BUILDINGENERGY BOSTON

Scaling Embodied Carbon Through Building Codes

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Andy Buccino, Stephens and Company

Curated by Tammy Ngo

Northeast Sustainable Energy Association (NESEA) | March 21, 2025

Session Outline

Provide an overview of existing and planned strategies to introduce and enhance embodied carbon provisions in codes, standards, and programs:

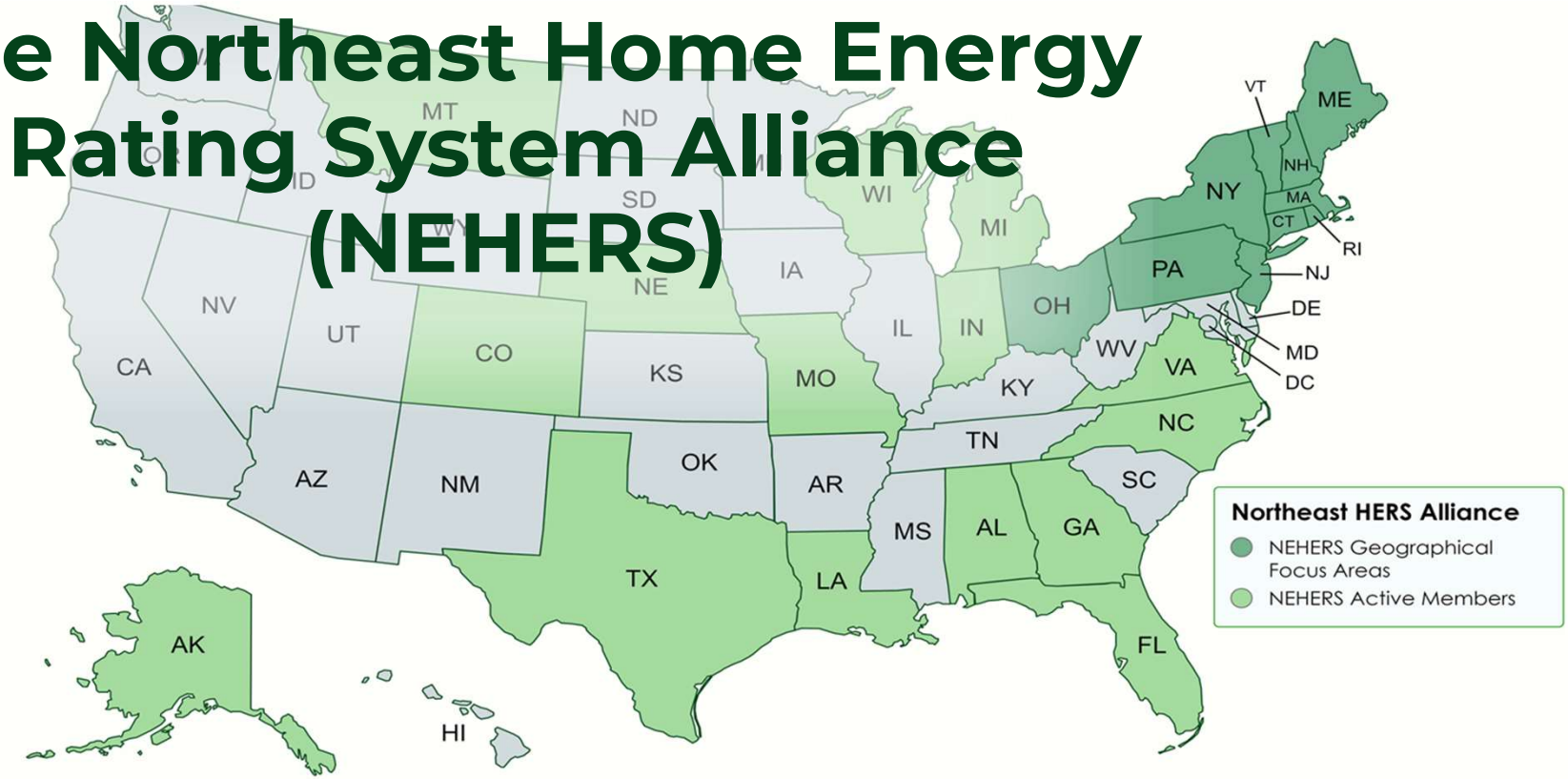
- Existing policy and codes landscape
- Ongoing efforts with commercial model codes and standards
- The residential embodied carbon policy ecosystem

Introductions

New Buildings Institute & Embodied Carbon

- Embodied Carbon Building Code and Residential Code Overlays
- Participant in ASHRAE 189.1 (IgCC) Working Group 9 on Materials and Resources and RESNET 1550
- GSA Procurement Specification
- State and jurisdictional building codes, reach codes, and associated research and reports
- Proponent of various code proposal
- Implementation & training

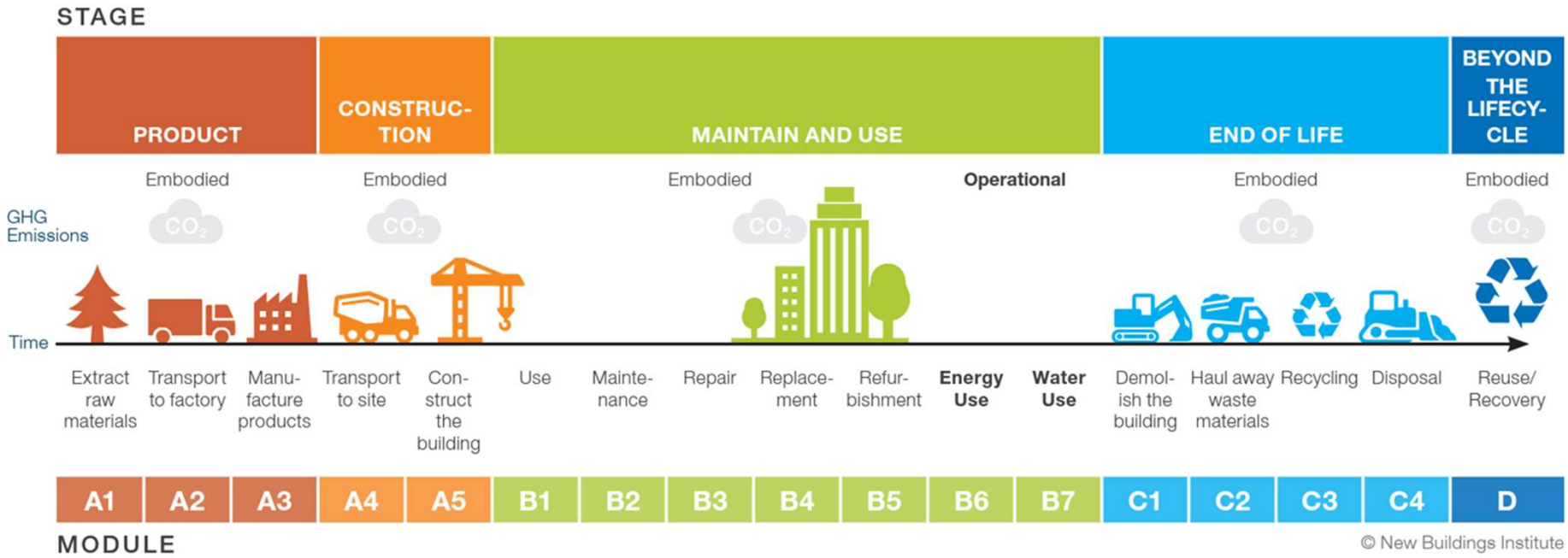
The Northeast Home Energy Rating System Alliance (NEHERS)



