# Decarbonizing construction materials is key to a net-zero future

FIGURE 1: LIFECYCLE STAGES
Data source: BS EN 15978:2011

**Global GHG emissions by sector (2019)**

STAGE

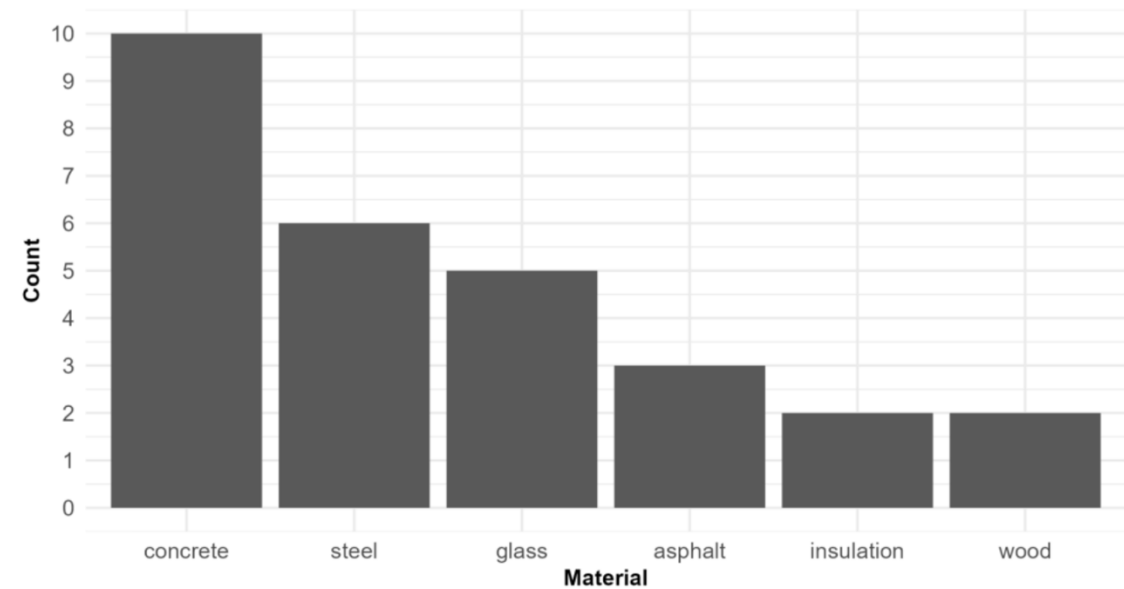| MATERIALS PRODUCTION | CONSTRUC-TION | MAINTAIN AND USE | END OF LIFE | BEYOND THE LIFECY-CLE |
|---|---|---|---|---|

GHG Emissions

Embodied | Embodied | Embodied | Operational | Embodied | Embodied

Time

Extract raw materials | Transport to factory | Manu-facture products | Transport to site | Con-struct the building | Use | Mainte-nance | Repair | Replace-ment | Refur-bishment | **Energy Use** | **Water Use** | Demol-ish the building | Haul away waste materials | Recycling | Disposal | Reuse/ Recovery

| A1 | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

MODULE

© New Buildings Institute

Global GHG emissions by sector (2019):
- Other (energy-related) 14%
- Building operations 18%
- Building materials 7%
- Infrastructure materials 10%
- Other Industry 13%
- Transportation 17%
- Waste 3%
- Land use change & forestry 3%
- Agriculture 14%

*Sources: Carbon Leadership Forum (2024). Embodied Carbon 101.* https://carbonleadershipforum.org/embodied-carbon-101-v2/ *and Benke, B., Roberts, M., Shen, Y., Carlisle, S., Chafart, M., and Simonen, K. (2024). The California Carbon Report: An Analysis of the Embodied and Operational Carbon Impacts of 30 Buildings. Carbon Leadership Forum, University of Washington. Seattle, WA.* http://hdl.handle.net/1773/51287; *adapted from New Buildings Institute (2024).* https://newbuildings.org/code_policy/embodied-carbon/

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# Policies are emerging worldwide to tackle "embodied carbon" ...

## Map of Embodied Carbon Policies by Category



● Building Codes/Planning    ● Clean Procurement    ● Climate Commitment
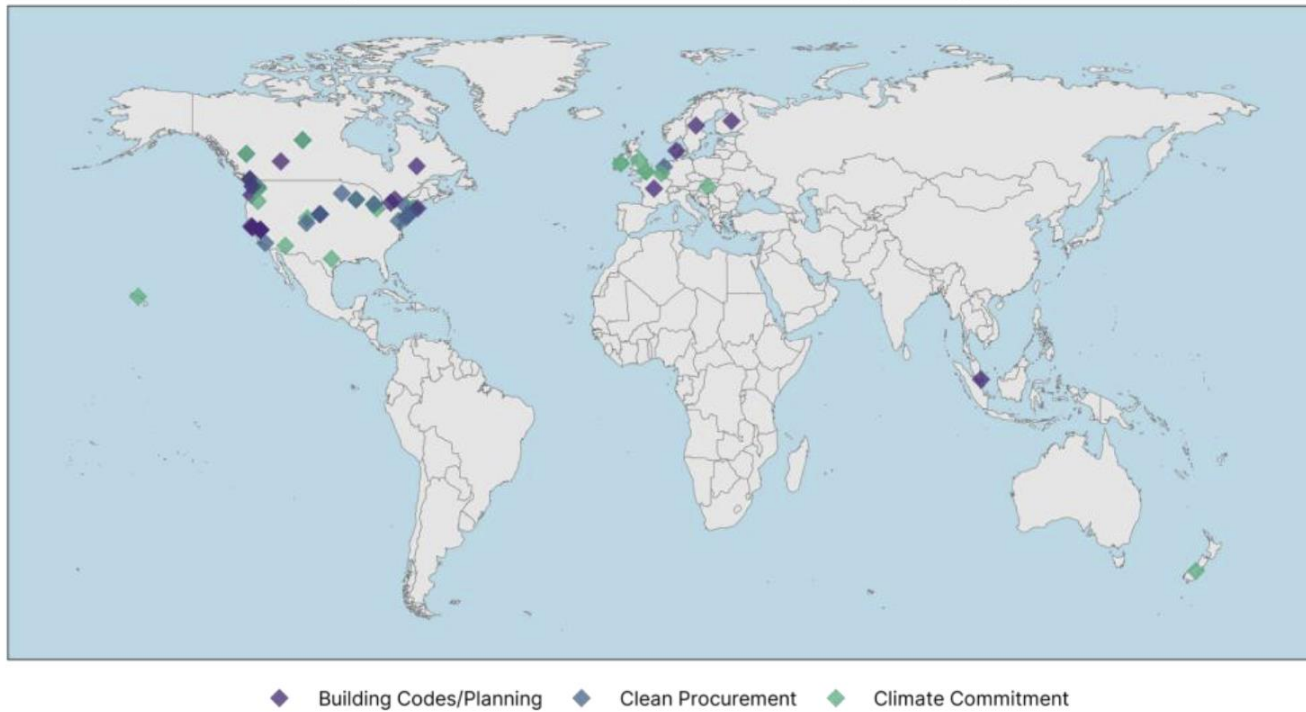
## Number of "Buy Clean" policies by covered material
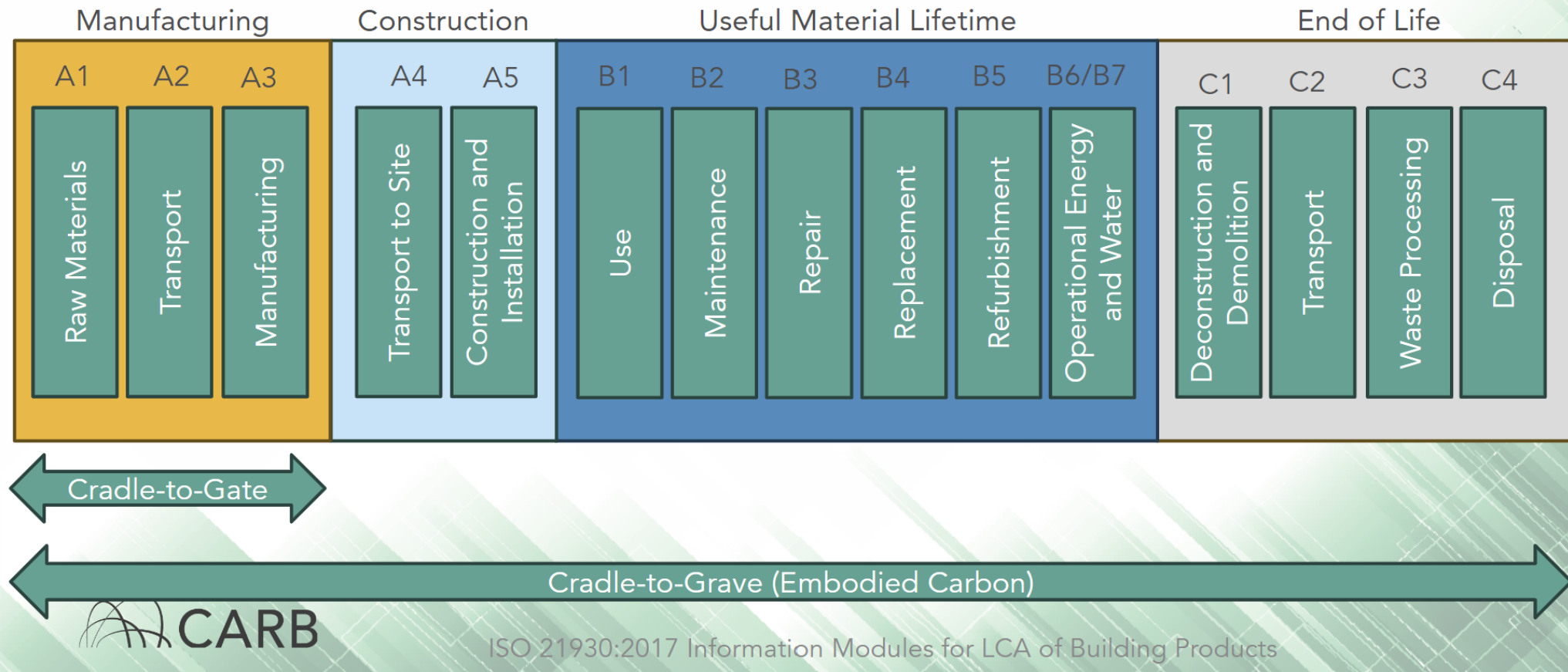


*Source: UCSB analysis*

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# … many of which require EPDs for compliance and implementation

