HILT CRC

Australian Government
Department of Industry, Science and Resources

Cooperative Research Centres Program

Research Report

PROJECT # 3.006

D4: MAPPING EMBEDDED EMISSIONS ACCOUNTING FRAMEWORKS FOR ALUMINIUM AND CEMENT'S LOW-CARBON TRANSITION

AUTHORS:

Hina Aslam
Research Lead, Heavy Industry Low-carbon Transition Cooperative Research Centre, Australian National University

Emma Aisbett
Project Lead, Heavy Industry Low-carbon Transition Cooperative Research Centre, Australian National University

DATE: JUNE/2025
HILT CRC REPORT 2025

HILTCRC.COM.AU

PROJECT

RP3.006 Certification and verification to enable a successful low-carbon transition for heavy industry

AUTHORS:

Hina Aslam,
Research Lead, Heavy Industry Low-carbon Transition Cooperative Research Centre, Australian National University

Emma Aisbett,
Project Lead, Heavy Industry Low-carbon Transition Cooperative Research Centre, Australian National University

ADDRESS BLOCK:

College of Law, Australian National University

ACKNOWLEDGEMENTS:

The work has been supported by the Heavy Industry Low-carbon Transition Cooperative Research Centre, whose activities are funded by its industry, research and government partners along with the Australian Government's Cooperative Research Centre Program. This is HILT CRC Document 25-225

OTHER MATTERS:

PROJECT PARTNERS:

The Australian National University

Curtin University

Fortescue

Grange Resources

Liberty Steel

BlueScope

Emirates Global Aluminium

Worley

CONTENTS

1. INTRODUCTION 4

Aluminium: A Strategic Material for the Energy Transition 4

Cement: A Hard-to-Abate Sector Requiring Policy Acceleration 4

The Role of EEFs in Australia's Decarbonisation Strategy 5

2. PURPOSE OF THE REPORT 6

3. OTHER LITERATURE AND CONTRIBUTION OF THIS REPORT 7

4. EMBEDDED EMISSIONS ACCOUNTING FRAMEWORKS (EEFS) FOR ALUMINIUM AND CEMENT 8

Major EEFs for Aluminium 8

Major EEFs for Cement 9

5. PRINCIPLE-BASED ANALYSIS OF EMBEDDED EMISSIONS FRAMEWORKS (EEFS) IN ALUMINIUM AND CEMENT SECTORS 11

Context and challenge 11

Core findings 21

6. REFERENCES 22

7. APPENDIX 23

INTRODUCTION

Industrial decarbonisation is fundamental to achieving global net-zero commitments, with aluminium and cement among the most emissions-intensive sectors. These industries are critical to infrastructure and the energy transition, yet their production processes remain highly carbon intensive.

Internationally, regulations and policy measures are being implemented to drive decarbonisation (detailed in report D3 for Aluminium and Cement), for instance, EU's CBAM will introduce emissions-based levies on carbon-intensive imports, including cement, while China and Canada have launched national roadmaps to support low-carbon cement production. China's roadmap, developed in collaboration with the Rocky Mountain Institute, outlines a strategy for emissions reductions (RMI & Energy Transitions Commission, 2019) while Canada's rising carbon price, set to reach C$170 per tonne by 2030, provides a strong market signal for decarbonisation. Embedded Emissions Accounting Frameworks (EEFs) are increasingly emerging in response to two converging drivers. First is a growing demand for greater transparency, accuracy, and environmental integrity in global trade, particularly in emissions-intensive sectors like aluminium and cement. Second, and more directly, a wave of regulatory and policy initiatives such as green public procurement strategies and carbon border adjustment mechanisms (CBAMs) is mandating the disclosure of embedded emissions. These developments are spurring the adoption of tools and methods to account for product-level emissions. However, the resulting landscape of fragmented EEFs presents significant challenges for producers, who must navigate overlapping and sometimes inconsistent requirements across jurisdictions (RP3.006 report (Aslam & Aisbett, 2024)).

ALUMINIUM: A STRATEGIC MATERIAL FOR THE ENERGY TRANSITION

Aluminium is a key enabler of the energy transition, used extensively in renewable energy technologies, electric vehicles, and transmission infrastructure. However, its production remains carbon-intensive, emitting approximately 270 Mt of direct CO_2 in 2022 which is around 3% of global industrial emissions (IEA, 2023). While emissions intensity has declined at a moderate pace (~2% per year over the past decade), the Net Zero Emissions by 2050 (NZE) Scenario requires a nearly 4% annual reduction through 2030. Achieving this will necessitate:

- Deployment of near-zero emission technologies in alumina refining and smelting
- Increased use of low-carbon electricity in production
- Expansion of scrap collection, sorting, and high-quality recycling

For Australia, as a leading global producer and exporter of alumina and Bauxite Australian (Bauxite, n.d.), the implementation of robust emissions accounting mechanisms is vital. Integrating EEFs within certification schemes and trade policies can help position Australian aluminium as a low-carbon alternative in global markets.

CEMENT: A HARD-TO-ABATE SECTOR REQUIRING POLICY ACCELERATION

Cement is a critical building material, yet its emissions challenge is compounded by process emissions from clinker production. The sector's direct CO_2 emissions intensity has remained largely unchanged over the past five years, with a slight increase of 1% in 2022 (IEA, 2023). To align with the NZE Scenario, a 4% annual reduction in emissions intensity is required through 2030, necessitating:

- Reduction of the clinker-to-cement ratio through alternative binders
- Enhanced energy efficiency in production
- Adoption of low-carbon fuels, including hydrogen and biomass
- Deployment of Carbon Capture and Storage (CCS) technologies

Australia's cement industry must navigate these evolving regulatory landscapes, particularly given its exposure to global trade. Incorporating EEFs into domestic policies, such as the Safeguard Mechanism, can enhance emissions transparency and facilitate compliance with international reporting requirements. Additionally, aligning with international low-carbon cement standards and investing in low carbon technologies will be critical for maintaining competitiveness.

THE ROLE OF EEFS IN AUSTRALIA'S DECARBONISATION STRATEGY

In aluminium and cement sectors, a variety of public and private standards, certification, and verification schemes have been introduced which depend heavily on accurate data regarding embedded emissions within supply chains and final products, discussed in companion report D3 on policy and regulatory drivers of EEFs for aluminium and cement. Consequently, an expanding array of EEFs specific to aluminium and cement has emerged, built on diverse standards, regulatory methodologies, certification protocols, and reporting initiatives. Manufacturers/producers often face difficulties navigating the overlapping and sometimes conflicting requirements of different EEFs, raising concerns about the reliability, consistency, and verifiability of emissions data. Divergences in methodological approaches, system boundaries, and lifecycle stages further hinder the ability to obtain trustworthy and comparable greenhouse gas emissions data across different supply chain stages. This fragmentation not only increases administrative and compliance costs for producers but also complicates access to low-carbon markets and risks enabling greenwashing through selective or inconsistent reporting. Most importantly, the lack of interoperability and mutual recognition among existing EEFs weakens efforts to build trust in embedded emissions data, thereby impeding progress toward a transparent, circular, and low-carbon industrial future for aluminium and cement.

PURPOSE OF THE REPORT

As Australia advances its industrial decarbonisation agenda, fostering interoperability between domestic and international emissions accounting frameworks will be critical. Aligning emissions transparency with market mechanisms is not only vital for reducing industrial emissions but also essential for ensuring that Australian aluminium and cement industries remain competitive in an increasingly carbon-constrained global economy.

This report aims to equip HILT partners with a comprehensive understanding of the evolving landscape of Embedded Emissions Accounting Frameworks (EEFs) for the aluminium and cement industries. It consolidates information on existing and emerging frameworks to support partners in navigating this complex space, facilitating seamless integration of emissions data across aluminium and cement supply chains to empower companies to accurately assess, manage, and disclose the embedded emissions associated with their products.

