BUILDING INNOVATION
Conference

Addressing Sustainable Concrete through Codes and Standards

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NRMCA

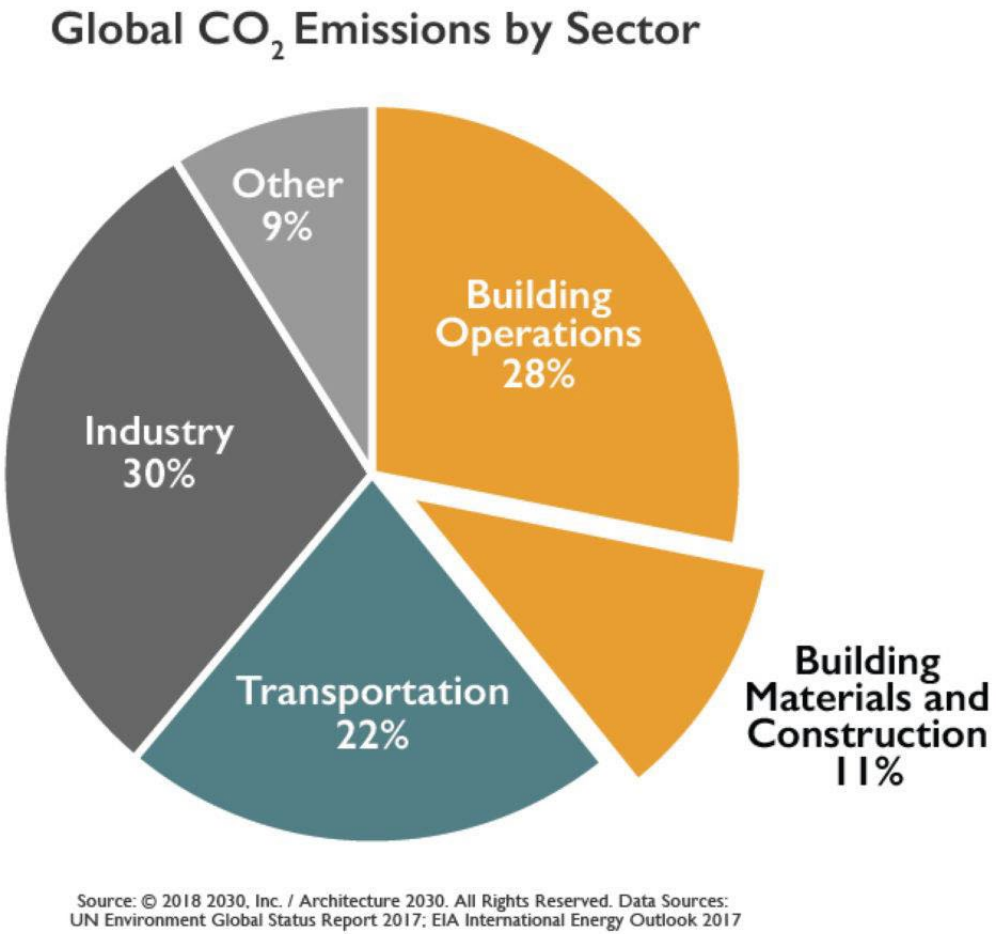
BUILD WITH STRENGTH


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?

