BUILDINGENERGY BOSTON

Slashing Upfront Embodied Carbon: How to Replicate Success

Jim Carreira, Boston Sand & Gravel
Beverly Craig, MassCEC
Meredith Elbaum, Built Environment Plus
Caroline Murray, Turner Construction Company

Curated by Karno Widjaja

Northeast Sustainable Energy Association (NESEA) | March 20, 2025

7 Replicable Strategies to Reduce Embodied Carbon

Meredith Elbaum

Built Environment Plus
Executive Director

Beverly Craig

MassCEC
Program Director

How to Specify Lower Emissions Concrete Fireside Chat

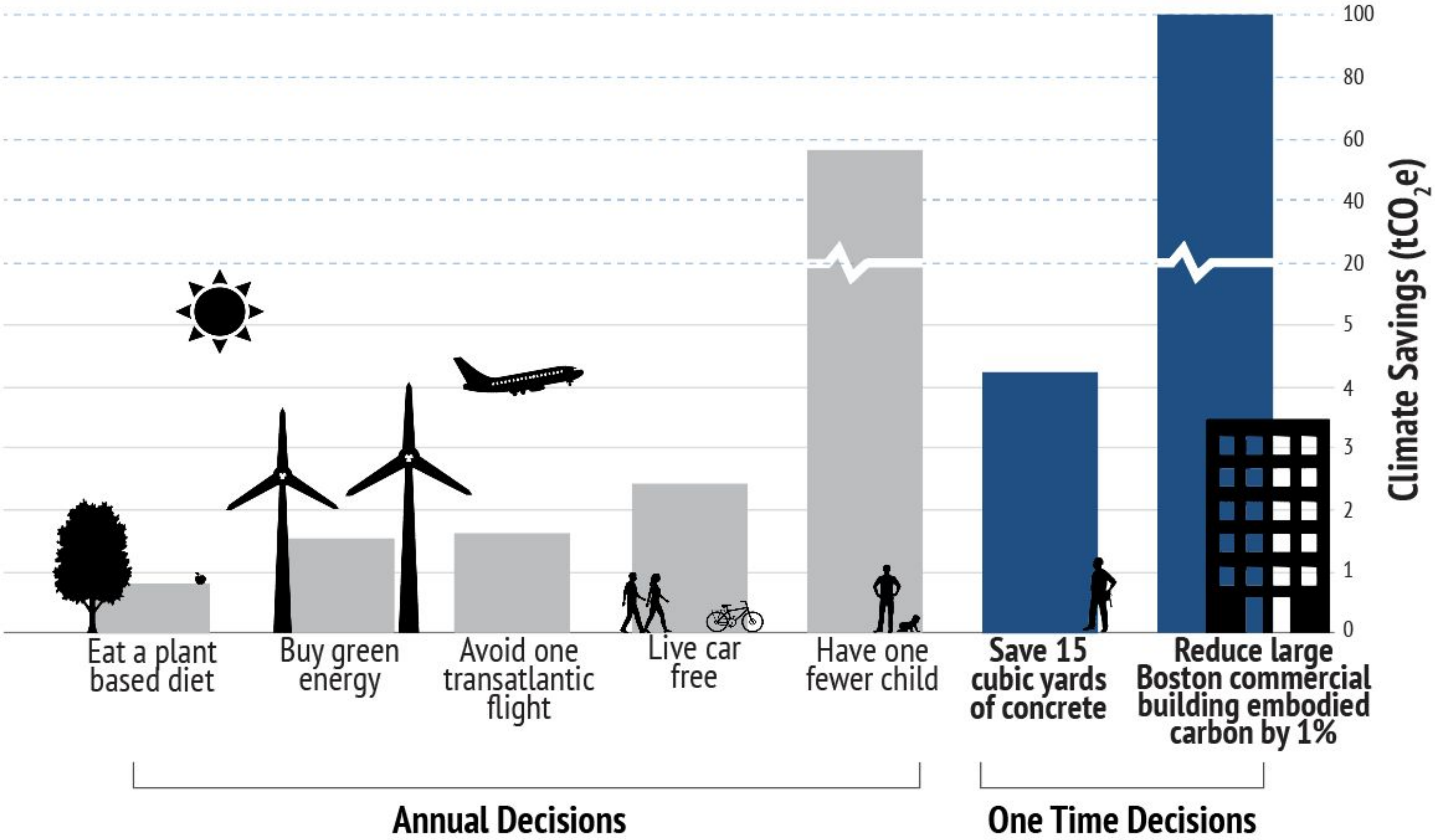
Caroline Murray

Turner Construction Co.
Regional Sustainability Manager

Jim Carreira

Boston Sand & Gravel
Technical Director

Building Professionals Can Make Large Impact with Small Changes



EMBODIED CARBON REDUCTION CHALLENGE

THE CHALLENGE: REDUCE UPFRONT CARBON OF BUILDINGS

7 Strategies

16 PROJECTS : 2024 - 2027 Completion

7 STRATEGIES

USE LESS

- Reuse and Rehabilitation
- Space Optimization
- Interior Efficiencies

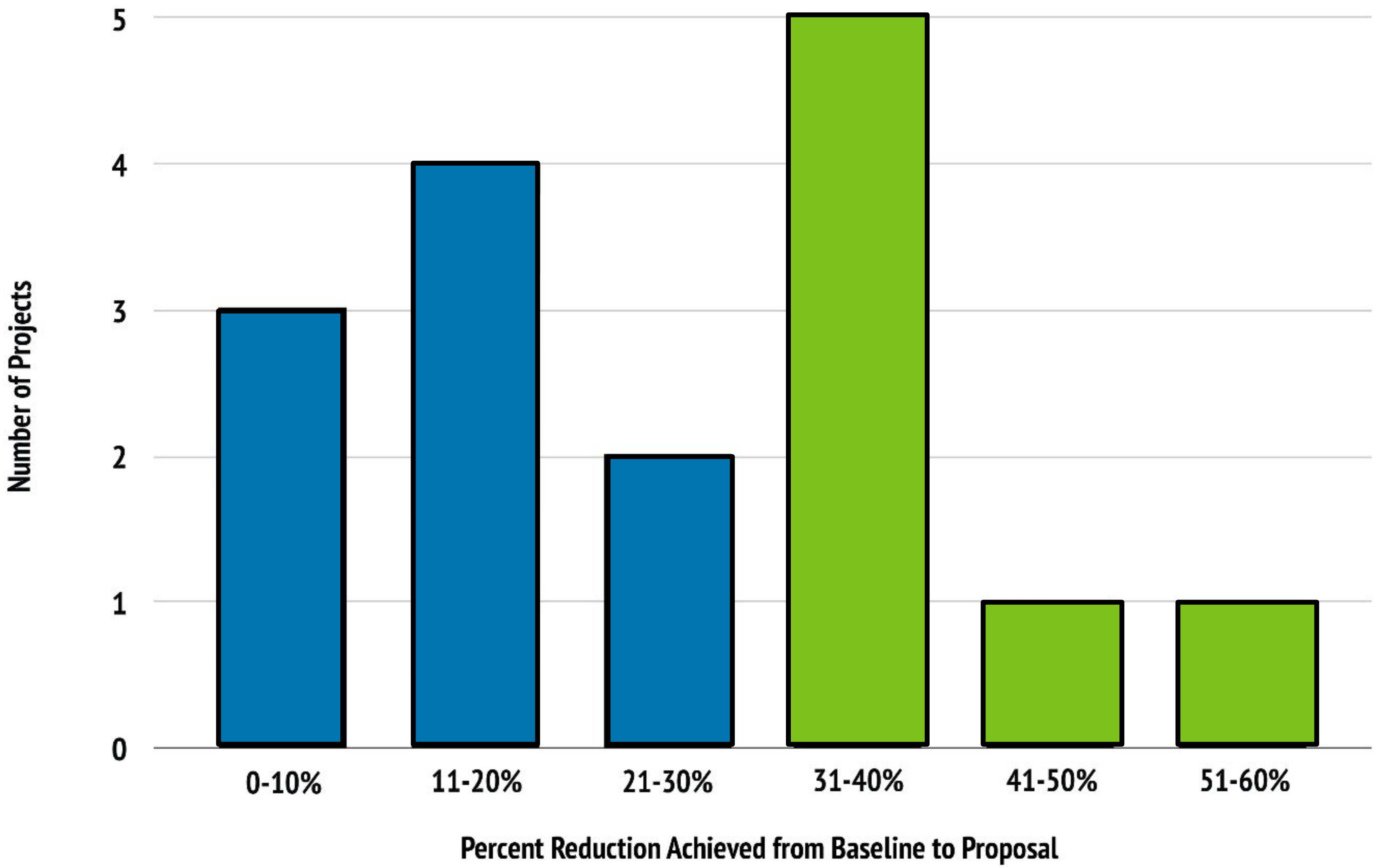
STRUCTURAL

- Timber Structure
- Lightweight Design

PROCUREMENT

- Low Carbon Concrete
- Low Carbon Insulation

Almost half achieved more than 30% reduction.



