Embodied Carbon Reduction: Guidance, Steps, Results

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Let's Talk About

- ANSI 1500
- Analysis Tools
- Operational and Embodied Carbon: Modeled Versus Actual
- Drivers
- Action Items
- Case Studies
- Questions/Answers/Discussion

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RESNET/ANSI Standard 1550

The RESNET/International Code Council **Standards Development Committee 1500 — Embodied Carbon** is responsible for proposed Standard RESNET/ICC 1550 to provide a **standardized method to calculate and report the embodied carbon impact of homes.**

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RESNET/ANSI Standard 1550

HERS ratings and the HERS carbon index are a very large and growing part of the **residential market**.

Raters also provide services for **PHIUS, Energy Star and DOE Zero Ready Homes** programs.

Creating a standard that enables **HERS raters** to create an embodied carbon assessment using the **same area-based models they already build to do their energy ratings.**

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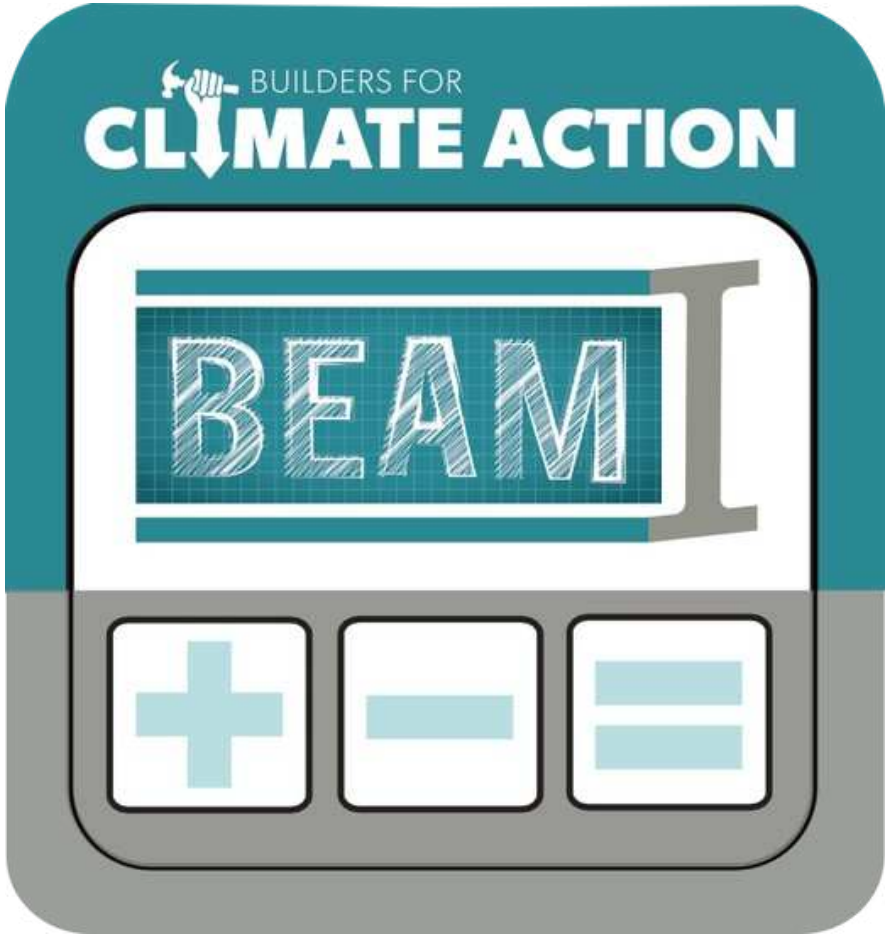
Tools for Analysis

TOOL	Early Design Hotspot	Enclosure Comparison	Individual Material Comparison	LCCA + ESG	Net Zero Carbon	Residential	Retrofit Avoided Carbon	Whole Building LCA
Autocase				x				
BEAM	x	x	x			x		
Building Ease			x					
CARE							x	
COVE	x							
EC3			x					
eTool	x	x	x	x	x	x	x	x
Kaleidoscope		x						
OneClick	x	x	x	x	x	x	x	x
PH Ribbon		x			x			
Tally	x	x	x	x	x	x	x	x
ZGF			x					

Tools for Analysis

- Direct side-by-side material comparisons
- Assembly comparisons
- Design development
- Whole building models and comparisons
- “Alternative” materials with EPDs or LCA studies



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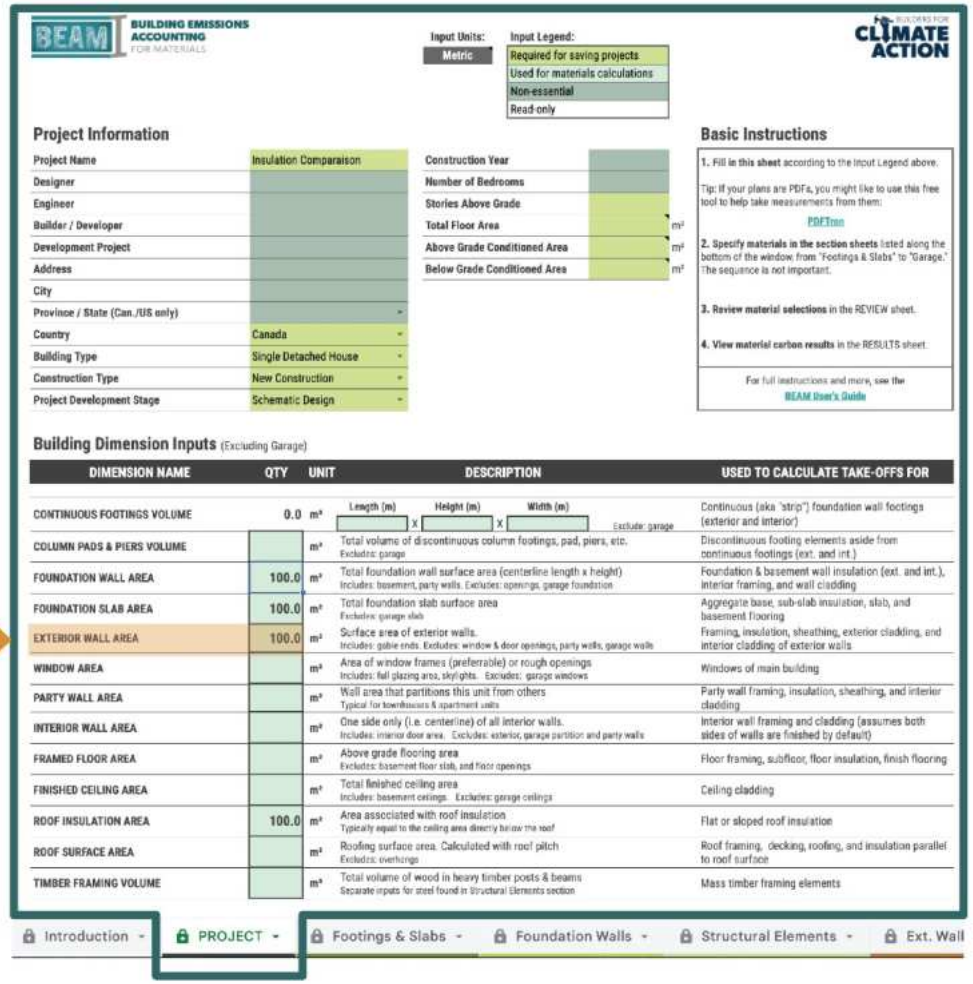
Tools for Analysis

1- INPUT DIMENSIONS

on the **project sheet**.

ex: 100 m² of exterior walls.



BEAM BUILDING EMISSIONS ACCOUNTING FOR MATERIALS

Input Units: Metric

Input Legend: Required for saving projects; Used for materials calculations; Non-essential; Read-only

BUILDERS FOR CLIMATE ACTION

Project Information

Project Name	Insulation Comparaison
Designer	
Engineer	
Builder / Developer	
Development Project	
Address	
City	
Province / State (Can./US only)	
Country	Canada
Building Type	Single Detached House
Construction Type	New Construction
Project Development Stage	Schematic Design

Construction Year	
Number of Bedrooms	
Stories Above Grade	
Total Floor Area	m²
Above Grade Conditioned Area	m²
Below Grade Conditioned Area	m²

Basic Instructions

1. Fill in this sheet according to the Input Legend above.

Tip: If your plans are PDFs, you might like to use this free tool to help take measurements from them: PDFTron

2. Specify materials in the section sheets listed along the bottom of the window from "Footings & Slabs" to "Garage." The sequence is not important.

3. Review material selections in the REVIEW sheet.

4. View material carbon results in the RESULTS sheet.

For full instructions and more, see the BEAM User's Guide

Building Dimension Inputs (Excluding Garage)

DIMENSION NAME	QTY	UNIT	DESCRIPTION	USED TO CALCULATE TAKE-OFFS FOR
CONTINUOUS FOOTINGS VOLUME	0.0	m³	Length (m) x Height (m) x Width (m) — Exclude: garage	Continuous (aka "strip") foundation wall footings (exterior and interior)
COLUMN PADS & PIERS VOLUME		m³	Total volume of discontinuous column footings, pad, piers, etc. Excludes: garage	Discontinuous footing elements aside from continuous footings (ext. and int.)
FOUNDATION WALL AREA	100.0	m²	Total foundation wall surface area (centerline length x height) Includes: basement, party walls. Excludes: openings, garage foundation	Foundation & basement wall insulation (ext. and int.), interior framing, and wall cladding
FOUNDATION SLAB AREA	100.0	m²	Total foundation slab surface area Excludes: garage slab	Aggregate base, sub-slab insulation, slab, and basement flooring
EXTERIOR WALL AREA	100.0	m²	Surface area of exterior walls. Includes: gable ends. Excludes: window & door openings, party walls, garage walls	Framing, insulation, sheathing, exterior cladding, and interior cladding of exterior walls
WINDOW AREA		m²	Area of window frames (preferrable) or rough openings Includes: full glazing area, skylights. Excludes: garage windows	Windows of main building
PARTY WALL AREA		m²	Wall area that partitions this unit from others Typical for townhouses & apartment units	Party wall framing, insulation, sheathing, and interior cladding
INTERIOR WALL AREA		m²	One side only (i.e. centerline) of all interior walls. Includes: interior door area. Excludes: exterior, garage partition and party walls	Interior wall framing and cladding (assumes both sides of walls are finished by default)
FRAMED FLOOR AREA		m²	Above grade flooring area Excludes: basement floor slab, and floor openings	Floor framing, subfloor, floor insulation, finish flooring
FINISHED CEILING AREA		m²	Total finished ceiling area Includes: basement ceilings. Excludes: garage ceilings	Ceiling cladding
ROOF INSULATION AREA	100.0	m²	Area associated with roof insulation Typically equal to the ceiling area directly below the roof	Flat or sloped roof insulation
ROOF SURFACE AREA		m²	Roofing surface area. Calculated with roof pitch Excludes: overhangs	Roof framing, decking, roofing, and insulation parallel to roof surface
TIMBER FRAMING VOLUME		m³	Total volume of wood in heavy timber posts & beams Separate inputs for steel found in Structural Elements section	Mass timber framing elements

Introduction | PROJECT | Footings & Slabs | Foundation Walls | Structural Elements | Ext. Wall

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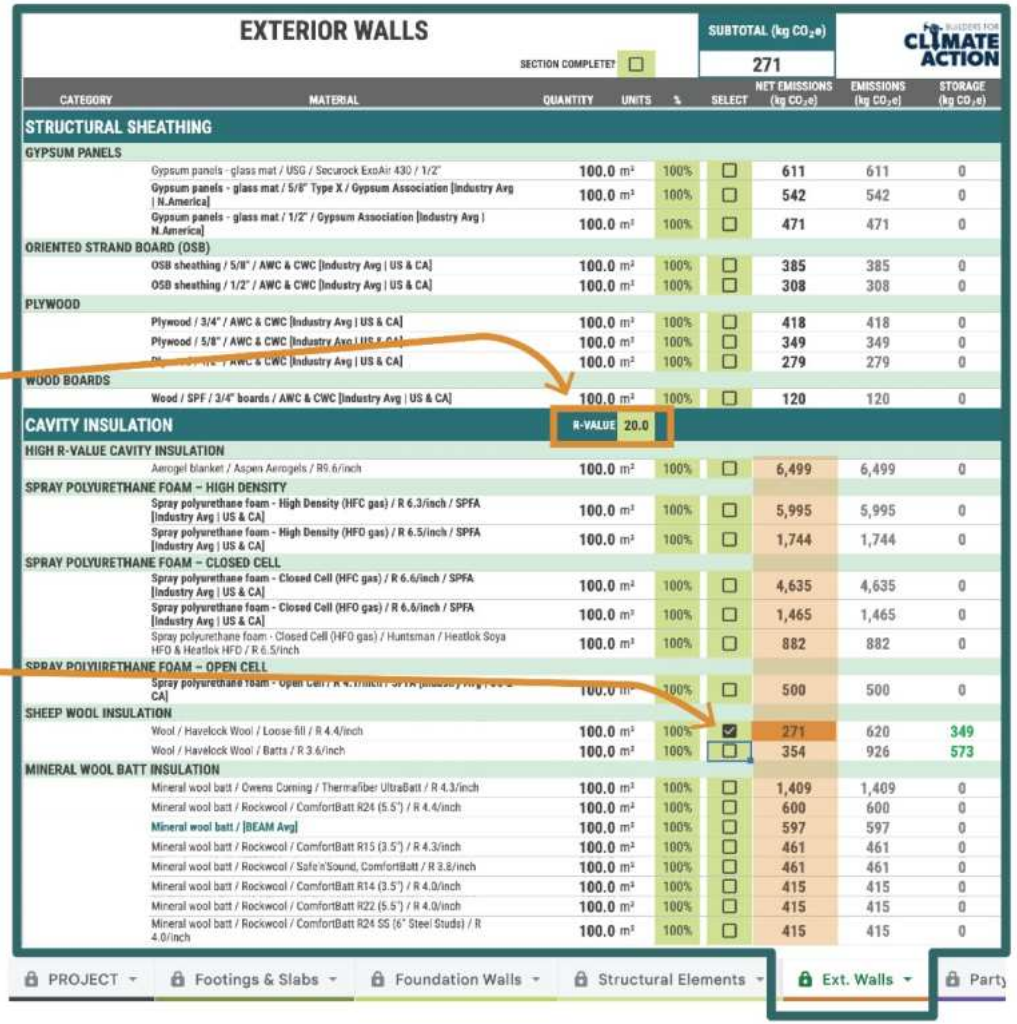
Tools for Analysis

2- SPECIFY + SELECT

on the **section sheets**,

Specify additional factors -> *e.i.* R-VALUE

ex: Compare 100m² of different cavity insulation with R-Value: 20 and select materials by checking the box.



EXTERIOR WALLS

SECTION COMPLETE?

SUBTOTAL (kg CO_2e): 271

CATEGORY	MATERIAL	QUANTITY	UNITS	%	SELECT	NET EMISSIONS (kg CO_2e)	EMISSIONS (kg CO_2e)	STORAGE (kg CO_2e)
STRUCTURAL SHEATHING								
GYPSUM PANELS								
	Gypsum panels - glass mat / USG / Securock ExoAir 430 / 1/2"	100.0	m²	100%	☐	611	611	0
	Gypsum panels - glass mat / 5/8" Type X / Gypsum Association [Industry Avg | N.America]	100.0	m²	100%	☐	542	542	0
	Gypsum panels - glass mat / 1/2" / Gypsum Association [Industry Avg | N.America]	100.0	m²	100%	☐	471	471	0
ORIENTED STRAND BOARD (OSB)								
	OSB sheathing / 5/8" / AWC & CWC [Industry Avg | US & CA]	100.0	m²	100%	☐	385	385	0
	OSB sheathing / 1/2" / AWC & CWC [Industry Avg | US & CA]	100.0	m²	100%	☐	308	308	0
PLYWOOD								
	Plywood / 3/4" / AWC & CWC [Industry Avg | US & CA]	100.0	m²	100%	☐	418	418	0
	Plywood / 5/8" / AWC & CWC [Industry Avg | US & CA]	100.0	m²	100%	☐	349	349	0
	[illegible] / AWC & CWC [Industry Avg | US & CA]	100.0	m²	100%	☐	279	279	0
WOOD BOARDS								
	Wood / SPF / 3/4" boards / AWC & CWC [Industry Avg | US & CA]	100.0	m²	100%	☐	120	120	0
CAVITY INSULATION		R-VALUE 20.0						
HIGH R-VALUE CAVITY INSULATION								
	Aerogel blanket / Aspen Aerogels / R9.6/inch	100.0	m²	100%	☐	6,499	6,499	0
SPRAY POLYURETHANE FOAM – HIGH DENSITY								
	Spray polyurethane foam - High Density (HFC gas) / R 6.3/inch / SPFA [Industry Avg | US & CA]	100.0	m²	100%	☐	5,995	5,995	0
	Spray polyurethane foam - High Density (HFO gas) / R 6.5/inch / SPFA [Industry Avg | US & CA]	100.0	m²	100%	☐	1,744	1,744	0
SPRAY POLYURETHANE FOAM – CLOSED CELL								
	Spray polyurethane foam - Closed Cell (HFC gas) / R 6.6/inch / SPFA [Industry Avg | US & CA]	100.0	m²	100%	☐	4,635	4,635	0
	Spray polyurethane foam - Closed Cell (HFO gas) / R 6.6/inch / SPFA [Industry Avg | US & CA]	100.0	m²	100%	☐	1,465	1,465	0
	Spray polyurethane foam - Closed Cell (HFO gas) / Huntsman / Heatlok Soya HFO & Heatlok HFO / R 6.5/inch	100.0	m²	100%	☐	882	882	0
SPRAY POLYURETHANE FOAM – OPEN CELL								
	Spray polyurethane foam - Open Cell / R 4.1/inch / SPFA [illegible] CA]	100.0	m²	100%	☐	500	500	0
SHEEP WOOL INSULATION								
	Wool / Havelock Wool / Loose-fill / R 4.4/inch	100.0	m²	100%	☑	271	620	349
	Wool / Havelock Wool / Batts / R 3.6/inch	100.0	m²	100%	☐	354	926	573
MINERAL WOOL BATT INSULATION								
	Mineral wool batt / Owens Corning / ThermaFiber UltraBatt / R 4.3/inch	100.0	m²	100%	☐	1,409	1,409	0
	Mineral wool batt / Rockwool / ComfortBatt R24 (5.5") / R 4.4/inch	100.0	m²	100%	☐	600	600	0
	Mineral wool batt / [BEAM Avg]	100.0	m²	100%	☐	597	597	0
	Mineral wool batt / Rockwool / ComfortBatt R15 (3.5") / R 4.3/inch	100.0	m²	100%	☐	461	461	0
	Mineral wool batt / Rockwool / Safe'n'Sound, ComfortBatt / R 3.8/inch	100.0	m²	100%	☐	461	461	0
	Mineral wool batt / Rockwool / ComfortBatt R14 (3.5") / R 4.0/inch	100.0	m²	100%	☐	415	415	0
	Mineral wool batt / Rockwool / ComfortBatt R22 (5.5") / R 4.0/inch	100.0	m²	100%	☐	415	415	0
	Mineral wool batt / Rockwool / ComfortBatt R24 SS (6" Steel Studs) / R 4.0/inch	100.0	m²	100%	☐	415	415	0

PROJECT | Footings & Slabs | Foundation Walls | Structural Elements | Ext. Walls | Party

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Tools for Analysis

3- REVIEW

materials selection on the **review sheet**.

