

The Boston Foundation

INAUGURAL BOSTON CLIMATE PROGRESS REPORT

Prepared for the Boston Foundation
By the Dukakis Center for Urban and Regional Policy at Northeastern University

NOVEMBER 2022

About the Boston Foundation

Founded in 1915, the Boston Foundation is one of the most influential community foundations in the country. Partnering with community members, donors, the public sector, businesses and nonprofits, we aim to repair past harms and build a more equitable future for our city and region. Supported by the Annual Campaign for Civic Leadership, we publish research into current critical issues, convene people in public forums to discuss the city's agenda and the region's trends—and use our shared knowledge to advocate for public policies that promote equity and opportunity for everyone. TBF is also one of New England's largest grantmakers, supporting nonprofits in Greater Boston through our endowment and working closely with our donors to support nonprofits locally, nationally and internationally.

About the Dukakis Center

The Kitty and Michael Dukakis Center for Urban and Regional Policy, housed in the School of Public Policy and Urban Affairs at Northeastern University, produces state-of-the-art applied research and seeks to influence the adoption of effective policies and practices based on that research. The Center's collaborative research and problem-solving model uses data analysis, multidisciplinary research and evaluation techniques, and a policy-driven perspective to address critical challenges facing urban areas. We integrate research and action in pursuit of social justice in Boston and other cities. The Center is a training ground for emerging practitioners and academicians.

Funding support for this report was provided by the Boston Green Ribbon Commission:

About the the Boston Green Ribbon Commission

The mission of the Green Ribbon Commission (GRC) is to accelerate the implementation of the City's Climate Action Plan by convening, organizing, and enabling leaders from Boston's key sectors. The City of Boston is committed to achieving net-zero carbon by 2050, climate equity, and climate resilience, even as the city grows. The GRC provides a forum for representatives of the private sector and the City to discuss, plan and act on the opportunities, challenges, ideas, and requirements of preparing Boston to meet the imperatives of climate change.

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INAUGURAL BOSTON CLIMATE PROGRESS REPORT

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Dear Reader,

A century of work improving lives and strengthening communities in the city has given the Boston Foundation a platform for civic leadership that we embrace as central to our role in the community and region. In that role, we are proud to partner with individuals and institutions seeking to effect positive change—from donors to nonprofits to policymakers and others who care deeply about our common future. And nothing is more common to our shared existence than our environment and the climate affecting it.

While climate work has not been a priority of the Foundation, time and tides, literally, have brought climate challenges and their inherent equity issues into sharper focus, demanding our attention. The City of Boston, a national leader on this issue, has approached it from several angles, with admirable rigor and ambitious goals. Yet the odds of reaching these goals are long. What is holding us back? That is what this report explores.

The creation of this *Inaugural Climate Progress Report* was a journey. The concept evolved through discussion with our partners at the Green Ribbon Commission over several years—and three mayoral administrations. Two years ago, we formed an exploratory committee with academic and policy experts to define the project and issue a request for proposals. The research team undertook the thorough examination of a massive, overlapping, and sometimes amorphous array of data and sources—and in the midst of writing had to recalibrate to encompass the passage of major new federal and state climate legislation.

The resulting report largely tracks Boston's progress toward its stated climate-related goals, but we all know climate honors no city limits. The City has done a lot and can do more, but work must proceed at all levels to combat the numerous systemic barriers to progress identified in these pages. This report looks at how our community can support and expand the City's efforts and bring more institutions and individuals into the fold to accelerate the climate agenda and to track a course to a safe and just future. It will require an all-hands-on-deck approach, one that centers equity, and involves participants at every level in many roles, from household and community to industry and government. And—with a mayor elected on a platform emphasizing a Green New Deal for Boston—the time is now.



