How to Scale Up High Impact Embodied Carbon Reductions through Projects and Policies

Andrea Love (Payette)
Carmen Torres (Perkins Eastman Architects)
Mark Webster (Simpson Gumpertz and Heger)
Michelle Lambert (Lambert Sustainability)

Curated by Beverly Craig (MassCEC)

Northeast Sustainable Energy Association (NESEA)
February 28, 2022
EMBODIED CARBON IN BUILDINGS

- **Structure**: 40%
- **MEP**: 22%
- **Envelope**: 20%
- **Finishes**: 14%
- **Site**: 0.5%
- **Other Equipment**: 1%
- **Appliances/Fixtures**: 2.5%

**Sources**: K. Simonen. Testing Whole Building LCA: Research and Practice, 2015
EMBODIED CARBON - FAÇADE SYSTEM SELECTION

Material Breakdown

<table>
<thead>
<tr>
<th>Category</th>
<th>Material</th>
<th>GWP (kgCO$_2$eq/sf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masonry Veneer (MV)</td>
<td>Granite</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Limestone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brick</td>
<td></td>
</tr>
<tr>
<td>Face Sealed (FS)</td>
<td>Insulated Metal Panel</td>
<td></td>
</tr>
<tr>
<td>Curtain Wall (CW)</td>
<td>Spandrel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Glass Fiber Reinforced Concrete (GFRC)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Terracotta</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fiber Cement</td>
<td></td>
</tr>
<tr>
<td>Rainscreen (RS)</td>
<td>Formed Zinc Panel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Granite</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Limestone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Formed Steel Panel</td>
<td></td>
</tr>
</tbody>
</table>

LEGEND

- Exterior Finish
- Support System
- Insulation

- MV - Granite
- MV - Limestone
- FS - Insulated Metal
EMBODIED CARBON - FAÇADE SYSTEM SELECTION

ENVELOPE CALCULATOR

- Initial Carbon (only Module A)  60 Year (with Module D)  60 Year (no Module D)

<table>
<thead>
<tr>
<th>Option 1</th>
<th>Type</th>
<th>Square Feet</th>
<th>GWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV - Granite</td>
<td>15470</td>
<td>$289,958.50</td>
<td>856g</td>
</tr>
<tr>
<td>CW - Spandrel (Alum w/ Backpan)</td>
<td>8665</td>
<td>$123,822.85</td>
<td>60g</td>
</tr>
<tr>
<td></td>
<td>24.135 ft²</td>
<td>410,791.35  kgCO₂eq</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option 3</th>
<th>Type</th>
<th>Square Feet</th>
<th>GWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV - Granite</td>
<td>2965</td>
<td>$493,444.45</td>
<td>60g</td>
</tr>
<tr>
<td>RS - Granite</td>
<td>12648</td>
<td>$269,046.84</td>
<td>856g</td>
</tr>
<tr>
<td>RS - Formed Zinc Panel</td>
<td>19,505</td>
<td>$33,022.25</td>
<td>60g</td>
</tr>
<tr>
<td></td>
<td>24.135 ft²</td>
<td>189,449.54  kgCO₂eq</td>
<td></td>
</tr>
</tbody>
</table>

54% reduction in embodied carbon!
EMBODIED CARBON - FAÇADE SYSTEM SELECTION

**Material Breakdown**

- Masonry Veneer (A): Granite
- Rainscreen (B): Granite

**Assumptions:**
- Building structure not included in LCA calculations
- Copper rivet only, no fasteners included
- Steel included, screw, stud, and panel fasteners included for thermal performance
- Porcelain panels and porcelain tiles included in rain system 3
- Frame is structural
- Timber used as structural

**Masonry Veneer - Granite**

- Initial carbon (only Module A)

**Rainscreen - Granite**

- Initial carbon (only Module A)