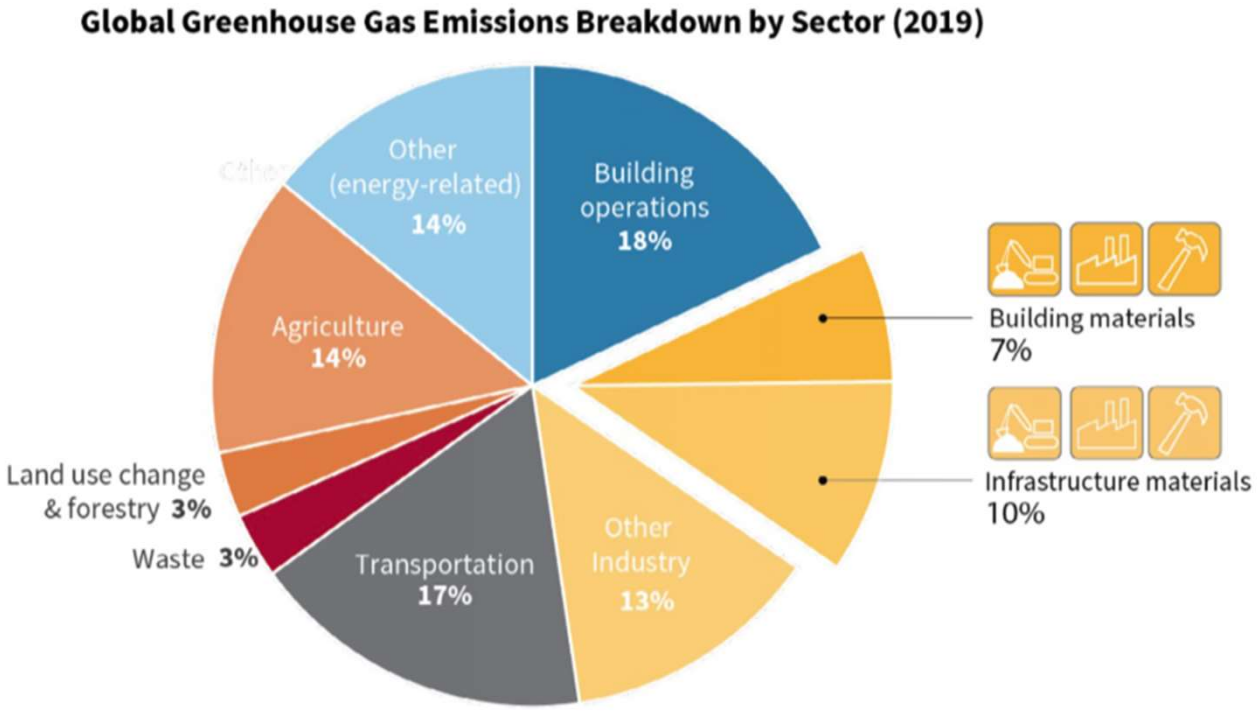
www.nehers.org

Embodied Carbon: An Overview

Embodied Carbon: An Overview

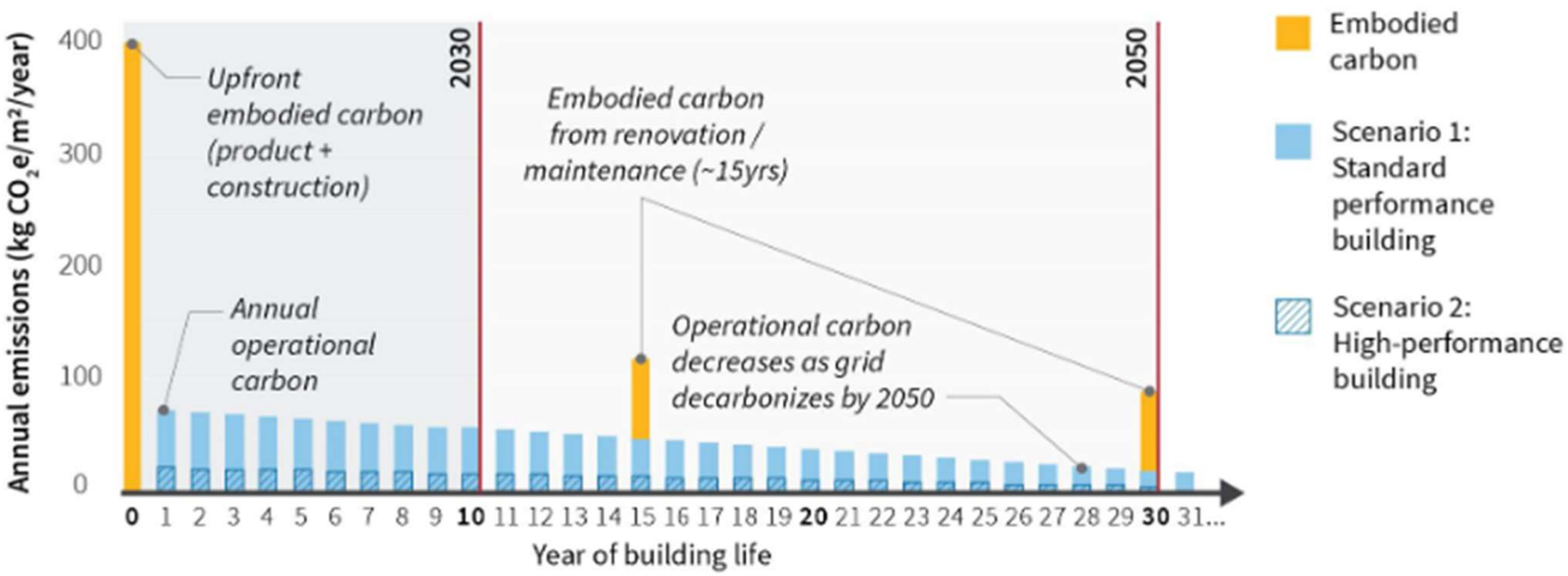


Embodied carbon from buildings makes up 7% of worldwide GHG emissions



Source: Carbon Leadership Forum, based on data from World Resources Institute (WRI) and International Energy Agency (IEA)

Upfront vs. Later-Life Embodied Emissions

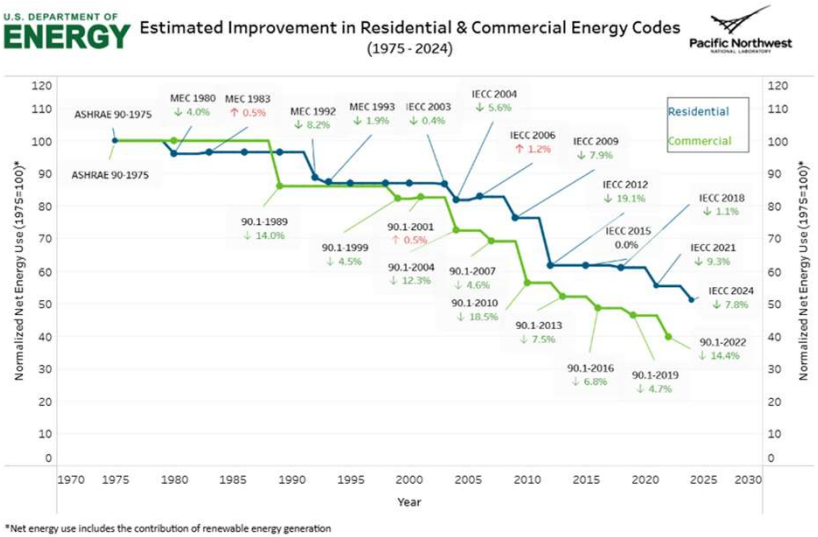


Source: Carbon Leadership Forum

Source: Carbon Leadership Forum

Embodied Carbon Code Approaches

Why Codes?



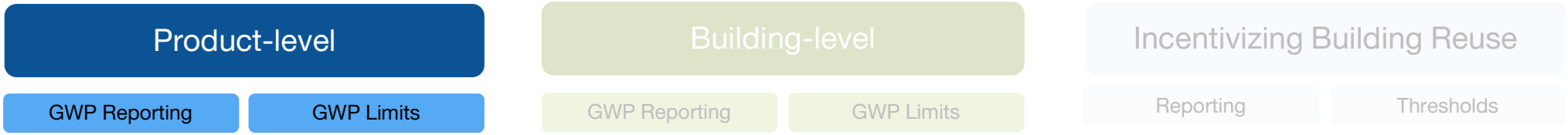
Source: U.S. Department of Energy and Pacific Northwest National Laboratory

- Building energy codes have been a powerful tool for addressing climate change [1]
- Building codes are intended to preserve public health, safey, and welfare, and have been proven to save lives and money [2]
- Building codes impact early decision-making on design and construction practices, which can lead to low-cost and high-impact strategies for embodied carbon

[1] U.S. Department of Energy
[2] U.S. Federal Emergency Management Agency

Typical Embodied Carbon Code Approaches

Typical Embodied Carbon Code Approaches



Product-Level Strategies

Product-level

GWP Reporting

Environmental product declarations (EPDs) communicate environmental impact of a construction product across its life cycle

GWP Limits

Sample provision: Meet GWP limit that is X% industry-wide EPD

Jurisdiction	Policy
California	Compliance pathway: 175% of industry average GWP for structural steel, rebar, flat glass, light and heavy duty mineral wool insulation, and ready mix concrete
Canada	Standard on Embodied Carbon in Construction: 10% below regional industry average for concrete
Marin County, CA	Nation's first low-carbon concrete code; low-carbon concrete codes adopted by 4 other CA jurisdictions
Denver, CO	Green Code: GWP limits for concrete and steel
Boulder, CO	Energy code: Optional credit for GWP reduction for insulation, concrete, masonry, steel, wood, glazing, gypsum, and others
Vermont	Energy Code: Optional credit for GWP reporting of insulation
Buy Clean Policies (not building code)	**WA; OR; NY; NJ; MD; MN; CO; CA; US GSA**

High-Impact Strategies by Material

Material	EC Reduction Strategy
Concrete / Cement	• Blended cements • Supplementary cementitious materials (SCMs) • Water-reducing admixtures to reduce cement content • Power with low-carbon energy
Steel	• Scrap content in electric arc furnace, powered with low-carbon energy
Aluminum	• >90% recycled content • Power with low-carbon energy
Wood	• Source locally • Source from sustainably managed forests • Low-carbon transport methods • Timber with bio-based adhesives • Power with low-carbon energy
Glass	• Recycled cullet • Furnaces that utilize Oxy Fuel technology • Design burners and nozzles to decrease energy use
Board and Foam Insulation	• Bio-based alternatives • Lower-GWP blowing agents • Mineral wool: increase renewable energy at furnace

Typical Embodied Carbon Code Approaches

Building-Level Strategies

Building-level

GWP Reporting	GWP Limits
Whole building life cycle analysis (WBLCA) evaluates the impact of a building throughout its life cycle (stages A-C)	**Sample provisions:** -Total carbon budget at building level: carbon per square foot; can be set by building type -Percentage reduction compared to a modeled baseline

Jurisdiction	Policy
Vancouver, Canada	Building Bylaws: 800 CO_2e/m^2 or 10% reduction compared to baseline; limit decreases over time
Toronto, Canada	Green Standard: 350 CO_2e/m^2; voluntary 250 CO_2e/m^2
California	10% reduction compared to baseline
Minnesota	Sustainable Building Guidelines: 10% compared to reference building

High-Impact Building-Level Strategies

- Build less
- Reuse more
- Build lighter and smarter
- Procure/ substitute lower-carbon products
- Use high-quality materials

Typical Embodied Carbon Code Approaches

- Product-level
  - GWP Reporting
  - GWP Limits
- Building-level
  - GWP Reporting
  - GWP Limits
- Incentivizing Building Reuse
  - Reporting
  - Thresholds

Building Reuse

- Realizes substantial embodied carbon reductions
- Avoids emissions associated with demolition and new construction
- Building codes do not have the authority to mandate building reuse
- Code strategies can encourage adaptive reuse or make it easier for applicants seeking to reuse (i.e., administrative flexibility, incentives through compliance pathways)

Jurisdiction	Policy
California	Compliance pathway: 45% reuse of structure and enclosure
ASHRAE 189.1	Consideration of new compliance pathway in chapter 9 on Materials and Resources

First in the Nation: Embodied Carbon in CALGreen

Product Path

Products: Structural steel, rebar, flat glass, light and heavy duty mineral wool insulation, and ready mix concrete

Exception: Concrete mixes can use a weighted average for all mixes

Lifecycle Analysis

Scope: 60-year cradle-to-grave WB LCA (ISO 14044), excluding operating energy. Show GWP analysis.

Components: Primary and secondary structural members, glazing, insulation, exterior finishes.

