, respectively.

The appendices provide the detail underpinning the research findings, including four in-depth analysis reports, and are referenced throughout the main body of the report. These are:

- **Appendix 1:** Key concepts: summarising commonly used concepts and terms which have been discussed within this report. Overarching key definitions are provided in Section 9.
- **Appendix 2:** Comparing methodologies and standards: in-depth report on the transparency and comparability of current carbon accounting methodologies.
- **Appendix 3:** Data quality and availability: in-depth report on different data sources used for LCA input data and evaluating what good data is.
- **Appendix 4:** Understanding carbon footprints of construction materials: a results section, describing the quantitative findings of the LCA Comparator Tool.
- **Appendix 5:** Future landscape – policy and standard evolution: suggests ways in which more consistency could be achieved through alignment of policy and standards.
- **Appendix 6:** Technical methodological notes: summary of the methodology underpinning the LCA Comparator Tool, developed for this research project.

- **Appendix 7:** Extracts from industry interviews: summarises discussions with manufacturers, verifiers and buyers interviewed as part of this research.
- **Appendix 8:** Bibliography: full list of reading which influenced this research.

## 4 Key findings

This section sets out the key findings, limitations and future research direction against each of the project objectives.

### 4.1 Objective 1

This section sets out the findings from research undertaken to address Objective 1:

*To understand the issues and impact of using generic (e.g. industry average, default values) or specific data (process-related data); variability in methodological choices; and choice of standards on the Life Cycle Assessments (LCAs) for steel, cement and concrete products.*

The research shows that data quality and specificity are the most critical factors shaping the accuracy and comparability of LCAs. Primary, product-specific data provides the most reliable results but is difficult and costly to obtain, while secondary datasets are often outdated or inconsistent. Results produced by the LCA Comparator Tool confirmed that reliance on generic benchmarks masks the wide spread of possible GWP outcomes, particularly for cement and steel. This highlights the risks of using generic averages for decision-making, as they can obscure genuine improvements achieved by manufacturers. For example, a steel producer using 100% renewable electricity and recycled scrap may have a significantly lower carbon footprint than the industry average, but this benefit would not be visible if a generic GWP value is applied.

In addition, methodological, standards and framework choices materially influence reported results. Differences in allocation methods, gross vs net reporting, and assumptions on renewable energy or recycling can alter reported emissions by 10–40%. Standards such as EPD and EU CBAM apply different system boundaries and terminology, meaning results serve different purposes and cannot be directly compared. While EPD remain the most transparent and verifiable option, market trends towards lower-cost reporting platforms could weaken rigour without stronger verification oversight.

The findings for Objective 1 are presented in two groups: data issues and methodological choices & standards. Supporting evidence and further detail are provided in Appendices 2 to 5.

#### 4.1.1 Data issues

##### **Finding 1: Primary, product-specific data provides the most accurate results but is resource-intensive**

Manufacturers consistently prioritise primary data, as it reflects real processes and enables them to demonstrate emissions reduction improvements such as the use of renewable electricity. However, collecting such data is resource-intensive and technically complex. Barriers include separating emissions at installation level under the EU Emissions Trading Scheme (ETS); managing large volumes of input data (up to 400 items for cement production);

interpreting renewable electricity certification outside Europe; and training staff across multiple sites. These challenges increase the cost and time required to produce accurate EPD<sup>10</sup>. Further information is presented in Appendix 3.1 and 3.2.

***Recommendation:***

The use of primary activity data for raw materials should be prioritised. This will enhance accuracy of GWP results in both EU CBAM and EPD.

**Finding 2: Secondary data is widely used but risks inconsistency and obsolescence**

Where primary data is unavailable, manufacturers depend on secondary datasets, such as industry databases or upstream EPD. Although secondary databases are often from verified sources, the data from suppliers may not be available in a verified format; an example of this would be an in-house carbon calculation being produced. Some datasets are outdated, with some industry databases unchanged for nearly a decade. Expired EPD are also still used as reference points. This undermines accuracy, comparability and credibility. Further information is presented in Appendix 3.1.2 and 3.2.

The following infographic (Figure 1) was developed to demonstrate the outcome of the analysis of data quality, accuracy and confidence, using data sourced from the research project. This summarises the data used by industry, the key gaps, the quality assessment of the benchmark data used across industry, and how primary and secondary data use affects the confidence in the final GWP result.

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<sup>10</sup> RECS, 2025, Public information, URL: <https://recs.org/public-information/>

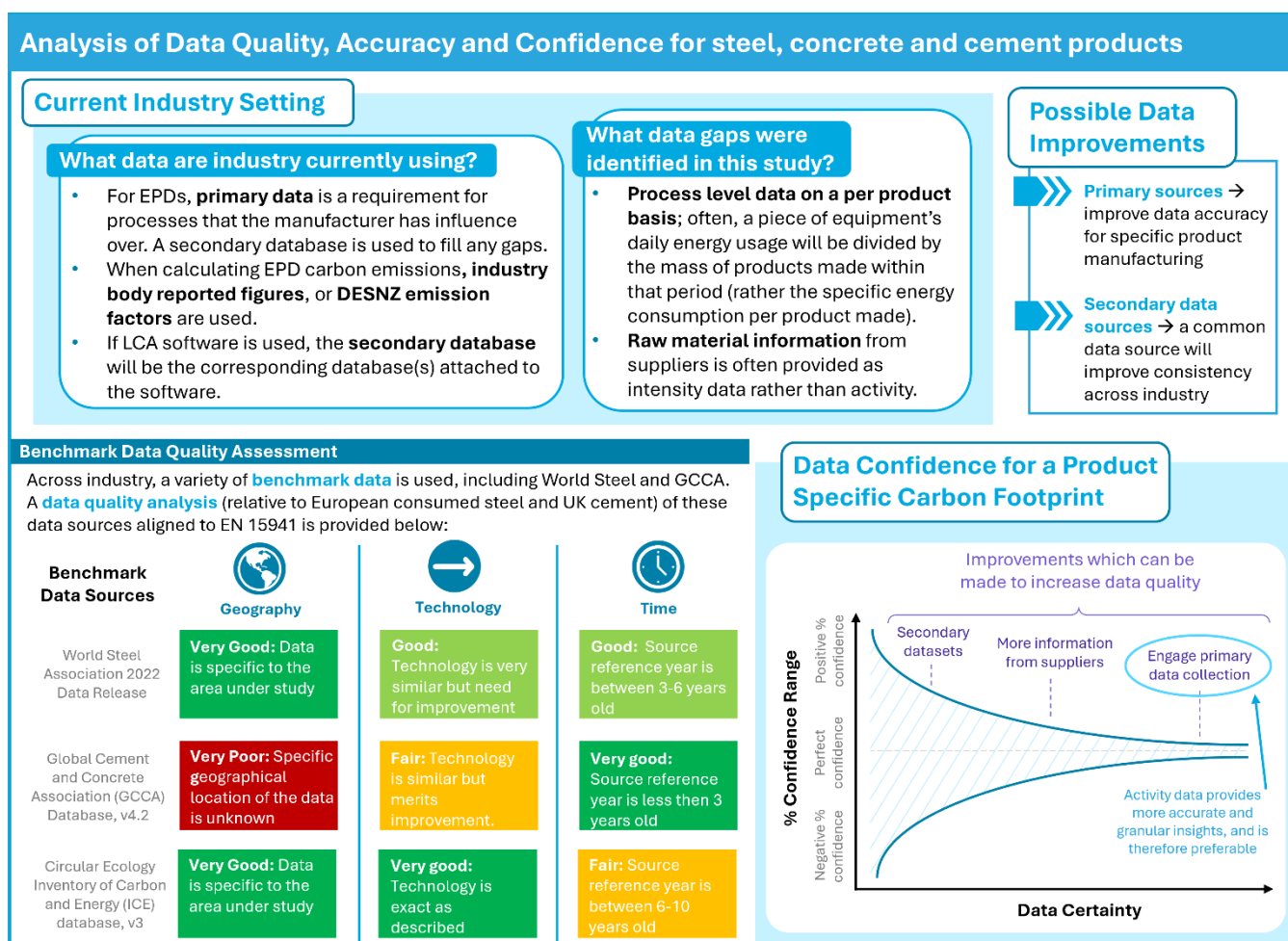


**Figure 1: Analysis of data quality, accuracy and confidence.**

The results obtained from the LCA Comparator Tool demonstrate that calculated cradle-to-gate emissions (A1 to A3) for steel products showed much greater variability than benchmark values (as highlighted in Figure 2), reflecting both the breadth of BREF input ranges and the outdated nature of some benchmark datasets<sup>11</sup>. Further information is presented in Appendix 4.3.

<sup>11</sup> The methodologies used to generate the benchmark data within the LCA Comparator Tool may vary, as they originate from different organisations.

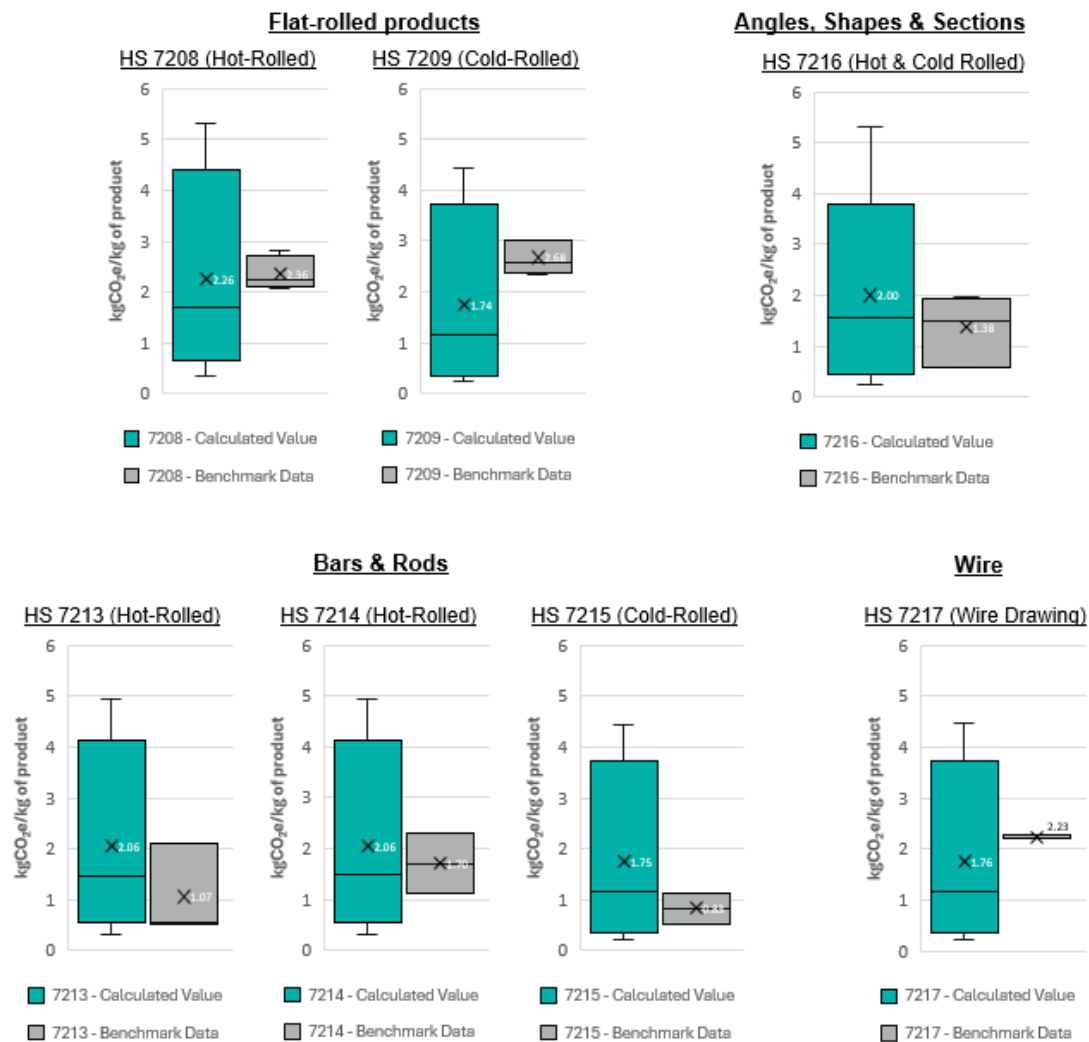


**Figure 2: Calculated A1–A3 life cycle emissions data for selected steel products, in comparison to benchmark data.**

Using a common set of secondary factors where primary data are not available will enhance repeatability of GWP results in EPD. Further research is needed into secondary factors already publicly available and which ones are most appropriate for UK industry. These could be presented as preferred factor sources in Government guidance on EPD creation. EU CBAM already mandates a specific default factor set for products, so this would be used initially for EPD, but will likely spread to other GWP calculation methodologies.

### **Recommendation:**

A study exploring how EPD verification schemes could align with existing monitoring, reporting and verification systems, particularly those used under UK ETS and CBAM, should be conducted.

### **Finding 3: Intensity-based reporting limits transparency**

This research found that publicly available data is often expressed as intensity values (e.g., kg CO<sub>2</sub>e/tonne), which provide a useful overview but conceal underlying processes and assumptions. EPD frequently use this format, limiting insight into product-level improvements or methodological differences. Further information is presented in Appendix 3.1.

The results obtained from the LCA Comparator Tool reinforce this finding for cement (as shown in Figure 3). The calculated emissions for CEM I, CEM II, and CEM III clearly show the benefit of reduced clinker content in blended cements, but benchmark intensity figures obscure these distinctions. Further information is presented in Appendix 4.3.

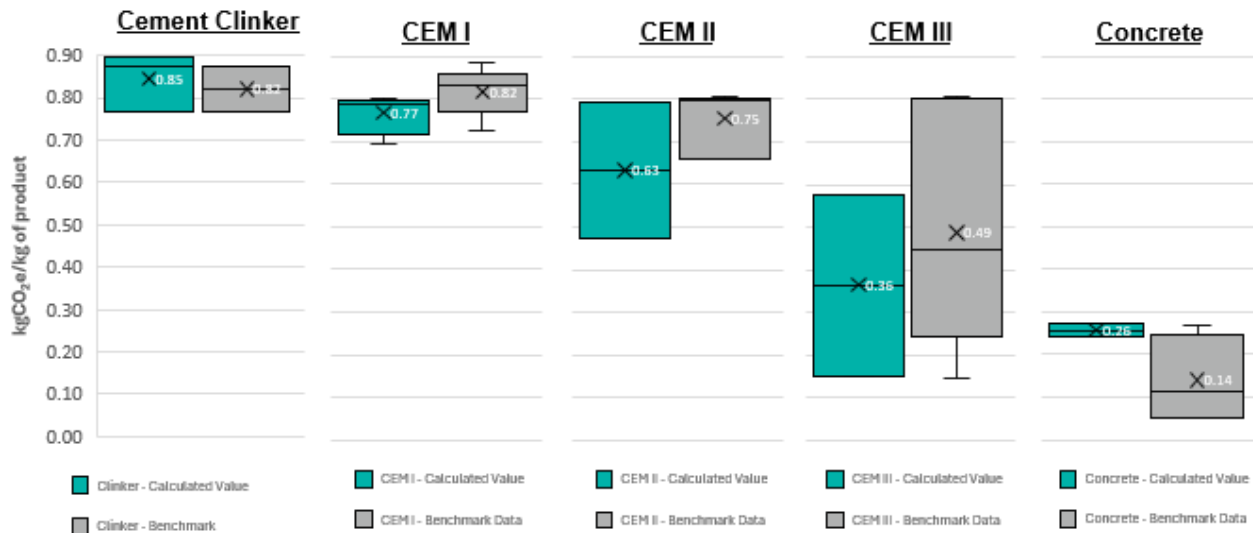


**Figure 3: Calculated A1–A3 life cycle emission data for selected cement and concrete products, in comparison to benchmark data.**

#### **Finding 4: Both primary and secondary data contain uncertainties**

Even primary data is affected by variability<sup>12</sup>, including measurement errors (e.g. gas meter accuracy varies by  $\pm 1.5\%$ ), reliance on periodic sampling of emissions, and variation in fuel composition and electricity mixes. Manufacturers attempt to manage these uncertainties through regular monitoring, though reported GWP values still vary. Further information is presented in Appendix 3.3.

#### 4.1.2 Methodological choices & standards

#### **Finding 5: Allocation methods significantly affect reported emissions**

Different allocation methods<sup>13</sup> (see Appendix 1) materially change results, particularly for steel and cement.

For steel, system expansion attributes avoided impacts to co-products, such as slag, reducing reported steel emissions by 3%–7% compared with economic allocation<sup>14</sup>. Under mass allocation, up to 40% of blast furnace impacts may be assigned to slag, reducing the burden on steel but overstating the impact attributed to cement.

<sup>12</sup> Construction Products Association, 2024, Environmental Product Declarations (EPD): Uncertainty A Technical Review, URL: [www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf](https://www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf)

<sup>14</sup> Worldsteel, 2021, Life cycle inventory (LCI) study 2021 data release, URL: <https://worldsteel.org/wp-content/uploads/2021-LCA-Study-Report.pdf>

For cement, allocation choice has a notable effect when ground granulated blast-furnace slag (GGBS) is used, with system expansion often neutralising differences across concretes and other methods distributing impacts differently. These choices affect the comparability of results across products and sectors. Further information is presented in Appendix 2.1.

### **Finding 6: Gross versus net emissions reporting creates inconsistency in cement and concrete LCAs**

The UK industry preference is to report gross emissions<sup>15</sup>, aligned with MPA guidance and UK ETS practice<sup>16</sup>. However, some producers report net emissions, offsetting fossil fuel emissions by crediting waste-derived fuels. BS EN 15804+A2:2019 provides the guidance for net reporting resulting in its prioritisation within Europe, it does however, state that for full transparency gross values can also be declared as additional information. Net reporting can reduce reported footprints by 10%–25%, in some cases resulting in negative emissions in the A3 life cycle module depending on the proportion of waste-derived fuel used in the manufacturing process. Manufacturers operating under different EPD programmes (e.g., IBU) may report net values in headline figures, with gross figures presented in footnotes. This inconsistency undermines transparency and risks misleading procurement decisions. Further information is presented in Appendix 2.1.

Results from the LCA Comparator Tool reinforce this finding. The use of net rather than gross emissions accounts for an approximate 10% reduction in cradle-to-gate results. Figure 4 compares A1 to A3 net and gross emissions for cement clinker, cement and concrete, illustrating the impact of methodological choices on reported GWP. Further information is presented in Appendix 4.3.

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<sup>15</sup> Defra, 2009, Guidance on how to measure and report your greenhouse gas emissions, URL: <https://assets.publishing.service.gov.uk/media/5a78e1df40f0b6324769ae8c/pb13309-ghg-guidance-0909011.pdf>

<sup>16</sup> Low Carbon Concretes Group, 2024, URL: [www.theclimategroup.org/sites/default/files/2024-07/ConcreteZero%20-%20Classification%20methodology%20for%20embodied%20carbon.pdf](http://www.theclimategroup.org/sites/default/files/2024-07/ConcreteZero%20-%20Classification%20methodology%20for%20embodied%20carbon.pdf)

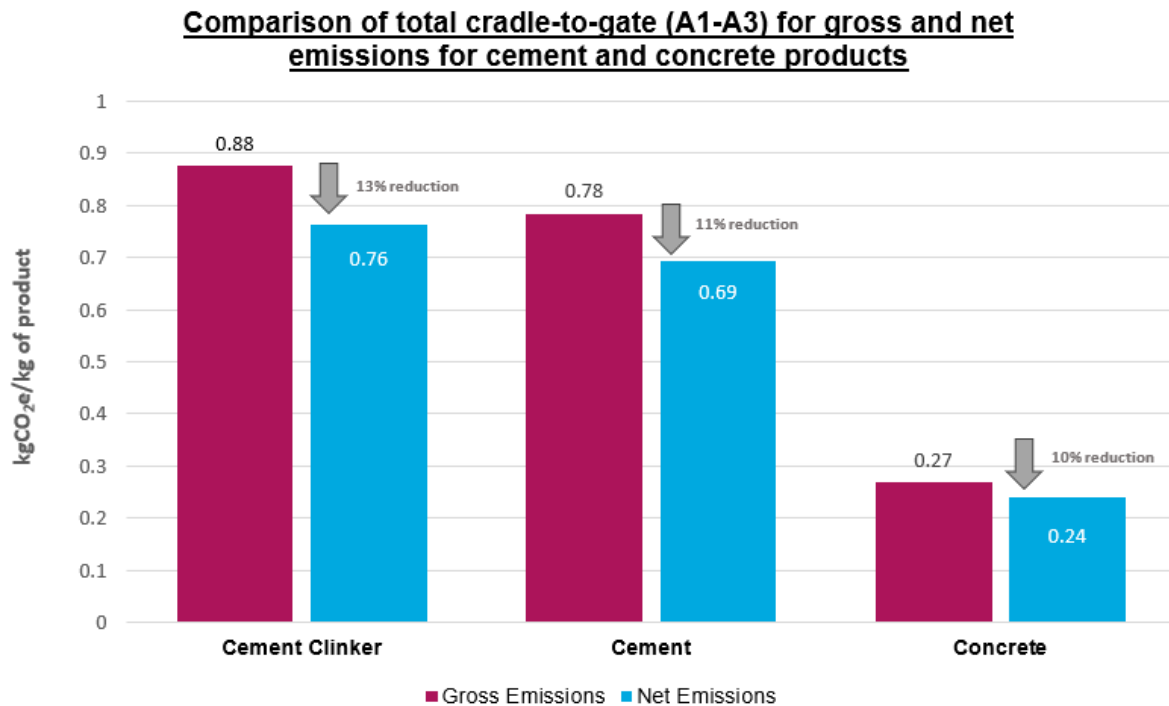


**Figure 4: A comparison of A1–A3 net and gross emissions for cement clinker, cement and concrete.**

***Recommendation:***

A preferred method for allocating emissions (and other environmental impacts) to products and co-products in EPD needs to be agreed and implemented across the sector. This method can then be presented in proposed UK Government guidance on embodied emissions reporting as the preferred method of allocating impacts.

Both net and gross emissions should be calculated and reported for EU CBAM and within EPD for increased comparability and transparency.

**Finding 7: Methodological assumptions reduce comparability of EPD**

Assumptions around renewable electricity (such as Guarantees of Origin), treatment of recycled content, inclusion of capital goods, and the choice of characterisation factors (such as Environmental Footprint (EF) method 3.0 vs EF 3.1<sup>17</sup>) can materially change results. For example, electricity accounting alone can shift GWP by 30% –40%. While BS EN 15804+A2:2019 requires disclosure of assumptions, these are often detailed in technical appendices rather than presented alongside results, limiting accessibility for non-specialists. Further information is presented in Appendix 2.1.

The following infographic (Figure 5) was developed to help buyers making procurement decisions, pointing out the key aspects for useful comparison of different EPD. It uses data sourced during this research.

<sup>17</sup> Stapel et al, 2022 found that there was a 3-5% increase in GWP between the characterisation factors in EN 15804+A1 and EF 3.0 for EN 15804+A2. EF 3.1 factors for methane are between these so the effect is likely to be between 1-3% lower for EF 3.1 than EF 3.0.

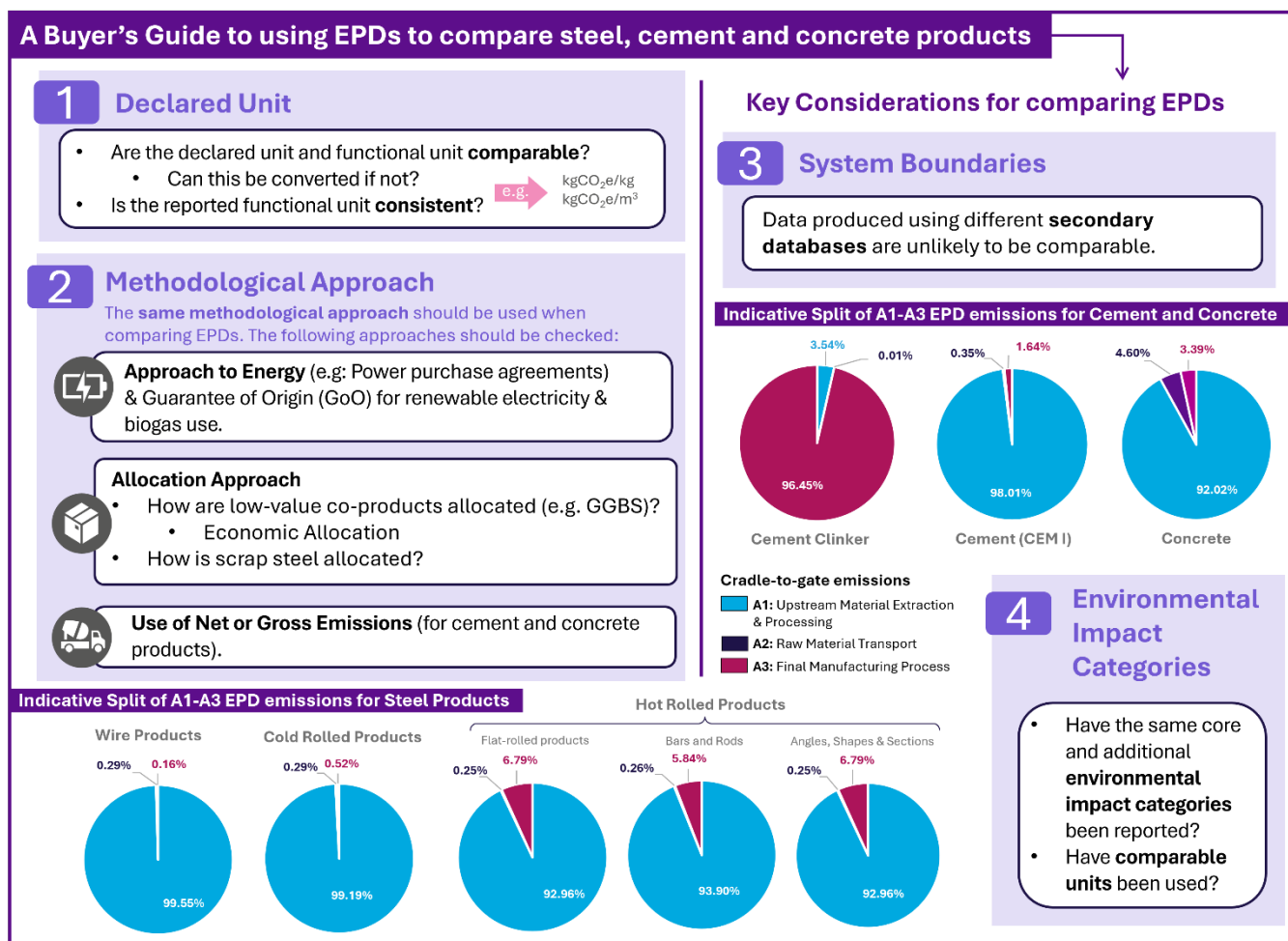


Figure 5: A buyer's guide to using EPD to compare steel, cement and concrete products.

### Finding 8: Verification improves robustness but varies across frameworks

EPD benefit from independent verification against PCRs, which provides checks on plausibility, data quality, and compliance with standards. Stakeholders interviewed during this research project regard EPD verification as generally robust, though verifiers differed in emphasis and recommended that results be treated as accurate only to one significant figure (i.e., >10% difference needed for a reliable comparison). Financial penalties for use of the high default emissions values where the product emissions value is truly lower incentivises manufacturers to collect their own data but risks inconsistency. Further information is presented in Appendix 2.1.

### Finding 9: Market and reporting trends may reduce rigour without stronger oversight

Stakeholders noted the shift towards lower-cost, self-service EPD platforms, which may reduce the scope for independent verification and therefore weaken methodological rigour. For example, values may be chosen in a database which are not appropriate, and a human verifier would be able to discern this and challenge it. Stakeholders cautioned that without maintaining robust methodological oversight, these developments could increase the risk of undermining the credibility of results and trust in EPD. Further information is presented in Appendix 2.1 and 2.2.

### **Recommendation:**

Verification activities including an independent plausibility check within verification schemes should be conducted to ensure that the data used within assessments are relevant, appropriate, consistent, representative and reproducible. This is currently undertaken by a human EPD verifier for EPD only, and they only have to be independent if the EPD is intended for business to consumer communication. This could be extended to other carbon assessment schemes. The plausibility check must confirm whether the datasets selected are appropriate.

### **Finding 10: Different standards define scope and reporting boundaries in ways that affect comparability**

EU CBAM is largely contained within A3 of BS EN 15804+A2:2019, with relevant precursor products such as coke, sintered ore, ferro-alloy components in steel, and calcined clay in cement, included in A1. These boundaries focus on the stages considered most significant for GWP emissions, capturing the majority of the product's carbon footprint. By contrast, EPD cover a broader range of modules (A1 to D), including less impactful upstream and downstream processes. Figure 6 illustrates the simplified scopes from the GHG Protocol plotted with EU CBAM boundaries and A1 to A4 from BS EN 15804+A2:2019.

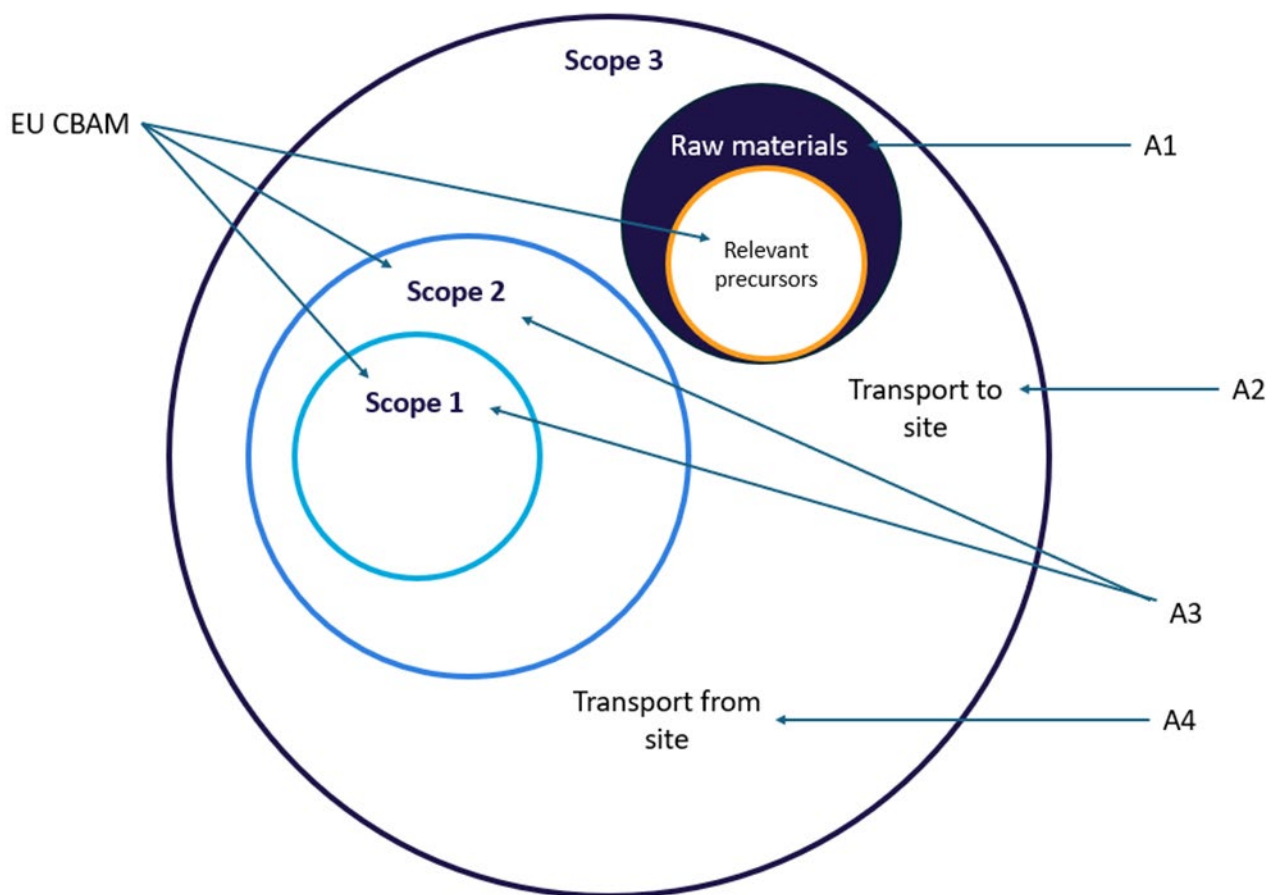


**Figure 6: Simplified scopes (GHG Protocol) plotted with EU CBAM boundaries and A1-A4 from BS EN 15804+A2:2019.**

EPD use modules A1 to D, whereas EU CBAM references direct and indirect emissions aligned with GHG Protocol concepts (Scope 1, 2, and 3), integrating aspects of ISO

14044+A2:2020 and ISO 14064-3:2019. EU CBAM requires waste-derived fuels to be reported while BS EN 15804+A2:2019 allows for them to be reported with or without. This divergence in language can make direct comparison challenging. Stakeholders interviewed in this research highlighted that standards should be interpreted in isolation, with EU CBAM results applied to regulatory compliance and EPD results to product-level decision-making. Misalignment in terminology may lead to overemphasis on differences rather than the actual impact of the product life cycle stage being reported. Further information is presented in Appendix 2.

## 4.2 Objective 2

This section sets out the findings from research undertaken to address Objective 2:

*Develop policy understanding of using different emissions accounting standards, their costs, and prevalence for different types of products, both imported and produced in the UK. In particular, focus on the methodological differences of EU CBAM and EPD, and develop understanding of the practicalities of implementing either methodology (e.g. on use of direct measurement, type of outputs and inputs).*

The research shows that EPD are common in industry and EU CBAM disclosures are mandatory for manufacturers exporting to the EU. The financial and administrative costs of both EU CBAM and EPD are closely linked to the quantity and complexity of data required for compliance. Manufacturers already collect management information for their own business records, but each different scheme, standard or protocol requires them to calculate and present that data in a different way. Notably, EU CBAM encompasses the majority of the emissions data required for EPD development (Results from the LCA Comparator Tool suggests 85-92%, see section 4.3).

### 4.2.1 Prevalence

#### **Finding 11: EPD have good uptake in the industry; EU CBAM is newer**

In January 2024, there were over 23,000 EPD, verified to BS EN 15804+A2:2019, for construction products registered with EPD programmes globally. At the start of 2024, there were 60,900 EPD for concrete products and 730 for steel digitised on EC3 to various standards<sup>18</sup>. Products over a certain threshold imported into the EU are subject to EU CBAM. All manufacturers interviewed for this study were preparing to undertake carbon assessments using EU CBAM methodology. A summary of EPD and EU CBAM requirements is presented in Appendix 1.

This research project analysed GHG emissions data from various sources, including EPD (where GWP is a key environmental indicator). Table 1 sets out the total count of data points used across the product types, following a data quality check and elimination.

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<sup>18</sup> ECO Platform, 2024, EPD Facts & Figures - Eco Platform en, URL: [www.eco-platform.org/epd-facts-figures.html](https://www.eco-platform.org/epd-facts-figures.html)

**Table 1: Count of emissions data points collected during the research, after data quality checks.**

| Material Type            | Count of GWP Emissions Data Points, applicable to the UK |
|--------------------------|----------------------------------------------------------|
| Selected cement products | 23                                                       |
| Concrete (ready to pour) | 5                                                        |
| Selected steel products  | 59                                                       |

## 4.2.2 Practicalities

### **Finding 12: EPD are voluntary, with their development being largely understood by manufacturers**

Creating an EPD for a construction product is often a voluntary undertaking. Manufacturers will undertake the development of an EPD on request of a customer or if the organisation is positioning themselves to enter a market that does require EPD for the products they sell, such as Norway, which requires at least ten products to have EPDs on any large public projects, with other requirements in other European countries<sup>19</sup>.

The steps to create an EPD<sup>20 21</sup> are:

1. Choose a Programme Operator;
2. Choose the applicable PCR;
3. Collect primary data and select secondary data;
4. Undertake the LCA;
5. Prepare the EPD report;
6. Send to the EPD verifier, usually an LCA professional approved by the Programme Operator;
7. Respond to comments from the verifier;
8. Once approved, publish the EPD with the Programme Operator; and
9. Revalidation every 5 years or sooner if significant changes are made to the product.

If the EPD is intended for business to consumer communication, the process requires the EPD to be verified by an independent LCA practitioner who is approved by the EPD Programme Operator to have the required competence and expertise to undertake verification. The verifier

<sup>19</sup> RICS, 2024, Environmental product declarations: why does the industry need more EPDs?, URL: [www.rics.org/news-insights/wbef/environmental-product-declarations-industry-need-epds](https://www.rics.org/news-insights/wbef/environmental-product-declarations-industry-need-epds)

<sup>20</sup> BRE, 2025, Environmental Product Declaration, URL: <https://bregroup.com/services/standards/environmental/en-15804-environmental-product-declaration-epd>

<sup>21</sup> Building Transparency, ND, How to get an EPD, URL: [www.buildingtransparency.org/how-to-get-an-epd/](https://www.buildingtransparency.org/how-to-get-an-epd/)

checks that the requirements of the relevant standards (e.g. BS EN 15804+A2:2019 or one of the PCRs) are met, and that the data provided by the manufacturer is plausible.

An EPD is generated on a specific product basis. This means that if there are variations in size or composition, separate EPD are required to represent each product. It is not cost effective to produce an EPD for concrete blends, as there can be hundreds produced by one plant. Most manufacturers therefore publish one or two cement EPD.

### **Finding 13: EU CBAM is mandatory, but as it is newer, requirements were less understood by manufacturers at the time of interview**

Under EU CBAM, importers and operators (referred to in this report as manufacturers) include those who operate installations and produce goods that are required to submit EU CBAM reports via the CBAM Transitional Registry, managed by the European Commission.

The process to develop EU CBAM<sup>22</sup> declaration are:

1. Become an authorised EU CBAM declarant.
2. Determine if goods are in scope.
3. Engage with supply chain to obtain detailed data on the production processes and total embedded emissions of the goods.
4. Set up reporting systems, usually based on existing UK or EU ETS systems.
5. Access the EU CBAM Registry and submit quarterly reports detailing those emissions by manufacturers to the European Commission. Records have to be kept of the data used in calculations, and the equipment used to gather the data must be calibrated. Independent verification of the reports will be required from 1st January 2026.
6. From 2026, the definitive stage begins, requiring declarants to purchase CBAM certificates to cover the embedded emissions of imports not already accounted for by carbon costs in the country of origin. By 31<sup>st</sup> May each year, declarants must declare the embedded emissions for the previous calendar year and surrender the corresponding number of CBAM certificates.

A recurring observation from interviewed stakeholders was that the EU CBAM scheme is not structured in a manner readily aligned with process engineering practice. Guidance is fragmented across multiple documents, creating a substantial burden on manufacturers seeking clarity on what emissions and processes are included or excluded. The inclusion of precursors increases the level of reporting complexity and inclusion boundaries for reporting.

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<sup>22</sup> EU Taxation and Customs Union, 2025, Carbon Border Adjustment Mechanism, URL: [https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism\\_en](https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en)

### **Finding 14: EU CBAM and UK ETS use similar primary data**

Manufacturers report that the data used in EU CBAM submissions closely aligns with data used in UK ETS disclosures. The additional work arises from incorporating modelling approaches to allocate emissions to specific products.

Appendix 2 presents further information on methodological differences and Appendix 3 details the exact data requirements for an EPD and EU CBAM, and how manufacturers collect and use the information.

### **4.2.3 Costs**

#### **Finding 15: The financial and administrative costs of both EU CBAM and EPD are closely linked to the quantity and complexity of data required for compliance**

The impact of EPD and EU CBAM on manufacturers is varied. Manufacturers already collect management information for their own business records, but each scheme, standard or protocol requires them to calculate and present that data in a different way.

EU CBAM encompasses a proportion of the emissions data required for EPD development, meaning manufacturers can reuse much of the primary emissions and production data collected for EU CBAM declarations when preparing EPD. This overlap helps reduce administrative burden associated with reporting. However, the collection of additional EPD-specific data may yield diminishing returns meaning that the effort required to collect the additional data is relatively high compared to its reporting value.

EPDs require broader life cycle data that often have minimal influence on the overall results or are associated with higher uncertainty due to limited data availability. As a result, the additional effort needed to collect these data points can be disproportionate to the value they add. Table 2 summarises the evidence evaluated on the costs associated with EU CBAM and EPD.

**Table 2: Cost of EU CBAM and EPD gathered from literature review and interviews (Further details presented in Appendix 7).**

| Methodology | Internal resource reported to handle demands of methodology                      | Cost reported per product                                                                                                                                                                                          | Number of times costs incurred                                                                   |
|-------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| EU CBAM     | 1 Full Time Equivalent (FTE) (usually already employed to support UK or EU ETS). | Cost varies, as cost of CO <sub>2</sub> per tonne based on the weekly average price of the UK ETS allowance and depends on the outcome of the calculation.                                                         | EU CBAM will require quarterly submissions to align with quarterly accounting periods from 2027. |
| EPD         | 1-6 FTE (usually, part of an environmental or sustainability team).              | Ranges from €3,100 per EPD for 5 years (EPD Ireland); £2390 - 2505; to €12,200 under IBU. £350 a year per product subsistence to Green Book Live to maintain the EPD on their database (as reported in interview). | EPD costs arise as and when a new EPD is created, with an annual subsistence due every year.     |

## 4.3 Objective 3

This section sets out the findings from research undertaken to address Objective 3:

*Develop an analysis tool comparing EU CBAM methodology and other standards for measuring the life cycle emissions (focus on GWP) of steel, iron, cement and concrete products.*

The LCA Comparator Tool produced for this research combines data from multiple sources, including BREF notes, EPD databases, academic studies, industry data, and applies them to cradle-to-gate stages (A1–A3). It was designed to test the sensitivity of results to different methodological frameworks, allowing EU CBAM and BS EN 15804+A2:2019 (EPD) approaches to be compared on a consistent basis. Where available, activity data was prioritised as it allows sensitivity testing, for example modelling the effect of switching fuel or using renewable electricity. Where only intensity data was available, this was used, with clear labelling of data gaps.

The analysis shows that differences in scope and methodological choices leads to systematic variation in reported results. For steel, emissions vary significantly depending on production routes and local grid electricity intensity. For cement and concrete, differences between methodologies are smaller but consistent. The results suggested EU CBAM results are around 8–15% lower than EPD results due to its narrower scope. These findings underline that EU CBAM is suited to regulatory compliance and trade purposes, while EPD provide a broader life cycle perspective for product benchmarking and improvement. Further analysis of the results is presented in Appendix 4.

### 4.3.1 Methodological comparison

The following infographic (Figure 7) summarises the key differences between EU CBAM and EPD methodological boundaries. It sets out definitions of system boundaries, identifies where EU CBAM differs, and uses data from the research project.

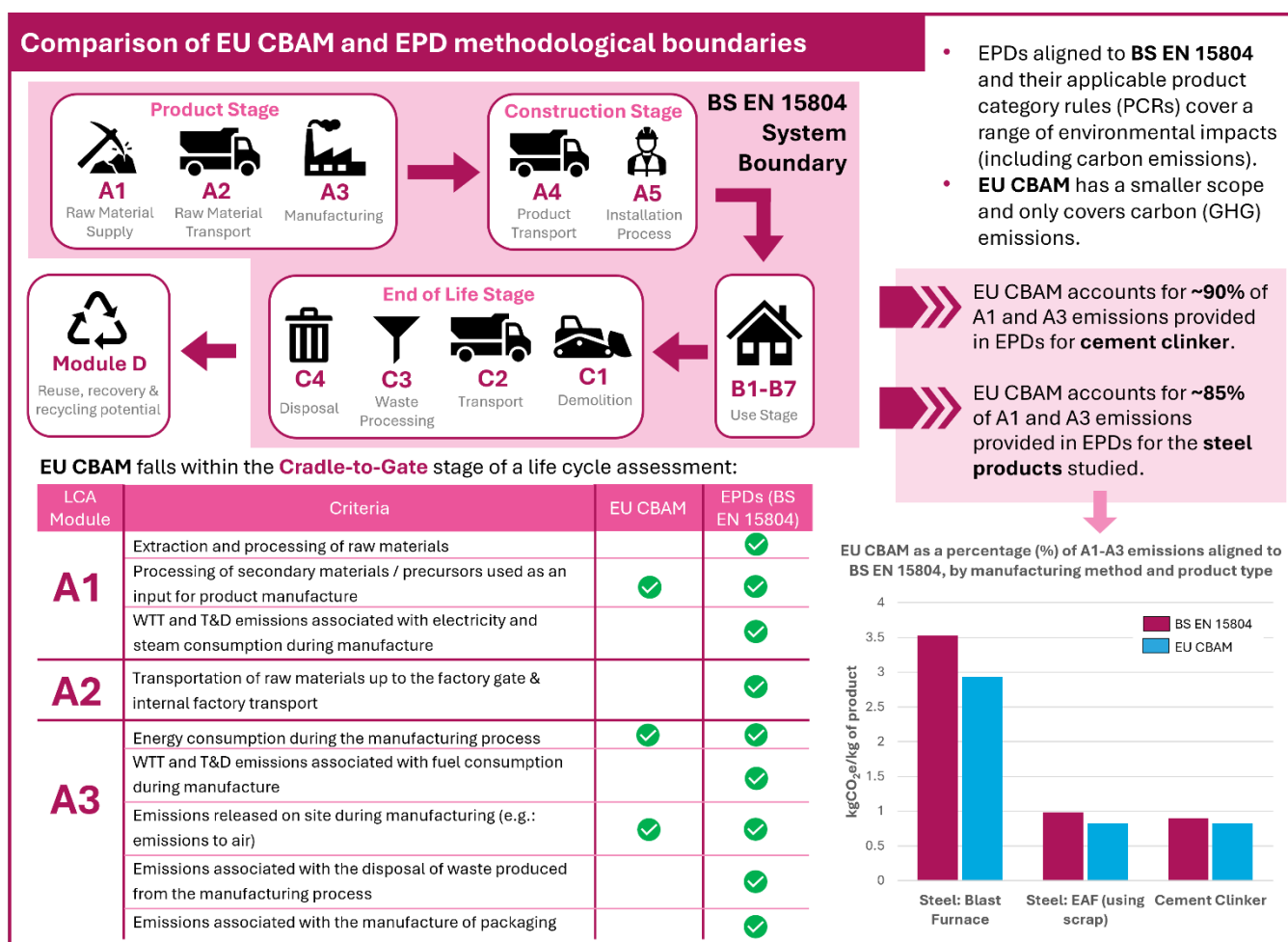


**Figure 7: Comparison of EU CBAM and EPD methodological boundaries.**

### Finding 16: EU CBAM results are systematically lower than EPD results

The LCA Comparator Tool showed that EU CBAM generates results around 8–15% lower than BS EN 15804+A2:2019 (EPD) for the same products (Figure 8). This is because EU CBAM focuses on A3 manufacturing emissions and key A1 precursors (such as coke, sintered ore, ferro-alloys and calcined clay). This approach therefore captures the majority of a product's footprint. By contrast, EPD cover modules A1–D, offering a broader but more resource-intensive assessment.