USE LESS

REUSE & REHABILITATION

SPACE OPTIMIZATION

INTERIOR EFFICIENCIES

USE LESS

REUSE & REHABILITATION

SPACE OPTIMIZATION

INTERIOR EFFICIENCIES

80 West Broadway

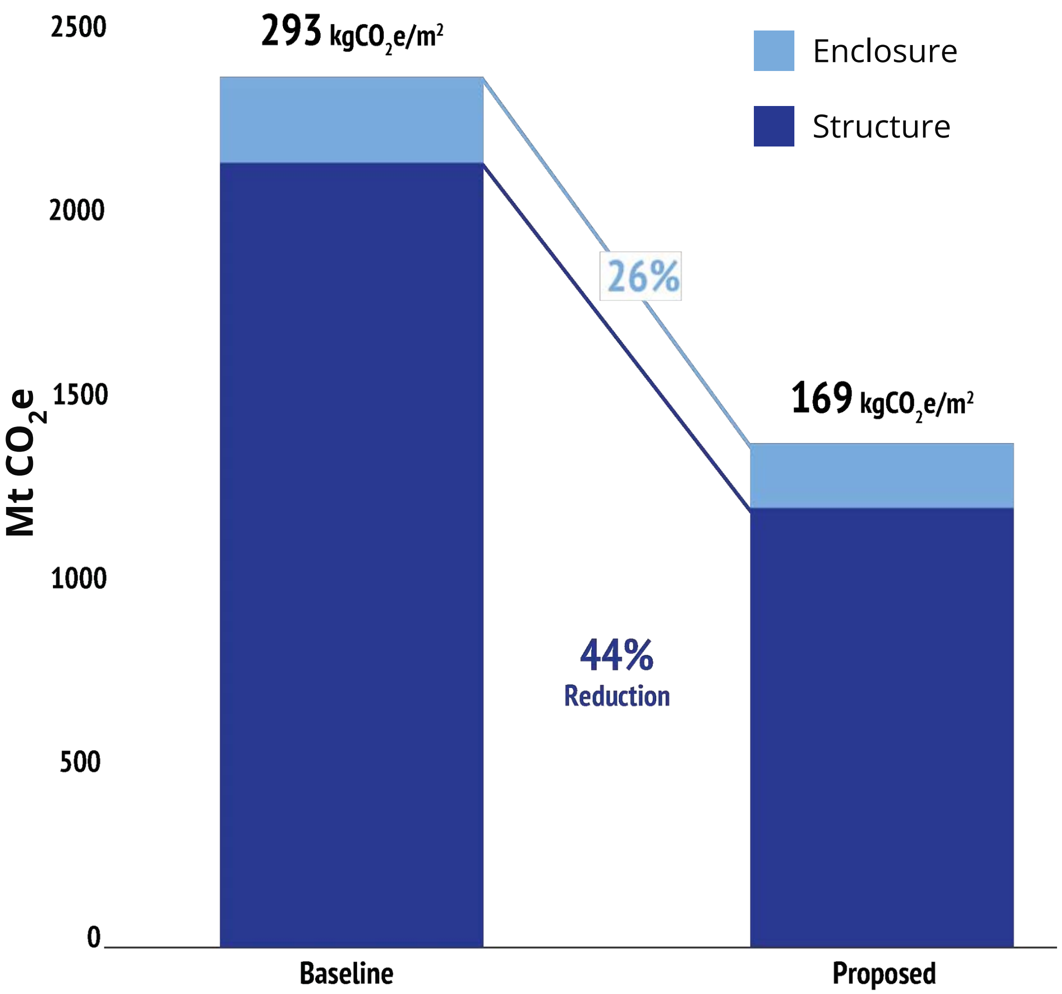
Submitted by Stantec Architects
Boston, MA

STRATEGIES

Use Less
- [x] Reuse and Rehabilitation
- [x] Space Optimization
- [x] Interior Efficiencies

Structural
- [x] Timber Structure
- [x] Lightweight Design

Procurement
- [x] Low Carbon Concrete
- [ ] Low Carbon Insulation



42%

Embodied Carbon Savings

999 $MtCO_2e$

Embodied Carbon Savings

Timber Structure

Most Impactful Strategy

GRAND PRIZE

Jones Library

Amherst, MA
Public Assembly - Major Renovation

<u>Completion Year </u>- 2026

Renovating and expanding one of the "most dysfunctional libraries in the Commonwealth;" improving safety, user friendliness and efficiency.

STRATEGIES

Use Less

- [x] Reuse and Rehabilitation
- [x] Space Optimization
- [x] Interior Efficiencies

Structural

- [x] Timber Structure
- [ ] Lightweight Design

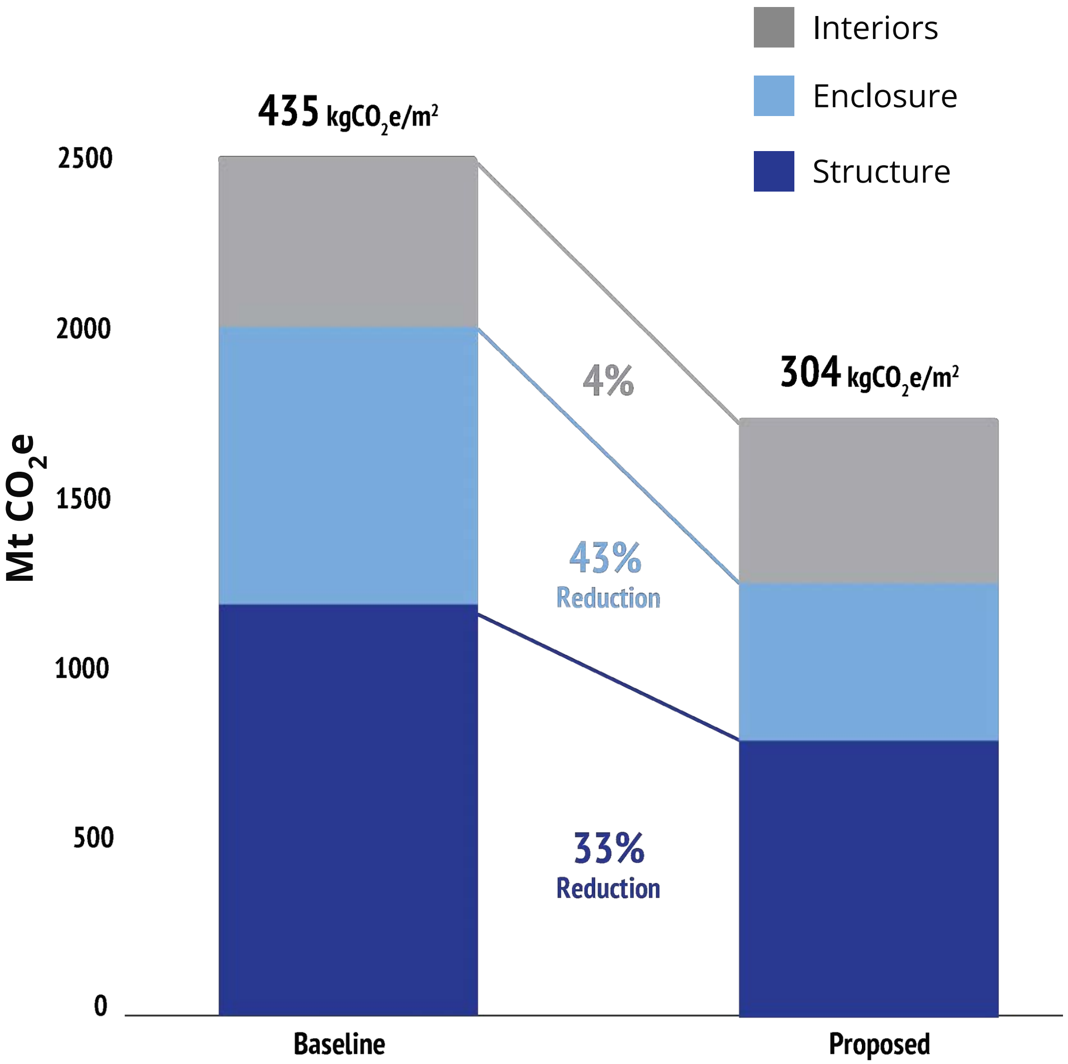
Procurement

- [x] Low Carbon Concrete
- [ ] Low Carbon Insulation

Jones Library

Submitted by Finegold Alexander Architects

Amherst, MA



GRAND PRIZE WINNER

30%

Embodied Carbon Savings

744 $MtCO_2e$

Embodied Carbon Savings

Reuse & Rehabilitation

Most Impactful Strategy

USE LESS

REUSE & REHABILITATION

SPACE OPTIMIZATION

INTERIOR EFFICIENCIES

Sustainable Engineering Laboratories

Amherst, MA
Laboratory - New Construction

Completion Year - 2026

Certifications (Expected)
ILFI Zero Carbon, LEED Platinum

Functioning as a living laboratory that represents UMass Amherst's sustainability and carbon neutral goals

