

Cement Carbon Intensity Framework v1.0

WHITEPAPER

Executive Summary

Cement Carbon Intensity Analysis

Cement production is responsible for **7% of global CO2 emissions**, mainly due to the high-heat combustion and chemical calcination required to create clinker, the primary component of the most common cements. While **decarbonization strategies** like the use of supplementary cementitious materials (SCMs), alternative fuels, and CCUS exist, **the scale of adoption is currently limited by regional costs, material availability, product demand and data availability.**

Sylvera's framework **assigns a comparable carbon intensity** to cement types produced around the globe, **shifting from discrete categories to a continuous scale.** This is key to **moving away from traditional categorical labels** (e.g., "blended"), **which often conceal the true environmental and financial opportunities** within global production.

Our Approach

Using Sylvera's proprietary methodology, we calculate **carbon intensity** values by combining open-source databases with manual data extraction. **Our model integrates commodity-specific expertise with Life Cycle Assessment (LCA)** principles and leading emission factors databases to provide **representative modeling pathways** based on the best available data.

Understanding the Score

The results are composed of a **Carbon Intensity** value representing the expected tonne of CO2e for 1 tonne of cement produced, and an attached **Confidence Score**, ranging from Very High to Very Low. This score reflects the completeness and relevance of the available facility data, as well as the representativeness of the emission factors used to generate the final assessment.

LCA Methodology

Framework Goal

The goal of the framework is to calculate facility-specific carbon intensity values for global cement production.

The framework is informed by the principles of ISO 14040, 14044, and 14067, and provide a **standardised approach to enable like-for-like comparisons across the global market**. It also provides an actionable alternative to the fragmentation of different reporting scheme requirements, presenting a carbon intensity continuum beyond the limiting industry categorisation.

This allow buyers and developers to identify where the strongest opportunities for carbon-related price premiums exist.

System Boundaries, Functional Unit, LCIA

Functional Unit: 1 tonne of cement

System Boundary: Cradle-to-gate

Included Processes:

- Clinker Production: raw material extraction and processing, calcination, fuel consumption
- Clinker grinding: electricity for grinding clinker into cement
- Low-carbon innovations (when relevant):
 - Alternative fuels (well-to-wake)
 - Carbon capture systems (emissions and removals)
 - Supplementary Cementitious Materials (cradle/grave-to-gate)

Allocation Approach: Clinker production carries the full carbon burden. Co-products and waste are considered emission-free. Also, waste products used as inputs (e.g., alternative fuels and supplementary cementitious materials) coming as waste flows from other processes are accounted for as burden-free, following [cut-off system modeling approach](#).

LCIA: IPCC 2021 - GWP100 (including biogenic CO₂)

Data Source

LCA Methodology

Data Source

Facility Activity Data	Background Data
<p>Database: GEM Global Cement and Concrete Tracker</p> <p>Manual Extraction: facility websites, GEM-referenced articles, EPDs, Baidu profiles for Chinese facilities</p>	<p>Database: EcolInvent 3.11</p> <p>Other: open-source literature emission factors, peer-reviewed literature on energy and electricity intensities</p>

Carbon Intensity Modeling

Description

The **Carbon Intensity** value, measured in tonnes of CO₂e per tonne of cement (tCO₂e/t cement), **allows the comparison of cement facilities' emissions on a single axis**. This value is calculated through a combination of public datasets and facility-specific data, LCA mapping, and common practice assumptions when necessary and appropriate. To reflect differences in data quality and data availability, **carbon intensity values are paired with confidence scores**.

