BUILDINGENERGY BOSTON

Driving Down Carbon in Concrete: From One Project to the Mainstream

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Curated by Beverly Craig

Northeast Sustainable Energy Association (NESEA)
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PAYETTE

Embodied Carbon Reduction Challenge

- ✔ $50,000 Grand Prize New Construction
- ✔ $50,000 Grand Prize Substantial Rehab
- ✔ 9 Runner-ups of $30,000
- ✔ $10,000 People's Choice Award

- New construction or substantial renovation of any type (multifamily, office, institutional, lab, etc.) 20,000+ sq. ft.
- Embodied carbon trainings coordinated by BE+
- 5 prizes reserved for teams that have never produced an LCA
- Applications due March 2024

MASSACHUSETTS CLEAN ENERGY CENTER®

Concrete EPD Kickstarter: Environmental Product Declarations

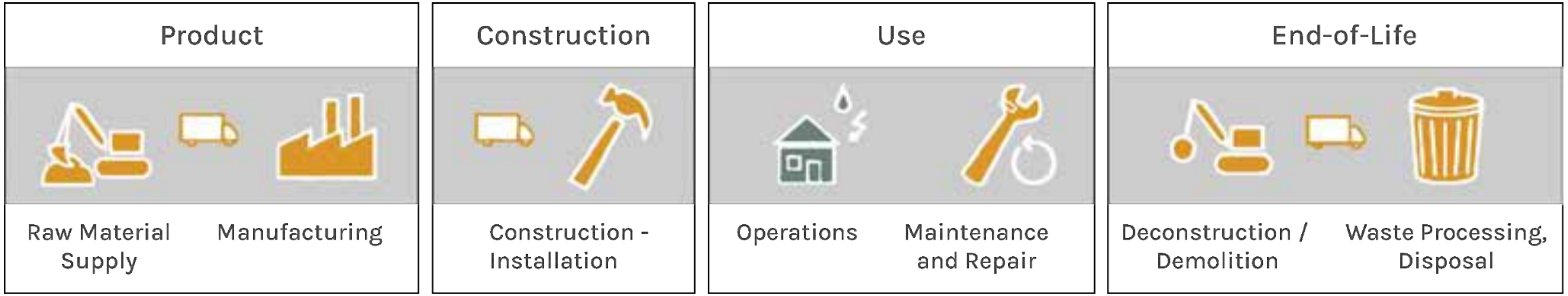
- $3,000 grant for each MA ready-mix plant; extra $1,000 for small companies (1-2 plants)
- To partially offset costs for third-party verified site specific instant EPDs
- Two years of volumes reporting to MaCAPA

MASSACHUSETTS CLEAN ENERGY CENTER®

What is Embodied Carbon?

Embodied Carbon

Operational Carbon



Embodied Carbon is the greenhouse gas emissions (CO_2) from the manufacturing, transportation, installation, maintenance, and disposal of building materials.

Unlike with operational carbon, there is no chance to decrease embodied carbon with updates in efficiency after the building is constructed.

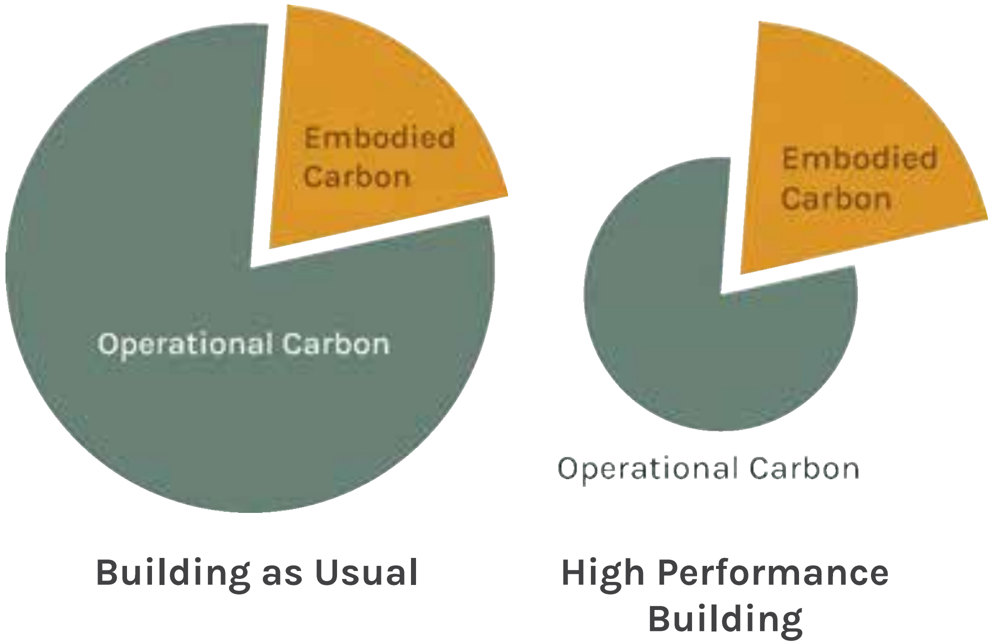
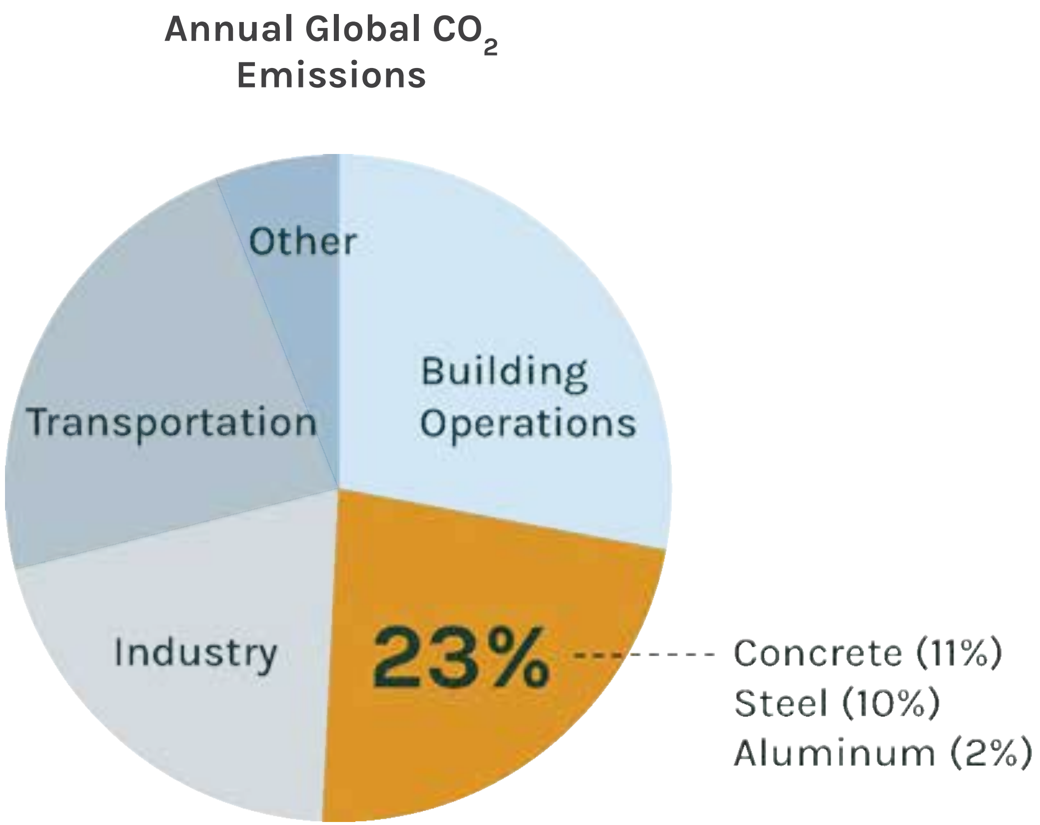
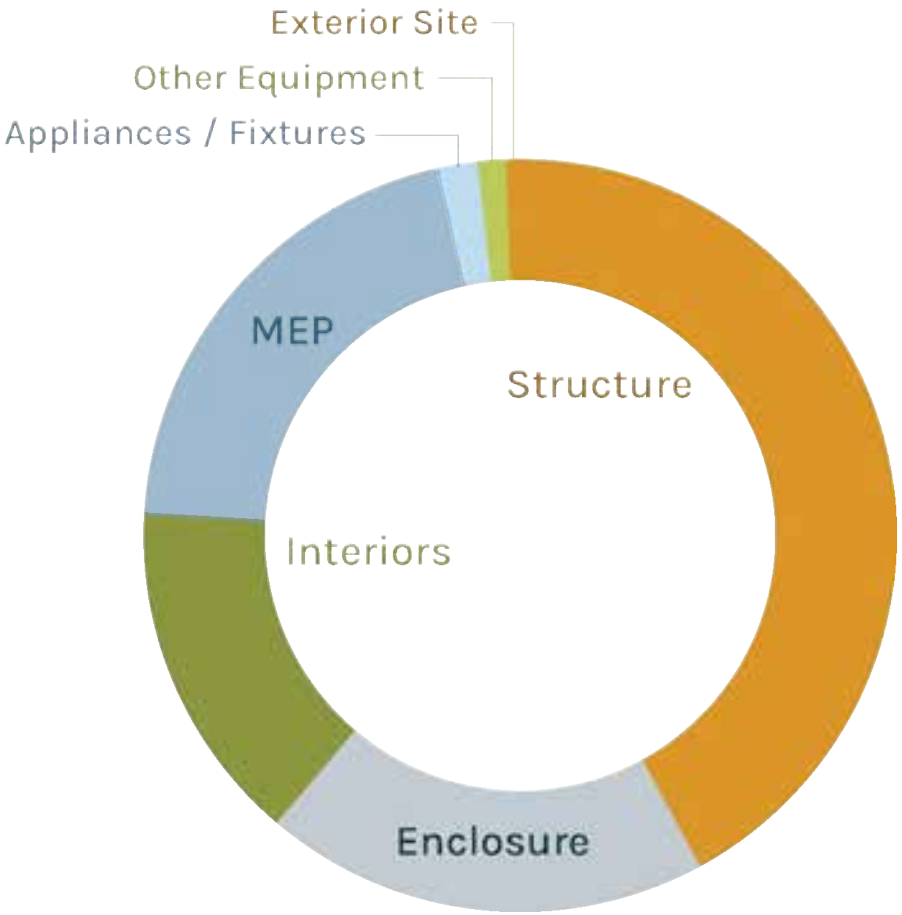


Image Source: *[Carbon Leadership Forum](), 2020*

Structural Impact in Embodied Carbon





Embodied carbon is a significant percentage of global emissions and requires urgent action to address it.

Image Source: Architecture 2030. Data source: Global ABC Status REport, 2018, EIA

Image Source: Buro Happold

Opportunities to Reduce Embodied Carbon

Materials / Systems

- Low Carbon Concrete
- Steel Production Process
- Innovative Biogenic Structure (eg Mass Timber, CLT)

Design / Process

- Stakeholder engagement
- Minimizing material
- Optimizing Sizing
- Specifications

Certifications / Synergies / Advocacy

- SE 2050 Commitment Program
- AIA 2030 Challenge
- LEED BD+C MR Credit
- Living Building Challenge
- Policy

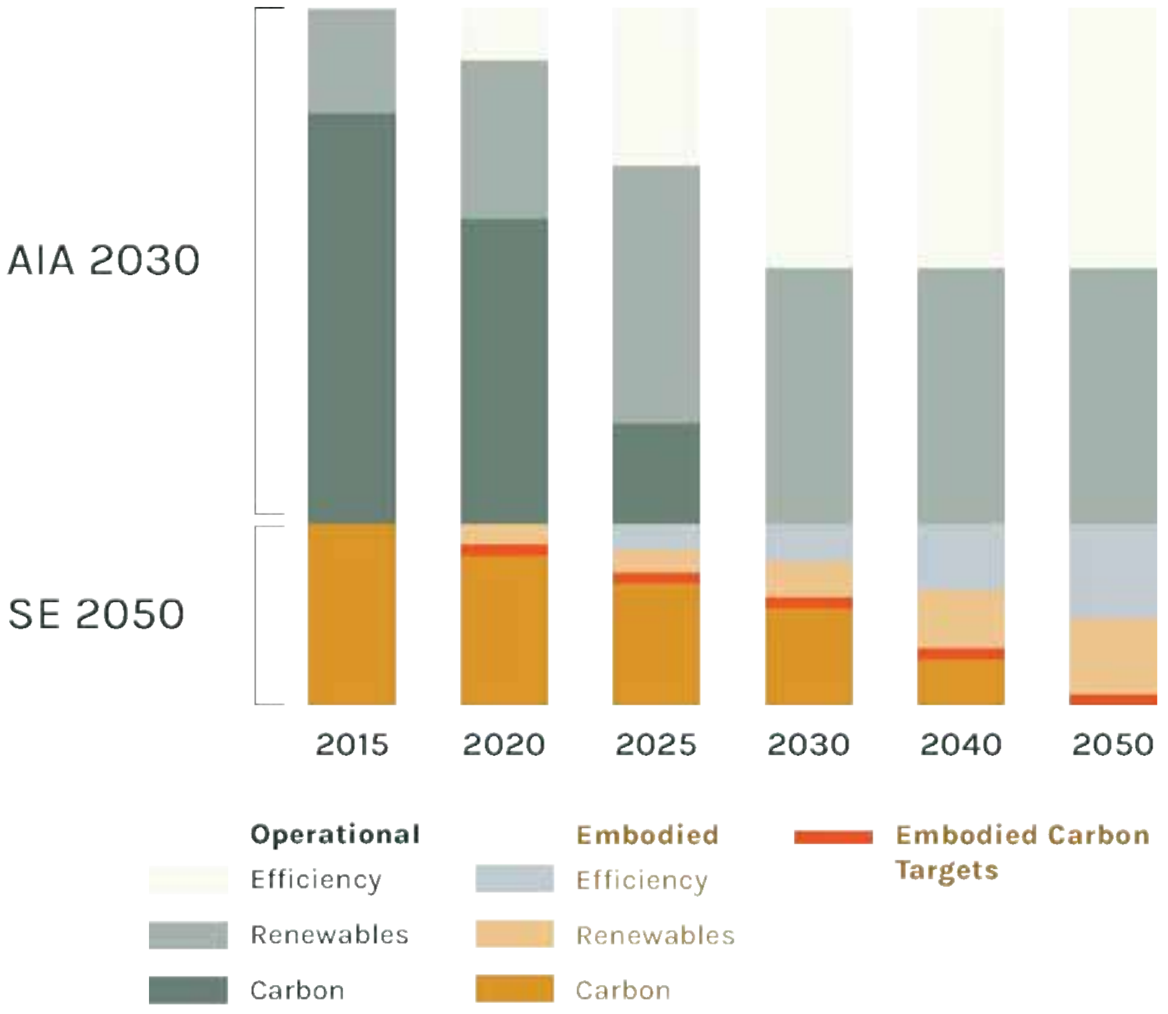


Image Source: [2018 SEI Sustainability Commitment]

The Basics of Concrete

Essential make-up of concrete

Cement

Supplementary cementitious materials

Fine & Coarse Sand

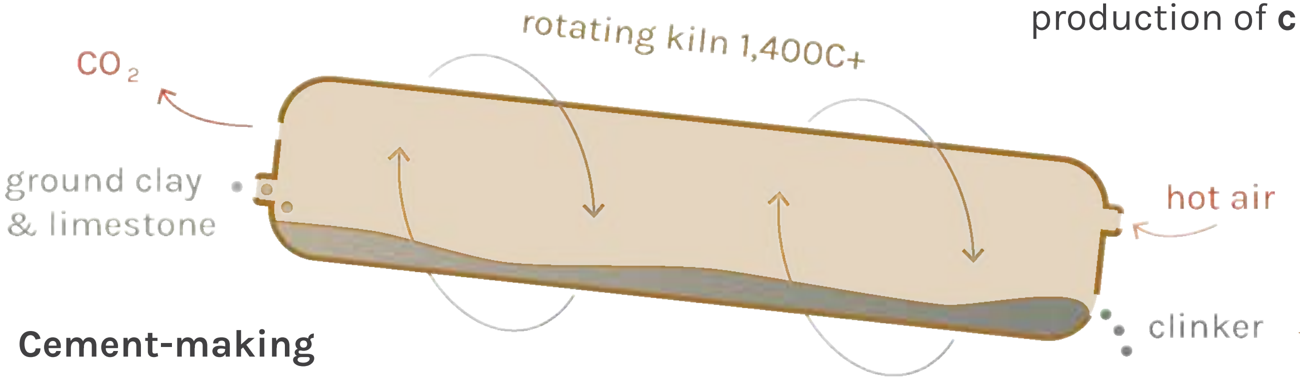
Aggregate

+ Water & other materials

Cement has the largest impact

- Cement production alone is responsible for **8% of global CO_2 emissions.**
- Manufacturing cement requires tremendous amounts of heat in **factories that use fossil fuels**
- CO_2 is a by-product of a chemical conversion process in the production of **clinker**

