BUILDINGENERGY BOSTON

A Total Carbon Analysis Conversation: Balancing Operational and Embodied Carbon

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

Let's Talk About

- RESNET Standard 1550
- Analysis Tools
- Operational and Embodied Carbon: Modeled Versus Actual
- Drivers
- Action Items
- Case Studies
- Questions/Answers/Discussion

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.**

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.**

RESNET/ANSI Standard 1550

Massachusetts 100-Home Embodied Carbon Study
(on going)

- designed an **beta integration tool** between HERS modeling software and the BEAM tool to quickly report on materials carbon
- tested raters' **workflow and enhanced workforce development** through training
- **Result: establish a baseline** for embodied carbon of homes in Massachusetts

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

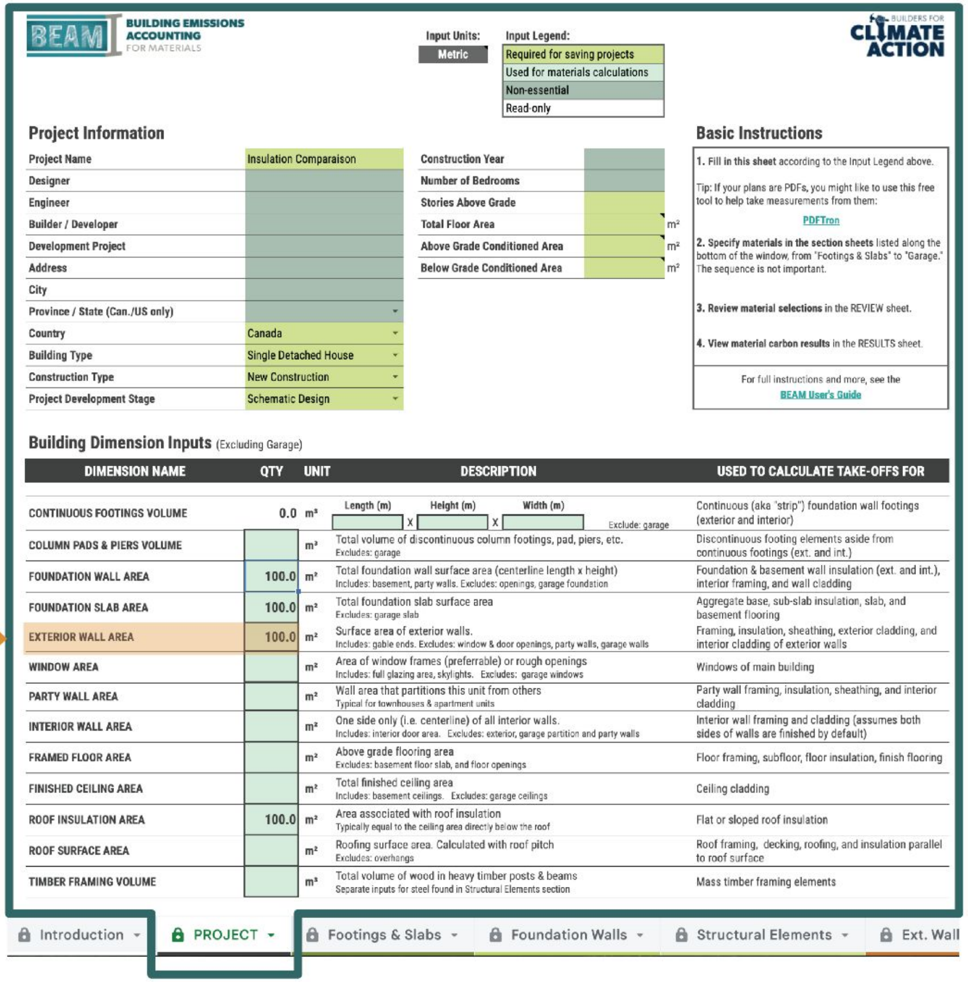
- Direct side-by-side material comparisons
- Assembly comparisons
- Design development
- Whole building models and comparisons
- “Alternative” materials with EPDs or LCA studies

Tools for Analysis

1- INPUT DIMENSIONS

on the **project sheet**.

ex: 100 m^2 of exterior walls.



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

BUILDERS FOR CLIMATE ACTION

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
	Plywood / 1/2" / 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 [Industry Avg | US & 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

Tools for Analysis

3- REVIEW

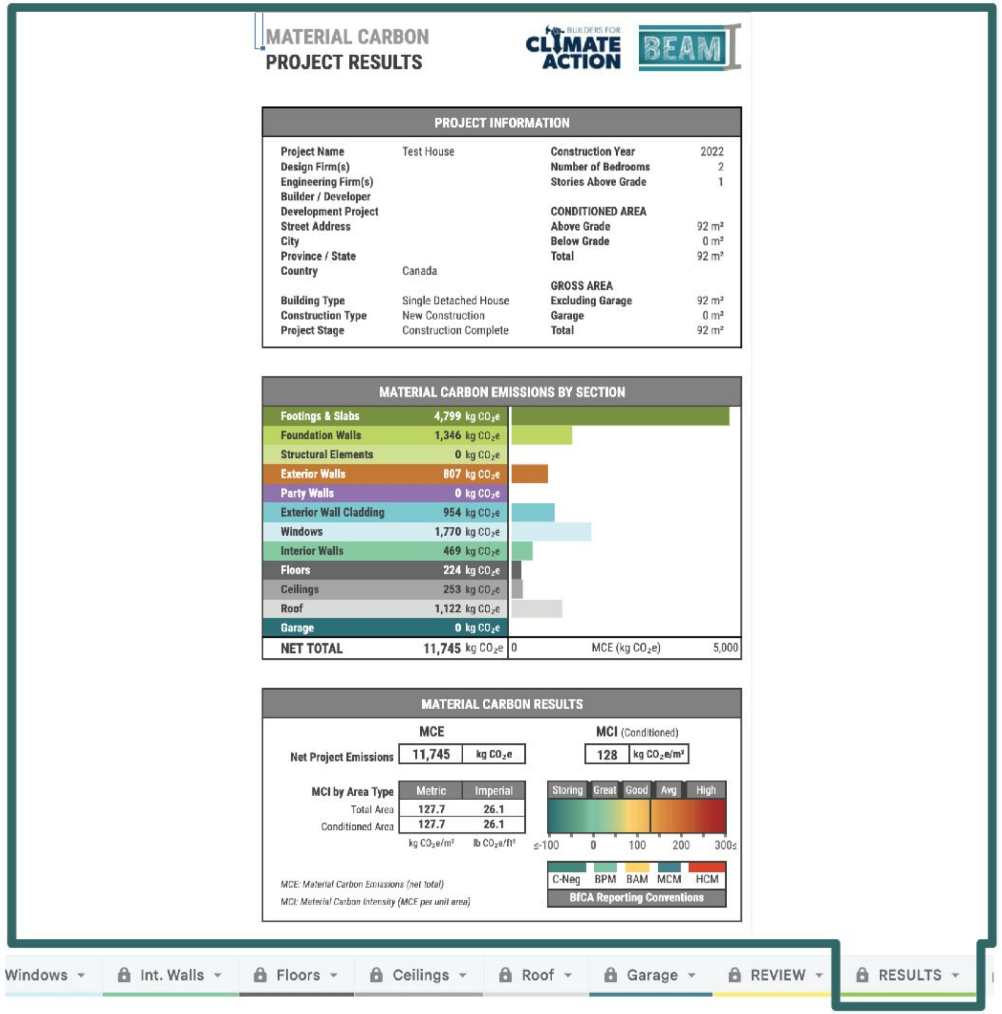
materials selection on the **review sheet.**

Quickly identify selected materials with highest and lowest carbon footprint

BEAM	BUILDERS FOR CLIMATE ACTION	REVIEW PROJECT MATERIALS	11,745	13,519	1,774
SECTION	CATEGORY	MATERIAL	NET EMISSIONS (kg CO_2e)	CARBON EMISSIONS (kg CO_2e)	CARBON STORAGE (kg CO_2e)
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 / 2x8 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 / BfCA 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 3.6/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

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.

Energy Use Intensity

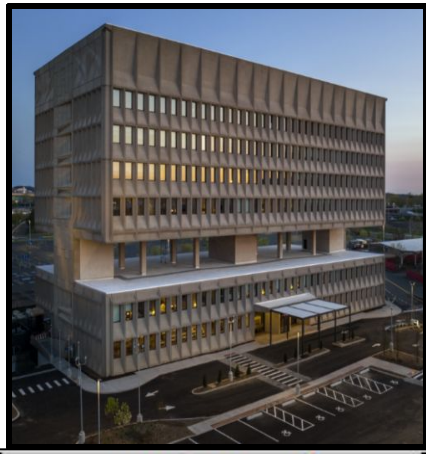
Carbon Equivalent Usage

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: Actual Emissions After a Year of Cx

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: Modeled vs. Actual Emissions

Hotel Marcel: Modeled vs. Actual Emissions

Operational Carbon Emissions

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

Actual kBtu/sf·yr 18

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

Actual kBtu/sf·yr 45

Embodied Carbon Emissions vs EUI

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

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**

Embodied Carbon Emissions (kg CO_2e/sf) = **10.48**

Embodied Carbon Emissions vs Average

RMI Low-rise Residential Study

Average home ~184 kg CO_2e/m^2

- New low-rise residential homes (SF, duplexes, townhomes, and apartments buildings <3 stories)
- ~5 occupants
- Based on 921 homes in US, Canada and Europe
- Includes structure, enclosure and partitions

https://rmi.org/insight/hidden-climate-impact-of-residential-construction/

Canaan Parish

Canaan Parish ~113 kg CO_2e/m^2

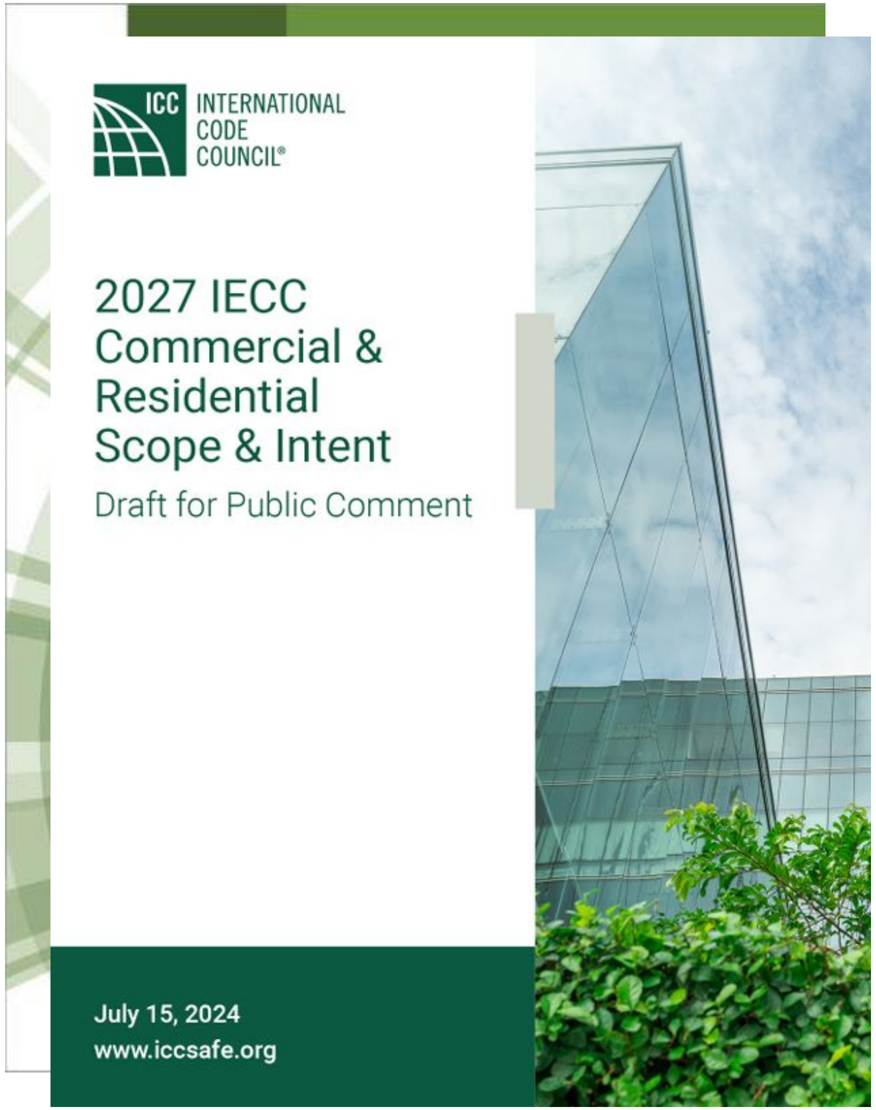
- 40 units, 4 stories
- ~130 occupants
- Includes structure, enclosure and partitions
- Excludes parking garage structure