Section 3 of this report identifies major EEFs relevant to the sectors. It also offers structured assessment on the sector specific EEFs provided in the appendices: table A1 and A2. In Section 4, these EEFs in the aluminium and cement sectors are assessed through the lens of embedded emissions accounting principles (proposed by White et al. 2024). The objective is to identify the strengths, challenges, and alignment of major EEFs in these sectors with the set of principles is **Accuracy, Conservativeness, Monotonicity, Non-discrimination, Least restrictive means, Relevance, Subsidiarity, and Transparency.** As a set, these principles can be used to guide governments' design and negotiation of embedded emissions frameworks for internationally traded products. These principles may also be useful in negotiations over EEFs that are increasingly occurring under the auspices of International Green Economy Agreements such as the Indo-Pacific Framework for Economic Prosperity (White et al., 2024).

- **Accuracy** – EEFs should accurately reflect the embedded emissions of traded products, ensuring that the accounting process is reliable and provides a true representation of the environmental impact.
- **Monotonicity** – Upholds the integrity of emissions reductions over time, ensuring that reported decreases reflect actual, irreversible improvements in carbon performance. The accounting framework should ensure that as emissions increase, the environmental impact also increases, and vice versa.
- **Non-discrimination**- The EEF should not discriminate against any country, product, or sector, ensuring that the framework is applied fairly and consistently.
- **Transparency** – Promotes openness in the methods, assumptions, and data used in emissions calculations, allowing stakeholders to verify, interpret, and rely on reported figures. The EEF should be transparent in its methodology and data, allowing for scrutiny and verification of the accounting process.
- **Least Restrictive Means:** The framework should pursue non-trade policy objectives using the least trade-restrictive means possible, minimising any negative impacts on international trade.
- **Relevance** – Aligns emissions metrics with industry-specific processes, regulatory requirements, and stakeholder expectations to ensure practical utility and actionable insights. The EEF should be relevant to the needs of its users, including those bearing the burden of producing the accounts, and should meet the needs of those who will use the information generated by the framework.
- **Conservativeness** – The accounting framework should be conservative in its approach, ensuring that emissions are not underestimated and that the environmental impact is not downplayed.
- **Subsidiarity:** The EEF should be designed in a way that respects the principle of subsidiarity, ensuring that decisions are made at the appropriate level (local, national, or international).

By applying these principles (Glossary in the appendix), the report contributes to efforts aimed at strengthening the design and implementation of EEFs, fostering consistency, comparability, and ambition across aluminium and cement decarbonisation pathways.

OTHER LITERATURE AND CONTRIBUTION OF THIS REPORT

In recent years, a range of organisations have made notable progress in advancing the transition to net-zero emissions within heavy industries, particularly in the green aluminium and cement sectors. However, there remains a critical gap: no comprehensive policy mapping currently exists to guide industry stakeholders on the development and application of Embedded Emissions Accounting Frameworks (EEFs) specific to these sectors. This project report addresses that gap by delivering a targeted assessment of aluminium and cement, offering an in-depth examination of both domestic and international, public and private EEF initiatives.

The report consolidates diverse information into a specialised knowledge base encompassing relevant guideline, methodologies, procurement policies, and tools underpinned by EEFs. This integrative approach establishes clear linkages to key regulatory developments, including the European Union's Carbon Border Adjustment Mechanism (CBAM) and Australia's Guarantee of Origin (GO) scheme, both of which depend heavily on product-level emissions accounting.

Beyond mapping the major EEFs relevant to these sectors, the report evaluates them against the core principles of embedded emissions accounting such as accuracy, transparency, and relevance—to determine the extent to which each framework aligns with the requirements of current and emerging domestic and international climate policies. This assessment helps identify which EEFs have made meaningful progress in overcoming challenges associated with product-level emissions accounting, and which are best positioned to support interoperability and comparability across frameworks. In doing so, the report provides practical insights for industry stakeholders seeking to navigate the evolving landscape of emissions reporting, certification, and low-carbon market access.

EMBEDDED EMISSIONS ACCOUNTING FRAMEWORKS (EEFS) FOR ALUMINIUM AND CEMENT

MAJOR EEFS FOR ALUMINIUM

Embedded Emissions Accounting Frameworks (EEFs) for aluminium focus on measuring, reporting, and verifying greenhouse gas (GHG) emissions across the aluminium value chain. Due to the energy-intensive nature of aluminium production particularly in the electrolysis (smelting) stage powered by electricity and the calcination of alumina, these frameworks aim to account for both direct process emissions and indirect emissions from electricity use. Multiple standards and methodologies have emerged to support accurate emissions accounting, traceability, and certification of low-carbon aluminium products. Several key Embedded Emissions Accounting Frameworks (EEFs) have been developed to facilitate standardised reporting and certification of aluminium product emissions. Detailed table and analysis are provided in the appendix A Table A1 and A2.

International Standards and GHG Protocols

- GHG Protocol Corporate and Product Standards: Provides standardised methodologies for corporate (Scope 1, 2, 3) and product-level emissions accounting in the aluminium sector.
- ISO 14067: Carbon Footprint of Products: Defines LCA-based carbon footprint methodologies, though debates remain on emissions treatment for scrap.
- European Standard EN 19694-4: Best practices for measuring emissions from primary aluminium production, supporting EU ETS compliance.

Industry-Specific Initiatives

- International Aluminium Institute (IAI) Good Practice Guidance: The most widely accepted framework for product-level GHG footprint calculation in aluminium, applicable to primary aluminium but with limited coverage for recyclers and fabricators.

Supporting documents under IAI guidance:

- Aluminium Carbon Footprint Technical Support Document – Defines three levels of system boundary disclosure (IAI 1, IAI 2, IAI 3), still referenced in London Metals Exchange (LME) listings.
- Good Practice Guidance: Measuring PFCs – Updates methodologies for direct PFC emissions measurement in line with 2019 IPCC guidelines.
- Guidelines on Transparency – Aluminium Scrap – Establishes reporting requirements for aluminium products incorporating scrap.
- Reference Document on Scrap Flows – Addresses conflicts between ISO standards and industry practices on scrap emissions.
- Aluminium Sector Greenhouse Gas Protocol: Aligns IAI guidance with the GHG Protocol Corporate Standard to integrate aluminium-specific emissions accounting into broader corporate frameworks
- Science-Based Targets Initiative (SBTi) – Aluminium Decarbonization Pathway: Provides a methodology for aluminium producers to align with 1.5°C climate targets.

Product Certification Schemes

- Aluminium Stewardship Initiative (ASI) Performance and Chain of Custody Standards
  - Performance Standard: Requires companies to assess and disclose GHG emissions.

- Chain of Custody Standard: Ensures certified sustainable aluminium supply chains.

- Environmental Product Declarations (EPDs) (ISO 14025, EN 15804): Used for LCA-based emissions disclosures of aluminium products.
- London Metals Exchange (LME) Responsible Sourcing Requirements: LME Passport Initiative mandates GHG footprint disclosure for aluminium producers listing products on the LME market, enhancing transparency.

Regulatory & Market-Based Initiatives

- EU ETS & CBAM (Carbon Border Adjustment Mechanism): aluminium producers operating in or exporting to the EU must report emissions under ETS and CBAM requirements.
- China ETS & NDRC Guidelines
- China's Emissions Trading System (ETS) formally included electrolytic aluminium emissions in 2023.
- China NDRC Guidelines – Supports emissions reporting for aluminium production enterprises, aligning with China's national carbon market.
- Environment Canada GHG Division Guidelines: Provides GHG estimation methodologies for primary aluminium production, compatible with IAI standards but not updated for recent revisions.

Emerging Certification Schemes

- Digital EPDs for aluminium (e.g. Climate Earth) – Enables real-time tracking of embedded emissions.
- Product Carbon Footprint (PCF) Labels (e.g. Carbon Trust) – Offers carbon labelling for low-carbon aluminium products.

