

An aerial photograph of a river winding through a forest. The water is a deep, clear blue. A single kayaker is visible in the middle of the river. The surrounding trees are in various stages of autumn, with vibrant reds, oranges, yellows, and some remaining greens. The sky is not visible, as the trees and water fill the frame.

# Northeast United States & Canada

Embodied Carbon Policy Case Studies

# Contents

|                                   |           |
|-----------------------------------|-----------|
| <b>Introduction</b>               | <b>3</b>  |
| <b>Planned Actions</b>            | <b>7</b>  |
| <b>Government Procurement</b>     | <b>11</b> |
| <b>Zoning and Permitting</b>      | <b>13</b> |
| <b>Building Codes and By-Laws</b> | <b>23</b> |
| <b>Deconstruction and Reuse</b>   | <b>26</b> |
| <b>Future in the Region</b>       | <b>29</b> |
| <b>Acknowledgments</b>            | <b>30</b> |
| <b>References</b>                 | <b>31</b> |

# Introduction

Embodied carbon refers to the greenhouse gas emissions generated by the manufacturing, transportation, installation, maintenance, and disposal of construction materials used in buildings, roads, and other infrastructure. Embodied carbon makes up a significant percentage of global emissions and requires urgent action to address it. Policy is an essential step towards creating the scale of action required to rapidly reduce embodied carbon in construction.

To be successful, low-carbon construction will require the implementation of a diverse set of policies and actions. Embodied carbon policies can include procurement policies (like Buy Clean and material-specific variations), climate action plans, building codes, city zoning, land use and building regulations, incentives, building and material reuse policies, and executive orders.

Policies that address embodied carbon are being proposed and adopted at all levels of government—federal, state and local—at a rapidly accelerating pace. This report highlights nine policies in the Northeast region of the United States and Canada as examples of successfully passed policies targeting embodied carbon reporting and reduction. Each case study explores the policy’s development process, the stakeholders engaged, any challenges faced, and keys to successful adoption.

National leadership on embodied carbon policies and programs in the U.S. and Canada—such as the U.S. Federal Buy Clean Initiative, the Inflation Reduction Act of 2022, and Canada’s Greening Government strategy—are critical to broadening awareness and accelerating action to reduce embodied carbon.

State, local and regional policies are a critical complement to federal action. State and local policies can play the role of:

- **Applying government requirements to state and local buildings and infrastructure projects**
- **Expanding requirements from the public sector to private projects through building codes and local land use and zoning requirements**
- **Establishing precedents that are then followed by national policies, as in the case of Buy Clean.**

This report takes a closer look at embodied carbon action in the Northeast region, highlighting case studies of the following policies:

- **Port Authority of New York and New Jersey’s (PANYNJ) Clean Construction Program**
- **New York State’s Executive Order 22**
- **New Jersey Low Embodied Carbon Concrete Leadership Act (LECCLA)**
- **Zoning Ordinance Amendment of the City of Cambridge, MA**
- **Zoning Ordinance Amendment of the City of Newton, MA**
- **City of Toronto’s Green Standard**
- **Boston’s Mass Timber Accelerator Program**
- **Vermont’s Energy Code**
- **City of Boston’s Deconstruction Initiative**

In addition to the case studies in this document, the Policy Action Map (pages 5-6) provides a broader view of policies and programs passed, in New York, New Jersey, Maryland, Washington D.C., Vermont, Massachusetts, Quebec, and Ontario.

See the [CLF Policy Tracker](#) for the larger map of embodied carbon policies around the globe.



## Planned Actions

Climate action plans, pledges, executive orders, and commitments.



## Government Procurement

Green purchasing programs and policies like “Buy Clean.”



## Zoning and Permitting

Land-use regulations and permitting incentive programs.



## Building Codes and By-laws

Regulations designating embodied carbon requirements.



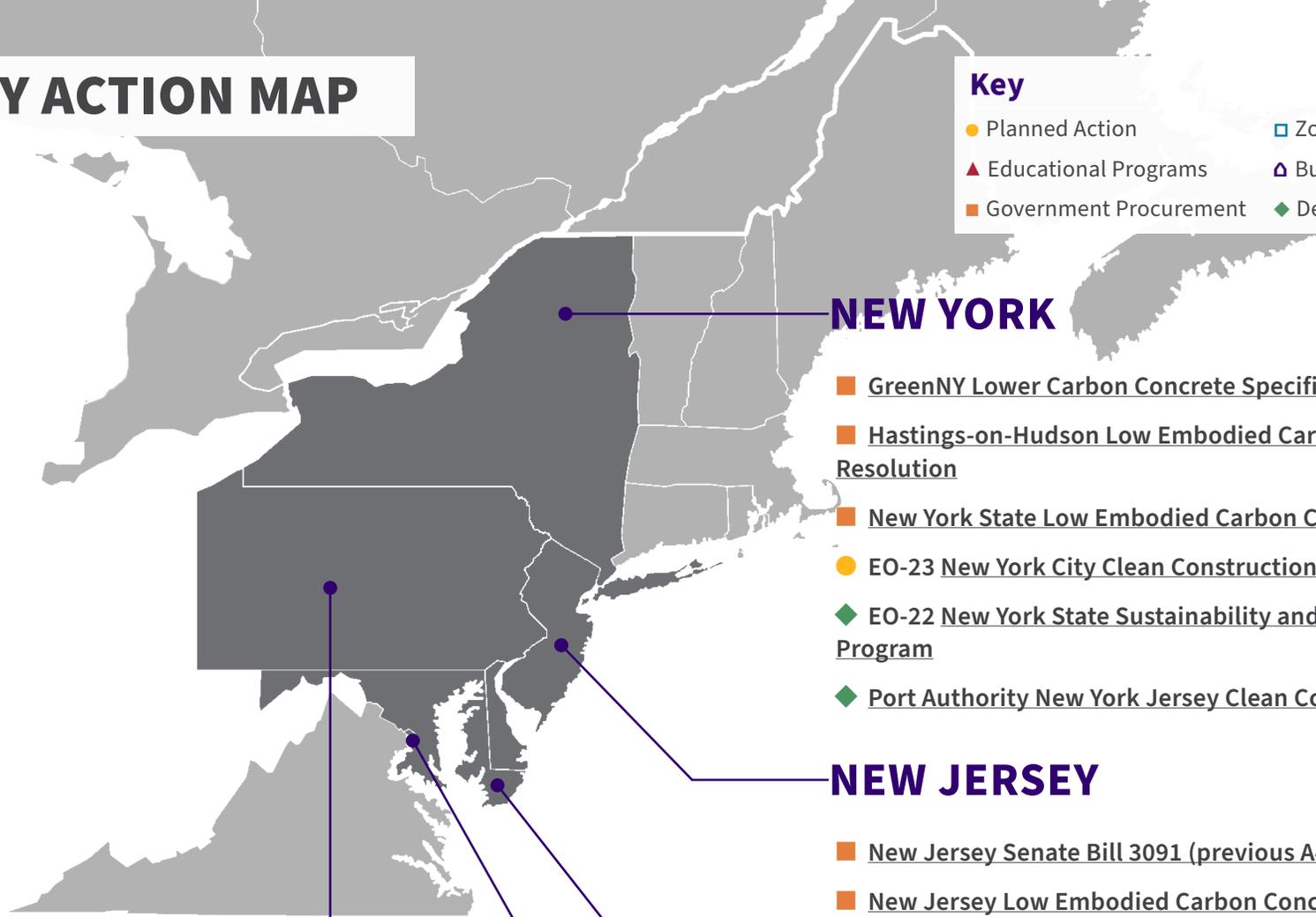
## Deconstruction and Reuse

Extending the life of a material or building to avoid embodied carbon emissions associated with new materials.

# POLICY ACTION MAP

**Key**

- Planned Action
- ▲ Educational Programs
- Government Procurement
- Zoning and Permitting
- △ Building Codes and By-laws
- ◆ Deconstruction and Reuse



## NEW YORK

- [GreenNY Lower Carbon Concrete Specification](#)
- [Hastings-on-Hudson Low Embodied Carbon Concrete Resolution](#)
- [New York State Low Embodied Carbon Concrete Leadership Act](#)
- [EO-23 New York City Clean Construction Program](#)
- ◆ [EO-22 New York State Sustainability and Decarbonization Program](#)
- ◆ [Port Authority New York Jersey Clean Construction Program](#)

## NEW JERSEY

- [New Jersey Senate Bill 3091 \(previous A4933\)](#)
- [New Jersey Low Embodied Carbon Concrete Leadership Act](#)
- ◆ [Port Authority New York Jersey Clean Construction Program](#)

## MARYLAND

- [Climate Solutions Now Act of 2022](#)
- [Buy Clean Maryland Act](#)

## WASHINGTON DC

- ▲ [D.C. Green Building Fund Grant Program](#)

## PENNSYLVANIA

- ◆ [Pittsburgh Deconstruction Executive Order](#)
- [City of Pittsburgh's Zoning Code Ordinances](#)
- ◆ [Pittsburgh Density Bonus for Building Reuse](#)

This policy map is a snapshot in time of current policies and programs as of 2023. The map does not reflect the many relevant policies that are proposed (i.e., bills) or are in development by city and state agencies and have not yet gone into effect.

