Build With Strength

Addressing Sustainable Concrete through Codes and Standards

Tiffany Reed-Villarreal, P.E., ENV SP
NRMCA Director, Sustainability Codes and Standards

Matthew Lemay
NRMCA Manager, Codes and Sustainability Programs

NRMCA

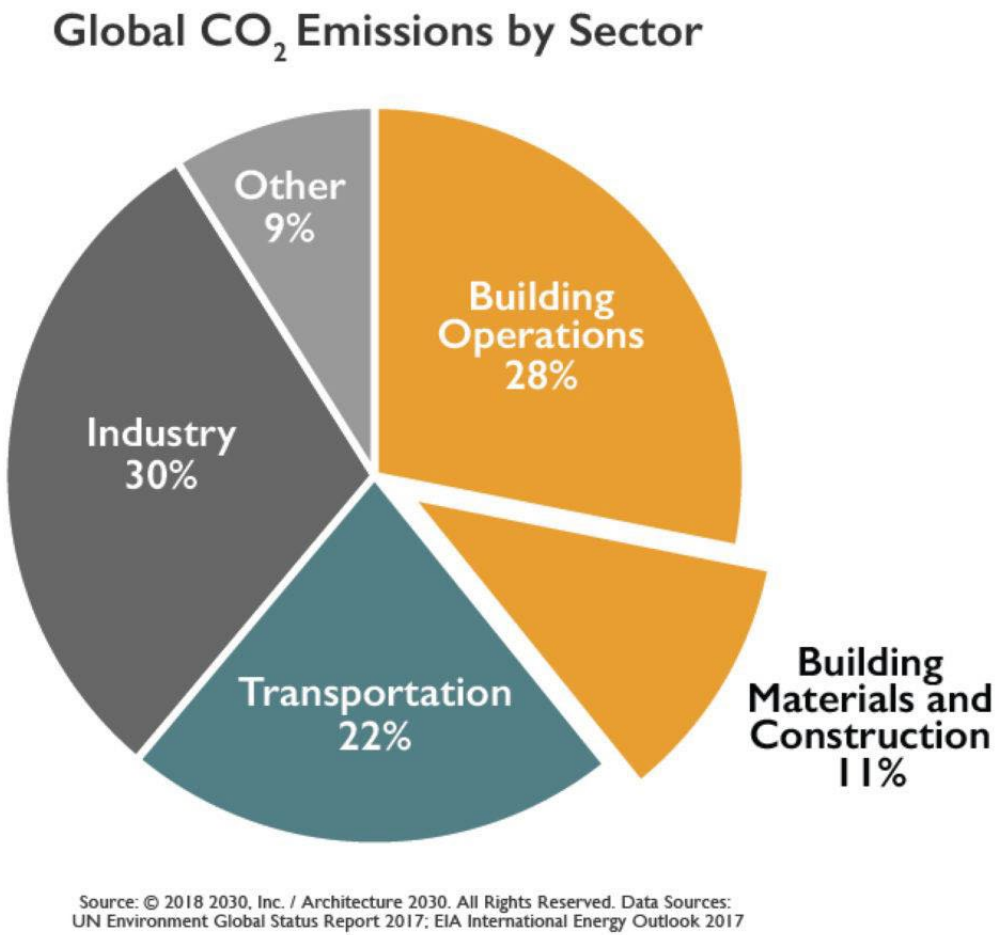
BUILD WITH STRENGTH


AmeriTex

Learning Objectives

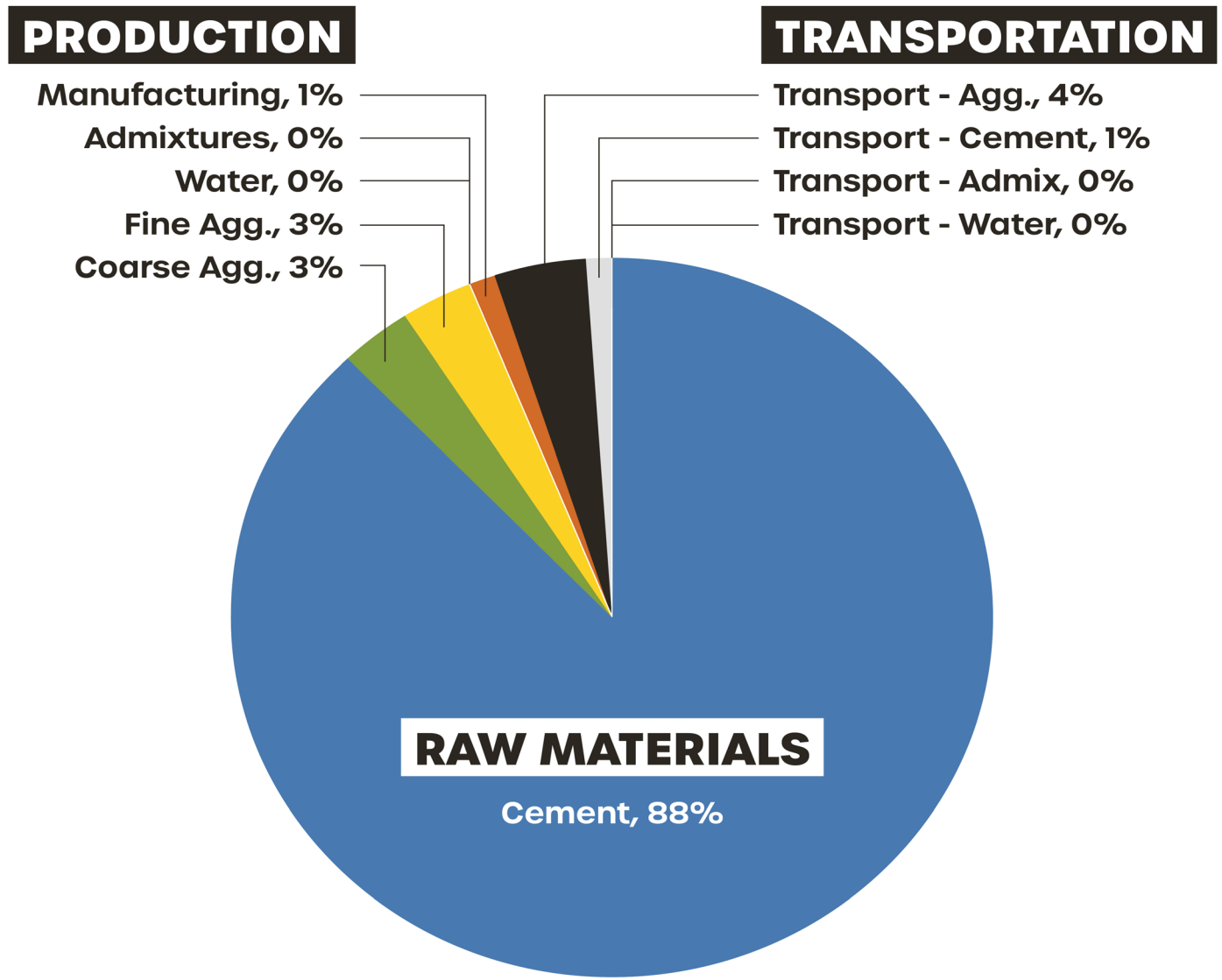
- Understand terminology and concepts relevant to sustainability standards, such as environmental product declarations (EPDs), life cycle inventory (LCI), life cycle assessment (LCA), responsible sourcing and material ingredient disclosure.
- Assess the roles of ASTM, ASHRAE 189.1, LEED v5, the International Green Construction Code, and Architecture 2030 in driving transparency in the AEC industry.
- Analyze concrete's contributions to LEED, and other green building standards.
- Discover the ways in which innovative concrete formulations/uses contribute to sustainability efforts in current Buy-Clean Federal and State requirements.

Global Building and Construction



- Embodied carbon from the building materials produce 11% of annual global GHG emissions.
- Concrete, iron, and steel alone produce ~9% of annual global GHG emissions.
- Likely will need to build with more robust materials like concrete.
- How do we minimize environmental impacts?

Where is the Embodied Carbon in Concrete?



Concrete Challenge: Sustainability

Limestone quarries and cement factories are often sources of air pollution. Photograph: Zoonar GmbH/Alamy

Best of 2019

Concrete: the most destructive material on Earth

HARD SCIENCE — SEPTEMBER 29, 2019

We may have to abandon concrete to fight climate change, architectural experts say

The building material seems so ubiquitous — what can we use in its place?

KEY TAKEAWAYS

● Concrete is a surprisingly dangerous contributor of greenhouse gas emissions. ● For years, architects haven't been concerned with these emissions since concrete buildings last for so long; their carbon footprint is spread out over their entire lifespan. ● However, as we approach climate "tipping points," the front-loaded cost of concrete construction may be too high.

How Did NRMCA Get Here?