Drivers

Code


IECC
INTERNATIONAL
ENERGY CONSERVATION
CODE
2021
ICC
INTERNATIONAL CODE COUNCIL

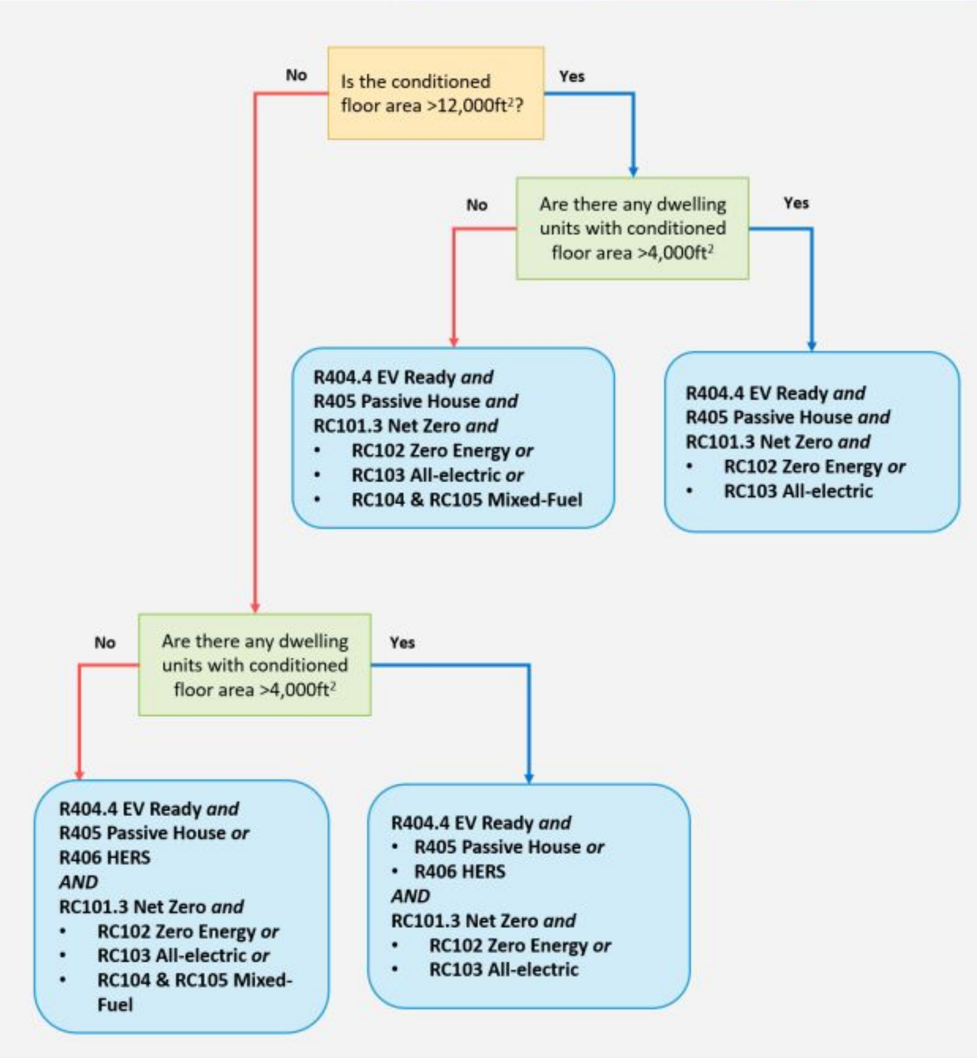
Code

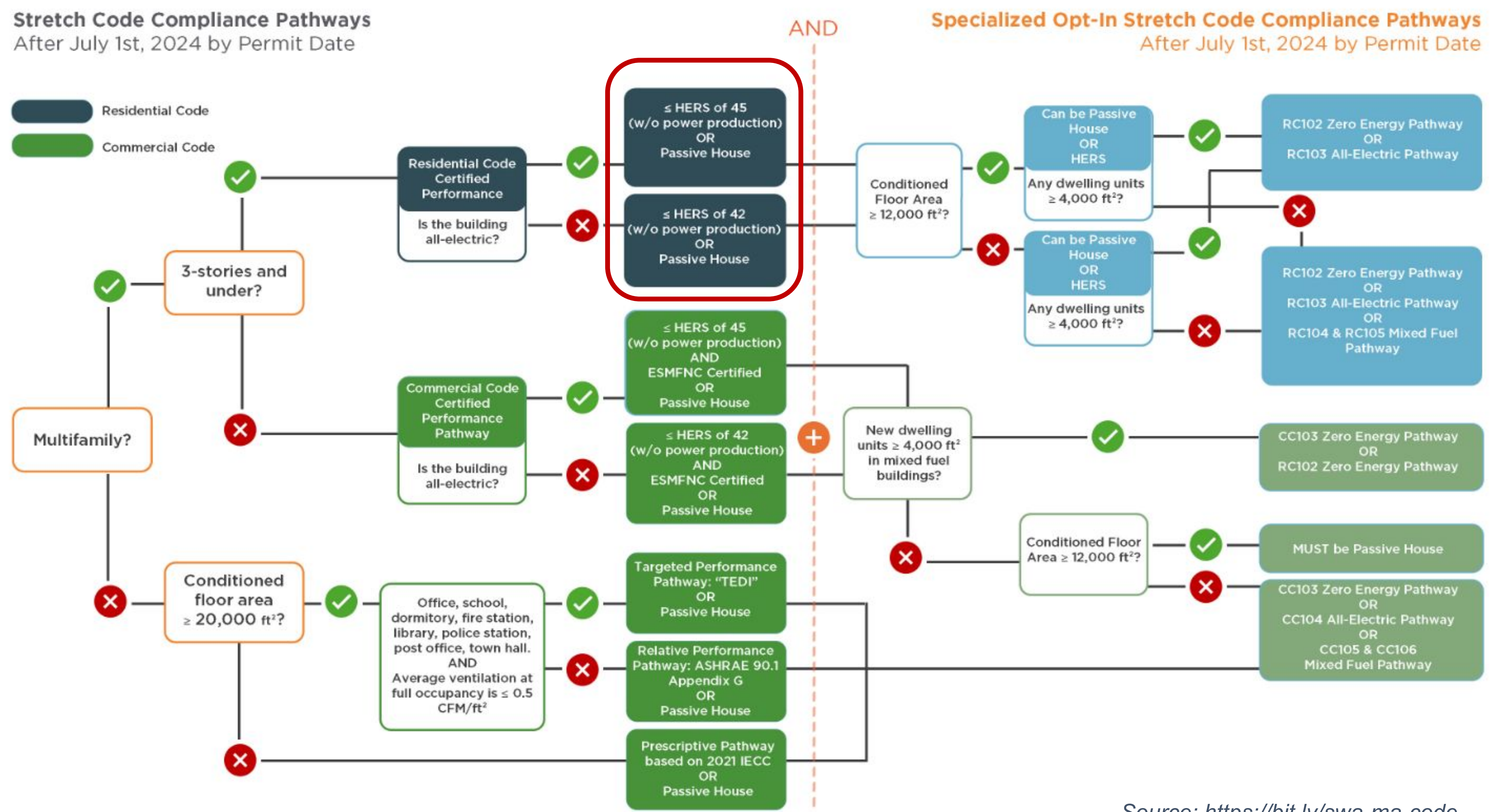


2024 IECC - What Happened?

https://bit.ly/4hldWPZ

Massachusetts Stretch Code





Source: https://bit.ly/swa-ma-code

Mass Stretch Embodied Carbon Credit

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 single dwelling units that demonstrate a calculated insulation GWP intensity (kg CO2e/m2) 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 single dwelling units that demonstrate a calculated concrete mix GWP ≤ 100% of the 2022 NRMCA Northeast Benchmark average . . .

DOER regulations went into effect in February 14, 2025

Mass Save Proposed Incentives

On 2/28/25…

We further see merit in the Program Administrators continuing to coordinate their energy efficiency programs with other building decarbonization programs initiated by the Commonwealth, such as the embodied carbon intergovernmental coordinating council, and we remain open to the future possibility of stacking energy efficiency funds with other funds focused on embodied carbon measures. However, for the reasons discussed above, we find that consideration of an Embodied Carbon measure in the context of the Three-Year Plans is premature.

Source: MA DPU order: https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/19886002

Embodied Carbon Education in Massachusetts

BUILT ENVIRONMENT PLUS

MASSACHUSETTS CLEAN ENERGY CENTER

EMBODIED CARBON REDUCTION CHALLENGE

THE CHALLENGE: REDUCE UPFRONT CARBON OF BUILDINGS

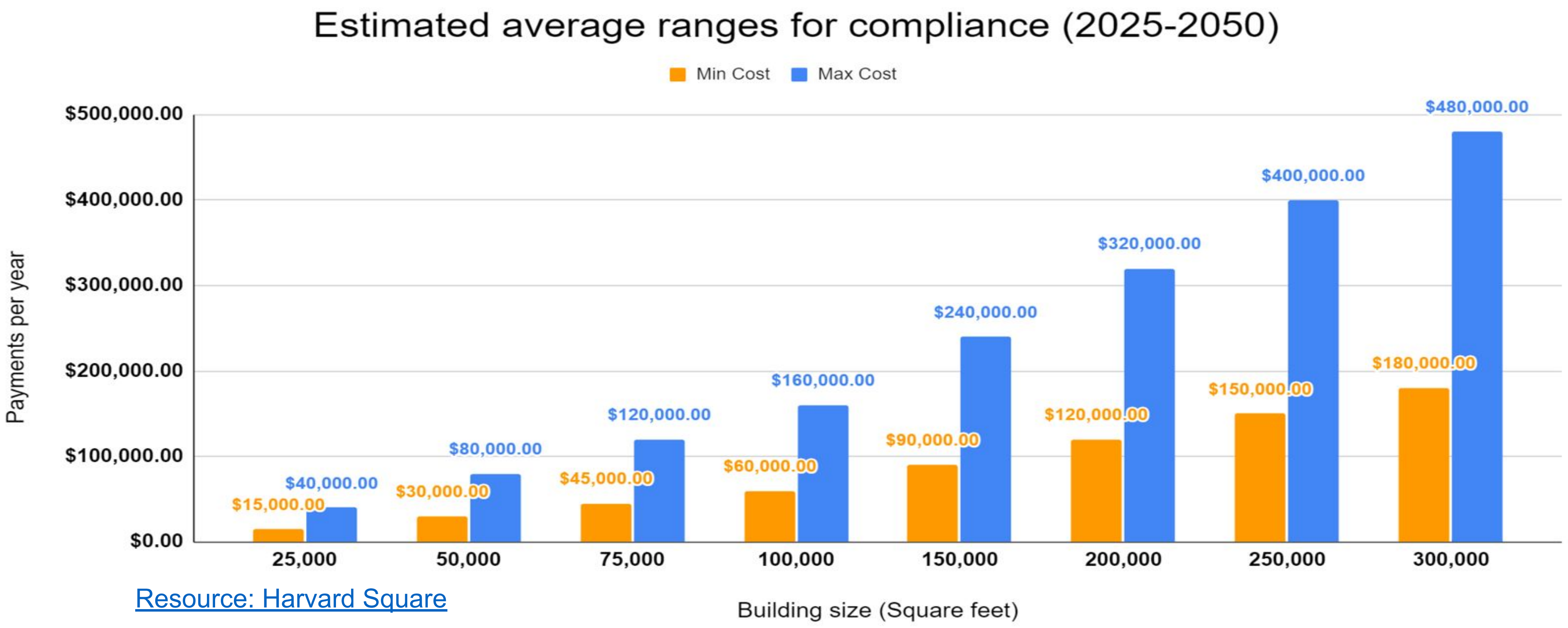
ENTRIES DUE APRIL 3, 2024 | 5:00 PM

~$400,000 in cash prizes awarded to 11 lead applicants

BERDO and BEUDO

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



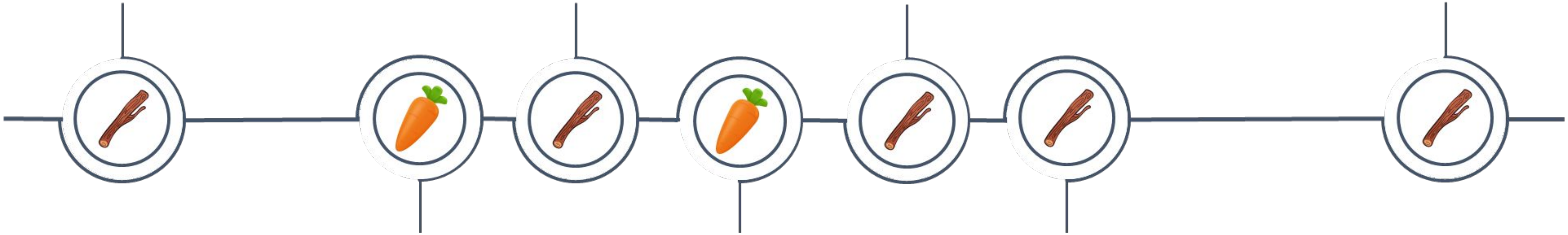
[Resource: Harvard Square]

Boston Net Zero Carbon Zoning Proposal

- Passed in January of this year
- Starting July 1, 2025, new project filings will be required to be **Net Zero Ready** through BERDO at **day of opening**
- Requires **reporting on embodied carbon**
- Applies to new buildings with 15+ units or 20,000+ SF and additions of 50,000+ SF

Source: https://www.bostonplans.org/getattachment/e7692da5-746b-4037-962a-a0cd43747205

Embodied Carbon Carrots and Sticks Timeline



Summer 2023:
Mass Stretch Code + Specialized Code adopted

May 2024:
Embodied Carbon Reduction Challenge

August 2024:
2024 IECC published without embodied carbon language

October 2024:
Mass Save embodied carbon incentives for public comment

January 2025:
Boston Net Zero Carbon Zoning Proposal adopted

February 2025:
Residential embodied carbon HERS Credit adopted in Mass Stretch Code

Mass Save embodied carbon incentives rejected

Fall 2026:
2027 IECC to be published…hopefully with embodied carbon language

Action

Action Items

1. **Retrofit / Reuse material**

2. **Design to minimize:**
   the size of your building, the concrete use and loads, the need of finishes

3. **Choose lower emission / carbon storing material** (insulation)

4. **Consider circular design :**
   reusability, recyclability, design for disassembly and durability

