
BUILD WITH STRENGTH
EPD's and Embodied Carbon
Skyway Cement
June 29th, 2022
Matthew Lemay
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NRMCA®

Build with Strength | Codes and Standards

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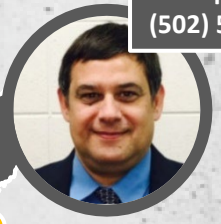

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Agenda:

- What is Embodied Carbon and what are EPD's?
- Market Perspective
- Specifications and Use
- Responsible Sourcing and Reduction Strategies
- Build with Strength Strategies

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What are EPDs and what is Embodied Carbon?

Other than busy work…?

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We must eliminate all GHG emissions from the built environment.

Embodied

Operational

Source: buildingtransparency.org

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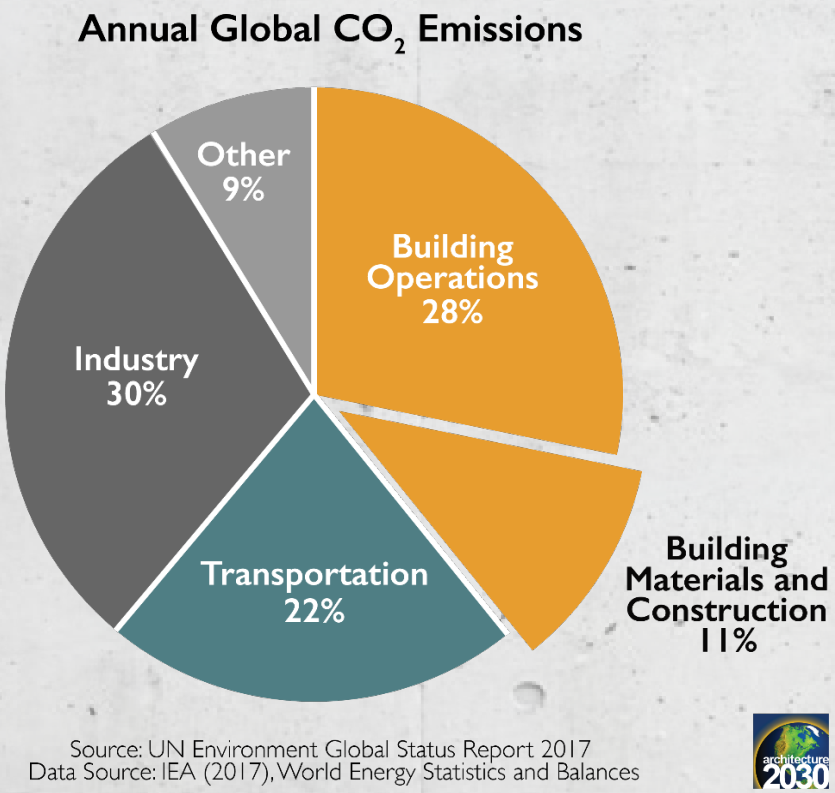
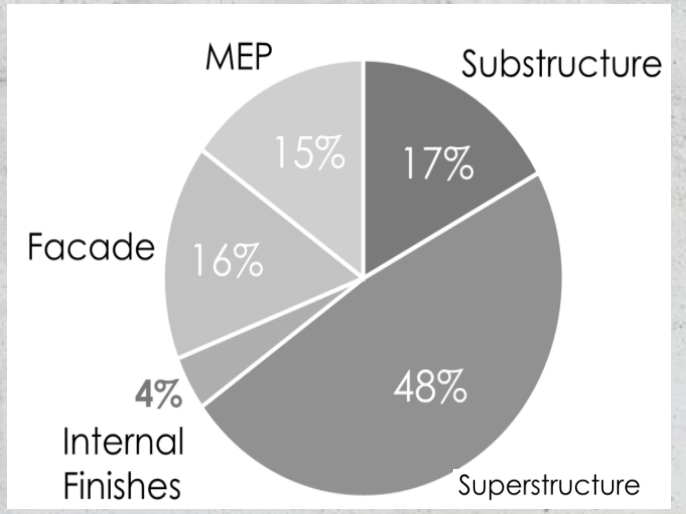
Background

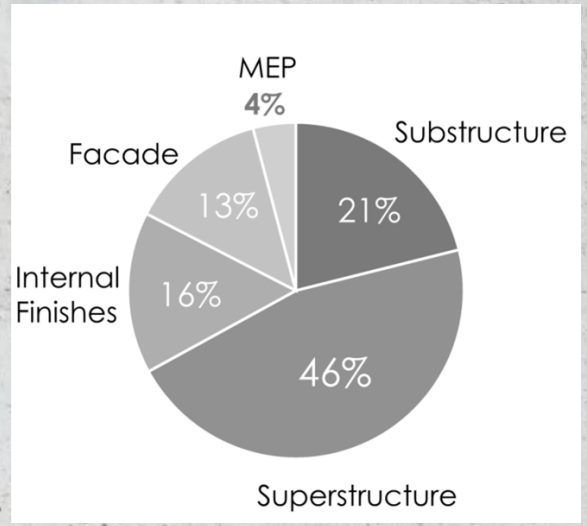


- Embodied carbon from the building materials produce 11% of annual global GHG emissions.
- Concrete, iron, and steel alone produce ~9% of annual global GHG emissions.
- Likely will need to build with more robust materials like concrete.
- How do we minimize environmental impacts?

Where is the embodied carbon?