**Major stages and elements of "Buy Clean"/embodied carbon policies**



Source: https://carbonleadershipforum.org/clf-policy-toolkit
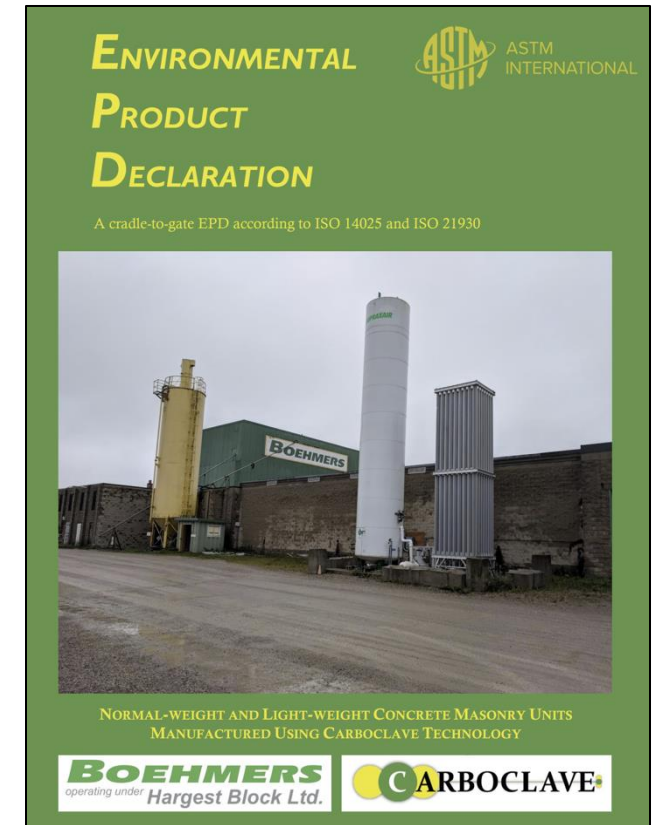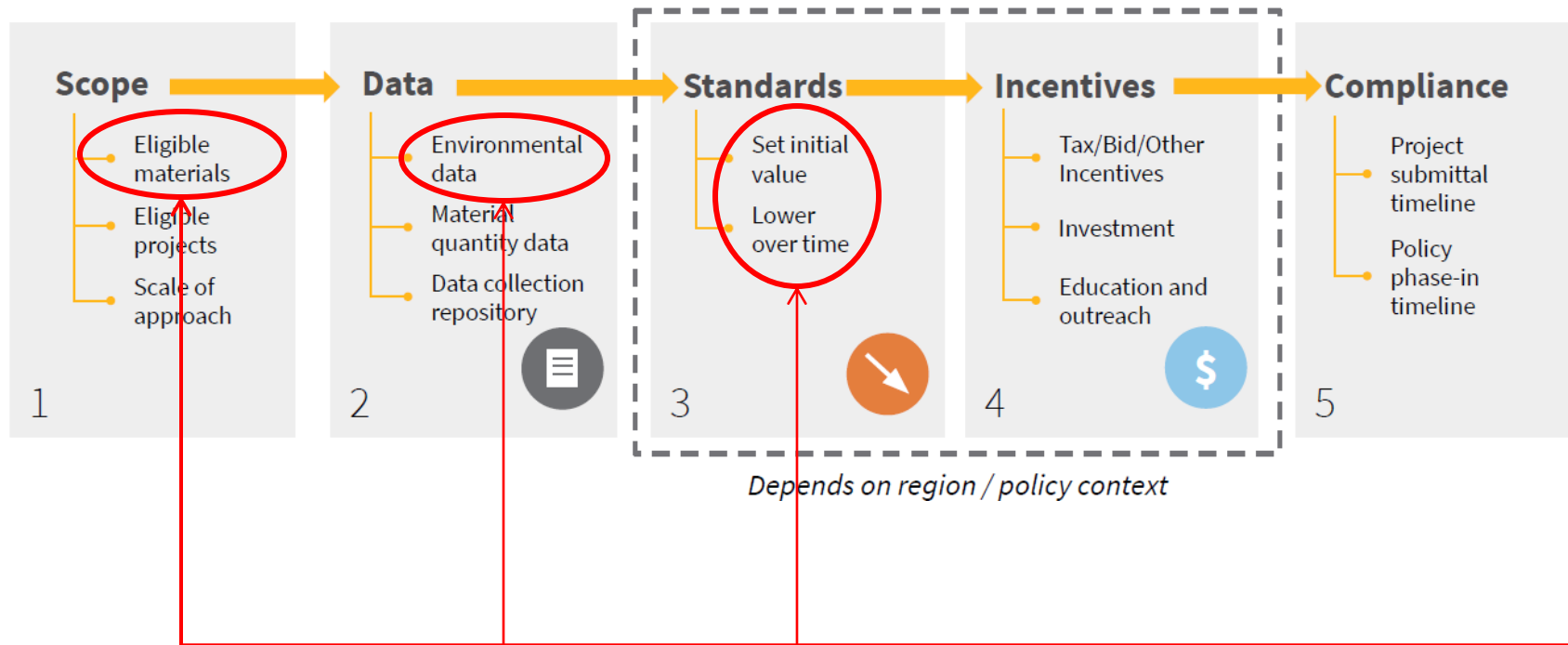
# Understanding the nomenclature



Life-Cycle Assessment of Building Materials

| Manufacturing | | | Construction | | Useful Material Lifetime | | | | | | End of Life | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6/B7 | C1 | C2 | C3 | C4 |
| Raw Materials | Transport | Manufacturing | Transport to Site | Construction and Installation | Use | Maintenance | Repair | Replacement | Refurbishment | Operational Energy and Water | Deconstruction and Demolition | Transport | Waste Processing | Disposal |

Cradle-to-Gate

Cradle-to-Grave (Embodied Carbon)

CARB

ISO 21930:2017 Information Modules for LCA of Building Products

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# What is an EPD?

- EPDs communicate standardized environmental information about a product

- Subject to international life-cycle assessment (LCA) standards

- For building materials, current reporting is mostly limited to "cradle to gate" (A1-A3)

- Subject to third-party review and verification

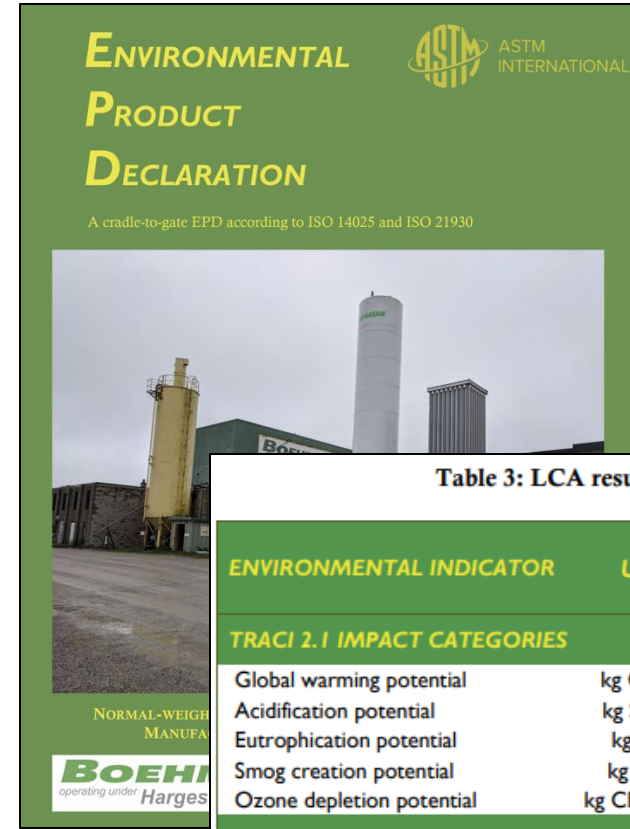- May contain additional information at the producer's discretion
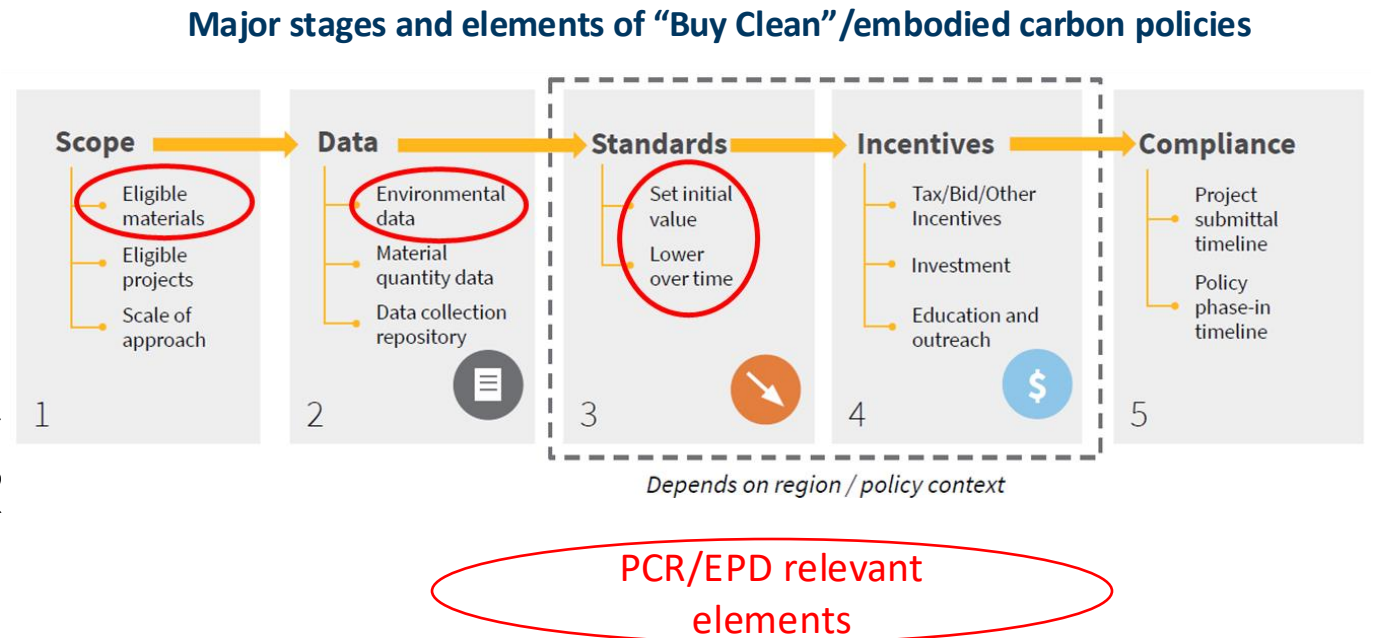