NOTE: [Click on link to visit the website for each policy.](#)

# POLICY ACTION MAP

## Key

- Planned Action
- ▲ Educational Programs
- Government Procurement
- Zoning and Permitting
- △ Building Codes and By-laws
- ◆ Deconstruction and Reuse

## VERMONT

- △ [Vermont Energy Code Amendment](#)

## MASSACHUSETTS

- [Somerville Zoning Ordinance](#)
- [Newton Sustainable Design Ordinance \(Zoning Amendment\)](#)
- [Boston Mass Timber Accelerator](#)
- [EO-594 Decarbonizing and Minimizing Environmental Impacts of State Government](#)
- [Amherst Climate Action Plan](#)
- [Lexington Climate Action Plan](#)
- [Andover Climate Action Plan](#)
- [City of Cambridge Zoning Ordinance](#)
- ◆ [Boston Deconstruction Initiative](#)
- [Brookline Resolution](#)

This policy map is a snapshot in time of current policies and programs as of 2023. The map does not reflect the many relevant policies that are proposed (i.e., bills) or are in development by city and state agencies and have not yet gone into effect.

NOTE: [Click on link to visit the website for each policy.](#)

# POLICY ACTION MAP

## Key

- Planned Action
- ▲ Educational Programs
- Government Procurement
- Zoning and Permitting
- △ Building Codes and By-laws
- ◆ Deconstruction and Reuse

## QUEBEC

- ▲ Gestimat (GHGMAT)

## ONTARIO

- Toronto Green Standard v4 (TGS)
- Township of Douro-Dummer's Sustainable Development Program
- Waterfront Toronto Green Building Requirements

This policy map is a snapshot in time of current policies and programs as of 2023. The map does not reflect the many relevant policies that are proposed (i.e., bills) or are in development by city and state agencies and have not yet gone into effect.

NOTE: [Click on link to visit the website for each policy.](#)

# Planned Actions

## Climate Action Plans, Executive Orders and Commitments

Governments of all levels make commitments to take action on climate issues. These can consist of executive orders, strategies, public pledges, frameworks, and climate action plans, to name a few.

City and regional Climate Action Plans (CAPs) are roadmaps that outline specific activities that an agency will undertake to reduce greenhouse gas (GHG) emissions. Historically, climate action has focused strongly on energy efficiency and reducing emissions from operations; however, in the past few years, CAPs have increasingly addressed the issue of embodied carbon in construction by focusing on emissions from building materials.

CAPs can include an assessment of embodied carbon, targets for reduction, and a timeline and strategies for meeting those targets. Case studies throughout this document highlight CAPs as a critical first step towards later regulations or incentive programs.

Executive orders are signed declarations by a governor, mayor, or other executive government leader that direct the government's actions or operations without the need for legislative process. Executive orders can provide political backing or pressure for agencies to use their existing powers, mobilize governments to coordinate across departments and agencies, and establish "lead by example" policies.

Similarly, public pledges and commitments to reach climate targets signal to an organization and the public that government leadership is prioritizing climate action on an issue. This can raise awareness and empower and inspire departments within the organization to take action and overcome pushback related to cost or other concerns.

The following case studies explore the development processes, stakeholders, and major lessons learned from a few Planned Action examples in the Northeast.

[Learn more about Planned Action policies and Embodied Carbon here.](#)

Case Studies:

- **Port Authority of New York and New Jersey's Clean Construction Program**
- **New York State's Executive Order 22**

# PORT AUTHORITY OF NEW YORK AND NEW JERSEY'S CLEAN CONSTRUCTION PROGRAM

## How is embodied carbon addressed?

The Port Authority of New York and New Jersey keeps the NY-NJ region moving by air, land, rail and sea so that the people and businesses continue to thrive. The Port Authority has a variety of climate and sustainability focuses, one of which is their [Clean Construction Program](#). Goals of this program include:

- **Reducing carbon emissions from construction (embodied carbon)**
- **Promoting the reduction and reuse of construction and demolition waste (circular economy)**
- **Reducing air quality impacts of construction activities**

The Port Authority's Clean Construction Program actions relating to embodied carbon are:

- **Sustainable construction requirements (specifications), including low-carbon concrete mixes, low-emission construction vehicles, and construction waste reduction**
- **Environmental Product Declaration (EPD) requirements, supporting the systematic collection of environmental data to further improve practices and track progress agency-wide**
- **Construction waste matching and reuse to reduce landfilling and curtail truck trips**

## Development

In 2020, the Port Authority formally launched its Clean Construction Program, with a particular focus on reducing the embodied carbon of key material streams, starting with concrete. Through its Low-Carbon Concrete Program (LCCP), the agency evaluated its past concrete mixes and developed emissions factors for calculating Global Warming Potential (GWP). In April 2023, the agency added enforceable concrete GWP limits into its concrete technical specification. Additionally, the Port Authority now requires contractors to submit Environmental Product Declarations (EPDs) for concrete, asphalt, steel, aluminum, and wood, or to provide proof that the EPD does not currently exist. Beginning in 2025, the agency will require an EPD for ready-mix concrete supplied to Port Authority construction sites. The agency is also rigorously collecting environmental data—including embodied carbon—directly from construction contractors to inform the selection of more environmentally focused materials.

## Challenges

The Port Authority met multiple times with ready-mix concrete suppliers and industry associations to address potential concerns, with particular focus on ensuring that smaller suppliers would not be precluded from doing business with the agency. Ultimately, all suppliers agreed that they could meet the new GWP limits without compromising quality or increasing cost.

## Keys to success

The Port Authority's Clean Construction Program goal is to lead by example, and push for change in order to participate in a shift in the market toward the production of lower carbon construction materials. This goal aligns with the agency's broader commitment to achieve Net Zero greenhouse gas emissions by 2050, with a 50% reduction by 2030—which has inspired strong executive and staff support.

The Port Authority has also successfully engaged its agency partners and members of industry to ensure its goals and standards are both sufficiently ambitious and achievable, resulting in more defensible and durable outcomes.

The Port Authority's LCCP also benefited greatly from academic assistance; the Center for Advanced Infrastructure and Transportation (CAIT) at Rutgers worked closely with the Port Authority on developing robust concrete emissions factors, baselining the GWP of past concrete mixes, and creating and testing new low carbon concrete mixes. The PA's academic partners have been engaged to support further field testing of the most promising new mix designs. The agency is also working with the FHWA's Sustainable Pavements Technical Working Group and has benefited from direct technical support.

## Resources

[Port Authority of New York and New Jersey's Clean Construction Program](#)

# NEW YORK STATE'S EXECUTIVE ORDER 22

## How is embodied carbon addressed?

[New York State's Executive Order 22 \(E.O.#22\)](#), published in September 2022, outlines the state's commitment to environmental quality, public health, economic prosperity, and social well-being. It also prioritizes reducing energy and resource consumption and promoting eco-friendly practices while addressing environmental justice concerns. E.O.#22 highlights the importance of green procurement, sustainable management practices, and using state facilities to test clean energy projects and technologies.

E.O.#22 states that, "Starting January 1, 2023, affected entities shall seek to reduce the embodied carbon in all new construction or construction projects consisting of adaptive reuse or significant renovations that cost greater than 50% of the cost of new construction." The E.O. also states specific actions that should be taken, including "Design teams shall calculate the total embodied carbon that will result from the project, including shipping, transportation, and construction equipment requirements." And "Bidders shall be required to submit environmental product declarations (EPDs) when available, that include the amount of embodied carbon in given building materials."

The first phase of the E.O.#22 Embodied Carbon Guidance, developed in response to the executive order, was issued in June 2023, and is focused on disclosure and reporting of EPDs and material quantities. The guidance requires State entities to collect EPDs for four common construction materials (concrete, steel, asphalt and glass), when used above minimum thresholds set out in the guidance. It is applicable to projects over \$1 million.

This guidance:

- **Establishes applicability criteria for disclosure and reporting**
- **Identifies commonly used, high-intensity construction materials for disclosure**
- **Contains sample contract language that agencies can include in their standard contract templates**
- **Lays out a reporting timeline for inclusion of language in existing templates**
- **Establishes a schedule of regular reporting**

The current objective is to disclose both quantities and EPDs, and to set a baseline for reduction. The second phase of guidance addressing the life cycle analysis of whole projects is currently under development.

## Development

Upon announcement of E.O.#22, the [GreenNY Council](#) member agencies began to develop implementation guidelines for State entities to achieve the Governor's ambitious goals. The GreenNY Council is a group of New York State agencies, leading the implementation of E.O.#22 by developing guidance for all agencies.

Two of the five co-leads of the GreenNY Council, the New York State Energy Research and Development Authority (NYSERDA) and the New York State Office of General Services (OGS), were tasked with leading the development of the Embodied Carbon Guidance. The development of the guidance was conducted in collaboration with members of the GreenNY Council, including the Department of Transportation (NYS DOT), Metropolitan Transportation Agency (MTA), State University of New York (SUNY), Office of Parks, Recreation and Historic Preservation (OPRHP), NY Power Authority (NYPA), and the Dormitory Authority of the State of New York (DASNY). Other leading organizations, such as the Port Authority of New York and New Jersey (PANYNJ), and the NYC Mayor's Office of Climate and Environmental Justice (MOCEJ), who are not impacted by this guidance, were also consulted for their expertise.

The GreenNY Council's Embodied Carbon policy leads, NYSERDA and OGS, had multiple conversations with NYS agencies to understand how their contracting systems work, how projects are tracked, and how E.O.#22 language would be implemented at their entity.

As part of this work, an interagency Embodied Carbon Working Group was created. The goals of the working group are to share information on embodied carbon, to develop a cohort of agency staff knowledgeable about embodied carbon who can implement E.O.#22 at their respective agencies, and to help support any issues that come up once reporting begins.

## Challenges

During the development of the guidance, some concerns were expressed about the reporting requirements set forth by E.O.#22 due to the potential time and effort demands of the reporting process and the potential burden placed on contractors and suppliers. In particular, data collection and tracking were identified as a major challenge, which was addressed by developing a New York State template within EC3—a free, online database of digital EPDs—which also allows for project level reporting.