OFFICE



MEDIUM SCALE RESIDENTIAL

Source: London Energy Transformation Initiative (LETI), 2020

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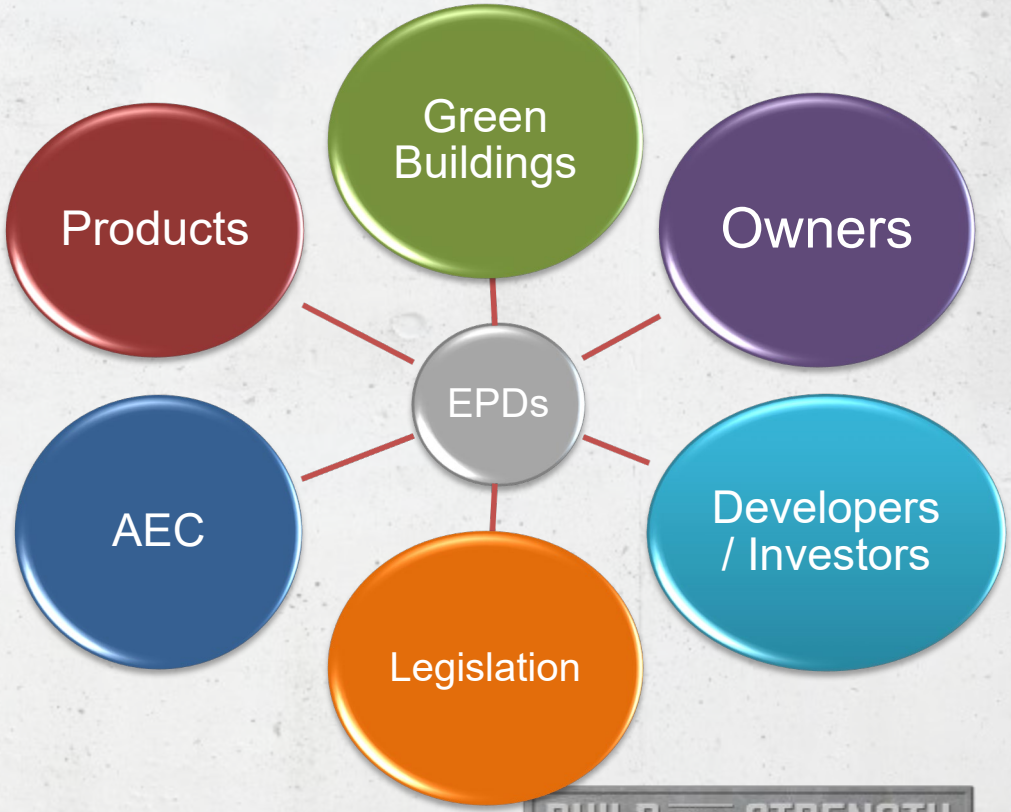
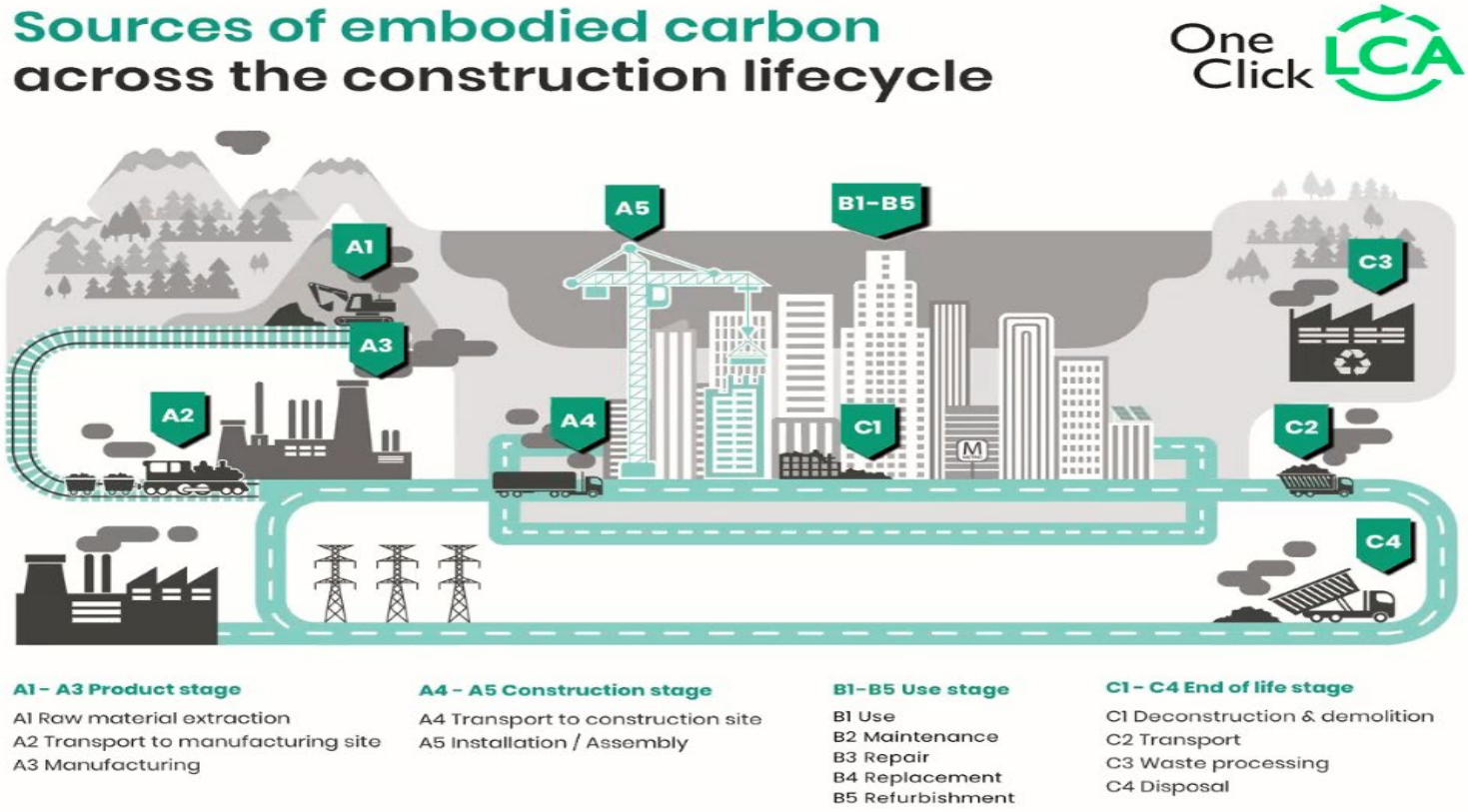
Drivers of Disclosure in Construction

- **Communication** and transparency tool between parties in any industry
- Objectively **quantify** a products environmental impact
- Science-based **verification** of claims with framework established for creation



Stages of the Building Life Cycle



Environmental Product Declaration (EPD)

