

From Position to Practice:

Taking Action on Operational and Embodied Carbon

Jacob Racusin, Builders for Climate Action
Chris Magwood, HomebuildersCAN at RMI



Why should we care about embodied carbon?



The Hidden Climate Impact of Residential Construction

Zeroing In on Embodied Carbon Emissions for Low-Rise Residential Buildings in the United States



Report / March 2023

2020-2023 Studies

2 billion square feet
per year new construction



53 million tons
CO₂e emissions



Austria	66.0
Greece	53.4
Hungary	50.7
Norway	42.3

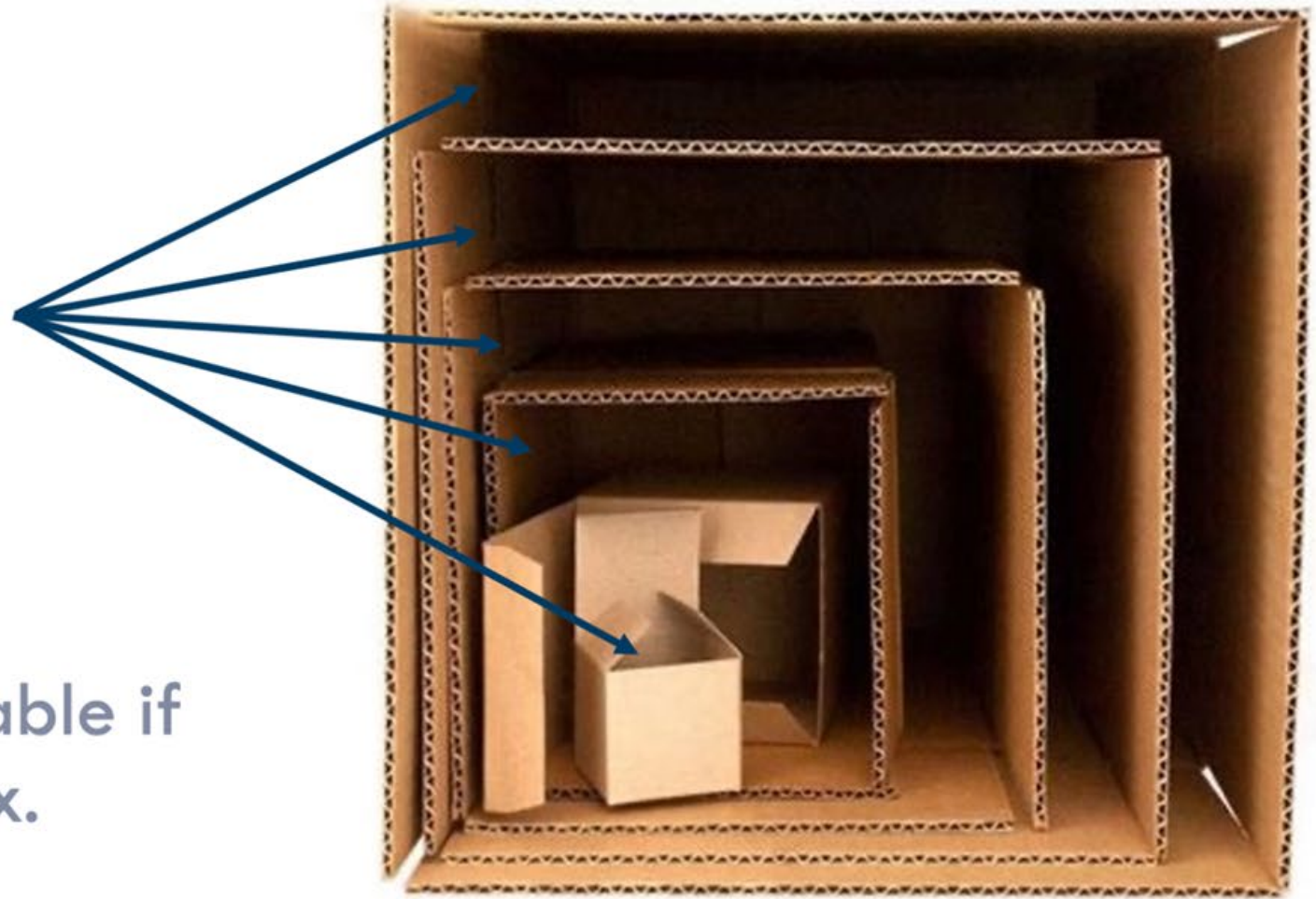
Why do we need a standard?

Life cycle stages

Project boundary

Building products

Results are only comparable if
we're using the same box.



Why a RESNET standard?



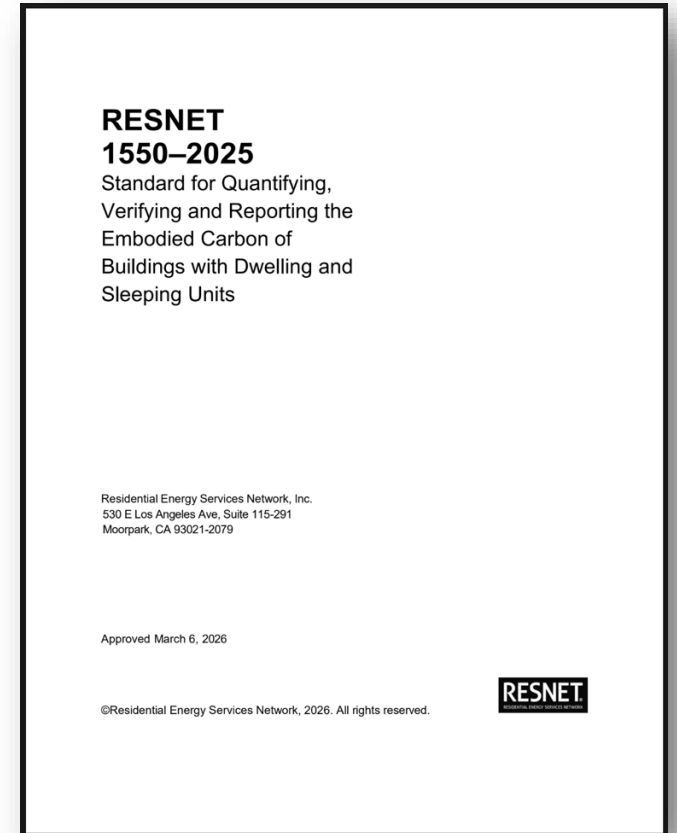
LEVERAGE EXISTING
MODELING DATA



RESNET Standard 1550

Purpose:

“...establish a methodology for **quantifying, verifying and reporting** the embodied carbon emissions associated with building products and buildings.”