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

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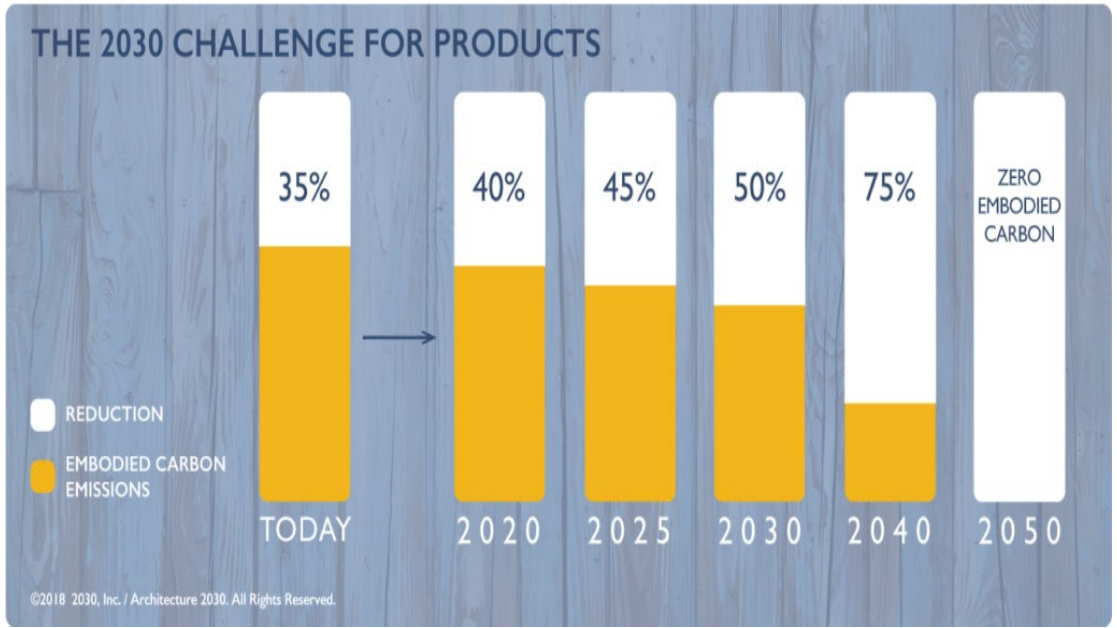
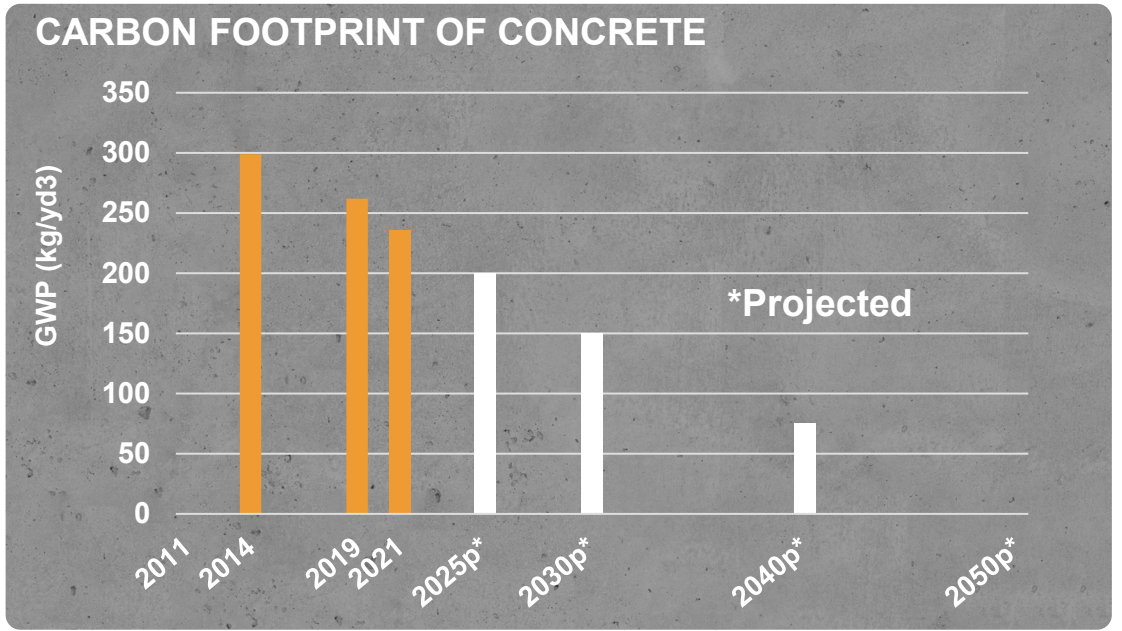