**Assumptions:**
- Building structure not included in LCA calculations
- Copper rivet only, no fasteners included
- Steel included, screw, stud, and panel fasteners included for thermal performance
- Porcelain panels and porcelain tiles included in rain system 3
- Frame is structural
- Timber used as structural
- Timber used as structural
- Steel included, screw, stud, and panel fasteners included for thermal performance
Reducing Embodied Carbon - Material Choices

Carbon Impacts of Insulation

- Extruded Polystyrene (XPS)
- Closed Cell Sprayfoam (HFC)
- Closed Cell Sprayfoam (HFO)
- Expanded Polystyrene (EPS)
- Mineral Wool Batt
- Fiberglass Batt
- Denim Batt
- Wool
- Dense Pack Cellulose
- Cork
- Hempcrete
- Straw Bale

kgCO₂ represents R-20 at 234 m²

6,735 kgCO₂ emitted

-7,437 kgCO₂ embodied

CO₂ emissions influenced largely by source energy type

1. Material Extraction
2. Manufacturing
3. Transit
4. Use
5. End of Life

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Carbon impacts data source: Builders for Climate Action - 2019 White Paper
"Low-Rise Buildings as a Climate Change Solution", Chris Magwood, 2019;
REDUCING EMBODIED CARBON – MATERIAL SELECTION

Embodied Carbon with Traditional XPS

- Slab Insulation
- Wall Insulation
- Curtain Wall
- Geothermal Wells
- Net Carbon
REDUCING EMBODIED CARBON – MATERIAL SELECTION

Embodied Carbon with Traditional XPS

Embodied Carbon with Low GWP XPS
• Goal of 35% reduction in greenhouse gas emissions by 2020
  • Have reduced by 18% already from 2005 levels
  • Ultimate goal of 80% reduction from 1990 levels by 2050
• PSU Scope 1, 2, & 3 Emissions
reducing embodied carbon on projects

**Building in wood has positive effects for the environment**

CO₂ emissions for different materials (in tonnes CO₂)

<table>
<thead>
<tr>
<th>Material</th>
<th>Concrete slab</th>
<th>Steel sub frame</th>
<th>Ceramic tiles</th>
<th>Brick</th>
<th>Steel</th>
<th>Stool</th>
<th>Aluminum</th>
<th>Timber</th>
<th>Window</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions (tonnes CO₂)</td>
<td>12</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: InWood International Magazine, issue 15, Feb-Mar 2004

**EMBODIED CARBON: in design**

1. **End Grain Wood Floor**
2. **CLT Deck**
3. **Glulam Mullion**
Levels 1, 2, 3, 4:
CLT DECK
ON STEEL FRAMING

Basement:
CONCRETE
FOUNDATION &
SLAB ON GRADE

Roof:
STEEL DECK &
STEEL FRAMING

High Bay:
REINFORCED CMU & STEEL FRAMING
end grain wood block flooring
reducing embodied carbon on projects

Global Warming Potential

<table>
<thead>
<tr>
<th>Resilient (R)</th>
<th>GWP (kgCO₂eq/sf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubber</td>
<td></td>
</tr>
<tr>
<td>Vinyl</td>
<td></td>
</tr>
<tr>
<td>Linoleum</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Misc. (M)</th>
<th>GWP (kgCO₂eq/sf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Topper</td>
<td></td>
</tr>
<tr>
<td>Thin-Set Terrazzo</td>
<td></td>
</tr>
<tr>
<td>Epoxy</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wood (W)</th>
<th>GWP (kgCO₂eq/sf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Softwood Plank</td>
<td></td>
</tr>
</tbody>
</table>
reducing embodied carbon on projects

Material Health Impact

LEGEND
- Green: Meets Payette Policy
- Light Green: Meets Payette Material Policy with Requests
- Yellow: Meets some of Payette Material Policy
- Red: Does not meet Payette Material Policy