Quickly identify selected materials with highest and lowest carbon footprint

REVIEW PROJECT MATERIALS

SECTION	CATEGORY	MATERIAL	NET EMISSIONS (kg CO_2e)	CARBON EMISSIONS (kg CO_2e)	CARBON STORAGE (kg CO_2e)
			11,745	13,519	1,774
Footings & Slabs	CONTINUOUS CONCRETE FOOTINGS	Concrete – 0-25 MPa, 0-14% FA/SL, GU / CRMCA [Industry Avg | CA]	1,225	1,225	0
Footings & Slabs	CONCRETE SLABS	Concrete – 0-25 MPa, 0-14% FA/SL, GU / CRMCA [Industry Avg | CA]	2,645	2,645	0
Footings & Slabs	REBAR FOR CONTINUOUS FOOTINGS	Rebar / Concrete Reinforcing Steel Institute [Industry Avg | N.America] / 10M	60	60	0
Footings & Slabs	REINFORCING MESH FOR SLAB	Welded wire mesh / Serfas / 6" x 6" x 6/6g / Norway	107	107	0
Footings & Slabs	SUB-SLAB INSULATION	EPS foam board / R 4.0/inch avg [BEAM Avg | US & CA]	656	656	0
Footings & Slabs	AGGREGATE BASE	Aggregate / US Average [Industry Avg]	106	106	0
Foundation Walls	CONCRETE FOUNDATION WALLS	Concrete – 0-25 MPa, 0-14% FA/SL, GU / CRMCA [Industry Avg | CA]	928	928	0
Foundation Walls	REBAR FOR FOUNDATION WALLS	Rebar / Concrete Reinforcing Steel Institute [Industry Avg | N.America] / 10M	90	90	0
Foundation Walls	CONTINUOUS INSULATION	XPS foam board / R 5.0/inch [BEAM Avg | US & CA]	328	328	0
Exterior Walls	LIGHT WOOD FRAME WALLS	Wood / SPF / 2x6 Lumber / AWC & CWC [Industry Avg | US & CA]	256	256	0
Exterior Walls	STRUCTURAL SHEATHING	Plywood / 1/2" / AWC & CWC [Industry Avg | US & CA]	279	279	0
Exterior Walls	CAVITY INSULATION	Wool / Havelock Wool / Loose-fill / R 4.4/inch	271	620	349
Exterior Walls	CONTINUOUS INSULATION	Wood fiber board / GUTEX / Multi-Therm / R 3.6/inch, 40, 60, 80, 100, 120, 140, 160, 180, 200 mm	-382	387	769
Exterior Walls	ADDITIONAL MATERIALS	Mineral wool batt / [BEAM Avg]	383	383	0
Exterior Wall Cladding	EXTERIOR WALL CLADDING	Fiber Cement Cladding / James Hardie / HardiePlank / 8 mm	681	734	53
Exterior Wall Cladding	STRAPPING / FURRING	Wood / SPF / 1x2 Lumber / AWC & CWC [Industry Avg | US & CA]	11	11	0
Exterior Wall Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Drywall 1/2" [BEAM Avg | US & CA]	163	163	0
Exterior Wall Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Drywall 5/8" Type X / Gypsum Association [Industry Avg | US & CA]	98	98	0
Windows	WINDOWS - DOUBLE-GLAZED	Window - double-glazed / Vinyl frame / DICA Study [US & CA]	1,770	1,770	0
Interior Walls	LIGHT WOOD FRAME INTERIOR WALLS	Wood / SPF / 2x6 Lumber / AWC & CWC [Industry Avg | US & CA]	16	16	0
Interior Walls	LIGHT WOOD FRAME INTERIOR WALLS	Wood / SPF / 2x4 Lumber / AWC & CWC [Industry Avg | US & CA]	83	83	0
Interior Walls	CLADDING FOR INTERIOR WALLS	Drywall 1/2" [BEAM Avg | US & CA]	370	370	0
Floors	LIGHT WOOD FLOOR FRAMING	Wood I-joist / TJI 230/360 / 9-1/2" Depth / AWC & CWC [Industry Avg | US & CA]	129	129	0
Floors	SUB FLOORING	Plywood / 1/2" / AWC & CWC [Industry Avg | US & CA]	75	75	0
Floors	FLOOR CAVITY INSULATION	Fiberglass batt / R 3.8/inch [BEAM Avg]	20	20	0
Ceilings	CEILING FINISHES	Drywall 1/2" [BEAM Avg | US & CA]	253	253	0
Roof	WOOD ROOF FRAMING	Wood / SPF / 2x12 Lumber / AWC & CWC [Industry Avg | US & CA]	134	134	0
Roof	ROOFING	Metal Panels - Steel / Canadian Sheet Steel Building Institute / 24 gauge [Industry Avg | CA]	1,182	1,182	0
Roof	ROOF CAVITY INSULATION	Cellulose / loose fill / R 3.7/inch / CIMA [Industry Avg | US & CA]	-414	190	604
Roof	ADDITIONAL MATERIALS	Plywood / 1/2" / AWC & CWC [Industry Avg | US & CA]	220	220	0

Windows | Int. Walls | Floors | Ceilings | Roof | Garage | REVIEW | RESULTS

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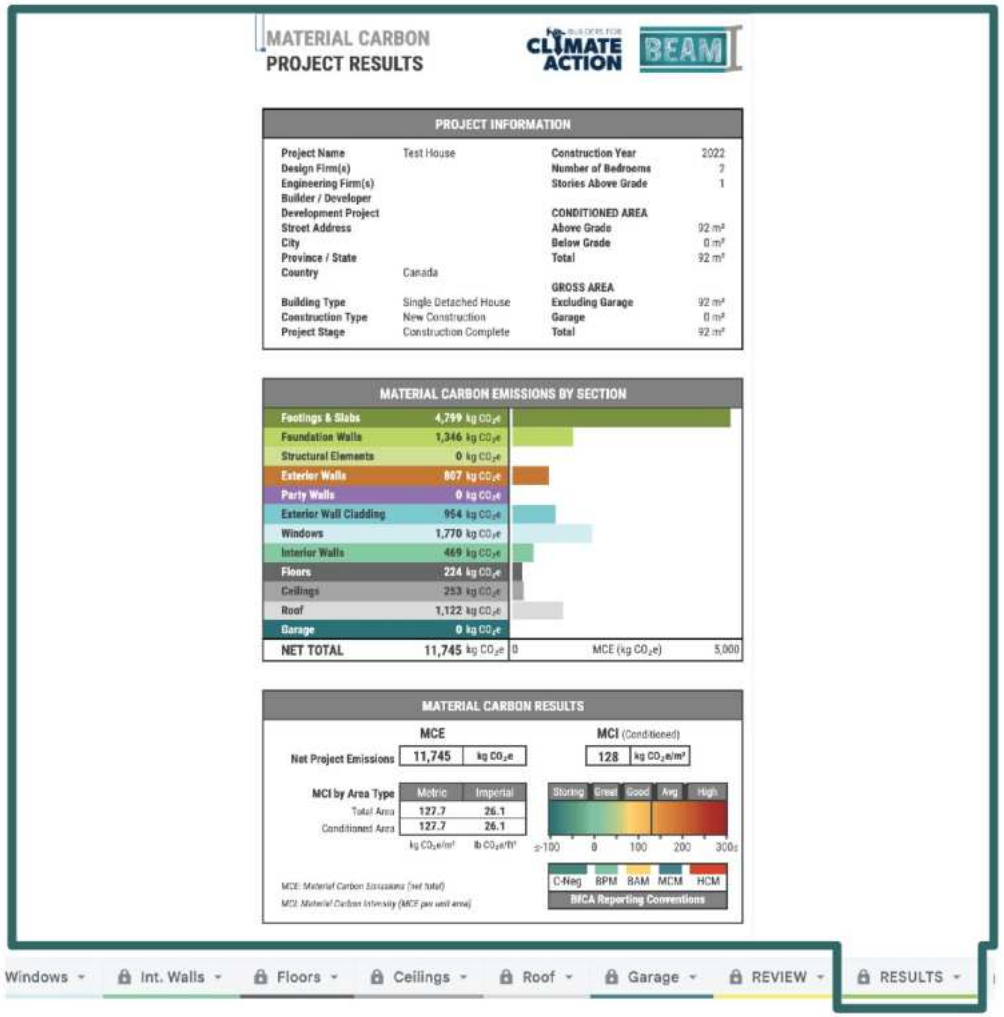
Tools for Analysis

4- SHARE

materials carbon results from the **results sheet**.

Represents the carbon footprint for the structure, enclosure and partitions of the whole building.



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Tools for Analysis

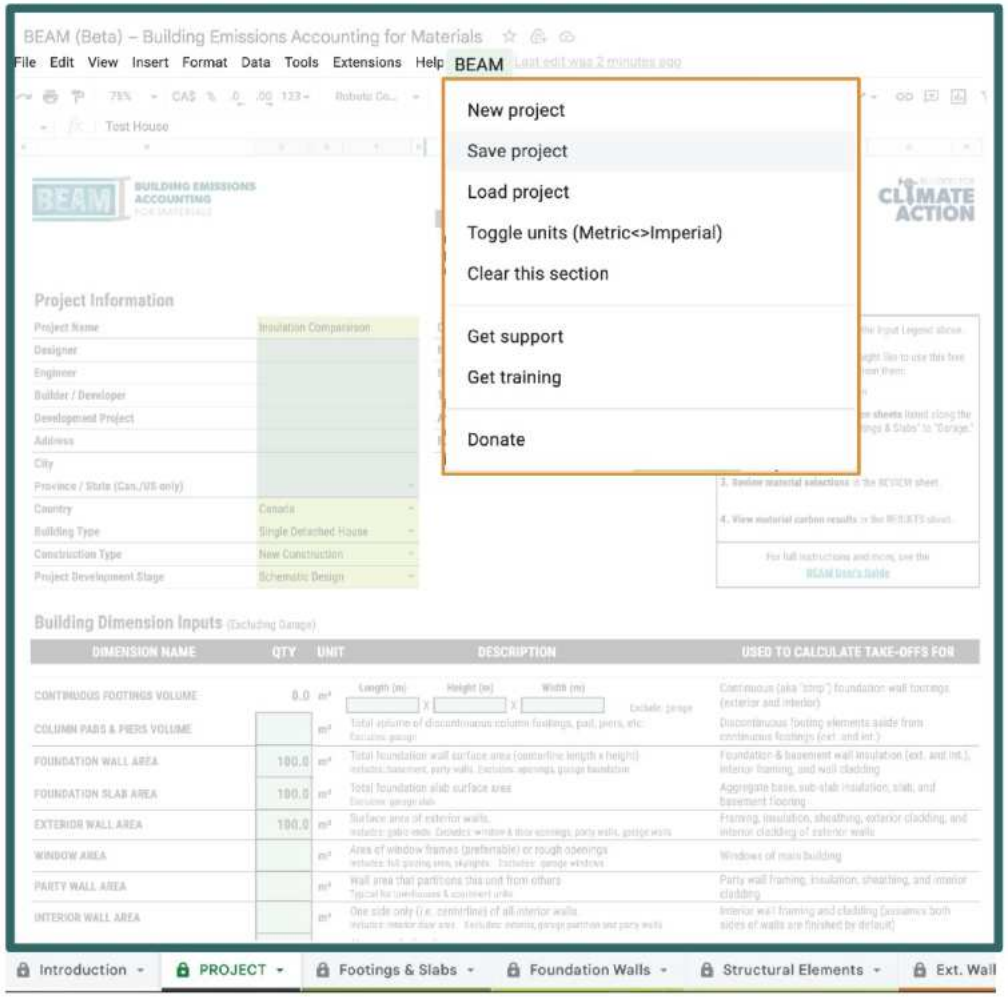
5- Save, Compare
and track multiple projects.

*Using the **BEAM menu** you can :*

-Save projects

-Load previous project

-Toggle units between Metric or Imperial



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Energy Use Intensity

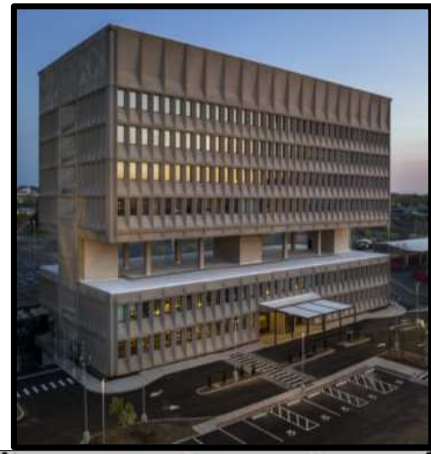
Carbon Equivalent Usage

Embodied Carbon Accounting

Energy: Modeled vs. Actual Emissions







	211 W 29th		511 E 86th		Columbus Commons		Cornell Tech		Hotel Marcel	
	Site Energy Consumption kBtu/sf.yr									
	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual
Heating	0.42	3.75	0.81	1.36	0.6	1.1	1.06	5.2	5.55	7.2
Cooling	0.79	1.09	1.18	1.39	0.4	4.1	0.92	1.9	1.34	3.8
Domestic Hot Water	4.53	9.4	5.81	10.04	4.4	9.1	5.88	7.8	2.69	8.4
Lighting and Plug Loads	8.48	16.63	7.21	20.02	9.7	8.9	9.81	16.94	20.49	42.9
Total EUI	14.2	**30.69**	15.0	**33.1**	15.1	**23.2**	17.7	**31.8**	30.1	**62.3**

