Center for Sustainable Building Research
University of Minnesota

Carbon Leadership Forum
University of Washington

January 28, 2020

# Construction materials: environmental impact study

## Contributors

### About the Center for Sustainable Building Research (CSBR)

The Center for Sustainable Building Research is a research center in the College of Design at the University of Minnesota. Building on past success and looking into the future the work of the center is focused in six areas, each directly linked to each other and to the built environment: Energy and climate change; the water cycle; Sustainable materials for a healthy built environment; Measuring regenerative design; Equitable designs to provide sustainability for all; and Creating regenerative and resilient communities. It is impossible to solve any of these problems in isolation from each other and transforming the building industry and built environment will strike at their root causes.

### About the Carbon Leadership Forum (CLF)

The Carbon Leadership Forum is a non-profit industry-academic collaborative at the University of Washington. We are architects, engineers, contractors, material suppliers, building owners, and policymakers who work collaboratively, pioneering research, creating resources, and incubating member-led initiatives for greatest collective impact. Our goal is to accelerate transformation of the building sector to radically reduce and ultimately eliminate the embodied carbon in building materials and construction.

### Authors

The Center for Sustainable Building Research (CSBR) at the University of Minnesota managed the research project, analyzed feasibility and provided recommendations on policy and next steps. Researchers from the CSBR that participated in the research and report:

- Richard Graves, AIA, Director, Center for Sustainable Building Research
- Garrett Mosiman, Senior Research Fellow, Center for Sustainable Building Research
- Elizabeth Kutschke, Research Fellow, Center for Sustainable Building Research

The report was based primarily on the research and data of the Carbon Leadership Forum at the University of Washington. They are leaders in the study of embodied carbon and the built environment in North America. The research team from the Carbon Leadership Forum at the University of Washington College of Built Environments who participated in this project included:

- Meghan Lewis, Senior Researcher, Carbon Leadership Forum
- Monica Huang, Researcher, Carbon Leadership Forum
- Kate Simonen, Executive Director, Carbon Leadership Forum

Author contributions: M.L. and K.S. led conceptualization; M.L. and M.H. conducted research and analysis; M.L., M.H., and K.S. performed review and editing; M.H. created the figures; M.L. and M.H. wrote the report.

## Conflicts of Interest

The Center for Sustainable Building Research (CSBR) is funded from federal, state, university and non-profit grants to support project-based research for the center. The center does not accept any sponsorships from manufacturers, trade associations or special interests.

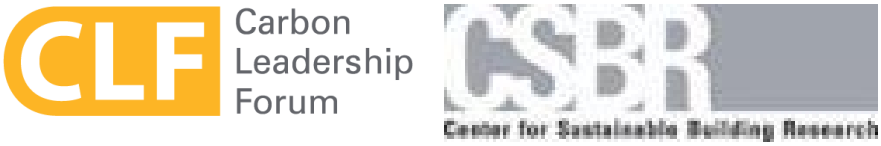
The Carbon Leadership Forum receives unrestricted gifts from sponsors, including manufacturers and trade associations, which are listed here: https://carbonleadershipforum.org/our-sponsors/

Kate Simonen is on the board of directors of Building Transparency, a non-profit organization that supports the Embodied Carbon in Construction Calculator (EC3) tool, which includes a database of environmental product declarations.

## Acknowledgements

We would like to thank:

- Brook Waldman at the Carbon Leadership Forum for his assistance in tallying the number of EPDs.
- Phil Northcott at C-Change Labs for providing EC3 data exports for tallying the number of EPDs.



## Table of Contents

## Introduction

The State of Minnesota Commissioner of Administration contracted with the Center for Sustainable Building Research (CSBR) at the University of Minnesota to provide the report outlined in the legislation passed in the 2021 session:

CONSTRUCTION MATERIALS; ENVIRONMENTAL IMPACT STUDY.
Subdivision 1.

Definitions.
(a) For purposes of this section, the following terms have the meanings given:

(b) "Eligible materials" means any of the following materials that function as part of a structural system or structural assembly:

(1) concrete, including structural cast in place, shotcrete, and precast;

(2) unit masonry;

(3) metal of any type; and

(4) wood of any type, including but not limited to wood composites and wood-laminated products.

(c) "Engineered wood" means a product manufactured by banding or fixing strands, particles, fiber, or veneers of boards of wood by using adhesives combined with heat and pressure, or other methods to form composite material.

(d) "State building" means a building owned by the state of Minnesota.

(e) "Structural" means a building material or component that (1) supports gravity loads of building floors, roofs, or both; and (2) is the primary lateral system resisting wind and earthquake loads. Structural includes but is not limited to shear walls, braced or moment frames, foundations, below-grade walls, and floors.

(f) "Supply-chain specific" means an environmental product declaration that includes supply-chain specific data for production processes that contribute to 80 percent or more of a product's lifecycle global warming potential. For engineered wood products, supply-chain specific also means an environmental product declaration that reports:

1) any chain of custody certification;
2) the percentage of wood, by volume, used in the product, itemized by the wood's source:
3) by a state, or by a province and country;
4) by the owner type, whether federal, state, private, or other; and
5) with forest management certification.

(g) "Type III environmental product declaration" means a document, verified and registered by a third party, that (1) contains a life cycle assessment of the environmental impacts, including but not limited to the use of water, land, and energy resources, in the manufacturing process of a specific product constructed or manufactured by a specific firm; and (2) meets the applicable standards developed and maintained by the International Organization for Standardization for environmental impact life cycle assessments.
Subd. 2.

Study; requirements.

*The commissioner of administration must contract with the Center for Sustainable Building Research at the University of Minnesota to examine the feasibility, economic costs, and environmental benefits of requiring (1) a bid that proposes to use or construct one or more eligible materials in the construction or major renovation of a new state building to include a supply-chain specific type III environmental product declaration for each of those materials, and (2) that the information under clause (1) included in a bid must be considered when making a contract award. In conducting the study, the* Center for Sustainable Building Research *must examine and evaluate similar programs adopted in other states.*

*Subd. 3.*

Report.

By February 1, 2022, the commissioner of administration must submit the findings and recommendations of the study to the chairs and ranking minority members of the legislative committees with primary jurisdiction over environmental policy.

## Materials Covered by the Research

Appendix A outlines the materials that could be considered in procurement by CSI division to comply with the definition of eligible materials in the legislation.

## Scope of the Report

CSBR has partnered with the Carbon Leadership Forum (CLF) at the University of Washington to perform this Construction Materials Environmental Impact Study. The CLF specializes in research and outreach on *embodied carbon*, which encompasses the greenhouse gas emissions arising from the manufacturing, transportation, installation, maintenance, and disposal of building materials.

This report provides an overview of low environmental impact material policies, focusing on the use of environmental product declarations (EPDs), which are thirty party–verified documents that report the environmental impacts of products. This report is divided into four sections:

1. Review of Type III environmental product declarations (EPDs) available for concrete, unit masonry, metal, wood: This section provides an accounting of the number of Type III EPDs available for concrete, unit masonry, metal (steel and aluminum), and wood in the US and abroad.

2. Review and summary of programs in other states and countries: This section provides a review of construction material procurement policies in the US and abroad.

3. Feasibility, economic costs, and environmental benefits of using EPDs in state construction: This section discusses the feasibility, potential economics costs and environmental benefits of using EPDs in state construction.

4. Policy recommendations: This section provides policy recommendations that the State of Minnesota could adopt to create policies around low-carbon construction material procurement.

## Section 1: Review of Environmental product declarations

### Environmental Product Declarations

Environmental Product Declarations (EPDs) are third party–verified documents written in conformance with international standards that report the environmental impacts of a product, including its global warming potential, based on life cycle assessment (LCA) models. This section summarizes the quantity and types of EPDs that are available for concrete, unit masonry, metal, and wood products, and discusses current challenges and future potential for increased adoption of EPDs.

The use of EPDs as standardized reporting tools for disclosing the global warming potential (GWP) of construction materials is increasingly prevalent in public procurement policy. EPDs are already used by consumers in the building industry to assess environmental impacts, enabling policymakers to build and improve upon the existing standards described in this section.

International Standards Organization (ISO) standards identify three types of environmental claims for products:

- Type I claims are third party–verified labels based on criteria set by a third party and are governed by ISO 14024.
- Type II claims are self-declarations made by manufacturers or retailers and are governed by ISO 14021. Type II claims are not third party–verified.
- Type III claims contain quantified product information based on life cycle impacts and are governed by ISO 14025. Type III claims must be third party–verified.

Of these three types of claims, Type III declarations are preferred for embodied carbon policy because they are third party–verified and contain the greatest amount of "quantified environmental information on the life cycle of a product," which helps "enable comparisons between products fulfilling the same function" (ISO 14025: 2006).

The development of EPDs and product category rules (PCRs) are governed by standards developed by the International Standards Organization (ISO), including:

- ISO 14025: *Environmental labels and declarations — Type III environmental declarations — Principles and procedures*
- ISO 14027: *Environmental labels and declarations — Development of product category rules*
- ISO 14040: *Environmental management — Life cycle assessment — Principles and framework*
- ISO 14044: *Environmental management — Life cycle assessment — Requirements and guidelines*
- ISO 21930: *Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services*

Each material's PCR dictates methodological decisions that are relevant and fine-tuned to the material supply chain of that product category (e.g., concrete, floor coverings, insulated metal panels, etc.). A PCR dictates which life cycle stages and scopes must be included in the LCA, which background data sources are acceptable or mandatory, and other modeling choices such as allocation method and impact assessment method.

There are two primary types of EPDs:

1. Type III **product-specific** EPDs, which represent products manufactured by a specific manufacturer. This type of EPD can be used to compare functionally equivalent products that follow the same product category rules. Within this category of EPDs, there are three subtypes:
    a. Manufacturer-specific EPDs, which represent a family of products produced by a single manufacturer
    b. Product-specific EPDs, which represent a specific product produced by a single manufacturer
    c. Facility-specific EPDs, which represent a specific product produced at a single facility by a single manufacturer.
2. **Industry-wide** EPDs, which represent multiple manufacturers within an industry. These types of EPDs are meant to provide an average of the industry as a whole. Industry-wide EPDs are useful for benchmarking what an average product's impact may be for a particular region. Industry-wide EPDs cannot be compared to each other, but they may be used to understand how product-specific EPDs relates to the average as whole (i.e., is it lower or higher in embodied carbon than the industry-average?)

## Overview

Presented below are general overviews of product-specific EPDs and industry-wide EPDs. The subsequent subsections present more information about each material category of EPDs.

The number of EPDs was determined by exporting data from the EC3 tool. EC3 (Embodied Carbon in Construction Calculator) is a cloud-based database of digitized EPDs maintained by Building Transparency. Building Transparency is a non-profit organization that was established to continue the management and development of the EC3 tool, as well as provide the resources and education necessary to ensure its adoption. EC3 is a comprehensive database for American EPDs, and also includes a large number of EPDs from around the world. New EPDs are being added every day. This tool stores the data presented in EPDs, which are normally published as PDFs, in a digital format so that the data can be easily searched and sorted.

## Product-specific EPDs

Figure 1 shows the total number of product-specific EPDs by state, based on data exported from the EC3 tool on October 24, 2021. This figure shows that California has the largest number of EPDs (33,872). Most of these EPDs are concrete EPDs. New Jersey also has many EPDs (13,885), as well as Washington (2,314) and Oregon (2,297).