- Resilient (R)
  - Rubber
  - Vinyl
  - Linoleum

- Misc. (M)
  - Concrete Topper
  - Thin-Set Terrazzo
  - Epoxy

- Wood (W)
  - Softwood Plank

EMBODIED CARBON: in design
**Timber Curtain Wall** | *Glulam*

- Natural wood interior, Durable aluminum exterior
- Thermal properties of wood insulate for higher energy efficiency than aluminum curtain wall
- Reduced Carbon Footprint
- Occupant Well-Being
- Meets visibility goals & desire to bring warmth to façade
embodied carbon reduction

Global Warming Potential

- Traditional Curtain Wall
- Timber Curtain Wall

54% Reduction
Curtain wall comparison | Glazing comfort tool + Therm

ALUMINUM + TRIPLE GLAZING
\[ U = 0.25 \]

TIMBER + TRIPLE GLAZING
\[ U = 0.14 \]

TIMBER + DOUBLE GLAZING
\[ U = 0.22 \]

Expanded comfort zone to 3’ 6”
**Timber Curtain Wall** | *Direct Annual Sun after 8am*

- No interior shades needed
87% reduction in energy usage
Conclusions

• you don’t need permission . . . there is a lot we can do now
• make a part of your design process from the beginning
  ...and your consultants
• bring LCA results to internal + external design discussions
• compare operation and embodied carbon
• reuse: the item with the lowest embodied carbon already exists
• reduce: look to materials that have lower embodied carbon
  ...or could the material be eliminated?
• consider the lifespan
TOBIN MONTESSORI & VASSAL LANE UPPER SCHOOLS
Cambridge, MA
275,000 SF
New Construction
Preschool to 8th grade
INTEGRATED APPROACH

- Low-carbon impact materials
- Embodied carbon
- Zero on-site greenhouse gas emissions
- On-site renewable energy
- On-site stormwater management
- Energy metering
- Hybrid structural system
- Low-energy LED lighting
- High-performance building envelope
- Solar shading
- Low-flow plumbing fixtures & heat pumps
- Education
- LEED Gold
- Energy recovery systems
- Maximize on-site renewable energy
• Design Option Matrix utilized to compare all options in Feasibility Study

• Embodied Carbon was studied for Design Goal ranking

• The Initial Assumption: The Renovation + Addition option would have less Global Warning Potential (GWP) than any of the new construction options.
EXISTING CONDITIONS
A BUILDING BEYOND ITS USEFUL LIFE
TO KEEP OR NOT TO KEEP?
RENOVATION/ADDITION VS. NEW CONSTRUCTION

Renovation + Addition:
- Structure could be salvaged with significant seismic reinforcement
- Square footage breakdown:

35% Existing
65% Addition

New Construction:
- Building pEUI set to match Reno+Addition
- On-site renewals were not included

Embodied Carbon Intensity

Global Warming Potential Intensity (kgCO2e/sq. ft.)

- New Construction: 22.16
- Renovation - Addition: 16.75
- NC Benchmark*: 26.34

TO KEEP OR NOT TO KEEP?
RENovation/Addition VS. NEW CONSTRUCTION

Embodied and Operational Carbon over 60 Year Life Span

Embodied Carbon
6,650 MT CO2e
5,025 MT CO2e

Embodied & Operational Carbon
41,000 MT CO2e
38,300 MT CO2e

Global Warming Potential
(MT CO2e)

Present
60 Years

Feasibility Study
- Renovation + Addition
- New Construction
based on 300,000 sq ft floor area
SITE REMEDIATION

CONCRETE

- Reduce soilcrete wall by over 60% to align with material and cost goals

Proposed
Reduced
SITE REMEDIATION
URBAN TREE CANOPY

PRE + POST CONSTRUCTION COMPARISON
Robin Montessori + Vassall Lane Upper Schools
• A preliminary embodied carbon study conducted at the outset of Schematic Design
• Steel and Concrete were primary targets
# BIG PICTURE – STRUCTURE