MAJOR EEFS FOR CEMENT

Embedded Emissions Accounting Frameworks (EEFs) for cement and lime focus on measuring, reporting, and verifying greenhouse gas (GHG) emissions associated with production. Given the high carbon intensity of these industries, primarily due to clinker production, process emissions from calcination, and energy use, several frameworks and standards have emerged to facilitate emissions accounting and low-carbon certification. Below are the major EEFs applicable to cement:

International Standards and GHG Protocols

- *ISO 14067:2018* – Specifies the carbon footprint of products (CFP), applicable to cement and lime products.
- *ISO 21930:2017* – Provides environmental declaration principles for building products, including cement and lime.
- *GHG Protocol Product Life Cycle Accounting and Reporting Standard* – Covers emissions accounting across the entire value chain.
- *ISO 14064-1 & ISO 14064-2* – Used for organisational and project-level GHG emissions reporting.

Industry-Specific Initiatives

- *The Cement Sustainability Initiative (CSI) – GCCA CO_2 and Energy Database:* Originally developed under the World Business Council for Sustainable Development (WBCSD), now managed by the Global Cement and Concrete Association (GCCA).
- *GCCA Carbon Neutrality Roadmap* includes emissions accounting methodologies based on clinker ratios, alternative fuels, and carbon capture.
- *The Science-Based Targets Initiative (SBTi)* – Cement Science-Based Target Guidance: Provides sector-specific decarbonisation pathways, aligned with 1.5°C or well-below 2°C scenarios.

- *Cement Industry Greenhouse Gas Protocol (Cement CO_2 Protocol):* Developed by GCCA, aligned with the GHG Protocol, detailing Scope 1, 2, and 3 emissions.

Product Certification Schemes

- *Environmental Product Declarations (EPDs) (ISO 14025, EN 15804):* Provide third-party verified LCA-based carbon footprints for cement and lime.
- Verified under EPD program operators like the International EPD System, ASTM, or BRE Global.
- *Product Carbon Footprint (PCF) Labels*
- *Initiatives like Carbon Trust and Cradle-to-Cradle Certified™* provide certifications for low-carbon cement and lime.
- *EU Level(s) Framework & EPDs for Cement*

Regulatory & Market-Based Initiatives

- EU ETS & CBAM (Carbon Border Adjustment Mechanism): CBAM applies embedded carbon pricing to cement imports into the EU.
- California Low Carbon Fuel Standard (LCFS) – Alternative Cement Pathways: Supports low-carbon cement under California's clean fuel programs.
- Buy Clean Policies (U.S., Canada, and EU Public Procurement Directives)[1]

Emerging Certification Schemes

- Climate Earth Digital EPDs for Cement & Concrete – Real-time carbon footprint tracking.
- The Carbon Trust Cement Footprint Certification – Carbon labelling for cement and lime producers.
- Concrete Sustainability Council (CSC) Certification – Certifies low-carbon concrete and cement supply chains.

Key Challenges

- Divergent Accounting Approaches – Different system boundaries (e.g. cradle-to-gate vs. cradle-to-grave).
- Lack of Uniformity in Verification – EPD methodologies vary across regions and programs.
- Sector-Specific vs. Cross-Sectoral Standards – Need for better alignment between ISO, GHG Protocol, and sectoral benchmarks (e.g. GCCA)

PRINCIPLE-BASED ANALYSIS OF EMBEDDED EMISSIONS FRAMEWORKS (EEFS) IN ALUMINIUM AND CEMENT SECTORS

CONTEXT AND CHALLENGE

As industrial sectors decarbonise, Embedded Emissions Frameworks (EEFs) including standards, certifications, and methodologies are playing an increasingly vital role in enabling low-carbon procurement, cross-border trade, and emissions disclosure. However, the effectiveness of EEFs depends on their alignment with core principles: **Accuracy, Conservativeness, Monotonicity, Non-discrimination, Least restrictive means, Relevance, Subsidiarity, and Transparency.** In this analysis, we assess major EEFs in the aluminium and cement industries through the lens of these principles, aiming to identify their strengths, challenges, and alignment with broader decarbonisation goals. By applying EEF principles to the review of industry standards, certification schemes, and regulatory initiatives, this analysis seeks to provide insights into how these frameworks can be strengthened and harmonised to ensure robust emissions reporting, facilitate circularity, and support sustainable practices across sectors.

Tab Table 4.1 Principle-based analysis of embedded emissions frameworks (EEFs) in aluminium and cement sectors

EEF	TYPE OF INITIATIVE	DESCRIPTION	RELEVANCE TO EEFS	RELEVANCE TO EEF PRINCIPLES
GHG Protocol Corporate and Product Standards (Aluminium)	International Standards and Protocols	Provides standardised methodologies for corporate (Scope 1, 2, 3) and product-level emissions accounting in the aluminium sector.	Standardises corporate (Scope 1, 2, 3) and product-level emissions accounting for aluminium.	***Accuracy*** *– Provides precise methodologies for emissions accounting at corporate and product levels.* ***Conservativeness*** *– Recommends conservative assumptions where uncertainty exists.* ***Monotonicity*** *– Enables trend analysis for emissions reductions across time.* ***Non-discrimination*** *– Ensures equitable emissions reporting for all sectors.* ***Least restrictive means*** *– Provides flexible, globally applicable standards for different sectors without imposing overly stringent rules.* ***Relevance*** *– Aligns with international reporting requirements (e.g. CDP, SBTi).* ***Subsidiarity*** *– Allows regions and sectors to adapt emissions accounting based on local conditions while maintaining global consistency.* ***Transparency*** *– Defines clear disclosure structures across Scope 1, 2, and 3 emissions.*
ISO 14067: Carbon Footprint of Products (Aluminium & Cement)	International Standards and GHG Protocols	Carbon Footprint of Products: Defines LCA-based carbon footprint methodologies, though debates remain on	Defines LCA-based carbon footprint methodologies for aluminium and cement products.	**Accuracy** – Ensures product-level carbon footprint is measured consistently using LCA. **Conservativeness** – Encourages overestimation when uncertain, ensuring a cautious approach to emissions accounting. **Monotonicity** – Enables longitudinal emissions tracking via LCA databases. **Non-discrimination** – Applicable to a wide range of product sectors, ensuring equal treatment of all product types. **Least restrictive means** – Facilitates emission reporting without imposing excessive restrictions,

EEF	TYPE OF INITIATIVE	DESCRIPTION	RELEVANCE TO EEFS	RELEVANCE TO EEF PRINCIPLES
		emissions treatment for scrap.		promoting a balance between rigor and flexibility. **Relevance** – Widely applicable across various sectors for low-carbon certification, supporting broad industry adoption. **Subsidiarity** – Allows local adaptation of methodologies while adhering to the core principles set by ISO. **Transparency** – Facilitates emissions reporting based on ISO-defined procedures, ensuring clarity and openness.
European Standard EN 19694-4 (Aluminium)	International Standards and GHG Protocols		Best practices for measuring emissions from primary aluminium production, relevant for EU ETS compliance.	***Accuracy*** *– Defines best practices for measuring emissions from primary aluminium.* ***Conservativeness*** *– Ensures emissions are not underreported to meet regulatory expectations.* ***Monotonicity*** *– Enables structured emissions reduction pathways over time, fostering continuous improvement.* ***Non-discrimination*** *– Ensures that all primary aluminium producers are subject to the same measurement standards.* ***Least restrictive means*** *– Balances compliance with regulatory requirements while maintaining flexibility in approach.* ***Relevance*** *– Directly supports compliance with EU climate policy and emissions reduction goals.* ***Subsidiarity*** *– Adaptation to regional EU regulations ensures that the approach is relevant to specific member states.* ***Transparency*** *– Specifies reporting protocols that align with EU ETS requirements, ensuring full transparency in emissions reporting.*
International Aluminium Institute (IAI) Good Practice Guidance	Industry-Specific Initiatives	Widely accepted for aluminium product-level GHG footprint calculation, applicable to primary aluminium. Supporting documents under IAI guidance: **Aluminium Carbon Footprint Technical Support Document** – Defines three levels of system boundary disclosure (IAI 1, IAI 2, IAI 3), still referenced in London Metals Exchange (LME) listings. **Good Practice Guidance: Measuring PFCs** – Updates methodologies for direct PFC emissions measurement in line with 2019 IPCC guidelines. **Guidelines on Transparency – Aluminium Scrap** – Establishes reporting requirements for aluminium products incorporating scrap.		**Accuracy** – Provides detailed sector-specific GHG footprint methodologies for aluminium. **Conservativeness** – Promotes prudent estimation, especially regarding uncertainties in scrap accounting. **Monotonicity** – Supports emissions reduction target setting (e.g. via SBTi), encouraging continuous improvement. **Non-discrimination** – Applies uniformly to aluminium industry operators, ensuring fair treatment. **Least restrictive means** – Aligns with existing GHG Protocol and IPCC guidelines without overburdening industry actors. **Relevance** – Tailored specifically to aluminium industry operations, offering sector-relevant insights. **Subsidiarity** – Supports local adjustments, allowing industry stakeholders to follow guidance while considering regional conditions. **Transparency** – Clearly defines levels of emissions boundary disclosure (IAI 1–3), promoting transparency across the supply chain.