RESNET Standard 1550

Life cycle modules:

Product Stage

Raw material
supply and
transport

Manufacture
products

A1-A2

A3



**Covered by
RESNET
Standard 1550**

Construction Stage

Transport
to site and
installation

A4-A5



Use and Maintenance Stage

Use and
maintenance

B1-B2



Repair and
refurbishment

B3-B5



Operational
energy and
water

B6-B7



**Covered by
HERS Index and
Carbon Index**

End-of-Life Stage

Deconstruction
and demolition

C1



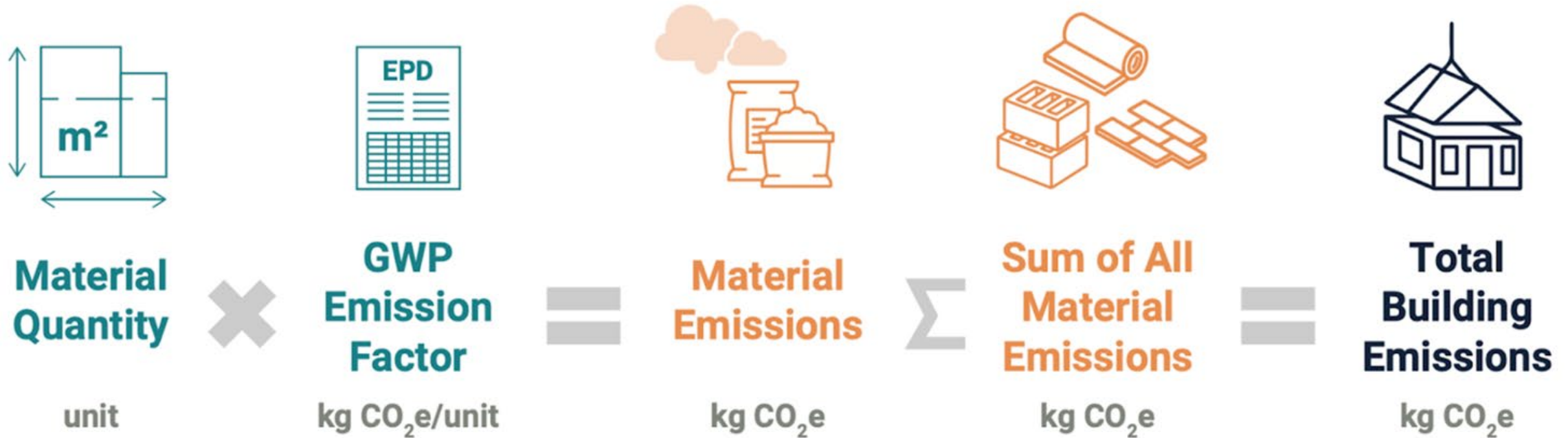
Waste transport
and processing
and disposal

C2-C4



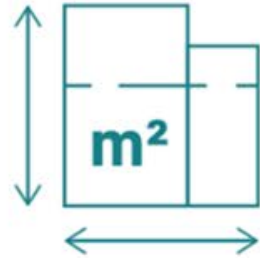
RESNET Standard 1550

Calculation methodology:



RESNET Standard 1550

Calculation methodology:



**Material
Quantity**

unit

1550 provides standard takeoff tables based on measurements aligned with HERS rating norms



**GWP
Emission
Factor**

kg CO₂e/unit

1550 provides data hierarchy to be used by tools to provide emissions factors

Building product categories

Taking a “drip-line in” approach



Included in Assessment:

Foundations & Slabs-on-grade

Exterior walls

Roofs

Interior construction

Interior finishes

Plumbing

HVAC

Electrical

Balconies, decks & porches

Garages (attached & detached)

Two types of assessment

Following HERS modeling method

Projected Assessment

Projected Assessments are generated prior to construction wherein the actual installed conditions, equipment, and systems are not yet completed or installed.

Confirmed Assessment

Confirmed Assessments are conducted, generated, and verified after completion of construction.

What are you looking to do today?

Pick a starting point. You can move between them at any time.



Explore

Materials

See what a product's emissions are, and how the alternatives compare.

[Browse the material library →](#)



Create

Assemblies

Put a wall, roof or floor together layer by layer, and compare build-ups.

[Create or open an assembly →](#)



Model

A whole building

Bring assemblies together for a building total, an intensity per floor area, and a report.

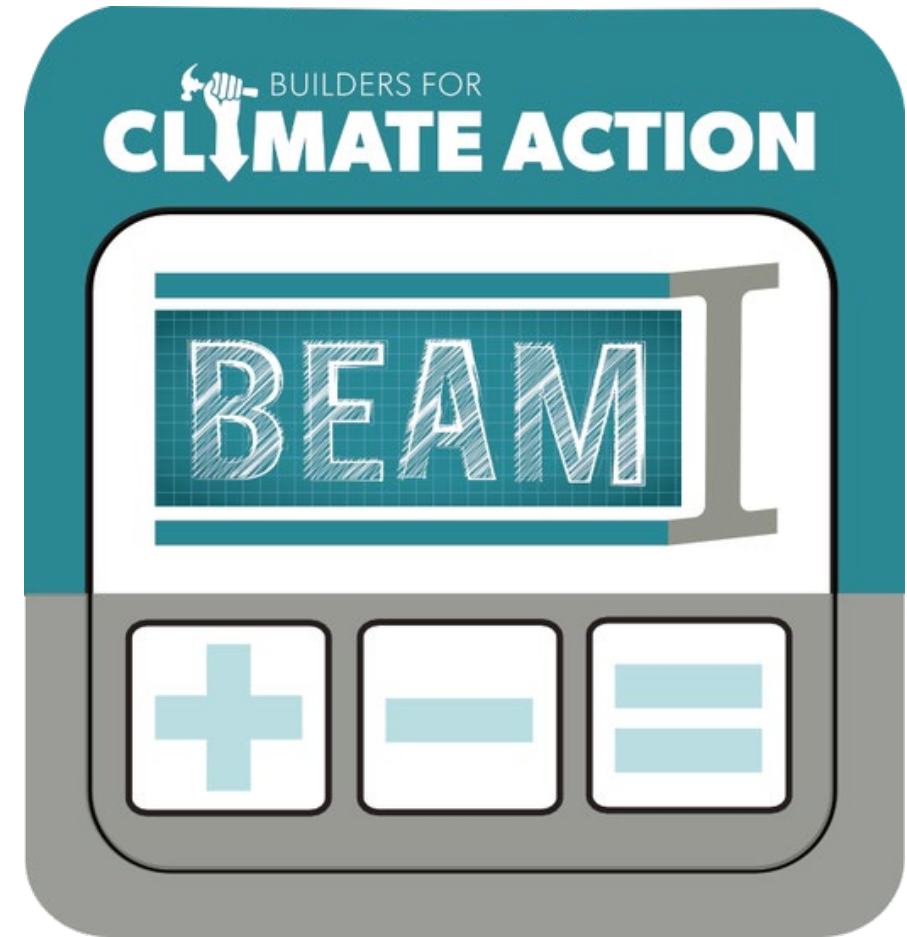
[Start or open a project →](#)

Or [continue test 3](#) · edited yesterday



Tools for Analysis

- Side-by-side material comparisons
- Assembly comparisons
- Whole building models & comparisons
- Compliance reporting & data mgmt
- **NEW** Pro features (coming soon!)



1- INPUT DIMENSIONS

- Area-based for a whole building
- 100 m² for materials/assembly comp

BEAM

BUILDING EMISSIONS ACCOUNTING TOOL

MaterialsAssembliesWhole buildings

Sample house (demo)BaselineREFERENCESample building

MetricImperial

Sample building — t CO₂eNotes

1 Dimensions2 Materials3 Energy4 Review5 Results6 Summary7 Reports

FilesHistorySharing

FOUNDATION

Footings concrete volume (ft³) ☐ N/A

316.6136

Used as the concrete volume for continuous footings, column pads & piers and pile foundations, and to size their rebar.