M. Lee Pelton, President and CEO
The Boston Foundation

TABLE OF CONTENTS

List of Abbreviations	8
Overview of the Report	11
Progress on Goals.....	31
Progress on Outcomes	57
Boston's Big Lifts.....	85
Conclusion	133
Acknowledgments.....	139
References	143

LIST OF ABBREVIATIONS

ABCD	Action for Boston Community Development
ARPA	American Rescue Plan Act of 2021
BCCE	Boston Community Choice Electricity
BERDO	Building Emissions Reduction and Disclosure Ordinance
BPDA	Boston Planning and Development Agency
CDR	Carbon Dioxide Removal
CRB	Climate Ready Boston
DOER	Department of Energy Resources (Mass)
DPA	Designated Port Area
DPU	Department of Public Utilities
EV	Electric Vehicle
GRC	Green Ribbon Commission
IRA	Inflation Reduction Act of 2022
ISO-NE	Independent System Operator-New England
MassCEC	Massachusetts Clean Energy Center

Additional Notes:

"the city" vs "the City"	While encompassing a global challenge and often referencing our region as a whole, this report focuses on Boston. We use upper and lower case letters to differentiate between the city as a geographic and social entity and the City (short for City of Boston) as a political and governance entity.
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The background of the slide features a dark gray or black surface with a complex pattern of thin, light-colored contour lines. These lines represent elevation changes, creating a topographic map effect. Scattered across the surface are numerous small, isolated white circles of varying sizes, some with internal dots, resembling data points or stars.

01

OVERVIEW OF THE REPORT

EXECUTIVE SUMMARY

Climate change is upon us now.



We see it in the flooding of our streets on a regular basis, feel it with summer temperatures in the 90s for days on end and drought that encompasses most of the Commonwealth. The scientific consensus is that it is caused by the warming of our planet due to rising greenhouse gas emissions from burning the fossil fuels that drive our economy.

Over the past decade the city's collective efforts on climate change have been substantial and should be celebrated. Yet Boston cannot achieve its goals of net zero emissions, resilience, and increased equity through climate action while moving at the present pace. Goals are not abstract numbers—people's lives and health are threatened by current conditions, with the most economically vulnerable among us at greatest risk.

Boston has elected a new mayor, Michelle Wu, who achieved a landslide victory in a historic campaign, largely based on her Green New Deal for Boston. It presents the city with a vision to address the challenge of the climate crisis while creating a more sustainable, healthy, and equitable city. Now is the time to act boldly.

Accelerating the climate agenda will require all hands on deck—city, state, and federal government; utilities; businesses; various community organizations; and residents.

We are all in this together and solutions require us all to participate in building a pathway to a climate-just future.

Reducing emissions will require nearly eliminating fossil fuels in our buildings and vehicles, improving and increasing public transit use, and massively reducing the amount of waste we produce. Making our city resilient to future climate shocks will require unprecedented investment in protecting our coastal areas, managing stormwater, and protecting all residents from extreme heat. These investments can dramatically improve the quality of life for our region's residents, providing us with cleaner air, lower energy bills, more comfortable homes, more green space, more affordable and convenient transportation options, and more equitable access to the waterfront. We must make these investments in a way that promotes greater racial equality and provides opportunities for residents of frontline communities that have borne the brunt of past discrimination and environmental harm.

We identified four areas in which we need “big lifts” to achieve these outcomes. These big lifts are actions that are essential to achieving aggressive climate goals. They require systemic transformations driven by funding, state and city legislation, increased staff capacity at City Hall, coordination among community organizations, metrics and accountability frameworks, leadership by the private sector, and guiding support of citizens.

This report identifies four BIG LIFTS necessary to accelerate climate progress:

- ▶ Retrofitting the Small Building Stock
- ▶ Local Energy Planning for an Electrified City
- ▶ Building a Resilient Coastline Through Improved Governance
- ▶ Prioritizing Reparative Planning for Boston’s Frontline Neighborhoods

It sounds daunting, but Boston has an opportunity to be a leader—in the state and nation—by mobilizing its entire community: the private sector; cultural, education, and other nonprofit institutions; community organizations; and residents to work together to create a climate-just city.

Success will require a high level of civic engagement.

