EMBODIED CARBON LIFE CYCLE ASSESSMENT REFERENCE GUIDE

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1. BACKGROUND

On January 29, 2025, the City of Boston Zoning Commission approved an amendment to the zoning code known as the 'Net Zero Carbon' zoning initiative. The new zoning introduces decarbonization requirements for development projects that accelerate progress on the City of Boston's goal of being carbon-neutral by 2050. The new requirements take effect for new project filings starting on July 1, 2025.

I. INTENT

The intent of this guidance is to provide clarity and consistency for embodied carbon accounting and reporting in compliance with the requirements of the zoning. The sections below outline the requirements for performing a life cycle assessment (LCA). The Building LCA Reporting Template available for download at this location (url) is aligned with this guidance and should be used to report the results. More information on reporting is available in the Reporting Requirements section of this guidance.

II. TIMELINE AND REQUIREMENTS

The Article 37 Large Project Submission Guidelines outlines the timeline and requirements consistent with the zoning process.

2. BUILDING LCA GUIDANCE

I. APPLICABILITY

Article 80B, 80C, and 80D projects, subject to the provisions of Article 37 Green Buildings and Net Zero Carbon, amended February 6, 2025 and effective July 1, 2025, are to provide an Embodied Carbon Life Cycle Assessment (LCA) Report. With the Design / Building Permit Filing, Projects are to report the Global Warming Potential (GWP) of the proposed building's structure and enclosure.

II. LCA REPORTING PROCEDURES

Compliance with the LCA requirements outlined in the zoning code process shall be demonstrated by:

1. Calculating the embodied carbon of the building at the building permit stage, following the guidance in this document.
2. Submitting the Building LCA Reporting Template and raw results from software tools as proof of compliance, covered in more detail in the Reporting Requirements section.

This is a reporting requirement. No comparative analysis or reduction requirement is required at this time, though project teams are encouraged to explore and document embodied carbon reduction strategies in the Building LCA Reporting Template narrative section, and/or in the Green Building Report.

Multiple buildings that are part of the same permit application may be combined and submitted as one calculation of embodied carbon for submission to the City of Boston, or multiple buildings may be submitted separately, at the team's discretion.

Please refer to Section 37-7 Procedures of Zero Net Carbon for further information on submission credentials and applicable provisions.

Projects must follow one of two LCA compliance procedures from Table 2 based on whether the project satisfies the criteria for applicable projects.

Table 2. LCA compliance procedures. Projects must use one of the following pathways to comply.

Pathway	Applicable Projects	Compliance Procedure
Primary Pathway	Available to all projects meeting the applicability criteria outlined in the Applicability section	Projects shall submit a life cycle assessment using an LCA tool that covers all life cycle stages covered by the guidance (minimum A1-A3, B4, C2-C4). These projects must provide manual calculations (as described in the Life Cycle Stages section) for A4 and A5 if missing from the LCA tool selected.
Multifamily Residential Pathway*	Available only to project of Type V construction under 100,000 ft^2	Applicable projects shall submit a life cycle assessment using a tool that covers only a subset of key life cycle stages covered by the guidance (A1-A3 or A1-A5) and use the "Additional stage estimation method" to report impacts from missing stages. These projects must provide manual calculations for all the stages missing from the tool selected.

** Informative note: The pathway is meant to act as a lower-cost and lower-effort option for multifamily residential housing projects. It is aligned with the forthcoming RESNET Standard 1550[1] using the HERS rating and the LEEDv5 prerequisite: MRp2 Quantify and Assess Embodied Carbon.*

Additional stage estimation method

If a project is using the secondary pathway for compliance, this guidance may be followed. If the chosen LCA software tool does not include estimates for life cycle stages beyond product stage, such as only covering A1-A3 or A1-A5 (for example EC3 and the BEAM Estimator), the following methodology[2] may be used to manually calculate the embodied carbon emissions for the missing additional stages:

- Construction process stage – transportation to the construction site (module A4) impacts shall be assumed equal to 3% of the A1-A3 impacts;
- Construction process stage – construction (module A5) impacts shall be assumed equal to 19% of the A1-A3 impacts;
- Use stage (modules B1-B5) impacts shall be assumed equal to 8% of the A1-A3 impacts;
- End-of-life stage (modules C1-C4) impacts shall be assumed equal to 10% of the A1-A3 impacts

Note: The above assumptions are provided as an interim measure that may be phased out in the future. These assumptions can only be used if the project meets the applicability requirements of the secondary pathway and when the noted life cycle stage or stages are missing in a software tool, and not when one or some submodules within a life cycle stage are missing.

