



City of Newton, Massachusetts Climate and Sustainability Team



MEMORANDUM

Date: March 23, 2023

To: Councilor Deborah Crossley, Chair, Zoning & Planning Committee, Members of the Zoning & Planning Committee

From: The Climate & Sustainability Team

RE: Embodied Carbon

CC: Members of the Embodied Carbon Working Group, Zachery LeMel, Chief of Long Range Planning, Jennifer Caira, Deputy Director

Last Spring the City Climate & Sustainability Team and the Embodied Carbon Working Group gave an “Embodied Carbon 101” presentation to the Zoning and Planning Committee, as an introduction to the topic with plans to return with draft ordinance language requiring large special permit projects to analyze the embodied carbon of their project. Almost a year later, after discussions with community stakeholders, we are returning with draft language.

Embodied carbon is the sum of greenhouse gas emissions associated with raw material extraction, manufacturing, and transportation for materials production and the emissions associated with the construction, maintenance, renovation, and end-of-life of buildings. Embodied carbon is estimated to account for over 11% of total global greenhouse gas (GHG) emissions. As buildings become more efficient in their operations, embodied carbon becomes an even larger portion of building emissions: in high-performance buildings, 50% of the building’s emissions in the first 10 years are estimated to be from embodied carbon.

Newton’s Zoning Ordinance currently includes sustainable development requirements for new construction and substantial reconstruction >20,000 sq ft. (section 5.13). Three of the requirements, one of which is embodied carbon (section 5.13.4.D), are currently listed as reserved.

Our proposed ordinance language to fill in this reserved section is attached. In short, the requirement is for projects between 20,000 and 50,000 square feet to conduct a limited analysis of the structural materials for the project, and for projects over 50,000 to conduct a whole-building life cycle assessment of both the structural and enclosure materials. Project teams would commit to conducting such analysis as part of their special permit application, and provide the completed analysis as part of the building permit document submissions. The City’s role would be to confirm that the analysis had been submitted and signed by a Registered Design Professional.

There are a number of embodied carbon analysis tools and software programs available, many of which are already in use by architects and sustainability consultants. Reporting requirements are thought to have minimal costs, under 0.25% of the total project cost.

Embodied Carbon FAQs

What is embodied carbon?

- Embodied carbon is the sum of carbon dioxide and other greenhouse gas emissions associated with raw material extraction, manufacturing, and transportation for materials production and the emissions associated with the construction, maintenance, renovation, and end-of-life of buildings and infrastructure. Greenhouse gas emissions are calculated relative to the impact of one molecule of carbon dioxide and reported as carbon dioxide equivalent (CO₂e) with units of mass. In Life Cycle Assessment reports and Environmental Product Declarations (EPDs), embodied carbon is equivalent to Global Warming Potential (GWP).

To which buildings would the proposed standards apply?

- The proposed standards would apply to projects subject to the Sustainability Requirements of the Zoning Ordinance: any proposed development in any zoning district that includes the construction or substantial reconstruction of one or more buildings totaling 20,000 sf or more of gross floor area.

What is the cost of the analysis requirements in the proposed ordinance language?

- There are two levels of analysis stipulated in the proposed ordinance language. For buildings between 20,000 and 50,000 square feet, the analysis is required to estimate the embodied carbon of the structural elements of the building that is already in design. Such analysis would likely be conducted by structural engineers already contracted for the project. In conversations with some Newton-area professionals, this is a cost add of \$1,500 to \$5,000. This represents under 0.1% of the construction value of a typical project of this size.
- For projects over 50,000 square feet, the analysis is also to include a Life Cycle Assessment of the structural and envelope (enclosure) systems of the building. This assessment is based on a credit in the LEED Rating System. Costs for this level of analysis and additional design might range between \$8,000 and \$25,000, representing a cost from under 0.1% to as much as 0.25% of the construction cost.

What is the difference between an embodied carbon assessment and a life-cycle assessment?

- Embodied carbon assessment is a more limited analysis than a life-cycle assessment. An embodied carbon assessment estimates only the global warming potential over the life of a project. A life-cycle assessment also includes other environmental impacts such as acidification and smog formation potential.

What is the cost/time difference between an embodied carbon assessment and a life-cycle assessment?

- The embodied carbon of most structural and envelope materials is well understood and the data are widely available, so in many cases simplified tools may be used to estimate embodied carbon. The data for other environmental impacts evaluated in a life-cycle

assessment are not as widely available and more specialized LCA tools must be used to estimate these impacts.