Roadmap to Carbon Neutrality
A more sustainable world is Shaped by Concrete





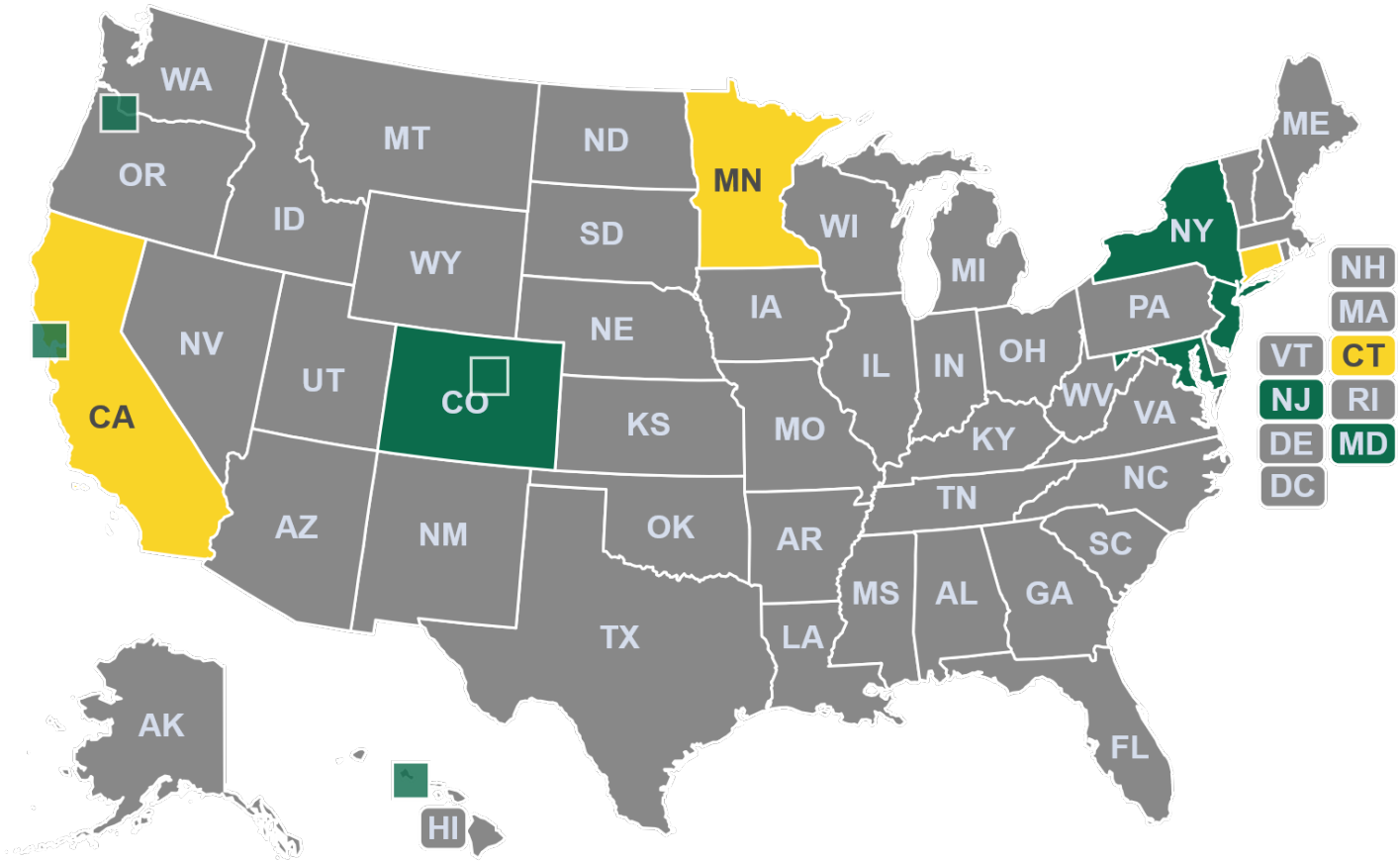
State and Local Buy Clean & Embodied Carbon Policies

