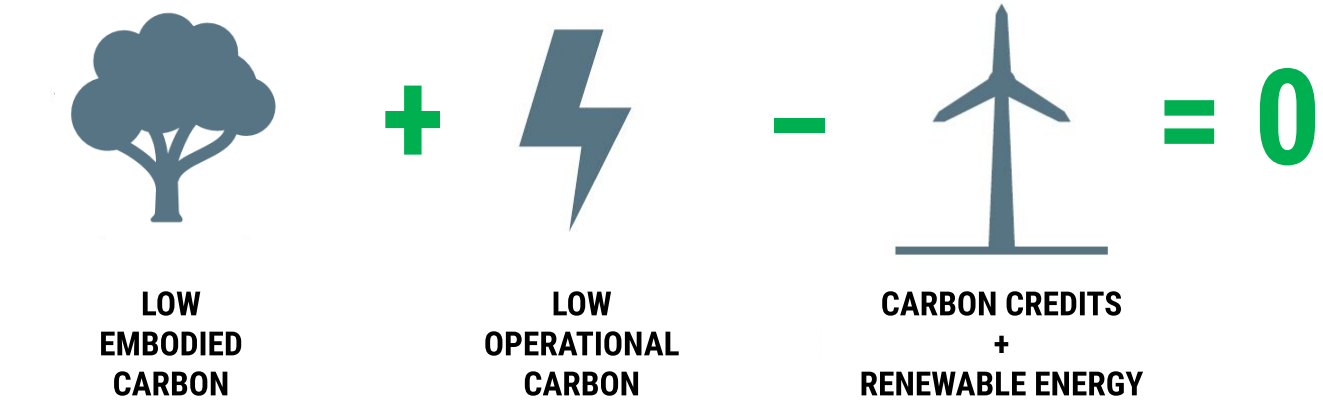
Built Environment Plus
Zero Carbon Buildings Municipal Summit

SUMMARY REPORT 2021

CARBON NEUTRAL



BUILT ENVIRONMENT PLUS

ABOUT US

Built Environment Plus (BE+) drives sustainable and regenerative design, construction, and operations of the built environment. We are a member-based organization providing green building education, networking, advocacy and leadership opportunities for the Massachusetts sustainable building community. We envision that the built environment will regenerate and sustain the health and vitality of all life within a generation. Our programs are supported and enhanced by the volunteer efforts of our members.

We provide opportunities for people to both learn and share expertise with each other through our many classes and workforce training programs. We build community through our topic based roundtables, networking events and green building celebrations. Based on community needs, we conduct research and publish reports in support of their work. Lastly we connect industry leaders with people advocating for advancing the sustainability of the built environment.

Through our many committees and roundtables, we address all aspects of the greening of the building industry: planning, design & engineering, construction, management & operation, and beyond. We help all practitioners by promoting market transformation.

Community members came together and formed the US Green Building Council Massachusetts Membership Forum in 2008. A year later we were incorporated as a Chapter of the USGBC. In 2016 the Chapter became the lead advocate for the WELL Building Standard, and also became the local collaborative for the International Living Future Institute.

In 2020, the Chapter's community and board voted to change the organization name to Built Environment Plus. This change reflected our growth and evolution as an organization, our new continued strong relationship with USGBC national, and our partnerships with other industry leaders.

For questions related to this report, please reach out to communications@builtenvironmentplus.org

To learn more about Built Environment Plus check out our website https://builtenvironmentplus.org/

This summary report was completed by Melissa Stok and Ethan Vonderheide.

PARTNERS AND SPONSORS

The event came to life in partnership with

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INTRODUCTION

A Virtual Event Held June 11th, 2021

The Zero Carbon Buildings Municipal Summit was an informative and interactive event organized by Built Environment Plus and led by Meredith Elbaum to discuss the present and future of Zero Carbon Buildings (ZCBs) in Massachusetts. We invited municipal staff, committee members, elected officials, and concerned citizens to learn and share about the path to achieving Net Zero within cities and towns in Massachusetts.

The Event Agenda:

1. **Educational Presentations By:**
   - » Jacob Knowles, BR+A
   - » Julie Janiski, BuroHappold Engineering
2. **Panel Discussion With:**
   - » Joseph Curtatone, Mayor of Somerville
   - » Stephanie Ciccarello, Sustainability Coordinator for Amherst
   - » Andrea Love, Net Zero Task Force Member in Cambridge
3. **Breakout Rooms to Answer:**
   - » What's currently happening in your municipality related to Zero Carbon?
   - » What would you like to see happen in 3-5 years? What are the obstacles and what are your needs?
   - » What's your vision for the Stretch Code?

This report includes a summary of the presentations and a summary and analysis of attendee responses and feedback.

Host

Meredith Elbaum
Executive Director at Built Environment Plus
As Executive Director, Meredith helps drive sustainable and regenerative design, construction, and operation of the built environment. Before BE+, she developed climate action plans, master plans, design guidelines and green buildings as President of the Elbaum Group. She launched the Health Product Declaration, as its Interim Executive Director. Meredith was Director of Sustainable Design at Sasaki for almost a decade and helped in USGBCMA Chapter's (BE+) creation and served as a founding board member. She earned a BArch from Rice University, a MSArch from MIT, and currently teaches at Wentworth Institute of Technology.

Presenter

Julie Janiski
Partner at BuroHappold Engineering
Julie leads integrated teams to deliver the highest performance projects at all scales. She provides solutions that encompass all aspects of regenerative design, from carbon reduction and water conservation to social equity and health. Recent work includes consulting for the MA Commercial Energy Code, USDA grant-funded research on heavy timber design, a Net Zero workforce training center, and The House at Cornell Tech – a residential high-rise in NYC which is certified LEED Platinum and Passive House. Shes a BE+ board member, co-chair of Boston Carbon Leadership Forum, and a key contributing author for a proposed Net Zero stretch code.

Presenter

Jacob Knowles
Director of Sustainable Design at BR+A
As Director of Carbon Neutral Planning at BR+A, Jacob leads a sustainability consulting team. He is a Zero Net Energy guru, spearheading millions of square feet of Carbon Neutral + Cashflow Positive projects. With BR+A he has developed carbon neutral master plans and with projects receiving awards such as AIA COTE Top Ten, I2SL Go Beyond, and major MA DOER high performance buildings and zero net energy grants. Jacob is also a board member of the Boston Society for Architecture.

WHY THIS EVENT?

The Zero Carbon Buildings Municipal Summit, convened by Built Environment Plus, set to empower Municipal Leaders and Staff with knowledge on Zero Carbon Buildings, so that they have the context and confidence to make the necessary transition towards our Zero Carbon Future.

Back in March 2021, Gov. Baker signed a landmark climate bill, An Act Creating a Next Generation Roadmap for the Massachusetts Climate Policy, into law. Included in this bill is an opt-in stretch code which represents a big win for municipalities. Elected and appointed officials from 59 municipalities representing 40% of the Commonwealth's population signed a letter to Governor Baker expressly calling for the development of an opt-in net-zero stretch code to allow communities to address building sector emissions.

Massachusetts is stepping up and empowering local municipalities to achieve their climate goals in an efficient and coordinated way. We need to work together over the next year to ensure the building sector is decarbonized in a way that is consistent with our shared carbon reduction goals.

According to Architecture2030, with data from the UN Environmental Global Status Report 2017, embodied carbon will be responsible for almost half of total new construction emissions between now and 2050, yet MA's Building Sector Report of the MA 2050 Decarbonization Roadmap Study doesn't even mention it.

Considering the goal is for Massachusetts to achieve net-zero greenhouse gas emissions by 2050, you just can't do this without considering the entire picture including embodied carbon.

Given this critical knowledge, we must prioritize solving this challenge in order to ensure we meet the global goals needed in the face of our shared climate emergency.

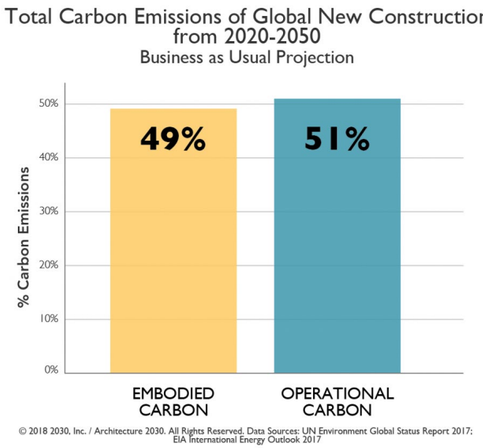


Figure 01
Embodied and operational carbon emissions
Source: Architecture 2030

MARCH 2021 REPORT

Back in March 2021, Built Environment Plus released the second draft of a report outlining that Massachusetts is ready for Net Zero. There are 7.2 million SF of built or in-progress projects in MA that are Net Zero or Net Zero Ready.

- The Net Zero and Net Zero Ready building stock exceeds 7 million square feet and is growing at an exponential rate in the Commonwealth today.
- The vast majority are doing this with little to no added cost. 85% reported ‹1% construction cost premium to achieve Net Zero Ready.**
- Net Zero Buildings span a wide range of types, with a high degree of representation from K-12, higher education, healthcare, laboratory, office, and multi-family.
- There are dozens of builders, architects, engineers and owners already bringing these projects to reality. Some are developers.
- Net Zero Ready buildings are highly energy efficient: 82% are at least 35% more efficient than the current stretch code baseline and all rely on heat pumps as the primary source of heat. *Net Zero buildings also procure on-site and/or off-site renewable energy to offset 100% of consumption on a net annual basis.

Given this knowledge, it was important for us to continue the conversation and demonstrate to municipalities how they can work towards Zero.