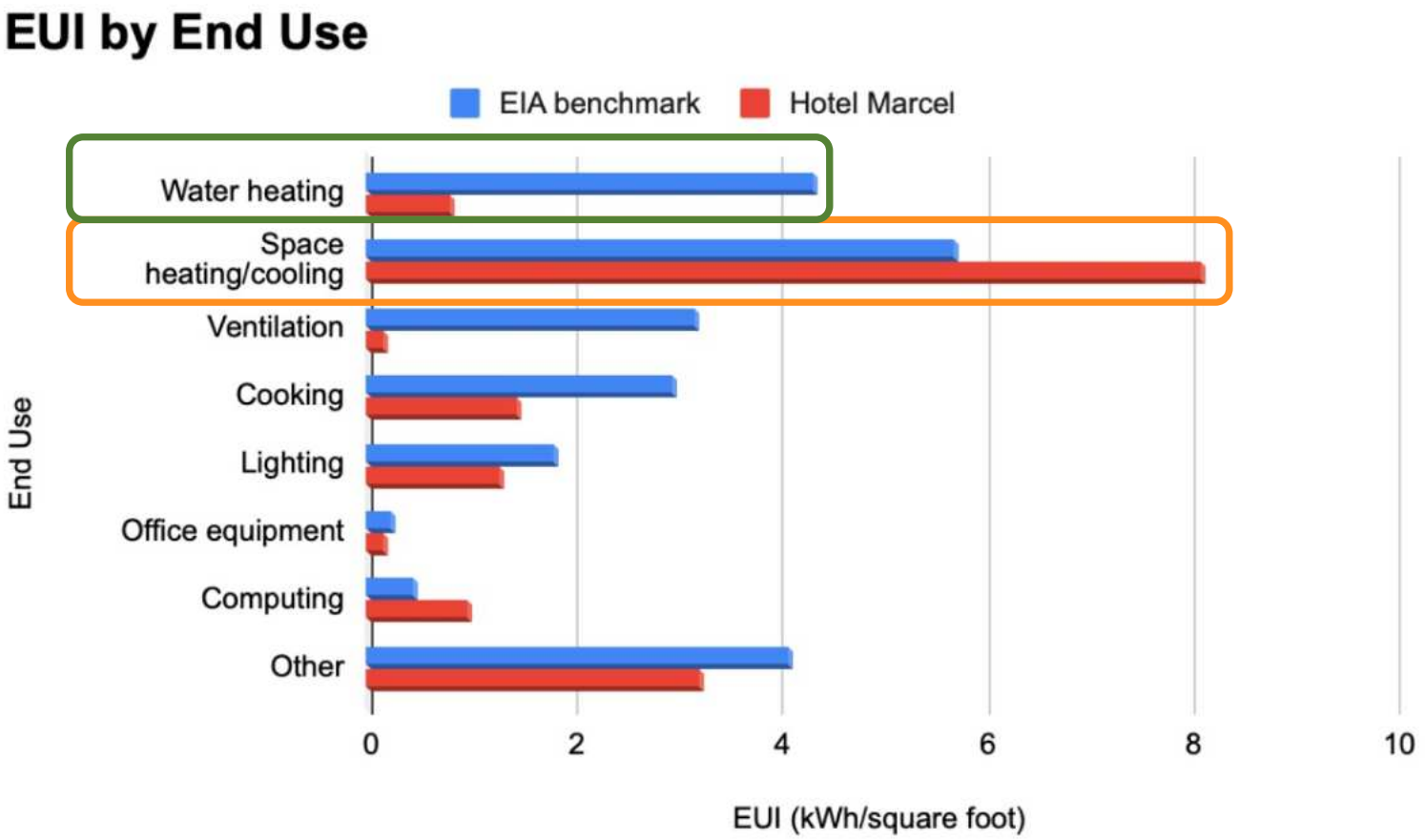
Energy: Modeled vs. Actual Emissions

Columbus Commons	
5 Stories over Amenity/Retail, 80 units, 110,600 GSF	
ASHP, NG Central DHW, ERV	
HERS Range Carbon Index	37 - 43 48 - 53
Modeled Total Building EUI	15.0
Actual Total Building EUI*	**18.0**
* July 2023 - June 2024	

Hotel Marcel	
Renovated 165 Room Hotel, 111,000 GSF	
VRF, HPWH, ERV	
Modeled EUI	30.1
First Year, Actual EUI	62.3
Second Year, Actual EUI*	**42.0**
*After Final Cx, and HP Dryers replaced Electric Dryers	

Canaan Parish	
4 story MF, 40 units, 61,500 GSF	
ASHP, NG Tankless, Exhaust Only	
HERS Range Carbon Index	49 - 60 70 - 89
Modeled EUI	35.0
Actual Total Building EUI*	**45.0**
* July 2023 - June 2024	

Hotel Marcel vs. Industry Benchmarks



Source: EIA Commercial Buildings Energy Survey 2022

Energy: Modeled vs. Actual Emissions

Energy: Modeled vs. Actual Emissions

Operational Carbon Emissions

Columbus Commons	
5 Stories over Amenity/Retail, 80 units, 110,600 GSF	
Operational Carbon Emissions (kg CO_2e •yr)	148,948
Operationsl Carbon Emissions (kg CO_2e/sf ·yr)	1.35

Actual kBtu/sf·yr 18

Canaan Parish	
4 story MF, 40 units, 61,500 GSF	
Operational Carbon Emissions (kg CO_2e •yr)	207,984
Operationsl Carbon Emissions (kg CO_2e/sf ·yr)	3.38

Actual kBtu/sf·yr 45

Embodied Carbon Emissions

Footings & Slabs	97,535 kg CO_2e
Foundation Walls	24,004 kg CO_2e
Structural Elements	29,112 kg CO2e
Exterior Walls	50,984 kg CO2e
Party Walls	19,625 kg CO2e
Exterior Wall Cladding	45,234 kg CO2e
Windows	55,620 kg CO2e
Interior Walls	36,908 kg CO2e
Floors	65,009 kg CO2e
Ceilings	18,212 kg CO2e
Roof	64,584 kg CO2e
Garage	0
NET TOTAL	**644,717 kg CO_2e**

Average home is ~184 kg CO_2e/m^2

Canaan Parish ~113 kg CO_2e/m^2

Canaan Parish ~130 occupants

Canaan Parish	
4 story MF, 40 units, 61,500 GSF	
Operational Carbon Emissions (kg CO_2e •yr)	207,984
Operationsl Carbon Emissions (kg CO_2e/sf ·yr)	3.38

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Drivers

Code

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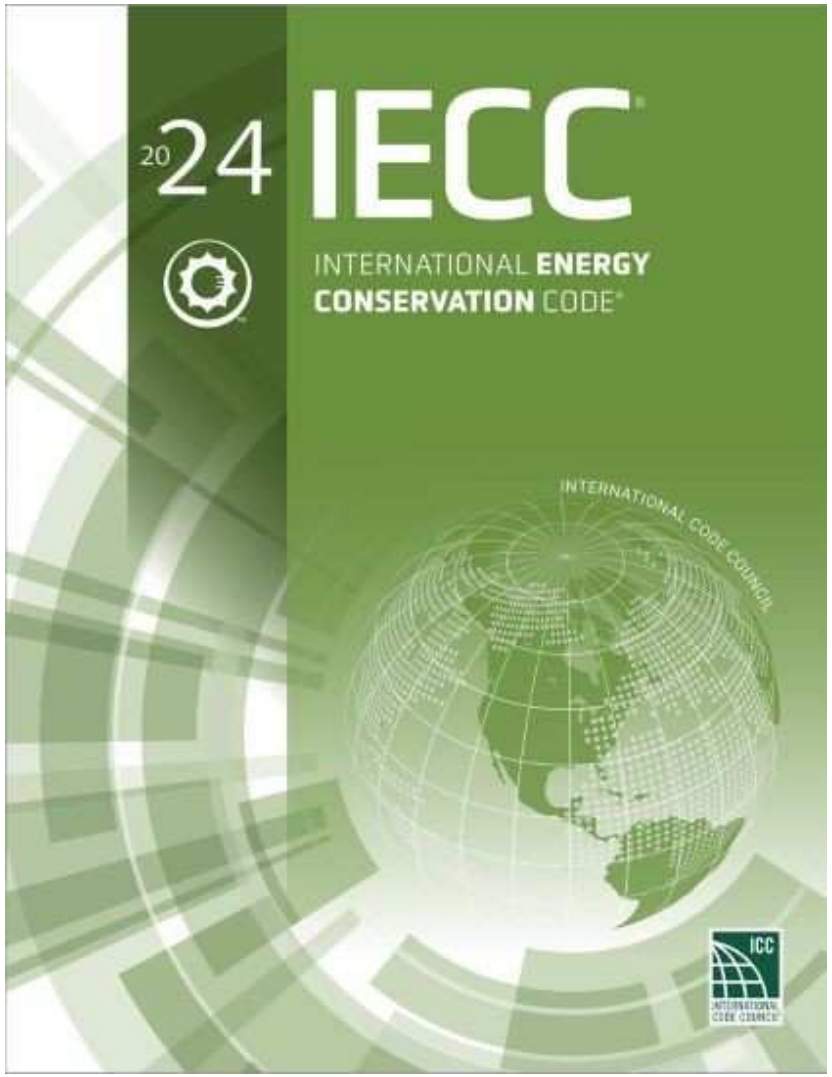
Code



2024 IECC - What Happened?

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Code

APPENDIX CD THE 2030 GLIDE PATH

This voluntary appendix is suited for adopting authorities that wish to extend beyond the mandatory provisions of this code toward zero net energy goals. Appendix CD is intended to be adopted by jurisdictions that will require new construction to operate at zero net energy by the year 2030. It **reduces** the net annual energy use of buildings **by** approximately **one-third in comparison with** buildings constructed in compliance with the **2021 IECC**. It is assumed that the **2027 and 2030 editions** will also **reduce** energy use **by one-third** each.

2024 IECC - What Happened?

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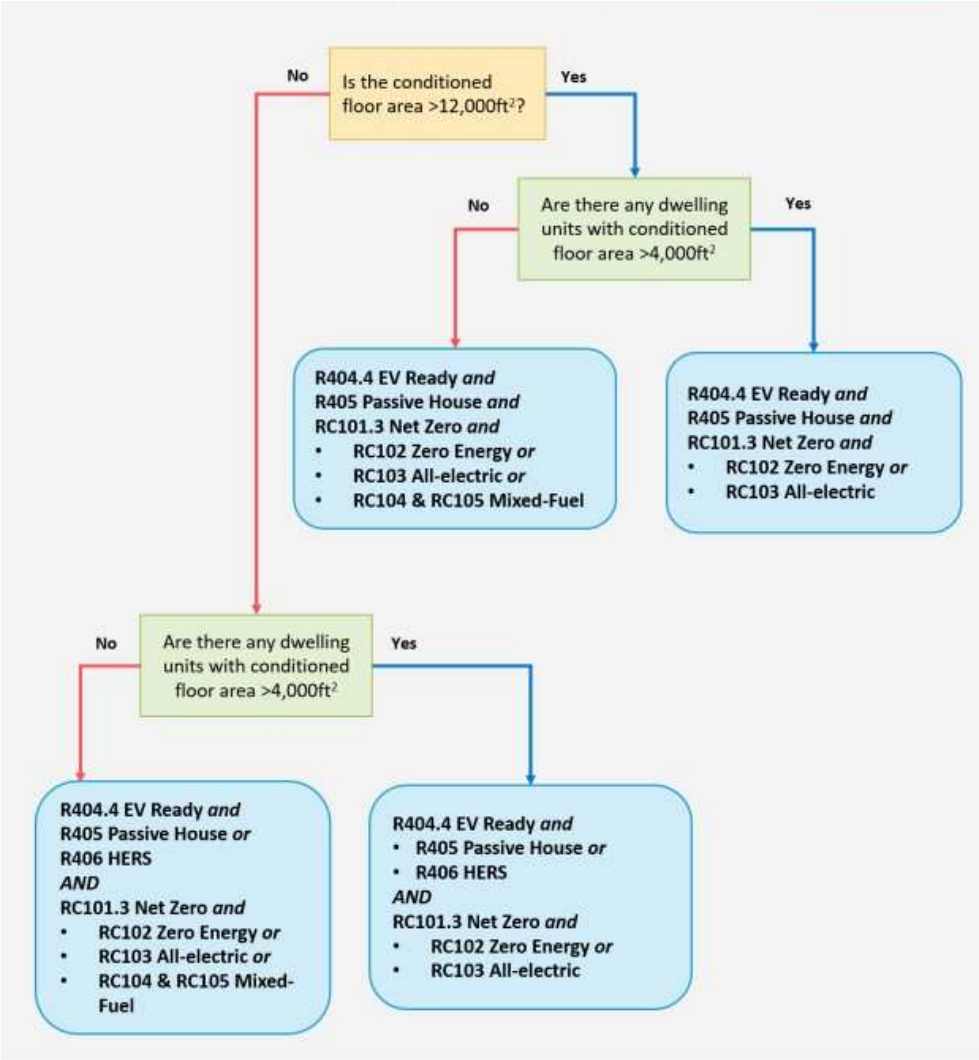
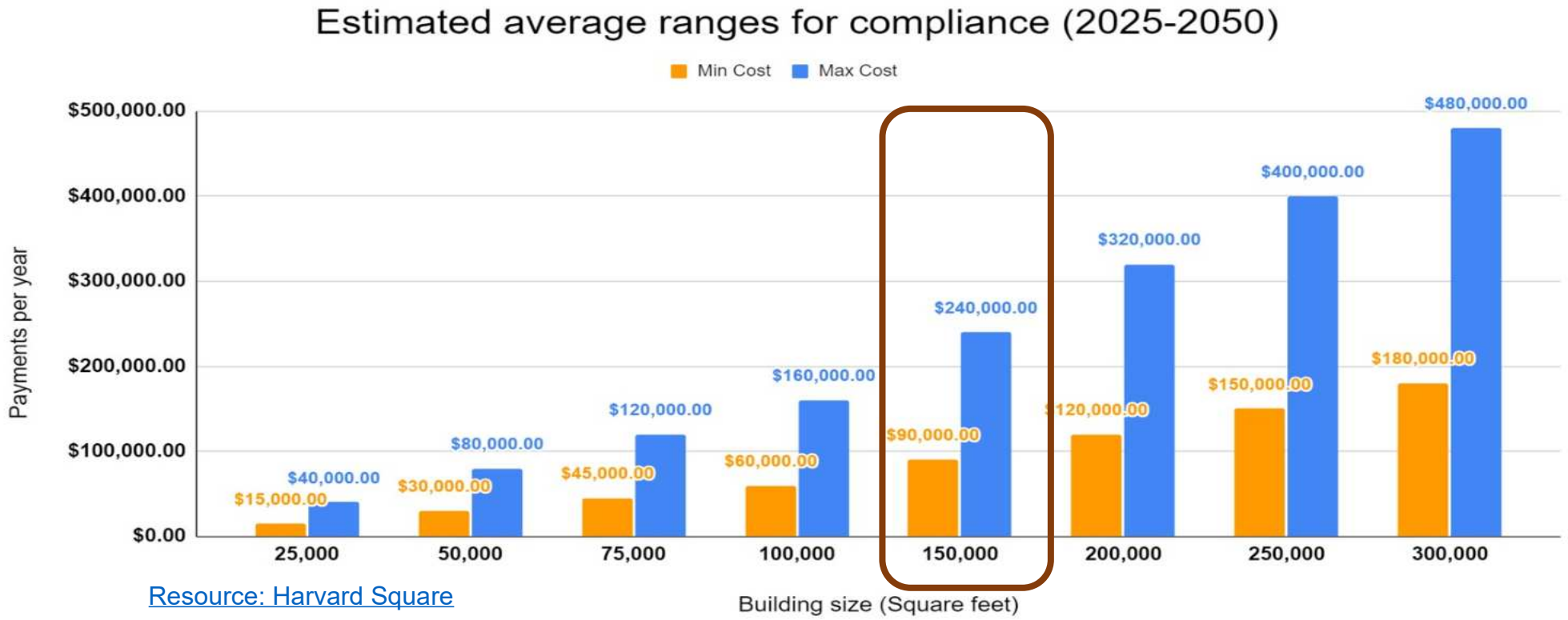
Stretch Code



Ordinances, Articles, Carrots, and Sticks

Boston's Building Emissions Reduction and Disclosure Ordinance (**BERDO**) - requirements for large existing buildings to reduce their greenhouse gas

The Building Energy Use Disclosure Ordinance (**BEUDO**) – enacted by the Cambridge City Council



Resource: Harvard Square

Ordinances, Articles, Carrots, and Sticks

Low Embodied Carbon Building is a building or structure that has been designed, engineered, and constructed to minimize and mitigate greenhouse gas Emissions from the extraction, harvesting, fabrication, transportation, installation, maintenance, and disposal of building products and materials, and from other construction-related activities, in accordance with the standards of Article 37-5.4.

Mass Stretch, Carrots and Sticks

Clean Energy Application	HERS Target	HERS Target with R406.5.2 EC Credit
Mixed Fuel Building	42	**45**
All-Electric Building	45	**48**

Add Subsection R406.5.2, Embodied Carbon Credit

1. Insulation: new dwelling units that demonstrate a calculated insulation GWP intensity (kg CO2e/ft2) less than 0 . . . based on table default values, or product specific EPDs or calculations in the approved tools: EC3 and BEAM, may be used . . .

OR

2. Low GWP Concrete Mix Credit: new dwelling units that demonstrate a calculated concrete mix GWP ≤ 70% of the 2022 NRMCA Northeast Benchmark average . . .

Northland Newton
Embodied Carbon Case Study

Overview

Material ingredients: Using the data included in the Carbon Leadership Forum 2021 Materials Baselines Report, specifications were written that identified lower embodied carbon targets than the average for structural and enclosure material components.

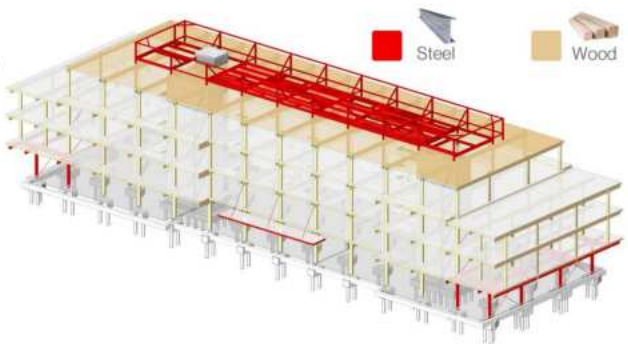
Component	Steel Baseline	CLT Baseline	CLT Design
CLT Floor Plates and Glulam Structure	No	Yes	Yes
Roof -Level Concrete Topping	Yes	No	No
Structural Slab Reduced from 12" to 4"	No	Yes	Yes
Low-EC Concrete	No	No	Yes
Low-EC Mineral Wool Insulation	No	No	Yes
GWP % Reduction From Steel Baseline	0%	44%	50%

Reduction of high embodied carbon materials:

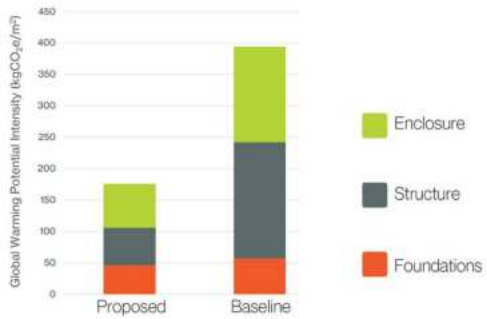
- Mass timber (cross laminated timber floor plates and glulam posts and beams) were used as the main structural components, reducing reliance on concrete and steel.
- CLT was used as the structural diaphragm at the roof level, eliminating concrete entirely.
- 12" reinforced concrete structural slab on grade was reduced to a 4" soil supported slab on grade.

