Commercial, Multi-Family, and All Other Construction

Embodied Carbon

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What's Included?

The 2025 Massachusetts Stretch and Specialized Code for commercial, multi-family, and all other construction now includes optional measures for embodied carbon!

This review guide offers code users and code enforcement officials guidance on how to understand and use the new embodied carbon optional code measures.

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What is Embodied Carbon?

Embodied carbon refers to the **Greenhouse Gas (GHG)** emissions associated with the manufacturing, transportation, installation, maintenance, and disposal of construction materials used in the built environment. Embodied carbon accounts for **11% of the total global emissions**, as shown in Figure 1.

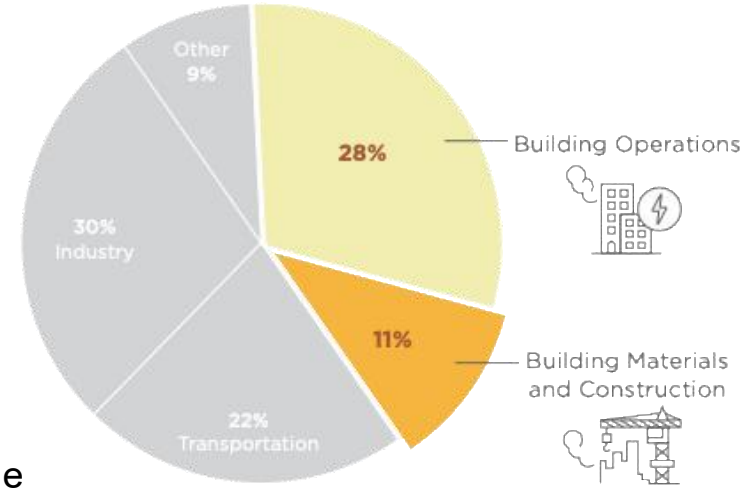

Figure 1: **Global Co2 Emissions by Sector**
Emissions from buildings comprise **39%** of total global greenhouse gas emissions.

Embodied carbon is quantified using **Global Warming Potential (GWP)**, which is reported in kilograms of CO_2 equivalent ($kgCO_2e$). To calculate the total GWP, a method called **Life Cycle Assessment (LCA)** is used, which evaluates the environmental impacts of various construction materials.

Figure 2 graphically illustrates a “cradle-to-grave” LCA approach, which starts with the initial extraction of raw materials and ends with the anticipated disposal or end-of-life process.

This information serves as a standardized metric for determining a product’s carbon footprint, which is documented by way of an **Environmental Product Declaration (EPD)**. EPDs should be third-party verified (Type III) and can either be industry-wide for a typical product, or product specific from a manufacturer.

Figure 2: **Building Material Life Cycle**
Cradle-to-grave embodied carbon emissions vs. operational emissions from buildings.

Product Stage	Construction	Use	End-of-Life	Beyond
▪ Raw Material Supply ▪ Material Transportation ▪ Manufacturing	▪ Transportation to Site ▪ Construction	▪ Energy, Water, and Regular Operations ▪ Maintenance, Repair, and Replacement	▪ Demolition ▪ Transport of Materials ▪ Waste Disposal	▪ Reuse ▪ Recovery ▪ Recycling

What Are The Codes and How Does C406 Work?

The **Stretch Code** and **Specialized Code** are both Municipal Opt-In Specialized Code for any municipality that go beyond the **Base Code** – 2021 IECC with MA amendments: 780 CMR Chapter 13 (commercial). Over 300 cities and towns have adopted either the stretch or specialized code. More information can be found at mass.gov/doc/building-energy-code-adoption-by-municipality/download.

The 2025 Massachusetts Stretch and Specialized Code for commercial, multi-family, and all other construction now includes optional measures for embodied carbon.