Building Reuse

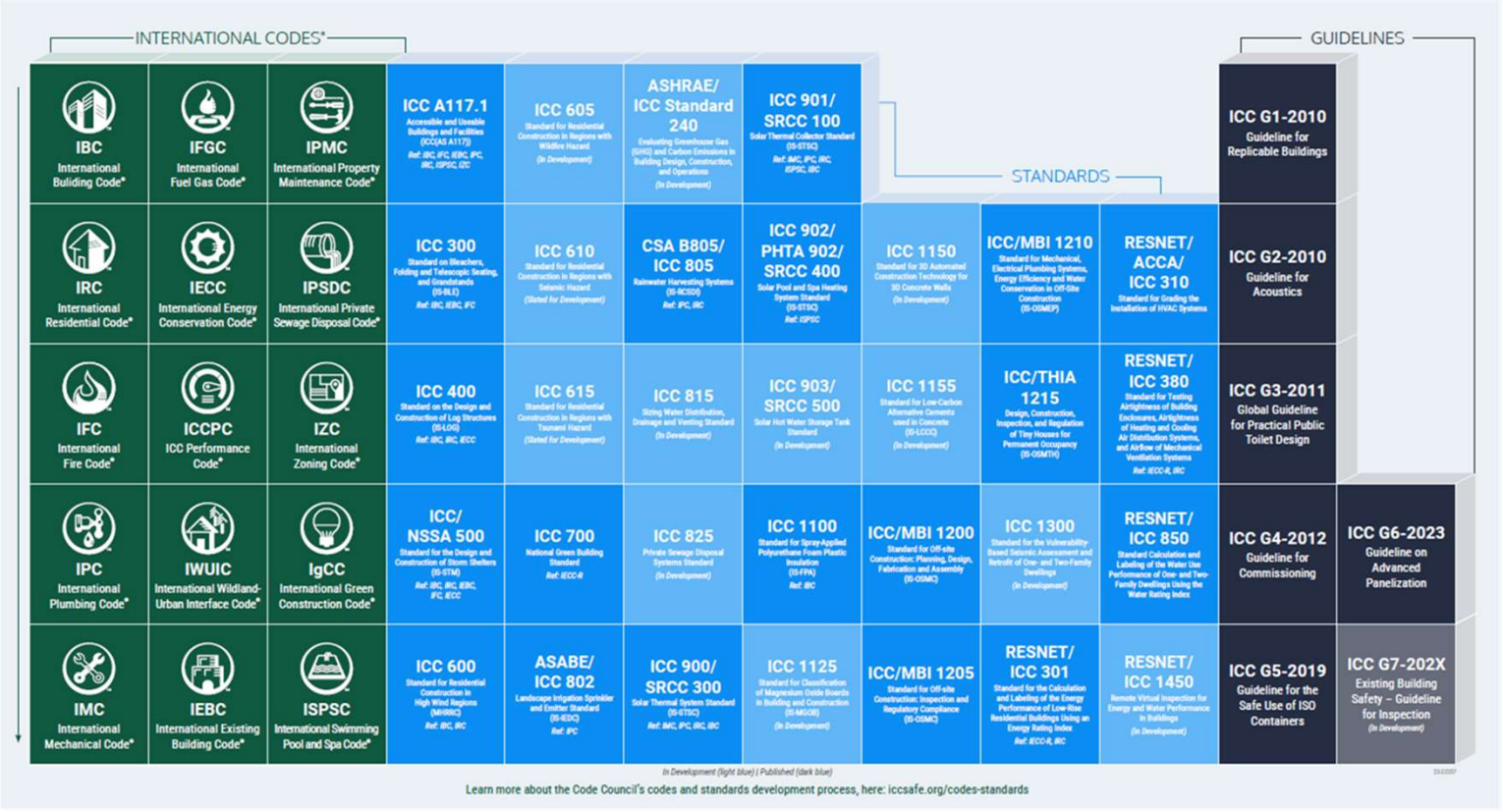
Components: Existing primary structural elements, enclosure, window assemblies, and insulation.

Exceptions: Additions 2x+ the area of existing building; windows, insulation, portions structurally unsound or hazardous, and hazardous materials that are remediated as part of the project

	Product Path	Lifecycle Analysis Path	Building Reuse Path
Mandatory	175% of IW-EPD GWP Limits	10% reduction from baseline	45% of the structure and enclosure to be reused
Tier 1	150% of IW-EPD GWP Limits	15% reduction from baseline	75% of the structure and enclosure to be reused
Tier 2	IW-EPD GWP Limits	20% reduction from baseline	75% of the structure and enclosure to be reused AND 30% of interior non-structural elements to be reused