- In addition, for projects under 50,000 square feet, the proposed ordinance language only requires the design team to evaluate the structural materials, which are limited in number and for which data are widely available. For projects over 50,000 square feet, the proposed ordinance language requires evaluation of both structural and envelope materials, and also requires that the developer compare design alternatives. Costs for the more encompassing life-cycle assessment are about 3 to 20 times the cost of a simple embodied carbon assessment of the structural materials measured as a percentage of the cost of construction. As indicated above, all costs associated with this ordinance requirement would be less than 0.25% of the construction value.

Who performs the embodied carbon assessment and the life-cycle assessment? Are these individuals or companies readily available?

- The project designers typically provide embodied carbon and/or life-cycle assessments. Professionals who would conduct these assessments are likely already contracted for projects of these sizes and most are well-versed in the topic. Some projects in Newton subject to the 5.13 Sustainability Requirements currently going through the special permit process have already committed to doing embodied carbon analyses.

Does the City have staff who can evaluate the embodied carbon assessments?

- City staff will review the reports submitted by the project team, similar to many other submittals required through the special permitting process.

How available are lower-carbon concrete mixes? How do we know they are structurally safe?

- Lower-carbon concrete mixes are readily available and already in wide use for specialty applications. The structural properties of the lower-carbon concrete usually equal or exceed the properties of conventional concrete. More detail can be found on the Carbon Leadership Forum and SE 2050 website.

What level of analysis can be reasonably expected of a project team at the special permit stage? At the building permit stage?

- Embodied carbon assessments can be conducted at any stage of project development. The closer the design is to completion, the more precise the computations become. That is why we are asking for an initial commitment for what type of analysis will be undertaken at the special permit stage, to start the conversation early, but not requiring the work of doing the analysis until the building permit stage – after the special permit has been approved.

Do we have sample embodied carbon assessments?

- The Carbon Leadership Forum and [SE 2050](#) websites include case studies. We hope to develop some local case studies as current projects are completed.

What resources do developers who do not know about embodied carbon have to learn more about this topic/how to meet the proposed requirements?

- The [Carbon Leadership Forum](#) and [SE 2050](#) websites both offer a wealth of information about embodied carbon and how to calculate it, including descriptions of available tools.

What is Newton doing about embodied carbon in its own building projects?

- The City has conducted embodied carbon analyses on its recent new construction projects, and will continue to do so for projects moving forward.

What are other cities and towns doing related to embodied carbon?

- Boston's efforts to address embodied carbon are part of the City's Zero Net Carbon Building Zoning Initiative, which is now in draft form out for public comment. The City has established a Technical Advisory Group that has presented a report and suggested avenues for how to address embodied carbon, including requiring life-cycle analyses for large projects.
- Cambridge is looking to first require reporting, then 20% reductions, and eventually 50% reductions as outlined in the City's Net Zero Action Plan.
- Brookline passed a resolution last year for the Town to use low-carbon concrete products (reduction of 10% emissions) in Town projects, including sidewalks.

Why are we focused on large new construction rather than smaller residential buildings, which make up the majority of the building stock in Newton?

- We have the ability to address embodied carbon in large projects through the special permit process; we do not have the same sort of oversight in by-right projects.

Sec. 5.13. Sustainable Development Design

5.13.1. Intent and Purpose

The intent of this section is to reduce the use of energy, water, and other natural resources in Newton's building stock and minimize adverse environmental impacts from buildings and development in both construction and long-term operation by:

- A. Increasing the use of renewable energy sources for electricity, transportation, heat/cooling, and hot water;
- B. Increasing the use of efficient electricity technology for transportation and buildings;
- C. Increasing the number of buildings built to Passive House, net zero, or similar standards;
- D. Minimizing the environmental impacts of construction materials and methods, including waste reduction;
- D.E. Encouraging sustainable material selection and the responsible reuse of existing structures.

5.13.2. Definitions

- A. **Green Commissioning.** The process of verifying and documenting that a building and all of its systems and assemblies are installed, tested, operated, and maintained to meet specified levels of environmentally sustainable performance in accordance with the provisions of Section 5.13 of this Zoning Ordinance.
- B. **Green Commissioning Agent.** An entity or person with documented experience on at least 2 building projects with a scope of work similar to the proposed project extending from early design phase through at least 10 months of occupancy.
- C. **Green Building Professional.** A professional who holds a credential from a Green Building Rating Program indicating advanced knowledge and experience in environmentally sustainable development in general as well as specific Green Building Rating Systems or otherwise possesses comparable experience in environmentally sustainable development. In instances where a Green Building Rating Program that does not offer such a credential is being applied to meet the provisions of Section 5.13, the designated Green Building Professional must have demonstrated experience as a project architect or engineer, or as a consultant providing third-party review, on at least 3 projects that have been certified using the applicable Green Building Rating Program.
- D. **Green Building Project.** Any development project that meets the provisions of Section 5.13.4.
- E. **Green Building Rating Program.** A collection of activities and services directed by an organization to promote environmentally sustainable development and to recognize projects that achieve defined environmentally sustainable development objectives, including the establishment and oversight of one or more Green Building Rating Systems.
- F. **Green Building Rating System.** A specific set of design standards for environmentally sustainable performance established under the auspices of a Green Building Rating Program against which a project or building design may be evaluated.