Adopted

- Colorado
- Maryland
- New Jersey
- New York
- Marin County, CA
- Denver, CO
- Honolulu, HI
- Portland, OR

In Progress

- California (Concrete in Buy Clean CA)
- Connecticut
- Minnesota



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

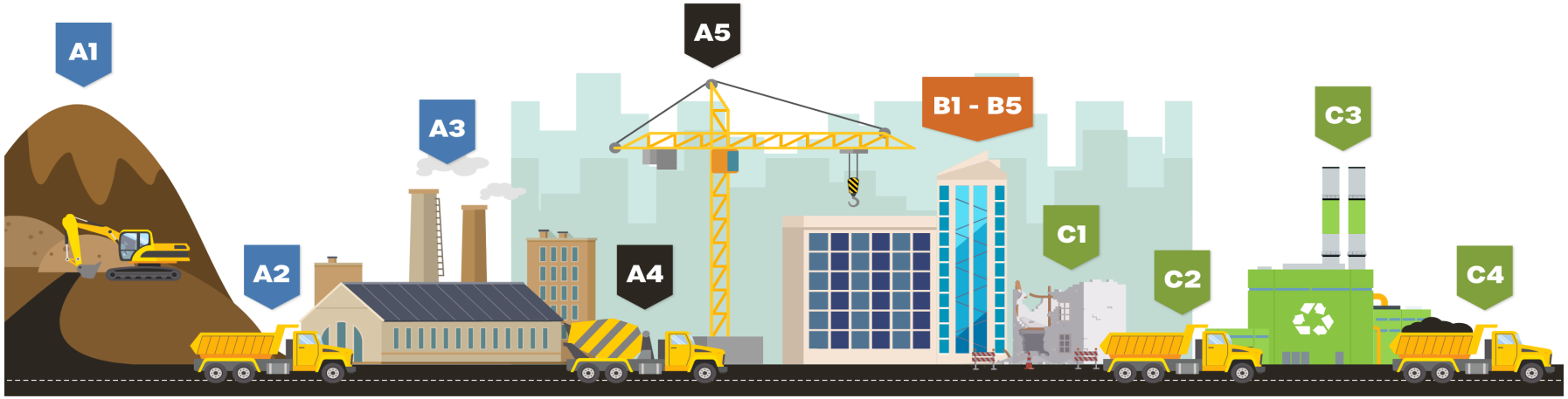
- $5.5B allocated across federal agencies — including $2.15 billion to GSA (SEC. 60503) and $2 billion to the FHWA (SEC. 60506) — to procure low-carbon materials for transportation and other projects

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)