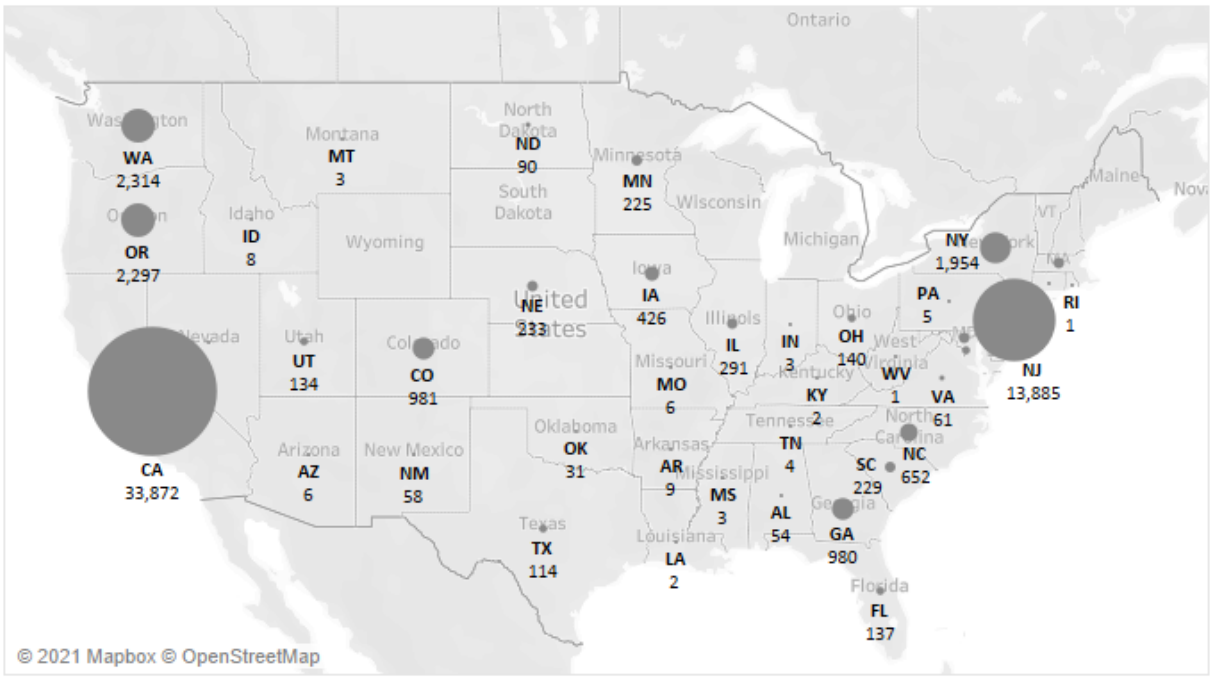



Figure 1. Total number of product-specific EPDs by state. Based on data exported from EC3 on October 24, 2021. Not shown: Hawaii, which had 0 EPDs, and Alaska, which had one EPD.

Figure 2 presents a heatmap of the number of product-specific EPDs by material subcategory and state. The top 6 states are shown, which are (in descending number of EPDs): 1) California, 2) New Jersey, 3) Washington, 4) Oregon, 5) New York, and 6) Colorado. Minnesota, which was ranked at #15, is shown at the far right (blue box) for comparison. This figure shows that concrete has the largest number of product-specific EPDs in the country (55,381), followed by masonry (98), steel (32), wood (14), and aluminum (3).

| | | | State/province | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Material category | Material subcategory | Grand Total | CA | NJ | WA | OR | NY | CO | MN |
| Grand Total | | 55,528 | 33,872 | 13,885 | 2,314 | 2,297 | 1,954 | 981 | 225 |
| Concrete | Total | 55,381 | 33,780 | 13,882 | 2,294 | 2,282 | 1,951 | 968 | 224 |
| | Ready-mix | 51,820 | 30,832 | 13,773 | 2,115 | 2,062 | 1,931 | 904 | 203 |
| | Flowable fill | 1,539 | 1,329 | 24 | 57 | 66 | 7 | 35 | 21 |
| | Shotcrete | 1,343 | 1,154 | 2 | 83 | 83 | | 21 | |
| | Cement grout | 475 | 380 | 20 | 33 | 39 | 1 | 2 | |
| | Concrete paving | 195 | 76 | 63 | 6 | 32 | 12 | 6 | |
| | Precast concrete | 9 | 9 | | | | | | |
| Masonry | Total | 98 | 77 | | 9 | | | 12 | |
| | CMU | 98 | 77 | | 9 | | | 12 | |
| Aluminum | Total | 3 | 3 | | | | | | |
| | Alum. extrusions | 2 | 2 | | | | | | |
| | Alum. suspension assembly | 1 | 1 | | | | | | |
| Steel | Total | 32 | 11 | 3 | 10 | 3 | 3 | 1 | 1 |
| | Rebar-steel | 25 | 7 | 3 | 8 | 3 | 3 | 1 | |
| | Cold-formed steel | 5 | 3 | | 2 | | | | |
| | Hot-rolled | 1 | | | | | | | 1 |
| | Misc metal fabrication | 1 | 1 | | | | | | |
| Wood | Total | 14 | 1 | | 1 | 12 | | | |
| | Sheathing panels | 4 | 1 | | | 3 | | | |
| | Wood joists | 4 | | | | 4 | | | |
| | Mass timber | 2 | | | 1 | 1 | | | |
| | Composite lumber | 1 | | | | 1 | | | |
| | Non-structural wood | 1 | | | | 1 | | | |
| | Prefabricated wood | 1 | | | | 1 | | | |
| | Wood framing | 1 | | | | 1 | | | |

Figure 2. Heatmap of the number of product-specific EPDs by material subcategory and state, showing the top 6 states, and Minnesota at the far right (blue box) for comparison. Darker blue shades correspond to larger numbers of EPDs. Based on data exported from EC3 on October 24, 2021.

Figure 3 shows a world map of countries that have at least one EPD, indicated by an orange dot. This figure shows that North America and Europe have fair coverage of EPDs, but the rest of the world is more sporadic.


Figure 3. World map showing which countries have at least one product-specific EPD, indicated by the orange dot. Based on data exported from EC3 on October 24, 2021.

### Industry-wide EPDs

Table 1 presents the number of industry-wide EPDs by material category and geographic scope. For concrete, there is one ready-mix industry-wide EPD from the NRMCA representing the US and Canada, and three precast industry-wide EPDs from the Canadian Precast/Prestressed Concrete Institute (CPCI) and Precast/Prestressed Concrete Institute (PCI), though two of these three precast EPDs are expired. For unit masonry, there is one industry-wide EPD from the Canadian Concrete Masonry Producers Association (CCMPA), which has expired. For steel, aluminum, and wood, there are a number of industry-wide EPDs representing different types of products.

Table 1. Number of industry-wide EPDs by material category and geographic scope. See the following material-specific subsections for more information.

| | Number of industry-wide EPDs | | |
|---|---|---|---|
| Material category | North America | Outside of North America | Total |
| Concrete | 2 (+2 expired) | 0 | 2 (+2 expired) |
| Unit masonry | 0 (+1 expired) | 0 | 0 (+1 expired) |
| Steel | 9 | 1 | 10 |
| Aluminum | 8 | 2 | 10 |
| Wood | 16 | 10 | 23 |

The following subsections for each material category provide more information about the industry-wide EPDs.

## Concrete

### *Current state of EPDs*

There are a large number of ready-mix concrete EPDs in the US and they are geographically well-spread. This is largely thanks to the availability of tools like Climate Earth's Ready Mix EPD Generator[1] that allow concrete suppliers to generate EPDs on-demand, and thanks to the efforts of the National Ready Mixed Concrete Association (NRMCA), an industry association of ready-mix concrete producers in the US. The NRMCA has led the following efforts to support the development of EPDs:

- The NRMCA sponsored a project to create an industry-wide EPD, which represents the average environmental impacts of concrete in the US. It provides separate environmental impacts for concrete of different strength categories and fly ash or slag content. This EPD was based on data contributed by various NRMCA members across the country.

- The NRMCA also published a Regional Benchmarks Report that reports the environmental impacts of products with varying strengths for different applications and exposure conditions at the national level as well as eight NRMCA regions.

- The NRMCA is a Program Operator, which means that it oversees the development and verification of concrete EPDs, which must be produced in accordance with concrete product category rules (PCRs) and are third party–verified.

- The NRMCA runs an EPD Program, which supports concrete producers in developing, verifying, and publishing certified EPDs. Through this program, the NRMCA helps manufacturers identify consultants

[1] https://www.climateearth.com/ready-mix-epd-generator/

and tools to perform the prerequisite LCAs and develop the draft EPDs. Once the draft EPD is developed, NRMCA certifies the EPD after verifying that the LCA and EPD were conducted in accordance with the selected PCR.

The Canadian Precast/Prestressed Concrete Institute (CPCI) and Precast/Prestressed Concrete Institute (PCI) have also created three industry-wide EPDs for precast concrete: (1) structural precast concrete, (2) underground precast concrete, and (3) architectural and insulated precast panels.

Concrete producers can also benefit from a number of tools and services that facilitate and expedite the creation of verified EPDs:

- The Athena Sustainable Materials Institute (ASMI) has a Concrete LCA/EPD calculator.

- Climate Earth has an online portal that produces a fully verified and company-branded EPD based on a mix design submitted by a user. This tool creates EPDs on-demand after a supplier has uploaded their information.

- The World Business Council for Sustainable Development's Cement Sustainability Initiative (WBCSD CSI) developed a tool, the CSI EPD Tool for Cement and Concrete, to facilitate the generation of sector-specific EPDs for cement, clinker and concrete. This tool is meant to facilitate and reduce the costs of preparing an EPD.

Figure 4 shows the number of concrete EPDs in the US. Minnesota has 224 concrete EPDs -- 203 ready-mix EPDs and 21 shotcrete EPDs.

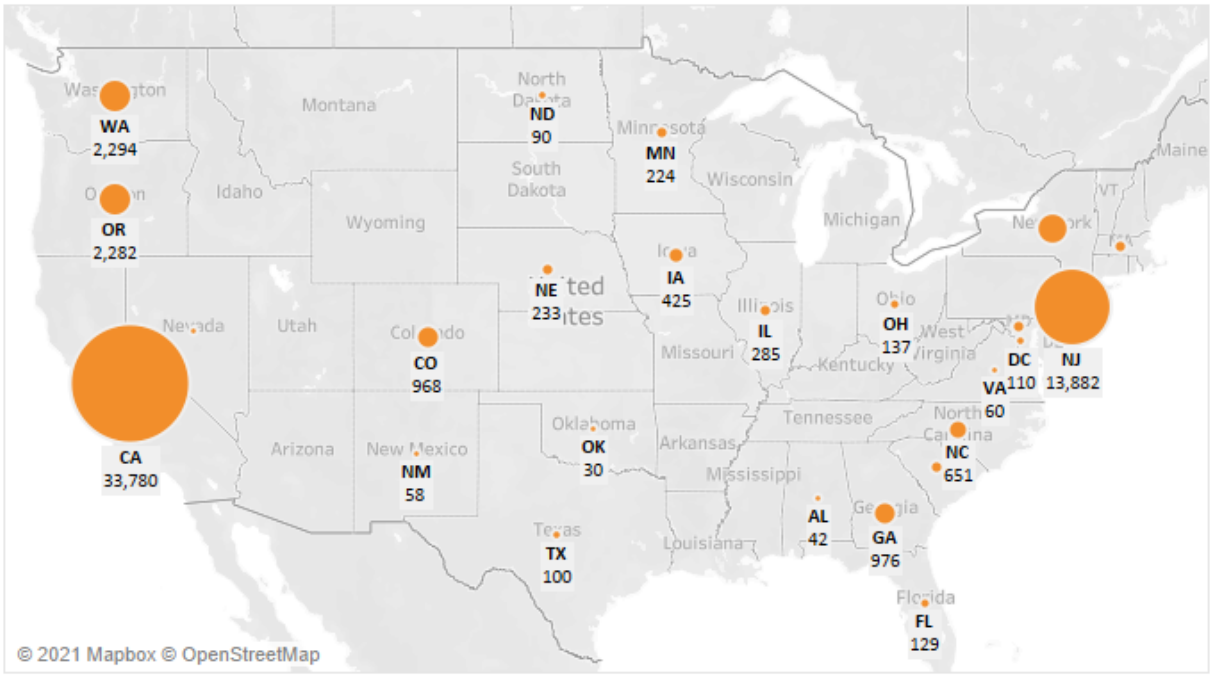



Figure 4. Number of concrete product-specific EPDs in the US. Based on data exported from EC3 on October 24, 2021.