**Comparison of the total cradle-to-gate (A1-A3) emissions calculated in accordance with BS EN 15804 and EU CBAM for a selected cement and steel product**

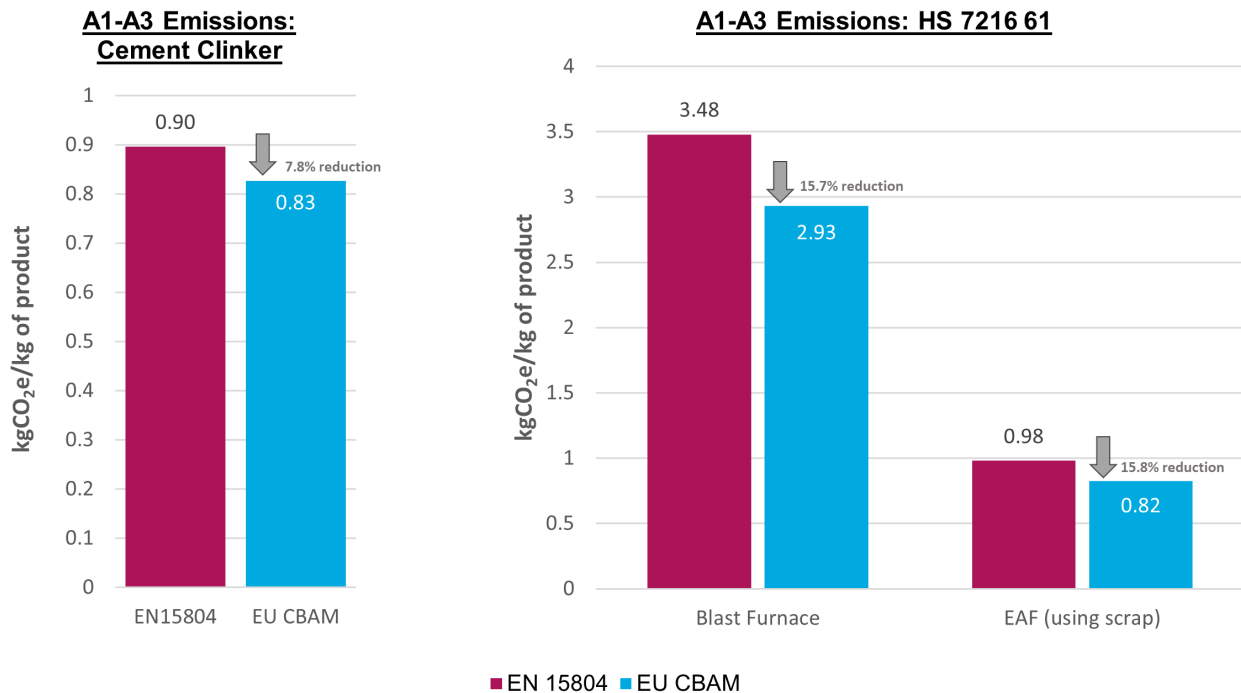


**Figure 8: The percentage difference in A1-A3 emissions for selected cement and steel products when using BS EN 15804+A2:2019 methodology in comparison to aligning to EU CBAM.**

**Finding 17: EU CBAM and EPD serve different but complementary purposes**

The narrower scope of EU CBAM makes it effective for regulatory compliance and trade, where the priority is to capture the largest emissions sources and establish a carbon price signal. EPD, in contrast, provide a more comprehensive life cycle perspective, which is valuable for product-level benchmarking, procurement decisions, and tracking decarbonisation over time. While results are not directly comparable, the two frameworks can be used in combination, EU CBAM for trade and compliance, and EPD for detailed product improvement through hotspot identification.

## 4.4 Objective 4

This section sets out the findings from research undertaken to address Objective 4:

*Produce quantified evidence to evaluate challenges in LCA methodology to feed into international consensus-building exercises such as the IEA Working Party for Industrial Decarbonisation (WPID), and the Industrial Deep Decarbonisation Initiative. As a minimum, examine the 7 methodological points raised by the IDDI Secretariat White paper on driving consistency in the greenhouse gas accounting system.*

The Industrial Deep Decarbonisation Initiative (IDDI) is a global coalition of public and private organisations who are working to stimulate demand for low carbon industrial materials<sup>23</sup>. This initiative published a pathway to harmonised standards for steel, cement and concrete, called ‘Driving consistency in the greenhouse gas accounting system’<sup>24</sup>.

This section takes each of the seven methodological points raised in the white paper and adds what this research has learnt about each.

### 4.4.1 Primary data use

The IDDI found that standards did not mandate the use of primary data to report upstream emissions for purchased material input.

In this research, it was found that EU CBAM requires data and information on precursors materials for calculating the embedded emissions of complex imported goods. Where this information does not exist, EU CBAM mandates the use of default factors. These are deliberately high values to encourage manufacturers to collect this information. Meanwhile, EPD require information on raw materials used in module A1 and, whilst it does not mandate the use of primary data, it requires that the data be representative and of suitable quality. It is the role of the verifier to assess whether the information provided is acceptable.

Every stakeholder interviewed stated that they use primary data where possible in their carbon assessments, including EPD and EU CBAM. Some described the extent of effort required to engage with supply chains to secure this information. All reported that where the information exists, they would either be given an EPD for the raw material, or another intensity-based value of the embedded emissions. Where the information does not exist, they would use a secondary source for information (for EPD) or default factors (for EU CBAM).

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<sup>23</sup> IDDI, ND, IDDI Homepage, URL: [www.unido.org/IDDI](http://www.unido.org/IDDI)

<sup>24</sup> IDDI, 2023, Driving consistency in the greenhouse gas accounting system, URL: [www.cleanenergyministerial.org/content/uploads/2024/12/driving-consistency-in-the-greenhouse-gas-accounting-system.pdf](http://www.cleanenergyministerial.org/content/uploads/2024/12/driving-consistency-in-the-greenhouse-gas-accounting-system.pdf)

**Finding 18: Access to primary activity data of all upstream processes or products, which are likely to be significant within a product's overall emissions footprint, would increase accuracy of a GWP footprint**

***Recommendation:***

In circumstances where primary activity data cannot be obtained, secondary data should be sourced from recognised sources (such as Sphera or Gabi databases) and clearly stated within EPD results (see Appendix 3).

A common set of industry benchmark values that manufacturers can use in circumstances where primary activity data is not available could also be created. Industry benchmark data derived from actual submissions would be more precise and representative to UK products actually being imported, compared to the use of currently available benchmark sources, such as market reports. Another example is to produce a survey on industry best practice; a UK-wide study into best available techniques specific to UK industry could be implemented, similar to how the EU Best Available Technique Reference (BREF) documents<sup>25</sup> were created.

#### 4.4.2 Reporting at a common step

The IDDI found that some stakeholders called for reporting at a common production step to enable greater comparability between products. The common production step could be calculated back to 1 tonne of main raw material for the product type (crude steel or cement).

This is similar to using a declared unit in LCA. A declared unit quantifies a product's environmental impact based on its physical properties, like mass or volume, rather than the service it provides. Using the declared unit of 1 tonne of raw material can play an important role in providing information on the magnitude of impacts by comparing them with a reference state. For example, by relating impacts to 1 tonne of cement in concrete products will show differences in concrete production specifically.

**Finding 19: Comparison of products using EPD results is difficult due to different declared and functional units used**

In this context, using the declared unit of 1 tonne of crude steel for steel products or cement for concrete products could help to communicate the relative environmental impacts of different products in an easily comparable way. This research found it would require an extra calculation step currently not undertaken in LCAs for EPD and EU CBAM, as the declared unit is usually 1 tonne of the finished product. Manufacturers would need guidance to complete this step.

***Recommendation:***

GWP results should also be reported at a common raw material level e.g. per 1 tonne of feedstock or precursor. This would align with the declared unit step of LCA standards. This recommendation could be delivered through the CEN committee update to BS EN

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<sup>25</sup> European Bureau for Research on Industrial Transformation and Emissions, ND, BAT reference documents, URL: <https://bureau-industrial-transformation.jrc.ec.europa.eu/reference>

15804+A2:2019 and by UK Government into CBAM methodology that would also support industry benchmarking.

#### 4.4.3 Allocation of emissions to co-products

The IDDI stated that co-outputs may be allocated a portion of emissions from a particular process, thus reducing the emissions allocated to the primary product. EPD already follow a hierarchy in allocating emissions to co-products, based on ISO 14044:2006. These are set out in Appendix 1.

This research found that EU CBAM also follows a hierarchy for emissions allocation to co-products, as outlined in Section 3.4.3 of the Implementing Regulation<sup>26</sup>. This hierarchy prioritises the use of physical relationships (such as mass, energy content, or chemical composition) as the primary basis for allocation. If these are not appropriate or do not reflect the environmental burdens accurately, economic allocation may be used as a secondary option.

Additionally, EU CBAM introduces what is often referred to as the "bubble approach" for installations with integrated production processes. Under this approach, emissions from an entire production system or facility can be grouped or "bubbled" together when emissions cannot be clearly attributed to individual outputs. This allows for the total emissions of a combined process to be distributed proportionally across multiple co-products based on the chosen allocation method. The bubble approach is particularly useful in complex industrial settings such as steel and cement production where processes are highly integrated, but emissions are difficult to disaggregate to process level with precision.

#### **Finding 20 (expansion of Finding 5): Each method of allocating emissions to co-products leads to a slightly different result because they each emphasise specific (but different) properties**

Whilst it is recognised that reaching a consensus on application of allocation methods (related to Finding 5 and subsequent recommendation) for co-products is essential to improve consistency, achieving this will be extremely challenging due to the vested interests of affected industries i.e. one allocation choice will favour an industry, and disfavour another.

#### 4.4.4 Utilising scrap metals in steel manufacture

The IDDI's research highlights that the recycling of steel should be encouraged and somehow recognised in the carbon footprint of steel products. Key questions arose during this research on whether, and how, to assign emissions to scrap, to account for its future recyclability and emissions incurred in original production.

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<sup>26</sup> European Commission Taxation and Customs Union, 2025, CBAM Guidance and Legislation, URL: [https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism/cbam-guidance-and-legislation\\_en](https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism/cbam-guidance-and-legislation_en)

### **Finding 21: Manufacturers using scrap steel want GWP results to reflect the associated emissions reductions, which would incentivise the practice**

This research found that UK steel product manufacturers would benefit from a GWP reduction for inclusion of scrap, or the likely recycled fate of their steel products at some unspecified point of time in the future. EPD covering module D specifically include recovery, reuse, recycling or energy recovery potential of a products components and raw materials. However, construction products containing steel may not be 100% recyclable, for example, insulated roof and wall panels as they also include insulation materials. Many of the EPD for these products encompass module A1 to A3 only.

While one study states that EU CBAM will provide an incentive for scrap steel use, subject to final scheme design<sup>27</sup>, this conclusion is based on the fact CBAM was introduced to reduce carbon emissions and not any analysis of the rules for scrap steel accounting.

Like other scrap products in the iron and aluminium sectors, imported steel scrap is not within the financial scope of CBAM. This applies to both the UK and EU CBAM systems and is based on the concept that scrap is a recycled input with a net benefit on emissions<sup>28</sup>.

#### ***Recommendation:***

A preferred method for determining the emissions of steel products that utilise recycled content in EPD should be agreed and implemented. Further research could explore incentivisation of scrap steel use, and which methodology is most robust in determining the GWP of steel products with recycled content. This method can then be presented in proposed UK Government guidance on embodied emissions as the preferred method.

#### **4.4.5 Using alternative fuels**

Within production processes (particularly cement) it is increasingly common for fossil fuels to be replaced with secondary biofuels and/or waste which can produce lower emissions (biofuels and biogenic fractions of wastes are typically considered to produce zero emissions when burnt). Currently there is a lack of consistency in when and how net and gross emissions are reported. Cement producers can take account of these emissions reductions by reporting a 'net emissions' figure which excludes emissions from biofuels and biogenic fractions of wastes, as opposed to 'gross emissions' which includes these emissions.

The IDDI recommends that both gross and net emissions are clearly reported in EPD, satisfying GHG Protocol reporting principles whilst still encouraging the future use of non-fossil fuels in production processes. However, this research found that EPD summary tables only allow space for one result. Whether gross or net is chosen comes down to industry body recommendation (the GCCA recommends reporting net) or country recommendation (the UK emphasises gross results are reported). Cement producers have indicated that customers

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<sup>27</sup> Rossetto, 2023, The carbon border adjustment mechanism: What does it mean for steel recycling? URL: [www.sciencedirect.com/science/article/pii/S2772737823000020](https://www.sciencedirect.com/science/article/pii/S2772737823000020)

<sup>28</sup> HM Revenue and Customs, 2025, Carbon border adjustment mechanism (CBAM): Policy update, URL: [www.gov.uk/government/consultations/draft-legislation-carbon-border-adjustment-mechanism/carbon-border-adjustment-mechanism-cbam-policy-update](https://www.gov.uk/government/consultations/draft-legislation-carbon-border-adjustment-mechanism/carbon-border-adjustment-mechanism-cbam-policy-update)

typically only look at the result provided in the main table of results (even if supplementary information is provided in text, footnotes or appendices) which could lead to misinterpretations when comparing products from different manufacturers.

In EU CBAM, emissions from the combustion of biogenic waste used as fuel are excluded from the calculation of gross emissions, in line with the treatment of biogenic CO<sub>2</sub> under the GHG Protocol and EU ETS methodologies.

### **Finding 21: There is a lack of clarity in the standards on alternative fuels**

The standards are unclear on which fuels should be classed as wastes and therefore subject to exclusion from net emissions reporting. They also do not provide clarity on how other waste fuel streams such as manmade textiles, paints and other hazardous wastes should be considered.

#### ***Recommendation:***

A consistent approach to account for the use of alternative fuels such as biofuels and wastes in EPD should be agreed and implemented. This method can then be presented in proposed UK Government guidance on embodied emissions as the preferred method.

### **4.4.6 Accounting for CCUS**

Carbon Capture and Storage (CCS) is a process where carbon emissions from industrial activities are captured and transported for permanent storage in underground geological formations such as depleted oil and gas reservoirs, preventing the release of these emissions to the atmosphere. CCS is an emerging technology. It is expected that CCS will be crucial in enabling both the steel and cement sectors to decarbonise and reach net zero emissions.

Despite the recognition of CCS in legislation, many standards do not currently set out a methodology or option to allow producers to claim a reduction in emissions through CCS adoption. This research found that BS EN 15804+A2:2019 only allows for emissions captured and stored from fossil fuels sources to be excluded from emissions calculations, whilst captured biogenic carbon emissions transferred to nature are not considered to be permanently stored. This approach contrasts with CBAM, which allows for producers using Bioenergy with CCS to deduct biogenic emissions from total reported emissions.

### **Finding 22: This inconsistency is likely to lead to uncertainty within the cement industry where manufacturers are increasingly using biogenic secondary fuels and wastes within production processes**

Standards need to include consistent approaches to account for Carbon Capture and Utilisation (CCU) which involves capturing CO<sub>2</sub> emissions from industrial activities and re-using them in other processes or products, supporting a circular economy.

Doing so will require additional challenges to be addressed including:

- Permanence of storage: Consideration of whether CCU should be technically classed as a removal, given that CO<sub>2</sub> may not be permanently removed from the atmosphere.

- Avoiding the risk of doubling counting: For example, if CO<sub>2</sub> captured by a cement manufacturer is sold onto another manufacturer for utilisation, there is the risk that both the emitter and the user of the captured carbon could claim an emissions reduction benefit. Standards will need to provide clarity on how potential double counting will be avoided.
- Transfer of biogenic carbon: Under current BS EN 15804+A2:2019, transfers of biogenic carbon out of the system must be shown as balancing emissions; therefore, the company which captures and transfers the biogenic carbon cannot receive the benefit as well.

**Recommendation:**

CCUS accounting approaches should be aligned. EPDs should adopt the approach implemented by EU CBAM. This could form a market signal that promotes uptake and expansion of the low carbon products market in the UK.

#### 4.4.7 Alternative chain of custody models

The IDDI found new approaches to life cycle assessment and reporting being proposed by industry, such as book and claim<sup>29</sup> to capture value more effectively from investments in decarbonisation. However, these methods come with concerns of greenwashing, where companies make unsubstantiated claims about their products.

**Finding 23: Neither EPD and EU CBAM permit alternative chain of custody models such as book and claim at present**

Further work is needed to investigate whether these schemes have merit in terms of incentivising the industry to invest in decarbonisation.

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<sup>29</sup> Book & claim is the method proposed for removals associated with Carbon Capture by some cement manufacturers (such as Heidelberg Cement): [www.evozero.com/docs/evozero-product-en.pdf](http://www.evozero.com/docs/evozero-product-en.pdf)

## 4.5 Objective 5

This section sets out the key findings from research undertaken to address Objective 5:

*To understand how UK steel, iron, cement and concrete products sit on different benchmarking thresholds, in particular the International Energy Agency (IEA) near- and low-emission benchmarking system.*

The research shows that international benchmarks are becoming increasingly defined around product composition (e.g. scrap content in steel, clinker ratios in cement, strength grades in concrete). These thresholds are designed to align heavy industry with net zero by 2050 and are being embedded in international standards and procurement schemes.

This research indicates that current UK product-level data is above most “near zero” or “future emission” thresholds, with EAF steel and blended cements (such as CEM III) being closest to these thresholds. However, comparing EPD data against crude steel or clinker-based thresholds is challenging, as EPD do not directly report at those thresholds. This highlights both progress in certain routes and the need for further methodological alignment to enable accurate benchmarking.

### **Finding 24: International benchmarks are converging around IEA thresholds but differ by sector and scope**

The IEA Secretariat has set “near zero” production thresholds that link directly to material inputs:

- **Steel:** 400 kg CO<sub>2</sub>e/t crude steel (100% iron input) down to 50 kg CO<sub>2</sub>e/t (100% scrap input).
- **Cement:** 125 kg CO<sub>2</sub>e/t (100% clinker) down to 40 kg CO<sub>2</sub>e/t (0% clinker).

These values represent technically possible but not yet commercially-scalable production scenarios. They have been adopted or adapted in several initiatives: ResponsibleSteel aligns with IEA thresholds, the Global Steel Climate Council (GSCC) sets long-term targets (380–400 kg CO<sub>2</sub>e/t hot-rolled steel by 2045, 120 kg CO<sub>2</sub>e/t by 2050), while Low Emission Steel Standard (LESS) extends the sliding scrap scale to cover additional processes. For cement, the GCCA has aligned its near-zero definition to the IEA threshold, and the IDDI procurement pledge applies thresholds based on clinker ratios. Concrete initiatives, such as GCCA and the UK Low Carbon Concrete Group, have begun to define progressive benchmarks by compressive strength (Appendix 2.2).

### **Finding 25: Current industry emissions remain above low- and near-zero benchmarks**

Analysis using the LCA Comparator Tool shows that UK steel and cement products are above aspirational thresholds, though performance varies by production route and product type.

**Steel:** Electric arc furnace (EAF) production using high scrap content is significantly closer to the GSCC and IEA targets than blast furnace–basic oxygen furnace (BF–BOF) routes.

However, further reductions are required even for EAF routes, particularly where grid electricity remains carbon intensive.

**Cement:** Blended cements with lower clinker content (e.g. CEM III) are closer to the IDDI target than CEM I or II, but still require substantial reductions to align with net zero scenarios.

**Concrete:** Thresholds proposed by GCCA and the Low Carbon Concrete Group suggest that UK products are currently above future performance targets across common strength grades.

Figure 9 and Figure 10 illustrate these comparisons, showing both the relative position of current products and the scale of reductions required (further information in Appendix 4). Current benchmark refers to the average value of the benchmark data collected in this research. Results from the LCA Comparator Tool was used to compare a sample of best practice thresholds. Other thresholds were not included because they included scrap inputs, and scrap content was not available to the LCA Comparator Tool due to data limitations (see Appendix 5).

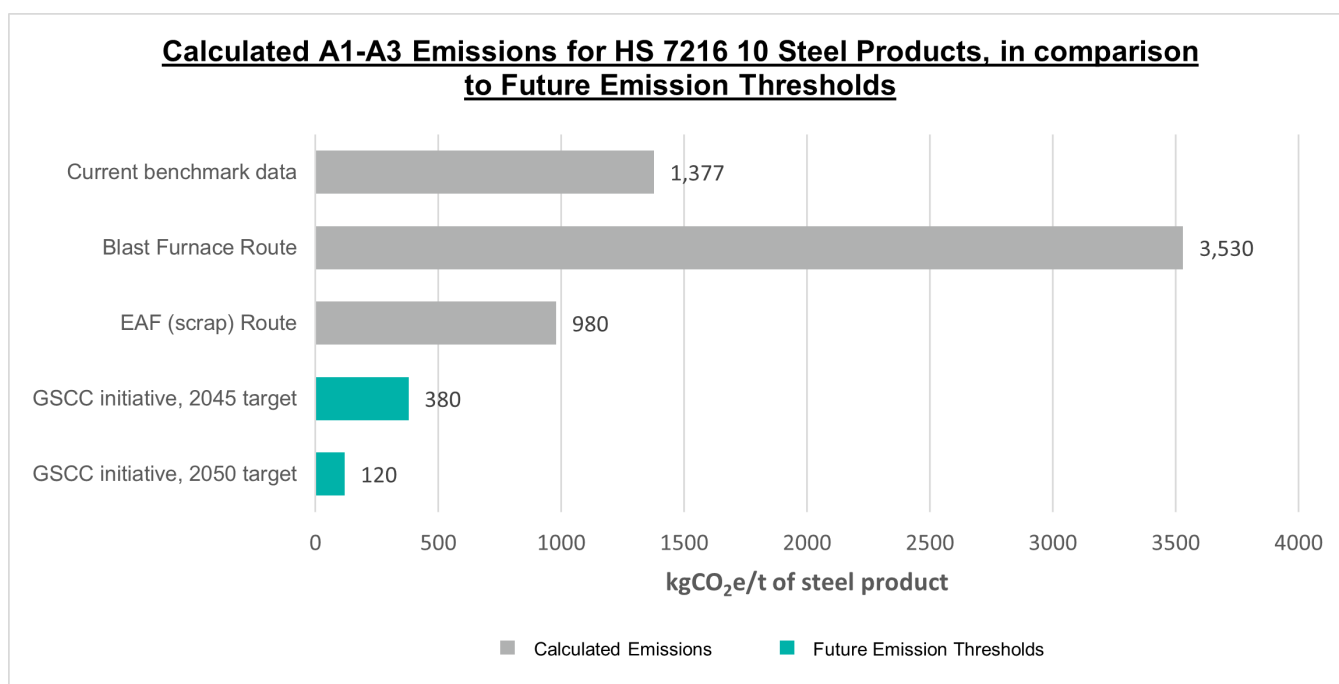


**Figure 9: A1-A3 emissions for HS 7216 10 steel products produced via EAF and blast furnace routes in comparison to the GSCC Future Emission Thresholds.**

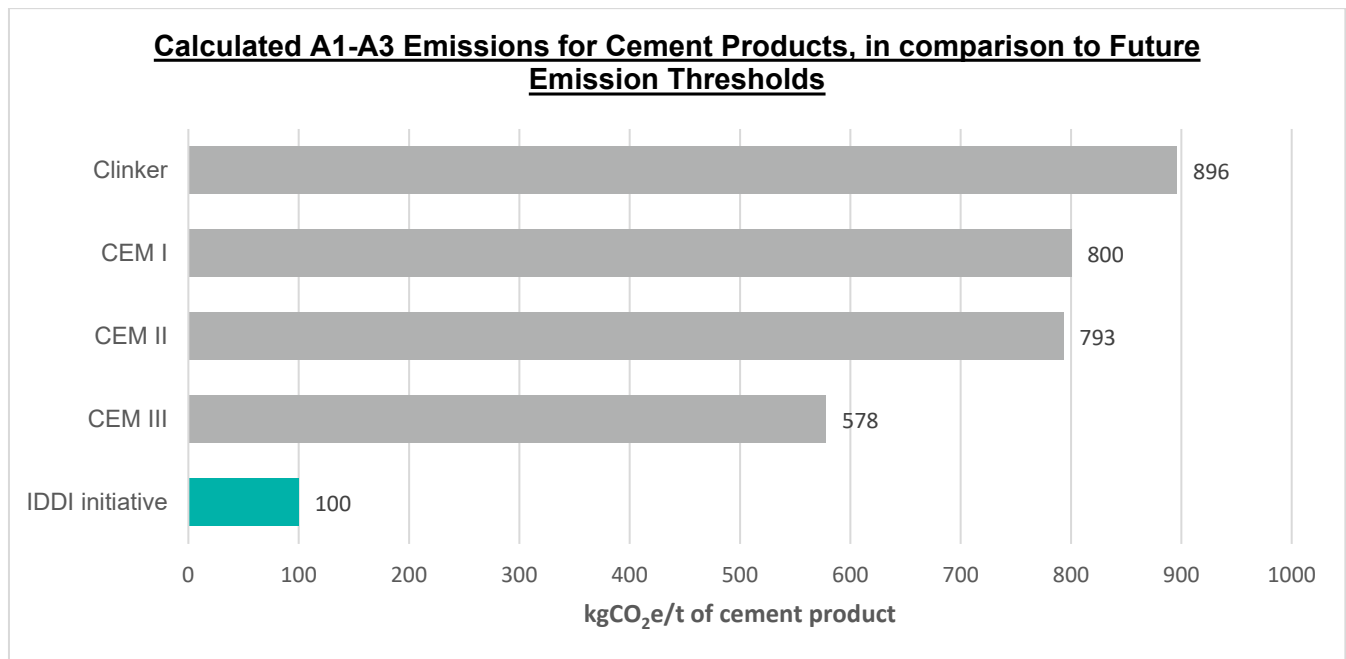


**Figure 10: A1-A3 emissions for cement products in comparison to the IDD Future Emission Threshold target (calculated using the global average clinker-to-cement ratio of 0.7)<sup>30</sup>.**

### **Finding 26: Benchmarking highlights product composition as a key driver**

The analysis confirms that scrap content in steel and clinker ratio in cement are the primary drivers of progress against thresholds. This reflects the material-based structure of the benchmarks, which link emissions intensity directly to these key inputs. For concrete, compressive strength is a proxy for clinker intensity, again underlining the central role of clinker reduction in meeting future targets (Appendix 2.2).

### **Finding 27: Mapping product-level EPD to crude steel and clinker benchmarks remains limited**

While EPD provide product-level emissions values, they rarely disclose results at the crude steel or clinker stage, which are the basis of most benchmarks. This prevents a straightforward comparison of UK products to international thresholds. To enable robust benchmarking, more granular data is required on process emissions, precursor materials, and energy sources at the manufacturing stage. Without this, comparisons rely on assumptions or aggregated averages, reducing accuracy and comparability (Appendix 2.2).

<sup>30</sup> IDD, 2023, Your commitment to green construction with public funds, URL: [www.industrialenergyaccelerator.org/wp-content/uploads/FINAL-The-GPP-Pledge-brochure-2023-update.pdf](http://www.industrialenergyaccelerator.org/wp-content/uploads/FINAL-The-GPP-Pledge-brochure-2023-update.pdf)

## 4.6 Objective 6

This section sets out the key findings from research undertaken to address Objective 6:

*Produce an initial assessment of the proportion of emissions across each life cycle stage, and how embodied emissions of steel, iron, cement and concrete products could be reduced based on the breakdown by life cycle stage.*

### 4.6.1 Carbon footprint of steel

**Finding 28: Within steel products studied, raw material extraction (A1) is the highest contributor to cradle-to-gate emissions, forming approximately 92%-99% of life cycle emissions (Figure 11)**

Hot-rolled products typically have a higher percentage of A3 emissions compared to cold-rolled products. This is likely due to the increased energy demand required to maintain the higher manufacturing process temperatures during the additional production steps of hot-rolled products.

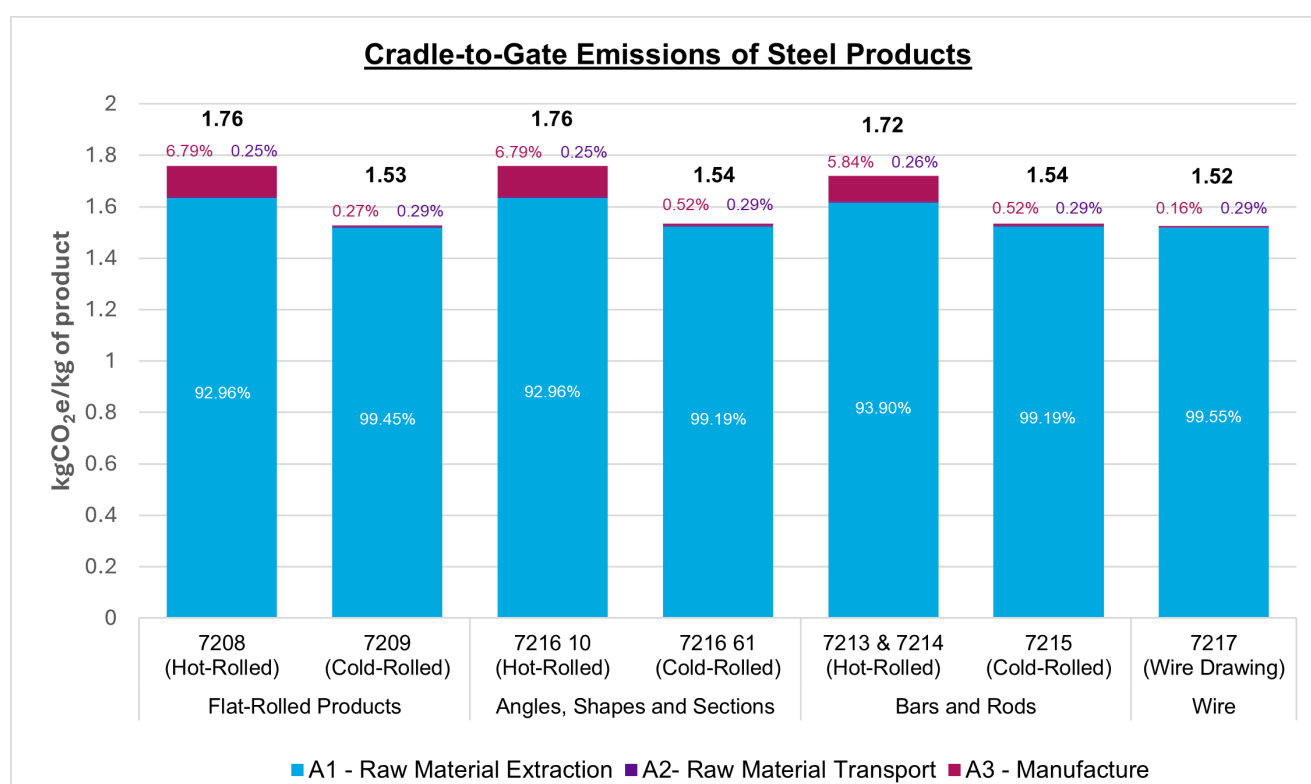


**Figure 11: Percentage contribution of each life cycle module to the total A1-A3 emissions for selected steel products with European (including UK) origins.**

Further results and information are provided in Appendix 4.

## 4.6.2 Carbon footprint of cement and concrete

**Finding 29: Manufacturing (A3) is the largest contributor to cradle-to-gate emissions within cement clinker production, whereas raw material extraction (A1) is the largest contributor for cement and ready to pour concrete products (Figure 12)**

A reduction in total embodied emissions can be seen from CEM I through to CEM III, correlating to the reduction in the percentage content of clinker from CEM I to CEM III.

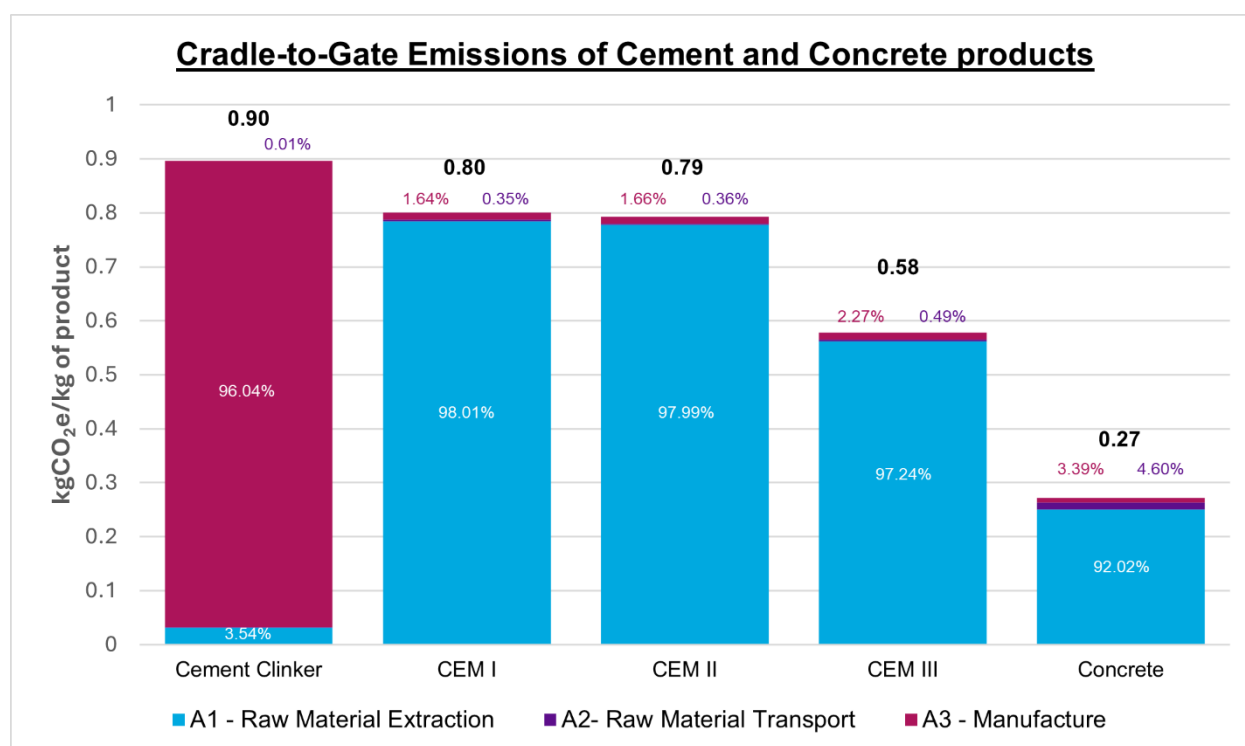


**Figure 12: Percentage contribution of each life cycle module to the total A1-A3 emissions for cement clinker, cement and concrete products with European (including UK) origins.**

Further results and information are provided in Appendix 4.

## 4.6.3 How emissions could be reduced

As set out against Objective 5, the analysis confirms that scrap content in steel and clinker ratio in cement are the primary drivers of progress against low carbon thresholds. Many EAF producers point to the UK-wide decarbonisation of the electricity grid driving their carbon intensity; similarly, cement producers wish to incorporate more bio-based fuels in their kilns, and the Mineral Products Association states CCUS is crucial for the industry to realise its 'net zero' target<sup>31</sup>. The industry is pursuing research and development projects to reduce the carbon intensity of their products.

<sup>31</sup> Mineral Products Association, 2024, MPA welcomes UK Government's commitment to fund CCUS, URL: <https://mineralproducts.org/News/2024/release21>

Reporting the emissions reductions achieved through process changes depends on methodological choices, with this research highlighting how data quality and methodology choice impacts the final GWP result (Section 4.1.2 and 4.4).

The following recommendations highlighted under Objective 4 will support determination of a consistent reporting approach:

- **Pursuing further research that explores incentivisation of scrap steel use**, and which methodology is most robust in determining the GWP of steel products with recycled content.
- **Evaluating the role of carbon capture utilisation and storage in concrete**, particularly innovative concretes, and determine how industry could account for this in EPD and EU CBAM methodology. This could form a market signal that promotes uptake and expansion of the low carbon product market in the UK.
- **Pursuing further research in the reporting mechanisms for biofuel content**, notably how this impacts the net vs gross emissions debate.

## 5 Research gaps

This section sets out the main limitations of the research and discusses future evidence gathering needs. Further detail is provided in Appendix 5.

### 5.1 Limitations

The main limitation of the research was having sufficient data to produce quantified supporting evidence for each research objective. The lack of granular primary data resulted in the use of intensity-based data, where required, within the LCA Comparator Tool – resulting in limitations to the extent of analysis possible. This is described further below.

In the early stages of research, to produce meaningful comparisons of life cycle emissions from steel, cement and concrete products, primary activity data was requested from manufacturers for the production processes that they operate. This was a challenge for manufacturers and industry bodies due to commercial confidentiality concerns.

Where data was subsequently provided by manufacturers, it was typically intensity based. Unlike activity data, intensity data does not allow for sensitivity analysis to be undertaken. For example, analysis to understand how the use of renewable electricity or use of low carbon fuels within a process affects overall emissions. Similarly, intensity data does not give insight into where emissions hotspots exist within a production process.

These challenges were partly overcome through the sourcing of activity data for steel and cement clinker from relevant Best Available Technique (BAT) Reference Documents (BREF notes)<sup>32</sup>, and from an LCA inventory produced by Portland Cement Association for concrete<sup>33</sup>. Whilst this data covered key production stages, it did not cover specific equipment items and was not sufficiently granular to assess differences in manufacturing emissions that may occur from the use of different precursors (e.g. sintered ore or iron ore pellets for steel production).

### 5.2 Where should future research be focused?

Data availability challenges could be overcome if UK Government was able to formally request activity data from manufacturers at a process equipment level, by guaranteeing the safeguard of commercial information. However, there are challenges to manufacturers collecting this data: some manufacturers stated that process equipment is often used to manufacture different products throughout the day, which would mean accurate product-level activity data would be difficult to isolate. In that case, an attribution methodology would need to be selected

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<sup>32</sup> European Bureau for Research on Industrial Transformation and Emissions, ND, BAT reference documents, URL: <https://bureau-industrial-transformation.jrc.ec.europa.eu/reference>

<sup>33</sup> Portland Cement Association, 2007, Life Cycle Inventory of Portland Cement Concrete, URL: <http://large.stanford.edu/courses/2016/ph240/pourshafeie2/docs/marceau-2007.pdf>

and specified to present the activity data to the best of the manufacturer's ability and with consistency across all manufacturers who cannot supply primary data on a product level.

Due to these challenges, other than a focus on improving data quality, benefit could be gained by focusing future research on the following:

1. Assessing other life cycle methodologies. There are many GWP-assessment methodologies, at both a product and organisational level. Research into the prevalence of other methodologies in industry and what data manufacturers use to complete these assessments would provide policy makers with a picture of how manufacturers complete GWP assessments outside of EPD and EU CBAM. Further research would help explore the full range of methodologies, manufacturer's preference, and results.
2. Investigating different methodologies to produce EPD such as PCRs. The approach to developing an EPD is set out by BS EN 15804+A2:2019, and then further refined at a product or sector level by PCRs. There are more PCRs which may be applicable to products on the UK market. Comparing the prevalence and requirements of the PCRs would assist policymakers in understanding the market. Investigating these would determine what impact different PCR approaches have on results.
3. Programme Operator approaches. EPD Programme Operators are independent organisations establishing the framework for EPD, including developing and maintaining PCRs, overseeing the EPD verification process, and publishing finalised EPD in a recognised database. During the course of this research, Programme Operators were noted as a potential source of variance, as they develop different PCRs which cause divergence in approaches to developing product EPD. Further research in this area would help determine what the impact that different operator approaches have on results and how variance could be minimised.

## 6 Conclusions and Recommendations

This research shows that data quality and methodology choice can significantly impact the final GWP result, which underpin the key conclusions. Enhancing interoperability across international schemes was not the focus of this research, but the conclusions do contribute to this goal.

To support the development of an effective EERF, this research has identified a range of actions that could enhance standardisation and increase accuracy and comparability of life cycle emissions reporting of steel, cement and concrete products.

This section brings together key conclusions, mapped against the recommendations developed from the key findings and research gaps.

### 6.1 Data quality

#### 6.1.1 Key conclusions

In terms of data quality, this research found that primary, product-specific data provides the most accurate results but is resource-intensive and can be technically complex to obtain. Using primary data (where available) for all upstream processes, which are likely to be significant within a product's overall footprint, will increase the accuracy of carbon footprints.

Secondary data is widely used by manufacturers, but datasets are often outdated and inconsistent. Additionally, secondary data is often intensity based, which limits transparency by concealing underlying process and assumptions.

Carbon intensity is the result of the calculation of a carbon assessment. It cannot be “reverse engineered” to reveal the components that went into the product, and therefore is more readily shared: the downside of this is that there is less primary data available, which reduces the accuracy of results.

#### 6.1.2 Recommendations

##### **Assessment data**

- Prioritising the use of primary activity data for raw materials. This will enhance accuracy of GWP results in both EU CBAM and EPD.
- Creating a common set of industry benchmark values for the UK that manufacturers can use in circumstances where primary activity data is not available. Industry benchmark data derived from actual submissions would be more precise and representative to UK products being imported, compared to the use of currently available benchmark sources, such as market reports.

- An example is to produce a survey on industry best practice; a UK-wide study into best available techniques specific to UK industry could be implemented, similar to how the EU Best Available Technique Reference (BREF) documents<sup>34</sup> were created.
- Another example is to provide reference values which are on the high end of the benchmarks for UK industry, as a way to incentivise manufacturers to collect better quality data, similar to the EU CBAM approach.

## Verification activities

- Including an independent plausibility check within all verification schemes to ensure that the data used within assessments is relevant, appropriate, consistent, representative and reproducible.

## 6.2 Methodological choice

### 6.2.1 Key conclusions

This research found that the methodologies for EU CBAM and EPD cover different amounts of the product life cycle. They both cover A3, with EU CBAM including parts of A1. Different EPD types (such as cradle to gate, cradle to cradle) mean different parts of the life cycle are included; a cradle to gate EPD covers all of A1 to A3. The LCA Comparator Tool showed that the EU CBAM methodology generates results typically 8-15% lower than EPD for the same product; therefore, EU CBAM covers the majority of product emissions that EPD do in general.

The narrower scope of EU CBAM makes it effective for regulatory compliance and trade, where the priority is to capture the largest emissions sources and establish a carbon price signal. EPD, in contrast, provide a more comprehensive life cycle perspective, which is valuable for product-level benchmarking, procurement decisions, and tracking decarbonisation over time. Data requirements of the two schemes are similar, although EPD require additional data to be collected due to the larger boundary of assessment.

While the methodologies are different, there are common shortfalls in both which may be relevant to carbon footprinting in general. Different approaches within EPD creation and EU CBAM declaration have an impact on the result, with the largest being allocation. Within EPD, assumptions made within the methodology can reduce the comparability of EPD.

To improve comparability of EPD, there should be consensus and consistency on the following:

- The declared unit and functional unit must be comparable or converted to be comparable if not.
- The same methodological approach in the EPD, particularly:

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<sup>34</sup> <https://bureau-industrial-transformation.jrc.ec.europa.eu/reference>

- Approach to energy (such as power purchase agreements and guarantee of origin).
  - Allocation approach.
  - Reporting of net or gross emissions (in cement and concrete products).
- The same system boundaries (such as A1 to A3, which cannot be directly compared to A1-A5, for example).
- The same environmental impact categories are reported, with comparable units.

These are all choices manufacturers make as they create their EPD. Guidance on which choices are preferred would help improve comparability over time. Streamlining reporting to reduce burden on manufacturers would be welcome, with the financial and administrative costs of EU CBAM and EPD to manufacturers closely linked to the quantity and complexity of data required for compliance. Adhering to one methodology which is independently verified and aligned with the UK's export markets would reduce this burden.

## 6.2.2 Recommendations

### Emissions allocation

- Agreeing and implementing a preferred method for allocating emissions (and other environmental impacts) to products and co-products in EPD. This method can then be presented in proposed UK Government guidance on embodied emissions reporting as the preferred method of allocating impacts.
- Agreeing and implementing a preferred method for determining the emissions of steel products that utilise recycled content in EPD. Further research could explore incentivisation of scrap steel use, and which methodology is most robust in determining the GWP of steel products with recycled content. This method can then be presented in proposed UK Government guidance on embodied emissions as the preferred method.

### Reporting requirements

- Calculating and reporting both net and gross emissions for EU CBAM and within EPD for increased comparability and transparency.

### Verification activities

- Exploring how EPD verification schemes could align with existing monitoring, reporting and verification systems, particularly those used under UK ETS and CBAM.

### Methodology comparison

- Assessing other LCA methodologies used outside of EPDs and EU-CBAM. Research into the prevalence of other methodologies and what data manufacturers use to complete these assessments would provide policy makers with a picture of how manufacturers complete GWP assessments outside of EPD and EU CBAM.

- Assessing EPD methodologies and PCR of other products. Comparing the prevalence and requirements of the PCRs would assist policymakers in understanding the market and determine what impact different PCR approaches have on results.
- Assessing approaches used by different Programme Operators to develop PCRs. This would help determine what impact different operator approaches have on results.

## 6.3 Enhancing methodologies

### 6.3.1 Key conclusions

Currently, improvements to methodologies are required to help comparability of results, and also incentivise good environmental practice or other low carbon policies:

- Reporting emissions at a common production step such as per 1 tonne of feedstock or precursor could help to compare the footprints of products more effectively.
- Clarity is needed on accounting for the use of alternative fuels such as wastes which can be excluded from net emissions reporting.
- Consistency across standards and methodologies to allow manufacturers to claim emissions reductions through the use of Carbon Capture and Storage or Utilisation.

Standards are being reviewed and shortfalls addressed through technical committees, although these will be behind the pace of policy and technological advancements. Government will need to intervene if faster change is desired, through guidance on preferred data quality decisions and method.

### 6.3.2 Recommendations

#### **Reporting requirements**

- Reporting GWP results at a common raw material level e.g. per 1 tonne of feedstock or precursor. This would align with the declared unit step of LCA standards and also support industry benchmarking.

#### **Accounting approaches**

- Agreeing and implementing a consistent approach to account for the use of alternative fuels such as biofuels and wastes in EPD. This method can then be presented in proposed UK Government guidance on embodied emissions as the preferred method.
- Aligning CCS accounting approaches, with EPD adopting the approach implemented by EU CBAM. This could form a market signal that promotes uptake and expansion of the low carbon product market in the UK.

## 6.4 Next steps

The recommendations (presented within 6.1.2, 6.2.2 and 6.3.2) have been developed to support identification of next steps. Implementing these measures will require collective input from industry and government.

As an example, the CEN committee is currently co-ordinating updates to BS EN 15804+A2:2019, (the main standard for producing EPD for construction products such as steel, cement and concrete). This presents an ideal opportunity to implement some of the recommended measures with EPD. The UK Government may be able to support this through BSI representation on the CEN committee.