As New York State pivots to implementation, State entities and contractors are now

starting to integrate data collection and reporting requirements into their procurement processes. Preparing the State agencies for the reporting requirements, educating them on embodied carbon as a concept, understanding how each of their contracting processes is set up and the specific types of projects they work on, and beta testing the data collection process are critical steps to the successful roll-out of this policy.

## Keys to success

In addition to the GreenNY Council, agencies such as NYSERDA and OGS recognized the importance of effective education and outreach and the development of resources to support implementation. Specifically, both agencies invested resources to produce guidance, educate NYS agency stakeholders and contractors, support the development of systems to verify and track, and build internal knowledge and capacity related to the embodied carbon of different construction materials.

There has been, and continues to be, substantial internal capacity building within State agencies as New York transitions to the more complex task of implementation of the guidance across all State entities. In addition to the interagency Embodied Carbon Working Group aforementioned, NYSERDA and OGS have hosted a publicly available webinar series since Oct 2023 which includes expert speakers such as the Carbon Leadership Forum (CLF), RMI, and other leaders in this field, covering relevant topics, such as embodied carbon, low carbon concrete, EPDs, and others.

Advising from the Carbon Leadership Forum and RMI on best practices for Buy Clean initiatives and data collection, and learning from other states like California, Oregon, Washington, and Massachusetts, and the Federal and Canadian Governments, helped in guidance development.

Coordination with local municipalities has also contributed to a strong, unified message to industry about the requirement to collect and disclose quantities of construction materials and EPDs.

In September 2022, New York City adopted [Executive Order 23: Clean Construction](#), calling for similar reporting, EPD submittals, and calculation of embodied carbon emissions. Contributors to these policies expressed the need and importance for regional leadership and policies that raise awareness about embodied carbon in the Northeast region.

## Resources

[New York State Executive Order 22 \(E.O.#22\)](#)

[Executive Order 22: Embodied Carbon Guidance](#)

# Government Procurement

Green procurement policies focused on lowering the carbon emissions of government-purchased building materials—often referred to as “Buy Clean”—aim to leverage the purchasing power of public agencies to achieve environmental or social outcomes. In the case of embodied carbon, the goal of these policies is to (i) directly reduce a government’s own embodied carbon footprint, (ii) increase the availability of embodied carbon data for products, and (iii) create demand for lower-carbon construction products and therefore, signal manufacturers to invest in lower-carbon practices, encouraging a shift toward more material options in the broader construction materials market.

Public spending on buildings, transportation infrastructure, and other projects is responsible for about a third of the total embodied carbon of US construction (Carbon Leadership Forum, 2020). Sustainable procurement is an area where state and city governments are uniquely positioned to lead.

Green procurement policies typically use a combination of reporting requirements, embodied carbon limits, and incentives:

**Reporting:** Projects must collect Environmental Product Declarations (EPDs)—which report product environmental impacts including greenhouse gas emissions, reported as Global Warming Potential (GWP)—for a list of construction products set by the policy. While the scope of each policy differs by jurisdiction, the most common materials included are concrete, cement, and steel. An increasing number of policies also include asphalt when purchasing for roadways is included.

**Limits:** Products must meet GWP limits. Depending on the policy, these may be set at the industry average to limit only the worst polluters or may be set lower to push for substantially lower carbon products.

**Incentives:** Some policies include tax credits or other support for manufacturers to create EPDs. Other mechanisms, such as bid incentives, have been introduced in variants of Buy Clean. Policies could also provide financial rewards for high performance.

Procurement policies like Buy Clean can be applied at the federal, state, or local level. Private building owners can also implement their own procurement guidance modeled after public Buy Clean policies. Similarly, many private sector leaders already integrate EPD reporting requirements and GWP limits into the specifications for a project.

The Low Embodied Carbon Concrete Leadership Act (LECCLA) is a newer model of green procurement policy, similar to Buy Clean, that has now been adopted in New York and New Jersey.

[Learn more about Government Procurement policies and Embodied Carbon here.](#)

Case Studies:

- **New Jersey Low Embodied Carbon Concrete Leadership Act (LECCLA)**

# NEW JERSEY LOW EMBODIED CARBON CONCRETE LEADERSHIP ACT (LECCLA)

## How is embodied carbon addressed?

The New Jersey Low Embodied Carbon Concrete Leadership Act (LECCLA), passed in 2023, is a government procurement program focused on lowering the embodied carbon of concrete. This policy uses a performance incentive approach, awarding tax incentives to concrete producers who supply concrete that has less than a certain threshold of embodied carbon. The goal of this policy is to create a market incentive for material producers to manufacture lower embodied carbon construction materials that will then be more widespread and available to purchasers.

LECCLA uses a performance-based approach in which ready-mix concrete suppliers who can demonstrate that the concrete is under a Global Warming Potential (GWP) threshold can receive a tax credit up to 5% of the total bid price. There is an additional incentive if suppliers are using concrete that "incorporates carbon capture, utilization, and storage technology." This policy applies to state buildings and infrastructure, and is an offshoot of the Buy Clean type procurement policy model that we have seen in other places in the US.

## Development

The New Jersey LECCLA development period was around two years and started during the COVID-19 pandemic in 2020. The policy development and drafting were primarily done by the [OpenAir Collective](#), a grassroots advocacy organization, and were based on the [New York State LECCLA](#) that was passed in 2019. The bill was later revised by sponsor Senator Linda Greenstein to address stakeholder concerns.

- **Legislation Development** - OpenAir members researched, developed and wrote various versions of LECCLA supporting its introduction in different state legislatures
- **Citizen Lobbying** - Direct engagement by citizen advocates to build support and co-sponsorship by legislators and Governors
- **Coalition-Building** - Outreach activities that aim to educate and enlist stakeholders and civil society organizations to formally support mission objectives.

OpenAir Collective worked closely with many stakeholder groups, including the Natural Resources Defense Council (NRDC), the New Jersey League of Conservation Voters, and multiple environmental and private sector stakeholder organizations conducting internal education with the state about this policy.

New Jersey LECCLA will take effect in 2024. The NJ Department of Environmental

Protection is responsible for developing guidelines regarding the tax incentive structure.

## Challenges

Policy stakeholders faced a few challenges along the way. One was concern from a local environmental group who expressed that this policy would lead to the burning of tires or other landfill waste, though they provided no evidence. Additionally, some groups pushed for the reduction of any cement kiln use and the reduction of concrete usage overall. General contractors and some building trades voiced their concerns around building safety with lower embodied carbon concrete.

Discussions with the Associated Construction Contractors Association (ACCA) and Utility and Contractors Association to get them feeling confident and on board was the biggest piece of the puzzle. To address their concerns, the incentive mechanism was changed from a bid preference to a tax incentive.

## Keys to success

Using a tax incentive as the mechanism rather than a bid preference or low-carbon concrete requirement was a critical way to garner strong bipartisan support (39-0 Senate and 74-4 Assembly votes). The policy's emphasis on performance specifications also allows for increased innovation and buy-in from multiple stakeholders. Sponsorship of the bill by several Senators was another key factor in its successful passing.

Education and awareness campaigns led by grassroots activists were a critical piece of getting LECCLA passed in New Jersey. Education efforts focused on a range of different technologies—including Supplementary Cementitious Materials (SCMs), engineered aggregate, carbon capture, utilization, or storage technology—that are available and can decrease the embodied carbon of concrete. Explaining that state procurement can help push the market towards novel technologies was also an important message. OpenAir Collective highlighted that a key to success was building off education that had already been achieved in this space by the New York and New Jersey Port Authority for their Clean Construction Program (also included in this case study report).

Overall, this policy—and the bipartisan consensus-building that led to its success—highlights a successful model of how to use low-carbon procurement to achieve environmental outcomes while promoting industry and innovation.

## Resources

[New Jersey Low Embodied Carbon Concrete Leadership Act \(LECCLA\) Bill](#)  
[New York State LECCLA Bill](#)

# Zoning and Permitting

City urban planning and building regulations such as zoning and land use policies, green building incentive programs, and permitting requirements are important levers for encouraging low-carbon construction early in the design process. This is an area where it is key for cities to take the lead, given their jurisdiction over local building regulations and development.

Zoning, permitting and land use policies have a unique opportunity to impact the design process early in design when it is still feasible to optimize the project and systems for embodied carbon. Decisions made in this phase have very high potential impact, starting from determining where different types of development are allowed to occur; the nature, function and density of buildings; and regulations for green space, public amenities and parking. Cities in particular are in a great position to implement regulations that are in line with local priorities and available solutions, along with having local purchasing power. They can require or incentivize developers to pursue green building, affordable housing and other benefits, and embodied carbon can also be addressed through those programs.

There are many performance and prescriptive policy approaches to reducing embodied carbon through zoning and permitting requirements and city incentive programs. Unlike codes, which establish the minimum requirements for a project, zoning and permitting incentives can have flexibility to push teams to pursue best practices and inspire innovation. These programs can accelerate embodied carbon reductions, increase the capacity of design teams to conduct whole building life cycle assessment, and link low-carbon construction strategies to incentives like density bonuses, reduction of parking requirements, technical assistance, or expedited permitting.

[Learn more about Zoning and Embodied Carbon Policies here.](#)

Case Studies:

- **Zoning Ordinance Amendment of the City of Cambridge, MA**
- **City of Toronto's Green Standard**
- **Zoning Ordinance Amendment of the City of Newton, MA**
- **Boston's Mass Timber Accelerator Program**



# ZONING ORDINANCE AMENDMENT OF THE CITY OF CAMBRIDGE

## Development

The first Net Zero Action Plan (NZAP) for the City of Cambridge, Massachusetts was adopted in 2015. Every five years, the plan is updated with input from a stakeholder advisory group consisting of Cambridge residents and businesses. During the five-year review process in 2020 - 2021, which was delayed due to the COVID-19 pandemic, stakeholders voiced the need to address embodied carbon. The updated NZAP was adopted in early 2023 and added, "Action 2.2: Address Embodied Carbon through Green Building Requirements."