Table 2 presents an accounting of industry-wide concrete EPDs in North America and around the world.

Table 2. Industry-wide concrete EPDs.

| Publisher | Geographic scope | EPD name | Count of industry-wide EPDs | |
|---|---|---|---|---|
| | | | North America | Outside of North America |
| NRMCA | US and Canada | NRMCA Member Industry-Average EPD for Ready Mixed Concrete (includes results for 72 products) | 1 | - |
| Canadian Precast/Prestressed Concrete Institute (CPCI) and Precast/Prestressed Concrete Institute (PCI) | US and Canada | Structural Precast Concrete Industry Wide EPD | 1 | - |
| | | Underground Precast Industry Wide EPD (expired 11/2020) | 1 | - |
| | | Architectural and Insulated Precast Panels (expired 11/2020) | 1 | - |
| Total | | | 4 | 0 |

### *Challenges*

The embodied carbon of concrete is driven by the amount of cement in the mix design. Cement is very carbon-intensive because cement production requires significant energy input and releases $CO_2$ as a part of the cement-making process. Most concrete EPDs, including product-specific EPDs, use generic (i.e., industry-average) GWP data for cement. This means that a typical concrete EPD does not precisely represent the actual embodied carbon of that concrete.

An additional challenge is the number of concrete manufacturers in the United States. Even though over 30 manufacturers currently have product-specific concrete EPDs, there are over 2000 concrete manufacturers in the United States. In contrast, there are only about 35 cement manufacturers in the US, five of which have EPDs.

### *Future potential*

Improving the quality of the upstream data, specifically that of cement, and increasing the adoption of supply chain–specific upstream data would greatly improve the precision of concrete EPDs. Batch-specific EPDs are also a potential next-step in improving concrete EPDs.

## Unit masonry

### *Current state of EPDs*

There are not very many EPDs of unit masonry, either bricks or concrete masonry units. Figure 5 shows the number of unit masonry EPDs in the US. No Minnesota manufacturers have a masonry EPD.

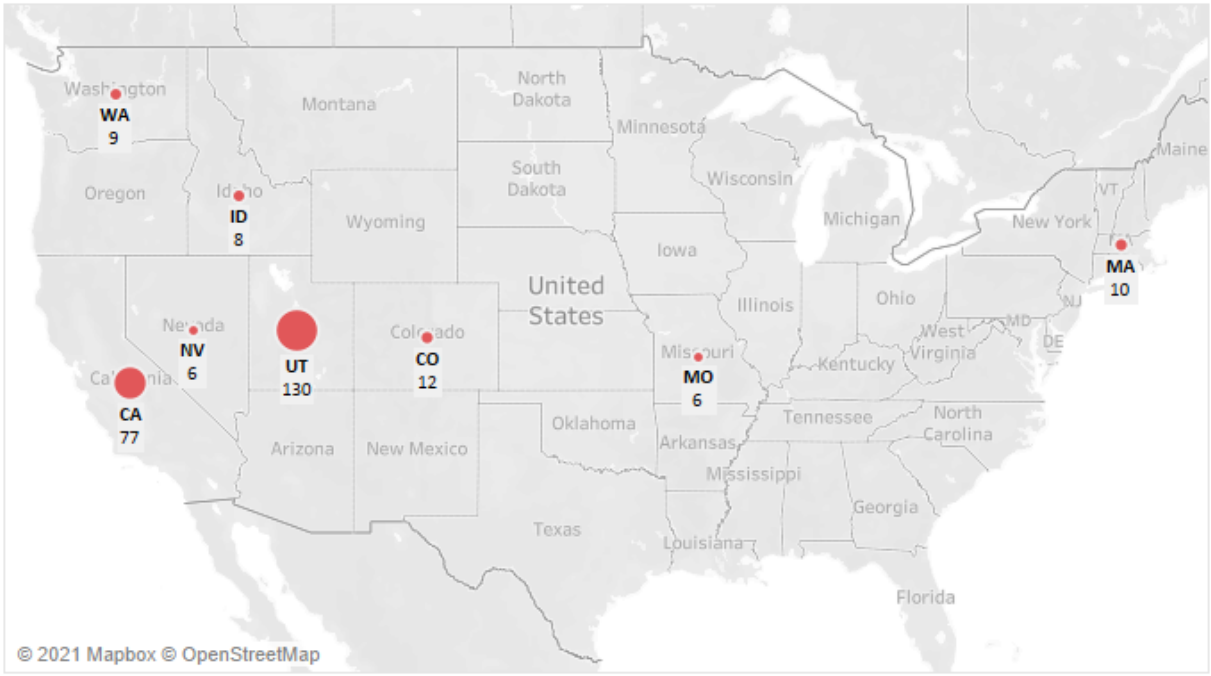



Figure 5. Number of masonry product-specific EPDs in the US. Based on data exported from EC3 on October 24, 2021.

There currently exists one industry-wide EPD for concrete masonry units in Canada: *Normal-Weight and Light-Weight Concrete Masonry Units as Manufactured by Members of the Canadian Concrete Masonry Producers Association (CCMPA)*, which includes two product types (normal- and light-weight). It is currently expired. There are currently no industry-wide brick EPDs.

### *Challenges*

There needs to be more market coverage and geographic coverage of masonry EPDs, and EPDs should use supply chain–specific cement data.

### *Future potential*

The US could benefit from having industry-wide EPDs for unit masonry. This could be done under the leadership of the National Concrete Masonry Association (NCMA) or the Brick Industry Association (BIA).

## Metal

### *Current state of EPDs*

#### Steel

Figure 6 presents the number of steel EPDs in the US. Minnesota has one steel EPD: a Fabricated Merchant Bar Quality (MBQ) Steel EPD produced by Gerdau in their St. Paul steel mill.

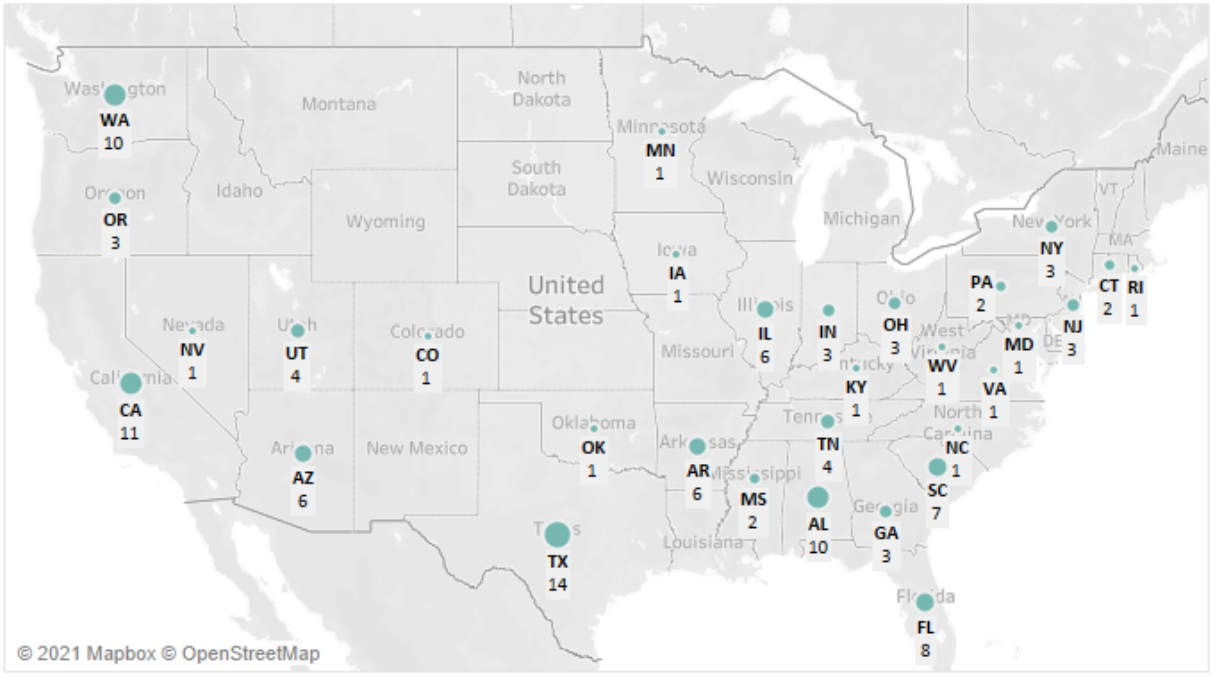



Figure 6. Number of steel product-specific EPDs in the US. Based on data exported from EC3 on October 24, 2021.

Table 3 presents an accounting of industry-wide steel EPDs in North America and around the world.

Table 3. Industry-wide steel EPDs.

| Publisher | Geographic scope | EPD name | Count of industry-wide EPDs | |
|---|---|---|---|---|
| | | | North America | Outside of North America |
| Concrete Reinforcing Steel Institute (CRSI) | US | Fabricated Steel Reinforcement | 1 | - |
| American Institute of Steel Construction (AISC) | US | Fabricated Hot-Rolled Structural Sections | 1 | - |
| | | Fabricated Steel Plate | 1 | - |
| Steel Tube Institute (STI) | North America | Hollow Structural Sections | 1 | - |
| American Institute of Steel Construction (AISC) & Steel Tube Institute (STI) | North America | Fabricated Hollow Structural Sections | 1 | - |
| Metal Building Manufacturers Association (MBMA) | US | Primary Structural Steel Frame Components | 1 | - |
| | | Secondary Structural Steel Frame Components | 1 | - |
| | | Roll Formed Metal Wall and Roof Panels | 1 | - |
| Metal Construction Association (MCA) | North America | Roll Formed Cladding - Wall and Roof Cladding Systems (includes results for steel and aluminum sheet metal) | 1 | - |
| European Association for Panels and Profiles | Europe | Steel profiles: liner tray; trapezoidal 35/207; standing seam | - | 1 |
| Total | | | 9 | 1 |

**Aluminum**

Figure 7 shows the number of aluminum EPDs in the US. No Minnesota manufacturers have created a product-specific aluminum EPD.


Figure 7. Number of aluminum product-specific EPDs in the US. Based on data exported from EC3 on October 24, 2021.

Table 4 presents an accounting of industry-wide aluminum EPDs in North America and around the world.

Table 4. Industry-wide aluminum EPDs.

| Publisher | Geographic scope | EPD name | Count of industry-wide EPDs | |
|---|---|---|---|---|
| | | | North America | Outside of North America |
| The Aluminum Association | US and Canada | Hot-Rolled Aluminum | 1 | - |
| | | Cold-Rolled Aluminum | 1 | - |
| | | Extruded Aluminum | 1 | - |
| | | Primary Ingot | 1 | - |
| | | Secondary Ingot | 1 | - |
| Aluminum Extruders Council (AEC) | North America | Aluminum Extrusions: Mill Finished, Painted, and Anodized (includes 3 product types) | 1 | - |

| | | | | |
|---|---|---|---|---|
| | | Thermally Improved Aluminum Extrusions: Mill Finished, Painted, and Anodized (includes 3 product types) | 1 | - |
| Metal Construction Association (MCA) | North America | Roll Formed Cladding - Wall and Roof Cladding Systems (includes results for steel and aluminum sheet metal) | 1 | - |
| Gesamtverband der Aluminiumindustrie e.V. (GDA) | DACH region (Germany, Austria, Switzerland) | Aluminium profile mill finished | - | 1 |
| Asociación Española del Aluminio y Tratamientos de Superficie (AEA) | Spain | Perfiles De Aluminio Anodizados Y Lacados (includes 4 product types) | - | 1 |
| Total | | | 8 | 2 |

### *Challenges*

Currently, most EPDs, including product-specific EPDs, do not use mill-specific or supply chain-specific data for upstream data. They use industry-average data, which is often based on data from a handful of manufacturers. This means that the EPDs may not reflect the true impact of that specific product. Steelmaking or aluminum-making requires high energy consumption to melt the metal, and contributes a significant portion of a metal product's environmental impact. Using more supply chain-specific data would improve the accuracy of these EPDs.