## 7 Abbreviations and acronyms

| Acronym       | Full term                                  |
|---------------|--------------------------------------------|
| <b>BF-BOF</b> | Blast Furnace Basic Oxygen Furnace         |
| <b>BOF</b>    | Basic Oxygen Steelmaking                   |
| <b>CBAM</b>   | Carbon Border Adjustment Mechanism         |
| <b>CCS</b>    | Carbon Capture and Storage                 |
| <b>CCU</b>    | Carbon Capture and Utilisation             |
| <b>CEN</b>    | European Committee for Standardisation     |
| <b>CPR</b>    | Construction Product Regulation            |
| <b>CRCF</b>   | Carbon Removal Certification Framework     |
| <b>DESNZ</b>  | Department of Energy Security and Net Zero |
| <b>DRI</b>    | Direct Reduced Iron                        |
| <b>EAD</b>    | European Assessment Document               |
| <b>EAf</b>    | Electric Arc Furnace                       |
| <b>EERF</b>   | Embodied Emissions Reporting Framework     |
| <b>EPBD</b>   | Energy Performance in Buildings Directive  |
| <b>EPD</b>    | Environmental Product Declaration          |
| <b>ETA</b>    | European Technical Assessment              |
| <b>ETS</b>    | Emissions Trading Scheme                   |
| <b>EU</b>     | European Union                             |
| <b>FEED</b>   | Front-End Engineering Design               |
| <b>GCCA</b>   | Global Cement and Concrete Association     |

| Acronym        | Full term                                           |
|----------------|-----------------------------------------------------|
| <b>GGBS</b>    | Ground Granulated Blast Furnace Slag                |
| <b>GHG</b>     | Greenhouse Gases                                    |
| <b>GNR</b>     | Getting Numbers Right Database                      |
| <b>GSCC</b>    | Global Steel Climate Council                        |
| <b>GWP</b>     | Global Warming Potential                            |
| <b>HMRC</b>    | HM Revenue & Customs                                |
| <b>HS</b>      | Harmonised System                                   |
| <b>IBU</b>     | Institut Bauen and Umwelt                           |
| <b>IDDI</b>    | Industrial Deep Decarbonisation Initiative          |
| <b>IEA</b>     | International Energy Agency                         |
| <b>LCA</b>     | Life Cycle Assessment                               |
| <b>LCCG</b>    | Low Carbon Concrete Group                           |
| <b>LCI</b>     | Life Cycle Inventory                                |
| <b>LESS</b>    | Low Emission Steel Standard                         |
| <b>PCF</b>     | Product Carbon Footprint                            |
| <b>PCR</b>     | Product Category Rules                              |
| <b>SCM</b>     | Supplementary Cementitious Material                 |
| <b>T&amp;D</b> | Transmission and Distribution                       |
| <b>TAB</b>     | Technical Assessment Body                           |
| <b>TC</b>      | Technical Committee                                 |
| <b>TCFD</b>    | Task Force on Climate-related Financial Disclosures |
| <b>UK</b>      | United Kingdom                                      |

| Acronym     | Full term                                    |
|-------------|----------------------------------------------|
| <b>WTT</b>  | Well-to-tank                                 |
| <b>WPID</b> | Working Party for Industrial Decarbonisation |

## 8 Definitions

| Term                                     | Definition                                                                                                                                                                                                                                                                                                              |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Activity data</b>                     | Data sourced which provides a quantitative measure associated with a specific activity that generates greenhouse gas emissions (for example kWh electricity consumed, kg of fuel combusted).                                                                                                                            |
| <b>Background data</b>                   | Background data are generally the part of the studied system over which the user of the information does not have direct control, for example the upstream supply chain and the downstream processes covering product use and end of life (BS EN 15941:2024 definition; secondary data is used in this report).         |
| <b>Benchmark data</b>                    | Data developed by organisations for the purpose of comparing their products against, for example, national averages or a low emissions target.                                                                                                                                                                          |
| <b>Biogenic carbon</b>                   | Carbon stored within biological materials (for example biomass) or emissions resulting from such carbon.                                                                                                                                                                                                                |
| <b>British Standards Institute (BSI)</b> | British Standards Institute (BSI) BSI has a Memorandum of Understanding with the UK Government, which establishes the position of BSI as the recognised UK National Standards Body (by geographic designation, there are international, regional, and national standards bodies (the latter often referred to as NSBs). |
| <b>Carbon accounting</b>                 | The process of measuring and reporting greenhouse gas emissions associated with a product or organisation.                                                                                                                                                                                                              |
| <b>Carbon dioxide equivalent</b>         | The measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential.                                                                   |
| <b>Carbon factor(s)</b>                  | An emissions or conversion factor, to measure how much carbon emissions are released into the atmosphere by an activity.                                                                                                                                                                                                |
| <b>Carbon footprint</b>                  | Measurement of global greenhouse gas emissions associated with a product, service, organisation, region, industry, nation, etc.                                                                                                                                                                                         |

| Term                                | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Carbon leakage</b>               | Carbon leakage is the movement of production and associated emissions from one country to another to avoid stricter climate mitigation policies. As a result of carbon leakage, the objective of decarbonisation efforts – to reduce global emissions – would be undermined <sup>35</sup> .                                                                                                                                                                    |
| <b>Declared unit</b>                | In life cycle assessment (LCA), a declared unit quantifies a product's environmental impact based on its physical properties, like mass or volume, rather than the service it provides, for example, CO <sub>2</sub> e or GWP per quantity, CO <sub>2</sub> e per kg of steel or CO <sub>2</sub> e per m <sup>3</sup> of cement. This contrasts with a functional unit, which measures impact based on a product's performance or function over its life span. |
| <b>Direct emissions (EU CBAM)</b>   | Emissions from the production processes of goods, including emissions from the production of heating and cooling consumed during the production processes, regardless of the location of the production of the heating and cooling.                                                                                                                                                                                                                            |
| <b>Downstream emissions</b>         | Greenhouse gases produced when a product or service is used and disposed of.                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Embedded emissions (EU CBAM)</b> | Emissions released during the production of goods, including the embedded emissions of relevant precursor materials consumed in the production process.                                                                                                                                                                                                                                                                                                        |
| <b>Embodied carbon emissions</b>    | Embodied carbon emissions are all emissions associated with materials, construction, maintenance, repair, demolition, and disposal of a product <sup>36</sup> .                                                                                                                                                                                                                                                                                                |
| <b>Foreground data</b>              | Foreground data represents that part of the whole studied system over which the user of the information has control. For a product, it can, for example, include the factory operations of the manufacturer and associated processes such as distribution or a take back scheme where they control this (BS EN 15941:2024 definition. Primary data is the term used in this report).                                                                           |

<sup>35</sup> DESNZ, 2023, Factsheet: voluntary standards and embodied emissions reporting - GOV.UK, URL: [www.gov.uk/government/consultations/addressing-carbon-leakage-risk-to-support-decarbonisation/outcome/factsheet-voluntary-standards-and-embodied-emissions-reporting](https://www.gov.uk/government/consultations/addressing-carbon-leakage-risk-to-support-decarbonisation/outcome/factsheet-voluntary-standards-and-embodied-emissions-reporting)

<sup>36</sup> UK Parliament, 2023, Building to net zero: costing carbon in construction, URL: <https://publications.parliament.uk/pa/cm5803/cmselect/cmenvaud/103/report.html>

| Term                                | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Functional unit</b>              | This metric quantifies emissions based on the product's performance in its end use, including its expected lifespan (e.g. 'x amount of CO <sub>2</sub> e in a 1-tonne steel beam, S grade designed to last for 80 years in a building' or 'x amount of CO <sub>2</sub> e in 1 m <sup>3</sup> of concrete with a strength class of C20/80 to be used for 60 years in a building' are functional units).                                                                                                                                                                                                                                                      |
| <b>Greenhouse gases</b>             | Gases in the Earth's atmosphere which trap heat. The Kyoto Protocol covers seven GHGs: Carbon dioxide (CO <sub>2</sub> ), methane (CH <sub>4</sub> ), nitrous oxide (N <sub>2</sub> O), sulphur hexafluoride (SF <sub>6</sub> ), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and nitrogen trifluoride (NF <sub>3</sub> ).                                                                                                                                                                                                                                                                                                                           |
| <b>Global Warming Potential</b>     | For each gas, the Global Warming Potential is defined as its warming influence in relation to that of carbon dioxide over a 100-year period. Emissions are then presented in carbon dioxide equivalent units (CO <sub>2</sub> e).                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Gross emissions</b>              | The GCCA define gross emissions as a value which includes the total direct carbon dioxide emissions (excluding on-site power generation) from a cement plant or organisation, including carbon dioxide from fossil wastes but excluding carbon dioxide from biomass wastes <sup>37</sup> , which is not reported. BS EN 15804+A2:2019 specifies that gross emissions values include the incineration and co-incineration of waste, and BS EN 16908:2017+A1:2022 includes processing, incineration and co-incineration of waste. Therefore, the definition used here is carbon emissions from the product including incineration of waste during production. |
| <b>Indirect emissions (EU CBAM)</b> | Emissions from the production of electricity, which is consumed during the production processes of goods, regardless of the location of the production of the consumed electricity.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Inertinite</b>                   | Biogenic carbon which becomes inert within biochar.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Intensity data</b>               | Data sourced which provides carbon dioxide equivalent emissions associated with the product output per life cycle module (e.g.: kg CO <sub>2</sub> e/tonne).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

<sup>37</sup> GCCA, 2019, GCCA Sustainability Guidelines for the monitoring and reporting of CO<sub>2</sub> Emissions from cement manufacturing, URL: [https://gccassociation.org/wp-content/uploads/2019/03/GCCA\\_Guidelines\\_CO2Emissions-v0.pdf](https://gccassociation.org/wp-content/uploads/2019/03/GCCA_Guidelines_CO2Emissions-v0.pdf)

| Term                          | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Kyoto Protocol Product</b> | Gases specified within the Kyoto Protocol which are typically emitted from anthropogenic activities which contribute to global warming. This includes carbon dioxide (CO <sub>2</sub> ), methane (CH <sub>4</sub> ), nitrous oxide (N <sub>2</sub> O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF <sub>6</sub> ), and nitrogen trifluoride (NF <sub>3</sub> ).                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Life Cycle Assessment</b>  | The process of evaluating the environmental impact of a product or service across its life cycle, and against a range of environmental indicators.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Life Cycle Inventory</b>   | The database of information created when conducting an LCA.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Location-based method</b>  | Carbon calculation methodology which uses the average grid emissions of the geographical location where the electricity is consumed. This would not account for renewable energy certificates purchased individually by product manufacturers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Market-based method</b>    | Carbon calculation methodology which is based on specific emissions associated with the electricity purchased by a company. This methodology allows for product manufacturers to account for renewable energy certificates within their emission calculations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Manufacturers</b>          | Companies in the steel, cement and concrete industry making goods for sale.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Net emissions</b>          | Emissions value which exclude 1) the carbon dioxide emissions of alternative fossil and non-biogenic content of mixed fuels used in production, i.e. from the incineration of wastes, and exclude 2) comparable benchmark emissions for external heat transfer, i.e. indirect carbon dioxide from emissions reductions achieved at waste disposal sites as a result of alternative fuels utilisation in cement plants <sup>38</sup> . In BS EN 16908:2017+A1:2022, net is defined as the impacts caused excluding the incineration of wastes, but does not include indirect carbon dioxide from emissions reductions at waste disposal sites.<br>Therefore, the definition used here is carbon emissions from the product excluding incineration of waste during production. |
| <b>Operator</b>               | Refers to the body operating an installation under the Emissions Trading Scheme.<br>See also Programme Operator for another context.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

<sup>38</sup> GCCA, 2019, GCCA Sustainability Guidelines for the monitoring and reporting of CO<sub>2</sub> Emissions from cement manufacturing, URL: [https://gccassociation.org/wp-content/uploads/2019/03/GCCA\\_Guidelines\\_CO2Emissions-v0.pdf](https://gccassociation.org/wp-content/uploads/2019/03/GCCA_Guidelines_CO2Emissions-v0.pdf)

| Term                                           | Definition                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Partitioning</b>                            | Carbon impacts are allocated to the co-products in a way that reflects the underlying physical relationships between them.                                                                                                                                                                                                                                                              |
| <b>Primary data</b>                            | Directly collected information. Examples of primary data include the weight of raw materials used, and the amount of energy consumed. Primary data is often from the processes and systems which the manufacturers are directly in control of.                                                                                                                                          |
| <b>Programme Operator</b>                      | EPD Programme Operators are independent organisations establishing the framework for EPD, including developing and maintaining PCRs, overseeing the EPD verification process, and publishing finalised EPD in a recognised database. They define detailed, specific rules on how EPD are created for a particular product category, to promote a standardised and transparent approach. |
| <b>Relevant precursor (EU CBAM)</b>            | A simple or complex good which has embedded emissions not equal to zero and which is identified as being within the system boundaries for the calculation of embedded emissions of a complex CBAM good.                                                                                                                                                                                 |
| <b>Secondary data</b>                          | Secondary data sources are defined as sources outside of primary data. This includes data from suppliers, data taken from other EPD, data from a LCI which the operator has not compiled themselves or data from standards or third parties such as industry bodies. Also called Background Data by BS EN 15941:2024.                                                                   |
| <b>Transmission and distribution emissions</b> | Emissions from the losses and activities associated with the transmission and distribution of electricity to the site where it is used.                                                                                                                                                                                                                                                 |
| <b>Upstream emissions</b>                      | GHG emissions which occur before the point of interest for the study. For example, from a customer's perspective, these will be emissions before the product or service is delivered to them. From a manufacturer's perspective, upstream emissions come from raw materials used in the manufacturing process.                                                                          |
| <b>Well to Tank emissions</b>                  | Upstream emissions associated with extraction, refining and transporting raw fuel sources to the site prior to combustion. In other terms, it includes all emissions before the point where the fuel is used in an engine, for example.                                                                                                                                                 |

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# Appendix 1: Key concepts

Appendix 1 provides an overview of key concepts that are included within this report. The purpose of this is to provide the necessary information for readers of all technical and non-technical backgrounds to be able to interpret the key findings and recommendations of this report. Consolidation into one Appendix reduces the need for, and duplication of, general descriptions throughout specific technical sections.

## A1.1 Summary of steel, cement and concrete production

### Steel

There are two main methods of steelmaking in the UK. Greenhouse gas (GHG) emissions arising from manufacturing will differ depending on the method used:

- Blast Furnace / Basic Oxygen Furnace (BF-BOF). This uses iron ore and coal along with electricity for some processes.
- Electric Arc Furnace (EAF). This uses scrap steel or Direct Reduced Iron (DRI) as the primary raw material, and electricity as the heat source.

### Steel production methods

#### ***Blast furnace basic oxygen steelmaking***

The BF-BOF route relies on the reduction of iron ore into 'pig' iron. Iron ore is a type of iron oxide, which requires a reduction agent to separate the iron from its oxide. The reduction agent employed is typically carbon, with coal/coke employed as the primary carbon-bearing reducing material<sup>1</sup>.

These carbonaceous materials are combined in a blast furnace, along with the iron ore and other materials including sinter (agglomerated iron ore, coke breeze, fluxes and fines) and fluxes (which act to remove impurities and form slag). They are then heated to extreme temperatures to produce liquid iron containing ~4% carbon.

This iron is then tapped from the blast furnace and transferred to a basic oxygen furnace (BOF). Here, oxygen is blown into the liquid iron to react with the carbon, forming CO<sub>2</sub>. Once the carbon level has been reduced to less than 0.3%, this is what the industry understands as low carbon or mild steel.

Prior to transferring liquid iron to the BOF converter, up to 20% scrap steel is placed in the empty BOS vessel to act as a coolant. This is to mitigate the significant heat generated during the oxygen blowing process. Finally, alloying additions are introduced to the BOS converter, and refining of the chemical composition takes place. At this stage, the steel is ready to be cast, typically by continuous casting in slab, billet, or bloom geometries. After solidification, the cast product is processed further via downstream operations.

Figure 13 outlines the steel production process using the BF-BOF route.

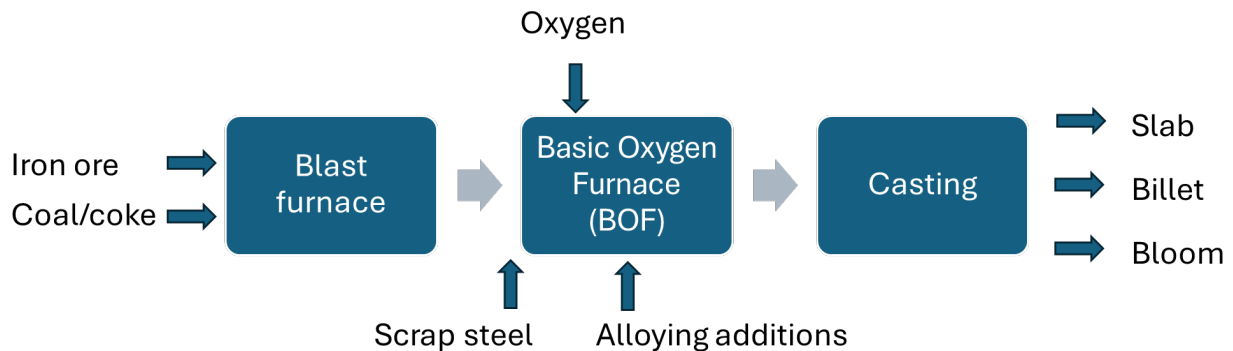


**Figure 13: Steel production schematic via BF-BOS.**

### **Electric Arc Furnace**

The EAF route's primary feedstock is scrap steel; however, this may be combined with alternative iron sources, including DRI and iron pellets. Materials are melted using high-power electric arcs in the electric arc furnace, converting the primary feedstock into liquid steel. This reaches the same quality as that of an integrated steel plant, creating slag as a by-product<sup>2</sup>. The liquid steel is then tapped into a ladle furnace for refining.

Once the required chemical composition is achieved through the addition of alloying elements, the steel is either continuously cast or ingot cast, then processed further via downstream operations into slab, billet or bloom. Figure 14 outlines the steel production process using the EAF route.

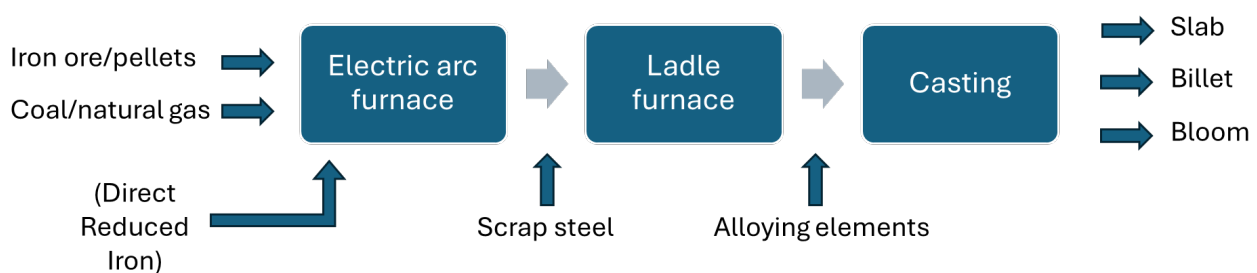


**Figure 14: Steel production schematic via EAF.**

### **Finished steel products**

Following liquid steelmaking, most steel products will start their solid life cycle in one of these forms (ingot, slab, billet or bloom). These have been referred to as intermediate steel products in this research. Steel is rarely used in this state and require processing to form a useable product. The downstream processing and supply chain is more complex. Figure 16 displays a selection of finished or near-finished states which are often produced for supply, non-specific to construction purposes.

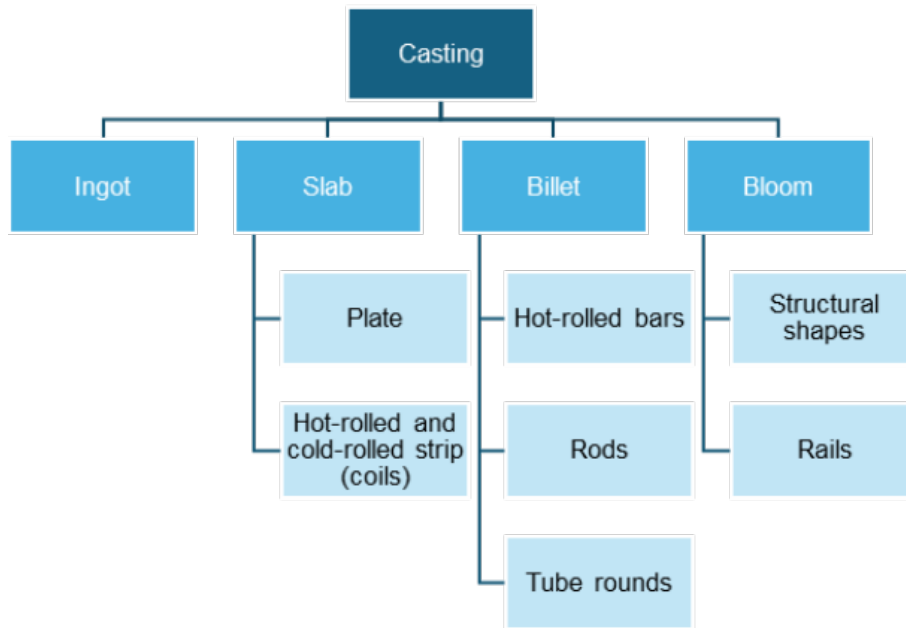


**Figure 15: Finished and near-finished steel products following casting.**

Most steelmakers in the UK have the capacity to complete several downstream operations in-house, or at another company-owned site, which would typically see the product pass through several subsequent stages to reach a finished or near-finished state. However, it is commonplace for steel to be extracted from any point in the downstream operation and supplied in that condition. For example, Tata Steel can roll from slab to cold rolled coil but can supply product from any interrupted point in the process, such as slab, plate, hot rolled coil, or cold rolled coil. Often, final processing stages prior to use, such as stamping, forming or machining, are performed by the product manufacturer (as opposed to the steel manufacturer / processing plant). In this report, hot rolled steel has been taken forward for analysis.

## Cement and concrete overview

Cements are defined in this study according to BS EN 197-1:2000 Part 1 section 4. CEM types are based on Portland Cement Clinker (PCC, also known as Ordinary Portland Cement or OPC). All commercial cements in the UK are based around PCC, with designation as seen in Figure 16 below:

| Cement Designation                                                                      | Main Constituents                              | Limitations on non clinker composition (# % by mass) |
|-----------------------------------------------------------------------------------------|------------------------------------------------|------------------------------------------------------|
| <i>Cement types permitted in EN 197-1</i>                                               |                                                |                                                      |
| CEM I                                                                                   | Portland Cement                                |                                                      |
| CEM II                                                                                  | Blastfurnace Slag                              | 35%                                                  |
|                                                                                         | Silica Fume                                    | 10%                                                  |
|                                                                                         | Natural Pozzolan                               | 35%                                                  |
|                                                                                         | Pulverized-fuel Ash (siliceous and calcareous) | 35%                                                  |
|                                                                                         | Burnt Shale                                    | 35%                                                  |
|                                                                                         | Limestone                                      | 35%                                                  |
|                                                                                         | Composite (mix of above constituents)          | 35%                                                  |
| CEM III                                                                                 | Blastfurnace Slag Cement                       | 95%                                                  |
| CEM IV                                                                                  | Pozzolana Cement                               | 55%                                                  |
| CEM V                                                                                   | Composite Cement                               | 50%                                                  |
| <i>Cement types permitted in BS8500 (combinations manufactured in the cement plant)</i> |                                                |                                                      |
| CEM I                                                                                   | Portland Cement                                |                                                      |
| CEM II                                                                                  | Silica Fume                                    | 10%                                                  |
| CEM III                                                                                 | Blastfurnace Slag Cement                       | 80%                                                  |
| CEM IV                                                                                  | Pozzolanic Cement                              | 55%                                                  |
| <i>Cement types permitted in BS8500 (combinations manufactured in the mixer)</i>        |                                                |                                                      |
| CII                                                                                     | Limestone Fines combination                    | 20%                                                  |
| CII                                                                                     | Pulverized-fuel Ash combination                | 35%                                                  |
| CIII                                                                                    | Blastfurnace slag combination                  | 80%                                                  |
| CIV                                                                                     | Pulverized-fuel Ash combination                | 55%                                                  |

**Figure 16: Cement types as per BS EN 197-1:2000 Part 1 section 4.**

Masonry elements (such as lime mortar and gauged mortar) and newer, non-Portland Cement based cements (such as alkali activated cements) are excluded from this research as they are not core to the construction sector in the UK.

Concrete may be defined as any granular composite bound together. For this report, the definition is refined to composites that are hydraulically bound. It is important to note that ‘concrete’ is not a single material but rather a family, which may be collectively described by certain physio-chemical principles. Concretes will vary based on the total water quantity, specific cement used, and the aggregate, which may vary in terms of physio-chemical properties, shape, size and overall volume. These differences lead to significant variation in performance in terms of physical strength, the time taken to achieve that strength, and the long-term durability of the material. It also leads to a wide range of products.

## Cement and concrete production overview

Raw materials used for cement and concrete are mined across the EU, including the UK. Aggregates for concretes are washed, graded, and if necessary crushed to achieve certain sizes and geometries, whilst minerals including limestone and clays undergo various processes to achieve specific chemical forms which are then combined and thermally treated to produce clinker.

As calcium carbonate ( $\text{CaCO}_3$ ) is converted to quicklime ( $\text{CaO}$ ) (the primary component of cement<sup>3</sup>), clinker is formed. Thermal treatment normally takes place via a rotary kiln<sup>4</sup>. This is a steel cylinder lined with firebrick, arranged on a slope so that feed travels through the kiln via gravity. The rotational speed of the kiln also controls the speed at which the feed moves, where a faster rotation results in a higher throughput.<sup>5</sup>

The clinker is then ground to produce the basis of cement powder. This may be combined with several other products, including gypsum, fly ash and ground granulated blast slag (GGBS) to produce a range of cements. The majority of cement used in the UK is based around ordinary Portland cement (CEM I), and variations are achieved by varying the total clinker content in the final mix. Proportions of fly and GGBS, for example, may be varied here. The cement powder can then be bagged and sold on the general market (including builders' merchants and ultimately to small builders and home improvers), bulk packaged (such as in a container or silo) and sold to the construction industry, or bulk package and used by the producer in their own ready-mix and precast products.

GHG emissions attributed to this stage are due to the combustion of fossil fuels to provide heating energy, and the chemical reaction emitting  $\text{CO}_2$  during calcination<sup>6</sup>.

Concrete is produced when cements are mixed with aggregates and water. This can occur on site (in situ) where the concrete is needed, or in a production plant to make concrete blocks.

Figure 17 outlines the cement and concrete production process.

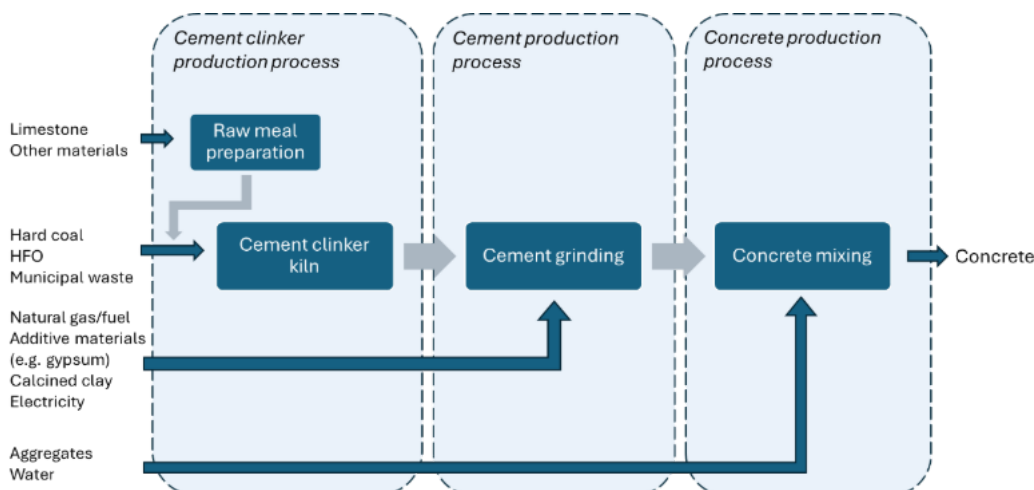


**Figure 17: Concrete production process schematic**

## A1.2 Summary of key standards

### ISO 14040:2006+A1:2020 and ISO 14044:2006+A2:2020

ISO 14040:2006+A1:2020 (ISO 14040+A1:2020) provides the overarching framework for Life Cycle Assessment (LCA) studies and Life Cycle Inventory (LCI) studies. The standard provides a high-level framework for LCAs which is adapted and tailored by other standards. It prescribes four main phases of an LCA study which are:

- a. Goal and scope definition
- b. Inventory analysis phase
- c. Impact assessment phase
- d. Interpretation phase

ISO 14044:2006+A2:2020 (ISO 14044+A2:2020) provides the specific guidelines and requirements for LCA and LCI's to conform to ISO 14040+A1:2020.

### ISO 14025:2010

ISO 14025:2010 provides guidance and principles for Environmental Labels and Declarations, which are often known as Type III Environmental Declarations. A Type III declaration is an environmental declaration providing quantified environmental data using predetermined indicators. These predetermined indicators are based on ISO 14040+A1:2020 and ISO 14044+A2:2020. They are primarily used in business-to-business communication.

### BS EN 15804+A2:2019

This standard provides the core product category rules for Environmental Product Declarations covering all construction products and services. It provides a structure to ensure that all EPD of construction products, construction services and construction processes are calculated, independently verified (if intended for business to consumer communication) and presented in a harmonised way. It defines the following:

- a. The system boundaries to be used
- b. The division of the life cycle into life cycle stages and information modules (and which modules are mandatory)
- c. The goal and scope, e.g.
  - i. Declared or functional units
  - ii. Criteria for the inclusion of inputs and outputs (cut-off)
  - iii. Data quality requirements
  - iv. Methodological considerations, including:
    - i. Co-product allocation,
    - ii. Allocation procedure of reuse, recycling and recovery
    - iii. The indicators to be declared including their methodology,
    - iv. The information to be provided and the way in which they are collated and reported.

Product Category Rules (PCRs) for steel (EN 17662 - which is still in development at the time of writing), cement (BS EN 16908:2017+A1:2022) and concrete (BS EN 16757:2022) are complementary PCRs (cPCRs) compliant with BS EN 15804+A2:2019, which provide more detailed requirements and guidance for the implementation of EN 15804 to the relevant product group.

## Greenhouse Gas Protocol: Product life cycle accounting and reporting standard

The Product Life Cycle Accounting and Reporting Standard is used to understand the full life cycle emissions of a product and focus efforts on the greatest emissions reduction opportunities. This standard can be used independently or in conjunction with the GHG Protocol Corporate and Scope 3 Standards. The accounting methodologies follow the life cycle approach established in ISO 14040+A1:2020 and ISO 14044+A2:2020. This establishes the life cycle phases of the product and therefore the emissions that should be accounted for in each phase.

## PAS 2050:2012

PAS 2050:2012 was developed in response to industry desire for a consistent method for assessing the life cycle GHG emissions of goods. PAS 2050:2012 recommends independent verification of GHG emissions assessments, which could be by an accredited certification body, another independent body or person, or could be self-declared. The verification ensures the assessment meets the requirements of PAS 2050:2012 and that the results are accurate and credible. The verification also allows the product provider to make claims and declarations about the GHG emissions of the product, such as carbon footprint labels, certificates or reports.

## BS EN ISO 14067:2018

BS EN ISO 14067:2018 is the International Standard for carbon footprinting of products, which drew on PAS 2050:2012 in its development. As with PAS 2050:2012, carbon footprints derived with BS EN ISO 14067:2018 can be verified, but verification principles, requirements and guidance on verification of carbon footprints to BS EN ISO 14067:2018 are covered in ISO 14064-3:2019.

## Standards defining data quality

There are standards which define data quality for LCAs produced to ISO 14040+A1:2020 and EPD produced to BS EN 15804+A2:2019.

ISO 14044+A2:2020 and BS EN 15941:2024 are the standards for life cycle assessments and data quality requirements for LCA-based indicator results of EPD respectively (Table 3).

**Table 3: Standards evaluated for definitions of data quality.**

| Standard          | Title                                                                                                                                        |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| ISO 14044+A2:2020 | Environmental management — Life cycle assessment — Requirements and guidelines                                                               |
| BS EN 15941:2024  | Sustainability of construction works. Data quality for environmental assessment of products and construction work. Selection and use of data |

According to these standards, data used for the purposes of a LCA, whether standalone or as part of producing an EPD, must have the categories presented in Figure 18 clearly defined and disclosed.

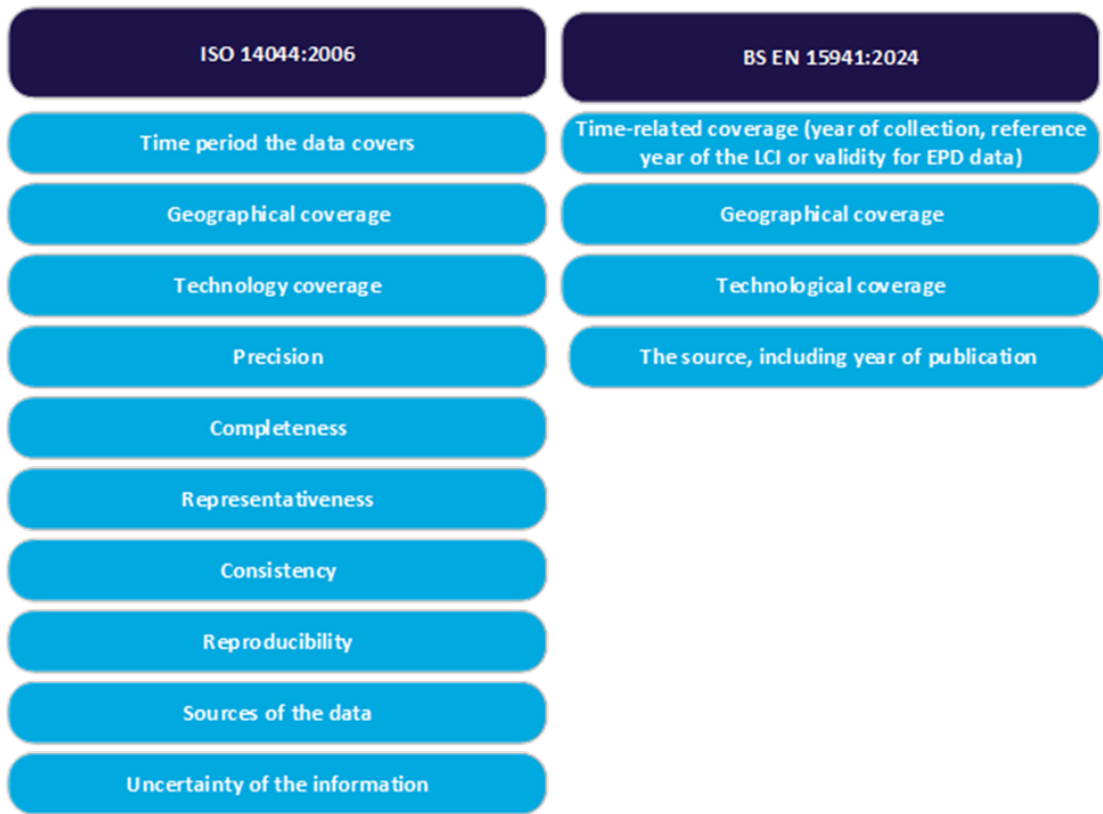


**Figure 18: Data tags required by ISO 14044+A2:2020 for LCA and BS EN 15941:2024 to assess data quality.**

The PCRs also define what good quality data sources are by referring back to BS EN 15804+A2:2019, or by specifying a dataset to use as a source of data. These are set out in Table 4.

**Table 4: Comparison of data required for each PCR studied.**

| Data                      | Steel (BS EN 17662: 2021)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Cement (BS EN 16908:2017+A1:2022)                          | Concrete (BS EN 16757:2022)                                |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|------------------------------------------------------------|
| <b>Dataset to be used</b> | <p>Datasets published by the worldsteel Association should be used.</p> <p>The dataset provides proxy data for transport (A2 and A4) in the absence of actual data.</p> <p>The draft standard states that worldsteel intermediate data for slab/sheet can be used as a substitute to steel sheet. However, worldsteel data uses a different allocation approach to BS EN 15804+A2:2019 and has been deemed not to comply with BS EN 15804+A2:2019 according to CEN TC350 and CEN BT Decision BT 020/2024. For this reason this substitution should not be used in EPD reporting.</p> | <p>The standard does not specify a dataset to be used.</p> | <p>The standard does not specify a dataset to be used.</p> |

| Data                                                           | Steel (BS EN 17662: 2021) | Cement (BS EN 16908:2017+A1:2022)                                                                                                                                                                                                                                                                              | Concrete (BS EN 16757:2022)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Selection of data</b>                                       | (As above).               | Refers to BS EN 15804+A2:2019. An EPD may cover a representative or average product rather than a specific product. Such EPD can be useful in order to provide LCA data relating to a typical product produced in a certain region or by a specific company. E.g. Average cement mix, Average European CEM II. | <p>BS EN 16757:2022 specifies that data must meet EPD objectives at national or European level especially for the following:</p> <ul style="list-style-type: none"> <li>• Cement;</li> <li>• Additions;</li> <li>• Reinforcement;</li> <li>• Transport;</li> <li>• Energy use; and</li> <li>• Water use.</li> </ul> <p>When data from EPD are used for upstream and downstream processes, the use of a BS EN 15804+A2:2019 compliant format for an EPD is preferable.</p> <p>Data assumption for average EPD can be developed at national level, taking into account principles employed at the place of production and place of use.</p> <p>When available, energy mixes used for EPD are those provided by the suppliers. If not available, reference databases shall be used.</p> |
| <b>Statements to include in accompanying report of the EPD</b> | Not specified             | Documentation of the representatives (technological, geographical, time-related representatives) of the input data shall be provided.                                                                                                                                                                          | State whether a specific concrete mix design or a generic design is used to make the assessment. State whether transport data are plant-specific or average.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| Data                                          | Steel (BS EN 17662: 2021)                                        | Cement (BS EN 16908:2017+A1:2022)                                 | Concrete (BS EN 16757:2022)                                      |
|-----------------------------------------------|------------------------------------------------------------------|-------------------------------------------------------------------|------------------------------------------------------------------|
| <b>How quality of data should be assessed</b> | Data quality should be assessed as per BS EN 15804:2012+A2:2019. | Data quality should be assessed as per BS EN 15804:2012+A2:2019 . | Data quality should be assessed as per BS EN 15804:2012+A2:2019. |

- BS EN 15804+A2:2019 and BS EN 15941:2024 state data shall be complete according to the cut-off rules in BS EN 15804+A2:2019;
- BS EN 15941:2024 and BS EN 15804+A2:2019 state generic data shall be checked for plausibility;
- BS EN 15941:2024 states data shall be checked for consistency with BS EN 15804+A2:2019; and
- Representativeness in BS EN 15804+A2:2019 and BS EN 15941:2024 is encapsulated by technical, geographical and temporal coverage.

As BS EN 15941:2024 has only recently been released, EPD will take time to be updated if EPD Programmes choose to follow this standard as well. If that happens, it is anticipated they will provide more information on the quality of data used and increase transparency, particularly around the use of Guarantee of Origin for electricity and biogas, and the use of market-based or location-based electricity. EPD Programme “ECO Platform” has already incorporated these requirements into its Calculation Rules and Verification Guidelines<sup>39</sup>.

## A1.3 Industry standards, benchmarks and thresholds

### worldsteel Life Cycle Inventory Methodology

The worldsteel Life Cycle Inventory Methodology is based on ISO 14040+A1:2020 and provides an internationally agreed method to quantify resource use, energy and environmental emissions associated with the manufacture of steel industry products. It encompasses from the extraction of raw materials in the ground through to the point at which they are ready to be shipped from the steelworks (steel factory gate). The standard is route specific, with data collection methodologies provided for the blast furnace-basic oxygen furnace (BF-BOF), direct reduced iron-electric arc furnace (DRI-EAF) and scrap electric arc furnace (EAF) processes.

<sup>39</sup> Construction Products Association, 2024, Environmental Product Declarations (EPD): Comparability A Technical Review, URL: [www.constructionproducts.org.uk/media/xqnn3jfl/cpa-bp-epd-comparability-a-technical-review-v1-august-2024-final.pdf](http://www.constructionproducts.org.uk/media/xqnn3jfl/cpa-bp-epd-comparability-a-technical-review-v1-august-2024-final.pdf)

## Responsible Steel Standard

The Responsible Steel (RS) Standard is a non-profit organisation that operates a global multi-stakeholder programme to certify and standardise the steel industry with the objective of achieving sustainability. Sites producing crude steel must first determine GHG emissions through Scope 1, 2 and 3 accounting. The GHG emissions intensity performance of sites producing crude steel is then disclosed allowing downstream users to support steelmakers in their effort to reduce GHG emissions. The standard also requires that companies who want to achieve a Responsible Steel Standard must also implement the recommendations of Task Force on Climate-related Financial Disclosures (TCFD) and must have long-term company level targets to reduce GHGs.

## Global Cement and Concrete Association (GCCA) CO<sub>2</sub> Protocol

The GCCA CO<sub>2</sub> and Energy Protocol is intended as a tool for cement companies to provide harmonised methodology for calculating CO<sub>2</sub> emissions. It is based on the GHG Protocol Corporate Standard. The GGCA requires its full members to attain compliance with its Sustainability Charter within five years of joining the organisation. The charter documents and incentivises members to improve environmental performance of cement and concrete producers. Alongside health and safety and social responsibility, the charter requires companies to publicly report data on climate change and energy, including GHG emissions from the production phase of cement and concrete.

## International Energy Association (IEA)

The IEA has published guidance for G7 members on Achieving Net Zero Heavy Industry Sectors, in which it defines “near zero emissions” materials production. The goal of "near zero emissions" production is to keep emissions low enough to align with the path that heavy industries need to follow to help the global energy system reach net zero emissions by 2050, as outlined in the IEA's Net Zero by 2050 roadmap. "Near zero" acknowledges the presence of residual emissions which are technically difficult, expensive or impractical to eliminate on a gross basis. The thresholds also reflect plant operators don't have control over the pace of transition of the energy sector (their energy providers). This is now being built on by national-level industry sectors, such as the Low Emissions Steel Standard (LESS) from the German Steel Association.

## Low-carbon Emissions Steel Standard (LESS)

LESS is a German-developed, voluntary standard and labelling system for steel that aims to make low-carbon and near-zero emission steel transparent, comparable, and measurable across different production technologies, like blast furnace and electric arc furnace routes. Launched by the German steel association WV Stahl with government support, it builds on the IEA's framework but expands its scope to cover downstream processes and specific quality grades. LESS provides standardised information on a steel product's carbon footprint, scrap ratio, and decarbonization level, empowering steel customers to meet their climate goals and driving market demand for sustainable steel.

## Low Carbon Concrete Group (LCCG)

The LCCG is a collaborative body of professionals from the UK's concrete and cement industry, academia, engineers, and clients, formed under the Green Construction Board. Its main purpose is to drive the decarbonisation of concrete by producing the Low Carbon Concrete Routemap and maintaining a Market Benchmark, which set out industry-wide actions, technologies, and data to reduce concrete's carbon impact and achieve net zero targets.

## A1.4 ETS, EU and UK CBAM and EPD

The **UK Emissions Trading Scheme (ETS)**, is the UK's carbon pricing system, operating as a cap and trade mechanism to reduce greenhouse gas emissions (GHG) in key industries. Established through the GHG Emissions Trading Scheme Order 2020<sup>40</sup>, it replaced the UK's participation in the EU-ETS. Under the UK ETS, one allowance gives the right to emit one tonne of CO<sub>2</sub>e. The scheme sets a cap on total emissions and allows companies to trade allowances, incentivising investment in low carbon technologies by creating a market for carbon. Each year, companies must surrender enough allowances to fully account for their emissions, otherwise fines are imposed.

ETS is primarily focussed on an installation's emissions; however, as this relates to the emissions associated with manufacturing products, it is an important scheme to recognise when looking at whole life carbon emissions of products.

The **EU CBAM** is an environmental policy instrument designed to apply the same carbon costs to imported products as would be incurred by installations operating in the EU and falling under ETS requirements. It is the EU's tool to put a fair price on carbon emitted during the production of carbon-intensive goods that are entering the EU, and to encourage cleaner industrial production in non-EU countries.

EU CBAM will be the EU's method of reducing carbon leakage. Carbon leakage occurs when there is movement of production and associated emissions from one country to another to avoid stricter climate mitigation policies. Carbon leakage undermines global decarbonisation efforts. EU CBAM aims to level the playing field by charging importers for the carbon emissions embedded in certain products.

The full implementation of EU CBAM is scheduled for 1<sup>st</sup> January 2026 and initially covers the cement, iron and steel, aluminium, fertiliser, hydrogen and electricity sectors. At the time of writing, the EU have only published full rules and guidance for the transitional phase of the EU CBAM. Details from January 2026 have not yet been confirmed or published beyond those in the main Regulation.

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<sup>40</sup> The Greenhouse Gas Emissions Trading Scheme (Amendment) Order 2020 (SI 2020/1557), [www.legislation.gov.uk/ukSI/2020/1557/contents](https://www.legislation.gov.uk/ukSI/2020/1557/contents)

Under EU CBAM, the Combined Nomenclature (CN) classification system defines the essential characteristics of goods and is used to identify those sector goods in scope for EU CBAM. From this date, importers must purchase EU CBAM certificates to cover emissions with the price of these certificates linked to the EU ETS carbon price. If a carbon price was already paid in the country of origin, it is allowed to be deducted from the EU CBAM obligation.

The EU CBAM scheme requires producers to include direct and indirect emissions of production of certain products in the boundary of the product carbon assessment.

While EU CBAM is not a full LCA, it shares many similarities. To calculate the embodied emissions of these goods, EU CBAM takes into account<sup>41</sup>:

- the direct emissions from the installation that produces the product;
- the quantities of input materials;
- the embedded emissions of these input materials;
- the indirect emissions released from the generation of the electricity consumed during the production of the product; and
- emissions from relevant precursor goods.

Under EU CBAM, the following definitions apply:

- **Direct emissions** are emissions from the production processes of goods, including emissions from the production of heating and cooling consumed during the production processes, regardless of the location of the production of the heating and cooling.
- **Indirect emissions** are emissions from the production of electricity, which is consumed during the production processes of goods, regardless of the location of the production of the consumed electricity.
- **Embedded emissions** are emissions released during the production of goods, including the embedded emissions of relevant precursor materials consumed in the production process.

EU CBAM emphasises production-phase emissions and not the entire lifecycle (e.g. use or disposal).