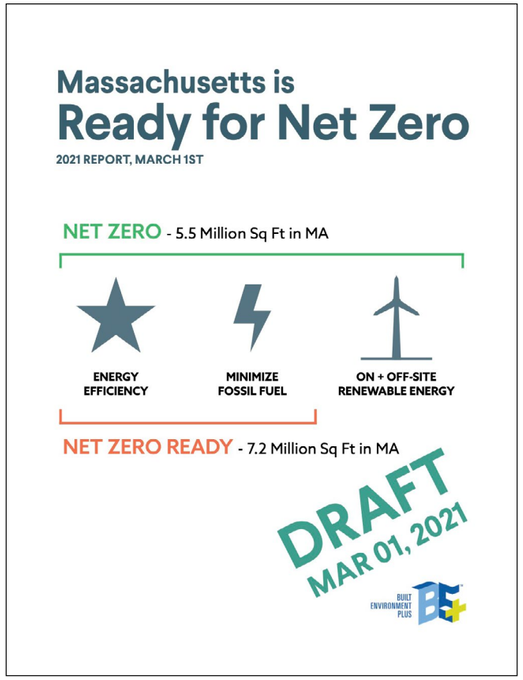


Figure 02
Massachusetts is Ready for Net Zero Report Cover
Source: Built Environment Plus

EVENT RECAP

In total, 123 people from Massachusetts Municipalities, and 8 people from 5 others states attended the event.

ACCORDING TO ATTENDEES:

The most popular zero carbon actions and goals for municipalites are:

› Lower carbon municipal buildings
› Education efforts
› Building energy disclosure

The Stretch Code and Base Code are extremely important to many municipalities. **Creating a strong base code with an opt-in stretch code will allow them to set targets and begin working towards them.**

It is essential to shift away from fossil fuels **by reducing dependency on them, stopping the creation of new infrastructure, and changing the definition of "luxury" appliances.**

The most popular short-term (0-3 years) policies include:

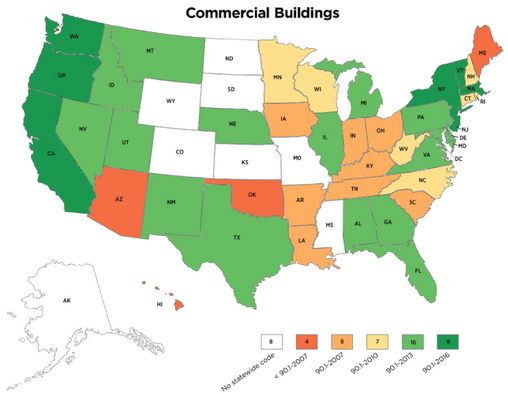
› adopt net zero ordinances
› retrofit incentive programs
› low carbon concrete procurement
› stop expanding gas delivery system and plan for deliberate electrification

Time. It's taking too long. **Massachusetts is ready to take on Zero Carbon policies. There is overwhelming support for the Stretch Code, and just about every supporter feels the same way: that the creation process is too long.**

The current lack of the Net Zero Stretch Code is making it difficult for communities to keep pushing forwards.

OVERVIEW - NET ZERO CODES

Across the United States



National
- IECC 2021
- ZNE Appendix
- IECC 2030/ASHRAE
- 90.1-2031 = Approaching ZNE

Seattle
- Energy Code approaching Net Zero

California
- Title 24-2019 - near Residential NZE
- Zero Code - proposed Commercial

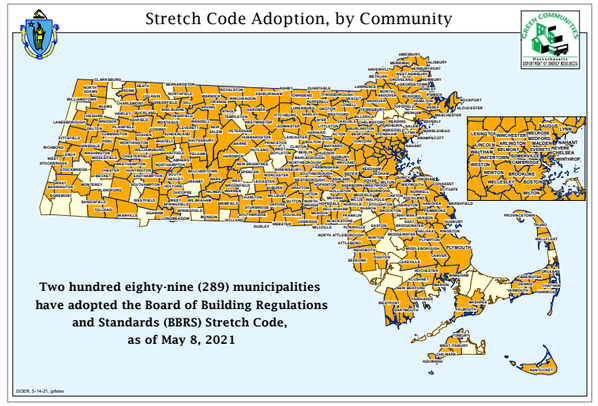
Washington, D.C.
- Appendix Z - voluntary compliance path

Across the country, there is a shift towards more efficient energy codes for buildings, some of which are moving towards Net Zero.

Figure 03

Breakdown of energy codes for commercial buildings by state.
Source: Office of Energy Efficiency and Renewable Energy

Massachusetts



Boston
- CO2 Neutral Zoning Ordinance for new buildings

Cambridge
- 2030 Climate Plan

Somerville
- Zoning Ordinance requiring Net Zero for most large buildings

Brookline
- Second Electrification Ordinance mandating no gas infrastructure

An updated Stretch Code will be published by early 2022, and municipalities will choose whether or not to adopt it.

Municipal leaders from towns that represent 40% of the MA population signed a Net Zero Stretch Code Support Letter. This support letter stated that they needed this code as a tool to establish more efficient energy codes in their municipalities.

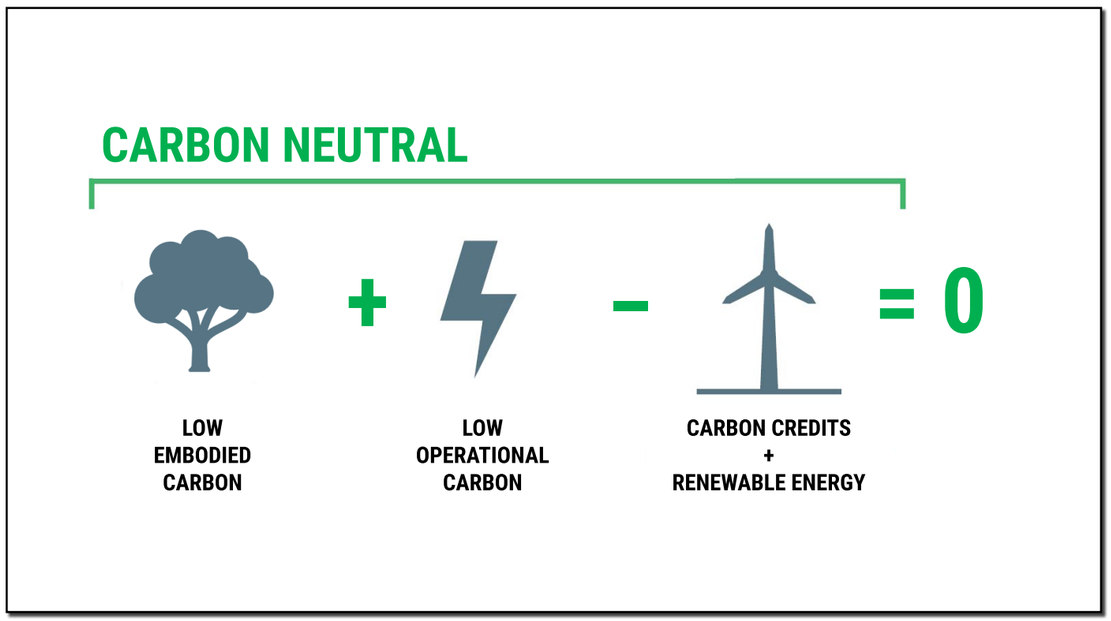
The Net Zero Strech Code may not be enough. Municipalities will need to take actions on their own to support the transition.

Figure 04

Breakdown of stretch code adoption by municipality in MA.
Source: Massachusetts Department of Energy Resources

OVERVIEW - WHAT IS NET ZERO?

Simple Equation



There are many definitions for Net Zero.

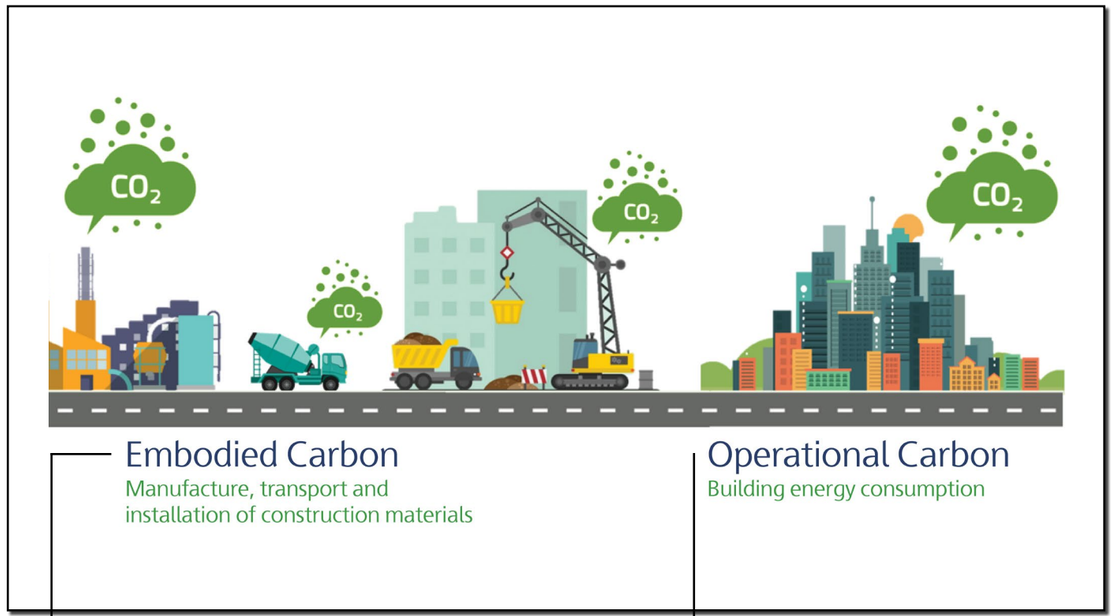
The first step in moving towards Zero Carbon Buildings is to define what this actually means. For a building to be Net Zero Carbon, it must be built with low embodied carbon materials. It must also operate in an energy efficient way. The energy that is used in the building should come from renewable energy sources. Finally, all carbon emissions must be offset with carbon credits.