Primary Contributing GWP Materials

28.3% Ready-Mix Concrete, 4000 PSI
20.1% Cross-Laminated Timber (CLT) and Glue-Laminated Timber (glulam)
9.7% XPS Insulation Boards
7.4% Flat Glass
5.4% Concrete Masonry
1,210,058 kgCO2 GWP of design without Biogenic
(190,910.82 kgCO2) GWP of Design Including Biogenic Contribution



Embodied Carbon Comparison



Lessons Learned

Start early with a preliminary analysis and set targets for structural material GWP.

Engage the construction and design team to reduce the amount of structural materials necessary.

Work with vendors and manufacturers to ensure cost and availability and request EPDs in specifications.

Investigate structural design to reduce the amount of material needed.

// Project Team

Client
Northland Investment Corp.

Structural
Odeh Engineers

Mass Timber Design Assist
TimberLab

Construction Manager
Cranshaw Construction

Sustainability Consultant
Steven Winter Associates

Sustainability Assist
Lambert Sustainability

Architect
Stantec Architecture

MASSACHUSETTS CLEAN ENERGY CENTER

EMBODIED CARBON REDUCTION CHALLENGE

THE CHALLENGE: REDUCE UPFRONT CARBON OF BUILDINGS

BUILT ENVIRONMENT PLUS

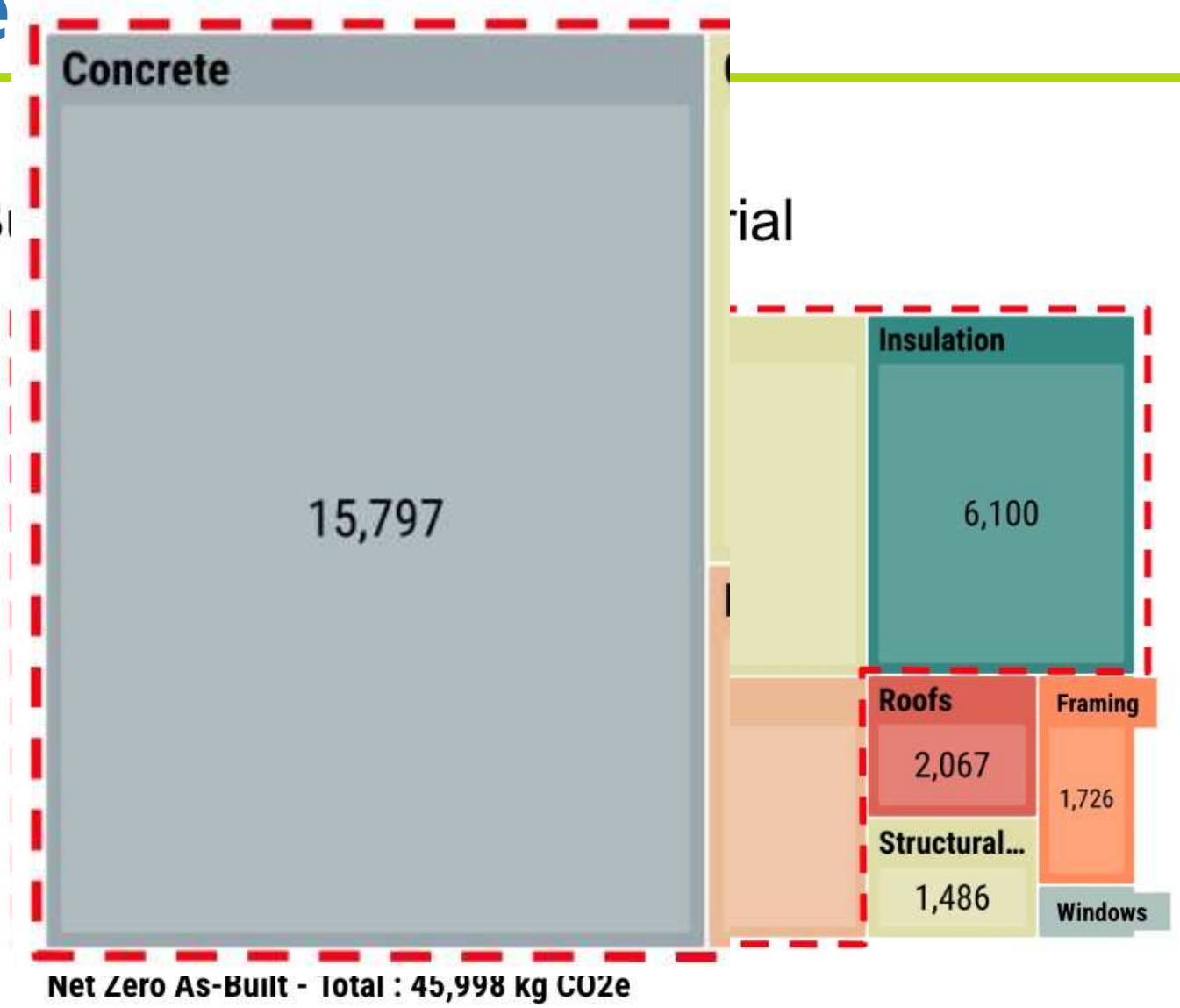
Action

Action Ite

Net Zero As-B ial

83% MCE from 4 material categories :

- ❑ Concrete
- ❑ Cladding
- ❑ Insulation
- ❑ Interior Surfaces



Net Zero As-Built - Total : 45,998 kg CO2e

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Concrete

Reduce Massing
Optimize Required Strength
Optimize Formulations: SCMs, PLC/Type 1L (Limestone), Gap-Graded Aggregate
Engage SE, CM, Ready Mix to Secure Lowest % GWP Reduction at Best Cost
Emerging tech: Pozzotive, Biochar, Natural SCMs/LC3, CarbonCure/Solidia
Novel Tech: Sublime Systems, Prometheus Materials, Blue Planet

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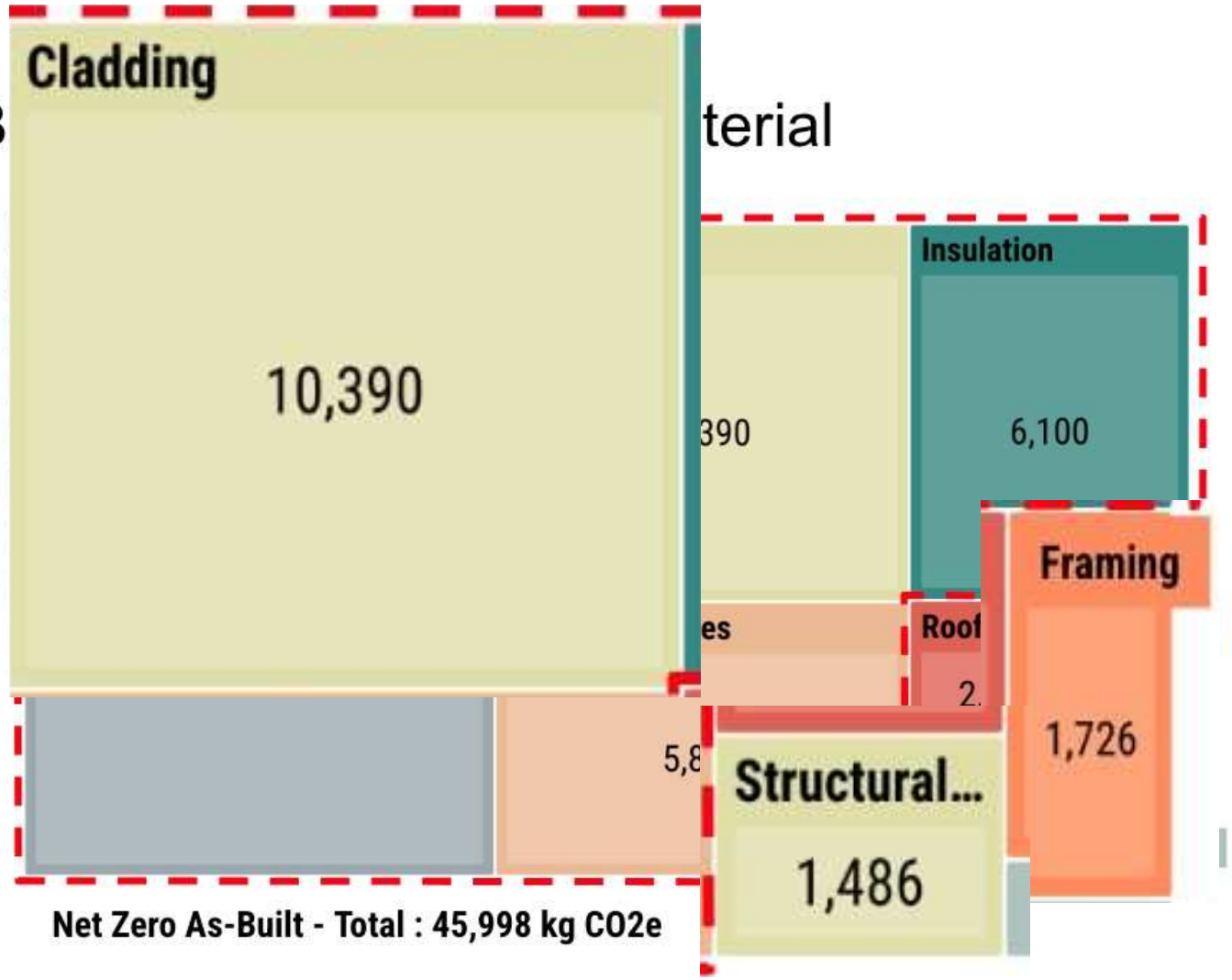
Action Items

Net Zero As-B terial

83% MCE from 4 material categories :

- ❏ Concrete
- ❏ Cladding
- ❏ Insulation
- ❏ Interior Surfaces



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Framing and Cladding

Reduce Massing

Optimize Required Strength (framing) / Optimize durability with rainscreens, species selection, etc. (cladding)

Wood Studs vs Steel Studs / Wood vs Fiber Cement

Do The Math and Know The Source: Mass Timber GWP Can Vary, Impacts Beyond GWP

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Framing

CATEGORY	MATERIAL	QUANTITY	UNITS	%	SELECT	NET EMISSIONS kg CO_2e	GROSS EMISSIONS kg CO_2e	STORAGE Short Cycle kg CO_2	STORAGE Long Cycle kg CO_2	SELECT Long Cycle
LIGHT STEEL FRAME WALLS	**FRAMING SPACING**	**16**	**in**							
LIGHT STEEL FRAMING – 16 GAUGE (2X6)										
	Steel studs - Load bearing / Steel Framing Industry Assn / 600-S-137-54, 16 gauge [Industry Avg, US & CA]	**200.0**	**ft²**	100%	☐	**449**	449	0	0	
	Steel studs - Load bearing / Scafco / 600-S-137-54, 16 gauge	**200.0**	**ft²**	100%	☐	**605**	605	0	0	
	Steel studs - Load bearing / MarinoWARE / Structural stud and track / 600-S-137-54, 16 gauge	**200.0**	**ft²**	100%	☐	**456**	456	0	0	
	Steel studs - Load bearing / ClarkDietrich / 600-S-137-54, 16 gauge	**200.0**	**ft²**	100%	☐	**438**	438	0	0	
LIGHT STEEL FRAMING – 20 GAUGE (2X4)										
	Steel studs - Non-loadbearing / Steel Framing Industry Assn / 362-S-137-54 20EQ gauge [Industry Avg, US+Can]	**200.0**	**ft²**	100%	☐	**108**	108	0	0	
	Steel studs - Non-loadbearing / Scafco / 362VS125-18, 20EQ gauge	**200.0**	**ft²**	100%	☐	**146**	146	0	0	
	Steel studs - Non-loadbearing / MarinoWARE / Viper Stud Viper 20 / 20EQ gauge	**200.0**	**ft²**	100%	☐	**110**	110	0	0	
	Steel studs - Non-loadbearing / ClarkDietrich / 362-S-125-18, 20EQ gauge	**200.0**	**ft²**	100%	☐	**106**	106	0	0	
LIGHT WOOD FRAME WALLS	**FRAMING SPACING**	**16.0**	**in**							
FRAMING LUMBER – SPRUCE-PINE-FIR										
	Wood / SPF / 2x8 Lumber / AWC & CWC [Industry Avg | US & CA]	**200.0**	**ft²**	100%	☐	**54**	54	0	**650**	☐
	Wood / SPF / 2x8 Lumber / Surfaced Dry Softwood Lumber Produced in British Columbia	**200.0**	**ft²**	100%	☐	**39**	39	0	**605**	☐
	Wood / SPF / 2x6 Lumber / AWC & CWC [Industry Avg | US & CA]	**200.0**	**ft²**	100%	☐	**41**	41	0	**493**	☐
	Wood / SPF / 2x6 Lumber / Surfaced Dry Softwood Lumber Produced in British Columbia	**200.0**	**ft²**	100%	☐	**30**	30	0	**459**	☐
	Wood / SPF / 2x4 Lumber / AWC & CWC [Industry Avg | US & CA]	**200.0**	**ft²**	100%	☐	**26**	26	0	**314**	☐

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Cladding

CATEGORY	MATERIAL	QUANTITY	UNITS	%	SELECT	NET EMISSIONS kg CO_2e	GROSS EMISSIONS kg CO_2e	STORAGE Short Cycle kg CO_2	STORAGE Long Cycle kg CO_2	SELECT Long Cycle
FIBER CEMENT SIDING										
	Fiber Cement siding [BEAM Avg]	187.8	m²	100%	☐	1,248	1,555	307	0	
	Fiber Cement siding / Equitone / Pictura, Natura Pro, sheets / 8 mm [EU]	187.8	m²	100%	☐	2,626	3,062	436	0	
	Fiber Cement siding / Equitone / Linea|Lunara sheets / 10 mm [EU]	187.8	m²	100%	☐	1,209	1,465	256	0	
	Fiber Cement siding / JamesHardie / Hardie Plank HZ5, Hardie Panel HZ5, Hardie Architectural Panel HZ5 / 8 mm	187.8	m²	100%	☐	1,107	1,433	326	0	
	Fiber Cement siding / JamesHardie / Hardie Plank HZ10, Hardie Panel HZ10, Hardie Architectural Panel HZ10 / 8 mm	187.8	m²	100%	☐	957	1,285	328	0	
	Fiber Cement siding / JamesHardie / Hardie Shingle HZ5 / 6.3 mm	187.8	m²	100%	☐	859	1,123	264	0	
	Fiber Cement siding / JamesHardie / Hardie Shingle HZ10 / 6.3 mm	187.8	m²	100%	☐	730	960	230	0	
NATURAL WOOD SIDING										
	Cedar Siding / Western Red Cedar Lumber Assn / 1x6 Boards [Industry Avg | CA]	187.8	m²	100%	☐	324	324	0	1,235	☐
	Wood / SPF / 3/4" boards / AWC & CWC [Industry Avg | US & CA]	187.8	m²	100%	☐	226	226	0	2,718	☐
	Wood cladding / BurntWood / ReUse with linseed oil treatment / 18 mm [EU]	187.8	m²	100%	☐	635	1,095	460	5,628	☐
	Wood cladding / BurntWood / ReUse without surface treatment / 18 mm [EU]	187.8	m²	100%	☐	449	449	0	5,628	☐
NATURAL WOOD SIDING										
	Cedar Siding / Western Red Cedar Lumber Assn / 1x6 Boards [Industry Avg | CA]	187.8	m²	100%	☐	-911	324	0	1,235	☑
	Wood / SPF / 3/4" boards / AWC & CWC [Industry Avg | US & CA]	187.8	m²	100%	☐	-2,492	226	0	2,718	☑
	Wood cladding / BurntWood / ReUse with linseed oil treatment / 18 mm [EU]	187.8	m²	100%	☐	-4,994	1,095	460	5,628	☑
	Wood cladding / BurntWood / ReUse without surface treatment / 18 mm [EU]	187.8	m²	100%	☐	-5,180	449	0	5,628	☑