SCMs are front line of reducing cement content in concrete



Cement-making process

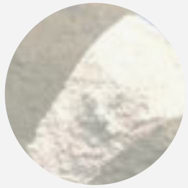
Image Source: ***BBC***

The Basics of Concrete

Essential make-up of concrete

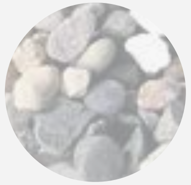
Cement

Supplementary cementitious materials

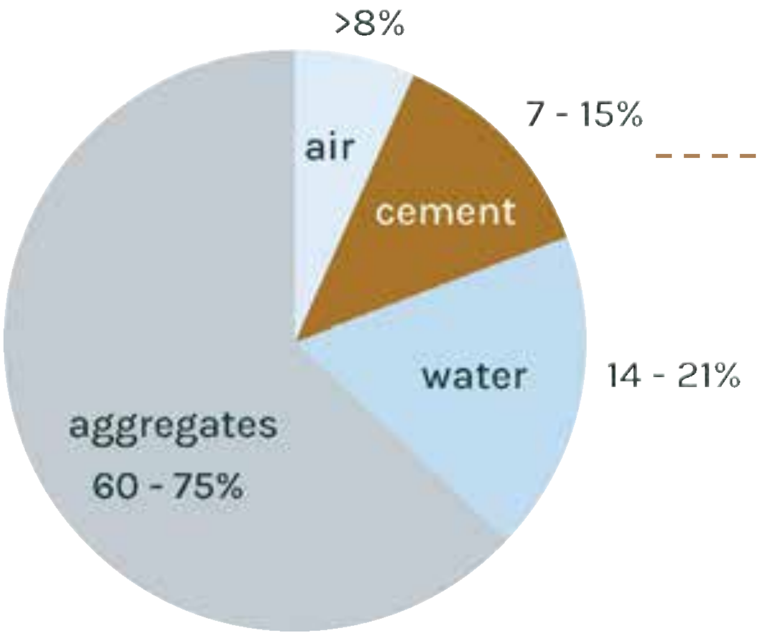


Fine & Coarse Sand

Aggregate

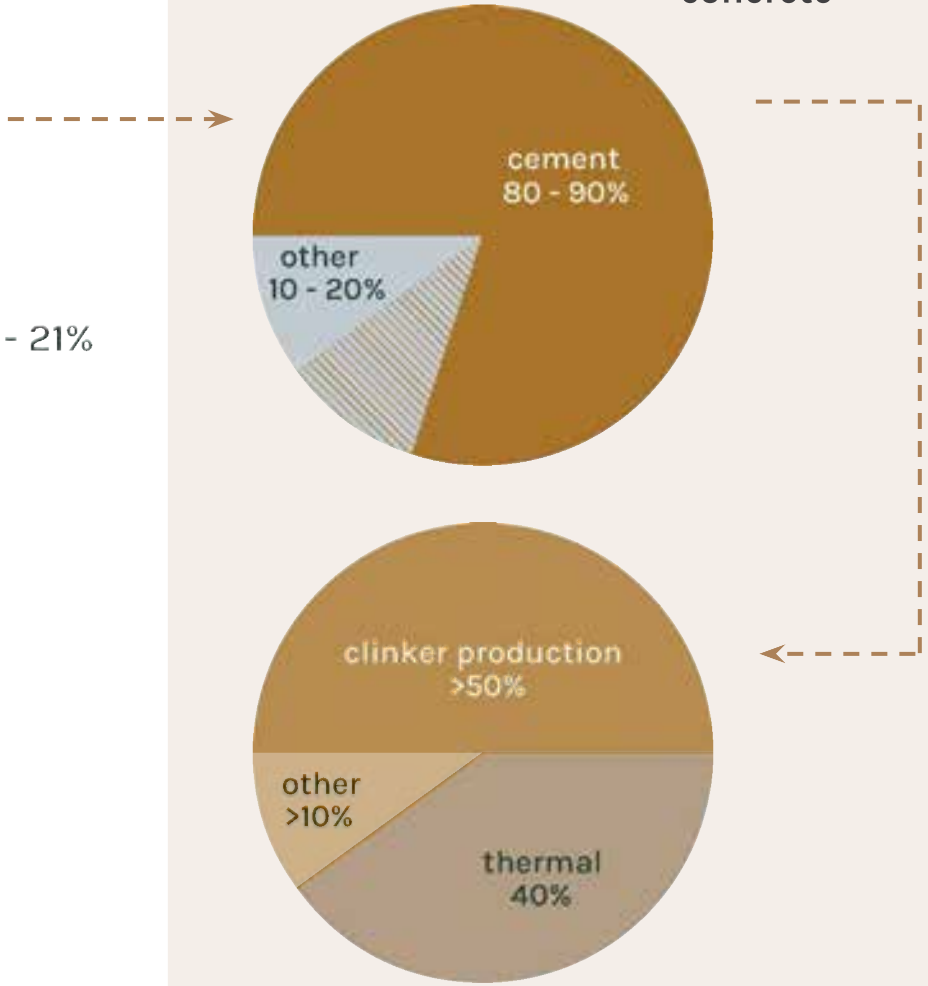


+ Water & other materials



Makeup of concrete

Source of CO2 emissions from concrete



cement production emissions sources

SCM’s: The Front Line

GWP (global warming potential)
of Portland Cement & SCMs

Readily-available

Fly Ash

Ground Granulated Blast Furnace Slag

Silica Fume

Calcined Carbonate

Natural Pozzolans: calcined clays, shale, metakaolin

Blended Cements - Portland Limestone Cement

“About to hit”

Ground Glass Pozzolan

In the Future

Biochar

Rice Husk Ash

Opportunities Throughout Concrete

Rebar

Using higher strength rebar to reduce the amount of rebar used

Consider using plain concrete where possible - eg, flatwork

Avoid “overspecifying” the strength of the concrete

Reuse

Where possible, explore opportunities to re-use existing buildings, building structures, and sitework instead of demolition

Explore the possibility of using recycled concrete

Carbon Neutral/Negative

Utilize concrete as a carbon sink (eg Carbon Cure)

Leveraging concrete’s continued carbon absorption in curing process

Biogenic processes
(eg Minus Materials & BioMason)

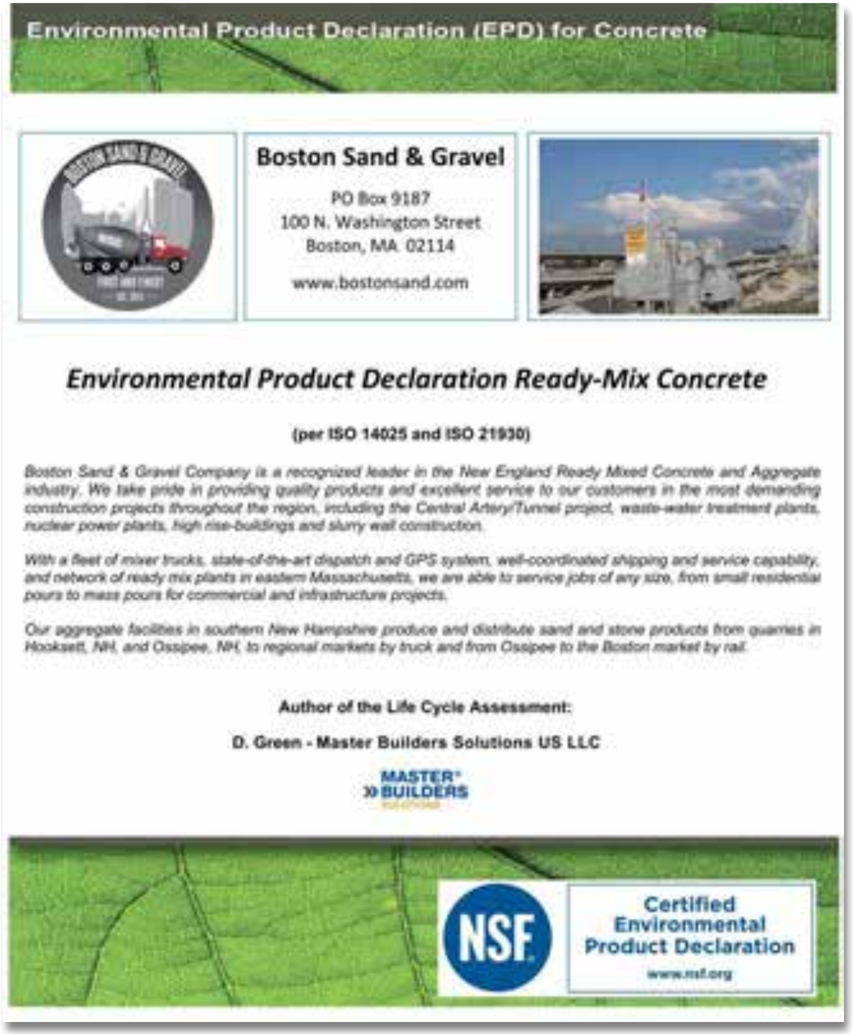
Embracing Opportunities, Working with Challenges

Opportunities	Challenges
Designing Efficient Structural Systems Consider Hybrid Structures (ie Mass Timber Frame)	A/E "Growing Pains"
Standardizing Specifications Low Concrete Specifications	Navigating regional differences Responding to market supply for SCM's
Establishing aggressive but realistic reductions	Weeding out inflated baselines
Requiring EPD's	Permutations of concrete mixes
Standardizing approach to ubiquitous applications (eg. sitewalks)	Establishing best practices for concrete mixes and applications
Adopting Innovative SCM's and SCM mixes	Industry "Growing Pains" Nascent Data & Research Adjusting schedule due to increased drying times

EPD’s

(environmental product declarations)

- **We need more concrete EPD’s!**
- **We need plant-specific EPD’s!**
- EPD’s help us set targets and see how we’re meeting them. The performance of a specific concrete mixture to benchmark data can be readily verified
- EPD’s provide room for flexibility in how concrete mixes are selected throughout the project.


Environmental Product Declaration (EPD) for Concrete

Boston Sand & Gravel

PO Box 9187
100 N. Washington Street
Boston, MA 02114

www.bostonsand.com

Environmental Product Declaration Ready-Mix Concrete

(per ISO 14025 and ISO 21930)

Boston Sand & Gravel Company is a recognized leader in the New England Ready Mixed Concrete and Aggregate industry. We take pride in providing quality products and excellent service to our customers in the most demanding construction projects throughout the region, including the Central Artery/Tunnel project, waste-water treatment plants, nuclear power plants, high rise-buildings and slurry wall construction.

With a fleet of mixer trucks, state-of-the-art dispatch and GPS system, well-coordinated shipping and service capability, and network of ready mix plants in eastern Massachusetts, we are able to service jobs of any size, from small residential pours to mass pours for commercial and infrastructure projects.

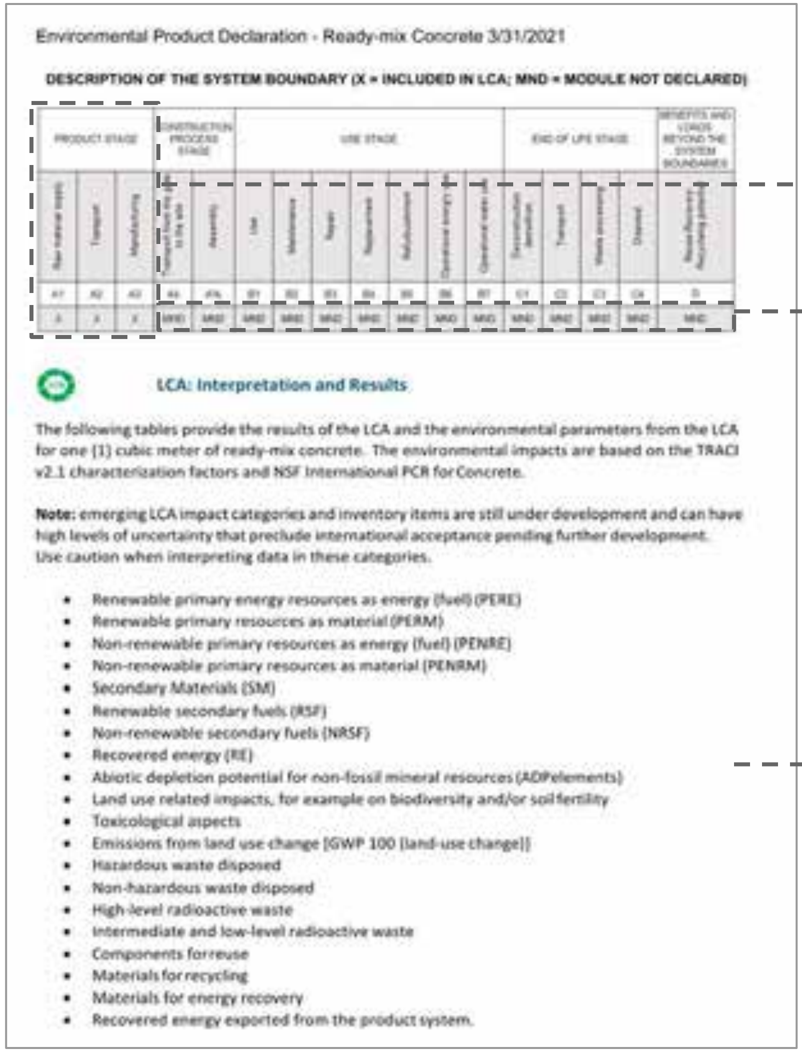
Our aggregate facilities in southern New Hampshire produce and distribute sand and stone products from quarries in Hooksett, NH, and Ossipee, NH, to regional markets by truck and from Ossipee to the Boston market by rail.

Author of the Life Cycle Assessment:

D. Green - Master Builders Solutions US LLC

NSF Certified Environmental Product Declaration www.nsf.org

EPD's



Environmental Product Declaration - Ready-mix Concrete 3/31/2021

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

LCA: Interpretation and Results

The following tables provide the results of the LCA and the environmental parameters from the LCA for one (1) cubic meter of ready-mix concrete. The environmental impacts are based on the TRACI v2.1 characterization factors and NSF International PCR for Concrete.

Note: emerging LCA impact categories and inventory items are still under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in these categories.

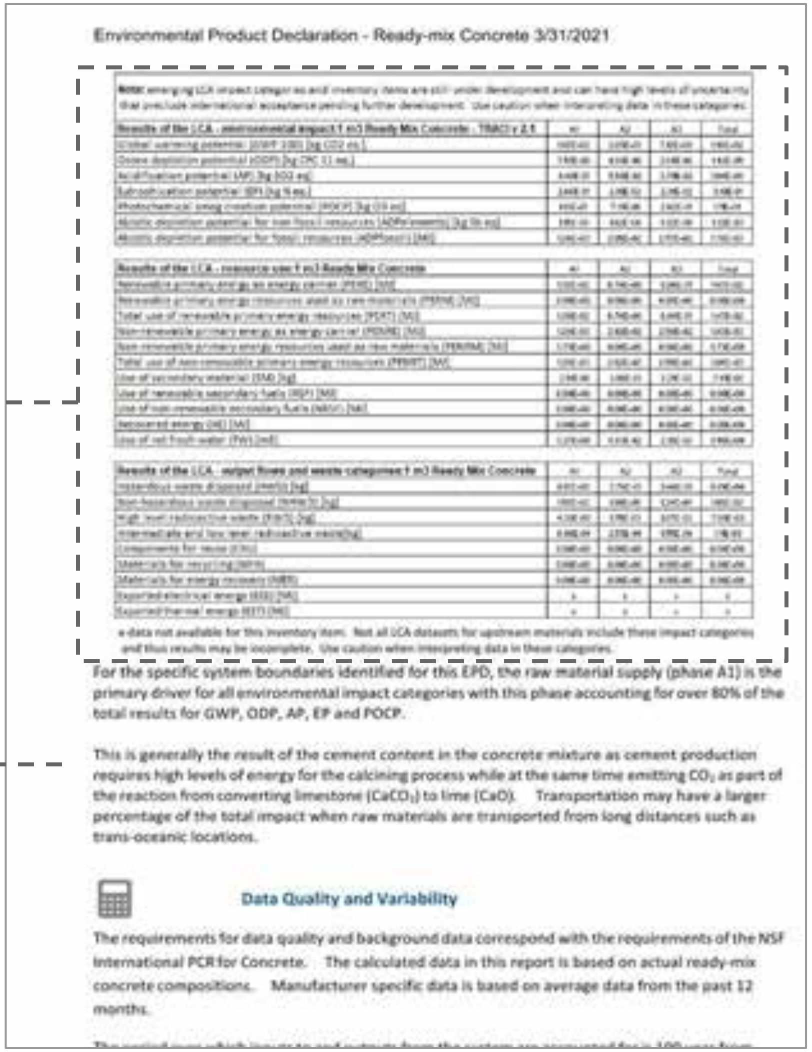
- Renewable primary energy resources as energy (fuel) (PERE)
- Renewable primary resources as material (PERM)
- Non-renewable primary resources as energy (fuel) (PENRE)
- Non-renewable primary resources as material (PENRM)
- Secondary Materials (SM)
- Renewable secondary fuels (RSF)
- Non-renewable secondary fuels (NRSF)
- Recovered energy (RE)
- Abiotic depletion potential for non-fossil mineral resources (ADPelements)
- Land use related impacts, for example on biodiversity and/or soil fertility
- Toxicological aspects
- Emissions from land use change [GWP 100 (land-use change)]
- Hazardous waste disposed
- Non-hazardous waste disposed
- High-level radioactive waste
- Intermediate and low-level radioactive waste
- Components for reuse
- Materials for recycling
- Materials for energy recovery
- Recovered energy exported from the product system.