NATIONAL READY MIX

ENVIRONMENTAL PRODUCT DECLARATION

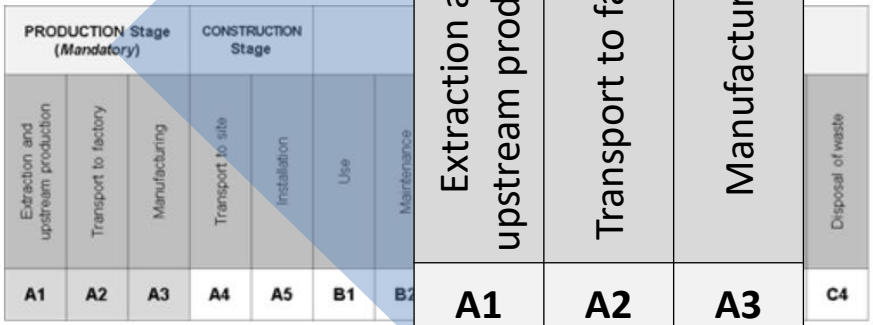
Mix S62C450011 • Irvine Plant

NATIONAL READY MIXED CONCRETE COMPANY

LIFE CYCLE ASSESSMENT

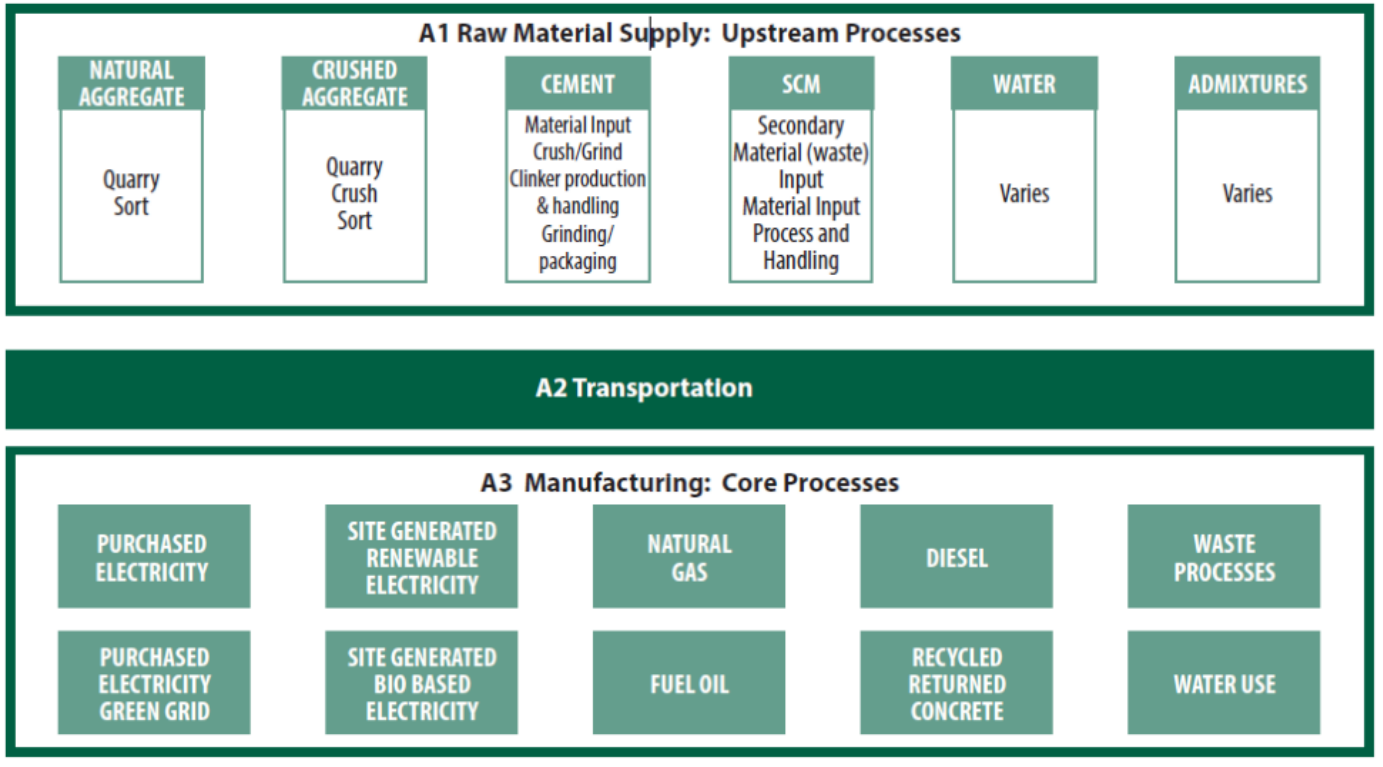
SYSTEM BOUNDARY

This EPD is a cradle-to-gate EPD covering the product stages (A



Production Stage (*Mandatory*)
Extraction and upstream production
Transport to factory
Manufacturing
A1
A2
A3

Environmental Product Declaration (EPD)



Environmental Product Declaration (EPD)

3rd party verified & registered documents that communicate transparency

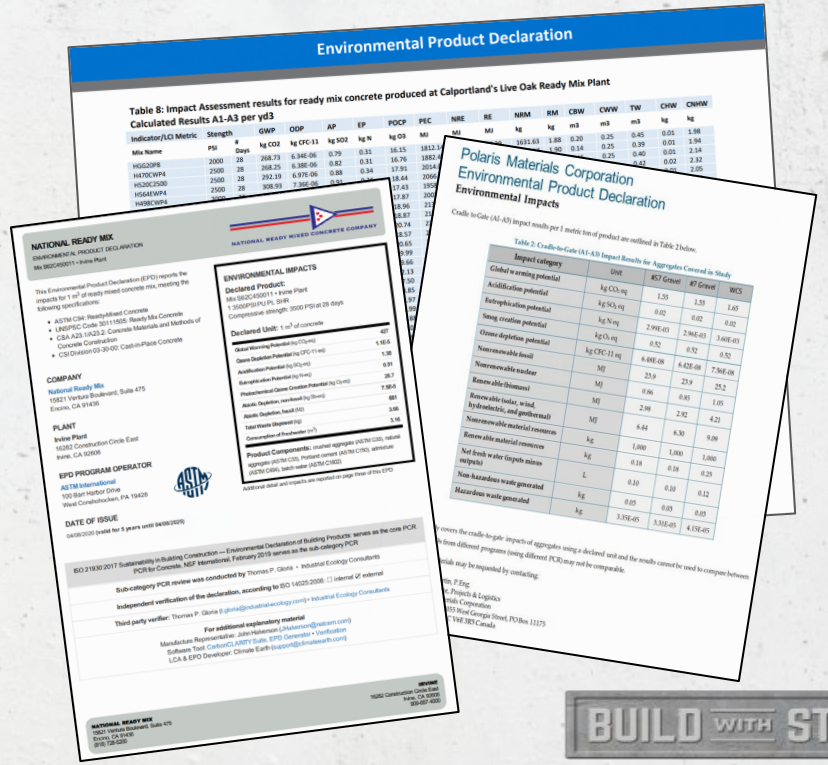
ENVIRONMENTAL IMPACTS

Declared Product:
Mix S62C450011 • Irvine Plant
1 3500PSI PU PL SHR
Compressive strength: 3500 PSI at 28 days

Declared Unit: 1 m^3 of concrete

Global Warming Potential (kg CO_2-eq)	427
Ozone Depletion Potential (kg CFC-11-eq)	1.1E-5
Acidification Potential (kg SO_2-eq)	1.38
Eutrophication Potential (kg N-eq)	0.51
Photochemical Ozone Creation Potential (kg O_3-eq)	28.7
Abiotic Depletion, non-fossil (kg Sb-eq)	7.5E-5
Abiotic Depletion, fossil (MJ)	681
Total Waste Disposed (kg)	3.66
Consumption of Freshwater (m^3)	3.16

Product Components: crushed aggregate (ASTM C33), natural aggregate (ASTM C33), Portland cement (ASTM C150), admixture (ASTM C494), batch water (ASTM C1602)