Figure 05

Definition of Carbon Neutral Buildings

Source: Built Environment Plus

Equation Components



Material Selection and Procurement

- Regional extraction/manufacture
- Less resources used to manufacture
- Industrial best practices for reuse/recycle
- High quality offsets

+ Building Performance

- High-performance envelope
- Efficient, electric systems
- Renewable energy, including high quality offsets

– Renewable Energy

- 100% of Building's Annual Energy Consumption
- Primary: On-Site Renewables
- Supplement: Off-Site Renewable Energy

= Carbon Neutral

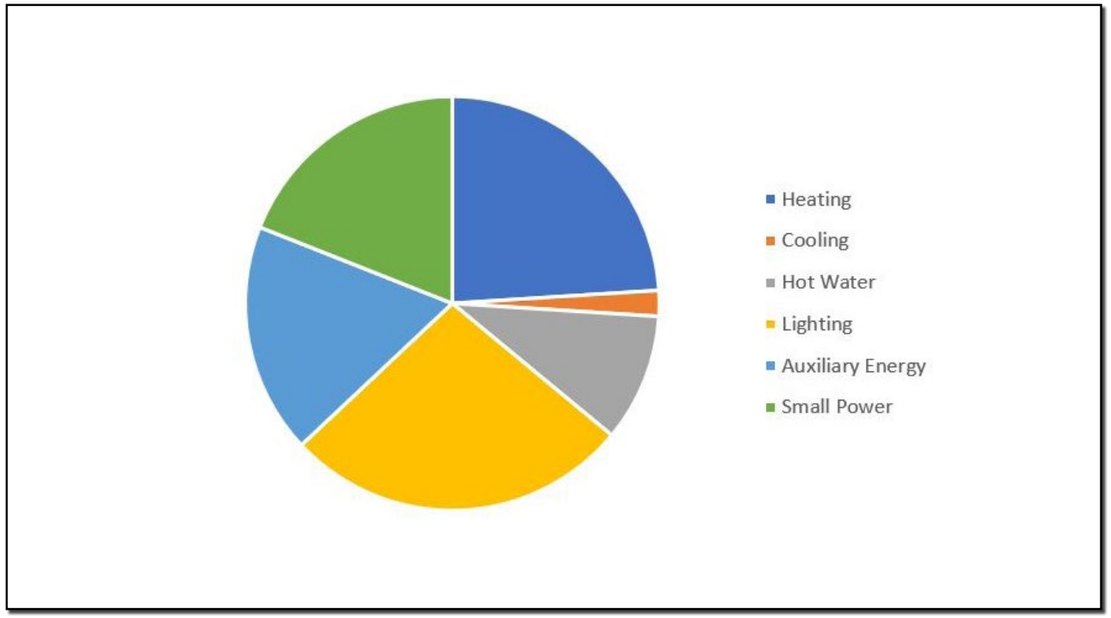
Figure 06 (Box Above)

Illustration depicting differences between embodied and operational carbon.

Source: Skanska

OPERATIONAL CARBON

Breakdown



Close to one third of operational carbon emissions are a result of the heating and cooling of buildings and water. As a result, many of the primary interventions to reduce buildings' carbon emissions revolve around minimizing the energy required for this process.

This can be done in three primary ways, which are explained on the following page.

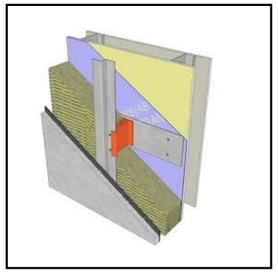
Figure 07

Breakdown of Operational Carbon Sources

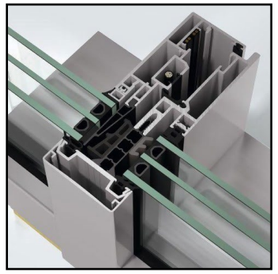
Source: Buro Happold

What is needed to reduce it?

1. Better Building Envelope



Thermally broken and highly insulated envelope



Triple glazing and high performance frame windows

Figure 08 (Left)

Highly insulated building envelope

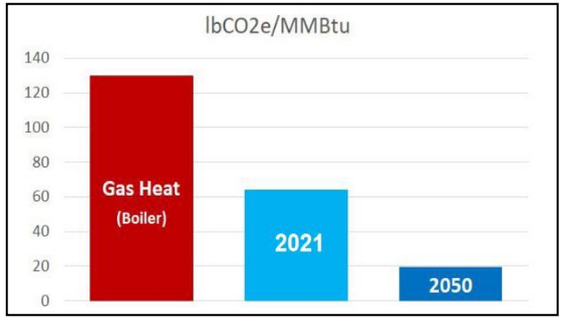
Source: Rockwool

Figure 09 (Right)

Triple-paned windows

Source: Schüco

2. Use Electric Heat Pumps



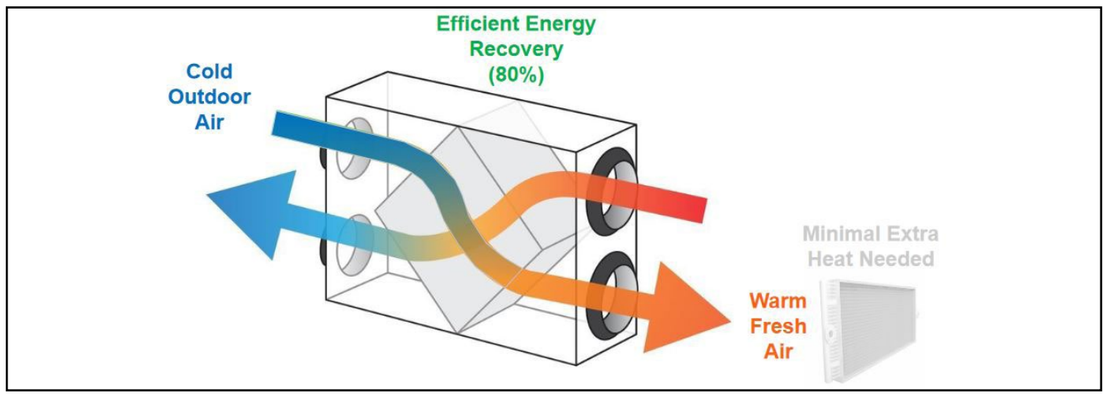
Ground-source or air-source heat pumps

Figure 10 (Middle)

Effect of switching to electric heat using MA electric grid

Source: BR+A

3. Use Heat Recovery Systems



Efficient heat recovery systems

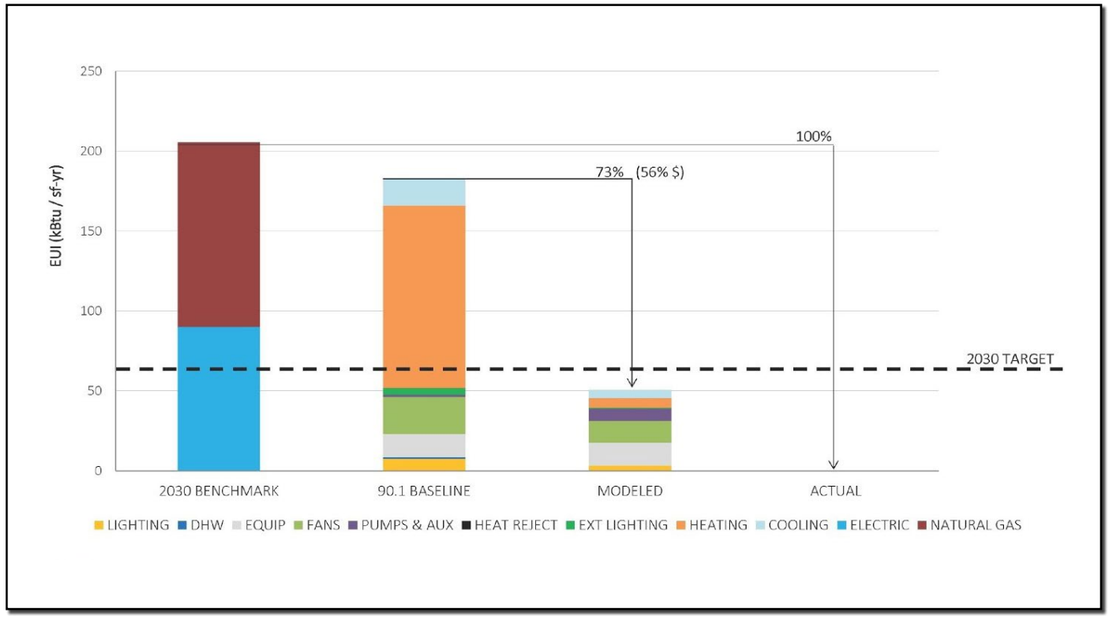
Figure 11 (Bottom)

Heat recovery system with 80% energy recovery

Source: RadonMarket

OPERATIONAL CARBON CASE STUDIES

Bristol Community College Sbrega Building



The Bristol Community College Sbrega Building is a 50,000 SF medical education and lab building. Originally, it was planned as a non net-zero design. However, the building was redesigned to be all-electric and to have a 70% reduction in energy consumption. This included a large solar array was installed to provide power to the building.

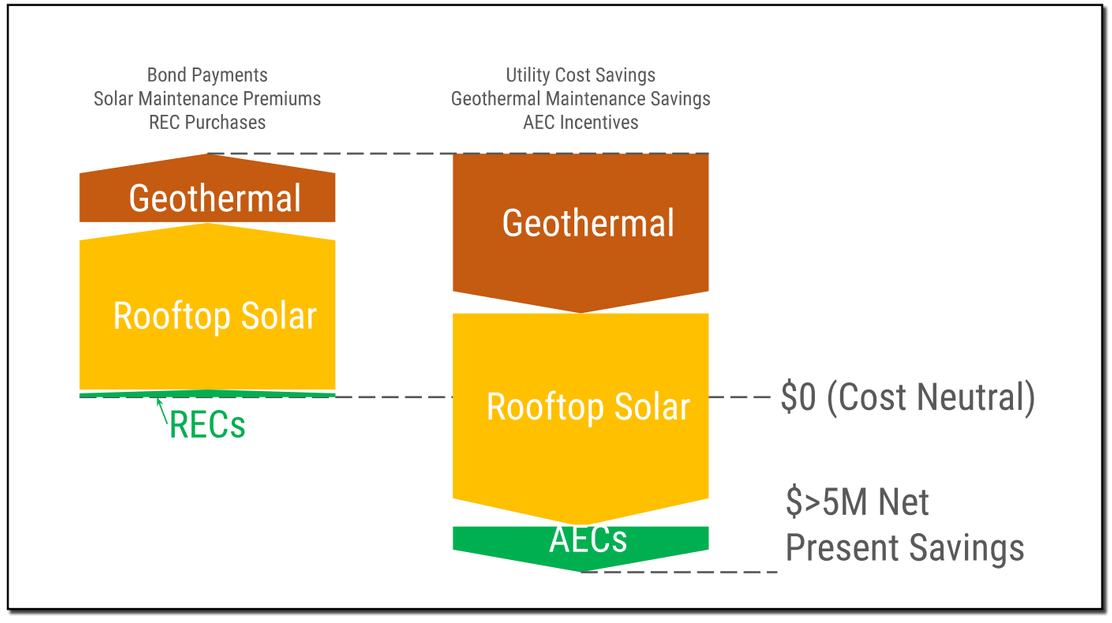
Overall, there was less than a 1% increase in construction cost for this building. It now saves $230,000 per year in operational costs, which is equal to 50 students' tuition.