System Boundary

Excluded

A1-A3 GWP data

Qualifying Information



Environmental Product Declaration - Ready-mix Concrete 3/31/2021

For the specific system boundaries identified for this EPD, the raw material supply (phase A1) is the primary driver for all environmental impact categories with this phase accounting for over 80% of the total results for GWP, ODP, AP, EP and POCP.

This is generally the result of the cement content in the concrete mixture as cement production requires high levels of energy for the calcining process while at the same time emitting CO_2 as part of the reaction from converting limestone ($CaCO_3$) to lime (CaO). Transportation may have a larger percentage of the total impact when raw materials are transported from long distances such as trans-oceanic locations.

Data Quality and Variability

The requirements for data quality and background data correspond with the requirements of the NSF International PCR for Concrete. The calculated data in this report is based on actual ready-mix concrete compositions. Manufacturer specific data is based on average data from the past 12 months.

Getting Lower Carbon Concrete in Early

EPD's available?

(environmental product declarations)

YES → specify low-carbon concrete using GWP as the performance metric, providing an accurate measure of climate performance

NO → capping cement limits as a reasonable proxy using a percentile-based approach

or

→ **for certain types of projects**, provide project Carbon "Budget" and allow GC to propose means & methods to achieve low carbon concrete

Specifications

Move away from prescriptive requirements

- Limits options, limits ability of manufacturers to apply creative solutions through different mixes, discourages innovations

Move towards performance requirements

- Define target carbon footprints by whole building and by concrete - eg, as percentage under benchmark established in NRMCA's Cradle-to-Gate Life Cycle Assessment v 3.2
- Understand market flux and availability

Available Resources:
[NRMCA Guide to Improving Specifications for Ready Mixed Concrete]

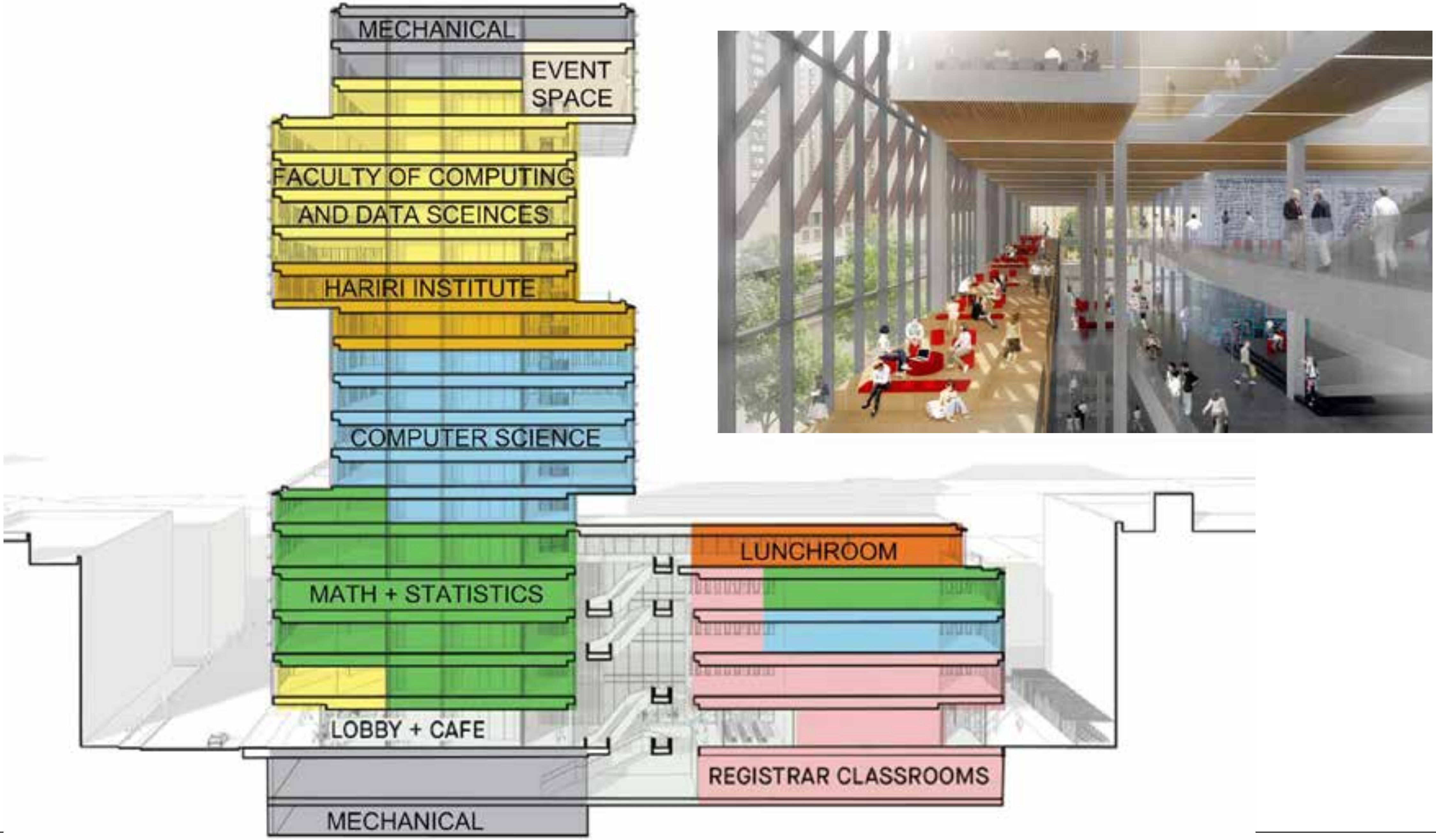
Percentile Based Approach:

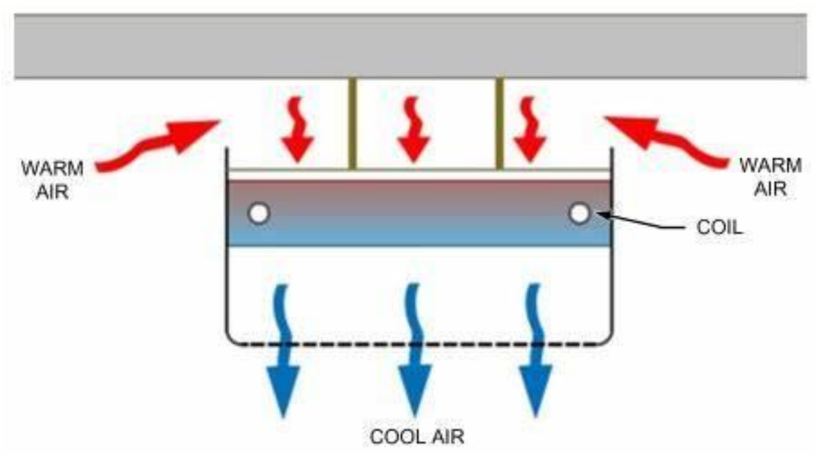
Specifier can set targets that exclude the use of a selected percentage of available mixes, with 50th percentile representing typical practice.

Athena Sustainable Materials Institute has published benchmark concrete mixes based on NRMCA industry-averaged EPD's for each region.

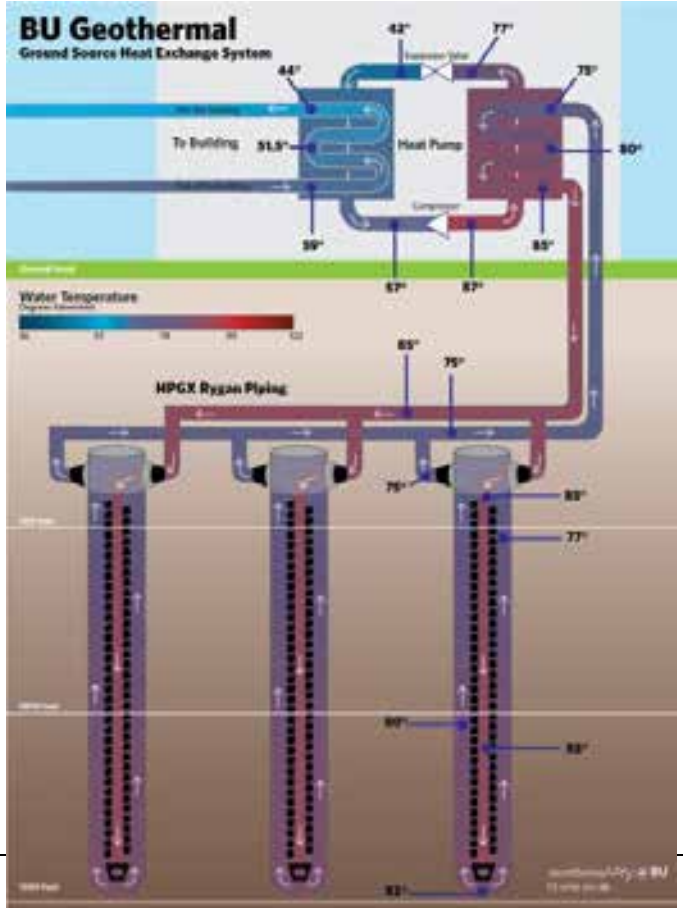
CASE STUDY
Boston University
Center for Computing and Data Sciences

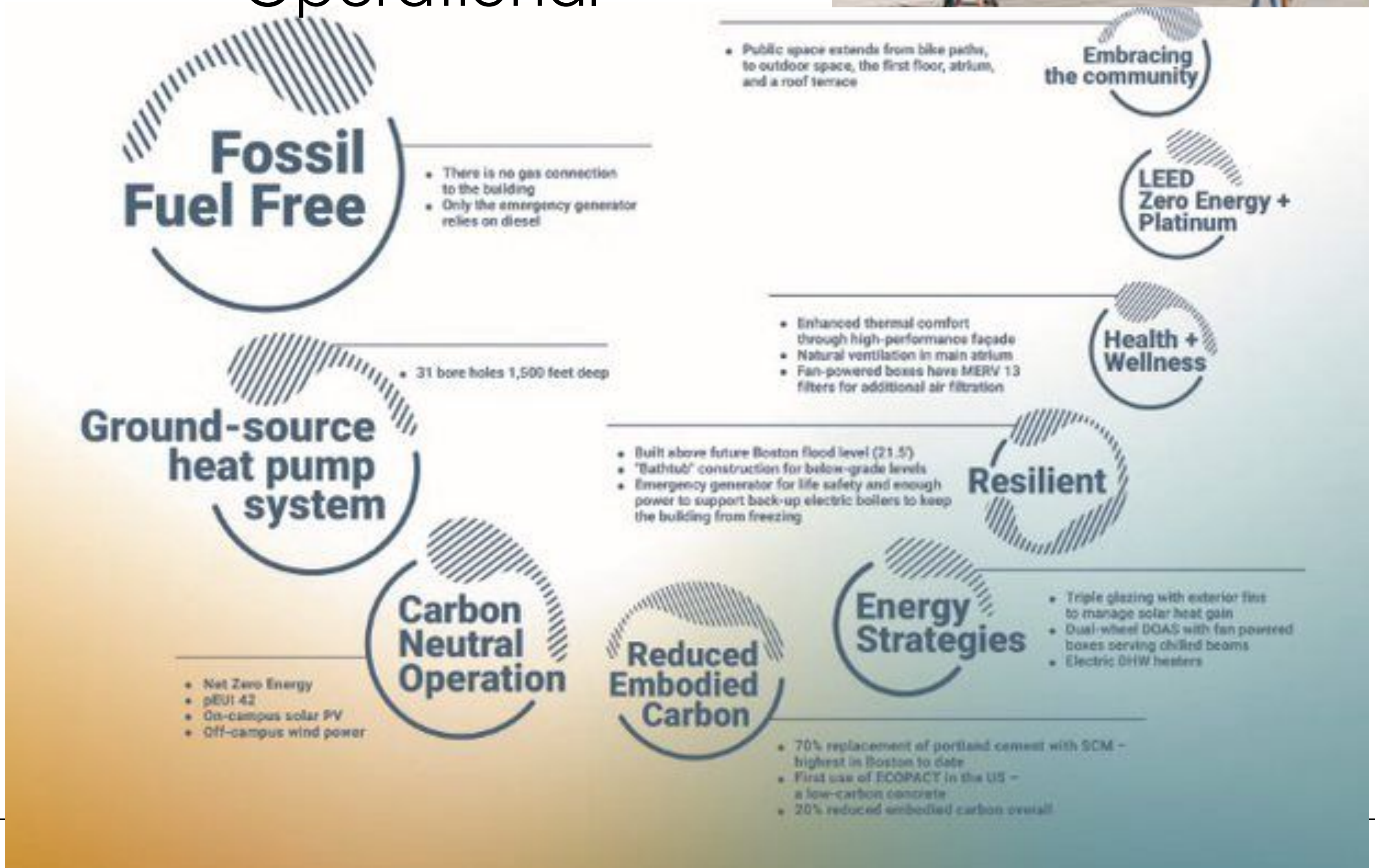
- Project Summary
- Sustainable Goals
- Structure
- Strategies
- Lessons Learned

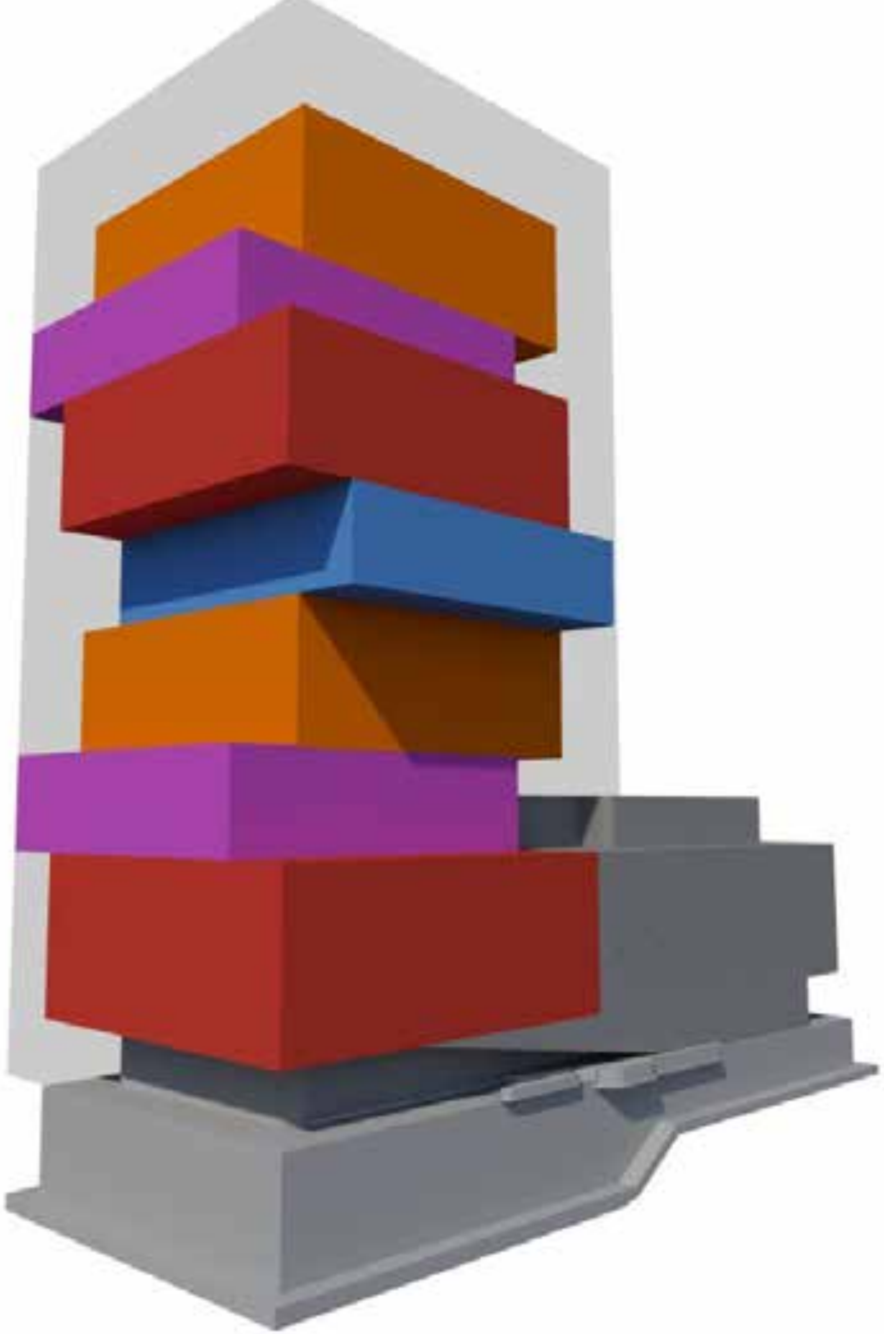

MECHANICAL
EVENT SPACE
FACULTY OF COMPUTING AND DATA SCEINCES
HARIRI INSTITUTE
COMPUTER SCIENCE
MATH + STATISTICS
LUNCHROOM
LOBBY + CAFE
REGISTRAR CLASSROOMS
MECHANICAL