EPDs for metal products also face additional challenges due to lack of global consensus on how to handle complex issues in LCA, such as recycling, scrap use, allocation of byproducts (such as slag), and use of off-site renewable energy. These issues are handled consistently within the US, but they are handled differently in other parts of the world. Interpreting metal product EPDs from other parts of the world would require careful attention to these issues.

### *Future potential*

Incorporating mill-specific or supply chain-specific data into steel and aluminum EPDs would greatly improve their data quality.

## Wood

### *Current state of EPDs*

Wood EPDs in North America are currently largely represented by a set of industry-wide EPDs from the American Wood Council and Canadian Wood Council.[2] There are currently relatively few product-specific EPDs of wood products, given the number of wood products available on the market.

Figure 8 shows the number of wood EPDs in the US. No Minnesota manufacturers have created product-specific wood EPDs.

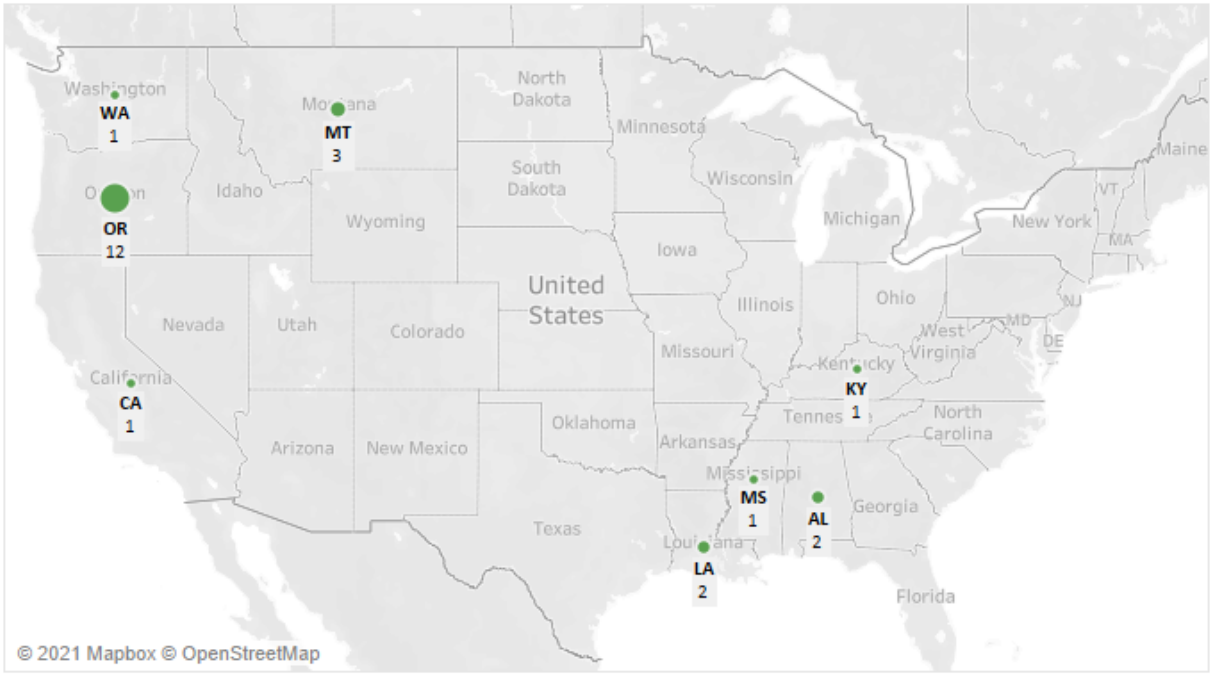



Figure 8. Number of wood product-specific EPDs in the US. Based on data exported from EC3 on October 24, 2021.

[2] American Wood Council (n.d.). *Sustainability> Environmental Product Declarations (EPDs) for Wood*. Retrieved October 9, 2021 from https://awc.org/sustainability/epd

Table 5 presents an accounting of industry-wide wood EPDs in North America and around the world.

Table 5. Industry-wide wood EPDs.

| Publisher | Geographic scope | EPD name | Count of industry-wide EPDs | |
|---|---|---|---|---|
| | | | North America | Outside of North America |
| American Wood Council (AWC) and Canadian Wood Council (CWC) | US and Canada | Softwood Lumber | 1 | - |
| | | Softwood Plywood | 1 | - |
| | | Oriented Strand Board | 1 | - |
| | | Glued Laminated Timber | 1 | - |
| | | Laminated Veneer Lumber | 1 | - |
| | | Wood I-joists | 1 | - |
| | | Redwood Lumber | 1 | - |
| | | Medium Density Fiberboard | 1 | - |
| | | Particleboard | 1 | - |
| | | Cellulosic Fiberboard | 1 | - |
| | | Laminated Strand Lumber | 1 | - |
| | | North American Hardboard | 1 | - |
| Quebec Wood Export Bureau (QWEB) | Quebec | Glued engineered softwood | 1 | - |
| | | Prefabricated light wood frame open web floor truss | 1 | - |
| | | Prefabricated light wood frame open wall | 1 | - |
| | | Prefabricated light wood frame roof truss | 1 | - |
| BaskEgur | Basque Country | Sector EPD: Radiata pine sawn board | - | 1 |
| Swedish Wood | Sweden | Swedish sawn dried timber of spruce or pine | - | 1 |
| | | Swedish Sawn and Planed Wood Product | - | 1 |
| WoodSolutions | Australia | Softwood Timber | - | 1 |
| | | Hardwood Timber | - | 1 |
| | | Particleboard | - | 1 |
| | | MDF | - | 1 |
| | | Plywood | - | 1 |
| | | Glulam | - | 1 |

| | | | | |
|---|---|---|---|---|
| Wood Processors' and Manufacturers' Association of New Zealand (Inc.) (WPMA) | New Zealand | Finger-Jointed and Laminated Timber Products including timber preservation options | - | 1 |
| Total | | | 16 | 10 |

### *Challenges*

Currently, there are very few product-specific EPDs for wood products. Users of EPDs want product-specific EPDs, but wood experts have cautioned that relying on cradle-to-gate EPDs could have unintended consequences. Potential challenges involve under-estimating the impact of transportation (shipping low-carbon products long distances for total increase in material impact) and added costs for small manufacturers. Current LCA practices treat all North American wood as sustainable if it is legally harvested from working forests. If this assumption is not true, then the results of LCA would be different.

There are many LCA methodological challenges surrounding wood. These issues are complex and difficult to capture succinctly in EPDs. For example:

- Biogenic carbon: Photosynthesis removes carbon dioxide from the atmosphere and converts it into plant matter. This storage of carbon in a plant via photosynthesis is known as "carbon sequestration" or "biogenic carbon storage." LCA often reports this quantity of carbon as a net negative impact or a "carbon credit." However, carbon removed from the forest takes years to re-grow and at the end-of-life, it is often emitted in landfills or through combustion. The value of this credit varies depending on the temporal frame of reference, but this variation is not commonly addressed. For EPDs, ISO 21930 dictates that biogenic carbon may only be counted as a credit when the wood originates from sustainably managed forests, i.e., "responsibly sourced and certified to the Canadian Standards Association (CSA), Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SF) Standards, as well as all other standards globally endorsed by the Programme for the Endorsement of Forest Certification International (PEFC International) and the FSC."

- Sustainable forest management and certification: Forest management certification and chain-of-custody certification are mechanisms that help encourage and document sustainable practices in the wood products industry. EPDs currently are not required to disclose this information, and it is not possible to determine whether a forest is sustainably managed based on the GWP values of the wood product reported in typical EPDs.

- Land use change and ecosystem impacts: LCA is good at capturing inputs and outputs for industrial processes, but the data and methods for capturing the effects on natural systems caused by land use change and ecosystem impacts are less developed and inconsistently applied. These can have important

implications for climate change but are difficult to quantify. It is currently not possible to determine the land use change effects and ecosystem impacts based on the GWP values of the wood product.

The wood product category rule (PCR) requires wood product EPDs to include statements about the limitations of wood EPDs with regards to landscape-level forest management impacts, additional social and environmental impacts, data averaging, and variability.[3]

### *Future potential*

EPDs for more engineered wood products (mass timber, in particular) may be available in the near future, whereas EPDs for dimensional lumber and other bulk wood products will likely take longer to appear on the market. Currently, the US has the following number of product-specific EPDs for the following types of wood products:

- Engineered wood products:
  - Composite lumber: 1
  - Mass timber: 6
- Bulk wood products:
  - Prefabricated wood: 1
  - Sheathing panels: 4
  - Wood framing: 1
  - Wood joists: 4
- Non-structural wood: 6

### *Discussion*

The number of construction material EPDs has grown exponentially over the past decade. Since the advent of the first state-level low environmental impact procurement legislation in California in 2017, there has been a particularly steep growth. See Figure 9.

[3] ULe, “Part B: Structural and Architectural Wood Products EPD Requirements,” 2018, www.ul.com/businesses/environment.

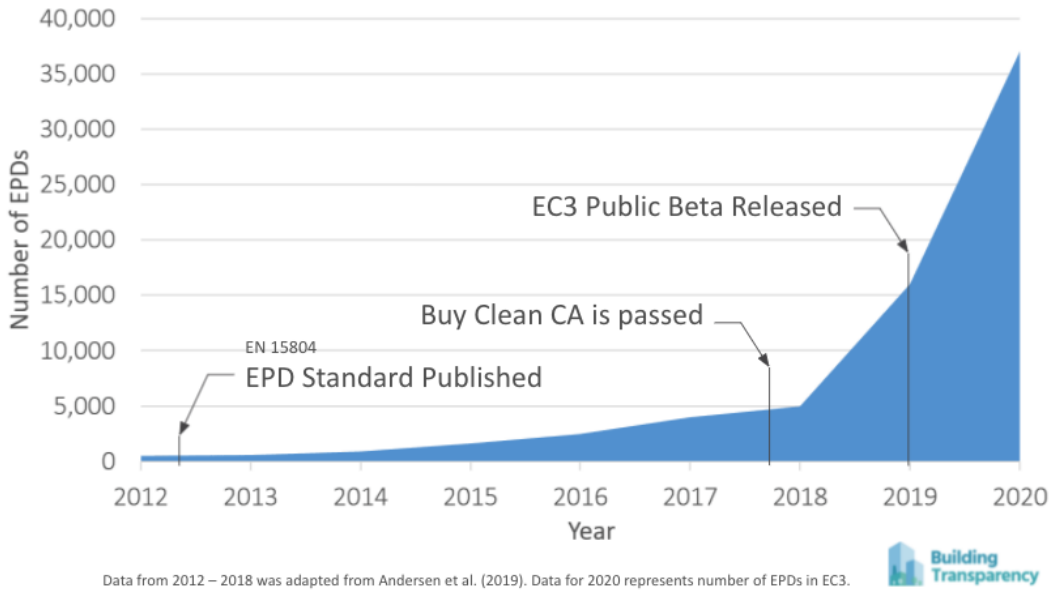



Figure 9. Growth of EPDs from 2012 - 2020. Source: Building Transparency.

### Minnesota-based manufacturers with EPDs

According to EC3, the following manufacturers in Minnesota have EPDs:

- Aggregate Industries USA has 203 ready-mix concrete EPDs and 21 flowable fill EPDs.
- Gerdau Long Steel has one steel 1 EPD (a fabricated Merchant Bar Quality (MBQ) steel EPD).

Minnesota-based manufacturers have not created EPDs for masonry, aluminum, nor wood.

## Section 2: Summary of Other programs

This section provides a review of construction material procurement policies both in place and in development in the United States and other countries.

Broadly speaking, there are two types of policies targeting reductions in greenhouse gas emissions associated with the supply chain or full life-cycle of construction materials:

- A material-approach, which focuses on measuring and reducing GHG emissions for a set list of carbon-intensive construction materials typically only from the extraction, transportation, and manufacturing phases. This targets improvements in clean manufacturing processes and requires action from general contractors and construction material manufacturers. Examples of this type of policy include the Portland Low Carbon Construction Purchasing Program and the Buy Clean California Act.