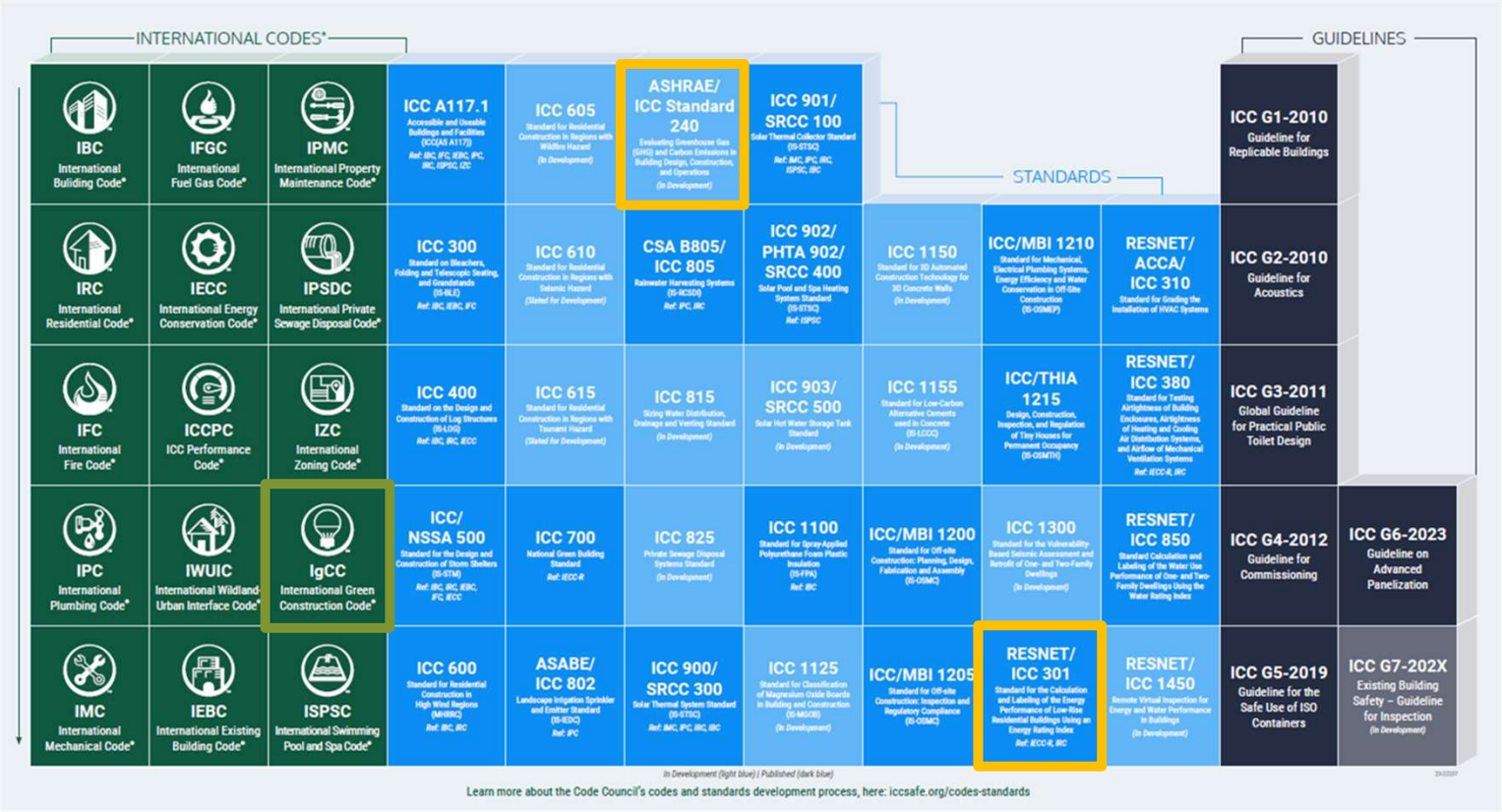
Model Codes Landscape

Model Codes: The Existing Landscape



Source: International Code Council

Model Codes: The Existing Landscape

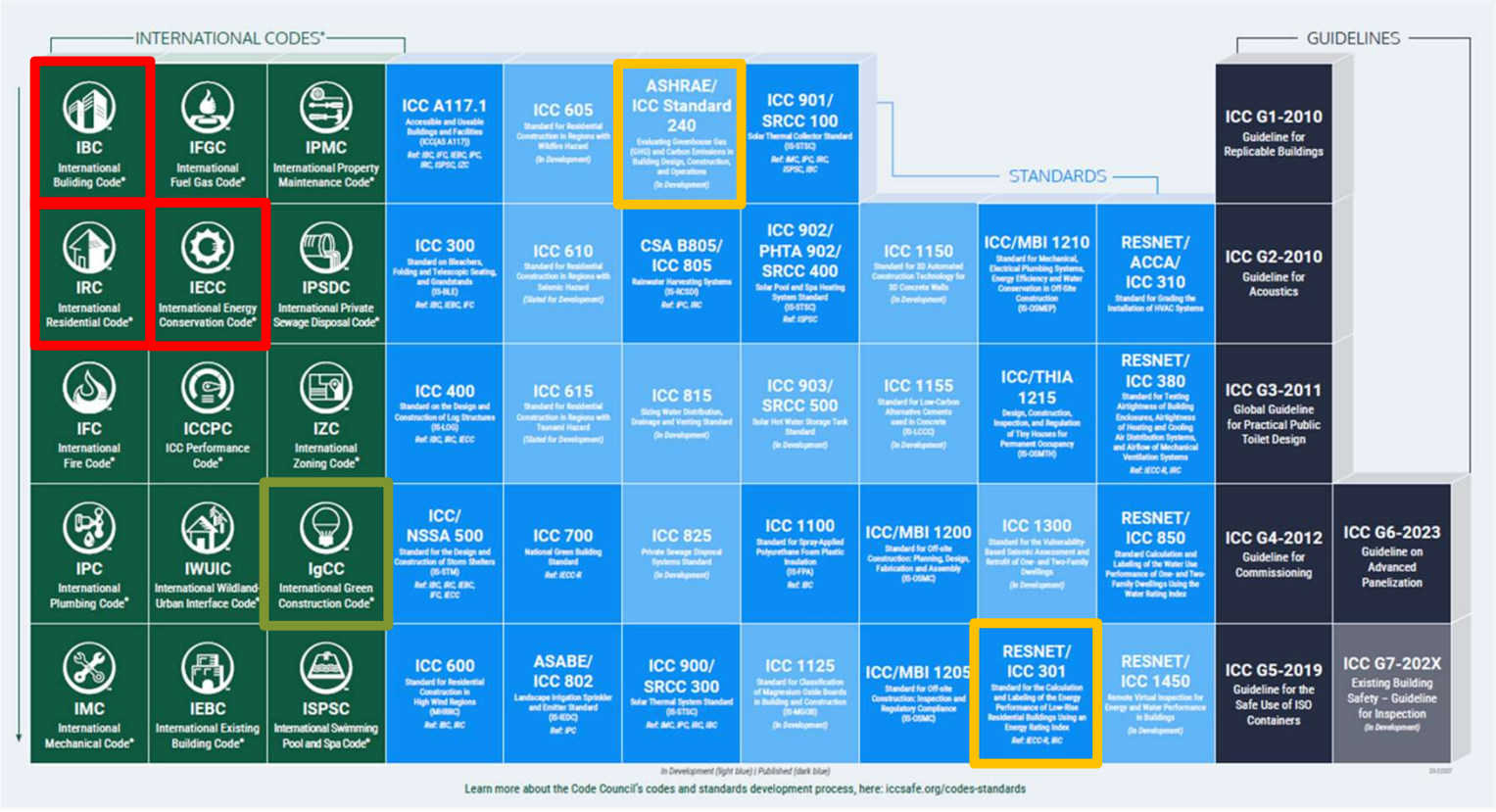


Existing EC provision; updates pending

EC provision under development

Source: International Code Council

Model Codes: The Existing Landscape



Existing EC provision; updates pending

EC provision under development

Potential focus of future efforts

Source: International Code Council

Why a RESNET standard?

RESNET Sets Yearly Target of 1,000,000 Homes by 2028

Raters Registered 436,798 Homes in 2024

https://www.resnet.us/

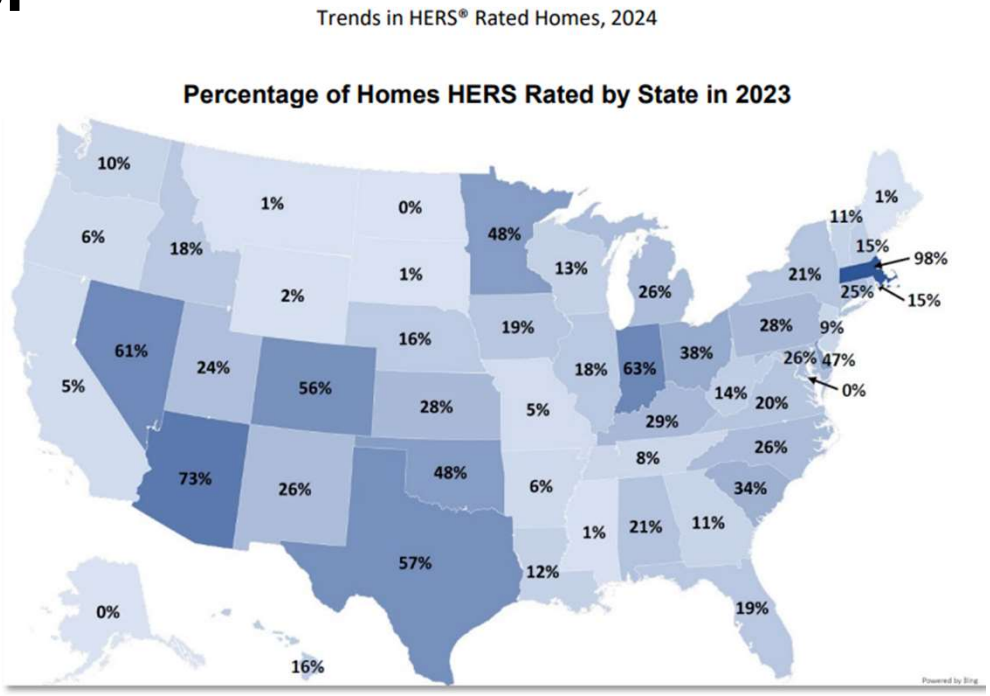


Figure 1. Percent of New Homes HERS Rated by State, 2023

https://www.resnet.us/wp-content/uploads/RESNET_2024_HERSTrendsDataReport_FINAL.pdf

RESNET Standard 1550

Purpose & Scope:

“

1. Purpose

The provisions of this document establish a methodology for **quantifying and reporting embodied greenhouse gas emissions** associated with building products using data commonly gathered by energy raters and according to the system boundary and data sources defined in Section 5.

2. Scope

This standard is applicable to **buildings with Dwelling Units and Sleeping Units** in Residential or Commercial Buildings, excepting hotels and motels .

This standard **does not set benchmarks or establish levels of building performance**.
This standard shall not be used to circumvent any safety, health, or environmental requirements.

”

RMI – Energy. Transformed.

Dr. David Goldstein

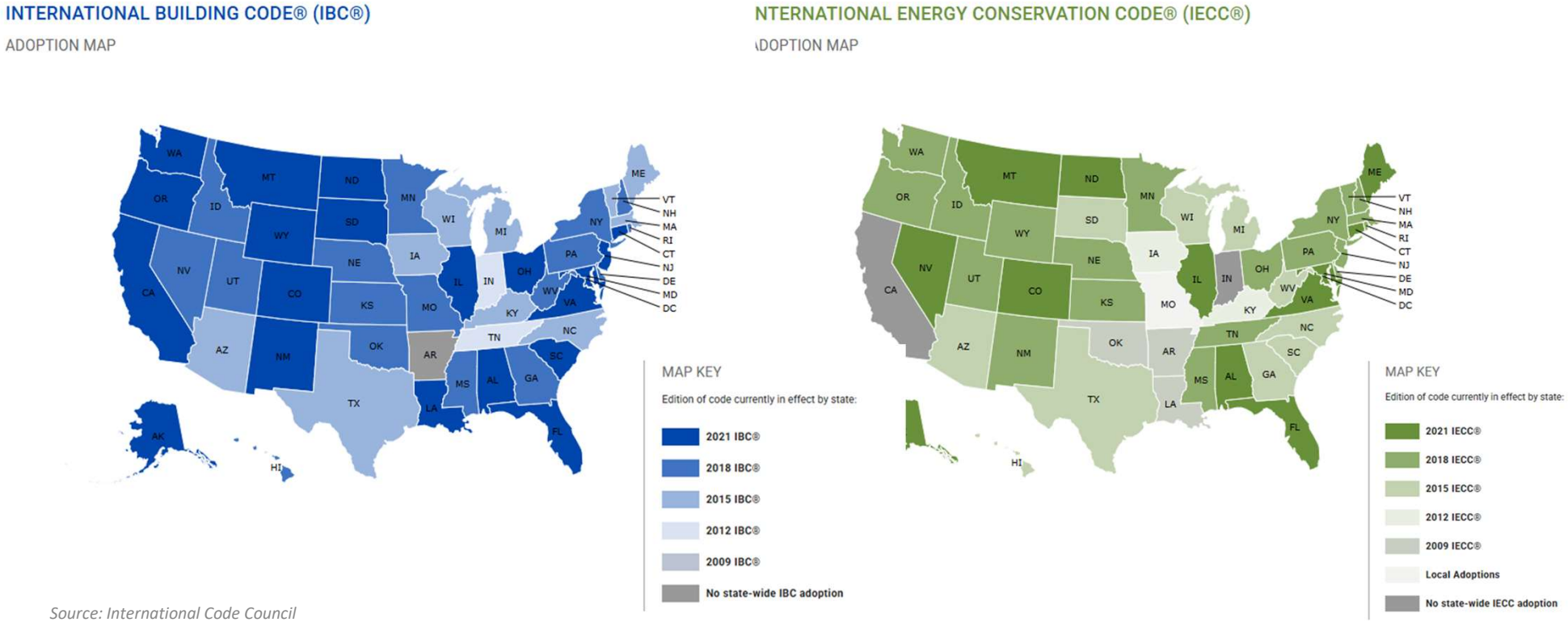
RESNET/ICC 1580-202x

- Provide a **consistent methodology** for using long run marginal emission rates by **Cambium generation** and emission assessment (GEA) region in the **calculation of CO2e emissions**.

- Requirements on **how to estimate CO2e emissions** from measured data on electricity and fuel consumption of a **facility or organization**.

- For the purposes of complying with standards on **disclosure of emissions** and of reducing emissions year after year using an Energy Management System.

