Total Building Carbon: Unlocking the Energy/Carbon Nexus

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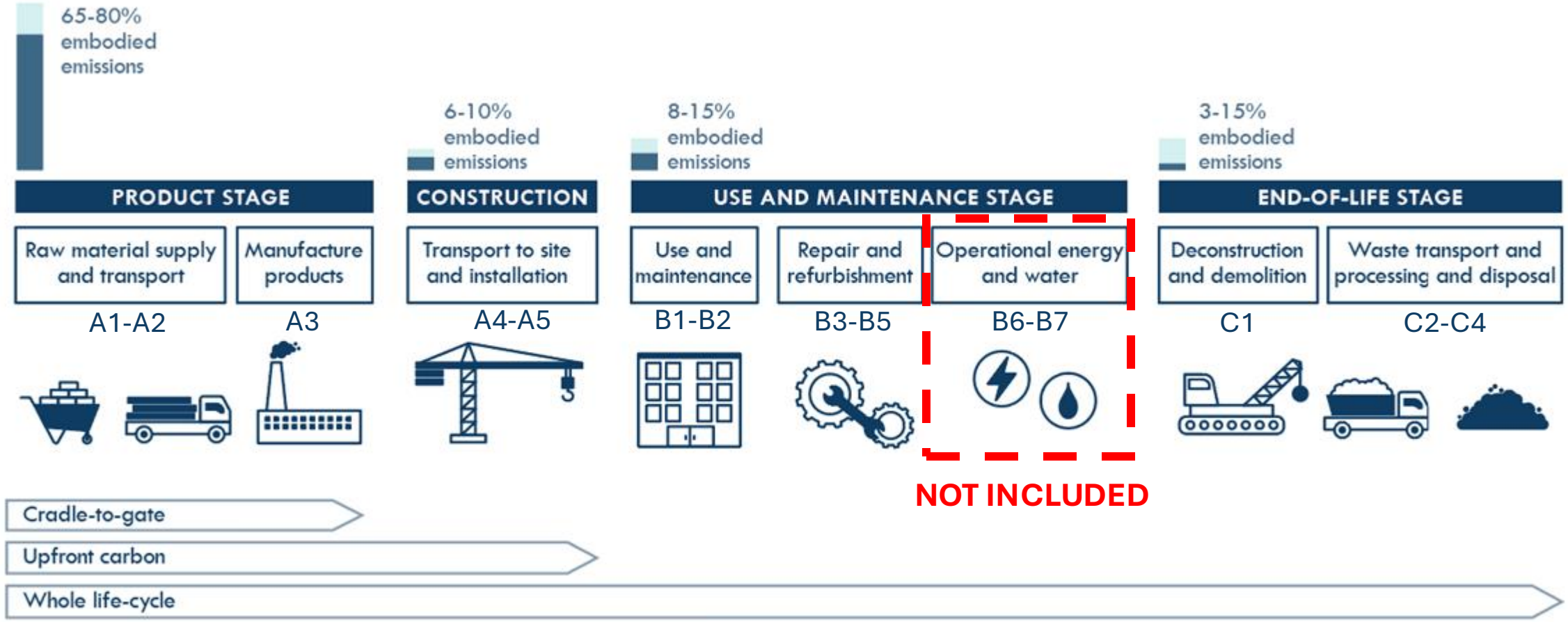
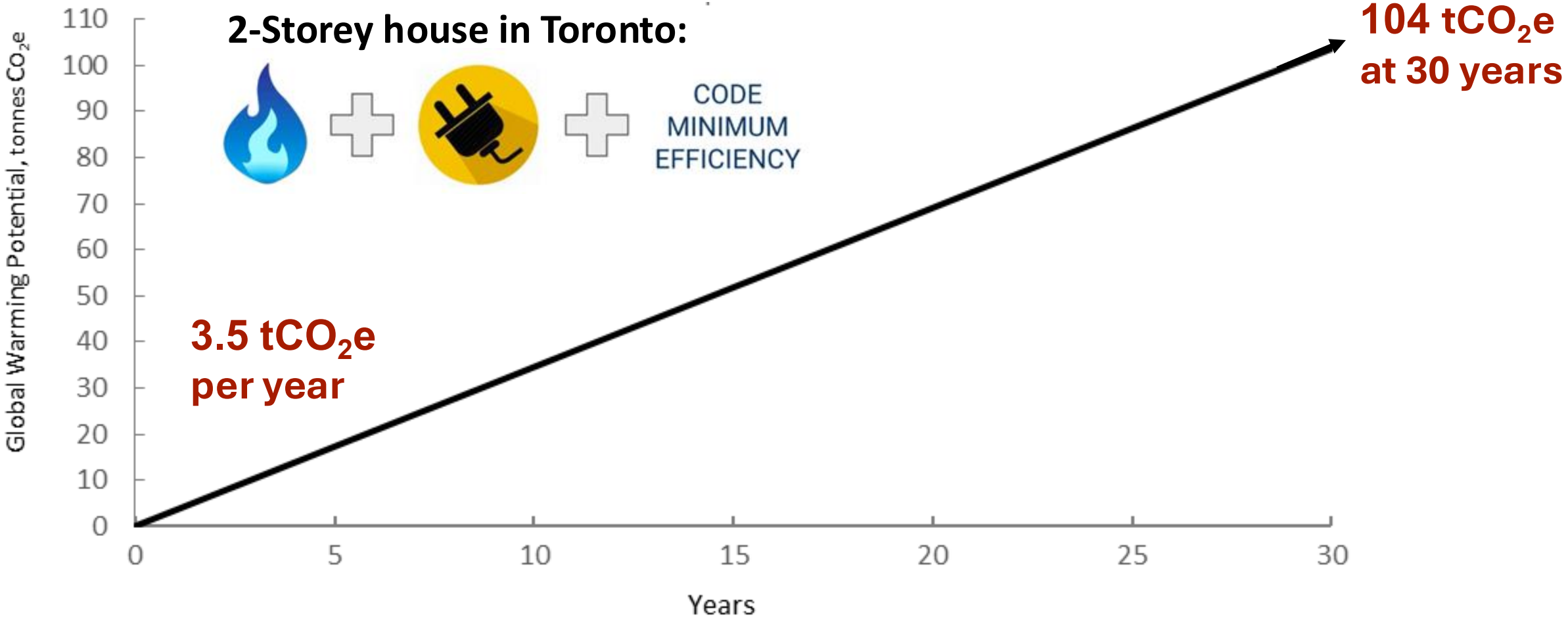
Lead Researcher and BEAM Developer
Builders For Climate Action