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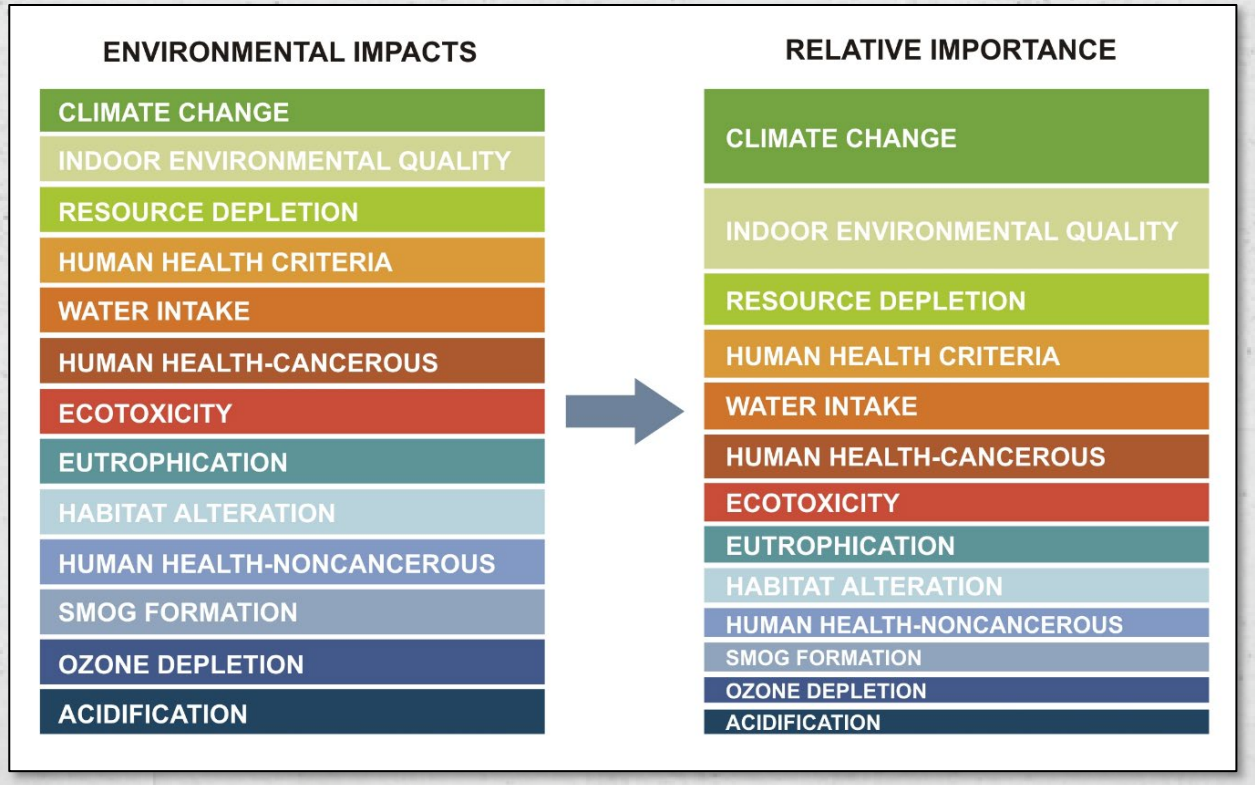
Quantifying/Prioritizing Impacts

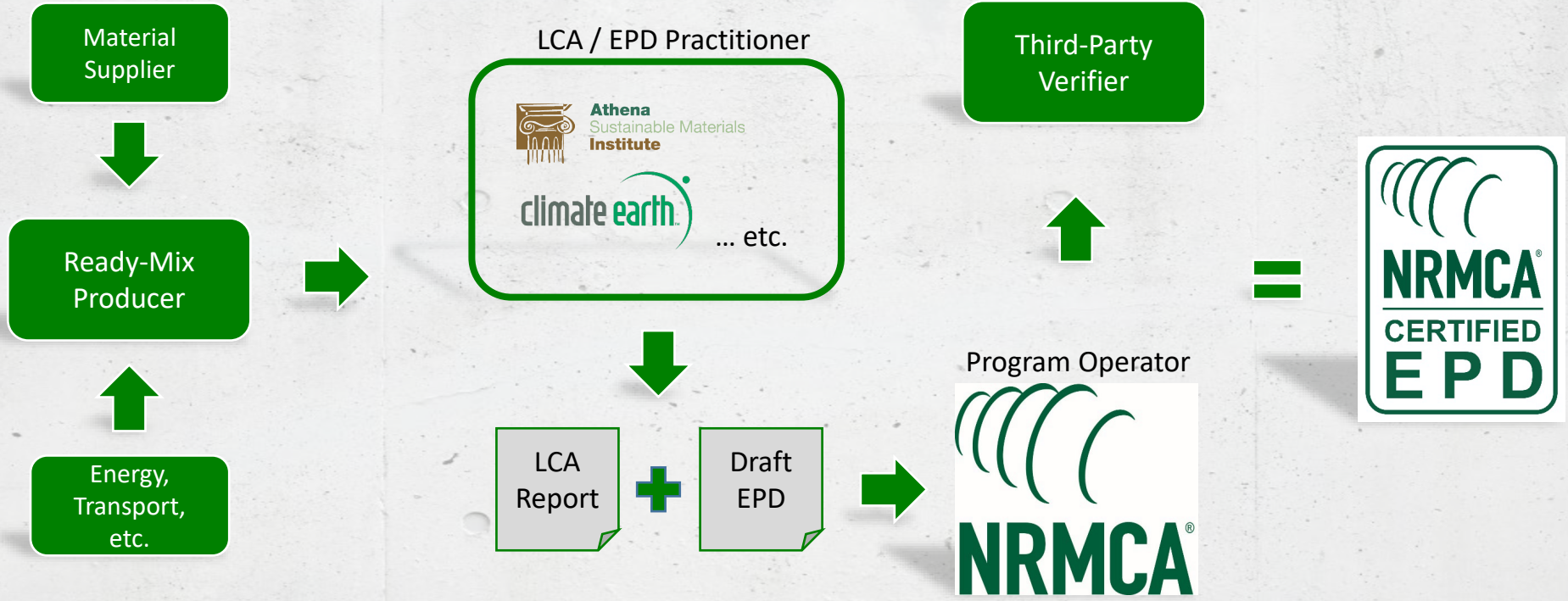


Source: Environmental impacts and relative importance of impacts (adapted from USGBC).

Product-Specific EPDs

- Specific to ready-mix producer & facility
- Includes environmental impact data for many mix designs
- Traditionally PDF documents
- Now, software tools store EPD data online
- >35,000 ready-mixed concrete EPDs on the market today

Product-Specific EPD Process



Market Perspective

Why Does Transparency Matter?

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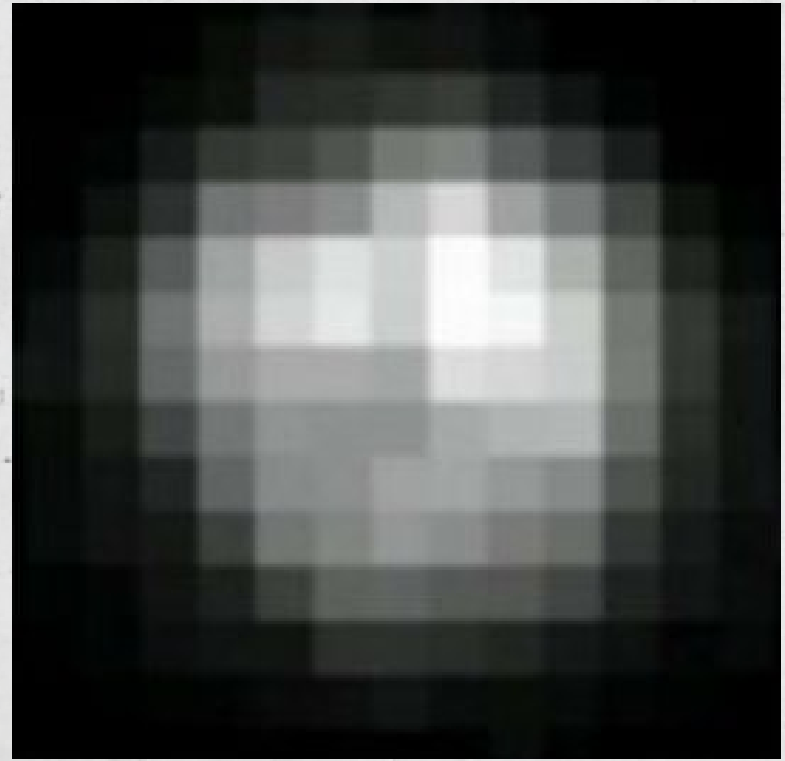
Pluto: 1984 vs 2018