III. IMPACT INDICATORS

Compliance requirement: An LCA submitted for demonstrating compliance requires reporting of the Global Warming Potential (GWP) environmental impact category. The life cycle impact assessment (LCIA) characterization factors used in the software tool shall be TRACI v2.1 or newer.

Optional: Other environmental impact category results are optional and may be reported separately in the raw results, if available in the software tool used.

IV. COVERED PROJECT ELEMENTS

Compliance requirement: Article 37, Section 37-7 requires that each assessment include above and below-grade structural and enclosure building product materials. The life cycle assessment submitted for compliance shall therefore include substructure, superstructure, and enclosure systems, consistent with the detailed list of included and excluded elements provided in Table 3.

Parking structures and elements (below or above-grade) must be included in the embodied carbon estimate, but the square footage of parking is not included in the adjusted gross floor area used for LCA reporting (see gross floor area in the

Definitions section). This adjustment to GFA is handled automatically in the Building LCA Reporting Template.

Optional: In addition to the required covered project elements, project teams are encouraged to optionally include additional project scopes, such as interior constructions and finishes; sitework; mechanical, electrical and plumbing systems; and furniture, fixtures and equipment (FF&E).

Note: While Omniclass is used for clarity on inclusions in Table 3, the bill of materials and LCA results do not need to be organized according to OmniClass. The Building LCA Reporting Template only asks projects to break out required results into two primary scopes: Structure (Substructure and Superstructure) and Enclosure. See the Building LCA Reporting Template for the full reporting format.

Table 3. Covered Project Elements. This table outlines the detailed list of elements that are required to be included in the life cycle assessments submitted for compliance.

OmniClass * Number	Element Category	Required	Exclude	Service Life
21-01 00 00	Substructure	X		Life of building
21-01 10	Foundation	X		Life of building
21-01 10 10	- Standard Foundations	X		Life of building
21-01 10 20	- Special Foundations	X		Life of building
21-01 20	Subgrade Enclosure	X		Life of building
21-01 20 10	- Walls for Subgrade Enclosure	X		Life of building
21-01 40	Slabs-on-grade	X		Life of building
21-01 40 10	- Standard Slabs-on-grade	X		Life of building
21-01 40 20	- Structural Slabs-on-grade	X		Life of building
21-01 40 30	- Slab Trenches	X		Life of building
21-01 40 40	- Pits and Bases	X		Life of building

OmniClass * Number	Element Category	Required	Exclude	Service Life
21-01 40 90	- Slabs-on-grade Supplementary Components	X		Life of building
21-02 10	Superstructure	X		Life of building
21-02 10 10	- Floor Construction	X		Life of building
21-02 10 20	- Roof Construction	X		Life of building
21-02 10 80	- Stairs	X		Life of building
	Enclosure			
21-02 20	Exterior Vertical Enclosure	X		35
21-02 20 10	- Exterior Walls	X		35
21-02 20 20	- Exterior Windows	X		30
21-02 20 50	- Exterior Doors and Grilles	X		30
21-02 20 70	- Exterior Louvers and Vents	X		30
21-02 20 80	- Exterior Wall Appurtenances	X		30
21-02 20 90	- Exterior Wall Specialties	X		30
21-02 30	Exterior Horizontal Enclosure	X		
21-02 30 10	- Roofing	X		20
21-02 30 20	- Roof Appurtenances		X	n/a
21-02 30 40	- Traffic Bearing Horizontal Enclosures	X		20
21-02 30 60	- Horizontal Openings	X		20
21-02 30 80	- Overhead Exterior Enclosures	X		20

*OmniClass™ is a North American classification system of construction information commonly used in the AEC industry.