- G. **Embodied Carbon.** The sum of greenhouse gas emissions associated with the building materials throughout multiple stages of the materials' lifecycle. Greenhouse gas emissions are calculated relative to the impact of one molecule of carbon dioxide and reported as carbon dioxide equivalent (CO₂e) with units of mass. In Life Cycle Assessment reports and Environmental Product Declarations (EPDs), embodied carbon is equivalent to Global Warming Potential (GWP).
- H. **Whole Building Life- Cycle Assessment.** A method for estimating the potential environmental impacts of a whole building throughout its life cycle.
- F.I. **Environmental Product Declaration (EPD).** A standardized report of the environmental impacts of a product, process, or service based on a life-cycle assessment.

5.13.3. *Application of the Sustainable Development Requirements*

- A. These sustainable development requirements apply to any proposed development in any zoning district that includes the construction or substantial reconstruction of one or more buildings totaling 20,000 sf or more of gross floor area that also requires issuance of a special permit under any provision of this Zoning Ordinance.
- B. No Segmentation. The zoning provisions of this Section apply to projects at one site or two or more adjoining sites in common ownership or under common control within a period of five years from the first date of application for any special permit for construction on the lot or lots, or for the 12 months immediately preceding the date of application for any special permit. An applicant for development may not segment or divide or subdivide or establish surrogate or subsidiary entities to avoid the requirements of Section 5.13. Where the City Council determines that this provision has been violated, a special permit will be denied. However, nothing in Section 5.13 prohibits the phased development of a property.

5.13.4. *Sustainable Development Requirements*

- A. A green building project must be designed to meet the standards of one of the authorized green building rating systems identified in Section 5.13.5 according to the requirements listed below.
 1. **LEED Green Building Rating Program.** A green building project being designed according to the LEED Green Building Rating Program must be designed to achieve a minimum 'Silver' level standard. Projects of greater than 50,000 sf of gross floor area must be designed to meet a minimum 'Gold' level standard. Certification by the LEED Green Building Rating Program is not required.
 2. **Passive House Green Building Rating Program.** A green building project being designed according to the Passive House Green Building Rating program must be designed to achieve certification. Certification by the Passive House Green Building Rating Program is required.
 3. **Enterprise Green Communities Green Building Rating System.** A green building project being designed according to the Enterprise Green Communities Green Building Rating program must be designed to achieve the minimum criteria for certification. Certification by the Enterprise Green Communities Green Building Rating Program is not required.

B. Electric Vehicle Charging Stations. A green building project must provide that a minimum of 10% of parking spaces have access to electric vehicle charging stations up to a maximum of 40 spaces. An additional 10% of parking spaces must be electric vehicle charging station ready, meaning that electrical systems and conduit are prepared to expand the number of charging stations as demand increases. This Section 5.13.4.B only applies to new or rebuilt parking facilities; those projects using existing parking lots are exempt.

C. Solar Panels. [reserved]

D. Embodied Carbon A green building project must provide an analysis that estimates the embodied carbon of a project. The type of analysis is determined based on gross square footage of the green building project.~~[reserved]~~

1. For projects under 50,000 sf, only structural materials must be evaluated using Life Cycle Analysis tools or Environmental Product Declarations.

2. For projects over 50,000 sf, the design team must use a Whole Building Life-Cycle Assessment tool to estimate the embodied carbon of both structural and enclosure materials, and the CO₂e per square foot of the project compared to an average CO₂e intensity (kg CO₂e/unit floor area) for projects of comparable use, and provide justification for the building materials and systems chosen. This requirement may be met by using one of the following methods:

a. LEED Credit for Whole Building Life-Cycle Assessment

b. Green Building Initiative's (GBI) Green Globes for New Construction (NC) Credit for Whole Building Life-Cycle Assessment

c. International Living Future Institute's (ILFI) Zero Carbon Standard.

d. Another method approved by the Planning Director.

3. Projects where at least 50% of the floor area comprises re-use of a pre-existing structure are not subject to these provisions.