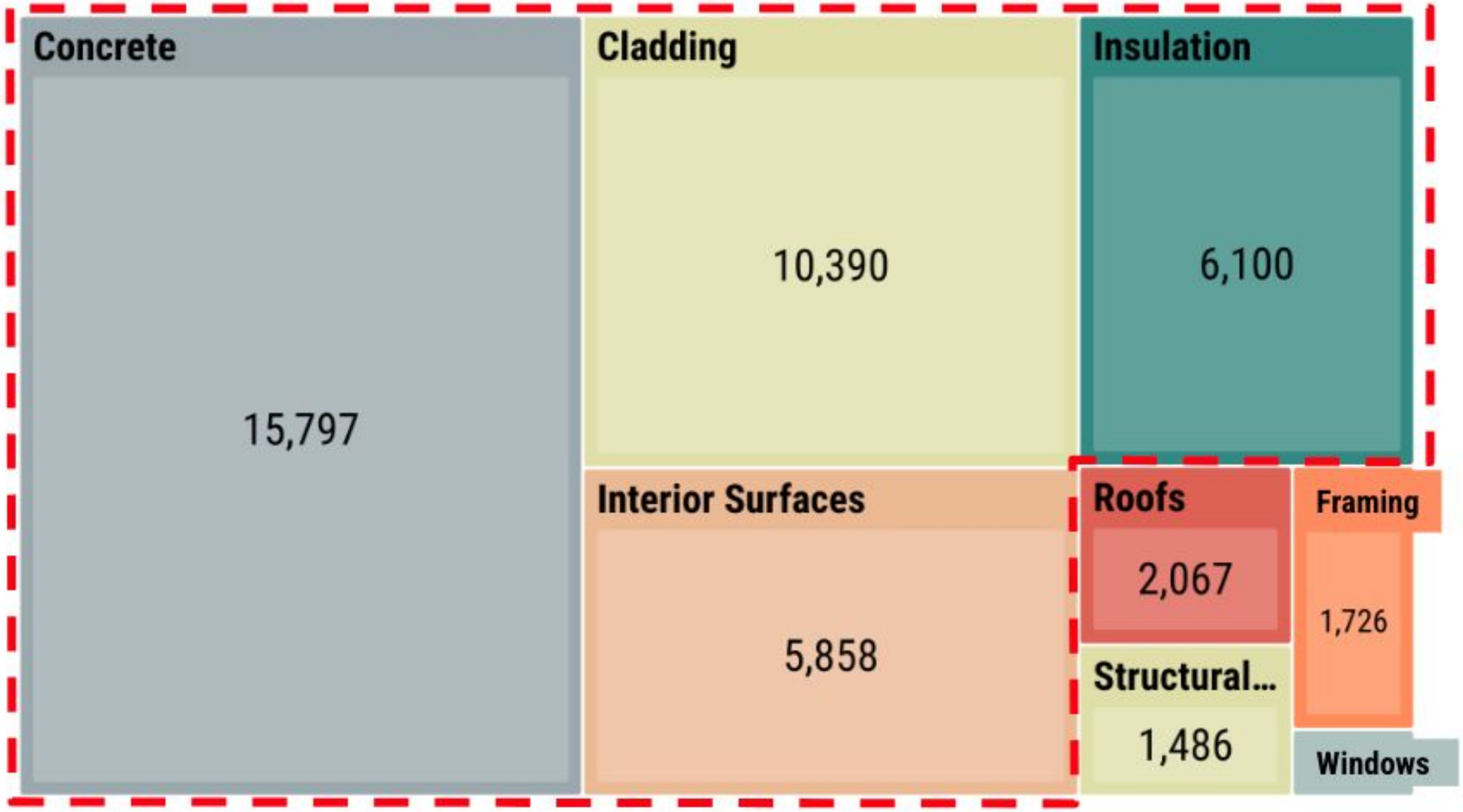
5. **Sourcing : sustainable, regenerative and/or local materials**

Action Items

Net Zero As-Built - MCE Results per material

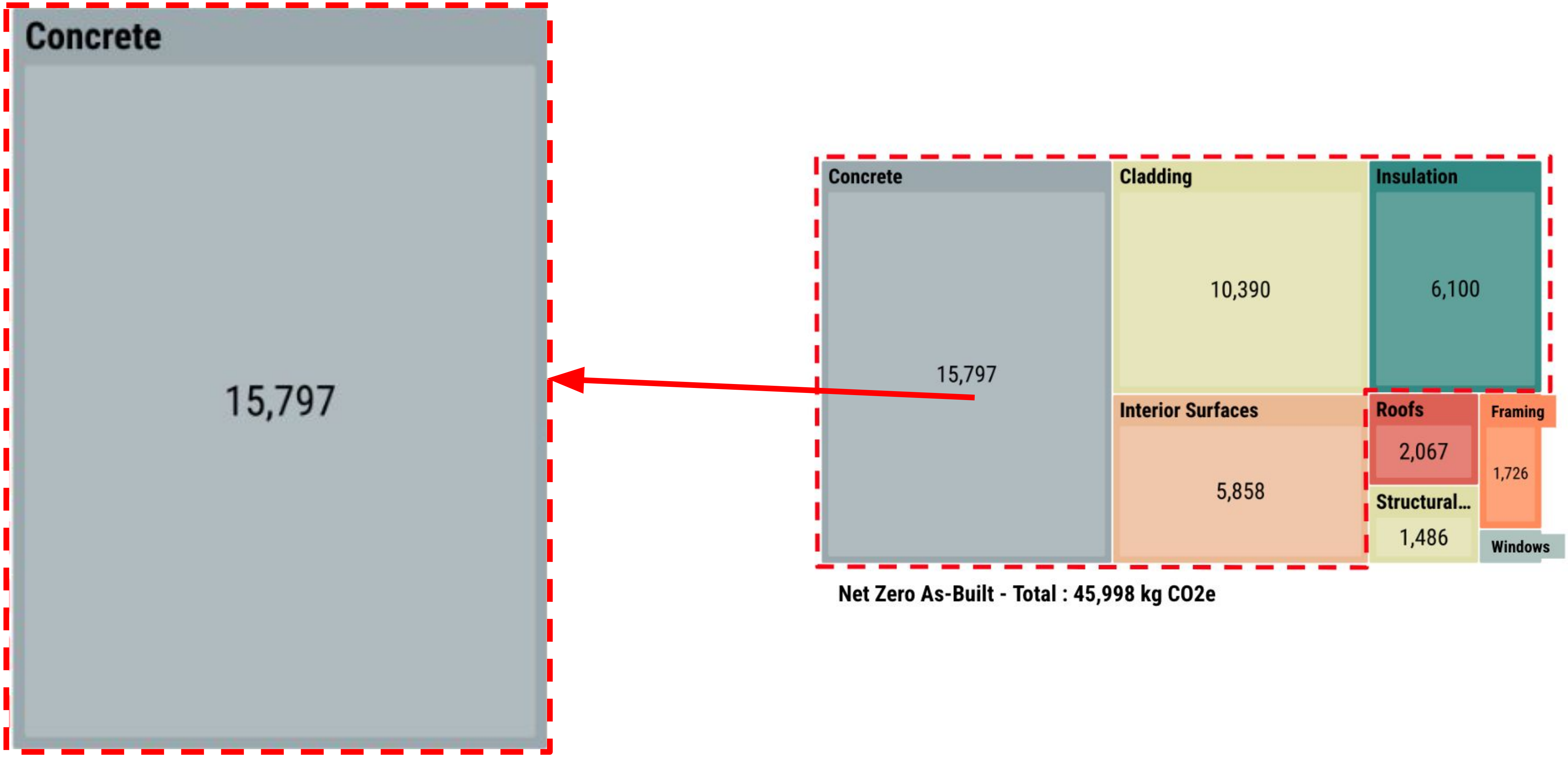
83% MCE from 4 material categories :