Sustainable Engineering Laboratories

Submitted by Payette

Amherst, MA

GRAND PRIZE WINNER

34%

Embodied Carbon Savings

1528 $MtCO_2e$

Embodied Carbon Savings

Space Optimization

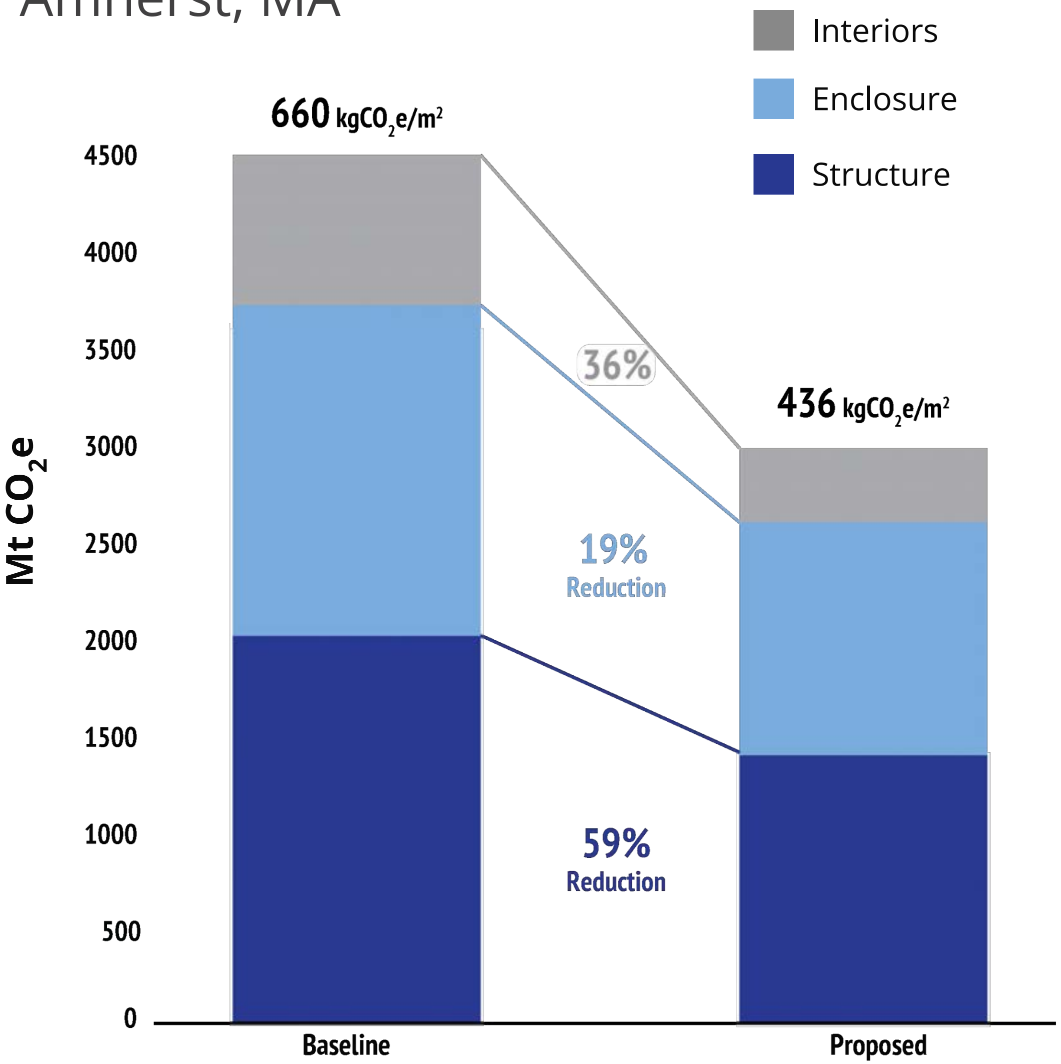
Most Impactful Strategy

STRATEGIES

Use Less
- [ ] Reuse and Rehabilitation
- [x] Space Optimization
- [x] Interior Efficiencies

Structural
- [x] Timber Structure
- [x] Lightweight Design

Procurement
- [x] Low Carbon Concrete
- [x] Low Carbon Insulation



Sustainable Engineering Laboratories

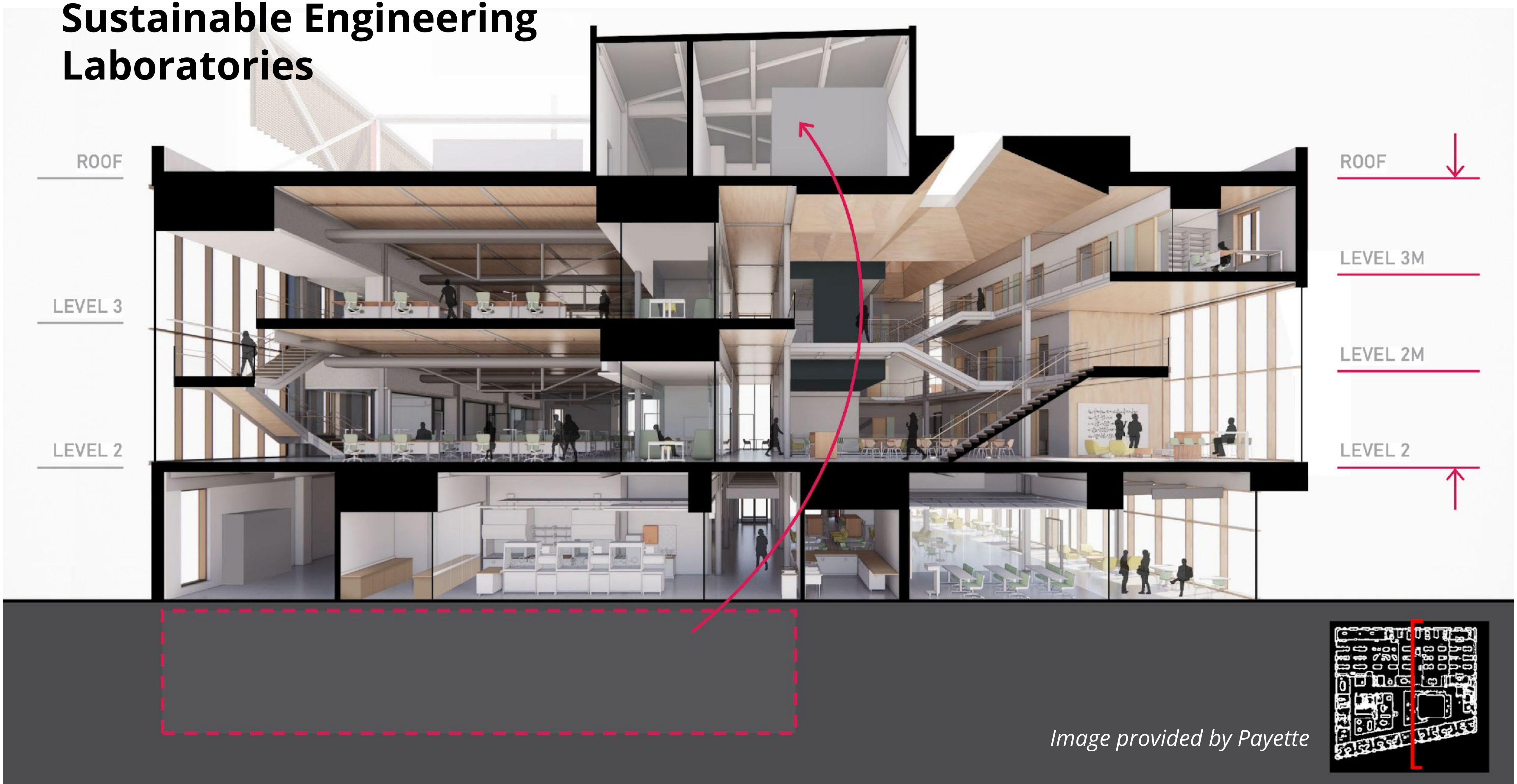
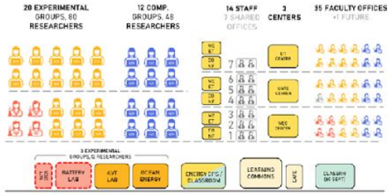


Image provided by Payette

Sustainable Engineering Laboratories

PROJECT DATA
NSF: 41, 700
GSF: 73,420
NET TO GROSS: 57%



SD > DD

-3% NET PROGRAM
-15% GROSS AREA
-25% STEEL TONNAGE

Image provided by Payette

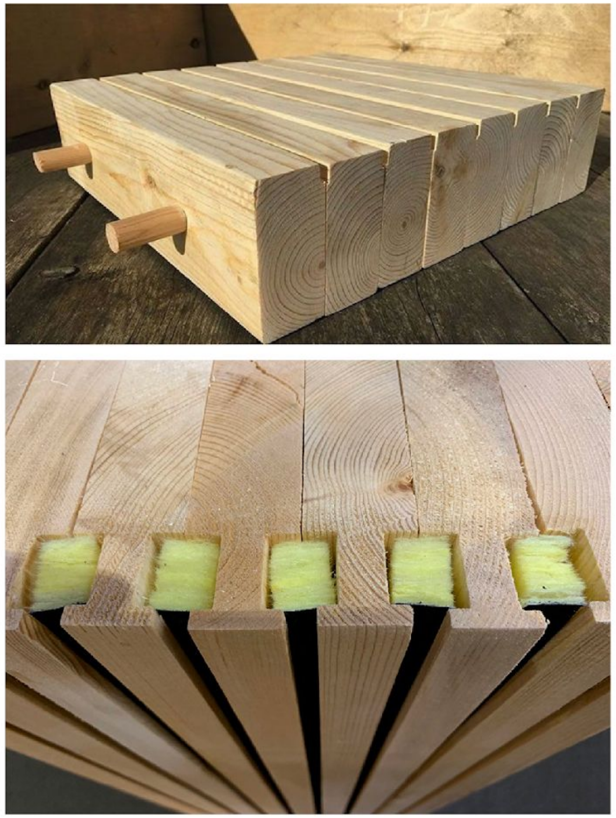
USE LESS

REUSE & REHABILITATION

SPACE OPTIMIZATION

INTERIOR EFFICIENCIES

Sustainable Engineering Laboratories



DOWEL-LAMINATED TIMBER
WITH INTEGRAL ACOUSTIC KERFS (NRC: 0.7)