The **UK CBAM** was announced in 2023 and is due to come into effect from January 2027. As confirmed in October 2024, the UK CBAM will apply to specific industrial goods imported to the UK from the aluminium, cement, fertiliser, hydrogen and iron & steel sectors<sup>42</sup>.

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<sup>41</sup> European Commission Taxation and Customs Union, 2025, CBAM Guidance and Legislation, URL: [https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism/cbam-guidance-and-legislation\\_en](https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism/cbam-guidance-and-legislation_en)

<sup>42</sup> HMRC and HMT, 2024, Introduction of a UK Carbon Border Adjustment Mechanism from January 2027 – Government response to the policy design consultation, URL: [https://assets.publishing.service.gov.uk/media/679cb194a9ee53687470a2fa/Introduction\\_of\\_a\\_UK\\_Carbon\\_Border\\_Adjustment\\_Mechanism\\_from\\_January\\_2027\\_-\\_Government\\_response\\_to\\_the\\_policy\\_design\\_consultation.pdf](https://assets.publishing.service.gov.uk/media/679cb194a9ee53687470a2fa/Introduction_of_a_UK_Carbon_Border_Adjustment_Mechanism_from_January_2027_-_Government_response_to_the_policy_design_consultation.pdf)

**Environmental Product Declarations (EPD)** (also known as Type III environmental declarations) are documents that aim to communicate the environmental performance of a product or material over its lifetime in a standardised LCA format. This is meant to be transparent, and to enable companies to make credible and verifiable claims. ISO 14025:2010 sets out the principles and specifies the procedures for developing EPD.

EPD themselves report the environmental impact of the product as determined by a separate LCA study, and detailed inputs and emissions results are not included in the EPD itself. Instead, results for certain environmental indicators are declared, such as global warming potential (GWP, expressed in kg CO<sub>2</sub>e), ozone depletion potential (ODP, expressed in kg CFC-11eq); resource use (such as total use of renewable and non-renewable primary energy resources, expressed in MJ) and output flows (such as hazardous and non-hazardous waste, expressed in kg). EPD intended to communicate product impacts to consumers must be verified by an independent expert to ensure accuracy.

EPD help support green building certifications (such as the Building Research Establishment Environmental Assessment Method), allow for product comparisons in the context of the building, provide data for building level assessments, and enable companies to make credible and verifiable environmental claims about their products.

EPD link to Product Category Rules (PCRs) which set out the rules for how LCAs and EPD must be done for a specific product type.

## A1.5 Life Cycle Assessment

A Life Cycle Assessment (LCA) is a method used to evaluate the environmental impacts associated with all stages of a product's life – from cradle to grave. This includes:

1. Raw material extraction (mining, harvesting etc.)
2. Material processing and manufacturing
3. Transportation
4. Product use
5. End-of-life disposal (e.g. landfilling, recycling, incineration)

The main goals of an LCA are to:

- Understand the total environmental impact of a product, process or service.
- Identify the areas for improvement or optimisation.
- Support eco-design, sustainability reporting and decision making.

The four main phases of an LCA (as defined by ISO 14040+A1:2020 and ISO 14044+A2:2020 standards) are as follows:

1. Goal and Scope Definition - Define the purpose of the assessment, the system boundaries and level of detail needed.
2. Life Cycle Inventory - Gather data on the inputs (such as energy, raw materials and water) and the outputs (including emissions and waste) for each life cycle stage.
3. Life Cycle Impact Assessment - Evaluation of the potential environmental impacts (e.g. Global Warming Potential, water use, ecotoxicity).
4. Interpretation - Analysis of the results to draw conclusions and make recommendations.

## A1.6 Life cycle stages

The majority of product footprinting and carbon assessment standards and methodologies are underpinned by LCA principles, which follow the guidelines set out in the international standards ISO 14040+A1:2020 and ISO 14044+A2:2020. They outline the same general life cycle stages as seen in Figure 19. The BS EN 15804+A2:2019 standard breaks down the product life cycle into standardised modules A to D.

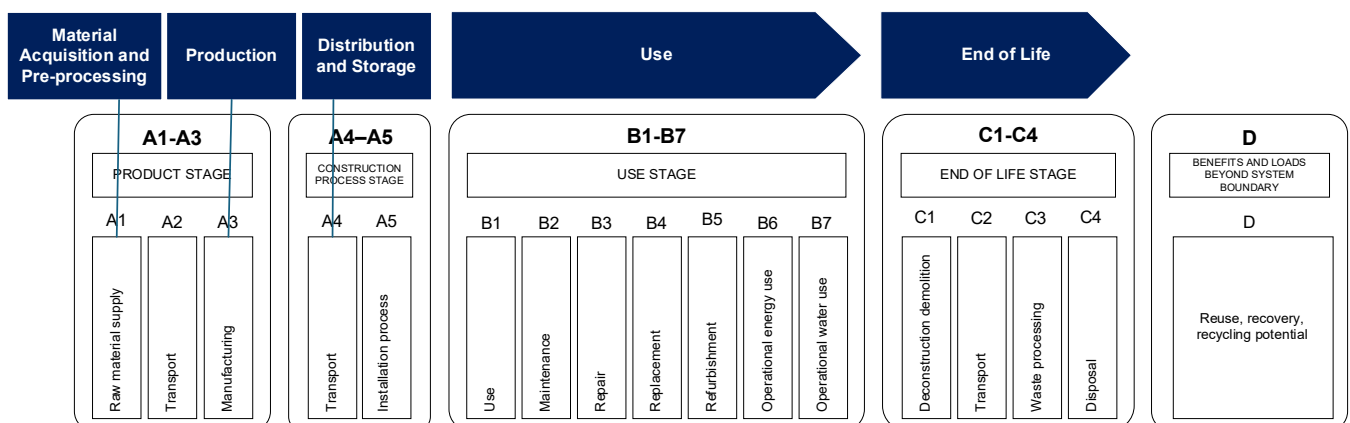


**Figure 19: Life cycle stages as defined by ISO 14010+A1:2020 (blue boxes) plotted against BS EN 15804+A2:2019 modules (A, B, C and D) (white boxes).**

As stated by BS EN 15804+A2:2019, construction products and materials shall declare stages A1 to A3, C1 to C4 and, in the A2 revision from 2019, module D. B1 to B7 use stage modules are optional for cradle to grave studies. Module D quantifies the net benefits or burdens from reuse, recycling, or energy recovery after the product's end of life. Cement products are exempt from reporting module D (as cement becomes concrete).

Cement, lime and other products which meet the exemption criteria, only need to report A1 to A3. These include:

- The product or material is physically integrated with other products during installation so they cannot be physically separated from them at end of life;

- The product or material is no longer identifiable at end of life as a result of a physical or chemical transformation process; and
- The product or material does not contain biogenic carbon.

There is a degree of variation between the requirements within BS EN 15804+A2:2019 and EU CBAM in terms of the A1 and A3 stages (Table 5).

**Table 5: Comparison of requirements within BS EN 15804+A2:2019 and EU CBAM. An 'X' represents the criteria is covered by the applicable methodology.**

| EPD requirements for A1 and A3                                                              | Covered within BS EN 15804+A2:2019                               | Covered within EU CBAM                      |
|---------------------------------------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------|
| A1: Extraction of raw materials                                                             | X                                                                |                                             |
| A1: Processing of secondary materials used as an input for product manufacture              | X                                                                | X                                           |
| A3: Emissions associated with manufacturing process (e.g. energy consumption)               | X (Note: this includes WTT <sup>43</sup> and T&D <sup>44</sup> ) | X (Note: this does not include WTT and T&D) |
| A3: Emissions associated with the manufacture of packaging                                  | X                                                                |                                             |
| A3: Emissions released on site during manufacturing (e.g. emissions to air)                 | X                                                                | X                                           |
| A3: Emissions associated with the disposal of waste produced from the manufacturing process | X                                                                |                                             |

<sup>43</sup> Well-To-Tank

<sup>44</sup> Transmission and Distribution

## A1.7 Allocation in LCA

In LCA, co-outputs or co-products produced alongside a primary product may be allocated a portion of emissions from a production process, thus reducing the emissions allocated to the primary product. EPD follow a hierarchy in allocating emissions to co-products, based on ISO 14044+A2:2020. This is:

- **Avoid allocation** through:
  - **Subdivision:** This involves breaking down multifunctional processes into smaller sub-processes, each producing only a single product.
  - **System expansion to avoid allocation:** This involves expanding the system boundary of the product to include the additional co-products. Although this method is outlined within ISO 14044+A2:2020, it is not permitted under BS EN 15804+A2:2019. worldsteel uses this methodology for its LCAs.
- **Physical partitioning:** This involves identifying a physical relationship between the co-products that can be used to share out the impacts in a way that reflects how inputs and outputs change as the quantities of each co-product change. Examples include mass, volume, area or energy content. The person carrying out the calculation must decide which approach is most suitable and provide justification.
  - **Mass allocation (mass balance):** impacts are assigned according to the relative weight of the products.
  - **Volume allocation:** impacts are assigned according to the relative volume of the products.
  - **Area allocation:** impacts are assigned according to the relative surface area of the products.
  - **Energy content allocation:** impacts are assigned according to the relative amount of energy required by each product during the process.
  - **Economic allocation:** This involves allocating impacts according to economic value, based on the relative revenue the manufacturer could receive from each co-product. Where a by-product is passed to another manufacturer and payment flows the other way, no environmental impacts are assigned to that by-product. Economic allocation is used when none of the higher-priority approaches can be applied. For example, it may be needed where the balance between co-products cannot be altered, or where no physical relationship reflects changes in outputs.

## A1.8 Differences in reporting

### Electricity reporting

Emissions associated with the use of electricity can be based on different emissions factors. The location-based method for reporting emissions from electricity involves emissions factors that represent the average greenhouse gas (GHG) emissions per unit of electricity generated in a specific geographic region. The market-based method for electricity emissions reporting

allows the use of supplier-specific emission factors or certificates with renewable energy claims linked to purchased electricity.

The Residual Mix is the 'leftover' electricity mix – and its associated emissions – after all renewable energy claims have been removed (such as those backed by Renewable Energy Certificates or Guarantees of Origin). When a company or individual purchases renewable energy certificates, they can claim the low-carbon attributes of that electricity. Those attributes are subtracted from the total national or regional mix which results in a residual mix. Those not using renewable energy certifications must use the residual mix; this ensures the prevention of double counting of renewable energy claims.

## Gross vs net emissions

The Global Cement and Concrete Association (GCCA) defines gross emissions as a value which includes the total direct carbon dioxide emissions (excluding on-site power generation) from a cement plant or organisation, including carbon dioxide from fossil wastes but excluding carbon dioxide from biomass wastes<sup>45</sup>, which is not reported. This is because the biogenic carbon is balanced by uptake or sequestration earlier in the life cycle of the fuel.

BS EN 15804+A2:2019 specifies that gross emissions values include the incineration and co-incineration of waste; as with the GCCA, biogenic CO<sub>2</sub> emissions from biomass waste are balanced by sequestration earlier in the life cycle. BS EN 16908:2017+A1:2022 (the Product Category Rule for cement and building lime EPD) includes processing, incineration and co-incineration of waste. Therefore, the definition used within this report is carbon emissions from the product including incineration of waste during production.

Net emissions (in this context) represent an emissions value which exclude the carbon dioxide emissions of alternative fossil and non-biogenic content of mixed fuels used in production, i.e. from the incineration of wastes. The GCCA also exclude comparable benchmark emissions from external heat transfer, i.e. indirect carbon dioxide from emissions reductions achieved at waste disposal sites as a result of alternative fuels utilisation in cement plants<sup>46</sup>. In BS EN 16908:2017+A1:2022, net is defined as the impacts caused excluding the incineration of wastes but does not include indirect carbon dioxide from emissions reduction at waste disposal sites. Therefore, the definition used within this report is carbon emissions from the product excluding incineration of waste during production.

## 'Well To Tank'

Well to Tank (WTT) emissions are the upstream emissions associated with extraction, refining and transporting of raw fuel sources to the site prior to combustion / use. WTT emissions expand the system boundary beyond direct use which helps capture the true environmental

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<sup>45</sup> GCCA, 2019, GCCA Sustainability Guidelines for the monitoring and reporting of CO<sub>2</sub> Emissions from cement manufacturing, URL: [https://gccassociation.org/wp-content/uploads/2019/03/GCCA\\_Guidelines\\_CO2Emissions-v0.pdf](https://gccassociation.org/wp-content/uploads/2019/03/GCCA_Guidelines_CO2Emissions-v0.pdf)

<sup>46</sup> GCCA, 2019, GCCA Sustainability Guidelines for the monitoring and reporting of CO<sub>2</sub> Emissions from cement manufacturing, URL: [https://gccassociation.org/wp-content/uploads/2019/03/GCCA\\_Guidelines\\_CO2Emissions-v0.pdf](https://gccassociation.org/wp-content/uploads/2019/03/GCCA_Guidelines_CO2Emissions-v0.pdf)

impact of fuels or energy systems. In LCAs, ignoring WTT may underestimate the total impacts.

### ‘Transmission and Distribution’

Transmission and Distribution (T&D) emissions are the emissions associated with the transport and delivery of electricity, including losses within the grid. Including T&D emissions increases the carbon intensity of delivered electricity.

## A1.9 Data types

Data used for carbon assessments can be categorised by source, specificity to the product and process under study, and whether it is expressed as direct measurement or intensity.

Source:

- Primary sources are defined as directly measured data. It is also sometimes referred to as raw data and activity data.
  - Examples of primary data include: the weight of raw materials used, or the amount of energy consumed.
  - These are data which manufacturers typically collect themselves.
  - Primary data is often from the processes and systems which the manufacturers directly control.
  - Primary activity data provides a quantitative measure associated with an activity that generates greenhouse gas emissions. This is often recorded in absolute measurement units, such as kg, kWh, MJ.
  - Primary data is highly specific to the product under study, because it is collected directly from the process making it. The manufacturer may collect it, but they do not necessarily publish or disclose it.
  - Primary data can be generic if the manufacturer averages it across products or processes.
- Secondary data is used by an organisation but not directly produced by it, unlike 'primary data'.
  - Examples of secondary data include: data from suppliers; data taken from other EPD; data from a Life Cycle Inventory (LCI) which the operator has not compiled themselves; data from standards; and data from third parties such as industry bodies.
  - Secondary data is often generic. Generic data is not site or enterprise specific, as per BS EN 15804+A2:2019.
  - Often but not always, secondary data are emissions factors where an input or precursor good (such as iron ore which is an input good for steel production) has a specified emissions factor per mass of the good.
  - Secondary data may be specific to a process.
  - Secondary data is useful for manufacturers to use when they do not have specific data from their suppliers.

Specificity:

- Specific: this refers to being specific to the product under study, using the same manufacturing methods or production process of that product.
  - Most primary data is specific.
  - The manufacturer can average their data across a time period, and still consider the data to be specific to their process.

- Generic: this refers to data being used which is similar to the product or manufacturing methods, but not the same.
  - Examples include industry averages of a product. These are taken from many sites with different energy and raw material usage, so when averaged, the values being generic of the product under study.

Additionally, the emissions associated with products can be reported as intensity. Intensity data provides carbon dioxide equivalent emissions associated with the product output, often expressed by product weight (e.g.: kg CO<sub>2</sub>e/tonne).

For example, an emissions intensity factor for iron ore mining (e.g. 'X kg of CO<sub>2</sub>e per unit of iron ore') that a steel producer can use when they buy a mass of iron ore and add to their own primary data for the product carbon footprint (PCF).

Intensity data can be reported by manufacturers to demonstrate the GWP impact of their product, without disclosing the inputs of that product.

## Appendix 2: Comparing methodologies and standards

This Appendix examines the transparency and comparability of current carbon assessment methodologies, focusing on EPD and the transitional phases of EU CBAM as of December 2024. The analysis covers how differences in methodology and system boundaries influence reporting, examines factors affecting transparency and the reliability of results, discusses associated financial and administrative costs, and addresses how outcomes can be effectively communicated to support consumer understanding.

### A2.1 Methodological differences and system boundaries

A central challenge in comparing EPD and the EU CBAM is differing methodological frameworks and system boundaries. These differences influence the interpretation of results and comparability across sectors and jurisdictions.

#### Allocation methods

Allocation is required where the environmental impacts of a single process must be distributed across multiple co-products. In steel production, for example, blast furnaces generate both pig iron and slag. Decisions on allocation determine how process emissions, including electricity consumption, are attributed between these outputs. The hierarchy of allocation methods includes: avoiding, system expansion, physical partitioning, economic allocation methodologies and is defined in ISO 14044+A2:2020 (detailed in Appendix 1).

#### Impact of allocation methods on steel emissions

worldsteel permits the use of system expansion to allocate co-products, such as slag from steelmaking that can be used in cement production. Under system expansion, market effects are modelled: when a by-product from one process is used, it reduces the need to produce the same material elsewhere. This can apply both to manufacturing by-products and to outputs recovered at end of life. ISO 14044+A2:2020 identifies system expansion as a preferred method because it avoids allocation. However, the steel sector has agreed that it cannot be applied to EPD produced in line with BS EN 15804+A2:2019.

Instead, the sector proposed the use of physical partitioning for pig iron and slag in pr EN 17662:2021, by separately considering the energy and inputs needed for each. In practice, these products cannot be made independently, and their production quantities cannot be varied to any significant extent. CEN TC350 and CEN BT Decision BT 020/2024 confirmed that this approach does not comply with BS EN 15804+A2:2019.

The draft standard pr BS EN 17662:2021 stated that worldsteel intermediate data for slab and sheet products could be used for steel sheet. However, worldsteel data should not be used in producing EPD, because it relies on system expansion and therefore does not meet BS EN 15804+A2:2019 requirements.

In practice, the choice of allocation method has only a modest effect on the GWP of steel, with estimates suggesting system expansion gives results around 3%–7% lower than economic allocation<sup>47</sup>. Under mass-based allocation, around 40% of blast furnace impacts are assigned to slag, as it represents 40% of the output by mass. This significantly reduces the impacts assigned to steel but is generally considered inappropriate. This is a particular concern when trying to establish the true greenhouse gas (GHG) emissions burdens in interconnected systems, such as when slag is used in cement production.

### Impact of allocation methods on cement emissions

The choice of allocation method can materially influence reported GHG emissions, as illustrated in Figure 20, for cements containing varying proportions of ground granulated blast-furnace slag (GGBS), a co-product derived from the blast furnace steel production route. Under the system expansion approach, emissions associated with GGBS are modelled through the avoided production of clinker. Consequently, this method attributes the environmental impact of clinker production to GGBS, while awarding a corresponding credit for cement production, consistent with the methodology employed in worldsteel's existing reporting framework<sup>48</sup>.

In contrast, economic allocation assigns impacts based on the relative economic value of the co-products. Given that GGBS represents only 1%–2% of the value of steel, this approach results in a substantially lower attribution of emissions to the slag. Physical partitioning and mass-based allocation methods distribute impacts according to measurable properties such as mass or energy content, offering alternative outcomes for comparative analysis.

The adoption of system expansion neutralises differences in reported emissions for concretes incorporating different proportions of GGBS. However, it can result in a notable increase in the reported CO<sub>2</sub> footprint relative to the outcomes obtained under physical partitioning, mass allocation, or economic allocation approaches, as illustrated in Figure 20. This demonstrates the significant influence of allocation choices on life cycle assessment results and underscores the importance of methodological consistency in reporting for policy and procurement purposes.

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<sup>47</sup> World Steel Association, 2021, Life cycle inventory (LCI) study 2021 data release, URL: <https://worldsteel.org/wp-content/uploads/2021-LCA-Study-Report.pdf>

<sup>48</sup> World Steel Association, 2014, A methodology to determine the LCI of steel industry co-products, URL: <https://worldsteel.org/wp-content/uploads/A-methodology-to-determine-the-LCI-of-steel-industry-co-products.pdf>

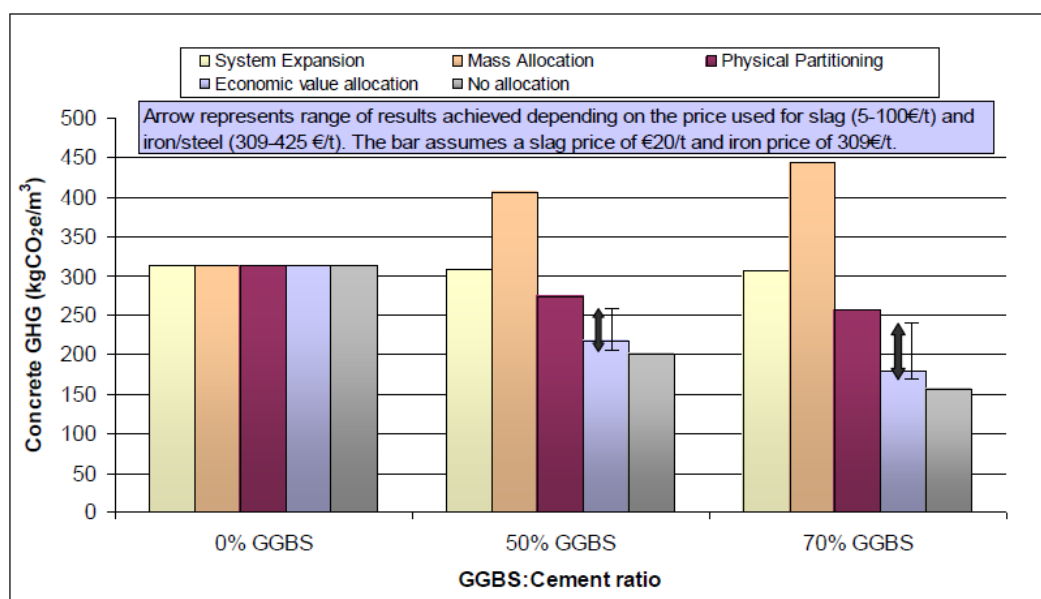


**Figure 20: Concrete CO<sub>2</sub> sensitivity to slag allocation method, from worldsteel 2014<sup>49</sup>.**

### Gross versus net reporting in cement

Within the cement industry, there is ongoing discussion regarding whether EPD should report GWP indicators as gross or net values (Appendix 1.1). An associated key difference between EU CBAM and BS EN 15804+A2:2019 methodologies is that EU CBAM requires waste-derived fuel impacts to be reported. Whilst BS EN 15804+A2:2019 default position is the use of net reporting (where waste-derived fuels impacts are not reported), which has resulted in its prioritisation within Europe. It does state that for full transparency gross values can also be declared as additional information.

The Global Cement and Concrete Association (GCCA) supports the net emissions approach. Under this methodology, the use of waste-derived fuels is considered to generate GWP savings by preventing emissions that would otherwise arise from landfill disposal or incineration without energy recovery. The GCCA therefore allows cement manufacturers to partially, fully, or even overcompensate for direct CO<sub>2</sub> emissions from waste combustion, effectively resulting in a negative carbon footprint in some instances. From this perspective, net emissions assign the GWP impacts of waste fuels to the waste processing system of the sector that generates them, thereby reducing the reported footprint of cement and concrete when these fuels are used<sup>50</sup>.

<sup>49</sup> World Steel Association, 2014, A methodology to determine the LCI of steel industry co-products, URL: <https://worldsteel.org/wp-content/uploads/A-methodology-to-determine-the-LCI-of-steel-industry-co-products.pdf>

<sup>50</sup> Jane Anderson, in conversation

## UK policy and industry practice

In the UK, the prevailing approach is to report gross emissions<sup>51</sup>. This aligns with Mineral Products Association (MPA) guidance, the majority of EPD for UK-produced cement and concrete, and the treatment of carbon emissions under the UK ETS<sup>52</sup>. Reporting gross emissions yields a higher reported carbon footprint compared to net reporting.

Individual company practices, however, may vary. For example, Heidelberg Materials UK reports net emissions in compliance with the International EPD (IBU) Programme, while providing gross emissions as supplementary information (see Figure 21).

| RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 tonne Portland Cement CEM I 52.5N |                                  |          |
|---------------------------------------------------------------------------------------------------------|----------------------------------|----------|
| Parameter                                                                                               | Unit                             | A1-A3    |
| Global Warming Potential total (GWP-total)                                                              | kg CO <sub>2</sub> eq            | 6.93E+02 |
| Global Warming Potential fossil fuels (GWP-fossil)                                                      | kg CO <sub>2</sub> eq            | 6.92E+02 |
| Global Warming Potential biogenic (GWP-biogenic)                                                        | kg CO <sub>2</sub> eq            | 1.74E-01 |
| Global Warming Potential luluc (GWP-luluc)                                                              | kg CO <sub>2</sub> eq            | 2.91E-02 |
| Depletion potential of the stratospheric ozone layer (ODP)                                              | kg CFC11 eq                      | 1.82E-05 |
| Acidification potential of land and water (AP)                                                          | mol H <sup>+</sup> eq            | 1.46E+00 |
| Eutrophication potential aquatic freshwater (EP-freshwater)                                             | kg P eq                          | 5.85E-02 |
| Eutrophication potential aquatic marine (EP-marine)                                                     | kg N eq                          | 5.32E-03 |
| Eutrophication potential terrestrial (EP-terrestrial)                                                   | mol N eq                         | 5.87E+00 |
| Formation potential of tropospheric ozone photochemical oxidants (POCP)                                 | kg NMVOC eq                      | 1.44E+00 |
| Abiotic depletion potential for non fossil resources (ADPE)                                             | kg Sb eq                         | 1.49E-04 |
| Abiotic depletion potential for fossil resources (ADPF)                                                 | MJ                               | 3.45E+03 |
| Water use (WDP)                                                                                         | m <sup>3</sup> world eq deprived | 8.04E+01 |

Remark to Global warming potential: For all GWP indicators in A1 – A3 net values are reported. The waste status of all (waste--based) fuels has been proven. Gross emissions (i.e. including CO<sub>2</sub> from combustion of proven wastes) are 804.3 kg CO<sub>2</sub>-Eq. / t (GWP--total), 804.0 kg CO<sub>2</sub>-Eq. / t (GWP--fossil), 0.3278 kg CO<sub>2</sub>-Eq. / t (GWP--biogenic).

**Figure 21: Screenshot of Heidelberg Materials UK EPD for Portland Cement (CEM I 52.5N), reporting net emissions with gross values noted in the accompanying text<sup>53</sup>.**

## Alternative fuels and impacts on reporting

The GCCA notes that some waste materials can substitute for conventional fossil fuels and minerals in cement production. These materials, known as alternative fuels and raw materials, reduce direct CO<sub>2</sub> emissions from fossil fuel combustion but generate emissions from waste-to-energy conversion. The net impact depends on the composition of the waste, which may be fossil, biomass, or mixed in origin.

GCCA's position maintains that the use of alternative fuels always results in overall GWP savings by avoiding emissions from disposal (landfill or incineration). Nevertheless, UK guidance consistently recommends reporting gross emissions<sup>54</sup>, in line with MPA guidance and

<sup>51</sup> Defra, 2009, Guidance on how to measure and report your greenhouse gas emissions, URL: <https://assets.publishing.service.gov.uk/media/5a78e1df40f0b6324769ae8c/pb13309-ghg-guidance-0909011.pdf>

<sup>52</sup> Low Carbon Concretes Group, 2024, URL: <https://www.theclimategroup.org/sites/default/files/2024-07/ConcreteZero%20-%20Classification%20methodology%20for%20embodied%20carbon.pdf>

<sup>53</sup> Heidelberg Material's EPD for Portland Cement, URL: [environmental-product-declaration-bulk-cem-i.htm\\_.pdf](environmental-product-declaration-bulk-cem-i.htm_.pdf)

<sup>54</sup> Defra, 2009, Guidance on how to measure and report your greenhouse gas emissions, URL: <https://assets.publishing.service.gov.uk/media/5a78e1df40f0b6324769ae8c/pb13309-ghg-guidance-0909011.pdf>

UK EPD practice, and consistent with UK ETS treatment<sup>55</sup>, which defines total emissions accordingly<sup>56</sup>.

The difference between net and gross emissions varies depending on the volume and type of waste-derived fuels used. Industry data indicate that net values may be 10%–25% lower than gross values. In the UK, the prevalent use of animal-derived waste, sewage sludge, and treated timber can reduce the gap between net and gross values while also lowering overall GWP emissions<sup>57</sup>. Most UK cement and concrete manufacturers report gross emissions in EPD results tables, supplementing with net values where appropriate. One manufacturer reported net values with gross values as additional information as a requirement of the IBU EPD Programme, while an LCA practitioner reported that EPD for cement produced in Eire provided net values<sup>58</sup>.

Other bodies, including the Low Carbon Concretes Group (LCCG), recommend that the embodied carbon of cement should be reported on a gross basis, including emissions from fossil waste-derived fuels (also referred to as alternative or secondary fuels)<sup>59</sup>.

The LCCG also emphasise that carbon offsets should be recorded separately under LCA Module D, “Benefits and Loads Beyond the System Boundary”, and should not be used to reduce the embodied carbon reported in LCA Modules A1 to A3. Under BS EN 15804+A2:2019, the use of carbon offsets is not permitted in GWP calculations for EPD<sup>60</sup>.

## EU CBAM methodology

For further details on EU CBAM please see Appendix A1.3. Under the EU CBAM, importers and operators include those who operate installations and produce goods that are required to submit CBAM reports via the CBAM Transitional Registry, managed by the European Commission.

Manufacturers report that the data used in EU CBAM submissions closely aligns with the EU ETS, incorporating modelling approaches to allocate emissions to specific products. Findings from this research, based on literature review, identified the following reporting requirements:

- **Inclusion of direct and indirect emissions:** Both direct and indirect emissions from primary processes are captured in the EU CBAM methodology.
- **Treatment of precursor products:** When a product is classified as a precursor, the embedded emissions of that product must be included. Embedded emissions encompass

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<sup>55</sup> Low Carbon Concretes Group, 2024, URL: [www.theclimategroup.org/sites/default/files/2024-07/ConcreteZero%20-%20Classification%20methodology%20for%20embodied%20carbon.pdf](http://www.theclimategroup.org/sites/default/files/2024-07/ConcreteZero%20-%20Classification%20methodology%20for%20embodied%20carbon.pdf)

<sup>56</sup> The Greenhouse Gas Emissions Trading Scheme Order 2020, (SI 2020/1265, URL: <https://www.legislation.gov.uk/uksi/2020/1265/contents>)

<sup>57</sup> Jane Anderson, in conversation.

<sup>58</sup> Various cement EPD for Breedon Cement and Irish Cement within EPD Ireland. <https://www.igbc.ie/epd-search>

<sup>59</sup> Low Carbon Concretes Group, 2024, URL: [www.theclimategroup.org/sites/default/files/2024-07/ConcreteZero%20-%20Classification%20methodology%20for%20embodied%20carbon.pdf](http://www.theclimategroup.org/sites/default/files/2024-07/ConcreteZero%20-%20Classification%20methodology%20for%20embodied%20carbon.pdf)

<sup>60</sup> Low Carbon Concretes Group, 2024, URL: [www.theclimategroup.org/sites/default/files/2024-07/ConcreteZero%20-%20Classification%20methodology%20for%20embodied%20carbon.pdf](http://www.theclimategroup.org/sites/default/files/2024-07/ConcreteZero%20-%20Classification%20methodology%20for%20embodied%20carbon.pdf)

all direct and indirect emissions associated with the creation of that product (see Figure 22 for an illustrative example).

- **Process aggregation (process bubbles):** Manufacturers may aggregate processes that contribute to a single product into a “process bubble,” but only if the installation produces one type of product. If multiple products are produced from the same process, aggregation is not permitted.
- **Allocation by mass balance:** Emissions are allocated using a mass balance approach. This method accounts for the quantity of all input materials and tracks how these inputs are released to the atmosphere, incorporated into outputs, or accumulated within the system. Allocation is applied both on a mass (weight) and carbon content basis. For example, if 1 kg of waste fuel is used in cement production, the methodology accounts for both the fraction of carbon released to the atmosphere and the fraction incorporated into the resulting clinker.
- **Biogenic content of plastic and fuels:** Plastic waste is recognised as containing biogenic carbon, which may be applied to offset emissions. Similarly, in accordance with the Renewable Energy Directive, biobased fuels in Europe are treated as biogenic carbon neutral when eligibility criteria are met.

A recurring observation from stakeholders (Appendix 7) is that the EU CBAM scheme is not structured in a manner readily aligned with process engineering practice. Guidance is fragmented across multiple documents, creating a substantial burden on manufacturers seeking clarity on what emissions and processes are included or excluded. The inclusion of precursors increases the level of reporting complexity and inclusion boundaries for reporting. An example process boundary is presented in Figure 22.

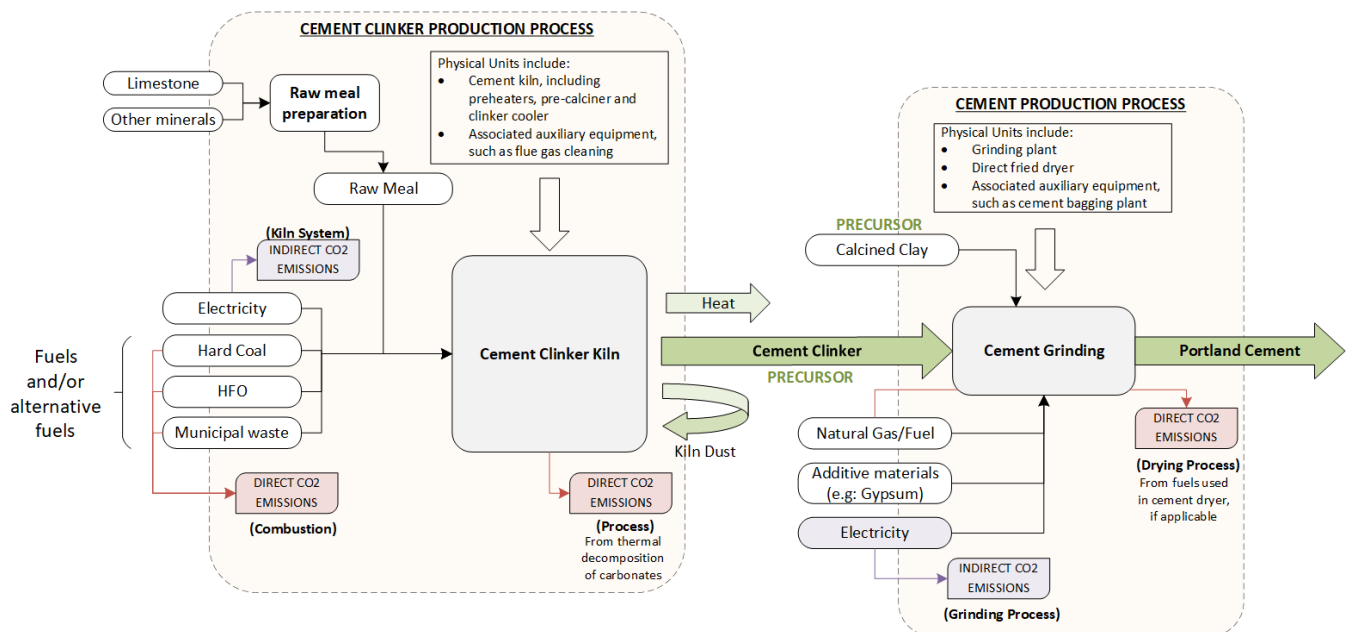


**Figure 22: Process boundaries for Portland Cement / CEM I under the transitional phase of EU CBAM. Grey boxes indicate precursor products, and all inputs according to this diagram are to be included. Direct and indirect emissions for the product are highlighted in red and purple respectively.**

## Methodology to create EPD

EPD are produced according to defined rules, using a standardised LCA methodology and reporting format. As with any quantitative product information, there is some uncertainty in the numerical values reported. This uncertainty arises from the data used in the assessments<sup>61</sup>.

The methodology to develop EPD for construction products is set out in ISO 14025:2010 and ISO 14044+A2:2020 (Appendix 1). Compliance with ISO 14025:2010 requires independent verification for EPD to be considered valid. The inclusion of different EPD modules, relative to life cycle stages, is illustrated in Figure 23.

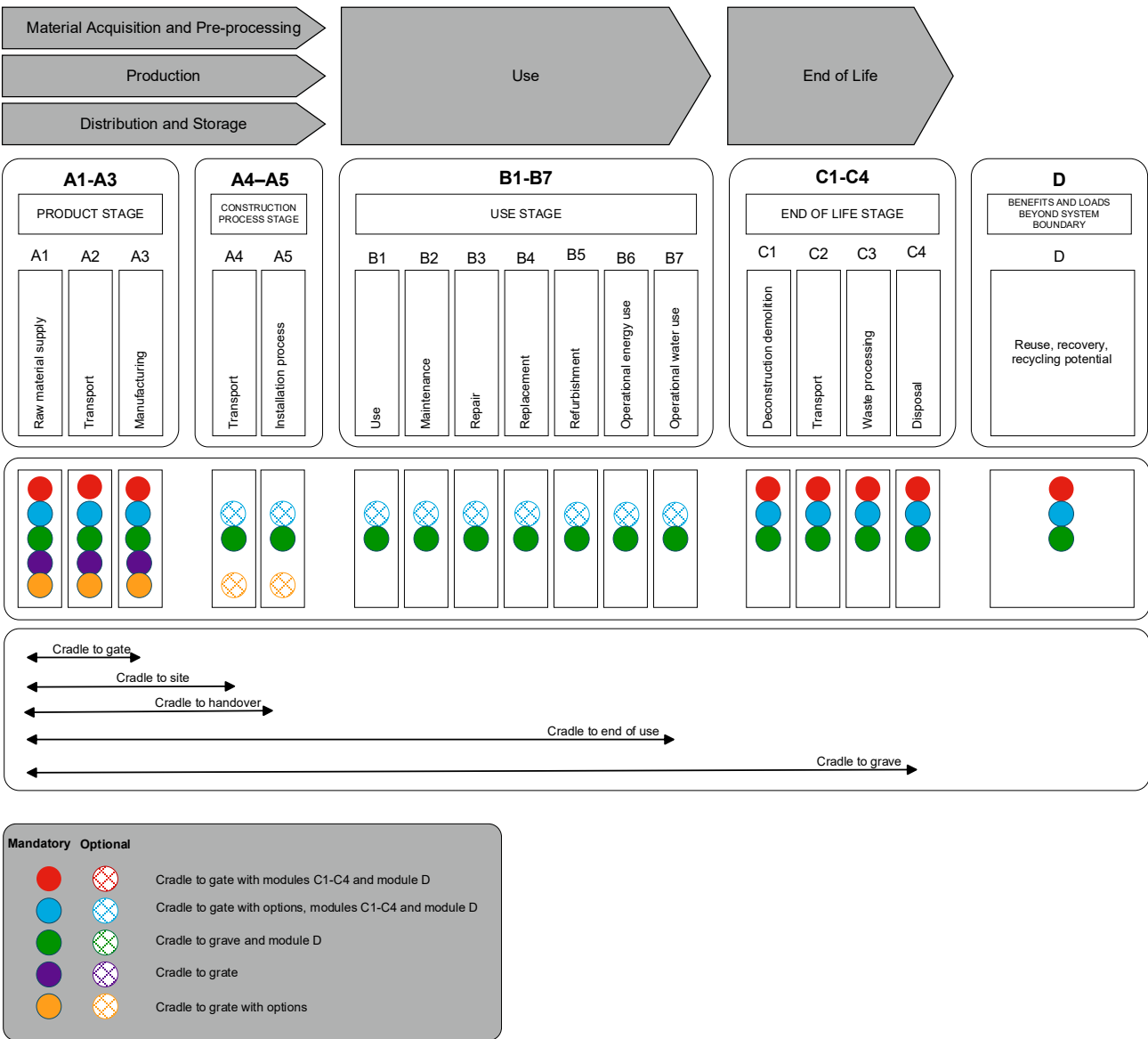


Figure 23: Boundaries of different EPD and required modules across life cycle stages.

<sup>61</sup> Construction Products Association, 2024, Environmental Product Declarations (EPD): Uncertainty A Technical Review, URL: [www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf](http://www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf)

A key consideration is that cement EPD are exempt from reporting modules C and D, in accordance with BS EN 15804+A2:2019, because the end-of-life stage for cement is as part of concrete. To claim exemption, a product must demonstrate that:

- It is physically integrated with other products during installation and cannot be separated at the end-of-life.
- It is no longer identifiable at the end of life due to physical or chemical transformation.

In contrast, all steel and concrete EPD aligned with BS EN 15804+A2:2019 are expected to include modules C and D. Intermediate steel products are not exempt because they can be standalone products. Concrete reporting modules are determined based on the intended route for end-of-life reuse, as shown in Figure 24.

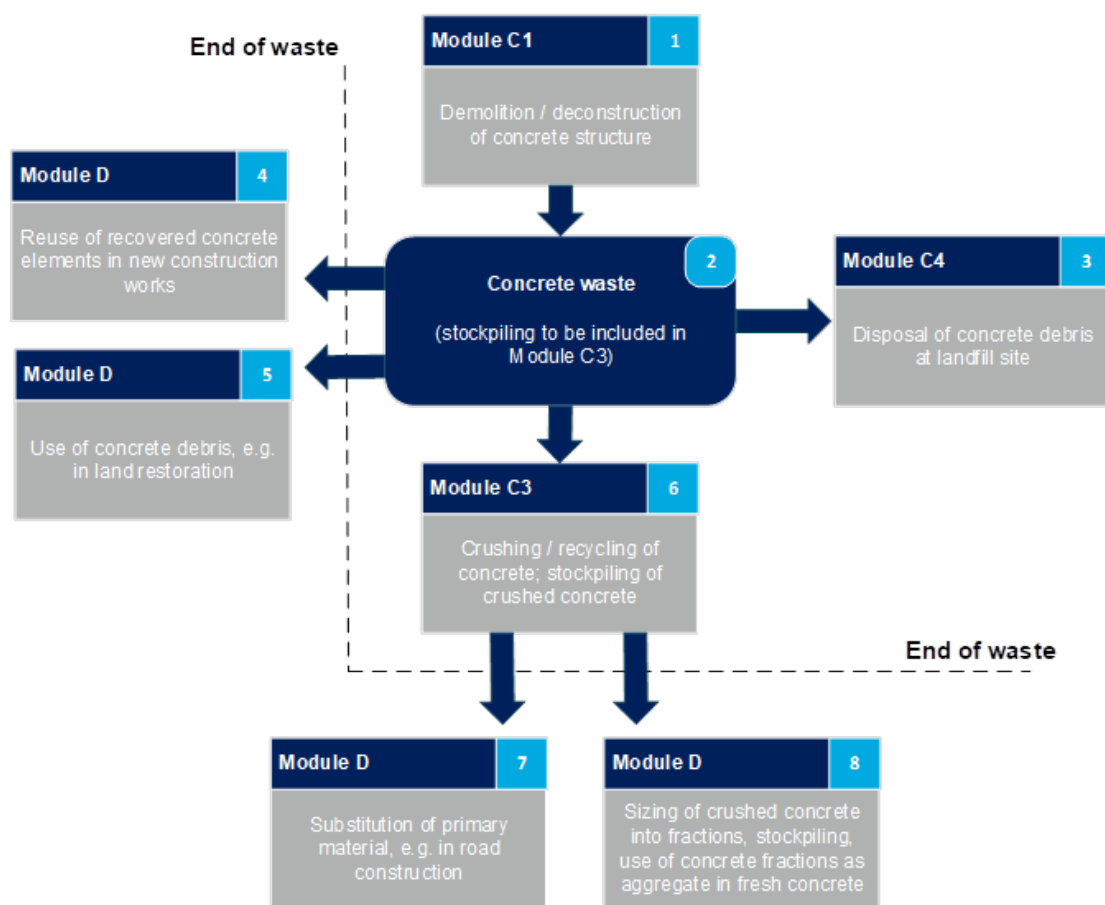


**Figure 24: Concrete reporting modules based on BS EN 16757:2022.**

Various accounting choices<sup>62</sup> underpin the LCA in EPD, including:

- The use of purchased Guarantees of Origin (GoO) to track electricity and biogas sources.
- Allocation of environmental burdens to pre-consumer recycled materials or low-value co-products, such as metals or blast furnace slag (Appendix 1).

<sup>62</sup> Construction Products Association, 2024, Environmental Product Declarations (EPD): Uncertainty A Technical Review, URL: [www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf](http://www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf)

- Inclusion of capital goods in the assessment.
- Application of Product Environmental Footprint (PEF) characterisation factors from BS EN 15804+A2:2019 versions EF 3.0 or EF 3.1, which differ in the GWP assigned to methane and may marginally reduce reported GWP when EF 3.1 is used<sup>63</sup>.

These methodological differences can significantly influence reported indicator values, particularly where electricity represents a substantial portion of manufacturing energy, products incorporate pre-consumer scrap or low-value co-products, or virgin materials generate significant pre-consumer waste.

The ECO Platform, an association of EPD Programmes for construction products, seeks to enhance consistency and transparency by providing supplementary calculation rules to BS EN 15804+A2:2019 and promoting a harmonised approach to verification. While variations may still occur, more recent EPD registered with ECO Platform member programmes disclose the approaches adopted, including:

- Whether market-based or location-based electricity and Guarantees of Origin have been used;
- Inclusion of capital goods;
- The version of PEF characterisation factors employed (with EF 3.1 required following a transition period); and
- Application of economic allocation for co-products used in cement and concrete.

This methodological transparency enables customers to understand the specific elements included or excluded from reported GWP results, provided they are aware of what is being compared. Transparency and standardisation in reporting are expected to improve further under BS EN 15941:2024<sup>64</sup>.

## A2.2 Transparency of EPD and EU CBAM

Transparency is a critical requirement for ensuring that EPD and the EU CBAM provide reliable and decision-useful data. However, current practice reveals significant variation in how methodologies, assumptions, and results are communicated to end users, particularly procurement professionals, designers, and regulators.

### Presentation of methodological assumptions in EPD

While BS EN 15804+A2:2019 requires EPD to disclose methodological choices, these are typically included in supporting text rather than in the main results tables. Industry stakeholders

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<sup>63</sup> Stapel et al, 2022 found that there was a 3-5% increase in GWP between the characterisation factors in EN 15804+A1 and EF 3.0 for EN 15804+2. EF 3.1 factors for methane are between these so the effect is likely to be between 1-3% lower for EF 3.1 than EF 3.0.

<sup>64</sup> Construction Products Association, 2024, Environmental Product Declarations (EPD): Uncertainty A Technical Review, URL: [www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf](http://www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf)

reported that this format limits accessibility and can lead to misinterpretation, particularly by non-specialists in procurement roles (further details presented in Appendix 2).