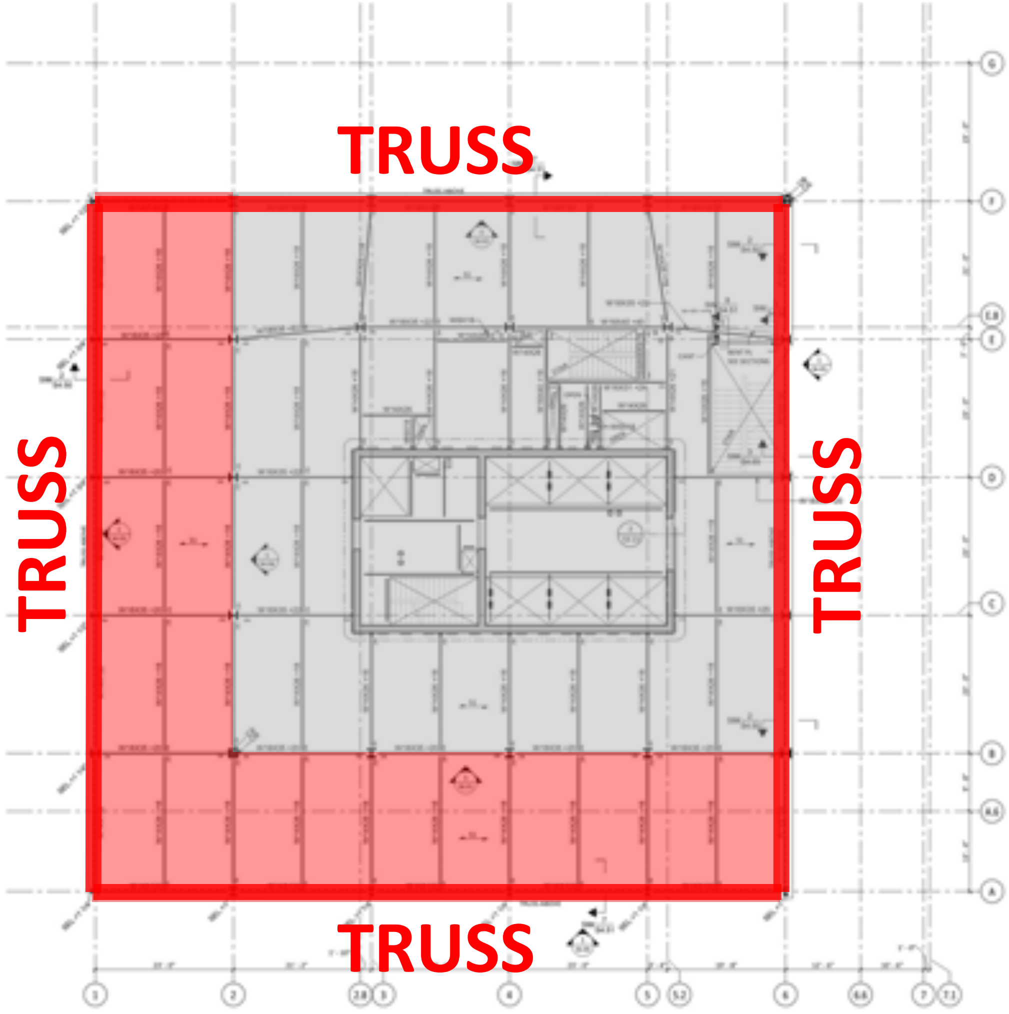


Operational








TRUSS
TRUSS
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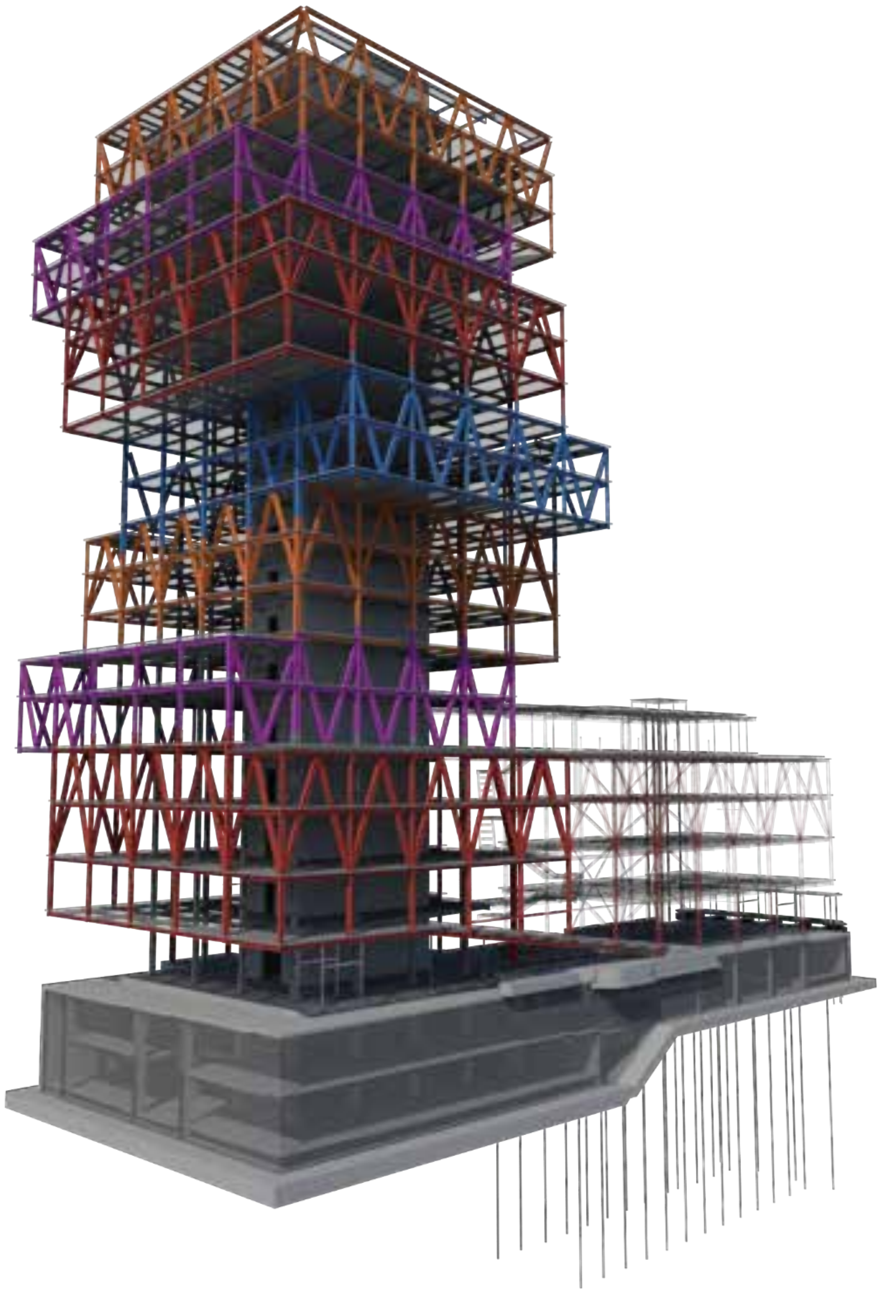
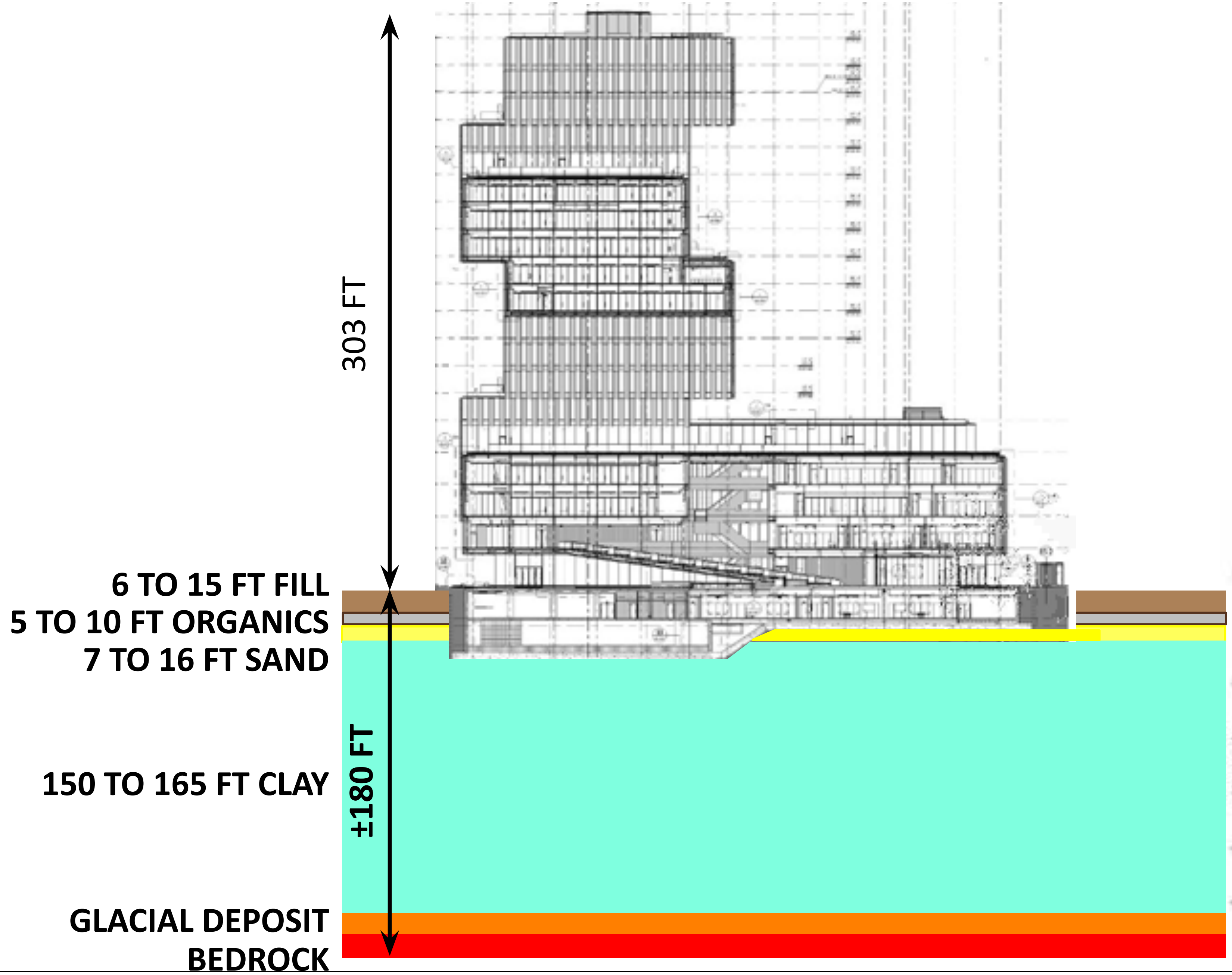
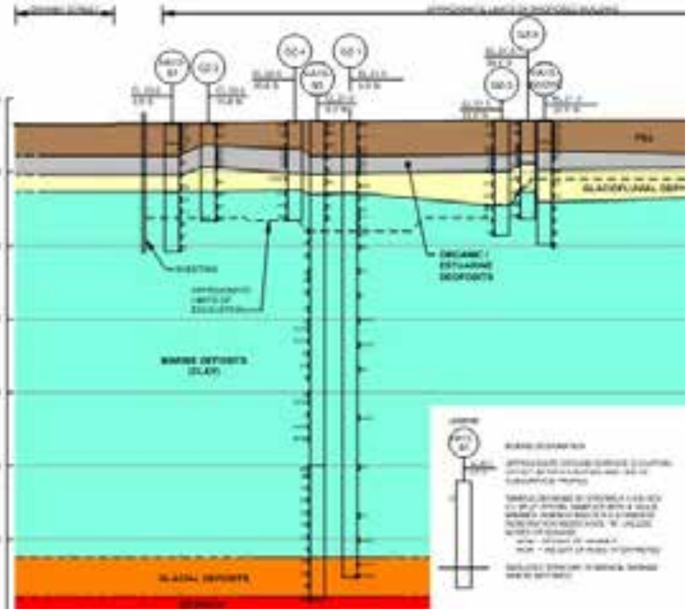
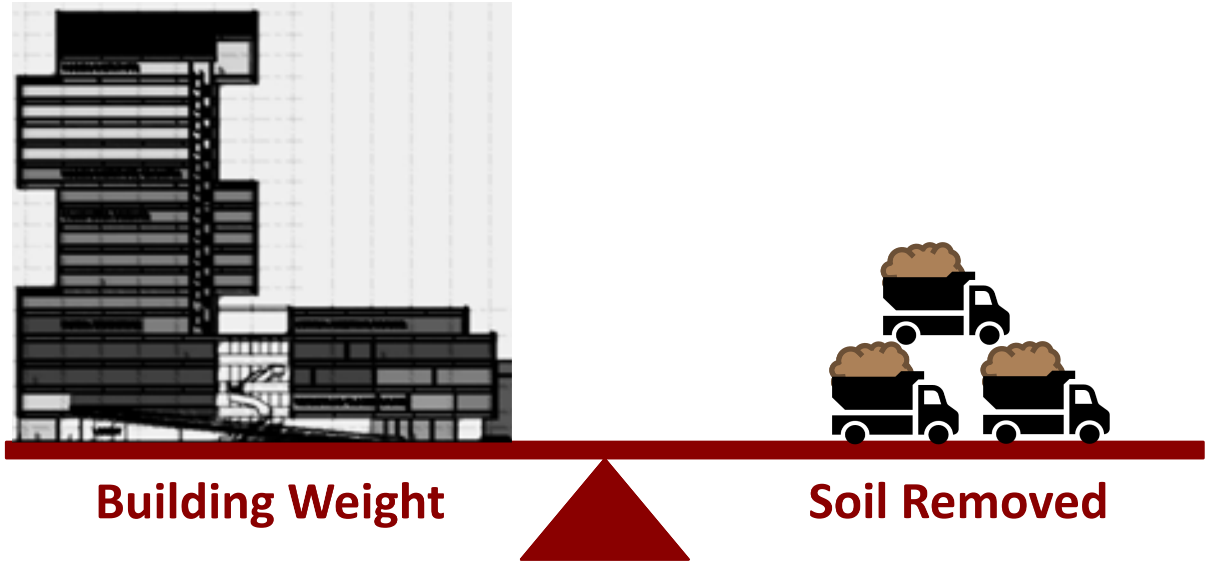
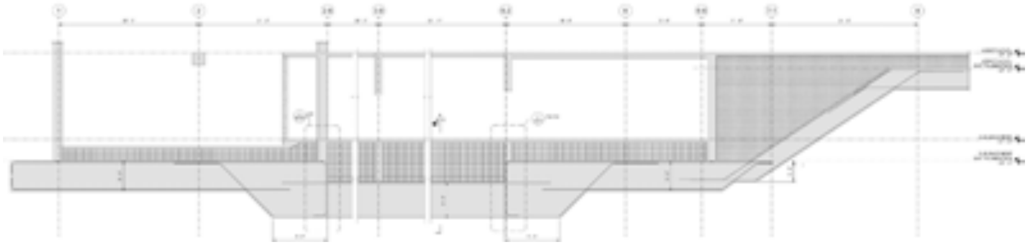