Embodied CO_2e Life Cycle Stage Calculations

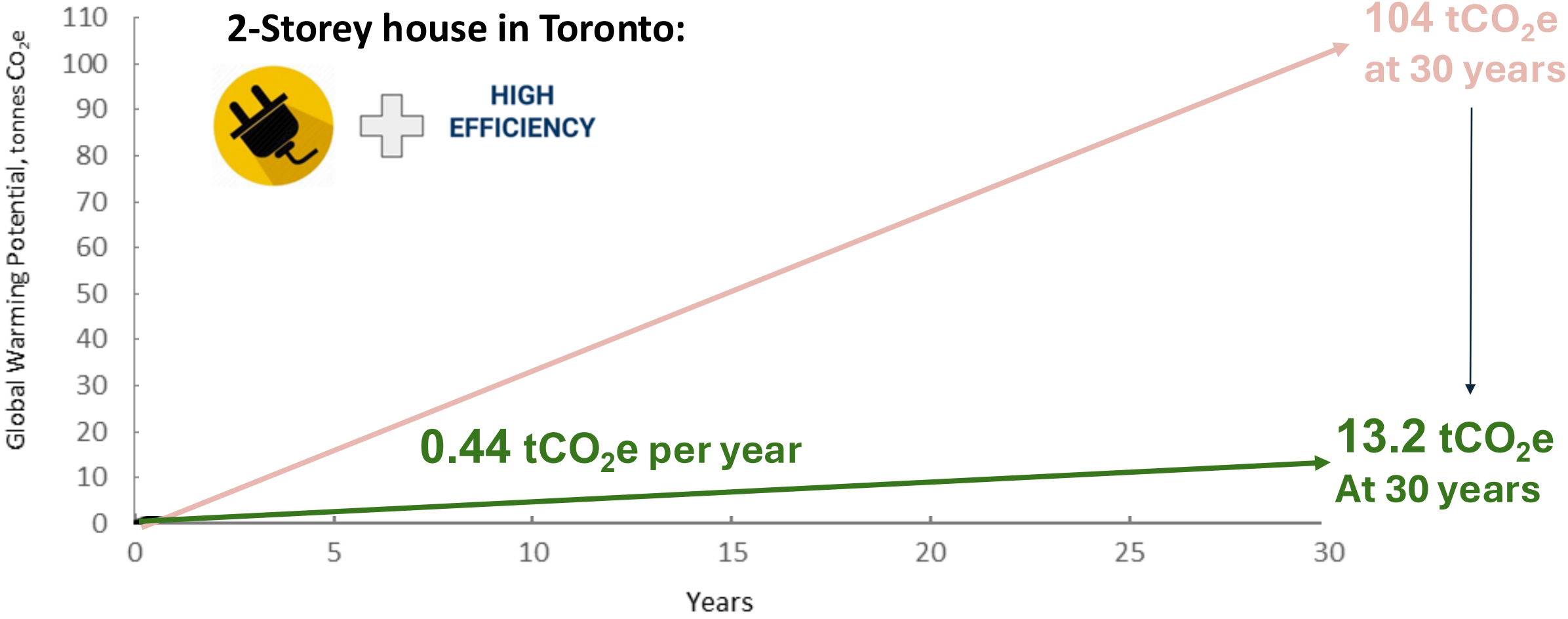


Cumulative Operational CO_2e Emissions – *Business as usual*



Source: Builders for Climate Action

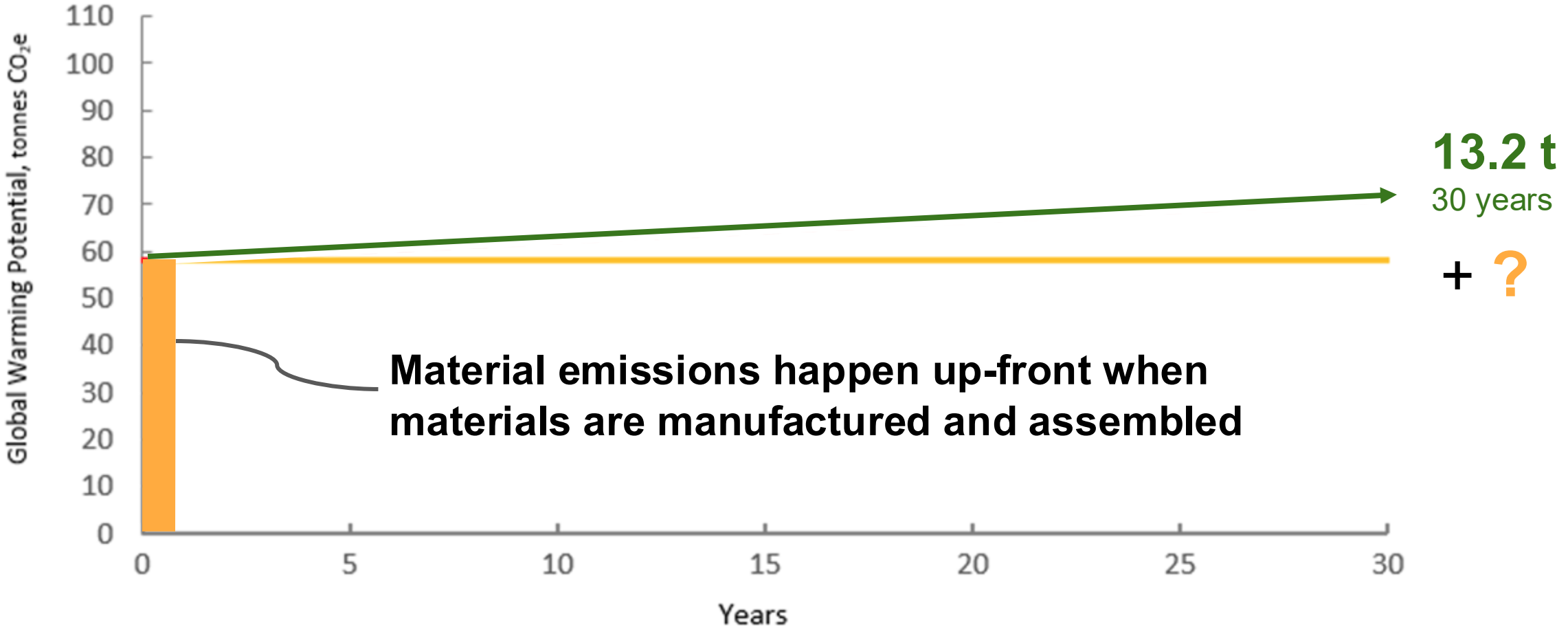
Cumulative Operational CO_2e Emissions – *High Efficiency*



Measuring and reducing OC is well understood…

Source: Builders for Climate Action

High Embodied + Low Operational CO_2e Emissions



Source: Builders for Climate Action

We need to reduce both!