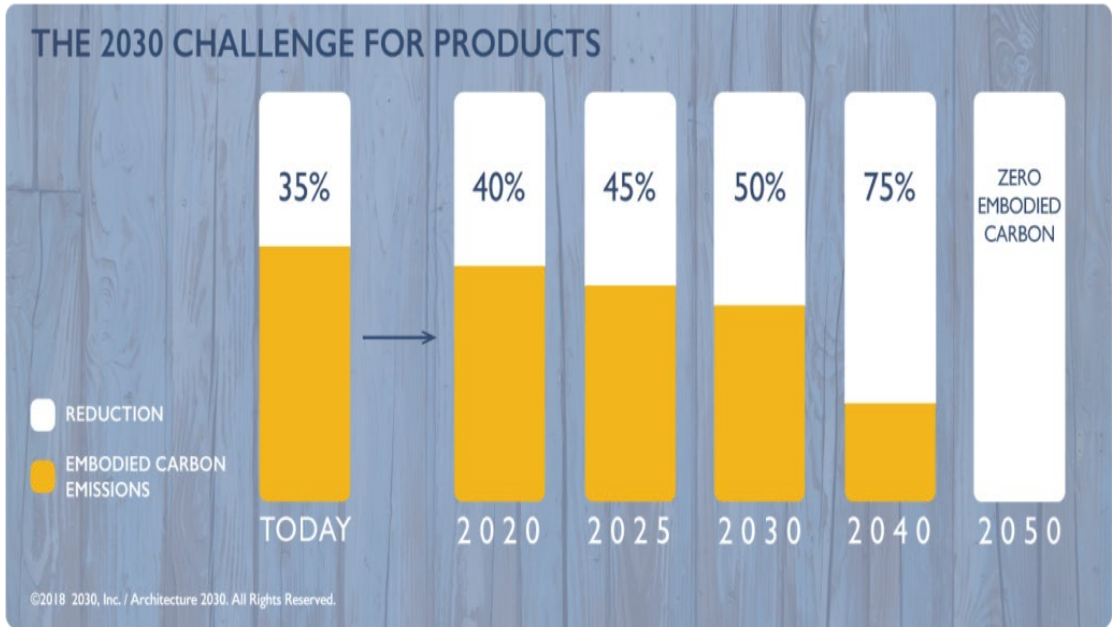
2009 2012 2014 2016 2021

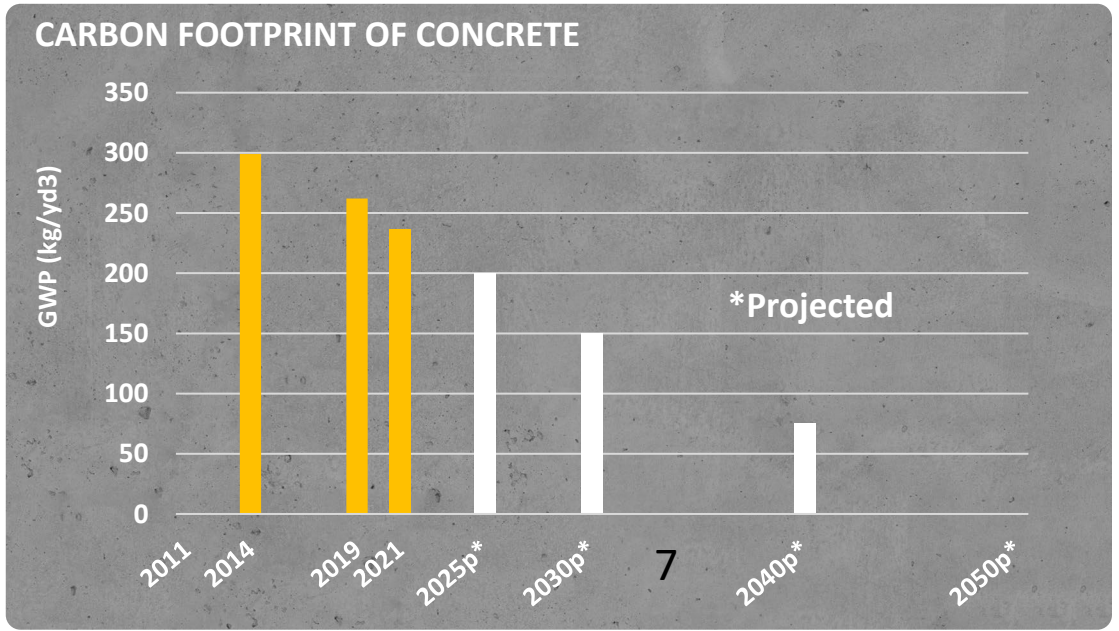
ADOPTER architecture 2030 CHALLENGE

NRMCA CERTIFIED EPD

BUILD WITH STRENGTH

Roadmap to Carbon Neutrality
A more sustainable world is Shaped by Concrete





H.R.5376 – Inflation Reduction Act (IRA) of 2022

- $5.8B allocated for an advanced manufacturing fund intended to help speed decarbonization at industrial plants (SEC. 50161)
  - Disbursed through grants and loans
  - Also expands eligibility for tax credits for installing emissions-reduction equipment at plants

- $5.5B allocated across federal agencies — including $2.15 billion to GSA (SEC. 60503) and $2 billion to the FHWA (SEC. 60506) — to procure low-carbon materials for transportation and other projects

H.R.5376 – Inflation Reduction Act (IRA) of 2022 (cont'd)

- $250M allocated to the Environmental Protection Agency (EPA) to help manufacturers develop Environmental Product Declarations (SEC. 60112)

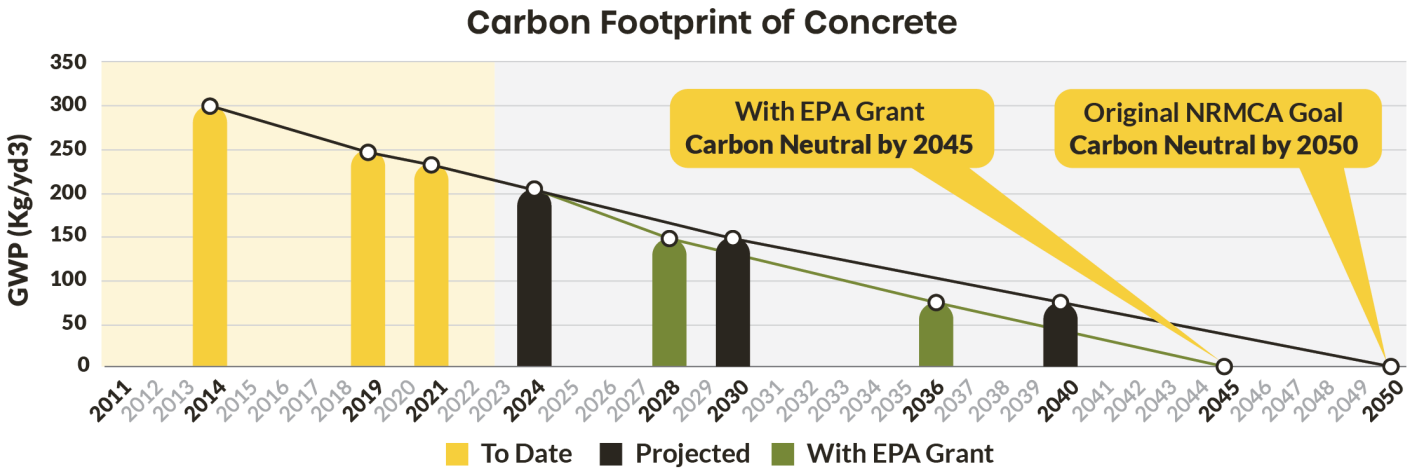
- $100M allocated for EPA, FHWA, and GSA to develop and carry out a program for construction materials to identify and label construction materials and products that have substantially lower levels of embodied greenhouse gas emissions (SEC. 60116)

NRMCA Selected for $9.63 Million EPA Grant

Accelerating Concrete's Drive To Carbon Neutrality

Project Goal

Reduce the carbon footprint of concrete by 50% by 2028 and achieve carbon neutrality by 2045.



Objectives

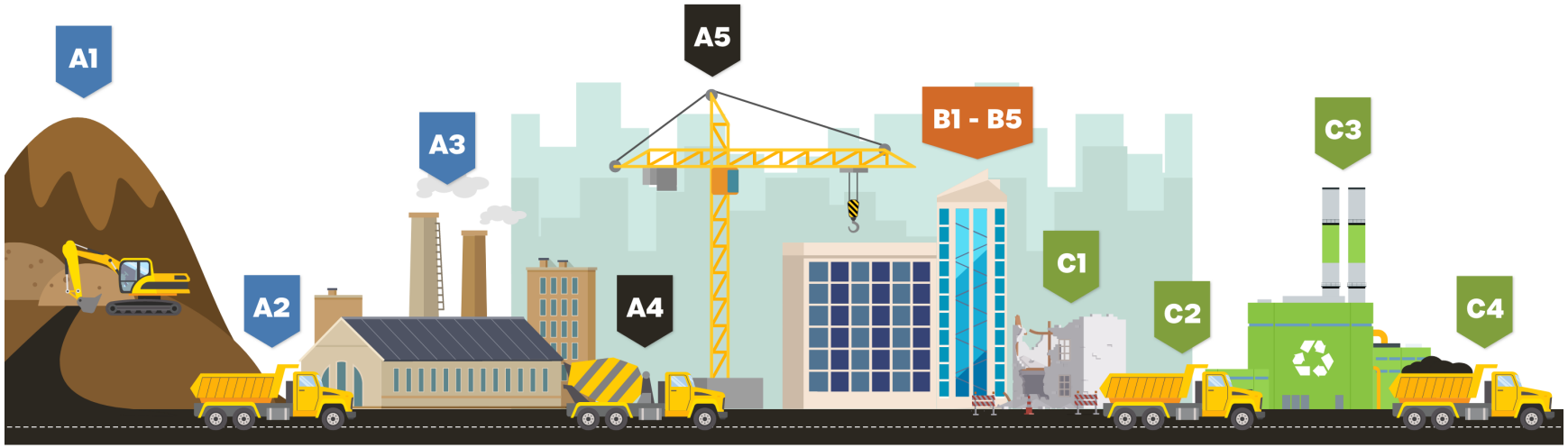
1. Increase concrete EPDs** from 1,500 plants to 4,500 plants in 5 years
2. Provide data quality management oversight and training for EPDs professionals
3. Enhance NRMCA's concrete calculator tool with low-carbon concrete guidance
4. Publishing carbon footprint benchmarks for 50 subregions to measure progress
5. Improve data availability for cement, SCMs, admixtures and aggregates