Foundation wall area (ft²) ☒ N/A

Marked not applicable — untick N/A to use this dimension.

Used to calculate quantities for foundation walls: concrete, CMU or earthen masonry and its fill, ICF and treated-wood systems, framed foundation walls, rebar, continuous and cavity insulation, barriers & membranes, and interior wall cladding.

Slab area (ft²) ☐ N/A

1188.3357

Used to calculate quantities for slabs: concrete slabs and earthen floor systems, rebar and reinforcing mesh, sub-slab insulation, barriers & membranes, basement flooring, and aggregate base.

WALLS & OPENINGS

Exterior wall area (gross) (ft²) ☐ N/A

2377.7478

Enter the gross area; the window & glazed opening area below is subtracted automatically. Used to calculate quantities for exterior walls — framing (wood, steel or TJI studs), structural sheathing, barriers & membranes, cavity and continuous insulation, laminated timber, CMU, ICF, earthen and SIP wall systems — and for the Cladding section: exterior wall cladding, strapping/furring, and interior cladding for exterior walls.

Window & glazed opening area (ft²) ☐ N/A

356.2854

Used to calculate quantities for double- and triple-glazed windows, and subtracted from the exterior wall area for framing, sheathing, insulation, membranes and cladding.

Party wall area (ft²) ☒ N/A

Marked not applicable — untick N/A to use this dimension.

Used to calculate quantities for party walls: framing (wood or steel), CMU and its fill, ICF systems, structural sheathing, barriers & membranes, cavity and continuous insulation, and interior cladding for party walls.

Interior wall area (ft²) ☐ N/A

2746.1943

Used to calculate quantities for interior walls: framing (wood or steel), interior wall systems, cladding for interior walls, and cavity insulation. Enter the area of the walls themselves; model cladding once for each finished face.

FLOORS & CEILINGS

Framed floor area (ft²) ☐ N/A

1123.7522

Used to calculate quantities for floors: floor framing (wood, steel joists, laminated timber panels or SIPs), sub flooring, underlayment, flooring, and floor cavity insulation. Measure to the outside face of the framing and subtract stair openings.

2- SELECT

- Compare materials at a glance
- Create and store assemblies

BEAM

BUILDING EMISSIONS ACCOUNTING FOR MATERIALS

MaterialsAssembliesWhole buildings

MetricImperialENFRJR

Sample house (demo)BaselineREFERENCESample building ▾

Sample building ▾ t CO₂eNotes

① Dimensions② Materials③ Energy④ Review⑤ Results⑥ Summary⑦ Reports

FilesHistorySharing

Footings & slabsExterior wallsCladdingWindowsInterior wallsFloor assemblyRoofFoundation wallsStructural elementsParty walls

+ New assembly

Footings & slabs

7,595.7 net kg CO₂e

Save to assembly library

☐

Not applicable

In this assembly

Type	Material	Additional factor	% of assembly	Amount	Emissions (gross) kg CO ₂ e	Stored carbon kg CO ₂ e	Net kg CO ₂ e	
CONCRETE - <= 2500 psi - N.AMERICA	Concrete - 0-2500 psi, Standard mix / NRMCA [Industry Avg US & CA]	Thickness (in) 6	100	594.1679 ft ³	4,703.6	—	4,703.6	Remove
CRUSHED STONE	Aggregate / NRMCA / US Average [Industry Avg]	Thickness (in) 6	100	594.1679 ft ³	269.4	—	269.4	Remove
WELDED/WOVEN WIRE MESH	Welded wire reinforcement / Insteel Industries / 6" x 6" x 6/6g [US & CA]	—	100	1188.3357 ft ²	391.5	—	391.5	Remove
SHEET BARRIER	Barrier, sheet / Polyethylene sheet / 10 mil	—	100	1188.3357 ft ²	67.3	—	67.3	Remove
LAMINATE FLOORING	Rigid core vinyl flooring / Resilient Floor Covering Institute [Industry Avg US & CA]	—	70	831.835 ft ²	1,584.2	—	1,584.2	Remove
CERAMIC TILE FLOORING	Ceramic tile / Tile Council of North America/ 18.8 kg/m2 / [Industry Avg US & CA]	—	30	356.5007 ft ²	467	—	467	Remove
STEEL REINFORCING BARS - US BAR SIZES	Rebar / Concrete Reinforcing Steel Institute / 98% recycled, EAF / [Industry Avg N.America] / #5	Total length (ft) 277.88	100	277.8871 ft	112.6	—	112.6	Remove

Search for a material to add...

Use custom EPD

3- REVIEW

- QA/QC model inputs
- Identify emission and storage hotspots



BUILDING EMISSIONS ACCOUNTING FOR MATERIALS

MaterialsAssembliesWhole buildings

MetricImperial

ENFR

JR

Sample house (demo) · Baseline **REFERENCE** · Sample building ·

Sample building — t CO₂e Notes

1 Dimensions

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4 Review

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7 Reports

FilesHistorySharing

Check the model over: every selection, quantity, and open question in one place.