Although many Boston residents are on board with climate action, they will support it more actively if they see it improving their quality of life, the quality of their neighborhoods, the viability of their businesses, and their economic opportunity. The city's businesses, cultural, education, and nonprofit institutions must support the climate agenda as well. We have identified ways that the private sector can embrace climate justice; ways that schools, community colleges, and higher education institutions can support residents in engaging in the green economy; ways the voices of environmental justice and other community organizations and residents can be incorporated; ways the legislature can better support cities in achieving climate goals; and ways various state agencies can work more cooperatively.

We are in a unique moment where federal, state, and local interests are mostly aligned. It is time to bring all stakeholders together to make Boston work as a climate-just city.

Boston is one of a few cities that updates its climate action plan every four years. Since the City's 2019 Climate Action Plan Update,¹ it has been tracking progress through a dashboard² and annual reporting³ on policy and programmatic actions. Earlier this year, the Environmental League of Massachusetts launched a tracking tool⁴ for the Next Generation Roadmap Act passed by the legislature in 2021. This tool evaluates progress on more than 30 state goals in the Commonwealth's Roadmap Act. Further, many of Boston's private sector institutions have produced their own climate action plans and report on their progress to varying degrees. These and other efforts serve as valuable tracking, transparency, and accountability tools for assessing progress; however, they focus on more narrow and siloed aspects of the transformation and state and city policy implementation.

This report is the first of the Boston Foundation's anticipated bi-annual series that will evaluate Boston's ongoing progress toward its goal of net-zero greenhouse gas emissions by 2050 and its goals for becoming climate ready. The purpose of this exercise is two-fold. First, it seeks to create an ongoing practice of data-informed assessment of climate progress. As this report and its supplementary materials discuss, improved reporting and assessment are urgently needed to better understand both progress and equity implications. Second, it aims to catalyze a conversation on how it can work to overcome seemingly insurmountable barriers and collectively build a better Boston by accomplishing these big, comprehensive goals.

Progress is not just a task of government. All relevant actors (Figure 1) need to take responsibility for action to facilitate system transformations and address the barriers to achieving them. The private sector must act independently to reduce its emissions and partner with the public sector to plan and fund resilience measures. The city's major institutions—particularly hospitals, universities, and cultural institutions—need to lead on their own climate/equity agenda as well as support the city. Boston residents need to be on board as well—not only in their own lifestyle choices, but also in engaging with their employers and legislators and pressuring them to push for climate mitigation

and resilience at corporate, City and Commonwealth levels. It is also important to emphasize that the big lifts to which Boston needs to turn its attention are relevant to other communities as well and will require substantial coordination at the state and regional level.

This summary report extracts our main findings and synthesizes our recommendations. Companion deep dives into the four big lifts provide further context.

Figure 1. **Actors with essential roles to play in ensuring Boston's Climate Progress**



HOW WE ASSESSED BOSTON'S PROGRESS

The purpose of this report is to assess Boston's progress toward achieving net-zero emissions and becoming resilient to future climate disruptions in an equitable manner.

It has been six years since the publication of the Boston Research Advisory Group Report on Climate Change and Sea Level Rise Projections for Boston⁵ and four years since the publication of Carbon Free Boston.⁶ While the main findings from Boston's reports remain relevant, our understanding of resilience needs and mitigation strategies has become much clearer.

Thus, our assessment of progress asks: **How well is Boston—as a civic community—driving system transformations to meet climate, resilience, and equity goals?**

This report evaluates the progress so far, considering the successes and challenges by reviewing:



Advances in the understanding of Boston's mitigation and resilience needs, drawing on locally and globally focused studies and scholarship. In the past several years we have seen rapid advances in our understanding of net-zero emissions energy systems, unexpected technological progress, and a clearer picture of the extent and impacts of climate change on Boston and the region.