Material Carbon Emissions

+

Operational Carbon Emissions

ENERGY USE INTENSITY

×

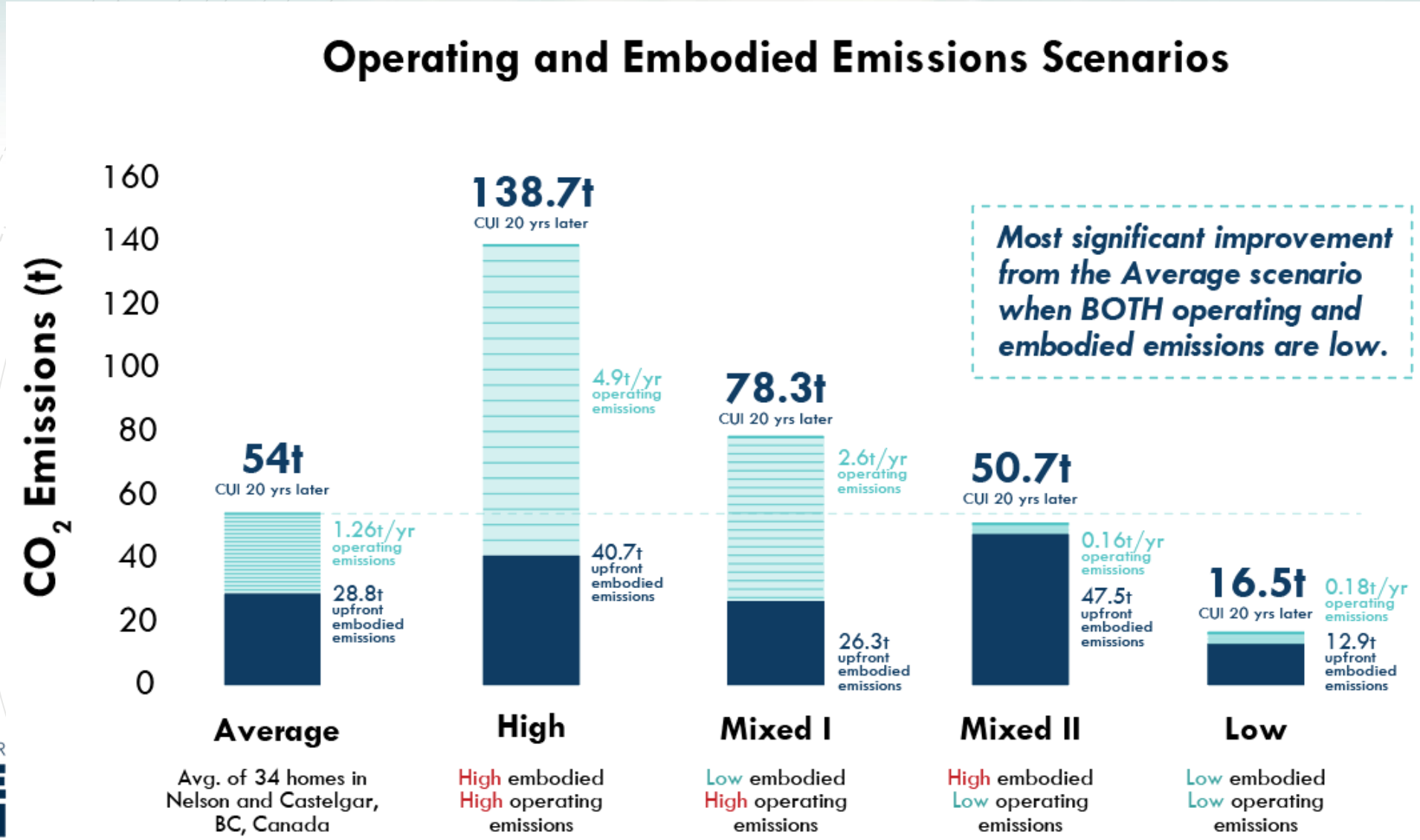
ENERGY SOURCE EMISSIONS

=

CARBON INTENSITY

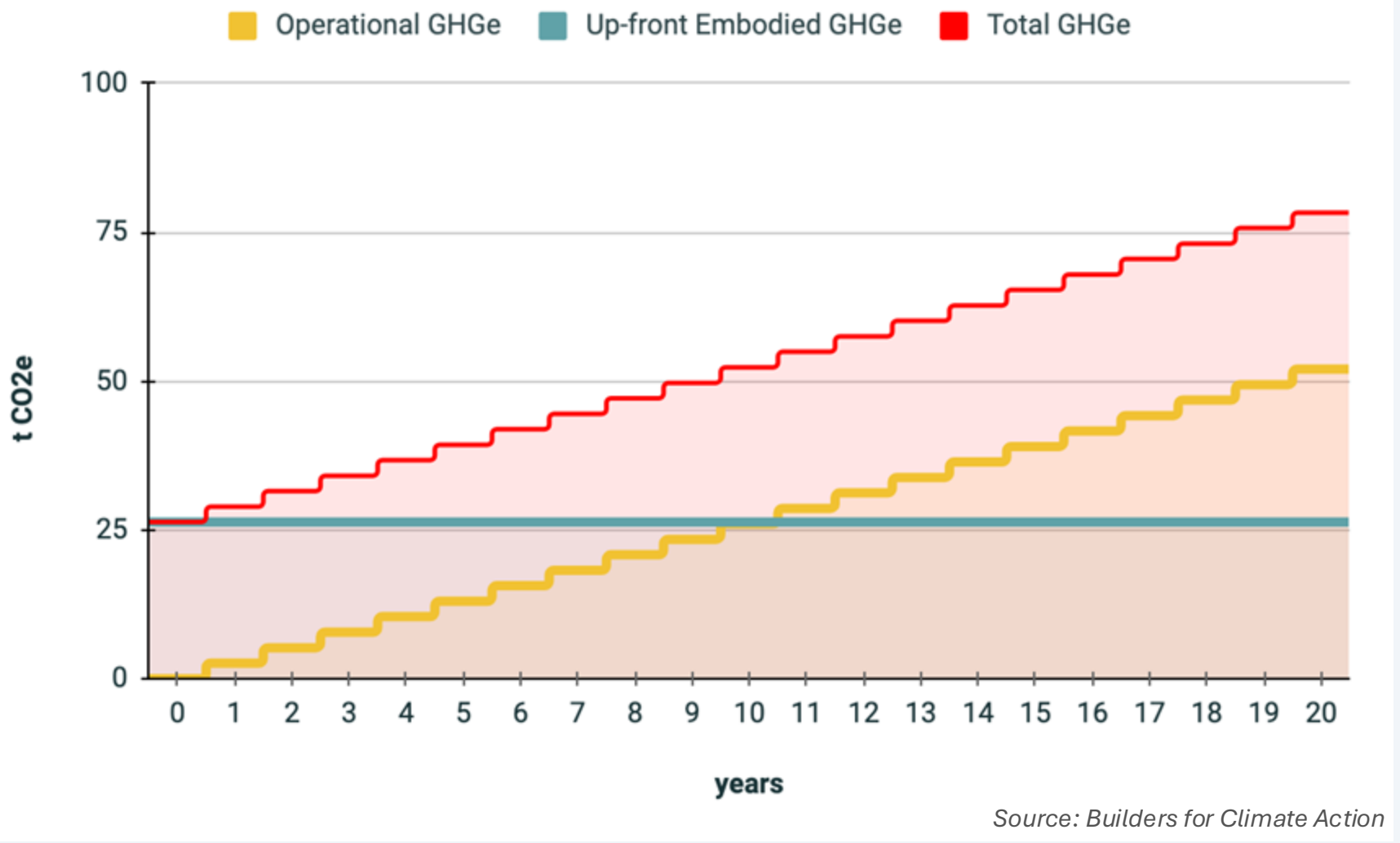
Graphic : Builders for Climate Action

Carbon Use Intensity – Nelson, BC



BUILDERS FOR CLIMATE ACTION

Cumulative Embodied and Operational Emissions - 20 years



Total GHGe
@ 20 years =

78 t CO_2e

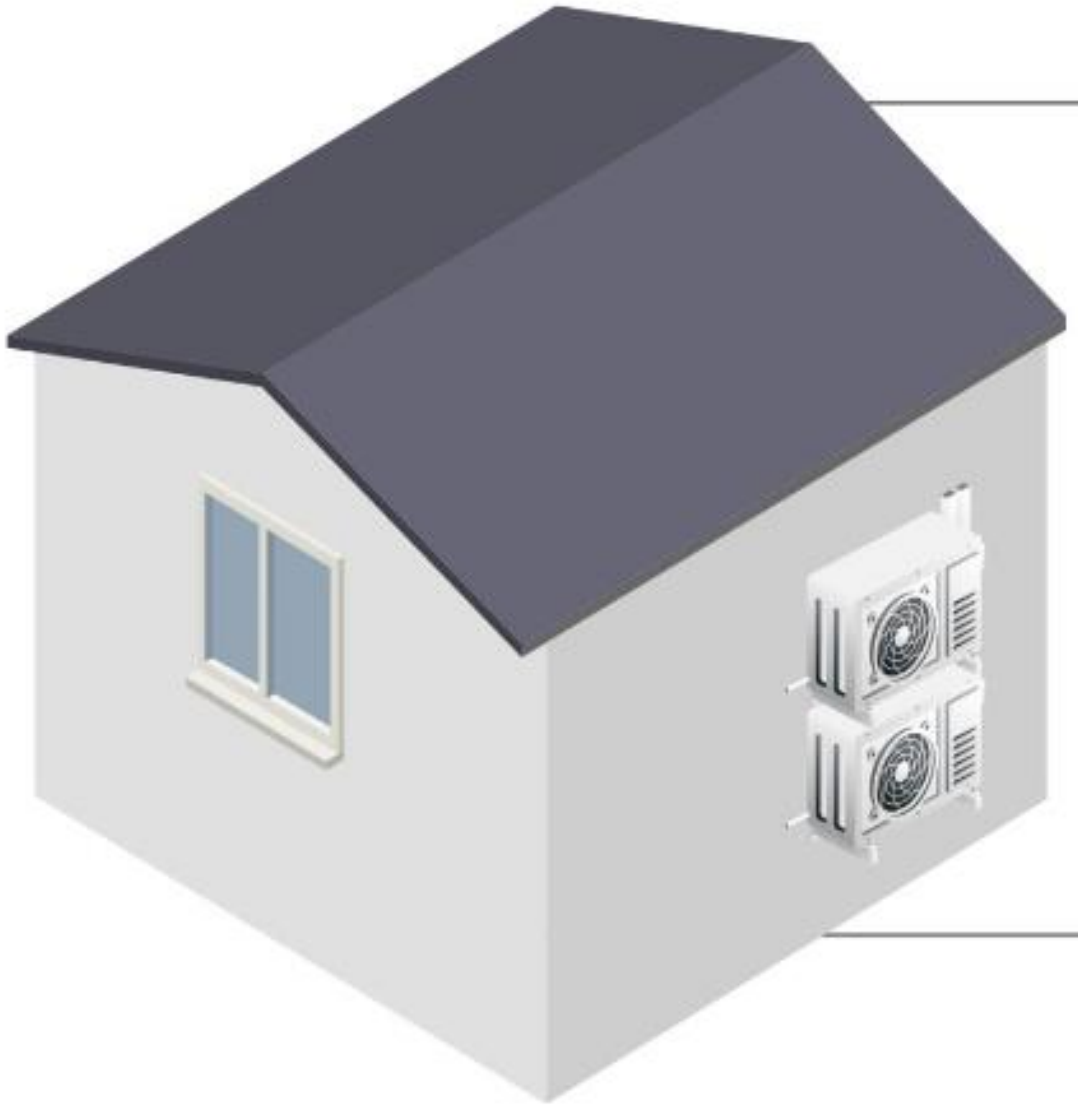
Source: Builders for Climate Action

Tackle Embodied & Operational Together