Scenario shown

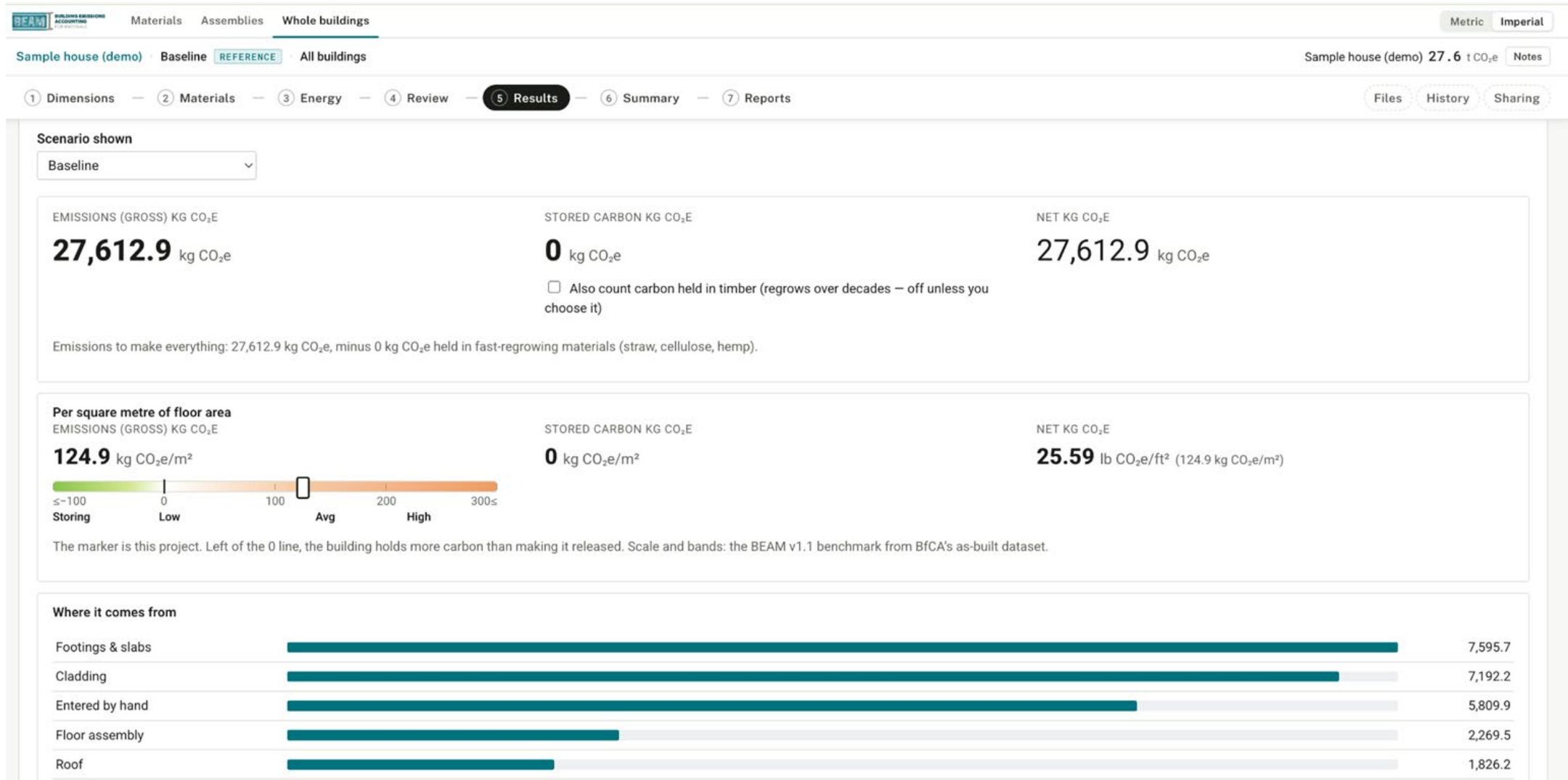
Baseline

Emissions (gross) 27,612.9 kg CO₂e Stored carbon 0 kg CO₂e Net 27,612.9 kg CO₂e

Material	Category	Inputs as entered	Quantity	Emissions (gross) kg CO ₂ e	Stored carbon kg CO ₂ e	Net kg CO ₂ e
▼ Footings & slabs				7 · 7,595.7 kg CO ₂ e		
Concrete - 0-2500 psi, Standard mix / NRMCA [Industry Avg US & CA] expired EPD	CONCRETE – <= 2500 psi – N.AMERICA	6 in	594.168 ft³	4,703.6	—	4,703.6
Aggregate / NRMCA / US Average [Industry Avg] expired EPD	CRUSHED STONE	6 in	594.168 ft³	269.4	—	269.4
Welded wire reinforcement / Insteel Industries / 6" x 6" x 6/6g [US & CA]	WELDED/WOVEN WIRE MESH	—	1,188.336 ft²	391.5	—	391.5
Barrier, sheet / Polyethylene sheet / 10 mil	SHEET BARRIER	—	1,188.336 ft²	67.3	—	67.3
Rigid core vinyl flooring / Resilient Floor Covering Institute [Industry Avg US & CA] expired EPD	LAMINATE FLOORING	70%	831.835 ft²	1,584.2	—	1,584.2
Ceramic tile / Tile Council of North America/ 18.8 kg/m2 / [Industry Avg US & CA] expired EPD	CERAMIC TILE FLOORING	30%	356.501 ft²	467	—	467
Rebar / Concrete Reinforcing Steel Institute / 98% recycled, EAF / [Industry Avg N.America] / #5	STEEL REINFORCING BARS - US BAR SIZES	—	277.887 ft	112.6	—	112.6
▼ Exterior walls				4 · 1,383.4 kg CO ₂ e		
Wood / SPF / 2x6 Lumber / AWC & CWC [Industry Avg US & CA] expired EPD	FRAMING LUMBER – SPRUCE-PINE-FIR	structure @16"	505.366 ft²	414	—	414
OSB sheathing / 5/8" / AWC & CWC [Industry Avg US & CA] expired EPD	ORIENTED STRAND BOARD (OSB)	—	2,021.462 ft² at 0.0159 m (5/8")	723.4	—	723.4
Int. Wall & Ceiling Barrier, sheet / Rothoblaas / Clima Control 80 / Moisture-variable / 0.22 mm / EU expired EPD	SHEET BARRIER MOISTURE-VARIABLE	98.37%	1,988.549 ft²	136.2	—	136.2