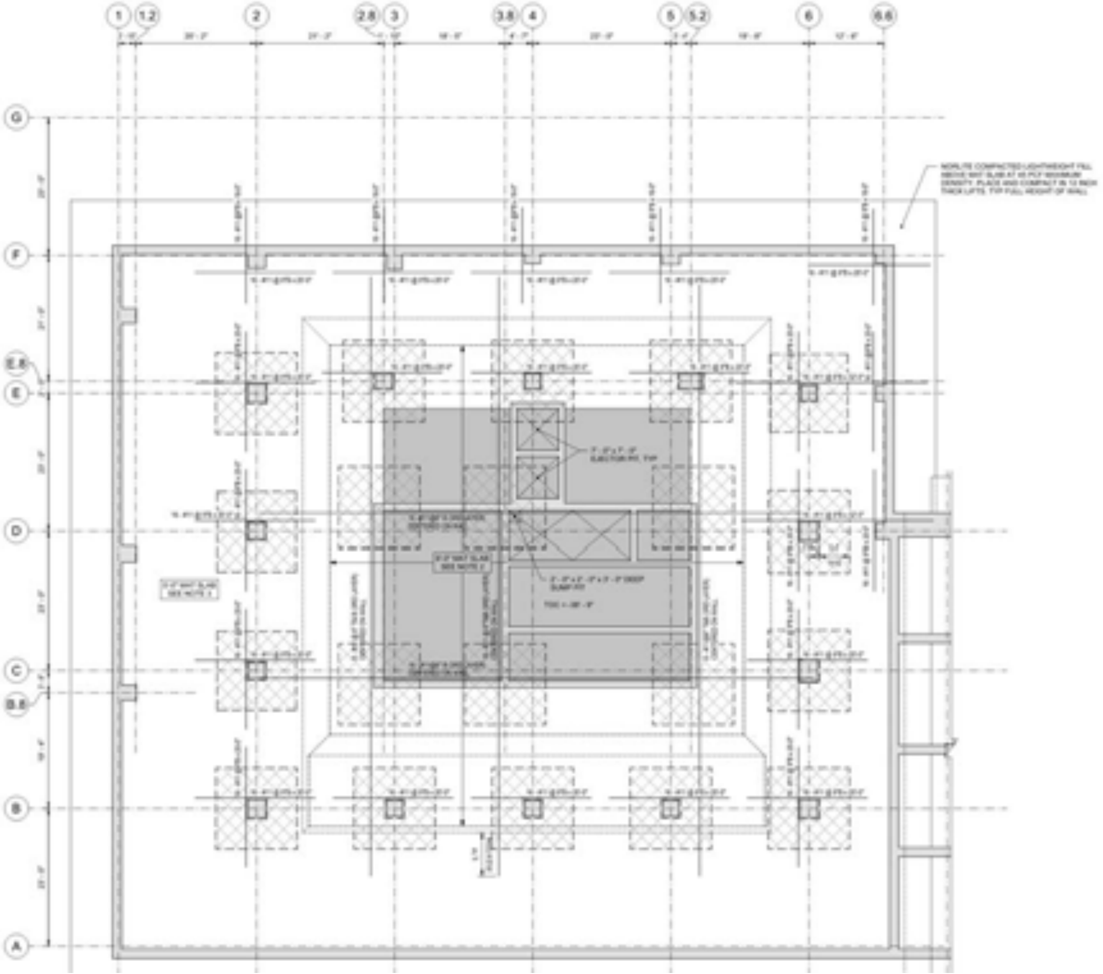

303 FT
6 TO 15 FT FILL
5 TO 10 FT ORGANICS
7 TO 16 FT SAND
150 TO 165 FT CLAY
±180 FT
GLACIAL DEPOSIT
BEDROCK


HALEY & ALDRICH
TEST BORING REPORT

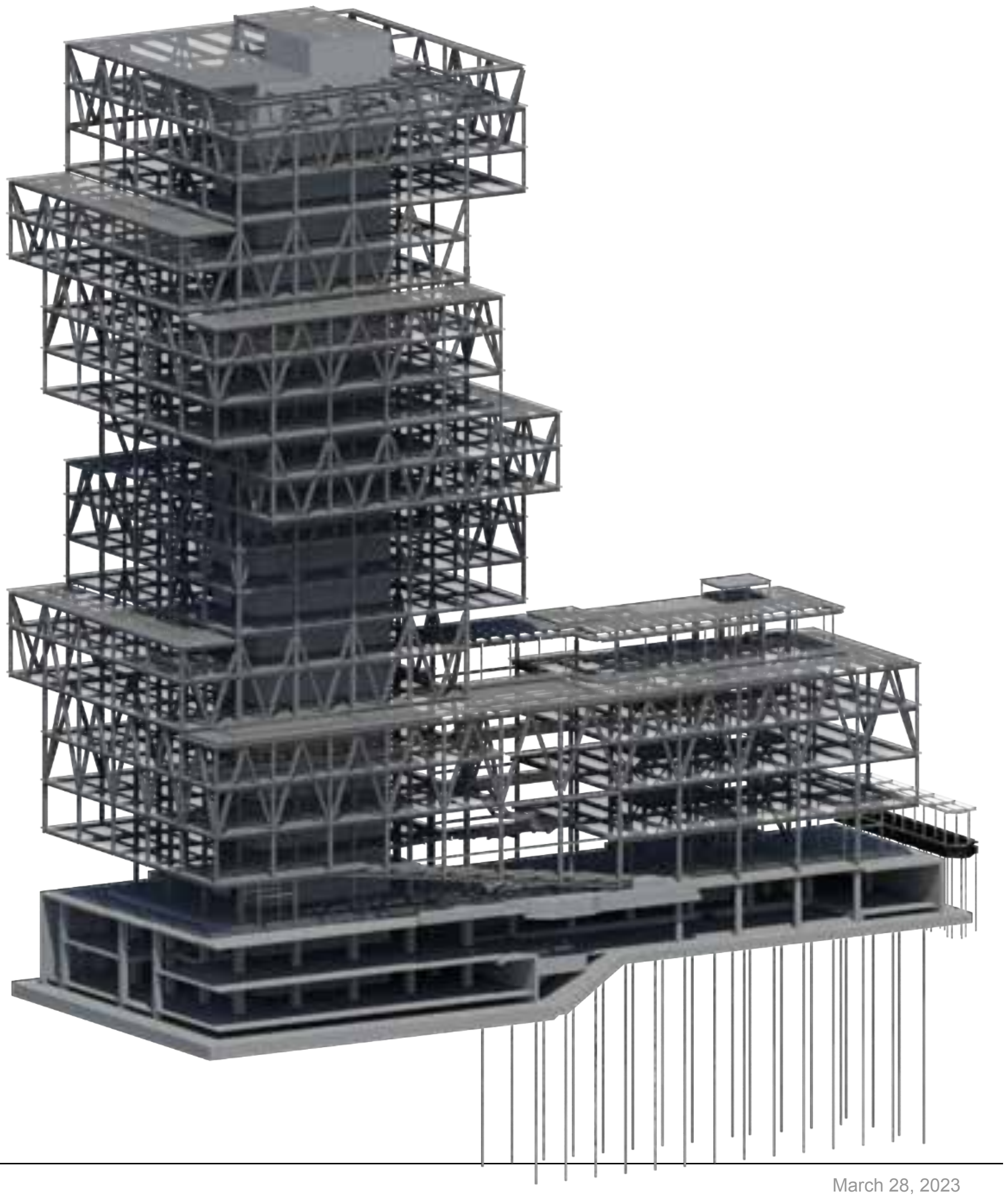



Building Weight
Soil Removed

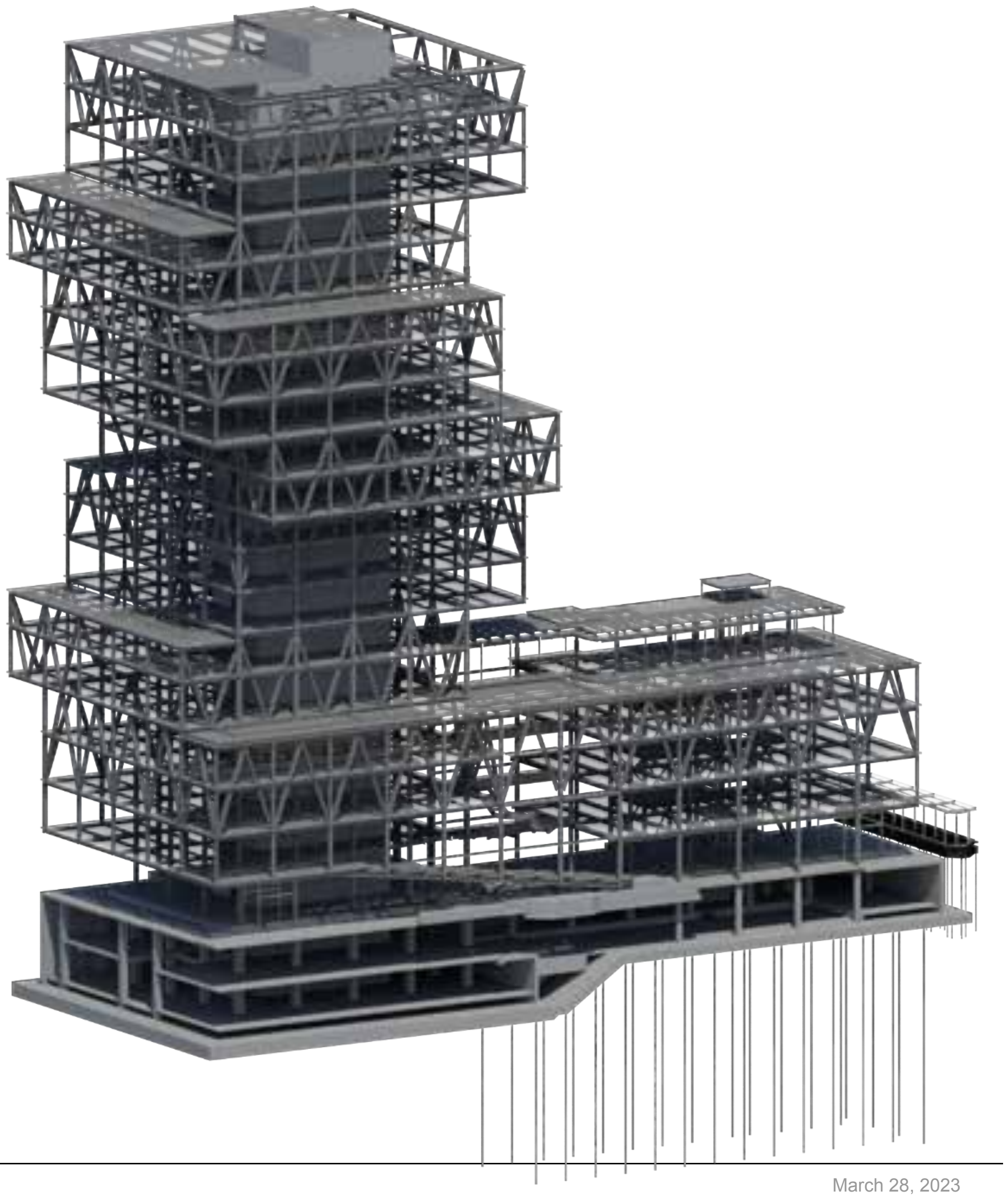




Embodied Carbon Opportunities



Reuse of Shoring



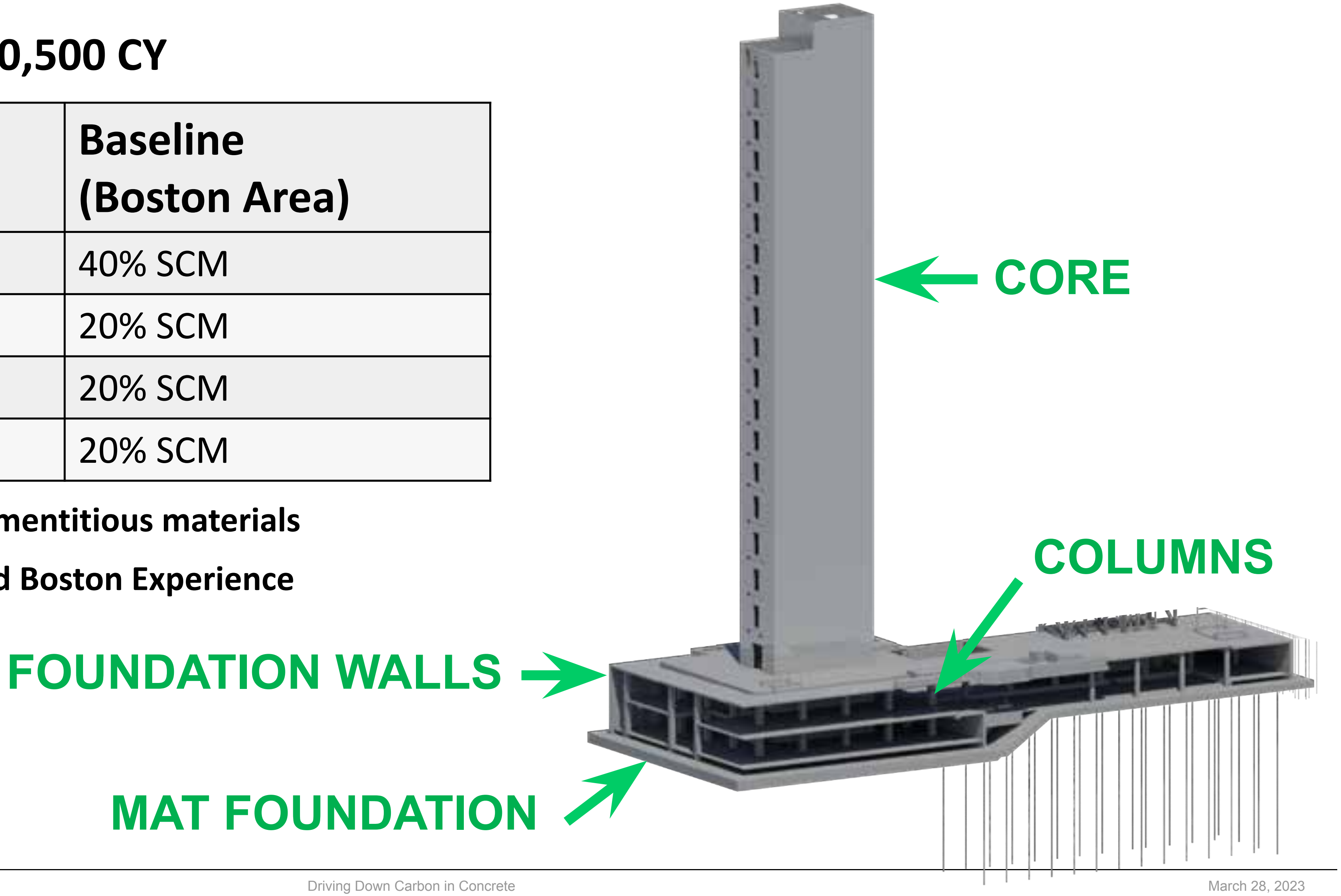
Low-Carbon Concrete

Total Concrete = 20,500 CY

Structural Component	**Baseline (Boston Area)**
Mat Foundation	40% SCM
Foundation Walls	20% SCM
Core	20% SCM
Columns	20% SCM

***SCM: supplemental cementitious materials**

**** Baseline; NRMCA and Boston Experience**



Performance Based Specifications

- **Update Concrete Specifications to a Performance-Based Approach**
  - **Eliminates the need for design team to assign prescriptive limits**
- **Assign durability exposure by structural component type**
  - **Limitations on mix design determined by durability exposure (e.g. maximum SCMs, w/cm, etc)**
- **Specify performance requirements**
- **Responsibility is on ready-mix concrete supplier to meet performance requirements**

Performance Requirements

- **Strength at time**
  - **Final design strength**
  - **Early design strength**
- **Modulus of Elasticity**
- **Slab workability / finishability**
- **Shrinkage**
- **Density of light weight concrete**
- **Maximum aggregate size**
- **Temperature limits**
  - **Thermal control**
  - **Hot / Cold weather placements**
- **Air content**

SCM Effects: Properties of Concrete

	Fly Ash		Slag Cement	Silica Fume
	Class F	Class C		
Water Demand	Lowers	Lowers	Lowers	Increases
Workability	Increases	Increases	Increases	Lowers
Bleeding and Segregation	Lowers	Lowers	May lower or increase	Lowers
Setting Time	Increases	May lower/increase	Increases	
Air content	Lowers	Lowers		Lowers
Heat of Hydration	Lowers	May lower or increase	Lowers	
Early Age Strength	Lowers		May lower or increase	Increases
Long-term Strength	Increases	Increases	Increases	Increases
Freeze/Thaw				
Corrosion Resistance	Increases	Increases	Increases	Increases

Fly Ash
ASTM C618

Slag Cement
ASTM C989

Silica Fume
ASTM C1240


DATA GATHERING – INITIAL MEETINGS

- Draft alternate mix design table provided to bidders
- CM organized meetings been RMC bidders and SE

- Allowed us to understand what was possible; allowed them to understand what we were aiming for
- Both parties took it as a learning experience