A proposal to address embodied emissions was made by the City Council towards the end of 2021, and an amendment to the zoning code was finally approved in March 2023. Accounting of embodied carbon is now included in Article 22 - Green Building Requirements of the code.

As part of the zoning amendment process in Cambridge, the Planning Board reviews petitions and makes recommendations. City staff also provide comments and suggest language refinements. This zoning petition was the first of its kind in Massachusetts and the region, so there were no precedents to draw from when developing the language.

## How is embodied carbon addressed?

The Cambridge Zoning Ordinance was amended to include embodied carbon in a few ways. This zoning amendment is an addition to the existing Cambridge Net Zero Narrative requirement and modifies an existing regulatory reporting framework to include embodied carbon. In the first phase, the amendment applies to special permit projects that are over 50,000 square feet (with an exception for projects that will house residential units). At this time, there is only a reporting requirement for data collection purposes. In the future, as described in the Net Zero Action Plan, Cambridge plans to use the data to create baselines and then develop embodied carbon reduction requirements as a series of phased-in targets over time.

Project teams are required to perform a whole building life cycle assessment (WBLCA) of the estimated embodied carbon emissions generated by the construction of a building project. At a minimum, reporting must include major building materials, including concrete, steel, wood, aluminum, and glass. The City developed a reporting template and an educational toolkit on embodied carbon as resources for project design teams and owners.

The policy was first rolled out as a pilot voluntary phase which launched in fall 2023. This was done to first collect feedback on the reporting template and educational resources. The final promulgation of regulations and mandatory reporting went into effect in early 2024.

## Challenges

The Cambridge City Council was overall in favor of embodied carbon accounting, but the Council and the Planning Board brought up a concern that additional requirements may impact housing production. They expressed a desire for a balanced approach between collecting embodied carbon data to help inform future decisions, and a concern that it may add a burden to housing production, particularly affordable housing projects. The outcome was a compromise between climate policy and housing policy.

Another concern by the development community related to the additional time and cost to comply with the new zoning amendment. This led the City to conduct a survey of architecture and consulting firms on the average time and cost it takes to perform a life cycle assessment, in order to be better informed on this issue.

## Keys to success

The two main stakeholder groups consulted in the development of this zoning amendment were the NZAP advisory group and the Planning Board. All NZAP meetings were public and open to anyone in Cambridge to attend. Additional outreach was also facilitated by Community Development Department staff, with institutions like Harvard and MIT, developers and others, to discuss the proposed policy and any concerns before it was finalized.

Once the policy was passed, stakeholders were invited to participate in the process to develop the embodied carbon reporting template and educational toolkit. Stakeholders were identified who might be required to do the reporting, including real estate developers, large institutions, architects, and sustainability consultants. Two virtual focus groups were held and a survey was distributed to collect input on the draft reporting tools.

This amendment falls directly in step with other climate policies in Cambridge. One of the ways in which cities can understand their impact is through reporting their greenhouse gas (GHG) emissions by conducting an inventory. In previous GHG inventories, the City of Cambridge has not considered the impacts of material consumption, embodied, and other non-operational sources of emissions. The City has

expressed interest in conducting a consumption-based inventory in the future to better understand how embodied carbon fits in the built environment development space.

The City's Net Zero Action Plan and its advisory group, which included many industry professionals who were already aware of embodied carbon, helped pave the way for the passing of this amendment. More so, decades of hard work by City staff and community members laid the groundwork for these current initiatives. Cambridge is a well-resourced community with residents active in policymaking. To be first in the region to pass such an amendment, required a foundation of an active municipality and community.

## Lessons learned

One major takeaway identified by the policymakers was a need for increased time in the process from policy adoption to implementation. They expressed that the topic of embodied carbon is still new and novel for both governments and for the industry. The City would have liked to have more time for stakeholder engagement, but at the same time, noting the urgency of the climate crisis and needing to move as quickly as possible.

The zoning amendment turned out to be a highly complex process of policymaking and implementation. Having dedicated and passionate leadership across all City organizations and stakeholder groups was identified as a key to success.

Cambridge is the first municipality in Massachusetts to have a zoning policy that addresses embodied carbon, and the City hopes to be a model for other communities looking to develop requirements. The City notes that when other municipalities see the success of getting legislation passed, they become curious about how it happened and reach out for lessons learned.

Lastly, as more cities and towns look to consider and adopt regulations addressing embodied emissions, regional coordination and collaboration will be important to successful implementation.

## Resources

[Cambridge Net Zero Action Plan](#)

[Article 22 Green Building Requirements](#)

[Section 22.20 of the Zoning Ordinance](#)

[Cambridge Net Zero Narrative Template](#)



# CITY OF TORONTO'S GREEN STANDARD

## How is embodied carbon addressed?

The City of Toronto first introduced its Toronto Green Standard (TGS) for sustainable design and performance standards in 2006 for city-owned and new private development including:

- **“Low-Rise Residential” - row and townhouses, up to 4 storeys with a minimum of 5 dwelling units and,**
- **“Mid to High-Rise Residential and Non-Residential” - residential apartment buildings 4 storeys and higher and all Industrial, Commercial and Institutional (ICI) Development.**

TGS was first introduced as a voluntary standard, then later went on to become mandatory in 2010. According to Toronto’s Chief Planner and Executive Director of City Planning, the Standard is, “a market transformation tool, readying and supporting the development industry in making positive changes to sustainable development.” The impact of this work supports the City’s climate action, economic recovery and social resilience goals” (Toronto City Planning, 2023). Since the original introduction of the mandatory TGS in 2010, there have been four subsequent versions containing updates. Additionally, there are different tiers within the Standard that set different requirements. Tier 1 is required through the planning approval process, and Tiers 2 to 4 are voluntary standards with higher levels of performance.

Embodied carbon is included as one of the performance measures within the Version 4 update that took effect in 2022. The inclusion of embodied carbon is intended to help advance Toronto’s net zero emissions goal by 2040, as set out in the ‘TransformTO’ Climate Action Plan and Net Zero Strategy (City of Toronto, 2017). The goals of the embodied carbon requirement are to reduce embodied carbon emissions associated with building construction and materials, as well as push the construction materials industry to create Environmental Product Declarations (EPDs) and produce materials with lower carbon footprints.

Updates in Version 4 set forth mandatory requirements for City-owned buildings and implemented an embodied carbon cap for private new developments on a voluntary basis. These caps were established based on the results of two benchmarking studies that looked at the embodied carbon associated with the construction of Part 3 (> 600m2) and Part 9 (< 600m2) buildings across the Greater Toronto and Hamilton Area (GTHA) (Passive Buildings Canada and Builders for Climate Action, 2022).

## Development

- **The Atmospheric Fund (TAF) Grant Application (Jan 2021 - June 2021)**
- **Benchmarking Studies (Aug 2021 - June 2022)**
- **Policy Primer (Aug 2022)**

**Official direction to explore embodied carbon came in TGS Version 4 adopted by council**



The process of including embodied carbon in the Version 4 update was initiated by city staff across multiple divisions (Environment and Climate Departments, City Planning), but using the basis of the strong climate action plan adopted by Council (TransformTO and the Official Plan). There was a need for municipalities to collaborate with academia and professionals to lead this work, so the city enlisted consulting help from Ha/f Climate Design, Mantle Developments, and Builders for Climate Action through the TAF grants. Additionally, planners of this update looked at other jurisdictions and how they were addressing embodied carbon, specifically policies in Vancouver (WBLCA Building By-Law- see [CLF Pacific Coast Collaborative Embodied Carbon Policy Case Studies](#)) and London's [Low Energy Transformation Initiative](#).

Four stakeholder groups were consulted in the development of the embodied carbon piece in TGS Version 4:

- **Municipalities** - including planning, urban design, and policy leads from across southern Ontario
- **Manufacturing** - including representation from Ontario cement, steel, and mass timber associations
- **Development** - representation from the major residential developers active in Toronto
- **Design & Engineering** - architects, engineers, and planners from leading regional practices

Major champions of this policy update included City Council members and broad political support within city government. For example, Toronto City Planning and Environment & Climate Departments, The Atmospheric Fund, The University of Toronto's Ha/f Research Studio, and city project management staff were involved in the initial embodied carbon analysis of City-owned projects as part of the pilot study.

## Challenges

The city didn't have local benchmarking data of the region's whole building life cycle assessments (WBLCA), and one challenge they faced was securing funding to support the benchmarking study and outreach work that underpins the validity of recommendations and increased support for the policy.

Opposition came from one home builders association in the form of written letters. Their stated concern was not carbon specific, but general concerns with increasing mandatory requirements and burden on practitioners. This was consistent with historic concerns of green building requirements and the perception that sustainability requirements lead to increased project costs. However, the embodied carbon section is voluntary at this time, and there may have been greater obstacles faced if it were introduced as a mandatory requirement.

## Keys to success

One of the major contributing factors to success was the general buy-in across Toronto to take climate action under TransformTO. Additionally, embodied carbon policy fits within the TGS structure and tools that were already in the Standard.

Another area of success was the fact that there were two distinct pieces in the update:

1. **The City's own projects were assessed to provide evidence of the policy's potential for transformation;**
2. **The benchmarking study engaged with the Greater Toronto and Hamilton Area's broader construction community to gather data and develop support for the policy primer. Specifically, the stakeholder groups uniformly encouraged more ambitious targets.**

Part of the study included a life cycle assessment (LCA) of two City-owned projects to determine the feasibility of implementing this policy. The results of that analysis were instrumental in demonstrating the efficacy of a capped approach, and how relatively easy it is to have immediate reductions to a City-owned project. Furthermore, the City's staff involved in that process became champions of the policy.