Examples of transparency issues include:

- **Gross versus net emissions in cement:** Gross values may be listed in the main table, with net emissions only referenced in supplementary notes, or vice versa depending on the EPD programme. This inconsistency creates confusion in procurement contexts where decisions may rely on headline figures.
- **Electricity accounting:** Use of renewable electricity backed by Guarantees of Origin (GoOs) is variably reported. Some EPD present market-based results (with GoOs applied) alongside location-based results; others only include one approach. Where GoOs are applied, results can differ by 30%–40% in GWP.
- **Pre-consumer recycled content:** BS EN 15804+A2:2019 permits producers to exclude impacts from pre-consumer recycled material. As a result, products with significant levels of re-used scrap or secondary materials (e.g. steel, aluminium) may present substantially lower footprints than competitors, despite equivalent underlying processes.
- **Post-consumer recycled content:** Post-consumer scrap requires no allocation and takes no impacts from its previous life. It would usually come with low A1 impacts.
- **Exclusion of capital goods:** While permitted under BS EN 15804+A2:2019, the exclusion of capital goods (e.g. plant and equipment) can lead to underestimation of life cycle impacts. Capital goods can account for up to 10% of total GWP in some industries. Some databases include these as “built in” to electricity grid and transport datasets, such asecoinvent.
- **Characterisation factors:** The choice between EF 3.0 and EF 3.1 characterisation factors affects reported results. While EF 3.1 includes improved modelling for particulate matter and toxicity, not all producers have transitioned to this method, reducing comparability.

The ECO Platform has sought to address these inconsistencies by requiring clear disclosure of methodological choices in EPD registered through its programme. However, stakeholders argued that the placement of this information in annexes or technical notes remains a barrier to effective decision-making.

## Transparency in EU CBAM reporting

Stakeholders consistently reported that EU CBAM’s transparency requirements are difficult to interpret in practice. The official guidance is dispersed across multiple Commission documents, each targeting different audiences, and is often framed in terminology unfamiliar to process engineers and plant operators.

Specific transparency concerns include:

- **System boundaries:** CBAM requires reporting of both direct and indirect emissions, including those from precursor products. However, the definition of system boundaries is not always aligned with industry's established EPD practices, leading to uncertainty.
- **Mass balance allocation:** The mandatory use of mass balance allocation for fuels creates challenges where mixed inputs are used, particularly for plants operating multiple parallel processes.
- **Treatment of fuels:** CBAM requires plastics to be reported as partly biogenic and biobased fuels as carbon neutral. Stakeholders reported that these provisions, while aligned with the Renewable Energy Directive, diverge from BS EN 15804+A2:2019 rules and create inconsistencies when comparing with EPD data.
- **Data format:** The CBAM Transitional Registry requires reporting in formats that are not compatible with standard industry monitoring, reporting and verification (MRV) systems. This results in significant additional administrative effort, particularly for small- and medium-sized enterprises.

Industry representatives highlighted that while EPD are subject to independent verification and must follow a published PCR, CBAM relies on self-declaration, albeit with later verification by accredited bodies. This discrepancy has raised concerns over the consistency and robustness of reported CBAM data.

## A2.3 Robustness and comparability

Robustness and comparability depend on the strength of verification processes, clarity on uncertainty, and strict alignment of methodological assumptions across datasets and programmes. Stakeholder testimony (Appendix 7) confirms that EPD currently offer the most transparent and comparable basis for construction products, while EU CBAM sits between ETS and EPD practice in terms of data granularity and assurance (Figure 25). EU ETS data validation involves assurance of calibration records.

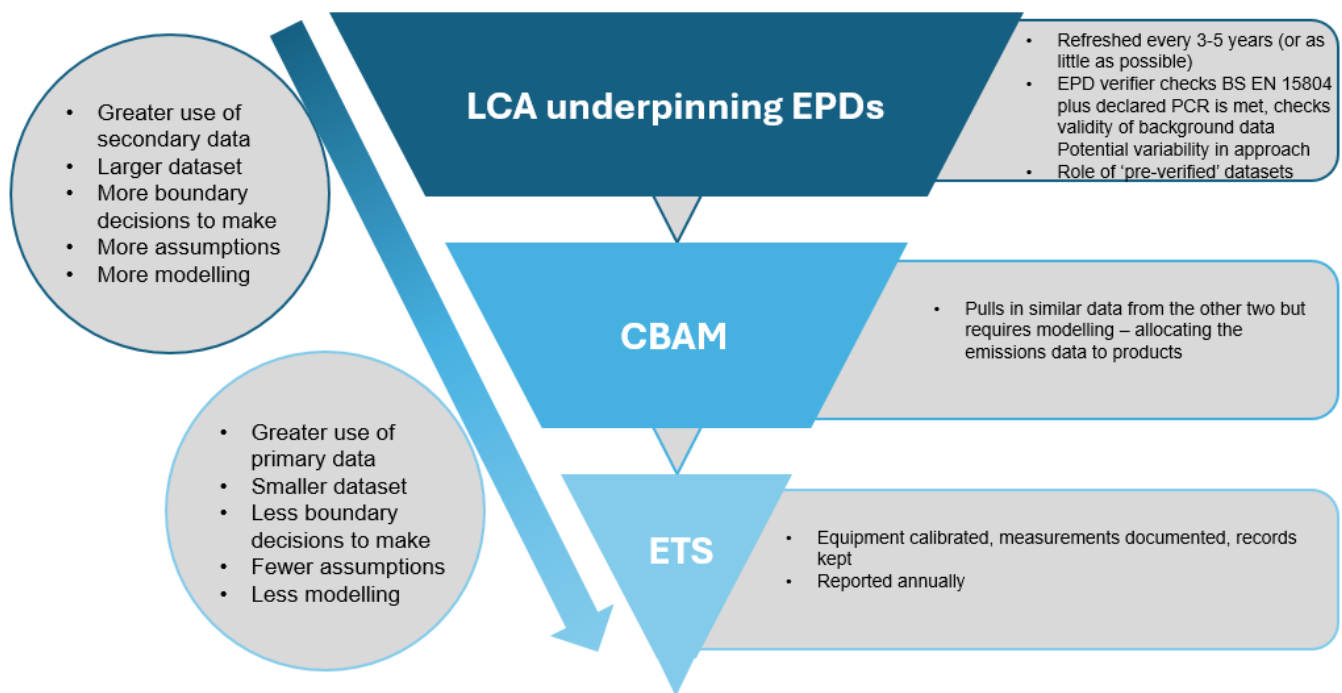


**Figure 25: Relationship between ETS, EU CBAM and LCA data.**

### Verification and data quality

**EU CBAM:** Manufacturers submit reports to the European Commission via the EU CBAM Transitional Registry. Third party country operators can also submit to the EU reporting declarant directly. Independent verification of EU CBAM reports will be required from 1<sup>st</sup> January 2026.

**EPD:** By contrast, EPD are verified prior to publication. This verification is done by independent LCA practitioners approved by the relevant EPD Programme Operator. Verification checks that:

1. Data provided by the manufacturer are plausible;
2. Foreground and background data quality has been assessed; and
3. The PCRs and overarching standards have been followed.

Stakeholder feedback indicates that EPD verification is generally robust, though individual verifiers may emphasise different aspects of the review. One experienced LCA practitioner advised that, given uncertainties, EPD results should not be considered to more than one significant figure: a product would need to be >10% better or worse in GWP to support a robust comparison. They also suggested drawing more explicitly on GWP audit practice (e.g. materiality thresholds and checks for calculation error). The overarching view is that embodied carbon calculations should be transparent and either independently verified or available for independent audit to be decision-grade.

## Market use and decision contexts

Industry examples show EPD data are already used in procurement:

- A steel manufacturer reported that EPD-based GWP impacts are being used in public procurement in the USA and the UAE.
- A concrete producer highlighted EPD use on HS2.
- In Norway, GWP must carry 30% weighting in public procurement decisions, with EPD required for products with the greatest building-level impact.
- A UK sustainability consultant cautioned that carbon is one of several factors in product selection, with cost often dominant.

Together, these examples illustrate that while EPD data is increasingly used in procurement, inconsistent formats and varying levels of assurance can undermine its effectiveness, highlighting the need for standardisation to ensure fair competition and meaningful policy impact.

## A2.4 Financial and administrative costs

### Environmental Product Declarations

The development of EPD requires significant internal resource and technical input. In most cases, responsibility for compiling the necessary data falls to environmental or sustainability teams within an organisation. These teams typically comprise between one and six full-time equivalent (FTE) staff, although EPD development is rarely their sole responsibility. Where data is already being collected for UK or EU ETS, or to support EU CBAM compliance, this information is often repurposed to support the development of EPD, thereby creating some administrative efficiencies.

Aside from internal resource costs, an industry participant reported that producing a single EPD can incur direct costs of up to £2,390–2,505. Third-party verification may cost up to £1,665–£2,780. In addition, uploading the verified EPD to BRE's Green Book Live platform can cost a further £725.

Costs vary across certification schemes. For instance:

- EPD Ireland charges from €3,100 per EPD (€1700 for verification and €1400 for registry and publication).
- The Institut Bauen und Umwelt (IBU) scheme charges up to €12,200 for a large manufacturer's EPD.

Where multiple EPD are developed from a single LCA project report, the marginal cost per EPD can be significantly reduced, due to economies of scale in data processing and model development. Several schemes offer preferential pricing or discounts to small- and medium-sized enterprises.

Under BS EN 15804+A2:2019, EPD typically remain valid for five years. Clause 9 of the standard notes: “An EPD does not have to be recalculated after 5 years, if the underlying data has not changed significantly.” However, this may result in environmental improvements, particularly in energy supply or raw material sourcing, not being reflected in the EPD if a recalculation is not undertaken.

## EU Carbon Border Adjustment Mechanism

The cost of complying with EU CBAM is primarily linked to the calculation of embedded emissions and the associated carbon cost, based on the prevailing weekly average price of the UK ETS allowance. As of April 2025, the UK ETS carbon price was £66 per tonne of CO<sub>2</sub>, with prices fluctuating between £60 (October 2024) and £84 (February 2025) over the previous year.

In addition to the carbon price, organisations incur resource costs related to administrative compliance. Interviews indicate that one FTE staff member per site is typically engaged to manage UK ETS compliance, with this individual often also supporting EU CBAM obligations (Appendix 7). These roles are commonly absorbed into existing environmental or sustainability teams and are not necessarily dedicated CBAM positions.

EU CBAM will require quarterly reporting from 2027 onwards, to align with standard quarterly accounting periods. Further detail on EU CBAM is in Appendix 1.

## Comparative analysis and data overlap

The financial and administrative costs of both EU CBAM and EPD are closely linked to the quantity and complexity of data required for compliance. Notably, EU CBAM encompasses a proportion of the emissions data required for EPD development. This overlap can offer some efficiency benefits; however, the collection of additional EPD-specific data may yield diminishing returns. In many cases, the additional information has minimal impact on the final results or carries a higher degree of uncertainty. Table 6 summarises the costs associated with EU CBAM and EPD. Further details are in Appendix 7.

**Table 6: Summarises the cost of EU CBAM and EPD gathered from literature review and interviews.**

| Methodology | Internal resource reported to handle demands of methodology     | Cost reported per product                                                                                                                                  | Number of times costs incurred                                                                   |
|-------------|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| EU CBAM     | 1 FTE<br><br>(usually already employed to support UK or EU ETS) | Cost varies, as cost of CO <sub>2</sub> per tonne based on the weekly average price of the UK ETS allowance and depends on the outcome of the calculation. | EU CBAM will require quarterly submissions to align with quarterly accounting periods from 2027. |

| Methodology | Internal resource reported to handle demands of methodology               | Cost reported per product                                                                                                                                                                                                 | Number of times costs incurred                                                               |
|-------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| EPD         | 1-6 FTE<br><br>(usually, part of an environmental or sustainability team) | Ranges from €3,100 per EPD for 5 years (EPD Ireland); £2390 - 2505; to €12,200 under IBU.<br><br>£350 a year per product subsistence to Green Book Live to maintain the EPD on their database (as reported in interview). | EPD costs arise as and when a new EPD is created, with an annual subsistence due every year. |

## A2.5 Visualising results for consumer understanding

The presentation of environmental results is as important as the underlying data in ensuring they are understood and used effectively. Evidence from stakeholders indicates that current formats for EPD are not easily interpretable by non-specialists such as architects, procurement professionals, or clients, and that the EU CBAM presents results in technical formats that are often inaccessible to most users. As a result, there is a strong case for improved approaches to both data visualisation and methodological transparency to support fair, clear, and informed decision-making.

The main users of EPD include purchasers, engineers, architects, contractors, and sustainability consultants. In the early design stages of a project, practitioners often rely on sector-level EPD or databases such as the ICE dataset. When specific products are under consideration, verified manufacturer-specific EPD are preferred. The stakeholders interviewed reported receiving many different types of carbon data that were not verified EPD and expressed significantly lower confidence in these sources (Appendix 7).

During design and procurement, using industry-average data to estimate embodied carbon is appropriate in early stages. However, as design choices become more defined (for example, when mix design, batching plant, and sources of constituents are known), the embodied carbon should be recalculated to reflect the actual product footprint.

From a manufacturer's perspective, customers often request EPD for use in their own assessments or as evidence in low-carbon procurement processes. These customers frequently focus only on GWP, especially for compliance or certification purposes (e.g. BREEAM). However, the level of understanding among EPD users varies considerably. Some users are unfamiliar with key reporting distinctions, such as gross vs net emissions (Appendix

1, Appendix 2.1), which can lead to misinterpretation and unintended consequences such as disadvantaging UK producers who report gross emissions<sup>65</sup>.

Furthermore, users often express scepticism toward carbon claims such as “zero-carbon” concrete or steel. One consultant, for instance, explained that they routinely scrutinise figures for pre-consumer recycled content and biogenic carbon accounting in detail (Appendix 7).

A number of good practices were identified to improve the accessibility and comparability of EPD results:

- **Visual comparison tools:** Graphical formats (e.g. bar charts, spider diagrams) enable users to compare multiple indicators more easily, improving transparency. For example, displaying both gross and net CO<sub>2</sub> values side by side can help clarify differences in methodology better than footnotes alone.
- **Dashboard-style summaries:** Digital platforms such as the BRE IMPACT database or One Click LCA summarise EPD data in compact visual formats while retaining access to full, verified datasets.
- **Traffic-light systems or rating scales:** Simplified rating schemes (e.g. A to E, or red–amber–green indicators) can help non-specialists interpret complex data, provided the methodology and assumptions are clearly disclosed.
- **Contextual framing:** Positioning results relative to sector benchmarks, averages, or regulatory thresholds can help users assess whether a product’s performance is above or below expectations.

In parallel with improved visualisation, the issue of comparability is critical. Stakeholders consistently highlighted that inconsistent methodologies and opaque presentation undermine the comparability of EPD. While BS EN 15804+A2:2019 is designed to ensure consistency in EPD development and theoretically enables comparability, the standard itself acknowledges that comparisons are only valid under specific conditions (BS EN 15804+A2:2019, clause 5.3). Comparability is considered appropriate at the product, component, or system level within defined life-cycle stages provided that:

- The required (functional or regulatory) performance is met;
- Any excluded elements are equivalent across comparisons (e.g. quantity and function);
- Methodological assumptions are aligned (e.g. biogenic carbon, carbon uptake, system boundaries)<sup>66</sup>.

However, in practice, EPD comparability is challenged by variations in presentation and methodology:

- EPD are often lengthy and unstructured, spanning 10–15 pages, and most users extract only headline GWP figures frequently overlooking crucial footnotes and context.

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<sup>65</sup> Defra, 2009, Guidance on how to measure and report your greenhouse gas emissions, URL: <https://assets.publishing.service.gov.uk/media/5a78e1df40f0b6324769ae8c/pb13309-ghg-guidance-0909011.pdf>

<sup>66</sup> Construction Products Association, 2024, Environmental Product Declarations (EPD): Comparability A Technical Review, URL: [www.constructionproducts.org.uk/media/xqnn3jfl/cpa-bp-epd-comparability-a-technical-review-v1-august-2024-final.pdf](http://www.constructionproducts.org.uk/media/xqnn3jfl/cpa-bp-epd-comparability-a-technical-review-v1-august-2024-final.pdf)

- Discrepancies in the treatment of gross vs net emissions (particularly in cement and concrete) create misleading comparisons, with some producers penalised for more transparent reporting.
- Differences in background datasets (e.g. ecoinvent vs GaBi), versioning, and assumptions (e.g. allocation of recycled content or use of Guarantees of Origin for electricity) which all introduce variance.

Improved comparability could be achieved by aligning key methodological choices and making them more visible in the main body of the EPD, not just in annexes. Stakeholders recommended prominently summarising assumptions such as:

- Choice of background database and version;
- Allocation methods (e.g. for pre-consumer recycled content or co-products like blast furnace slag);
- Electricity sourcing (e.g. with or without GoOs or mass balance approaches);
- Inclusion of capital goods and characterisation factors (see Appendix 3.4.3).

In terms of best practice for comparability, EPD developers and users should:

- Ensure declared or functional unit equivalence—e.g. converting data to a common reference such as per m<sup>2</sup> for building applications;
- Standardise environmental indicators and calculation rules across comparisons;
- Recognise that EPD modelled using different databases are not directly comparable without expert interpretation;
- Disclose uncertainty ranges—e.g. stakeholders reported that even high-quality A1–A3 GWP data may carry uncertainty of  $\pm 10\%$ , meaning small differences should not be over-interpreted<sup>67</sup>.

Ultimately, improving both visualisation and comparability will enhance the decision-usefulness of EPD across the construction sector. For policymakers, standardised and accessible formats would reduce misinterpretation, support transparent procurement, and align with broader UK data disclosure initiatives. For industry, improved presentation and comparability would support more level competition. For consumers and project teams, clearer and more contextualised results would enable better-informed and more confident decisions—while retaining access to full datasets for technical verification.

## A2.6 What is industry currently doing?

This section summarises the findings regarding what manufacturers, buyers and EPD verifiers are currently doing with regard to methodology.

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<sup>67</sup> Construction Products Association, 2024, Environmental Product Declarations (EPD): Uncertainty A Technical Review, URL: [www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf](https://www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf)

## Manufacturers

- Manufacturers report organisational carbon footprints under the GHG Protocol, framing results in terms of Scope 1, 2 and 3 emissions.
- For product-level assessments, manufacturers frequently combine primary data with verified secondary values. This often means using GWP values from EPD of upstream products, or factors from industry bodies. DESNZ carbon factors are sometimes used for organisational reporting.
- Some manufacturers also build internal GWP calculators to monitor emissions and track progress towards net zero.
- Across the board, manufacturers reported customer demand for simple, independently verified GWP figures, leading to requests for low-cost alternatives to full EPD.
- One additional common problem with concrete EPD is the number of different possible combinations of properties that can be specified, and that actual batch weights can change during a contract as control systems increase and decrease cements content, making it difficult to produce EPD for ready mixed concrete, even for a specified type and strength.

## Buyers

- Buyers agreed they generally focus on GWP and view EPD as a trusted “carbon number”.
- Verification was described as important, even though many admitted they lacked technical engineering knowledge to interpret results properly. For example, a concrete EPD showing lower emissions per cubic metre may actually be for a lower strength concrete, meaning more material is required at the building level.
- Conversely, buyers may over-specify strength, increasing embodied carbon unnecessarily.
- Buyers review EPD dates, regional relevance, and declared units (e.g. kg CO<sub>2</sub> per tonne vs per cubic metre).
- Some rely on EPD aggregators such as One Click LCA.
- Larger buyers sometimes cascade their own carbon assessment approaches through the supply chain (to architects, engineers, contractors) via bespoke spreadsheets or tools, to improve consistency.

## Verifiers

- Verifiers emphasised that EPD checks cannot achieve the same robustness as ETS audits, given the larger data scope. Full verification of both manufacturing and upstream datasets to  $\pm 5\%$  certainty was described as unrealistic.
- Verifiers will evaluate the list of datasets used to model impacts based on their experience of appropriate datasets to use. Computer-based verification will confirm a pre-approved dataset was used, but not whether that was an appropriate dataset to use.

- Verifiers have the ability to spot check results, and often do when an input, value or results stretches credibility based on their experience in the sector.
- Suggested improvements include greater manufacturing process knowledge among verifiers, and adopting materiality-based verification approaches such as the use of the 5 principles from the GHG Protocol (Relevance, Completeness, Consistency, Transparency, and Accuracy).
- They reported inconsistencies in cement EPD, with some showing net and others gross values, though most present net in the main results tables.
- Differences were also highlighted in boundary reporting:
  - For ready-mix concrete, off-site production includes impacts in A1 to A3 (except site transport in A4, pumping and compaction in A5). For on-site production, A1 to A3 excludes mixing and on-site admixtures.
  - For precast concrete, some EPD include structural topping added during installation, while others do not.

## A2.7 Current industry practices

During interviews across the steel, cement and concrete sectors, researchers spoke to producers of both intermediate products and finished products. In steel, intermediate products included flat or bar products, while finished products included structural steel or reinforcing steel. In cement, intermediate products included Portland Cement Clinker (PCC), CEM I (Portland Cement, sometimes called Ordinary Portland Cement), and blended mixes such as CEM II and CEM III. For concrete, finished products included ready-mix concrete, mortars and precast concrete products. Intermediate products are actively bought and sold in the UK as raw materials, while finished products are consumed directly in construction - for example, steel panels used in cladding.

The interviews identified that primary data are typically gathered through monitors or meters. Examples include air quality measurements and energy consumption. Production output data are often derived from production records rather than direct metering. These inputs and outputs are generally collated through internal software systems that serve other business functions, such as management systems or accounting platforms.

Secondary data usage varies by industry segment. Finished steel producers, as well as cement and concrete manufacturers, tend to prioritise data sourced from EPD. These are valued both for being verified and for their public availability. By contrast, intermediate steel product manufacturers reported relying more heavily on the GaBi (now called Sphera) database.

Both intermediate steel and cement manufacturers already report under the ETS. Their data collection systems for combustion-related emissions arising directly from the manufacturing processes are therefore well developed. In parallel, both groups also report organisational carbon footprints in accordance with the GHG Protocol. Their language and definitions often

reflect this framing, with references to emission scopes (Scope 1, 2 and 3), or to direct, indirect and supply chain emissions, rather than to LCA modules as defined in BS EN 15804+A2:2019.

In-house LCA initiatives were also found to be well developed, with most aligning to ISO 14040+A1:2020 guidelines. Data is collected at the unit process level wherever possible<sup>68</sup>. However, this process-level information does not always translate directly to the product level. Allocation of impacts to specific products therefore requires further data manipulation, usually performed by experienced LCA or environmental professionals. Where EPD are produced, the relevant PCRs are followed.

Finished steel producers making rebar, cladding, and steel for sections and many companies who are part of the Certification Authority for Reinforcing Steel (CARES) create EPD for their products.

Finished steel producers covered by the British Constructional Steel Association and stockholders<sup>69</sup> were more likely to report their carbon footprint at an organisational scale. Where product-level footprints were produced, these were calculated using input data from EPD for intermediate steel (the raw material), combined with calculations based on annual average facility energy consumption. In some cases, this involved estimations linked to contract time. This approach involves a significant number of assumptions.

For concrete, it is common practice to use cement EPD (either manufacturer-specific or from trade associations) to cover impacts in module A1. Manufacturers would then add their own primary inputs and outputs for module A3.

Manufacturers consistently reported that their customers often focus exclusively on GWP. As a result, they are seeking a solution similar to an EPD but tailored to GWP, offering a verified figure at a lower cost. In response, some manufacturers have developed internal GWP calculators, designed to provide values solely for GWP, GHG emissions, or carbon emissions, depending on their definitions.

## Tools

Tools and background datasets varied by industry. A clear split emerged:

- Intermediate steel manufacturers primarily use GaBi (Sphera) software as their LCA tool. The background database is also GaBi/Sphera, which has exclusive access to the worldsteel database, the only dataset currently containing most of the raw materials and processes needed to model intermediate steel.
- Cement manufacturers most commonly use the GCCA tool to produce EPD, although others use tools such as ecochain (e.g. Cemcor in Northern Ireland). The GCCA tool relies on a combination of GCCA default data and the ecoinvent database, while ecochain uses ecoinvent and measured manufacturer emissions.

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<sup>68</sup> Unit process level is a discrete step in a larger process that involves a specific chemical or physical change.

<sup>69</sup> Organisations holding steel stock, selling and providing services related to steel products.

- Some cement and concrete manufacturers reported having previously used GaBi/Sphera tools. However, at least one reported moving to ecoinvent because of licensing problems when transferring Life Cycle Inventory (LCI) data generated in GaBi to non-Sphera tools for generating concrete EPD.

Certain EPD Programmes constrain database choice, which can reduce uncertainty within those programmes when comparing products:

- GaBi is required for German-produced products within IBU, Kiwa ecoability, BauEPD and European Aluminium.
- ecoinvent is required for MRPI (Netherlands) and BRE EPD (to be used in the BRE IMPACT database).

All respondents were asked to self-assess the quality of their data collection processes. Their responses and insights are documented in Annex 3. One common challenge reported across all sectors was the selection of appropriate secondary or background datasets for carbon assessments, described as a significant pain point.

## A2.8 International benchmarks and schemes

Several international initiatives are in place defining benchmarks or near-/net zero definitions for steel, cement and concrete. Most are linked to material compositions, such as the scrap content in steel, clinker-to-cement ratios in cement, and strength grades in concrete.

### International Energy Agency (IEA) thresholds:

The IEA Secretariat has defined net zero emissions thresholds<sup>70</sup>. For steel, progressive thresholds are defined according to scrap content:

- 100% iron input: 400 kg CO<sub>2</sub>e per tonne of crude steel (even though the IEA states all steel contains some scrap, this value provides a theoretical reference point for threshold calculations).
- 100% scrap input: 50 kg CO<sub>2</sub>e per tonne of crude steel.

For cement, thresholds are linked to clinker-to-cement ratio:

- 100% clinker: 125 kg CO<sub>2</sub>e per tonne of cement.
- 0% clinker: 40 kg CO<sub>2</sub>e per tonne of cement (though cement with no clinker has not yet been demonstrated at commercial scale).

The IEA suggests that these production-level thresholds could form the basis for comparable definitions at the product level e.g. from crude steel to finished steel, or from cement to concrete.

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<sup>70</sup> URL: [www.iea.org/reports/definitions-for-near-zero-and-low-emissions-steel-and-cement-and-underlying-emissions-measurement-methodologies](https://www.iea.org/reports/definitions-for-near-zero-and-low-emissions-steel-and-cement-and-underlying-emissions-measurement-methodologies)

However, as the IEA is not a standard-setting body nor a policy-making body<sup>71</sup>, these thresholds would require further rulebooks to specify robust accounting and verification methods.

Other steel-specific initiatives include:

- ResponsibleSteel International Production Standard (V2.1, Principle 10)<sup>72</sup>, which adopts a near-zero approach aligned with IEA thresholds. This has been criticised by electric arc furnace steelmakers for focusing too heavily on blast furnace routes. At present, over 80 sites in 19 countries are certified, but no UK sites. In Europe, 9 companies covering 54 sites are certified. Certification fees range from \$6,000/year (standalone sites) to \$7,400/year (large sites with >10 million tonnes production or >10,000 staff). A September 2024 consultation paper indicates potential changes, including boundary definitions (crude steel vs hot rolled), accounting for process gases and by-products, and updated scope 2 guidance. CARES (UK certification body) acts as an approved auditor. They confirmed the training is valuable, and noted the ResponsibleSteel scope differs from EPD as it covers only up to crude steel. CARES still considers the approach robust.
- Industrial Deep Decarbonisation Initiative (IDDI) Green Public Procurement Pledge<sup>73</sup>, applying thresholds on a sliding scrap-content basis.
- Low Emission Steel Standard (LESS)<sup>74</sup>, which extends IEA's scrap-based sliding scale to include broader emissions (alloys, hot rolling). Its thresholds are adjusted upwards to reflect wider scope and the higher emissions often associated with high-quality steel.
- Global Steel Climate Council (GSCC) Standard<sup>75</sup>, which sets long-term emission intensity targets: 380 kg–400 kg CO<sub>2</sub>e/t hot-rolled steel by 2045, and 120 kg CO<sub>2</sub>e/t by 2050.

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<sup>71</sup> IEA, 2024, URL: <https://iea.blob.core.windows.net/assets/0910c4ff-4008-48f5-a3ec-c52996ed694d/Definitionsfornear-zeroandlow-emissionssteelandcementandunderlyingemissionsmeasurementmethodologies.pdf>

<sup>72</sup> ResponsibleSteel, 2024, Standards, URL: [www.responsiblesteel.org/standards](http://www.responsiblesteel.org/standards)

<sup>73</sup> IDDI, 2023, Your commitment to green construction with public funds, URL: [www.industrialenergyaccelerator.org/wp-content/uploads/FINAL-The-GPP-Pledge-brochure-2023-update.pdf](http://www.industrialenergyaccelerator.org/wp-content/uploads/FINAL-The-GPP-Pledge-brochure-2023-update.pdf)

<sup>74</sup> WV Stahl, 2025, URL: [www.wvstahl.de/](http://www.wvstahl.de/)

<sup>75</sup> Global Steel, Climate Council, 2025, The Steel Climate Standard, URL: <https://globalsteelclimatecouncil.org/the-standard/>

These thresholds are compared in Figure 26:

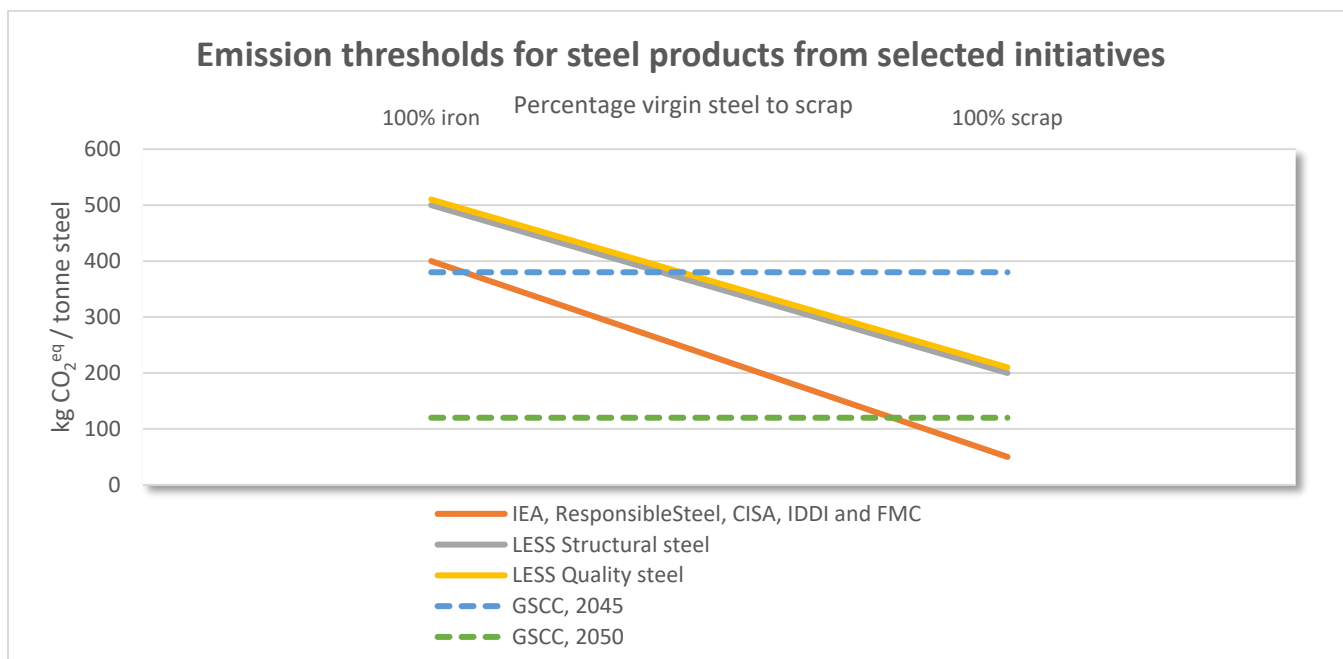


**Figure 26: Steel emission thresholds from selected initiatives. Please note the dotted lines do not correlate to the % of scrap steel (unlike the other benchmarks) and has been provided purely for a visual comparison against the other benchmarks.**

Cement initiatives include:

- IDDI Green Public Procurement Pledge, allowing countries to adopt a static clinker-to-cement ratio (e.g. the global average of 0.7)<sup>76</sup>.
- GCCA has proposed adopting the same near-zero threshold as IEA<sup>77</sup> but tailored to national clinker-to-cement ratios. The GCCA recommends EPD as the basis for product comparisons. The IEA confirms that the GCCA's preference for net emissions but allows gross/net reporting to be chosen nationally. The IEA also state that the GCCA recommends that EPD are used to compare products with the threshold.

Figure 27 shows these thresholds against one another and the global reference value IEA use.

<sup>76</sup> IDDI, 2023, Your commitment to green construction with public funds, URL:

[www.industrialenergyaccelerator.org/wp-content/uploads/FINAL-The-GPP-Pledge-brochure-2023-update.pdf](https://www.industrialenergyaccelerator.org/wp-content/uploads/FINAL-The-GPP-Pledge-brochure-2023-update.pdf)

<sup>77</sup> Global Cement and Concrete Association, 2024, Definitions for Low Carbon and Near Zero Cement, URL:

[https://gccassociation.org/wp-content/uploads/2024/10/GCCA\\_Cement\\_Definitions\\_for\\_Low\\_Carbon\\_and\\_Near\\_Zero\\_Policy.pdf](https://gccassociation.org/wp-content/uploads/2024/10/GCCA_Cement_Definitions_for_Low_Carbon_and_Near_Zero_Policy.pdf)

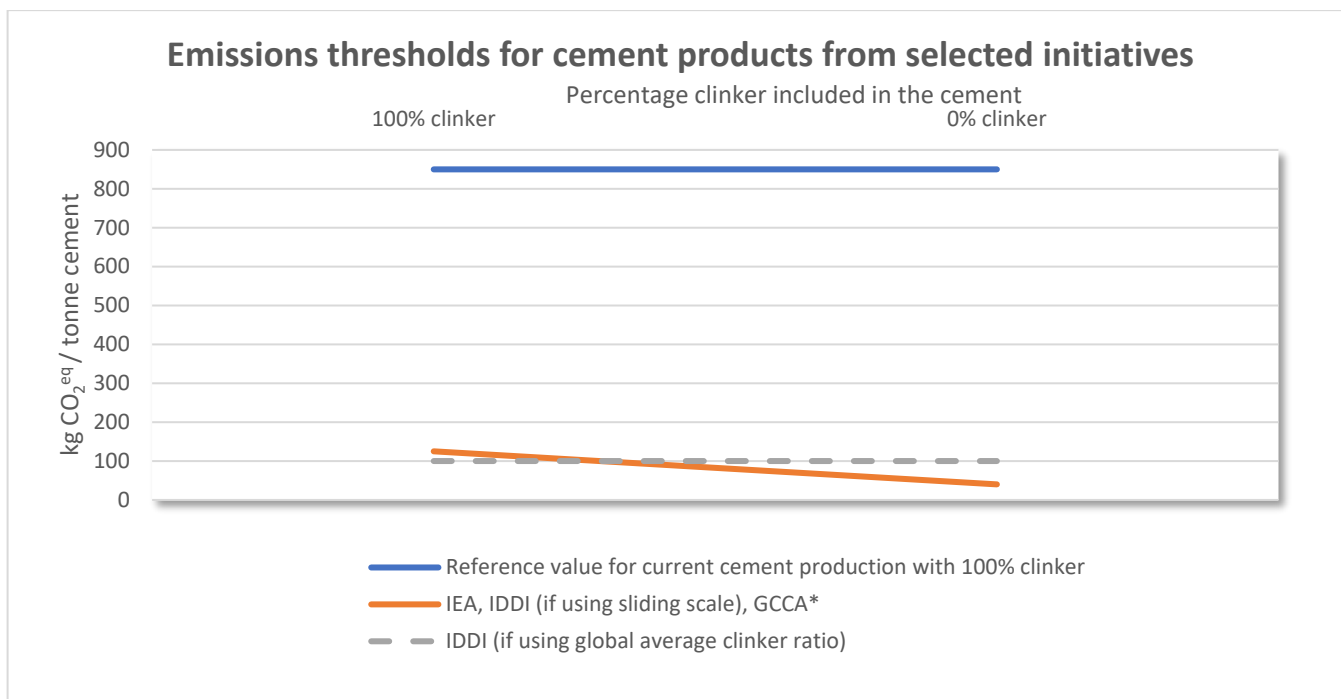


**Figure 27: Cement emissions thresholds from select initiatives. Please note the dotted line represents a fixed clinker ratio (unlike the other benchmarks) and has been provided purely for a visual comparison against the other benchmarks.**

Concrete initiatives include:

- GCCA<sup>78</sup> proposal for progressive thresholds based on compressive strength, underpinned by a fixed clinker ratio of 0.52 (from the GCCA 2050 Net Zero Roadmap). Thresholds range from 21 kg CO<sub>2</sub>e/m<sup>3</sup> for 20 MPa concrete to 36 kg CO<sub>2</sub>e/m<sup>3</sup> for 50 MPa. GCCA represents ~40% of global cement production (80% outside China). At the time of writing, it is the only known major definitions proposal that specifically includes a near-zero emission threshold for concrete<sup>79</sup>.
- Low Carbon Concrete Group (LCCG), which developed UK-specific benchmarks for normal weight concrete (covering A1 to A3)<sup>80</sup>. It uses embodied carbon data from MPA members and other sources, and presents results in numerical bands (not alphabetical, to avoid confusion with grading schemes). LCCG aims to update annually.

<sup>78</sup> Global Cement and Concrete Association, 2024, Definitions for Low Carbon Cement and Concrete Green Procurement: Launch of GCCA Definitions, URL: [https://gccassociation.org/wp-content/uploads/2024/10/20241015\\_GCCAConcreteDefinitions-Webinar.pdf](https://gccassociation.org/wp-content/uploads/2024/10/20241015_GCCAConcreteDefinitions-Webinar.pdf)

<sup>79</sup> IEA, 2024, URL: <https://iea.blob.core.windows.net/assets/0910c4ff-4008-48f5-a3ec-c52996ed694d/Definitionsfornear-zeroandlow-emissionssteelandcementandunderlyingemissionsmeasurementmethodologies.pdf>

<sup>80</sup> Low Carbon Concrete Group, 2024, Classification methodology for embodied carbon of concrete, URL: [www.theclimategroup.org/sites/default/files/2024-07/ConcreteZero%20-%20Classification%20methodology%20for%20embodied%20carbon.pdf](http://www.theclimategroup.org/sites/default/files/2024-07/ConcreteZero%20-%20Classification%20methodology%20for%20embodied%20carbon.pdf)

Figure 28 shows these thresholds compared with one another.

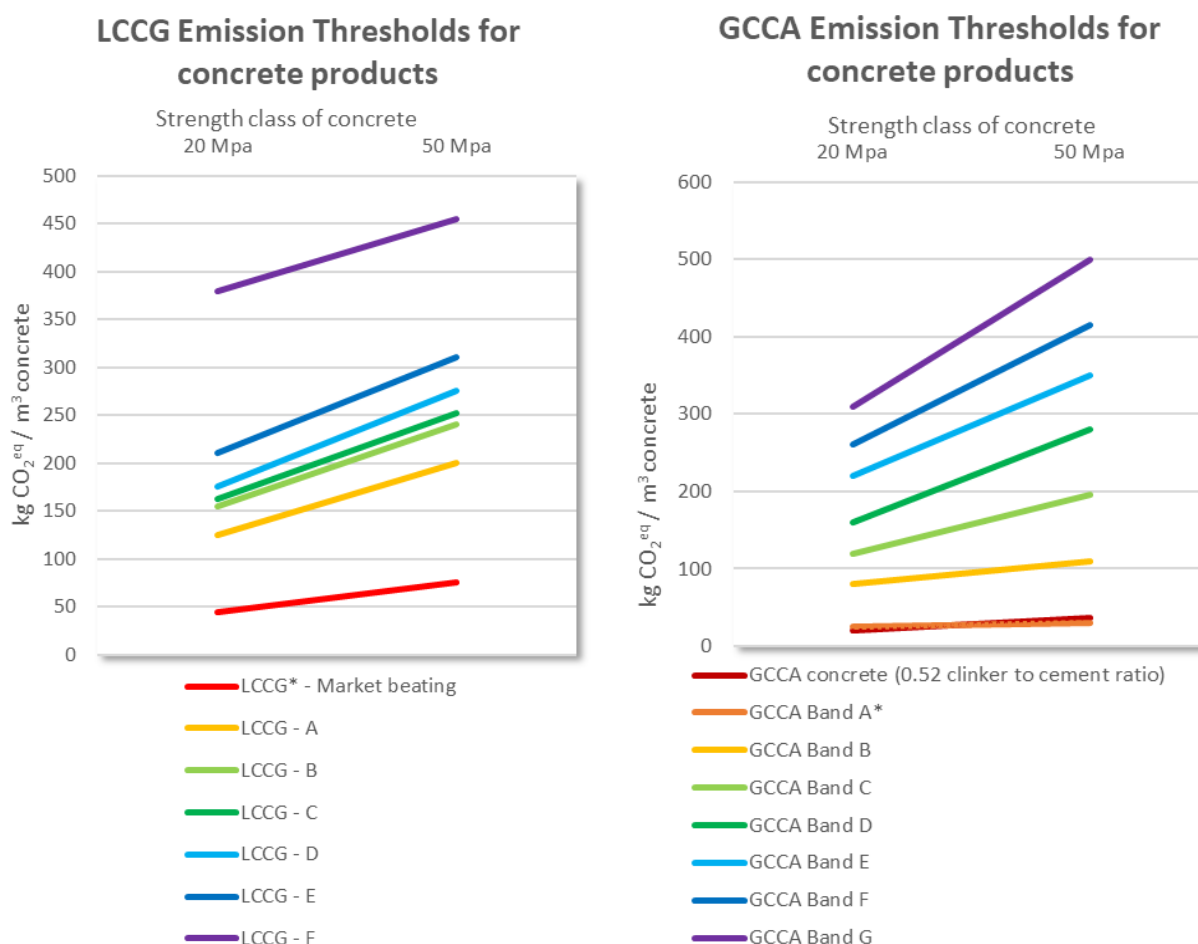


**Figure 28: Concrete emissions thresholds from selected initiatives.**

### Using EPD data against thresholds

EPD do not directly state the carbon intensity of crude steel or cement clinker inputs. To compare product-level EPD (e.g. hot-rolled steel or ready-mix concrete) against crude steel or clinker-based thresholds, more detailed production data (e.g. for cold rolling, wire drawing, mixing) are required to be collected by the producer. At present, such data limitations prevent accurate mapping of product EPD results to benchmark thresholds.

## Appendix 3: Data quality and availability

First, the research defined what good data is, before evaluating the data used in EPD production and EU CBAM submissions by manufacturers. The research project qualified data collection challenges experienced by manufacturers and reviewed the data-related challenges in the databases and tools they use. It assesses the different data sources used for LCA input data (e.g. DESNZ conversion factors, ecoinvent, ICE database), and LCA repositories (E.g. BECD, BRE Register).

### A3.1 What defines “good data” for carbon assessments?

#### A3.1.1 What types of data is there?

This research encountered many types of data being used for carbon assessment. Data types are defined in Section 8 and in further detail in Appendix 1. Different types of data are categorised according to source, specificity, and whether it is intensity data.

- Source:
  - Primary data is directly from product production or manufacturing process. Also called activity data.
  - Secondary data is provided by a third party.
- Specificity:
  - Specific is about the product, using the same manufacturing methods of the product under study.
  - Generic is a similar product or manufacturing methods, but either not exactly the same, or has been manipulated in some way (for example, presented as an average).

Additionally, GWP impact of products can be reported as intensity. Intensity data provides carbon dioxide equivalent emissions associated with the product output, often expressed by product weight (e.g. kg CO<sub>2</sub>e/tonne).

Intensity data can be reported by manufacturers to demonstrate the GWP impact of their product, without disclosing the inputs of that product. This is how it is displayed in EPD.

This research project found intensity data was the most publicly available data associated with GWP impact of products. Therefore, this type of data largely informs the findings of this research.

#### A3.1.2 What are the characteristics of high-quality data?

This research project found that there are set definitions of high-quality data in relevant standards, and manufacturers principally adhere to these where practicable. Manufacturers aim to source data useful for the purpose of their assessment:

- EPD require data for wider environment impact categories, and therefore only LCA-suitable data can be used and not purely GWP data.
- EU CBAM requires data to relate to a certain time period, be primary data, and be as specific as possible.

For data to be considered high-quality, this research found that several categories should be transparently communicated when data is published, according to the two standards concerned with the quality of this type of data: ISO 14044+A2:2020 and BS EN 15941:2024. The common categories in these two standards were:

- Time related coverage – how old is this data?
- Geographical coverage – where in the world does this data relate to?
- Technological coverage – what process or manufacturing method does this data relate to?

More detail on the standards and the characteristics of high-quality data for the purposes of LCA and EPD production is set out in Appendix 1.

In practice, manufacturers (or their nominated practitioners) will make decisions on the quality of data used in their assessments. In EPD, this is then evaluated by EPD verifiers as part of the verification process.

A2.2 sets out how verification takes place, based on stakeholder interviews (Appendix 7). A plausibility check confirms that the data used in the LCA are consistent, representative, reproducible, and appropriate. This is often completed by human EPD verifiers: where EPD have been produced by pre-verified EPD tools, it will still be necessary for the EPD to be verified. For example, the checks on plausibility of the data entered into the tool and that inputs have been linked with the right LCA datasets still need to be done by an independent verifier<sup>81</sup>. If EPD verifiers deem a data source is inappropriate, insufficient, out of date or otherwise requiring replacement, then the verifier can reject the EPD.

Where EPD tools and their use are integrated into company Environmental Management and Quality Management systems, “process verification” can be allowed by some EPD Programmes. This will require the tool to be pre-verified and the checks on training and the use of the tool to be approved, often by a Certification Body, for example within International EPD Programme<sup>82</sup>. There will be random checks of EPD by the verifier and annual checks of the relevant processes and the records of the EPD produced.

EPD represent the only product carbon footprint (PCF) studied in this research which has this external verification step.

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<sup>81</sup> ConstructionLCA, 2021, When is an EPD not an EPD 2, URL: <https://constructionlca.co.uk/2021/08/05/when-is-an-epd-not-an-epd-2/>

<sup>82</sup> International EPD System, ND, EPD Process certification, URL: [www.environdec.com/epd-process-certification](http://www.environdec.com/epd-process-certification)

### A3.1.3 How can the reliability and accuracy of data used in carbon assessments be enhanced?

Overall, in any carbon assessment, accuracy is enhanced through using primary data specific to the product under consideration. Manufacturers reported prioritising primary, specific data where they can as raw data for their carbon assessments.

To increase repeatability of results between manufacturers or practitioners, a mandatory secondary source could be used. However, these are likely to be generic, which would reduce the specificity of the assessment. Making assessments more generic would mean manufacturers cannot show GWP improvements in their product if they make any. For example, if a mandatory electricity factor is prescribed, but the manufacturer uses renewable energy with a lower carbon factor, the benefit of them sourcing renewable energy is reduced. The accuracy of the product carbon footprint will be compromised.