Source: Adapted from ASHRAE, ICC, & BSR. (2024). *Standard 240P: Quantification of Life Cycle Greenhouse Gas Emissions 1st PR Draft*. BSR/ASHRAE/ICC.

V. LIFE CYCLE STAGES

Compliance requirement: Article 37, Section 37-7 requires that each assessment consider the embodied emissions from the raw material supply, transport,

manufacturing, construction, use, and end-of-life of building product materials, as well as other construction-related activities such as the installation, replacement, and disposal of materials. The LCA submitted for compliance shall therefore include life cycle stages A1-A3 (product), A4-A5 (construction), B (minimum B4 replacement), and C (minimum C2-C4 end-of-life). See Figure 1 for a visual explanation of these life cycle modules.

If A4 (transit to site) and/or A5 (A5-1 demolition or deconstruction, A5-2 construction activities and A5-3 construction waste) are not covered by LCA tool, teams must provide additional calculations following the A4 and A5 as-designed methods outlined in ASHRAE 240p Draft standard[3], and documented in Appendix A and B in this guidance for reference. Projects should report estimated demolition and deconstruction impacts for A5-1 following the methods outlined in Appendix B, except in cases where the demolition predates the letter of intent or initial filing by more than 1 year. If used, the manual calculations using these additional methods should be combined with tool outputs and documented in a manual calculation document (see Reporting Requirements section).

Optional: Modules B6, B7, and D shall not be included in the calculations for compliance, but may be calculated and reported separately.

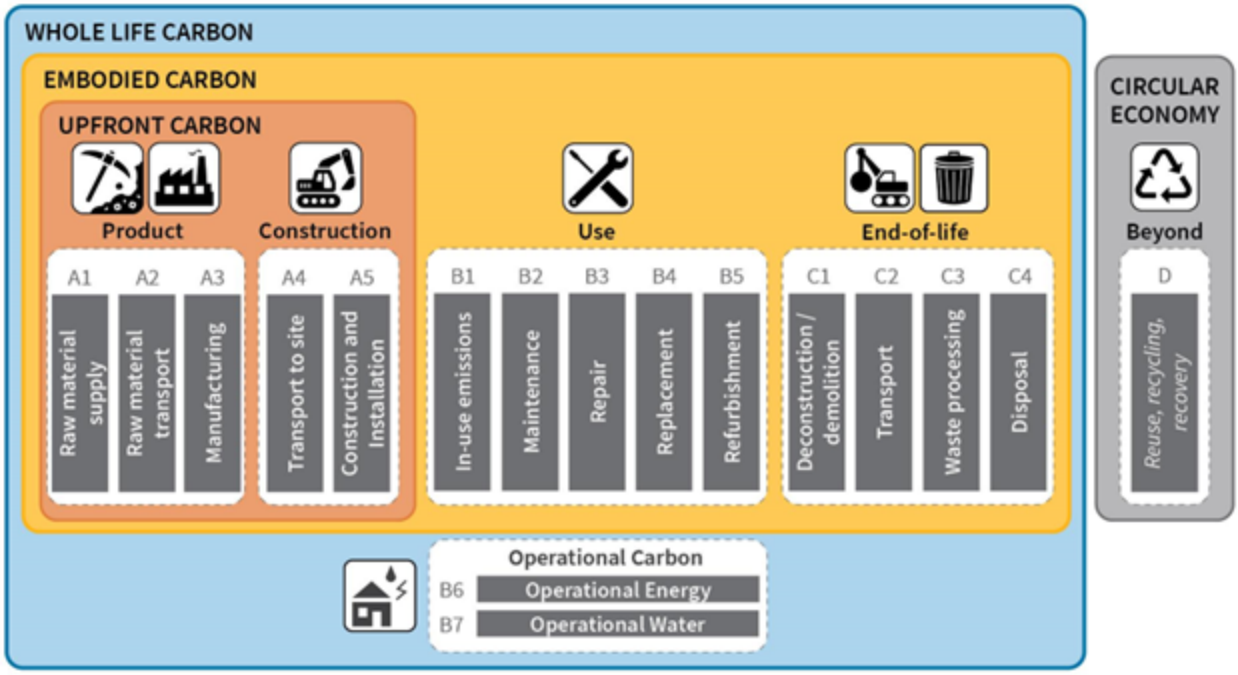

Figure 1. Life cycle stages and modules used in project LCAs. Source: Carbon Leadership Forum (CLF), 2024. Building LCA 101: Embodied Carbon Accounting for Buildings.