## Lessons learned

Key lessons learned from working on this policy were the importance of engaging leaders in the region from the design, planning, and construction community, and writing implementable policy. The City assessing its own buildings as part of the study and leading by example was another important factor. Policy development ended up taking more staff time than expected, but the City took time to invest in internal capacity building and embodied carbon literacy, which created a solid foundation to write and pass this policy. One item that would have been helpful was if Toronto's Consumption-Based Inventory had been completed, and they could have assessed the impact of this measure in advance. However, this did not stop the completion of the new update and adds additional Canadian examples to guide other municipalities.

## Future in the region

Areas of importance identified by the TGS embodied carbon policymakers for future steps included the following:

- **"We can't stop at caps."** Phase 2 of the embodied carbon work is important to establish the 'how' questions. The same team members are now working to ease the pathways to lower carbon construction practices across the region.
- **"Policy makers can't stop at policy."** It is important to help develop the tools that

- the industry needs, and the tools that a municipality’s staff need to successfully implement policy.
- **“We don’t have to reinvent the wheel.”** We can learn from each other. Cities across the region don’t have to start from scratch and can move ahead with action.
- **“We can’t stop at buildings.”** As a City, we build infrastructure (water, roads, transit) and need to bring a similar approach to these domains.
- **“Acknowledging that embodied carbon is the pressing issue.”** The time-value of embodied carbon is the key source of emissions in buildings in Ontario.
- **“Use a whole life carbon perspective.”** Harmonization of our operational and embodied carbon policies is needed to address the whole life carbon of buildings.

## Resources

[Toronto Green Standard Update: Advancing Net Zero Emissions in New Development](#)

[TransformTO Net Zero Strategy](#)

[Emissions of Materials Benchmark Assessment for Residential Construction](#)



# NEWTON ZONING AMENDMENT

## Development

The City of Newton is a suburban community of about 87,000 residents neighboring Boston. In 2019, the City adopted its first climate action plan (CAP) to guide and reduce climate impacts, with a stated long-term goal for Newton to be carbon neutral by 2050. The CAP did not include any action items for addressing embodied carbon directly, but did include a note that “Embodied energy will need to be addressed in the future, as accounting methodologies and mitigation strategies continue to be developed.” The same year, the City adopted a Sustainable Development Design Ordinance which includes a number of sustainability requirements for projects over 20,000 sf, such as a green building certification. The ordinance language included a section for embodied carbon requirements, but left the section blank as a placeholder, as the City Council and Planning Department staff decided the industry was not yet aligned enough to create a requirement.

Green Newton, a citizen volunteer advocacy organization, has a Building Standards Committee (BSC) which works to improve the environmental performance of new and existing buildings in the city. In the fall of 2021, the BSC developed proposed language to address embodied carbon in the special permit ordinance and worked closely with the City Climate and Sustainability Team to refine and implement it. The City staff and BSC members formed an Embodied Carbon Working Group, which launched an education campaign highlighting the importance of embodied carbon and how to address it, making presentations to the City Council, Chamber of Commerce, and other stakeholder groups. The Working Group took feedback at these presentations and made changes to the draft ordinance language based on these meetings. With strong support from the Council Zoning and Planning Committee, the City Council approved the proposed language in April 2023.

## How is embodied carbon addressed?

Special permits are required for most new construction projects over 20,000 sf. The embodied carbon provisions require projects between 20,000 and 50,000 sf to estimate the embodied carbon of the structure only and projects over 50,000 sf to estimate the embodied carbon of both structure and enclosure. Projects incorporating over 50% re-use of an existing building are exempt from this analysis requirement.

When submitting for a special permit, the team must describe in its Sustainability Narrative how it intends to meet the embodied carbon requirements. The embodied carbon analysis must be submitted with the building permit application.

## Challenges

Implementation challenges included legal review of the provisions. Early drafts of the proposed regulations aimed to specifically address the embodied carbon of concrete used on projects, but the team learned that the state building code precludes municipalities from “regulating” building materials.

A challenge of using the special permit ordinance to address embodied carbon is that not all projects need to obtain a special permit. When the updated language passed in April 2023, almost all projects over 20,000 sf needed a special permit. However, in December 2023, new by-right zoning options were introduced in five of the Newton village centers, which will allow developers to bypass the special permit process. We hope to find a mechanism for including such projects in the future. The BSC also hopes to find a way to address the embodied carbon of smaller projects (those under 20,000 sf, including one- and two-family homes), which account for most of the new construction in the city.

## Keys to success

The education process laying the groundwork for the ordinance was critical. Many city councilors were not familiar with embodied carbon, and some developers were worried about the cost of implementing the provisions. The proponents wrote a set of FAQs addressing these concerns and met with these groups to discuss the importance of embodied carbon and the low cost of estimating embodied carbon. They emphasized that the estimation tools and methods are well developed and that most project design teams are comfortable using them.

## Lessons learned

- Laying the groundwork for embodied carbon requirements is critical. The City found that meeting with stakeholders to explain embodied carbon, how to measure it, and how to address it, went a long way towards facilitating the passage of the provisions.
- Both citizen advocacy and governmental support were critical to developing and implementing the provisions. Newton is fortunate to have knowledgeable and engaged volunteers in addition to a city administration and council that recognize the dangers posed by climate change and are willing to take action to address those dangers at the local level.

- Although Newton's ordinance was written independently of the nearby City of Cambridge zoning ordinance to address embodied carbon (see case study included in this report), which was passed one month earlier, both take a similar approach to addressing embodied carbon. Newton city staff and advocates recognize the importance of regional uniformity and hope that other communities in the Boston metropolitan area will adopt similar provisions so that developers have a level playing field and common expectations when proposing new projects.

## **Resources**

The zoning ordinance language may be found [here](#), woven into Section 5.13 (key details are in 5.13.4.D). The BSC and the City are working together on a separate implementation guide and submittal template that will be published on the City's website. The BSC also created a [guide](#) to reducing the embodied carbon of projects which will be shared with developers.

[Newton Sustainable Development Ordinance](#), Sec. 5.13 Sustainable Development Design

[Newton Climate Action Plan](#)

# BOSTON MASS TIMBER ACCELERATOR

## Development

The Boston Mass Timber Accelerator (MTA) program builds on the work of a 2019 USDA Wood Innovations Grant multidisciplinary team led by the market transformation firm Olifant. This team sought to expand the use of mass timber for its carbon storage benefits and create a broad state-level policy document that many states in the Northeast ultimately signed on to. To engage developers and create a market signal for potential manufacturers on the need for regional mass timber supply, they suggested highlighting the few mass timber projects in development or under construction in the Northeast.

Concurrently, the City of Boston and the Boston Planning & Development Agency (BPDA) were working on decarbonization policies, including the [Zero Net Carbon Building Zoning Initiative \(ZNCZ\)](#), to "assess and identify strategies to strengthen green building zoning requirements to a zero net carbon standard for new construction" ([Boston Planning & Development Agency, 2022](#)). One of the four ZNCZ Technical Advisory Groups (TAGs) was tasked with making recommendations to reduce the embodied carbon of buildings. The Boston/Northeast Hub of the Carbon Leadership Forum has a working group focused on policy, and those volunteer members stepped up to lead the ZNCZ embodied carbon TAG. Together with the BPDA, over nine months, that group developed recommendations for approaches to measure and reduce embodied carbon, to be incorporated into the Zero Net Carbon Zoning Initiative.

Funding for the Boston Mass Timber Accelerator program came from the USDA Forest Service, the Softwood Lumber Board, ClimateWorks Foundation, and technical assistance from Woodworks. The Boston Society for Architecture (BSA), whose mission includes work in the areas of climate and equity and who is a longstanding partner with the City of Boston, joined the BPDA as a program partner to facilitate the mass timber accelerator. The BPDA Board of Directors authorized the program in July 2021.

## How is embodied carbon addressed?

The [Boston Mass Timber Accelerator program](#) provided support for building projects to design and build with lower embodied carbon building materials, in this case specifically mass timber. The City of Boston has a climate goal to be carbon neutral by 2050 ([City of Boston, 2019](#)). Mass timber and low carbon building materials are part of the larger puzzle of getting to net zero for the City. The MTA program was structured to engage with stakeholders—in particular the local Boston and regional development, design, engineering, and construction community—to assess practices, expand expertise, and bring more awareness to the benefits of mass timber as a building material.

The program awarded ten projects \$25,000 each and provided expert technical assistance including office hours with Woodworks staff on a bi-weekly basis. Program funding supported the project teams in designing and engineering their mass timber structural solutions, and incorporating practices including Life Cycle Assessments. Project teams were also required to present their work, attend related presentations and educational sessions, and were invited to join building tours.

Goals of the program highlighted by the [BPDA](#) and the [Boston Society for Architecture](#) were to:

- **Raise public awareness of the carbon and economic benefits and beauty of mass timber construction**
- **Introduce more practitioners to the details and feasibility of mass timber construction**
- **Identify the potential for new development, affordable housing, business, and job creation through the expansion of mass timber construction**
- **Bring about new building projects constructed with mass timber material**

## Challenges

Participants identified several key challenges through the process, and strategies that the accelerator is adopting to alleviate them, including the following:

- Stakeholders have supply chain concerns surrounding the availability of mass timber products in the Northeast. The accelerator program itself aims to lessen this issue by increasing demand to drive investment in new mass timber manufacturing in the region.
- A “new practice premium” for mass timber, combined with a high sensitivity to continually rising construction costs, has some decision-makers hesitant to adopt new construction practices. The accelerator program aims to lessen this too, as each new mass timber project expands design and construction expertise, drives innovation and more cost-effective solutions, and demonstrates the feasibility of mass timber.
- Elevated pre- and post-construction insurance premiums are possibly attributable to a lack of familiarity and history with mass timber buildings. Woodworks is leading efforts to educate insurers on the long history and safety of mass timber structures.