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



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

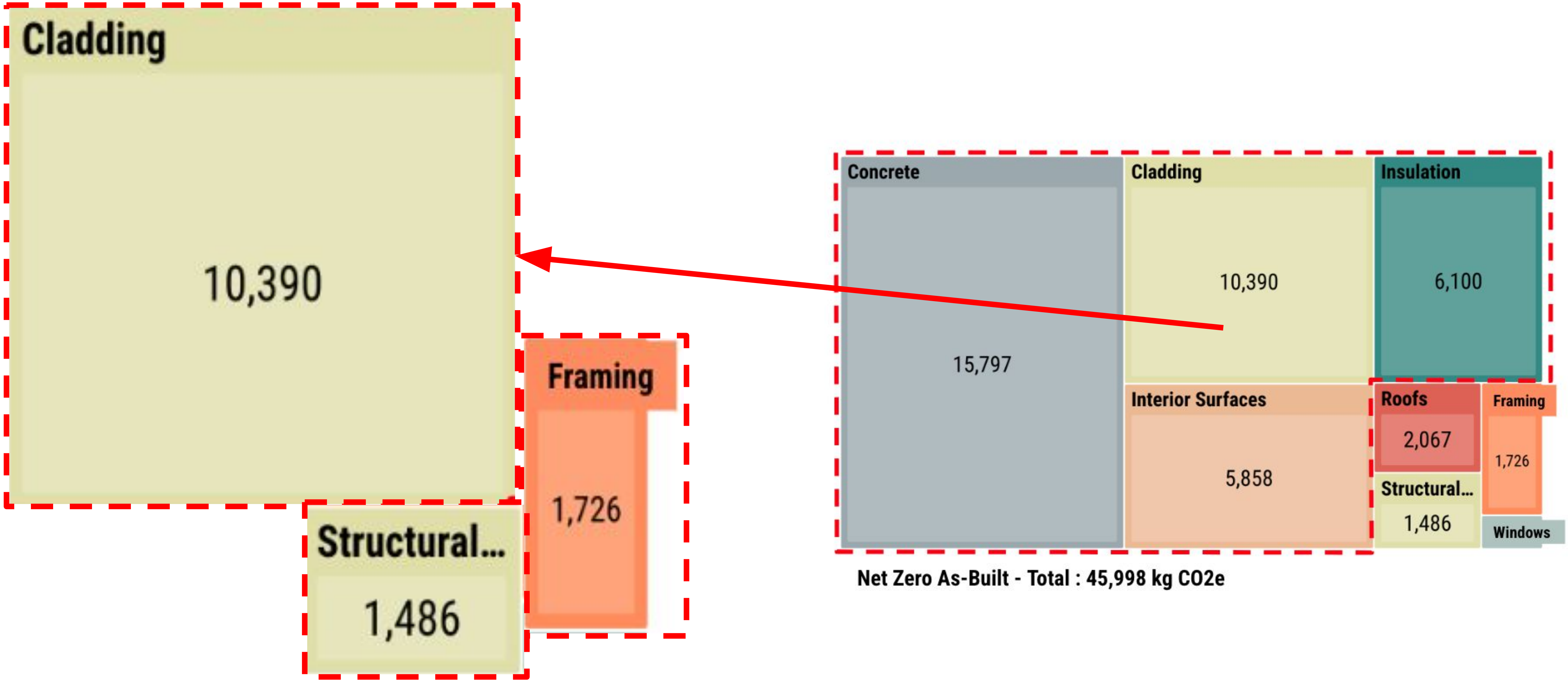
Action Items



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

Action Items



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

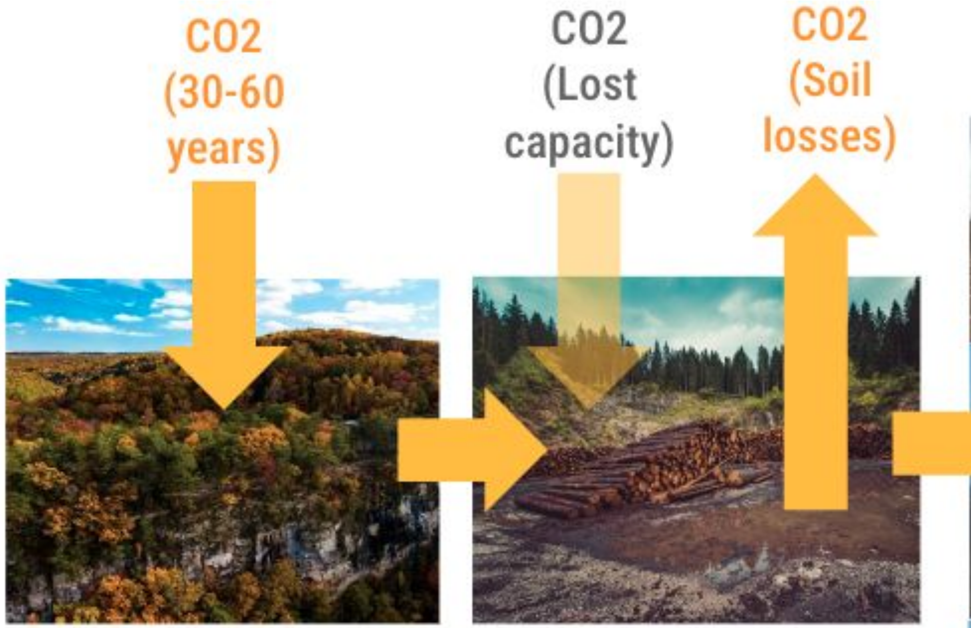
Framing

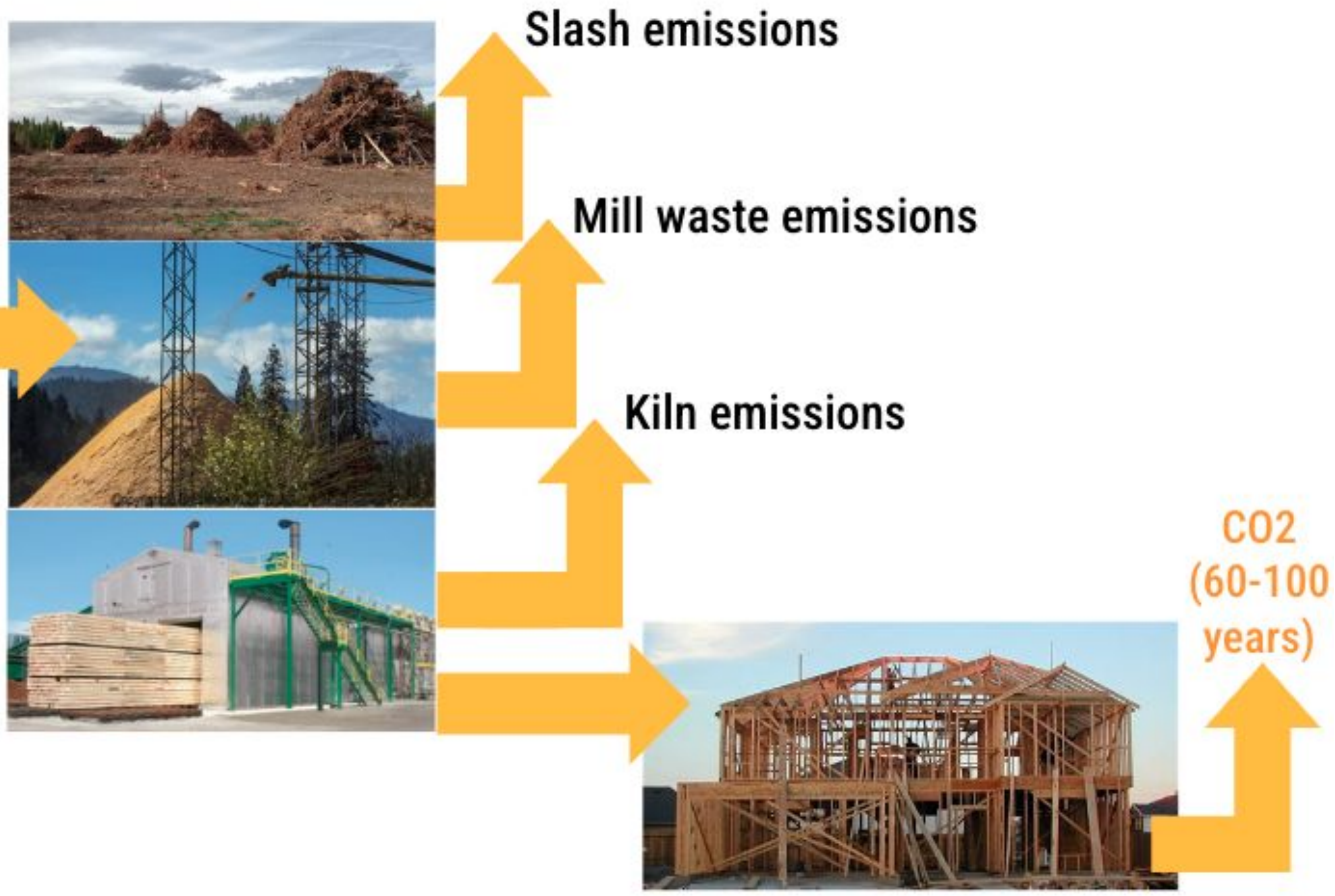
CATEGORY	MATERIAL	QUANTITY	UNITS	%	SELECT	NET EMISSIONS kg CO_2e	GROSS EMISSIONS kg CO_2e	STORAGE Short Cycle kg CO_2	STORAGE Long Cycle kg CO_2	SELECT Long Cycle
LIGHT STEEL FRAME WALLS	FRAMING SPACING	16	in							
LIGHT STEEL FRAMING – 16 GAUGE (2X6)										
	Steel studs - Load bearing / Steel Framing 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	☐

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	☑

Wood Carbon Storage

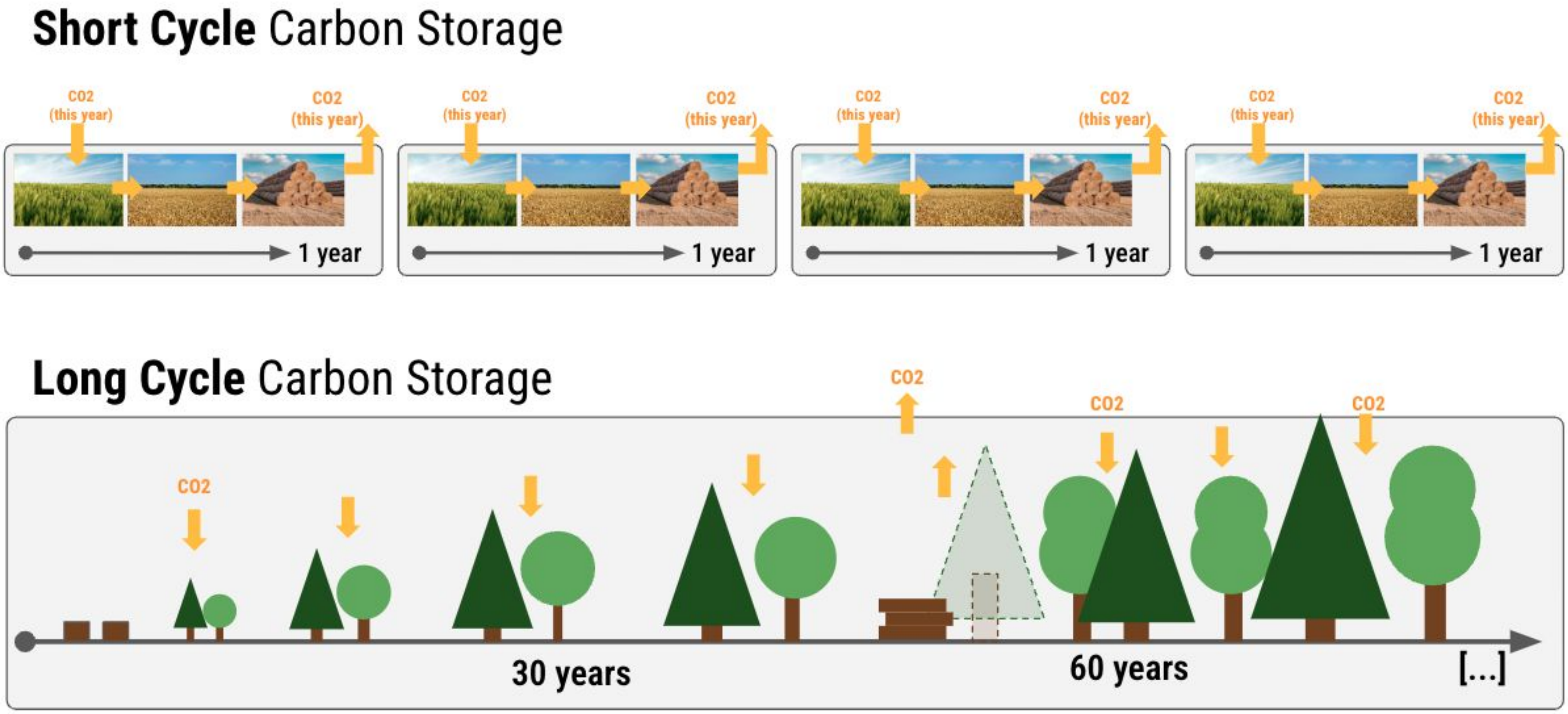




Long cycle carbon storage
comes from feedstocks that are:

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

Wood Carbon Storage



Wood Carbon Storage

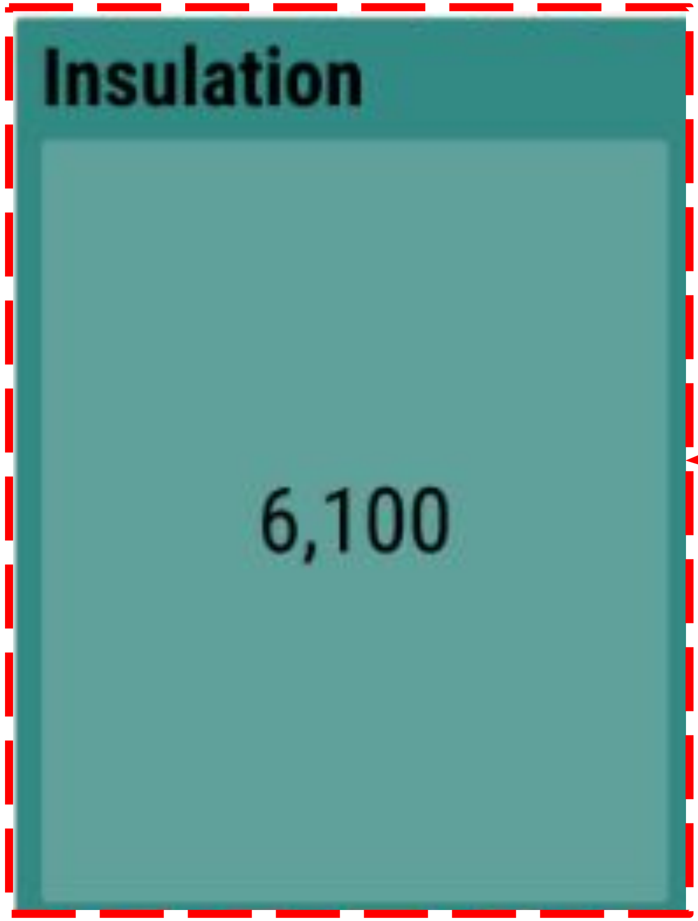
BEAM v1.1 enables selective carbon storage for timber

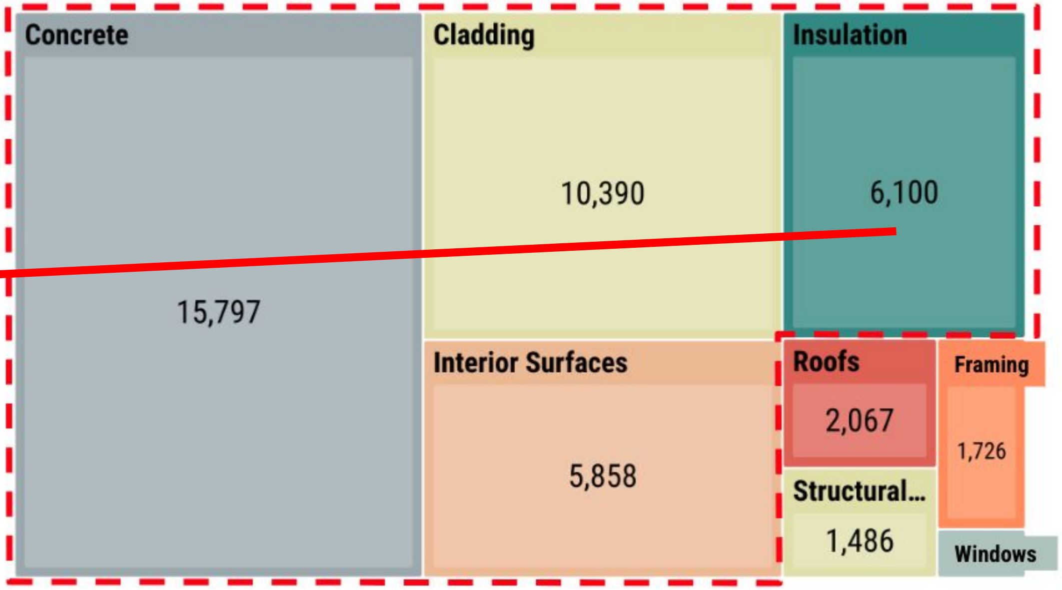
PROJECT NAME: Sample Project DOE Prototype
SCENARIO: Baseline
BEAM VERSION: V1.1

SECTION COMPLETE? ☐

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
						0	0	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]	100.0	ft²	100%	☐	-298	27	0	325	☑
	Wood / SPF / 2x8 Lumber / Surfaced Dry Softwood Lumber Produced in British Columbia	100.0	ft²	100%	☐	20	20	0	302	☐
	Wood / SPF / 2x6 Lumber / AWC & CWC [Industry Avg | US & CA]	100.0	ft²	100%	☐	20	20	0	246	☐
	Wood / SPF / 2x6 Lumber / Surfaced Dry Softwood Lumber Produced in British Columbia	100.0	ft²	100%	☐	15	15	0	229	☐