Model Codes Adoption



Source: International Code Council

NBI’s IBC Effort

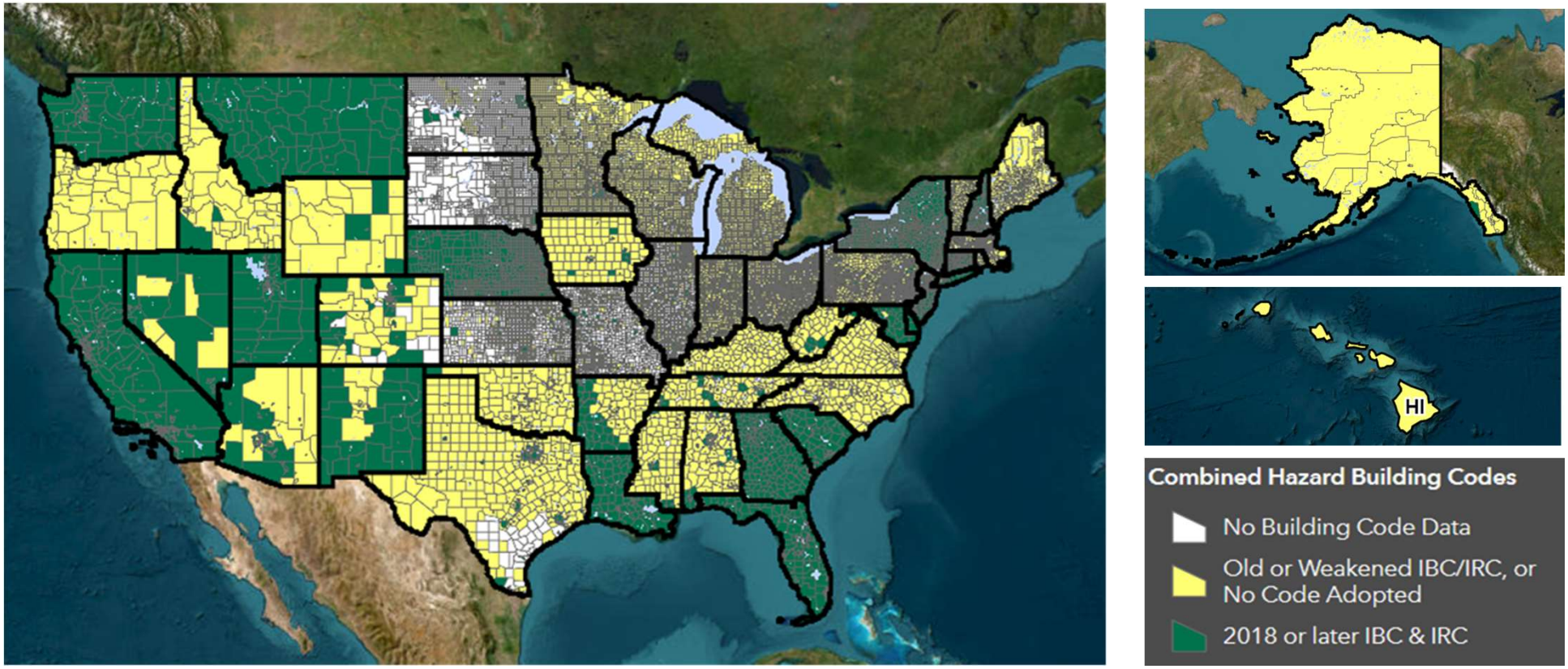
Model Codes Adoption

New appendix
for adoption by interested jurisdictions

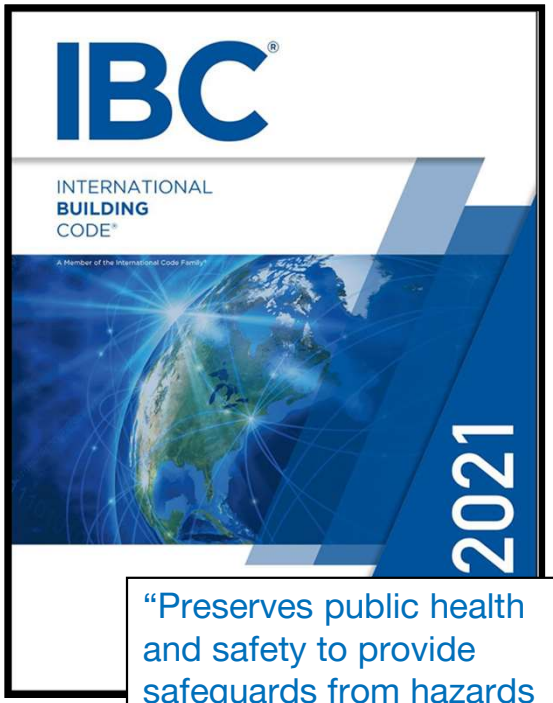
Product-level	Building-level	Incentivizing Building Reuse
Submit product-specific EPDs for covered products (concrete, steel, wood, glass, insulation) that indicate a % reduction in GWP compared to industry-average values	Submit a WBLCA for the building's structure and enclosure that indicates a % reduction in GWP compared to a baseline or compared to 500 $kgCO_2e/m^2$	Submit proof of reuse of at least 45% of existing building's structure and enclosure

Why the IBC?

Source: FEMA Building Codes Adoption Tracker



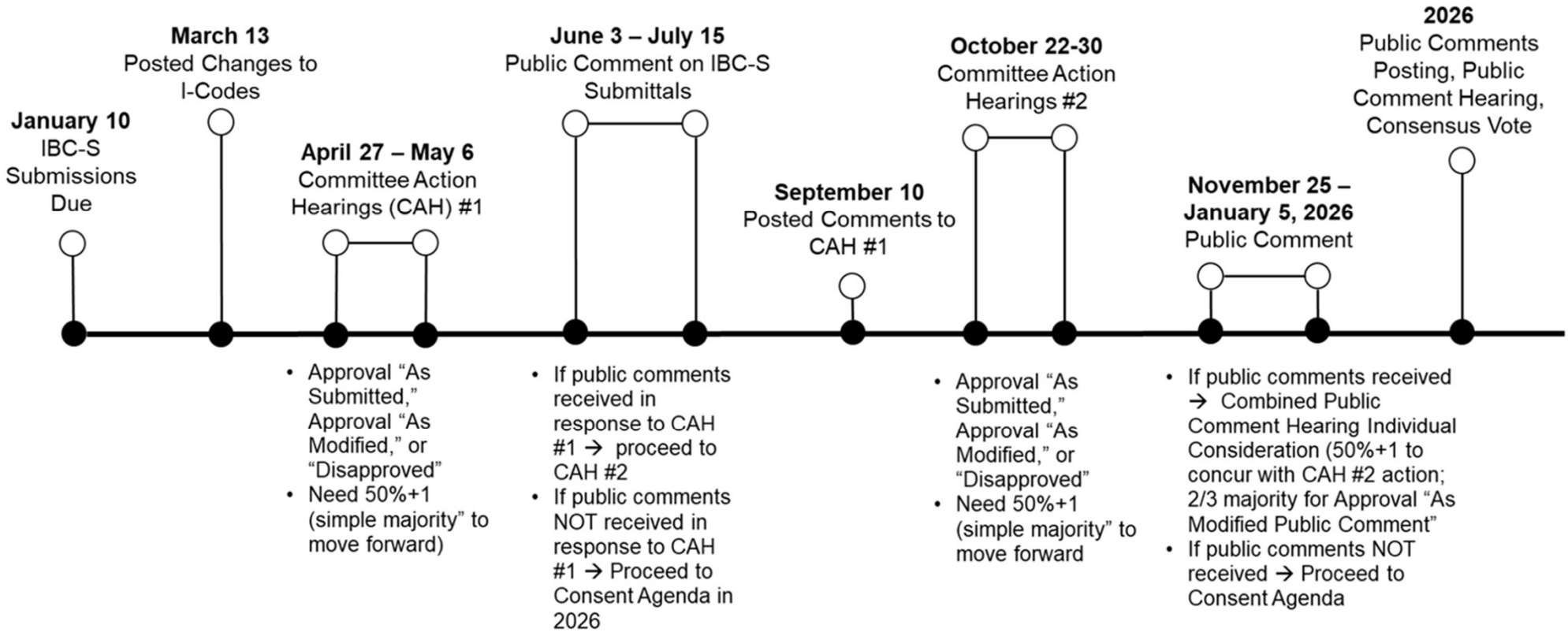
Why the IBC?: Scope Compatibility



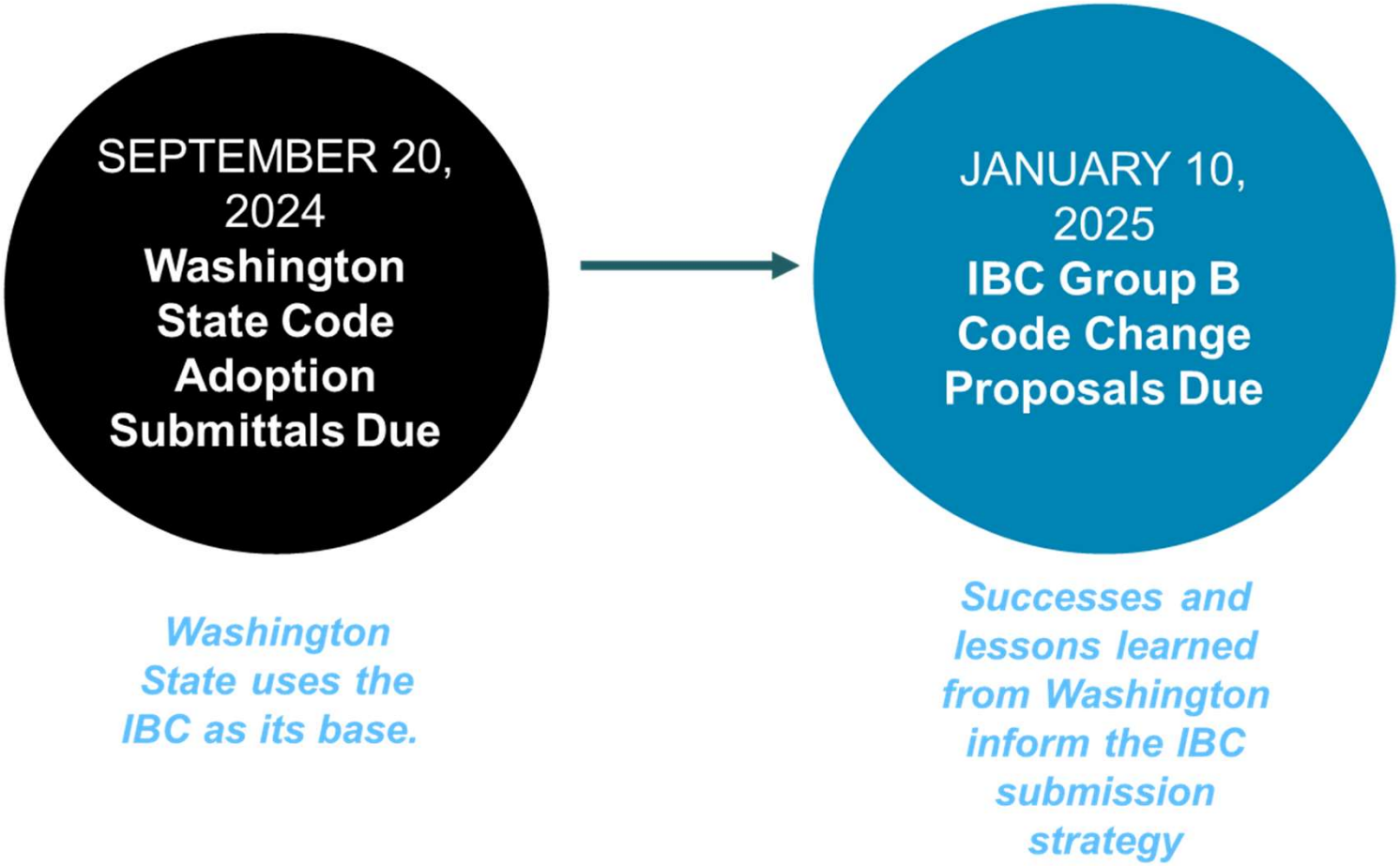
"Preserves public health and safety to provide safeguards from hazards associated with the built environment."