www.nrmca.org/EPAGrant

Green Public Procurement: Current Progress and Policies

Saturday, 2-4 pm

Sources of embodied carbon across the construction lifecycle



A1 - A3 Product Stage

A1 Raw material extraction
A2 Transport to manufacturing site
A3 Manufacturing

A4 - A5 Construction Stage

A4 Transport to construction site
A5 Installation/Assembly

B1 - B5 Use Stage

B1 Use
B2 Maintenance
B3 Repair
B4 Replacement
B5 Refurbishment

C1 - C4 End of Life Stage

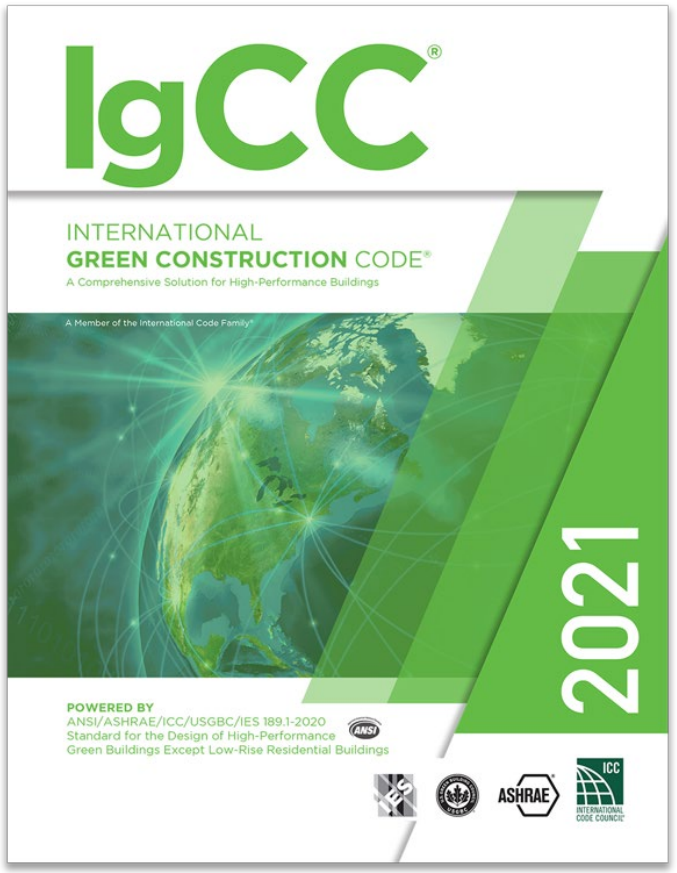
C1 Deconstruction & demolition
C2 Transport
C3 Waste processing
C4 Disposal

NRMCA

PAVE AHEAD
DURABLE. SUSTAINABLE. CONCRETE.

BUILD WITH STRENGTH

IgCC (ASHRAE 189.1-2023)



New Section 9.4.2 Added

9.4.2 Product Procurement. Documentation in accordance with 9.4.2.1 and 9.4.2.2 and the corresponding industry-wide Type III EPD, where available.

ASHRAE 189.1

2023

Revise *Table 4.2 as follows.*

Table 4.2 Requirements Determined by the Jurisdiction

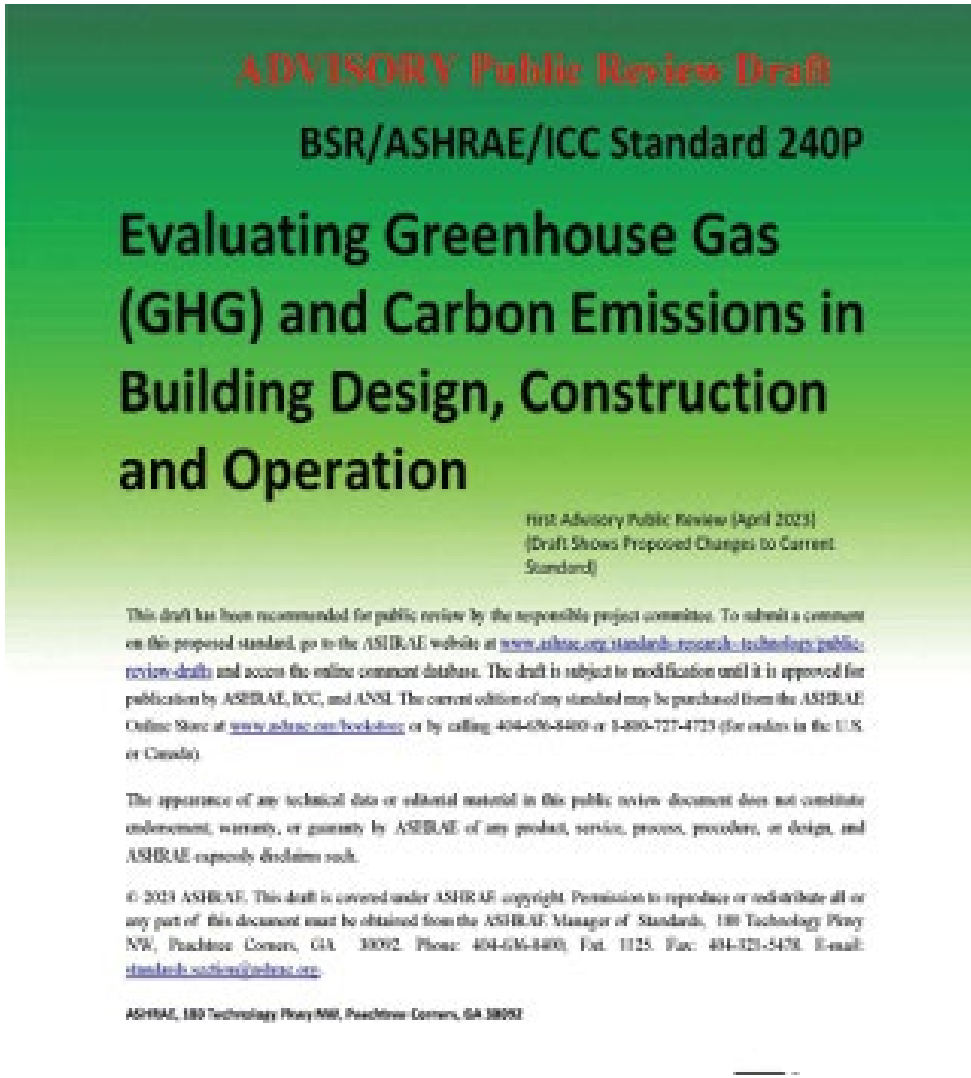
Section	Section Title and Description	Jurisdictional Requirement
9.4.2	Product Procurement	[ ] No
9.4.2~~.a~~	Product Procurement - Percentage of Building Product Cost	[ ] 10% [ ] 15%

2023 Draft: **Material neutral** and preferable to previous drafts that singled out performance for cement, concrete, and steel.

ASHRAE 240P: Public Comments

ASHRAE/ICC Standard 240P:

Evaluating Greenhouse Gas (GHG) and Carbon Emissions in Building Design, Construction and Operation, present a methodology for quantifying and documenting GHG emissions associated with the construction and operating phases of buildings, building systems and equipment.



ADVISORY Public Review Draft

BSR/ASHRAE/ICC Standard 240P

Evaluating Greenhouse Gas (GHG) and Carbon Emissions in Building Design, Construction and Operation

First Advisory Public Review (April 2023)
(Draft Shows Proposed Changes to Current Standard)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at www.ashrae.org/standards-research--technology/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by ASHRAE, ICC, and ANSI. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

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ASHRAE, 180 Technology Pkwy NW, Peachtree Corners, GA 30092

Low-Carbon Standards Activities

The National Institute of Standards and Technology (NIST)

https://www.nist.gov/programs-projects/low-carbon-cements-and-concretes-consortium

ASTM E60 on Sustainability

Workshop on Decarbonization: A Gap Analysis of LCA Standards for Industry

Sponsored by ASTM Committee E60 on Sustainability

ASTM E50 on Environmental Assessment, Risk Management and Corrective Action

ASTM INTERNATIONAL

ACI 323 Low-Carbon Concrete Code

- First Low-Carbon Concrete Code
  - Limited to cast-in-place concrete structures and its purpose is to provide requirements for the maximum global warming potential of concrete.
  - Limit set at 15% reduction over NRMCA Benchmark values.