Performance Improvement	Reduce Operation GHGe	Possible to Achieve with Equivalent or Reduced Embodied GHGe
Reduced building size and/or surface area	✓	✓
Increased quantity of insulation	✓	✓
High performance windows	✓	✓
Improved air tightness	✓	✓
Improved equipment efficiency	✓	✓
Fuel switching	✓	✓
Passive solar/ventilation design	✓	✓

Source: Builders for Climate Action

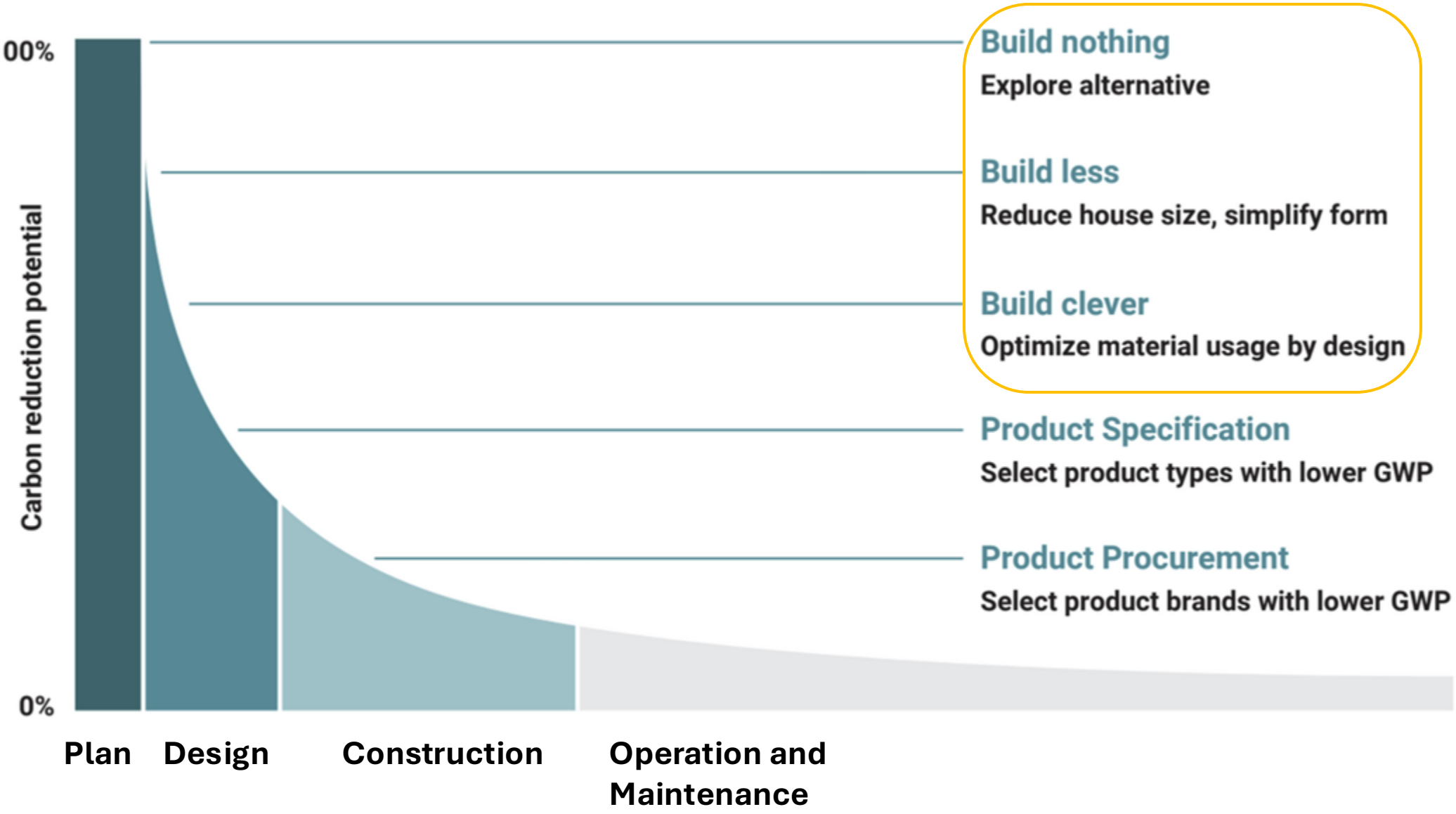
System Size and Life Cycle Emissions



Oversized Equipment Means

- more embodied emissions
- more refrigerant leakage
- shorter service life
- more replacements
- occupant discomfort