VI. REFERENCE STUDY PERIOD

Compliance requirement: The reference study period for an LCA submitted for compliance shall be 60 years.

VII. LCA TOOLS

Compliance requirement: Software tools used for the submission of the LCA for compliance shall conform to international standard EN 15978:2011 with datasets compliant with international standards ISO 14040 and ISO 14044. The life cycle impact assessment (LCIA) characterization factors used in the software tool shall be TRACI v2.1 or newer.

The following pre-approved tools include:

- tally
- One Click LCA LEED US tool
- Athena Impact Estimator (*free*)
- BEAM Estimator Tool (*free, only available for Secondary pathway*)
- EC3 (*free, only available for Secondary pathway*)

If the project team wishes to use a tool not on this list, the project team should provide a narrative describing how the project team's suggested tool meets all the standards outlined above and the requirements throughout this guidance document.

VIII. MATERIAL QUANTITY DATA

Compliance requirement: Material quantity data used for the building LCA submitted for compliance shall include all covered project elements. Project documentation including models, drawings, and specifications may be used to develop quantity takeoffs, and reasonable assumptions may be used and documented where detailed modeling of components is not available.

IX. EMBODIED CARBON DATA

Compliance requirement: Embodied carbon data sources used for the LCA submitted for compliance shall be selected based on the data hierarchy guidance in Table 4, and based on the state of the design specifications at the time of compliance.

Optional: It is optional to include product-specific EPDs in the LCA results, but if a team chooses to model with product-specific EPDs, the guidance in Table 4 should be followed. Projects should choose data sources and EPDs based on the capabilities of the LCA tool chosen and the level of detail in the project specifications. Product-specific EPDs do not need to be submitted for compliance.

Table 4: Embodied Carbon Data Hierarchy. This table outlines which embodied carbon data sources are acceptable for use based on the project documentation available.

Product Specification Approach	Embodied Carbon Data Hierarchy (listed in order of preference)
If the product specification does not list a specific product and manufacturer	1. Industry-wide EPD (use values specific to the Boston geographical area, if available) 2. Regionally appropriate generic values from LCA tool dataset or appropriate proxy data if generic values are not available
If the product specification does list a basis-of-design product and manufacturer	1. Facility-specific and/or supply-chain specific EPD 2. Product-specific EPD 3. Industry-wide EPD (use values specific to the Boston geographical area, if available) 4. Regionally appropriate generic values from LCA tool dataset or appropriate proxy data if generic values are not available
If the product specification lists multiple basis-of-design products	Select the product with the highest GWP for the declared unit as the basis-of-design, using the following data hierarchy: 1. Facility-specific and/or supply-chain specific EPD 2. Product-specific EPD 3. Industry-wide EPD (use values specific to the Boston geographical area, if available) 4. Regionally appropriate generic values from LCA tool dataset or appropriate proxy data if generic values are not available
If product specification includes an Embodied Carbon performance requirement	1. Embodied Carbon data representing the specified performance

Source: Arup developed this table for the forthcoming publication of "Policy Report and Recommendations for NYS EO22: Project LCA Guidance for State Projects. New York State Office of General Services"

X. TREATMENT OF SPECIAL TOPICS

Biogenic Carbon

Compliance requirement: All biogenic carbon flows and biogenic carbon storage (i.e., negative emissions in the form of carbon storage or positive emissions in the form of biogenic carbon releases) shall be excluded from the reporting of embodied carbon for compliance.

Optional: Reporting biogenic carbon is optional, and if included, shall be calculated according to the method referenced by the LCA software tool and shall be reported separately.

Concrete Carbonation

Compliance requirement: Concrete carbonation shall be excluded from the reporting of embodied carbon for compliance.

Optional: Reporting concrete carbonation is optional. If included, carbonation shall be calculated according to the method referenced by the software tool and shall be reported separately.