- Public Review in 2024
  - Public comment period closed
  - In appeals process

Design Community Actions

ECHO
Embodied Carbon Harmonization and Optimization
Project

30

Project Life Cycle Assessment Requirements

ECHO Recommendations for Alignment

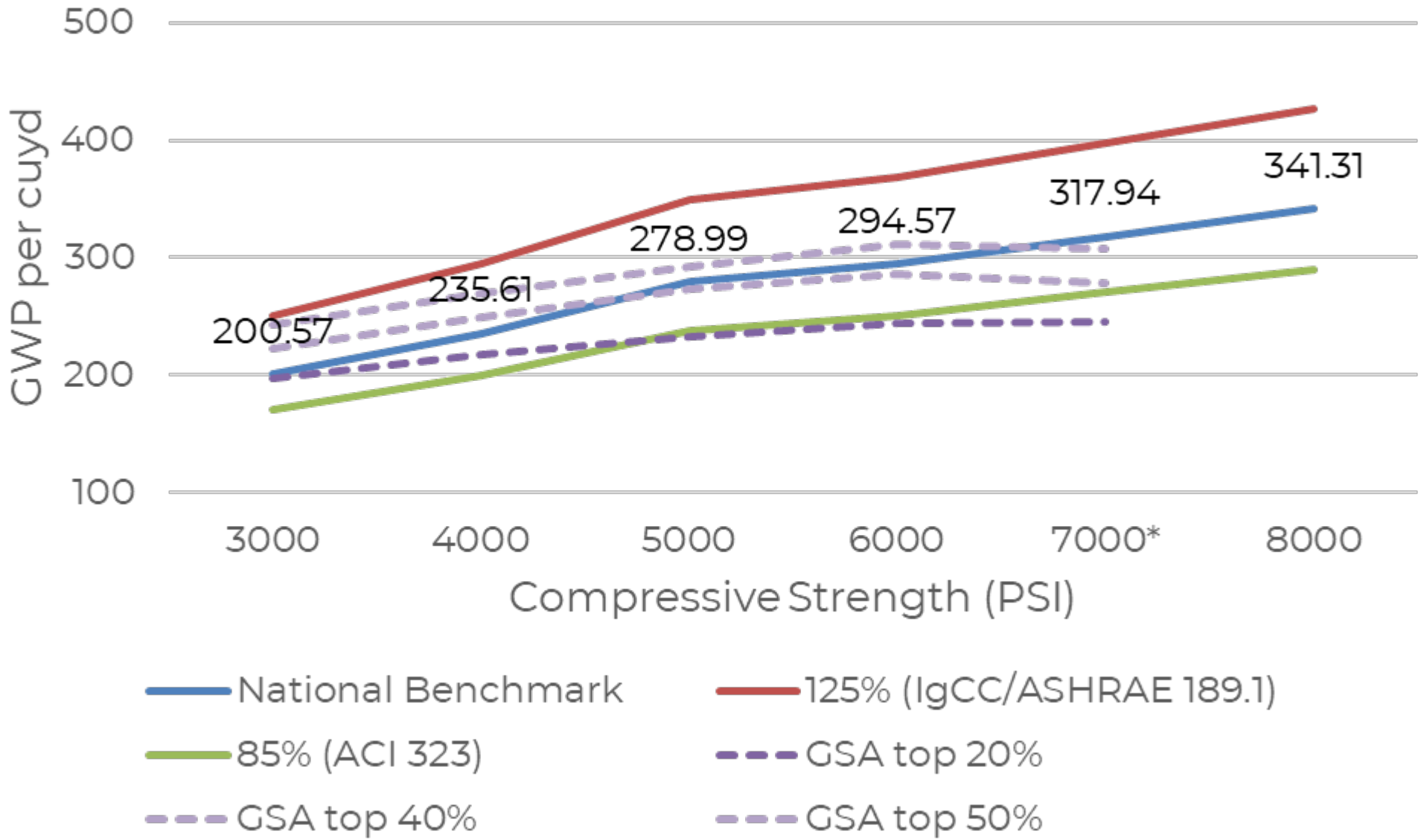
Version 1.0

September 30, 2024

Where is WBLCA Cited

- **Codes**
  - IgCC
- **Standards**
  - LEED
  - ASHRAE 189.1
  - Green Globes
  - Living Building Challenge
- **State codes**
  - CalGreen
  - Minnesota B3

Carbon Limits in Codes & Standards



LEED v5 – On the Horizon

SYSTEM GOALS	CLIMATE ACTION	QUALITY OF LIFE	ECOLOGICAL CONSERVATION & RESTORATION
WEIGHTINGS	50% OF POINTS	25% OF POINTS	25% OF POINTS

LEED V5: Embodied Carbon

Prerequisite:

Assess Embodied Carbon

"All projects must track the embodied carbon impacts… using either whole-building life-cycle assessment or EPDs."

- Whole-building comparison to benchmarks
- Based on as-built quantities
- Regional or national average EPDs acceptable

Credit:

Reduce Embodied Carbon

1-6 points

3 compliance options:

- Cradle-to-grave WBLCA & comparison to a baseline project (1-6 points)
- Procurement: Whole-building carbon budget for all materials together (1-4 points)
- EPD Analysis: material-by-material comparison to whole-building carbon budget (1-5 points)

Extra 1-2 points for tracking construction process emissions (A4 & A5)

LEED V5: Embodied Carbon

All compliance options compare embodied carbon on a whole-building basis and award more points for greater reductions.

Option	10%	20%	30%	40%	Extra
1. WBLCA	2	3	4	5	+1
2. Low-Carbon Procurement	1	2	3	4	

Material	1 GSA 50%	2 GSA 40%	3 GSA 20%
Concrete	1	2	3
Steel	1	2	3
Wood	1	2	
Other		1	

Option 3: EPD Analysis

Concrete & steel have the greatest possible contributions (3 of 5 total)

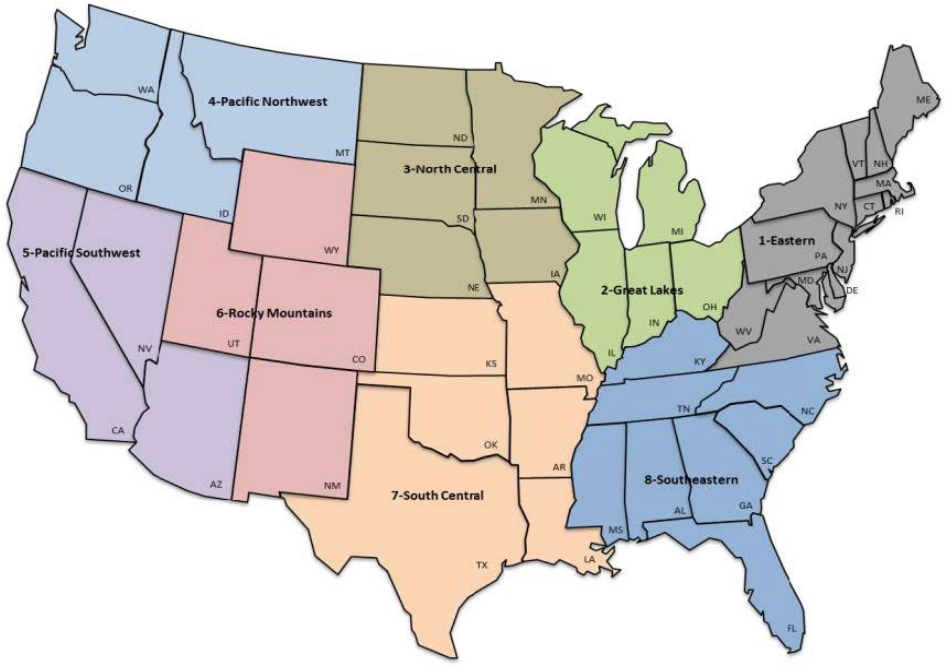
LEED V5: Embodied Carbon

Concrete GWP benchmarks in the "Assess Embodied Carbon" prerequisite are identical to GSA Benchmarks

GWP/m^3	2500 psi	3000 psi	4000 psi	5000 psi	6000 psi	7200 psi	8000 psi
GSA 50%	277	318	352	382	407	402	
NRMCA National	240	262	308	365	385		446
NRMCA Regional	226-257	245-279	286-323	336-378	356-401		409-456

Comment:

LEED should publish and require <u>regional benchmarks.</u> These are more representative than a single national benchmark.



LEED v5 – Public Comment

WIN: CSC Pilot Credit Responsible Sourcing – Public Comment open

- We no longer need to compete for space in the same credit with finishes and non-structural materials.
- Concrete, wood, and steel are being treated equally, which is a winning proposition for concrete.

CSC Regional System Operator website: https://us.csc.eco

Pilot credit example: IN credit Responsible Sourcing of Structural Materials

LEED v5 BD+C

1-2 points

Intent

To support the procurement of structural materials that have optimized human and ecosystem outcomes.