Figure 1: Concrete Masonry Unit

### Table 3: LCA results – Normal-weight CMU, per m³

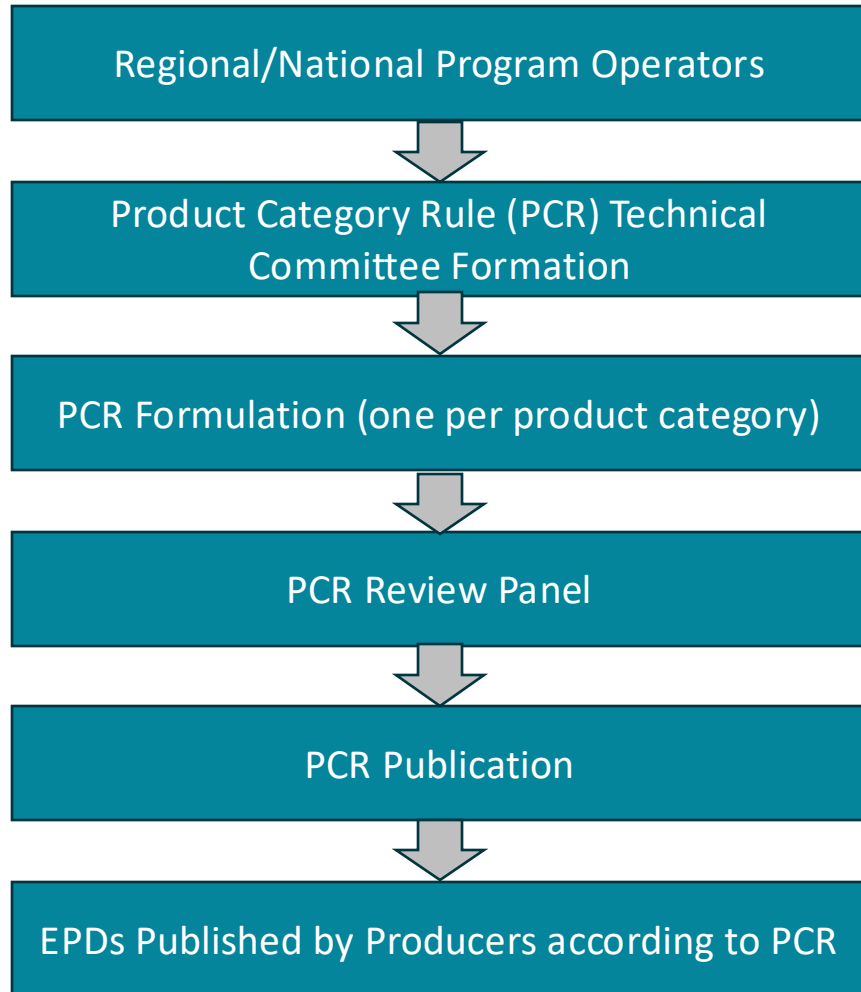| ENVIRONMENTAL INDICATOR | UNIT | A1 | A2 | A3 | TOTAL |
|---|---|---|---|---|---|
| **TRACI 2.1 IMPACT CATEGORIES** | | | | | |
| Global warming potential | kg $CO_2$ eq. | 158 | 3 | 34 | 196 |
| Acidification potential | kg $SO_2$ eq. | 0.87 | 0.02 | 0.25 | 1.14 |
| Eutrophication potential | kg N eq. | 0.0442 | 0.0013 | 0.0045 | 0.0500 |
| Smog creation potential | kg $O_3$ eq. | 13.6 | 0.6 | 1.1 | 15.3 |
| Ozone depletion potential | kg CFC-11 eq. | 3.20E-06 | 1.45E-10 | 2.96E-08 | 3.23E-06 |
| **TOTAL PRIMARY ENERGY CONSUMPTION** | | | | | |
| Non-renewable fossil | MJ (HHV) | 1,177 | 52 | 565 | 1,794 |
| Non-renewable nuclear | MJ (HHV) | 184 | 1 | 230 | 415 |
| Renewable (non-biomass) | MJ (HHV) | 76 | 0 | 35 | 111 |
| Renewable (biomass) | MJ (HHV) | 99 | 0 | 9 | 108 |
| **MATERIAL RESOURCES CONSUMPTION** | | | | | |
| Non-renewable material resources | kg | 2,580 | 0 | 0 | 2,581 |
| Renewable material resources | kg | 4.68 | 0.00 | 3.83 | 8.51 |
| Net fresh water | l | 792 | 0 | 73 | 865 |
| **WASTE GENERATED** | | | | | |
| Non-hazardous waste generated | kg | 0.3 | 0.0 | 40.6 | 41.0 |
| Hazardous waste generated | kg | 0.006 | 0.000 | 0.111 | 0.117 |

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# PCRs/EPDs are proliferating, but can they be improved?

**Key research questions**

1. How up-to-date are the "embodied carbon" values reported in an EPD?

2. How clearly is data quality communicated?

3. How often are production practices reported?

4. What is the role of regulator and/or policymakers in PCR development?

5. What are best practices for future EPD requirements?



**Major stages and elements of "Buy Clean"/embodied carbon policies**

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# How are EPDs created?

Regional/National Program Operators

↓

Product Category Rule (PCR) Technical Committee Formation

↓

PCR Formulation (one per product category)

↓

PCR Review Panel

↓

PCR Publication

↓

EPDs Published by Producers according to PCR

# How are EPDs created?

## Dozens of Program Operators worldwide

Regional/National Program Operators

### AENOR
**Industry:** Building & Construction Materials
**Location:** Spain

Website

### AFNOR
**Industry:** Building & Construction Materials
**Location:** France

Website

### ASTM
**Industry:** Building & Construction Materials
**Location:** USA

Website

### Australasia EPD
**Industry:** Uses Environdec
**Location:** Australia/NZ

Website

### Bau-EPD
**Industry:** Building & Construction Materials
**Location:** Austria

Website

### BRE
**Industry:** Building & Construction Materials
**Location:** UK

Website

### Carbon Leadership Forum
**Industry:** Building & Construction Materials
**Location:** USA

Website

### CSA
**Industry:** Building & Construction Materials
**Location:** USA

Website

### DAP Habitat
**Industry:** Building & Construction Materials
**Location:** Portugal

Website

### DAPCO
**Industry:** Building & Construction Materials
**Location:** Chili

Website

### EDF Taiwan
**Industry:** B&C, machinery & equipment, transport
**Location:** Taiwan

Website

### Environdec
**Industry:** B&C, Food and beverage, Electricity, other
**Location:** Sweden

Website

### EPD Belge
**Industry:** Building and Construction materials
**Location:** Belgium

Website

### EPD Denmark
**Industry:** Building and Construction materials
**Location:** Denmark

Website

### EPD India
**Industry:** Building and Construction materials
**Location:** India

Website

### EPD Ireland
**Industry:** Building and Construction materials
**Location:** Ireland

Website

### EPD Italy
**Industry:** Building and Construction materials
**Location:** Italy

### EPD Norge
**Industry:** Building and Construction materials
**Location:** Norway

### EU PEF
**Industry:** Multiple
**Location:** EU

### FP Innovations
**Industry:** Wood Products
**Location:** USA

https://aclca.org/pcr/program-operators/

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# How are EPDs created?

Regional/National Program Operators

↓

Product Category Rule (PCR) Technical Committee Formation

## Product Category Rule
### for Environmental Product Declarations

*PCR for Portland, Blended, Masonry, Mortar, and Plastic (Stucco) Cements v3.2*

**NSF**

**Program Operator**
NSF International
National Center for Sustainability Standards
Valid through March 31, 2025
ncss@nsf.org
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### APPENDIX A: TECHNICAL REVIEW COMMITTEE

The following individuals participated in the review committee from June 2019 through March 2020.

**Manufacturers**

— Hamid Farzam, Cemex
— Shawn Kalyn, Votorantim / St. Marys Cement LLC
— Kirk McDonald, CalPortland
— Adam Swercheck, Heidelberg Technology Center
— Cheng Qi, Ash Grove Cement / CRH

**Trade Associations**

— Adam Auer, Cement Association of Canada
— Jamie Farny, Portland Cement Association

**Users**

— James Bogdan, National Ready Mixed Concrete Association
— David Green, BASF Corp.
— Emily Lorenz, Precast / Prestressed Concrete Institute
— Martha VanGeem, Consultant

**LCA Expertise**

— Jamie Meil, ATHENA Sustainable Materials Institute
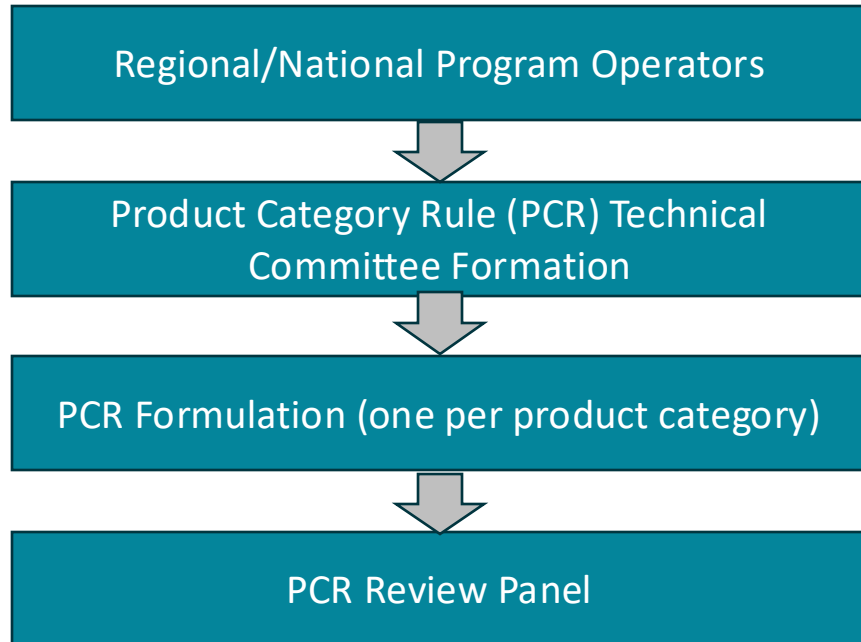— Eric Masanet, Northwestern University

**NSF**

— Andrea Burr

https://www.astm.org/products-services/certification/environmental-product-declarations/epd-pcr.html

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# How are EPDs created?
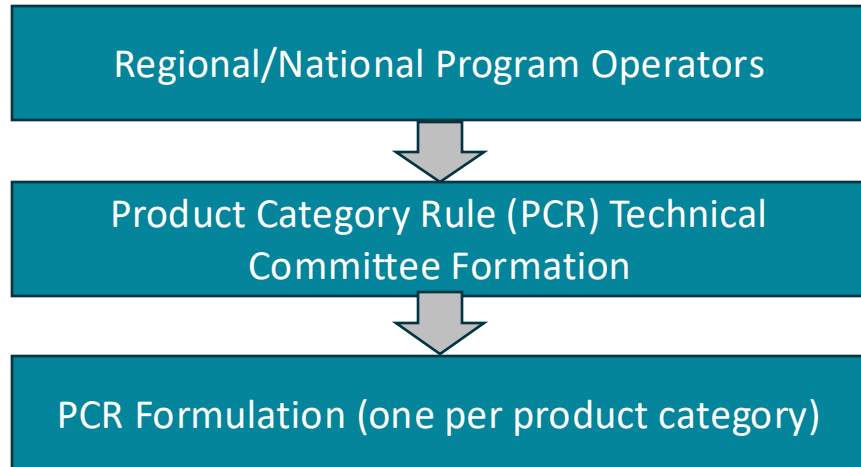
**Typical PCR scope and contents**

```
Regional/National Program Operators
```
⬇
```
Product Category Rule (PCR) Technical
Committee Formation
```
⬇
```
PCR Formulation (one per product category)
```

https://www.astm.org/products-services/certification/environmental-product-declarations/epd-pcr.html

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# How are EPDs created?

```
Regional/National Program Operators
          ↓
Product Category Rule (PCR) Technical
       Committee Formation
          ↓
PCR Formulation (one per product category)
          ↓
       PCR Review Panel
```



**NSF**

## Product Category Rule
### for Environmental Product Declarations

*PCR for Portland, Blended, Masonry, Mortar, and Plastic (Stucco) Cements v3.2*

*v3.2*

**PRODUCT CATEGORY RULES REVIEW PANEL**

**Program Operator**
NSF International

**Recommended for adoption by**
The PCR Committee for Portland Cement

**Review panel**

Dr. Thomas P. Gloria, PhD
Industrial Ecology Consultants
35 Bracebridge Road
Newton, MA 02459-1728
t.gloria@industrial-ecology.com

Mr. Bill Stough
Sustainable Research Group
PO Box 1684
Grand Rapids, MI 49501-1684
bstough@sustainableresearchgroup.com

Mr. Jack Geibig
EcoForm
2624 Abelia Way, Suite 611
Knoxville, TN 37931
jgeibig@ecoform.com

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# How are EPDs created?