Asset reuse, and Salvaged and reused materials

Compliance requirement: This guidance applies to modeling asset reuse, and salvaged and reused materials (see Definitions section for more detail). If asset reuse or salvaged and reused materials are applicable to the project, A1-A3 emissions from these materials shall be excluded from the LCA for compliance. However, A4-A5, B and C phase emissions shall be included for these materials to accurately assess the construction, maintenance, replacement and end-of-life emissions from these materials. If the project team must deviate from this guidance due to the functionality of the tool used, it is acceptable to document the difference in approach in the Building LCA Reporting Template.

Optional: For asset reuse, A4 and A5 impacts may also be omitted. If a project is using the manual calculations in the appendices for estimating A4 and A5, the transit factors and waste factors for reused materials can be assumed to be the same as for new materials.

XI. REPORTING REQUIREMENTS

Compliance requirement:

- Embodied Carbon LCA Reporting Template (required). To submit the LCA for compliance, project teams are required to report the results of

the life cycle assessment in the reporting Embodied Carbon LCA Microsoft Excel spreadsheet to demonstrate compliance. This template must include the combined results from the LCA tool and the manual calculations (if used). The projects shall break out the required results into two scopes: Structure (Substructure and Superstructure) and Enclosure and report the impacts by life cycle stage. See the Building LCA Reporting Template for the full reporting format. Projects shall report results in total embodied carbon ($kgCO_2e$) and normalized per gross floor area in units of embodied carbon intensity (ECI) per the definition in this guidance that has been adjusted from the gross floor area calculation required by Boston's Zoning Code. Teams are also encouraged to respond to the optional sections of the reporting template, including a narrative of reduction strategies taken by the team, and/or the reporting of the optional scopes.

- Raw results from software tool (required). Project teams are required to submit spreadsheet tabular LCA results exported by the LCA tool. The export of raw data from the software tool used should contain both the embodied carbon emissions breakdown and the bill of materials (i.e. material quantities). Depending on the software tool used, this data may be provided in a spreadsheet format as a single document or multiple separate documents. The total GWP and ECI of the project, however, should be reported in aggregate within the Embodied Carbon LCA Reporting Template.
- Manual calculations (required). Where manual calculations have been conducted outside the software tool due to the limitations in the tool, a document or documents containing these calculations shall be submitted. This submission shall be submitted in spreadsheet format. This is in addition to the raw results submission. The manual calculations may be a modified version of the raw data exported from the software tool, if changes are made directly on the raw data from the tool, or may also be a separate file containing the manual calculations. One tab should be labeled "Boston totals for reporting template" and should include the sum of the values from both the raw results and manual calculations to show

how the user derived the totals reported in the building Embodied Carbon LCA Reporting Template.

Optional:

- Green Building Report (required, but optional to include embodied carbon aspects). It is optional to submit embodied carbon information in the required Green Building Report. If including embodied carbon information, this informational LCA report may be auto-generated by the software tool or be a customized report created by the project team. This report shall be in PDF format. The report may contain further information that could not be included in the reporting template, such as modeling assumptions, data sources, or more discussion of approaches taken to reduce embodied carbon emissions.

APPENDIX A. CALCULATING A4 EMISSIONS

Transportation to Site (A4) shall include all emissions arising from the travel of products from the point of final manufacture to the site along with any stops and return trips between the two.[1] If the A4 stage is not included in the selected LCA tool, the material or product quantities of covered project elements shall be multiplied by the appropriate emission factor from Table A based on the best available assumptions of the team to estimate A4 impacts. Where A4 is included in the relevant EPD, the corresponding GWP value for A4 can supersede the transportation factors provided in Table A.

Table A. Default emissions factors for transportation to project site

Type/Source of Product	Emissions Factor
Ready-mixed concrete from a local plant	11.3 kg CO_2e/yd^3
Manufactured Products	
Locally manufactured & sourced (within 100 miles)	25.7 kg CO_2e/metric tons
Regionally manufactured & sourced (within 500 miles)	129 kg CO_2e/ metric tons
Nationally manufactured & sourced	257 kg CO_2e/ metric tons
European manufactured to Eastern US	459 kg CO_2e/metric tons
European manufactured to Western US	331 kg CO_2e/ metric tons
Asian manufactured to Eastern US	500 kg CO_2e/ metric tons
Asian manufactured to Western US	371 kg CO_2e/ metric tons

Source: ASHRAE, ICC, & BSR. (2024). *Standard 240P: Quantification of Life Cycle Greenhouse Gas Emissions 1st PR Draft*. BSR/ASHRAE/ICC.