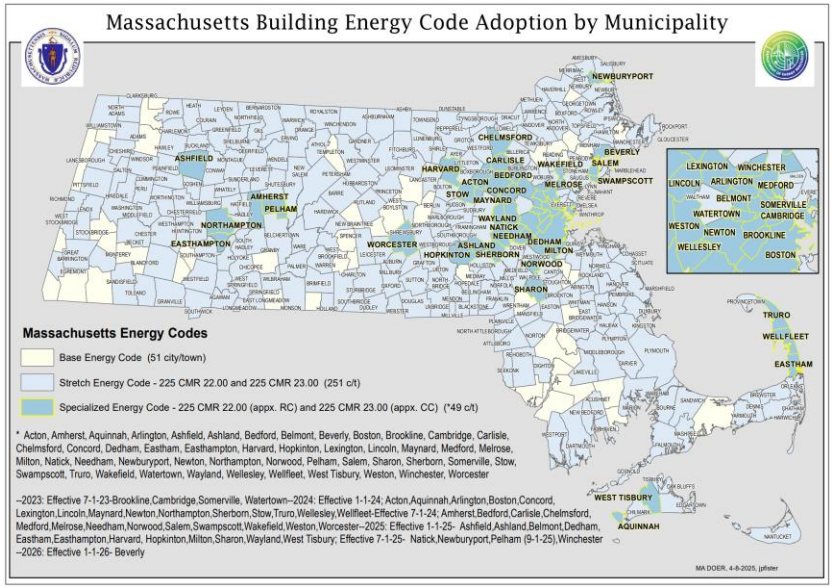

Figure 3: **Massachusetts Building Energy Code Adoption by Municipality, courtesy of MA DOER.** mass.gov/orgs/massachusetts-department-of-energy-resources

C406.1 Additional Energy Efficiency Credit Requirements

New buildings shall achieve a total of **15 credits from Tables C406.1(1) through C406.1(5)** where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit.

The following slides will show you how to document and earn the following embodied carbon additional energy efficiency credits:

C406.13 Heavy Timber Construction = 8 credits

C406.14 Low GWP Concrete Mix = 8 credits

C406.15 Net Zero GWP Insulation = 8 credits

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Heavy Timber Construction

While mass timber has lower embodied carbon compared to similarly designed traditional concrete and steel buildings, it is also lighter structurally, which results in reduced quantities of foundation (in turn also lowering embodied carbon). Mass timber buildings can often be constructed faster, reducing overall project schedule, saving teams both time and money. Fire testing has demonstrated mass timber burns at a predictable rate and in a predictable fashion, with charring properties providing a reliable measure of fire-resistive performance without added noncombustible protection. Exposed wood also improves occupant health and wellbeing, through principles of biophilia, by promoting connection to nature.

C406.13 Heavy Timber Construction: In buildings with 4 stories or more of Type IV heavy timber construction either above grade, or above podium.[1]

602.4.4 Type IV-HT Type IV Heavy Timber Construction is that type of construction in which the exterior walls are of non-combustible materials and the interior building elements are of solid wood, laminated heavy timber or structural composite lumber (SCL), without concealed spaces or with concealed spaces complying with Section 602.4.4.3.[2] The minimum dimensions for permitted materials including solid timber, glued-laminated timber, SCL and cross-laminated timber (CLT) and the details of Type IV construction shall comply with the provisions of this section and Section 2304.11. Exterior walls complying with Section 602.4.4.1 or 602.4.4.2 shall be permitted. Interior walls and partitions not less than 1-hour fire-resistance rated or heavy timber conforming with Section 2304.11.2.2 shall be permitted.

(Above) Glue Laminated Timber (Glulam) Beams & Columns

(Above) Cross-Laminated Timber (CLT) Solid Sawn Laminations

(Above) Cross-Laminated Timber (CLT) SCL Laminations

[1]Per 225 CMR 23.00
[2]Per 2021 IBC

Low GWP Concrete Mix

C406.14 Low GWP Concrete Mix: In new buildings where EPDs are provided with construction documentation that **demonstrate an average calculated concrete mix Global Warming Potential (GWP) for at least 90% of all concrete mix** used in the building of not more than **100% of the 2022 NRMCA North-East Benchmark average values** shown in Table C406.14.