Structural component	Durability Exposure				Strength, f'c(psi)	Age (days)	Shrinkage Limit	Max w/cm	Nominal max aggregate size (in)	% SCM (min)	% SCM (goal)
	F	S	W	C							
60" and 72" mat	F0	S0	W0	C1	6,000	90	–	–	1	50%	70%
Tower core walls	F0	S0	W0	C0	8,000	56	0.04	–	¾	50%	70%
Tower core walls	F0	S0	W0	C0	10,000	56	0.04	–	¾	50%	70%
Podium core walls	F0	S0	W0	C0	5,000	56	–	–	¾	50%	70%
Foundation walls	F1	S0	W0	C1	5,000	56	–	0.55	1	50%	70%
Columns	F0	S0	W0	C0	8,000	56	–	–	1	50%	70%

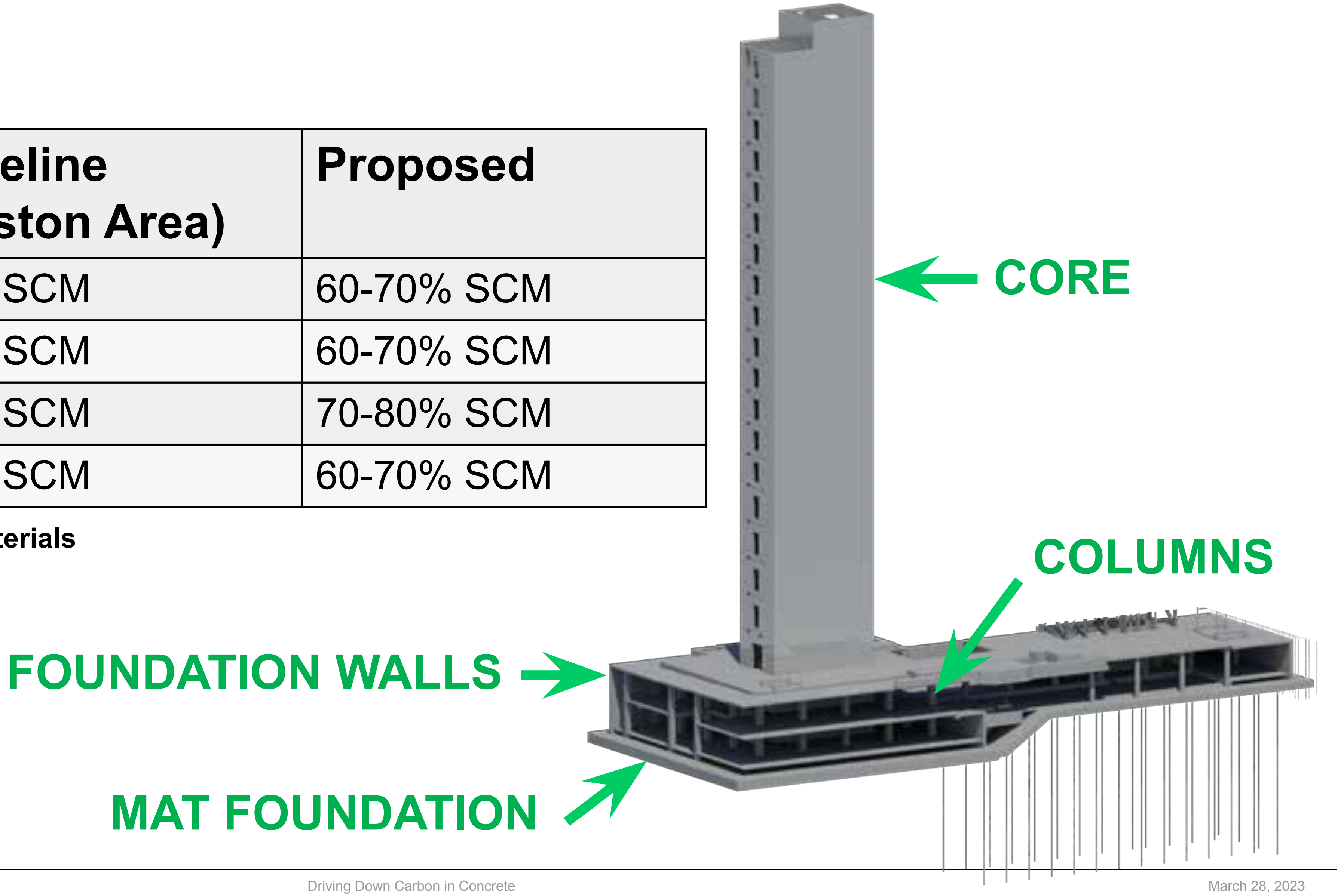
NEXT STEPS

- Conversations & planning
  - Focused on concrete
  - RMC bidders
    - Provided alternate mix design table
    - Reviewed available test data
    - Ran trial batches
- Follow up discussions incl. RMC vendors
  - Trial batch results
  - Reviews of mix design options
  - Plan for longer strength gain mixes

Low-Carbon Concrete

Structural Component	Baseline (Boston Area)	Proposed
Mat Foundation	40% SCM	60-70% SCM
Foundation Walls	20% SCM	60-70% SCM
Core	20% SCM	70-80% SCM
Columns	20% SCM	60-70% SCM

SCM: supplemental cementitious materials



LEED + Embodied Carbon

LEED BD+C v4: New Construction

MRc1 Building life-cycle impact reduction

Option 4: whole-building life-cycle assessment

(3 points)

REQUIREMENTS:

- **Conduct LCA of structure and enclosure**
- **Demonstrate 10% reduction in at least 3 of the 6 impact categories (including GWP)**

LEED + Embodied Carbon

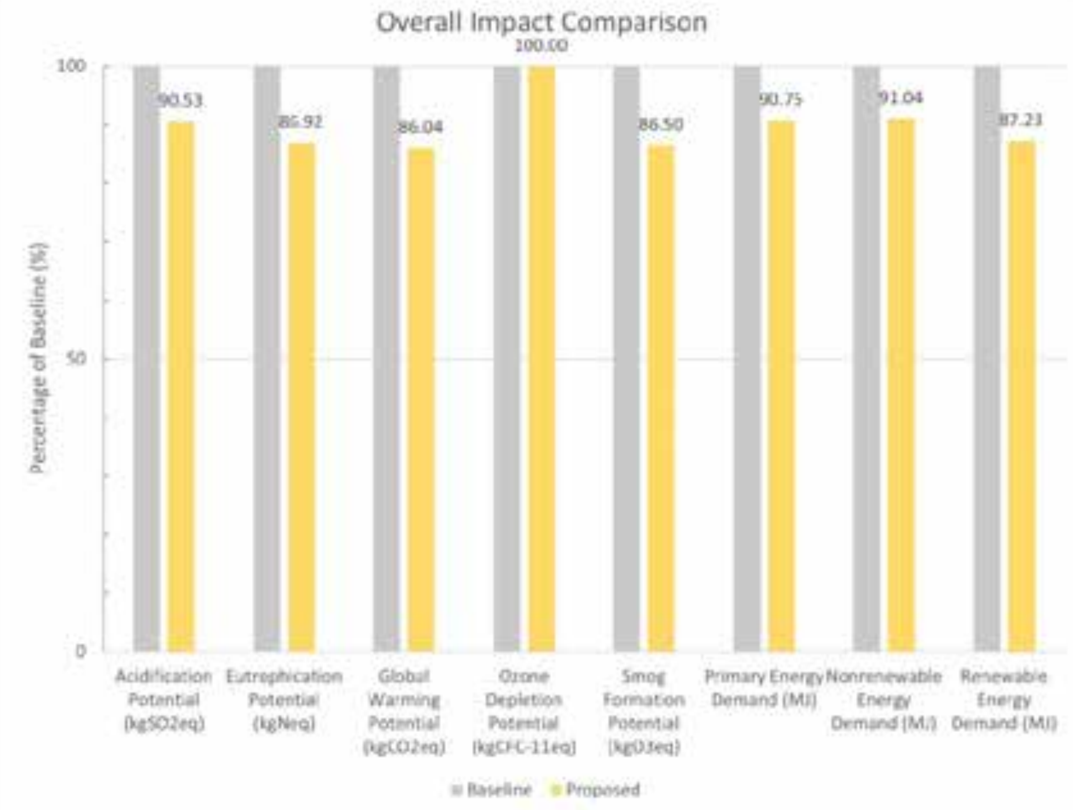
LEED v4.1 MRc1

Up to **5** points achievable via WB-LCA

- 1 point for disclosure,
- 2 points for **5%** reduction,
- 3 points for **10%** reduction,
- 4 points for **20%** reduction & reuse,
- +1 regional priority point

Potentially 4 points under LEED v4.1

Life Cycle Assessment

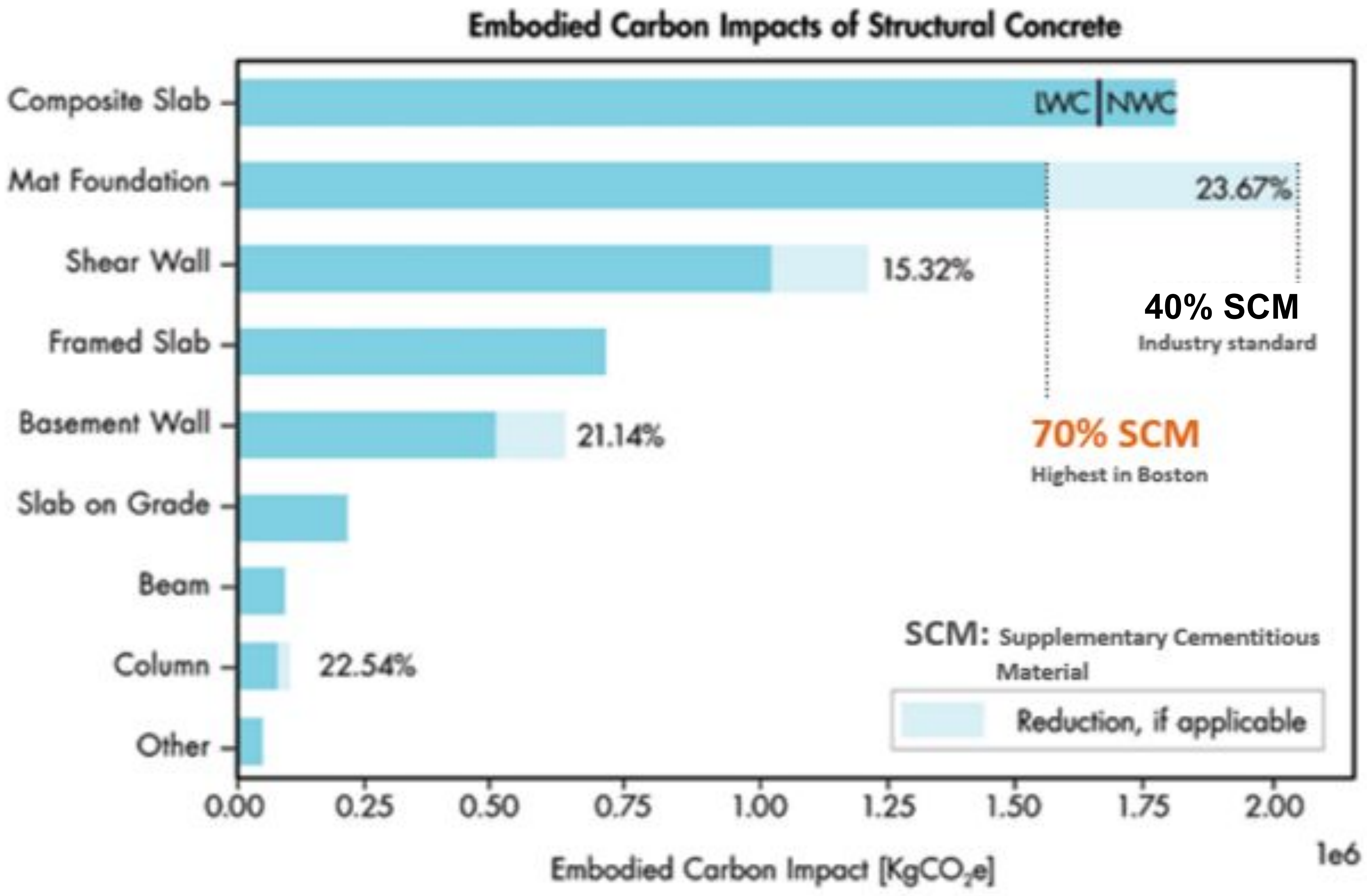


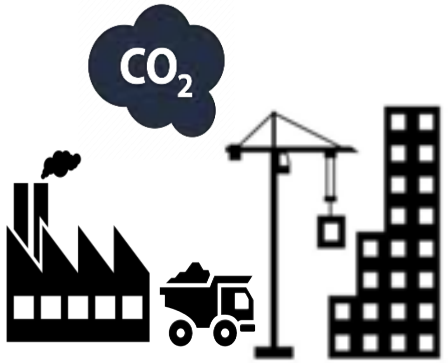
Whole Building Life Cycle Analysis (WBLCA):

- **Structure**
- **Enclosure**

Impact Category	Baseline Building Value	Proposed Building Value	Units	Percent Reduction (%)
Global Warming Potential	13,846,076	11,912,481	kgCO₂ eq	14%
Ozone Depletion Potential	1.51	1.51	kgCFC-11 eq	0%
Acidification Potential	48,849	44,224	kgSO₂ eq	10%
Eutrophication Potential	2,643	2,297	kgN eq	13%
Smog Formation Potential	741,623	641,486	kgO₃ eq	14%
Non-renewable Energy Demand	125,920,735	114,637,982	MJ	9%
Number of Measures with at least a 10% reduction:				4

***Table 1:** Summary of Required Impact Categories between Baseline and Proposed Buildings*

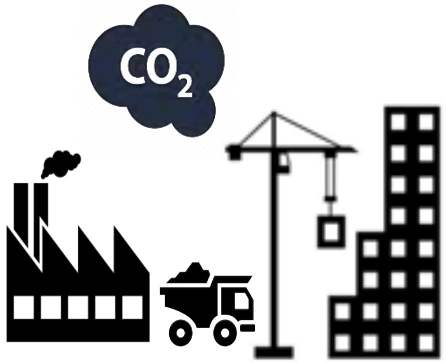

Embodied Carbon Impacts of Structural Concrete
Composite Slab
Mat Foundation
Shear Wall
Framed Slab
Basement Wall
Slab on Grade
Beam
Column
Other
LWC
NWC
23.67%
15.32%
21.14%
22.54%
40% SCM
Industry standard
70% SCM
Highest in Boston
SCM: Supplementary Cementitious Material
Reduction, if applicable
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
1e6
Embodied Carbon Impact [KgCO2e]


CO2

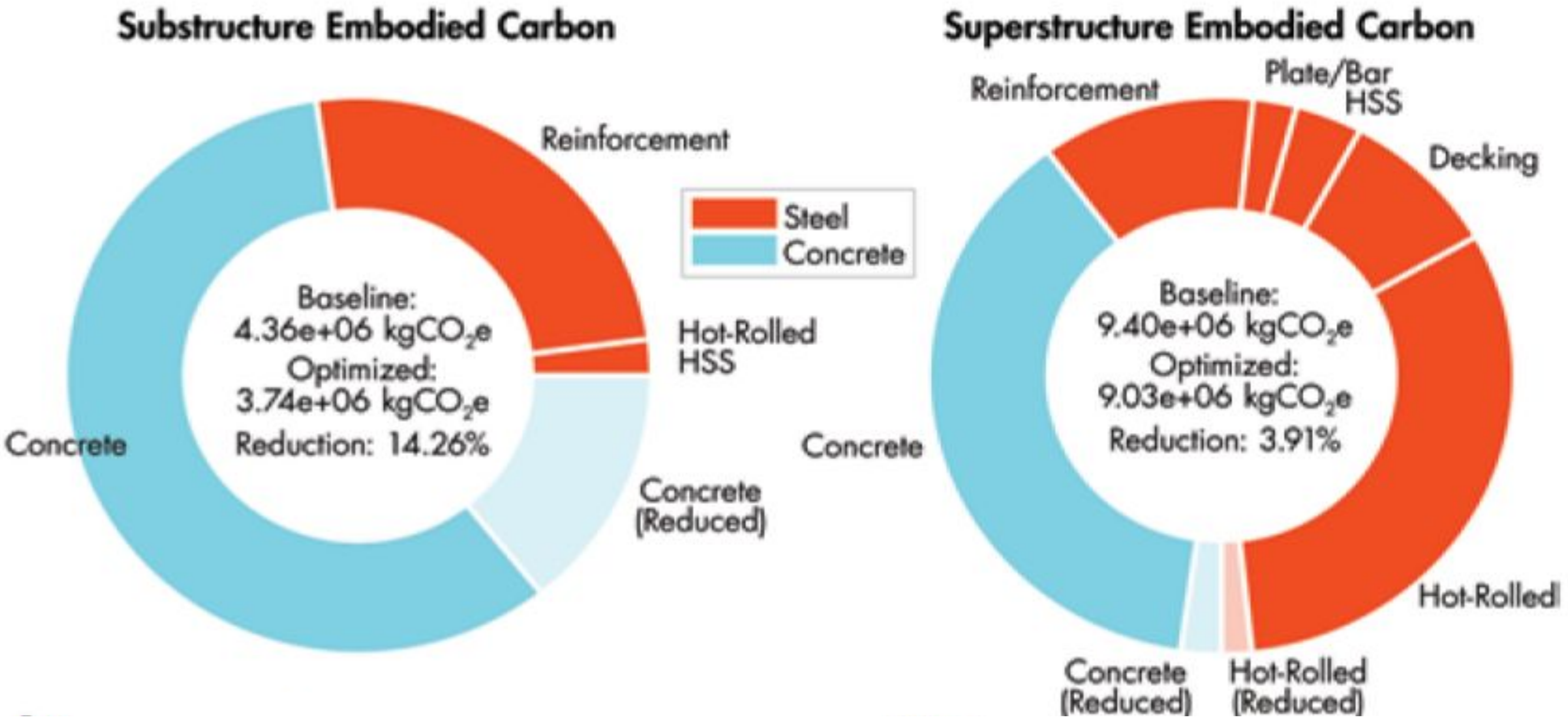
Embodied

WBLCA (Structure + Façade)