Scoring Logic

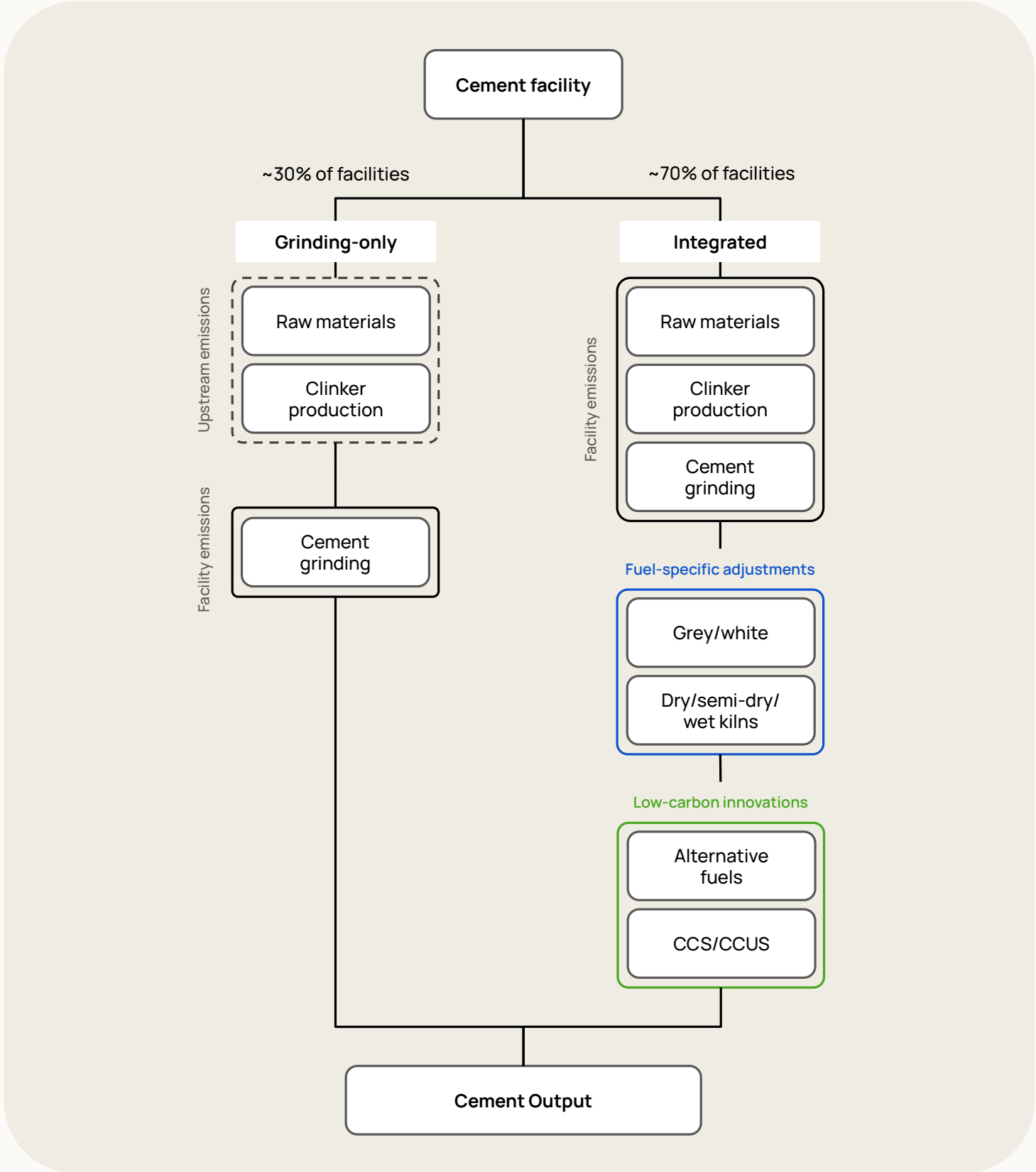
Two Carbon Intensity scoring pathways exist depending on the production method.

- **Pathway 1 - grinding:** Facilities that use clinker produced elsewhere to make cement.
- **Pathway 2 - integrated:** Facilities that produce clinker and grind clinker into cement.

All pathways use cradle-to-gate LCA data, ensuring a consistent and comparable approach across production methods.