C406.14.1 Documentation for Low GWP Concrete Mix credit: In order to apply the low GWP concrete mix credits, the architect or engineer of record must **submit specific EPDs for concrete** used in the project. Where multiple concrete mixes are used, a complete **calculation to summarize estimated embodied carbon emissions from at least 90% of all concrete materials** used in the project is required. The output metric for this measure shall be **global warming potential (GWP) per cubic meter** as supplied, with the EPD verified by the concrete ready-mix provider. The C406.14 credits shall be applied when the **GWP per cubic meter is demonstrated to be less than the Maximum GWP per cubic meter value shown** in Table C406.14. for at least 90% of all concrete used for the project.

Maximum GWP (kg CO_2e) Limits for Concrete Adapted from Table C406.14

Normal Weight Concrete	
Specified Compressive Strength (fc in psi)	**GWP per cubic meter***
0 – 2,500	240
2,501 – 3,000	264
3,001 – 4,000	314
4,001 – 5,000	378
5,001 – 6,000	399
6,001 – 8,000	472

Light Weight Concrete	
Specified Compressive Strength (fc in psi)	**GWP per cubic meter***
0 – 3,000	517
3,001 – 4,000	573
4,001 – 5,000	628

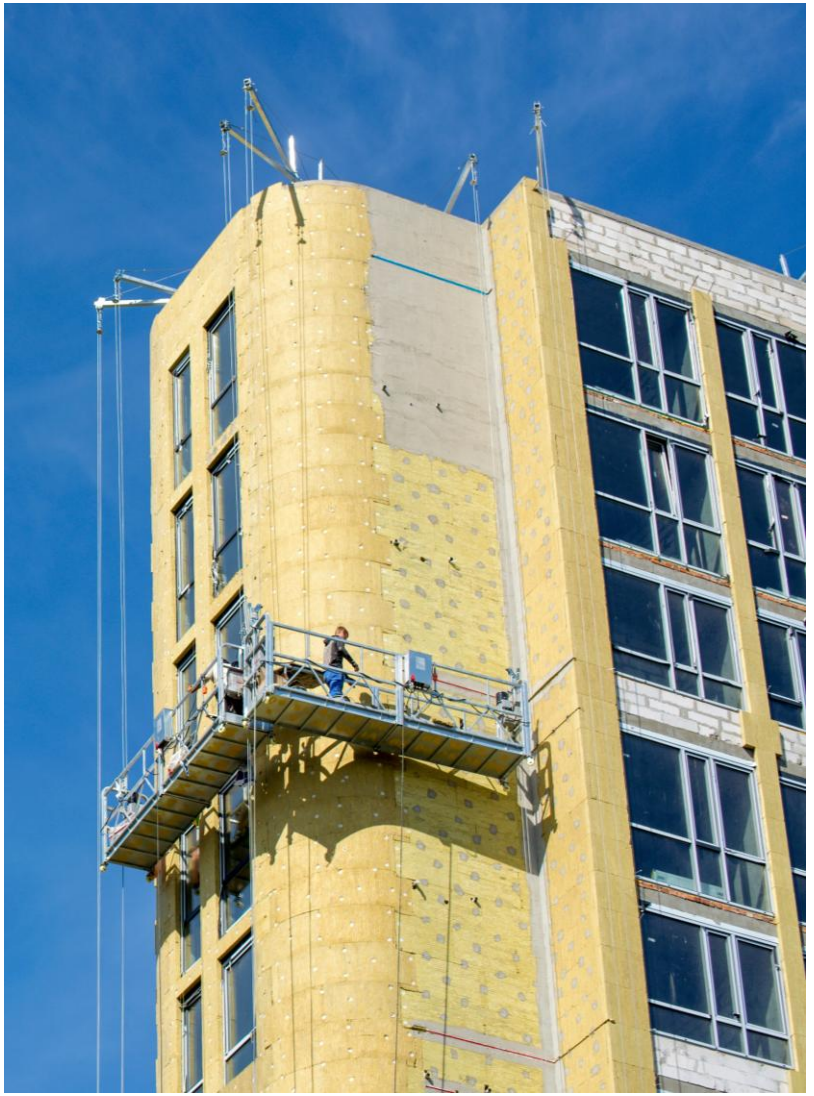
*These numbers are 100% of the Eastern Region average GWP figures from the National Ready Mix Concrete Associations' "A Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete Manufactured by NRMCA Members, Version 3.2," (July 2022), pg. 65.NRMCA LCAReportV3-2_ 20220224.pdf