EEF	TYPE OF INITIATIVE	DESCRIPTION	RELEVANCE TO EEFS	RELEVANCE TO EEF PRINCIPLES
		Reference Document on Scrap Flows – Addresses conflicts between ISO standards and industry practices on scrap emissions. **Aluminium Sector Greenhouse Gas Protocol**: Aligns IAI guidance with the GHG Protocol Corporate Standard to integrate aluminium-specific emissions accounting into broader corporate frameworks **Science-Based Targets Initiative (SBTi)** – Aluminium Decarbonization Pathway: Provides a methodology for aluminium producers to align with 1.5°C climate targets.		
Aluminium Stewardship Initiative (ASI) Performance Standard	Product Certification Schemes	Ensures companies disclose and manage GHG emissions through certified sustainable aluminium supply chains. Aluminium Stewardship Initiative (ASI) Performance and Chain of Custody Standards Performance Standard: Requires companies to assess and disclose GHG emissions. Chain of Custody Standard: Ensures certified sustainable aluminium supply chains.		**Accuracy** – Requires GHG emissions assessment using credible methods. **Conservativeness** – Certification frameworks require minimum criteria to avoid underreporting. **Monotonicity** – Encourages emissions improvement through performance-based requirements. **Non-discrimination** – Ensures equitable treatment of all companies within the aluminium supply chain. **Least restrictive means** – Provides a certification framework that allows flexibility in achieving sustainability goals. **Relevance** – Designed to drive low-carbon transformation in the aluminium value chain. **Subsidiarity** – Encourages region-specific improvements while maintaining a unified standard. **Transparency** – Mandates public disclosure of environmental performance for certified companies.
Environmental Product Declarations (EPDs) (ISO 14025, EN 15804) (Aluminium & Cement)			LCA-based disclosures for aluminium and cement products to communicate carbon footprints.	**Accuracy** – Uses verified LCA data for environmental profiling, ensuring reliable emissions data. **Conservativeness** – Third-party verification ensures conservative default values are applied. **Monotonicity** – Enables time-series analysis for environmental improvement. **Non-discrimination** – Offers equal transparency for all certified products, ensuring fair representation. **Least restrictive means** – LCA disclosures allow flexibility, avoiding overly restrictive reporting formats. **Relevance** – Widely used across construction, manufacturing, and product labelling industries. **Subsidiarity** – EPDs can be adapted to local regulatory and market conditions while adhering to ISO/EN standards. **Transparency** – Publicly available declarations ensure open disclosure of product-level emissions.
London Metals Exchange (LME)		LME Passport Initiative mandates GHG footprint	Mandates GHG footprint disclosure for aluminium	**Accuracy** – Requires verified GHG disclosures, ensuring the integrity of the emissions data. **Conservativeness** – Conservative disclosure expected for product listing eligibility.

EEF	TYPE OF INITIATIVE	DESCRIPTION	RELEVANCE TO EEFS	RELEVANCE TO EEF PRINCIPLES
Responsible Sourcing Requirements (Aluminium)		disclosure for aluminium producers listing products on the LME market, enhancing transparency.	producers listing on the LME market.	**Monotonicity** – Supports tracking and incentivising carbon footprint reductions over time. **Non-discrimination** – Ensures all producers listing on LME are subject to the same responsible sourcing requirements. **Least restrictive means** – Provides a framework for disclosure without imposing burdensome reporting requirements. **Relevance** – Enhances demand for low-carbon metals in global markets, supporting a transition to cleaner production. **Subsidiarity** – Adaptable to various regional regulatory contexts within the LME framework. **Transparency** – LME Passport publicly shares emissions data, ensuring visibility for consumers and stakeholders.
Science-Based Targets Initiative (SBTi) - Aluminium Decarbonization Pathway			Guides aluminium producers to align with 1.5°C climate targets through emissions accounting.	**Accuracy –** Uses science-aligned carbon budgets to ensure precise target setting. **Conservativeness –** Promotes conservative baselines to avoid greenwashing. **Monotonicity –** Designed to ensure progressive emissions reduction in alignment with 1.5°C targets. **Non-discrimination –** Applies universally to all aluminium producers committed to science-based targets. **Least restrictive means –** Offers flexibility in how companies achieve their targets, focusing on outcome-based criteria. **Relevance –** Directly supports the aluminium sector's transition to a low-carbon future by aligning with international climate targets. **Subsidiarity –** Allows industry stakeholders to adapt the methodology to their specific contexts while maintaining global consistency. **Transparency –** Requires disclosures of methods, progress, and alignment with 1.5°C targets, ensuring transparency throughout the process.
Cement Sustainability Initiative (CSI) - GCCA CO_2 and Energy Database			Provides emissions accounting methodologies for cement production, including clinker ratios and alternative fuels.	**Accuracy** – The initiative offers sector-specific emissions tracking tools and clinker ratios, ensuring precise emissions measurement in cement production. This accuracy is vital for compliance, carbon accounting, and strategic emissions reductions. **Conservativeness** – The database accounts for alternative fuels and co-processing with safety margins to prevent underreporting of emissions. It takes a conservative approach by building in buffers to ensure that reported emissions reflect real-world conditions.

EEF	TYPE OF INITIATIVE	DESCRIPTION	RELEVANCE TO EEFS	RELEVANCE TO EEF PRINCIPLES
				Monotonicity – The initiative supports time-based progress tracking, allowing cement producers to measure continuous improvement in emissions reductions. This encourages sustained progress over time. **Non-discrimination** – The database is available to all cement producers, ensuring equitable access to the tools and resources needed for emissions tracking. No entity is excluded from participation based on size or location. **Least restrictive means** – The open-source nature of the tool and its flexible use of alternative fuels aligns with the least restrictive approach. It offers producers multiple pathways for emissions reductions without imposing rigid, uniform constraints. **Relevance** – The tool is highly relevant to cement and concrete producers, as it provides critical data to help them track and reduce their emissions in line with industry-specific needs and climate goals. **Subsidiarity** – The initiative respects subsidiarity by allowing local cement producers to use the database to report emissions at their level of operation, while still being aligned with global standards. It empowers local action within a globally consistent framework. **Transparency** – As an open-source tool, the database offers full transparency in its emissions and energy data, which fosters accountability and trust in the reported results.
Cement Industry Greenhouse Gas Protocol (Cement CO_2 Protocol)			Aligns cement industry emissions with the GHG Protocol, detailing Scope 1, 2, and 3 emissions.	**Accuracy** – The protocol provides detailed guidance on Scope 1, 2, and 3 emissions, offering accurate measurements of all emissions associated with cement production, from direct emissions to supply chain impacts. **Conservativeness** – The protocol includes conservative default factors for cases where precise data is unavailable. This ensures that emissions are not underestimated, providing a cautious approach to reporting. **Monotonicity** – It allows for tracking emissions reductions over time, ensuring that reductions are sustained and that companies are progressing towards net-zero goals. **Non-discrimination** – The protocol applies equally to all cement producers, regardless of scale or region, ensuring non-discriminatory access to emissions accounting and reporting.