OPEN LAB LOFT / WORKSHOP WITH DLT STRUCTURE

Image provided by Payette

STRUCTURAL APPROACHES

TIMBER STRUCTURE

LIGHTWEIGHT DESIGN

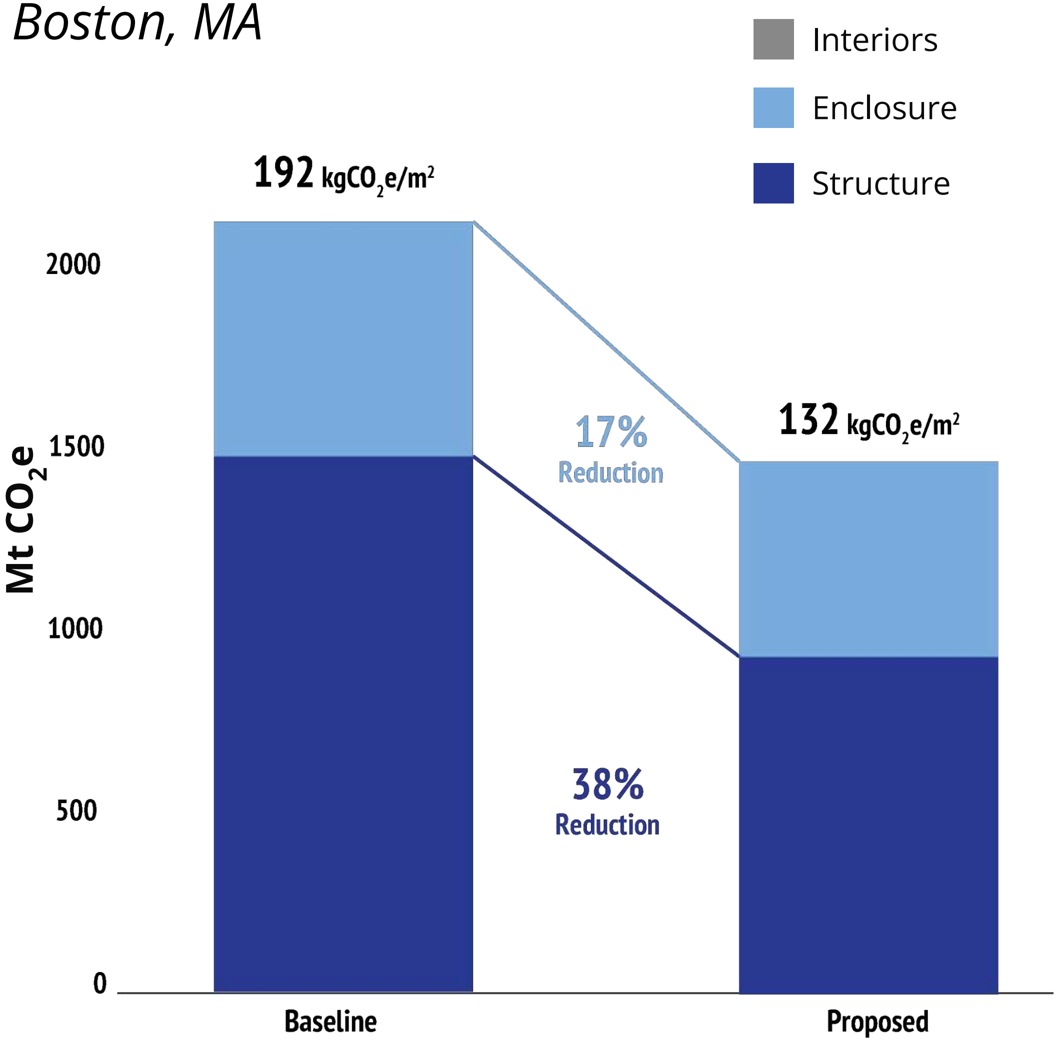
STRUCTURAL APPROACHES

TIMBER STRUCTURE

LIGHTWEIGHT DESIGN

Bunker Hill Housing - Building M

Submitted by Elkus Manfredi Architects
Boston, MA



TIMBER STRUCTURE

31%
Embodied Carbon Savings

664 MtCO_2e
Embodied Carbon Savings

Timber Structure
Most Impactful Strategy

STRATEGIES

Use Less
- [ ] Reuse and Rehabilitation
- [ ] Space Optimization
- [ ] Interior Efficiencies

Structural
- [x] Timber Structure
- [x] Lightweight Design

Procurement
- [ ] Low Carbon Concrete
- [ ] Low Carbon Insulation

STRUCTURAL APPROACHES

TIMBER STRUCTURE

LIGHTWEIGHT DESIGN

Cooper Center for Active Living

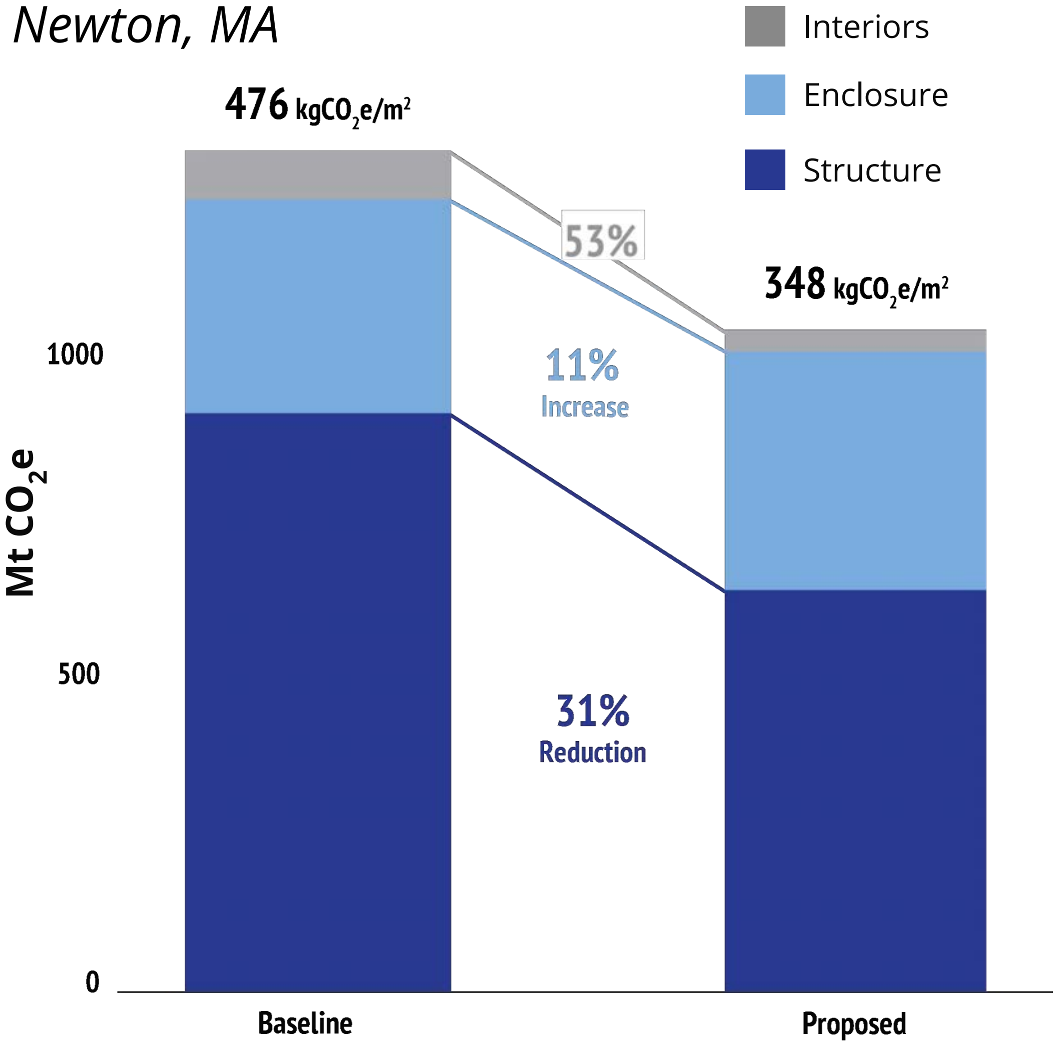
Submitted by The Green Engineer
Newton, MA

STRATEGIES

Use Less
- [ ] Reuse and Rehabilitation
- [ ] Space Optimization
- [ ] Interior Efficiencies