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

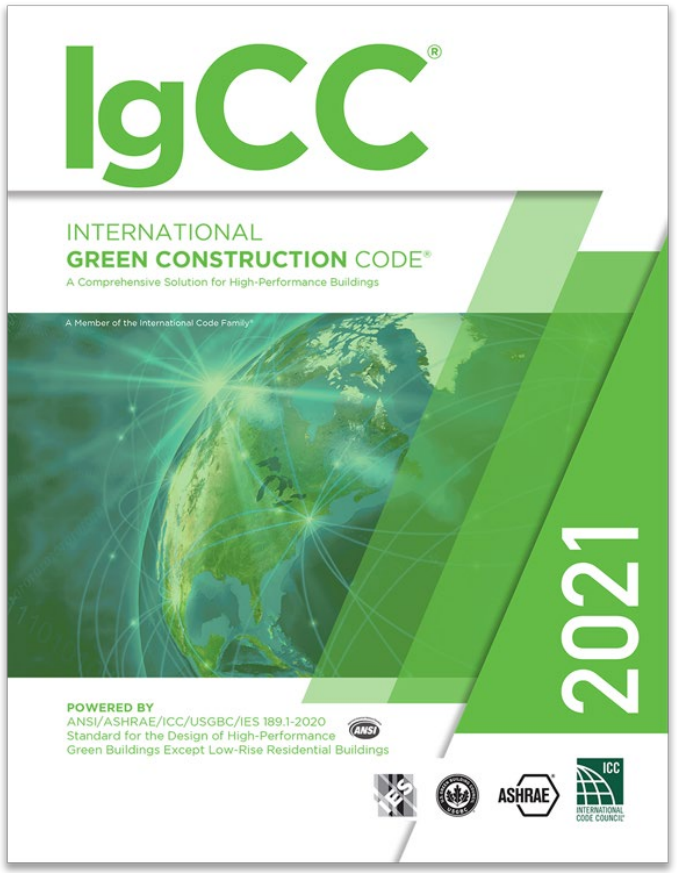
C1 Deconstruction & demolition
C2 Transport
C3 Waste processing
C4 Disposal

NRMCA

PAVE AHEAD
DURABLE. SUSTAINABLE. CONCRETE.

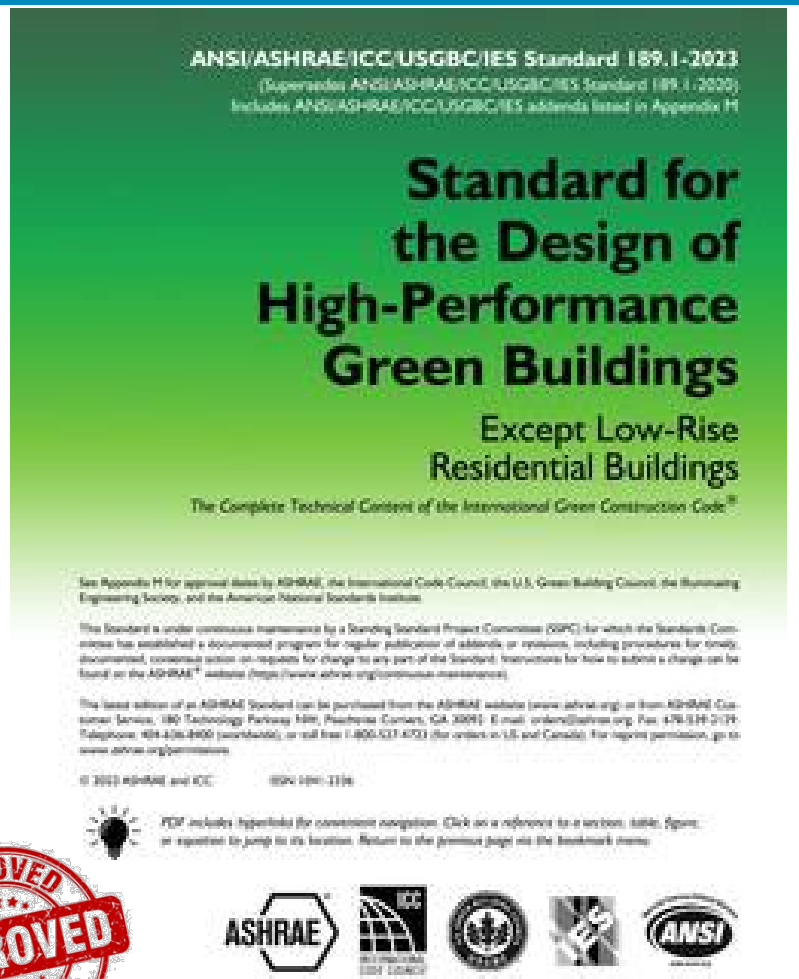
BUILD WITH STRENGTH

IgCC (ASHRAE 189.1)



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.



IgCC (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 Comment

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

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.
- Public Review in 2024
  - Public comment period closed

Design Community Actions

Architecture 2030 Challenge

- All new buildings, developments, and major renovations carbon-neutral by 2030

AIA 2030 Commitment Program

- Member firms annually report progress toward carbon neutral design

SE2050 Challenge

- Promote/design/construct net zero embodied structures by 2050

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

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 at 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)	1,635 (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

LEED v4 MR Credits

MATERIALS & RESOURCES		POSSIBLE 13
MRp1	Storage and collection of recyclables	REQ
MRp2	Construction and demolition waste management planning	REQ
MRC1	Building life-cycle impact reduction	5
MRc2	Building product disclosure and optimization – environmental product declarations	2
MRc3	Building product disclosure and optimization – sourcing of raw materials	2
MRc4	Building product disclosure and optimization – material ingredients	2
MRc5	Construction and demolition waste management	2

USGBC LEED v4 by Credit Category

Sustainable Sites	11 Points	Concrete Contribution
Heat Island Reduction	1-2	• Light colored pavements lower site albedo • Parking under cover (concrete parking garage)
Light Pollution Reduction	1	• Light colored pavements reduce lighting requirements • Concrete used as a material to reduce bird collisions
Rainwater Management	1-3	• Concrete water collection and distribution • Pervious concrete pavement