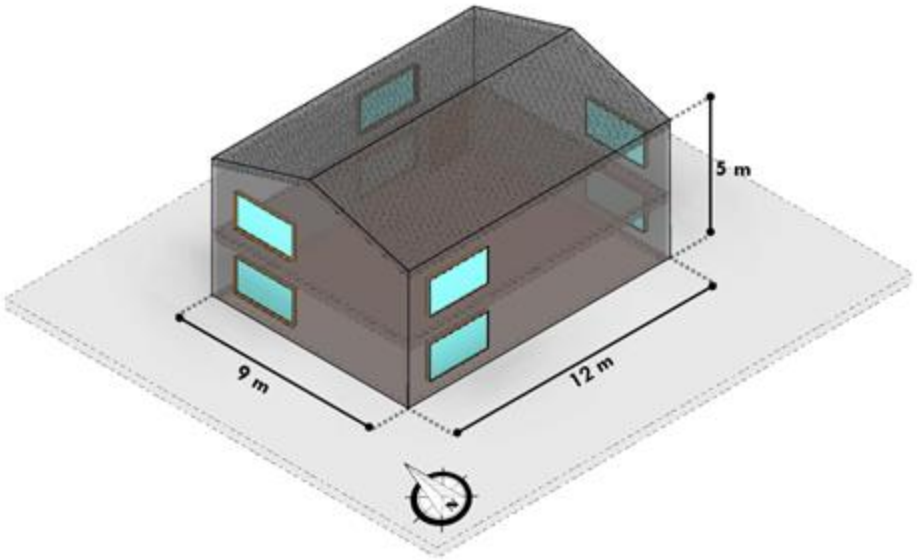
Carbon Reduction Potential Over Project Stages



Graphic: Builders for Climate Action

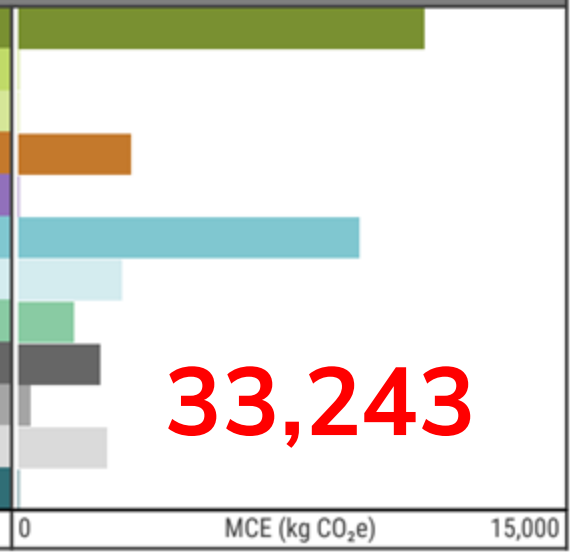
DOE Model Home As A Unit Of Housing

PROJECT INFORMATION			
Project Name	Sample Project DOE Prototype	**Construction Year**	2024
Design Version	Baseline	**Stories Above Grade**	2
Beam Version	V1.1	**Number of Bedrooms**	3
Design Firm(s)	US Department of Energy		
Engineering Firm(s)		**CONDITIONED AREA**	
Builder / Developer		**Above Grade**	2379 ft²
Development Project		**Below Grade**	0 ft²
Street Address		**Total**	2379 ft²
City			
Province / State	Vermont		
Country	United States	**GROSS AREA**	
Building Type	Single Detached House	**Excluding Garage**	2379 ft²
Construction Type	New Construction	**Garage**	0 ft²
Project Stage	Permits & Contracts	**Total**	2379 ft²



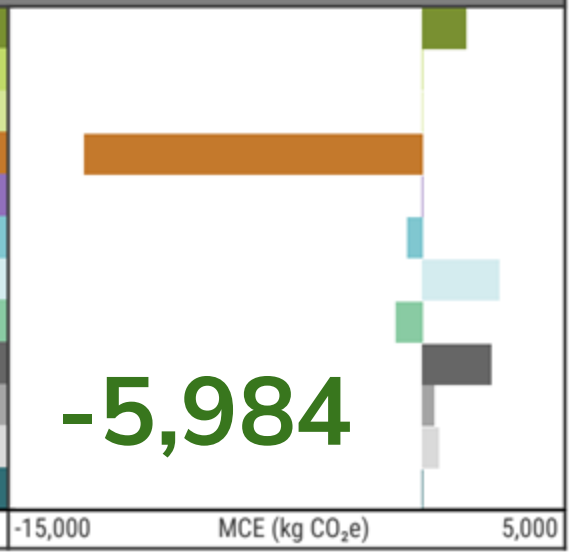
MATERIAL CARBON EMISSIONS BY SECTION

Footings & Slabs	11,229	kg CO_2e
Foundation Walls	0	kg CO_2e
Structural Elements	0	kg CO_2e
Exterior Walls	3,119	kg CO_2e
Party Walls	0	kg CO_2e
Cladding	9,453	kg CO_2e
Windows	2,847	kg CO_2e
Interior Walls	1,536	kg CO_2e
Floors	2,269	kg CO_2e
Ceilings	341	kg CO_2e
Roof	2,450	kg CO_2e
Garage	0	kg CO_2e
NET TOTAL	33,243	kg CO_2e



MATERIAL CARBON EMISSIONS BY SECTION

Footings & Slabs	1,612	kg CO_2e
Foundation Walls	0	kg CO_2e
Structural Elements	0	kg CO_2e
Exterior Walls	-12,479	kg CO_2e
Party Walls	0	kg CO_2e
Cladding	-567	kg CO_2e
Windows	2,847	kg CO_2e
Interior Walls	-977	kg CO_2e
Floors	2,534	kg CO_2e
Ceilings	439	kg CO_2e
Roof	608	kg CO_2e
Garage	0	kg CO_2e
NET TOTAL	-5,984	kg CO_2e



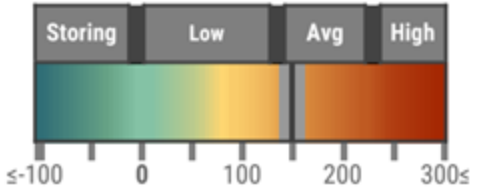
BEAM RESULTS (+/- 10%)

PROJECT EMISSIONS (MCE)

NET EMISSIONS kg CO_2e	GROSS EMISSIONS kg CO_2e	STORAGE SHORT CYCLE kg CO_2	STORAGE LONG CYCLE kg CO_2
33,243	33,743	400	100

PROJECT EMISSIONS INTENSITY (MCI)

	Metric kg CO_2e/m^2	Imperial lb CO_2e/ft^2
MCI Conditioned Floor Area	**150**	**31**
MCI Total Floor Area	150	31
MCI Per Bedroom	11,081	24,430



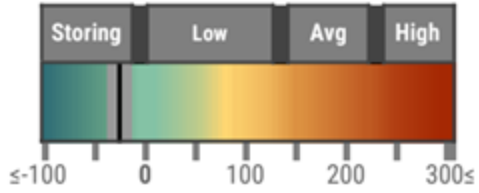
BEAM RESULTS (+/- 10%)

PROJECT EMISSIONS (MCE)