Structural
- [x] Timber Structure
- [x] Lightweight Design

Procurement
- [ ] Low Carbon Concrete
- [ ] Low Carbon Insulation



TIMBER STRUCTURE

27%
Embodied Carbon Savings

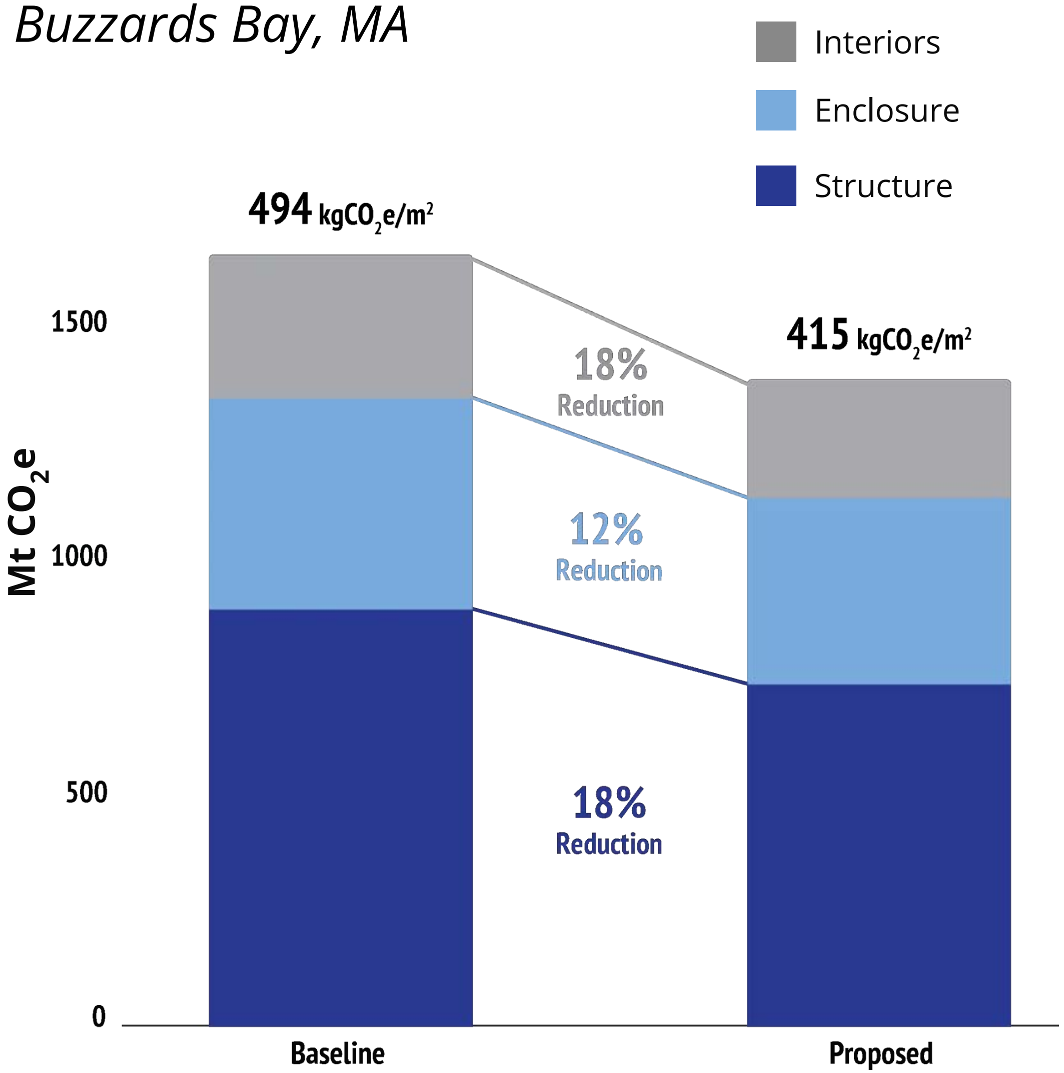
380 MtCO$_2$e
Embodied Carbon Savings

Timber Structure
Most Impactful Strategy

Mass Maritime Lab Modernization

Submitted by Ellenzweig

Buzzards Bay, MA



STRATEGIES

Use Less
- [ ] Reuse and Rehabilitation
- [x] Space Optimization
- [ ] Interior Efficiencies