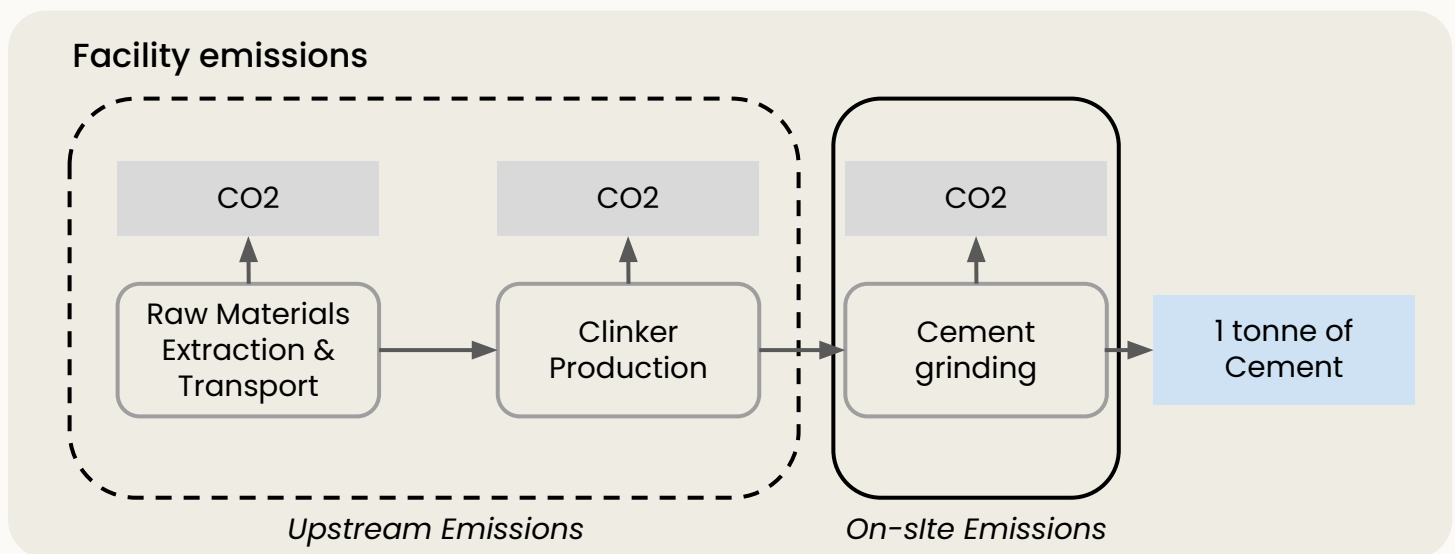
*Note: **clinker-only facilities** are not included in the scope as it would not provide a like-for-like comparison with cement production. This is based on the fact that most of cement emissions variability exist at the cement composition level, being clinker the main emissions driver.*

Carbon Intensity Logic



Grinding facilities

CARBON INTENSITY MODELING



Scoring Logic

Grinding-only facilities are modeled by attributing upstream clinker-related emissions to cement output, based on known or inferred clinker content.

When facility-level clinker-to-cement ratios are not available, reported cement types are mapped to representative classes from international cement standards (EN 197-1), and mid-range clinker shares are used.

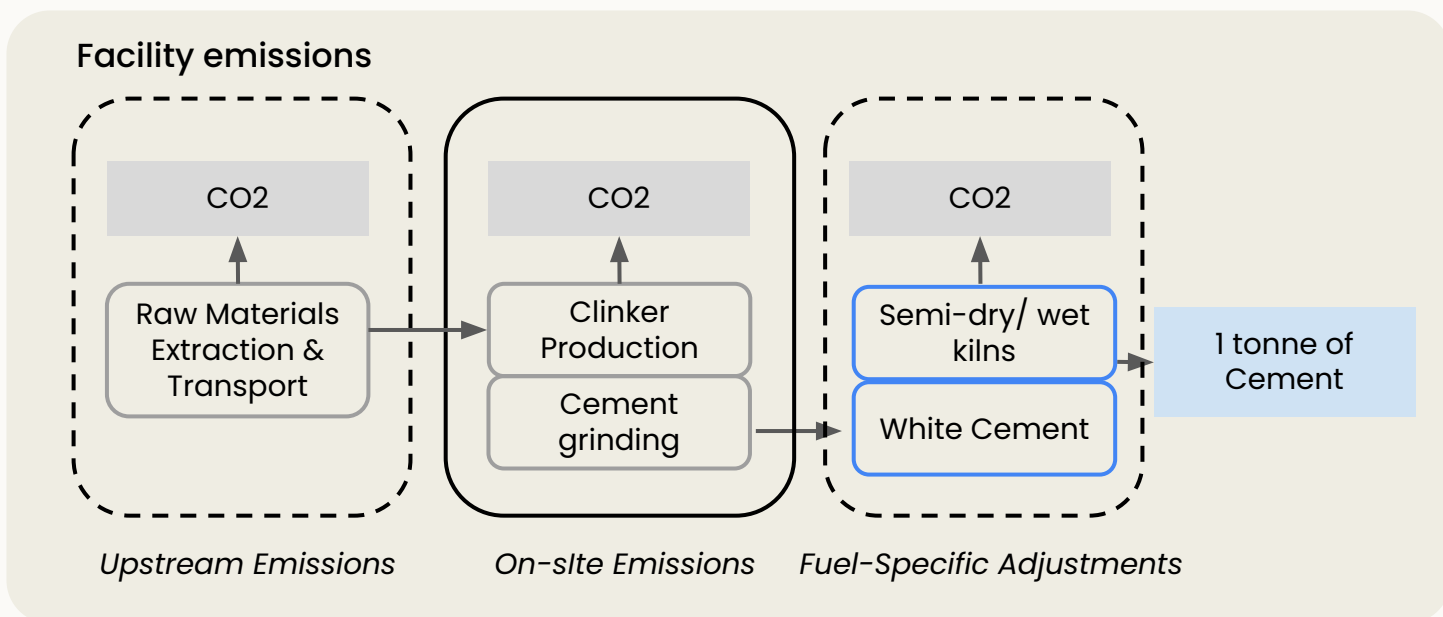
Clinker-related emissions are calculated by multiplying the assigned clinker share by country- or region-specific clinker production emission factors. Electricity consumption from cement grinding is included using a global average grinding intensity, combined with country-specific grid emission factors.