Plans, implementation, self-assessments, and recent policy developments, which climate planning and implementation have accelerated over the past several years, becoming more domain-specific and focused. The City of Boston is one of the few US cities to self-track its near-term mitigation and resilience efforts, which were established by the Climate Action Plan and Climate Ready Boston exercises.³⁷ Our assessment complements these efforts by focusing on Boston's long-term transformational needs and how a wide variety of actors is driving forward the necessary transformation. As part of the research, the project team also reviewed the plans and progress of the Commonwealth, various institutions in Boston, and plans and initiatives of other jurisdictions.



Findings from more than 50 interviews with practitioners, elected officials, staff of regulatory agencies, academic experts, environmental justice groups, community development agencies, members of private sector and nonprofit organizations, foundation staff, members of the public, and other stakeholders. Interviewees and their organizations are listed on [page 141](#).



Quantitative indicators of change from various data sources that show progress with respect to technological adoption, interventions, investment, and impacts. While there is a growing amount of data available, much of it is not being managed in a way that can be readily used for assessment of progress in net-zero goals. Common challenges include inconsistent data formats, out-of-date databases, and data privacy concerns. Lack of specificity makes it challenging to understand equity implications; and disruptions from the COVID-19 pandemic make it hard to evaluate trends.



Boston's many contexts. Boston's strength is its rich diversity in people, economic activity, neighborhoods, buildings, and open spaces. This report recognizes that to drive system transformations, efforts to catalyze change must be broad and targeted.

We summarize progress across **12 outcomes** needed to achieve the City's climate and equity goals.

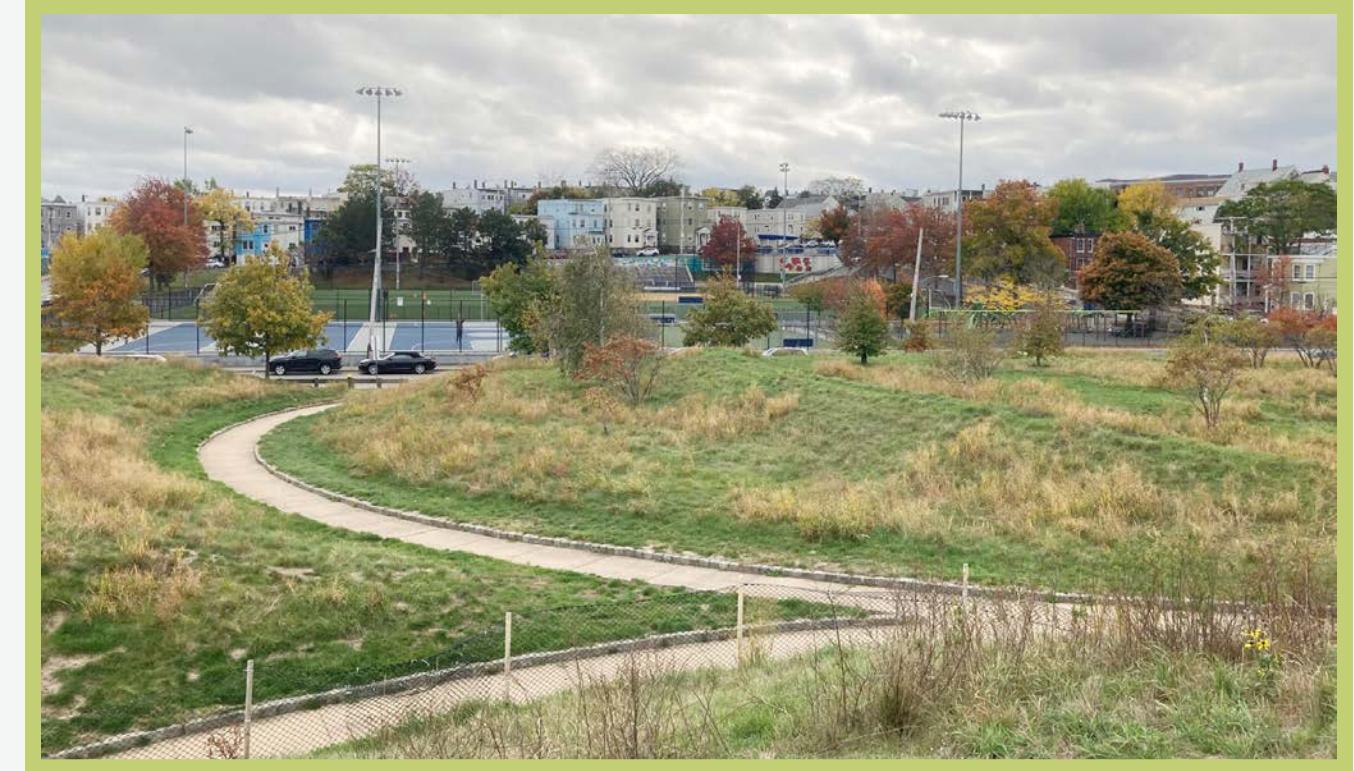
These goals are evaluated in the next section (2), while the outcomes are evaluated in section 3. Within these assessments we highlight advances while identifying financial, regulatory, and jurisdictional (e.g., state v. city) needs, opportunities, and barriers. Across our assessment we identified nine barriers to progress (Table 1). Informed by the assessment of the goals and outcomes we then propose four "big lifts" needed to overcome these barriers to advance progress.