	Building Code	Residential Code	Mechanical Code	Plumbing Code	Electrical Code	Green Code	Energy Code
Primary Systems							
	Structure and envelope	All	Air supply, distribution, conditioning	Water supply, disposal, hot water	Electrical service, wiring, and systems	Site, Materials, Energy, IAQ,	
Materials Covered							
Concrete	X	X	X	X		X	
Steel	X	X	X	X			
Glass	X	X					
Aluminum	X		X				
Wood	X	X					
Copper			X	X	X		
Plastic	X	X	X	X			
Insulation	X	X	X				
Refrigerants			X			X	

2025 IBC Timeline and Milestones



Interplay with Washington State Efforts

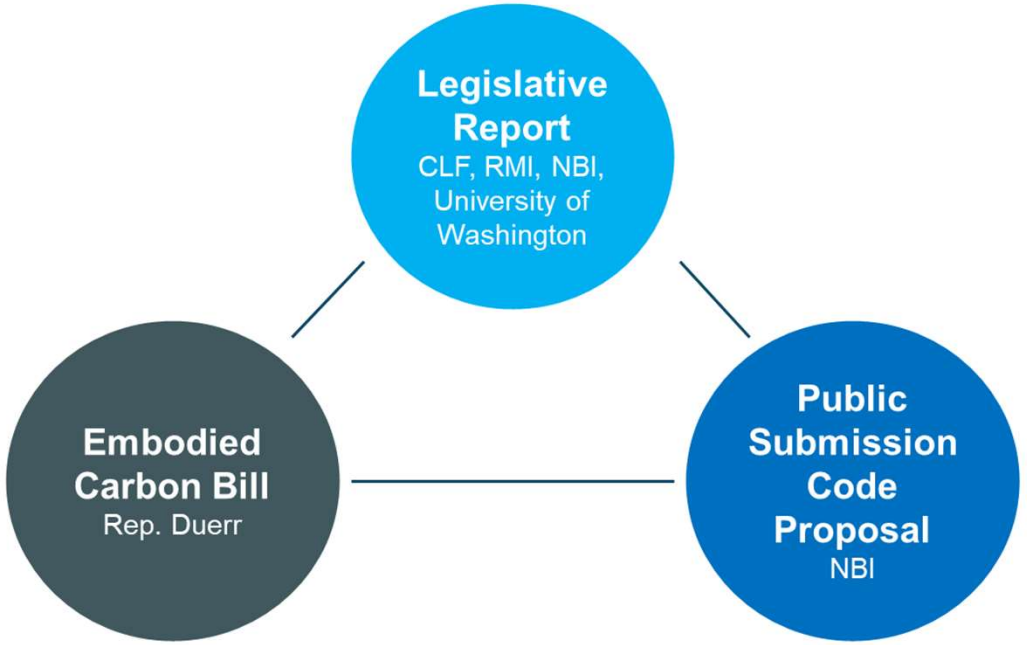

SEPTEMBER 20, 2024
Washington State Code Adoption Submittals Due
JANUARY 10, 2025
IBC Group B Code Change Proposals Due
Washington State uses the IBC as its base.
Successes and lessons learned from Washington inform the IBC submission strategy

Complementary Embodied Carbon Efforts in Washington State

2024:
Washington Buy Clean Buy Fair Act

- Requires state projects to submit EPDs for major construction materials
- Directs the development of statewide database and clear guidelines for reporting

Recent and Ongoing:



Context and Takeaways from Past and Ongoing Proposals

Past Proposals:

- **Prescriptive only:** GWPs for concrete and steel, EPDs for some wood products

Current Proposals:

- **3 pathway options:** prescriptive (material-level caps), performance (whole building LCA), or building reuse

Takeaways:

- A successful code proposal will have a clear methodology for determining compliance.
- Sensitivity to ensuring no materials were treated preferentially.
- Most consensus around incorporating as new appendix. Other sections discussed include chapter 1, chapter 4, and a new chapter.
- General support from industry for the 3 pathway options.
- What constitutes the right GWP value for the state requires conversation with industry.

Implementation

SECTION Q104
DOCUMENTATION OF REDUCTION OF EMBODIED GHG EMISSIONS

Q104.1 Registered design professional.

A *registered design professional* shall prepare the *construction documents* and provide signature verifying compliance with the requirements of this appendix.

Q104.2 Amended construction documents for embodied GHG emissions.

Covered products shall be installed in accordance with the approved *construction documents*. Prior to the issuance of the certificate of occupancy, the *registered design professional* that submits documentation per Sections Q103.3, Q103.4, or Q103.5 shall ensure that as-built product selection matches the approved *construction documents*. If as-built products differ from those submitted on the approved construction documents, the *registered design professional* shall update the *embodied GHG emissions* calculations based on the updated procured products and attest that they are accurate to the best of the *registered design professional*'s knowledge.

Massachusetts EC Landscape

SENATE . . . . . No. 2967

The Commonwealth of Massachusetts

In the One Hundred and Ninety-Third General Court
(2023-2024)

An Act promoting a clean energy grid, advancing equity and protecting ratepayers.

"Environmental product declaration" or "EPD", an independently verified and registered declaration that provides a life cycle assessment of a product's global warming potential and facilitates a comparison of environmental impacts between products fulfilling the same function; provided, however, that such declaration shall be a Type III or higher as defined by the International Organization for Standardization (ISO), 14025:2006, or substantially similar life cycle assessment and comparative methodologies that have uniform standards in data collection and scientific integrity, and any pertinent product category rule developed in conformance with ISO 14025:2006.