**Regional/National Program Operators**

↓

**Product Category Rule (PCR) Technical Committee Formation**

↓

**PCR Formulation (one per product category)**

↓

**PCR Review Panel**

↓

**PCR Publication**
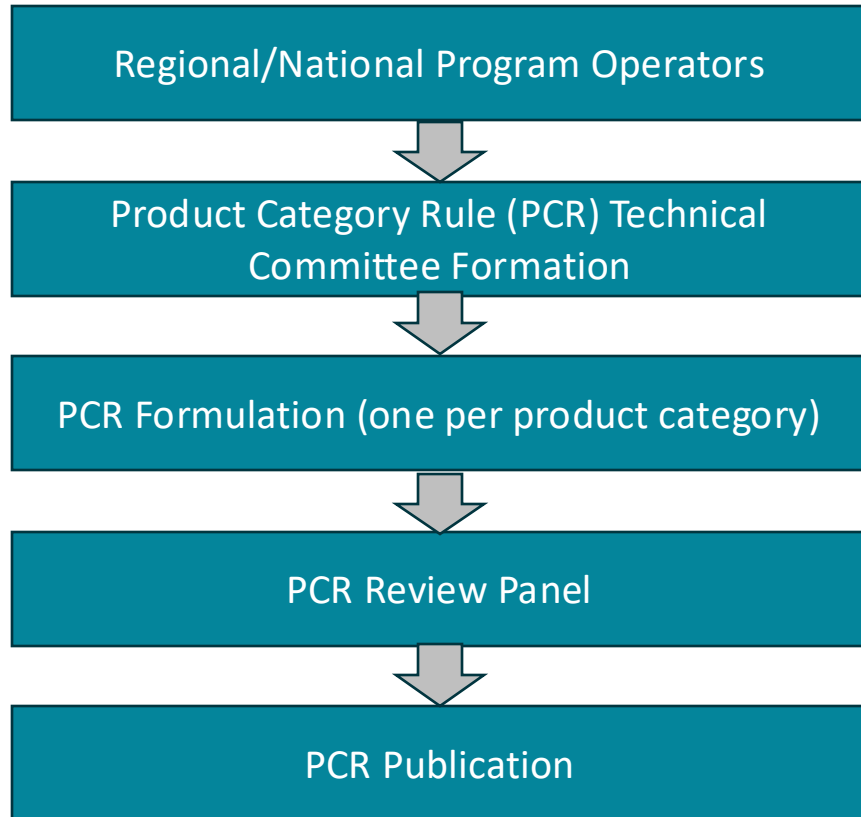
## Hundreds of PCRs Worldwide

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# How are EPDs created?

Regional/National Program Operators

↓

Product Category Rule (PCR) Technical Committee Formation

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PCR Formulation (one per product category)

↓

PCR Review Panel

↓

PCR Publication

↓

EPDs Published by Producers according to PCR

https://buildingtransparency.org/ec3/epds

**Tens of thousands of EPDs worldwide**

# How are EPDs created?

**Independent verification of EPDs**

Regional/National Program Operators

↓

Product Category Rule (PCR) Technical Committee Formation

↓

PCR Formulation (one per product category)

↓

PCR Review Panel

↓

PCR Publication

↓

EPDs Published by Producers according to PCR

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# Research methods

- Initial focus limited to covered materials in California and U.S. Federal "Buy Clean" programs

| Buy Clean Policies with Set Thresholds | | | |
|---|---|---|---|
| **Policy** | **Location/ Application** | **Material** | **Threshold** |
| Buy Clean California Act[10]/L.A. Executive Directive No. 25[16] | California Public Projects, Los Angeles City Public Projects | Structural Steel | 1,010 kg $CO_2$eq/metric ton (Hot-rolled), 1,710 kg $CO_2$eq/metric ton (Hollow), 1,490 kg $CO_2$eq/metric ton (Steel Plate) |
| | | Concrete Reinforcing Steel ("Rebar") | 890 kg $CO_2$eq/metric ton |
| | | Flat Glass | 1,430 kg $CO_2$eq/metric ton |
| | | Mineral Wood Board Insulation | 3.33 kg $CO_2$eq/ $1m^2$ at $R_{SI} = 1$ (light-density), 8.16 kg $CO_2$eq/$1m^2$ at $R_{SI} = 1$ (high-density) |
| U.S. Federal Buy Clean/GSA Low Embodied Carbon[17] | U.S. Federal Projects | Concrete* | 242 kg$CO_2$eq/$m^3$ (standard mix, lowest compressive strength up to 2499 f'c in PSI) 414 kg$CO_2$eq/$m^3$ (standard mix, lowest compressive strength of 6500 f'c in PSI and up) |
| | | Steel, Asphalt, Flat Glass | 40% below average (best) 20% below average (better) "Below average" (acceptable) |

# Research methods

- Initial focus limited to covered materials in California and U.S. Federal "Buy Clean" programs

- EPD database (500+)
  - Focus on:
    - BCCA and U.S. federal products
    - Producer locations relevant to California
  - Data fields
    - Common/required reporting fields
    - Additional assessment fields

| EPD content | Data tag/field |
|---|---|
| Declaration information | Declaration number |
| | Date of issuance |
| | Program Operator |
| | Company |
| | Product Name |
| | Product Definition |
| | Declaration Type |
| | PCR Reference |
| | Period of Validity |
| | Geographic Scope |
| | Product application |
| | Specificity level |
| Scope and boundaries | System boundary (A1, A2, A3, etc.) |
| | Declared unit (e.g., ton, m3) |
| | Are production technologies described? (Y/N) |
| | Are recycled material inputs indicated? (Y/N) |
| | Are supply chain locations/logistics documented? (Y/N) |
| Data quality | Are data quality ratings/descriptions offered? (Y/N) |
| | Temporal representativeness rating |
| | Geographical representativeness rating |
| | Technological representativeness rating |
| | Data sources (by stage) primary or secondary |
| Results by stage (A1, A2, etc.) | Primary energy - total |
| | Primary energy - renewable (MJ) |
| | Final energy use by fuel (MJ) |
| | Electricity grid mix |
| | Which LCIA characterization model(s) was/were used? (e.g., TRACI 2.0) |
| | Global warming potential (GWP) (kg CO2 eq) |
| | Ozone depletion potential (ODP) (kg R11 eq) |
| | Acidification potential (AP) (kg SO2 eq) |
| | Eutrophication potential (EP) (kg N eq) |
| | Smog formation (kg O3 eq) |
| | Abiotic depletion potential (ADP) |

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# Research methods

- Initial focus limited to covered materials in California and U.S. Federal "Buy Clean" programs

- EPD database (500+)
  - Focus on:
    - BCCA and U.S. federal products
    - Producer locations relevant to California
  - Data fields
    - Common/required reporting fields
    - Additional assessment fields

- PCR characteristics database (40+)
  - Focus on North American and major import partners
  - Process and stakeholder assessment





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# How up-to-date are EPD data?

## Why it matters

- Setting initial embodied carbon thresholds
- Lowering allowing thresholds over time
- Setting threshold reduction cadence

| Material class | Relevant PCRs | Maximum data age | | Data quality ratings |
| --- | --- | --- | --- | --- |
| | | Primary data (A3/A2) | Secondary data (A2/A1) | |
| Steel | UL Environment: Part B: Designated Steel Construction Product EPD Requirements (8/2020, version 2.0) | | | Encouraged |
| | SCS Global Services' PCR for Designated Steel Construction Products (5/2015, version 1.0) | | | Not addressed |
| Glass | NSF International: NGA PCR for Flat Glass: UN CPC 3711, Version 2.0 | | | Encouraged |
| Mineral wool/insulation | UL Environment, Part B: Building Envelope Thermal Insulation EPD requirements, Volume 3.0 | | | Encouraged |
| Concrete | ASTM International's PCR for Precast Concrete (5/2021, version 3.0) | 5 years | 10 years | Not addressed |
| | NSF International's Product Category Rule for Concrete (8/2021, version 2.1) | | | Not addressed |
| | UL's Part B: Concrete Masonry and Segmental Concrete Paving Product EPD Requirements (3/2022, version 1.1) | | | Encouraged |
| Cement | NSF International's Product Category Rule for Portland, Blended, Masonry, Mortar, and Plastic (Stucco) Cements (9/2021, version 3.2; or 5/2020, version 3.0) | | | Not addressed |
| Asphalt | National Asphalt Paving Association's Product Category Rule for Asphalt Mixtures, (4/2022, version 2.0) | | | Not addressed |

**Building life cycle stages**



**Primary data** = collected directly from operations
**Secondary data** = obtained from general LCA datasets

*Source: https://www.reset.build/standard/embodied/carbon*

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## Contribution of life-cycle stage by product



| Category | Product | Relative contribution to total A1-A3 GWP by stage |
| --- | --- | --- |
| Concrete | Ready mix concrete | 93% |
| | Precast | |
| Masonry | Brick* | |
| | Concrete masonry unit § | 65% / 10% / 24% |
| Aluminum | Aluminum extrusions, painted, standard extrusion | 73% / 27% |
| | Aluminum extrusions, painted, thermally improved | 67% / 33% |
| Wood | I-joists | 78% / 7% / 16% |
| | Softwood lumber | 17% / 16% / 67% |
| | Redwood lumber | 40% / 19% / 41% |
| | Laminated veneer lumber | 46% / 48% |
| | Glue laminated timber | 48% / 17% / 34% |
| | Medium density fiberboard (MDF) | 42% / 57% |
| | Particleboard | 57% / 42% |
| | Softwood plywood | 32% / 63% |
| | Oriented strand board (OSB) | 40% / 56% |
| Cladding | Insulated metal panels | 39% / 60% |
| | Other types of wall and roof panels* | |
| Glazing | Flat glass | 37% / 63% |
| Insulation | Expanded polystyrene (EPS) | 75% / 21% |
| | Extruded polystyrene (XPS)* | |
| | Fiberglass §§ | 27% / 8% / 65% |
| | Loose-fill cellulose insulation** | |
| | Mineral wool board, heavy density | 8% / 92% |
| | Mineral wool board, light density | 14% / 86% |
| | Polyiso insulation boards (roof) | 88% / 9% |
| | Polyiso insulation boards (wall) | 94% |
| | Sprayfoam* | |
| Wallboard | Glass mat gypsum panels (5/8") | 40% / 11% / 49% |
| | Type X conventional gypsum board | 20% / 76% |
| Flooring | Resilient flooring** | |
| | Other types of flooring* | |
| Other types of finishes (wall, FF&E, etc.)* | | |