- A building-approach, which focuses on measuring and reducing GHG emissions from a whole building or infrastructure project across the entire life cycle. This targets a broader range of strategies, such as material and building reuse and architectural and structural design changes, such as system and material selection or material efficiency. Examples of this type of policy are Vancouver's Green Building Requirements, Denmark's Bæredygtighedsklassen and the current B3 requirements in Minnesota for state construction.

A rigorous approach to reducing embodied carbon in building construction should integrate both types of policies to both avoid embodied carbon during pre-design with a building approach and minimize embodied carbon during procurement with a material approach.

### United States

Embodied carbon policy has been growing in the US in recent years. Some of these policies address embodied carbon in government projects by incorporating low-carbon construction purchasing requirements into government purchasing. Other governmental policies address embodied carbon through green building programs, climate action plans, pilot study bills, and even legislation that specifically addresses a single material such as concrete.

This section provides an overview of embodied carbon policies at the federal and state levels.

#### *Federal*

The federal government has a few programs in place that address embodied carbon, and several pieces of introduced legislation that have not passed. This past year (2021), President Biden signed an executive order directing federal agencies to introduce a Buy Clean program as part of reaching net-zero emissions from procurement by 2050, Congress included embodied carbon in the appropriations bill (Build Back Better Act) and

introduced a Federal Buy Clean program in the CLEAN Future Act, and the General Services Administration (GSA) adopted an advice letter that outlines low embodied carbon strategies for the GSA.

**Federal Sustainability Executive Order**

On December 8, Biden signed an executive order[4] that directs the federal government to achieve net-zero emissions from federal procurement no later than 2050, including a Buy Clean policy to promote the use of construction materials with lower embodied emissions.

**Build Back Better Act**

The Build Back Better Act[5] (waiting for a vote in the Senate as of January 2022) appropriates over $4 billion to fund:

- An environmental product declaration (EPD) technical support and grant program to be administered by the EPA to support product manufacturers, which would remove the financial barrier to widespread creation of EPDs across the U.S.;
- A Federal Highway Administration program to identify low carbon materials for transportation projects based on data from EPDs, supporting the adoption of low carbon procurement by departments of transportation across the U.S.; and
- Federal pilot programs for procurement of low carbon materials on General Services Administration (GSA) projects and projects administered by the Federal Emergency Management Agency (FEMA).

**CLEAN Future Act: Federal Buy Clean Program**

In March 2021, the House Committee on Energy & Commerce introduced the *Climate Leadership and Environmental Action for our Nation's (CLEAN) Future Act*. This climate-oriented bill aims to "achieve net zero greenhouse gas pollution no later than 2050, with an interim target of reducing pollution by 50 percent from 2005 levels no later than 2030." It is a wide-ranging bill that tackles the power, building, transportation, and industrial sectors. Sections 521-525 of the CLEAN Future Act lay out the Federal Buy Clean program.

**General Services Administration Advice Letter**

In February of 2021, the Green Building Advisory Committee (GBAC) approved an advice letter on procurement policy recommendations to reduce embodied carbon at the GSA.[6] The GSA is a federal agency that supports the basic functions of the federal government, including procurement. The approved letter outlines the environmental, economic, human health, and social justice benefits of reducing industrial greenhouse gas emissions. The letter also asserts that the benefits of reducing embodied energy and carbon in the GSA's construction portfolio could be achieved with "little to no additional cost [to the GSA] beyond a minimal amount

[4] The White House. (2021). FACT SHEET: President Biden Signs Executive Order Catalyzing America's Clean Energy Economy Through Federal Sustainability.
https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/08/fact-sheet-president-biden-signs-executive-order-catalyzing-americas-clean-energy-economy-through-federal-sustainability/

[5] US Congress. (2021). H.R.5376 - Build Back Better Act.
https://www.congress.gov/bill/117th-congress/house-bill/5376/text

[6] US General Services Administration. (2021). *Advice Letter: Policy Recommendations for Procurement of Low Embodied Energy and Carbon Materials by Federal Agencies.*
https://www.gsa.gov/cdnstatic/GSA%20GBAC%20Low%20EC%20Procurement%20Policy%20Advice%20Letter-2-17-21.pdf

of administrative time" while encouraging a market shift towards lower-energy and lower-carbon materials. The recommendations describe material-based and building-based approaches to reduce embodied carbon, such as collecting EPDs for eligible materials and conducting whole building LCAs to measure and reduce embodied carbon. The policy recommendations outlined in the letter were intentionally aligned with existing federal policy and systems. This makes it relatively easy for the GSA to expand its current procurement standards (*Facilities Standards for Public Buildings Service (P100)*) to include embodied carbon because the recommendations would be similar to existing environmental policies on energy targets, accessibility, or waste diversion.

**Summary table**

Table 6 below summarizes ongoing federal policies related to embodied carbon and their current status. In addition to the policies described above, the Federal Highway Administration (FHWA) runs a sustainable pavements program that addresses embodied carbon.

Table 6. Summary of federal policies and programs related to sustainable construction material procurement.

| Name | Status | Year implemented | Description |
|---|---|---|---|
| Federal Sustainability Executive Order | Signed/ Active | December 2021 | Directs the federal government to create a Buy Clean policy as part of achieving net-zero emissions from federal procurement no later than 2050. |
| FHWA Order 4460.3A - Green Procurement Planning | Passed/ Active | June 2010 | This order establishes a policy for implementing a green purchasing program for the Federal Highway Administration (FHWA). |
| FHWA Sustainable Pavements Program | Passed/ Active | Circa 2011 | This program provides resources for transportation agencies to reduce embodied carbon, such as the Pavement LCA Tool and a webinar series on asphalt sustainability. |
| Build Back Better Act | Proposed (as of 2021) | N/A | Appropriates funding to create an EPD grant program administered by the EPA, for pilot projects at the GSA and FEMA, and to support the FHWA in identifying low carbon materials for transportation projects. |
| Federal Buy Clean Program (CLEAN Future Act) | Proposed | N/A | Part of this bill would establish federal "Buy Clean" standards using federal funds. These standards would promote the procurement of building materials and products that were manufactured through low-GHG intensity processes. The bill would also establish a National Environmental Product Declaration (EPD) database to help verify the embodied carbon of materials and products acquired with federal funds. |
| GSA Advice Letter | Proposed | N/A | This letter describes approaches that the GSA could adopt to reduce embodied carbon in its construction portfolio, including collection of EPDs during procurement. |

### *States*

Many state governments are beginning to show interest in embodied carbon legislation. The first piece of legislation that targeted low-carbon construction material procurement was known as "Buy Clean," and was first introduced and passed in California in 2017. Similar legislation is currently being explored by other state governments (as well as the federal government). Colorado recently passed a similar version of this bill, while Minnesota, Oregon, Washington have introduced (but not successfully passed) similar bills. Other states -- Connecticut, Hawaii, New Jersey, New York -- have passed concrete-specific legislation that addresses the carbon emissions of concrete.

Table 7 provides an overview of state-level construction material procurement policies on embodied carbon by status and state. Many of these policies were introduced in the past two years (2019 - 2021), focusing on government procurement and targeting a specific set of materials, also known as "eligible materials." Some of these policies are even specifically targeted at concrete or cement. Some policies only require the submission of

EPDs, while others are more aggressive and apply GWP limits to eligible materials. Note that more policies/programs have passed (or are active) than not.

Table 7. State-level policies (outside of Minnesota) on construction material procurement policies.

| Status | State | Name of policy | Year implemented | Description |
|---|---|---|---|---|
| Passed/ active | California | Buy Clean California Act (BCCA) Public Contract Code Sections 3500-3505 | January 2019 | This bill requires facility-specific EPDs to be provided for eligible materials in state-funded construction starting in January 2019. Beginning July 1, 2021, eligible materials must be below the maximum GWP limits set by the Department of General Services (DGS). |
| | | Senate Bill 596: Greenhouse gases: cement sector: net-zero emissions strategy | Passed September 2021 | This bill will require the state board, by December 31, 2022, as part of, or in coordination with, the scoping plan, to develop a comprehensive strategy for the state's cement sector to achieve net-zero emissions of greenhouse gases associated with cement used within the state as soon as possible, but no later than December 31, 2045 |
| | | Caltrans EPD Implementation Project | January 2019 | This project collects EPDs for materials incorporated into construction projects in order to quantify the GWP emissions of construction materials in Caltrans projects. |
| | Colorado | HB21-1303: Global Warming Potential for Public Project Materials | July 2021 | This bill requires the Office of the State Architect and Colorado Department of Transportation (CODOT) to set global warming potential (GWP) disclosure requirements and limits for eligible materials in state building and transportation construction projects. |
| | New Jersey | Assembly Bill 4933: An Act concerning the purchase and use of unit concrete products that utilize carbon footprint-reducing technology... | Passed both houses June 2021 | This is a bill to establish state purchasing preferences and tax incentives related to unit concrete products (not including ready mix) that utilize carbon footprint-reducing technology. |

| | | | | |
|---|---|---|---|---|
| | New York | Senate Bill 542A: An act to amend the state finance law, in relation to provisions in state procurement contracts involving the use of low embodied carbon concrete | Passed both houses June 2021 | This is a bill to establish requirements for the procurement of low embodied carbon concrete in state contracts. This bill is also known as the New York State Low Embodied Carbon Concrete Leadership Act (LECCLA). |
| | Oregon | Oregon Concrete EPD Program | 2016 | This program is a partnership between Oregon DEQ and Oregon Concrete and Aggregates Producer Association (OCAPA) to help concrete businesses measure and disclose the environmental impacts of their concrete mixes using Environmental Product Declaration (EPDs). |
| | Washington | Budget proviso: Buy Clean Buy Fair (BCBF) Washington Pilot Program and Reporting Database | June 2021 | This budget proviso requires the University of Washington to create a reporting database for Buy Clean Buy Fair and conduct a case study/pilot analysis of 2 - 10 pilot projects. |
| Proposed | California | Senate Bill 778: Buy Clean California Act: Environmental Product Declarations: concrete | N/A (introduced 2021) | An amendment to the Buy Clean California Act that introduces concrete as an eligible material, updates the EPD requirements, and adds performance-based specification requirements and performance incentives for concrete. |
| | Massach-usetts | House Bill 4182: An act relative to green building materials | N/A (introduced 2021) | This is a bill to require submission of EPDs for eligible materials on state projects. GWP must not exceed set limits. |
| | New Jersey | Assembly Bill 5223: An act concerning the purchase and use of low embodied carbon concrete... | N/A (introduced 2021) | This is a bill to establish state purchasing preferences for low embodied carbon concrete and tax credits for the costs of creating EPDs. |
| Did not pass | California | California Assembly Bill 1369 | N/A (introduced 2021) | This is an amendment to the Buy Clean California Act that would have introduced finish materials and shifted the requirement for EPDs to be product-specific instead of facility-specific. |
| | Connecticut | HB 5444: An act concerning the carbon content of concrete used in state projects | N/A (introduced 2021) | This bill would have required low embodied carbon concrete to be used in Connecticut state projects. |

| | | | | |
|---|---|---|---|---|
| | Hawaii | HB1282 HD1: Relating to state building construction | N/A (introduced 2019) | This bill would have required all state building construction that uses concrete to use post-industrial carbon dioxide mineralized concrete. |
| | Oregon | HB 2688: Relating to procurements of certain materials at the lowest carbon dioxide cost; declaring an emergency | N/A (introduced 2021) | This bill would have established bid selection requirements for state contracting agencies based on the environmental product cost of certain products, as calculated and defined by the Department of Environmental Quality. |
| | Washington | HB 1103: Improving environmental and social outcomes with the production of building materials | N/A (2021) | This bill would have required the submittal of supply chain-specific EPDs and working conditions data for structural materials on Washington State construction projects, |

### *Minnesota programs and policies*

Minnesota has the Buildings Benchmarks and Beyond (B3) Program, which is a set of tools and programs to evaluate and improve sustainability in buildings. All projects funded by the state must use the B3 guidelines as performance requirements. These tools and programs include:

- B3 Guidelines, which help meet sustainability goals for site, water, energy, indoor environment, materials and waste for new buildings or renovations
- SB 2030 Energy Standard, which describes carbon/energy goals for new buildings or renovations
- B3 Benchmarking, which tracks and compares carbon/energy use on existing buildings and for all new buildings for the first ten years of operations.
- B3 Energy Efficient Operations, which helps minimize energy use during building operations
- B3 Post Occupancy Evaluation, which helps determine occupants' perceptions of the buildings' indoor environmental quality

Several low environmental impact material bills have been proposed in the Minnesota legislature in 2021 and in previous years. In May 2021, Minnesota funded the commissioner of Administration to contract with the University of Minnesota Center for Sustainable Building Research (CSBR) to complete a study to examine the feasibility, economic costs, and environmental benefits of requiring Type III supply chain-specific EPDs for eligible materials, including the evaluation of similar programs adopted in other states. That amendment resulted in this report.