Age of Transparency

- “Marketing in the age of transparency”
- Customers / influencers are investigating the risks from the products or companies
- Effort of making more informed and responsible decisions

Concrete's LEED Contributions

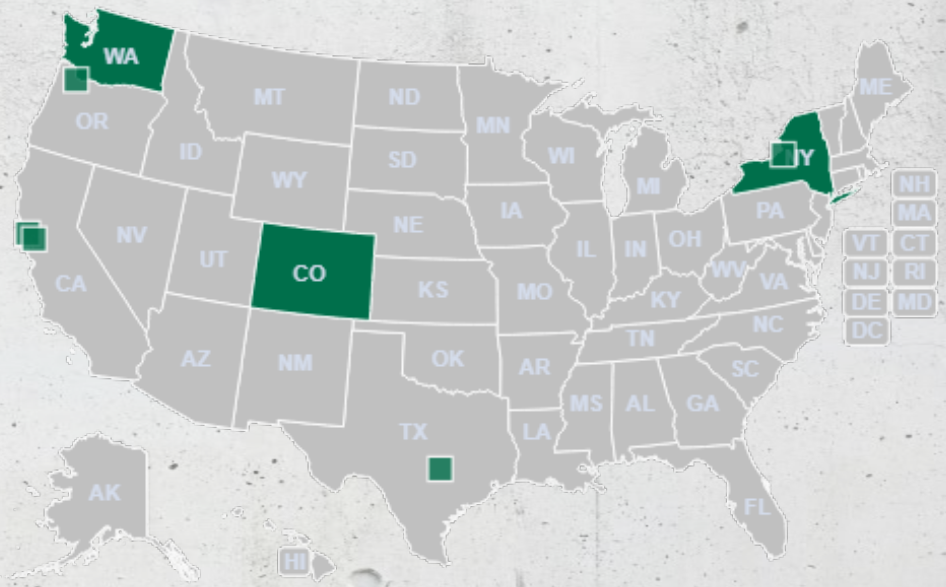
Building product disclosure and optimization

- 20 EPDs for permanently installed products (5 manufacturers)
  - Declaration vs. Industry Average vs. Product Specific
- Sourcing of raw materials
  - Locally sourced materials
- Responsibly sourced materials
- Material ingredients reporting i.e. recycled content
- Other indirect contributions in design
  - Lighting, heat island, etc.

Embodied Carbon Legislation

"Buy Clean" policy

- State-owned or funded building projects
- EPDs required for eligible materials
  - Concrete, steel, engineered wood
  - May be required at bid or before installation
- GWP of eligible materials must be below state-defined maximum
  - May be based on multi-year period of EPD gathering before GWP max. is set



Federal Buy Clean – GSA, DOT, DOD

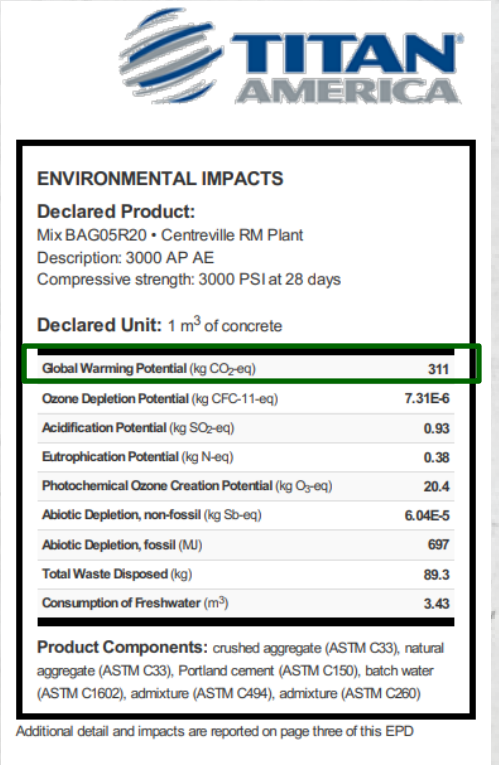
- GSA standard effective as of March 2022 for Concrete and Asphalt
  - GSA considering setting limits on additional materials
- GSA energy efficiency standard effective as of March 2022
- DOT and DOD likely to follow

GSA Embodied Carbon Limits for Concrete

	Maximum Global Warming Potential Limits for GSA Low Embodied Carbon Concrete (kilograms of carbon dioxide equivalent per cubic meter - CO_2e kg/m^3)		
Specified compressive strength (f'c in PSI)	**Standard Mix**	**High Early Strength**	**Lightweight**
up to 2499	**242**	**326**	**462**
2500-3499	**306**	**413**	**462**
3500-4499	**346**	**466**	**501**
4500-5499	**385**	**519**	**540**
5500-6499	**404**	**546**	**N/A**
6500 and up	**414**	**544**	**N/A**

These numbers reflect a 20% reduction from GWP (CO_2e) limits in model code language: "Lifecycle GHG Impacts in Building Codes" by the New Buildings Institute, January 2022.

Crash Course in Embodied Carbon



TITAN AMERICA

ENVIRONMENTAL IMPACTS

Declared Product:
Mix BAG05R20 • Centreville RM Plant
Description: 3000 AP AE
Compressive strength: 3000 PSI at 28 days

Declared Unit: 1 m^3 of concrete

Global Warming Potential (kg CO_2-eq)	311
Ozone Depletion Potential (kg CFC-11-eq)	7.31E-6
Acidification Potential (kg SO_2-eq)	0.93
Eutrophication Potential (kg N-eq)	0.38
Photochemical Ozone Creation Potential (kg O_3-eq)	20.4
Abiotic Depletion, non-fossil (kg Sb-eq)	6.04E-5
Abiotic Depletion, fossil (MJ)	697
Total Waste Disposed (kg)	89.3
Consumption of Freshwater (m^3)	3.43

Product Components: crushed aggregate (ASTM C33), natural aggregate (ASTM C33), Portland cement (ASTM C150), batch water (ASTM C1602), admixture (ASTM C494), admixture (ASTM C260)