Life cycle stages

A1: Extraction and upstream production | A1 - A2 (Only combined data available) | A2: Transport | A3: Manufacturing
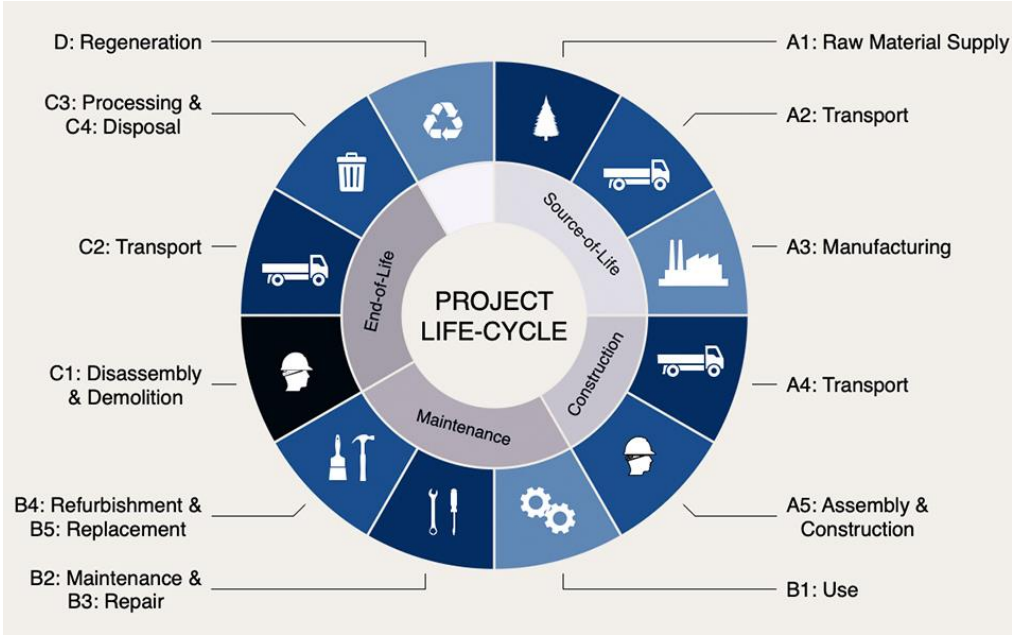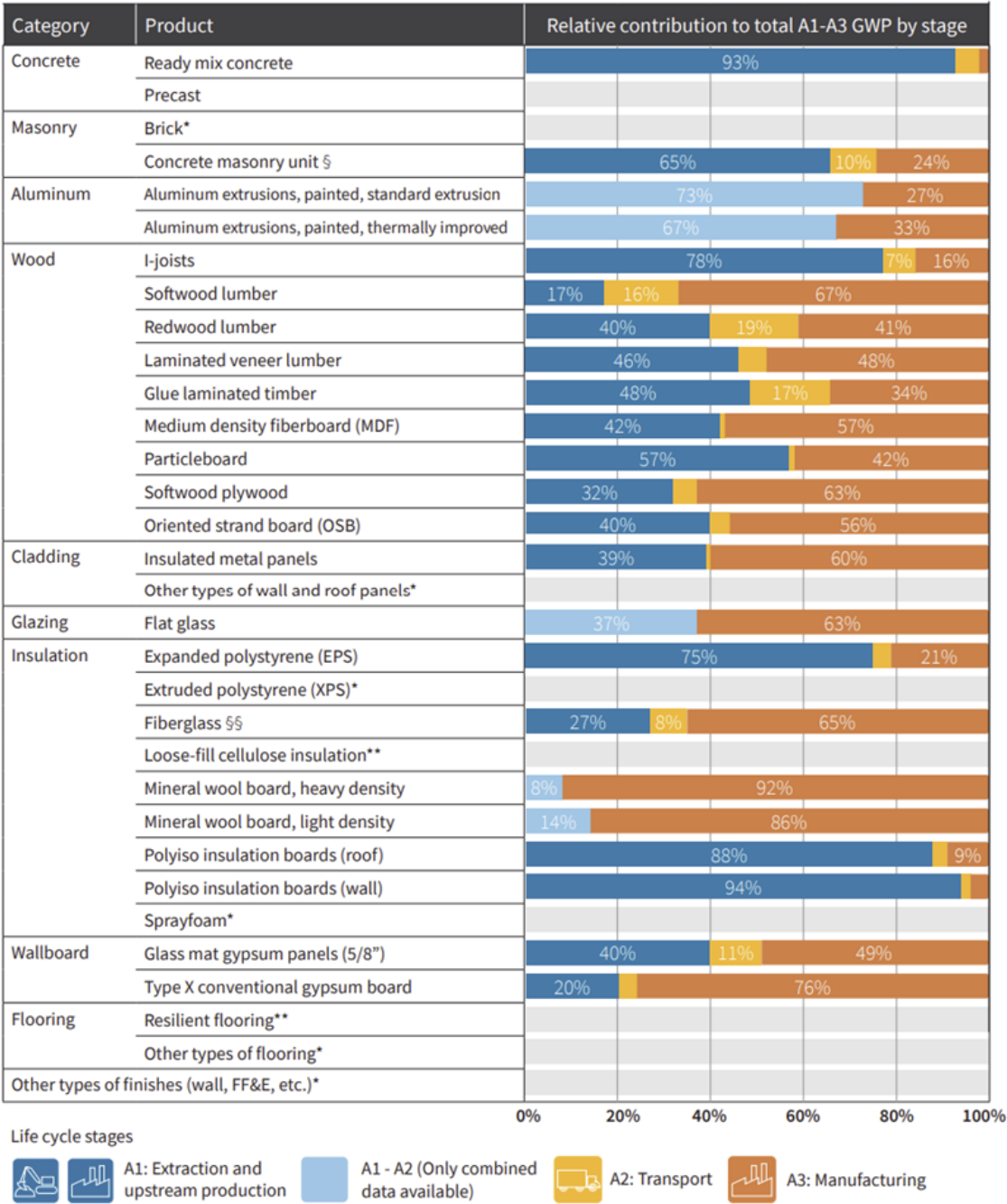
# How up-to-date are EPD data?

## Why it matters

- Setting initial embodied carbon thresholds
- Lowering allowing thresholds over time
- Setting threshold reduction cadence

**5-10 years**

| Material class | Relevant PCRs | Maximum data age | | Data quality ratings |
| --- | --- | --- | --- | --- |
| | | Primary data (A3/A2) | Secondary data (A2/A1) | |
| Steel | UL Environment: Part B: Designated Steel Construction Product EPD Requirements (8/2020, version 2.0) | 5 years | 10 years | Encouraged |
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**Buy Clean Limit Reduction Cadences**

Buy Clean State (y-axis): Colorado, Maryland, New York, Massachussetts, California
Year (x-axis): 2022, 2024, 2026, 2028, 2030

- Colorado — 4 Year Cadence
- Maryland — 3 Year Cadence
- New York — 2 Year Cadence
- Massachussetts — 5 Year Cadence
- California — 3 Year Cadence

Legend:
- First Year Lowered
- Start Year

*Source: Lewis, M., Huang, M., Waldman, B., Carlisle, S., and Simonen, K. (2021). Environmental Product Declaration Requirements in Procurement Policies. Carbon Leadership Forum, University of Washington. Seattle, WA*

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# How clearly is EPD data quality communicated?

## Why it matters

- Selecting materials
- Setting initial embodied carbon thresholds
- Lowering allowing thresholds over time

**Table 1**   Pedigree matrix with 5 data quality indicators

| Indicator score | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Reliability | Verified[a] data based on measurements[b] | Verified data partly based on assumptions or non-verified data based on measurements | Non-verified data partly based on assumptions | Qualified estimate (e.g. by industrial expert) | Non-qualified estimate |
| Completeness | Representative data from a sufficient sample of sites over an adequate period to even out normal fluctuations | Representative data from a smaller number of sites but for adequate periods | Representative data from an adequate number of sites but from shorter periods | Representative data but from a smaller number of sites and shorter periods or incomplete data from an adequate number of sites and periods | Representativeness unknown or incomplete data from a smaller number of sites and/or from shorter periods |
| Temporal correlation | Less than three years of difference to year of study | Less than six years difference | Less than 10 years difference | Less than 15 years difference | Age of data unknown or more than 15 years of difference |
| Geographical correlation | Data from area under study | Average data from larger area in which the area under study is included | Data from area with similar production conditions | Data from area with slightly similar production conditions | Data from unknown area or area with very different production conditions |
| Further technological correlation | Data from enterprises, processes and materials under study | Data from processes and materials under study but from different enterprises | Data from processes and materials under study but from different technology | Data on related processes or materials but same technology | Data on related processes or materials but different technology |