This research found that citing the coverage and source of data provides transparency and potentially increases the plausibility and accuracy of comparison between product carbon footprints.

## A3.2 What are current practices and challenges in data collection?

### A3.2.1 What are current industry practices in data collection?

A full summary of the stakeholders interviewed and the findings (primary and secondary data which manufacturers collected, and the methods and the tools they used) can be found in Annex 3 of this Appendix.

#### **Typical illustrative approach for data collected for EPD and EU CBAM**

- For EPD, manufacturers use measured emissions direct in modelling, or default emissions (e.g. emissions from fuel combustion from a database) may be used if direct measured emissions are not available.
- For EU CBAM, the calculated emissions based on fuel content direct from manufacturers may be used in modelling. This may be using installation-level EU ETS data the manufacturer collects, and they will need to transpose that to individual products.
- Primary data would be gathered from across the organisation. It will be specific to the product, but may not necessarily be activity data relating to the product under study.
  - For example, total energy use in a day will be spread across site operations. Deciding how to apportion what energy use to which process and therefore to which product will be determined by the practitioners or environmental professionals on site.
- Secondary data would be gathered following a hierarchy. First, verified information from the suppliers of the raw material being purchased will be sourced, such as EPD from

suppliers. If that is not available, information from UK industry bodies or published figures from UK authorities (such as the DESNZ Company Reporting Factors) will be used.

Generic secondary data would commonly be used for upstream processes; for example, raw materials.

### **Primary / Activity data collection**

Overall, manufacturers stated that primary data is gathered either from monitors or meters (for example, air quality and energy use). Data on production output might be from production records, rather than through a meter. These inputs and outputs might be collated on an internal software system which has other uses, such as the accounting system.

Information is often collected on a unit process -level<sup>83</sup>, which does not necessarily translate cleanly to outputs of product. Data manipulation is then required to allocate impacts to specific products. This is undertaken by experienced LCA or environmental professionals.

Intermediate steel and cement manufacturers both report under ETS, and therefore their data collection systems for emissions arising from combustion during the manufacturing process are very mature.

### **Secondary data collection**

All respondents reported that choosing secondary or background datasets was a challenge in carbon assessments.

Finished steel producers and the cement and concrete sector prioritise information from EPD. They state this is because they are verified sources of information which are publicly available. Intermediate steel product manufacturers use data from the GaBi (now called Sphera) database.

Respondents were asked to self-assess the quality of their data collection process.

### **Reporting**

For intermediate products of both steel or cement, in-house LCA initiatives for the purpose of producing EPD or reducing environmental impact of products were well-developed and found to be largely adhering to ISO 14040+A1:2020 guidelines. Where EPD are produced, they use the relevant PCR.

When finished steel producers and stockholders<sup>84</sup> generate a carbon footprint for a product, they will use data from the EPD of the intermediate steel they are using as their raw material and a calculation of the annual average of energy used in their facility. This could be based, for example, on estimated time taken per contract. There are a lot of assumptions inherent in this approach.

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<sup>83</sup> Unit process level is a discrete step in a larger process that involves a specific chemical or physical change.

<sup>84</sup> Organisations holding steel stock, selling and providing services related to steel products.

For concrete, it is common to use EPD for the cement, either manufacturer specific or from a trade association, as data for module A1 and add their own inputs and outputs to module A3.

In terms of organisation-wide reporting, stakeholders may report or disclose their organisational carbon footprint using GHG Protocol methodologies to the public. Their terminology and definitions reflect this, referring to emissions scopes (as in Scope 1, 2 and 3) or direct, indirect and supply chain emissions, rather than framing emissions through the lens of LCA modules such as in BS EN 15804+A2:2019. Finished steel producers and stockholders<sup>85</sup> are more likely to report their carbon footprint at an organisational level rather than product level.

Manufacturers stated their customers often only want to focus on GWP, and as such manufacturers are looking for a solution similar to a verified EPD to provide this information to them in a verified way. Some manufacturers have developed their own internal calculators to provide this information; these are often not externally verified.

### A3.3 What challenges did industry identify regarding data?

The challenges of collecting primary data include:

- Inability to separate processes. For ETS, monitors are calibrated, verified and set at installation level. Under ETS, an installation is the static technical unit where regulated activities take place, for example, a stationary combustion activity with a combined thermal input capacity of more than 20 MW thermal. This may not relate to discrete products, and additional data manipulation is needed to estimate product-level emissions.
- The number of variables for the cement industry, which may need to collect information on around 400 raw materials and fuels. This increases cost and time.
- Understanding renewable electricity certifications in countries outside Europe, and how their credits should be interpreted under EPD standards or EU CBAM. A wide array of non-standardised Energy Attribute Certificate markets exist outside of Europe<sup>86</sup>, making it difficult for manufacturers sourcing raw materials to examine claims of renewable energy use in their overseas suppliers.
- Training staff at different sites to collect the data required for EPD, who then often delegate this to other staff who haven't received the required training.

The challenges of selecting and using secondary data include:

- Finding verified information. Data from EPD was prioritised by manufacturers as it has gone through a third-party verification process, along with published figures from industry or national associations. Suppliers may not be able to supply verified information.

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<sup>85</sup> Organisations holding steel stock, selling and providing services related to steel products.

<sup>86</sup> RECS, 2025, Public information, URL: <https://recs.org/public-information/>

- Obtaining an understanding of the composition of products used in production which may be purchased as brand names, for example admixtures in concrete or pigments, so that they can be modelled more accurately.
- Keeping data up to date. One intermediate steel manufacturer asserted the GaBi / Sphera database had been updated less than 10 years ago but cannot be sure exactly; others were using expired EPD data as the best available data, knowing that it will not be approved by an EPD verifier if used in an EPD.

All data carries uncertainties, and manufacturers sought to minimise the risk of this through their systems and choice of verified information.

### A3.3.1 What uncertainties are there in primary data?

As is common with quantitative information, there are uncertainties inherent in primary data. Some of these are well understood and the variability is within relatively narrow ranges<sup>87</sup>.

Common uncertainties identified include (in no particular order):

- Measured gas consumption is based on meters whose accuracy is at best typically +/- 1.5%.
- Point source emissions, those released from a single point such as a single chimney, from factories are normally based on sample measurements - taken maybe once per year or once per month - scaled up to a full year of operation. These can vary throughout the year (for example, if production is halted on weekends, or different products are made on different days), therefore an annual average is often used to smooth out these variations.
- The compositions and calorific values of basic resources like hard coal, crude oil, and natural gas vary. For waste derived fuels, the variability of fossil- /bio-based carbon content and calorific value vary even more, depending on the ratio of fossil to bio-based materials. Some cement manufacturers mentioned that they monitor fuel composition: for example, waste derived fuels are monitored in terms of calorific value and content of carbon, sulphur etc. on a monthly basis, so that variability is known.
- The mix of electricity generating technologies (i.e. fossil fuel power stations, wind turbines) feeding electricity grids normally varies hour by hour as well as year by year. The annual UK grid averages are included in UK Government conversion factors for company reporting of greenhouse gas emissions; for hourly averages, the National Grid releases an API of data and there are websites displaying these data<sup>88</sup>. Annual emissions factors for the UK grid, for example, show how changes in electricity generation, such as the move away from coal fired generation and the introduction of more offshore wind, influence carbon emissions per kWh. There are short-term fluctuations behind these annual

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<sup>87</sup> Construction Products Association, 2024, Environmental Product Declarations (EPD): Uncertainty A Technical Review, URL: [www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf](http://www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf)

<sup>88</sup> Example of website showing hourly carbon intensity of the UK grid: [National Grid: Live](https://www.nationalgrid.com/uk/eng/CO2-intensity)

averages. Database mixes are based on UK Government statistics and are often several years out of date<sup>89</sup>.

- Energy consumption of an energy-using product will vary due to both external conditions and its age.

## A3.4 What LCA databases and tools are used by industry?

### A3.4.1 What sources of secondary data is used by industry?

This research project provides an overview of secondary databases used by the stakeholders interviewed. The overall assessment of these databases is presented in Table 7, with a more detailed assessment in Annex 3.

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<sup>89</sup> The consumption mixes published by ecoinvent and Sphera for use in EPD rely on annual data for all countries published by the IEA, which in turn use individual Government statistics (this is why their background datasets are normally several years out of date).

**Table 7: Assessment of secondary databases used by respondents.**

| Database                                                                                        | Data quality process transparent?           | Specific or generic?                                                                                                           | Comments on using the data                                                                                                                                                            |
|-------------------------------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>EPD databases (ECO Platform ECO Portal<sup>90</sup> Inies (French National EPD database)</b> | Relies on verifiers.                        | Specific products, specific manufacturers, specific regions.                                                                   | Best for building level assessments and searching for EPD for products which are being considered or are being used. Note: manufacturers will prioritise EPD from products they used. |
| <b>Embodied Carbon in Construction Calculator (EC3) (GWP only)</b>                              | Yes, and includes an uncertainty weighting. | Specific products, general manufacturers, specific regions.                                                                    | Best for those with a general product in mind but cannot be used to develop EPD. Filters must be used to select EU data and confirm the methodology used.                             |
| <b>Paid Life Cycle Inventory (LCI) databases (ecoinvent, GaBi / Sphera)</b>                     | Yes, regularly reviewed.                    | General products (more at material level unless specific data is provided), general manufacturers, sometimes specific regions. | Best for those with full LCA needs.                                                                                                                                                   |

Other LCI databases used by respondents:

| Database                   | Data quality process transparent? | Specific or generic?                                       | Comments on using the data                                             |
|----------------------------|-----------------------------------|------------------------------------------------------------|------------------------------------------------------------------------|
| <b>worldsteel database</b> | Yes, in their methodology report. | Specific products, general manufacturers, general regions. | Best for experienced practitioners as the raw dataset is very complex. |

<sup>90</sup> GlobalEPD in Spain is an audited ECO Platform EPD Programme but does not add its EPD to the ECO Portal for technical reasons. They can be downloaded from the Global EPD website.

| Database                                                                                | Data quality process transparent?                                                                                                                            | Specific or generic?                                                                                                                            | Comments on using the data                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Global Cement and Concrete Association Industry EPD Tool for Cement and Concrete</b> | Yes, in their methodology report.                                                                                                                            | Specific products (if own data used alongside default clinker), specific manufacturers (if own data used), specific regions (if own data used). | Best for accessibility and promoting EPD consistency because of the limited datasets available on key raw materials such as clinker.                                                                                                                             |
| <b>ICE database (GWP only, cannot be used to develop EPD)</b>                           | Yes, prominently displayed in database itself. Takes data from MPA UK EPD and worldsteel global data. For concrete, it builds up the mixes from cement data. | Specific products, general manufacturers, specific regions.                                                                                     | Best for transparent quality of the data at building level – but cannot be used to develop EPD.<br><br>This database is UK focussed, providing data for the products used in the UK, unlike all these other databases which cover EPD/LCA from around the world. |

## Secondary data for EPD

In order to develop EPD, manufacturers need full life cycle data with a range of environmental categories attached to it.

- Commercial LCI databases (ecoinvent, GaBi / Sphera) have vast databases with quality control processes for general product categories, meaning the data is not specific to a product, region or particular manufacturer, although some datasets are based on data collected from only one manufacturer.
- More often the datasets are based on data collected from a sector, and the data is then adapted to different regions such as Europe or the Rest of the World, based on reviews of literature.

Industry specific databases have also been developed, which can be used for full LCA or EPD development.

- The worldsteel database and the GCCA Cement and Concrete EPD Tool were both cited as useful by interview participants. (The GCCA Tool is technically software, but this section looks at the database provided by the tool). Using industry-specific data will assist in increasing the specificity of the study and enhance data quality.

- However, the published worldsteel database allows for a methodology of allocating co-products which the CEN Technical Board has decided is non-compliant with BS EN 15804+A2:2019. The operators of the worldsteel database are able to provide datasets for use in BS EN 15804+A2:2019 assessment; the published datasets use the non-compliant methodology.
- The worldsteel database is currently only available in GaBi / Sphera, while the GCCA tool uses someecoinvent datasets and default factors.

## Data for GWP only

For purely GWP values, construction product specific EPD aggregators (EC3, ICE) display an aggregated GWP value to use, which can be specific to a product but not to a region or manufacturer.

- Within ICE, the approach to providing carbon data for different products varies. For example, for UK cement and UK CEM I, it provides the carbon data directly from the MPA EPD for UK average cement and CEM I respectively rather than averaging available EPD. For steel, it takes carbon impacts directly from the worldsteel global datasets, which use system expansion; worldsteel state that this method is expected to reduce GWP by 3-7%<sup>91</sup>.
- Both ICE and EC3 data is intended for use in building and infrastructure-level assessments, not product level LCA or carbon assessments. This means that the data from these is a generic representation of a construction product. The data quality processes of EC3 and ICE in particular try to present the difficulty and uncertainty issues of the data within them in a transparent way:
  - The ICE database provides a coloured Data Quality Index (DQI) to clearly signal their assessment of the quality of the numbers they are providing for use, but do not include any adjustment of the value they provide based on its data quality.
  - EC3 factors an uncertainty-adjusted GWP and is transparent about the calculation used. However, it can result in an industry average EPD being given an additional uncertainty factor, but as an 'industry average' it already represents the product across different manufacturers. The main intention of the uncertainty factor provided by EC3 is to take into account uncertainty between manufacturer average and sector average EPD. EC3 does provide a link to the original, unmodified EPD and GWP impacts.
  - When comparing generic and specific information from EPD, an academic study found that EPD using generic databases gave a GWP figure 15% higher than EPD using specific data in the context of a building level assessment<sup>92</sup>, however, this could be explained by the manufacturer-specific EPD accounting for products chosen for their low carbon impact.

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<sup>91</sup> worldsteel, 2021, Life cycle inventory (LCI) study 2021 data release, URL: <https://worldsteel.org/wp-content/uploads/2021-LCA-Study-Report.pdf>

<sup>92</sup> Loli et al, 2023, Comparing embodied GHG emissions between environmental product declaration and generic data models: Case of the ZEB laboratory in Trondheim, Norway.

Whether for EPD or calculating only GWP, it is important to be aware that:

- The different databases have often been developed for a specific country or region, with a specific purpose. That purpose needs to be understood to determine whether the database is appropriate to use in a project.
- Sources such as the ICE and EC3 are EPD aggregators<sup>93</sup>, only take the GWP value from the EPD (though for steel, ICE takes data from worldsteel). As such, cannot in themselves be a source of data for a full EPD, which requires more data across different impact categories.
- Databases are not unique or exclusive to one product type. For example, raw steel manufacturers often use and invest in GaBi / Sphera due to the extensive range of datasets specific to steel manufacture; however, users who need a generic dataset for a steel product such as galvanised steel sheet or steel reinforcement for their product, and have access to another database such as ecoinvent, would likely continue to use that database rather than invest in another. Additionally, GaBi / Sphera databases can only be used in Sphera tools, which is another reason why manufacturers may prefer to use ecoinvent.

#### A3.4.2 What are the main inconsistencies in LCA databases?

The main factors explaining the inconsistency of LCA databases include:

1. Data amount and substitution of generic datasets. Inside the database itself, proxy figures or primary information may be used, and it's not always immediately apparent which it is;
2. Allocation rules (see Appendix 1);
3. Data documentation; to understand where the data has come from, the geographical, technical and temporal scope;
4. Data sources and traceability, who has supplied the data;
5. Frequency of data updates; aging data may not be reflective of technical improvements;
6. The amount of recycled or secondary content or material; as this may not be reflective of the product under study; and similarly,
7. Energy mix for electricity generation; the source of electricity, whether fossil fuel based or renewables, as this may not be reflective of the product under study<sup>94</sup>.

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<sup>93</sup> A database that pulls lots of EPD together, extracts the GWP and basics such as material and functional unit, and presents the result as an average.

<sup>94</sup> Teng et al, 2023, The impact of life cycle assessment database selection on embodied carbon estimation of buildings, Building and Environment, Volume 243, URL: [www.sciencedirect.com/science/article/pii/S0360132323006753](https://www.sciencedirect.com/science/article/pii/S0360132323006753)

### A3.4.3 What is the impact of using different databases?

Using different databases for secondary data in two product EPD will result in inconsistencies, introduced by the variation in data treatment across databases. To fully compare materials, the secondary dataset needs to be consistent in how it treats the data. Expert LCA practitioner guidance is needed if more than one database is used, to help reconcile these differences or be aware they exist in the treatment of the data to inform correct interpretation.

Changing the background data in a building model from a specific EPD (for products selected for their low carbon impact) to generic datasets from ecoinvent increased impacts by 15% in a building level assessment in one academic source<sup>95</sup>. This is one example and cannot be extrapolated as the difference between all specific EPD and the generic data available on ecoinvent.

These differences are well known by practitioners, such as the inclusion of capital goods which is available in ecoinvent but not included in GaBi. Capital goods or infrastructure is a category that includes the construction and maintenance of roads used in transport processes; the provision of factory buildings and machinery; and the provision of the distribution network for electricity. Academic studies state the inclusion of infrastructure made a significant difference in GWP for non-fossil electricity, agricultural products, transport services and certain waste management services<sup>96</sup>.

### A3.4.4 What tools are used by industry?

Tools such as software are used by manufacturers in either Life Cycle Assessment and analysis (LCA tools) or EPD creation (EPD tools).

There was a clear split by industry between tools used to produce their EPD and/or secure the background data for their LCAs:

- The intermediate steel manufacturers use GaBi (Sphera) software as their LCA tool. The background database is the GaBi (Sphera) database.
  - This is because currently only Sphera has access to the Worldsteel database, which includes most of the raw materials and processes needed to create intermediate steel.
- Cement manufacturers commonly use the GCCA tool to produce EPD, but other tools are used: for example, ecochain for cement EPD from Cemcor in Northern Ireland.
  - The background database of the GCCA tool is the GCCA default data and ecoinvent database whilst the ecochain tool uses ecoinvent data and the manufacturer's measured emissions.

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<sup>95</sup> Loli et al, 2023, Comparing embodied GHG emissions between environmental product declaration and generic data models: Case of the ZEB laboratory in Trondheim, Norway; Building and Environment, Volume 242, URL: [www.sciencedirect.com/science/article/pii/S0360132323006108](https://www.sciencedirect.com/science/article/pii/S0360132323006108)

<sup>96</sup> URL

- Some cement and concrete manufacturers mentioned they had used GaBi and Sphera tools, but one said they had moved to ecoinvent because of licencing problems in transferring LCI data for their cements generated in GaBi to other non-Sphera tools to generate concrete EPD.
- Where purely carbon or GWP calculations are required, many manufacturers will use their own in-house calculation tool sometimes based on BS EN 15804+A2:2019 or PAS 2050:2012, perhaps based on which a customer has suggested. These carbon tools and outputs are normally not verified.

## **LCA tools**

LCA tools such as SimaPro and Sphera / GaBi have been developed specifically as professional tools for evaluating the environmental impact of products. Both can be used to provide the underlying assessment and database used in EPD which are then taken forward for verification by an approved EPD verifier<sup>97, 98</sup>.

### **Advantages**

As the professional tools have been developed over many years for a broad LCA purpose, the advantages are the robust analysis available with data taken from well-documented databases.

### **Disadvantages**

The disadvantages are the many different analysis choices. This may result in users not choosing the right one for them, causing results to differ on that basis; and also that many datapoints in the accompanying database are generic.

Sources of uncertainty in the ecoinvent database, version 3.8, as searched in SimaPro 9.6.01, include:

- Unit and System processes, and how they are treated in LCA software.
  - A unit process contains all of the processes which are included in a material. For instance, a steel making process might include one for iron and another for coke. Unit processes have the advantage that they can be very easily interrogated in great detail to understand exactly what causes impacts. The problem with them is that they can be slow to run on computers. This means that some practitioners prefer to use system processes.
  - A system process is one in which all of the underlying data of unit processes has been made into a list of substances which flow into or out of the process. For instance, CO<sub>2</sub> might be emitted in multiple processes. To run a unit process, LCA software first has to look for all instances of CO<sub>2</sub> and total them up to a single figure. A system process has already done this step. This means that system processes can run much faster, but lack the transparency of unit processes.

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<sup>97</sup> Simapro, 2019, Creating EPD in Simapro, URL: <https://support.simapro.com/s/article/Recorded-webinar-Creating-EPD-in-SimaPro>

<sup>98</sup> Sphera, 2025, Environmental Product Declaration Services, URL: <https://sphera.com/solutions/sustainability-and-esg-consulting/sustainability-performance-improvement/environmental-product-declaration-epd-services/>

- In an example of pozzolana and clinker, the user would never have discovered the up-to-date clinker process underpinning an otherwise obsolete pozzolana process.
- Finding the source of background data for a process is not always possible. Sometimes a specific document is referenced, or a web resource. However, phrases such as “data collected from several companies”, or “expert opinion” are often used. The requirement in BS EN 15804+A2:2019 and BS EN 15941:2024 is to describe the source of generic datasets used, but this only means that the database and dataset used should be described, together with its representativeness if it is a “relevant process” contributing to 80% of any of the core impact category results. The verifier will then check whether these datasets are as plausible and as representative as the LCA practitioner has assessed.
- Assessment methods are varied (e.g. for valid EPD to BS EN 15804:2012+A1:2013, BS EN 15804+A2:2019 and ISO 21930:2017), and with a lack of a single one specified for EPD it can make using EPD (or other LCA studies) produced with different methods impossible to inform new ones. Unless the actual inventory data is available which underpinned the study, it can be very difficult to compare impact results.
- Even if specific inventory data is provided in a study (e.g., a scientific paper), unless the exact processes used are listed, then re-creating the impacts can be near impossible. For example, energy might be stated as “heat” in a table, but without knowing the form of heat used, or even if steam is specified or the pressure, a practitioner has to use best judgement to pick relevant processes when re-creating it in software like SimaPro. The generated impact results are likely to be “close enough”, but almost never the same.
- The indicators themselves are also a source of uncertainty. The models of these cause-effect chains used to derive the indicator values in EPD are stronger for some environmental categories than for others. For some categories, certain models suit certain regions better than others. The globally applicable models used for climate change and ozone depletion are considered robust, but nevertheless the GWP of certain greenhouse gases (for example methane, nitrous oxide) have been adjusted by small amounts in successive reports from the Intergovernmental Panel on Climate Change (IPCC)<sup>99</sup>.

These potential differences in methodology inside LCA tools were cited in one academic study as causing an 8% difference in outcome, but this was concluded to be trivial compared to the contribution of raw materials (in this case, Portland Cement)<sup>100</sup>.

## EPD-specific tools

EPD tools assist manufacturers in compiling the LCI for an EPD and producing the EPD results. It requires primary data from the manufacturer, and often manufacturers have a range of secondary data to choose from to supplement that.

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<sup>99</sup> Construction Products Association, 2024, Environmental Product Declarations (EPD): Uncertainty A Technical Review, URL: [www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf](http://www.constructionproducts.org.uk/media/g3uies4v/cpa-bp-epd-uncertainty-a-technical-review-v1-august-2024-final.pdf)

<sup>100</sup> Asari Jafari et al, 2021, Towards comparable environmental product declarations of construction materials: Insights from a probabilistic comparative LCA approach.

Common tools mentioned include GCCA EPD Tool, OneClickLCA, and others.

### **GCCA**

The GCCA tool was mentioned by respondents. GCCA produced a web-based calculation tool for EPD of clinker, cement, aggregates, concrete and precast elements. It produces two major outputs:

- A self-declaration in GCCA format, not an official EPD but can be used in communications as it contains the main / background information and LCA results of the specific product; and
- A background report with the complete set of input data and results of the specific product. This contains all the information needed to produce an EPD and for a verifier to validate it.

Documentation states the database is expected to be completed with primary data from users, but default datasets for clinker, cement and concrete are provided for users if required. These default datasets are based on a reference ecoinvent dataset along with statistical data from the Getting the Numbers Right (GNR) dataset, apart from concrete which is a standalone reference ecoinvent concrete dataset. Default parameters for transport (based on ecoinvent) and regional electricity mixes (based on IEA 2017 data) amongst other default values are also provided in the tool.

GCCA is transparent about the limitations in the methodology document<sup>101</sup>. As the tool is meant to be used by a large number of users with variable LCA knowledge, detail was reduced for accessibility. This means that customisation is limited. The limited customisation means EPD produced with this tool will be consistent with one another, although it is unclear whether the data source is applicable to the UK.

### **OneClickLCA**

OneClickLCA was used by a number of respondents, who commented on the speed of verification of EPD. There are two versions of OneClickLCA: one for buildings, and one for products. For product level, there are specific tools to create LCAs and EPD, and users comment on the speed of verification of EPD by OneClickLCA when their tools are used in the creation of EPD.

OneClickLCA states users do not need to be an LCA expert to use it effectively. It also offers a comprehensive construction library to address shortages in available data.

Anecdotal information links OneClickLCA to EPD Hub, an EPD programme which delivers “integrated EPD verification and publishing” in line with standards. They have their own PCR, which they state is in compliance with BS EN 15804+A2:2019, ISO 21930:2017, BS EN 50693:2019 and ISO 14067:2018, and their PCR supports all products<sup>102</sup>.

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<sup>101</sup> Quantis and Kleis Technology, n.d., GCCA Industry EPD Tool for cement and concrete (v4.2) LCA Model International version. Available by request from GCCA.

<sup>102</sup> EPD Hub, ND, Why choose EPD Hub? URL: [www.epdhub.com/why-choose-epd-hub](http://www.epdhub.com/why-choose-epd-hub)

### **Other EPD tools**

Within larger European EPD programmes, it is not economically feasible to register EPD for each individual site. European programmes have cost models which preclude the registration of hundreds of EPD, such as for 20,000 different concrete mixes. However, with pre-verified EPD tools, it is possible to generate project-specific EPD for them. For example, in Institut Bauen und Umwelt e.V. (IBU), it is not necessary to register the EPD from pre-verified tools, but they must be recorded. With process verification in EPD International, it is also not necessary to register every EPD from a pre-verified tool with the programme<sup>103</sup>.

A cement manufacturer in the UK has used the Emidat tool to produce EPD for a number of company average concretes, and can use the tool to provide site and mix specific EPD on demand.

In the US, ASTM International for example have certified thousands of EPD for concrete, based in the most part on a number of verified EPD tools which are used to provide site and mix specific EPD<sup>104</sup>. These EPD are made for download via the ASTM site and as searchable digitised data via the EC3 tool.

### **EU CBAM**

This research did not identify software for EU CBAM submissions. Many companies used their internal accounting or recording software to collect and display data and submit using reporting spreadsheets.

#### **A3.4.5 Is the role of the practitioner significant?**

It is not possible to quantify practitioner-related variance separate from other sources of variance e.g. data and methodology choices. Practitioner-related effects include choosing data and using the tools. Challenges of choosing data and using the software include:

- Searching databases within SimaPro is very text specific. This includes instances of “Portland cement” returning completely different results to “cement, Portland.” Search time can be prohibitive to finding relevant processes. Some search strings did not return any hits. However, it is often necessary to limit the scope of the search in order to allow them to run in a reasonable time. A full search can be too time consuming.
- There are instances when a search might bring up an obsolete process. For instance, processes containing “pozzolana and fly ash” are all obsolete. However, delving into the processes revealed a “clinker” process underpinning them, and is used as a proxy for fly ash. The clinker process is still supported, but the use of it as a proxy is not obvious without digging into an otherwise obsolete process (using ecoinvent database, version 3.8, as searched in SimaPro 9.6.01).

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<sup>103</sup> URL: [www.tarmac.com/sustainability/epd/](http://www.tarmac.com/sustainability/epd/)

<sup>104</sup> URL: [www.astm.org/products-services/certification/environmental-product-declarations/epd-pcr.html](http://www.astm.org/products-services/certification/environmental-product-declarations/epd-pcr.html)

## Annex 3

This annex provides supporting information that informs the finding presented in Appendix 3.

### Annex 3.1 Supporting information for A3.2

This research interviewed manufacturers of:

- Intermediate products. Intermediate products are bought and sold in the UK as raw materials for finished products.
  - In steel, this included flat or bar products.
  - In cement, this included Portland Cement Clinker (PCC) or CEM I (Portland Cement, sometimes referred to as Ordinary Portland Cement) and further mixes of cement such as CEM II, III.
- Finished products. Finished products are consumed in the construction industry, for example, steel panels for cladding.
  - In steel, this included structural steel or reinforcing steel.
  - In cement and concrete, this included different types of concrete such as ready-mix concrete, mortars and precast concrete products.

Table 8 provides a summary of data, methods and tools used by stakeholders for steel (intermediate and finished products), cement and concrete.

**Table 8: Summary of data collected and methods and tools used by stakeholders.**

| Sector              | Steel – Intermediate products                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Steel – Finished steel products                                                                    | Cement and concrete                                                                                                                                                                                                                              |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Primary data</b> | <ul style="list-style-type: none"> <li>Raw materials (weight).</li> <li>Unit process data.</li> <li>Energy use (gas and electricity) from meters.</li> <li>Water use from meters.</li> <li>Internal and external movements onsite via weighbridge. Weighbridges record how heavy trucks are upon entering site and leaving site, to check how much was delivered / taken away.</li> <li>Systems Application Products system data (procurement, logistics and warehouse information). A business' accounting system will record how much value was spent in procuring an item, and sometimes volume, number of items, or weight. This is a useful source of data.</li> </ul> | <ul style="list-style-type: none"> <li>Energy use (broken down by minutes) from meters.</li> </ul> | <ul style="list-style-type: none"> <li>Raw materials (weight) – can be around 400 materials for a cement plant.</li> <li>Energy use (gas and electricity) from meters.</li> <li>Truck travel distance (miles) from an online tracker.</li> </ul> |

| Sector                | Steel – Intermediate products                                                                                                                                                                                                                                                                                                                                                 | Steel – Finished steel products                                                                                                                             | Cement and concrete                                                                                                                                                                                                                                                                         |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Secondary data</b> | <ul style="list-style-type: none"> <li>Information from suppliers (such as transportation).</li> <li>GaBi database.</li> </ul>                                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>EPD from intermediate steel providers.</li> <li>National Association data (e.g. Road Haulage Association)</li> </ul> | <ul style="list-style-type: none"> <li>EPD from suppliers.</li> <li>National association data (e.g. National Highways).</li> <li>Supply chain data from procurement.</li> <li>Calculated averages (particularly for travel).</li> <li>ecoinvent database.</li> <li>ICE database.</li> </ul> |
| <b>Methodology</b>    | <ul style="list-style-type: none"> <li>ETS reporting.</li> <li>GHG protocol reporting (note: at organisational level, and then manipulated to product level).</li> <li>LCA-led approach.</li> <li>Own EPD programme: where EPD are made, they are based on Worldsteel data, and usually only for customer products using the intermediate steel as a raw material.</li> </ul> | <ul style="list-style-type: none"> <li>Carbon footprint (Scope 1, 2 and 3)</li> <li>EPD</li> </ul>                                                          | <ul style="list-style-type: none"> <li>ETS reporting.</li> <li>EPD with PCR for cement.</li> <li>GHG Protocol.</li> <li>LCA following ISO 14044+A2: 2020.</li> </ul>                                                                                                                        |
| <b>Tools</b>          | <ul style="list-style-type: none"> <li>GaBi (now Sphera) tool and database.</li> </ul>                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>In-house created spreadsheet or one specified by a client. National Highways.</li> </ul>                             | <ul style="list-style-type: none"> <li>GCCA Tool to create EPD.</li> <li>EPD created by consultants.</li> </ul>                                                                                                                                                                             |

Respondents were asked to self-assess the quality of their data collection process. Answers and insights include:

**Steel intermediate manufacturers:**

- For Emissions Trading Scheme (ETS), all Scope 1 impacts are primary data collected onsite and granular to the level of activity, and often per unit process. Measurement equipment has to be regularly calibrated to provide assurance on the data collected, and data itself has to be logged to provide a paper trail. As this relates to a regulation, organisations focus their attention on this. One intermediate steel manufacturer stated that assurance of data is higher in ETS, because there are financial implications for the manufacturer, and verification goes to the level of assuring data at the meter level. At the same time, ETS does not include all sources of carbon emissions, nor upstream emissions, except for fuel containing carbon which is burnt onsite. There are also thresholds for reporting certain carbon emissions (such as gas used in forklifts).
- Environmental Permits are also a legal requirement, but they often do not specify carbon emissions to be reported to the regulator (the Environment Agency). Other air emissions may be captured depending on the terms of the site's Environmental Permit. The Environmental Permit will be site specific, not organisation wide. Annual datasets for Environmental Permit reporting can and are sometimes used in LCAs.
- Life Cycle Assessment data is collected much less frequently than data for ETS. One intermediate steel manufacturer described their LCA process as a 5-year cycle. Data for LCAs might come from the same meter as ETS, but often will be handled in a different way (for example, if the LCA was to examine a particular process, data might be handled as an annual average). Unit process data will often be annualised to help smooth out differences between the different types of products produced on that unit process. One intermediate steel manufacturer collects Scope 3 data on an annual basis, not monthly, so there will be a lag between their data types. One intermediate steel manufacturer reported sharing information with worldsteel to collate and disseminate, to promote generic data based on up-to-date figures. In return, worldsteel send back an LCA model of the flows, which forms the basis of some EPD produced by the intermediate steel manufacturer.
- Relevant background datasets are taken from the GaBi (now Sphera) software database. One intermediate steel manufacturer asserted that the last revision of these datasets took place less than 10 years ago.
- EPD take data from the production processes relevant to the time period. One intermediate steel manufacturer is a programme operator, creating EPD for their customers who use their intermediate steel as raw materials for their products. Stakeholders stated that assurance of data in EPD is not as robust as ETS, as it does not provide assurance on the data points used. However, verifiers are required to check plausibility of data generally under 9.2 of BS EN 15804+A2:2019 as well as specific calculations relating to mass balance and primary energy flows (section 12.5 of BS EN 15804+A2:2019). Additionally, verifiers may ask to see the model or check manufacturer data, particularly if they are uncertain of the modelling, methodology or

calculation used. Where there are small volumes of product produced, but an EPD is required, primary data will be added to relevant secondary data (for example, in galvanised product, one intermediate steel manufacturer will use their own data for steel making and those parts under their operational control and then zinc information from publicly available sources).

- Scope 3 – Information from suppliers is used with some assumptions and data handling. One intermediate steel manufacturer described their Scope 3 impacts as making up 52% of their total carbon footprint, and they calculate Scope 3 on an annual basis, not a monthly basis.
- EU CBAM is described as only covering direct emissions (Scope 1). One intermediate steel manufacturer breaks their CBAM returns by their three key products (hot, cold and finished cold rolled coil). This is because the products underneath these three categories have the same default number applied to them, and therefore it would be more work for no reward. For EU CBAM, data per process is collated on an annual basis, not per grade of product. This indicates that although this is a product-based scheme, manufacturers are having to use the data per process because that's how their data collection has historically been set up.

### **Fabricated steel product insights:**

Overall estimation of fabricated (secondary) steel product is adding 7-10% of the carbon footprint, while 93% is from the manufacturing steel plant itself.

### **Cement manufacturers:**

- ETS and EPD – similar to intermediate steel manufacturers.
- LCA – One cement manufacturer collects information for around 400 materials used in ready mix cement. Completing an LCA per cement mix would be an enormous undertaking as there can be multiple thousands of mixes made a year.
- Relevant background datasets are taken from other EPD but, where this is not available, cement manufacturers tend to use data from ecoinvent database or the ICE database, being clear on where the data comes from. Sector EPD or product specific EPD are used, with the preference being for sector EPD. Verified information is preferred (such as EPD, national associations, or other traceable data). Where raw material information is unverified, such as delivered by email with no traceability, it will be treated as such. Because of the number of raw materials used in cement, manufacturers will focus their effort on elements that contribute the most to the carbon footprint, and less on elements such as pigments.
- EPD are usually put together from other EPD, a calculation for transport (often with assumptions) and annualised operational data. Often, cement manufacturers will use averages taken across all their cement plants in order to make the EPD applicable to their cement as a whole. This means that cement EPD are averages.

- Industry-spanning EPD are also averages. They allow the industry access to an EPD based on their data, but they lower best practice visibility and could reduce the incentive for manufacturers to improve their processes and quality of data. An industry EPD often averages data across contributing members; this dilutes the ability to clearly see which plant, technology or technique results in a product with the lowest GWP impact.

## Annex 3.2 Supporting information for A3.4

Table 9 provides a summary of the secondary databases used by respondents.

**Table 9: Overview of secondary databases used by respondents.**

| Database                                                                                                                                                                                                                                                                            | How quality of data is assured                                                                                  | How uncertainty is dealt with                                                                                                                                                                                                                                                                           | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>EPD databases</b><br>Databases such as Environdec <sup>105</sup> , INIES <sup>106</sup> and Okobaudat <sup>107</sup> are available online and host EPD as downloadable PDFs. This increases transparency in EPD validity for customers to confirm the products have a valid EPD. | In general, EPD databases are repositories of EPD information. EPD can only be uploaded once they are verified. | The databases display verified EPD and so it is the role of the verifier to assess uncertainty. Additionally, databases may impose other rules on what EPD can be uploaded to their site (for example, Okobaudat datasets are compliant to BS EN 15804+A2:2019, not A1, and using GaBi background data. | EPD databases are a useful starting point but as EPD themselves do not reveal their background data (only the source), users have to rely on the verification process to determine whether valid and appropriate data were used. Databases only include registered EPD. This means that the EPD produced from pre-verified tools which are not registered with the EPD programme will not be listed or made publicly available by the EPD programme, but the EPD programme still allows the production and use of these EPD. Note that manufacturers will prioritise EPD from products they've used where possible. |

<sup>105</sup> URL: [www.environdec.com/library](http://www.environdec.com/library)

<sup>106</sup> URL: [www.inies.fr/en/](http://www.inies.fr/en/)

<sup>107</sup> URL: [www.oekobaudat.de/no\\_cache/en/database/search.html](http://www.oekobaudat.de/no_cache/en/database/search.html). Okobaudat has two databases, one to EN 15804+A1 and another to EN 15804+A2. It also provides a separate database for EPD using ecoinvent (from non-German producers).

| Database                                                                                                                                                                                                                                                                                                                                                                                                                      | How quality of data is assured                                                                                                                                                                                                        | How uncertainty is dealt with                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Embodied Carbon in Construction Calculator (EC3) – GWP only</b></p> <p>EC3 takes EPD uploaded to their site and uses them in a tool to benchmark embodied carbon of construction products in the context of a building project. It uses building material quantities from construction estimates and/or BIM models and a robust database of digital, third-party verified Environmental Product Declarations (EPD).</p> | <p>Similar to the EPD databases, EC3 only ingests verified EPD. They are either automatically transferred from LCA developers such as Climate Earth or Smart EPD, or from EPD aggregator websites, or uploaded directly by users.</p> | <p>EC3 is upfront on the uncertainty within the database and how it's built into their comparison tools. For each EPD, they produce an uncertainty-adjusted GWP, calculated from the reported GWP in the EPD multiplied by their own uncertainty factors in the product category. These uncertainty factors are driven from the way they categorise an EPD as being either manufacturer specific, facility specific, product specific, and batch specific. Clearly, their approach shows they consider EPD produced for a specific product to have less uncertainty in the result.</p> | <p>Unlike the other databases, EC3 reports the GWP emission (including uncertainty factor adjustment) as part of the metadata for each EPD.</p> <p>There is always a link to the EPD to provide the other indicators.</p> <p>All the other EPD databases do not provide any indicator data directly, but as part of the link to the whole dataset.</p> <p>EC3 does not check or confirm what primary or secondary data were used in the production of the EPD: this is, rightfully, the role of the verifier. At the same time, this means they can't confirm the data it and whether the data used were specific or general. It's relying on manufacturers to be using specific data for their specific mix.</p> <p>With more "pre-verified" EPD software offerings on the market, and more EPD produced as a result, EC3's approach may need to be revised.</p> |

| Database                                                                                                                                                                                                                                                                                                                                  | How quality of data is assured                                                                                                                                                                                                                                                                                                                         | How uncertainty is dealt with                                                                                                                                                                                                                  | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Paid LCI databases (ecoinvent, GaBi / Sphera)</b></p> <p>ecoinvent (based in Switzerland) and GaBi / Sphera (based in the USA) produce LCI datasets which users can obtain via a licence agreement. Often, software solutions will come with one database (Simapro comes with ecoinvent; Sphera comes with the Sphera dataset).</p> | <p>Their datasets are reviewed by a third party and reports produced. Data is mainly taken from industry reports, statistics and scientific literature published by well-known institutions. Independent reviews find that data sources used are generally of high quality and in general can be classified as relevant, independent and reliable.</p> | <p>Datasets undergo an annual quality check by internal experts which review the representativeness of the data sources and models. Uncertainty itself is left to the practitioner to determine the best factors to use for their project.</p> | <p>As their business model is to provide data, both ecoinvent and GaBi/ Sphera's internal quality management system is integral to this. The datasets are updated with new releases regularly. Uploads are encouraged and subject to an editorial review.</p> <p>The downsides to LCI databases are the costs of licence and the skill required to determine which factors to use for each project. Datasets also have regional limitations (for example, data collected from one country or aggregated to a global level) and can affect specificity.</p> |

LCI databases used in industry; usually available to members.

| Database                                                                                                                                                                                                                                                                                                                          | How quality of data is assured                                                                                                                                                                                                                                                  | How uncertainty is dealt with                                                                                                                                                                            | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>worldsteel database</b><br>The worldsteel Association complies a database from members based on ISO 14040:2006+ A1:2020 and ISO 14044+A2:2020 standards, to quantify the resource use, energy and environmental emissions associated with the manufacture of steel products, from raw material extraction to the factory gate. | The methodology has been developed over many years (since 1995, updated 2000, 2005 and 2011), and critically reviewed by a panel of expert LCA experts each time. Data quality requirements give strong preference to measured data, followed by calculated and estimated data. | The data quality requirements under the method state precision of data collected should be regarded as +/- 5%. Any uncertainty in data, models and assumptions "should" be documented "where necessary." | The worldsteel LCI database feeds into GaBi / Sphera and the worldsteel Association uses Sphera software to construct their LCA models, so inoperability across intermediate steel manufacturers across WSA members is increased. However, the methodology allows co-products (such as slag) to be allocated using the system expansion method. While this is cited in ISO 14044+A2:2020 as one of the preferred methods to use since it "avoids" allocation, it is a source of controversy in this project. |

| Database                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | How quality of data is assured                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | How uncertainty is dealt with                                                                                                                                                                                                                                            | Comments                                                                                                                                                                                                                                                                                                                         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Global Cement and Concrete Association Industry EPD Tool for Cement and Concrete (underlying database)</b></p> <p>GCCA produced a web-based calculation tool for EPD of clinker, cement, aggregates, concrete and precast elements. It produces two major outputs:</p> <p>A self-declaration in GCCA format, not an official EPD but can be used in communications as it contains the main / background information and LCA results of the specific product; and</p> <p>A background report with the complete set of input data and results of the specific product. This contains all the information needed to produce an EPD and for a verifier to validate it.</p> | <p>The documentation states the database is expected to be completed with primary data from users, but default datasets for clinker, cement and concrete are provided for users. These default datasets are based on a reference ecoinvent dataset along with statistical data from the Getting the Numbers Right (GNR) dataset, apart from concrete which is a reference ecoinvent concrete dataset alone. Default parameters for transport (based on ecoinvent) and regional electricity mixes (based on IEA 2017 data) amongst other default values are also provided in the tool.</p> | <p>GCCA is transparent about the limitations in their methodology document<sup>108</sup>. As the tool is meant to be used by a large number of users with variable LCA knowledge, detail was sacrificed for accessibility. This means that customisation is limited.</p> | <p>The limited customisation that EPD produced with this tool will be consistent with one another, although there are questions on the data source and whether this is applicable to the UK.</p> <p>Integrated concrete producers using the GCCA tool will use their own specific data for cement and aggregates production.</p> |

<sup>108</sup> Quantis and Kleis Technology, n.d., GCCA Industry EPD Tool for cement and concrete (v4.2) LCA Model International version. Available by request from GCCA.

| Database                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | How quality of data is assured                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | How uncertainty is dealt with                                                                                                                                                                                                                                                                                       | Comments                                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>ICE database – GWP only</b></p> <p>The Inventory of Carbon and Energy (ICE) database is maintained by a limited company, Circular Ecology. Version 3 (2019) was recently superseded by Version 4 (2024).</p> <p>ICE extracts data manually from EPD PDFs (and now digitally) from EC3 and Ecoportal to create a database of over 28,000 materials. They then subject this to an additional analysis, cleansing and categorisation of data, which is done manually.</p> | <p>The new system addresses material appropriateness (as ERDs can cover more complex products made from several materials, such as insulation), accounting differences (from different reporting methodologies, boundaries and standards), and unclear or missing data. They ingest data which seem appropriate (representative) and check its accuracy in a mass balance. They have also implemented a Data Quality Index (DQI) scoring, taking into account core and category average data quality indices.</p> | <p>The aggregated data for a material type is displayed alongside its DQI score, however it's left to users can determine uncertainty. The score represents the quality of the background data in the database according to Circular Ecology's data quality process, which is different to and on top of EC3's.</p> | <p>The ICE database represents a good starting point for transparent GWP only data. While arranged in product categories, it's still highly aggregated data, and the DQI score might cause an inexperienced practitioner to choose the parameter with the highest scores even though it's not the most appropriate factor.</p> |

## Appendix 4: Understanding carbon footprints of construction materials

This Appendix presents the key results and findings for cradle-to-gate (A1 to A3 - see Appendix 1 for descriptions of life cycle stages) emissions for the steel, cement, and concrete products investigated within this research project. These life cycle stages were selected to allow for a direct comparison between the different products, due to cement having an exemption under BS EN 15804+A2:2019 for further life cycle stages.

As part of this research project, a bespoke Comparator LCA Tool was developed, which provides the origin for the calculated results presented below. A summary of calculation methodologies and data used to develop these results can be found in Appendix 6. For all displayed figures within this section, a list of the specific data used to compile the results is provided in Annex 4.

For the analysis presented within Section 4, specific steel and cement products were selected to demonstrate the implications of using different calculation methodologies. The justification for these products is provided below:

- **Hot Rolled Steel Angles, Sections & Shapes (HS 7216 10):** This product is currently manufactured within the UK, with a direct production route managed by one company (unlike many flat rolled steel products which are currently imported). This product was therefore decided as an accurate product to select for the UK.
- **Cement Clinker:** Clinker is the most carbon-intensive component used within cement manufacture, therefore exploring the emissions associated with this provides a clear insight for emissions within cement.

## A4.1 What is the carbon footprint for steel products?

Figure 29 below presents the range of calculated A1 to A3 emissions for steel products by Harmonised System (HS) code, in comparison to selected benchmark data. The wide range of data is due to the variety of possible steel production routes (such as blast furnace, EAF or DRI), alongside the range of data provided within the BREF notes in the form of upper and lower limits for material and fuel consumption.