Massachusetts Carbon Matrix

Synergy across the State

Government Leadership

From the Governor's office to the Building Officials

DOER

Actionable Policy across Residential, Commercial & industrial

Utilities

3-year plans in tight alignment with state policy -

MASS Save

Performance Based Incentives

Workforce Development

Weatherization, Energy Consultants, Builder Training

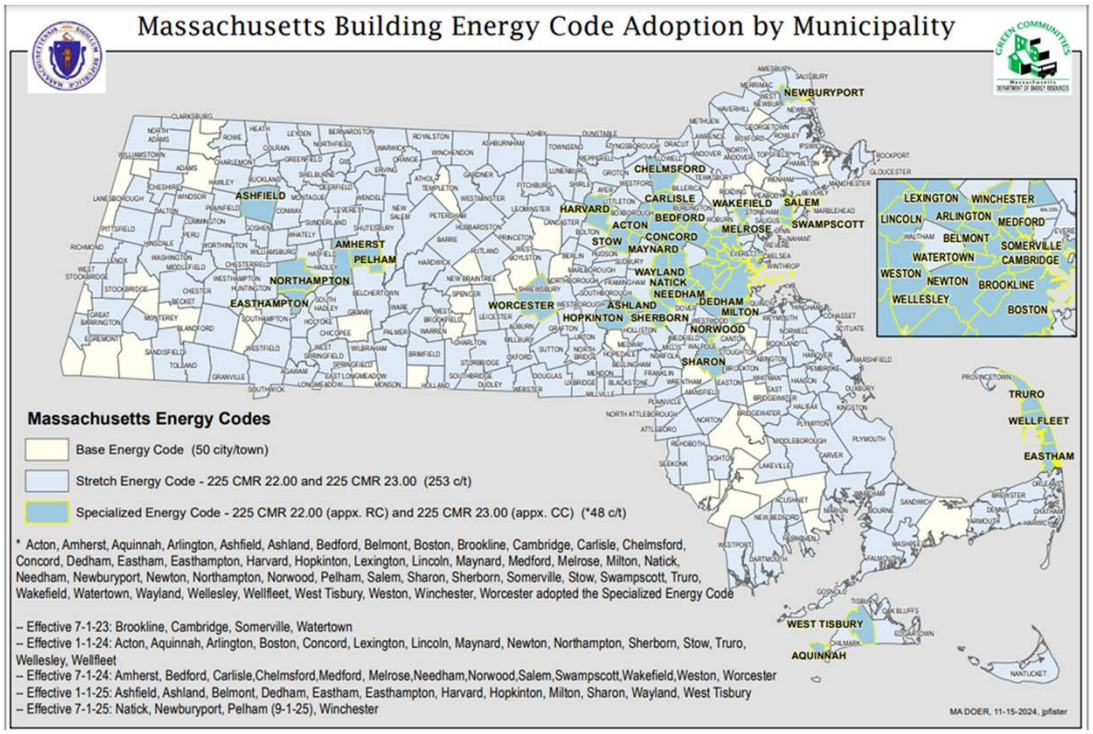
Architects / Engineers / Designers

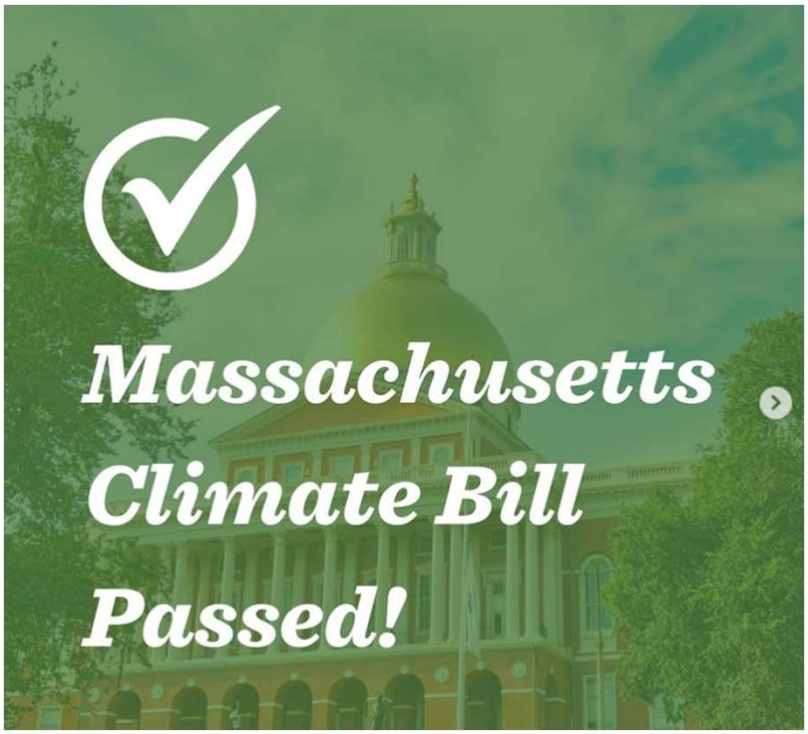
HERS Raters

MASS Clean Energy Center

Innovation through investment

Massachusetts: The Test Kitchen



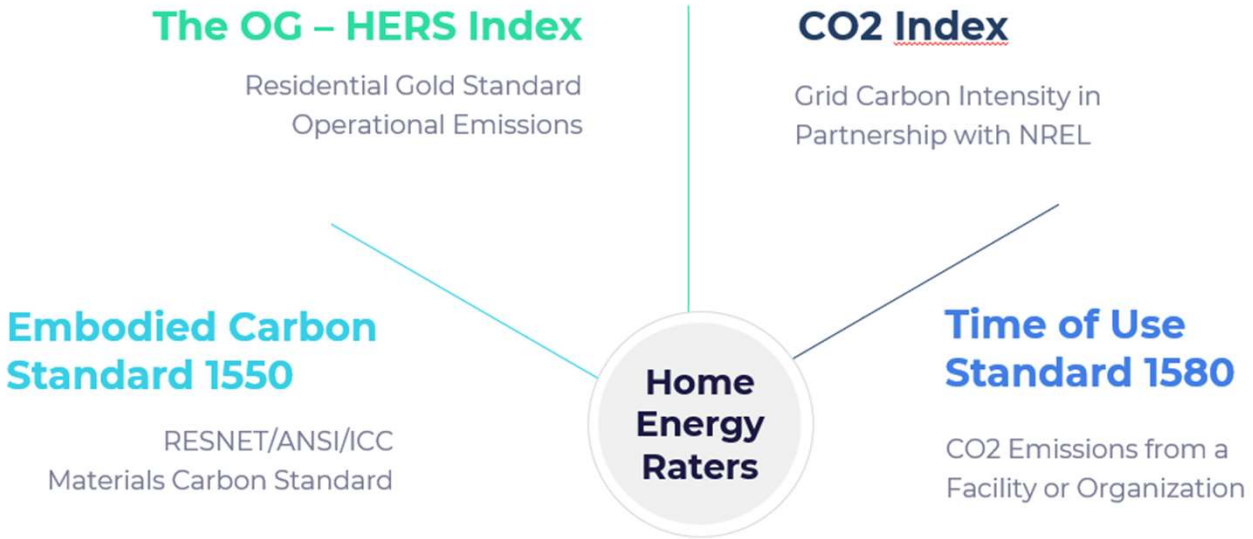


https://www.mass.gov/doc/building-energy-code-adoption-by-municipality/download

https://www.instagram.com/officialmasssierraclub/p/DCXT6jayBO-/?img_index=1

The RESNET Ecosystem

The Trifecta + 1



What does the next decade hold for the Rating Industry?

Residential Embodied Carbon Developments:
A Timeline

2019	NESEA Boston	• Chris Magwood, Ace McArleton, Jacob Racusin Deliver NESEA 2019 Keynote
2020-2021	Northeast HERS Alliance Embodied Carbon Committee	• What role will HERS Raters play in Tracking EC in 400,000 Homes annually?
2022	Networking and Development	• ASHRAE 90.2 • Builders for Climate Action • New Buildings Institute
2023	RESNET votes for the Development of a Standard	• Chris Magwood joins Rocky Mountain Institute • Along with Tracy Hyun spearhead Standard 1550 • Massachusetts pushes the envelope
2024	RESNET Develops 1550	• Delivery of Standard Summer 2025

MA DOER - Residential
Stretch Code Effective 2/14/2025

TABLE R406.5 MAXIMUM ENERGY RATING INDEX

Clean Energy Application	Maximum HERS Index score [a,b]				
	~~New construction until June 30, 2024~~	New construction permits after July 1, 2024	New Construction with R406.5.2 embodied carbon credit	Accessory Dwelling Units	Major alterations, additions, or change of use[c]
Mixed-Fuel Building	~~52~~	42	45	52	~~52~~ 65
Solar Electric Generation	~~55~~	42	45	55	~~55~~ 70
All-Electric Building	~~55~~	45	48	55	~~55~~ 70
Solar Electric & ~~All-Electric Building~~ *All-Electric Building*	~~58~~	45	48	58	~~58~~ 75

[a] Maximum HERS rating prior to onsite renewable electric generation in accordance with Section R406.5

Embodied Carbon Credit

R406.5.2 Add Subsection R406.5.2

1. Insulation embodied carbon credit:

- Up to 3 HERS points off for low carbon insulation
- Leverages a state of VT GWP chart of materials

2. Low GWP concrete mix credit:

- Up to 3 HERS points off for GWP reduction from regional baseline

https://www.mass.gov/doc/fall-2024-stretch-specialized-code-residential-redlines-full/download

MA DOER - Commercial
Stretch Code Effective 2/14/2025

For prescriptive projects, embodied carbon is now an option to earn 8 credits in Section C406, with C406.14 for concrete and Section C406.15 for insulation.

- **C406.14 for concrete:**
  - **Your average Concrete Mix is lower than the regional average or not**

- **C406.15 for insulation**
  - **The building shell is either negative carbon (carbon storing) or not**

Enhancement #6: Include an embodied carbon reduction component

Embodied carbon is a term for GHG emissions released during upstream stages of a product's life cycle. Those stages typically include extraction, production, transport, and manufacturing. As new buildings become more energy efficient, embodied carbon will represent a growing share of total building emissions. According to Architecture 2030, embodied carbon is on track to represent most carbon emissions from new buildings and infrastructure between now and 2030.[122]

1. Collaborate with the Massachusetts Clean Energy Center to increase workforce diversity, doubling annual funding to $24 million per year

Massachusetts Carbon Matrix

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DOER

Actionable Policy across Residential, Commercial & industrial

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3-year plans in tight alignment with state policy -

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Workforce Development

Weatherization, Energy Consultants, Builder Training

Architects / Engineers / Designers

HERS Raters

MASS Clean Energy Center

Innovation through investment

How to Get Low Emissions Concrete

1. Find Ready-Mix partner **EXPERIENCED** in:
   - Environmental Product Declarations (EPDs)
   - Supplying better than NRMCA Eastern benchmark

MA Ready-Mix Concrete Plants with EPD Capability via MassCEC grant

1. Set performance based specification **EARLY** and engage ready-mix partner **EARLY**

MASSACHUSETTS CLEAN ENERGY CENTER

EMBODIED CARBON REDUCTION CHALLENGE

LEARN 7 STRATEGIES

SEE 16 CASE STUDIES

100-Homes Study

Software workflow

BEAM
BUILDING EMISSIONS ACCOUNTING FOR MATERIALS

ekotrope

Software connectivity

- Prototype of connectivity between HERS and embodied carbon software in MA

MASSACHUSETTS CLEAN ENERGY CENTER

NEHERS
NORTHEAST HOME ENERGY RATING SYSTEM ALLIANCE

BUILDERS FOR CLIMATE ACTION

ASSESSING THE UPFRONT CARBON OF BUILDING MATERIALS IN HOMES

https://www.masscec.com/resources/assessing-upfront-carbon-building-materials-homes

On the Precipice of Carbon Reporting at Scale

ekotrope

Carbon Index	HERS® Index
59	52

About these ratings:
Both ratings are relative performance scores. A lower Carbon Rating Index means fewer carbon emissions for a home. The lower the HERS Rating, the more energy efficient the home. For more Info: www.resnet.us/about/resnet-carbon-rating-index www.hers.com

Home: 151 S Nantu
Builde Steve

	CO_2e Emissions [tons/yr]	Annual Cost
Heating	2.5	$2,227
Cooling	0.0	$14
Hot Water	0.8	$505
Lights/Appliances	2.9	$2,627
Service Charges		$122
Generation (e.g. Solar)	0.0	$0
Total:	6.2	$5,495