EEF	TYPE OF INITIATIVE	DESCRIPTION	RELEVANCE TO EEFS	RELEVANCE TO EEF PRINCIPLES
				Least restrictive means – The protocol provides a flexible framework for emissions reporting, accommodating various methods and emissions reduction strategies without enforcing overly restrictive rules. **Relevance** – This protocol is highly relevant to cement producers, as it provides an established framework for emissions reporting and aligns with global standards, making it integral for companies seeking to reduce their carbon footprint. **Subsidiarity** – The protocol aligns with subsidiarity by enabling companies to report emissions in a way that fits their local context yet contributes to global emissions reductions goals. T**ransparency** – The protocol promotes transparency by clearly defining emissions categories, ensuring that companies disclose their emissions data in a standardised manner that is accessible to external stakeholders.
Carbon Trust and Cradle-to-Cradle Certified™ (Cement & Lime)			Certifies low-carbon cement and lime products, supporting low-carbon pathways in the cement industry.	**Accuracy** – The certification verifies the carbon footprints and resource use in cement and lime products, providing accurate data on environmental performance, which is crucial for establishing credibility in low-carbon construction. **Conservativeness** – It adopts conservative material assessments to ensure that carbon footprints are not underestimated, particularly in cases where data might be incomplete or uncertain. **Monotonicity** – The certification process encourages progress over time, with companies required to improve material reuse and reduce their carbon impact across certification cycles. **Non-discrimination** – The Cradle-to-Cradle certification is available to any cement or lime producer meeting the necessary sustainability criteria, ensuring all companies can participate regardless of size or geographical location. **Least restrictive means** – The framework is not prescriptive in terms of how a company must achieve low-carbon outcomes; instead, it offers a set of criteria that allows companies to explore various pathways towards sustainability. **Relevance** – The certification is highly relevant to both the cement and lime industries, particularly in the context of sustainable building materials and low-carbon procurement policies. **Subsidiarity** – This certification respects subsidiarity by empowering local producers to meet global standards while adapting to their own local environmental and economic conditions.

EEF	TYPE OF INITIATIVE	DESCRIPTION	RELEVANCE TO EEFS	RELEVANCE TO EEF PRINCIPLES
				Transparency – Through public labeling and product reports, the certification provides transparency regarding emissions and resource use, allowing consumers and stakeholders to make informed decisions.
Climate Earth Digital EPDs (Aluminium, Cement & Concrete)	Emerging Certification Schemes		Real-time tracking of carbon footprints for aluminium, cement, and concrete products.	**Accuracy** – The real-time carbon footprint tracking system provides accurate emissions data, enabling companies to assess and report their environmental impact in real time. **Conservativeness** – The platform allows for setting conservative thresholds in real-time analytics, ensuring that reported emissions reflect cautious estimates where data might be uncertain. **Monotonicity** – The system facilitates continuous improvements in emissions reductions, allowing companies to track progress over time and demonstrating long-term commitment to sustainability. **Non-discrimination** – The digital platform is accessible to all producers of aluminium, cement, and concrete, ensuring that every company can participate in emissions tracking and reporting, regardless of size or location. **Least restrictive means** – By offering digital tools and APIs, the system supports flexibility in how companies track and report their emissions, without imposing overly strict protocols. **Relevance** – This real-time system is highly relevant to industries looking for instantaneous data on carbon footprints, particularly in response to the growing demand for transparency and quick access to sustainability data. **Subsidiarity** – The digital nature of the tool allows for localised implementation, while still being part of a global movement toward improving sustainability across sectors. **Transparency** – The platform offers transparent access to real-time emissions data, providing stakeholders with continuous insight into the carbon performance of products.
Verified EPD Programs for Cement (ISO 14025, EN 15804)- Cement and AI			Third-party verification of LCA-based emissions disclosures for cement products.	**Accuracy** – Supports third-party LCA data verification, ensuring that the emissions data disclosed by cement producers is accurate and reliable, based on lifecycle assessments. **Conservativeness** – The third-party verification process minimises the risk of underreporting emissions, adopting conservative practices where necessary to ensure integrity.

EEF	TYPE OF INITIATIVE	DESCRIPTION	RELEVANCE TO EEFS	RELEVANCE TO EEF PRINCIPLES
				Monotonicity – The verified EPDs enable continuous emissions tracking over time, allowing companies to demonstrate ongoing improvements in emissions reductions. **Non-discrimination** – The EPD programs are open to all cement producers, providing a standardised framework that ensures fair participation and equal access for companies of all sizes and regions. **Least restrictive means** – The program offers flexibility in terms of how companies conduct their lifecycle assessments and report emissions, as long as they meet the verified standards. **Relevance** – This program is directly relevant to cement producers who wish to certify and disclose their environmental impacts, especially in procurement and green infrastructure projects. **Subsidiarity** – By allowing for local implementation of verified EPDs, the program empowers companies to manage their emissions reporting according to their specific operations while adhering to globally recognised standards. **Transparency** – Public databases provide emissions disclosures that are open to external stakeholders, promoting transparency in the cement industry's environmental performance.
California Low Carbon Fuel Standard (LCFS) - Cement			Supports low-carbon cement pathways under California's clean fuel programs.	**Accuracy –** The LCFS requires accurate emissions quantification using lifecycle tools like GREET, ensuring that carbon intensity pathways for cement meet rigorous data standards. **Conservativeness –** The program penalises underestimation by applying default values for emissions calculations, ensuring that reported emissions do not fall short of actual levels. **Monotonicity** – The LCFS incentivises continuous emissions reductions through a crediting system, fostering long-term progress towards low-carbon cement production. **Non-discrimination** – The LCFS applies equally to all cement producers participating in California's clean fuel programs, providing fair opportunities for companies to reduce their carbon intensity. **Least restrictive means –** The LCFS allows companies to choose from a variety of low-carbon cement pathways, providing flexibility without imposing overly restrictive rules.

EEF	TYPE OF INITIATIVE	DESCRIPTION	RELEVANCE TO EEFS	RELEVANCE TO EEF PRINCIPLES
				Relevance – The program is highly relevant to cement producers in California, aligning with the state's low-carbon goals and clean fuel regulations. **Subsidiarity** – Local cement producers can apply the LCFS methodology to their operations, ensuring that emissions reductions are tailored to their specific contexts within California's regulatory framework. **Transparency** – The publicly accessible carbon intensity pathways promote transparency, allowing stakeholders to understand the carbon performance of cement producers under the LCFS.
Concrete Sustainability Council (CSC) Certification			**Certifies low-carbon concrete and cement supply chains, supporting low-carbon construction materials.**	**Accuracy** – The CSC certification validates emissions data across the supply chain, ensuring that the reported carbon footprints are accurate and reflect the entire lifecycle of concrete production. **Conservativeness** – The certification requires third-party reviews of emissions and resource use, preventing the underreporting of emissions and ensuring the conservative assessment of sustainability. **Monotonicity** – The certification process encourages continuous improvement in carbon intensity by incentivising producers to enhance their sustainability performance over time. **Non-discrimination** – The certification is available to all concrete producers, ensuring equal access to sustainability certification regardless of company size or location. **Least restrictive means** – The certification offers flexibility in how companies achieve low-carbon outcomes, focusing on continuous improvement rather than rigid compliance with prescribed standards. **Relevance** – The CSC certification is highly relevant to the construction industry, as it links concrete sustainability to low-carbon supply chain goals, helping the industry transition toward greener infrastructure. **Subsidiarity** – The certification empowers local producers to meet global sustainability standards while accounting for their unique operational contexts, contributing to global emissions reductions goals.