Structural
- [ ] Timber Structure
- [x] Lightweight Design

Procurement
- [x] Low Carbon Concrete
- [x] Low Carbon Insulation

LIGHTWEIGHT DESIGN

16%

Embodied Carbon Savings

263 $MtCO_2e$

Embodied Carbon Savings

Lightweight Design

Most Impactful Strategy

PROCUREMENT

LOW CARBON CONCRETE

LOW CARBON INSULATION

PROCUREMENT

LOW CARBON CONCRETE

LOW CARBON INSULATION

STRATEGIES

Use Less

- ☐ Reuse and Rehabilitation
- ☐ Space Optimization
- ☐ Interior Efficiencies

Structural

- ✔ Timber Structure
- ✔ Lightweight Design

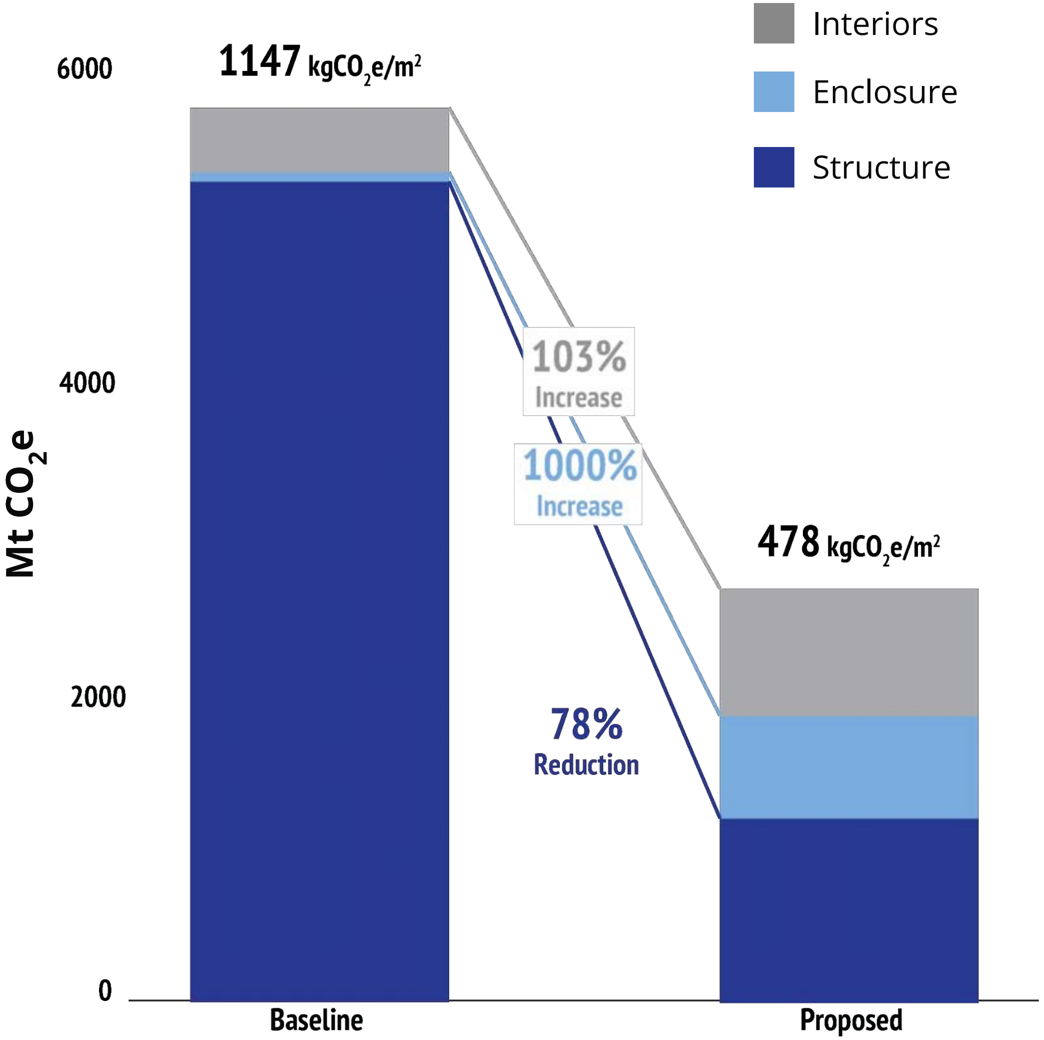
Procurement

- ✔ Low Carbon Concrete
- ✔ Low Carbon Insulation

David Rubenstein Treehouse Conference Center

Submitted by Harvard University

Boston, MA



LOW CARBON CONCRETE

58%

Embodied Carbon Savings

3357 $MtCO_2e$

Embodied Carbon Savings

Timber Structure

Most Impactful Strategy

PROCUREMENT

LOW CARBON CONCRETE

LOW CARBON INSULATION

2400 Mass Ave

Submitted by Linnean Solutions

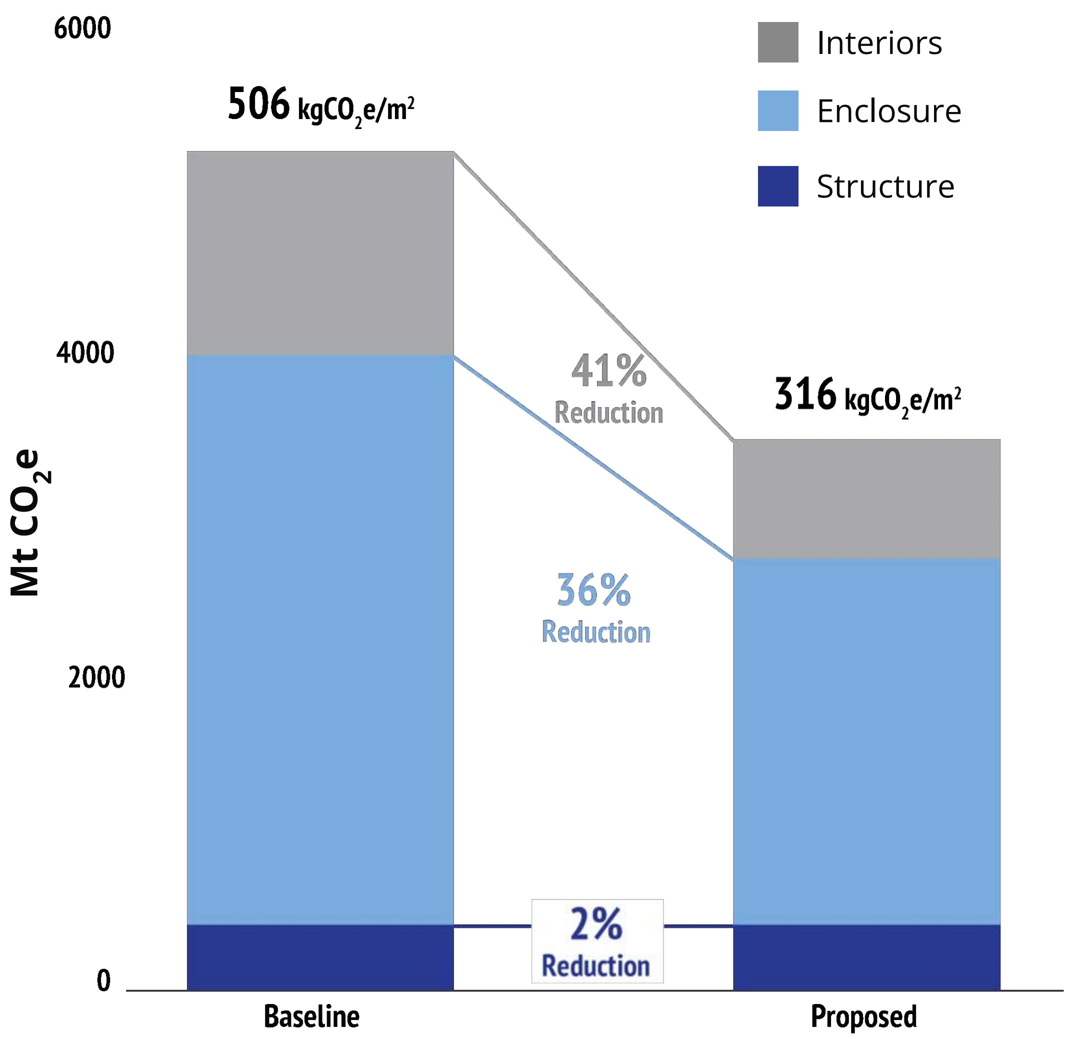
Cambridge, MA

STRATEGIES

Use Less
- [ ] Reuse and Rehabilitation
- [ ] Space Optimization
- [ ] Interior Efficiencies

Structural
- [x] Timber Structure
- [ ] Lightweight Design

Procurement
- [ ] Low Carbon Concrete
- [x] Low Carbon Insulation



38%

Embodied Carbon Savings

2003 $MtCO_2e$

Embodied Carbon Savings

Material Optimization

Most Impactful Strategy

STRATEGIES RECAP

USE LESS

- ☑ Reuse and Rehabilitation
- ☑ Space Optimization
- ☑ Interior Efficiencies

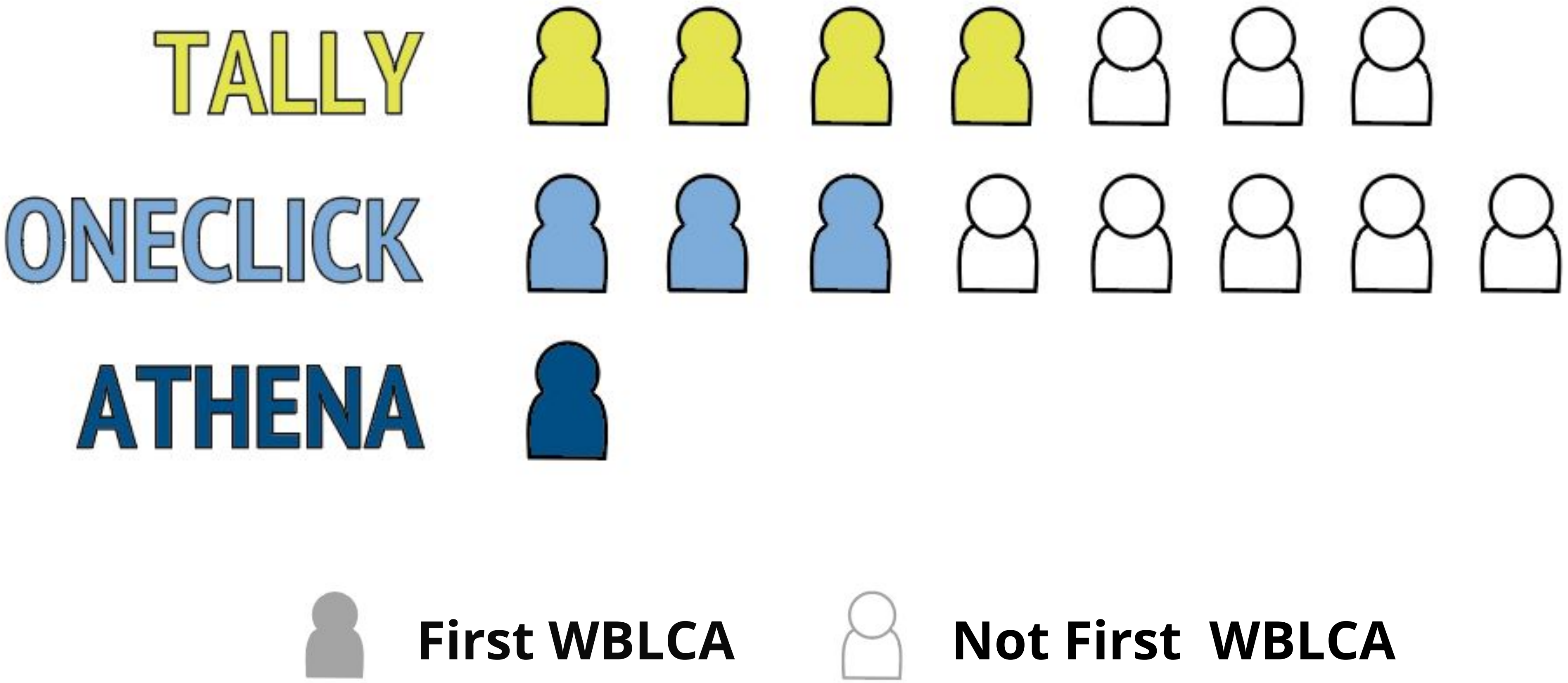
STRUCTURAL

- ☑ Timber Structure
- ☑ Lightweight Design

PROCUREMENT

- ☑ Low Carbon Concrete
- ☑ Low Carbon Insulation

1st Whole Building LCA for 50% of Participants



Sustainable Engineering Laboratories

Embodied Carbon Challenge Results

34% Reduction of Carbon

224 $kgCO_2e$ Reduction per m^2

1,528 $MtCO_2e$ Reduced from Baseline

Space Optimization Most Impactful Strategy

Client / Owner
UMass Amherst

Competition Participant
Payette

Project Type
Laboratory - New Construction

WBLCA Software
Tally

Anticipated Completion Year
2026

Location
Amherst, MA

Primary Structural System
Mass timber + steel

GRAND PRIZE

Project Overview — Exterior Rendering by Payette

Sustainable Engineering Laboratories (SEL) will function as a living laboratory platform and model for UMass Amherst's College of Engineering to counter the effects of climate change. The project is guided by campus sustainability and carbon neutrality goals, with the building expected to achieve ILFI Zero Carbon and LEED Platinum. SEL makes new ground by incorporating mass timber construction in a program type traditionally averse to it. The program area was also maximized via efficient planning and a 'skip stop' sectional strategy enclosing more program with less facade area and less structure.

Innovation and Replicability

Reductions were primarily driven by highly replicable design-based decisions and further material optimizations were cost neutral. Innovative strategies include a cost per carbon method, timber mullions, a matrix of structural systems, and the use of Dowel Laminated Timber (DLT) with acoustic treatment instead of CLT.

Low Carbon Strategies

In order to achieve a 34% reduction, six of the common low carbon strategies were incorporated. Additionally, they had a number of unique strategies, which set this project apart, such as:

- Creating a "cost per carbon reduction method" model in order to make informed decisions that were cost effective and low carbon
- Reduced floor to floor heights and structural grid optimization
- Specifying Polyiso instead of XPS for the roof assembly
- Mechanical relocation from the basement to ground level and roof to reduce excavation and foundation work

Reuse & Rehabilitation	Space Optimization	Interior Efficiencies	Lightweight Design	Timber Structure	Low Carbon Concrete	Low Carbon Insulation	
	✓	✓	✓	✓	✓	✓	SIX

EMBODIED CARBON REDUCTION CHALLENGE

FOR MORE INFO:

CHECK OUT THE FULL CASE STUDIES DOCUMENT →

People Impact

Before the Challenge to After Change

Familiarity with Embodied Carbon: 2x

Familiarity with WBCLA: 3x

Likely to implement in future: 100%

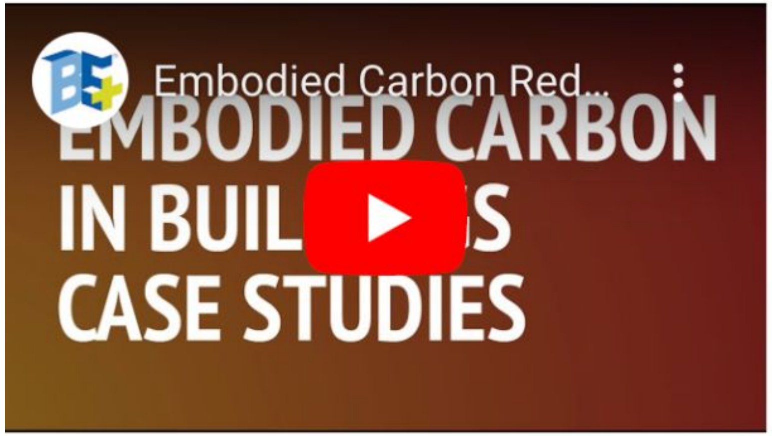
“The Challenge ***jump started our firm's work*** *around embodied carbon by providing the training and tools to make meaningful carbon reductions and conduct our first Whole Building Life Cycle Analysis.*