Annual Savings*
8.0 Tons CO_2e
$7,327
*Relative to an average U.S. home

5.62 kgCO_2e/yr

BEAM

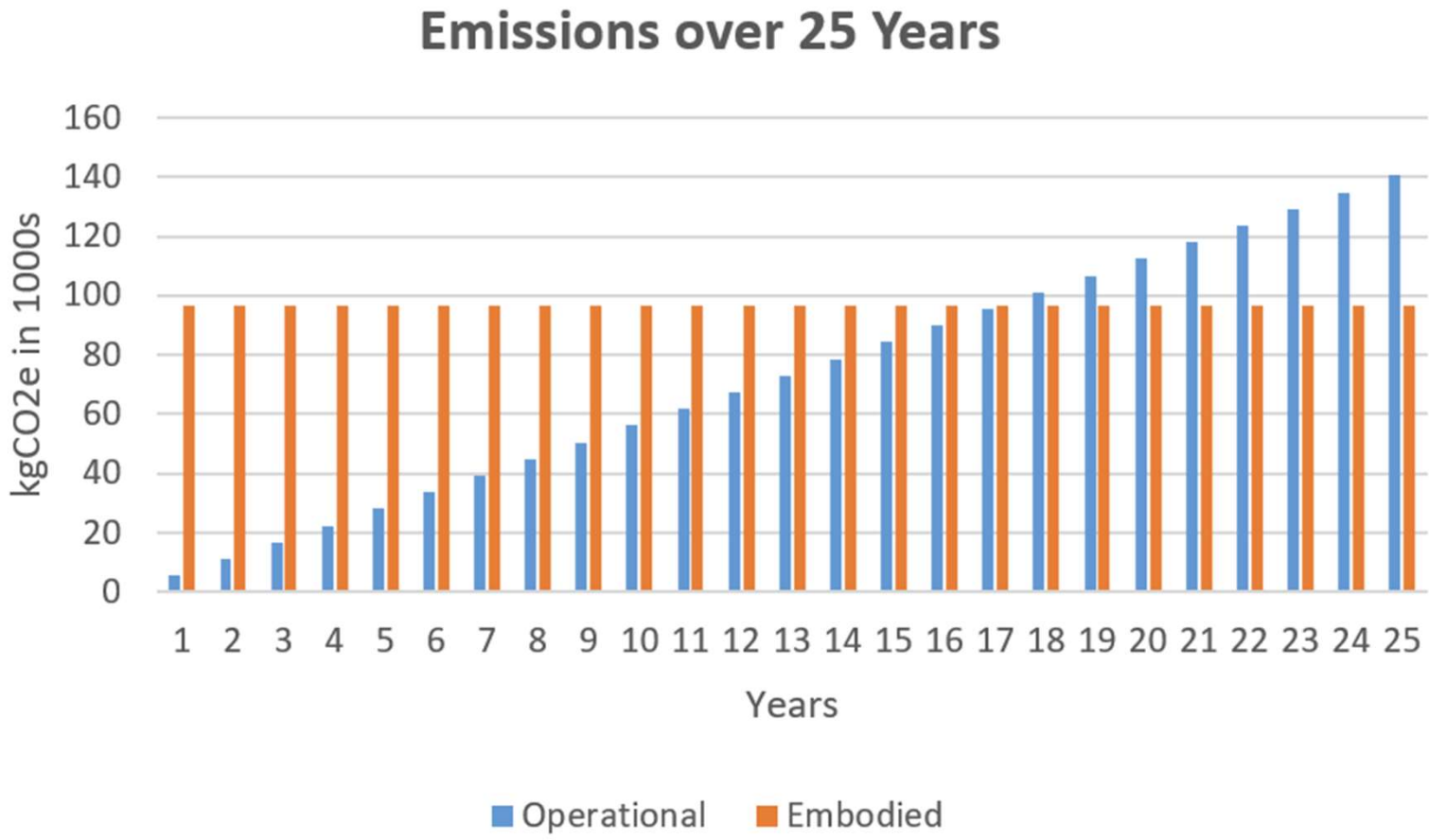
Footings & Slabs	18,558 kg CO_2e
Foundation Walls	24,513 kg CO_2e
Structural Elements	1,896 kg CO_2e
Exterior Walls	3,579 kg CO_2e
Party Walls	0 kg CO_2e
Cladding	1,427 kg CO_2e
Windows	6,113 kg CO_2e
Interior Walls	3,913 kg CO_2e
Floors	7,827 kg CO_2e
Ceilings	1,956 kg CO_2e
Roof	4,784 kg CO_2e
Garage	0 kg CO_2e
NET TOTAL	74,566 kg CO_2e

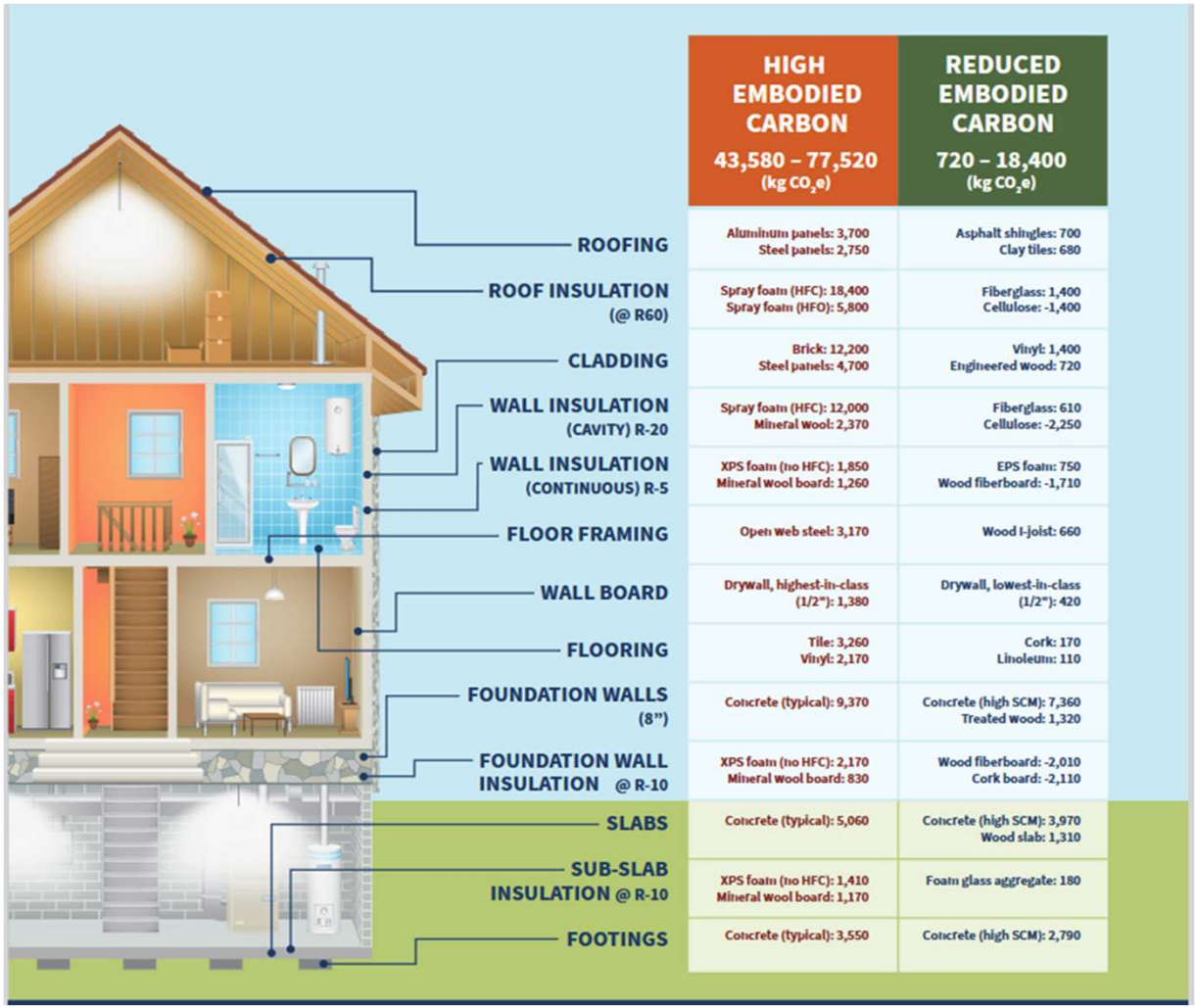
74,566 kgCO_2e

Ekotrope-BEAM
INTEGRATION WORKSHEET (BETA)
STEP 4.1 - MEP :

Electrical	2,123
Plumbing	4,070
HVAC	16,048

22,241 kgCO_2e


Emissions over 25 Years
kgCO2e in 1000s
160
140
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Years
Operational
Embodied

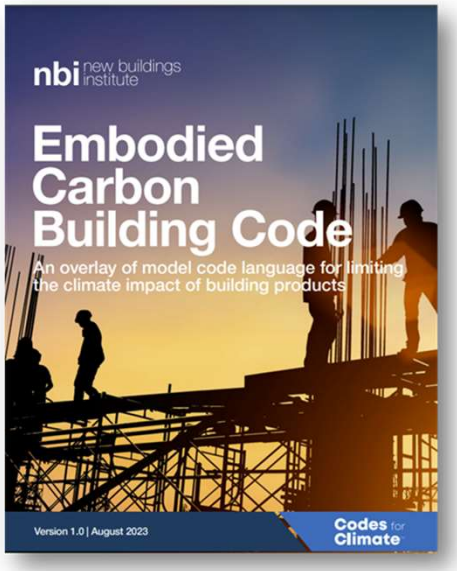


Source: HomebuildersCAN

What’s Next?


ALBERTA
MANITOBA
BRITISH COLUMBIA
Edmonton
SASKATCHEWAN
NEWFOUNDLAND AND LABRADOR
Calgary
ONTARIO
QUEBEC
Winnipeg
Vancouver
Seattle
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
Ottawa
Montreal
NB
PE
NOVA SCOTIA
MAINE
OREGON
IDAHO
WYOMING
SOUTH DAKOTA
WISCONSIN
MICHIGAN
Toronto
VT
NEW YORK
Boston
Chicago
NEBRASKA
IOWA
ILLINOIS
OHIO
PENN
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
INDIANA
Washington
New York
San Francisco
CALIFORNIA
Las Vegas
WEST VIRGINIA
KENTUCKY
VIRGINIA
OKLAHOMA
TENNESSEE
NORTH CAROLINA
Los Angeles
San Diego
ARIZONA
NEW MEXICO
ARKANSAS
MISSISSIPPI
SOUTH CAROLINA
Dallas
ALABAMA
GEORGIA
TEXAS
LOUISIANA
San Antonio
Houston
Gulf of California
FLORIDA
Monterrey
Gulf of America
Miami
Mexico
Havana
Cuba
Guadalajara
Mexico City
Santo Domingo
Puerto Rico
Guatemala
Google
Contact map owner
Map data ©2025 Google, INEGI
200 mi
Type of program
Regulatory
Incentive
Public Pilot/Study
Planned (Action Plan/EO)
Agency Program
Government funded tool
Education/Training
(No Value Provided)
Passed/Active

For More Information:



For information or to get involved in code efforts:
ariel@newbuildings.org

For a copy of the 100 Homes Study:
andyb@stephensandcoinc.com

Questions and Discussion

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Thank You!