*Source: Weidema and Waesnes (1996)*


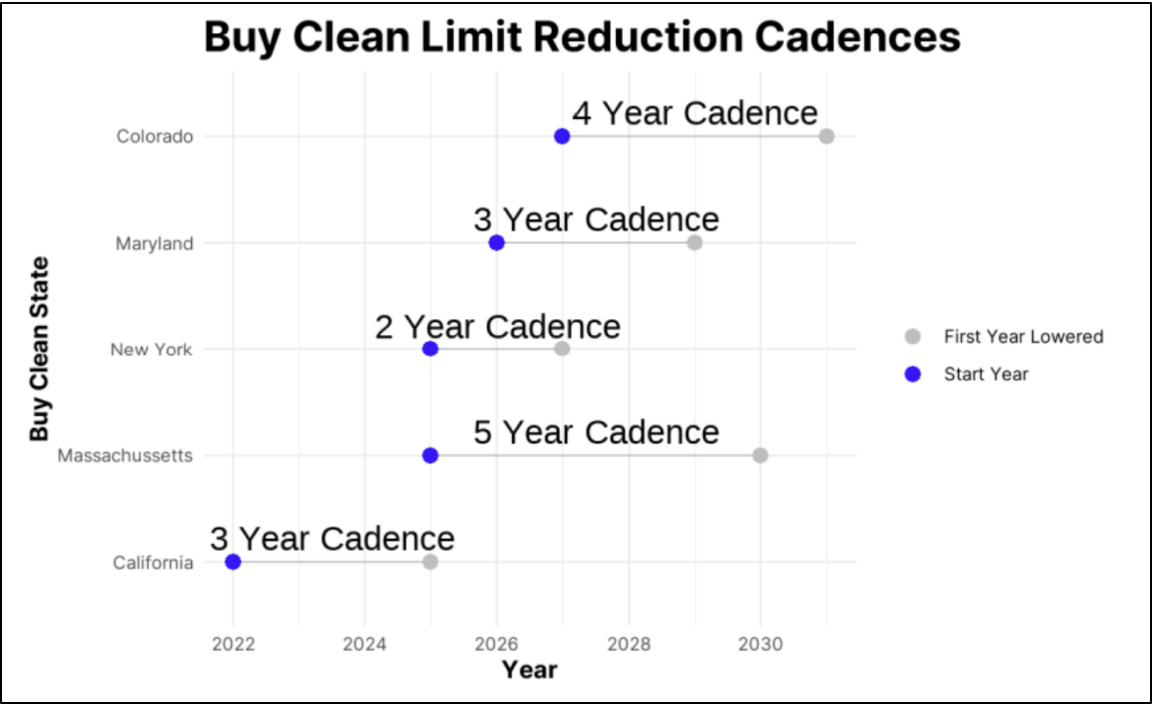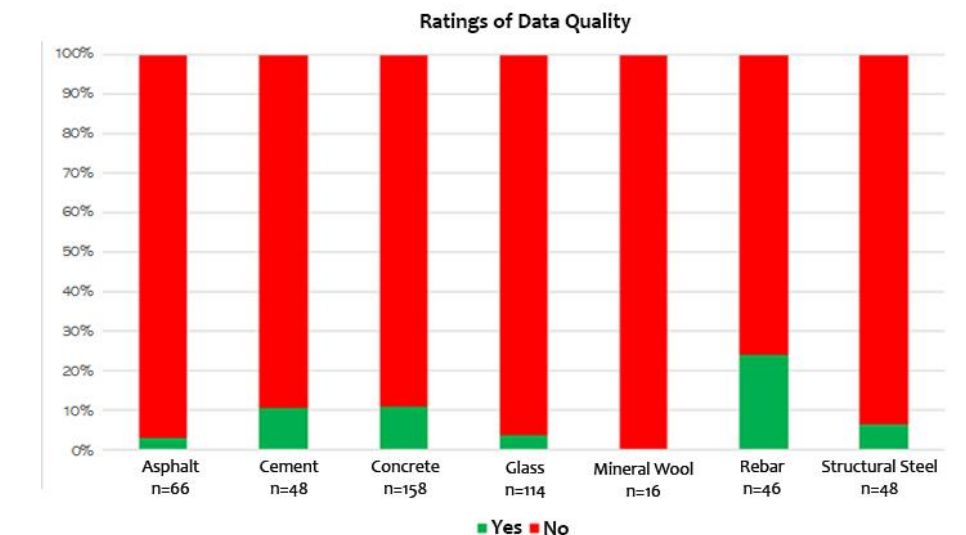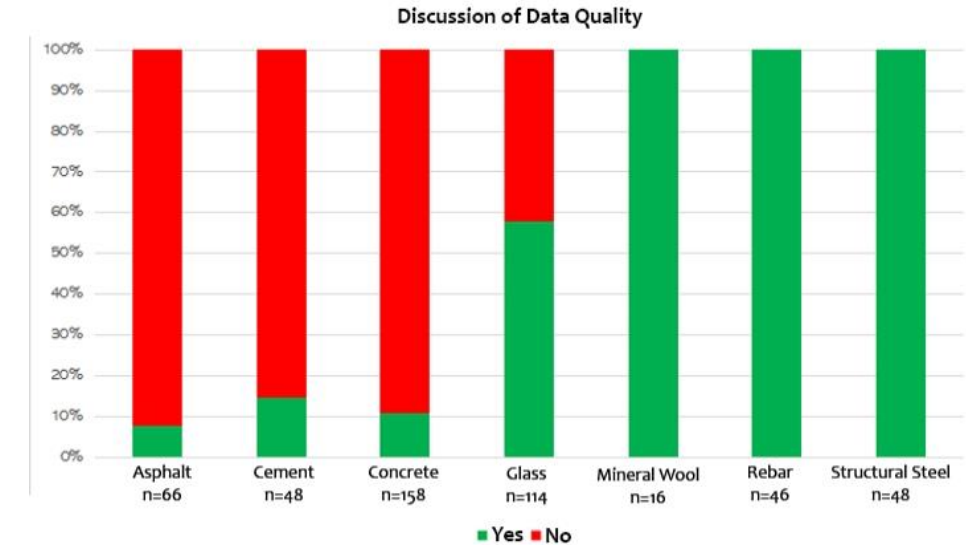Discussion of Data Quality


Ratings of Data Quality

# How often are production characteristics reported?

## Why it matters

- Setting initial embodied carbon thresholds
- Lowering allowing thresholds over time

Exhibit 9  **Recommended US federal procurement targets for various ready mix concrete strengths to achieve net zero by 2050**

— 0–2,500 PSI   — 2,501–3,000 PSI   — 3,001–4,000 PSI   — 4,001–5,000 PSI
— 5,001–6,000 PSI   — 6,001–8,000 PSI   — More than 8,000 PSI

**2025 Target —**
**Efficiency in Concrete Production**
*Average: 340 kg $CO_2e/m^3$*

**2030 Target —**
**Savings in Cement and Binders**
*Average: 294 kg $CO_2e/m^3$*

**2035 Target —**
**Savings in Clinker Production**
*Average: 213 kg $CO_2e/m^3$*

**2045 Target —**
**Carbon Capture and Utilization/Storage**
*Average: 30 kg $CO_2e/m^3$*

**2050 Target —**
**$CO_2$ Sink: Recarbonation**
*Average: 0 kg $CO_2e/m^3$*

### Emerging low-carbon technology availability for the cement sector
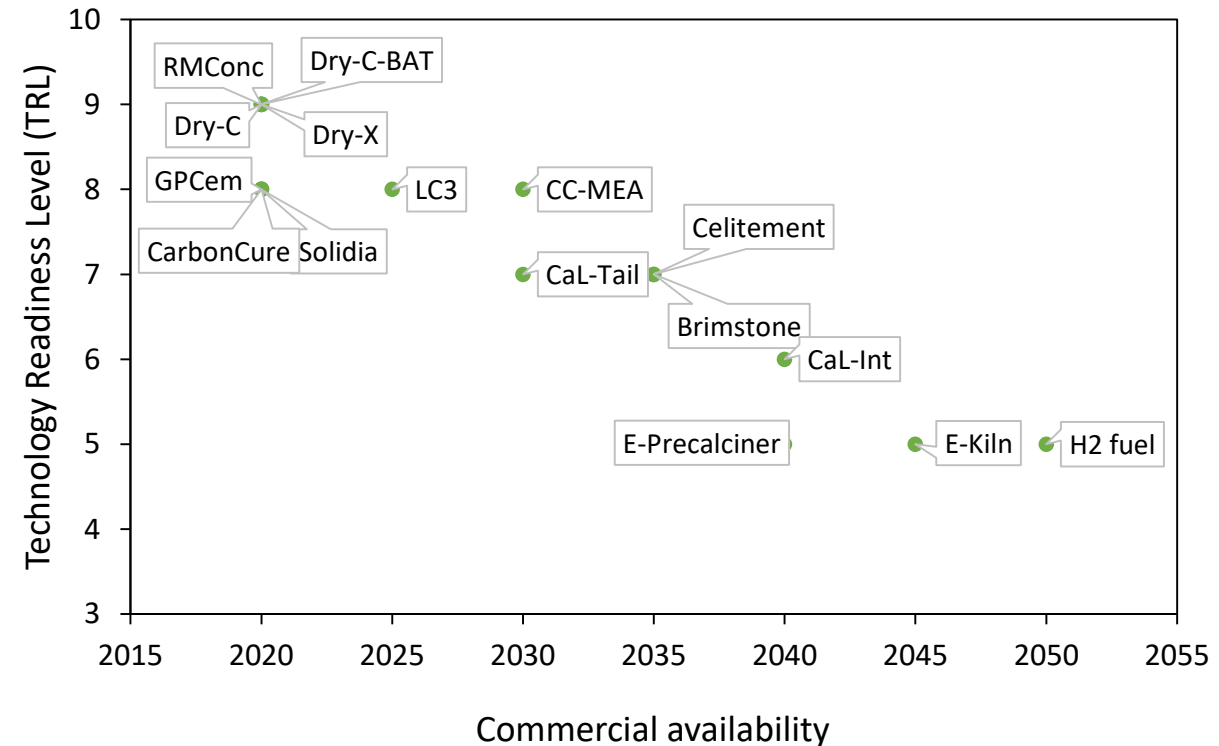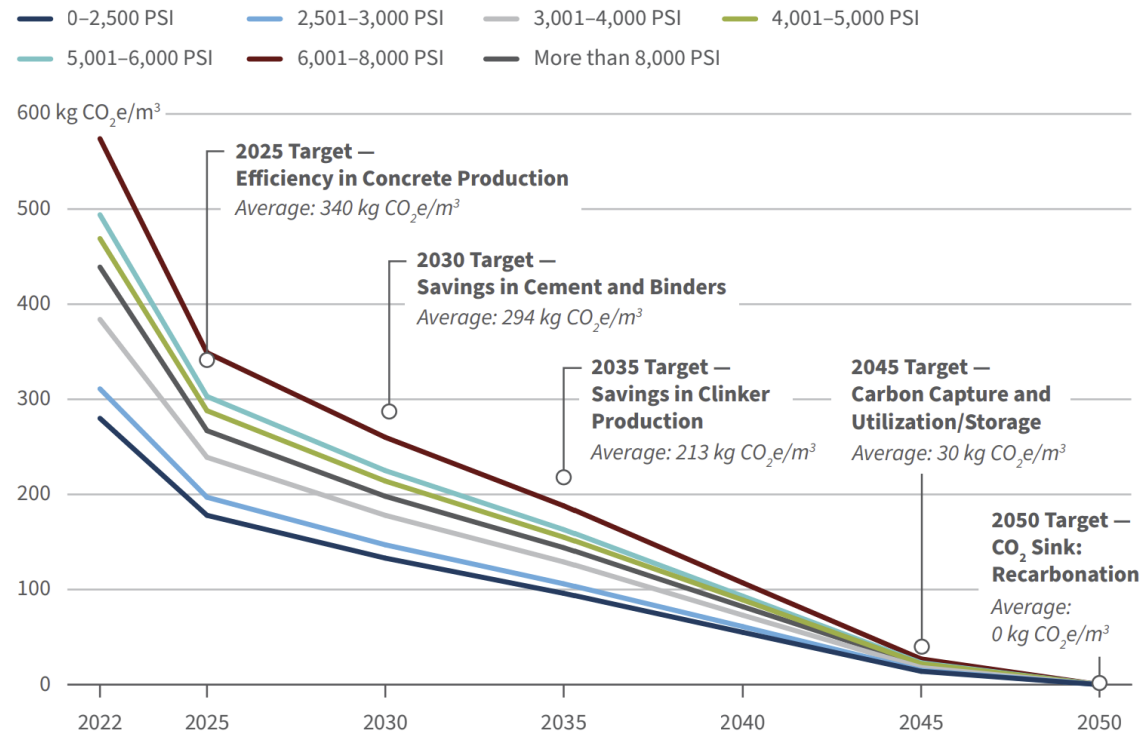