EEF	TYPE OF INITIATIVE	DESCRIPTION	RELEVANCE TO EEFS	RELEVANCE TO EEF PRINCIPLES
				Transparency – The certification discloses carbon footprints and sustainability performance, promoting transparency and enabling stakeholders to make informed decisions about concrete procurement.

CORE FINDINGS

Embedded Emissions Accounting Frameworks (EEFs) play a pivotal role in the decarbonisation of industries by offering standardised methods to track and report carbon emissions. These frameworks, such as the Cement Sustainability Initiative (CSI) and Verified EPD Programs, provide sector-specific emissions tracking tools that ensure accuracy in measuring emissions. By offering consistent methodologies across various industries, these frameworks support uniformity in emissions reporting, which enhances transparency and accountability.

The emphasis on Conservativeness within these frameworks is crucial for ensuring that emissions are not underestimated. Many of these initiatives, such as Carbon Trust and Cradle-to-Cradle Certified™ and Cement Industry Greenhouse Gas Protocol, incorporate safety margins in their methodologies, particularly when accounting for alternative fuels or scrap materials. This conservatism prevents any underreporting and ensures a more robust and reliable emissions accounting process.

In addition to ensuring accuracy and conservatism, EEFs promote Monotonicity, which ensures that the reported reductions in embedded emissions reflect real declines rather than accounting artifacts. This principle is designed to prevent producers from using offsets and shifting emissions elsewhere in the value chain to create illusion of their progress. For example, frameworks like the California Low Carbon Fuel Standard (LCFS) and Climate Earth Digital EPDs support transparent tracking and monitoring of progress and improvements in emissions intensity, encouraging industries to enhance their sustainability efforts and track their emissions over multiple cycles. However, the others lack explicit mechanisms for guaranteeing continuous, irreversible reductions in emissions highlighting the need for verification systems that ensure reductions are globally additive, durable and verifiable. Without such mechanisms, frameworks risk enabling emissions accounting that undermines long term decarbonisation.

These frameworks are designed to be Relevant to the needs of industries while also fostering alignment with broader climate goals. The Science-Based Targets Initiative (SBTi), for instance, aligns companies with the 1.5°C global climate targets, ensuring that their emissions pathways are in sync with international climate goals. Additionally, frameworks like Cement Industry GHG Protocol ensure that emissions disclosures are in line with global reporting standards, supporting industries in carbon trading and meeting regulatory compliance.

The principle of Transparency is evident across all initiatives, with many providing open-source databases, public access to emissions data, and third-party verification. Initiatives like Environmental Product Declarations (EPDs) and ISO 14067 have made significant progress in enhancing transparency, but more work is needed to ensure that emissions data is consistently accessible and understandable to all stakeholders. Initiatives like the London Metals Exchange (LME) Responsible Sourcing Requirements require verified GHG disclosures and make emissions data publicly available, enhancing the credibility and reliability of the information shared. From 15 june 2025, the LME will be integrating CBAM requirements into LME Rulebook in respect of LME primary aluminium and listed brands to implement mandatory CBAM emissions reporting in line with CBAM regulations and voluntary International Aluminium Institute (IAI)-Aluminium carbon footprint methodology.

The use of the Subsidiarity principle ensures that emissions accounting frameworks are tailored to the specific needs of each sector while remaining aligned with overarching climate and policy goals.

Lastly, the principle of Non-discrimination and Least Restrictive Means is embedded in these frameworks by ensuring that emissions accounting methods do not unfairly disadvantage any particular segment of industry. These standards, while strict, are designed to provide flexibility and avoid overly burdensome requirements, thereby enabling industry-wide adoption without compromising the integrity of the accounting process. The risk of discrimination arises when certain industries or regions are disproportionately affected by emissions reporting requirements due to differing capacities or regulatory environments. To avoid this, EEF systems must be designed to be inclusive, offering flexibility and support for emerging markets and sectors while maintaining rigorous standards for emissions accounting. This requires balancing global sustainability goals with local contexts and capacities, ensuring that all stakeholders can participate in emissions reductions without facing unfair barriers.

REFERENCES

Aslam, H., & Aisbett, E. (2024, November). *Policies and regulatory drivers of embedded emissions accounting for Australian heavy industry low-carbon transition: The case of the iron and steel sector* (Research Report No. 25/200, Project RP3.006). Heavy Industry Low Carbon Transition Cooperative Research Centre. Retrieved from https://hiltcrc.com.au/wp-content/uploads/2025/04/HILT-CRC_25-200_RP3.006_Policies-and-regulatory-drivers-of-embedded-emissions-accounting.pd

Australian Bauxite. (n.d.). *The Australian Aluminium Council*. Retrieved from www.aluminium.org.au/our-members/australian-bauxite

White, L. V., Aisbett, E., Pearce, O., & Cheng, W. (2024). Principles for embedded emissions accounting to support trade-related climate policy. *Climate Policy, 24*(3), 345–360. https://doi.org/10.1080/14693062.2024.2356803

World Business Council for Sustainable Development (WBCSD). (2011). *Cement CO_2 Protocol: CO_2 and energy accounting and reporting standard for the cement industry* (Version 3.0). Retrieved from https://ghgprotocol.org/sites/default/files/co2_CSI_Cement_Protocol-V2.0_0.pdfghgprotocol.org+1ctc-n.org+1

EPD Australasia. (n.d.). *Environmental Product Declarations (EPDs)*. Retrieved from https://epd-australasia.com/epd-australasia.com

Carbon Trust. (n.d.). *What are Scope 3 emissions and why do they matter?* Retrieved from www.carbontrust.com/our-work-and-impact/guides-reports-and-tools/what-are-scope-3-emissions-and-why-do-they-mattercarbontrust.com

Cradle to Cradle Products Innovation Institute. (2023). *Cradle to Cradle Certified® Product Standard, Version 3.1*. Retrieved from https://api.c2ccertified.org/assets/gui_c2ccertified_guidance_v3.1_final_051823-2.pdfapi.c2ccertified.org+1c2ccertified.org+1

California Air Resources Board (CARB). (2024). *Low Carbon Fuel Standard (LCFS) Guidance 19-05: Reporting and Recordkeeping for Natural Gas and Book-and-Claim Accounting for Biomethane*. Retrieved from ww2.arb.ca.gov/sites/default/files/2024-02/lcfsguidance_19-05_0.pdfww2.arb.ca.gov+1ww2.arb.ca.gov+1

Climate Earth. (n.d.). *EPDs Made Easy™*. Retrieved from https://climateearth.com/climateearth.com+3climateearth.com+3climateearth.com+3

Science Based Targets initiative (SBTi). (2019). *SBTi Criteria and Recommendations*. Retrieved from https://files.sciencebasedtargets.org/production/legacy/2019/03/SBTi-criteria.pdffiles.sciencebasedtargets.org+1files.sciencebasedtargets.org+1

International Organization for Standardization (ISO). (2018). *ISO 14067:2018 – Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification*. Geneva, Switzerland: ISO.

London Metal Exchange (LME). (2025). *Responsible Sourcing Requirements*. Retrieved from www.lme.com/en/Metals/Responsibility/Responsible-Sourcing

International Aluminium Institute (IAI). (n.d.). *Aluminium Carbon Footprint Methodology*. Retrieved from https://international-aluminium.org/sustainability/aluminium-carbon-footprint-methodology/

RMI & Energy Transitions Commission. (2019). *China 2050: A fully developed, rich, zero-carbon economy*. Rocky Mountain Institute.