Requirements

Source and install structural materials from suppliers that demonstrate compliance with the responsible sourcing criteria according to Table 1.

Table 1. Responsible and equitable sourcing

Material Category	Achievement Threshold (1 point each, up to 2 points)
Concrete	50% or more of concrete suppliers (by number of suppliers or cost) for the project are Concrete Sustainability Council (CSC) certified.
Steel	50% or more of reinforcing and structural steel suppliers (by number of suppliers or cost) for the project are Responsible Steel certified.
Structural wood and composites	50% or more of structural wood products (by area or cost) for the project are documented to come from legal sources. Demonstrate legality by selecting wood products that are certified by PEFC, SFI, or FSC. Non-certified wood can demonstrate compliance through source disclosure with risk analysis and documentation that the wood comes from low-risk sources or other equivalent protections.

CSC in LEED

Aim

CSC enables the concrete industry and its main suppliers – i.e. cement and aggregate industry – to communicate and demonstrate the responsible sourcing credentials of its products

Credibility and Influence

CSC is independent and the certification process review is performed by independent certification bodies. CSC promotes knowledge sharing, outreach and awareness rising.

Responsible sourced concrete

Responsible sourcing is an issue in procurement, and increasingly in construction material procurement

Collaboration

CSC is supported by competent and strong partners around de world, namely industry associations, certification bodies, concrete, cement and aggregates producers

… founded in November 2016

… the first & only certification system for concrete established world-wide

… ‘FSC for concrete’

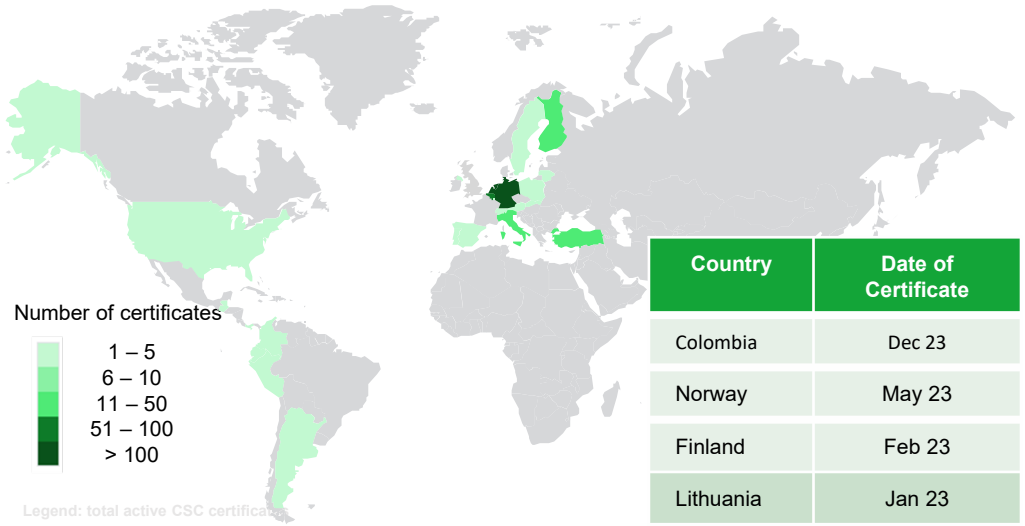
Industry Focus

Organized by industry, CSC certification provides concrete producers with the opportunity to gain an in-depth understanding of their sustainability performance, including its supply chain and take action

Reward System making concrete more sustainable

- CO2 emission reduction
- Fair business practice & compliance
- Enhancing biodiversity
- Excellence in occupational health & safety
- Moving towards circularity using water in a responsible manner
- Enhanced responsibility in the supply chain

CSC in LEED



Country	Date of Certificate
Colombia	Dec 23
Norway	May 23
Finland	Feb 23
Lithuania	Jan 23

Supported by competent and strong partners

BREEAM

- Official recognition of CSC V2.1 in the responsible sourcing of construction products credit

DGNB, ÖGNI

- Official recognition of certificates in the responsible sourcing credit

CASA

- Official recognition in the “Materials” category of the voluntary certification system developed by the Guatemala Green Building Council

Envision

- Official recognition in the US infrastructure certification system developed by the Institute for Sustainable Infrastructure (ISI)
- Ongoing dialogue to achieve recognition in “CR1.1 Reduce Net Embodied Carbon” via CO2-module and in “RA1.2 Use Recycled Materials” via R-module

LEED

- Recognition in V4.1 “Social equity within the supply chain” credit
- Ongoing dialogue with USGBC to achieve permanent recognition in “Responsible sourcing of raw materials” credit”

Pilot credit

B.E.S.T.

- Official recognition by the Turkish Green Building Council of CSC V2.1 in B.E.S.T. (Ecological and Sustainable Design in Buildings) residential certification system

State & Local Buy Clean and Embodied Carbon Policies

Adopted

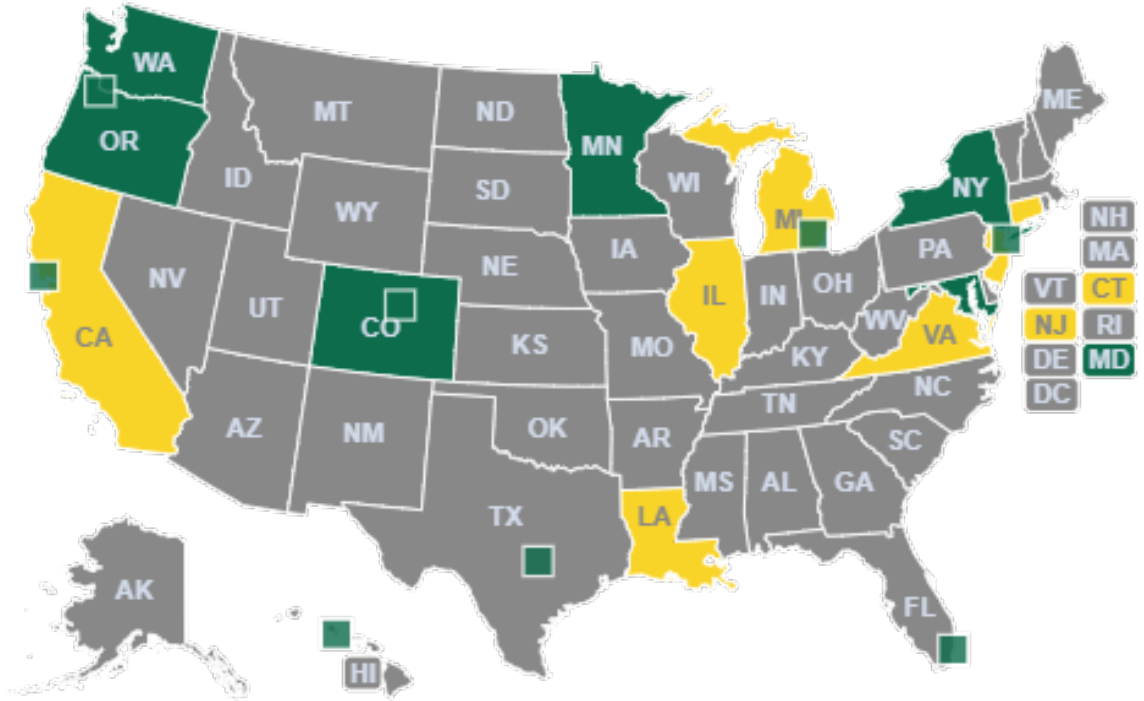
- Colorado
- New York
- Washington (2025)
- Maryland (2026)
- Minnesota (concrete 2026, other materials 2028)
- Oregon (paving, 2027)

Proposed

- Connecticut
- Illinois
- Louisiana
- Michigan
- Virginia

Other

- California (excludes concrete)
- New Jersey (tax incentive)



Local

- Marin County, CA
- Denver, CO
- Honolulu, HI
- Portland, OR
- Ann Arbor, MI (incentive)
- Austin, TX (resolution)
- Miami, FL (resolution)

What is Life Cycle Assessment

An objective process that:

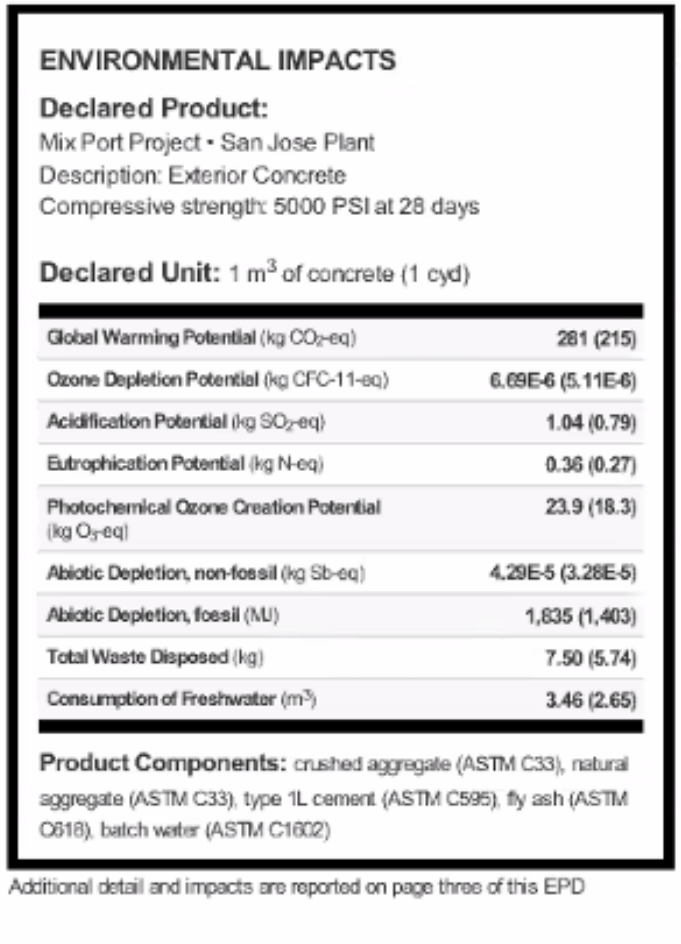
- Investigates and evaluates all stages of product, process, or service
- Identifies and measures energy and materials used (inputs) and wastes released (outputs)
- Assesses the impact of those inputs/outputs to the environment, and
- Evaluate and implement opportunities to affect environmental improvements

Environmental Product Declarations (EPD)

EPDs

- **Product specific declaration** – publicly available
- **Industry average EPD** – Third party certified Type III
- **Product specific EPD** – Third party certified Type III

EPDs must conform to ISO 14025, 14040, 14044, and 21930 and have a least a cradle to gate scope.



ENVIRONMENTAL IMPACTS

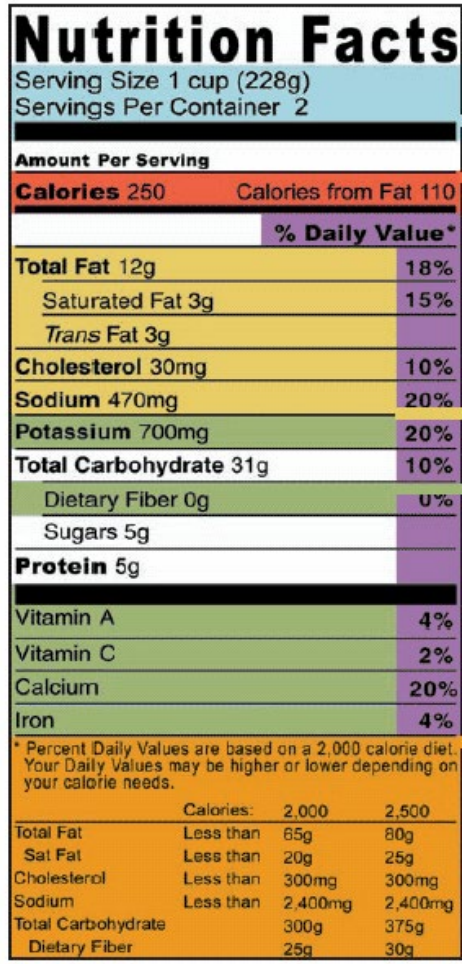
Declared Product:
Mix Port Project • San Jose Plant
Description: Exterior Concrete
Compressive strength: 5000 PSI at 28 days

Declared Unit: 1 m^3 of concrete (1 cyd)

Global Warming Potential (kg CO_2-eq)	281 (215)
Ozone Depletion Potential (kg CFC-11-eq)	6.69E-6 (5.11E-6)
Acidification Potential (kg SO_2-eq)	1.04 (0.79)
Eutrophication Potential (kg N-eq)	0.36 (0.27)
Photochemical Ozone Creation Potential (kg O_3-eq)	23.9 (18.3)
Abiotic Depletion, non-fossil (kg Sb-eq)	4.29E-5 (3.28E-5)
Abiotic Depletion, fossil (MJ)	1,835 (1,403)
Total Waste Disposed (kg)	7.50 (5.74)
Consumption of Freshwater (m^3)	3.46 (2.65)

Product Components: crushed aggregate (ASTM C33), natural aggregate (ASTM C33), type 1L cement (ASTM C595), fly ash (ASTM C618), batch water (ASTM C1602)

Additional detail and impacts are reported on page three of this EPD



Nutrition Facts
Serving Size 1 cup (228g)
Servings Per Container 2

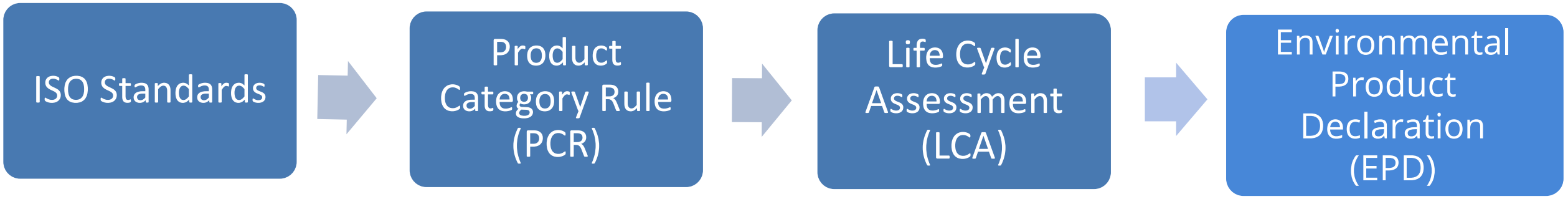
Amount Per Serving
Calories 250 — Calories from Fat 110

	% Daily Value*
Total Fat 12g	18%
Saturated Fat 3g	15%
Trans Fat 3g	
Cholesterol 30mg	10%
Sodium 470mg	20%
Potassium 700mg	20%
Total Carbohydrate 31g	10%
Dietary Fiber 0g	0%
Sugars 5g	
Protein 5g	
Vitamin A	4%
Vitamin C	2%
Calcium	20%
Iron	4%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

How are Concrete EPDs Developed



Product Category Rule (PCR) for Concrete

Concrete PCR Revisions 2024

Current: Version 2.2 of the Product Category Rules (PCR) for ISO 14025:2006 Type III Environmental Product Declarations (EPDs) of Concrete (w/ deviation to consider mobile concrete plants)