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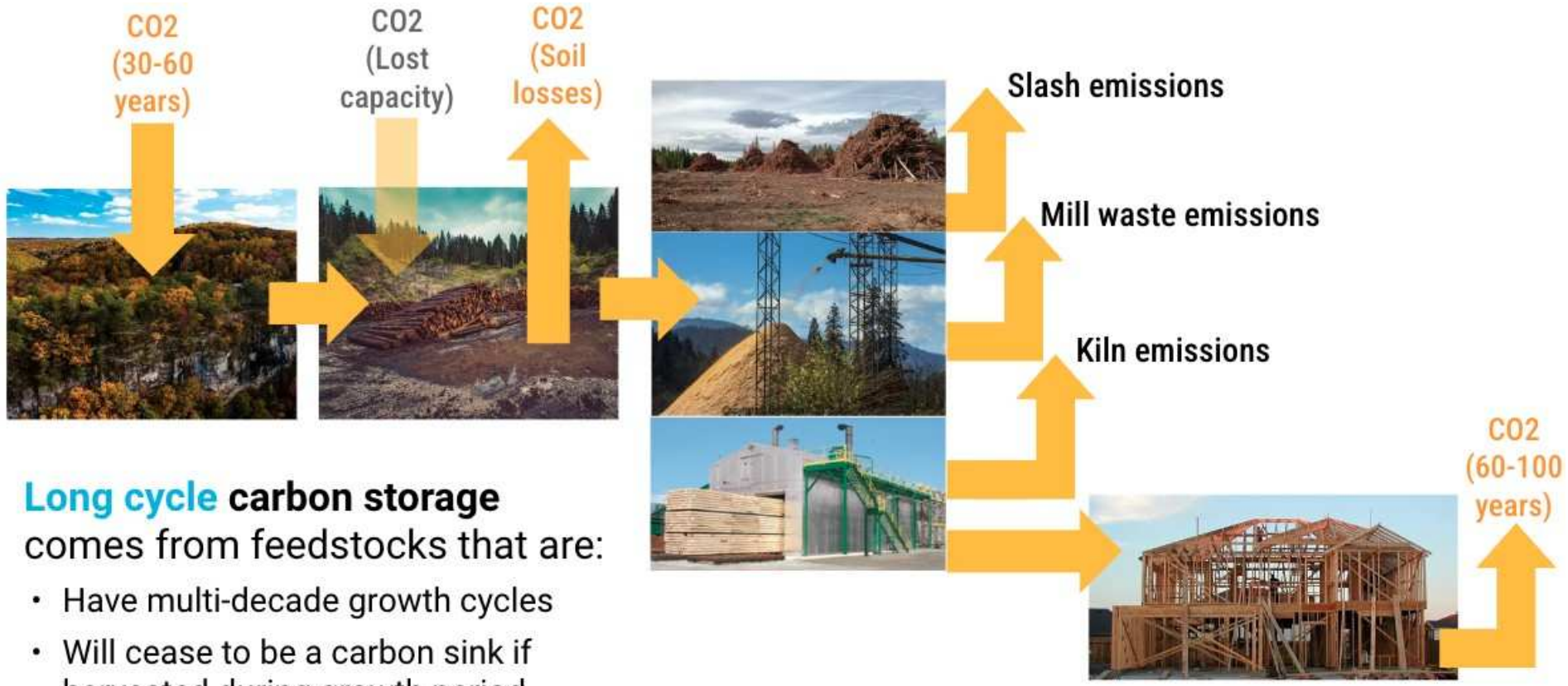
Wood Carbon Storage



Long cycle carbon storage comes from feedstocks that are:

- Have multi-decade growth cycles
- Will cease to be a carbon sink if harvested during growth period

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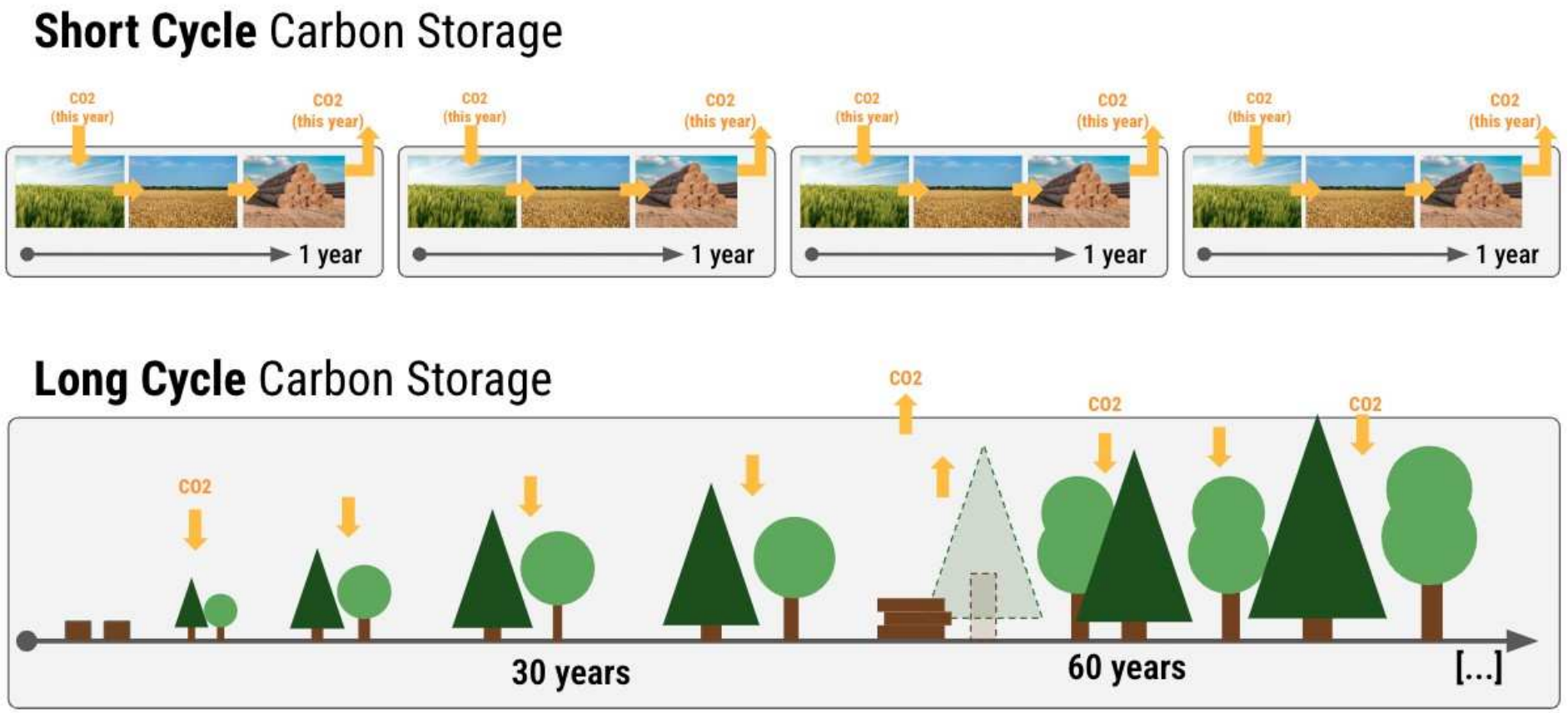
Wood Carbon Storage



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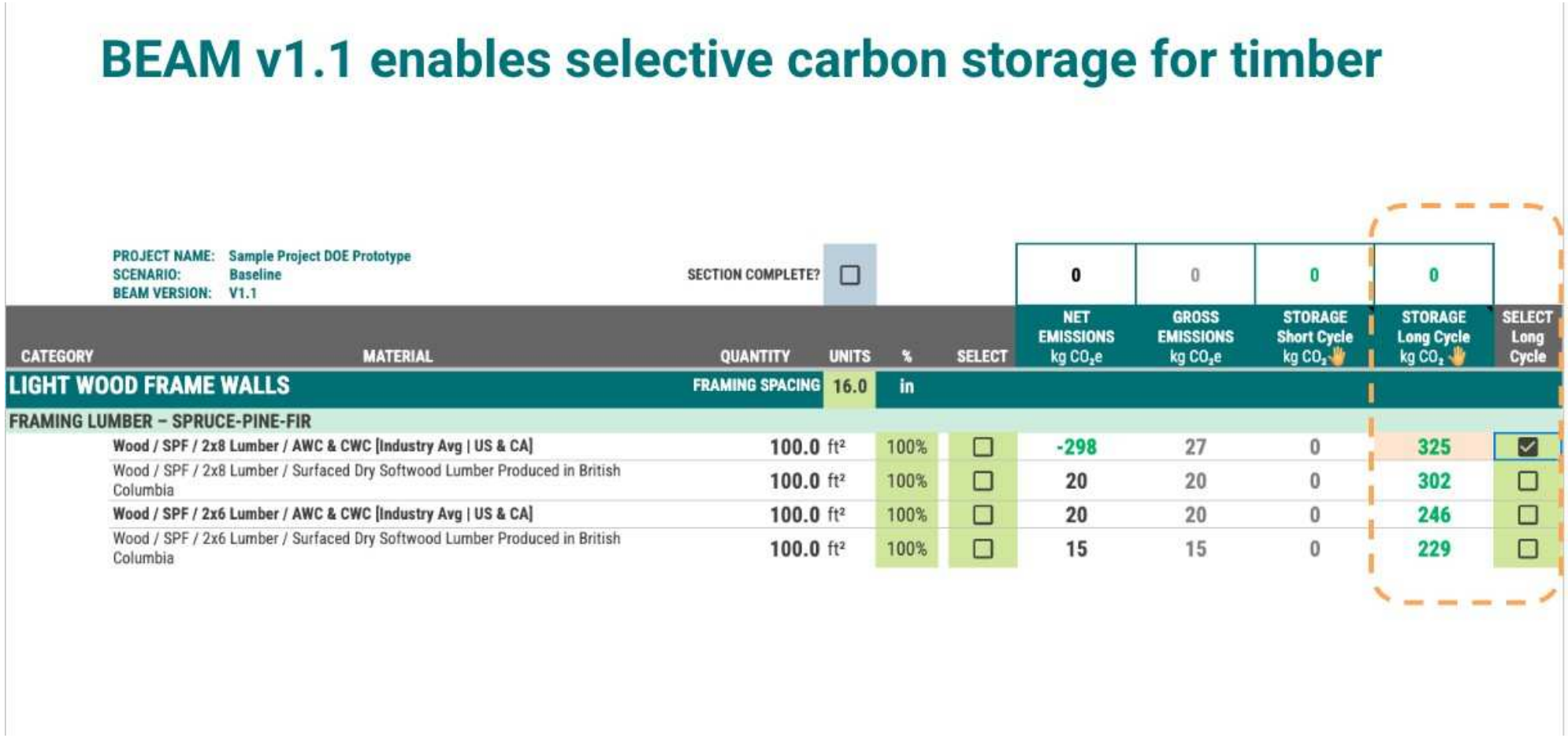
Wood Carbon Storage



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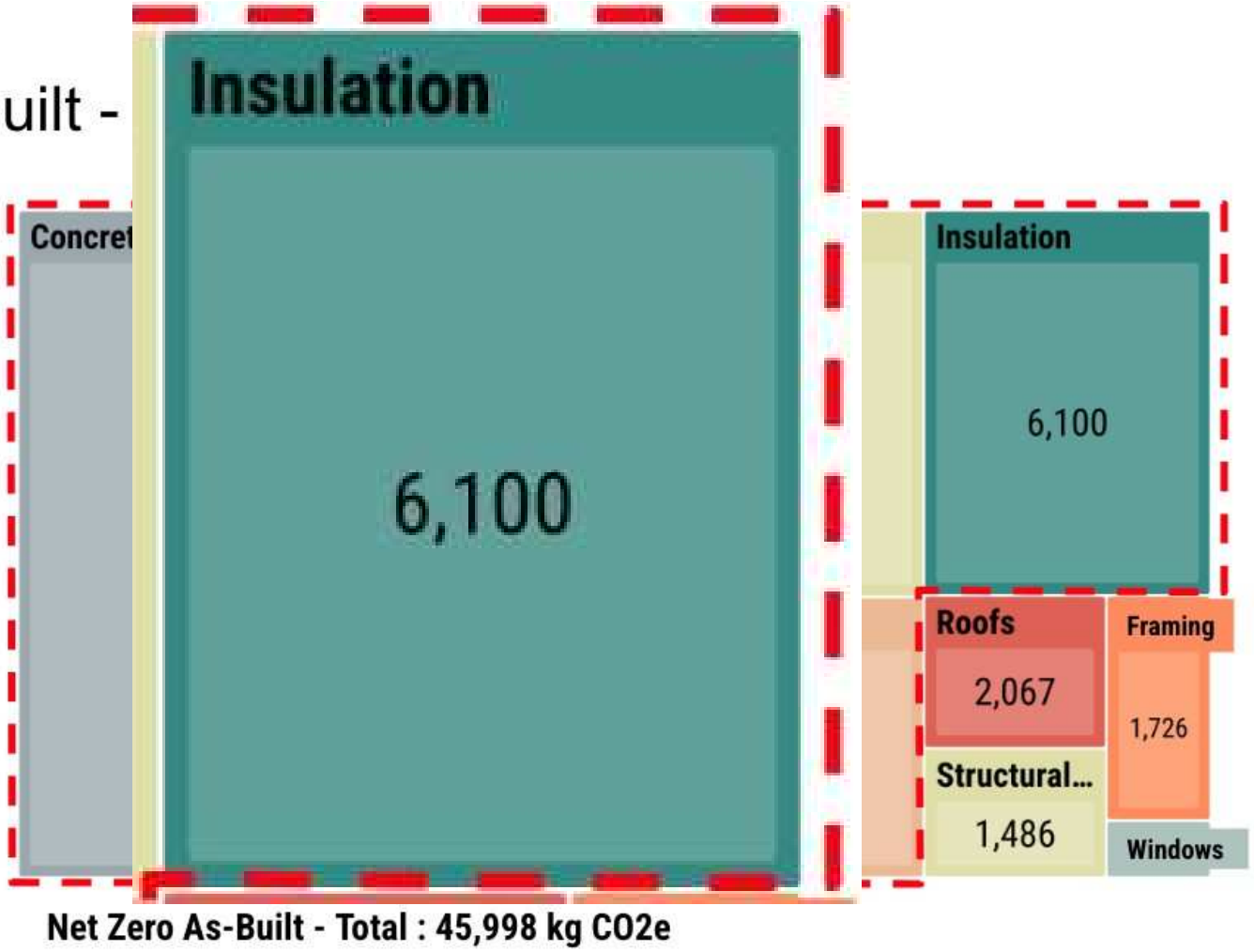
Action Items

Net Zero As-Built -

83% MCE from 4 material categories :

- ❏ Concrete
- ❏ Cladding
- ❏ Insulation
- ❏ Interior Surfaces



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Insulation

Find the Optimal Thermal Value (don't over-insulate)

Choose Plant Based Products

Avoid Plastic Based Products

Pay attention to the Chemicals (Binders, Fire Retarders, VOC’s)

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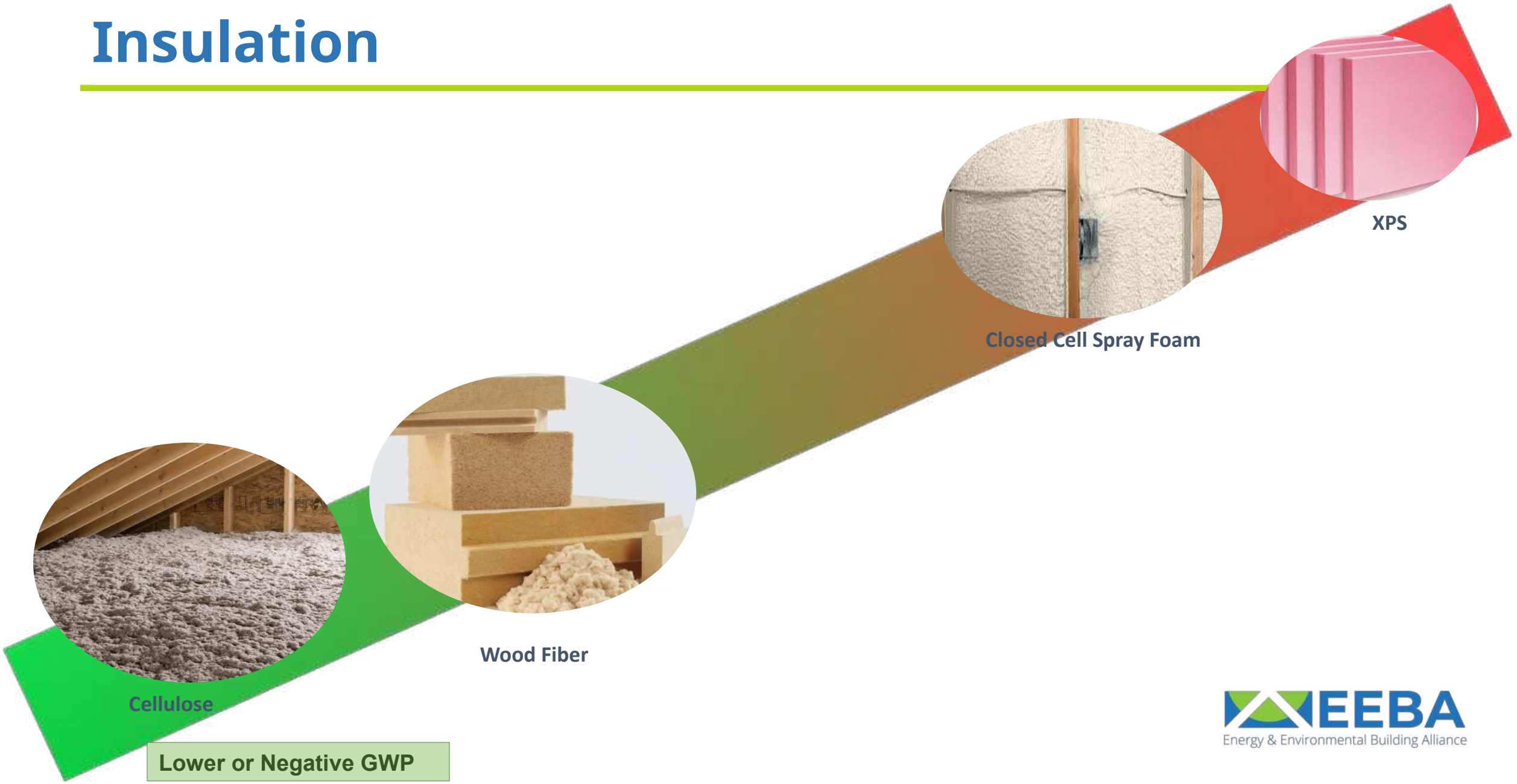
Higher GWP