- Labor and unions are another consideration in the implementation of mass timber projects. Developers of this program shared that mass timber structures are still relatively new in the Northeast region, and there is some debate among unions whether the on-site assembly should be done by carpenters or steel workers.

## Results and Outcomes

Launched in September of 2021, seven project teams participated in the first funding round. The MTA program attracted an unexpectedly wide range of project types and sizes and broadened the understanding of the opportunity to use mass timber. Building types ranged from mid-rise to high-rise with a focus on multifamily residential uses, and solutions targeted the identification of efficiencies and benefits of mass timber construction. A primary goal of the MTA program was to address the lack of awareness and experience with mass timber in the Boston area, and the limited number of participants applying for the first round seemed to confirm that assumption. Project teams choosing not to apply may have been hesitant to investigate a new structural approach and either did not have the expertise or it was outside of their comfort zone to design with mass timber. Even if the architect or structural engineer was willing to investigate it, some teams may have faced a challenge convincing the project owner to apply for the grant.

A second funding round was offered in February of 2023, with a focus on taller, 10 story plus, mass timber structures. Perhaps reflecting the growing awareness of embodied carbon impacts and mass timber options, one applicant was already proposing to use CLT for their buildings and focused their application on how to accelerate construction assembly and the related carbon reduction benefits. Teams proposed projects ranging from 6-9 to 24 stories, with a focus on large-scale highrise and multi-building development projects and the overall embodied carbon reduction benefits.

Prior to the MTA program, two mass timber projects had been completed in the City of Boston. As of this writing, the BPDA is tracking eight active projects totaling over 1.3M sq. ft. that will be constructed utilizing mass timber materials. Of the ten MTA program participants, two are fully committed to mass timber construction, with several others still in the design and permitting phases.

## Keys to success

The progress and final presentation technical assistance sessions provided by WoodWorks were very popular and invoked a lot of collaboration across teams, which was unique. Participation was primarily by the architects and engineers, but almost all developers / owners participated as well. As a result of this initiative, the City of Boston is now maintaining a 'Mass Timber Tracker' of projects across the city, from schematic design through construction, including information about buildings such as their square footage and principal characteristics. This has potential to become a visual public map once more projects are completed.

The successes of the Boston Mass Timber Accelerator and the program model itself have sparked interest in other cities and regions nationally seeking to accelerate low embodied carbon building practices. The USDA Forest Service now offers funding through the Wood Innovations Program for Mass Timber Accelerators modeled on Boston's program, with new programs already launched in the following cities:

- **In September 2023, New York City launched the New York City Economic Development Corporation (NYCEDC), [New York City Mass Timber Studio](#)**
- **Atlanta, GA, in partnership with the Georgia Forestry Foundation also launched an [Atlanta Mass Timber Accelerator](#) program in September 2023**

The Boston Mass Timber Accelerator program showed that mass timber is a cost-feasible low carbon building strategy and that partnership / incentive-type programs can be a great way to engage stakeholders in the industry to increase awareness on the subject. The City of Boston is transitioning from the incentivised pilot practices of the MTA program to assessing and including mass timber as an embodied carbon impact reduction strategy for projects. Local organizers, including the BSA and Boston/ Northeast CLF Hub, are building on the momentum of the MTA program with education, awareness, and recognition efforts focusing on the beauty and feasibility of mass timber construction and the embodied carbon reduction benefits. Overall, the Boston MTA grant program raised awareness, expanded knowledge, and broadened the conversation around embodied carbon and mass timber projects in the region. The program has driven up the number of mass timber projects, increased demand for CLT and mass timber products, and is providing the business case for investor groups working to reactivate and retool idled timber mills to start new production in the Northeast.

### Links for more information

[Boston Mass Timber Accelerator- BPDA](#)

[Boston Mass Timber Accelerator- BSA](#)

[Zero Net Carbon Building Zoning Initiative | Boston Planning & Development Agency](#)

[Zero Net Carbon Building Zoning Initiative - Final Report](#)

[Olifant - Advancing mass timber construction as a climate solution](#)

# Building Codes and By-Laws

Building codes are a comprehensive set of interconnected regulations that are designed to govern new construction, renovations/remodels, repairs and demolitions. In the U.S. and Canada, they are adopted by state/province or local jurisdictions, are enforceable by law, and provide minimum requirements for the design and construction of buildings to protect the health and safety of building occupants. There are separate codes for commercial and residential buildings, and different topics of building performance which can be addressed by different types of code. Some of these include building code, energy code, or fire code, and cover everything from structural design to energy use.

Over the past few decades, advancements in building and energy codes—and in the underlying research on reducing operational energy consumption and related greenhouse (GHG) emissions—have stimulated changes in building design and operation. In contrast, embodied carbon has been largely excluded from building code conversations until the last few years. In August 2023, the California Green Building Standards Code (CALGreen) adopted embodied carbon requirements, making California the first state in the U.S. to address embodied carbon in a mandatory building code.

Code amendments can establish prescriptive or performance-based paths to reducing embodied carbon of specific construction materials or whole buildings.

For example, codes can limit the carbon intensity of a product or building by setting product embodied carbon intensity limits (as verified by an environmental product declaration (EPD)) or building-level limits or reduction requirements (as verified by a whole building life cycle assessment). Codes can also advance embodied carbon reductions by allowing for new practices, such as the use of salvaged wood products in new construction.

A benefit to addressing embodied carbon through codes is that they include the largest number of projects covered compared to other policy types, and thereby have a large potential for emissions reductions. Building codes can also send clear market signals to manufacturers to meet demands for new materials. However, there are challenges, including the complexity of the code development process and the length of time required to make changes.

[Learn more about Codes and Embodied Carbon Policies here.](#)

Case Studies:

- **Vermont Energy Code Embodied Carbon Amendment**

# VERMONT ENERGY CODE AMENDMENT

## Development

The [Vermont Climate Action Plan \(CAP\)](#), first introduced in December 2021, was the primary lever for incorporating embodied carbon into the Vermont State Building Energy Standard. The Vermont CAP set state climate goals and listed buildings as a high-impact area to address in order to achieve reductions in greenhouse gas emissions. This CAP is legally binding and therefore the state must take action to reduce emissions, with buildings being the largest source in the state ([Vermont 2023 Annual Progress Report](#)).

Amendments to Vermont's Residential and Commercial Energy Standards to include embodied carbon reporting on insulation materials were introduced on two separate occasions. The first was in 2018 for the 2020 code cycle, and the second in 2021 for the 2023 code cycle, which passed. Insulation was proposed as a material to start with because there is a direct relationship between enclosure performance requirements and the embodied carbon of those materials, which fit well within the energy code scope. The language will be finalized for public distribution in 2024.

A robust stakeholder engagement process played a significant role in the passing of the amendment to include embodied carbon in the code. This process was facilitated by Energy Futures Group, a clean-energy consulting firm in VT, on behalf of the Vermont Department of Public Service, which administers the standard. Throughout 2021 and 2022, multiple stakeholder meetings were held, for both residential and commercial audiences. There were also public meetings held to obtain broader input. Having participants with a diverse set of backgrounds engage in these meetings (such as builders, designers, nonprofit organizations, consumer advocates, and industry representatives) allowed for a greater range of input from different stakeholders whom this code may impact.

## How is embodied carbon addressed?

Starting with the implementation of the new Energy Standard in July 2024, builders in Vermont can earn optional credits if they report on the Global Warming Potential (GWP) of the insulation materials used in the project. This amendment is under the energy code and not the building code because there is no statewide residential building code in Vermont at this time. To earn points in this section, projects must use a provided table to estimate their embodied carbon emissions from foundation, wall, and roof insulation materials. Both residential and commercial projects can apply for these points. The points are self-reported for residential projects and there is a more robust reporting requirement for commercial projects.

## Challenges

There were a few challenges in the process of incorporating embodied carbon into Vermont's energy code. One was the time and effort required to educate code officials and impacted stakeholders about embodied carbon. Advocates for the amendment explained that embodied carbon is still a new and novel concept for code officials as well as in the industry, and this education took a considerable amount of time to conduct. There was significant pushback based on misconceptions about the definition of "embodied carbon," along with the scope and boundaries associated with accounting for the carbon emissions of building materials.

Another challenge was concerns from some stakeholders that the energy standard was not the right place to address embodied carbon. Advocates working to include embodied carbon brought attention to the climate goals included in the CAP and the language in the code that identifies the reduction of climate impact as a core purpose. The CAP is a binding statute, requiring the state to take action on its climate goals. They concluded that voluntary reporting, starting with just insulation, was a good first step to take. Cost implications were expressed as another concern from the industry. However, because the code only covers insulation at this time and is voluntary in its application, there was no cost burden on builders or owners, and cost parity could be achieved across a range of GWP emission factors for different insulation materials. Additionally, homebuilders associations expressed concerns about the increased stringency of the energy code revisions overall, and some chemical trade associations argued that their insulation products were being targeted while not addressing other building materials. These concerns were addressed by the code advocates. The amendment was ultimately passed and will go into effect in 2024.