Key assumptions:

- All clinker is assumed to be produced domestically. Grinding facilities do not generate new clinker production emissions; they redistribute upstream clinker emissions across cement output.
- Assigned clinker shares represent typical values and do not capture plant-specific blending practices.

Integrated facilities

CARBON INTENSITY MODELING



🔄 Scoring Logic

Integrated facilities produce cement through both clinker production and grinding. Their carbon intensity is calculated by combining direct clinker-related emissions with electricity consumption from cement grinding.

When no primary data is provided, facility-level cement types have been extracted, and clinker content inferred from cement type using representative midpoint values from international cement classifications. Clinker-related emissions are calculated by multiplying the clinker fraction by country- or region-specific clinker production emission factors.

For semi-dry and wet kilns, which are expected to be more energy-intensive, a multiplier is applied to the dry-process emission factor based on peer-reviewed literature. For white cement, which is expected to use more energy-intensive processes, a separate multiplier is applied following published literature.

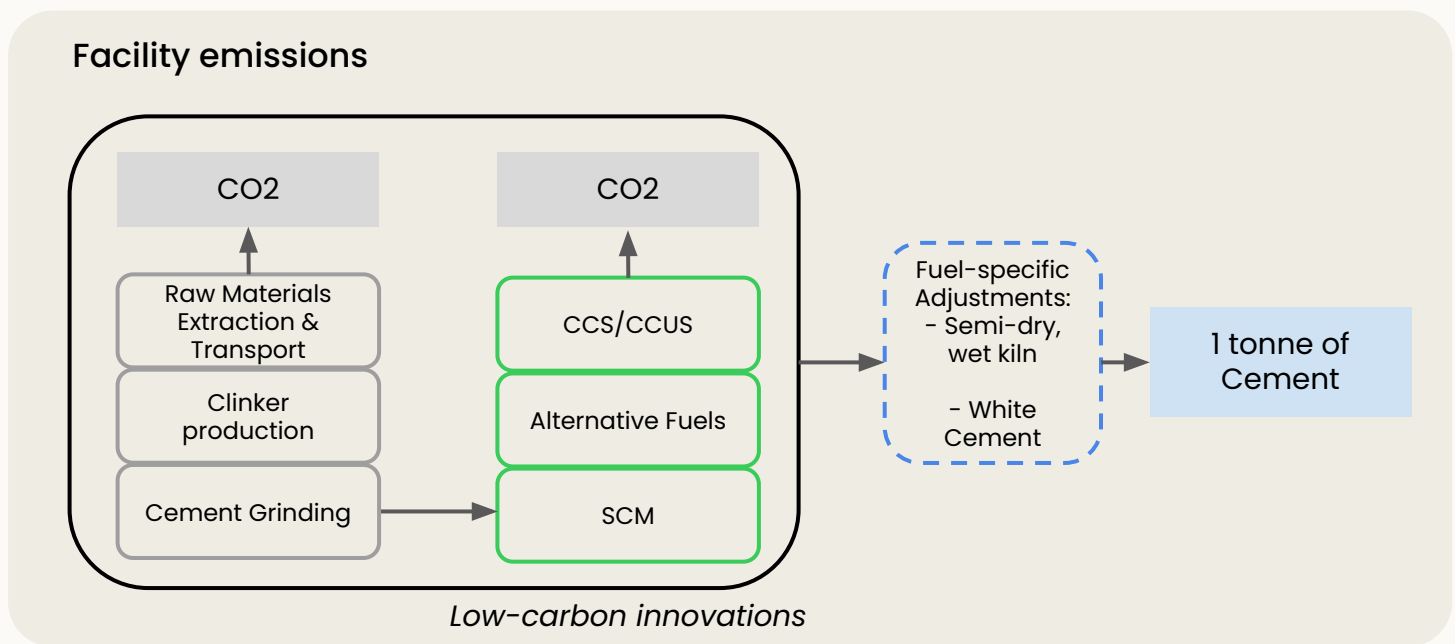
Electricity for cement grinding is included using a global average grinding intensity, combined with country-specific grid emission factors.