### City/local jurisdictions

City governments and local agencies have been taking action on embodied carbon through executive orders, resolutions, climate action plans, and deconstruction plans. Some jurisdictions have enacted policies that target concrete -- Marin County (CA), Honolulu (HI), Hastings-on-Hudson (NY), Port Authority of New York and New Jersey (PANYNJ), and Portland (OR). The City of Los Angeles passed an executive order that required the city to

adopt the State of California's Buy Clean requirements, while the City of Newton (MA) introduced a program that provides guidelines for selecting low embodied carbon materials.

Table 8 summarizes these city/local policies on embodied carbon by status and state.

Table 8. Local policies on embodied carbon related to construction material procurement policies. Note that additional policies related to embodied carbon (such as climate action plans) and proposed policies are excluded from this summary.

| Status | State | Name | Year implemented | Brief description |
|---|---|---|---|---|
| Passed/ active | California | Los Angeles Executive Order No. 25: LA's Green New Deal | February 2020 | This executive order requires the City Engineer to require the Bureau of Engineering (BOE) to adopt the Buy Clean CA requirements for steel, insulation, and glass and to study the use of building materials that sequester carbon |
| | | Marin County Low Carbon Concrete Code | 2019 | This policy project requires new projects in Marin County to meet cement limit or GWP limits (verified by an EPD) at the concrete mix level or for the building in total. |
| | | San Diego Incentive Program | 2019 or earlier (unknown) | This program offers incentives (such as reduced plan-check turnaround time) if projects meet certain resource conservation measures. |
| | Hawaii | Honolulu Concrete Mineralization Resolution | April 2019 | This resolution requests the city administration to consider using carbon dioxide mineralization concrete for all future city infrastructure projects utilizing concrete. |
| | New York | Hastings-on-Hudson Low Embodied Carbon Concrete Resolution | May 2020 | This is a resolution to provide education related to low-carbon concrete on local building/infrastructure projects. |
| | New York and New Jersey | PANYNJ Clean Construction Program | September 2020 | This program will advance supply chain decarbonization, create demand for lower-carbon materials, and significantly reduce waste and air pollution by addressing carbon emissions at every step of the construction life cycle. |
| | Oregon | Portland Low-Carbon Concrete Purchasing | August 2021 | This policy requires the City's (Pre)Approved Concrete Mix Design List to have a product-specific Type III Environmental Product Declaration (EPD) that is 3rd party–verified and within its 5-year period of validity. |

| | | | | |
|---|---|---|---|---|
| | Washington | City of Seattle Priority Green Expedited Program | Updated Spring 2021 | Requires EPDs to be provided for concrete and steel as part of a holistic green building incentive program. |

## International

Most of the known international policies and programs for construction material procurement in the world are based in Europe. Table 9 provides a summary of policies related to low-carbon construction material procurement from countries outside of the US.

European countries tend to be more progressive than the US in the realm of environmental legislation, and this trend holds true for policies and programs related to embodied carbon. However, while European countries have more advanced policies related to the design of green buildings and measurement of embodied carbon at the building scale (through a practice called whole building life cycle assessment), the US seems to be on par or ahead of Europe in terms of procurement policy. Some European countries have policies specifically on public procurement, such as Finland, France, and the Netherlands, while the US has multiple policies at the state level or local level that address construction materials at the procurement stage. In Europe, procurement policies are less widespread than other kinds of green building policies, at least compared to the United States.

Table 9. List of international (non-US) requirements and legislation related to construction material procurement.

| Geographic scope | Name of requirement/legislation | Summary |
|---|---|---|
| Belgium | Royal Decree on environmental messages | This is a Royal Decree setting the minimum requirements for environmental displays on construction products and for the registration of environmental product declarations in the federal database. |
| Canada | Vancouver Green Building Rezoning Requirements | In order to receive a rezoning permit, design teams must commit to pursuing either Passive House or the City's 10 Low Emission Building Requirements one of which includes reporting the building's embodied carbon through a WBLCA. |
| | Waterfront Toronto Green Building Requirements | One of these requirements is that new buildings must use more sustainable building materials. Options include using 50% recycled metal in steel and rebar, low-carbon concrete (with 25% Supplementary Cementitious Materials), or timber products certified by the Forest Stewardship Council. |

| | | |
|---|---|---|
| Denmark | Bæredygtighedsklassen ("The Sustainability Class") | When applying for a building permit and when completing a building, an LCA assessing the building's life cycle climate impact must be documented. Limits on the building's climate impact are being developed with the goal of establishing limits in 2023. |
| | Sustainability in Construction and Civil Works (Public Project Requirements) | These requirements include: 1) performing LCAs of at least two elements in a building, 2) using crushed builders' rubble as a substitute for base gravel, 3) analyzing which building elements can be reused before demolition or renovation, 4) recycling uncontaminated materials. |
| Finland | Act on public procurement and concession contracts 1397/2016 (Green Public Procurement Requirements) | These requirements include 1) calculating the GHG emissions of materials, 2) selecting options that are both low-cost and carbon-optimal, 3) at least 10% of materials should be renewable or recycled, 4) perform an audit of reusable components before demolition. |
| | Finnish life cycle carbon limits to be published by 2025 | Finland is developing legislation for low-carbon construction to aid in reaching carbon neutrality by 2035, including normative carbon limits for different building types before 2025. Finland's Ministry of the Environment has developed an assessment method and will develop a generic emission database. |
| France | French bio-based procurement requirement for municipal buildings | All new public buildings must be built from at least 50% timber or other natural materials. In addition to wood, the mandate can be fulfilled by bio-based materials made from matter derived from living organisms such as hemp and straw. |
| | Bâtiment à Énergie Positive & Réduction Carbone / Énergie Positive et Réduction Carbone (E+C-) | This is a pilot program incentivizing builders and developers to achieve energy and carbon performance-based targets for the whole life cycle of buildings.<br>This pilot program will become mandatory in 2022, through the 'RE2020' policy included in the Energy Transition for Green Growth law. Projects will no longer receive incentives for participation and will be expected to meet life cycle carbon limits. |
| Netherlands | Building Decree | As of 2013, all new residential and office buildings in excess of 100 $m^2$ must have their embodied carbon emissions calculated and reported (called an 'MPG'). As of January 1, 2018, a maximum limit value of 1.0 applies to the MPG. On 1 July 2021, the environmental performance for new homes (not for offices) tightened from 1.0 to 0.8. The aim is to gradually tighten the requirement and to halve it by 2030 at the latest. |

| | | |
|---|---|---|
| | Dutch Sustainable Public Procurement (SPP) Policy | This procurement policy expresses a preference for bidders who can prove that their operations lead to significant $CO_2$ reductions and a preference for circular economy principles. The Dutch government also developed a Sustainable Public Procurement (SPP) Tool [Maatschappelijk verantwoord inkopen (MVI)] and the DuboCalc software to calculate environmental life cycle costs. |
| Switzerland | Zurich Minergie-Eco requirements | Minergie-ECO is a construction label for new or renovated buildings. It requires embodied energy calculations. The program provides a free Excel tool for calculating embodied energy in early design stages (and recommends other tools for use that are paid). This requirement is voluntary but required by the City of Zurich. |

In general, multiple European countries have their own national certification schemes and government-funded tools and environmental databases to support the environmental assessment of buildings. Table 10 provides a summary of government-funded tools and databases in Europe, including national databases with EPDs and average (i.e., non product-specific) product life cycle assessment information.

In contrast, the United States does not have government-sponsored tools for embodied carbon assessment of buildings. Users must rely on privately-funded tools (often funded through non-profit organizations), such as Athena, Tally, or EC3. Although the United States does have a federally-funded national life cycle inventory database, it does not have a federally-funded database specific to building materials. The United States LCI database is not adequately funded or supported.

Table 10. List of international (non-US) government-funded tools and databases related to construction material procurement.

| Geographic scope | Name of tool / database |
|---|---|
| Austria | Bau-EPD (EPD Database and reporting framework) |
| | Eco2soft (software for whole building life cycle assessments) |
| Belgium | Tool to Optimise the Total Environmental impact of Materials (TOTEM) (LCA framework/ tool for calculating and communicating environmental performance of construction materials) |
| | Belgium EPD Program (B-EPD) (a national EPD database) |
| France | INIES (a national EPD and life cycle inventory database) |

| | |
|---|---|
| Germany | ÖKOBAUDAT (a database including company-specific EPDs and generic (average) datasets for performing whole building life cycle assessments) |
| Ireland | Transport Infrastructure Ireland (TII) Carbon Assessment Tool for Road and Light Rail Projects |
| Netherlands | Dutch National Environmental Database with average life cycle inventory data and EPDs |
| | Sustainable Public Procurement (SPP) Tool [Maatschappelijk verantwoord inkopen (MVI)] |
| | DuboCalc (a software tool for quick and easy calculation of sustainability and environmental design variants of ground, road and water works) |
| Sweden | Klimatkalkyl (web-based tool or 'climate calculator' that includes a database of embodied energy and GHG emissions of different transportation infrastructure types) |
| Switzerland | KBOB Platform life cycle assessment data in the construction sector |

### Voluntary programs

A large number of voluntary green rating systems and commitment programs around the world include embodied carbon measurement and reduction. *The Embodied Carbon Review - Embodied Carbon Reduction in 100+ Regulations and Rating Systems Globally* by Bionova identified 105 green building certifications in addition to BREEAM, LEED v4, and the Zero Carbon standard that also include voluntary embodied carbon reporting and reduction requirements.[7]

Under the US Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) rating system, project teams can earn points for quantifying the embodied carbon of the project and further points if this carbon is reduced. Project teams can also earn points for cataloguing and optimizing EPDs. Product-specific Type III EPDs are valued highest, promoting transparency within the industry by encouraging suppliers to commission EPDs.

Under the International Living Future Institute's (ILFI) Living Building Challenge (LBC) and Zero Carbon Certification, teams are required to quantify their embodied carbon and prove a reduction. Through these programs, project members are encouraged to not only focus on a particular material or product, but to also view the project holistically.

Table 11 provides a list of international green building certification programs and government standards that include credits or requirements related to procurement of low-carbon construction materials.

[7] Bionova Ltd. (2018). *The Embodied Carbon Review - Embodied Carbon Reduction in 100+ Regulations and Rating Systems Globally*. https://www.oneclicklca.com/embodied-carbon-review/

Table 11. List of international (non-US) green building certification programs and government standards that include credits or requirements related to procurement of low-carbon construction materials.

| Geographic scope | Name of green building certification program |
|---|---|
| Austria | Österreichische Gesellschaft für Nachhaltiges Bauen (ÖGNB) / Total Quality Building (TQB) Assessment |
| Canada | CaGBC Zero Carbon Building Standard |
| Germany | DGNB Certification System |
| Japan | EcoLeaf Environmental Label |
| Singapore | Singapore Green Mark Scheme |
| Sweden | Miljobyggnad |
| Switzerland | Swiss Sustainable Building Standard / Standard Nachhaltiges Bauen Schweiz (SNBS) |
| UK | Home Quality Mark |
| UK (can be global) | Building Research Establishment Environmental Assessment Method (BREEAM) |
| | CEEQUAL |
| Global | EDGE (Excellence in Design for Greater Efficiencies) |
| | Green Globes |
| | International Living Future Institute Living Building Challenge |
| | International Living Future Institute Zero Carbon Certification |
| | LEED v4 |

Table 12 provides a list of international (non-US) certifications for sustainable construction materials.