Figure 12

Energy consumption reduction after re-design of Sbrega Building

Source: BR+A

Belmont Middle and High School



Belmont Middle and High School is a 400,000 SF school building. The construction of this building was funded by bonds, resulting in no higher upfront costs and only a small increase in bond payments.

Throughout the use of the building, there has been a large decrease in operational costs, primarily through utilities. As a result, the building has now generated more than $5M net present savings.

Figure 13

Utility and net savings resulting from addition of geothermal, rooftop solar, and AECs on school building.

Source: BR+A

EMBODIED CARBON

Breakdown

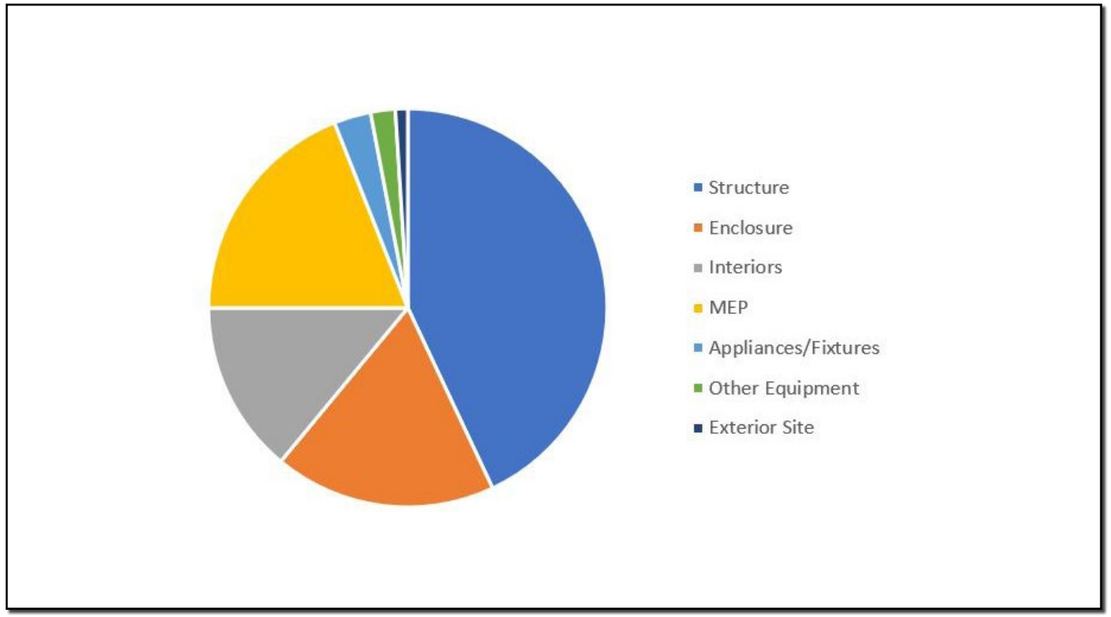


Figure 14

Breakdown of Embodied Carbon Sources

Source: Buro Happold

A building's embodied carbon is directly related to the materials that go into it. These make up the building's structure, enclosure, and insulation. New technologies are allowing for the development of new materials that have low or negative embodied carbon. This number accounts for the material extraction, manufacturing, and transportation.

Concrete and steel, which are used in the structure of many larger buildings, These both have high embodied carbon.

Additionally, selecting newer MEP systems that use next-generation technologies will greatly reduce carbon emissions as well as other harmful gases.

What is needed to reduce it?

1. Building Structure

Move away from concrete and steel

Increase use of wood and timber

Figure 15 (Left)

Building structure made primarily of steel and concrete

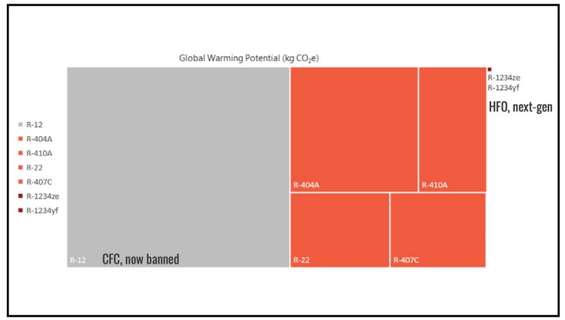
Source: Buro Happold

Figure 16 (Right)

Building structure made primarily of concrete and timber

Source: Buro Happold

2. Mechanical, Electrical, and Plumbing Systems



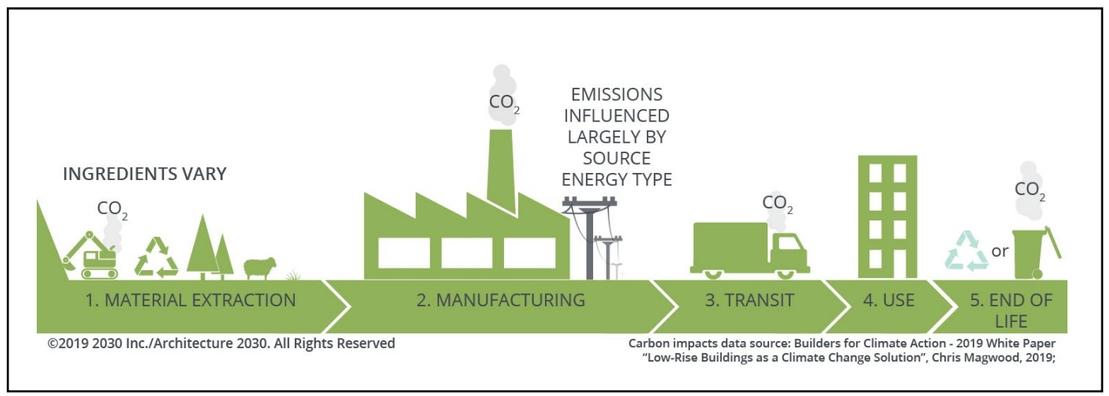
Shift towards next-generation (HFOs and HFO blends) refrigerants

Figure 17 (Middle)

Global warming potential of CFC, transition, and next-generation refridgerants

Source: Buro Happold

3. Enclosure and Insulation



Account for material procurement, manufacturing, and transportation process

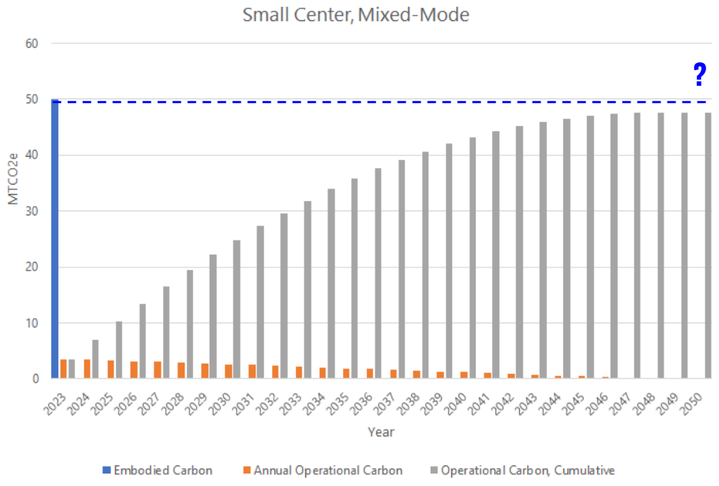
Figure 18 (Bottom)

Considerations in material selection process

Source: Architecture 2030

EMBODIED CARBON CASE STUDIES

Small Education Center



This graph represents the embodied and operational carbon emissions for a small 2,600 SF, 2-story education center. Several actions were taken to reduce the embodied carbon of this building. It was supported by a FSC timber structure and insulated with mineral wool. Additionally, it has less aluminum extrusion profiles and uses CarbonCure concrete with maximum SCMs.

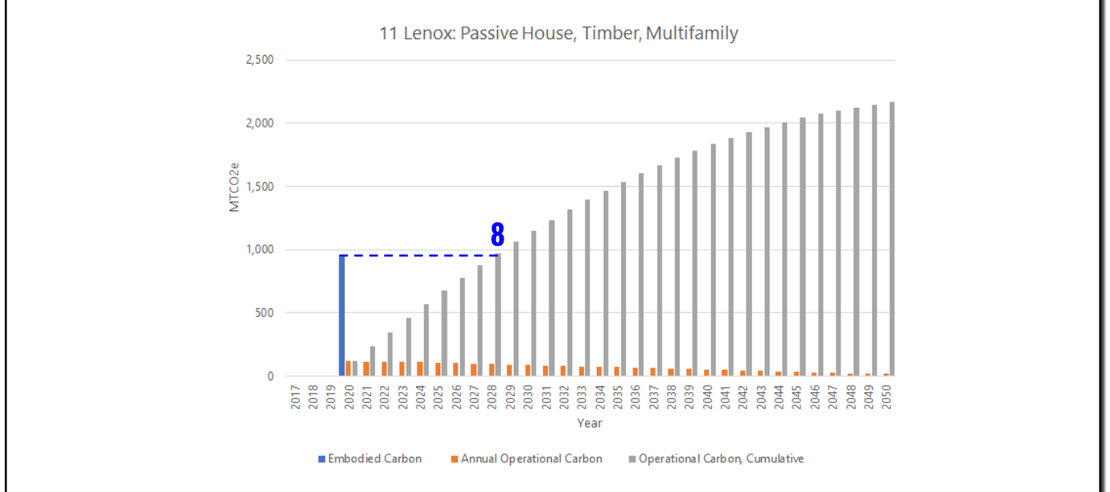
This building was designed for disassembly and is an ILFI Zero Carbon building.