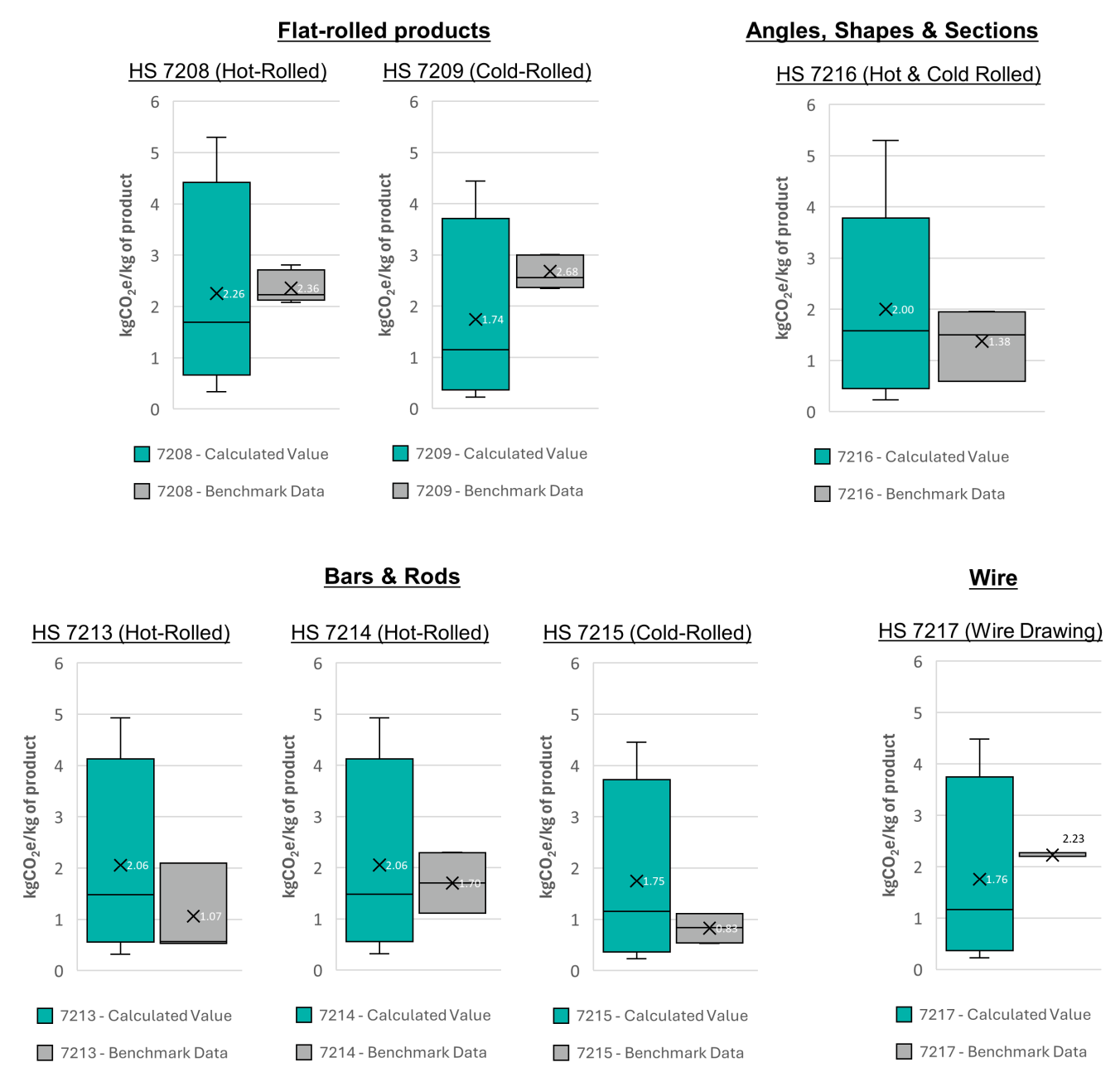


**Figure 29: Calculated A1-A3 life cycle emission data for selected steel products, in comparison to benchmark data.**

Figure 30 highlights A1 is the largest contributor to the carbon footprint of steel products, forming ~92%-99% of life cycle emissions. Hot-rolled products typically have a higher percentage of A3 emissions compared to cold-rolled products. This is likely due to the

increased energy demand required to maintain the higher manufacturing temperatures as the hot-rolled products are further worked, whereas cold-rolled steel is further processed at lower temperatures.

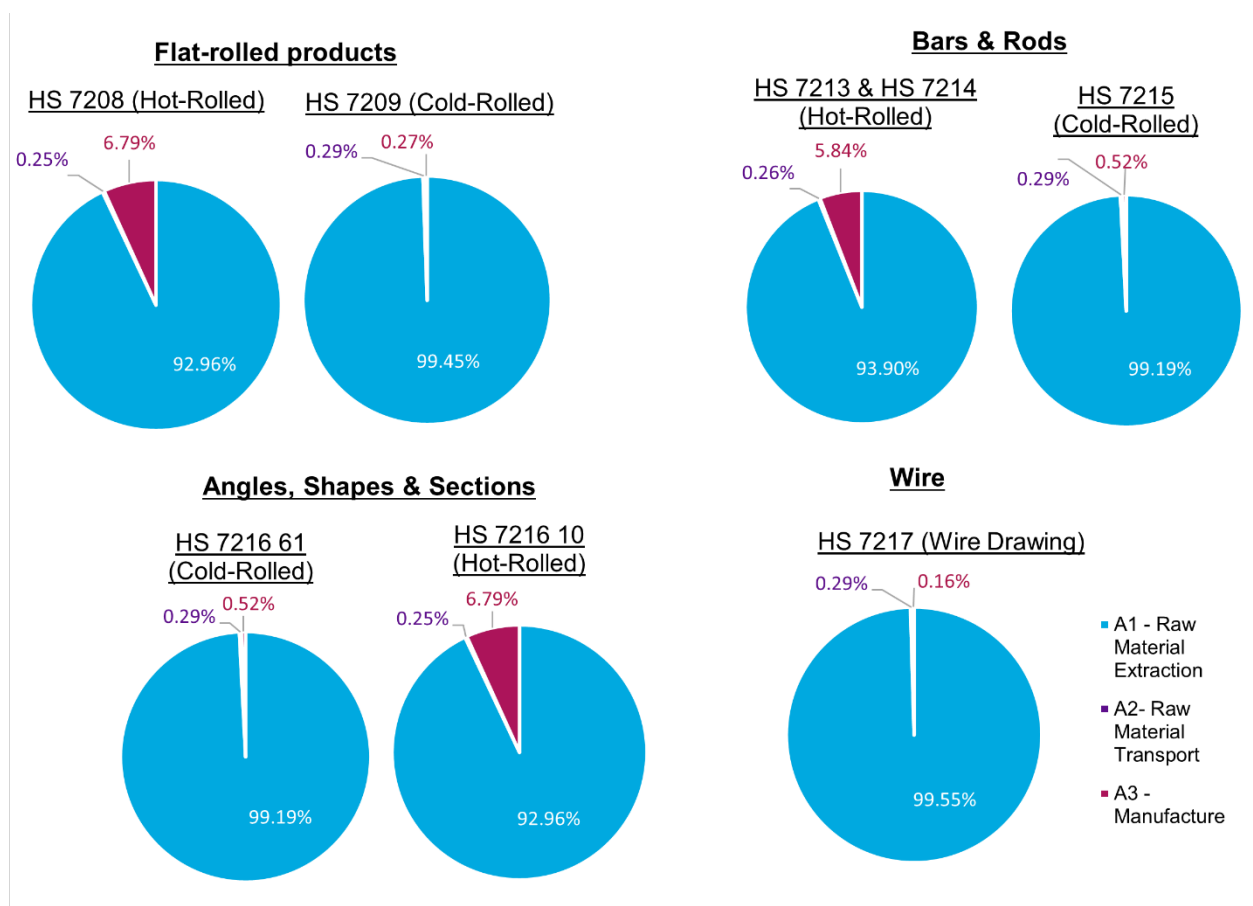


**Figure 30: Percentage contribution of each life cycle module to the total A1-A3 emissions for steel products.**

The production route used has a significant impact on the cradle-to-gate carbon emissions for steel products, as highlighted below in Figure 31.

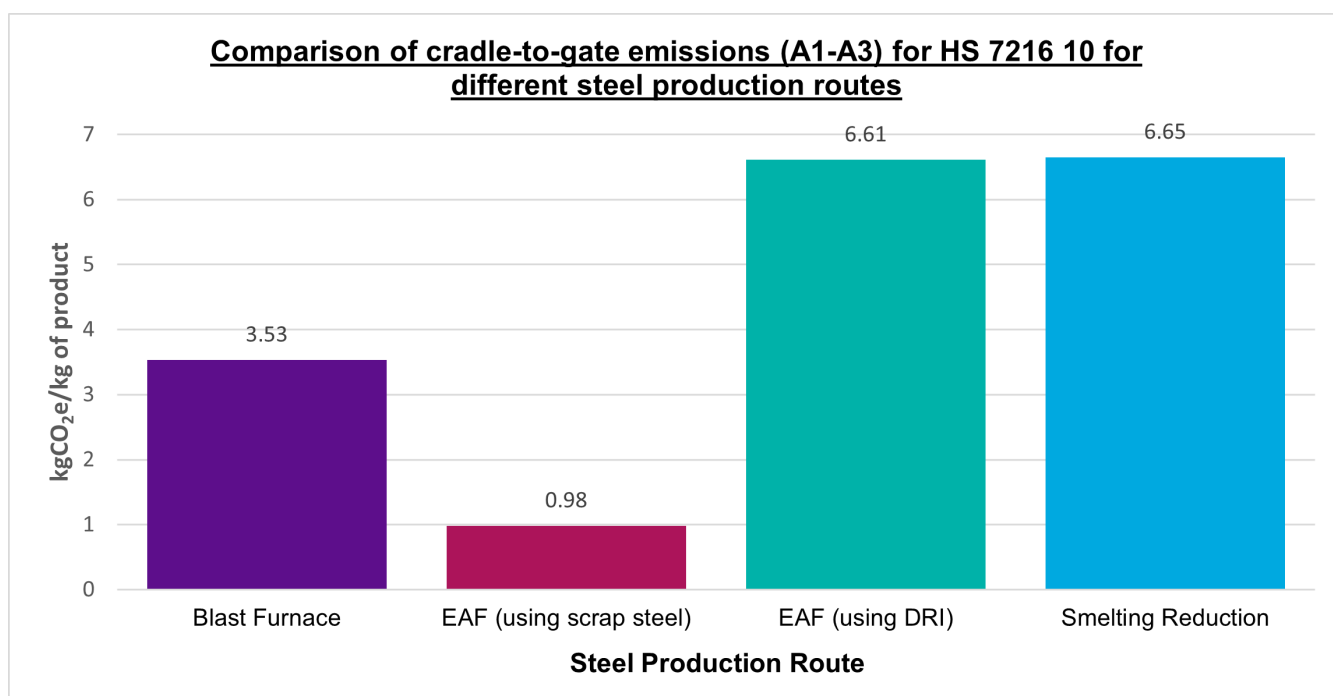


**Figure 31: A1-A3 emissions for a selected steel product (HS 7216 10) produced via different manufacturing processes.**

Figure 31 highlights that the standard EAF process using scrap steel is the iron production route with the lowest associated carbon emissions. EAF furnaces using scrap as an input have been reported to reduce carbon emissions compared to BF-BOF by approximately 20%<sup>109</sup>. The magnitude of emissions reduction associated with EAF compared to BF-BOF is dependent on the carbon intensity of the local electricity grid. For example, in 2024, the UK carbon intensity was 207 gCO<sub>2</sub>e per kWh<sup>110</sup> whereas the carbon intensity in Germany, a leading exporter of EAF fabricated steel to the UK<sup>111</sup>, was 371 gCO<sub>2</sub>e per kWh. The intensity is higher in Germany due to their coal power generation<sup>112</sup>.

DRI is often produced using coal as the fuel, which typically results in emissions greater than those of the BF-BOF process (as highlighted within Appendix 1). In contrast, when DRI production is powered by renewable energy, research suggests EAF production routes can maintain their low emissions advantage<sup>113</sup>.

<sup>109</sup> World Economic Forum 2023, Net-Zero Industry Tracker, URL: [www.weforum.org/publications/net-zero-industry-tracker-2023/in-full/steel-industry-net-zero-tracker/](https://www.weforum.org/publications/net-zero-industry-tracker-2023/in-full/steel-industry-net-zero-tracker/)

<sup>110</sup> DESNZ, 2025, Greenhouse gas reporting: conversion factors 2024, URL:

[www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024](https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024)

<sup>111</sup> Statista, 2024, Main export countries of iron and steel products to the UK in 2024, URL:

[www.statista.com/statistics/626726/uk-iron-steel-product-imports-origin-countries/](https://www.statista.com/statistics/626726/uk-iron-steel-product-imports-origin-countries/)

<sup>112</sup> EMBER, 2024, European Electricity Review 2024, URL: <https://ember-energy.org/latest-insights/european-electricity-review-2024/eu-electricity-trends/>

<sup>113</sup> US Energy Information Administration, 2022, Energy Implications of Potential Iron- and Steel-Sector Decarbonization Pathways, URL: [www.eia.gov/outlooks/ieo/iif\\_industrial/pdf/IIF\\_industrial.pdf](https://www.eia.gov/outlooks/ieo/iif_industrial/pdf/IIF_industrial.pdf)

## Post cradle-to-gate life cycle stages

The manufacturing stage (A3) is the most carbon-intensive life cycle stage for steel production. Table 10 provides an approximate percentage break down of the emissions associated with each life cycle stage across A1 to A5. Source data was only available in percentage ranges, with no absolute values available.

**Table 10: Approximate percentage of carbon emissions across A1 to A5 for blast furnace steel production (Arup, 2023)<sup>114</sup>.**

| Life Cycle Module |                                | Approximate percentage contribution across A1 to A5 life cycle stages |
|-------------------|--------------------------------|-----------------------------------------------------------------------|
| A1                | Raw Material Supply            | 15-30%                                                                |
| A2                | Transport (Product stage)      | 5-15%                                                                 |
| A3                | Manufacturing                  | Blast furnace: 30-45%<br>BOF and Caster: 5-10%<br>Hot mill: 20-30%    |
| A4                | Transport (Construction stage) | 2-10%                                                                 |
| A5                | Construction Installation      | 1-5%                                                                  |

End of life emissions for steel will vary depending on whether the steel is reused, recycled or landfilled. The reuse or recycle of steel will be shown as a negative “avoided impact” in Module D of an EPD, accounting for the future use of that product within a new life cycle. Literature suggests recycling one tonne of primary steel saves 1.67 tonnes of CO<sub>2</sub><sup>115</sup>.

## A4.2 What is the carbon footprint for cement and concrete products?

Figure 32 presents the range of calculated A1 to A3 emissions for cement and concrete products, in comparison against selected benchmark data (generated using the LCA Comparator Tool). For cement products, the highest emissions are associated with cement clinker production. A reduction in total embodied emissions can be seen from CEM I through to CEM III, correlating to the reduction in the percentage content of clinker from CEM I to CEM III. (See Appendix 1 for information on cement manufacturing and cement types).

<sup>114</sup> Arup, 2023, Embodied carbon of steel, URL: [www.istructe.org/IStructE/media/Public/Resources/ARUP-Embodied-carbon-steel\\_1.pdf](http://www.istructe.org/IStructE/media/Public/Resources/ARUP-Embodied-carbon-steel_1.pdf)

<sup>115</sup> Circular Economy Europe, ND, Metal Recycling Factsheet, [https://circulareconomy.europa.eu/platform/sites/default/files/euric\\_metal\\_recycling\\_factsheet.pdf](https://circulareconomy.europa.eu/platform/sites/default/files/euric_metal_recycling_factsheet.pdf)

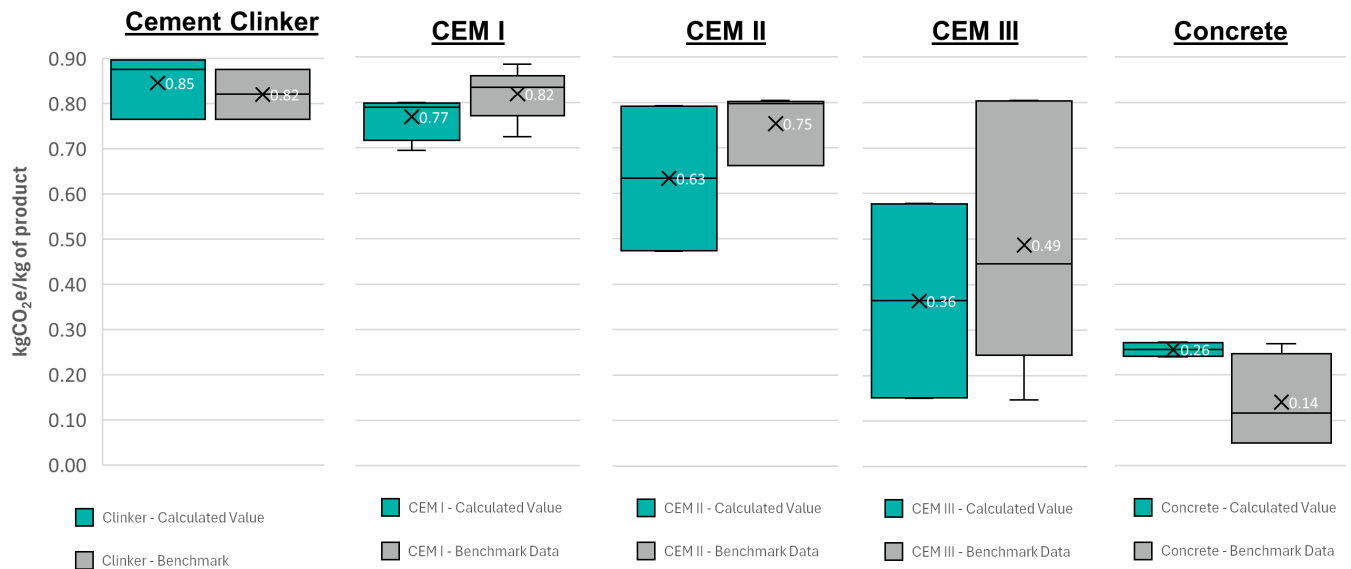


**Figure 32: Calculated A1-A3 life cycle emission data for selected cement and concrete products, in comparison to benchmark data.**

For each product itemised above, a breakdown of the composition of emissions for each life cycle stage is provided in Figure 33. A3 is the largest contributor to cradle-to-gate emissions within cement clinker production, whereas A1 is the largest contributor for cement and ready to pour concrete products.

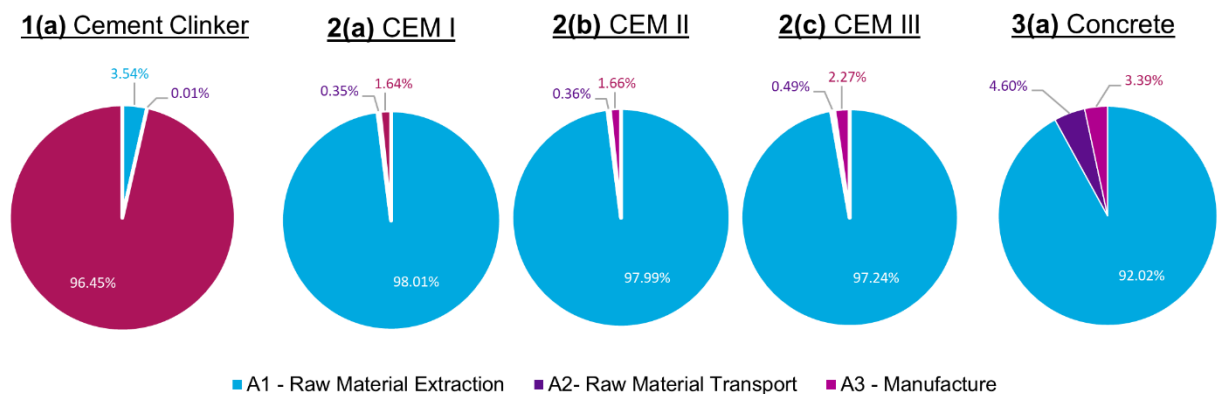


**Figure 33: Percentage contribution of each life cycle module to the total A1-A3 emissions for cement clinker (1), cement (2) and concrete (3) products.**

The use of net emissions over gross emissions (see Appendix 2.1) accounts for an approximate 10% reduction in cradle-to-gate emissions, as shown within Figure 34.

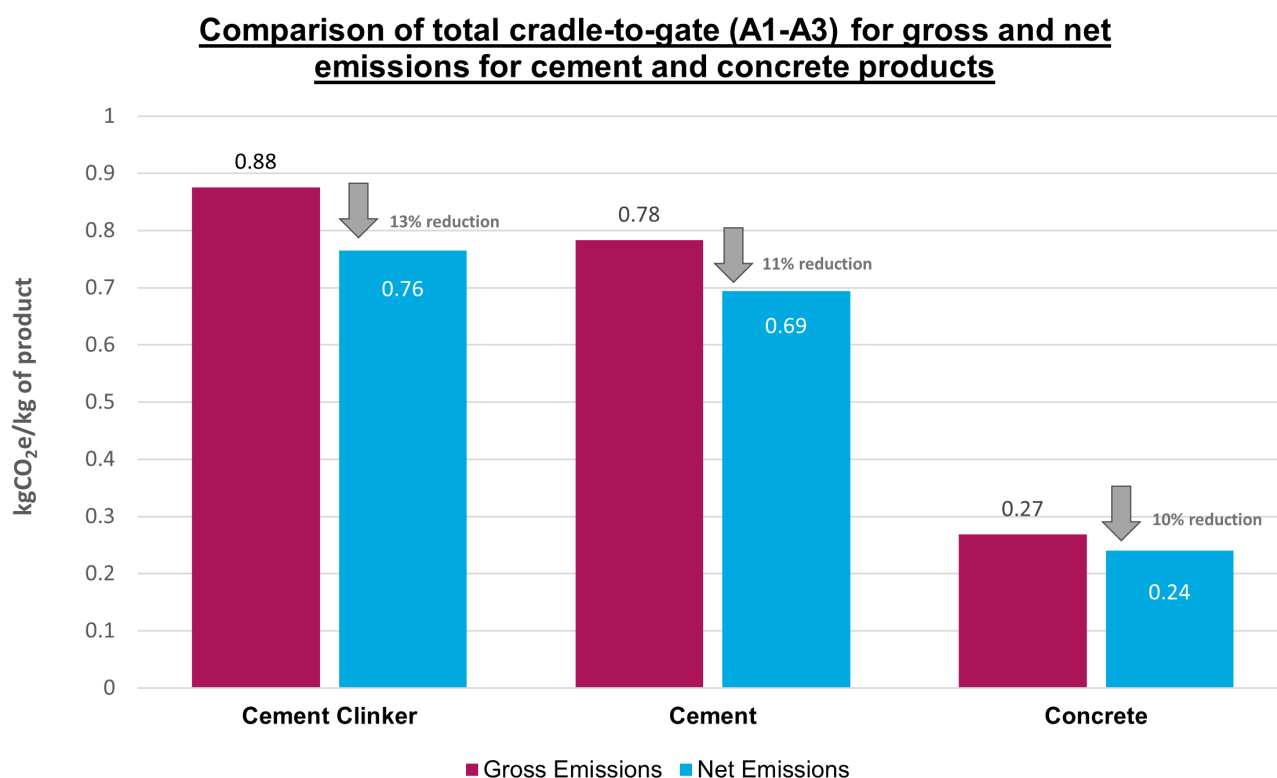


**Figure 34: A comparison of A1- A3 net and gross emissions for cement clinker, cement and concrete.**

## A4.3 What impact does utilising different methodologies have on A1 to A3 life cycle emissions?

### Comparison of the total cradle-to-gate (A1-A3) emissions calculated in accordance with BS EN 15804 and EU CBAM for a selected cement and steel product

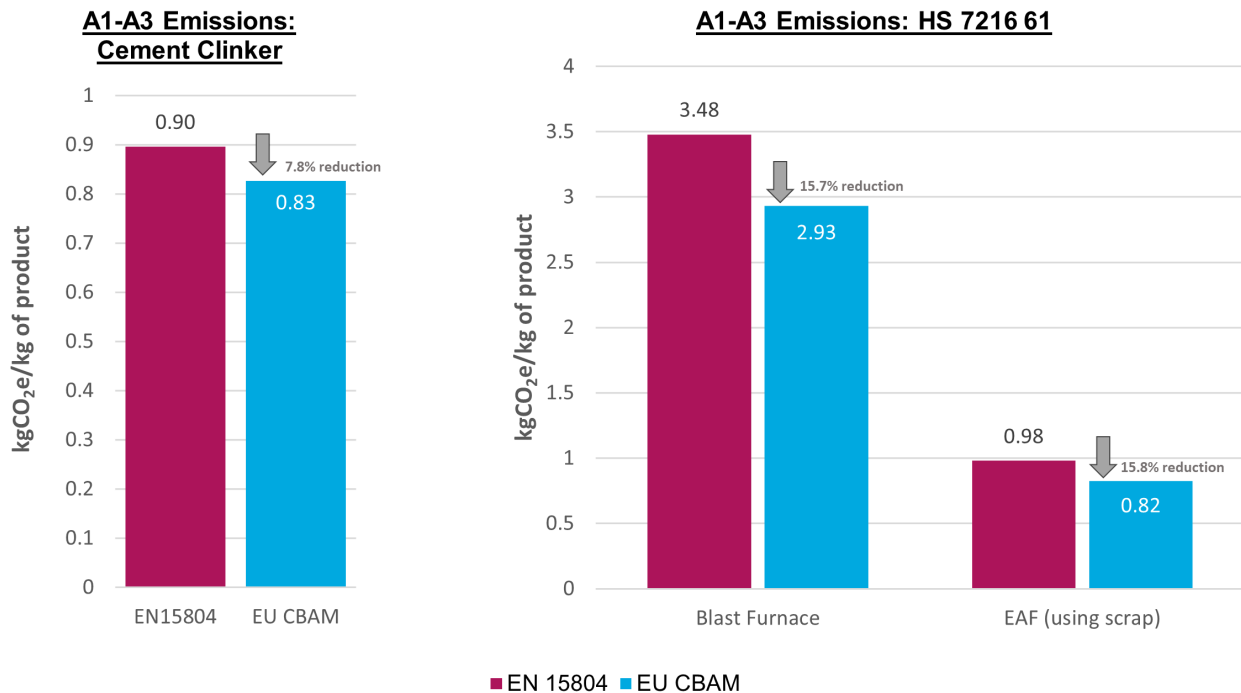


**Figure 35: The percentage difference in A1-A3 emissions for selected cement and steel products when using BS EN 15804+A2:2019 methodology in comparison to aligning to EU CBAM.**

Figure 35 highlights EU CBAM generates results that are ~8-15% lower than the same products aligned to BS EN 15804+A2:2019 methodology.

The most significant difference between these emission values is the exclusion of emissions associated with Well-to-Tank (WTT) and transmission and distribution (T&D) within EU CBAM. Figure 36 highlights that these WTT and T&D emissions make up ~8% of emissions for cement clinker, and ~8-13% of emissions for steel products. For steel, this forms ~50-75% of the difference between BS EN 15804+A2:2019 and EU CBAM.

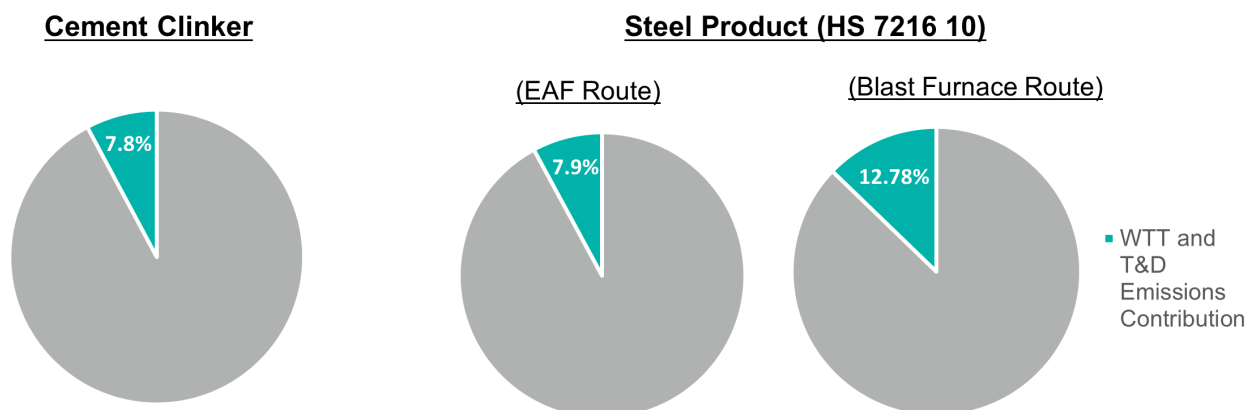


**Figure 36: Percentage contribution of emissions associated with WTT for A1-A3 emissions for a selected cement and steel product.**

## A4.4 How does current data compare against future emission thresholds?

This section presents the A1 to A3 emissions associated with cement products and HS 7216 10 steel products manufactured using different production routes, against future emissions thresholds (see Appendix 2). These future thresholds are set as performance targets which incorporate industry best practice and are compatible with IEA Net Zero Emissions Scenarios<sup>116</sup>.

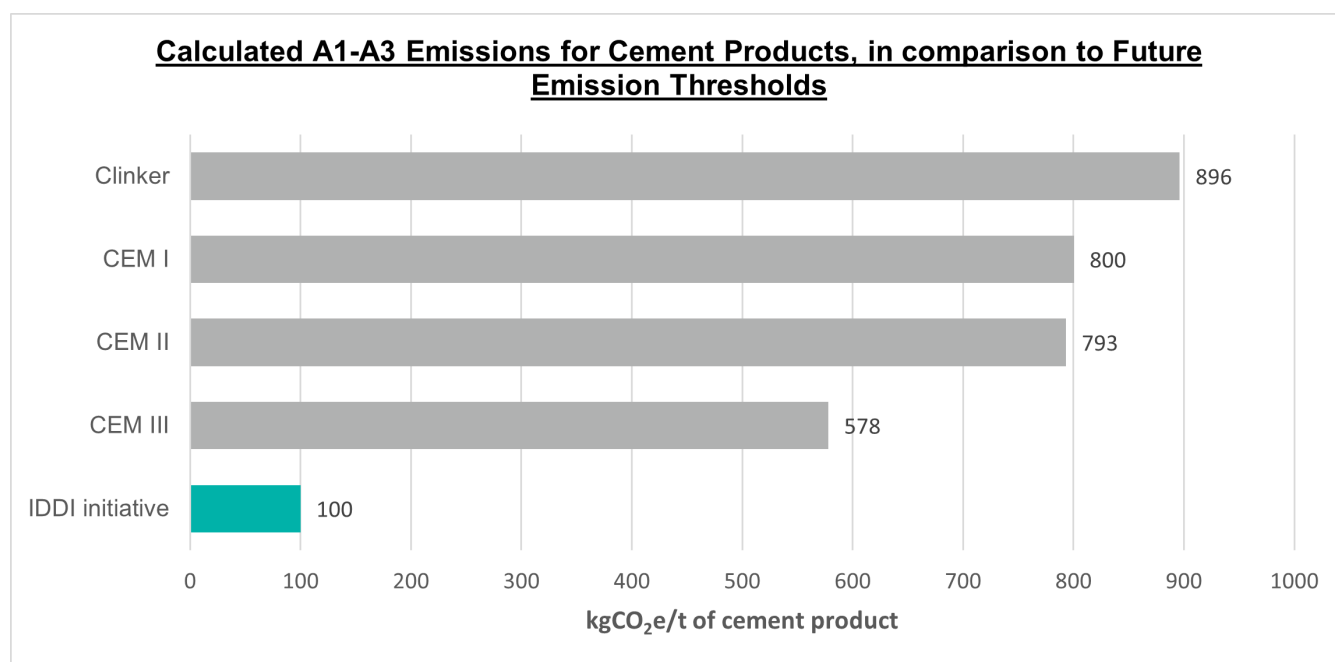


**Figure 37: A1-A3 emissions for cement products in comparison to the IDD Future Emission Threshold target (calculated using the global average clinker-to-cement ratio of 0.7)<sup>117</sup>.**

Current industry emissions for cement products are notably higher than the IDD targets, as shown in Figure 37. CEM III, which has the lowest percentage contribution of clinker in comparison to CEM I and CEM II, is the closest to the IDD target, however there is still a significant reduction in embodied emissions required to achieve this target.

<sup>116</sup> International Energy Agency, ND, Achieving Net Zero Emissions in G7 Members, URL:

[www.iea.org/reports/achieving-net-zero-heavy-industry-sectors-in-g7-members/recommendations-for-the-g7](https://www.iea.org/reports/achieving-net-zero-heavy-industry-sectors-in-g7-members/recommendations-for-the-g7)

<sup>117</sup> IDD, 2023, Your commitment to green construction with public funds, URL:

[www.industrialenergyaccelerator.org/wp-content/uploads/FINAL-The-GPP-Pledge-brochure-2023-update.pdf](https://www.industrialenergyaccelerator.org/wp-content/uploads/FINAL-The-GPP-Pledge-brochure-2023-update.pdf)

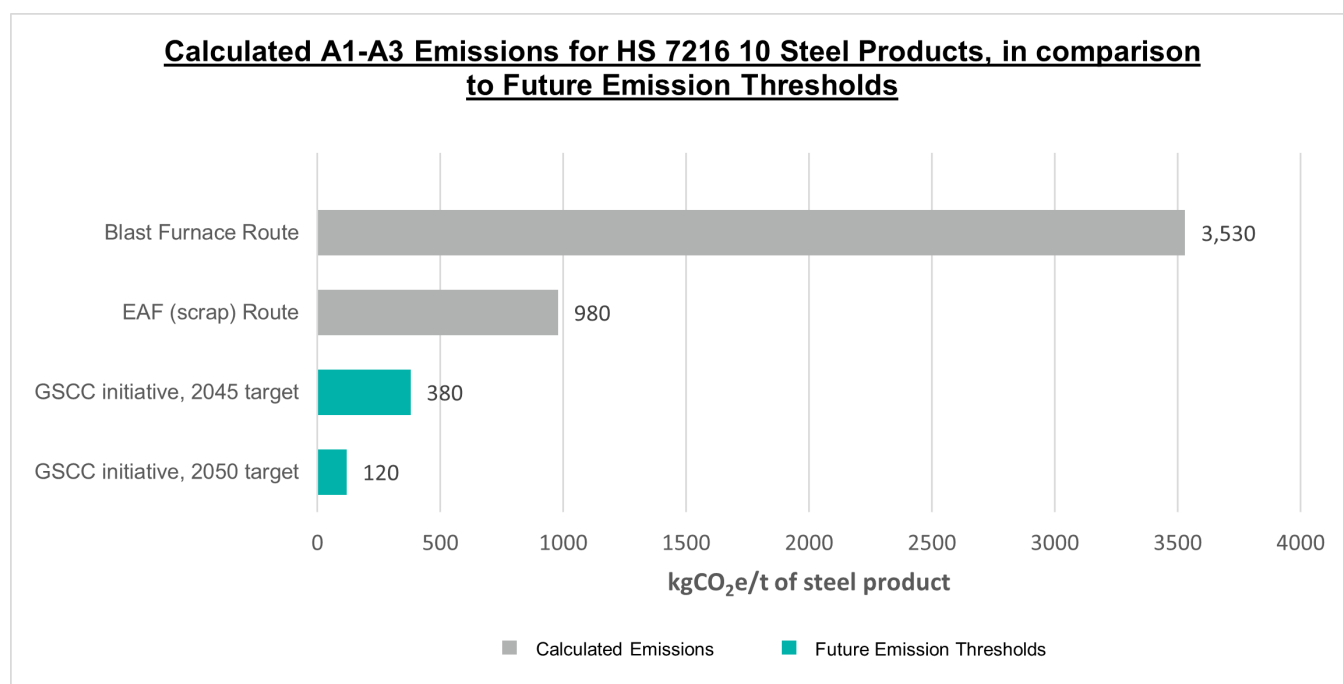


**Figure 38: A1-A3 emissions for HS 7216 10 steel products produced via EAF and blast furnace routes in comparison to the GSCC Future Emission Thresholds.**

Figure 38 highlights the steel produced via EAF scrap steel production routes is significantly closer in value to the GSCC targets in comparison to blast furnace production. Similarly to cement products however, there is still a significant reduction in embodied emissions required to achieve this target.

## Annex 4

This annex provides supporting information that informs the finding presented in Appendix 4.

**Table 11: Source data and descriptions of data presented in Appendix 4.**

| Figure    | Dataset Description <sup>118</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Figure 29 | <p>Calculated data has been produced using the LCA Comparator Tool. A variety of dataset selection options for each product type have been selected to portray a possible range of emissions (for example using both upper values and lower values specified within the BREF notes). Transport distances for each A2 selection within the tool have been set respectively as the following: 32km (distance from port to Scunthorpe for steel transport<sup>119</sup>) for the initial production stage, and an assumption that the steel product is transported from Scunthorpe to Teesside prior to the steel forming process. Any other transport distances have been assumed to be 0km (assuming co-location).</p> <p>Benchmark data is collected from EC3 database, Circular Ecology ICE Database v3, a data request issued to Worldsteel, Worldsteel LCI Data Release 2022 and academic papers. A full list of these sources can be found in the Bibliography.</p> |
| Figure 30 | <p>Graphs have been produced using the LCA Comparator Tool. For each product, a blast furnace production route has been selected, and the lower BREF values have been selected. Transport distances for each A2 selection within the tool have been set respectively as the following: 32km (distance from port to Scunthorpe for steel transport) for the initial production stage, and an assumption that the steel product is transported from Scunthorpe to Teesside prior to the steel forming process. Any other transport distances have been assumed to be 0km (assuming co-location).</p>                                                                                                                                                                                                                                                                                                                                                                      |
| Figure 31 | <p>Graphs have been produced using the LCA Comparator Tool. For the selected HS 7216 60 product, the lower BREF values have been used for each production route. Transport distances for each A2 selection within the tool have been set respectively as the following: 32km (distance from port to Scunthorpe for steel transport) for the initial production stage, and an assumption that the steel product is transported from Scunthorpe to Teesside prior to the steel forming process. Any other transport distances have been assumed to be 0km (assuming co-location).</p>                                                                                                                                                                                                                                                                                                                                                                                     |

<sup>118</sup> Data sets used within the tool have been sourced from multiple sources which use different methodologies including BS EN 15804+A2:2019. CEM II mixes can vary significantly in terms of material proportions used, this could result in different emissions results.

<sup>119</sup> URL: <https://britishsteel.co.uk/who-we-are/sites-locations/ports/>

| Figure    | Dataset Description <sup>118</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Figure 32 | <p>Calculated data has been produced using the LCA Comparator Tool. A variety of dataset selection options for each product type have been selected to portray a possible range of emissions (for example using both gross and net emissions).</p> <p>Benchmark data is collected from EC3 database, Circular Ecology ICE Database v3, GCCA Tool and academic papers. A full list of these sources can be found in the Bibliography.</p>                                                                                                                                                                                                                                                                                                                                                                                                   |
| Figure 33 | <p>Graphs have been produced using the LCA Comparator Tool:</p> <ul style="list-style-type: none"> <li>• Cement clinker: Dataset 1 (GCCA Gross Emissions for default clinker) for A1, Dataset 3 (GCCA default transport distances by train) for A2 and Dataset 3 (BREF data) for A3.</li> <li>• Cement products: Dataset 1 (GCCA Gross Emissions for default cement) for A1, Dataset 3 (GCCA default transport distances by train) for A2 and Dataset 1 (GCCA Gross Emissions for default cement) for A3. A ratio of 0.8: 1 (clinker: cement) has been applied for cement product, and the maximum clinker percentage for each cement product has been selected.</li> <li>• Concrete, Dataset 1 for A1, Dataset 1 for A2 and Dataset 4 for A3.</li> </ul>                                                                                  |
| Figure 34 | <p>Graph has been produced using the LCA Comparator Tool, selecting Dataset 1 (GCCA Gross Emissions for cement clinker/cement/concrete) for the displayed gross values, and Dataset 2 (GCCA Net Emissions for cement clinker/cement/concrete) for the displayed net values. A ratio of 0.8: 1 (clinker: cement) has been applied for cement product.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Figure 35 | <p>Graphs have been produced using the LCA Comparator Tool, with selections inputted for both BS EN 15804+A2:2019 and EU CBAM methodologies.</p> <ul style="list-style-type: none"> <li>• Cement clinker: Dataset 1 for A1, Dataset 3 for A2 and Dataset 3 for A3 were selected.</li> <li>• Steel: an average value was calculated for EAF and Blast Furnace production, using both upper and lower BREF values. Transport distances for each A2 selection within the tool have been set respectively as the following: 32km (distance from port to Scunthorpe for steel transport) for the initial production stage, and an assumption that the steel product is transported from Scunthorpe to Teesside prior to the steel forming process. Any other transport distances have been assumed to be 0km (assuming co-location).</li> </ul> |

| Figure    | Dataset Description <sup>118</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Figure 36 | <p>Graphs have been produced using the LCA Comparator Tool sensitivity analysis.</p> <ul style="list-style-type: none"> <li>• Cement clinker: Dataset 1 (GCCA Gross Emissions for default clinker) for A1, Dataset 3 (GCCA default transport distances by train) for A2 and Dataset 3 (BREF data) for A3 were selected.</li> <li>• Steel: an average value was calculated for EAF and Blast Furnace production, using both upper and lower BREF values. Transport distances for each A2 selection within the tool have been set respectively as the following: 32km (distance from port to Scunthorpe for steel transport) for the initial production stage, and an assumption that the steel product is transported from Scunthorpe to Teesside prior to the steel forming process. Any other transport distances have been assumed to be 0km (assuming co-location).</li> </ul>                                                                                                       |
| Figure 37 | <p>Graphs have been produced using the LCA Comparator Tool, alongside IDDI benchmark data.</p> <ul style="list-style-type: none"> <li>• Cement clinker: Dataset 1 for A1, Dataset 3 (GCCA default transport distances by train) for A2 and Dataset 3 (BREF data) for A3.</li> <li>• Cement products: Dataset 1 for A1, Dataset 3 (GCCA default transport distances by train) for A2 and Dataset 1 for A3. A ratio of 0.8: 1 (clinker: cement) has been applied for cement product, and the maximum clinker percentage for each cement product has been selected.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                             |
| Figure 38 | <p>Graphs have been produced using the LCA Comparator Tool, alongside GSCC benchmark data.</p> <p>A variety of dataset selection options for each product type have been selected to portray a possible range of emissions (for example using both upper values and lower values specified within the BREF notes). Transport distances for each A2 selection within the tool have been set respectively as the following: 32km (distance from port to Scunthorpe for steel transport) for the initial production stage, and an assumption that the steel product is transported from Scunthorpe to Teesside prior to the steel forming process. Any other transport distances have been assumed to be 0km (assuming co-location).</p> <p>Benchmark data is collected from EC3 database, Circular Ecology ICE Database v3, a data request issued to worldsteel, worldsteel LCI Data Release 2022 and academic papers. A full list of these sources can be found in the Bibliography.</p> |

## Appendix 5: Future landscape – policy and standard evolution

This Appendix identifies future research and evidence gathering needs based on the key findings and limitations of this research project, and suggestions of ways in which more consistency could be achieved through alignment of policy and standards.

### A5.1 What limitations were encountered in this study and where could future research be focused?

#### A5.1.1 What limitations were encountered in this study?

The main limitation encountered during this study related to data availability and granularity. In order to allow the most meaningful comparisons of life cycle emissions from steel, cement and concrete products, primary activity data was requested from manufacturers for the production processes that they operate. The manufacturers and industry bodies engaged during the study were reluctant to provide this information due to commercial confidentiality concerns.

Where data was provided by manufacturers, it was usually intensity based. Carbon intensity is the result of the calculation of a carbon assessment. It cannot be “reverse engineered” to reveal the components that went into it and therefore is more readily shared. Unlike activity data, intensity data doesn’t allow for sensitivity analysis to be undertaken, for example, analysis to understand how the use of renewable electricity or use of low carbon fuels within a process affects overall emissions. Similarly, intensity data does not give insight into where emissions hotspots exist within a production process.

These challenges were partly overcome through the sourcing of activity data for steel and cement clinker from relevant Best Available Technique Reference (BREF) Documents<sup>120</sup>, and from an LCA inventory produced by Portland Cement Association for concrete<sup>121</sup>. Whilst this data covered key production stages it did not cover specific equipment items and was not sufficiently granular to assess differences in manufacturing emissions that may occur from the use of different precursors (e.g. sintered ore or iron ore pellets for steel production). Increased data granularity at an equipment level and for specific precursors would increase the accuracy of the calculated emissions (see Appendix 4) and provide further insight into manufacturing emissions hotspots and differences in carbon emissions from precursors.

Where data was collected from EPD, these were intensity based. Moreover, certain modules were not available, such as module D for emissions savings associated with reuse/recycling of the product. There is a significant variety of types of steel product in which scrap steel might be

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<sup>120</sup> European Bureau for Research on Industrial Transformation and Emissions, ND, BAT reference documents, URL: <https://bureau-industrial-transformation.jrc.ec.europa.eu/reference>

<sup>121</sup> Portland Cement Association, 2007, Life Cycle Inventory of Portland Cement Concrete, URL: <http://large.stanford.edu/courses/2016/ph240/pourshafeie2/docs/marceau-2007.pdf>

included (such as bars, rods, wire, etc), and an even greater array of use cases for this recycled steel. Producers do not record what happens to the product once it is sold, therefore the reuse pathway is not known, data cannot be sourced, and an accurate estimation cannot be developed without knowing that pathway.

### A5.1.2 Where should future research be focused?

In future, data availability challenges could be overcome if UK Government was able to formally request activity data from manufacturers at a process equipment level and guarantee the safeguarding of commercially sensitive information. However, there are challenges to manufacturers collecting this data: some manufacturers stated that process equipment is often used to manufacture different products throughout the day, which would mean accurate product-level activity data would be difficult to obtain. In that case, an attribution methodology would need to be selected and specified to present the activity data to the best of the manufacturer's ability and with consistency across all manufacturers who cannot supply primary data on a product level.