## MATERIAL IMPACTS

<table>
<thead>
<tr>
<th>ALTERNATIVES</th>
<th>QUANTITY (cy)</th>
<th>A1-A3 (kgCO2e)</th>
<th>CHANGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Project Concrete (Baseline)</strong></td>
<td>8994</td>
<td>2.72 MILLION</td>
<td></td>
</tr>
<tr>
<td>20% Fly Ash in 30% of concrete</td>
<td>8994</td>
<td>2.60 MILLION</td>
<td>-4.41%</td>
</tr>
<tr>
<td>20% Fly Ash in 100% of concrete</td>
<td>8994</td>
<td>2.32 MILLION</td>
<td>-14.71%</td>
</tr>
<tr>
<td>30% Fly Ash in 30% of concrete</td>
<td>8994</td>
<td>2.54 MILLION</td>
<td>-6.62%</td>
</tr>
<tr>
<td>30% Fly Ash in 100% of concrete</td>
<td>8994</td>
<td>2.10 MILLION</td>
<td>-22.79%</td>
</tr>
</tbody>
</table>

*Based on NRMCA industry average*

<table>
<thead>
<tr>
<th>ALTERNATIVES</th>
<th>QUANTITY (cy)</th>
<th>A1-A3 (kgCO2e)</th>
<th>CHANGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inject CO2 in 30% of concrete</td>
<td>8994</td>
<td>2.67 MILLION</td>
<td>-1.80%</td>
</tr>
<tr>
<td>Inject CO2 in 100% of concrete</td>
<td>8994</td>
<td>2.56 MILLION</td>
<td>-6.00%</td>
</tr>
</tbody>
</table>

*Based on average 6% reduction in GWP from CarbonCure documentation (carboncure.com)*
BIG PICTURE – STRUCTURE

MATERIAL IMPACTS

INTERIOR
4000 psi: 20% - 30% fly ash
4000 Lightweight: 25% slag
6000 psi Mat Slabs: 25% slag
8000 psi: 25% - 30% slag

EXTERIOR
4000 psi: 35% Slag or 20% - 30% fly ash
4000 psi (Foundations, Walls, etc.): 40% slag
5000 psi Exterior Exposed: 25% slag
WHERE WE ARE
FROM FEASIBILITY TO REALITY

Embodied and Operational Carbon over 60 Year Life Span

- Embodied Carbon
  - 8,360 MT CO2e
  - 6,650 MT CO2e
  - 5,025 MT CO2e

- Embodied & Operational Carbon
  - 41,000 MT CO2e
  - 38,300 MT CO2e
  - 20,043 MT CO2e

Feasibility Study
- Renovation + Addition
- New Construction
  - based on 300,000 sq ft floor area

Current
- New Construction
  - based on 400,000 sq ft floor area
WHERE WE ARE
FROM FEASIBILITY TO REALITY

Waste Management from Demolition and Construction

Optimization

Material Selections
Carbon is everywhere
Recognizing Scale is Key
Once Carbon is spent, it is gone. Therefore, let’s spend it wisely.
First united Methodist Church
embodied carbon case study
nesea building energy boston

Mark D. Webster
Senior Consulting Engineer
Simpson Gumpertz & Heger

1 March 2022
project team

Design Team
Owner: First United Methodist Church
Architect: Maple Hill Architects
Structural Engineer: Simpson Gumpertz & Heger
MEP Engineer: Norian/Siani Engineering
Civil Engineer: Samiotes Consultants
Landscape Architect: Suzanne Hopkins McDonough

Construction Team
General Contractor: ACS Group
Concrete Subcontractor: Stashis Property Maintenance
Ready-Mix Supplier: Dauphinais Concrete
fumc facts

Existing
- built around 1967
- masonry exterior walls
- steel framing and bar joists
- wood-framed roof

Addition
- basement + two stories
- 2800 sf
- ICF walls
- wood-framed floors and roof
construction