## Keys to success

There was a lot of support from the residential green building community in Vermont to help get this amendment into the code. Nonprofit groups like Builders for Climate Action, and Vermont Energy Investment Corporation, were imperative to the passage of this amendment. Other groups who had advocated for the passage of the Climate Action Plan, such as the Vermont Climate Action Network, laid the essential groundwork. Policy champions from these nonprofit groups helped with technical assistance in developing the code language and reporting data table. They also made sure to connect these issues with the state's larger climate goals in their education and outreach. Additionally, there were internal policy champions in the state which came from the Department of Public Service. More broadly, in Vermont, there is a culture of environmentally conscious living, and this translated to the building industry in the form of market demand for, and understood value of, lower-emission, energy-efficient, and nontoxic building solutions.

Education on what embodied carbon is and why it is important was a huge contributing factor to the passage of this amendment. Nonprofit organizations mentioned above, as well as industry stakeholders such as [New Frameworks](#), helped with this education and in building consensus on the importance of embodied carbon in Vermont's building industry. The voluntary reporting of embodied carbon in the energy code serves as a way to introduce the industry to these concepts and build confidence in reporting. In the future, Vermont may see mandatory reporting requirements in the code, expansion of the scope of the code, and the inclusion of other embodied carbon reduction strategies. This was the first step in increasing the visibility of embodied carbon in the state. Policymakers hope that this work will become visible to other states and increase the level of embodied carbon reporting in the Northeast region.

## Resources

[Vermont Climate Action Plan \(CAP\)](#)

[Vermont Residential Building Energy Standard \(RBES\)](#)

[2024 Amendments](#)

- **TABLE R402.1.2.3: Points by Component for Base Code and Stretch Code, Insulation Embodied Carbon Emissions**
- **SECTION R408: Insulation Embodied Carbon Emissions**
- **TABLE R408.1.1: Calculation Table**
- **TABLE R408.1.2: Default Insulation Global Warming Potential Values**

[Vermont Commercial Building Energy Standard \(CBES\)](#)

[2024 Amendments](#)

- **TABLE C406.3.1: Renewable and Load Management Credit Requirements by Building Occupancy Group**
- **SECTION C406.3.9 C01: Insulation Embodied Carbon**
- **TABLE C406.3.9(3): Points Options for Insulation Embodied Carbon**

# Deconstruction and Reuse

Reusing buildings and materials reduces embodied carbon and waste, while promoting environmental and human health. Deconstruction is the process of disassembling buildings to allow for the salvage of building materials for reuse. Building reuse, also referred to as adaptive reuse or renovation, describes a process wherein the structure, envelope, or other portions of an existing building are retained rather than the total demolition and construction of a new building on the same site.

Extending the life of a material or building avoids the cradle-to-gate embodied carbon from the process of extracting and manufacturing new materials. Building or material reuse is a significant opportunity for reducing carbon emissions because it avoids the emissions that result from manufacturing, transporting and installing new materials. Extending the life of a material also avoids materials ending up in landfills, reducing the emissions and negative environmental and health impacts from landfills.

Reuse and deconstruction have many co-benefits such as the creation of jobs and addition of new regional markets for the removal, sale, and distribution of salvaged materials. Deconstruction requires more skilled contractors than demolition, thereby creating new training opportunities and jobs in deconstruction, transportation, storage, refurbishing, and reselling of these materials. Deconstruction can result in the creation of new markets, reuse warehouses, and local community hubs.

There are multiple ways policy can move the needle on reuse and deconstruction.

[Learn more about Deconstruction and Reuse and Embodied Carbon Policies here.](#)

Case Studies:

- **City of Boston's Zero Waste Deconstruction Initiative**



# CITY OF BOSTON'S ZERO WASTE DECONSTRUCTION INITIATIVE

## Development

Boston's Zero Waste Plan, adopted in 2019, set out a goal of being a zero waste city by 2050. The Zero Waste Plan includes both commercial and residential waste and highlights strategies for waste diversion instead of landfilling or waste-to-energy routes. In Boston, commercial waste collection and disposal is the responsibility of individual businesses to handle (hiring haulers for example), while residential waste is collected through the City.

To address commercial waste from construction and demolition, the City connected with the reuse working group of the Carbon Leadership Forum's (CLF) Boston/Northeast Regional Hub and developed a pilot initiative. As part of this work, the Boston Environment Department coordinated a local reuse and deconstruction working group to gain stakeholder perspectives and assist with development.

The Boston Environment Department worked with the Boston Landmarks Commission and the Interagency Green Building Committee (IGBC) to determine what buildings would be good candidates for deconstruction. They prioritized buildings by identifying those trying to obtain LEED (Leadership in Energy and Environmental Design) certification and aiming for waste management credits, assessing whether projects had salvageable assets, and potentially interested developers. The Environment Department developed a [Deconstruction One Pager](#) in order to increase awareness of adaptive reuse, deconstruction, and the wide variety of forms it can take. The one-pager includes several prior case studies of deconstruction projects in Massachusetts, including Williams College, Northampton State Hospital, and two single-family homes.

Timeline:



## How is embodied carbon addressed?

The Boston Environment Department's goals around deconstruction include the following:

- **Consider continued use or adaptive reuse of buildings**
- **Maximize the salvage of building materials for reuse**
- **Recycle building materials that cannot be reused**
- **Reduce carbon emissions associated with demolition**
- **Retain building character within neighborhoods**
- **Build awareness of quality secondary building materials**

The initiative leverages the no-cost technical assistance available through the Massachusetts Department of Environmental Protection's [RecyclingWorks in Massachusetts](#) program to help owners and developers move towards the best deconstruction pathway and create a work plan to do so. Examples of assistance provided include waste management planning, identifying deconstruction crews, cost/benefit analysis, and connecting with outlets for salvaged materials.

The City of Boston worked with owners and developers, who had already received building demolition permits, to create waste management plans, instruct pre-demo cleanouts, and develop plans for soft-stripping materials that were still usable (such as appliances and attached assets like flooring and windows). Additionally, through this program, the City provides an outlet for owners and developers to connect with deconstruction businesses.

## Challenges

Contractors involved in the initiative tended to express that their main priorities are efficiency and cost. A common construction industry challenge is that projects can take many years to complete and there may be competing interests. It is crucial to start thinking about deconstruction early and identify deconstruction as a goal from the beginning. The City emphasized that they should reuse what they could to the extent possible.

One lesson learned is that material reuse and circularity need to be explicit early on in the process. Early action and education of the construction team are essential. The City found that this deconstruction program was ultimately a great first step and driver for change. Asking questions about deconstruction and material reuse on a commercial construction scale was found to introduce contractors to the concept of deconstruction, and it gently pushed for more transparency around building and material waste processes.

## Keys to success

The City framed deconstruction as a way to promote the reusing and retrofitting of buildings instead of demolishing them, and tied this Initiative directly into the Zero Waste Plan from 2019. A lesson learned was that while it may be possible to sell the idea of deconstruction to the general contractor, there is an inherent need for demolition contractors to be deeply involved and buy into the process from the beginning. Boston took inspiration from deconstruction ordinances in San Francisco (California), Portland (Oregon), Vancouver (Canada), and San Antonio (Texas). Additionally, the Los Angeles California Adaptive Reuse ordinance for low-income housing was noted as an inspiration. The future of the deconstruction initiative is uncertain; however, the City has great interest in converting commercial buildings to residential housing and sees this as a potential next step. RecyclingWorks is available to provide free technical assistance to any business/institution/construction project across Massachusetts interested in exploring deconstruction.

## Pilot Projects

One of the successful pilot projects was Simmons University's renovation of their Park Science Center. The project team successfully recovered and reused over 24,000 pounds of material, including furniture, fixtures, and glassware items, from the existing classroom and lab building. More information on the project is available on the RecyclingWorks of Massachusetts [blog](#).

## Future in the region

- **There is a need to grow the market for reused building materials in Boston, both in deconstruction services and in reused material storage, upcycling and resale.**
- **The entire New England region needs technical support, financial incentives, and a large reuse vendor to illuminate that circularity is not only possible, but carries many yet unrealized benefits.**

### Links for More Information

[Zero Waste Boston](#)

[Zero Waste Boston - Recommendations of Boston's Zero Waste Advisory Committee](#)

[Zero Waste Boston - Deconstruction Initiative](#)

[RecyclingWorks in Massachusetts](#)

# Future in the Region

Policy is an essential step towards creating the scale of action required to rapidly reduce embodied carbon in construction. In the Northeast region and other areas of North America, we have historically seen embodied carbon reporting primarily be of a voluntary nature. However, in the coming years we expect these policies to cover more projects and more materials and to become mandatory.

These nine policy case studies highlight only a small portion of embodied carbon action in the Northeast region of the U.S. and Canada. Looking forward, we expect action to continue to grow:

- **Embodied carbon has been included more recently in Climate Action Plans, and we are now seeing an increase in regulatory policies passed targeting embodied carbon assessment and reductions.**
- **Federal Buy Clean, the Canadian Greening Government initiative, and regional leadership from New York and New Jersey, have sparked additional interest in green procurement policies, and we expect government procurement for low embodied carbon materials to continue to grow.**
- **Funding from the US Inflation Reduction Act (IRA) will help increase embodied carbon data availability and potentially fund state and local jurisdictions related to embodied carbon in infrastructure.**

It is clear that there is great work already happening in this region, but there is a need for increased education and capacity building in order to pass and implement more of these policies. Policymakers and advocates across the nine policy case studies highlighted education and awareness as key to successfully adopting their policies and programs.



# Acknowledgments

## Authors

The research team from the Carbon Leadership Forum at the University of Washington, College of Built Environments:

- **Megan Kalsman, Policy Researcher**
- **Michelle L. Lambert, Policy Researcher**
- **Meghan C. Lewis, Senior Researcher**
- **Kate Simonen, Professor and Founding Director**

Author contributions: M.K. led conceptualization; M.K., M.L.L, and CLF Regional Hub volunteers (see Hub Volunteers section) conducted research and analysis; M.L.L, M.C.L, and K.S. performed review and editing; M.K and M.L.L. wrote the document.