Due to these challenges, other than a focus on improving data quality, benefit could be gained by focusing future research on the following:

1. **Assessing other life cycle methodologies.** There is a plethora of life cycle methodologies, at both a product and organisational level which were not considered in this study as they are not used to support EPD development or EU CBAM. Research into their prevalence in industry and what data manufacturers use to complete these assessments would provide policy makers with a picture of how manufacturers complete GWP assessments outside of EPD and EU CBAM.
2. **Investigating different methodologies to produce EPD through PCRs.** The approach to developing an EPD is set out by BS EN 15804+A2:2019, and then further refined at a product or sector level by PCRs. There are more PCRs which may be applicable to products on the UK market. Comparing the prevalence and requirements of the PCRs would assist policymakers in understanding the market. For example, for steel, there is:
  - a. *CARES PCR for Type III EPD of Semi and Finished Steel Products.* For finished steel products and semi-finished steels used in construction, infrastructure, automotive, and other sectors<sup>122</sup>.
  - b. *PCR for Designated Steel Construction Products from UL Solutions.* Covers mill level products, fabricated structural steel, cold-formed steel sections, and concrete reinforcing steel products for the North American market<sup>123</sup>. The UK is a

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<sup>122</sup> CARES, 2025, Product Category Rules (PCR) for Type III Environmental Declaration (EPD) of Semi-Finished and Finished Steel Products, URL: [www.carescertification.com/content/HtmlContent/d7cc4369-ff70-4b95-8c62-24b076626737/56759e27-4ec7-4ef5-8762-15e9b9e5422d/CARES%20PCR%20for%20Type%20III%20EPD%20of%20Semi%20and%20Finished%20Steel%20Products\\_Feb2025.pdf](http://www.carescertification.com/content/HtmlContent/d7cc4369-ff70-4b95-8c62-24b076626737/56759e27-4ec7-4ef5-8762-15e9b9e5422d/CARES%20PCR%20for%20Type%20III%20EPD%20of%20Semi%20and%20Finished%20Steel%20Products_Feb2025.pdf)

<sup>123</sup> UL Environment, 2020, Product Category Rule Guidance for Building-Related Products and Services, Part B: Designated Steel Construction Product EPD Requirements; URL: [www.ul.com/sites/g/files/qbfbbp251/files/2020-05/10010-34\\_Steel%20Products%20Public%20Comment.pdf](http://www.ul.com/sites/g/files/qbfbbp251/files/2020-05/10010-34_Steel%20Products%20Public%20Comment.pdf)

significant exporter to the US: in 2024, the UK exported 180 thousand tonnes of semi-finished and finished steel to the US, worth £370 million. This accounts for 7% of the UK's total steel exports by volume and 9% by value<sup>124</sup>. It is not known whether or how many UK exporters follow US PCRs to place these products on the market or continue to use European EPD. This could be another focus of future research.

c. *Product Category Rules - Structural Steel Products from Global GreenTag.*

Another example for structural steel products<sup>125</sup>.

3. **Investigating Programme Operator approaches.** EPD Programme Operators are independent organisations establishing the framework for EPD, including developing and maintaining PCRs, overseeing the EPD verification process, and publishing finalised EPD in a recognised database. They define detailed, specific rules on how EPD are created for a particular product category, to promote a standardised and transparent approach. During this research, programme operators were identified as a potential source of variance, as they develop different PCRs which cause divergence in approaches to developing product EPD. Further research in this area would help determine what impact different operator approaches can have on results and how variance could be minimised.

### A5.1.3 Should other environmental impacts be considered in future research?

Steel, cement and concrete production has the potential for significant environmental impact beyond just the generation of carbon emissions, however consideration of these impacts was not within the scope of this research project.

The focus of this research project has been on the life cycle carbon emissions of steel, cement and concrete products, with emphasis placed on emissions arising from manufacturing processes (specifically GWP as the environmental indicator). This approach also mirrors feedback from producers (see Appendix 7) who state that buyers are typically only concerned with the carbon emissions associated with the products they purchase and less so on other environmental impacts that may arise during the products life cycle.

Whilst the sole focus of EU CBAM is carbon emissions, BS EN 15804+A2:2019 requires a wider range of core environmental impact indicators to be reported against, as well as additional environmental impact indicators for which reporting is optional. Table 12 sets out the core and additional environmental impact indicators described by BS EN 15804+A2:2019.

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<sup>124</sup> UK Steel, 2025, UK-US trade deal sees steel tariffs removed, URL: [www.uksteel.org/steel-news-2025/uk-us-trade-deal-sees-steel-tariffs-removed](https://www.uksteel.org/steel-news-2025/uk-us-trade-deal-sees-steel-tariffs-removed)

<sup>125</sup> Global GreenTag, 2024, Structural Steel subPCR STS:2024 v1; URL: [www.globalgreentag.com/get/files/1490/sub-pcr-sts-2024-structural-steel.pdf](https://www.globalgreentag.com/get/files/1490/sub-pcr-sts-2024-structural-steel.pdf)

**Table 12: Environmental Impact Indicators described on BS EN 15804+A2:2019.**

| Core Indicators                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Additional Indicators                                                                                                                                                                                                                                                                                            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Climate Change – total;</li> <li>• Climate Change – fossil;</li> <li>• Climate Change – biogenic;</li> <li>• Climate Change – land use and land use change;</li> <li>• Ozone Depletion;</li> <li>• Acidification;</li> <li>• Eutrophication aquatic freshwater;</li> <li>• Eutrophication aquatic marine;</li> <li>• Eutrophication terrestrial;</li> <li>• Photochemical ozone formation;</li> <li>• Depletion of abiotic resources – minerals and metals;</li> <li>• Depletion of abiotic resources – fossil fuels;</li> <li>• Water Use.</li> </ul> | <ul style="list-style-type: none"> <li>• Particulate matter emissions;</li> <li>• Ionizing radiation, human health;</li> <li>• Exo-toxicity (freshwater);</li> <li>• Human toxicity, cancer effects;</li> <li>• Human toxicity, non-cancer effects;</li> <li>• Land use related impacts/soil quality.</li> </ul> |

In Europe, steel and cement production facilities are subject to stringent environmental regulation, with facilities required to operate in accordance with environmental permits that contain legally binding conditions that aim to minimise pollution. Conditions set out in environmental permits cover management arrangements, operating techniques, emissions limits and monitoring requirements, record keeping and reporting requirements. Emissions limit values are set out for emissions to air, water and land, and are aligned to relevant EU Best Available Technique Reference (BREF) Documents. It is therefore considered that the environmental impacts associated with manufacturing activities are well understood, managed and regulated, with further research in this area unnecessary.

Environmental impacts associated with raw material extraction prior to manufacturing activities may be less well controlled, particularly outside of Europe. Further research to understand these impacts and how they may vary across countries where raw material is extracted/mined could be of benefit. This would provide producers with a greater understanding of the environmental impacts associated with the extraction of the raw materials that they rely on.

## A5.2 How can greater consistency in LCA and emissions reporting be achieved across the steel, cement and concrete sectors?

### A5.2.1 What updates are needed to standards?

To enable greater consistency in LCA and emissions reporting, harmonisation and alignment of requirements across key standards is needed. Specifically, consensus across standards is needed on the following issues, which have been highlighted by the Industrial Deep Decarbonisation Initiative (IDDI)<sup>126</sup> and also encountered during this study:

#### **Use of primary activity data:**

The IDDI found that many reporting standards currently do not mandate the use of primary activity data to report upstream emissions such as from raw materials. Upstream emissions often form a significant part of a products emission footprint, especially in cement and concrete production.

EU CBAM requires information on precursor materials for calculating the embedded emissions of complex imported goods. Where this information does not exist, EU CBAM mandates the use of default factors. These are deliberately high values to encourage manufacturers to collect and use actual data. EPD require information on raw materials used in module A1 and, whilst they do not mandate the use of primary data, they require that the data is representative and of suitable quality. It is usually the verifier who will decide whether the information provided is acceptable. Currently, standards allow manufacturers to use secondary data sources which can be generic and not accurately reflect emissions from upstream process for a particular product.

Every stakeholder engaged with in this study (see Appendix 7) reported that they use primary data where possible in their carbon assessments, including for EPD and EU CBAM. Some go to great lengths to engage with their supply chains to secure this information. Where this information was available it would be provided within an EPD for the raw material, or as an intensity-based value for the embedded emissions. Where the information was not available, secondary source for information (for EPD) or default factors (for EU CBAM) would be used.

Primary data on raw materials is not collected by manufacturers, but by their suppliers. Both suppliers and manufacturers are only comfortable sharing intensity data with one another and with this project.

To increase accuracy of a GWP footprint, standards should specify that, where available, primary activity data is used for all upstream processes or products which are likely to be significant within a products overall emissions footprint. In circumstances where primary activity data cannot be obtained, secondary data should be sourced from recognised sources such as Sphera or Gabi databases and clearly stated within EPD results.

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<sup>126</sup> [IDDI Driving Consistency in the Green House Gas Accounting System](#)

## **Reporting emissions at a common production step**

To ensure commonality in reporting across steel, cement and concrete products, EPD should report emissions associated with production of crude steel and cement as this is where most emissions occur within the production processes, with 'finishing' processes generally contributing much smaller quantities to overall emissions. This would enable comparison of emissions across key production steps and enable purchasers of intermediate products to make informed purchasing decisions and drive decarbonisation across crude material production processes.

The IDDI has recommended that all EPD declare emissions associated with 1 metric tonne of crude steel for steel products and 1 metric tonne of cement for concrete products, allowing for consistent comparison of product emissions and evaluation against low emissions steel and cement thresholds. This is similar to using a declared unit in LCA. A declared unit quantifies a product's environmental impact based on its physical properties, like mass or volume, rather than the service it provides. Using the declared unit of 1 tonne of raw material can play an important role in providing information on the magnitude of impacts by comparing them with a reference state.

In this context, using the declared unit of 1 tonne of crude steel or cement for concrete products could help to communicate the relative environmental impacts of different products in an easily comparable way. It would require an extra calculation step currently not undertaken in LCAs for EPD and EU CBAM, as the declared unit is usually 1 tonne of the finished product. Manufacturers would need guidance in order to complete this step.

## **Allocation of emissions to co-products**

Where manufacturing processes produce more than one output (co-products), each may be allocated a portion of emissions from the manufacturing process, thus reducing emissions allocated to the primary product. Various allocation methods are available to industry and despite ISO 14044+A2:2020 defining an allocation hierarchy (see Appendix 1), there are differing views and perspectives across industry about preferred allocation methods and when they should be applied.

For example, ground granulated blast furnace slag (GGBS), produced in the steel making process, can be used as a supplementary cementitious material (SCM) within cement manufacture. The steel industry considers GGBS as a co-product and subject to allocation of process emissions, depending on the allocation method chosen. This view may not be necessarily shared by the cement industry, which will not consider emissions allocated to GGBS production.

Whilst it is recognised that reaching a consensus on allocation methods for co-products is essential to improve consistency, achieving this will be extremely challenging due to the vested interests of affected industries and may require government intervention to reach consensus.

## Utilising scrap metals in steel manufacture

The IDDI suggests that the recycling of steel should be encouraged and somehow recognised in the carbon footprint of steel products. Key questions arose on whether and how to assign emissions to scrap, to account for its future recyclability and emissions incurred in original production.

This was also raised in interviews undertaken as part of this study (see Appendix 7), with many stakeholders wanting to claim some kind of benefit or emissions reduction for inclusion of scrap, and the recyclability of their steel products at an unspecified time in the future at a products end of life. EPD covering module D specifically include recovery, reuse, recycling or energy recovery potential of a products components and raw materials. However, construction products containing steel may not be 100% recyclable, for example, insulated roof and wall panels also include insulation materials, and many of the EPD for these products only cover modules A1 to A3.

While one study states that EU CBAM will provide an incentive for scrap steel use, subject to final scheme design<sup>127</sup>, this conclusion is based on the fact EU CBAM was introduced to reduce carbon emissions and not analysis of the rules for scrap steel accounting.

Like other scrap products in the iron and aluminium sectors, imported scrap steel is not within the financial scope of either UK or EU CBAM as scrap is considered a recycled input with a net benefit on emissions<sup>128</sup>.

## Using alternative fuels

The use of alternative fuels such as wastes is increasingly common (particularly in the cement industry) with emissions from these fuels not included under a 'net emissions' reporting approach. Currently there is a lack of consistency in when and how net and gross emissions are reported. Most cement EPD report both values, however, within the main table of results only one figure is given and standards do not stipulate which figure should be prioritised. The MPA position is for the UK Cement industry to provide both values with gross values prioritised.

The IDDI recommends that both gross and net emissions are clearly reported in EPD, satisfying GHG Protocol reporting principles whilst still encouraging the future use of non-fossil fuels in production processes. This research project findings also support this approach.

Further clarity is also needed on which fuels should be classed as wastes and therefore subject to exclusion from net emissions reporting. Bio-based wastes burnt as fuel are already excluded from the definition of gross emissions<sup>129</sup>. However, standards need to provide clarity

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<sup>127</sup> Rossetto, 2023, The carbon border adjustment mechanism: What does it mean for steel recycling? URL: [www.sciencedirect.com/science/article/pii/S2772737823000020](https://www.sciencedirect.com/science/article/pii/S2772737823000020)

<sup>128</sup> HM Revenue and Customs, 2025, Carbon border adjustment mechanism (CBAM): Policy update, URL: [www.gov.uk/government/consultations/draft-legislation-carbon-border-adjustment-mechanism/carbon-border-adjustment-mechanism-cbam-policy-update](https://www.gov.uk/government/consultations/draft-legislation-carbon-border-adjustment-mechanism/carbon-border-adjustment-mechanism-cbam-policy-update)

<sup>129</sup> GCCA, 2019, GCCA Sustainability Guidelines for the monitoring and reporting of CO2 Emissions from cement manufacturing, URL: [https://gccassociation.org/wp-content/uploads/2019/03/GCCA\\_Guidelines\\_CO2Emissions-v0.pdf](https://gccassociation.org/wp-content/uploads/2019/03/GCCA_Guidelines_CO2Emissions-v0.pdf)

on how other wastes fuel streams such as manmade textiles, paints and other hazardous wastes should be considered.

## Accounting for Carbon Capture Methods

Carbon Capture and Storage (CCS) is a process where carbon emissions from industrial activities are captured and transported for permanent storage in underground geological formations such as depleted oil and gas reservoirs, preventing the release of these emissions to the atmosphere. CCS is an emerging technology, one of the worlds most advanced CCS projects is at the Brevik Heidelberg Cement Plant in Norway, with the plant ramping up to capture and store around 50% (400,000 tonnes per annum) of its own emissions<sup>130</sup>. It is expected that CCS will be crucial in enabling both the steel and cement sectors to decarbonise and reach net zero emissions.

The role of CCS is recognised by key legislation including EU ETS and EU CBAM. Under the EU ETS, operators that capture and store CO<sub>2</sub> emissions are not required to surrender emissions certificates, effectively providing financial incentives for CCS adoption. Similarly, under EU CBAM a product manufacturer can exclude captured and stored CO<sub>2</sub> emissions from reported embedded emissions. To achieve this, producers must be able to provide verifiable evidence that the CO<sub>2</sub> is permanently stored.

Despite the recognition of CCS in legislation, many standards do not currently set out a methodology or option to allow producers to claim a reduction in emissions through CCS adoption. Future updates to standards should address CCS requirements in line with EU CBAM and emerging certification frameworks such as the EU CRCF, discussed further below. Future updates will also provide an opportunity to create consistency in how emissions from the use of bioenergy are accounted for. Currently BS EN 15804+A2:2019 only allows for emissions captured and stored from fossil fuels sources to be excluded from emissions calculations, whilst captured biogenic carbon emissions must be considered to be transferred to nature and not permanently stored. This approach contrasts with EU CBAM which allows for producers using Bioenergy deduct biogenic emissions from total reported emissions. This inconsistency is likely to lead to uncertainty within the cement industry where manufacturers are increasingly using biogenic secondary fuels and wastes within production processes.

Standards also need to include consistent approaches to account for Carbon Capture and Utilisation (CCU) which involves capturing CO<sub>2</sub> emissions from industrial activities and re-using them in other processes or products, supporting a circular economy. Doing so will require additional challenges to be addressed including:

- Permanence of storage: Consideration of whether CCU should be technically classed as a removal, given that CO<sub>2</sub> may not be permanently removed from the atmosphere. Under UK ETS the minimum permanence requirement is 200 years.
- Avoiding the risk of doubling counting: For example, if CO<sub>2</sub> captured by a cement manufacturer is sold onto another manufacturer for utilisation, there is the risk that both

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<sup>130</sup> Heidelberg Materials 2025, First CO<sub>2</sub> captured in Brevik as part of ramp-up phase, URL: [www.brevikccs.com/en/node/522705](https://www.brevikccs.com/en/node/522705)

the emitter and the user of the captured carbon could claim an emissions reduction benefit. Standards will need to provide clarity on how potential double counting will be avoided.

- Transfer of biogenic carbon: Under current BS EN 15804+A2:2019, transfers of biogenic carbon out of the system must be shown as balancing emissions; therefore, the company which captures and transfers the biogenic carbon cannot receive the benefit as well.

### **Alternative chain of custody accounting**

Alternative approaches such as ‘book and claim’ and ‘mass balance’ exist that allow manufactures to apportion embodied emissions unevenly across products, thus concentrating emission savings in certain products that can be marketed as ‘green’ and capturing value more effectively from investments made in decarbonising<sup>131</sup>. However, there are uncertainties around how such approaches should be managed to avoid greenwashing and manufacturers making unsubstantiated claims about their products.

The use of these alternative approaches wasn’t raised by manufacturers during interviews undertaken as part of this study. This is because, currently, neither EPD nor EU CBAM allow alternative chain of custody approaches to be used.

Should these approaches be progressed in the future, further work will be needed establish whether they will genuinely incentivise industry to invest in decarbonisation and if so, clear guidance will be required to ensure consistent and transparent implementation across industry.

### **A5.2.2 When will standards be reviewed and updated?**

The information in this section reflects the landscape at the time of writing, October 2025.

In order to address the reporting issues, inconsistencies and challenges, discussed above, BS EN 15804+A2:2019 and relevant PCR standards will require harmonisation and alignment.

All ISO and CEN standards are required to be reviewed at a regular basis (every 5 years). Committees can decide (via a ballot of NSBs) whether to revise a standard or keep it as is. For European Standards, the European Commission can also provide a standardisation request to revise a standard. The European Commission has indicated that it will issue a standardisation request to revise BS EN 15804+A2:2019 in 2026. Once this is revised and updated, all applicable PCRs for steel, cement and concrete will then need to be revised and updated if non-compliant. It is expected that the standardisation request for BS EN 15804+A2:2019 as revised will incorporate decisions already implemented in updates made to the published PCRs listed below.

- For cement products, BS EN 16908:2017+A1:2022;
- For concrete products, BS EN 16757:2022;
- For steel products, prEN 17662:2021 (Note: this standard is still in draft).

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<sup>131</sup> Book & claim is the method proposed for removals associated with Carbon Capture by some cement manufacturers (such as Heidelberg Cement): [www.evozero.com/docs/evozero-product-en.pdf](http://www.evozero.com/docs/evozero-product-en.pdf)

Creating consistency across BS EN 15804+A2:2019 and relevant cPCRs will potentially take several years. Revisions to BS EN 15804+A2:2019 may take up to 3 years after which relevant cPCRs will have a further 3 years in which to update and align. Meaning harmonisation and common interpretation of terminology across the standard landscape may not be achievable until the early 2030's.

### A5.2.3 What changes in legislation are expected and how might these impact on emissions reporting across the steel, cement and concrete sectors?

The information in this section reflects the landscape at the time of writing, October 2025.

## Construction Product Regulations

Whilst industry awaits revisions and updates to BS EN 15804+A2:2019 and relevant cPCRs, the updated EU Construction Product Regulations (CPR) may enable producers to adopt more consistent approaches to EPD development.

This updated regulation, introduced in November 2024, provides a clear set of rules for construction product marketing and will allow for a fair comparison of a product's life cycle performance across a variety of manufacturers and countries.

Products are marked with a CE marking to indicate the product's conformity to its declared performance. A product's CE marking will be assessed according to either:

- **Harmonised European Standard:** CE marking will be assessed by the appropriate technical committee (TC) from the European Committee for Standardisation (CEN). For cement, concrete and steel products, the relevant TC is CEN/TC 350: Sustainability of Construction Works<sup>132</sup>;
- **European Technical Assessment (ETA):** Voluntary path provided for products not covered under CE markings, therefore helping to promote innovative products. A relevant technical assessment body (TAB) will issue an ETA based on a European Assessment Document (EAD)<sup>133</sup>.

The new CPR amendment states that by 8th January 2026, product CE marking must include the emissions associated with the following criteria:

- **Fossil Fuels:** Accounts for emissions generated from fossil fuel sources;
- **Biogenic:** Accounts for emissions associated with carbon which originates from a biomass source;
- **Land Use and Land Use Change:** Accounts for emissions associated with land transformations (for example deforestation or afforestation);

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<sup>132</sup> CENCENELC, Construction Products: Sustainability, Safety and Accessibility, URL: [www.cencenelec.eu/areas-of-work/cen-sectors/construction/sustainability-safety-and-accessibility/](http://www.cencenelec.eu/areas-of-work/cen-sectors/construction/sustainability-safety-and-accessibility/)

<sup>133</sup> European Commission, Construction Products Regulation (CPR), URL: [Construction Products Regulation \(CPR\) - European Commission](https://ec.europa.eu/commission/presscorner/detail/en/ip_24_1911)

- **Total:** The sum of all emissions associated with the product (including GWP values for fossil fuels, biogenic carbon and land use and land use change).

These criteria are termed as ‘Climate Change Effects’<sup>134</sup>. From January 2030 and 2032, further broader environmental impacts will be required to be reported as part of CE marking, including impacts such as eutrophication, water use, particulate matter and biotic/abiotic depletion. These impacts align to the core environmental impacts (by 2030), and additional environmental impacts (by 2032) specified within BS EN 15804+A2:2019.

Only one result can be assigned for each essential characteristic within the CE mark, with no opportunity to provide any accompanying explanatory text. This means it will not be possible to dual report both net and gross emissions values, for example, or results using the market-based and location-based approaches to purchased electricity.

CE marking generally requires that ‘worst-case’ data is reported, to avoid understating the product’s performance. In the context of concrete, for example, the lowest strength class achievable for a product is reported currently. A similar concept is likely to apply to GWP results reported in the CE mark, i.e., reporting of gross emission values rather than net. This approach is inconsistent with the IDDI recommendation for EPD to report both gross and net values.

The European Commission have explained that product environmental performance must be considered at a site level<sup>135</sup>. An average emissions value taken across several manufacturing sites cannot be used, because there is the potential that the emissions value of the worst performing site is higher than the value of the average emissions across several sites. This means data from the environmentally ‘worst’ site must be applied, or products from different sites must be CE marked separately. The European Commission has confirmed that average values over a year’s production will be accepted, however there is uncertainty about how extensive the requirement to account for worst case data will be (e.g. in relation to the use of several suppliers or the appropriate use of generic data).

Similarly for a product range, a worst-case emissions scenario will need to be reported, unless emissions from each product are to be declared individually. If manufacturing companies apply a value higher to a product to save costs (by using the ‘worst-case’ site and product for that product range or using provided default worst case data), this will result in overstatement of GWP value for certain products. Subsequently, building level assessments will also appear to increase in environmental impact.

Producing and maintaining environmental data as part of the CE mark generates an extra cost for industry. However, it is not expected to be more expensive than producing an EPD in accordance with BS EN 15804+A2:2019, unless specific data is provided for each product per

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<sup>134</sup> European Union, 2024, Regulation (EU) 2024/3110 of the European Parliament and of the Council of 27 November 2024 laying down harmonised rules for the marketing of construction products and repealing Regulation (EU) No 305/2011, URL: <https://eur-lex.europa.eu/eli/reg/2024/3110/oj/eng>

<sup>135</sup> CENCLEC, 2025, Presentation by Oscar Nieto, DG Grow to cPCR workshop 24/2/2025, URL: <https://experts.cenelec.eu/trainings-materials/events/2025/2025-02-24-workshop-cpr/>

site, and may encourage producers to utilise the same data within both thus creating consistency in reporting.

CPR currently requires a site audit for the type of verification being proposed for environmental data in CE Marking. There are discussions in CPR Acquis<sup>136</sup> as to what this would constitute, but this is not yet clear.

## **Carbon Removal Certification Framework and Energy Performance in Buildings Directive**

Comprehensive certification frameworks are emerging globally for CCS and CCU. These frameworks are designed to ensure the transparency, credibility, and long-term climate integrity of carbon removal projects by quantifying benefits and preventing greenwashing.

In December 2024, the EU published the Carbon Removal Certification Framework (CRCF) Regulation to incentivise carbon removal initiatives. The intention is for the European Commission to establish an EU wide framework to certify carbon removals. This regulation will improve the EU's ability to verify, monitor and quantify carbon removals<sup>137</sup> and include methodologies for accounting for and certifying.

- Permanent removals (CCS) – CO<sub>2</sub> from industrial sources stored for several centuries
- Permanent removals (CCU) – CO<sub>2</sub> captured and incorporated into construction materials such as concrete.
- Temporary removals (CCU) – CO<sub>2</sub> capture and stored in products for a minimum duration of 35 years.

For CRCF, there is a risk of double counting. If carbon storage and removals are considered in both EPD GWP results and building level carbon storage calculations, then the emissions savings will be counted twice. It is not yet clear how this will be managed<sup>138</sup>.

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<sup>136</sup> Construction Product Regulation acquis, 2025, Construction Products Regulation acquis, URL: [https://single-market-economy.ec.europa.eu/sectors/construction/construction-products-regulation-cpr/acquis\\_en](https://single-market-economy.ec.europa.eu/sectors/construction/construction-products-regulation-cpr/acquis_en)

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<sup>138</sup> ECO Platform ECO Round Table #5, 30 April 2025

## Appendix 6: Technical methodological notes

This Appendix provides an overview of the technical approach and methodology used to calculate life cycle emissions throughout this research project's duration. All data results presented within this report have been generated using the project's accompanying LCA Comparator Tool.

Further details on the data specifics, assumptions and reference sources used can be found in the LCA Comparator Tool and the accompanying Quality Assurance report.

### A6.1 Data collection

#### Data sources

A literature review was undertaken, sourcing data for steel, cement, and concrete products across all life cycle stages. A range of sources were evaluated, including:

- **Best Available Technique Documents:** BREF notes for steel and cement production published by the European Commission.
- **Embodied carbon databases:** including the ICE circular ecology database and GCCA EPD Tool LCA Database.
- **EPD:** data sourced from product EPD and aggregated average emissions intensities from product EPD databases.
- **Published academic literature:** various LCA and LCI studies undertaken by academics.
- **Data requests:** requested data from the worldsteel Association.

A detailed list of all references used throughout this research project is provided in the bibliography (Appendix 8).

The collected data was categorised into two forms:

- **Activity data:** data which provided a quantitative measure associated with a specific activity that generates greenhouse gas emissions (for example kWh electricity consumed, kg of fuel combusted).
- **Intensity data:** data which provided carbon dioxide equivalent emissions associated with the product output per life cycle module (e.g. kg CO<sub>2</sub>e/tonne).

Where possible, activity data was sourced as the preferred data format, as this data allowed for a detailed sensitivity analysis to be undertaken (for example exploring the impact of renewable electricity or fuel switching). However, within this research project, activity data was not publicly available across all life cycle stages (as discussed within Section 5.1 and Appendix

5). Often, data was provided as intensity data. In some cases, a total quantity of fuel used, however the type of fuel or fuel mix was not provided, so this data could not be utilised.

Figure 39 provides a summary of the data sourced for each life cycle module within this research project.

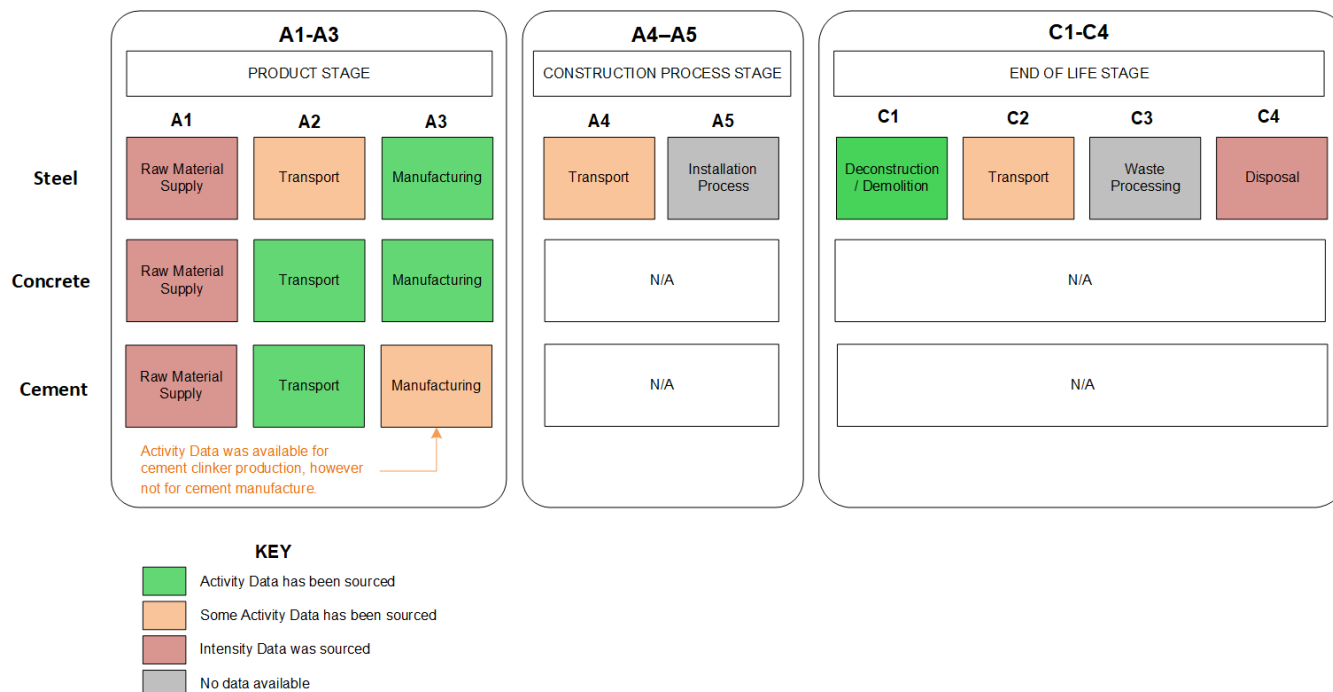


**Figure 39: Summary of the sourced publicly available data used within this research project.**

Information obtained from manufacturers and EPD was centred around cradle-to-gate emissions; covering the raw material extraction (classified as A1), raw material transport (A2) and manufacturing (A3), while there is a lack of reliable information for later life cycle stages (A4 to A5, B1 to B7, C1 to C4 and D).

Data for the construction stage (A4 to A5) and end-of-life stage (C1 to C4) was less readily available to source in comparison to A1 to A3. This was also echoed in interviews with manufacturers and prospective buyers who use EPD to make purchasing decisions. For steel and concrete products, it is mandatory for an EPD produced in accordance with BS EN 15804+A2:2019 to report emissions associated with module C (end of life). For cement products, the inclusion of modules A4 to A5 and module C is optional, due to their end of life being concrete.

Modules B1 to B7 (the product's use stage) have been excluded from this study, due to the wide range of potential product use cases resulting in data which cannot be compared. Module D has also been excluded from this study due to the wide variety of reuse and recycling options available for products.

## Data processing

Following extraction of data, both activity and intensity data were processed and cleansed prior to integration within the tool, transforming the data into useable tables which can be formulated and referenced by worksheets to enable calculations. The process for this is highlighted within Figure 40 below.

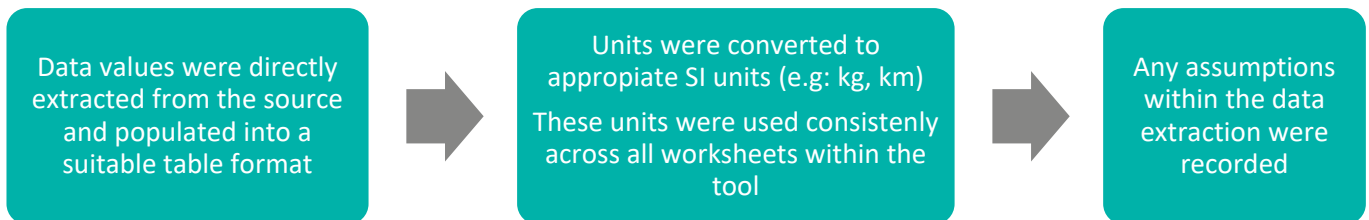


**Figure 40: Data processing undertaken for all collected data.**

## A6.2 Life cycle emission calculation methodologies

For each data source and type of product, the total emissions associated with that life cycle module were calculated, using the collected data. Activity data was converted into kg/CO<sub>2</sub>e per product using specific fuel, waste, transportation and Kyoto protocol product emissions factors.

The following sections provide an overview of the calculations used to calculate the total life cycle emissions from the life cycle modules in accordance with BS EN 15804+A2:2019 and EU CBAM respectively.

### BS EN 15804+A2:2019 and applicable PCRs

The total life cycle emissions calculated for BS EN 15804+A2:2019 (and applicable PCRs) cover A1 to A3 (cradle-to-gate), A4 to A5 (construction stage) and C1 to C4 (end-of-life stage) emissions (see Appendix 1). This total has been calculated using the following equation:

$$Emissions\ Total = A_1 + A_2 + A_3 + A_4 + A_5 + C_1 + C_2 + C_3 + C_4$$

The emissions associated with precursor manufacture (e.g. emissions associated with the production of a material input for product manufacture) have been added under A1 of the product in accordance with BS EN 15804+A2:2019, using the following equation:

$$A_{1(pro)} = Raw\ Material\ Extraction_{(pro)} + A_{1(pre)} + A_{2(pre)} + A_{3(pre)}$$

Where,

- (pro) refers to the product
- (pre) refers to the applicable precursor(s)

## EU CBAM

In accordance with the three reported categories under EU CBAM (see Appendix 1), total emissions have been calculated using the following equation:

$$Total\ emissions = \sum direct\ emissions + \sum indirect\ emissions + \sum embedded\ emissions$$

The direct and indirect emissions of the associated precursors are added together to form the embedded emissions of the product:

$$Total\ EU\ CBAM\ Emissions_{(pro)} = Direct_{(pro)} + Indirect_{(pro)} + Embedded_{(pro)}$$

Where,

$$Embedded_{(pro)} = Direct_{(pre)} + Indirect_{(pre)}$$

Where,

- (pro) refers to the product
- (pre) refers to the relevant precursor(s)

## A6.3 Key assumptions

A list of key assumptions underpinning the calculations is provided below. Further detail of all assumptions for each data source can be found in the LCA Comparator Tool.

- Emissions associated with electricity consumption have been reported assuming a location-based grid-average.
- All waste generated by the production process is assumed to be commercial and industrial waste.
- Diesel is assumed to be the fuel powering the construction and demolition machinery.
- For road transport, the mode of transport is assumed to be an average-laden unknown-fuel HGV.

### Cement/concrete-specific assumptions

- Calcined Clay (an EU CBAM precursor to cement production) has been assumed to not be added as an additive within cement production.  
This assumption was implemented due to calcined clay being a newer supplementary material within cement production, and the required life cycle module data to be inputted within the model could not be located.

### Steel-specific assumptions

- Steel formed is virgin steel, and no scrap steel has been inputted into the production process.  
This assumption was implemented due to the lack of specifics on scrap steel content within collected data for steel production. Subsequently, the calculations were

developed assuming no scrap steel input. As the data availability matures, the integration of scrap steel would be possible within the tool following some modifications to the background calculation worksheets. Additional user selection requirements would also need to be put in place for this.

- If applicable to the steel production process, emissions associated with secondary steelmaking are included within the emissions for Basic Oxygen Furnace (BOF).
- All process steps within the steel production route up to steel forming are co-located at the same facility.
- Prior to the steel forming production process, the steel product is fully cooled.

# Appendix 7: Extracts from industry interviews

Appendix 7 provides a summary of the interviews conducted during this research project, containing members from across the steel, concrete and cement industries. This provides a direct insight into how LCAs are used by industry, the underpinning data used, the challenges they face and the future landscape they are predicting. This information has helped to set the scene for what industries are doing in practice.

## Summary of key themes

The summary below presents the key themes identified from the interviews.

|                    |                                                                                                                                                         |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>EPD</b>         | EPD are widespread in use but produce mixed perceptions due to limited product coverage; verification and accuracy issues.                              |
| <b>DATA</b>        | Varied data sources are used in EPD and LCAs but the GCCA Tool is frequently cited. There is an industry desire for common standards, and data formats. |
| <b>COSTS</b>       | EPD are seen as expensive to produce. Production of EPD is only focussed around high-demand products.                                                   |
| <b>LCA METHODS</b> | It's reported that there is misalignment between LCA and ETS/CBAM requirements.                                                                         |
| <b>BARRIERS</b>    | The multiple overlapping schemes (EPD, CBAM, SBTi etc) create resource and reporting burdens.                                                           |
| <b>DRIVERS</b>     | There is a growing demand for carbon transparency and need for harmonisation and simplification of reporting requirements.                              |

Table 13 provides an overview of the interviews conducted with steel, concrete and cement manufacturers, industry bodies and also data providers. The interviews have been anonymised.

**Table 13: Overview of interviews.**

| Steel:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Specialist Fabricator |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <p><b>EPD:</b> This fabricator has produced EPD for different products using data and information collected directly from producers. This stakeholder also makes use of existing EPD that are readily available from sources such as British Steel and Tata Steel.</p> <p><b>Data Sources:</b> Where possible they use national association data. National Highways Gantries have developed a spreadsheet where the user plugs in values of material used, and the spreadsheet has precalculated what those values are worth. This stakeholder attempted to replicate this by producing an in-house spreadsheet. This is purely carbon focused and does not consider wider environmental factors that EPD address.</p> <p><b>LCA Methodology:</b> The fabricator looked at using OneClickLCA as a tool; however, ultimately was priced out and did not progress.</p> <p><b>Drivers:</b> Lots of customers have EPD and LCA firmly fixed in agenda. Most customers are only interested in CO<sub>2</sub> per tonne of material.</p> <p><b>Cost / Barriers:</b> This stakeholder believes it would cost around £10k to produce each EPD, with hundreds required to cover all their products. Also, the value of scrap was noted, as a scrap recycling company was their 10<sup>th</sup> largest customer in terms of value. They noted overtime the customer will want more precise and better data, which will likely increase the resources required.</p> |                       |
| Steel:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Manufacturer          |
| <p><b>Data Sources:</b> This manufacturer uses a SAP system (tracks raw materials procured, transport etc.) The SAP portal is not currently considered mature, but they are looking to improve this. All Scope 1 raw data is collected for ETS. This data is extremely granular. This stakeholder uses GHG protocol to calculate their organisational footprint.</p> <p><b>LCA Methodology:</b> Due to how Scope 1 and Scope 2 data is captured, LCA data is considered to be fairly granular. ETS is considered to be a robust mechanism for calculating Scope 1 as the creative accounting that takes place for GWP and LCAs cannot take place.</p> <p><b>EPD:</b> They consider EPD to be ‘creative accounting’. They are aware their competitors are ‘gaming the system’. They noted there are considerable loopholes whereby as long as the verifier agrees, the EPD are fine. The stakeholder considers themselves a sustainability professional and does not believe EPD demonstrate a true reflection.</p> <p><b>LCA Methodology:</b> The approach taken depends on the product. For example, for slag they use mass balance, for mill scale (by-product) they use economic allocation. This stakeholder feels you can “cheat the system” for EPD and LCAs based on methodological choices.</p>                                                                                                                                                   |                       |

The biggest challenge around LCAs is the lack of full control. This stakeholder believes EPD are too static, there is a need for something which works in real time. For example, an LCA model which can be added to monthly, allowing monthly modelling.

**CBAM:** This stakeholder confirmed there are two ways to do the calculations required for CBAM, using the combustion method or mass balance. The combustion method is more focussed on the process gasses generated, whereas the mass balance method is more focussed around the mass of coal being input. UK producers use the combustion method more frequently.

**ETS:** The challenges around ETS include that it is time consuming. In particular, it is difficult to obtain accurate data and to make sure everything is calibrated and logged using verifiable data. ETS is at an organisational level whereas customers want to know product level so there is a mismatch.

**Other:** This stakeholder believes the most important conversation is not pitting EAF and BF processes against each other as it is recognised that both steelmaking routes have distinct strength, applications and sustainability goals.

**Steel:**

**Manufacturer**

**LCA Methodology:** This stakeholder conducts LCAs aligned to the worldsteel Methodology.

**EPD:** EPD cover A1 to A3, C1 to C4 and D. All relevant background datasets are taken from the GaBi software data base. An assessment of the quality of data used in that study has been made using the scheme provided in the UN Environment Global Guidance on LCA database development (referenced in BS EN 15804+A2:2019). This stakeholder has its own program operator (PO) and has produced EPD for other companies. They undertake EPD on behalf of their supply chain partners/customers.

They noted that EPD verification is not at the same level of granularity as you might have at ETS.

EPD are not to the level of accuracy that financial accounting and auditing is. This can become a challenge when people are comparing numbers with that level of accuracy. This stakeholder queries if EPD are truly meant for comparison. The challenge with comparison at a product level is whether the products are functionally equivalent. It is unfair to compare on a cradle to gate basis. Generally, they produce EPD for steel products only, not the by-products. This can be a contentious area as buyers want only the GWP value, but “there is no governance there,” i.e. that there is no verification of compliance against a relevant standard.

**CBAM:** They described CBAM as complicated. They use data to analyse the site and scale ETS emissions accordingly. They use the CBAM template for collecting data for CBAM. Not everything in an EPD is covered in the CBAM as only direct emissions are covered. CBAM numbers are often lower than EPD by around 10%.

**Cost / Barriers:** Conversions of data can be problematic and can interfere with mass balances adding up correctly. The biggest barrier or challenge for this stakeholder is the data itself in terms of its usefulness and interoperability. They note that LCAs require a much larger data set, whereas ETS

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| uses the most common dataset, which is well verified and reported yearly. As they cannot use ETS verification for CBAM verification there are separate systems for each, which is a big resource drain.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                       |
| <b>Steel:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Industry Body</b>                                                  |
| <p><b>Data Sources:</b> They described collecting data as an extremely iterative process involving collation, and benchmark checks.</p> <p><b>Cost / Barriers:</b> This stakeholder explained that the plethora of current schemes and data formats (e.g. STBi, CBAM, and EPD) creates a burden. They include carbon footprint metrics in supplier assessment questionnaire. Aware that global average data levels out differences. There are discussions with Steel Standards around developing a common set of upstream GWP values that the industry could use to mitigate some data accuracy issues.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                       |
| <b>Cement / Concrete:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Raw Earth Materials Producer</b>                                   |
| <p><b>EPD:</b> This producer only makes EPD for a few of their products as they claim there isn't demand for EPD for every single mix they produce. They use the GCCA tool, based on the GHG Protocol, for their EPD as the data as already been pre-verified.</p> <p><b>Data Sources:</b> They use generic value data from recognised industry led data collection sources. If an EPD is available, they will also use data from them. They also use trade associations for secondary data and figures from DEFRA.</p> <p><b>Cost / Barriers:</b> This producer is only focusing on a small selection of its products as their customers are not demanding EPD. They explain that there are annual fees involved in maintaining their EPD on EPD International; however, this cost is relative insignificant compared to the wider reporting commitments.</p> <p><b>LCA Methodology:</b> Their calculation methodology is based on life cycle modules A1-A3 and follow the principles of ISO 14044+A2:2020. They mentioned that their EPD are not compliant with BS EN 15804+A2:2019 as they do not do a full LCA including all elements.</p> <p><b>Drivers / Future Landscape:</b> Although the end product may be low in carbon, this producer explains that a lot of the hard work can be undone at the construction stage due to poor construction practices and cheap design. As a lot of construction practices have not changes in recent years, some construction firms will not use low-carbon products because it could invalidate insurance.</p> |                                                                       |
| <b>Cement / Concrete:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Building Materials Supplier of Aggregates, Concrete and Cement</b> |
| <p><b>EPD:</b> This supplier explains that their EPD are created by averaging values from their three cement plants. This means that providing actual values is difficult. They report modules A1-A3 for their EPD and use the GCCA tool.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                       |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| <p><b>Data Sources:</b> A lot of the data feeding into EPD is collected specifically for the production of the EPD, but they are able to use data that is collected for other reasons, such as ETS, to reduce the duplication of effort. For some materials they use default travel values which they claim does not impact the end result (no further elaboration).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                   |
| <p><b>Cement / Concrete:</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p><b>Aggregates Trade Association</b></p>        |
| <p><b>EPD:</b> EPD are produced using the GCCA tool. They note that due to the nature of the products, the data underpinning concrete EPD are dependent on the data underpinning cement EPD.</p> <p><b>Data Sources:</b> This Trade Association collects data directly from its members which include UK cement producers. Members have their own data quality management systems in place and each site is required to report carbon emissions under UK ETS.</p> <p><b>LCA Methodology:</b> Their EPD are produced in alignment with BS EN 15804+A2:2019, and they report Gross emissions as this approach is the most aligned with UK ETS and therefore CBAM. They stated at the time of interview they do not have a bias for gross emissions over net emissions but prefer consistency across the industry (see Appendix 1). Later, they confirmed their position was to use gross as it aligns with EU CBAM and ETS.</p> <p><b>Drivers / Future Landscape:</b> They are currently looking at what kind of data they can collect to help support downstream users of the materials. They want to align corporate reporting with how the sector is reporting on its materials. They state that cement production is very well regulated under CBAM. They state that the GCCA scheme is one likely to become the default system worldwide and may be added to the next BS 8500 (concrete specification standard) revision. They also state GCCA's scheme is also more equipped to handle differences such as gross vs net or ready mixed vs precast.</p> |                                                   |
| <p><b>Cement / Concrete:</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p><b>Tailored Concrete Supplier</b></p>          |
| <p><b>EPD:</b> They outsource the production of their EPD to their consultants, which means they have less oversight into data collection.</p> <p><b>Data Sources:</b> This supplier does not use the GCCA tool, instead using ecoinvent and the ICE database as that is what their sustainability consultant uses. Data for the A1 module is collected from existing EPD. For A2, they are able to calculate site specific transport data and for A3 they recalculate every year for each plant based on electricity consumption.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                   |
| <p><b>Data:</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p><b>Embodied Carbon Calculator Provider</b></p> |
| <p><b>EPD:</b> This organisation does not produce EPD, but they did explain that it is difficult to tell from an EPD how much primary data is used.</p> <p><b>Data Sources:</b> This organisation runs a series of data gathering projects. They collect and extract data from EPD for their publicly available embodied carbon calculator tool. They also run a project</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                   |

focusing on full LCAs of concrete, steel and wood. This uses a combination of existing LCA models, publicly available data from industry associations, and academic studies.

**Drivers / Future Landscape:** They stated that people are embracing the practice of LCA more. More programme operators of EPD are appearing.

|              |                                          |
|--------------|------------------------------------------|
| <b>Data:</b> | <b>Embodied Carbon Database Provider</b> |
|--------------|------------------------------------------|

**Data Sources:** This database uses LCAs from industry bodies. They implement a data cleansing process during which they identify potentially erroneous entries from data sources, identify data points for appropriateness and accuracy and remove any unresolved or problematic data points from the sample. They also have a Data Quality Index scoring system which measures compatibility, assurance, temporal correlation, geographical comparability and transparency.

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