16 December 2019
construction

2 March 2020
construction

15 May 2020
construction

24 October 2021
(Dedication Ceremony)
concrete drives structural embodied carbon

Achieving Net Zero Embodied Carbon in Structural Materials by 2050
(https://seisustainability.files.wordpress.com/2020/05/how-to-get-to-zero-200525.pdf)
specifying low carbon concrete

<table>
<thead>
<tr>
<th>Element</th>
<th>56-Day Strength</th>
<th>28-Day Strength</th>
<th>Max. Aggregate</th>
<th>Max. Portland Cement</th>
<th>Min. Cementitious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundations</td>
<td>4,000 psi</td>
<td>3,000 psi</td>
<td>3/4”</td>
<td>300 lb/cy</td>
<td>585 lb/cy</td>
</tr>
<tr>
<td>ICF Walls</td>
<td>4,000 psi</td>
<td>3,000 psi</td>
<td>3/8”</td>
<td>350 lb/cy</td>
<td>600 lb/cy</td>
</tr>
</tbody>
</table>

We specified a cap on the Portland cement content. The ready-mix supplier could decide how to meet the strength requirement. In this case, they opted to use slag to replace cement. Other materials could also serve this purpose, including Pozzotive, a finely ground glass product.
procurement strategies for reducing embodied carbon

Concrete

Environmental Product Declarations

This graphic shows just how much change we need to make happen here in Massachusetts!

Image Source: NBI
## Concrete Performance

<table>
<thead>
<tr>
<th>Day of Placement</th>
<th>Mix</th>
<th>Tested 28-Day Strength</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/19/19</td>
<td>Foundations 0% slag</td>
<td>6000 psi</td>
<td>Wrong Mix Delivered</td>
</tr>
<tr>
<td>12/23/19</td>
<td>Foundations 50% slag</td>
<td>9100 psi</td>
<td></td>
</tr>
<tr>
<td>1/24/20</td>
<td>Foundations 20% slag</td>
<td>7600 psi</td>
<td>Contractor concerned about cold weather (low temp that night in the high 20s)</td>
</tr>
<tr>
<td>2/21/20</td>
<td>Foundations 50% slag</td>
<td>7400 psi</td>
<td>Much colder than 1/24 (temp in low teens that night).</td>
</tr>
<tr>
<td>3/11/20</td>
<td>ICF walls 44% slag</td>
<td>7700 psi</td>
<td></td>
</tr>
<tr>
<td>4/22/20</td>
<td>ICF walls 44% slag</td>
<td>6800 psi</td>
<td></td>
</tr>
</tbody>
</table>
Life cycle assessment

Athena Environmental Impact Estimator

• Free LCA software.
• Includes wide range of materials with A-C life cycle (cradle-to-grave) and Module D option (beyond building life).
• Includes a concrete mix calculator.
• Input options:
  • Select from pre-designed systems
  • Input bill of materials
  • Combination of the above
defining the concrete baseline mix

• NRMCA Eastern Regional Benchmark for 4000 psi concrete has 21% cement replacement.
• 20% cement replacement common in our region if no special provisions.
• Dauphinais provided a 20% slag mix when concerned about the cold weather.
• I used the Dauphinais mix for my baseline mix.
Embodied Carbon of Concrete Mixes
(kg CO2e/cy)

- Reference Mix (20% Replacement): 300 kg CO2e/cy
- 50% Replacement: 219 kg CO2e/cy
- 44% Replacement: 242 kg CO2e/cy

Estimated Using Athena Custom Concrete Mix Tool
defining the reference building

What if Building Had Been Constructed Like the Original Building?