Table 12. List of other international (non-US) certifications for sustainable construction materials.

| Geographic scope | Name of certification |
|---|---|
| Global | Concrete Sustainability Council (CSC) Certification System |
| | Responsible Steel Certification |

In addition to voluntary green building rating systems, there are a growing number of voluntary commitments targeting different stakeholder groups that relate to embodied carbon, such as the 2030 Challenge for Embodied Carbon, the C40 Clean Construction Declaration, the SE2050 Commitment Program for structural engineering firms, and the AIA Materials Pledge. Table 13 provides a list of international (non-US) voluntary commitment programs related to construction material procurement.

Table 13. List of international (non-US) voluntary commitment programs related to construction material procurement.

| Geographic scope | Name of program | Description |
|---|---|---|
| Global | The 2030 Challenge and the AIA 2030 Commitment | Commitment to reduce embodied carbon to 45% or better in 2025, 65% or better in 2030, or Zero GWP by 2040. |
| | C40 Clean Construction Declaration | Pledge for cities to reduce embodied emissions by at least 50% for all new buildings, major retrofits, and infrastructure projects by 2030, striving for at least 30% by 2025, and to procure and use only zero emission construction machinery from 2025 and require zero emission construction sites city-wide by 2030. |
| UK | RIBA 2030 Climate Challenge | Commitment for British architecture firms' projects to meet operational energy, embodied carbon, and operational water use targets by 2030. |
| US | SE2050 | Commitment for structural engineering firms' projects to reach net-zero by 2050 |

## Section 3: Feasibility, Economic Costs and Environmental Benefits

This section discusses the feasibility, economic costs, and environmental benefits of using EPDs in state construction.

### Feasibility

EPDs are currently being used in construction procurement across the country. The jurisdictions that have started requiring EPDs in construction procurement have identified the following challenges:

- Setting baseline numbers. Having material baseline numbers helps set emissions reduction targets. In addition to the data provided by industry-wide EPDs, the CLF publishes material baseline reports with a summary of low, median, and high baselines for over 30 types of products: https://carbonleadershipforum.org/material-baselines/. Currently, there is not much robust data to set geographically-specific baseline numbers to help set reduction targets, aside from the NRMCA's Regional Benchmark Report.

- Clarity on the submission process. Currently, not all jurisdictions are set up to collect EPDs in terms of digital infrastructure (i.e., having an online portal or database). Additionally, project teams don't always know where, to whom, and when during the design-construction process they should submit data.

Agencies responsible for policy compliance typically require dedicated staff to manage the submittal process and establish internal policies. Dedicated staff would be needed to respond to questions such as: What if a company submits the wrong EPD, or if they don't submit any EPDs at all? How should the jurisdictional authority verify that the correct EPDs are submitted? How would they enforce EPD submittals? What kind of incentives would be useful and how could they be implemented?

EPDs are useful for comparing the environmental impacts of construction materials on the market, but there are drawbacks and limitations:

1. EPDs can be costly to produce, which may discourage or prevent smaller manufacturers from producing EPDs of their products.

2. The specificity of EPDs varies (e.g., product-specific vs manufacturer-specific vs industry-wide), and the background LCA data of EPDs also vary in source and level of specificity, all of which make it difficult to ensure confidence in the precision of EPD results.

In terms of market coverage, different material categories have different levels of EPD market coverage. For concrete, even though there are a lot of concrete EPDs (more than any other material category by far), the number of concrete producers who publish EPDs is relatively small compared to the total number of concrete producers in the country. For steel, even though there are fewer steel EPDs on the market than concrete, a relatively large number of steel producers do have EPDs, since there are not as many steel producers in the

country. For wood, there are currently very few product- or manufacturer-specific EPDs relative to the number of companies that produce wood products.

In conclusion, using EPDs in construction procurement policies is feasible, but agencies would need to employ dedicated staff to support and enforce the policy, and contractors and suppliers may run into challenges complying with these policies. However, a well-designed policy can accommodate these potential adoption challenges while encouraging widespread production of EPDs.

### Economic costs

Using EPDs in state construction can potentially have a financial impact on the State, suppliers, and design/construction teams in the following ways:

- State: The State will likely have to spend money to set up a digital reporting infrastructure and hire staff to manage the submitted data. If the State decides to set Global Warming Potential (GWP) limits, they will need staff or consultants to develop the limits, lead a stakeholder engagement and public feedback process, and manage compliance. For example, the Buy Clean California and Buy Clean Colorado legislation both funded 1 full time equivalent (FTE) staff at the California Department of General Services and Colorado Office of the State Architect. Further research would be needed to evaluate potential impact on cost of materials if GWP limits are established. Initial research from Rocky Mountain Institute (RMI) indicates that 19 to 46 percent reductions in embodied carbon are achievable at cost premiums of less than 1 percent.[8]

- Suppliers: Suppliers who don't already have EPDs would have to spend approximately $10,000 - $30,000 USD[9] to hire a consultant to develop a third party-verified EPD for their products. This could be a significant cost to smaller companies. If GWP limits are used, a portion of suppliers may have to invest money in modifying their manufacturing processes to lower their product's embodied carbon. However, performing an LCA (in order to create an EPD) can also help suppliers identify low-cost opportunities to reduce the carbon of their projects by identifying hot spots in their manufacturing or supply chain. If manufacturing processes require energy efficiency upgrades, these often have quick payback periods.

- Design and construction teams: Project teams would have to integrate EPD requirements into specifications and provide or seek training about the EPD requirements. This level of effort would be similar to existing LEED reporting programs and the existing B3 programs, so project teams should be familiar with the process. The cost to project teams is estimated to be low. Project teams would also have to collect and report EPD data, which is estimated to be a relatively low effort task (estimated to be between 2 days - 2 weeks of staff time for one staff member over the course of the project). The impact

[8] Esau, R., Jungclaus, M., Olgyay, V., Rempher, A. (2021). Reducing Embodied Carbon in Buildings: Low-Cost, High-Value Opportunities. Available at https://rmi.org/insight/reducing-embodied-carbon-in-buildings/

[9] Tasaki, T., Shobatake, K., Nakajima, K., & Dalhammar, C. (2017). *International Survey of the Costs of Assessment for Environmental Product Declarations*. Procedia CIRP, 61, 727-731. https://www.datocms-assets.com/37502/1614956558-internationalsurveyofthecostsofassessmentfo.pdf

on construction itself is estimated to be low, unless procuring an EPD causes schedule delays, or if GWP limits force the contractor to find another more expensive supplier.

### Economic benefits

Low environmental impact material policies can benefit suppliers as well as design/construction teams.

Suppliers can benefit from these types of policies in multiple ways. Manufacturers who have invested in lower-carbon manufacturing processes will have a competitive advantage. For example, most countries around the world use the basic oxygen furnace (BOF) route to produce steel out of raw materials, which results in a very high environmental impact, whereas in the United States, most steel manufacturers use the electric arc furnace (EAF) route to produce steel out of recycled stock, and this results in a lower carbon footprint. Certain American-made materials may have the competitive advantage under these types of policies.

Low environmental impact policies can also motivate suppliers to improve the energy efficiency of their manufacturing processes. Better energy efficiency will result in lower energy bills for suppliers.

Design and construction teams will also have a competitive advantage over teams that do not have experience using EPDs on projects. Embodied carbon reporting and reduction requirements are becoming increasingly prevalent in green building certification programs, standards, and owner requirements. The sooner that contractors and design teams have experience using EPDs, the quicker they can get ahead of these types of environmental regulations.

### Environmental benefits

Low environmental impact material policies have the real potential to reduce carbon emissions. At least 11% of global energy-related greenhouse gas emissions arise from the production of building materials.[10] This number is even larger when considering non-energy-related emissions from the manufacturing of cement, steel, and other construction materials. Procurement policies are widely recognized as a key strategic lever for driving innovation and increasing the sustainability of the private and public sectors across the globe.[11,12] Procurement policies leverage the large purchasing power of governments – which typically make up 12-30% of a country's gross domestic product[13] – to standardize embodied carbon emissions reporting and reward companies doing their part to reduce emissions.

To estimate the potential carbon benefits of a low environmental impact material policy, data from the US Census Bureau and the US Environmentally-Extended Input-Output (USEEIO) model were combined to produce a ballpark value for avoided carbon emissions. The US Census Bureau's Value of Construction Put in Place Survey

[10] UNEP. (2019). *2019 Global Status Report for Buildings and Construction.* https://www.unep.org/resources/publication/2019-global-status-report-buildings-and-construction-sector
[11] UNEP. (2017). *Factsheets on sustainable public procurement in national governments*. https://www.oneplanetnetwork.org/sites/default/files/factsheets2017.pdf
[12] Hasanbeigi, A., Becqué, R., Springer, C. 2019. *Curbing Carbon from Consumption: The Role of Green Public Procurement*. San Francisco CA: Global Efficiency Intelligence. https://www.globalefficiencyintel.com/s/Green-Public-Procurement-Final-28Aug2019.pdf
[13] UNEP. (2017). *Factsheets on sustainable public procurement in national governments*. https://www.oneplanetnetwork.org/sites/default/files/factsheets2017.pdf

provides estimates on the total dollar value of construction work done in the US.[14] This data provides "Annual Value of State and Local Construction Put in Place by State," including values for the State of Minnesota. The total value of state and local construction spending by the State of Minnesota between 2010 - 2020 was approximately $70,250,000,000. The USEEIO model was created by the Environmental Protection Agency (EPA) and provides environmental life cycle results per dollar value for 389 sectors defined by the US Bureau of Economic Analysis (BEA). Global warming potential (GWP), measured in kilograms of carbon dioxide equivalent, per dollar (USD) is one of the life cycle impacts included in the USEEIO model. This USEEIO data was applied to the US Census Bureau's federal construction data (linking building typologies with best-fit economic sectors in USEEIO), to establish a single factor to estimate an overall GWP per dollar of public construction spending.

Using the US Census Bureau spending data and the federal GWP per dollar of public construction spending factor based on the USEEIO data, public construction in Minnesota was responsible for approximately 29,501,000 metric tonnes of CO2e over the ten year period from 2010-2020. According to RMI's recent study, *Reducing Embodied Carbon in Buildings*, embodied carbon can be reduced by 24 - 46% with a less than 1% cost premium.[15] If a low environmental impact policy in Minnesota could reduce embodied carbon emissions by just 10%, this could prevent the release of approximately 295,000 metric tonnes of $CO_2e$ into the air per year.

Low environmental impact material policies (such as Buy Clean) are relatively new and untested policies. It is not yet known if these policies will definitely result in widespread industry transformations, but procurement policies are widely recognized as a key strategic lever for driving innovation and increasing the sustainability of the private and public sectors across the globe.[16,17] More rigorous economic analyses would need to be done in order to understand the broader costs, benefits, and implications of these policies. In the meantime, policymakers can observe how similar policies play out in other jurisdictions, conduct pilot studies, and/or implement innovative policies based on the recommendations proposed in the next section.

[14] United States Census Bureau. *Construction Spending, Historical Value Put in Place*. https://www.census.gov/construction/c30/historical_data.html
[15] RMI. (2021). *Reducing Embodied Carbon in Buildings*. https://rmi.org/insight/reducing-embodied-carbon-in-buildings/
[16] UNEP. (2017). *Factsheets On Sustainable Public Procurement on National Government*. https://www.oneplanetnetwork.org/sites/default/files/factsheets2017.pdf
[17] Hasanbeigi, A., Becqué, R., Spring, C. (2019). *Curbing Carbon from Consumption: The Role of Green Public Procurement.* https://www.climateworks.org/wp-content/uploads/2019/09/Green-Public-Procurement-Final-28Aug2019.pdf

## Section 4: Policy Recommendations and Next Steps

This section presents policy recommendations that the State of Minnesota could consider to create a low environmental impact material policy. More background information on these policy recommendations can be found in the CLF's Embodied Carbon Policy Toolkit.[18]

### Policy components

Low environmental impact material policies typically include three to five components that answer the following questions:

1. Scope: Which materials and projects are impacted by the policy? Under which government agency?
2. Data disclosure: What type of environmental and project data must be submitted to comply with the policy?
3. Standards [optional]: Do materials or projects need to be below a global warming potential (GWP) threshold?
4. Incentives [optional]: Is there financial and educational support available for manufacturers and/or companies that comply with the policy?
5. Compliance: What is the timeline for submission and for implementation of each component of the policy?