Insulation



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Action Items

Net Zero As-Bu

83% MCE from 4 material categories :

- ❑ Concrete
- ❑ Cladding
- ❑ Insulation
- ❑ Interior Surfaces

Net Zero As-Built - Total : 45,998 kg CO2e

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Drywall

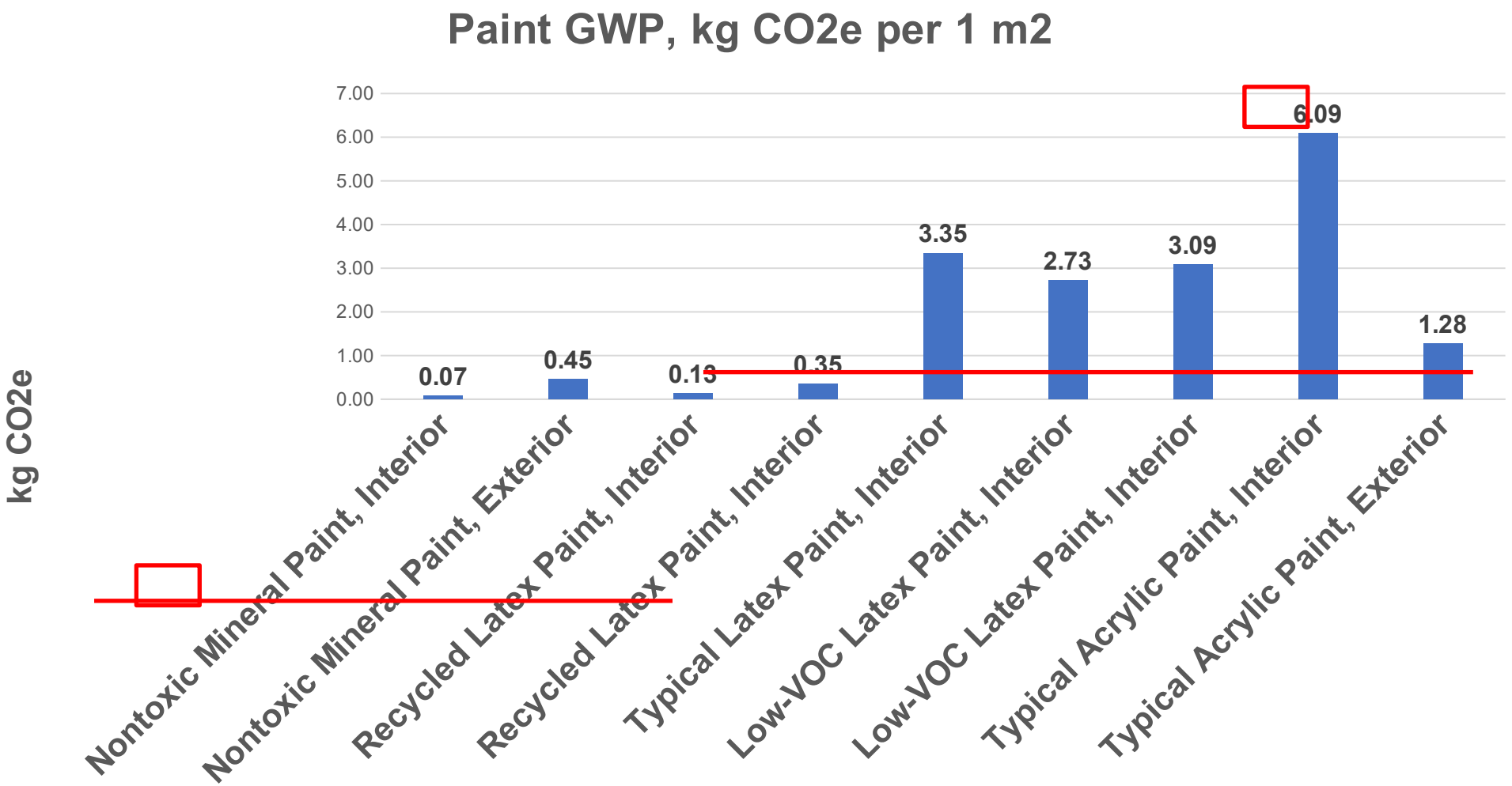
Specify Lightweight Gypsum Board

~ 550 kg/m³ instead of 800 kg/m³

Specify the Correct & Smallest Thickness

Reduce Waste

Paint



87X Total Range

10X Median Range

5% MCE – Year 1
25% MCE – Lifetime

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Paint

Forbes

Paint Is The Largest Source Of Microplastics In The Ocean, Study Finds

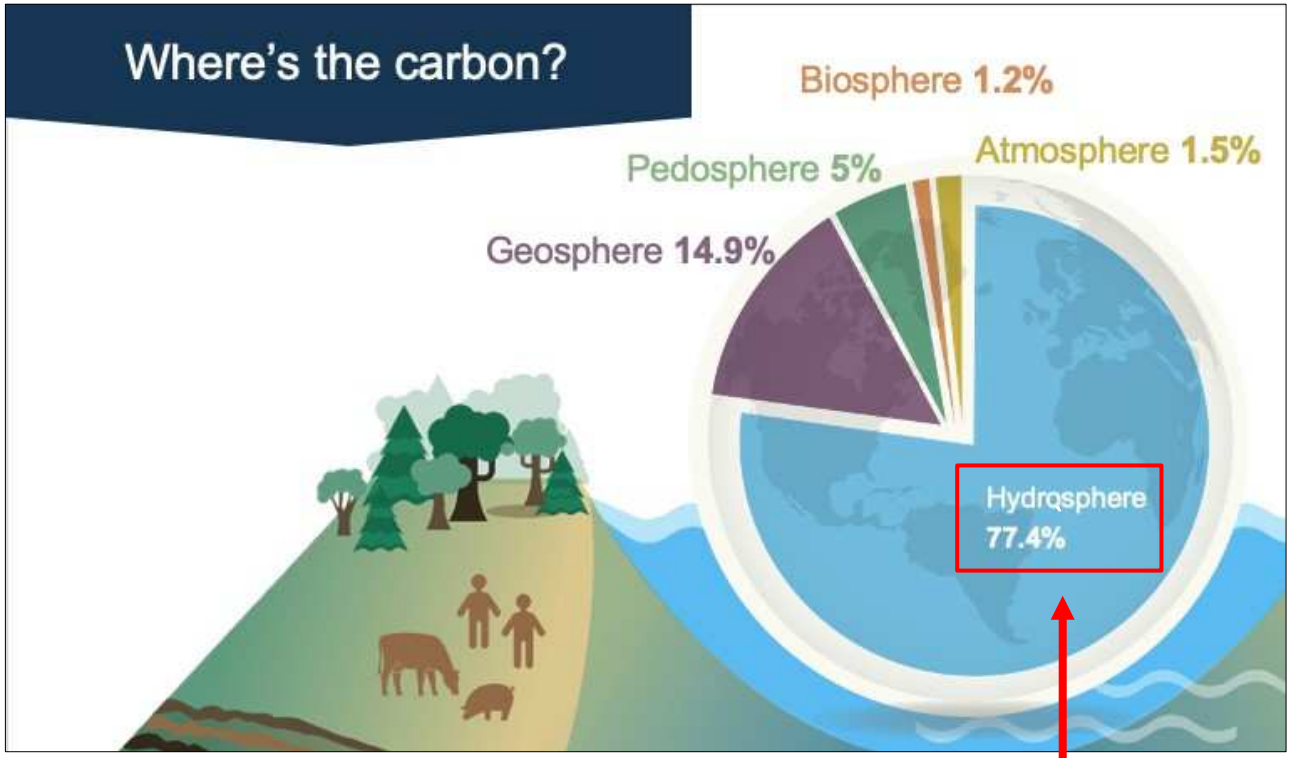
Jamie Hailstone Contributor ⓘ
I write about air quality and the environment.

Follow

Feb 9, 2022, 03:41am EST

TOPSHOT - A wave carrying plastic waste and other rubbish washes up on a beach in Koh Samui in the ... [+] AFP VIA GETTY IMAGES

Particles of paint account for more than half (58%) of all the microplastics that end up in the world's oceans and waterways every year, according to a new study.



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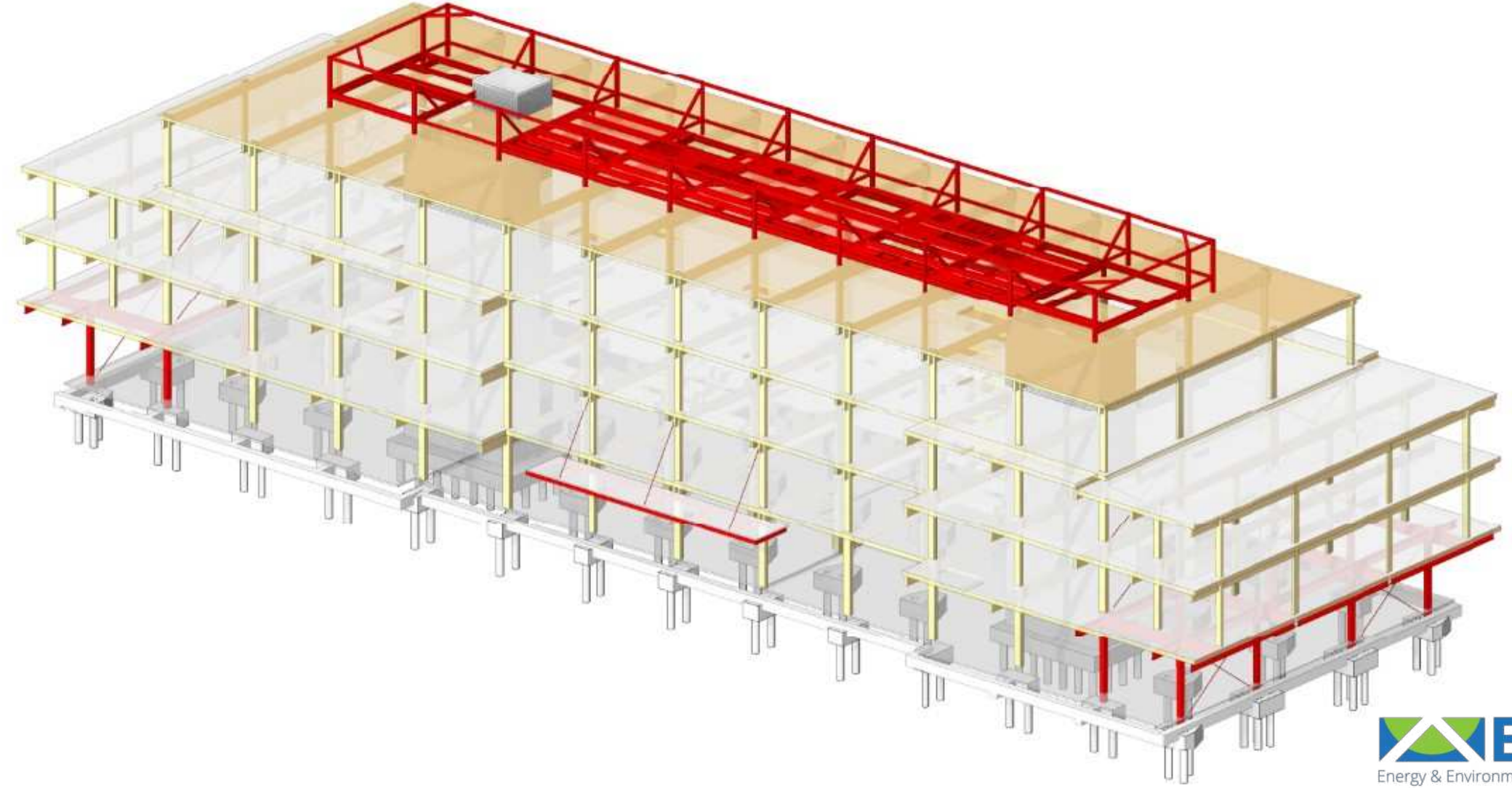
Case Studies

BE+ EC Reduction Challenge



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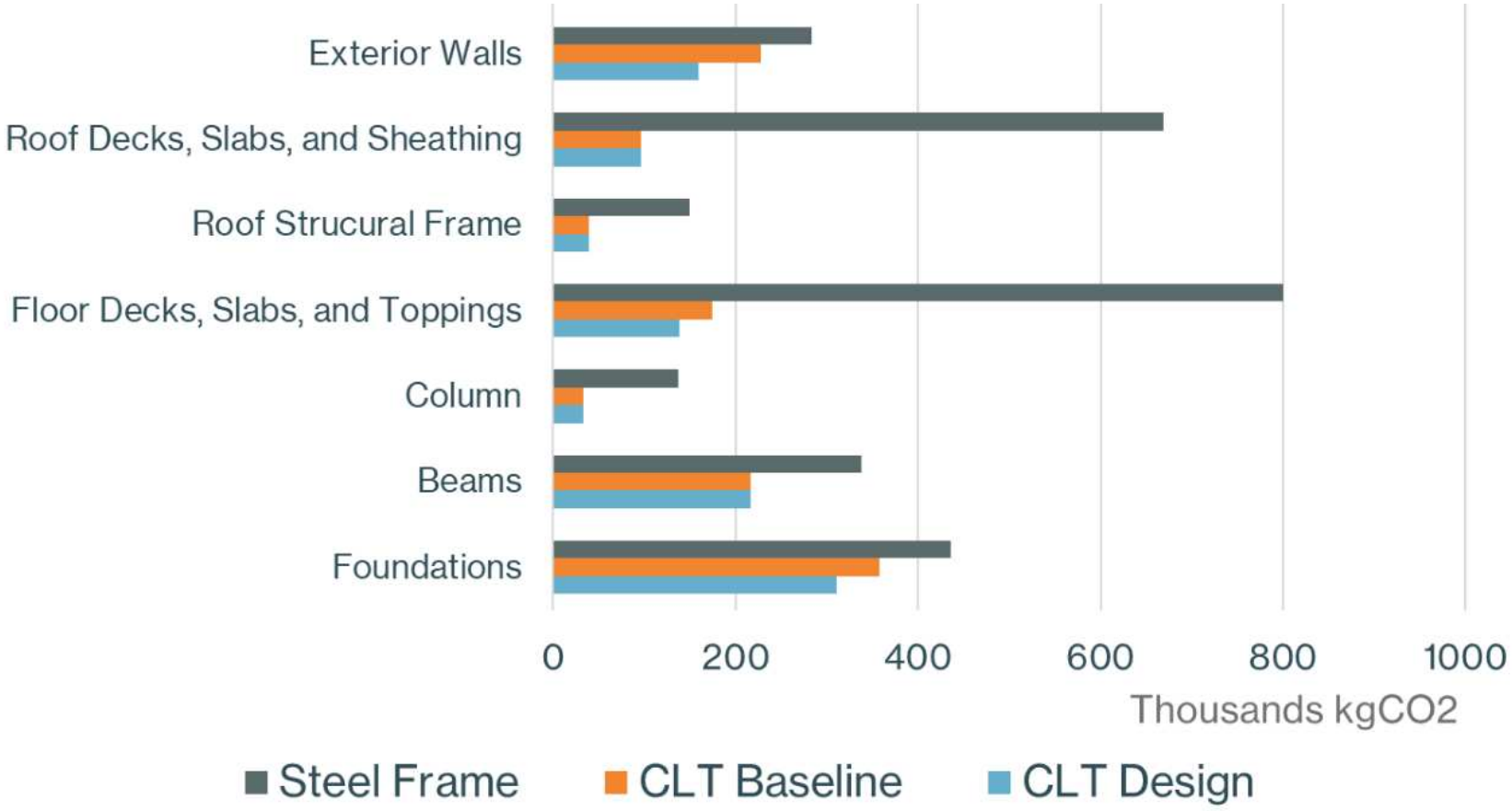
BE+ EC Reduction Challenge