- Concrete Foundation Walls
- CMU Exterior Walls
- Concrete Slabs on Steel Deck and Bar Joists
- Wood-Framed Roof
calculating material quantities

Structural Steel and Rebar Shop Drawings
results for the addition

**Embodied Carbon (kg CO2e/sf)**

- **BASELINE SIM. TO EXISTING**
  - Cradle-to-Grave: 15.1
  - With Module D: 14.3

- **WITH REFERENCE CONCRETE**
  - Cradle-to-Grave: 12.8
  - With Module D: 11.3

- **AS SPECIFIED**
  - Cradle-to-Grave: 10.4
  - With Module D: 8.9

**With Module D:**
- 38% reduction from baseline building
- 22% reduction from reference concrete

**Cradle-to-Grave:**
- 31% reduction from baseline building
- 19% reduction from reference concrete
CLF embodied carbon benchmark study

Whisker Plots:
Box = +/- quartiles
Line in Box = median
Outliers not shown

Embodied Carbon of FUMC Project (Structure Only)

Note: 1 kg/m² ≈ 0.2 psf
500 kg/m² ≈ 100 psf
Embodied carbon by material (as designed, no sequestration)

GWP by Material

Concrete

Steel Framing

Rebar

Wood Framing

Rebar

4000 psi 3/4"

4000 psi 3/8"

Rebar

WWR

Hot-Rolled Shapes

HSS

Sawn Lumber

LVL

OSB

MPCs
Embodied carbon by system (baseline cmu building)
lessons learned

- We can easily do useful embodied carbon calculations for our small projects using free LCA tools such as Athena.
- 50% replacement concrete mixes provided ample strength at 28 days and performed well in cold weather.
- Make sure the contractor understands the mix requirements and delivers the approved mixes.
some useful embodied carbon resources for structure

• Structural Engineering (SE) 2050 Commitment (se2050.org/)

• Achieving Net Zero Embodied Carbon in Structural Materials by 2050 (seisustainability.files.wordpress.com/2020/05/how-to-get-to-zero-200525.pdf)

**Current MA Policies that Address Building-related Energy/Carbon**

**OPERATING ENERGY/CARBON**

**MA State-level:**
- Energy Code- updated every 3 years, next Jan 2023
- Stretch Energy Code- last updated 5 years ago, next Jan 2023
- EO 594 Leading by Design- LEED+ for state facilities
- MassSave Incentives for energy reductions and Passive House

**City/Town-level:**
- Green building standards/requirements-
  - Boston- Article 37 LEED Certifiable and net zero study; BERDO for existing buildings
  - Cambridge- Article 22 LEED Gold; BEUDO
  - Newton- Special Permit Sustainability Ordinance- LEED or Passive House
  - And many others

**EMBODIED ENERGY/CARBON**

**MA State-level:**
- SEVERAL IN DEVELOPMENT...

**City/Town-level:**
- SEVERAL IN DEVELOPMENT...
Policy *Types* that Address Building-related Embodied Carbon

**EMBODIED ENERGY/CARBON**

**State/County-level:**
- Executive Orders
- Procurement Requirements – ‘Buy Clean’ Policies for specific materials
- Building and Energy Codes

**City/Town-level:**
- Climate Action Plans
- Zoning/Permitting
- Building Reuse/Deconstruction Ordinances
- Incentives
Embodied Carbon Policies – US and Canada
Embodied Carbon Policies - Northeast
MA Policies *In Development* that Address Building-related Energy/Carbon

**EMBODIED ENERGY/CARBON**

**MA State-level:**
- MA Executive Order 594
- MA DOER Net Zero Stretch Energy Code- *PROPOSED*

**City/Town-level:**
- Boston
- Cambridge
- Newton
- Somerville
Massachusetts State Policy *Enacted*

**MA Executive Order 594, Leading by Example: Decarbonizing and Minimizing Environmental Impacts of State Government**

- Issued April 2021 by Governor Baker
- **Section 3:** “Evaluate and implement strategies to reduce embodied carbon contained in building materials, where possible and cost-effective.”
Massachusetts State Policy *Proposed/In Development*