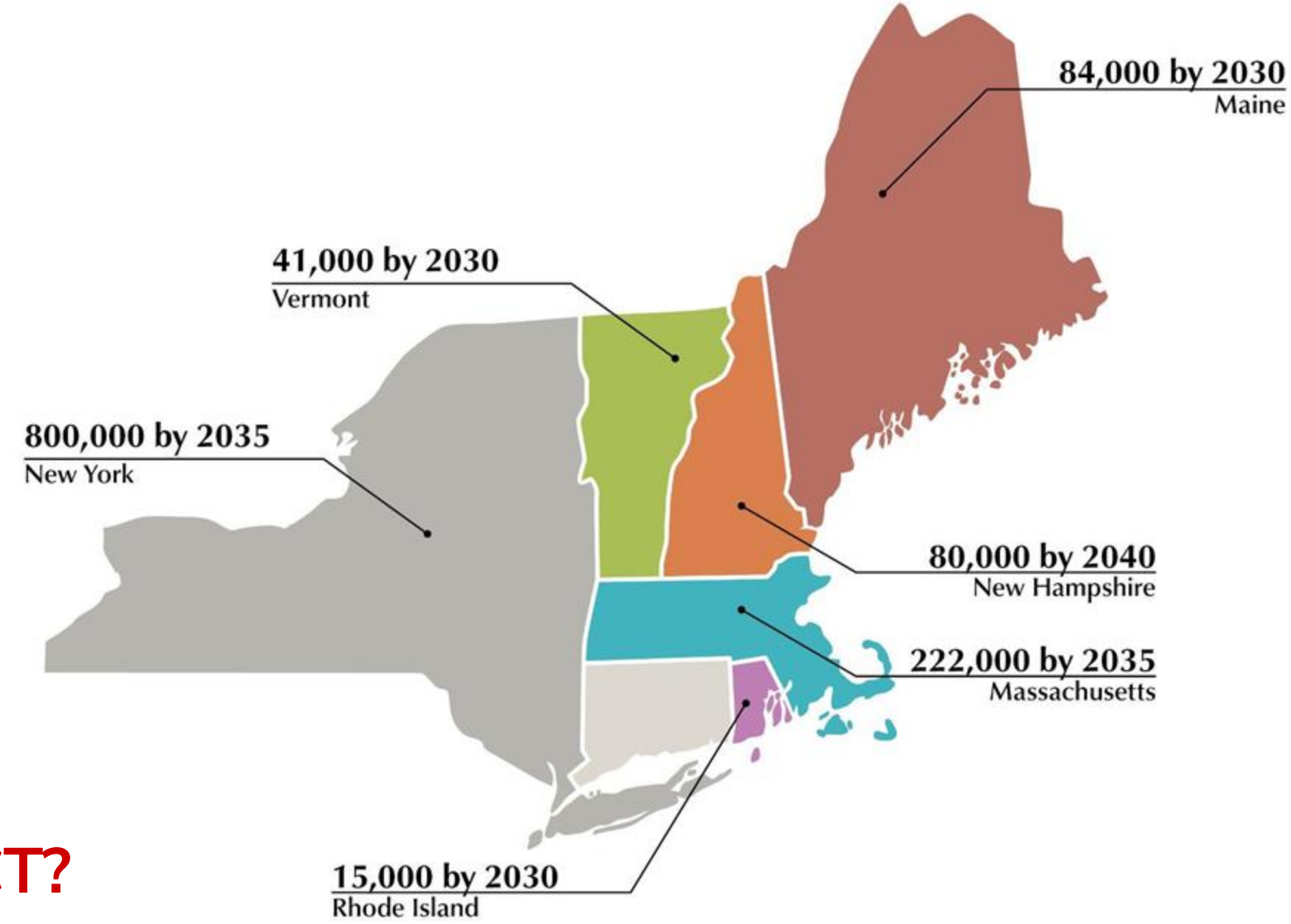
NET EMISSIONS kg CO_2e	GROSS EMISSIONS kg CO_2e	STORAGE SHORT CYCLE kg CO_2	STORAGE LONG CYCLE kg CO_2
-5,984	19,028	22,202	2,810

PROJECT EMISSIONS INTENSITY (MCI)

	Metric kg CO_2e/m^2	Imperial lb CO_2e/ft^2
MCI Conditioned Floor Area	**-27**	**-6**
MCI Total Floor Area	-27	-6
MCI Per Bedroom	-1,995	-4,398



New England & NY are projected to need nearly 2m new residential units by 2040



WHAT'S THE CARBON IMPACT?

WORST CASE

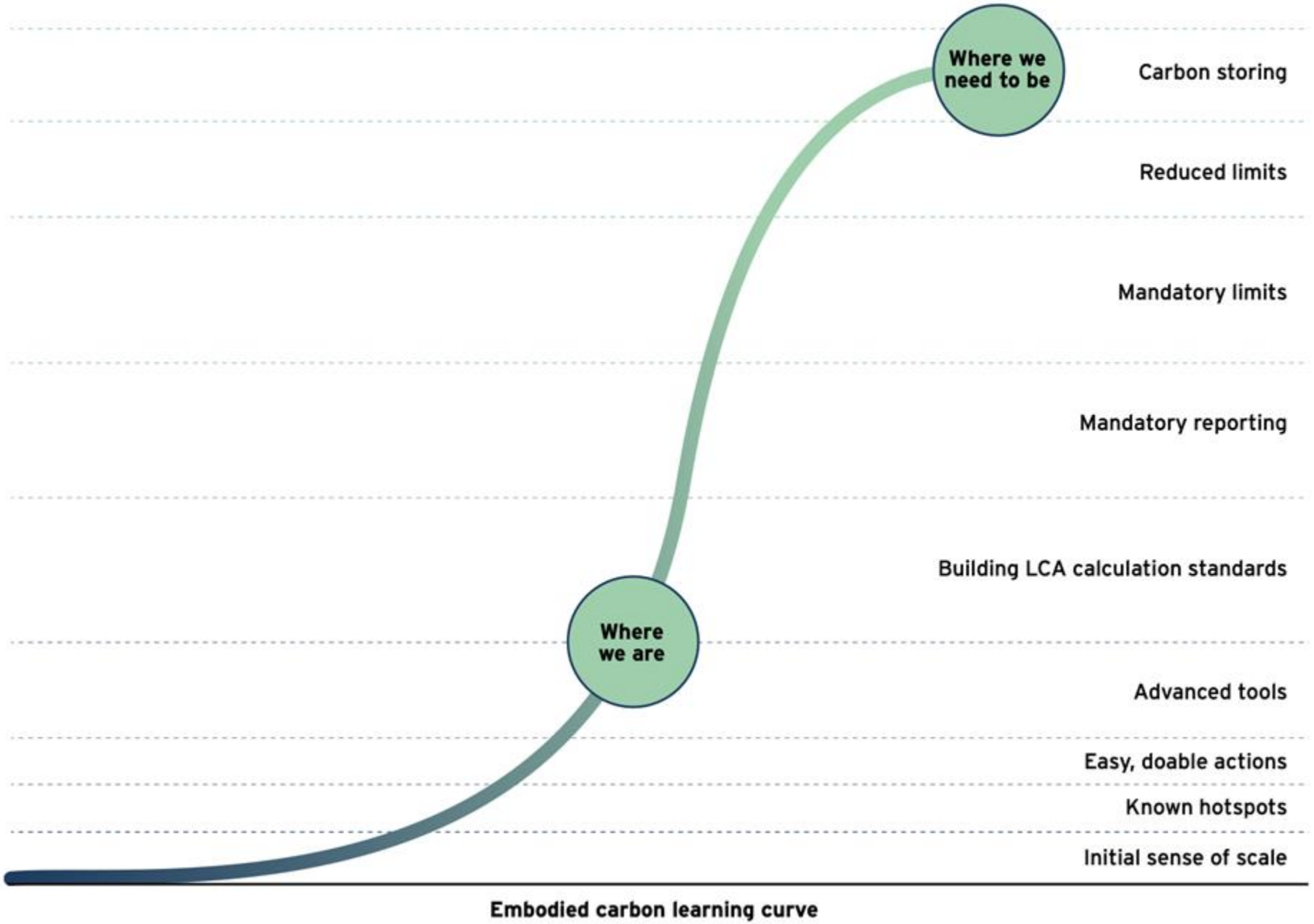
71,565,995 TONS CO_2e
=20.5 NEW Coal Fired
Power Plants

**500 MW PLANT WITH 3.5 MILLION TONS OF CO_2e EMISSIONS ANNUALLY*

BEST CASE

-12,882,439
TONS CO_2e
=3.7 RETIRED
Coal Power Plants

We must accelerate our position on this curve to meet climate thresholds



interconnected thinking

phius ZERO REVIVE

RESNET Leading the Path to Net Zero Energy Homes

Standard 1550 Embodied Carbon Task Group

RESNET Standard 1550

- Developed through RESNET, will be an ANSI standard
- Explicitly for energy professionals to assess EC in residential construction
- Fills large gap in low-rise residential-specific EC methodology
- BFCA: engaged in development process led by RMI, developed MEP default values table

Draft PDS-02
Standard RESNET C1550

Standard for
Calculating and Reporting
the Embodied Carbon of Buildings
with Dwelling and Sleeping Units

Pilot Program – It's Happening!