Water Efficiency	9 Points	Concrete Contribution
Water Reuse	1-2	• Onsite water reuse systems can use concrete collection and distribution

USGBC LEED v4 by Credit Category

Energy & Atmosphere	33 Points	Concrete Contribution
Reduce Peak Thermal Loads	1-5	• Thermal mass to meet Passive House Requirements
Enhanced Energy Efficiency	1-10	• Thermal mass to improve energy efficiency

Materials & Resources	18 Points	Concrete Contribution
Construction and Demolition Waste Diversion	1-2	• Concrete can be recycled or diverted from waste streams

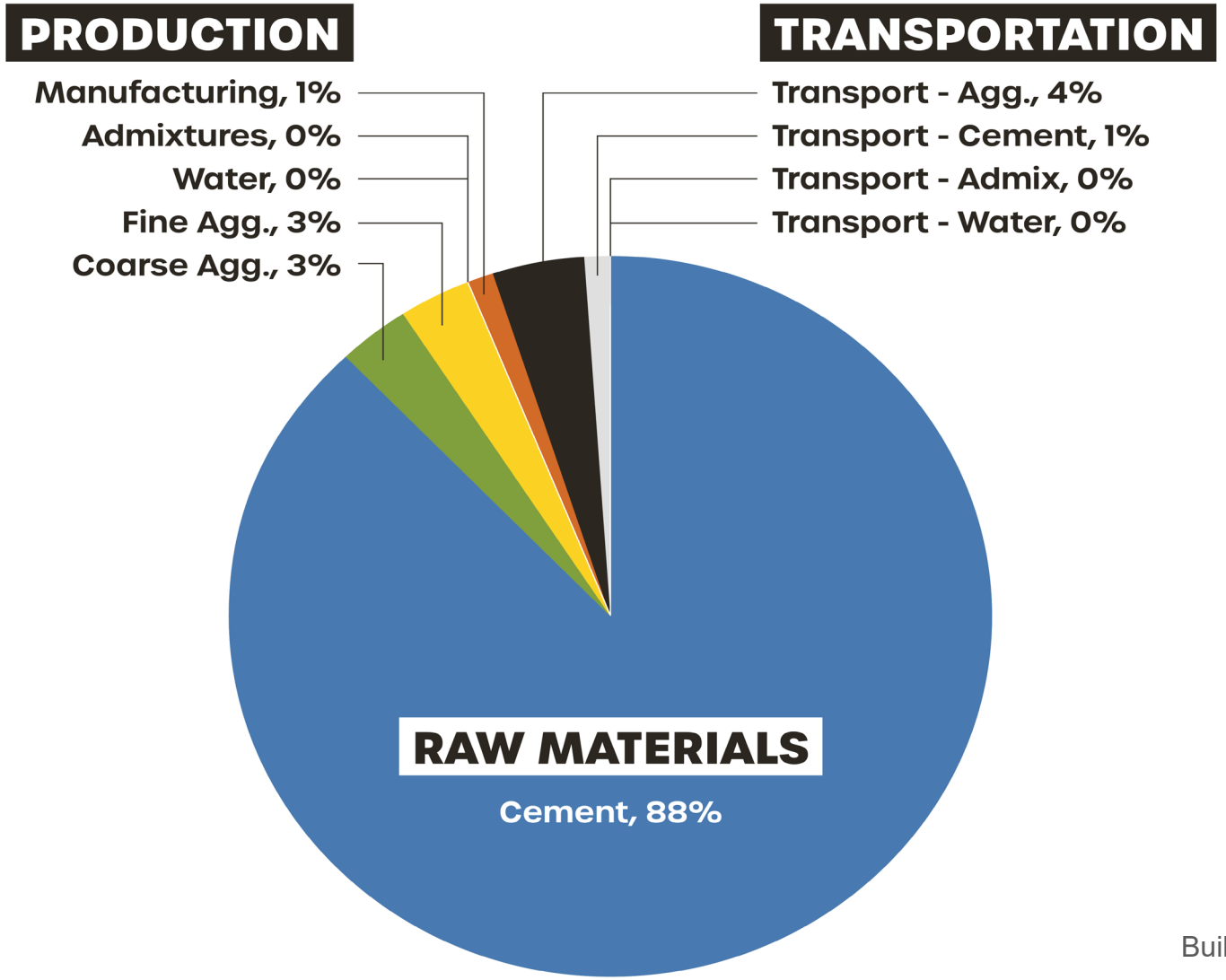
LEED v5 – On The Horizon

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

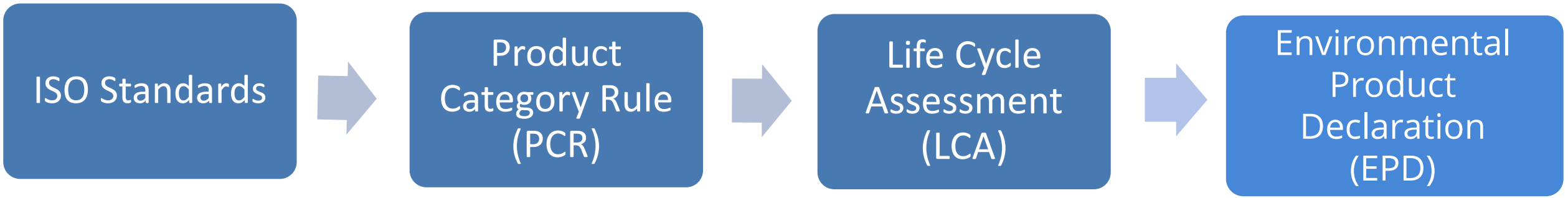
Where is WBLCA Cited

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

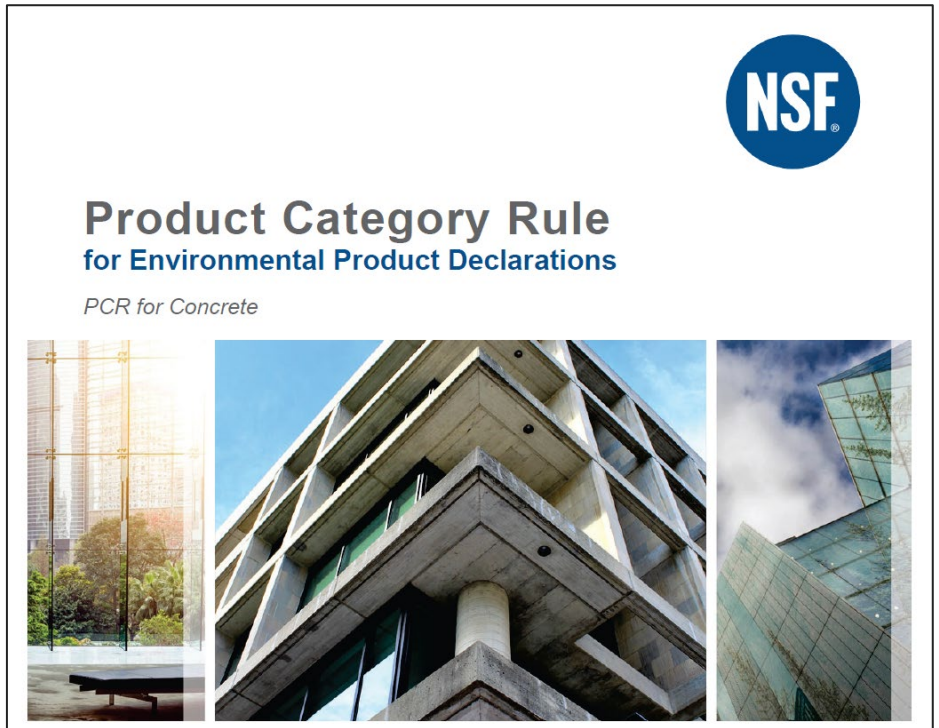
Where is the embodied carbon in concrete?



How are Concrete EPDs Developed?



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)

v3 – Renew with a slight modification including updated background data sets

Timeline:

March 2024: PCR v3 (cradle to gate)