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

Material Quantity x GWP = EC

500m^3 x 311 kgCO2e/m^3 = **155,500 kgC02e/m^3**

GWP = Global Warming Potential
EC= Embodied Carbon
EC unit of measure = kgCO2e
EPD = Environmental Product Declaration
IW = Industry Wide
PS = Product Specific

LCA Software Tools

- LCA and EPD Generation
  - Athena
  - Climate Earth
  - GCCA
- WBLCA
  - Athena
  - Tally
  - One Click
- Embodied Carbon Calculators
  - EC3
- Other concrete LCA/embodied carbon tools
  - Beacon (Thornton Tomasetti)
  - Concrete LCA Tool (ZGF)
  - Slag Cement Association Calculator

Athena
Sustainable Materials
Institute

GCCA EPD Tool – Stages considered

A1 – A3
Product Stage

- A1 Raw Material Supply
- A2 Transport
- A3 Manufacturing

A4 – A5
Construction

- A4 Transport
- A5 Construction Process

B1 – B7
Use Stage

- B1 Use
- B2 Maintenance
- B3 Repair
- B4 Replacement
- B5 Refurb.
- *B6 Op. Energy*
- *B7 Op. Water*

C1 – C4
End of Life

- C1 De-construction
- C2 Transport
- C3 Waste Processing
- C4 Disposal

GCCA EPD Tool 3.1

International Version

- Verified by Studio Fieschi
- Based on ISO 14025 and EN 15804

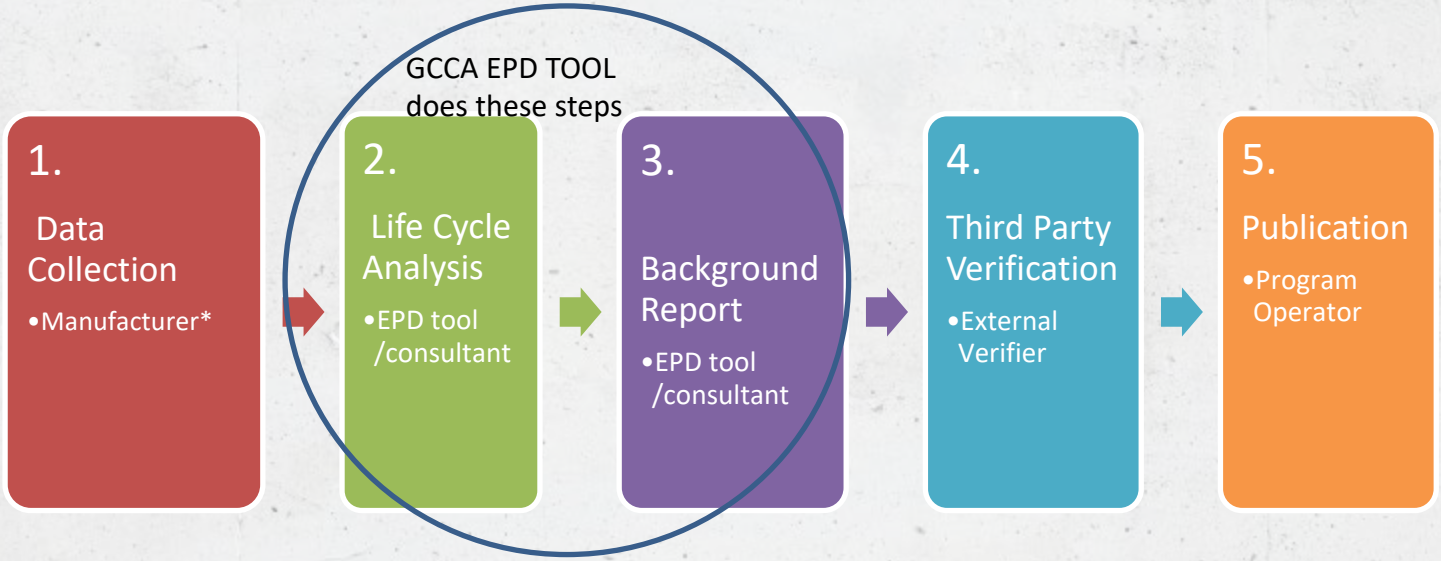
STUDIO FIESCHI & SOCI
sostenibilità su misura

N American Version

- Verified by Athena
- Complies with N American Concrete PCR (transport and energy on-site processes updated in version 3.1)