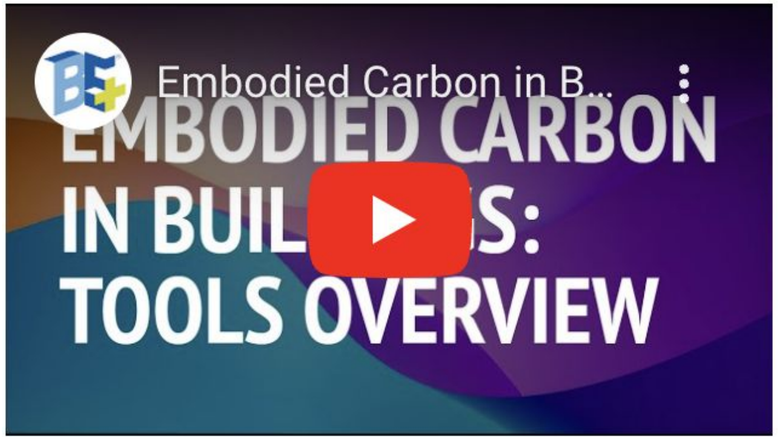
We've since ***integrated embodied carbon reduction into our everyday workflow****, building upon the success of our pilot project.*

We could not have made such rapid gains *in understanding and practice of embodied carbon reduction without the resources and programming of the Challenge.”* challenge participant

Policy Influence

EDUCATION



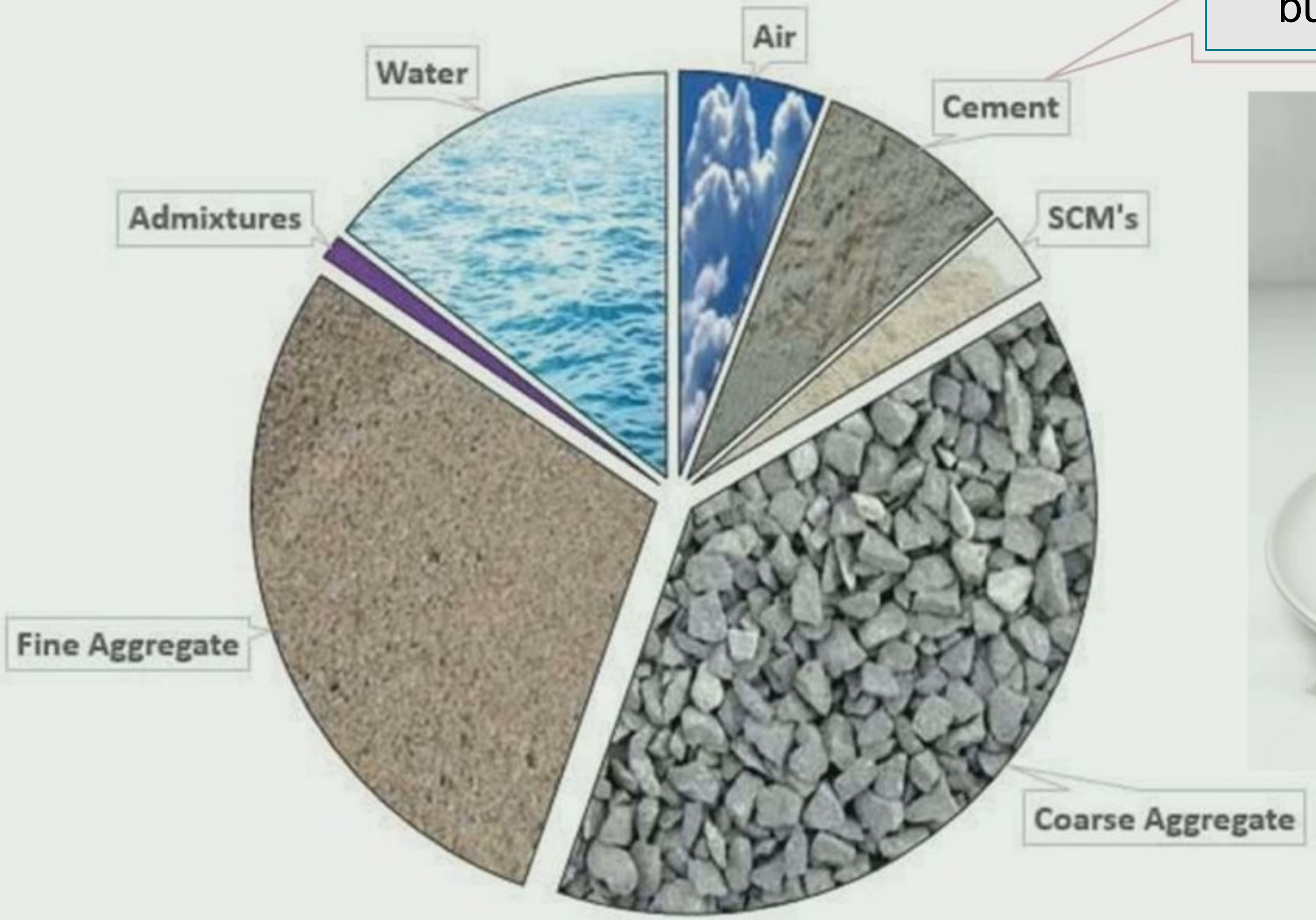


1200+
views

Event & Training recordings available online for **FREE**

Questions?

Concrete Mix Ingredients



Portland Cement is only 5-15% by mass but is **80-90% of embodied carbon**

Mike Gryniuk, Principal, CORA Structural

Cake Mix Specifications

Prescriptive

- Sets limits on the amounts of ingredients based on past experience.

- **Prescriptive Example:**
  a. The ratio of milk to eggs cannot exceed 0.45.
  b. The minimum amount of flour in the cake shall be ½ lb for every 10 cups of cake mix.
  c. For every cup of almond flour used in lieu of all-purpose flour add one egg.

Cake Mix Specifications

Performance-Based

- Specifies concrete requirements for the application and conducts tests to verify compliance.
- No pre-required ratios or amounts of ingredients.

- **Performance Example:**
  a. The cake shall be ready to serve in 2 days.
  b. The cake shall have less calories than a typical cake.
  c. The cake shall withstand the drive to auntie's house.

How to Get Lower Emission Concrete

1. Find Ready-Mix partner **EXPERIENCED** in:
   - Environmental Product Declarations (EPDs)
   - Supplying better than Eastern benchmark

MA Ready-Mix Concrete Plants with EPD Capability via MassCEC grant

2. Set performance based specification **EARLY** and engage ready-mix partner **EARLY**

3. **Early kick-off meeting**

How to Specify Lower Emission Concrete Fireside Chat

Caroline Murray

Turner Construction Co.
Regional Sustainability Manager

Turner

Jim Carreira

Boston Sand & Gravel
Technical Director

BOSTON SAND & GRAVEL
BSG
FIRST AND FINEST
EST. 1914

What is Lower Emission Concrete?

The National Ready Mix & Concrete Association (NRMCA) publishes average greenhouse gas impact in the **Eastern Regional Benchmark**

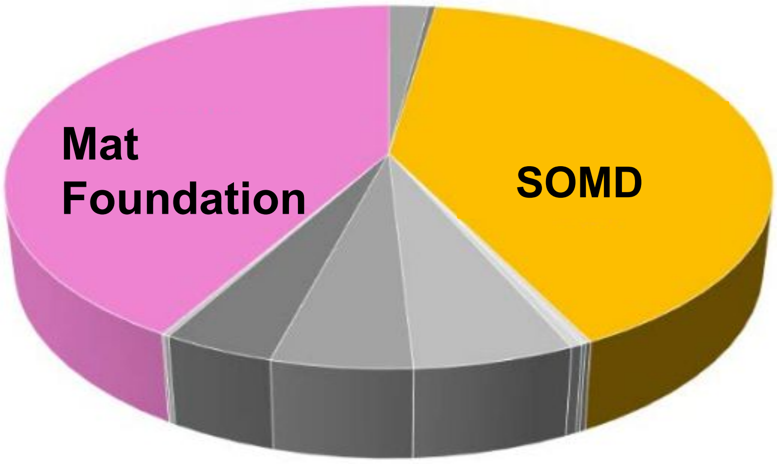
Lower Emission Concrete **beats** the regional benchmark