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

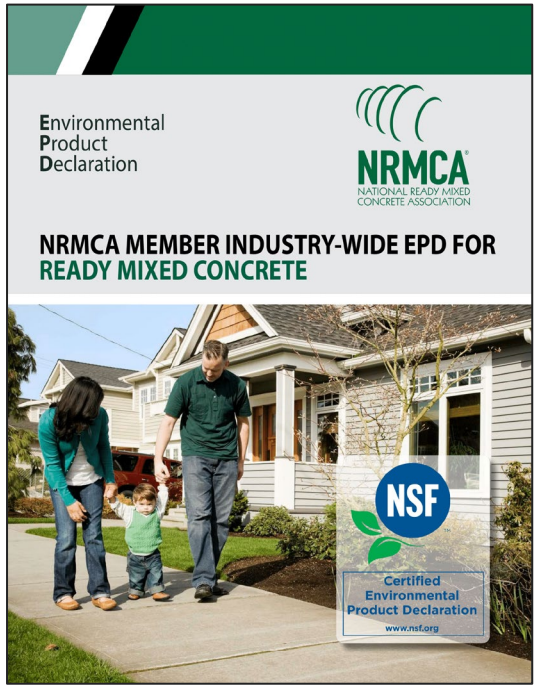
Verification Fee

NRMCA®

Program Operator

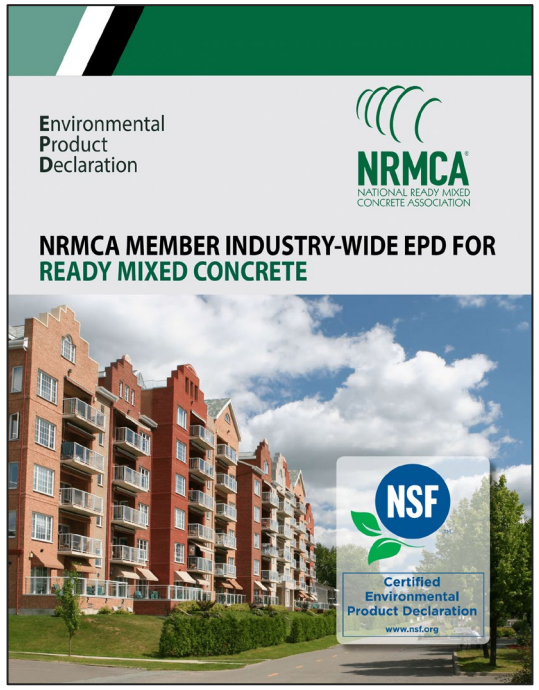
NRMCA Selects Verifier

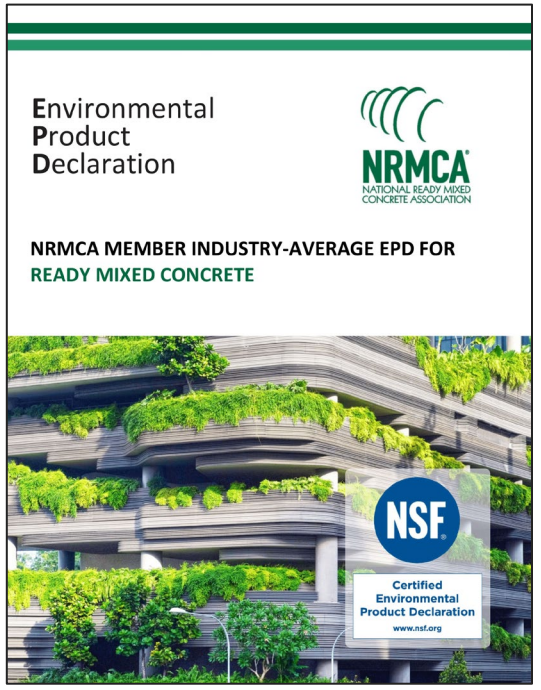
Industry Wide EPD Revisions



Version 1 (2013)

Version 2 (2016)





Version 3 (2019)

- v3.1 (2021)
- v3.2 (2022)

Version 4 (2024)