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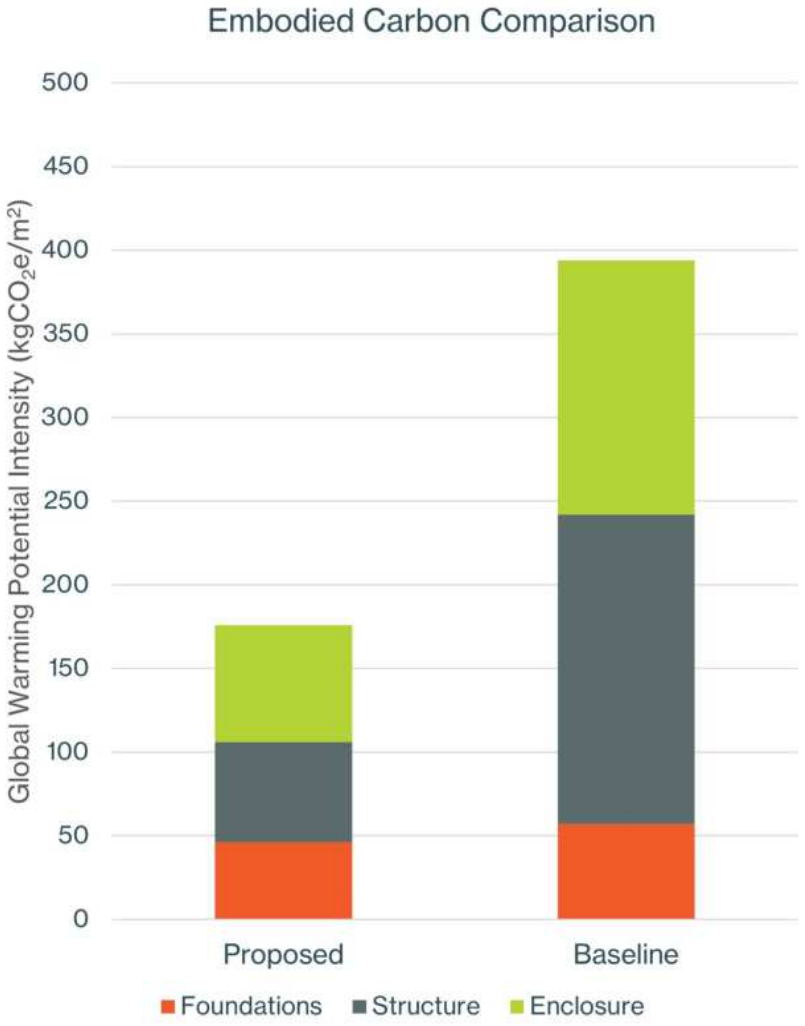
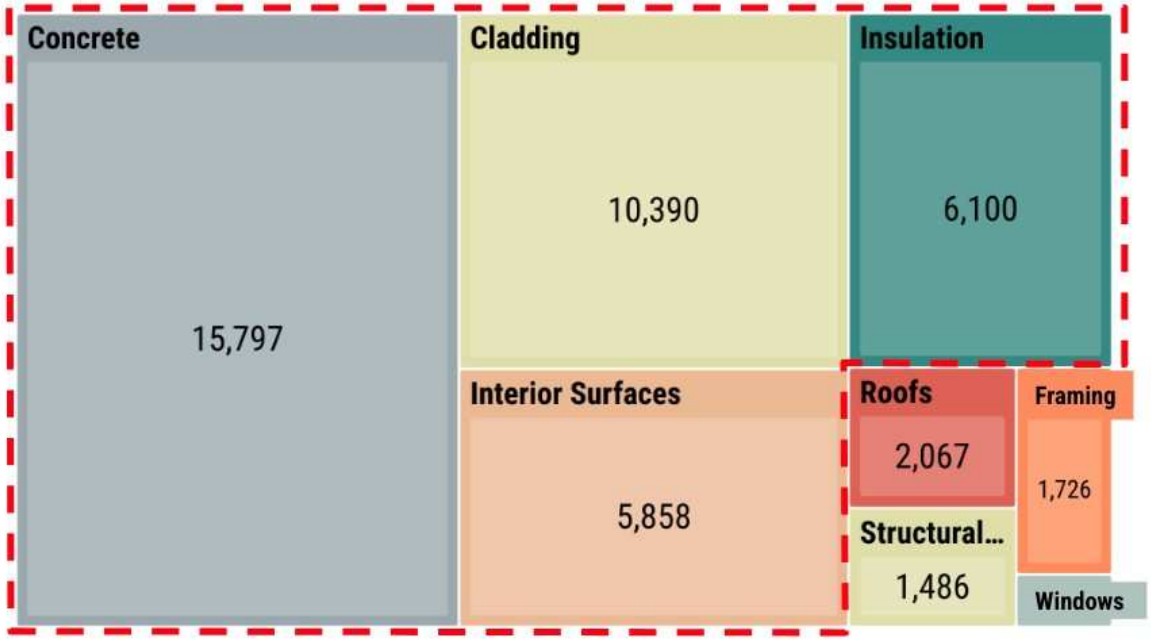
BE+ EC Reduction Challenge





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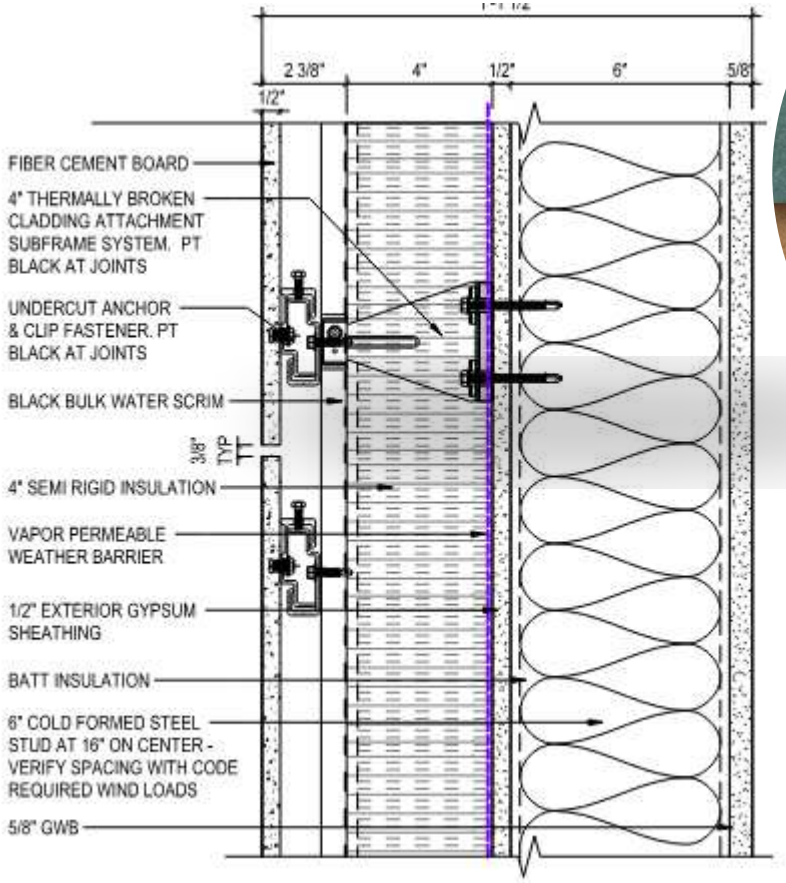
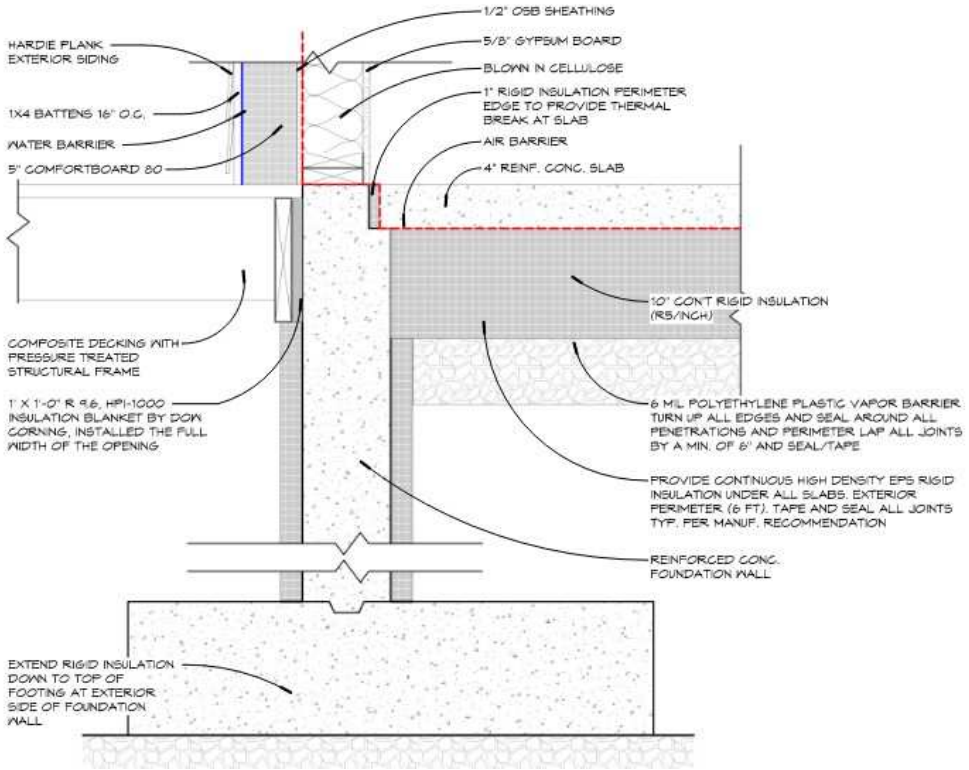
BE+ EC Reduction Challenge



Eagleville Green



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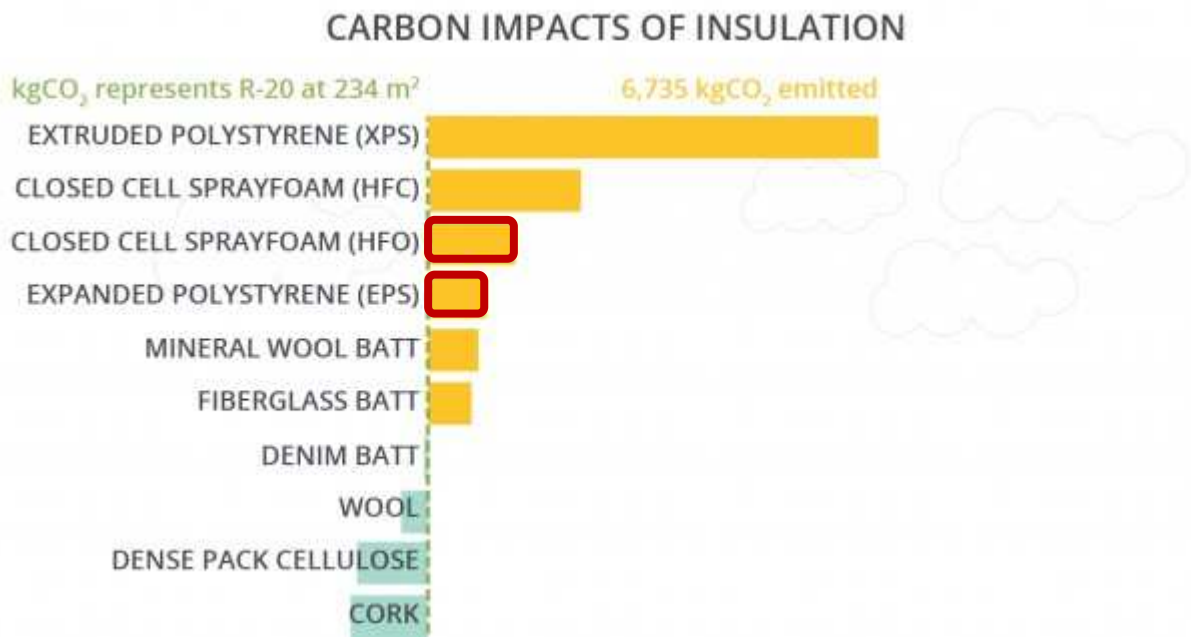
Eagleville Green



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Eagleville Green

Manufacturer	Product	R-value per inch	Global Warming Potential* (A1-A3) per 1m2
TimberHP	TimberBoard	3.6	- 10.3 kg CO2e
Gutex	Thermowall	5.7	- 1.2 kg CO2e
Rockwool	Comfortboard 80	4.2	4.937 kg CO2e
Knauf Insulation	Earthwool® Insulation Board	4.3	6.075 kg CO2e
Johns Manville	JM Cladstone 80	4.2	8.02 kg CO2 e
Owens Corning	Thermafiber® Fire & Sound Guard® Plus	3.5- 4.2	1.33 kg CO2e (Wabash plant) 8.78 kg CO2e (Joplin plant)

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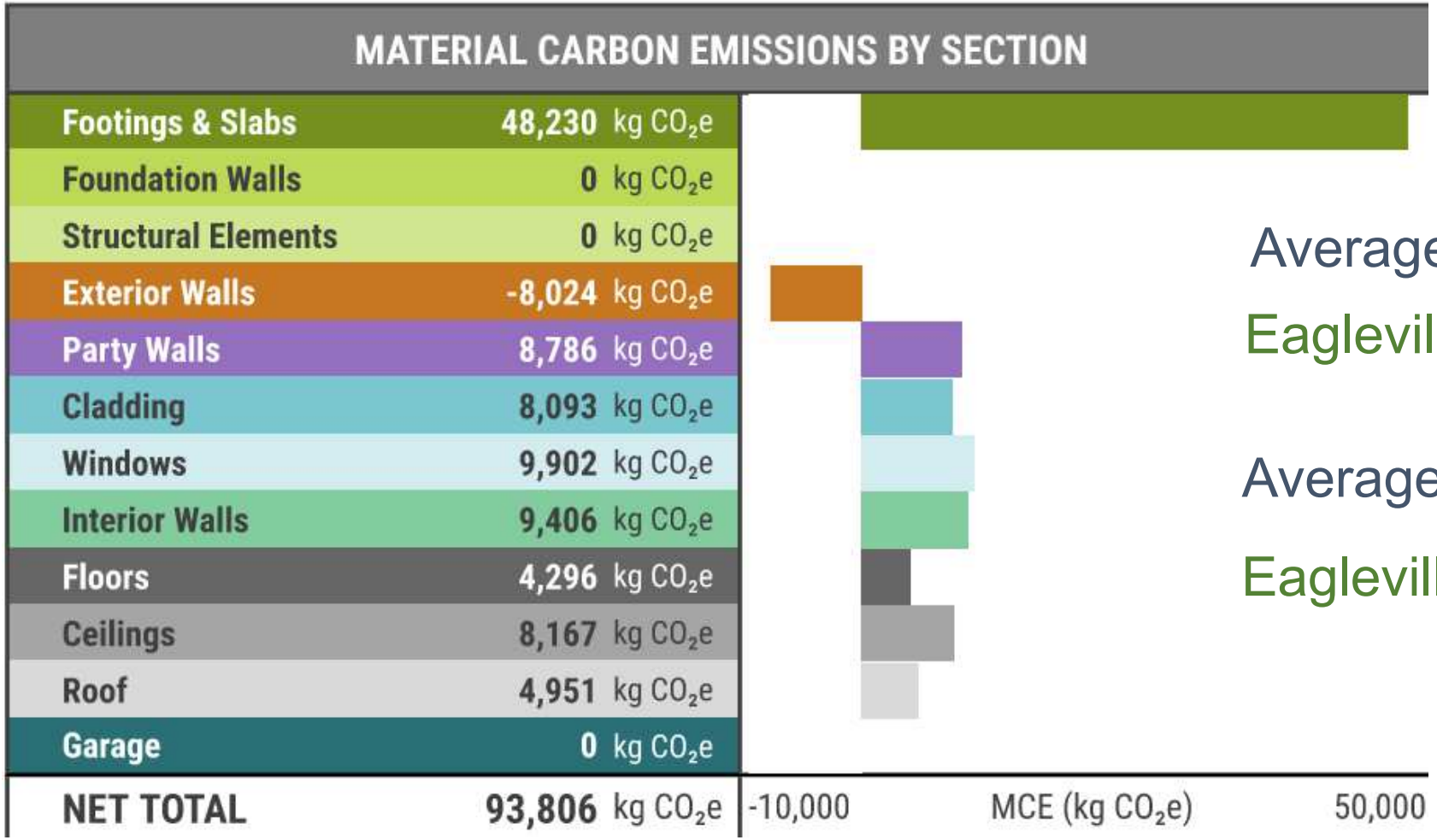
Eagleville Green



Average home is ~184 kg CO_2e/m^2

Eagleville Green ~169 kg CO_2e/m^2

Average home is 4 beds (5 ppl)

Eagleville is 8 beds (14 ppl)