[1] Source: Adapted from ASHRAE, ICC, & BSR. (2024). *Standard 240P: Quantification of Life Cycle Greenhouse Gas Emissions 1st PR Draft*. BSR/ASHRAE/ICC.

APPENDIX B. CALCULATING A5 EMISSIONS

Construction (A5) shall include preparation activities occurring on construction site until project delivery, inclusive of pre-construction demolition (A5-1), if applicable, and construction activities (A5-2), as well the impacts from waste generated during construction (A5-3). Worker transportation to and from the site during the construction process shall be excluded.[2] If the A5 stage is not included in the selected LCA tool, the embodied carbon emissions of A5 shall be estimated based on Formula 1.

$$GWP_{A5\text{-}1} + GWP_{A5\text{-}2} + GWP_{A5\text{-}3} = GWP_{A5} \qquad (1)$$

$GWP_{A5\text{-}1}$= the gross floor area of the portion of the building being demolished or deconstructed multiplied by the A5-1 emissions factor from Table B

$GWP_{A5\text{-}2}$ = the gross floor area of the project multiplied by the A5-2 emissions factor from Table B

$GWP_{A5\text{-}3}$ = the A1-A3 ECI of materials multiplied by their respective wastage factors provided in Table C

Table B. Default emissions assumptions for construction (A5-1 and A5-2)

Activity	Emissions Factor
Pre-construction Demolition (A5-1)	35 kg CO_2e/m^2 of Gross Floor Area of the portion of the building or site being demolished or deconstructed
Construction Activities (A5-2)	40 kg CO_2e/m^2 of Gross Floor Area of the new building area being built

Source: Adapted from ASHRAE, ICC, & BSR. (2024). *Standard 240P: Quantification of Life Cycle Greenhouse Gas Emissions 1st PR Draft*. BSR/ASHRAE/ICC.

[2] Source: Adapted from ASHRAE, ICC, & BSR. (2024). *Standard 240P: Quantification of Life Cycle Greenhouse Gas Emissions 1st PR Draft*. BSR/ASHRAE/ICC.

Table C. Default waste factors for construction waste (A5-3)

Waste Scenario			Waste factor
Pre-fabricated assemblies	Standardized assembly and small MEP equipment (400 lbs or less) selected from a manufacturer's catalogue. • Applies to standardized pre-fabricated assemblies or equipment that are shipped to site ready to be installed without any alterations resulting in wastage such as cutting or trimming or drilling. For example: standard windows, small appliances. Any additional material to be applied on site such as coatings or connection materials shall be accounted for separately with applicable on-site wastage ratios.		1%

	Custom assembly made to order and large MEP equipment (more than 400 lbs).
	• Applies to custom pre-fabricated assemblies meeting all of the following:
	  ○ Weighs more than 200 lbs per piece
	  ○ Fabricated to the specific dimensions required for the project.
	  ○ Shipped to site as a kit of parts or as a single piece ready to be installed without any alterations resulting in wastage such as cutting or trimming or drilling.
	• For example: unitized curtainwall, volumetric modular construction, structural steel members, glue-laminated beams and CLT panels, architectural precast panels.
	Any additional material to be applied on site such as coatings or connection materials shall be accounted for separately with applicable on-site wastage ratios.
			0%

By delivery/ installation method	Delivered by a concrete mixer truck and poured in place (ready-mix concrete)		5%
	Sprayed (shotcrete, sprayed fire resistive material)		10%
	Soil mixing or jet grouting (grout)		20%
	Driven into the ground (piles)	Precast Concrete	5%
		Steel piles or casing	3%
		Timber Piles	20%
	Troweled (mortar, skim coating)		15%
	Liquid Applied (paint, self-leveling concrete topping, roof membrane)		10%
By element size/type	Blocks and bricks		5%
	Tiles (including carpet) and siding		8%
	Sheets, boards or panels delivered in standard sizes to be cut as needed on site	Metal (steel decking, roofing, flashing, welded wire fabric)	10%
		Non-metal (gypsum, plywood)	15%
	Elements delivered to site in standard length to be trimmed as needed to required length on site (metal studs, light-weight timber framing, plumbing pipes)		10%