*Source: RMI (2022). Roadmap to Reaching Zero Embodied Carbon in US Federal Building Projects (left) and LBNL analysis (right)*

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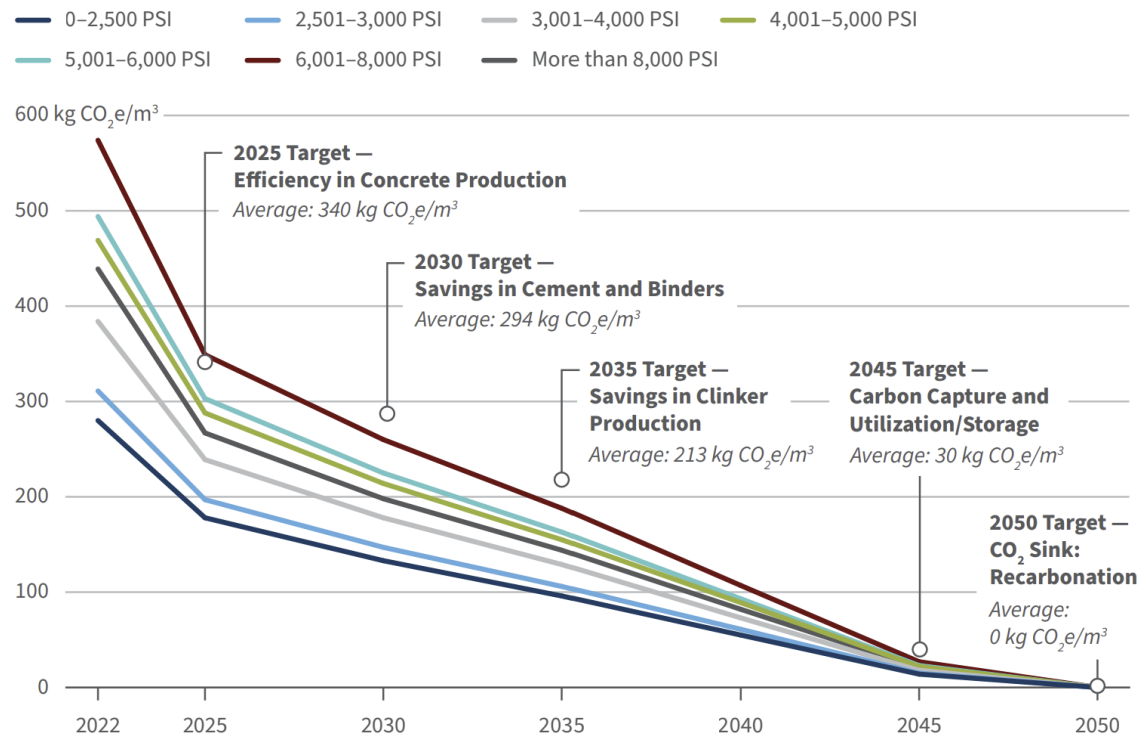# How often are production characteristics reported?

## Why it matters

- Setting initial embodied carbon thresholds
- Lowering allowing thresholds over time



Exhibit 9 — Recommended US federal procurement targets for various ready mix concrete strengths to achieve net zero by 2050


Production Technologies Used for A3
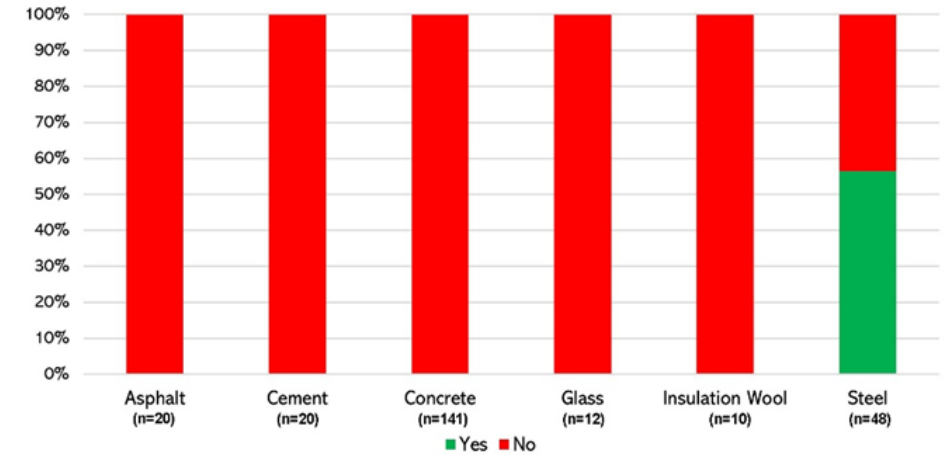

Direct fuel use reporting at the production facility (A3)

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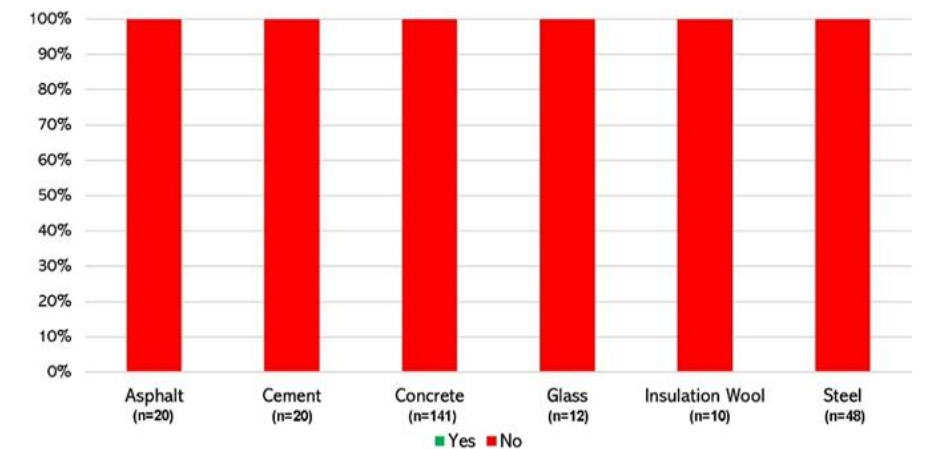
# How often are supply chain locations reported?

## Why it matters
- Ensuring environmental co-benefits



Global Warming Potential (GWP) vs Acidification Potential (AP)
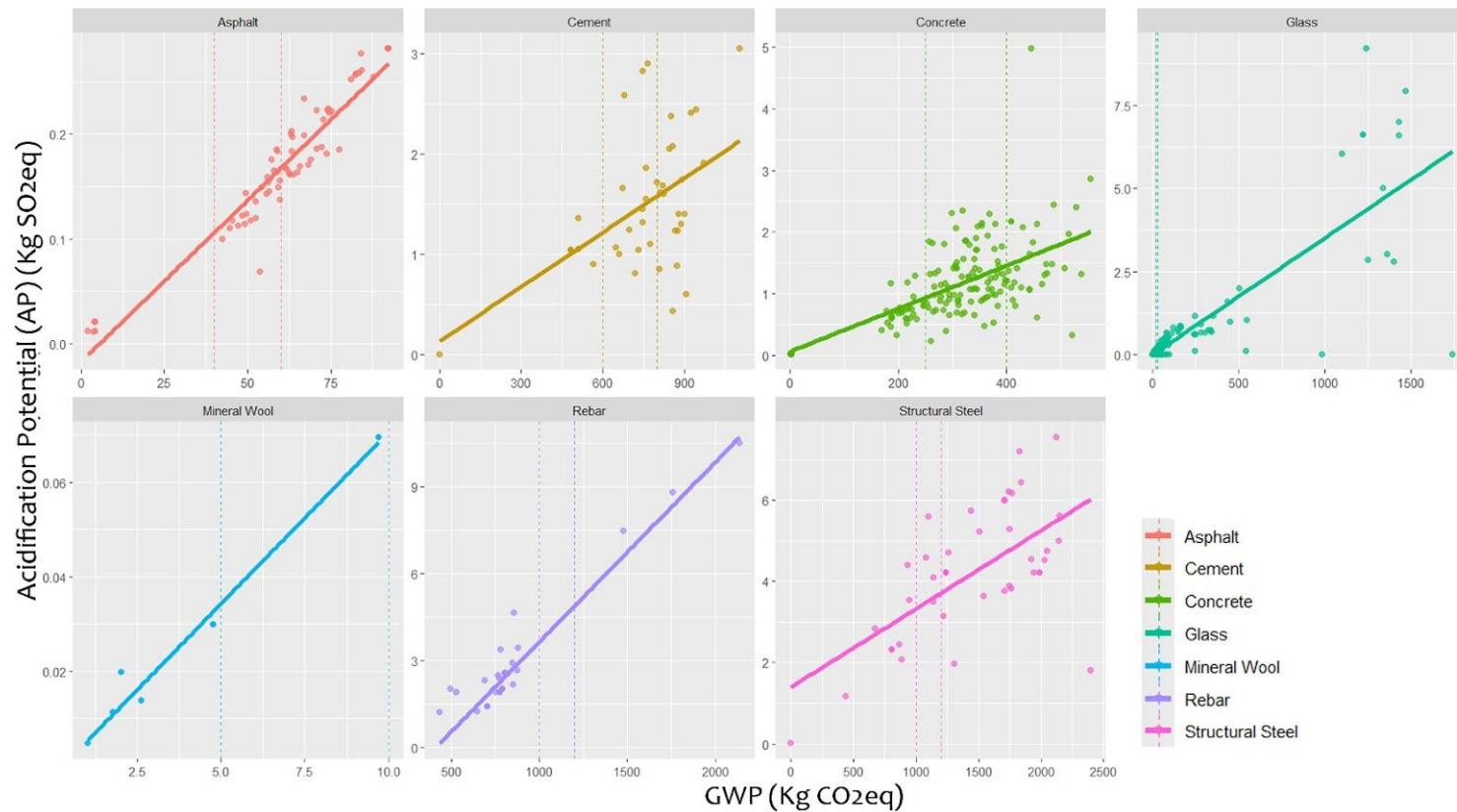