Net Zero GWP Insulation

C406.15 Net Zero GWP Insulation: In new buildings that demonstrate an **average calculated insulation Global Warming Potential (GWP) intensity (kg CO_2e/m^2) less than 0** across the whole building envelope. GWP intensity shall be based on the default values in Table C406.15. or product specific EPDs or calculations in the approved tools: EC3 and BEAM, may be used in place of default table C406.15 values.

C406.15.1 Documentation for Insulation embodied carbon credit: In order to apply the insulation embodied carbon credits for a building, the architect or engineer of record for the building must **submit a complete calculation to summarize estimated embodied carbon emissions from all insulation materials** used in the building project. The output metric for this measure shall be **Global Warming Potential (GWP) intensity, capturing insulation GWP per conditioned square meter of project area**.

Projects may substitute **product-specific data for the default GWP value if the specified product has a lower reported GWP than the default value**. Substitution of default GWP values is only allowed when **type III product-specific EPDs** are sourced and noted. Projects shall use GWP values that include A1-A3 lifecycle stages, as documented in product-specific EPDs, with the exception of SPF and XPS products. For these products, the A5 and B1 values shall be included in the documented GWP value to account for the on-site and off-gassing impact of blowing agents. **Projects shall provide the EPDs declaration number in product-specific data substitution.**



Default GWP (kg CO_2e) for Insulation

Adapted from Table C406.15. See Stretch & Specialized Code – Commercial on the Resources page for more information.

Insulation Material		Default GWP (kg CO_2e per m^2 RSI-1)
Cellular Glass	Aggregate	3.93
Cellulose	Densepack	-2.00
	Blown/Loose fill	-0.90
Cork	Board	-4.30
EPS/Graphite	Board, Unfaced, Type II – 15 psi	2.30
	Board, Unfaced, Type IX – 25 psi	3.10
EPS	Board, Unfaced, Type I – 10 psi	2.50
	Board, Unfaced, Type Ii – 15 psi	3.40
	Board, Unfaced, Type IX – 25 psi	4.30
Fiberglass	Batt, Unfaced	1.00
	Blown/Loose fill	1.00
	Blown/Spray	1.93
Hemp	Batt	-0.50
	HempCrete	-4.10
Mineral Wool	Batt, Unfaced	1.50
	Blown loose fill	1.90
	Board, Unfaced, "Light" density	2.70
	Board, Unfaced, "Heavy" density	6.90

Insulation Material		Default GWP (kg CO_2e per m^2 RSI-1)
Phenolic Foam	Board	1.54
Polyiso	Wall Board	4.10
	Roof Board (GRF facer)	2.11
	Roof Board (CGF facer)	2.95
SPF, Spray	Open Cell	1.40
	Closed Cell HFO	3.50
	High Density HFO	4.00
	Closed Cell HFC	13.10
	High Density HFC	17.00
Straw	Panel	-5.45
Vacuum Insulated	Panel	7.40
Wood Fiber	Board, Unfaced, European	-4.38
	Board, Unfaced, North American	-10.30
	Batt, Unfaced	-1.60
Wool (Sheep)	Batt	0.20
	Loosefill	0.80
XPS	Board, 25 psi HFC	55.5
	Board, 25 psi, "Low GWP" (HFO/HFC)	5.50

Guidance For Using The Low GWP Concrete Measure

Compare the ready-mix concrete product's **GWP** stated from its respective **EPD** against the maximum allowed **GWP** from **Table C406.14 Default Concrete Global Warming Potential Values.**

In the example below, a 3,000 psi ready-mix concrete product from Boston Concrete (1) is compared against the maximum GWP limit for 3,000 psi concrete from Table C406 (2).14 Default Concrete Global Warming Potential Values. The Table C406.14 values are established using the 2022 NRMCA Northeast Benchmark dataset.