	• Applies to flat products at least 18in in two directions. Otherwise use "tiles" or "elements delivered to site in standard length."	
	Rebar	3%
	Steel connection materials (bolts, studs, welding electrodes, straps, anchors)	5%
All other		5%

Source: Adapted from ASHRAE, ICC, & BSR. (2024). *Standard 240P: Quantification of Life Cycle Greenhouse Gas Emissions 1st PR Draft*. BSR/ASHRAE/ICC.

APPENDIX C. DEFINITIONS

Asset reuse. This refers to repurposing or extending the life of an existing building or infrastructure project in situ (or a portion of a project, such as structure or envelope) rather than demolition and new construction. When a building is reused in a different capacity, this is typically referred to as adaptive reuse. This does not require deconstruction and reinstallation but may require some minimal reprocessing in place. Asset reuse does *not* refer to recycled content in manufactured materials or products or to designs that create a future potential for reuse.

Biogenic Carbon. Biogenic carbon refers to carbon that is derived from or contained in biomass (e.g. plants and trees) (EN 16485:2014). This contrasts with fossil carbon, which comes from dead matter that has accumulated and been compressed over time into concentrated fuel. Fossil carbon from burning fossil fuels is the primary source of greenhouse gas emissions from human activities. In contrast, incorporating biogenic carbon into the built environment through the use of bio-based building materials can provide the benefit of storing carbon throughout the building's life cycle.

Carbon Dioxide Equivalent (CO_2e). Greenhouse gas emissions, including carbon dioxide, methane and nitrous oxide.

Concrete Carbonation. Carbonation is a naturally occurring reaction in concrete products when atmospheric CO_2 (in the presence of water) reacts with the cement. Carbon is sequestered in the process.

Embodied Carbon. The greenhouse gas (GHG) emissions generated by the manufacturing, transportation, installation, maintenance, and disposal of construction materials used in buildings, roads, and other infrastructure. The terms "embodied carbon," "embodied carbon emissions," and "embodied emissions" can be used interchangeably.

Embodied Carbon Intensity (ECI). A metric to describe the global warming potential (GWP) associated with the embodied emissions of a building and expressed as

kilograms of carbon dioxide equivalents per square meter or square foot ($kgCO_2e/m^2$ or $kgCO_2e/ft^2$).

Environmental Product Declaration (EPD). Standardized, independently verified documents that report the environmental impacts of a construction product based on a product life cycle assessment. EPDs must conform to international standards and follow the rules for each product category. An EPD is referred to as a "Type III environmental declaration" in ISO 14025: 2006.

Global Warming Potential (GWP). The potential climate change impact of a product or process as measured by an LCA. GWP is reported in units of carbon dioxide equivalent (CO_2e) and is the agreed-upon metric for tracking embodied carbon.

Gross Floor Area (GFA). *For embodied carbon calculations, the reporting template will facilitate a revision to the GFA used for embodied carbon compliance equivalent to the Boston Zoning Code definition minus the above-grade parking area. The Boston Zoning Code GFA is defined as follows:*

> The sum of areas of the several floors of the structure, as measured by the exterior faces of the walls, including fully enclosed porches and the like as measured by their exterior limits, but excluding the areas specified in part 1 of this definition.

1. Areas excluded from calculation of Gross Floor Area: (a) Garage space: garage space in the basement of a building, and grade-level garage space accessory to a dwelling; however, above-grade parking shall be included in gross floor area, (b) Accessory uses below grade: basement and cellar areas devoted exclusively to uses accessory to the operation of the structure, (c) Certain above-grade mechanical equipment: Except as otherwise specified in part 2 of this definition (concerning laundry and storage areas in certain districts), areas elsewhere in the structure devoted to housing mechanical equipment that is customarily located in the basement or cellar, such as heating and air conditioning equipment, plumbing, electrical equipment, laundry facilities and storage facilities, (d) Public transit improvements: Public transit improvements by or for a Public Agency within the Lot, above or below grade, including head houses and/or structures designated for use by,

access to or egress from public transit services, provided that any exterior changes are subject to Small Project Review.