E. Electrification of heating/cooling and residential cooking, domestic water heating, and laundry [reserved]

5.13.5. Authorized Green Building Rating Programs

~~A. Any of the following green building rating programs may be used to meet the requirements of this Section 5.13.~~

~~1. The Leadership in Energy and Environmental Design ("LEED") Green Building Rating Program developed and overseen by the United States Green Building Council;~~

~~2. The Passive House Green Building Rating Program developed and overseen by either Passive House Institute US, Inc. or the Passive House Institute; or~~

~~3. The Enterprise Green Communities Green Building Rating Program developed and overseen by Enterprise Community Partners, Inc.~~

B.A. Applicability of Rating Systems.

1. If a green building rating program offers different green building rating systems, a green building project must use the system that is most directly applicable to the project or building type, as ~~determined~~ approved by the Planning Director.

2. The green building rating system must address the design and construction of buildings, not building operations or neighborhood development.

3. A green building project must use the most current version of the applicable green building rating system at the time of the special permit application.
4. The green building rating system, including the applicable version, must be specified at the time of special permit application.

5.13.6. *Sustainable Development Review Procedures*

A. **Special Permit Submittal Requirements.** The following must be submitted with the special permit application:

1. **Rating System Checklist.** A document enumerating the criteria set forth in the applicable green building rating system and indicating which technical and design requirements will be met in the green building project design and the resulting rating level of the green building project.
2. **Rating System Narrative.** A written description of the technical and design elements of the green building project that will be utilized to achieve compliance with the applicable green building rating system.
3. **Energy Sustainability Narrative.** A written description of the energy efficiency, renewable energy, and other technical and design elements of the green building project that serve to minimize energy use, make use of renewable energy sources, and otherwise demonstrate how close the project is to achieving net zero energy use status. This narrative should include the following, referencing how the requirements listed in Section 5.13.4 are achieved:
 - A. ~~Descriptions of building envelope performance, anticipated energy loads, mechanical systems, and site planning strategies;~~~~mechanical systems and~~
 - B. Description of on-site and off-site renewable energy systems;
 - C. Description of ~~.-The narrative must also describe~~ how the building could be made to achieve net zero status in the future~~;~~
 - D. Specified commitment to electric vehicle charging infrastructure; and
 - E. Specified procedure that will be used to analyze embodied carbon.
4. **Credentials.** A document demonstrating the credentials of the green building project's designated green building professional, which must include a credential from the green building rating program indicating advanced knowledge in the specific green building rating system being applied to the green building project.
5. **Affidavit.** An affidavit signed by the green building professional stating that ~~he/she/they~~ has~~es~~ reviewed all relevant documents and that to the best of their knowledge, the documents provided indicate that the green building project is being designed to achieve the requirements of this Section 5.13.

B. **Building Permit Submittal Requirements.** When applying for a building permit for a Green Building Project, the documentation listed in Section 5.13.6.A above, updated from any previous version to reflect the current Green Building Project design, and the additional documentation listed below must be submitted to the Department of Planning and Development.

1. Credentials of the Green Building Project's Green Commissioning Agent.
2. For a Green Building Project using the Passive House Green Building Rating Program, the following set of documents is required:

a. Credentials of the Passive House rater/ verifier who will perform testing and verification and letter of intent stating he/ she has been hired to complete the on-site verification process;

b. Credentials of the Certified Passive House Consultant who has provided design, planning, or consulting services;

3. Embodied carbon analysis as required by section 5.13.4.D and affidavit signed by a Registered Design Professional confirming the embodied carbon analysis follows the requirements committed to in the special permit submittal documents and required herein.

C. **Certificate of Occupancy Submittal Requirements.** When applying for a temporary certificate of occupancy for a Green Building Project, the documentation listed in Sections 5.13.6.A and 5.13.6.B above, updated from any previous version to reflect the current Green Building Project design, must be submitted to the Department of Planning and Development. The additional documentation listed below must be submitted prior to issuance of a final certificate of occupancy.

1. An affidavit signed by the Green Commissioning Agent, certifying that the pre-construction commissioning process requirements of the applicable Green Building Rating Program have been met and that the post-construction commissioning process requirements of this Section were included in the scope of work and will be met, including a schedule of when each commissioning requirement was or will be met.

2. For Green Building Projects using the Passive House Green Building Rating Program, the final testing and verification report completed by the Passive House rater/verifier.

3. Credentials of the Green Building Project's accredited Green Building Professional and an affidavit signed by that professional stating that he/shethey has reviewed all relevant documents and that to the best of his/hertheir knowledge, the documents provided indicate that the Green Building Project was built to achieve the requirements of Section 5.12.

5.13.7. Exceptions

A special permit may be granted to allow for exceptions to this Section 5.13 if an applicant can demonstrate that the same or better environmental outcomes can be achieved through a different approach or project design. An exception may also be granted where literal compliance is impracticable due to the nature of the use or that such exceptions would be in the public interest.