Graphic design adapted by Sindhu Raju (CLF Student Assistant) from a template originally designed by Hannah Adams (hannahadamsdesign.myportfolio.com).

## Citation

Kalsman, M., Lambert, M., Lewis, M., & Simonen, K. (2024). Northeast U.S. & Canada Embodied Carbon Policy Case Studies. Carbon Leadership Forum. <https://doi.org/10.6069/Q8K9-ED23>

## Copyright

Northeast United States & Canada Embodied Carbon Policy Case Studies is licensed under a Creative Commons Attribution 4.0 International Licence.

## Acknowledgments

This research was funded by the ClimateWorks Foundation. A huge thank you to the interviewees and CLF Hub volunteers who contributed time to make this report possible.

We would like to thank the following individuals for contributing their experience through interviews and providing content for the report (in order of the case studies):

- **Amy Cole, Miriam Voss, and Kasey Motley of the Port Authority of New York and New Jersey**
- **Mikhail Haramati, Formerly at New York State Energy Research and Development Authority (NYSERDA)**

- **Mariane Jang, New York Office of General Services (OGS)**
- **John Dalzell, AIA, LEED Fellow, Boston Planning & Development Agency**
- **Jennifer Effron and Madeleine Hykes, Boston Society for Architecture**
- **Nicole St. Clair Knobloch, Olifant**
- **Chris Neidl, OpenAir Collective**
- **Sue Dorward, Sustainability & Energy Coordinator at Raritan Valley Community College**
- **Sean Mohen, Tri-County Sustainability**
- **Thomas O’Neill, City of Cambridge, Community Development Department**
- **Mason Wells, City of Cambridge, Community Development Department**
- **Susanne Rasmussen, Director of Environmental and Transportation Planning, City of Cambridge, MA**
- **David MacMillan and Shayna Stott, City of Toronto, Canada**
- **Liora Silkes, City of Newton Energy Coach**
- **Mark Webster, Green Newton Building Standards Committee**
- **Jacob Deva Racussin, New Frameworks**
- **Susan Cascino, Boston Environment Department**
- **Lauren Potter and Abbey Massaro, RecyclingWorks of Massachusetts**
- **Michael Orbank, STO Building Group and CLF Boston/Northeast Hub**

## CLF Regional Hub Volunteers

This research was supported by the following volunteers from CLF Regional Hubs in the Northeast region:

- **Kelly Alvarez Doran (Ha/f Climate Design, Canada and United Kingdom)**
- **Randall Anway (New Tapestry, Boston/Northeast Hub)**
- **Jacob Deva Racusin (New Frameworks, Boston/Northeast Hub)**
- **Kathy Dorgan (Dorgan Architecture and Planning, NY Hub)**
- **Aurora Jensen (Brightworks Sustainability, NY Hub)**
- **Iza Khan (Columbia University, NY Hub)**
- **Alyssa Manypenny Murphy (Placework Studio, Boston/Northeast Hub)**
- **Brian Sandford (MASS Design Group, Boston/Northeast Hub)**
- **Joshua Plourde (Atelier Ten, NY Hub)**
- **Mark Webster (SGH, Boston/Northeast Hub)**

## Photos

- **Page 01: Mark Lotterhand, Adobe Stock**
- **Page 02: Josh Olalde (2020), Unsplash**
- **Page 07: Bannafarsai, Adobe Stock**
- **Page 13: Hamza Erbay (2020), Unsplash**
- **Page 15: Frames For Your Heart (2020), Unsplash**
- **Page 17: SeanPavone, Adobe Stock**
- **Page 20: Berkay Gumustekin (2017), Unsplash**
- **Page 23: Frames For Your Heart (2020), Unsplash**
- **Page 26: Jonbilous, Adobe Stock**
- **Page 29: Mark Olsen (2019), Unsplash**

## References

### Planned Actions

1. Port Authority New York and New Jersey. (2021). Clean Construction program. <https://www.panynj.gov/port-authority/en/about/Environmental-Initiatives/clean-construction.html>
2. New York State. (2022). No.22: Leading by Example: Directing State Agencies to Adopt a Sustainability and Decarbonization Program (Executive Order 22). <https://www.governor.ny.gov/executive-order/no-22-leading-example-directing-state-agencies-adopt-sustainability-and>
3. New York State. (2022b) Executive Order 22: Embodied Carbon Guidance. <https://ogs.ny.gov/executive-order-22-embodied-carbon-guidance>
4. New York City. (2022). Executive Order 23: Clean Construction. <https://www.nyc.gov/office-of-the-mayor/news/023-002/executive-order-23>

### Government Procurement

5. Carbon Leadership Forum. (2020). What is a Buy Clean Policy? <https://carbonleadershipforum.org/what-is-a-buy-clean-policy/>
6. State of New Jersey. (2023). Low Embodied Carbon Concrete Leadership Act. <https://www.njleg.state.nj.us/bill-search/2022/S287>
7. New York State. (2022c). Senate Bill S542A. <https://www.nysenate.gov/legislation/bills/2021/S542>

### Zoning and Permitting

8. City of Cambridge. (2015). Net Zero Action Plan. <https://www.cambridgema.gov/CDD/Projects/Climate/netzerotaskforce>
9. City of Cambridge. (2023). Article 22 Green Building Requirements. <https://www.cambridgema.gov/CDD/zoninganddevelopment/sustainabledevelopment/article22greenbldgrequirements>

10. City of Cambridge. (2022). Article 22.000 Sustainable Design and Development Zoning Ordinance. [https://library.municode.com/ma/cambridge/codes/zoning\\_ordinance?nodeId=ZONING\\_ORDINANCE\\_ART22.000SUDEDE](https://library.municode.com/ma/cambridge/codes/zoning_ordinance?nodeId=ZONING_ORDINANCE_ART22.000SUDEDE)
11. City of Cambridge. (2023b). Net Zero Narrative Template. [https://www.cambridgema.gov/-/media/Files/CDD/ZoningDevel/GreenBuildings/netzeronarrative2023update/netzeronarrativetemplate\\_final.pdf](https://www.cambridgema.gov/-/media/Files/CDD/ZoningDevel/GreenBuildings/netzeronarrative2023update/netzeronarrativetemplate_final.pdf)
12. City of Newton. (2023). Chapter 30: Zoning Ordinance. <https://www.newtonma.gov/home/showpublisheddocument/29823/638055970231470000>
13. Green Newton. (2023). Building Standards Committee Embodied Carbon Recommendations. <https://greennewton.org/wp-content/uploads/Green-Newton-Embodied-Carbon-Reduction-Guidelines-231211.pdf>
14. City of Newton. (2019). Climate Action Plan. <https://www.newtonma.gov/government/climate-and-sustainability/climate-action-plan>
15. Toronto City Planning. (2023). Toronto Green Standard Update: Advancing Net Zero Emissions in New Development. <https://www.toronto.ca/legdocs/mmis/2023/ph/bgrd/backgroundfile-235868.pdf>
16. City of Toronto. (2022). Green performance standards. <https://www.toronto.ca/news/city-of-toronto-raises-green-performance-standards-for-new-development-and-mandates-net-zero-ghg-emissions-for-new-city-owned-buildings/>
17. City of Toronto. (2017). TransformTO. <https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/transformto/>
18. Passive Buildings Canada and Builders for Climate Action. (2022). Emissions of Materials Benchmark Assessment for Residential Construction Report. <https://www.buildersforclimateaction.org/report---embarc-report.html>
19. Doran, K. A. (2021). Why We Need Embodied Carbon Benchmarks and Targets in Building Standards and Policies: An Open Letter. <https://www.canadianarchitect.com/why-we-need-embodied-carbon-benchmarks-and-targets-in-building-standards-and-policies-an-open-letter/>
20. Boston Planning & Development Agency. (2022). Zero Net Carbon Building Zoning Initiative. <https://www.bostonplans.org/planning/planning-initiatives/zero-net-carbon-building-zoning-initiative>
21. Boston Planning & Development Agency. (2021). Boston Mass Timber Accelerator. <https://www.bostonplans.org/planning/planning-initiatives/boston-mass-timber-accelerator>
22. City of Boston. (2019). Boston Climate Action. <https://www.boston.gov/departments/environment/boston-climate-action>

## Building Codes and By-Laws

23. State of Vermont. (2021). Vermont Climate Action Plan. <https://climatechange.vermont.gov/readtheplan>
24. Vermont Department of Public Service. (2023). Residential Building Energy Standards, Embodied Carbon Amendment. <https://publicservice.vermont.gov/document/2023-redline-vermont-residential-building-energy-standards-amendmentslcar>
25. Vermont Department of Public Service. (2023). Commercial Building Energy Standards, Embodied Carbon Amendment. <https://publicservice.vermont.gov/sites/dps/files/documents/07.11.23%20-%2022P29%20-%20PSD%20Adopted%20Rule%20Filing%20-%20Commercial%20Building%20Energy%20Standards.pdf>
26. Vermont's Energy Action network. (2023). 2023 APR Key Findings. <https://eanvt.org/annual-report/2023-apr-key-findings/>

## Deconstruction and Reuse

27. Boston's Zero Waste Advisory Committee. (2019). ZERO WASTE BOSTON Recommendations of Boston's Zero Waste Advisory Committee. [https://www.boston.gov/sites/default/files/imce-uploads/2019-06/zero\\_waste\\_bos\\_recs\\_final.pdf](https://www.boston.gov/sites/default/files/imce-uploads/2019-06/zero_waste_bos_recs_final.pdf)
28. City of Boston. (2019). Zero Waste Deconstruction Initiative. <https://www.mass.gov/doc/city-of-boston-presentation/download>