Figure 19

Embodied, annual operational, and total operational carbon emmissions for a small educational center

Source: Buro Happold

11 Lenox Street, Boston



11 Lenox Street in Boston is a 37.500 SF, 7-story multi family building. Similarly to the educational center, it is supported by a FSC timber structure. It is also built with glulam posts and beams and CLT floors. The insulation is made of lightweight recycled material, and the concrete cores are prefabricated and modular.

The total cost for this building was $14M. In addition to these embodied carbon reductions, it was also built to Passive House (PHIUS) standard.

Figure 20

Embodied, annual operational, and total operational carbon emissions for 11 Lenox Street, Boston

Source: Buro Happold

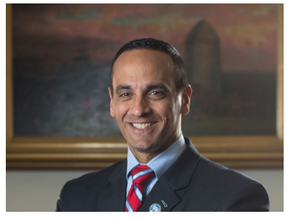
COMMUNITY INPUT

Panel Discussion

Panelists from three MA towns discussed the actions being taken by their communities to work towards Zero Carbon Buildings.

On pages 22 & 23 we provide a summary of what was shared by each of the panelists. They provided attendees with some insight into what their current steps are. This not only inspired everyone, but also proved that taking steps towards ZCBs is possible today in Massachusetts.

Panelist



Joseph Curtatone
Mayor of Somerville

As Mayor of Somerville, Joseph Curtatone has implemented a wide range of reforms and new programs that have earned the city many distinctions by regional and national organizations, including "the best-run city in Massachusetts" (The Boston Globe) and the designation as one of the 15 most influential cities in the U.S (Boston University study). Under his leadership, the transformational and Smart Growth development of the Assembly Square neighborhood has become one of the most exciting mixed-use projects on the east coast, and forward-looking investments in the city's pedestrian and bicycle infrastructure has earned the City status as one of the most walkable and bike-able cities in the nation.

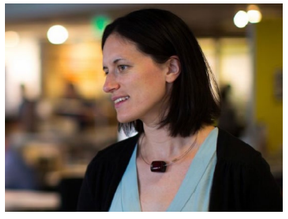
A vocal advocate for sustainable transportation, Mayor Curtatone brokered the construction of the first new MBTA subway stop in a quarter century and also worked with MassDOT and the MBTA to save the Green Line Extension project, which will bring 7 more new T stops. Recent initiatives include an aggressive and multi-pronged plan to increase housing affordability, regional leadership on Climate Change and the Somerville Climate Forward Plan to achieve carbon neutrality by 2050, and numerous supports and unwavering advocacy for immigrant residents. Mayor Curtatone is the Chairperson of the Metropolitan Mayors Association and past president of the Massachusetts Mayors' Association.

Panelist

Stephanie Ciccarello
Sustainability Coordinator for Amherst

As Sustainability Coordinator for the Town of Amherst, Stephanie Ciccarello has worked for over two decades addressing municipal energy efficiency, regional climate change and carbon emissions, alternative transportation and food security. She was the staff liaison for one of the state's more successful Solarize Mass campaigns, co-founder of Grow Food Amherst, is a founding member of the Valleybike regional bikeshare program as well as a current member of the state's Green Communities Advisory Committee.

Panelist



Andrea Love
Net Zero Task Force Member in Cambridge

Andrea Love is a Principal and the Director of Building Science at Payette, a member of the Cambridge Net Zero Task Force, and serves on the board of the Boston Society for Architecture. As a Building Scientist, Andrea's interests are in pushing the performance and minimizing the environmental impact of her projects. She also enjoys building the firm's knowledge and intuition about sustainability through research endeavors and project explorations.

At Payette, Andrea works across projects to bring rigor to the performance of projects. She integrates performance modeling tools into Payette's design process at the very beginning to inform and push designs. Additionally, she leads a number of internal research projects, and was the Principal Investigator on the 2012 AIA Upjohn Research Initiative-funded "Thermal Performance of Facades," a research project focused on thermal bridging. She also leads the firm's efforts on the AIA 2030 Commitment, tracking and benchmarking the performance of projects across the firm.

COMMUNITY INPUT

Actions

Each of these communities are taking different steps, but there is some overlap in their actions. All of them have or are creating a Climate Action or Net Zero Plan to outline their sustainability plans.

Governments in Somerville and Amherst are pushing for the MA Net Zero Stretch Code to be created and are hoping to adopt it in their municipalities. All new municipal buildings will be Net Zero in Amherst and Cambridge, while a 2019 City-Wide Zoning Ordinance in Somerville mandates that all new lab-buildings be fossil-fuel free.

Cambridge is unique because it has a strong focus on Embodied Carbon in buildings, while many other communities, including Somerville and Amherst, have yet to include these considerations into their plans and primarily have legislation targeting Operational Carbon.

Joseph Curtatone

Somerville

SomerVision

- Carbon neutral by 2050
- Community-based Climate Action Plan
- Carbon neutral buildings

Pushing for MA Net-Zero Code

City-Wide Zoning Ordinance (2019)

- Strong incentives for Net-Zero buildings
- All non-lab buildings fossil-fuel free
- LEED Platinum lab buildings
- Residential buildings built to Passive House standards

Green Lab Buildings

- Attract lab buildings to Somerville
- Small cost premium compared to building cost
- Operational cost reductions

Stephanie Ciccarello

Amherst

Net Zero Building Bylaw (2017)

- New municipal construction over $2 million must be Net Zero capable
- Renewable energy as primary energy source
- Fossil fuels can be used as backup energy source
- Focus on operational carbon

Pushing for MA Net-Zero Code

Planning for New Municipal Buildings

- School: Coordinating with utilities company throughout process
- DPW
- Fire department

Energy and Climate Action Committee

- Creating Climate Action Adaptation and Resiliency Plan
- Pushing for Net-Zero construction

RMI Electrification Accelerator

Andrea Love

Cambridge

Citizen Petition for Net-Zero Buildings (2013)

- Led to creation of task force to develop action plan

Net-Zero Action Plan

- 15-20 action items touching on existing buildings, new buildings, and the energy supply
- 2015 - all new municipal buildings will work towards Net Zero
- 2030 - all lab buildings will work towards Net Zero

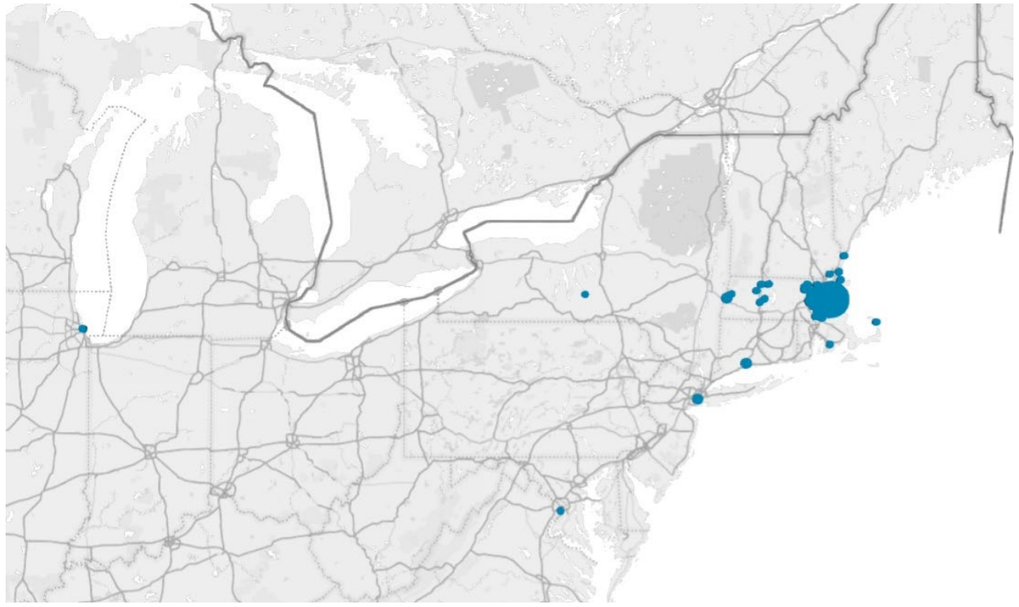
Embodied Carbon in Future Proposals (2020)

- Short-term (1-3 years)
  - » Quantification of embodied carbon for all new projects
  - » Educational materials
  - » Technology assessments
  - » Policies to prioritize reuse of existing building structures
  - » Peer learning with other municipalities
- Mid-term (3-5 years)
  - » Whole building life cycle assessments
  - » 20% reduction in embodied carbon for new projects
- Long-term (5+ years)
  - » 50% reduction in embodied carbon for new projects
  - » Development of future goals

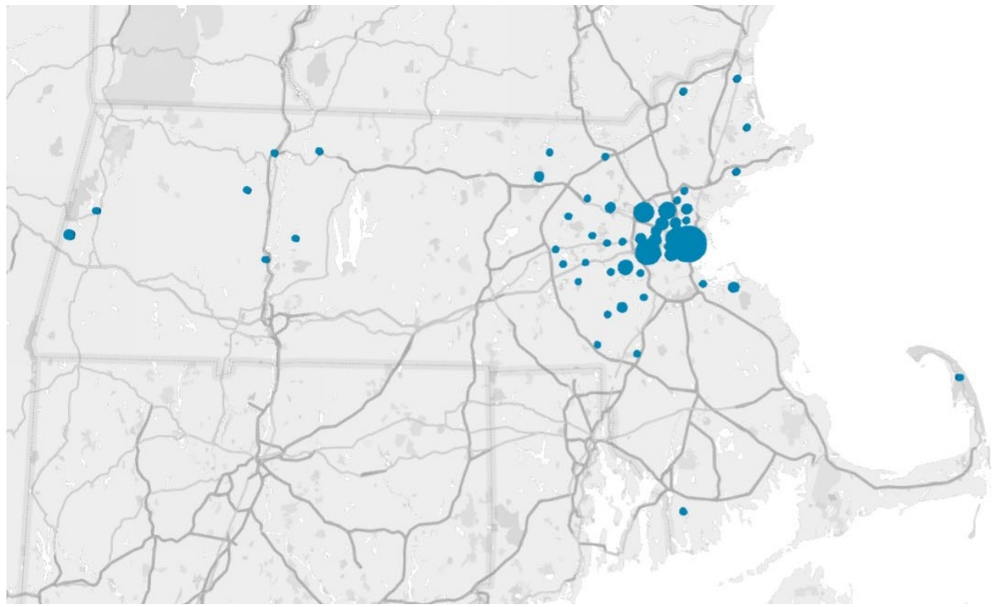
WHERE ATTENDEES ARE FROM

Attendees Mapped

131 people from Massachusetts and 6 other locations attended the event



54 Massachusetts towns were represented



Massachusetts Towns

Acton	1
Allston	1
Amherst	1
Arlington	3
Ashland	1
Belmont	2
Beverly	1
Boston	23
Brookline	3
Cambridge	7
Chelmsford	1
Chestnut Hill	1
Concord	2
Conway	1
Devens	2
Erving	1
Foxboro	1
Framingham	1
Franklin	1
Greenfield	1
Groton	1
Haverhill	1
Hingham	2
Ipswich	1
Lexington	7
Malden	1
Marlborough	1
Medfield	2
Medford	2
Melrose	2
Millis	1
Natick	1
Needham	1
Newburyport	1
Newton	11
Northampton	1
Pittsfield	1
Quincy	1
Richmond	2
Somerville	4
Southborough	1
Stoneham	1
Stow	1
Sudbury	1
Truro	1
Wakefield	1
Waltham	2
Watertown	3
Wayland	1
Wellesley	4
Weston	1
Westport	1
Westwood	1
Winchester	5