Action Items

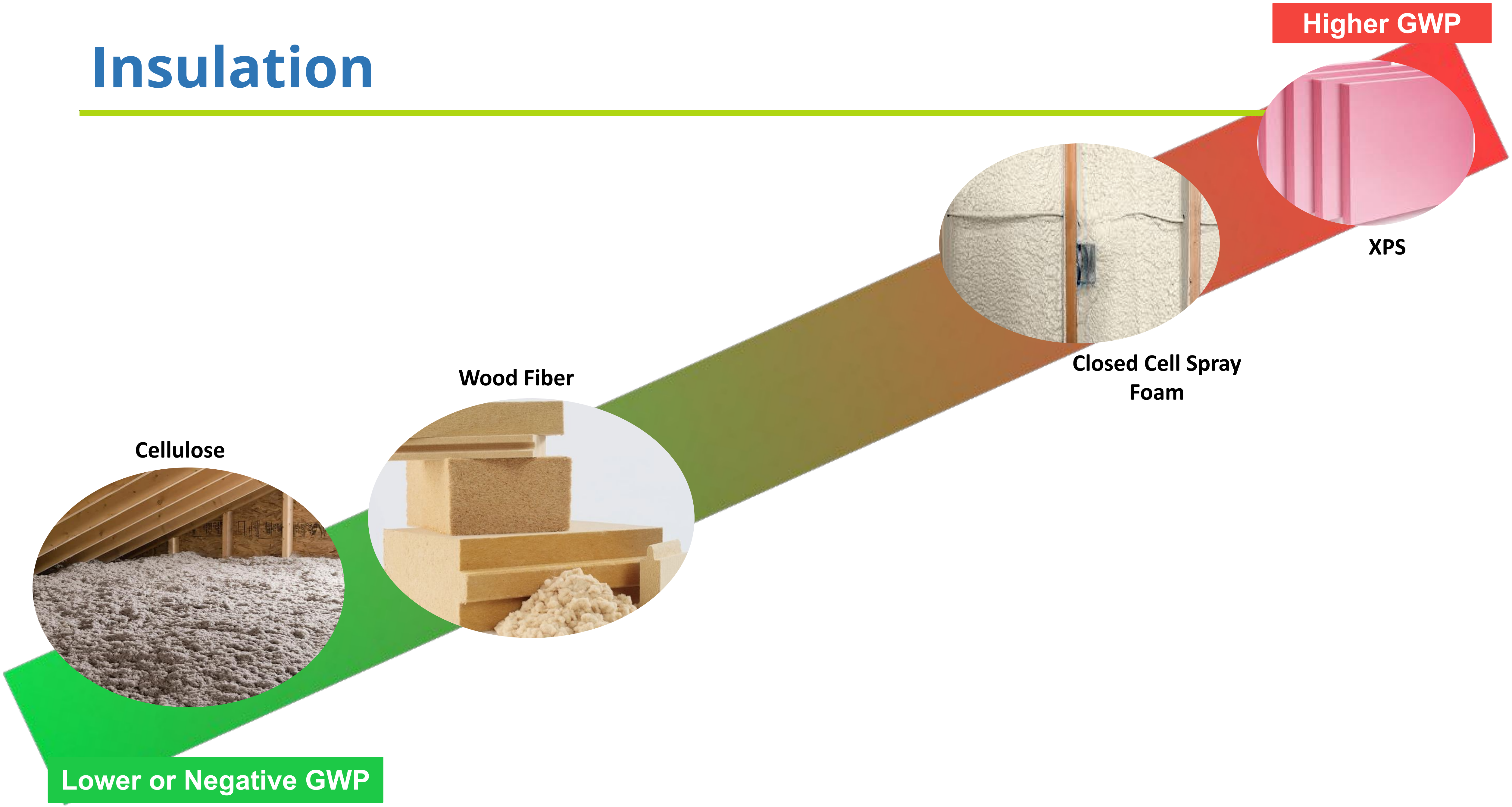




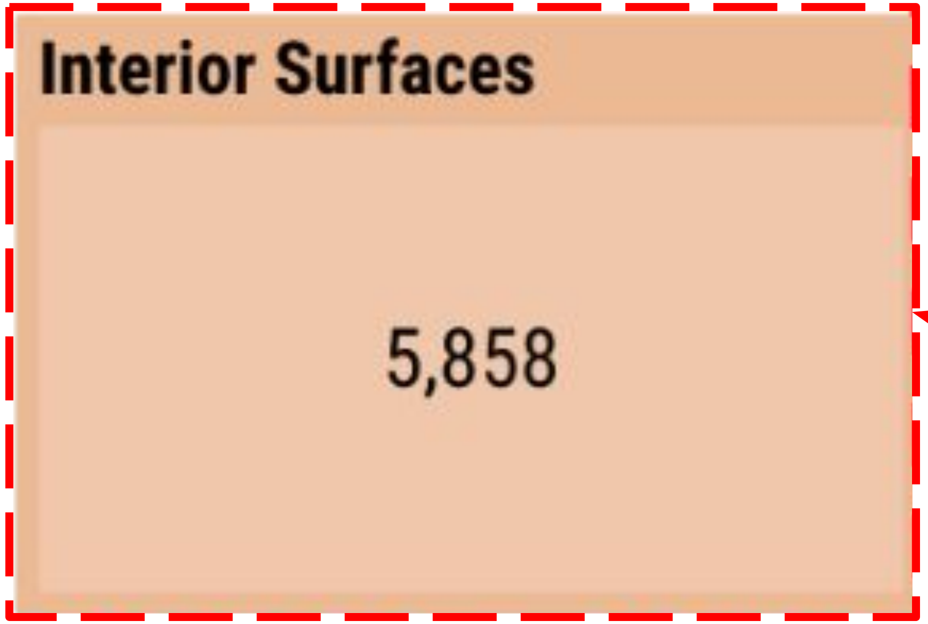
Insulation

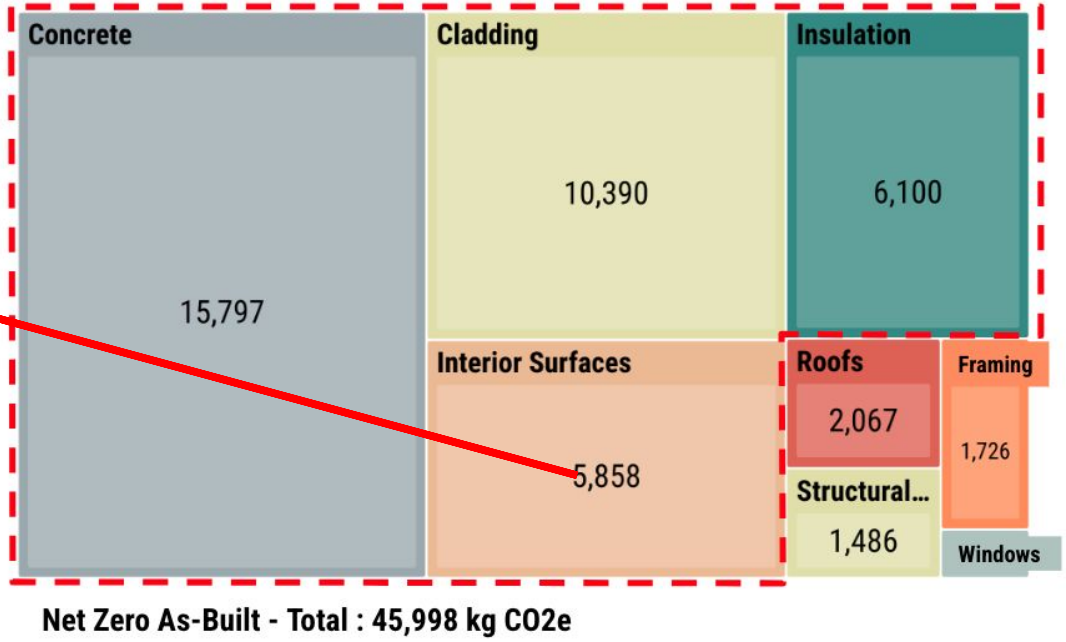
- ➔ **Find the Optimal Thermal Value**
  (don't over-insulate)
- ➔ **Choose Plant Based Products**
- ➔ **Avoid Plastic Based Products**
- ➔ Pay attention to the Chemicals (Binders, Fire Retarders, VOC’s)

Insulation


Higher GWP
XPS
Closed Cell Spray Foam
Wood Fiber
Cellulose
Lower or Negative GWP

Action Items





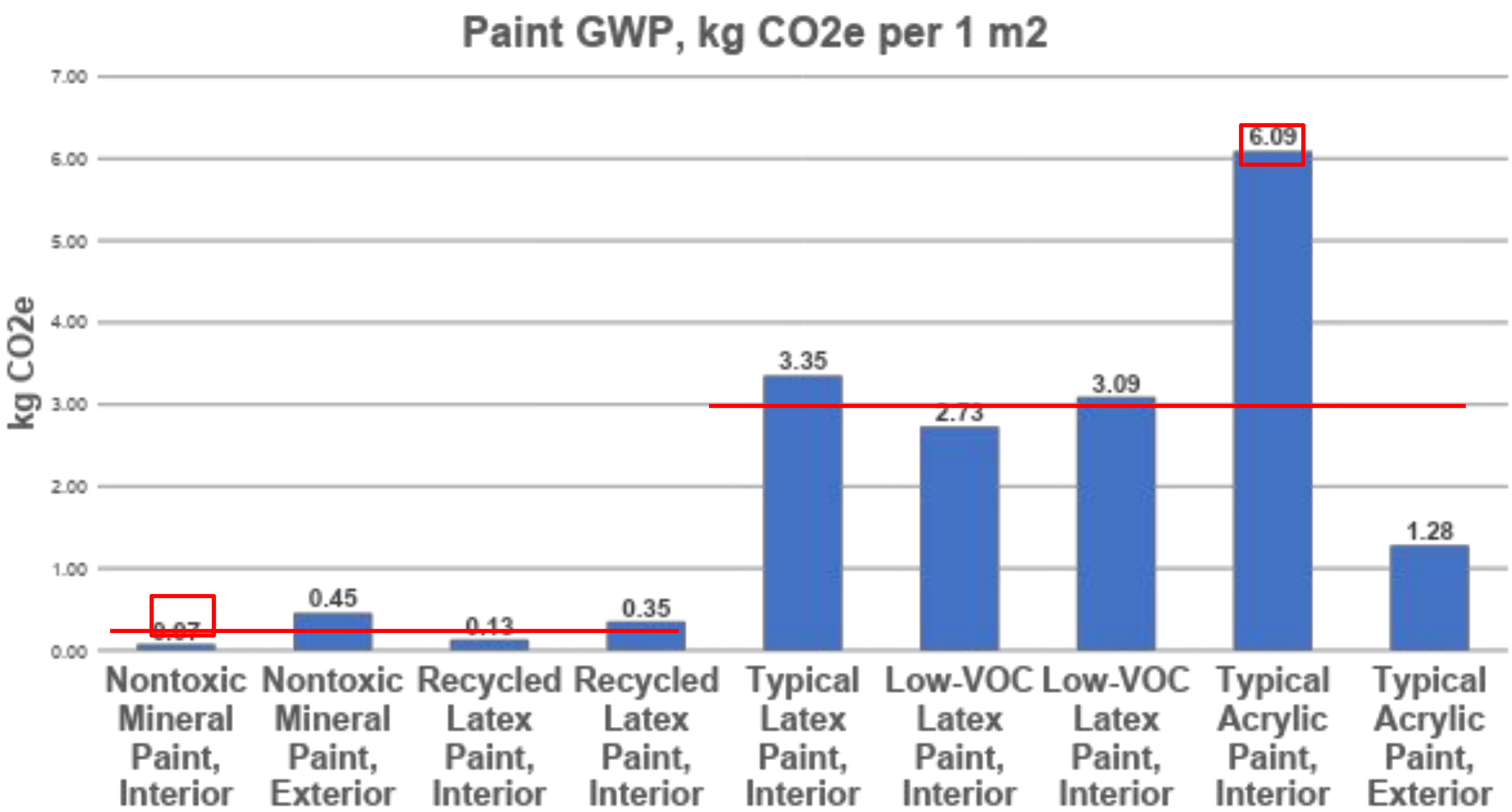
Drywall

- **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

Paint

Forbes

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

Jamie Hailstone Contributor

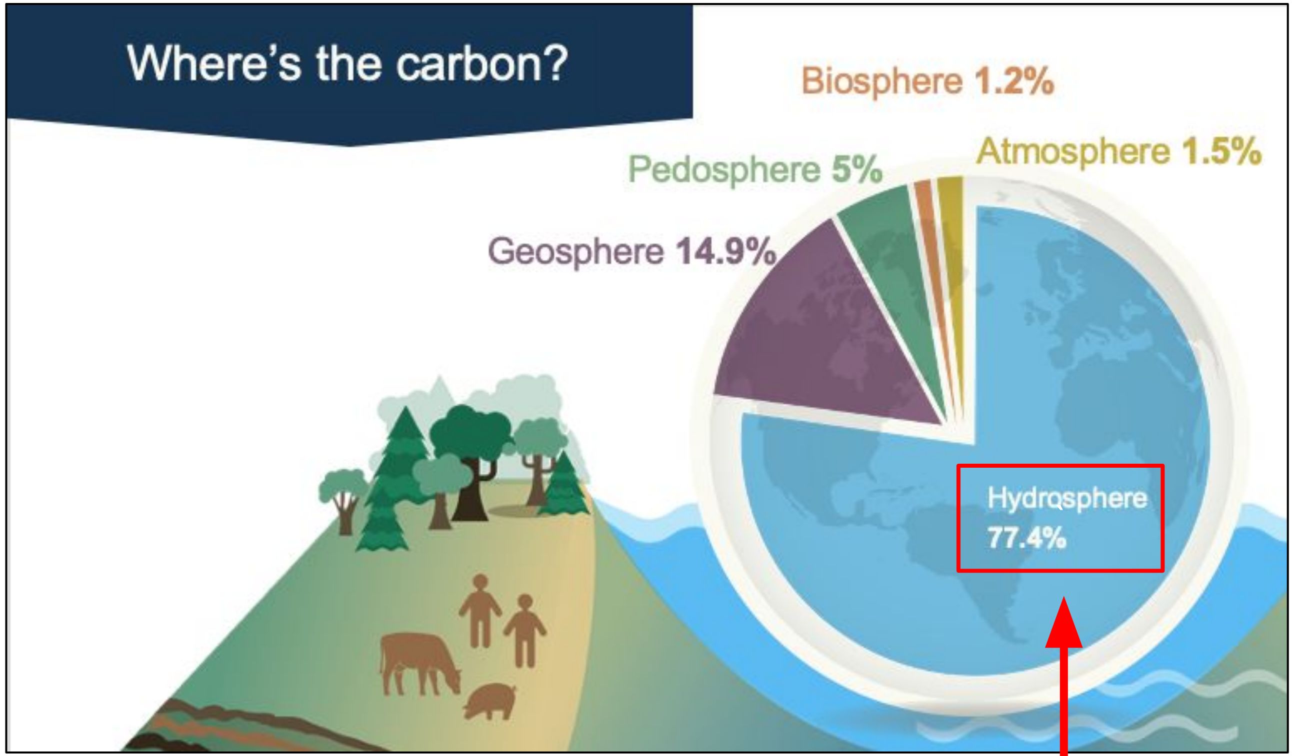
I write about air quality and the environment.

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.