*Proposed MA DOER Net Zero Stretch Energy Code*

- Pathway: For commercial buildings/large scale multi-family only
  - For curtainwall buildings *only* - must demonstrate embodied carbon reduction from menu of options:
    - Low carbon concrete
    - Carbon sequestering materials (wood fibre, mass timber)
    - Recycled materials
    - Reused materials/building reuse

- Timeline for adoption - spring/summer public comment and revisions; Fall 2022 final draft; in effect January 2023
MA Local Policy *Proposed/In Development*

CITY OF BOSTON


2. Mass Timber Accelerator Grants

City of Boston - Article 37 and Zero Net Carbon Update

Recommendations

Low Carbon Buildings
On-site Renewable Energy
Renewable Energy Procurement
Embodied Carbon
## Embodied Carbon TAG – 12 Recommendations

<table>
<thead>
<tr>
<th>POLICY</th>
<th>PRACTICE</th>
<th>AWARENESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>[02] Building reuse and deconstruction ordinance(s)</td>
<td>[07] Incentives</td>
<td>[10] City Capacity and Expertise</td>
</tr>
<tr>
<td>[04] Require whole-building LCA in zoning/permitting process</td>
<td></td>
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October 20, 2021
Provide development teams with technical assistance and funding grants to assess and integrate low carbon mass timber building practices into their projects.

**Partners:**
- BPDA, BSA, WoodWorks, USDA Forest Service, Softwood Lumber Board, ClimateWorks Foundation
Boston Building Deconstruction Pilot Program

- Identified 5 projects to pilot demonstration
- City with RecyclingWorks providing technical assistance to identify opportunities for deconstruction and recycling or reuse
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Cambridge 2.2 Address Embodied Carbon Through Green Building Requirements

**Short Term (1-2 Years)**
1. Adopt embodied carbon narrative for new construction.
2. Assess LEED alternative pathways and zero carbon certification
3. Design and develop policy to prioritize re-use
4. Design carbon intensity targets
5. Develop toolkit / templates
6. Perform technical assessment of carbon impacts
7. Participate in peer learning sessions with other cities

**Medium Term (3-5 Years)**
8. Adopt Life Cycle Analysis/carbon reduction requirements
9. Implement and monitor performance

**Long Term (5+ Years)**
10. Adopt enhanced LCA/carbon reduction requirements
Newton Sustainability Ordinance

Sustainable Development Requirements, Adopted December 2019

Applies to any new proposed development > 20,000 sf that requires special permit

- “The Petitioner’s design teams will utilize the best available information to assess embodied carbon in building materials and incorporate that information into the design process so that low embodied carbon materials can be incorporated when cost, availability and performance is feasible.”
Newton PROPOSED Zoning Requirement for Embodied Carbon

1. Owner/developer must notify design team that embodied carbon reductions are a priority

2. Design team must estimate embodied carbon of the project
   - Projects < 50,000 sf, only structural materials
   - Projects > 50,000 sf, structural and enclosure materials and demonstrate a 10% embodied carbon reduction
   - For projects > 50,000 sf, must also consider the embodied carbon of at least three enclosure systems and justify selection of system that does not have lowest embodied carbon.

3. The embodied carbon of concrete used for the project must be capped

4. The design team must consider various means of reducing embodied carbon and prepare a narrative summary

Projects where at least 50% of the floor area comprises re-use of a pre-existing structure are not subject to these provisions.
MA Local Policy *Proposed/In Development*

**OTHER MUNICIPALITIES**
- Somerville
- Amherst
- Others
Thank You!

Boston Society for Architecture (BSA), Embodied Carbon 101 Webinars and Impact Series
architects.org/embodied-carbon-101

Carbon Leadership Forum (CLF)
carbonleadershipforum.org

CLF Boston/Northeast Hub- join us!
architects.org/knowledge-communities/clf-boston

Architecture 2030 - architecture2030.org
Carbon Smart Materials Palette

Rocky Mountain Institute
Report- Reducing Embodied Carbon in Buildings
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