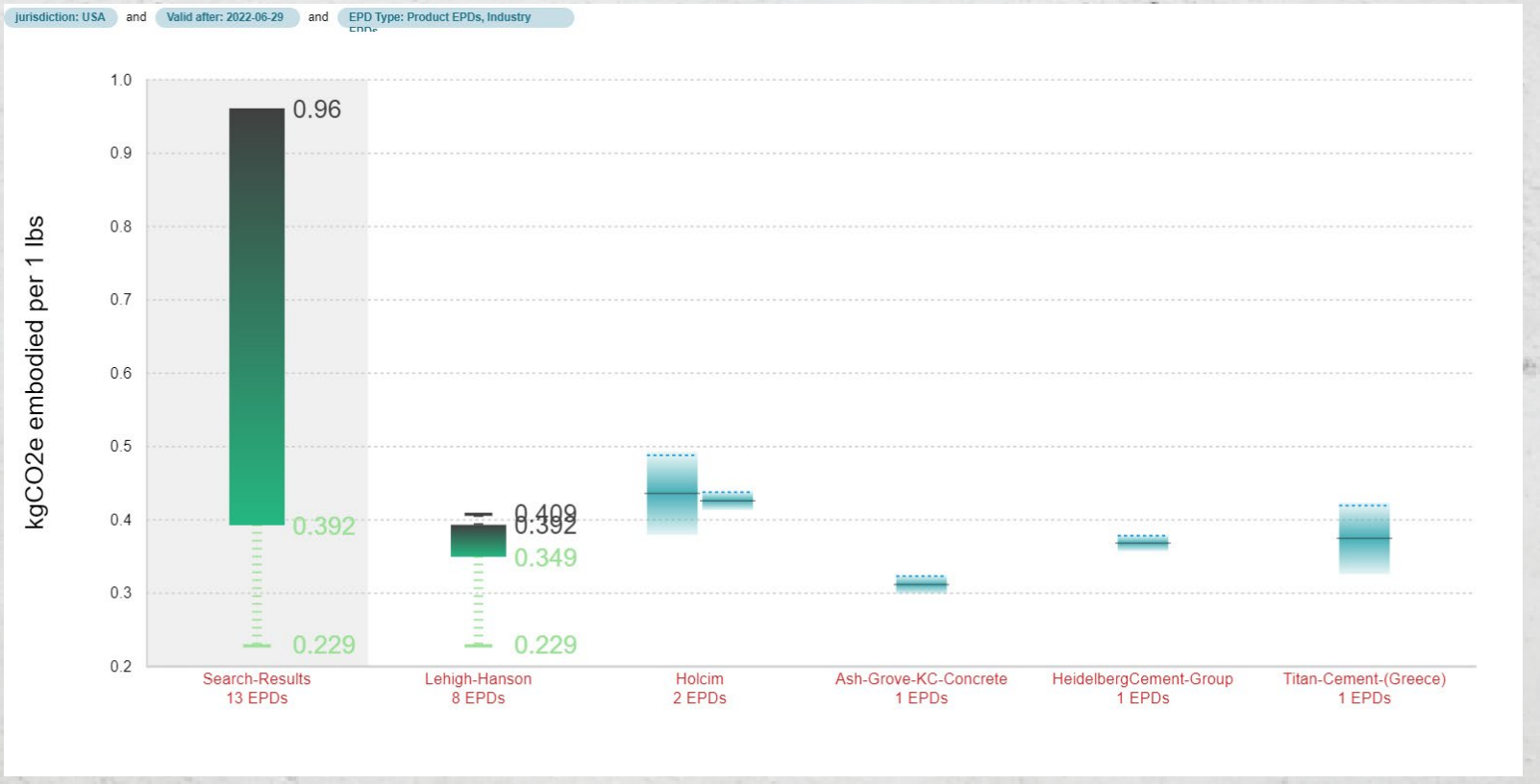
Athena Sustainable Materials Institute

Traditional EPD Process



*Manufacturer manages all stages and liaises with many point of contacts

EC3 Demo


jurisdiction: USA
and
Valid after: 2022-06-29
and
EPD Type: Product EPDs, Industry
kgCO2e embodied per 1 lbs
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.96
0.392
0.229
0.409
0.392
0.349
0.229
Search-Results
13 EPDs
Lehigh-Hanson
8 EPDs
Holcim
2 EPDs
Ash-Grove-KC-Concrete
1 EPDs
HeidelbergCement-Group
1 EPDs
Titan-Cement-(Greece)
1 EPDs

Specification Impacts

What does it look like?

Professional Services (A/E)

If You Don't Spec It, You Won't Get It…

1.3 ACTION SUBMITTALS

A. Product Data: Submit product data for each type of product indicated.

B. Sustainable Design Submittals:

1. Sustainability Criteria Worksheet: Submit one worksheet for each component material of the product or assembly used in the installation of Work of this Section
2. Environmental Product Declaration: An EPD is required, submit in accordance with Section 01 81 13.14 "Sustainability Design Requirements," Article 1.6C.1 "ACTION SUBMITTALS; Sustainable Design Documentation Submittals; MRc2.1 – EPDs."
3. Reports from raw materials suppliers: If available, submit CSR reports from suppliers in accordance with Section 01 81 13.14 "Sustainability Design Requirements," Article 1.6C.2 "ACTION SUBMITTALS; Sustainable Design Documentation Submittals; MRc3.1 – CSR…"
4. Leadership ex… program; bio-… and/or recycle… Requirements… Documentatio…
5. Material Ingre… HPD, C2C certificate at Bronze level or above, C2C Material Health Certificate, Declare product label, or other acceptable material ingredient inventory in accordance with Section 01 81 13.14 "Sustainability Design Requirements," Article 1.6C.4 "ACTION

O. Environmental Product Declaration: Submit in accordance with Section 01 81 13.14, part 1.6.C.1 LEED Submittals – BPDO – Environmental Product Declarations. All submitted material, of all framing types, must be accompanied by EPDs. Design-Build team will consider the Global Warming Potentials disclosed therein when selecting bids.

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What About Embodied Carbon?

- Do not specify carbon footprint for each mix (application)
- Specify a carbon budget for all the concrete on the project
- Permit more flexibility to meet other performance criteria

Specifying EPDs

SECTION 03300 – CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

1. The basis for designing concrete mixtures and demonstrating compliance with carbon budget targets shall be in accordance with:

   a. National Ready Mixed Concrete Association (NRMCA) Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete Manufactured by NRMCA Members – Version 3 (or later).

   b. National Ready Mixed Concrete Association, NRMCA Member Industry Average EPD for Ready Mixed Concrete – Version 3 (or later).

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Proposed Specification Language

Option 1

Supply concrete mixtures such that the total Global Warming Potential (GWP) of all concrete on the project is less than or equal to 4,298,000 kg of CO_2 equivalents as calculated using the Athena Impact Estimator for Buildings Software available at www.athenasmi.org.

Option 2

Supply concrete mixtures such that the total Global Warming Potential (GWP) of all concrete on the project is 30% or more below the GWP of a reference building using Benchmark mixes as established by NRMCA and available for download at www.nrmca.org. Submit a summary report of all the concrete mixtures, their quantities and their GWP to demonstrate that the total GWP of the building is 30% or more below the GWP of the reference building. Contractor may use the Athena Impact Estimator for Buildings software available at www.athenasmi.org or other similar software with the capability of calculating GWP of different mix designs.

www.buildwithstrength.com/design-center

- Structural system recommendations
- Cost comparisons
- Specification review
- Design/construction team collaboration

Design Recommendations: What's Inside?

Recommendations for:

Tar Heel Development

Tar Heel Village, Charlotte, NC

Prepared by:
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LLemay@nrmca.org

Chris Dagosta
(602) 930-3793
CDagosta@nrmca.org

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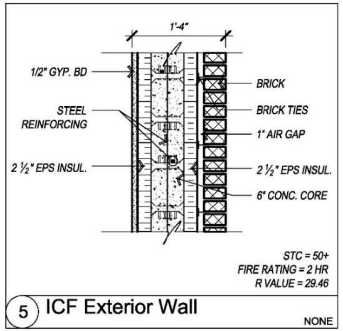
Wood Frame Construction Cost	Concrete Construction Cost
$19,255,832	$19,229,089



Beach Green North, Rockaway, New York

This 101-unit, 94,000-square-foot apartment building is built in an area devastated by Hurricane Sandy in 2012. The Bluestone Organization selected ICFs for exterior, corridor and demising walls and precast hollow-core floors for disaster resilience and energy efficiency. The building is so energy efficient it is certified by the Passive House institute. ICFs create a solid concrete wall with continuous insulation, resulting in a comfortable and airtight structure that lowers energy bills. The reinforced concrete system results in a structure that's strong, durable and can stand up to fire, floods and wind. This developer builds exclusively with concrete.

Image courtesy of The Bluestone Organization

Walker's Landing, Milwaukee, Wisconsin

Bedford Development chose ICF walls and precast hollow-core floors for thermal efficiency, fire rating and speed of construction. Walker's Landing has four floors of residential over two floors of parking. The project is located on an infill urban site requiring fire rated exterior walls. The ICF provides more than enough fire rating at a significant cost savings over wood frame. The ICFs are so energy efficient that some tenants have never turned their heat on all winter. The building also has garage heaters that have never been turned on. Bedford Developments used the vertical TF Forming Systems ICF resulting in minimal waste on the job site.

Image courtesy of Bedford Development

Most Common Prescriptive Requirements

Prescriptive Requirement	Frequency Seen
Restriction on SCM quantity	85%
Max w/cm (when not applicable)	73%
Minimum cementitious content	46%
Restriction on SCM type, characteristics	27%
Restriction on aggregate grading	25%

CSC-Certification for Responsibly Sourced Concrete CO_2 Module for Low Carbon Concrete

Concrete Sustainability Council

https://www.concretesustainabilitycouncil.com/

What does the certification system reward?