APPENDIX

TABLE A1: LANDSCAPE OF GLOBAL EEFS RELEVANT TO ALUMINIUM PRODUCTS

Framework/ Initiative	Category	Lead Organisation	Participatory/ Supporting Organisations	Mandatory/ Voluntary	Scope (Product/ Organisation)	System Boundaries	Scope 3 Upstream Included?	Allocation Method	Chain of Custody Required?	Verification Required ?	Year establishment
BREEAM (Building Research Establishment Environmental Assessment Method)	Certification /Framework	Building Research Establishment (BRE)	Various industry stakeholders, including aluminium producers	Voluntary	Building projects (including aluminium as material)	Cradle to Gate	Yes	Pass-through emissions	Yes	Yes	1990
EPD (Environmental Product Declaration)	Certification /Standard	Various industry certification bodies	Producers, environmental organisations	Voluntary	Product-specific (including aluminium)	Cradle to Gate	Yes	Direct emissions (Scope 1)	No	Yes	1998
ISO 14064-1:2006	Standard	International Organization for Standardization (ISO)	UNFCCC, WRI, others	Mandatory	Organisational level	Cradle to Gate	Yes	Direct emissions (Scope 1)	Yes	Yes	2006
Recycled Aluminium Certification	Certification	Various industry certification bodies	Aluminium recycling stakeholders	Voluntary	Recycled aluminium production	Cradle to Gate	Yes	Direct emissions (Scope 1)	Yes	Yes	2007

Framework/ Initiative	Category	Lead Organisation	Participatory/ Supporting Organisations	Mandatory/ Voluntary	Scope (Product/ Organisation)	System Boundaries	Scope 3 Upstream Included?	Allocation Method	Chain of Custody Required?	Verification Required ?	Year establishment
Carbon Footprint of Aluminium Production (CFAP)	Methodology/Framework	International Aluminium Institute (IAI)	Aluminium producers, industry stakeholders	Voluntary	Aluminium production	Cradle to Gate	Yes	Emissions intensity benchmarks	No	Yes	2009
International Aluminium Institute (IAI) - Carbon Footprint and Emissions Benchmarking	Standard	International Aluminium Institute (IAI)	N/A	Voluntary	Aluminium production	Cradle to Gate	No	Pass-through emissions	No	Yes	2010
Green Power Aluminium Certificate	Certification	Various industry certification bodies	Renewable energy suppliers, aluminium producers	Voluntary	Aluminium production with renewable energy	Cradle to Gate	No	Indirect emissions (Scope 2)	No	Yes	2016
The Responsible Aluminium (RA) Framework	Certification /Standard	Aluminium Stewardship Initiative (ASI)	Australian Aluminium Council (AAC), Various stakeholders	Voluntary	Entire aluminium supply chain	Cradle to Gate	Yes	Pass-through emissions	Yes	Yes	2017
Global Aluminium Supply Chain Initiative (GASI)	Initiative	International Aluminium Institute (IAI)	Various stakeholders in the aluminium supply chain	Voluntary	Aluminium supply chain	Cradle to Gate	Yes	Pass-through emissions	No	Yes	2018
Green Power Aluminium Certificate	Certification	Various industry certification bodies	Renewable energy suppliers, aluminium producers	Voluntary	Aluminium production with renewable energy	Cradle to Gate	No	Indirect emissions (Scope 2)	No	Yes	2016

Framework/ Initiative	Category	Lead Organisation	Participatory/ Supporting Organisations	Mandatory/ Voluntary	Scope (Product/ Organisation)	System Boundaries	Scope 3 Upstream Included?	Allocation Method	Chain of Custody Required?	Verification Required ?	Year establishment
CGMC's Certification	Standard	China National Development and Reform Commission (NDRC)	Electrolytic aluminium producers	Mandatory	Aluminium production	Cradle to Gate	Yes	Direct emissions (Scope 1)	No	Yes	2011
Aluminium Industry Greenhouse Gas Initiative	Initiative	International Aluminium Institute (IAI)	Global aluminium producers	Voluntary	Entire aluminium value chain	Cradle to Gate	Yes	Pass-through emissions	No	Yes	2019
Green Star	Certification /Framework	Green Building Council	Construction industry stakeholders	Voluntary	Buildings incorporating aluminium materials	Cradle to Gate	Yes	Pass-through emissions	No	Yes	2003
RMI Horizon	Certification	Responsible Minerals Initiative (RMI)	Metal producers, suppliers	Voluntary	Global supply chain	Cradle to Gate	Yes	Direct and indirect emissions	Yes	Yes	2022
ASI Chain of Custody Standard	Standard	Aluminium Stewardship Initiative (ASI)	Producers, recyclers, stakeholders	Voluntary	Primary and secondary aluminium	Cradle to Gate	Yes	Pass-through emissions	Yes	Yes	2017

TABLE A2: LANDSCAPE OF GLOBAL EEFS RELEVANT TO CEMENT

Guidance/Tool for Emission Accounting	Emission Intensity Baseline	Linked Regulation	Leading/Participating Organisations	Organisation/Initiative	Year Established
Cement CO_2 and Energy Protocol	Based on industry data	Voluntary industry reporting	World Business Council for Sustainable Development (WBCSD), GCCA	Cement Sustainability Initiative (CSI) (now GCCA)	1999
GCCA Sustainability Guidelines	Targets net-zero by 2050; includes scope 1-3 emissions	Supports net-zero pledges	Leading global cement companies (e.g. HeidelbergCement, LafargeHolcim, Cemex, CRH), GCCA Board	Global Cement and Concrete Association (GCCA)	2018
Technology Roadmap: Cement	0.6-0.8 tCO_2/t cement by 2050 (aligned with Paris Agreement)	Global frameworks such as Paris Agreement	IEA, global governments, cement industry stakeholders	International Energy Agency (IEA)	1974
Sectoral Decarbonisation Approach for Cement	Based on the IEA 2DS pathway	Voluntary, supports corporate sustainability goals	Collaboration between CDP, United Nations Global Compact (UNGC), World Resources Institute (WRI), and WWF	Science Based Targets initiative (SBTi)	2015
Industrial Decarbonisation Roadmap	Highlights reductions through alternative fuels, carbon capture	US industrial decarbonisation policies	U.S. DOE, Argonne National Laboratory, cement producers	U.S. Department of Energy (DOE)	-
Circularity Roadmap for Cement and Concrete	Targets a 2.6 billion metric ton CO_2 reduction via recycling by 2050	Advisory guidance	WEF, Global Alliance for Building and Construction, industry participants	World Economic Forum (WEF)	1971

Guidance/Tool for Emission Accounting	Emission Intensity Baseline	Linked Regulation	Leading/Participating Organisations	Organisation/Initiative	Year Established
Electrification of Cement kilns	Emission reductions through electrification trials	EU ETS	Swedish Cement and Concrete Research Institute (CBI), Vattenfall, HeidelbergCement	CemZero (Sweden)	2022
Direct separation carbon capture technology	Pilot trials, data informs sector averages	Linked to EU carbon pricing	European Commission Horizon 2020, HeidelbergCement, Calix, Cementa	LEILAC (Low Emissions Intensity Lime and Cement)	2016
Mission Possible Platform	Net-zero roadmap for heavy industries, including cement	Global voluntary initiatives	ETC, McKinsey & Company, ArcelorMittal, LafargeHolcim	Energy Transition Commission (ETC)	2015
Frameworks for alternative clinker use	Reducing clinker content to mitigate emissions	Linked to EU sustainability policies	CIC, European Cement Research Academy (ECRA), HeidelbergCement	Cement Innovation for Climate (CIC)	2023
Technology sharing, research in alternative binders and fuels	No direct baseline, but promotes sustainability practices	Advisory for U.S. and global policymakers	National Renewable Energy Laboratory (NREL), U.S. DOE, cement manufacturers	NREL Cement Decarbonisation Meeting	2024
Certification for Cement, Concrete & Concrete Products (CCCPv1.0i-2017)	Meets lifecycle-based environmental criteria	Voluntary certification for eco-label products	Good Environmental Choice Australia (GECA)	GECA Ecolabel	2000
Good Environmental Choice declaration for sustainable products	Independent assessment	Australian labelling standard	Australian Environmental Labelling Association Inc. (AELA)	Good Environmental Choice (AELA)	-
Green Star rating for sustainable buildings	Focus on design, construction, and operation	Supports national and global sustainability	Green Building Council of Australia (GBCA)	Green Star (GBCA)	2003