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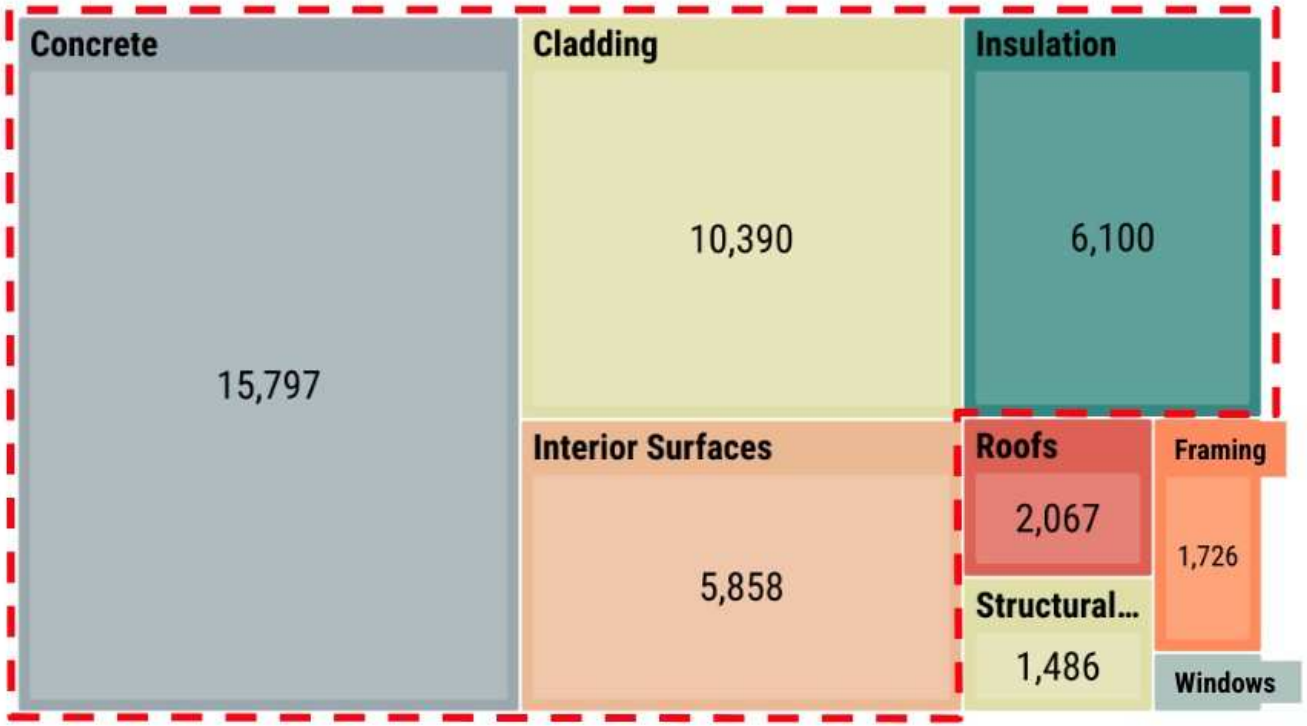
Sample Case Study "Wrap Up" Slide

Net Zero As-Built - MCE Results per material

83% MCE from 4 material categories :

- ❏ Concrete
- ❏ Cladding
- ❏ Insulation
- ❏ Interior Surfaces



Net Zero As-Built - Total : 45,998 kg CO2e

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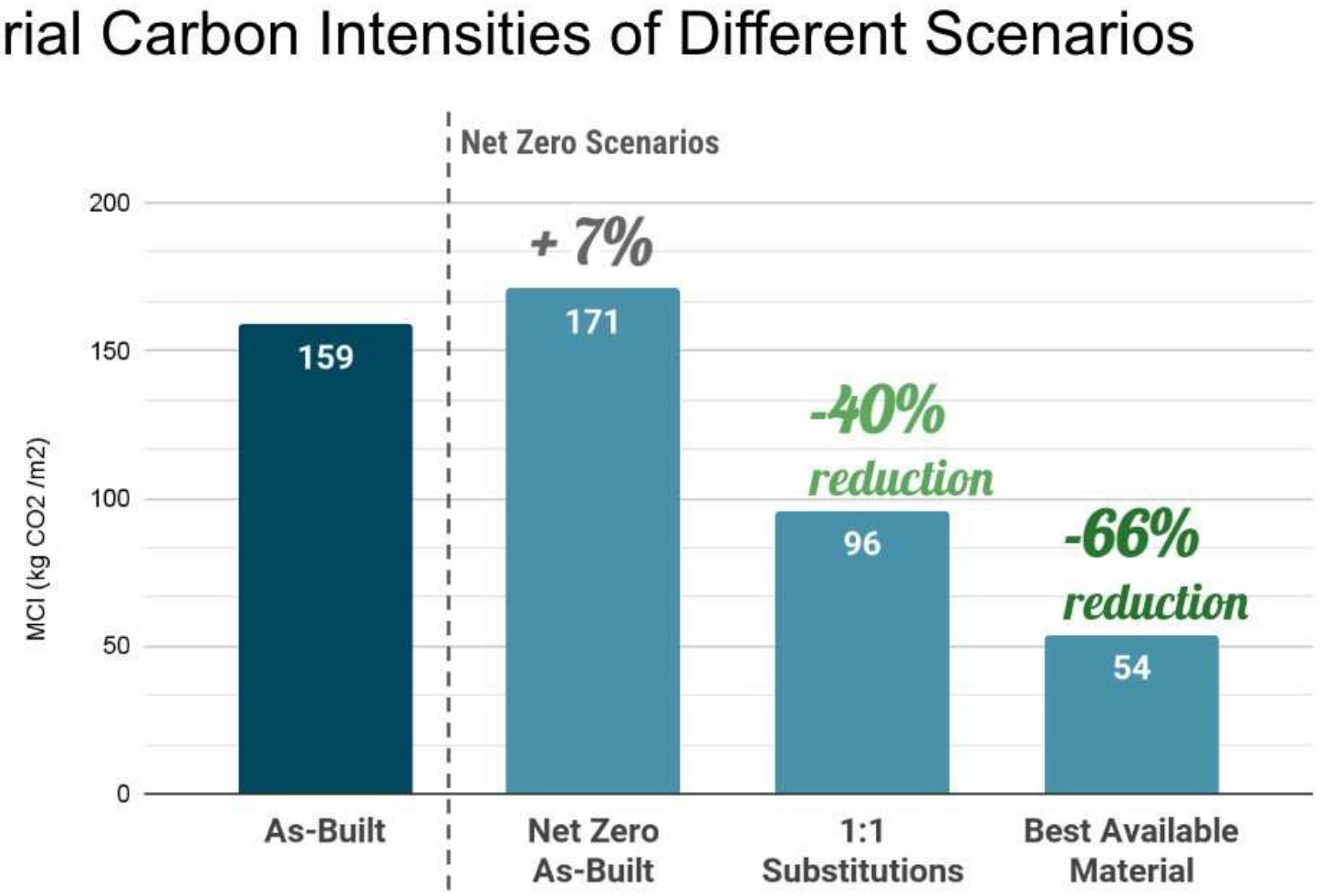
Sample Case Study "Wrap Up" Slide



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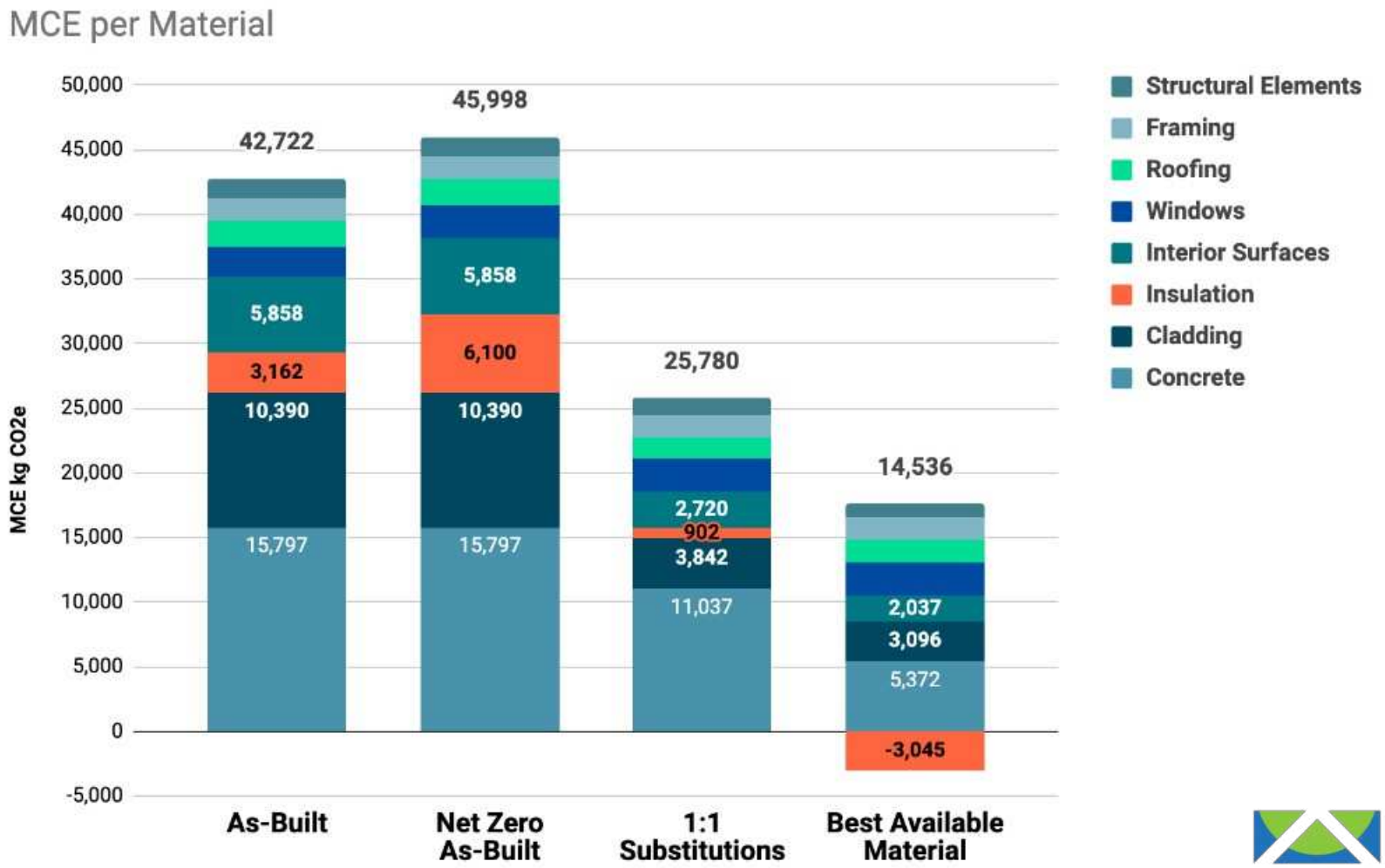
Sample Case Study “Wrap Up” Slide



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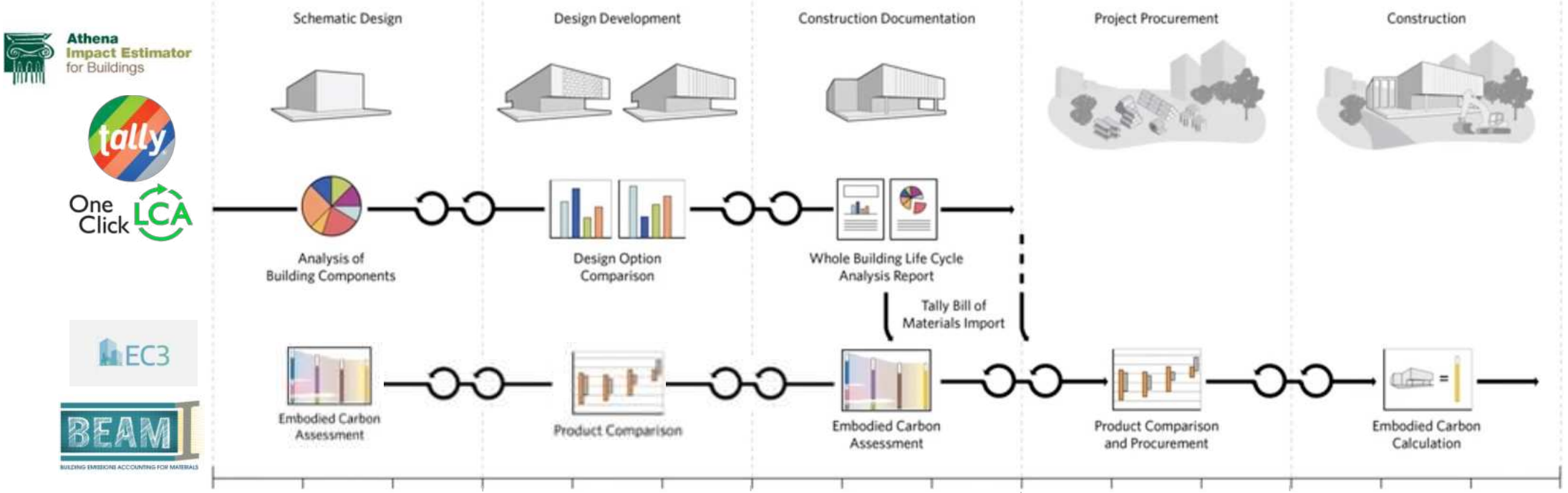
Sample Workflow Slide



Retrofit or Build?
Massing / Program
Materials Palette

epic.
CARE Tool

Assemblies & Materials

Kaleidoscope

Product Specification

Product Selection

Product Submittals & Verification

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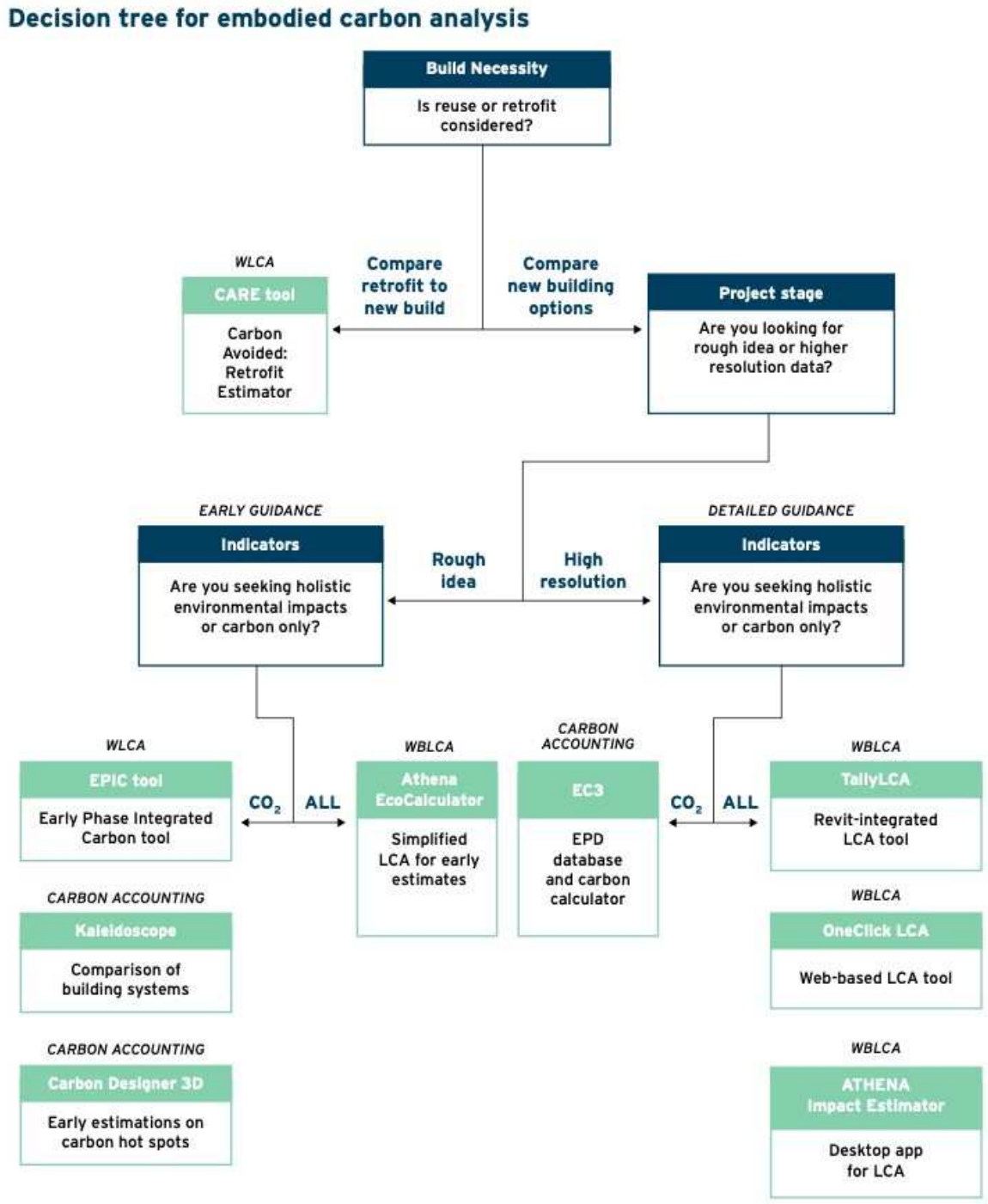
Sample Workflow Slide



Source: Tracy Huynh, Chris Magwood, Victor Olgyay, Laurie Kerr, and Wes Sullens, Driving Action on Embodied Carbon in Buildings, RMI and U.S. Green Building Council (USGBC), 2023, https://rmi.org/insight/drivingaction-on-embodied-carbon-in-buildings/ and https://www.usgbc.org/resources/driving-actionembodied-carbon-buildings.

Resources

TOOL	Early Design Hotspot	Enclosure Comparison	Individual Material Comparison	LCCA + ESG	Net Zero Carbon	Residential	Retrofit Avoided Carbon	Whole Building LCA
Autocase				x				
BEAM	x	x	x			x		
Building Ease			x					
CARE							x	
COVE	x							
EC3			x					
eTool	x	x	x	x	x	x	x	x
Kaleidoscope		x						
OneClick	x	x	x	x	x	x	x	x
PH Ribbon		x			x			
Tally	x	x	x	x	x	x	x	x
ZGF			x					