1. Find the 3,000 psi ready-mix concrete GWP (Row 1, Column "Per M3")
2. Compare to the maximum GWP limit in Table C406 (2).14 for 3,000 psi concrete mix (Row 2)

The GWP on the EPD should be less than the GWP from Table C406.14.

1

BOSTON CONCRETE

EPD

ENVIRONMENTAL PRODUCT DECLARATION

ALLOCATION

The allocation of co-products or secondary flows cross the system boundary conforms with the ISO 21930: 2017 Section 7.2.4. Specifically, the allocation criteria were applied as follows:

- Allocation was not applied to any of the gate-to-gate production facilities.
- For Secondary Data sources, the NSF PCR default allocation selection (i.e., "Cut-off" or "Alloc Rec") was applied.
- The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input.
- A portion (30%) of the reported fleet energy use for truck mixing plants was allocated to the mixing facility.

CALCULATED RESULTS A1- A3

CORE MANDATORY IMPACT INDICATOR			PER YD3	PER M3
Global warming potential	GWP	kg C02e	192.72	252.07
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	6.31E-06	8.26E-06
Acidification potential of soil and water sources	AP	kg SO2e	1.05	1.37
Eutrophication potential	EP	kg Ne	0.24	0.32
Formation potential of tropospheric ozone	POCP	kg 03e	24.17	31.62
Abiotic depletion potential for fossil resources	ADPf	MJ, NCV	1289.45	1686.53
Abiotic depletion potential for non-fossil mineral resources *	ADPe	kg Sbe	1.03E-04	1.34E-04
Fossil fuel depletion	FFD	MJ Surplus	84.08	109.98

2

Maximum GWP (kg CO_2e) Limits for Concrete	
NORMAL WEIGHT CONCRETE	
Specified Compressive Strength (f'c in psi)	Maximum GWP per cubic meter[a]
0-2500	240
2501-3000	264
3001-4000	314
4001-5000	378
5001-6000	399

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Guidance For Using The Low GWP Concrete Measure

Attachment F: Low-Carbon Concrete Mixes available in MA is an excel database resource from mass.gov that provides approximately 1,000 ready mix concrete products with their associated GWP. This tool is a reference to ensure that building owners, designers, and general contractors can easily specify and procure ready mix concrete products that meet the GWP limits of C406.14 Default Concrete GWP Values and earn credits under C406.

1. Ready-mix concrete product number (Column D)
2. Concrete compressive strength of the ready-mix (Column F)
3. Global Warming Potential (GWP) in $kgCO_2e$ (Column G)
4. If the ready-mix product falls under the GWP limit required in C406.14 (Column H)