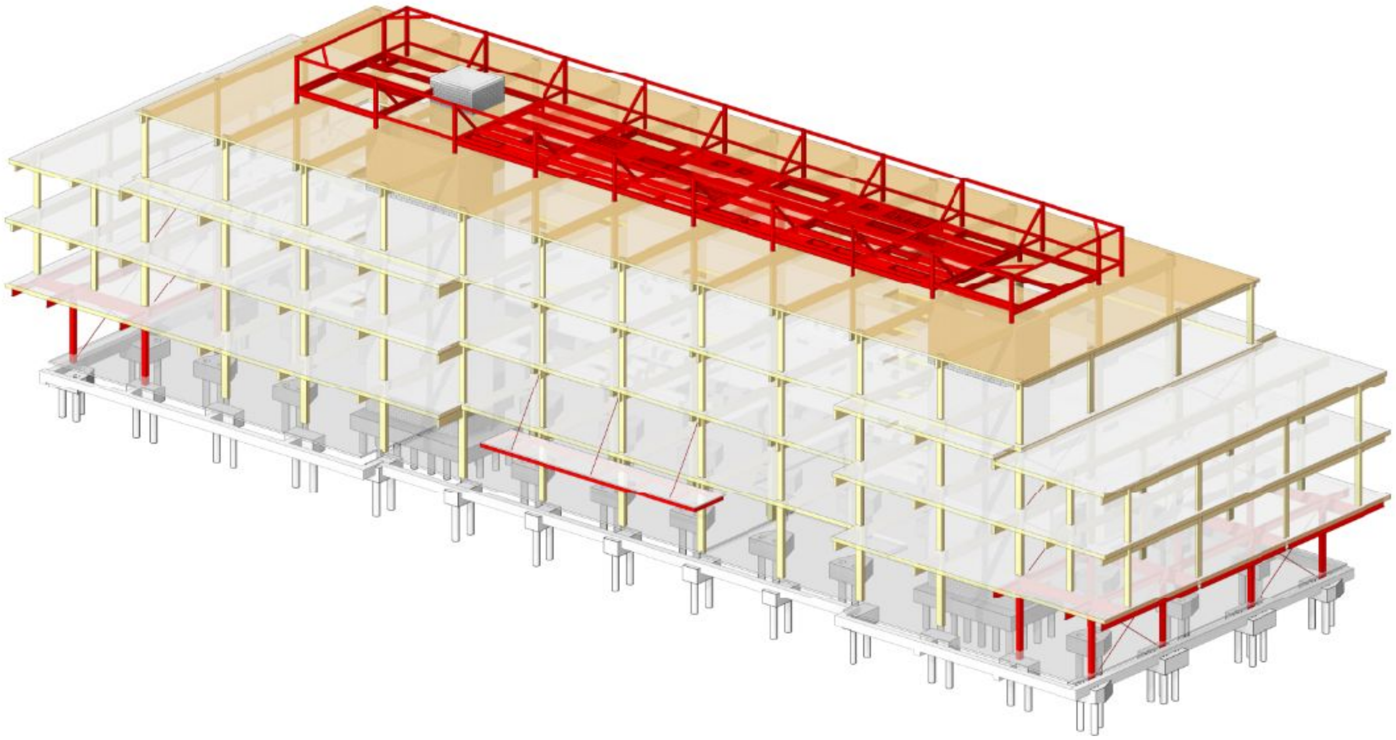


Case Studies

EC Reduction Challenge: Northland Newton B7

MASSACHUSETTS CLEAN ENERGY CENTER

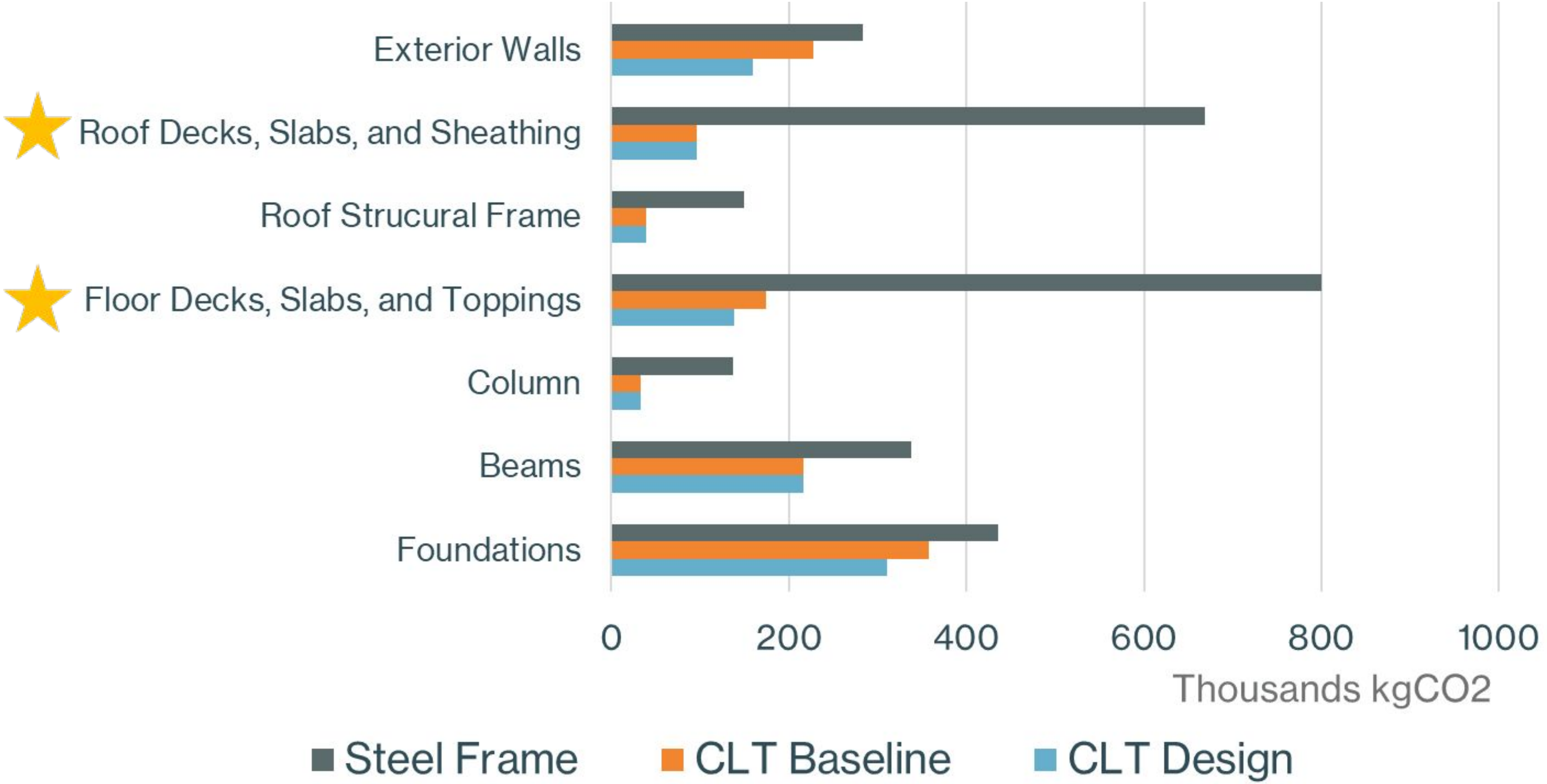
EMBODIED CARBON REDUCTION CHALLENGE



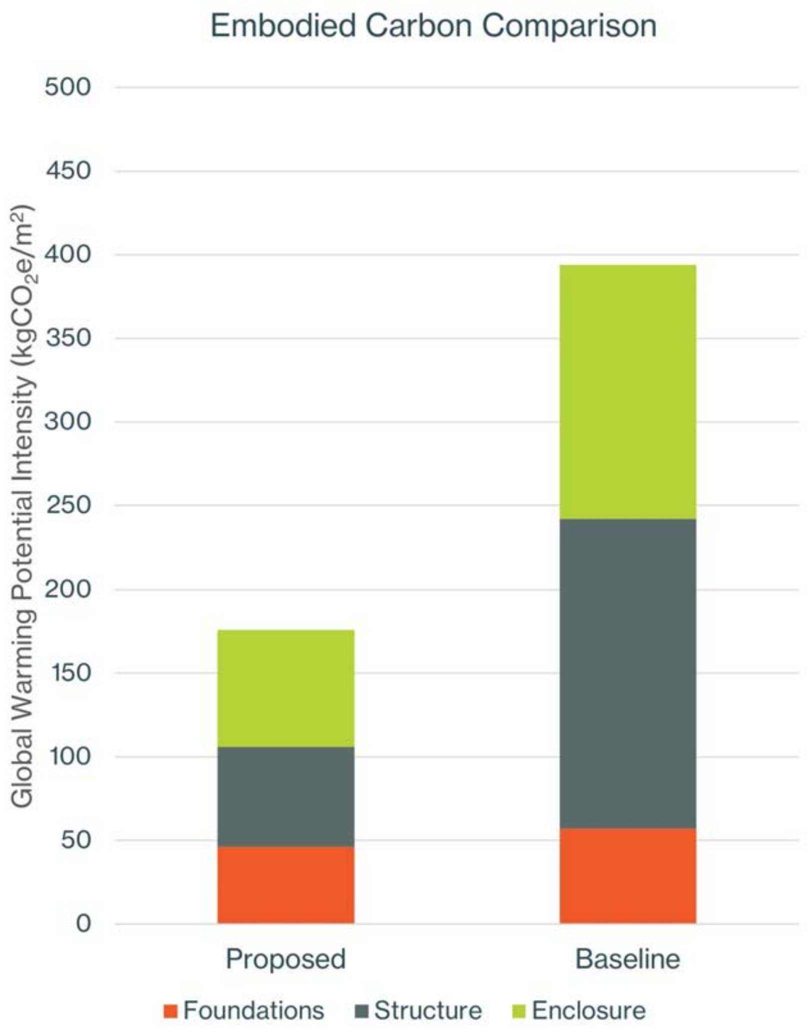
Red = Steel

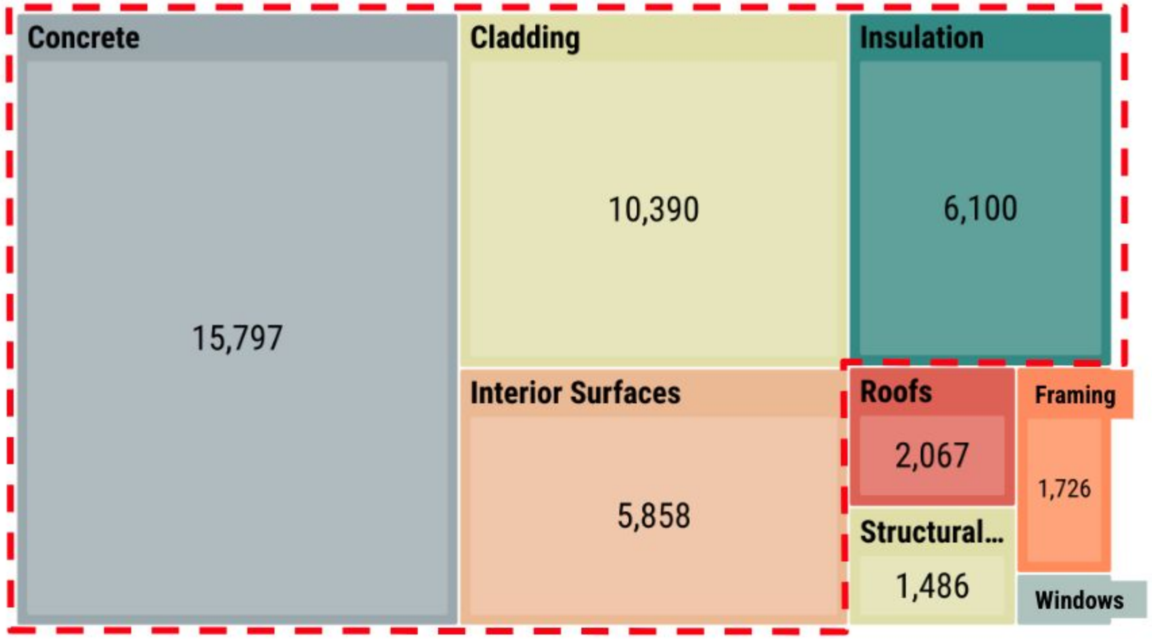
Yellow = Wood

EC Reduction Challenge: Northland Newton B7

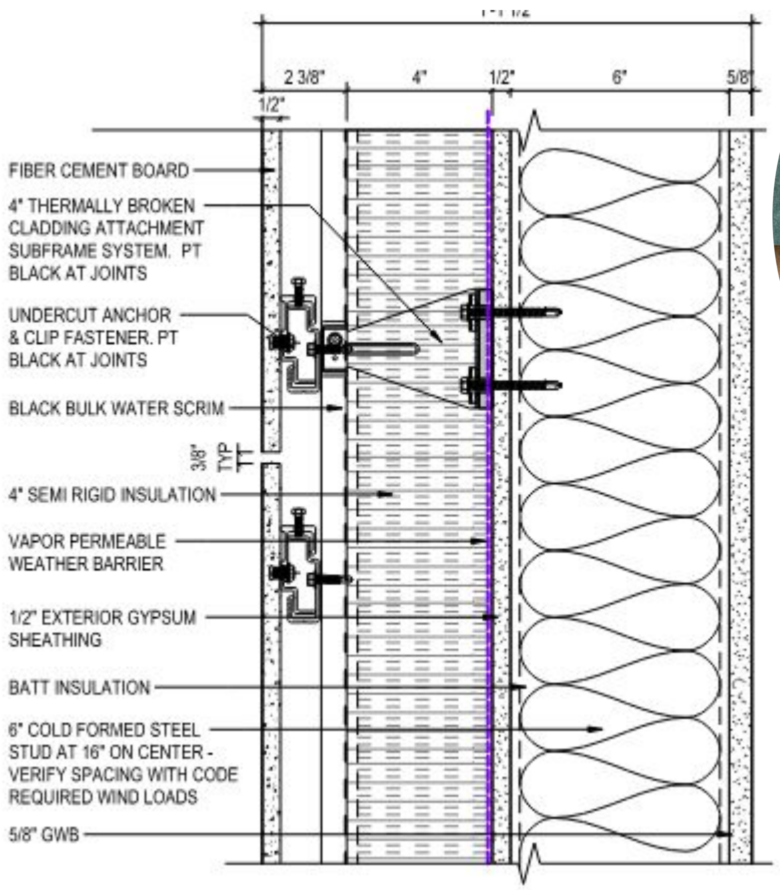