- Proposed: 14% reduction T CO_2e



Embodied



Environmental Product Declaration (EPD)

MAT SLAB

This Environmental Product Declaration (EPD) reports the impacts for 1 m^3 of ready mixed concrete mix, meeting the following specifications:

- ASTM C94: Ready-Mixed Concrete
- UNSPSC Code 30111505: Ready Mix Concrete
- CSA A23.1/A23.2: Concrete Materials and Methods of Concrete Construction
- CSI Division 03-30-00: Cast-in-Place Concrete

COMPANY

Aggregate Industries
6401 Golden Triangle Drive Suite 400
Greenbelt, MD 20770

PLANT

Everett Plant
2018 Rover Street
Everett, MA 02149

EPD PROGRAM OPERATOR

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428

DATE OF ISSUE

10/31/2020 **(valid for 5 years until 10/31/2015)**

ENVIRONMENTAL IMPACTS

Declared Product:
Mix ECOPACT6 • Everett Plant
6000,EMERALD HS90ETHZT70,N
Compressive strength: 6000 PSI at 56 days

Declared Unit: 1 m^3 of concrete

Global Warming Potential (kg CO_2-eq)	231
Ozone Depletion Potential (kg CFC-11-eq)	8.1E-6
Acidification Potential (kg SO_2-eq)	1.19
Eutrophication Potential (kg N-eq)	0.29
Photochemical Ozone Creation Potential (kg O_3-eq)	22.1
Abiotic Depletion, non-fossil (kg Sb-eq)	8.7E-6
Abiotic Depletion, fossil (MJ)	722
Total Waste Disposed (kg)	1.82
Consumption of Freshwater (m^3)	3.10

Product Components: crushed aggregate (ASTM C33), natural aggregate (ASTM C33), slag cement (ASTM C989), fly ash (ASTM C618), Portland cement (ASTM C150), admixture (ASTM C494), batch water (ASTM C1602)

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

CORE

This Environmental Product Declaration (EPD) reports the impacts for 1 m^3 of ready mixed concrete mix, meeting the following specifications:

- ASTM C94: Ready-Mixed Concrete
- UNSPSC Code 30111505: Ready Mix Concrete
- CSA A23.1/A23.2: Concrete Materials and Methods of Concrete Construction
- CSI Division 03-30-00: Cast-in-Place Concrete

COMPANY

Aggregate Industries
6401 Golden Triangle Drive Suite 400
Greenbelt, MD 20770

PLANT

Everett Plant
2018 Rover Street
Everett, MA 02149

EPD PROGRAM OPERATOR

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428

DATE OF ISSUE

04/15/2021 **(valid for 5 years until 04/15/2026)**

ENVIRONMENTAL IMPACTS

Declared Product:
Mix AGILIA10 • Everett Plant
10000,AGILIA,S3DETH,PS30,S3SR
Compressive strength: 10000 PSI at 56 days

Declared Unit: 1 m^3 of concrete

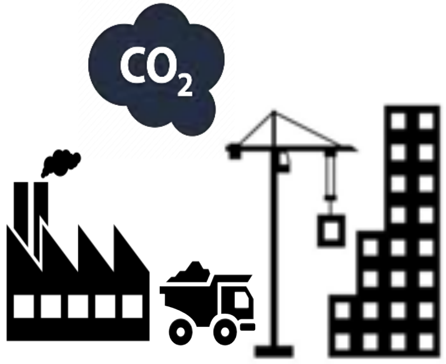
Global Warming Potential (kg CO_2-eq)	481
Ozone Depletion Potential (kg CFC-11-eq)	1.43E-5
Acidification Potential (kg SO_2-eq)	1.76
Eutrophication Potential (kg N-eq)	0.58
Photochemical Ozone Creation Potential (kg O_3-eq)	33.0
Abiotic Depletion, non-fossil (kg Sb-eq)	1.04E-5
Abiotic Depletion, fossil (MJ)	657
Total Waste Disposed (kg)	4.01
Consumption of Freshwater (m^3)	3.11

Product Components: crushed aggregate (ASTM C33), natural aggregate (ASTM C33), Portland cement (ASTM C150), slag cement (ASTM C989), admixture (ASTM C494), batch water (ASTM C1602)

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

WBLCA (Structure + Façade)

- Proposed: 14% reduction T CO_2e
- Revised Realized: 13.3% reduction T CO_2e



Embodied

	Structural Material Quantities	
	Difference between Delivered v BIM Model or Documented	Difference Adjusted for Typically Not Modeled (known)
Concrete	14.9%	8.3%
Concrete reinforcement	13.7%	8.8%
Structural steel	12.6%	10.8%
Steel decking	13.7%	13.7%

BU CCDS - Lessons Learned

- **Structural Engineer**
  - **Performance based concrete specifications**
  - **Identify exposure class of all structural components**
  - **Identify SCM targets for concrete structural components**
  - **Make a connection with the local ready-mix concrete suppliers earlier in design**
- **General Contractor / CM**
  - **Identify early age strength needs for sequencing and scheduling**

BU CCDS - Lessons Learned

- **Architect**
  - **Identify areas where concrete finishes are exposed and/or considered critical**
    - **Color**
    - **Texture**
    - **Jointing**
    - **Test panels**

BU CCDS - Lessons Learned

- **Ready-mix concrete plants (supplier)**
  - **What have they done before?**
  - **What test data do they have available to share? Ask for EPDs**
  - **What do they expect is achievable?**
  - **Where is their comfort level with high SCM mixes?**
- **Concrete subcontractor (installer)**
  - **What have they done before?**
  - **What do they expect is achievable?**
  - **Where is their comfort level with high SCM mixes?**

BU CCDS – Key Points to Successful Implementation

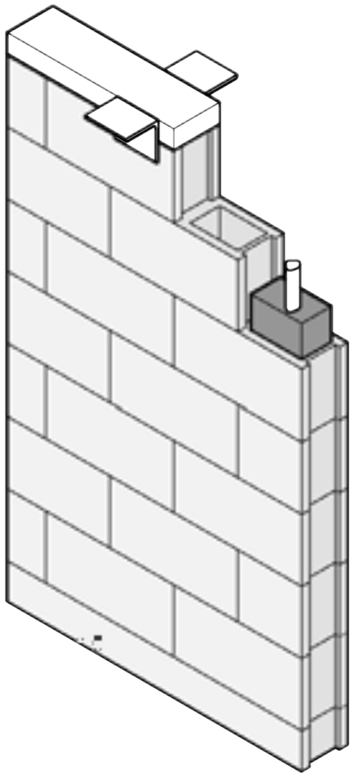
1. Start early – DD or earlier
2. Have a "Low-carbon kick-off meeting"
3. Gather the stakeholders – review
   - Owner / OPM
   - General Contractor / CM
   - Architect
   - Structural Engineer
   - Sustainability Consultant
4. Build consensus & buy-in: follow up, research, and planning
   - What is the embodied carbon in concrete (baseline)?
   - Does the team want to reduce it? And by how much?
   - What are the possible performance / visual implications of reducing?
   - Will there be a cost or schedule impact?
5. Schedule the follow up(s) – periodic check ins

"Who are the individuals who will support this effort the most and help maintain the much-needed momentum throughout the entire process? Stick with them." – Owner

Embodied Carbon Policy - Working Groups

CLF Boston | NE
- Policy Subgroup
- BPDA TAG, MCAN

Jampart Charitable Trust
- CLF / BSA
- Concrete Ready-Mix Stakeholder Engagement



Carbon Leadership Forum
Boston | Northeast

BSA

boston planning & development agency

MCAN
Mass Climate Action Network

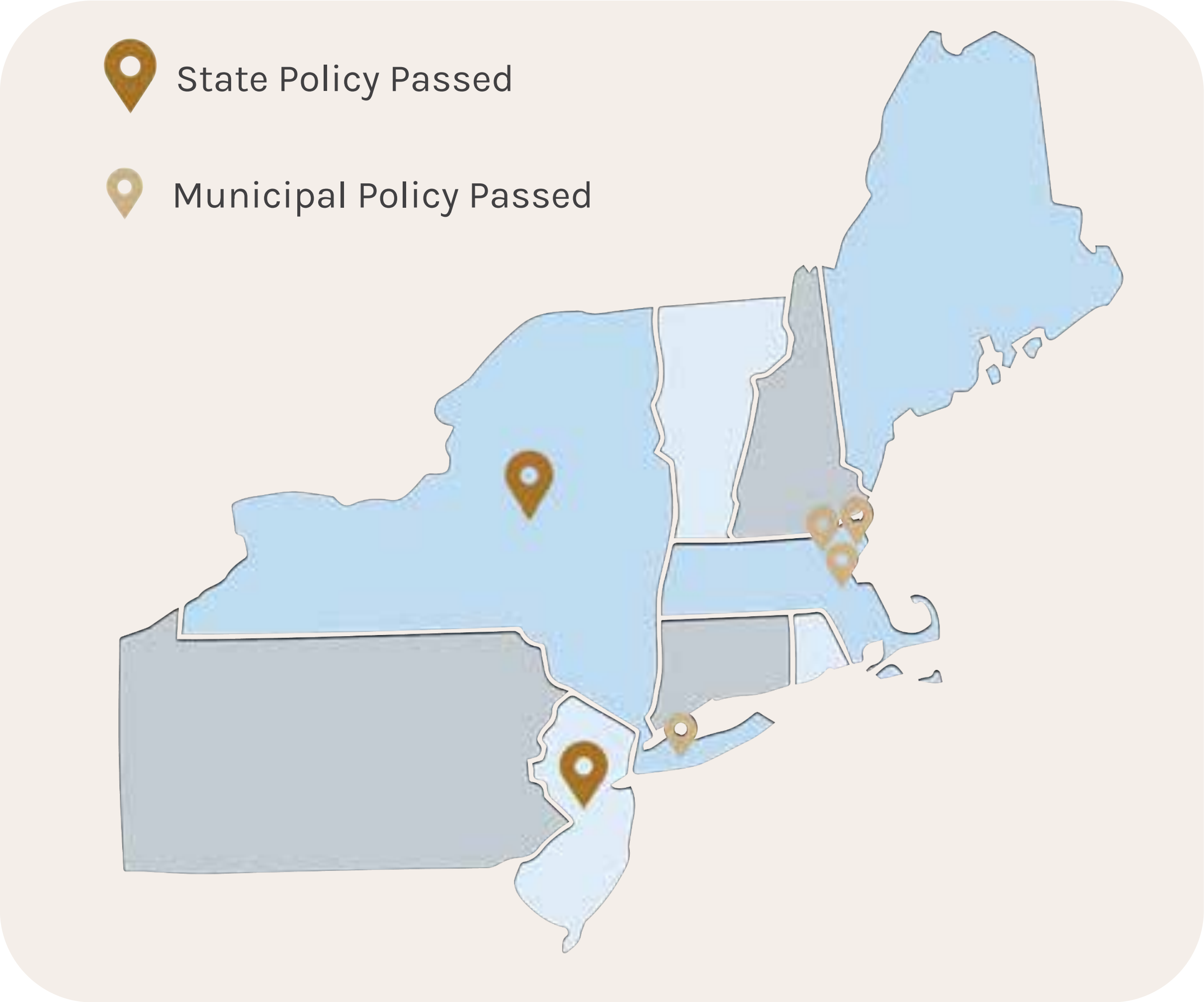
Embodied Carbon Policy - NE

Local is moving faster than State

- Need for regional consistency
- All are moving the needle

Industry Readiness

- Architects, structural engineers, contractors and suppliers are incorporating assessment and reductions into practice as policy progresses



Embodied Carbon Policy Approaches

Optimize **Project**	Optimize **System**	Optimize **Procurement**
• Build less, reuse more • Design to reduce EC and increase material/structural efficiency	• Choose low-carbon systems and assemblies • Use alternate, low-carbon materials	• Select the lowest carbon version of the selected product • Clean manufacturing (efficiency, fuel switching)
Early Design Calculators, Rules of Thumb	Whole Building Life Cycle Assessment (WBLCA)	Environmental Product Declarations (EPDs) / EC3

Reuse & Deconstruction

Zoning & City Incentive Programs

Procurement (Buy Clean)

Building Codes & Regulations

Climate Action Plans

Image Source: *[Carbon Leadership Forum](), 2020*

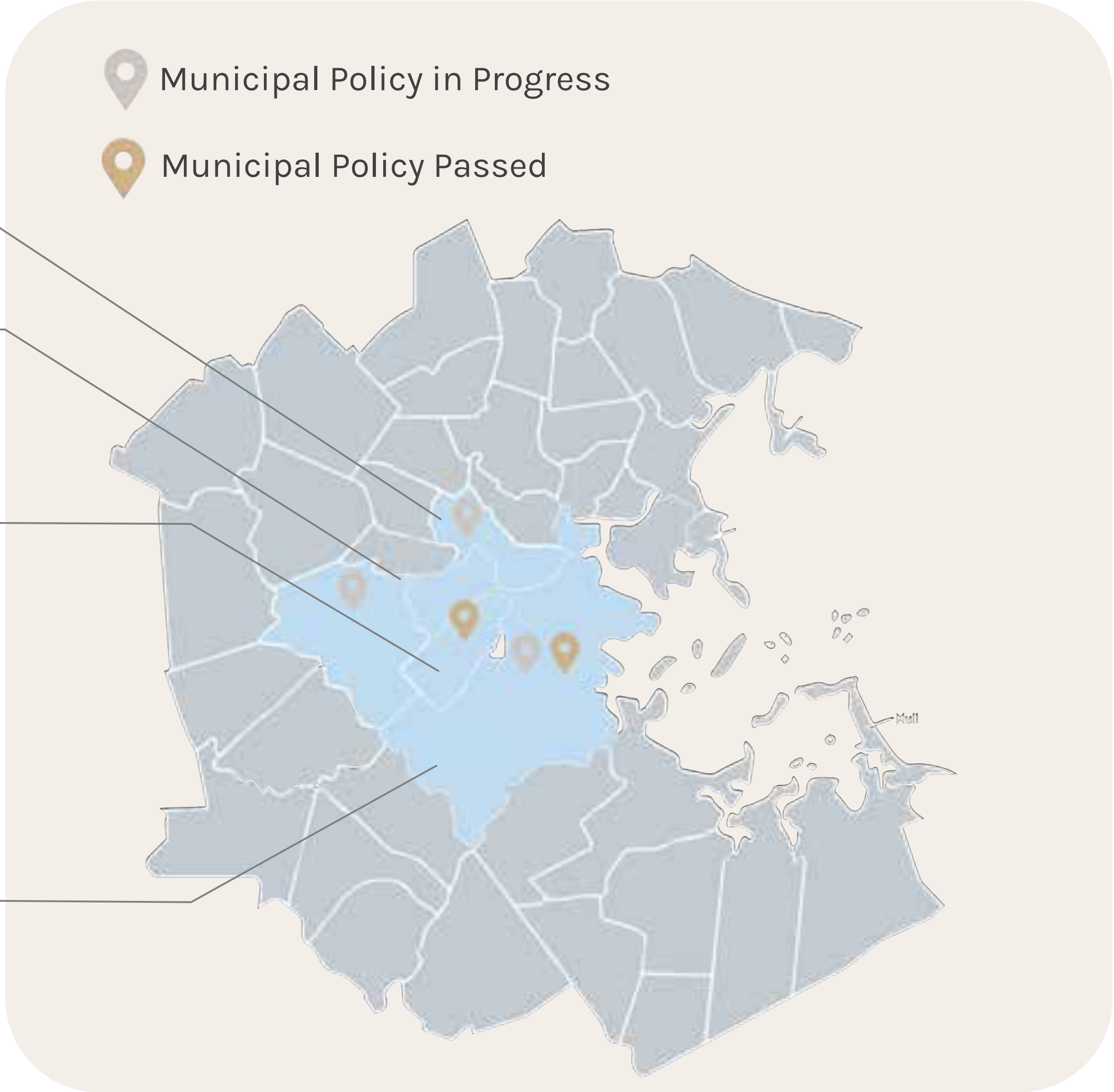
Municipal Policy - MA

Cambridge
- Net Zero Action Plan

Newton
- Sustainability Ordinance
- Measurement requirements in progress

Brookline
- Resolution for Embodied Carbon Reduction in Concrete
    - Municipal Projects & Infrastructure