1 2 3 4

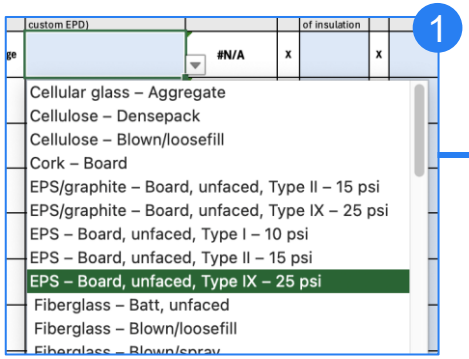
	A	B	C	D	E	F	G	H
1	**Category**	**Manufacturer**	**Plant/ Plant Group**	**Product**	**Description**	**Compressive Strength**	**GWP**	**HERS 3 Point Qualified**
2	Ready Mix	Boston Concrete Corporation	Boston Concrete	404E03MR	4000 3/4 Slag NA-MR	4000 psi	213.3 kgCO2e	Yes
3	Ready Mix	Boston Concrete Corporation	Boston Concrete	404E00MR	4000 50% slag- MR	4000 psi	215.2 kgCO2e	Yes
4	Ready Mix	Boston Concrete Corporation	Boston Concrete	604E403MR	6000 - 40% slag MR	6000 psi	296.1 kgCO2e	Yes
5	Ready Mix	Boston Concrete Corporation	Boston Concrete	604E400MR	6000 - 40% slag MR	6000 psi	292.4 kgCO2e	Yes
6	Ready Mix	Boston Concrete Corporation	Boston Concrete	604E303MR	6000 - 30% slag MR	6000 psi	329.1 kgCO2e	Yes
7	Ready Mix	Boston Concrete Corporation	Boston Concrete	604E300MR	6000 - 30% slag	6000 psi	323.4 kgCO2e	Yes
8	Ready Mix	Boston Concrete Corporation	Boston Concrete	504E400MR	5000 - 40% Slag MR	5000 psi	277.7 kgCO2e	Yes
9	Ready Mix	Boston Concrete Corporation	Boston Concrete	404E403MR	4000 - 40% slag MR	4000 psi	243.8 kgCO2e	Yes
10	Ready Mix	Boston Concrete Corporation	Boston Concrete	404E400MR	4000 - 40% slag MR	4000 psi	241.7 kgCO2e	Yes
11	Ready Mix	Boston Concrete Corporation	Boston Concrete	404E400	4000 - 40% slag	4000 psi	241.4 kgCO2e	Yes
12	Ready Mix	Boston Concrete Corporation	Boston Concrete	4.04E+02	4000 50% slag	4000 psi	215.2 kgCO2e	Yes
13	Ready Mix	Boston Concrete Corporation	Boston Concrete	4.54E+02	4500 -3/4 Air	4500 psi	228.4 kgCO2e	Yes
14	Ready Mix	Boston Concrete Corporation	Boston Concrete	2.54E+02	2500 3/4 Slag AE	2490 psi	153.6 kgCO2e	Yes
15	Ready Mix	Boston Concrete Corporation	Boston Concrete	404E00LAEA	4000 3/4 Slag 5% AE	4000 psi	215.2 kgCO2e	Yes
16	Ready Mix	Boston Concrete Corporation	Boston Concrete	4.04E+05	4000 3/4 Slag NA	4000 psi	213.3 kgCO2e	Yes

mass.gov/doc/embodied-carbon-insulation-calculator/download

Guidance For Using The Net Zero GWP Insulation Measure

Attachment E: Embodied Carbon Insulation Calculator is an excel tool from mass.gov that assists building owners, designers, and general contractors with **C406.15 Net Zero GWP insulation** compliance. Follow the steps below to evaluate compliance for your project.

1. Select insulation type from the dropdown in Column B
2. Input total R-Value for the specific insulation application in Column C
3. Input Total Surface Area in gross square feet in Column D
4. Check to see if Total Net Insulation GWP is negative and points are earned for Section C406!



1 2 3

A	B		C	D	E	F	G (option instead of B)	H	I
Portion of building assembly	Insulation Material type used	Default Global Warming Potential (kg CO2e / sq m RSI-1) (from table)	Product R-Value	Surface Area (gross square feet)	Conversion factor (square feet to square	Framing Factor ("1.0" for continuous insulation, "0.8" for cavity insulation)	Project has sourced a Type III - Product specific Environmental Product Declaration (EPD)	Product Specific Global Warming Potential (kg CO_2e / sq m RSI-1)	GWP Result (kg CO_2e)
Notes:	Select insulation material type from List (or Other if using a custom EPD)		To account for thickness of insulation				Insulation material & EPD Number (if applicable)	Add product specific EPD GWP value if using:	
Below grade, slab, slab edge	EPS – Board, unfaced, Type IX – 25 psi	4.30	10.0	1200	0.0929	1.0			4793.6
Basement walls (1)	EPS – Board, unfaced, Type I – 10 psi	2.50	15.0	1800	0.0929	1.0			6270.8
Above grade walls, cavity	Cellulose – Densepack	-2.00	19.0	2400	0.0929	0.8			-6778.0
Above grade walls, continuous	Polyiso – Wall Board	4.10	5.0	2400	0.0929	1.0			4570.7
Roof, flat	Cellulose – Densepack	-2.00	48.0	1300	0.0929	1.0			-11593.9
Roof, sloped cavity		#N/A			0.0929	0.8			#N/A
Roof, sloped, continuous		#N/A			0.0929	1.0			#N/A
Other: add rows above here		#N/A			0.0929	1.0			#N/A
Insert additional rows as needed							Total net Insulation GWP (kg CO_2e)		-2,736.8
	HERS rater signature		6/23/25	Date signed			HERS points credit		3
							Section C406 Points		8