Non-Massachusetts Locations

New York City	2
Chicago	1
Alexandria	1
New Haven	2
Ithaca	1
Portsmouth	1

In total,

123 people from 54 MA municipalities

and

8 from 5 other states

attended the event.

COMMUNITY INPUT

Breakout Sessions and Miro Board

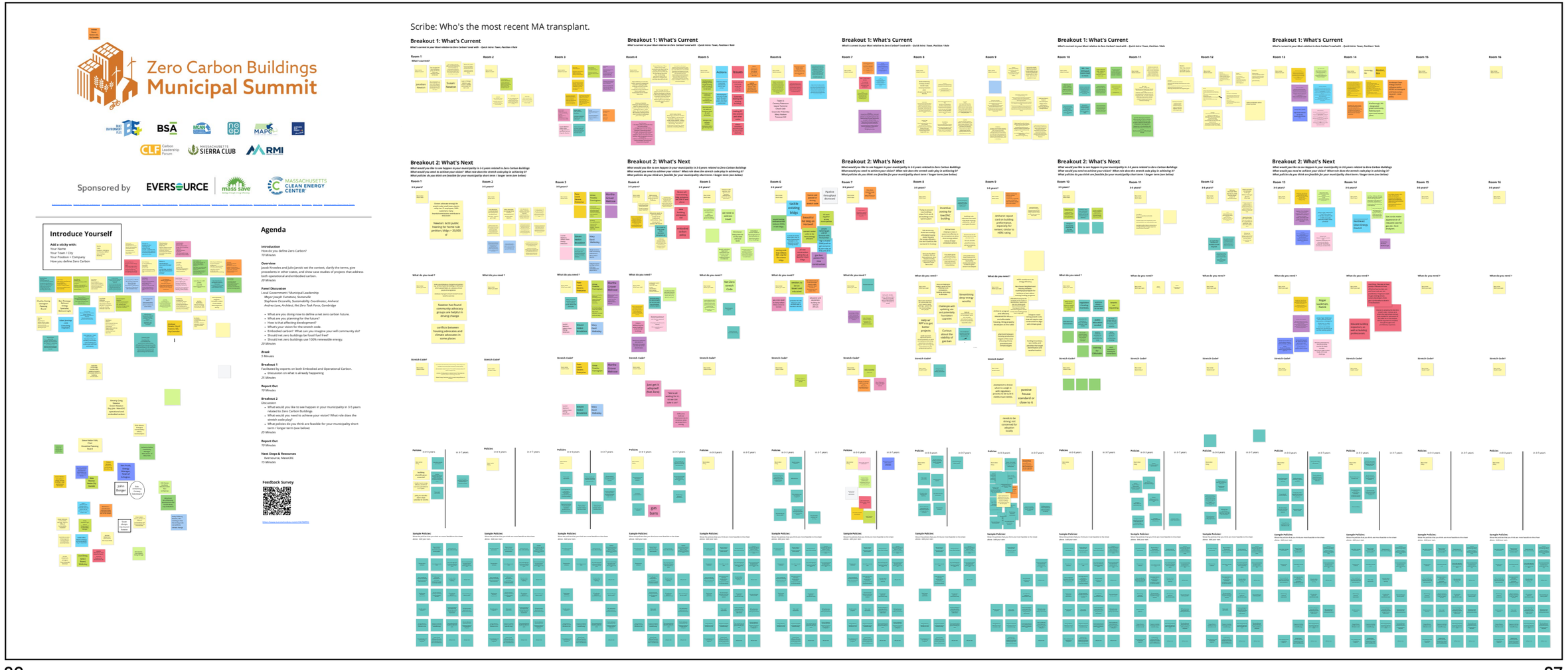
Following the panel discussion, event attendees split off into breakout rooms to discuss the work being done in their communities. They talked about their current actions and goals and what they need to achieve them, selected policies that they believe are feasible for implementation in the coming years, and provided input on the MA Net Zero Stretch Code.

These responses were recorded by a designated scribe into a Miro Board. The board also has information for participants, including the agenda and additional resources.

Post- Event Analysis

After the event, Built Environment Plus organized and analyzed all responses. This analysis allowed us to determine what the most common current actions and goals are, the greatest barriers to ZCBs, and what policies and regulations have the potential to pop up around MA in the coming few years.

It is important to note that all of the responses and analysis included in the following pages is based only on attendees' responses. Since municipal staff, committee members, elected officials, and concerned citizens were invited to this event, it is possible that the information they had to share was not the most up-to-date. If you would like detailed information on what is being done in a municipality, be sure to consult their website and contact relevant community members.



CURRENT ZCB ACTIONS AND GOALS BY PLACE

What's currently happening in your municipality related to Zero Carbon? What would you like to see happen in 3-5 years?

During the first breakout session, we asked attendees to describe the actions taken and goals set by their municipalities. We received responses from all of the communities listed on the right. Attendees from the cities on the right outlined actions taken and goals set by their municipalities. Note that these represent an individual's knowledge, and may not be factual. Although not all of the responses were identical, we were able to organize them into the 20 categories that are listed on the following page.

This graphic is organized by color into seven major themes:

New Buildings | Existing Buildings | Codes & Policies | Education & Resources | Costs & Incentives | Equity | Other

Key Takeaways

According to attendees, Newton, Arlington, and Lexington have done and are continuing to do a lot of work related to Zero Carbon.

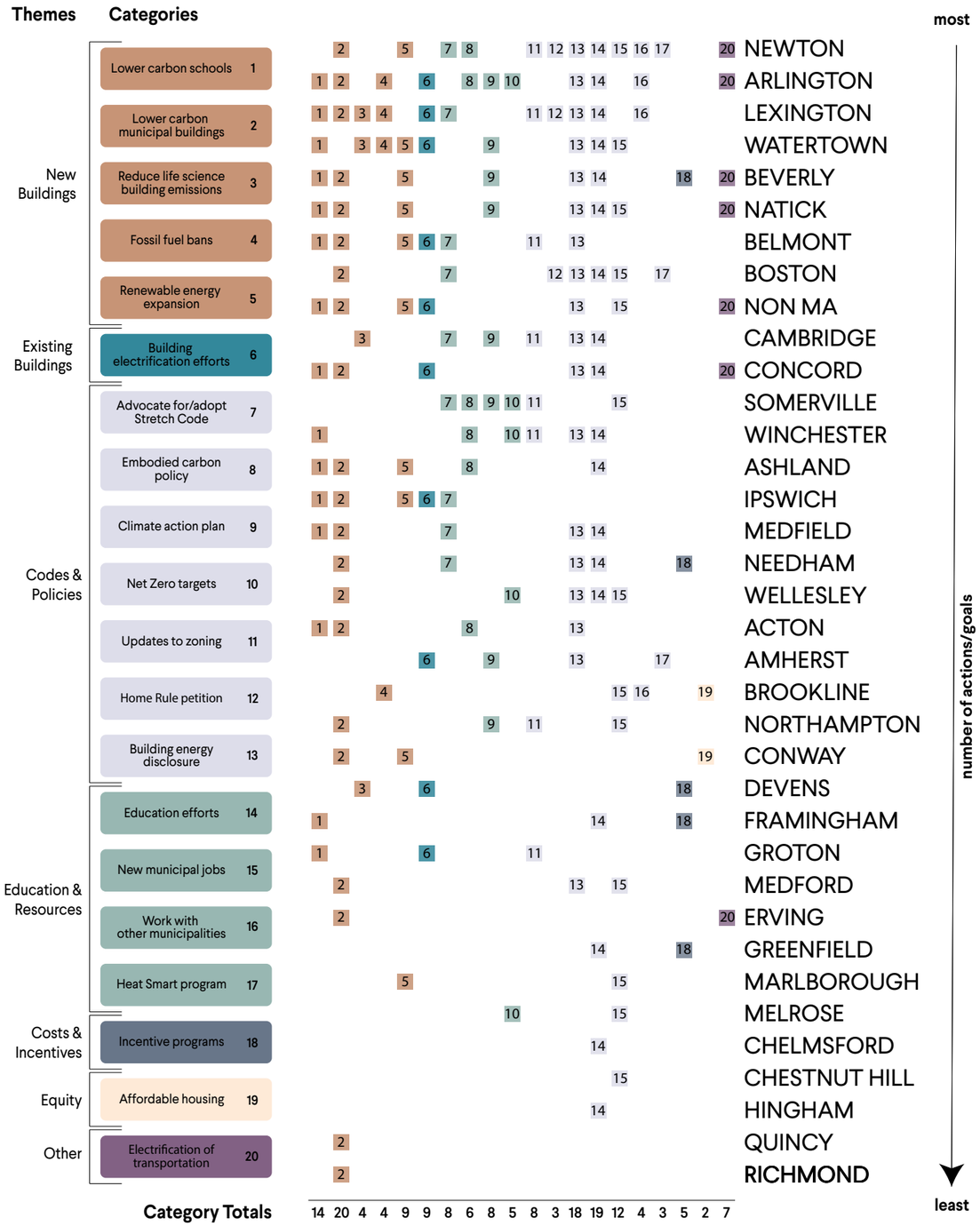
The most popular actions and goals are:

- **Lower carbon municipal buildings**
- **Education efforts**
- **Building energy disclosure**

Two other actions that have a lot of attention on them are lower carbon schools and new municipal jobs related to Zero Carbon.