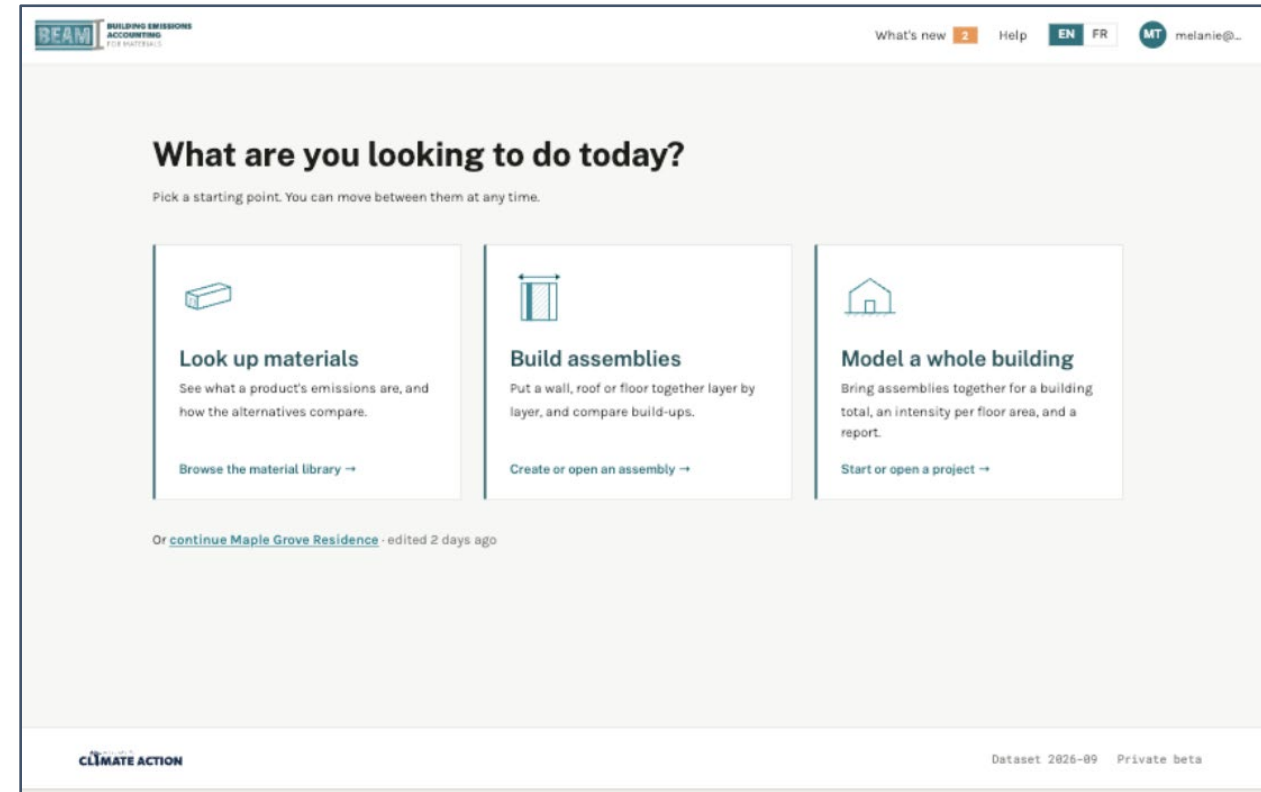
4- SHARE

- Report results & share with team
- Built-in analysis to guide decisions



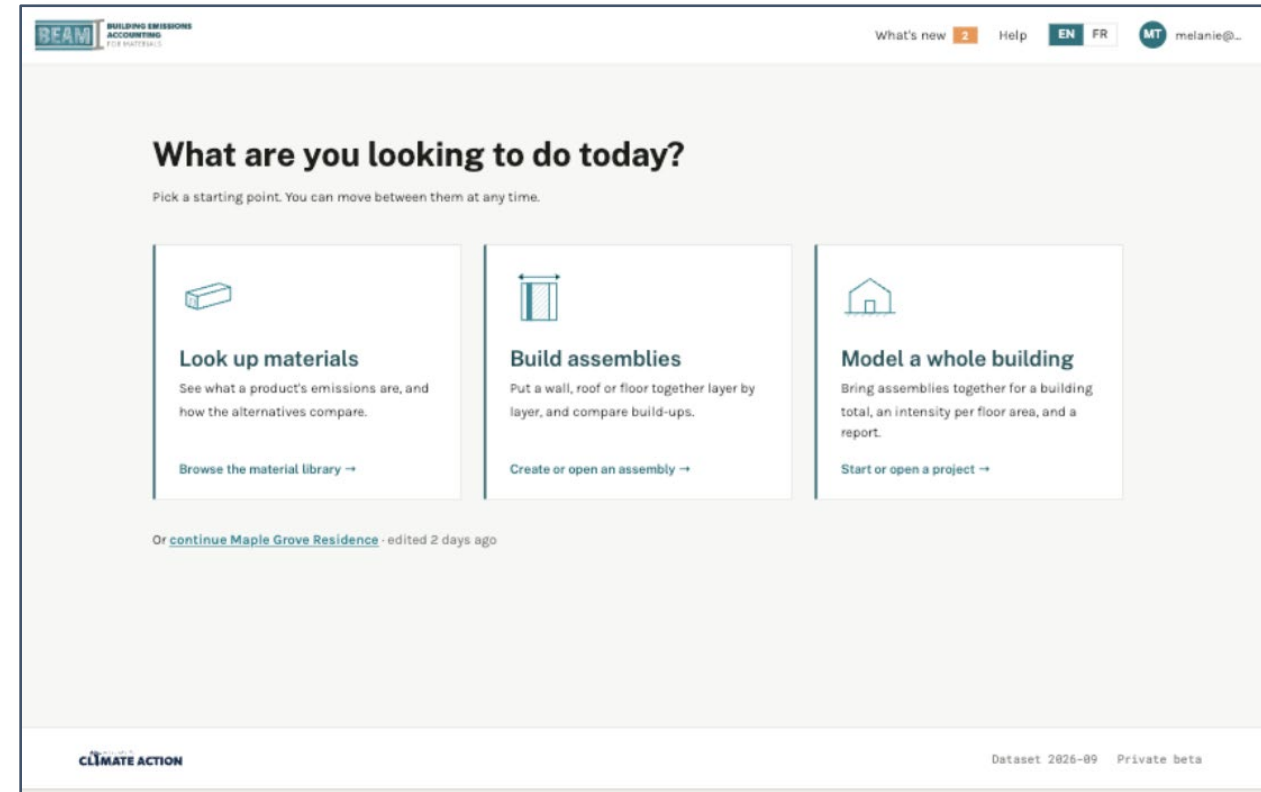
Coming Soon: BEAM 2.0!

- Web+ application
- Interfaces for raters and others
- Expanded data and sourcing
- Energy data / HOT2000
- New: paint, MEP, stairs, more!
- Compliance: 1550, VBBL, NMBC



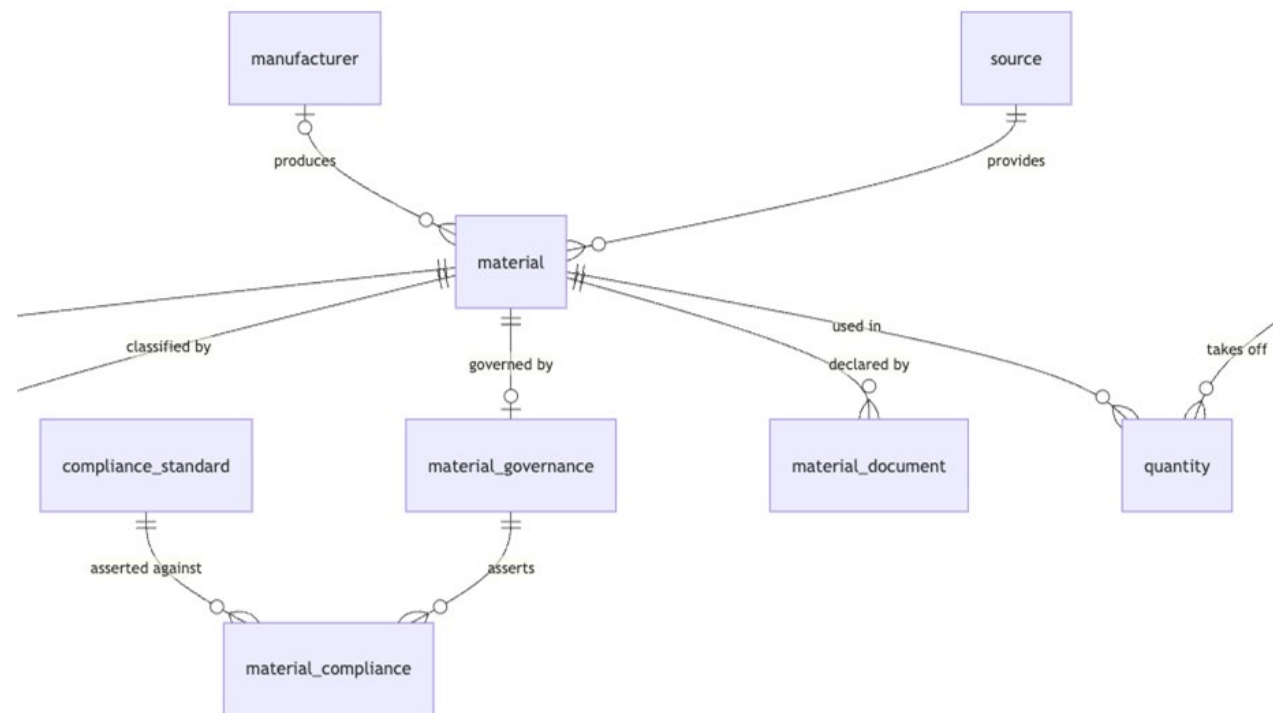
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Bldg 2 *Saved*