Guidance/Tool for Emission Accounting	Emission Intensity Baseline	Linked Regulation	Leading/Participating Organisations	Organisation/Initiative	Year Established
Environmental management systems for continuous improvement	Not baseline specific	Supports compliance with environmental laws	International Organization for Standardization (ISO), national standard bodies	AS/NZS ISO 14001	1996
GECA Ecolabel and Good Environmental Choice certified	Lifecycle-based analysis	Aligns with Australian and voluntary standards	Independent Cement and Lime	Independent Cement and Lime's Ecoblend	-
GECA Ecolabel and Good Environmental Choice certified	Lifecycle-based analysis	Aligns with Australian and voluntary standards	Independent Cement and Lime	Australian Builders (Type GB)	-
GECA Ecolabel and Good Environmental Choice certified	Lifecycle-based analysis	Aligns with Australian and voluntary standards	Independent Cement and Lime	Steel Cement	-
Border carbon tax adjustment tools	Linked to EU ETS benchmarks	EU CBAM Regulation	EU CBAM Details	Carbon Border Adjustment Mechanism (CBAM)	2023
Global Status Reports on Buildings and Construction	Regional baselines (e.g. Asia-Pacific)	Paris Agreement	UNEP GSR	United Nations Environment Programme (UNEP)	1972
Roadmap to Carbon Neutrality by 2050	Varies by U.S. baseline	N/A	PCA Roadmap	Portland Cement Association (PCA)	1916

Guidance/Tool for Emission Accounting	Emission Intensity Baseline	Linked Regulation	Leading/Participating Organisations	Organisation/Initiative	Year Established
Cement Sustainability Initiative (CSI)	Varied, depending on member projects	N/A	WBCSD CSI	World Business Council for Sustainable Development (WBCSD)	1995

Global Cement and Concrete Association (GCCA) CO_2 and Energy Database	Industry Initiative	Cement & Concrete	Tracks CO_2 & energy use	Global	Self-reported, external verification for select data	https://gccassociation.org
Cement Sustainability Initiative (CSI) EPD Tool (Now under GCCA)	Industry-led	Cement	EPD-based emissions reporting	Global	Third-party verified EPDs	https://gccassociation.org
Product Category Rules (PCR) for Cement and Concrete	Standard	Cement & Concrete	Standardises EPDs	Global	Third-party verification required	www.environdec.com
EU Emissions Trading System (EU ETS) for Cement	Regulatory	Cement production	Regulates emissions trading	EU	Mandatory third-party verification	https://ec.europa.eu/clima
Carbon Border Adjustment Mechanism (CBAM) – EU	Trade Policy	Imported Cement	Links emissions to trade tariffs	EU	Compliance-based verification required	https://ec.europa.eu/taxation_customs
California's Low Carbon Fuel Standard (LCFS) – Alternative Cement Pathways	Market-based	Cement (alternative fuels)	Encourages low-carbon fuels	USA (California)	Mandatory third-party verification	ww3.arb.ca.gov
Buy Clean California Act	Regulatory	Public procurement of Cement	Mandates low-carbon procurement	USA (California)	Third-party verified EPDs required	www.dgs.ca.gov
ISO 14067 – Carbon Footprint for Cement Products	Standard	Cement	LCA-based emissions footprinting	Global	Certification via accredited bodies	www.iso.org/standard/71206.html

The Climate Bonds Standard – Cement Criteria	Financial Standard	Cement projects	Supports green finance for low-carbon cement	Global	Third-party verification required	www.climatebonds.net/standard
ResponsibleSteel's Cement Annex (Draft)	Multi-sector Standard	Cement in steel supply chains	Expands responsible sourcing	Global	Third-party verification	www.responsiblesteel.org
Australian Standards (AS) Certification	National Standard	Cement	Ensures compliance but not emissions-focused	Australia	Certification required for market access	www.standards.org.au
ISO 9001 Quality Management System Certification	International Standard	Cement Manufacturing	Quality control, not emissions-focused	Global	Third-party certification required	www.iso.org/iso-9001-quality-management.html
NATA Accreditation	Testing & Accreditation	Cement	Ensures quality & durability	Australia	Certification required	www.nata.com.au
Environmental Product Declarations (EPD)	Transparency & Reporting	Cement & Concrete	Provides full transparency on carbon footprint	Global	Third-party verified	www.environdec.com
Global GreenTag Certification	Eco-labeling	Cement	Certifies eco-friendliness of cement	Global	Third-party verified	www.globalgreentag.com
BlueScope Certification	Industry Standard	Cement-Steel Compatibility	Ensures compatibility with sustainable steel	Australia	Certification required for compliance	www.bluescope.com
Green Building Council of Australia (GBCA) Approval	Green Building Standard	Cement for Green Buildings	Supports sustainable construction	Australia	Certification-based approval	https://new.gbca.org.au
WaterMark Certification	Regulatory	Cement for Water Management	Ensures durability but not emissions-focused	Australia	Certification required	www.abcb.gov.au
Fair Trade Certification	Ethical Sourcing	Cement Production	Ensures ethical labor but not emissions-focused	Global	Third-party verified	www.fairtrade.net
LEED Certification (LEED v4)	Green Building Standard	Cement in Construction	Supports low-carbon building materials	Global	Third-party verification	www.usgbc.org/leed
NRMCA Sustainability Certifications	Sustainability Certification	Ready-Mixed Concrete	Encourages sustainability in concrete production	USA	Third-party verified	www.nrmca.org
International Green Construction Code (IgCC)	Green Building Code	Cement & Concrete	Supports low-carbon building materials	USA	Compliance-based	www.iccsafe.org
Architecture 2030 Challenge for Products	Carbon Benchmarking	Cement & Concrete	Sets embodied carbon reduction targets	Global	Compliance-based	https://architecture2030.org
Sustainable Concrete Plant Certification	Environmental Standard	Concrete Production	Guides sustainability in concrete plants	Global	Certification-based	www.nrmca.org/green-star
Responsible Sourcing Certification (CSC)	Sustainability Standard	Cement Supply Chain	Ensures responsible material sourcing	Global	Third-party verified	https://csc.eco
Concrete Sustainability Professional Certification	Industry Certification	Cement & Concrete	Recognises professionals in sustainable concrete practices	Global	Third-party certification	https://csc.eco/certification

GLOSSARY OF EMBEDDED EMISSIONS ACCOUNTING PRINCIPLES

Principle	Definition
Accuracy	The EEF should accurately reflect the embedded emissions of traded products, ensuring reliable accounting and a true representation of environmental impact.
Monotonicity	Ensures integrity of emissions reductions over time. Reported decreases reflect actual, irreversible improvements in carbon performance; increases in emissions reflect increases in impact.
Non-discrimination	The EEF should be applied fairly and consistently, without discriminating against any country, product, or sector.
Transparency	Promotes openness in methods, assumptions, and data. Stakeholders can verify, interpret, and rely on reported figures.
Least Restrictive Means	Pursues non-trade policy objectives using the least trade-restrictive methods possible, minimising negative impacts on international trade.
Relevance	Aligns emissions metrics with industry-specific processes, regulatory requirements, and stakeholder expectations, providing practical utility and actionable insights.
Conservativeness	Adopts a conservative approach, ensuring emissions are not underestimated and environmental impact is not downplayed.
Subsidiarity	Decisions respect the principle of subsidiarity, ensuring they are made at the appropriate level—local, national, or international.

HILT CRC

hiltcrc.com.au

General enquiries
enquiries@hiltcrc.com.au

Connect with us
hiltcrc.com.au/connect

Australian Government
Department of Industry, Science and Resources

Cooperative Research Centres Program