100 Homes Benchmarking Study in MA (2024-25):

- Create regional benchmark for policy and program development
- Pilot RESNET Standard 1550 to inform improvements
- Prepare industry: rater training, workflow, QA/QC
- Integrate energy modeling and embodied carbon assessment software

MASSACHUSETTS CLEAN ENERGY CENTER®

NEHERS
NORTHEAST HOME ENERGY RATING SYSTEM ALLIANCE

BUILDERS FOR CLIMATE ACTION

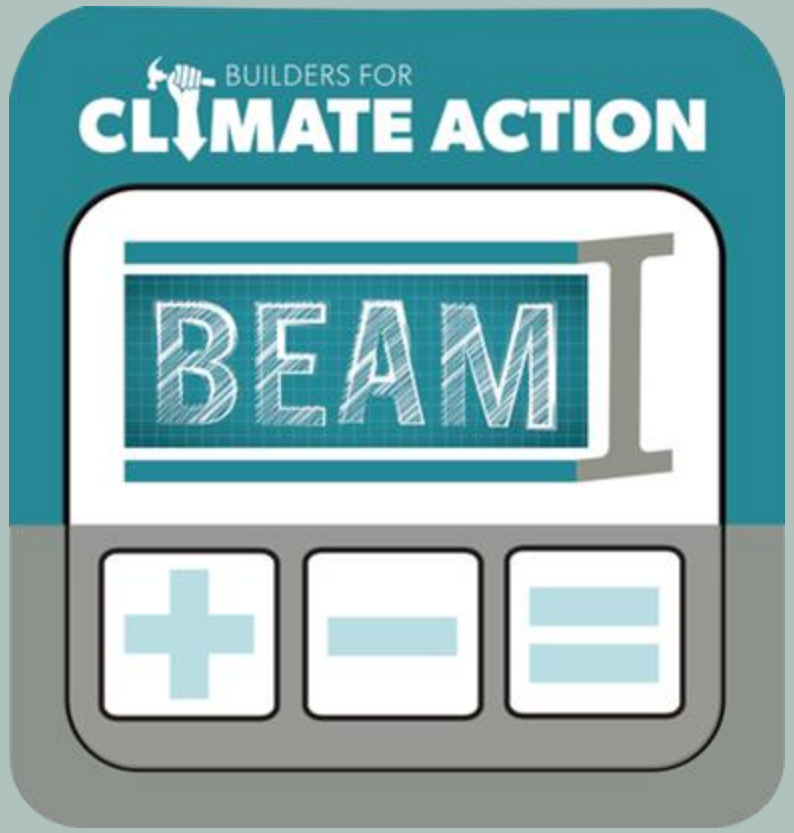
STEPHENS & COMPANY, INC.

NMR Group, Inc.

EVERSOURCE

ekotrope

BEAM Redevelopment



COMING SOON - NEW BEAM!

- Web application
- 1550 compliant
- More product categories (incl MEP!)
- More Ux’s, user features, inputs

BUILDING EMISSIONS ACCOUNTING FOR MATERIALS

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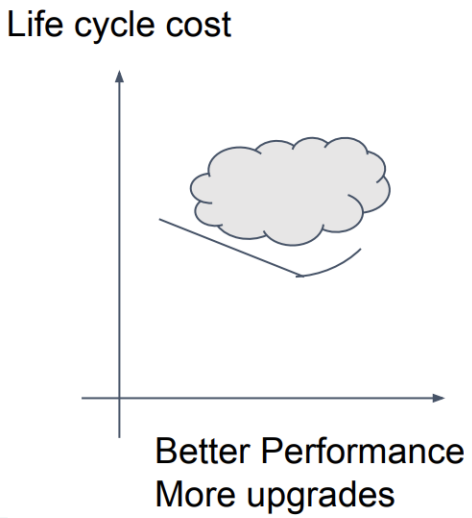
Decarbonization

Cost Metric = Sum of these annualized costs:

- Direct energy cost. E.g. site kWh * $/kWh = $
- Direct building retrofit measures cost (material & labor)
  including building-level electrification cost. E.g. ft3 of stuff * $/ft3 = $
- Cost of carbon -- upfront/embodied. CO2e kg * $0.25/kg = $
- Cost of carbon – operating. CO2e kg * $0.25/kg = $
- Energy system transition cost. E.g. new solar + storage. $/W * W = $