High-level strategies for successful policy implementation include the following:

1. Start simply with a short list of high-impact materials for which EPDs are already available.
2. Engage stakeholders early and often, particularly if the policy includes GWP limits.
3. Align with existing frameworks and tools to reduce training requirements and administrative burdens on manufacturers and project teams.
    - Phase in the policy over time.
    - If possible, provide financial incentives to small manufacturers.
    - Provide education and training directly or through partnerships with other organizations.

### Scope

#### *Materials*

The most common materials included in low-carbon procurement policies are concrete and steel (including both structural and reinforcing steel products). Additional materials that have been included in low-carbon procurement legislation include engineered wood, asphalt, flat glass, insulation, and masonry.

Policymakers can consider the following categories of materials:

- Major structural materials, including concrete, steel, and wood
- Civil materials, including asphalt pavement, concrete, and steel
- High-impact trade-exposed materials
- Potentially high-impact architectural materials and finishes, including aluminum, glass, insulation, ceiling tile, gypsum board, and flooring materials

Naming terminology for materials should be aligned with industry terminology to clearly communicate the scope to contractors, engineers, architects, and manufacturers. Policymakers can ensure clear communication of the

[18] https://carbonleadershipforum.org/clf-policy-toolkit/

scope by engaging the local AEC community and suppliers to review material descriptions for clarity. See categories developed in the EC3 tool for examples that have been refined with industry input. Appendix A outlines an initial analysis of the five materials listed in the legislation and the classification in the Construction Specifications Institute (CSI) format.

If limits are included in the policy, it is important that subcategories are developed for each material. For example, the Buy Clean California Act includes three subcategories of structural steel products. The Buy Clean Colorado Act allows the Office of the State Architect and Department of Transportation to establish additional subcategories within each eligible material with distinct maximum global warming potential limits.

### *Projects*

Low environmental impact material policies may focus on vertical construction (e.g., buildings), horizontal construction (e.g., transportation infrastructure), or both.

Additional considerations:

- Allow vertical and horizontal construction to have different compliance requirements. For example, the Buy Clean Colorado Act requires the Office of the State Architect to set requirements for materials for vertical construction, and the Department of Transportation to set requirements for horizontal construction.
- Include an project size threshold (e.g., “projects greater than 20,000 square feet”) or a budget threshold (e.g., “projects with a budget greater than one million USD”) to identify which projects are included and to limit the impact on smaller projects, which often have tighter budgets and less capacity within design and construction teams. The size cutoff for the Small Method in the B3 Guidelines (20,000 gsf of conditioned space) should be considered.

## Disclosure requirements

Low environmental impact material policies should require the following information:

- A valid Type III product-specific EPD
- Material quantities
- Name of company and location of manufacturing facility

Type III EPDs are third party–verified and publicly accessible. This third-party verification is beneficial for agencies, as it removes the burden from agencies to perform verification of the results included in the EPD. However, there is still concern regarding the third-party verification process, particularly for international EPDs. EPDs should be valid at the time of construction and should not be an industry-wide EPD.

Policies may include or phase-in additional data requirements, such as inclusion of facility- or manufacturer-specific upstream data. Policies should require reporting of supply chain specific data for processes that dominate the environmental impacts of cement and steel production (e.g., if the process contributes more than 80% of the overall impact of the product).

### *Limits*

Low environmental impact material policies typically include either a “carrot or stick” approach. In this case, the “stick” approach is to set maximum global warming potential (GWP) limits.

Buy Clean California and Buy Clean Colorado set limits at the industry average and require the identified agency to re-visit every 3-4 years and lower as needed to meet the new industry average. By setting limits, policymakers can anticipate a certain amount of reduction in emissions over time. In order to align with global climate targets, policies may introduce long-term carbon reduction timelines to automatically reduce targets over time. Table 14 presents examples of carbon reduction targets set by global building-related organizations. Policies can “ratchet-down” the limits every 3-4 years to reach these reduction targets by the target year.

Table 14. Embodied carbon reduction targets from global organizations.

| Embodied carbon reduction targets | | | | |
|---|---|---|---|---|
| *Organization* | Target year | | | |
| | *2025* | *2030* | *2040* | *2050* |
| Architecture 2030 | 45% | 65% | Net-zero | |
| LETI | 40% | 60% | - | - |
| C40 | 30% | 50% | - | - |
| WGBC | - | 40% | - | Net-zero |

### *Incentives*

A range of incentives can be used to encourage construction materials to reduce their impact over time. Incentives can be particularly important for addressing equity concerns by providing additional technical assistance, financial incentives, and/or alternative compliance pathways for small businesses.

#### Performance incentives

Agencies may award a performance bonus to general contractors at project completion for materials or projects that achieve a certain reduction in emissions associated with materials. This approach has not yet been used by public agencies for embodied carbon, but this is similar to the type of bonus that is awarded for accelerated project schedules or other cost, schedule, and quality considerations.

### Bid incentives

Bid incentives require contractors to consider carbon alongside cost during the bid process when selecting products. Examples include:

- Scoring carbon impacts alongside price and other qualifications when selecting a bid
- Applying a sliding discount rate by ranking bids according to submitted GWP values and providing a price discount to the lowest carbon bids.
- Applying a performance discount rate by awarding a 5% discount rate to bids with GWPs below the 20$^{th}$ percentile of the range of available EPDs or CLF's low baseline or another low baseline.
- Converting estimated carbon into a cost and adding to each bid price, also referred to as "carbon shadow pricing"

These types of bid incentives have been utilized by the private sector, but there are not yet public agency precedents at the state or federal level specifically related to embodied carbon. The sliding discount rate and performance discount rate were proposed in the original bill language for New York Senate Bill S542A.[19]

### Financial incentives

Financial incentives such as tax credits or direct grants can be provided for the creation of EPDs. This type of incentive is best suited to providing support for small businesses who may not already have EPDs.
Oregon State established a voluntary program that operated from 2017 to 2020 for Oregon suppliers to create EPDs led by the Oregon Department of Environmental Quality (DEQ) in partnership with Oregon Concrete Aggregates Producer Association (OCAPA). The program focused on financial, technical, and educational assistance to Oregon concrete producers and resulted in approximately $50,000 of direct reimbursements for the cost of producing concrete EPDs and successful publication of over 1500 EPDs across 20 different Oregon concrete plants. Another example is the tax credit of up to $3,000 proposed by New York Senate Bill S542A to cover the cost of EPD analysis for concrete and concrete component manufacturers for 2 years.[20]

### *Compliance*

Depending on the policy, compliance requirements may be specified in the policy or left up to the implementing agency. These elements are typically established in the policy:

- Timeline: When are EPDs required? When are incentives available? When will products be required to meet GWP limits, and how often are these limits updated?
- Implementing agency: Which agencies are responsible for setting maximum GWP limits, and which are responsible for tracking compliance to these limits? Agencies with previous experience in rulemaking and public feedback processes may be more readily able to develop GWP limits. Agencies required to set limits will likely require a dedicated staff member.

These strategies are helpful for successful implementation, but do not need to be included in policy language:

- Evaluate past public procurement practices to benchmark the environmental impact of current practices and identify the largest opportunities for improvement.
- Conduct pilot projects to demonstrate feasibility on state projects and publish the results as case studies.

[19] New York State Senate. S542A (original text). 2021–2022 Regular Session (2020). Available at https://www.nysenate.gov/legislation/bills/2021/s542/amendment/original

[20] Ibid.

- If setting global warming potential limits, publish the methodology used to establish limits and invite feedback through a transparent public comment period and invitation to stakeholders to participate in an advisory during their development.
- Establish an online resource portal with clear information on compliance requirements, resources, and FAQ.
- Collect EPDs and material quantities in a central reporting database to track compliance and allow for analysis. This may be built into a state system already used for tracking materials on projects, tied to a third party or public database, or developed by the agency specifically for tracking compliance with the program.
- Provide informational sessions and training opportunities internally for staff and externally for impacted stakeholders, such as manufacturers, contractors, and others in the building design and construction community. Leverage freely available resources and third party organizations to deliver cost-effective educational opportunities.

# Section 5: Conclusion and Next Steps

## Conclusion

This report provides the background research for the availability of environmental product declarations (EPDs) for concrete, unit masonry, metal, wood and engineered wood. Similar policies are reviewed from not only other states, but also federal, municipal and international policies. It is feasible to design a policy to minimize the economic costs to capital construction while providing the benefit of reducing the embodied carbon of the materials for state construction projects. Requiring EPDs for high embodied carbon materials in state construction projects would complement the existing pre-design strategies included in the B3 guidelines for new construction and renovations. The policy for submitting EPDs for some materials could also be used to reduce the embodied carbon of horizontal construction, renovations and other projects beyond B3. Successful policy design requires the following next steps.

## Next Steps

The report establishes the initial context and considerations for the design of an embodied carbon policy for state construction in Minnesota. Engaging stakeholders in the design of the policy is important to balance feasibility/goals and increase the successful implementation.-After establishing clear goals and engaging stakeholders to understand the constraints and opportunities for a policy, a compliance approach should be developed to meet the requirements while minimizing additional administration costs.

### *Establish Goals*

The report assumes the primary goal of an environmentally preferable materials policy is the reduction of embodied carbon in state construction. If there are additional goals for a policy, these should be established before a stakeholder process.

### *Stakeholder Process*

Successful policies in other jurisdictions included a broad stakeholder process in their development. This allows manufacturers, designers, construction companies and building owners to understand the goals of the policy while providing insight into potential constraints. The process can determine the time required to expand the availability of EPDs for the construction materials supply chain on Minnesota state construction projects, the type and timing of the submission of compliance materials and the cost/impacts/benefits of potential policy trajectories.

### *Policy Design and Compliance Approach*

After a stakeholder process, the compliance approach will be developed in detail to support the policy with staffing and support to assure effective management of the policy to optimize the environmental benefits while minimizing the initial and ongoing administrative costs. Funding for additional staffing and ongoing support recommended in the policy design will need to be secured. Updating the Minnesota Sustainable Building Guidelines or B3 to include specific performance metrics, processes and reporting is a natural process to implement embodied carbon requirements into state funded projects . Requiring embodied carbon limits for projects beyond state funded building construction may necessitate changes in statute.

## Appendix A - "Eligible Materials" by CSI Division

CSI Divisions (2020) that relate to the eligible materials of "concrete, unit masonry, metal, wood and engineered wood".

Division 01 - General Requirements

- 014000 - Quality Requirements
- 016000 - Product Requirements

Division 03 - Concrete (Entire Division)
Division 04 - Masonry (Entire Division)
*Does not include:*

- 044000 - Stone Assemblies
- 045000 - Refractory Masonry

Division 05 - Metals (Entire Division)
Division 06 - Wood, Plastics and Composites Entire Division)

*Does not include:*

- 065000 - Structural Plastics
- 066000 - Plastic Fabrications
- 067000 - Structural Composites
- 068000 - Composite Fabrications

The work may include the following divisions:
Division 09 - Finishes

- 093000 - Tiling
- 095126 - Acoustical Wood Ceilings
- 095133 - Acoustical Metal Ceilings
- 095400 - Specialty Wood or Metal Ceilings
- 096200 - Specialty Wood Flooring
- 096300 - Masonry Flooring
- 096400 - Wood Flooring
- 096600 - Terrazzo Flooring
- 097800 - Interior Wall Paneling

The work does not include the following divisions:
Division 02 - Existing Conditions
Division 07 - Thermal and Moisture Protection
Division 08 - Openings
Division 09 - Finishes (sections not listed above)
Divisions 10 through 48