Key assumptions:

- All clinker is produced on-site, and facilities are assumed to operate according to the assigned kiln type.
- Integrated facilities generate clinker-related emissions directly.
- Cement types produced are assumed to contribute equally to total production.

Modelling low-carbon innovations

CARBON INTENSITY MODELING



Scoring Logic

Alternative fuels:

When statistics for fuel use are not reported, common practice values, stratified by geography, are used to inform both the total percentage and the blend of alternative fuel used. Biogenic fuel sources are assumed to emit zero emissions; fossil-derived waste fuels are assumed only to emit combustion-related emissions, with upstream emissions excluded. Emissions from fossil-derived fuels are calculated from literature values, fitted to the fuel-based emissions of clinker production.

CCS/CCUS:

CCS is modeled by applying a capture efficiency directly to clinker-related emissions. When found, exact carbon capture efficiency percentages are applied to reduce the expected emissions from clinker production. Otherwise, technology is assumed to be post-combustion capture with a default efficiency. Conservative assumptions are applied throughout: a deduction factor is included to account for capture process emissions based on Sylvera research.

Note: low carbon innovations are generally found at integrated or clinker-only facilities, rather than grinding ones, given that the majority of carbon emissions associated with the cement supply chain derive from the clinker production.

Confidence Score Logic

Description

Each carbon intensity assessment is accompanied by a **confidence score** that reflects **how reliable and complete the underlying data and assumptions are**. It indicates how much trust users should place in the analysis, given data availability and quality.

Scoring logic

The confidence score aggregates across three components:

1. Facility data reliability
2. Data completeness for key emission drivers
3. Emission factor Quality

Each score is reported on a 1-5 scale, where:

- 1 = very high confidence
- 5 = very low confidence

Very High Confidence

The data is primary source data provided directly by the owner and backed by verifiable evidence, modeled with recent and representative emission factors.

High Confidence

The data is provided by the owner or extracted by official sources, sense-checked and covering most of the emissions hotspots. The carbon intensity is modeled with recent and representative emission factors.

Fair Confidence

The data is extracted from public records, websites, or databases. Accuracy is maintained through cross-checking or "controlled data gaps", and the data covers about half of the total emissions.

Low Confidence

The data is gathered from public sources, but it is incomplete or unverifiable. Information covers less than half of expected emissions, leaving significant room for error.

Very Low Confidence

Facility technologies and energy inputs are fully unknown. The coverage is unknown, representing a significant risk of inaccuracy for any carbon intensity claim.

Facility Data Reliability and Completeness

Confidence Score Logic

Description

Data Reliability: this component evaluates **how reliable and verifiable** the facility-level information used in the carbon intensity assessment is.

Completeness: this component evaluates **how complete the data** is for the main emissions driver. For cement, that is generally the production of clinker.

Scoring Logic

Data Reliability scores depend on whether facility data was sourced directly from owners or official documentation, and if key operational features affecting emissions—such as alternative fuel usage—have been explicitly reported and confirmed.

Facilities only relying on default dataset values receive lower confidence scores, while facilities with verified, quantified production and technology data receive higher confidence.

Completeness scores depend on whether the type of cement or cement composition is reported and confirmed at the facility-specific level or a producer-wide level.

Facilities which do not provide exact or facility-specific cement type information receive lower confidence scores, whereas facilities with verified cement data receive higher scores.

Note: When no information was provided on cement type, it is assumed to be Ordinary Portland Cement (OPC) in alignment with industry convention. Confidence was automatically set to “very low” to reflect the lack of data availability.

Emission Factor Quality

Confidence Score Logic

Description

This component assesses the **representativeness and consistency** of the emission factors used in the carbon intensity calculation.

Scoring Logic

Emission factors are assessed against **five criteria**:

1. Geographical representativeness
2. Temporal representativeness
3. Technological representativeness
4. Data Source reliability
5. Methodological consistency with the study goal and scope, and across facility-level assessments

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