Attendees were less aware of embodied carbon policy and affordable housing that meets lower or zero carbon standards.

CURRENT ZERO CARBON BUILDING ACTIONS/GOALS SHARED BY ATTENDEES



The data shown reflects the knowledge of the individuals in attendance of the Built Environment Plus Zero Carbon Buildings Municipal Summit held on June 11th, 2021, and may not accurately represent the correct or comprehensive intended actions / goals of the given represented place.

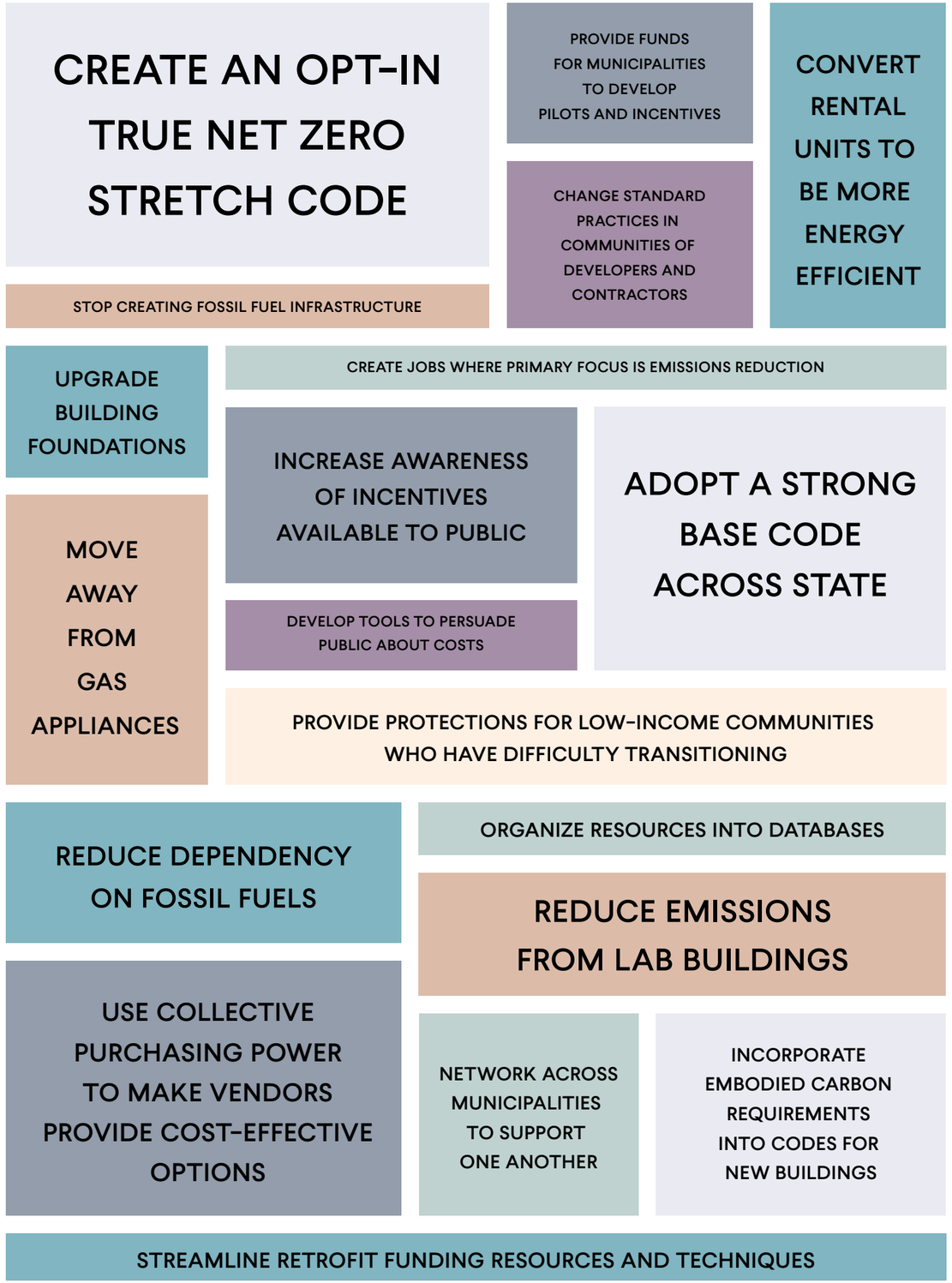
MUNICIPAL NEEDS

What is needed in your municipality in order to achieve ZCBs?

We also asked attendees to describe their most pressing needs. This not only allows for networking between communities who have similar needs, but also for us to continue to develop resources and programming to meet these needs. We sorted and organized these needs to create the graphic to the right. Needs with larger fonts correspond to those that were expressed more frequently.

This graphic is organized by color into the same seven major themes as the current actions and goals graphic on the previous page:

New Buildings | Existing Buildings | Codes & Policies | Education & Resources | Costs & Incentives | Equity | Other



Key Takeaways

The Stretch Code and Base Code are extremely important to many municipalities. Creating a strong base code with an opt-in stretch code will allow them to set targets and begin working towards them.

Nobody wants to go through this process alone. **Municipalities are relying on each other and the Commonwealth of Massachusetts** to help throughout this transition process. Everybody would like:

- **Databases of resources** for municipal leaders, industry professionals, and community members.
- To know that adopting **strong policies will not push development into neighboring cities and towns.**

It is essential to shift away from fossil fuels by reducing dependency on them, stopping the creation of new infrastructure, and changing the definition of "luxury" appliances.

ZERO CARBON BUILDING POLICIES

What policies are feasible for implementation in the coming years?

During the second breakout session, we wanted to gain some more insight into policies that attendees believed could be implemented in the next few years. We provided them with 26 sample policies that covered a large array of operational and embodied carbon topics and also gave them the option to define their own policies. We asked each breakout room to place policies into a 0-3 years or 3-7 years category if they believed they could be achieved in that time frame. On the right, we tallied up the number of times each of these policies was put into one of the two time frames. For every policy, each bar represents one time that it was placed into the 0-3 years (dark blue) or 3-7 years (light purple) section on the Miro Board.

Following the event, we grouped these policies by main idea. Some of these overlap with the themes on the current actions/goals and needs graphics, while others differ slightly.

Key Takeaways

The most popular short-term (0-3 years) policies include:

› adopt net zero ordinances

› retrofit incentive programs

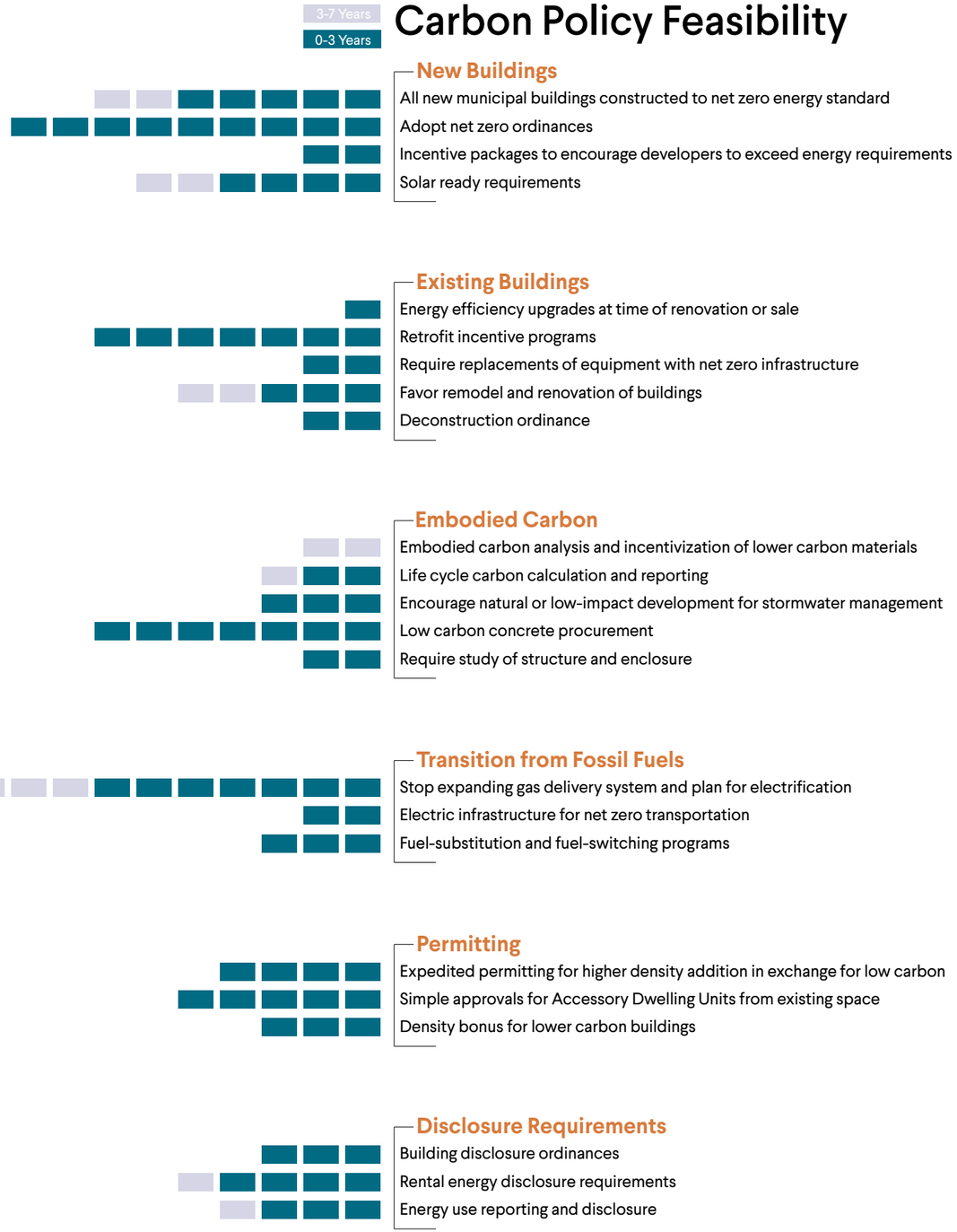
› low carbon concrete procurement

› stop expanding gas delivery system and plan for deliberate electrification

Overall, attendees had an easier time defining policies for the coming three years than for the years after that.