4

mass.gov/doc/embodied-carbon-insulation-calculator/download

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Summary

The **2025 Massachusetts Stretch Code** for commercial, multi-family, and all other construction now includes optional measures for Embodied Carbon.

Eight (8) additional energy efficiency credits can be earned in C406 from C406.13 Heavy Timber Construction, C406.14 Low GWP Concrete, or C406.15 Net-Zero GWP Insulation each. Measures can be combined in order to comply with C406's 15 total additional energy efficiency credit requirement.

- **C406.13 Heavy Timber Construction = 8 credits**
- **C406.14 Low GWP Concrete Mix = 8 credits**
- **C406.15 Net Zero GWP Insulation = 8 credits**

Compliance for the new measures is made easy with the **Attachment E Embodied Carbon Insulation Calculator** and **Attachment F Low-Carbon Concrete Mixes available in MA** resources provided by mass.gov.

Start incorporating embodied carbon measures into your projects today.

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Definition of Terms

Embodied Carbon – refers to the greenhouse gas emissions arising from the manufacturing, transportation, installation, maintenance, and disposal of building and infrastructure materials.

Environmental Product Declaration (EPD) – is a report that documents the ways in which a product, throughout its lifecycle, affects the environment, including resource use, greenhouse gas and other emissions, waste generation, and more.

Global Warming Potential (GWP) – is a common unit of measure, which allows analysts to add up emissions estimates of different gases, typically reported in $kgCO^2e$.

Greenhouse Gas Emissions (GHG) – are gases that trap heat in the atmosphere.

Life Cycle Assessment (LCA) – is a systematic analysis of environmental impact over the course of the entire life cycle of a product, material, process, or other measurable activity.

Type III product-specific EPDs – are product-specific with a third-party certification, including external verification and external critical review.

Whole Building Life Cycle Assessment (wbLCA) – is like an LCA, but specific to a building and its bill of materials.

Resources

mass.gov:

Stretch & Specialized Code – Commercial: mass.gov/doc/stretch-specialized-code-commercial/download

Attachment E: Embodied Carbon Insulation Calculator: mass.gov/doc/embodied-carbon-insulation-calculator/download

Attachment F: Low-Carbon Concrete Mixes available in MA: mass.gov/doc/stretch-code-technical-documents-attachment-f-low-carbon-concrete-mixes-available-in-ma/download

Embodied Carbon Reduction Challenge:
masscec.com/sites/default/files/documents/BEPlusEmbodiedCarbonChallenge_16CaseStudies.pdf

Other Embodied Carbon Resources:

Carbon Leadership Forum (CLF): carbonleadershipforum.org/embodied-carbon-101-v2/

RMI: rmi.org/embodied-carbon-101/

Department of Energy: energy.gov/sites/default/files/2024-02/bto-abc-embodied-carbon-022624.pdf

Environmental Protection Agency: epa.gov/greenerproducts/cmore

EC3: buildingtransparency.org/tools/ec3/

BEAM: buildersforclimateaction.org/beam-estimator.html

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An Avangrid company

Cape Light Compact

EVERSOURCE

Liberty

nationalgrid

Unitil