Updated v3 – Renew with a modifications including updated background data sets

Timeline: Completion February 2025

EPD Verification Process

Consultant

climate earth

WAP SUSTAINABILITY CONSULTING

Revisions & Comments

Draft EPD

Third-Party Verifiers

Concrete

Industrial Ecology Consultants

ecoform

LABELING sustainability

Other materials

Ready Mix Producer

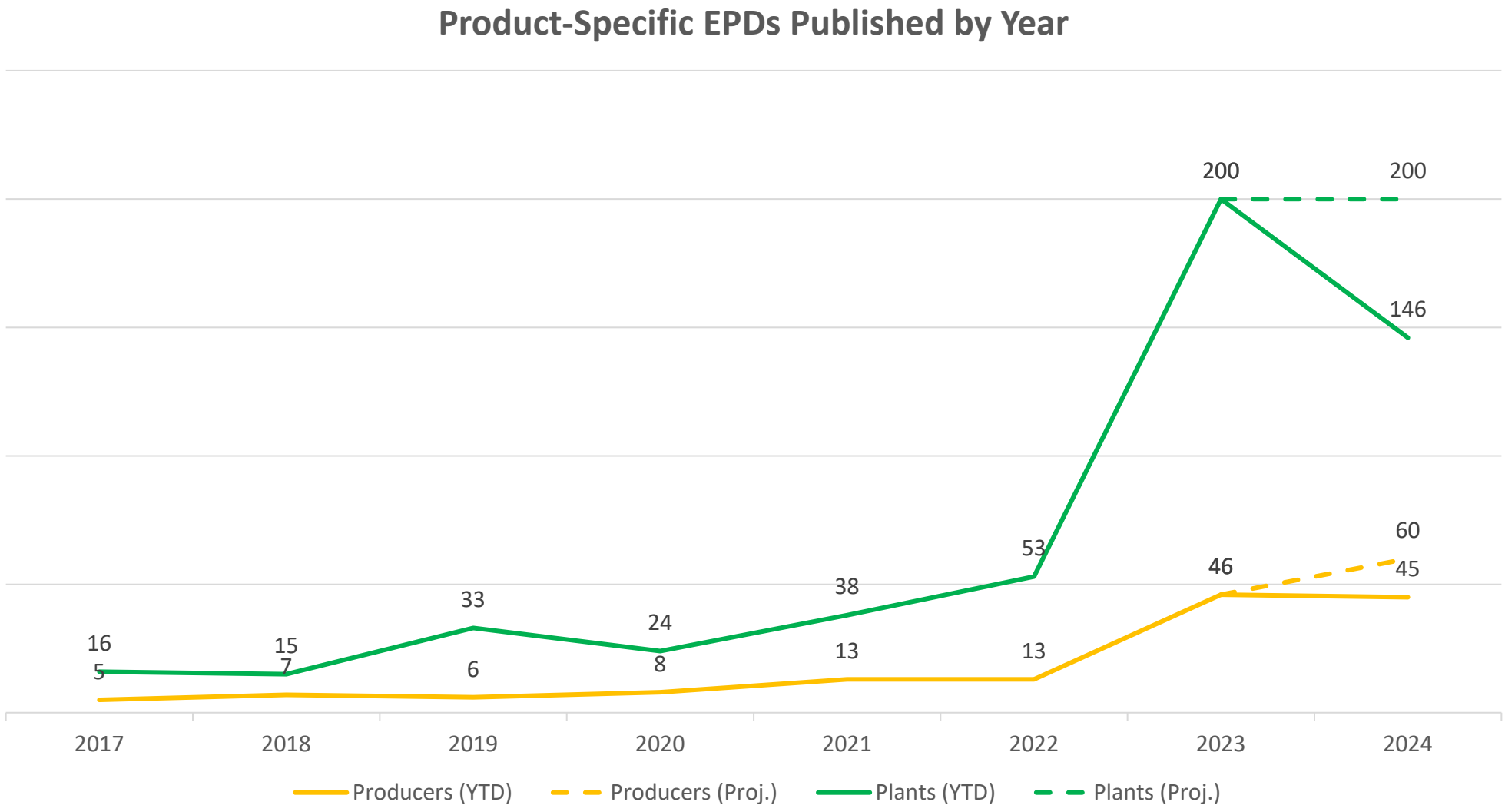
Verification Fee

NRMCA®

Program Operator

NRMCA Selects Verifier

EPD Program


Product-Specific EPDs Published by Year
16
15
33
24
38
53
200
200
146
5
7
6
8
13
13
46
60
45
2017
2018
2019
2020
2021
2022
2023
2024
Producers (YTD)
Producers (Proj.)
Plants (YTD)
Plants (Proj.)

EPD Program

2 NEW NRMCA Program Verifiers

Prior to 2024

ecoform

Industrial Ecology Consultants

LABELING sustainability

Added in 2024

GreenPlum Street LLC

Emily Lorenz
Consulting Engineer

2-3 NEW EPD Generators in 2025

Current

climate earth
EPDs made easy

WAP SUSTAINABILITY CONSULTING

More EPD generator tools are in development. We expect 2 to 3 new tools to enter the market in 2025.

Industry-Wide EPD & Regional Benchmark v4

Version 1 - 2013

Version 2 - 2016

Version 3 - 2019
3.1 - 2021
3.2 - 2022

Version 4 - 2025

Features

- State & metro-level benchmarks (previously regional)
- Accounts for increased market share of Type IL cement
- Will use latest concrete PCR v3 (under development)

Timeline

- March-August 2024: Data gathering surveys
- February 2025: Concrete PCR v3 completion
- March-April 2025: IW-EPD v4 completion target

Industry-Wide EPD & Regional Benchmark v4

Bigger than ever before thanks to NRMCA member participation

- Larger sample size = smaller error margins = more credibility outside industry
- Shows commitment to continuously growing green building sector

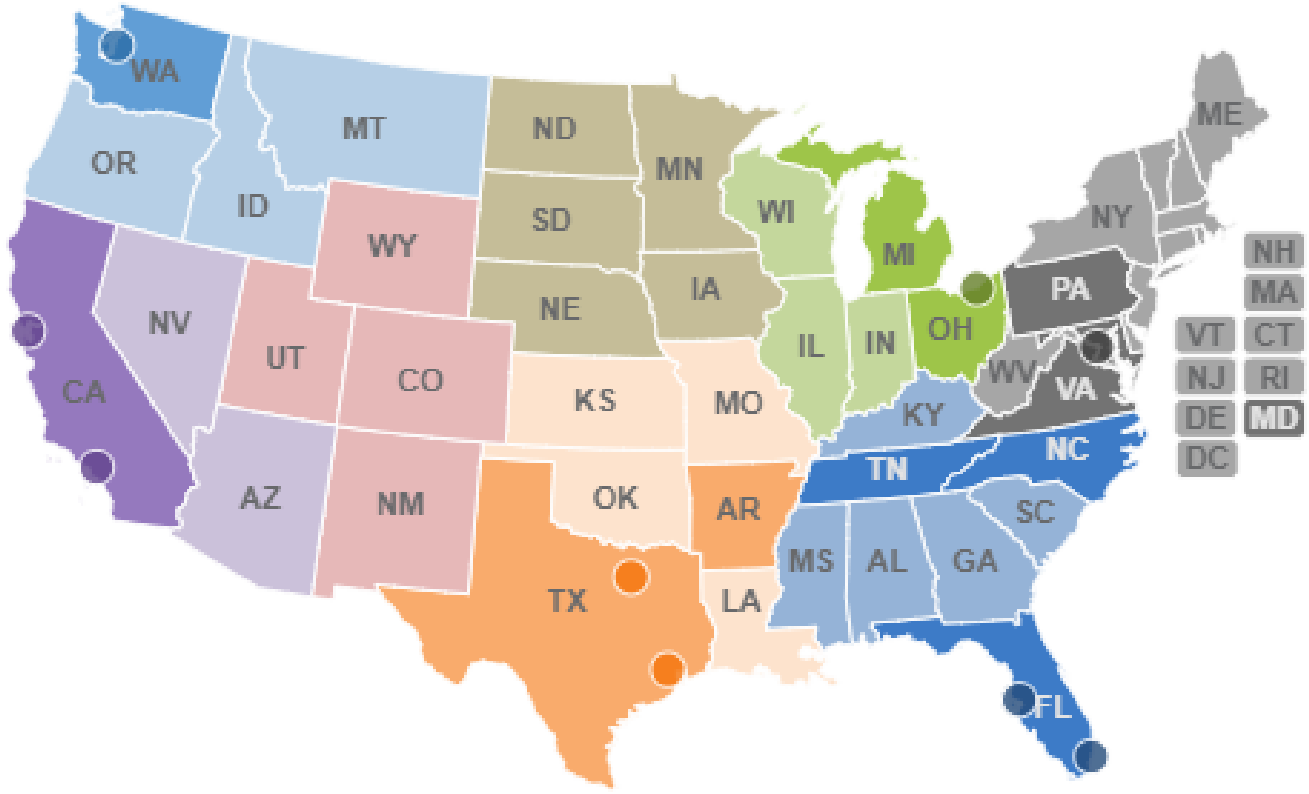
>38%

increased participation from version 3
(total plants)

V1 (2014)	V2 (2016)	V3 (2019-2021)	V4 (2025)
412 surveys	412 surveys (same plants as V1)	489 surveys	**>675 surveys**
48 products	72 products + lightweight	72 products	**>100 products + >8000 psi + interior & exterior mixes**

Regional Benchmark v4

- Previous IW-EPDs:
  8 regions + national average
- V4: **State** and **metro area** level benchmarks
- Target: 30 total benchmarks



Build Sustainably with Concrete!

- Get product-specific EPDs!
- Evaluate low carbon technologies that are available in your area such as:
  - Type IL Cements
  - SCM's
  - Water Reducing/Strength Enhancing Admixtures
- Educate the contractors and design teams you work with
  - Advocate for performance-based specifications
  - Advocate for WBLCA and Project Carbon Budgets