Policies that fall into the New Buildings main idea received the most attention from attendees and were chosen as the most feasible in both the short and mid-term.

Attendees believe that it is extremely important to implement policies related to a community-wide transition away from fossil fuels by stopping expansion of the gas delivery system and preparing and planning for the electrification of buildings.



The data shown reflects the opinions of the individuals in attendance of the Built Environment Plus Zero Carbon Buildings Municipal Summit held on June 11th, 2021, and does not necessarily represent the formal opinion of their given represented place.

NET ZERO STRETCH CODE

What is your vision for the Stretch Code? What role does the Stretch Code play in defining and achieving your goals?

Another component of the second breakout session included asking attendees about the forthcoming municipal opt-in net-zero stretch code that will allow communities to address building sector emissions. We asked them what they wanted to have included in the code and how it could support them. Their comments are quoted on the right. We modified some of them for clarity.

Key Takeaways

Time. It's taking too long. **Massachusetts is ready to take on Zero Carbon policies. There is overwhelming support for the Stretch Code, and just about every supporter feels the same way: that the creation process is too long.**

The current lack of a Net Zero Stretch Code is making it difficult for communities to keep pushing forwards.

There are several topics and issues that supporters would like to see included:

- **Embodied carbon policy** and education/resources
- **Greenhouse gas performance benchmarks** and auditing requirements
- **Operational carbon policy** and reducing emissions from heating/cooling needs

Public officials need to be encouraged to adopt the Net Zero Stretch Code through the implementation of a statewide campaign.

As was already discussed in the needs section, many people feel that the Net Zero Stretch Code must be paired with additional resources to educate the public, industry, and municipal leaders about the importance of Zero Carbon Buildings.

It is **difficult to dedicate time and resources** to initiatives when we know the Stretch Code is coming.

It should be **Passive House standard** or close to it.

The **18-month process** for creating the new Stretch Code is **too long**.

The Stretch Code needs to help **reduce confusion** and be **paired with additional resources.**

Provide more public **information** on the positives of Net Zero to get **public support** for passing the Stretch Code.

Embodied carbon needs to be part of the update... **education about embodied carbon** needs to happen now!

It needs to make regulations state-wide to **address concerns of losing projects to adjacent towns** if a municipality is too restrictive.

We're all **waiting** for it so we can **take it on**!

Just get a **Net Zero Stretch Code** adopted!

It should include **GHG performance benchmarks** and **auditing requirements.**

Stretch code should be paired with **statewide campaign** so that public officials feel adopting it is 'just the right thing to do.'

RESOURCES

On the following pages, we provide many resources related to embodied and operational carbon that can be used to support the transition to Zero Carbon Buildings. We have curated this collection of resources from CLF, MassSave, and other organizations. We have separated them into six different sections by category:

1. Definitions/Background
2. Guides
3. Articles, Reports, and Events
4. Resources and Incentives
5. Policies
6. Tools

Additional resources can be found on the websites of our partner and sponsor organizations.

We recognize that these are constantly changing and this list just represents a snapshot of resources available at the time of the Municipal Summit. Please reach out to us if you would like specific resources.

Definitions/Background:

Embodied Carbon:

Embodied Carbon Definition
- BuildingGreen definition and associated articles

Environmental Product Declarations
- BuildingGreen feature article
- Describes the importance of and relevance of EPDs

Embodied Carbon in Buildings Facts and Figures
- Carbon Leadership Forum importance and statistics on embodied carbon

Operational Carbon:

Net Zero Buildings Informational Flyer
- Sierra Club MA definition of net zero buildings
- Explains how building codes work and the net zero stretch code

Energy Efficiency Definition
- BuildingGreen definition and associated articles

Both:

Life Cycle Assessment Definition
- BuildingGreen definition and associated articles

Embodied/Operational Carbon
- PennState presentation
- Highlights current research and tradeoffs

Architecture 2030 Zero Code Resources
- Database of information about the Zero Code
- Includes background information and additional resources

Guides:

Embodied Carbon:

Turning Buildings into Carbon Sinks
- Northeast Sustainable Energy Association presentation
- Explains how materials can have negative embodied CO2 emissions

High Impact Material Choices
- Building Green feature article
- Highlights eight high-impact product categories

BSA Embodied Carbon 101 Series
- Boston Society of Architecture 12-part series
- Provides AEC professionals with knowledge to immediately incorporate embodied carbon considerations

Concrete Embodied Carbon
- MIT Concrete Sustainability Hub embodied carbon of concrete
- Definitions, basics, news, research, and webinars

City Policy Framework for Dramatically Reducing Embodied Carbon
- Carbon Neutral Cities detailed local policies to reduce embodied carbon

Operational Carbon:

Best Practices for Achieving Zero Over Time for Building Portfolios
- Rocky Mountain Institute zero-over-time approach steps
- 48-page process guide with examples and a case study

Both:

Net Zero Carbon Buildings: Three Steps to Take Now
- ARUP resource for the road to zero
- 25-page guide on designing for new and existing net zero buildings

Articles, Reports, and Events:

Embodied Carbon:

The Secret Life of Materials
- Rocky Mountain Institute short intro article on carbon in materials

Reducing Embodied Carbon in Building Materials: How Local Governments Can Help
- NESEA event to describe policies and programs that local governments can implement

Building to Combat the Climate Crisis
- NESEA webinar on how leveraging embodied carbon of materials can be used to combat the climate crisis

The Urgency of Embodied Carbon and What You Can do About It
- BuildingGreen feature article
- Outlines assessing embodied carbon, optimizing structures, and enclosures

Structural Engineers Hold the Keys to Carbon Neutrality
- ARUP perspective article about challenges to industry-wide change

Importance of Embodied Carbon
- Shepley Bulfinch article about perspectives for architects and designers

Beyond Fly Ash: How to Optimize Your Concrete Structure to Reduce Embodied Impacts
- Tally Webinar on concrete use in buildings
- Minutes 28 and 34: things to avoid and questions to ask structural engineer

Re-framing Steel: How to Optimize Your Steel Structure to Reduce Embodied Impacts
- Tally Webinar on steel use in buildings
- Minute 26: description of specification with CO2 limits

Both:

Implementing Life Cycle Carbon Emissions Standards in Urban Development
- Rocky Mountain Institute article featuring examples from around the world

Net Zero Carbon Healthcare
- ARUP presentation/guide on challenges and approaches to net zero in healthcare

How can you reduce your carbon emissions?
- ARUP perspective on locating and reducing hidden carbon emissions

BE+ Net Zero Hub
- 2021 report on status and 2019 report on cost of Net Zero Buildings in MA

Resources and Incentives:

Embodied Carbon:

Carbon Leadership Forum
- Research, resources, and initiatives

Operational Carbon:

Zero Energy Commercial/Industrial Incentive
- Mass Save technical expertise and financial incentives for ZNE projects

Passive House Incentives
- Mass Save Passive House incentives

Whole Home ASHP Pilot
- Program providing rebates for installation of whole-home air-source heat pumps

Triple Decker Design Challenge
- Winning designs for replicable and scalable all-electric energy retrofit approaches for existing triple deckers

Triple Decker Retrofit Pilot
- Technocal support, incremental financial incentives, and performance monitoring for implementation of high-efficiency, all-electric retrofits of triple deckers

EmPower Massachusetts
- Initiative offering funding for exploration, development, and implementation of projects providing access to clean energy for underserved MA populations

Massachusetts RMI Resource Library
- Resources compiled by RMI building electrification accelerator program
- Includes legal and technical resources, campaign materials, communications tools, and presentation slides
- Contact Lisa Cunningham (linked email) for more information

Both:

Architecture 2030 Actions
- Provides actions for new and existing buildings to obtain zero carbon emissions

Policies:

Embodied Carbon:

Embodied Carbon Policy Toolkit
- Carbon Leadership Forum educational series and policy database

Zero Net Carbon Building Zoning
- Boston Planning and Development Agency presentation
- Minutes 13-32 summarizing the Embodied Carbon Policy Guidance

Operational Carbon:

Codes and Policies
- New Buildings Institute strategies, tools, and guides

Both:

Guidebook for Zero Emission Buildings
- City of Boston Department of Neighborhood Development
- Outlines key strategies and highlights multiple building types

Tools:

Embodied Carbon:

Embodied Carbon Tools: Assessing the Options
- BuildingGreen list of tools for various applications

Kaleidoscope Tool
- Payette tool to supplement whole-building LCA in early design phases

Beacon Methodology
- ARUP global carbon-reporting tool to identify carbon hotspots throughout an organisation's supply chain

Tally
- Autodesk Revit tool to calculate whole building LCA and compare designs and materials

EC3
- Building Transparency database of construction EPDs

BHoM LCA Toolkit
- Building and Habitats object Model collaborative computational development project

BEAM
- Builders for Climate Action estimator that provides material selection based on building dimensions

SE2050
- Structural Engineering Institute basic embodied carbon estimator

Athena
- Sustainable Materials Institute LCA software tools

Operational Carbon:

Ladybug/Honeybee
- Enables CAD interfaces to host environmental simulation engines

Design Explorer and Design Explorer Lite
- Parametric analysis viewers

THERM
- Heat flow modeling tool

Winter Comfort Tool
- Payette tool that displays the impact of glazing geometry and U-value on thermal comfort

Both:

Pathfinder
- Climate Positive Design carbon footprint offset timeline calculator

2Build or Not 2Build Carbon Calculator
- Zero Net Carbon Collaboration tool to compare building renovation and rebuilding

FIGURES