Run mode: **manual**

Annual energy (kWh/yr)
7670

Annual operational carbon: **260.8 kgCO₂e/yr**

Operational emission factor
NBC 2025 (proposed) electricity — Ontario (Ontario) — 0.034 kgCO₂e/kWh

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☐ Mechanical		Subtotal :	5768 Kg CO2e
Heating and Cooling Equipment			
Natural Gas Furnace	Equip capacity :	0 kBtu capacity	0
Ducted Heat Pump + Compressor	Equip capacity :	5 tons	3420
Mini-Split Heads + Compressor	Equip capacity :	1 tons	720
Central A/C Compressor	Equip capacity :	0 tons	0
Electric Aux Heater	Equip capacity :	0 kBtu capacity	0
Electric Baseboard	Equip capacity :	0 kBtu capacity	0
Gas boiler	Equip capacity :	0 kBtu capacity	0
Air-to-water heat pump	Equip capacity :	0 tons	0
Ground source heat pump equipment	Equip capacity :	0 tons	0
Ground source heat pump ground loop borehole	Li. feet of borehole :	0 linear foot	0
Other Equipment			
Fan coil	Equip capacity :	0 tons	0
Exhaust Fan (e.g. bath, range hood)	Number of Fan :	0 unit	0
Balanced ventilation with energy recovery	Number of units:	1 unit	350
Pump, small (e.g. circulator)	Number of small pump :	0 unit	0
Pump, large (e.g. sump, booster)	Number of large pump :	0 unit	0
Distribution			
Ductwork heating and cooling	Duct area, sq ft	380 sq ft of duct	912
Ductwork heating and cooling insulation	Duct area, sq ft	0 sq ft of duct	0
Ventilation supply distribution ductwork is shared with heating/cooling distribution		☐	
Ventilation return distribution ductwork is shared with heating/cooling distribution		☐	
Ductwork ventilation	Duct area, sq ft	152 sq ft of duct	365
Ductwork ventilation insulation	Duct area, sq ft	8 sq ft of duct	1
Hydronic radiant distribution	Sq ft radiant surface :	0 sq ft	0
Hydronic baseboard	Equip capacity :	0 kBtu	0

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RESNET

1550–2025

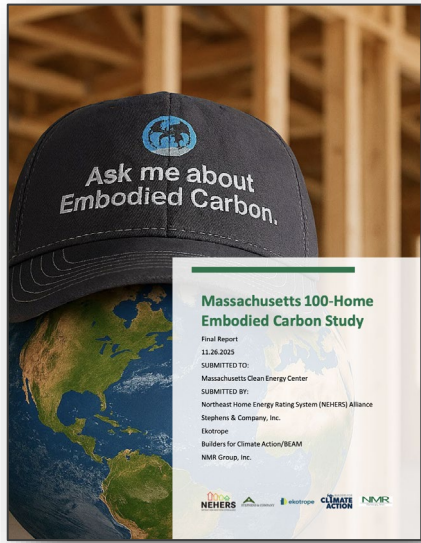
Standard for Quantifying,
Verifying and Reporting the
Embodied Carbon of
Buildings with Dwelling and
Sleeping Units

Residential Energy Services Network, Inc.
530 E Los Angeles Ave, Suite 115-291
Moorpark, CA 93021-2079

Approved March 6, 2026

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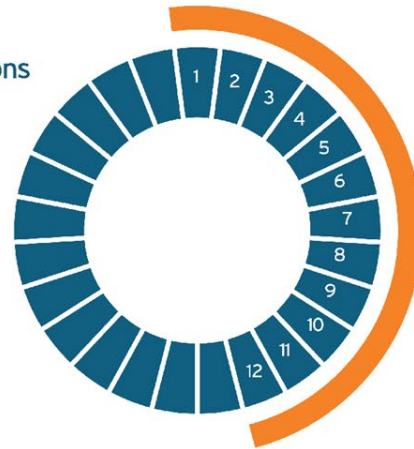


MASSACHUSETTS 100-HOME EMBODIED CARBON STUDY KEY FINDINGS

The average up-front embodied carbon for new homes in the study is 56 tons CO₂e.

This makes up 32% of total operational and embodied carbon emissions over a 25-year period.

118 tons CO₂e:
Operational emissions
over 25 years



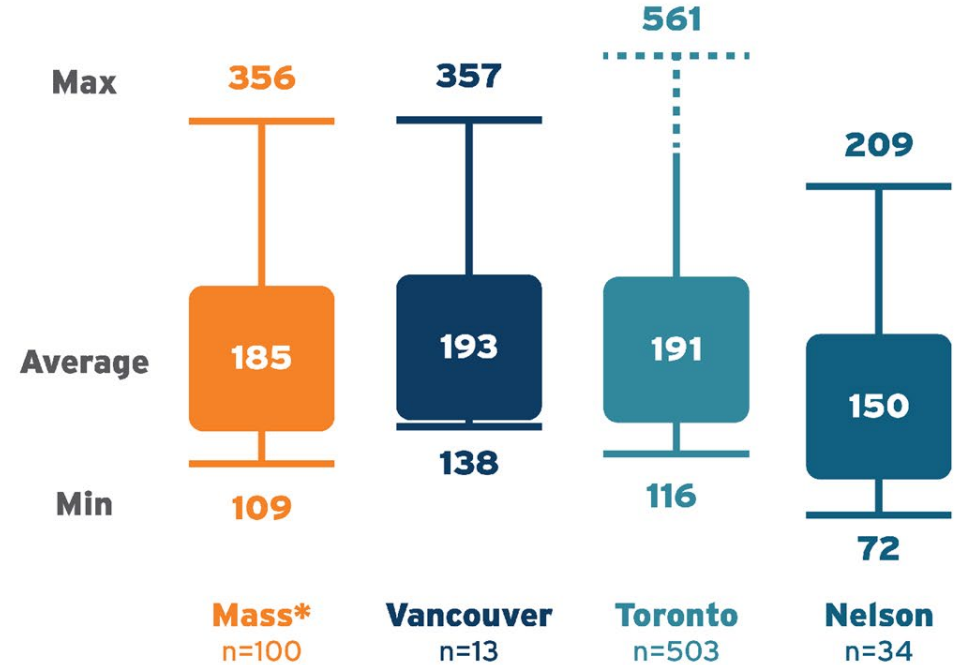
56 tons CO₂e:
Embodied emissions
equates to 12 years of
operational emissions



MASSACHUSETTS 100-HOME EMBODIED CARBON STUDY KEY FINDINGS

ECI Benchmarks from Previous Studies

(kgCO₂e/m² CFA, excluding MEPs)