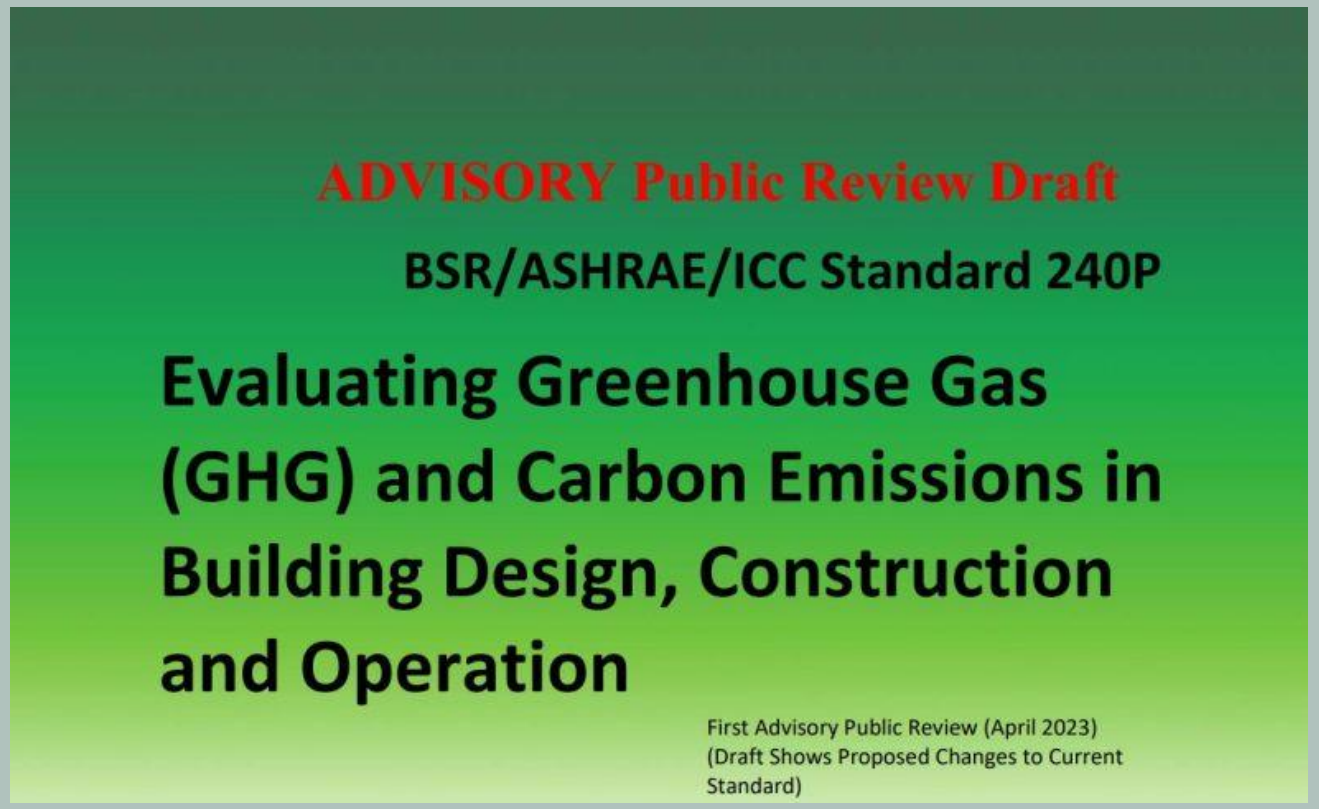


Plus additional decarbonization effort

- Electrification, renewable sources
- Embodied carbon

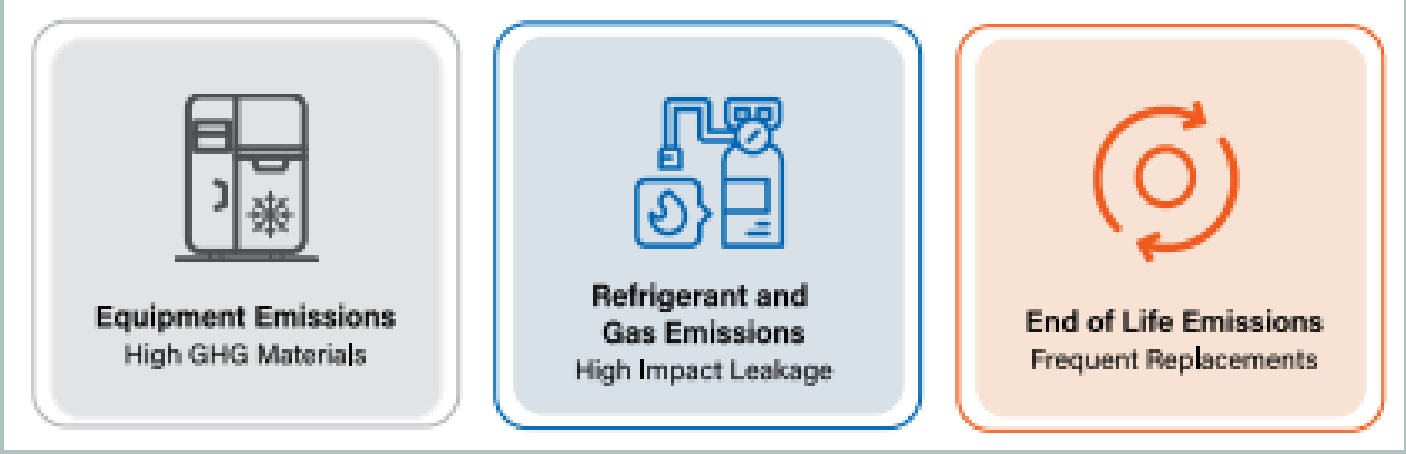
- Design as if there's a cost of carbon.
- Minimize total life cycle cost.

Non-Residential Standards and Resources



Standard Research and Development Frameworks

- Identifies three key areas of emission release from residential equipment
- Provides 15 recommendations for integrating embodied carbon into standards for residential equipment



STANDARDS RESEARCH

Embodied Carbon Pathways for Canadian Residential Equipment

September 2025

Radical Collaboration

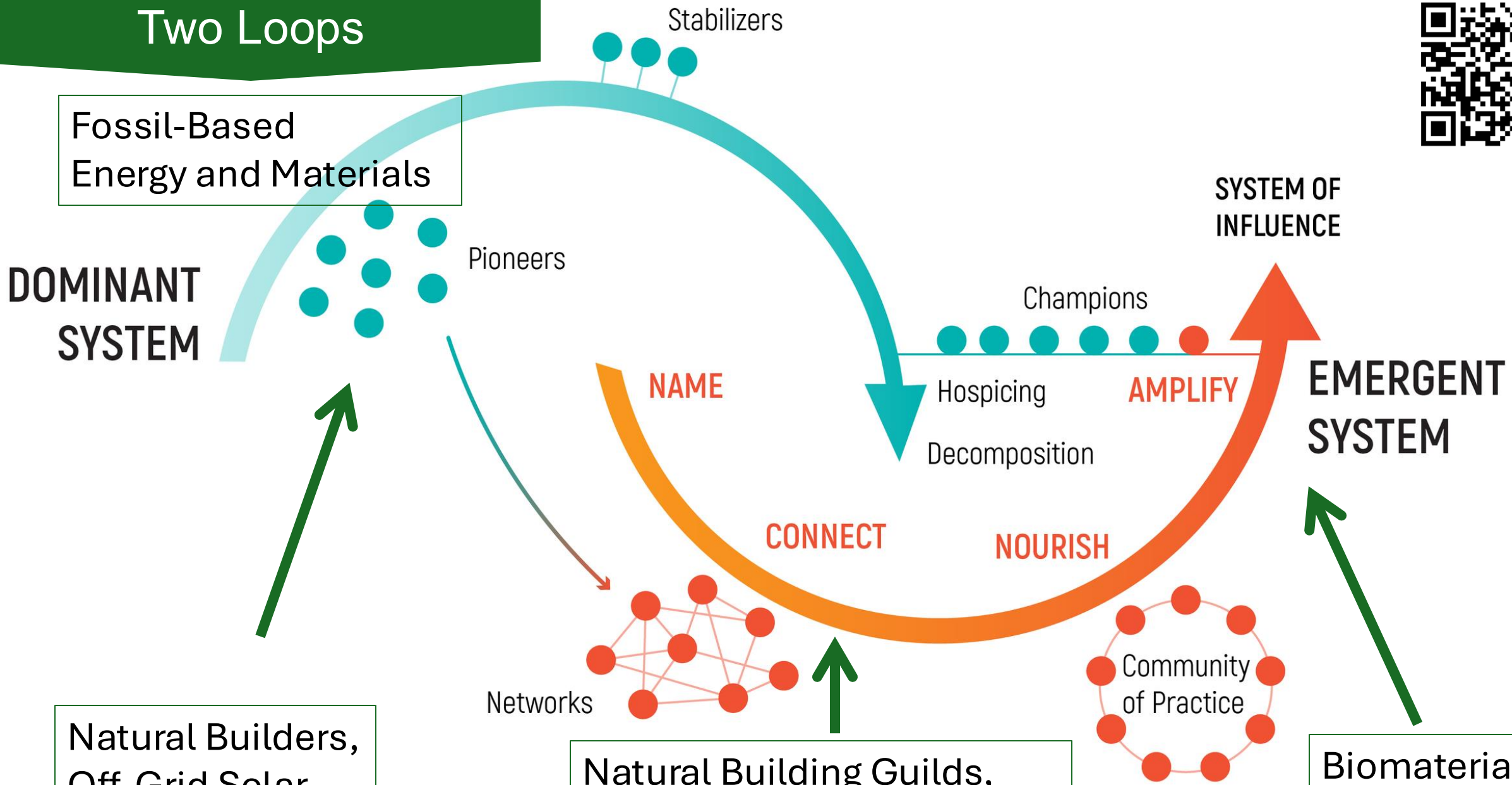
ECHO Project

Convening Organizations

Participating Organizations

Two Loops

Fossil-Based Energy and Materials



Natural Builders, Off-Grid Solar 1960s-2000s

Natural Building Guilds, Solar Energy Associations 2000s-2010s

Biomaterials and RE Movements

THANK YOU!
LET'S STAY CONNECTED

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