Reduction Strategies and Innovation


Source: Wilsonville Concrete/Solid Carbon


Source: MAN Energy Solutions

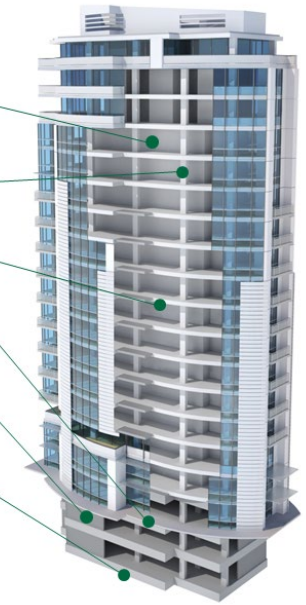

Source: Pozzotive

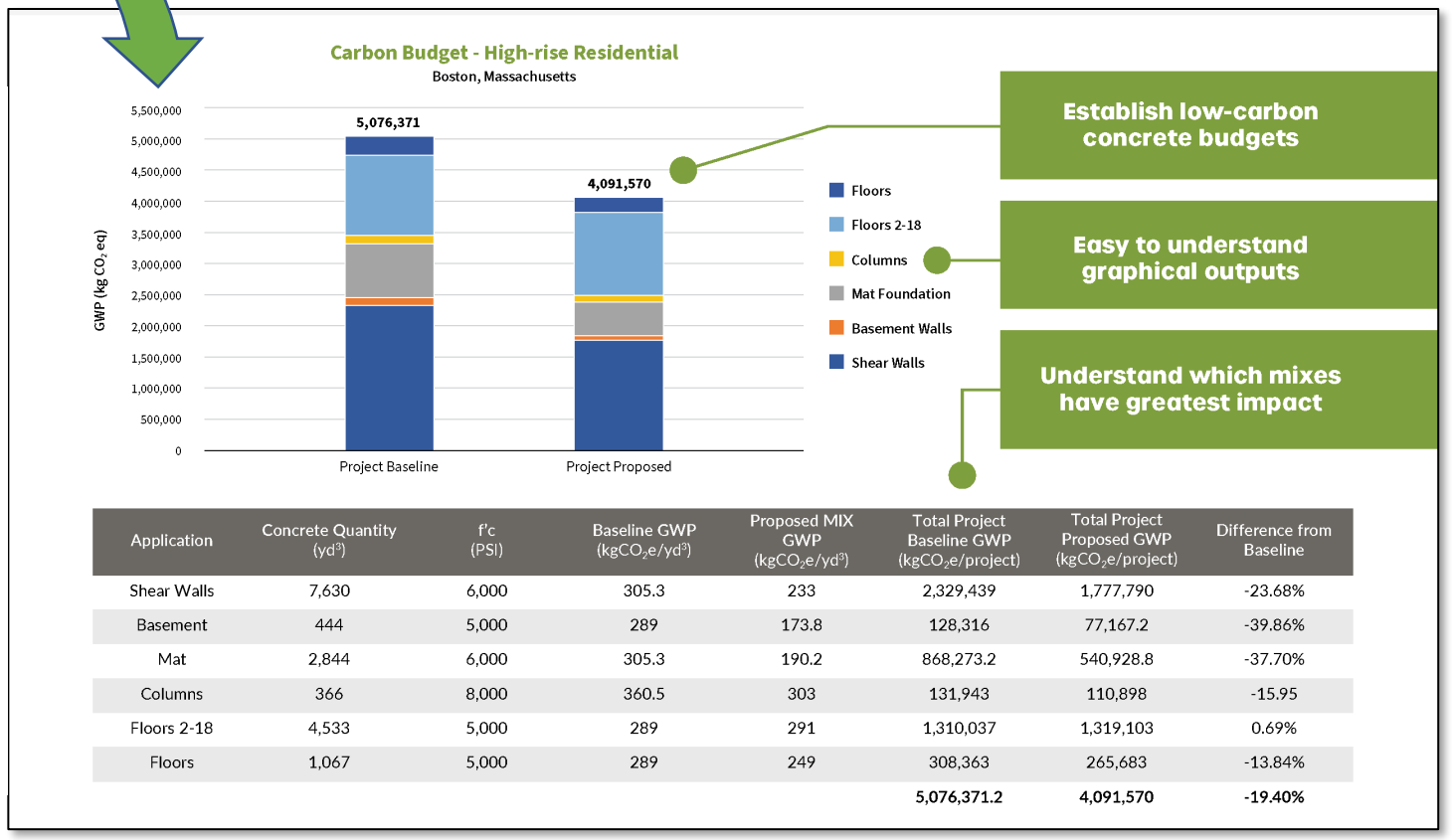

Source: BBC

NRMCA Concrete Carbon Calculator

Concrete Strengths and Volumes

- Shear Walls: 6,000 psi; 7,630 yd³
- Columns: 8,000 psi; 366 yd³
- Floors 2-18: 5,000 psi; 4,533 yd³
- Floors B2-1: 5,000 psi; 1,067 yd³
- Basement Walls: 5,000 psi; 444 yd³
- Mat Foundation: 6,000 psi; 2,844 yd³





Application	Concrete Quantity (yd^3)	f'c (PSI)	Baseline GWP ($kgCO_2e/yd^3$)	Proposed MIX GWP ($kgCO_2e/yd^3$)	Total Project Baseline GWP ($kgCO_2e$/project)	Total Project Proposed GWP ($kgCO_2e$/project)	Difference from Baseline
Shear Walls	7,630	6,000	305.3	233	2,329,439	1,777,790	-23.68%
Basement	444	5,000	289	173.8	128,316	77,167.2	-39.86%
Mat	2,844	6,000	305.3	190.2	868,273.2	540,928.8	-37.70%
Columns	366	8,000	360.5	303	131,943	110,898	-15.95
Floors 2-18	4,533	5,000	289	291	1,310,037	1,319,103	0.69%
Floors	1,067	5,000	289	249	308,363	265,683	-13.84%
					5,076,371.2	**4,091,570**	**-19.40%**

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Challenges

Opportunities

- Prescriptive Specifications
- Low carbon material availability and supply chain variability
- Codes and Standards Acceptance
- Customer Demand

- Market Differentiation
- Carbon Value Engineering
- Increased use of innovative approaches
- Value add to customers
- Reputational
- Risk Management

Conclusion: Sustainable Concrete

- **Establish applicable requirements for products via codes and standards**
- **Carbon Footprint Reduction**
  - Performance specifications
  - Minimize prescriptive limits
  - Permit innovation
  - WBLCA
  - Carbon Budgets
  - Product Specific EPDs
- **Communicate and partner early with industry stakeholders**

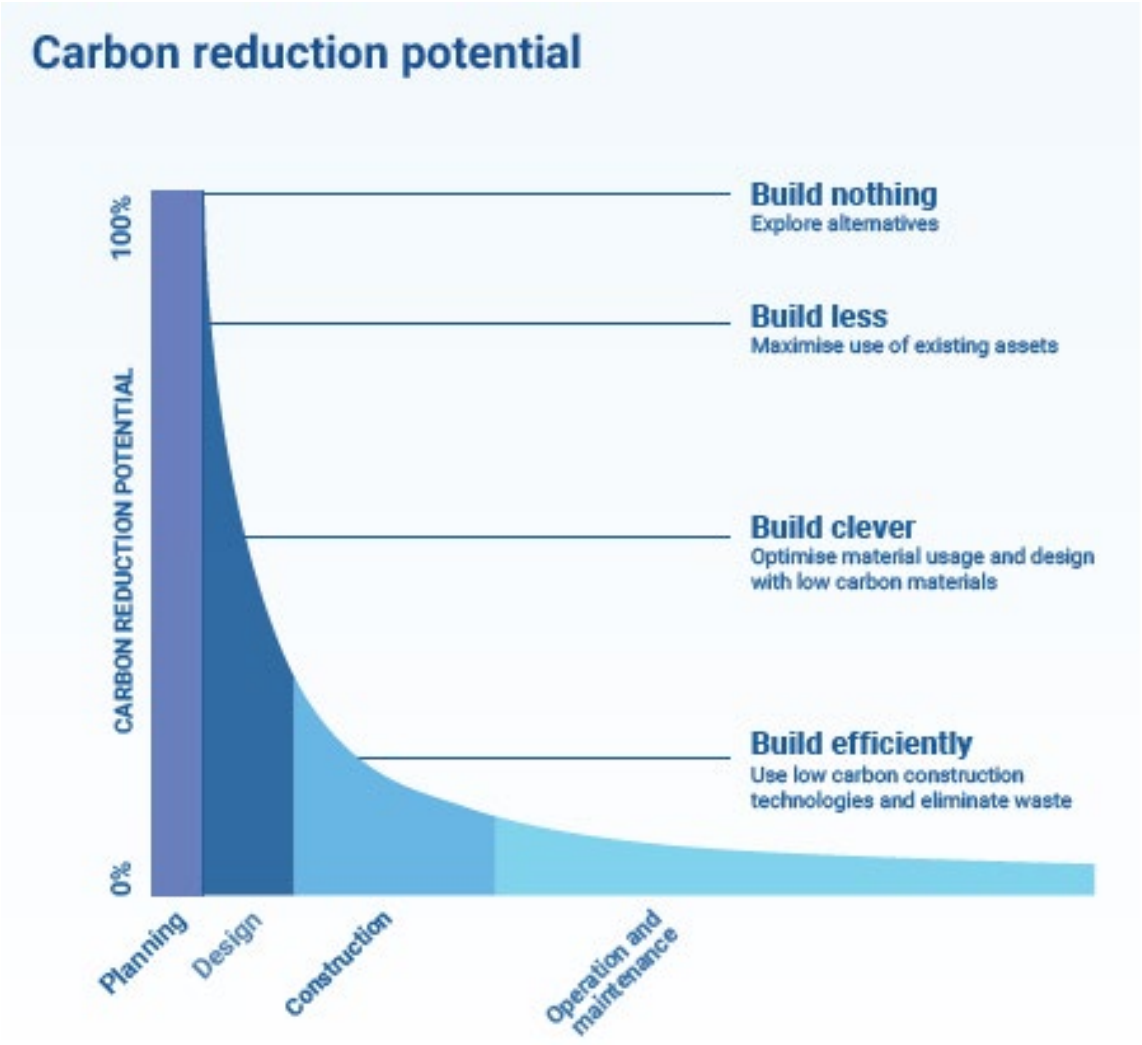

Figure 4: Opportunities to reduce embodied carbon from stage of design process.
Source: HM Treasury: Infrastructure Carbon Review, 2013

How Can NRMCA Help You?

Training for Staff

Educational Presentations

Specification and Design Assistance Center

https://www.nrmca.org/association-resources/design-center

Policy Review and Implementation

https://www.nrmca.org/advocacy/state-and-local-advocacy

Concrete Innovations Monthly Webinars

https://www.concreteinnovations.com

General Consulting on Low-Carbon Solutions

https://www.nrmca.org/association-resources/sustainability

Questions?

Tiffany Reed-Villarreal. P.E.

Director, Sustainability Codes and Standards

Treedvillarreal@nrmca.org

817-771-3595

Matthew Lemay

Manager, Codes and Sustainability

Mlemay@nrmca.org

847-323-0413