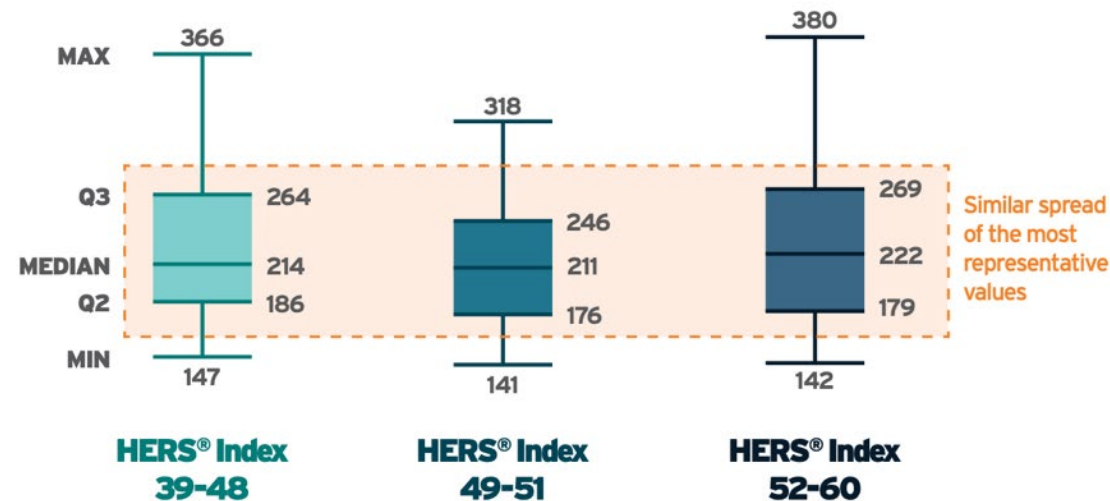
*MEP excluded from results to ensure comparability with other studies.

MASSACHUSETTS 100-HOME EMBODIED CARBON STUDY KEY FINDINGS

The level of energy efficiency is not a predictor of embodied carbon performance.

The spread of embodied carbon intensities across different ranges of HERS® Scores mostly stays the same with similar medians and quartiles.

Net Embodied Carbon Intensities per Conditioned Floor Area by HERS® Index (kg CO₂e/m²)



ECE and energy efficiency

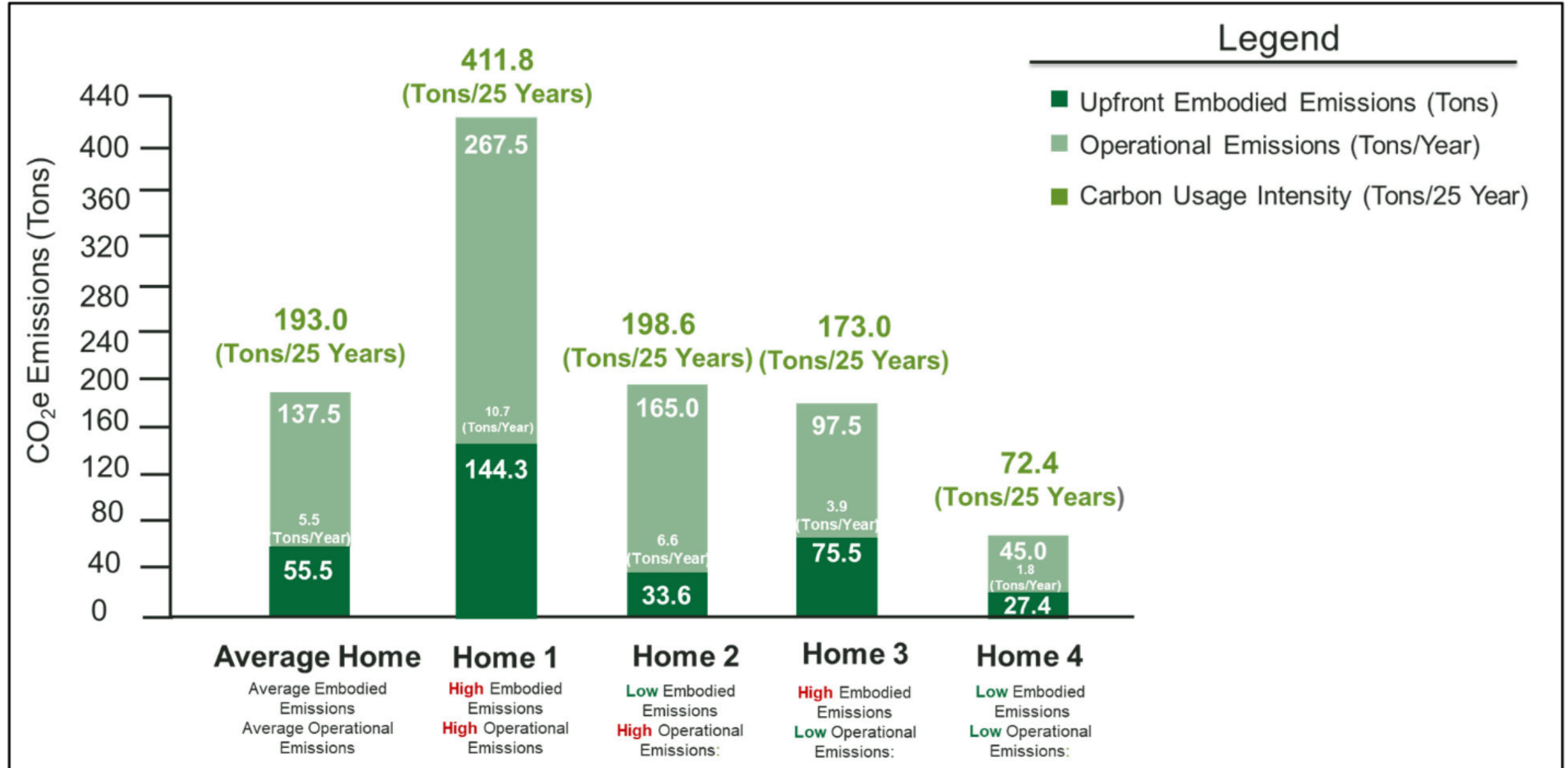
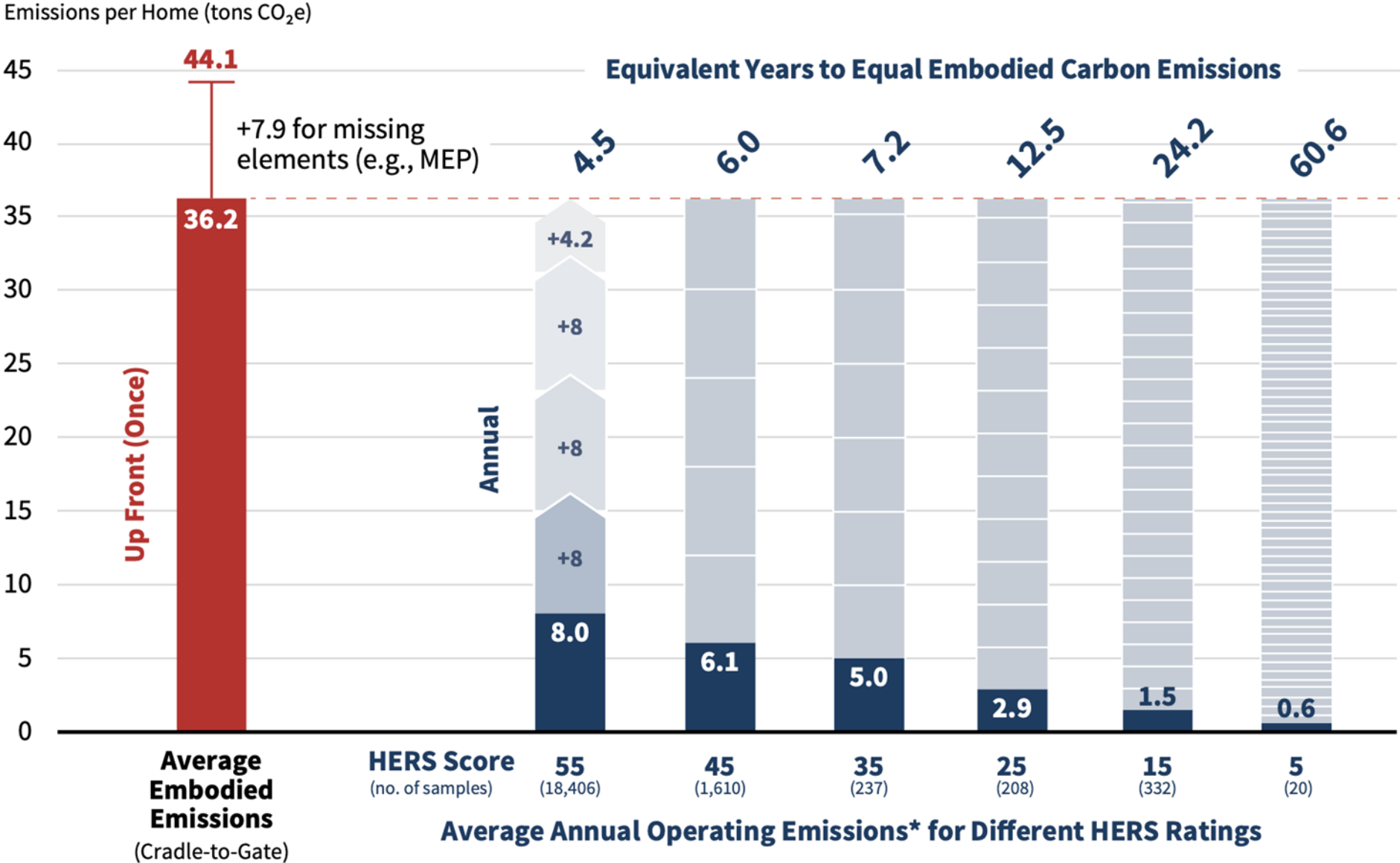