Boston
- Mass Timber Accelerator Incentive
- Article 37 and Zero Net Carbon Building Zoning Update
- Zero Waste Boston Deconstruction Initiative



Municipal Policy

New York City

- EO 23: Clean Construction
  - Capital Projects & Infrastructure

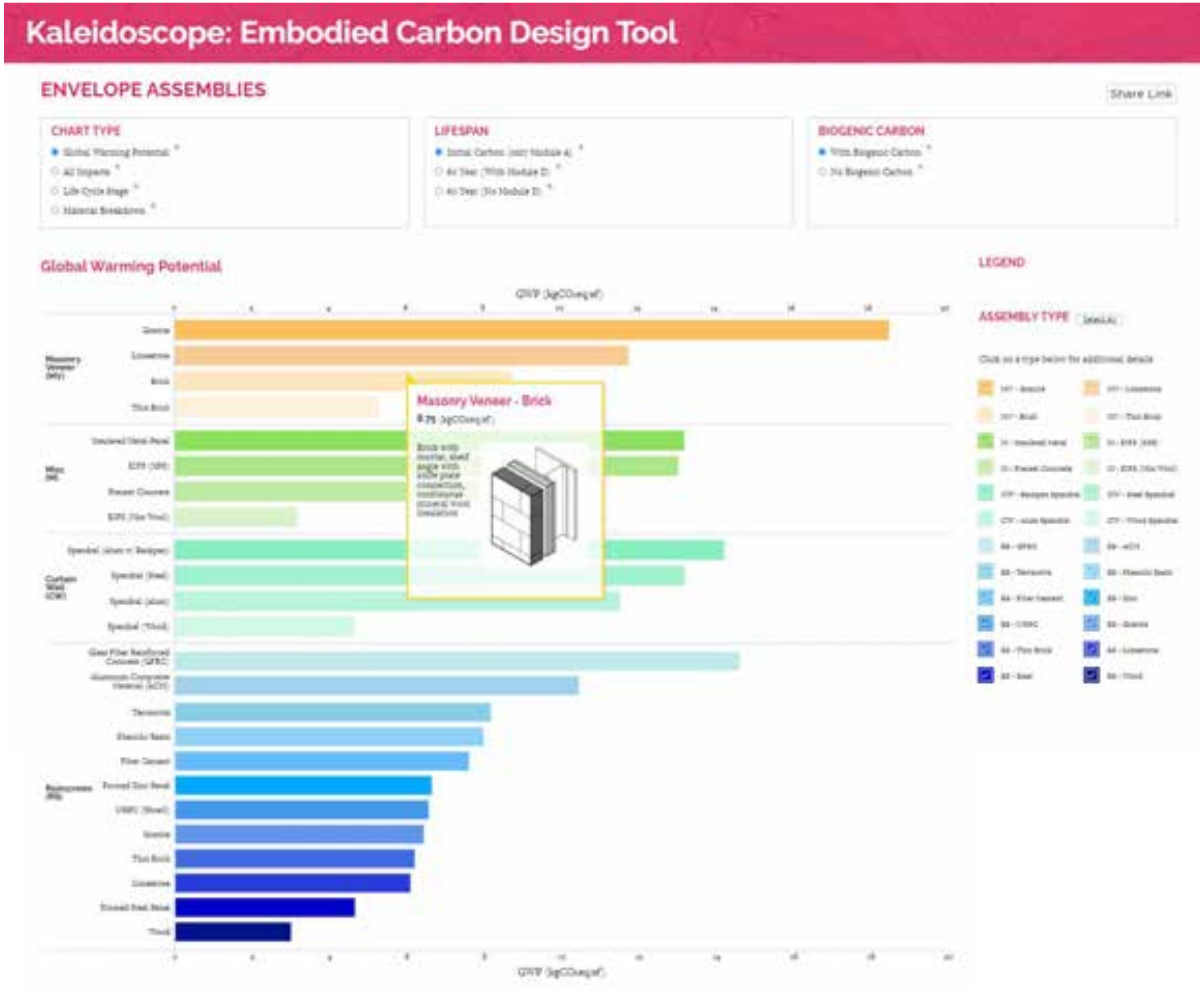
San Francisco

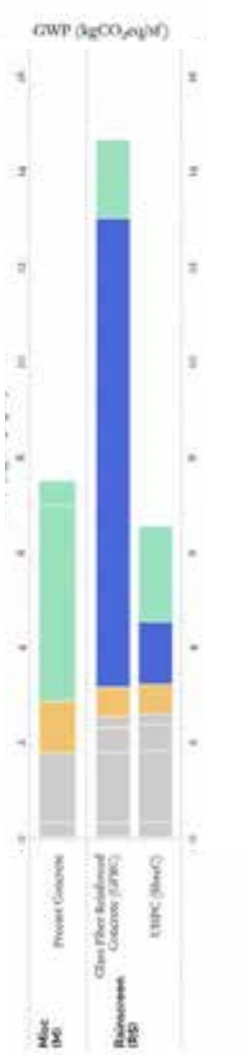
- Construction & Demolition Law

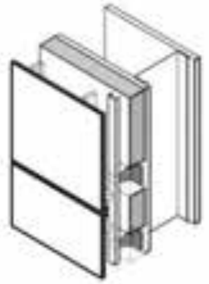
City of Vancouver

- Whole Building Life Cycle Assessment Zoning Requirement

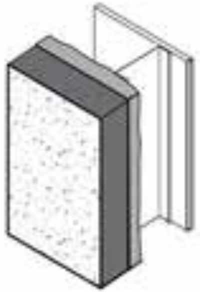
Industry Influencing Policy



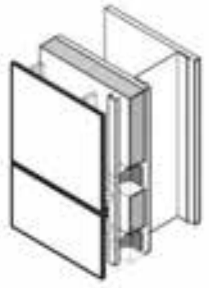




GFRC



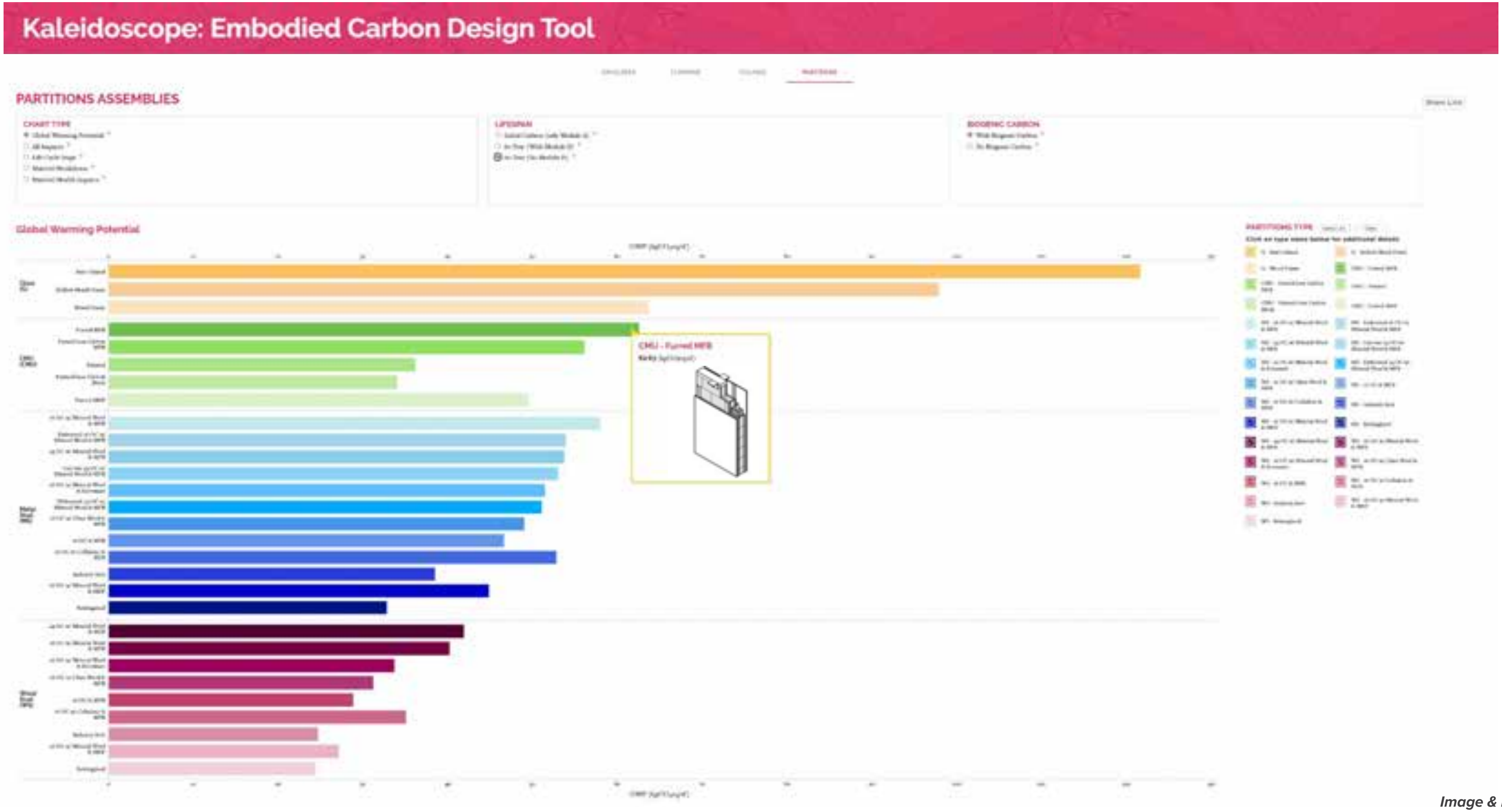
Precast Concrete

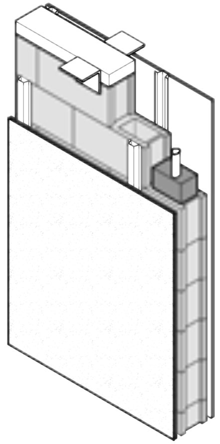


UHPC

Image & Data Source: Kaleidoscope, 2023

Kaleidoscope Early Design Tool: Partitions Launch!





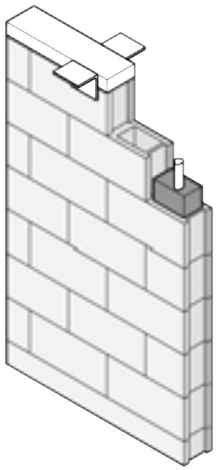
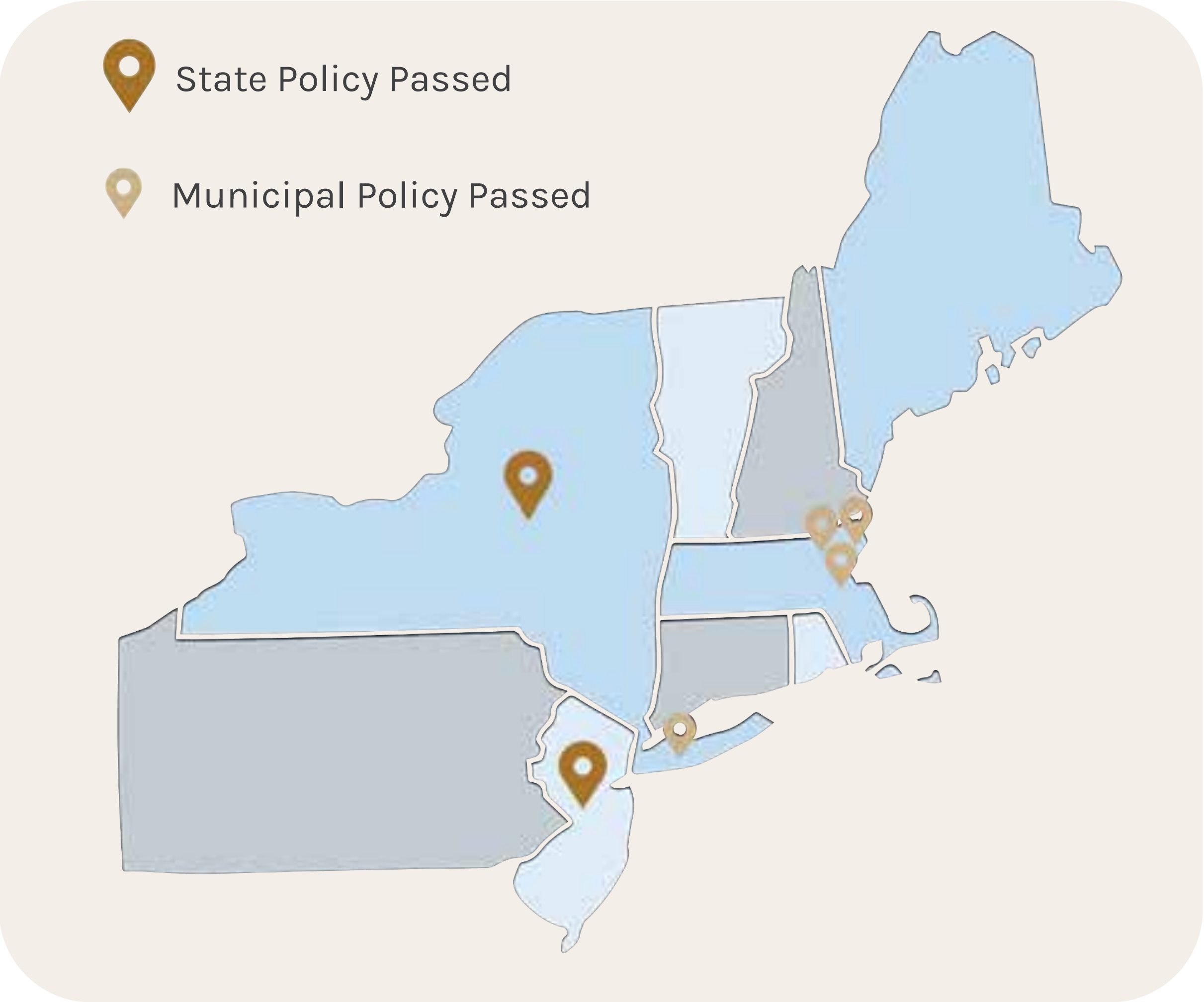


Image & Data Source: *Kaleidoscope, 2023*

State Policy - MA

MCAN & CLF Working to Develop

- An Act Incorporating Embodied Carbon into State Climate Policy
  - **Private Sector**
- An Act Requiring State Procurement of Low-Carbon Building Materials
  - **State Projects**
- An Act Relative to the Use of Low-Embodied Carbon Concrete
  - **State Projects & Infrastructure**



LECCLA

(LOW EMBODIED CARBON CONCRETE LEADERSHIP ACT)

New York

Passed 2021

Requires state to include climate impact in selection criteria for concrete procurement

New Jersey

Passed 2023

Provides income tax credit of up to 8% of the concrete cost for development and provision of a product whose carbon footprint is below a soon-to-be set benchmark

Image Source: *CarbonCure, 2023*

Buy Clean State Policy

	Buy Clean CA (2017)	**Buy Clean CO** (2021)	**Buy Clean OR** (2022)	**LECCLA NY** (2021)	**LECCLA NJ** (2023)
materials	steel, glass, mineral wool	asphalt, cement, concrete, glass, steel, wood	concrete, asphalt, steel	concrete	concrete
includes **buildings**	✓	✓	✗	✓	✓
includes **infrastructure**	✓	✓	✓	✓	✓
requires **disclosure**	✓	✓	✓	✓	✓
GWP **Standards**	industry average	industry average	TBD	TBD	TBD
provides **incentives**	✗	✗	✓	TBD	✓

Image Source: *Carbon Leadership Forum, 2020*

Federal Policy

Inflation Reduction Act (IRA), Aug. 2022

- Funding to develop & standardize EPDs
- Funding to identify and label low-carbon materials (Federal Projects)
- EPA administrator to identify materials

EPA Public Engagement Webinars - April 19th

- Reducing Embodied Greenhouse Gas Emissions: Carbon Labeling

There is room to reduce emissions on **every design.**

Ask for **concrete EPDs** as much as possible

Comment on the EPA's carbon RFI on how to make the biggest impact

Get involved **educating** legislators at the local and state level

Get involved with **CLF**: clf.boston@gmail.com

Questions?

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