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

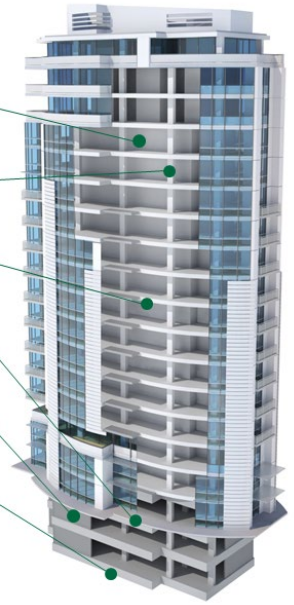

Source: Pozzotive

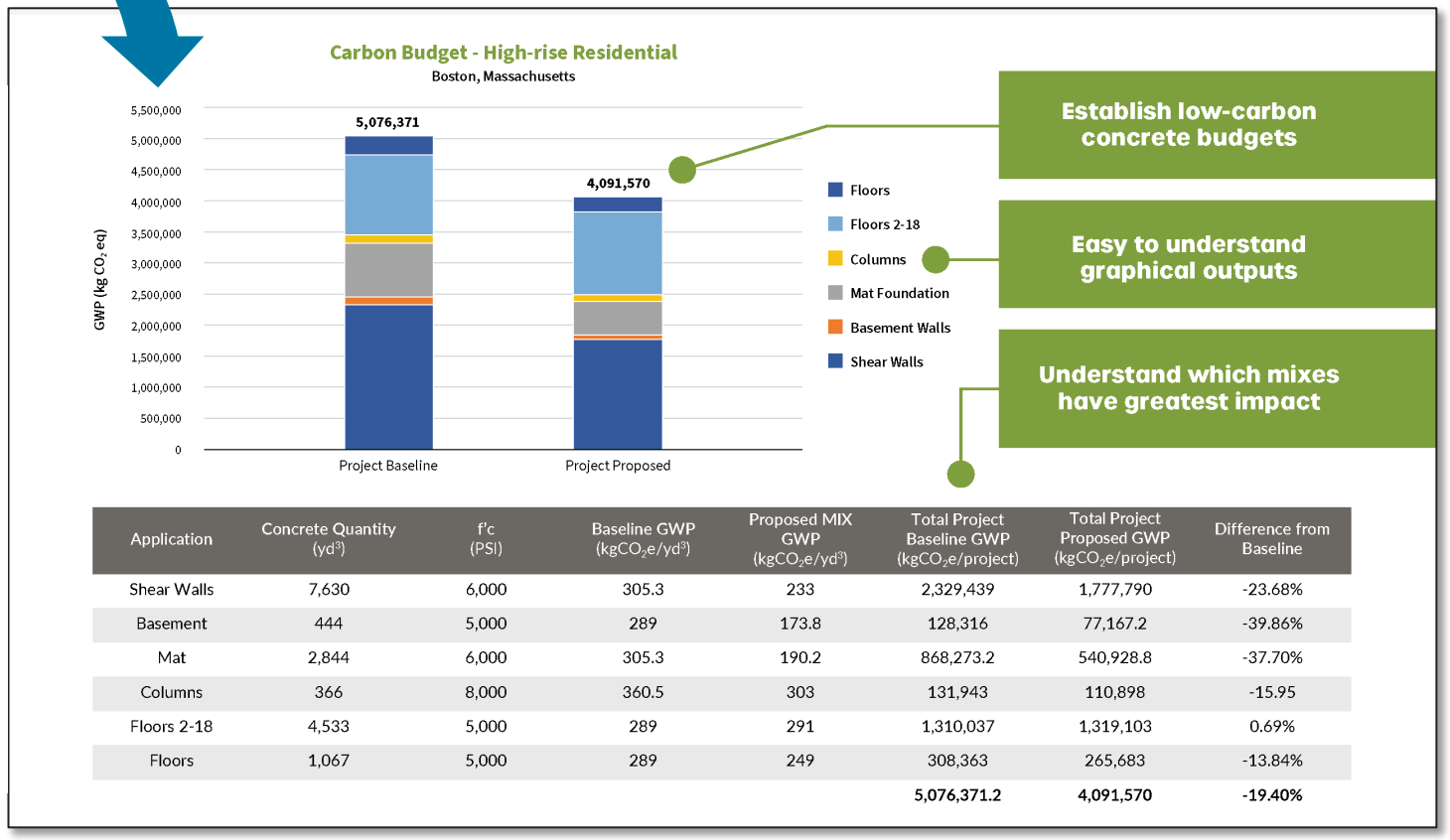

Source: BBC

NEW: 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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climate earth
EPDs made easy

www.nrmca.org/sustainability

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

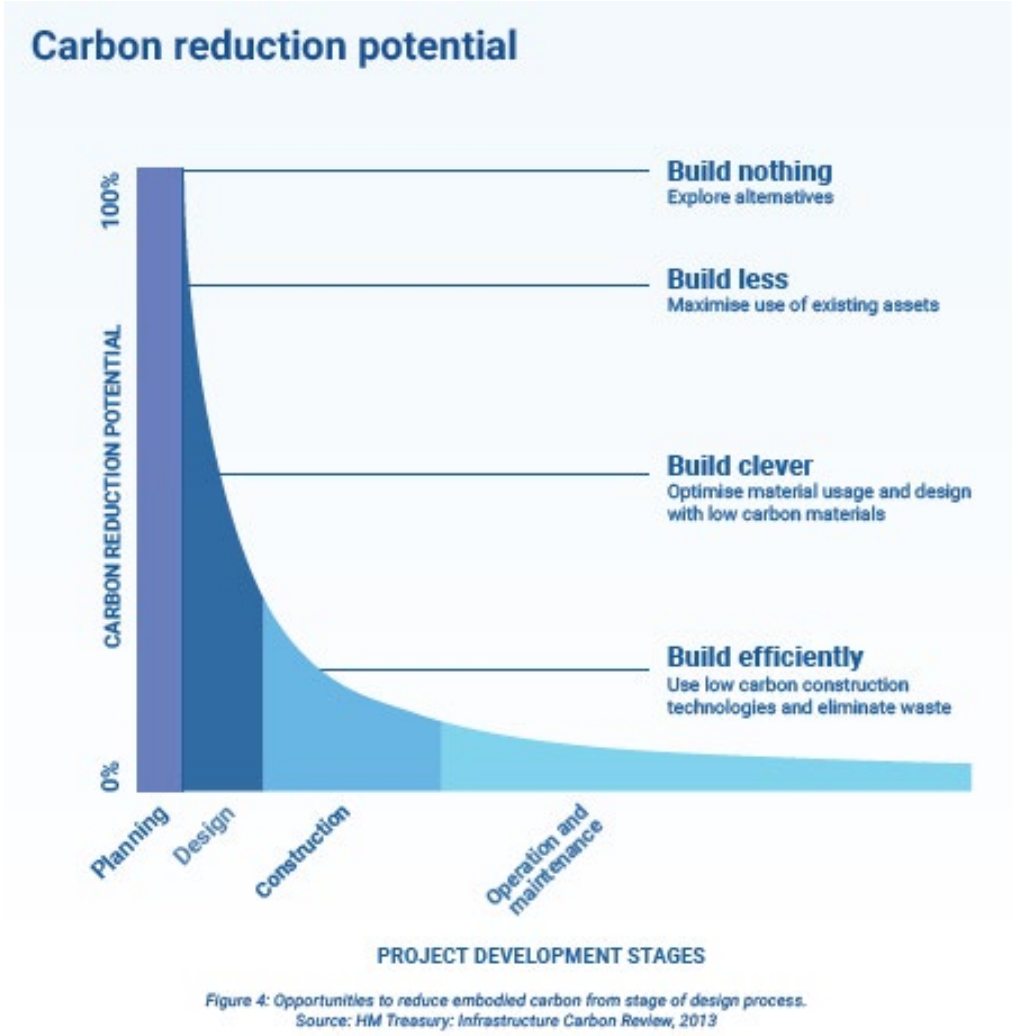

Figure 4: Opportunities to reduce embodied carbon from stage of design process.
Source: HM Treasury: Infrastructure Carbon Review, 2013

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?

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