Exhibit 2 **Average Embodied Carbon Emissions per Home Compared with Operational GHG Emissions for a Range of HERS Scores**



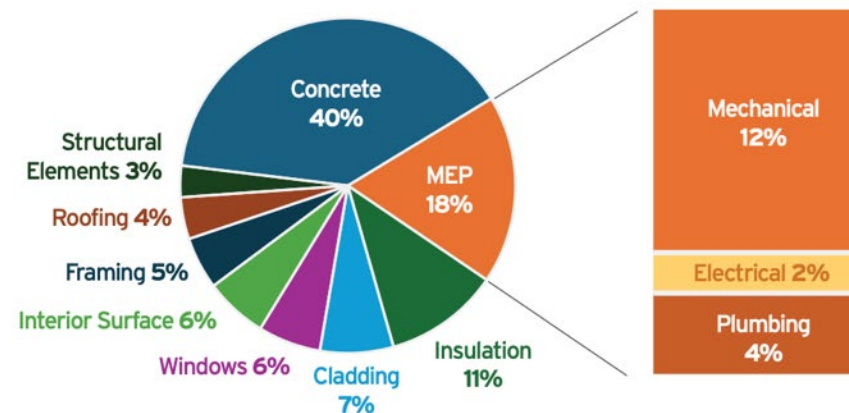
*Annual operating emissions data collected from HERS carbon index.

Source: RMI analysis, data provided by RESNET

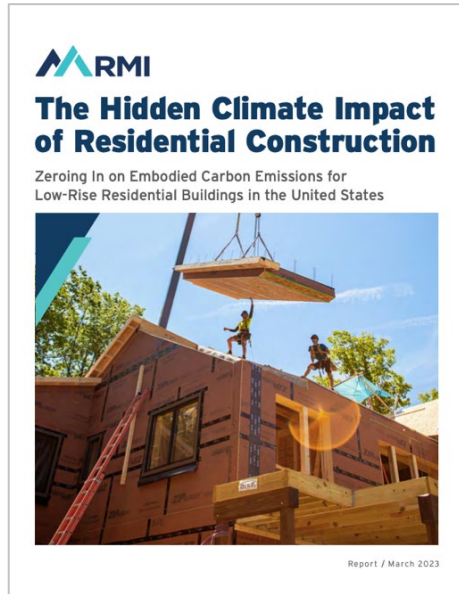
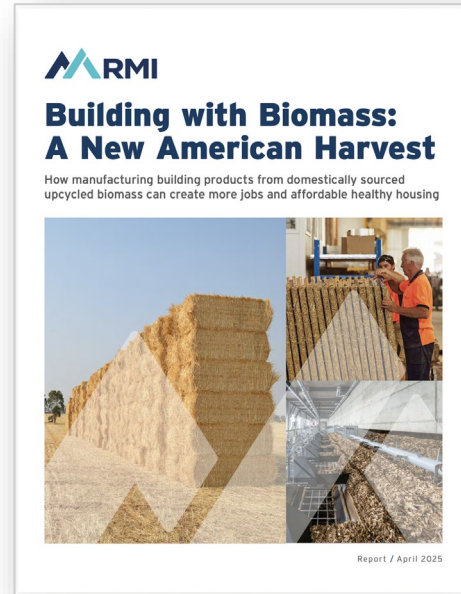
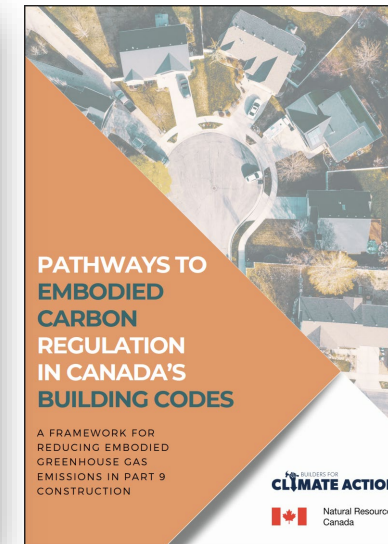
MEP systems were measured for the first time and contribute an average 18% of embodied carbon.

Mechanical systems dominate embodied carbon contributions within the category of MEP products.

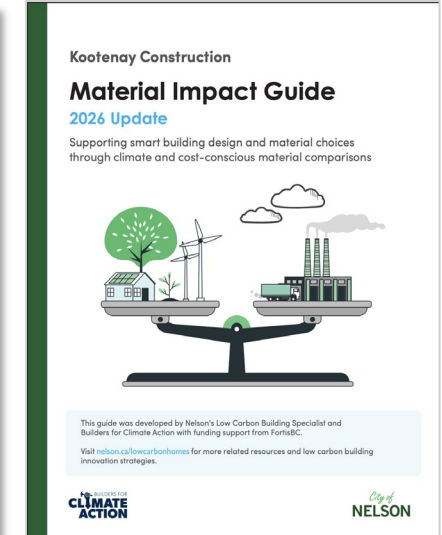
Gross Material Emissions by Category (% contribution of total)



Resources



<https://rmi.org/our-work/buildings/embodied-carbon-initiative/>



<https://www.buildersforclimateaction.org/our-work.html>