Supply Chain Locations and/or Logistics Details

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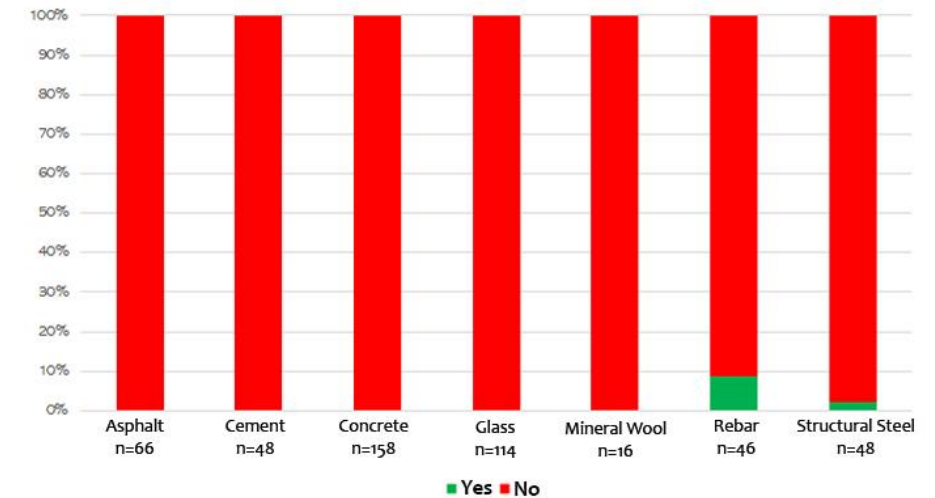
# Developing best practices for EPDs: current status



**ADVANCE ROBUST ENVIRONMENTAL PRODUCT DECLARATIONS**

**Phase I: Data Quality Improvement**

- Draw on ongoing data improvements to Federal LCA Commons and fill existing data gaps
- Determine PCRs meeting EPA's PCR Criteria
- Collect third-party-verified EPDs and industry benchmarks

**SET THRESHOLDS FOR LOW EMBODIED CARBON MATERIALS**

**Phase II: Threshold Setting**

- Develop thresholds for each material/product type, considering performance requirements, regionality and viable industry averages
- Finalize thresholds, informed by stakeholder input via public comments

**LAUNCH LOW EMBODIED CARBON LABEL**

**Phase III: Labeling**

- Label materials/products meeting thresholds using EPDs
- Launch publicly accessible registry of labeled materials/products
- Highlight labeled materials in other platforms, federal programs, and procurement policies

**Figure 2. Three Phases of the Label Program.**

Implementation Approach for the U.S. EPA Label Program for Low Embodied Carbon Construction Materials

Office of Chemical Safety and Pollution Prevention
EPA-740-B24-010
August 2024

EPA

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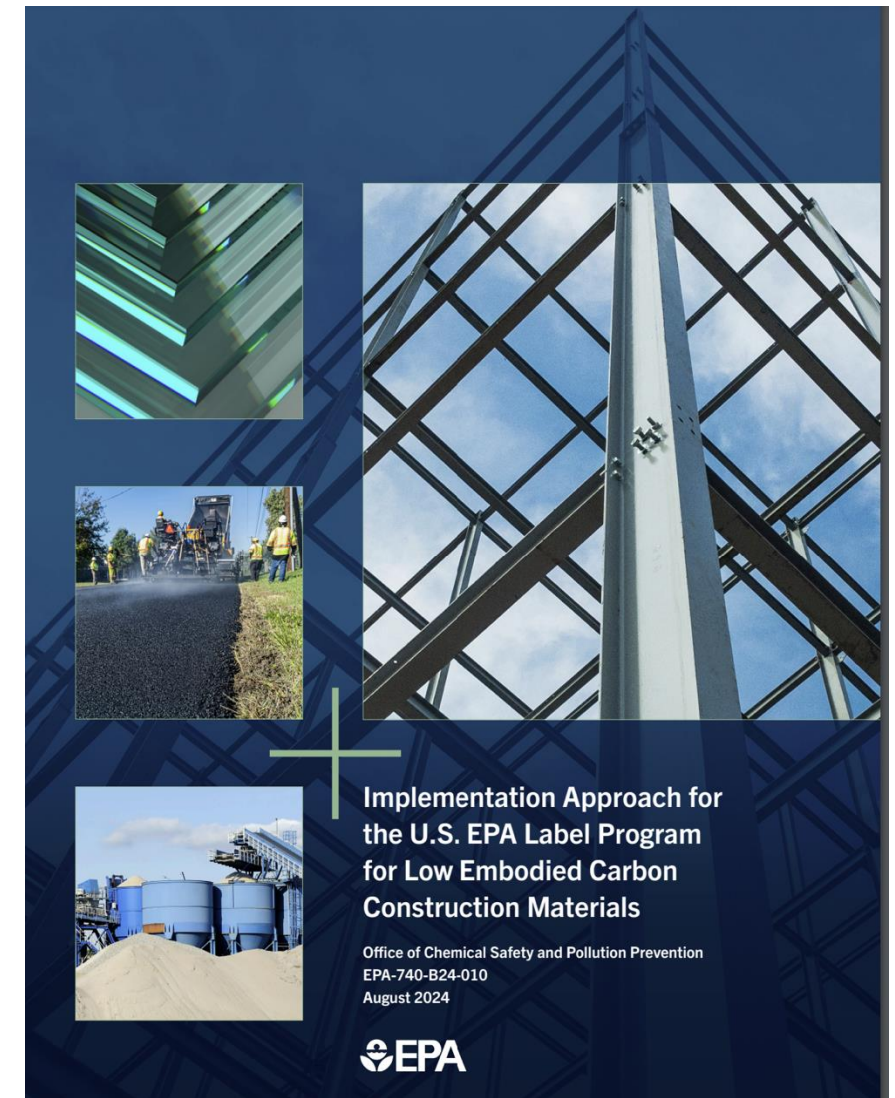
# Best practices for EPDs: current status



Data Quality Assessment Method to Support the Label Program for Low Embodied Carbon Construction Materials (Version 1)

Office of Chemical Safety and Pollution Prevention
August 2024

EPA

**Table 1. Flow-Level DQIs**

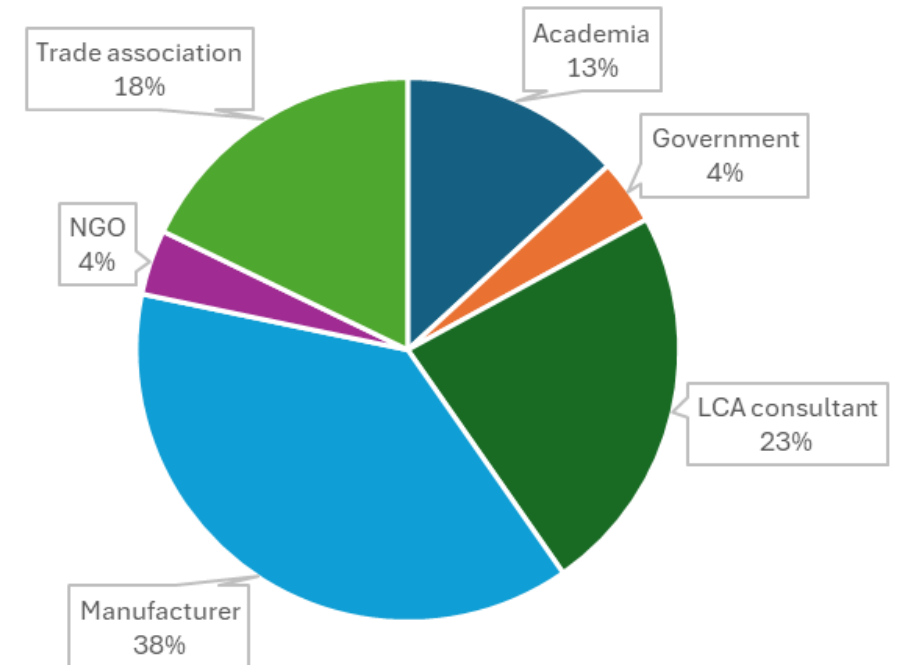| Indicator | Definition | ← Highest Data Quality (Lowest Score) | | | Lowest Data Quality (Highest Score) → | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 (Default) |
| Temporal representativeness | Indicates the temporal difference between the date of data generation and the date the data are supposed to represent based on the PCR. | Less than 3 years of difference | Less than 6 years of difference | Less than 10 years of difference | Less than 15 years of difference | Age of data unknown or more than 15 years |
| Geographical representativeness | Indicates how well the geographical area from which data for a unit process are collected satisfies the goal of the study (ISO 14044). | Data from same resolution[a] and same area of study | Within one level of resolution and a related area of study[b] | Within two levels of resolution and a related area of study | Outside two levels of resolution but a related area of study | From a different or unknown area of study |
| Technological representativeness | Indicates technical representativeness based on four categories: process design, operating conditions, material quality/type and process scale. | All technology categories[c] are equivalent | Three of the technology categories are equivalent | Two of the technology categories are equivalent | One of the technology categories is equivalent | None of the technology categories are equivalent |
| Data collection methods | Assessment of the robustness of the sampling methods and data collection period. | Representative data from >80% of the relevant market,[d] over an adequate period[e] | Representative data from 60–79% of the relevant market, over an adequate period, or representative data from >80% of the relevant market, over a shorter period | Representative data from 40–59% of the relevant market, over an adequate period, or representative data from 60–79% of the relevant market, over a shorter period | Representative data from <40% of the relevant market, over an adequate period, or representative data from 40–59% of the relevant market, over a shorter period | Unknown or data from a small number of sites and from shorter periods |

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# PCR development: who's at the table?

**Program operators reviewed to date**

| Country | Program Operator for PCRs |
|---|---|
| Austria | Bau-EPD |
| Canada | FPInnovations |
| France | AENOR |
| Germany | Institut Bauen und Umwelt e.V. (IBU) |
| India | EPDIndia |
| Ireland | EPDIreland |
| Italy | EPDItaly |
| Japan | Japan Environmental Management Association for Industry |
| Netherlands | Milieu Relevante Product Informatie (MRPI) |
| Poland | Instytut Techniki Budowlanej (ITB) |
| Korea | Korea Environmental Industry & Technology Institute (KEITI) |
| Sweden | The International EPD System |
| Taiwan | EPDTaiwan |
| UK | Building Research Establishment (BRE) |
| US | ASTM International |
| | Carbon Leadership Forum |
| | CSA |
| | NAPA |
| | NRMCA |
| | NSF International |
| | SCS Global Services |
| | Smart EPD |
| | Sustainable Minds |
| | UL Environment |

**Covered products to date**

| Country |
|---|
| Asphalt |
| Building and Construction Products |
| Cement |
| Concrete |
| Flat Glass |
| General |
| Mineral Wool |
| Reinforcing Steel |
| Thermal Insulation |
| Wood |

### Stakeholder representation (n=130)



- Academia 13%
- Government 4%
- LCA consultant 23%
- Manufacturer 38%
- NGO 4%
- Trade association 18%

*Source: UCSB analysis*

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# Summary

- Embodied carbon policies are proliferating globally, particularly for building materials
- PCRs and EPDs are also proliferating, but are still works in progress:
  - Their coverage of building materials and products is incomplete
  - Their processes and contents can be improved to better support embodied carbon regulations
- Efforts are underway to make improvements, particularly in the U.S.
  - Data quality ratings, secondary data, comparability, and transparency
- Key remaining opportunities include:
  - Ensuring comparability in reporting and consistency in data quality
  - Production and supply chain characteristics transparency
  - Broader stakeholder engagement
  - Timeliness of data

# Thank You!