2. Areas not excludable in certain districts: In an H-2-45, H-2-65, H-3-65, L-2-65 or B-3-65 district, floor area is not excludable from the calculation of Gross Floor Area as an area for storage facilities or laundry facilities if: (i)The floor area was previously included in Gross Floor Area in an existing structure, or (ii)The floor area is located in an addition to an existing structure; except that floor area in an addition shall be excludable from Gross Floor Area if it is used for storage or laundry facilities in areas not used or designed to be used for human occupancy (such as attics, basements, cellars or space under sloping eaves).

   (From City of Boston Zoning Code Article 2)

Life Cycle Assessment (LCA). The agreed-upon methodology for measuring embodied carbon. LCA is a systematic set of procedures for compiling and evaluating the inputs and outputs of materials and energy, and the associated environmental impacts directly attributable to a product or process throughout its life cycle. LCA provides an estimate of greenhouse gas emissions over all (or a portion of) the building's life cycle, reported as global warming potential (GWP). The term building life cycle assessment is used to refer to LCA performed at the building scale, commonly including foundations, structure, and enclosure elements.

Life Cycle Stages. Life cycle stages (product, construction, use, end-of-life) and modules (A1, A2, etc.) subcategorize the life cycle of a building to communicate when environmental impacts occur and what parts of the life cycle are included in an assessment.

Proposed Project. The erection, extension, alteration, rehabilitation, or substantial demolition of any structure, land, or part thereof, or the change of use of any structure or land (including Flowed Tidelands), for which the Applicant is required to obtain a building or use permit. A Proposed Project may proceed in phases, and may include more than one building, structure, or use. (From City of Boston Zoning Code Article 2).

Reference Study Period. EN 15978:2011 defines reference study period (RSP) as the period over which the time-dependent characteristics of the object of assessment are analyzed in a life cycle assessment.

Residential Uses. Congregate living complex; elderly housing; group residence, limited; homeless shelter; lodging house; mobile home; mobile home park; multifamily dwelling; one-family detached dwelling; one-family semi-attached dwelling; orphanage; row house; temporary dwelling structure; three-family detached dwelling; townhouse; transitional housing; two-family detached dwelling; or two-family semi-attached dwelling. (From City of Boston Zoning Code Article 2).

Salvaged and reused materials. Previously used materials or products that require limited to no processing for reinstallation and use on the same or a different project (EPA). Salvaged materials refer to materials that were deliberately deconstructed and reclaimed, stored, and distributed for use on a separate project. Material reuse is the installation of a previously used material or product that requires limited to no processing for reinstallation and use on the same project, typically within the same site by the same owner. This may still require deconstruction and reinstallation. Salvaged and reused materials do not refer to recycled content in manufactured materials or designs that create a future potential for reuse. A material that requires some minimal level of reprocessing (e.g., resawing salvaged lumber) would still be considered a reused and salvaged material.

Upfront Carbon. The emissions associated with manufacturing, transportation, and construction activities (life cycle stages A1-A5) occur before a building is occupied.

APPENDIX D. CREDITS

This document was prepared by the Carbon Leadership Forum in May of 2025 in collaboration with the Planning Department at the City of Boston, with reference to several key documents:

- City of Vancouver. (2023). *City of Vancouver Embodied Carbon Guidelines v1.0 - Approved 2023*. https://vancouver.ca/files/cov/embodied-carbon-guidelines.pdf
- *First public draft (not yet published)*:
    - ASHRAE & International Code Council. (2023). *BSR/ASHRAE/ICC Standard 240P Evaluating Greenhouse Gas (GHG) and Carbon Emissions in Building Design, Construction and Operation*. ASHRAE.
- *Forthcoming (not yet published)*:
    - Arup and Carbon Leadership Forum (2025). *Policy Report and Recommendations for NYS EO22: Project LCA Guidance for State Projects.* New York State Office of General Services. Funded by US Climate Alliance and UN Climate Foundation.