Eastern Regional Benchmark is moving target

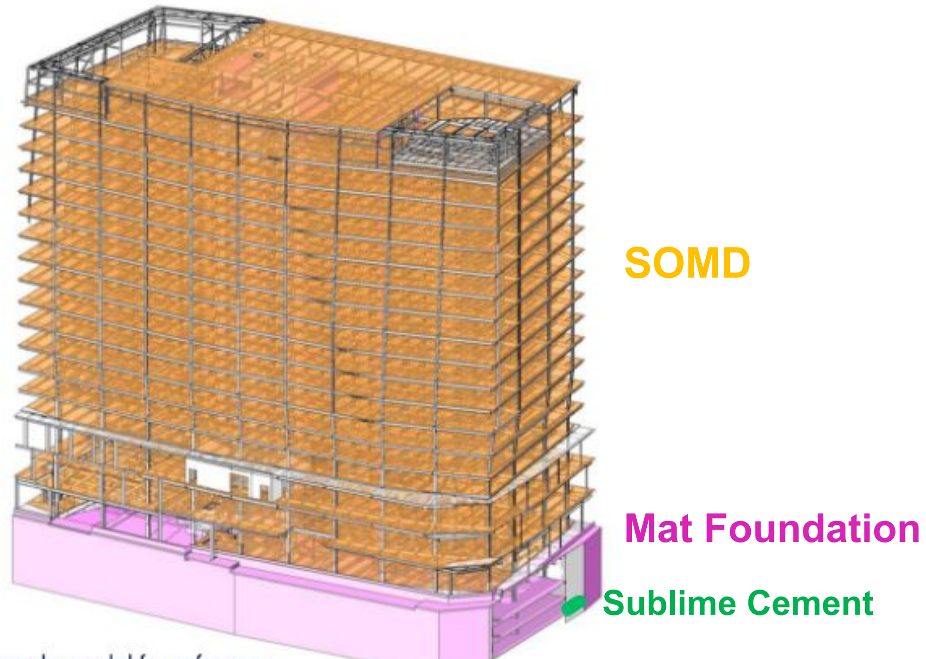
We aimed for **25% reduction** from the Eastern Regional Benchmark v3 and succeeded in achieving a **49% reduction**

It wasn't that hard!

Precon: Evaluate The Concrete Mix Volumes



Description	Locations/Uses	Mix Design	Qty (cy)	NRMCA Baseline V3 kg CO2e/cy	Specified kg CO2e/cy	Final kg CO2e/cy	% EC Reduction over baseline
4000 3/8 LW NA MRWR	Equipment Pads (Interior)	624164	557	464.2	335	319	31%
4000 3/4 MRWR	Construction Hoist Pad, etc.	324064	96	266.7	196	168	37%
4000 3/8 HRWR	Ductbanks	234074	62	266.7	196	202	24%
4000 3/8 NA HRWR	Pan Stairs	234174	38	266.7	196	199	25%
5000 3/8 HRWR+ 3 Gal CNI	Column Encasements	235054	116	321.4	196	258	20%
5000 3/4 HRWR+ 3 Gal CNI	SOG	335054	1,587	321.4	237	217	32%
5000 3/4 HRWR	Foundation Walls, Kneewalls	335074	1,385	321	237	217	32%
5000 3/4 NA HRWR	Interior	335174	1,103	321	237	206	36%
6000 3/4 HRWR+ 3 Gal CNI	Water Tank Lid	336054	49	339.5	250	244	28%
6000 3/4 NA HRWR	Social Stairs	336184	24	339.5	250	214	37%
All as above	All as above	**Various**	5,017	335	246	226	33%
4000 3/4 NA MRWR	SOMD Level 2 - Roof	**xxxx64**	11,185	266.7	196	179	33%
8000 3/4" NA HRWR (low heat)	Mat Foundation	**xxxx76**	11,553	401.4	297	164	59%



sample model for reference

Precon: Set The Goal and Raise the Bar

Achieved 49% reduction vs eastern regional benchmark NRMCA v3

Spec target was 25% reduction in Concrete

Description	Locations/Uses	Mix Design	Qty (cy)	NRMCA Baseline V3 kg CO2e/cy	Specified kg CO2e/cy	Final kg CO2e/cy	% EC Reduction over baseline
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All as above	All as above	Various	5,017	335	246	226	33%
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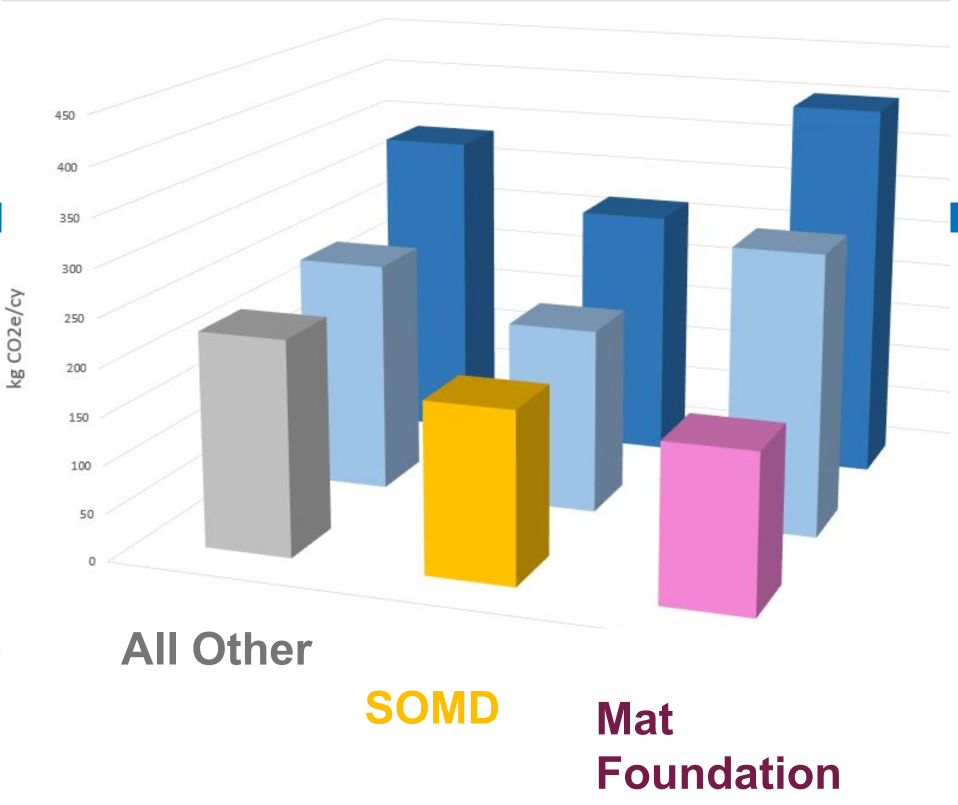
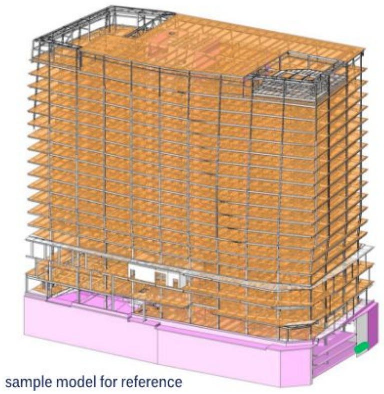


Early Engagement Was Key to Success



sample model for reference

SOMD
Mat Foundation
Sublime

- **Performance spec issued**
- Mix calculator and evaluation
- Project groundbreaking
- Submittal, EPD, EC
- Mockups and testing
- First **mat foundation** pour
- Final **mat foundation** pour
- **Sublime** field validation pour
- 28-day break data for **Sublime**
- First **SOMD** pour
- Final **SOMD** pour

Oct Nov

Precon

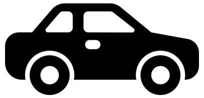
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct

Construction

How much carbon did we save?

Description	Locations/Uses	Producer's Mix Design #	Qty (cy)	Specified kg CO2e/cy	NRMCA Baseline V3 kg CO2e/cy	Final kg CO2e/cy	% EC Reduction over baseline for this mix design	Actual CO2 savings over baseline (kg CO2e)
4000 3/8 LW NA MRWR+ 1.5 lb/cy fi	Equipment Pads (Interior)	624164	557	335	464.2	319	31%	80876
4000 3/4 MRWR	Construction Hoist Pad, etc.	324064	96	196	266.7	168	37%	9475
4000 3/8 HRWR	Ductbanks	234074	62	196	266.7	202	24%	4011
4000 3/8 NA HRWR	Pan Stairs	234174	38	196	266.7	199	25%	2573
5000 3/8 HRWR+ 3 Gal CNI	Column Encasements	235054	116	196	321.4	258	20%	7354
5000 3/4 HRWR+ 3 Gal CNI	SOG	335054	1,587	237	321.4	217	32%	165683
5000 3/4 HRWR	Foundation Walls, Kneewalls	335074	1,385	237	321	217	32%	144040
5000 3/4 NA HRWR	Interior	335174	1,103	237	321	206	36%	126845
6000 3/4 HRWR+ 3 Gal CNI	Water Tank Lid	336054	49	250	339.5	244	28%	4680
6000 3/4 NA HRWR	Social Stairs	336184	24	250	339.5	214	37%	3012
All as above	All as above	Various	5,017	246	335	226	33%	Above
4000 3/4 NA MRWR	SOMD Level 2 - Roof	xxxx64	11,185	196	266.7	179	33%	980,925
8000 3/4" NA HRWR (low heat)	Mat Foundation	xxxx76	11,553	297	401.4	164	59%	2,742,682

4,272,156	4,272
TOTAL KG	TOTAL METRIC TONS



4,272 metric tons CO2e = 996 gasoline-powered passenger vehicles driven for one year!

EMBODIED CARBON
REDUCTION CHALLENGE

THE CHALLENGE: REDUCE UPFRONT CARBON OF BUILDINGS

LEARN 7 STRATEGIES REPLAY

SEE 16 CASE STUDIES →