EC Reduction Challenge: Northland Newton B7

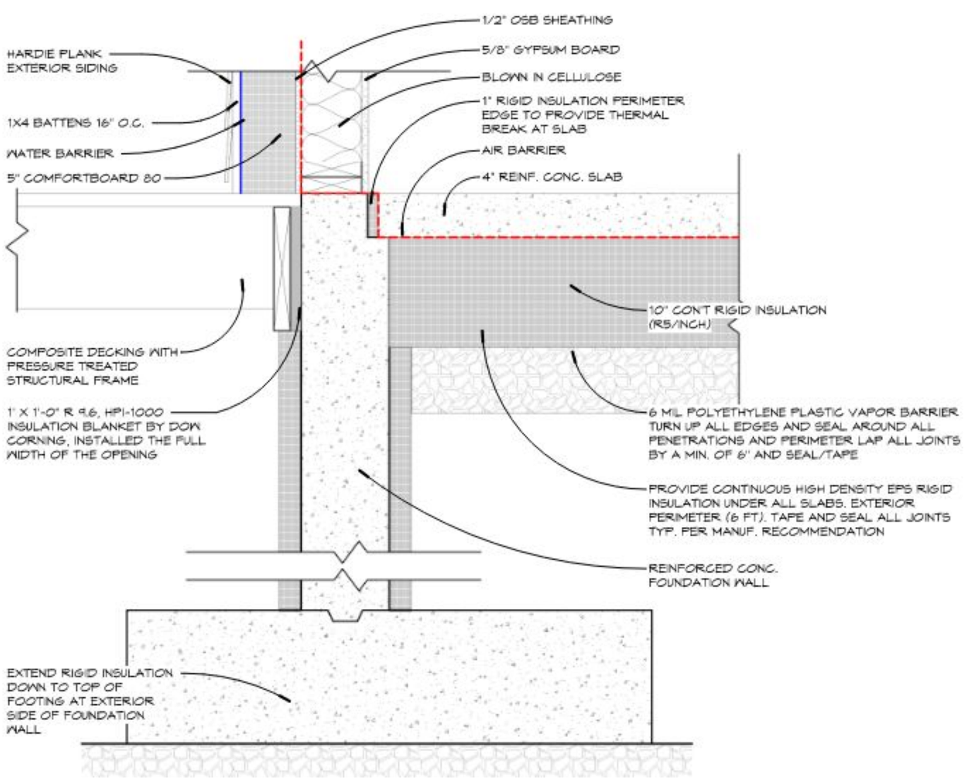




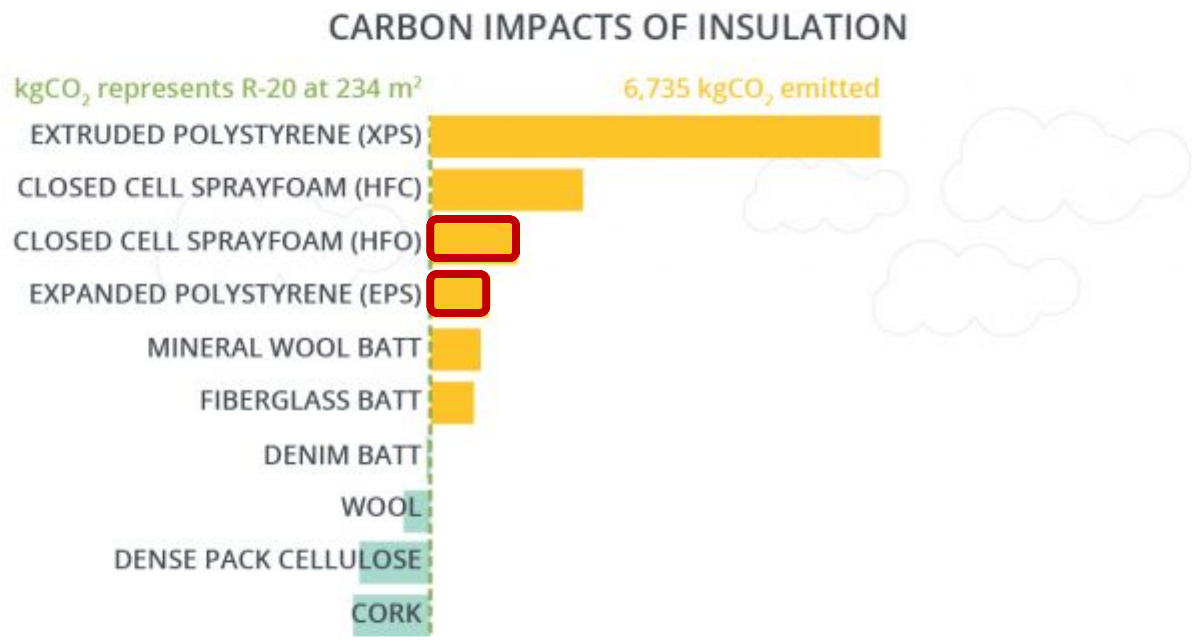
EC Reduction Challenge: Northland Newton B7



Eagleville Green



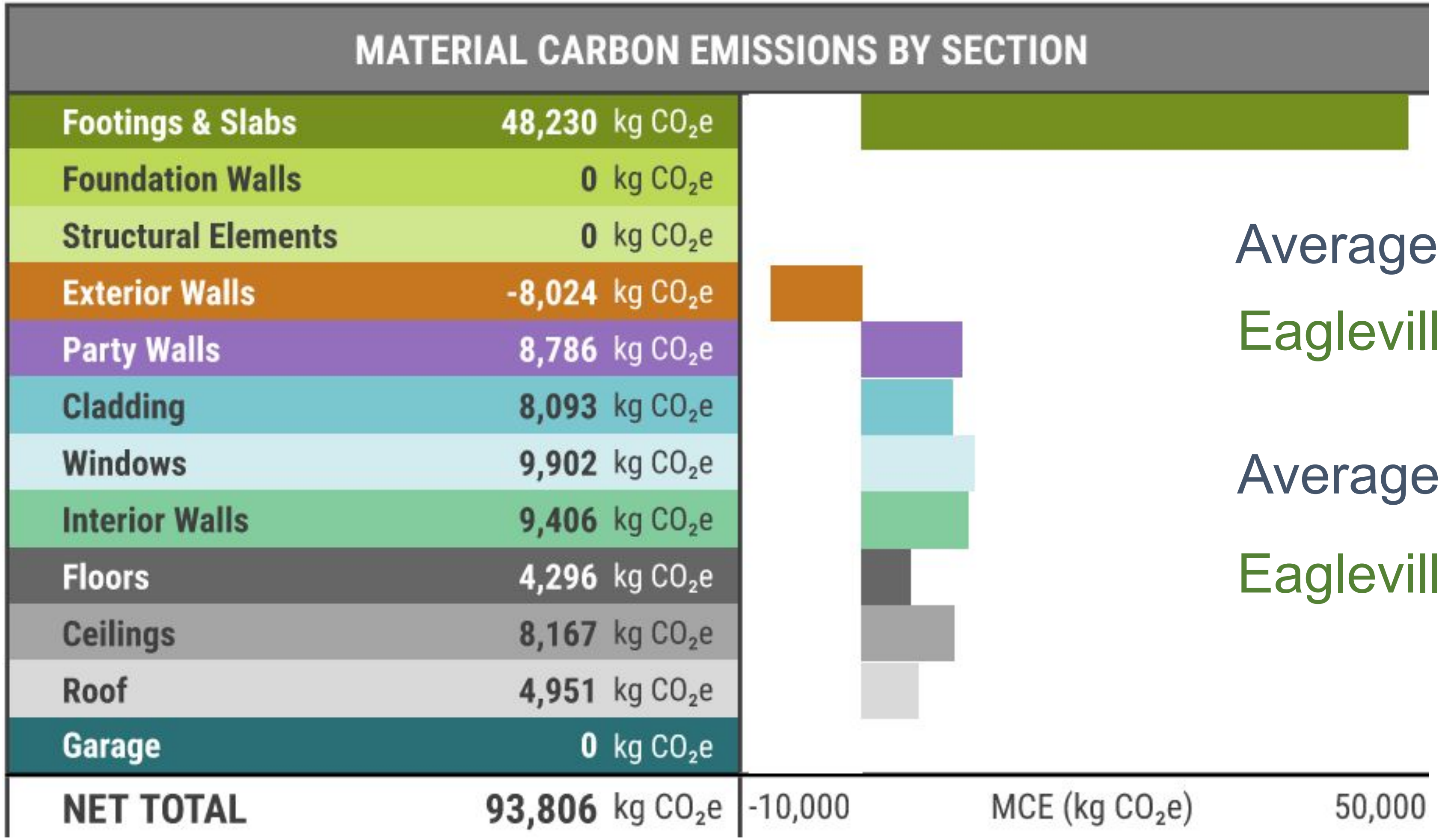
Eagleville Green



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)

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)

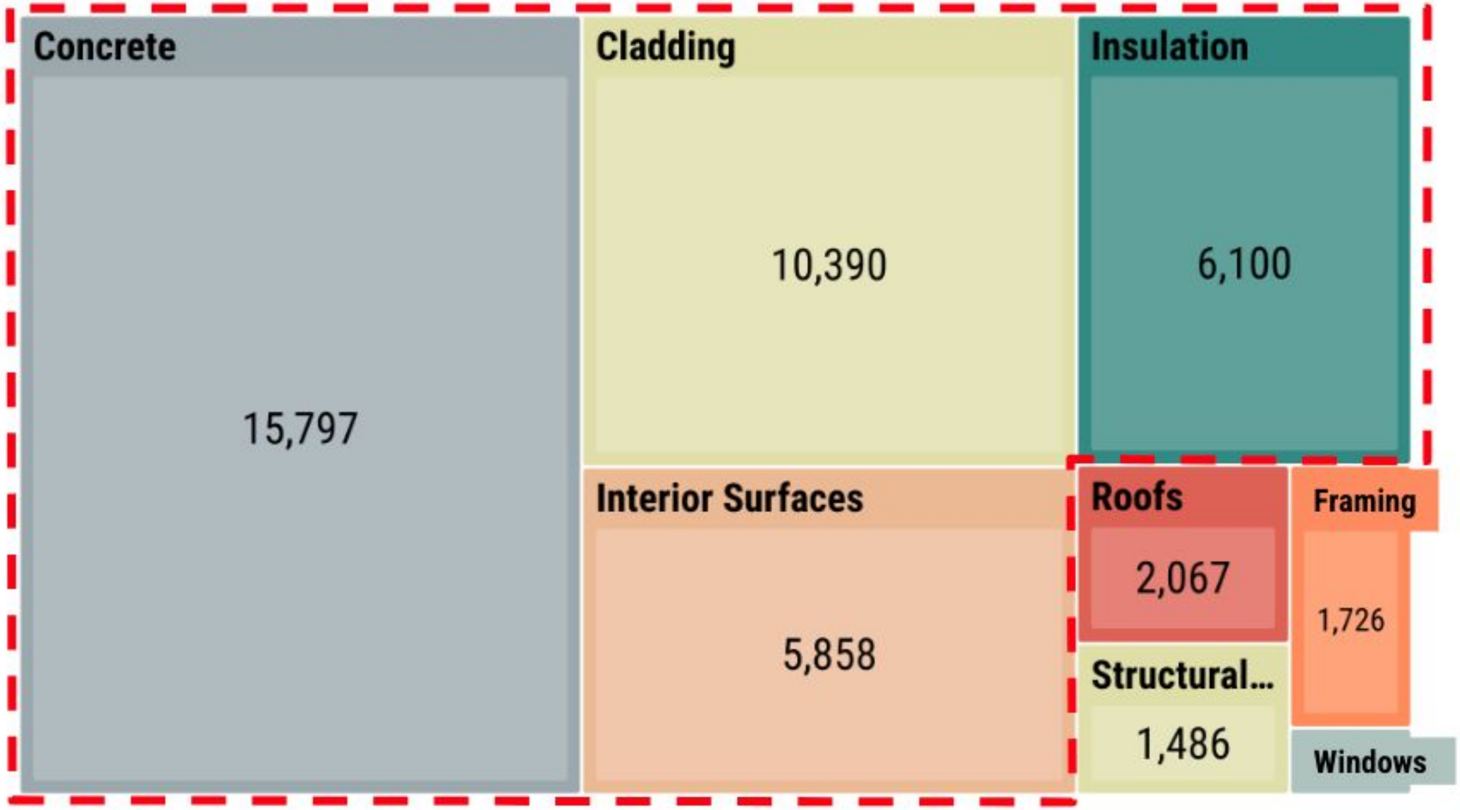
Eagleville is 8 beds (14 ppl)