PREREQUISITES

P1 Ethical and Legal Compliance
P2 Human Rights
P3 Indigenous People Rights
P4 Environmental and Social Impact
P5 Traced Materials

MANAGEMENT

M1 Sustainable Purchasing
M2 Environmental Management
M3 Quality Management
M4 Health & Safety Management
M5 Benchmark

ENVIRONMENTAL

E1 Life Cycle Impact
E2 Land Use
E3 Energy & Climate
E4 Air Quality
E5 Water
E6 Biodiversity
E7 Secondary Materials
E8 Transport
E9 Secondary Fuels

SOCIAL

S1 Local Community
S2 Health Product Information
S3 Occupational Health & Safety
S4 Labor Practices

ECONOMICS

B1 Local Economy
B2 Ethical Business
B3 Innovation
B4 Feedback Procedure

CHAIN OF CUSTODY

C1 Cement
C2 Aggregates

The Top 10 List

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1. Communicate Carbon Reduction Goals
2. Ensure Good Quality Control and Assurance
3. Optimize Concrete Volume
4. Use Alternative Cements
5. Use Supplementary Cementitious Materials
6. Use Admixtures
7. Don’t Limit Ingredients
8. Set Targets for Carbon Footprint
9. Sequester Carbon Dioxide in Concrete
10. Encourage Innovation

How did we get here?

2009 → 2012 → 2014 → 2016 → 2021

ADOPTER architecture 2030 CHALLENGE

NRMCA CERTIFIED EPD

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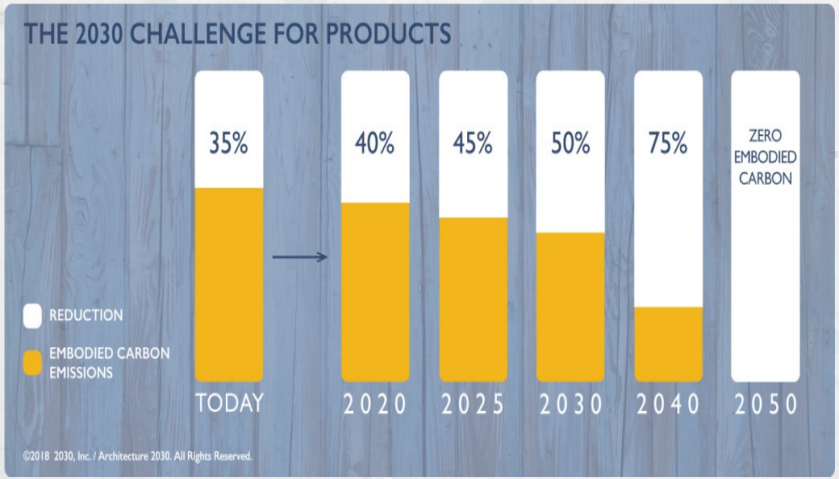
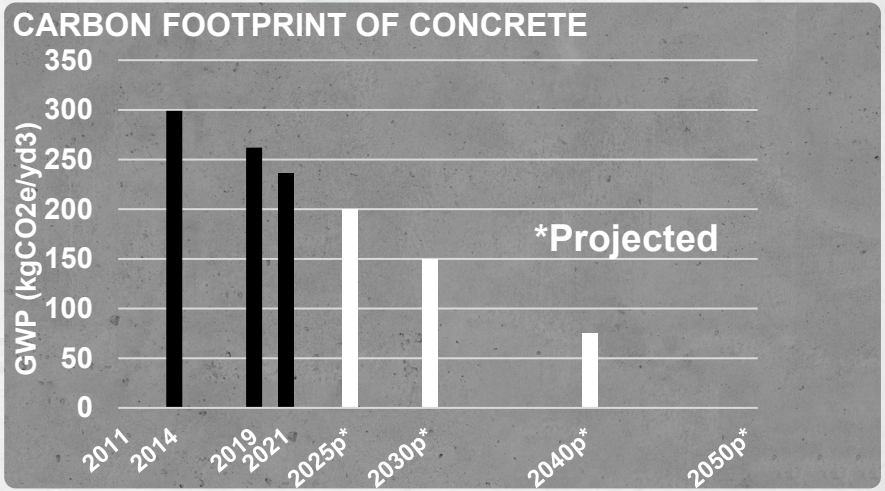
Roadmap to Carbon Neutrality
A more sustainable world is Shaped by Concrete





Activity: Carbon Reduction Roadmap

- Group brainstorm on how to reduce embodied carbon locally
  - Mix Design Optimization and Carbon Value Engineering
  - SCM's
  - Natural Pozzolans i.e. calcined clay or metakaolin
  - Admixtures
  - Type IL Cement
  - Alternate blended cements
  - Recycled Concrete Aggregate (RCA)
  - Carbon Storing Aggregates

Plus/Delta

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Strategies and Promotion Efforts

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GOAL: Increase Market Share from 23% to 30% by 2030

NRMCA + State Affiliates + Sustainability

COMMUNICATE

- Greater Emphasis on Innovation
- More Paid Media
- More Social Media especially LinkedIn
- More Trade Shows
- More Sponsorships

ADVOCATE

- Greater Emphasis on Sustainability Codes
- EPD / HPD / CSR
- Focus on Concrete Strengths
- Resilience, LCA, Innovation

PROMOTE

- Greater Emphasis on Education
- Focus on Value, Innovation, Resilience
- Sponsored Workshops (AIA/USGBC/SEA)
- More Online

CONNECT

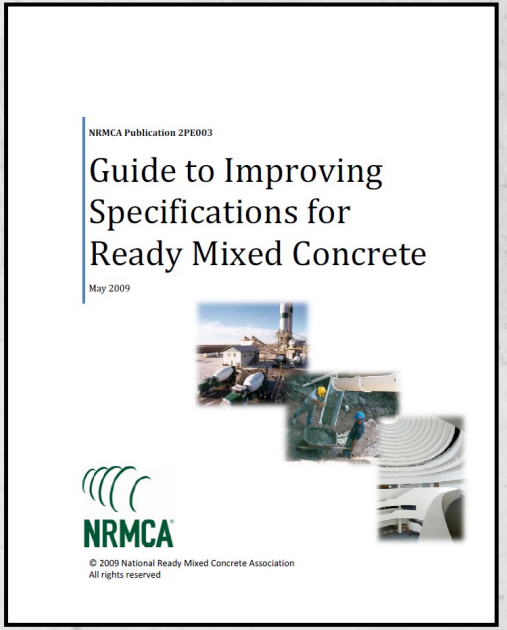
- Large, Influential Owners, Specifiers
- Apartments, Hotels, Dormitories, Offices and Schools
- Change Specifications, Low-carbon Concrete, Innovative Cements

Performance Specifications

General Guidelines

- Do not limit material ingredients that are permitted in standards
- Do not try to control means and methods such as early age strength and slump
- Do not limit Global Warming Potential or Carbon Footprint for each mix, but establish a carbon budget for the entire building

- TIP: Download guide spec
- TIP: Download whole build LCA example



Questions?

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