Sample Case Study “Wrap Up” Slide

Net Zero As-Built - MCE Results per material

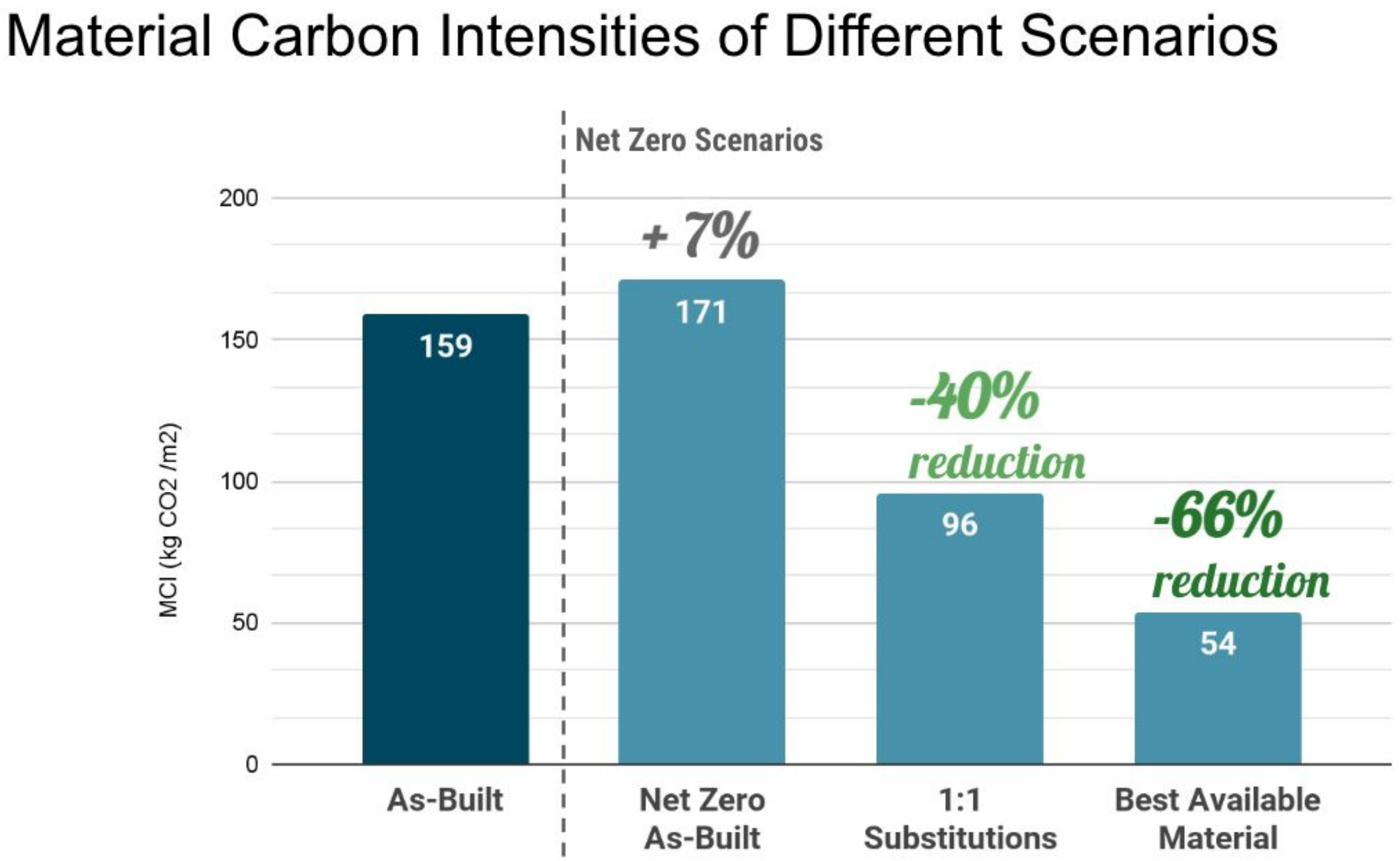
83% MCE from 4 material categories :

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

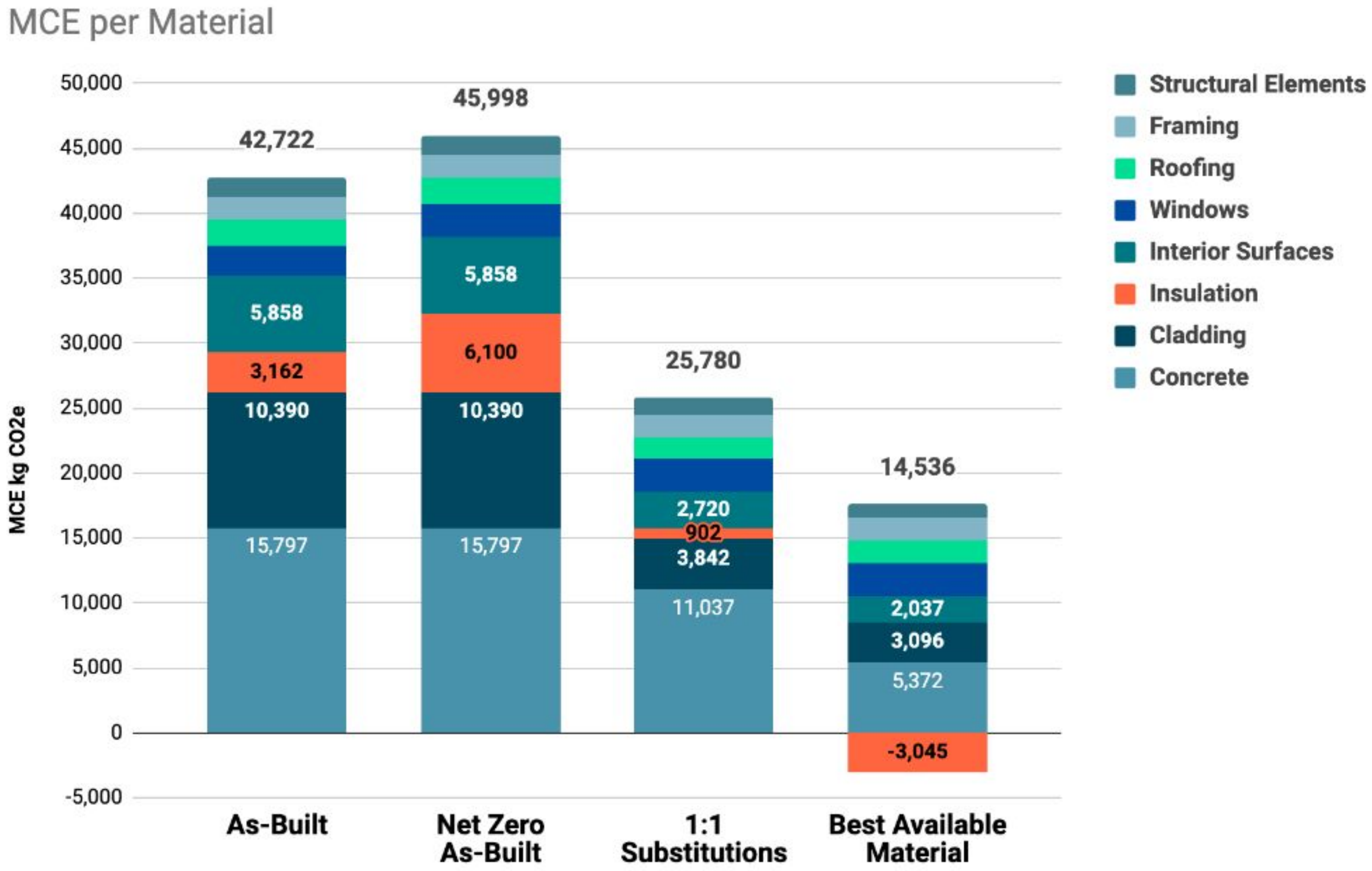


Net Zero As-Built - Total : 45,998 kg CO2e

Sample Case Study "Wrap Up" Slide



Sample Case Study "Wrap Up" Slide



Key Takeaways

We can reduce BOTH operational & embodied emissions! It’s not an either/or decision.

Stay ahead! **New standards, policies and incentives** are in development to support EC reduction efforts.

Leverage existing tools - integrate EC assessment seamlessly into existing workflows.

Act early! Use life cycle analysis from the start to **shape low-carbon design decisions**.

Reduction opportunities vary by building typology—tailor strategies accordingly.

Focus on high-impact materials—a small proportion of building materials drive the biggest results.

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					

Sample Workflow Slide

Athena Impact Estimator for Buildings

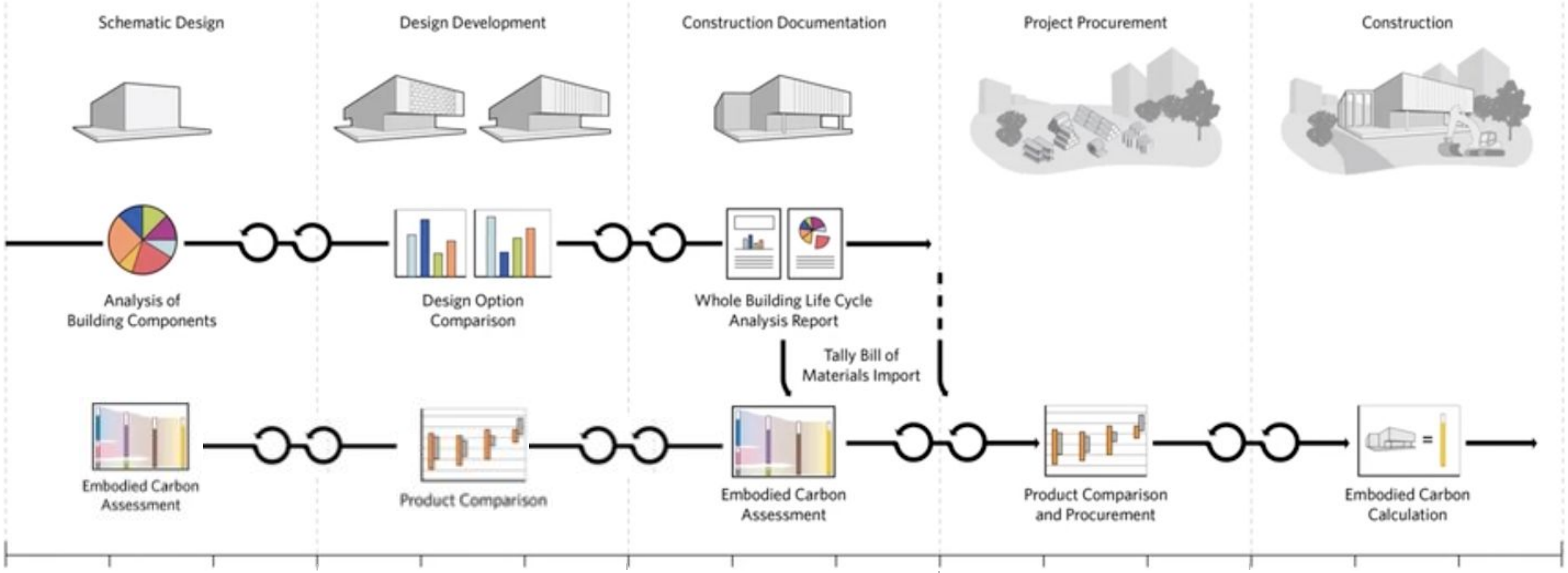
tally

One Click LCA

EC3

BEAM

BUILDING EMISSIONS ACCOUNTING FOR MATERIALS



Retrofit or Build?
Massing / Program
Materials Palette

Assemblies & Materials

Product Specification

Product Selection

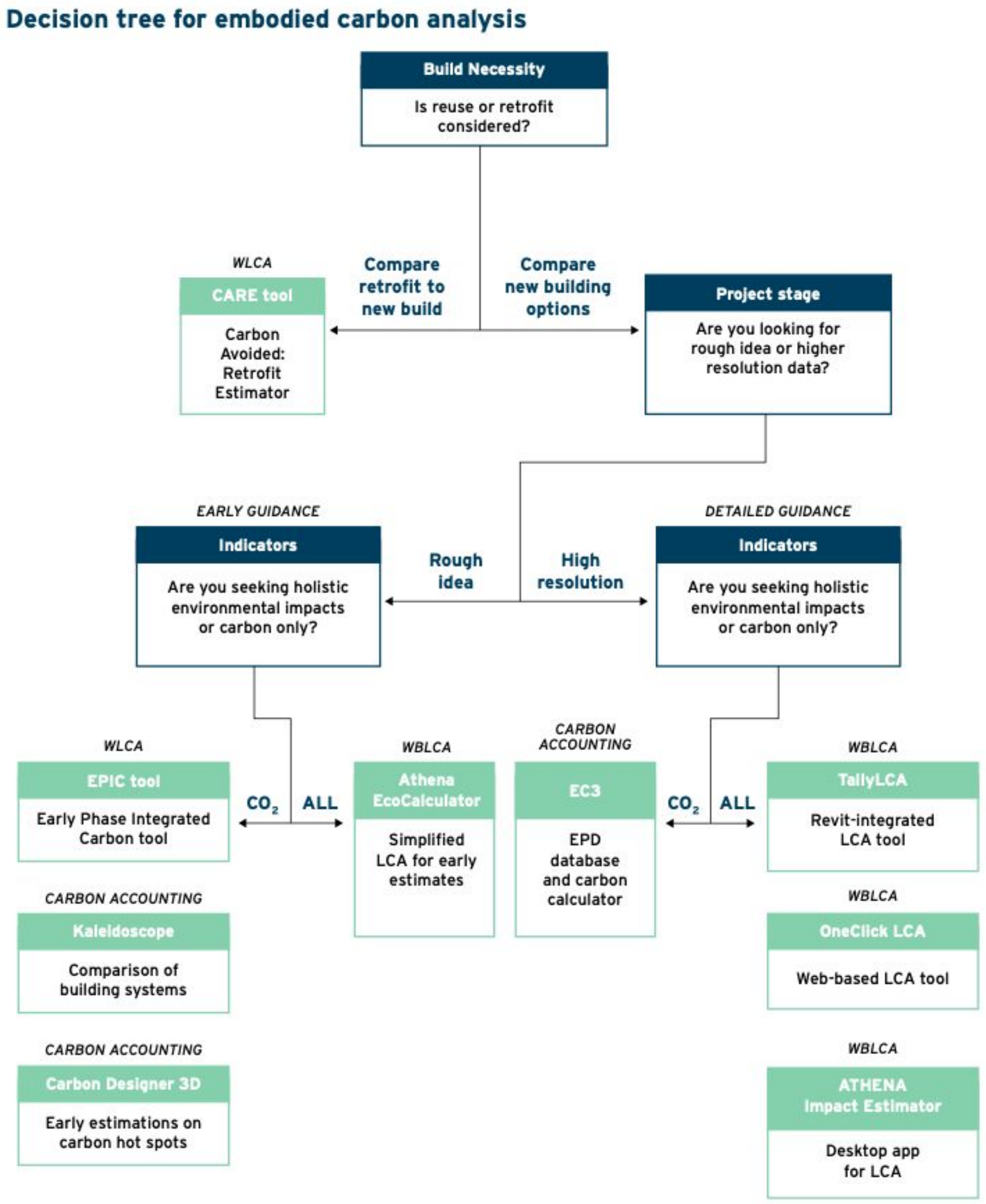
Product Submittals & Verification

epic.

CARE Tool

Kaleidoscope

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.