Table 1.
Identified barriers to systematic action needed to address climate change

Barrier	Definition
Conflicting interests	A city goal or policy is opposed by a constituency or stakeholder (e.g., neighbors, a community, a corporation, developers) that fights against it due to a competing need, divergent vision, divergent conception of risk, etc.
Contradictions	A policy/program supporting climate action or resilience is undermined by another city policy.
Jurisdictional limits	A city does not have the authority to act on an element of the plan (e.g., transit is usually operated by a regional authority).
Funding gap	Policy or program does not have sufficient funding or funding stream slows progress.
Misalignment of goals among policy or political actors	The city's action on a goal is prohibited or stalled because of nonaligned policy at higher levels of government.
Unintended consequences	An attempted climate or resilience solution creates new problems or costs that are not anticipated (e.g., gentrification).
Technical feasibility	A solution for a climate action is not yet technically feasible or feasible under current policy.
Knowledge gaps	Information needed to pursue a policy goal is not available.
Inertia	Progress is stalled because it is easier for policy actors, businesses, developers, or residents not to change what they are doing.

An important aspect of the assessment is examining how Boston can integrate climate action with environmental justice and racial and economic equity. We argue this integration requires a reparative planning process (Big Lift #4).

While the report uses several indicators to characterize social equity concerns (e.g., transit and energy access, utility spending, and household energy insecurity) and suggests others that might be considered for measuring progress over time; it does not propose specific, community-informed equity indicators to be included in future progress reports. Engaging frontline communities in the selection of equity indicators is critical to ensuring that the concerns, interests, and needs of socially vulnerable groups are reflected in the assessment process.



The region has made progress in its climate response, such as developing land for coastal resilience and expanding renewable energy use, but must bear down harder across all sectors.

Top American Legion Playground, East Boston. (Source: UrbnParks.com);

Bottom Wind turbines in Gloucester, Mass. (Source: Fletcher6/Wikimedia Commons)

STRUCTURE OF THIS REPORT

Eliminating greenhouse gas emissions, rebuilding infrastructure and human systems to deal with rising seas and increasingly extreme weather, and undoing decades of injustices are incredibly complex tasks that no one report can fully address.

This report, however, seeks to structure the understanding of those complex tasks, evaluate progress at a broad cross-cutting level, and give detailed attention to several areas where it is critically needed.

It does so in three parts:

01

02

03

Progress on Goals evaluates movement toward Boston's overarching climate-oriented goals: net-zero emissions by 2050, climate resilience, and increasing social equity through climate action. Here we review the comprehensive plans and existing overarching climate policies and find that while there are several examples of incremental action, the comprehensive changes that are needed to achieve stated goals have yet to be started.

Progress on Outcomes names and assesses 12 measurable outcomes of the programs, projects, and initiatives whose success is imperative to reaching the overarching goals. We acknowledge that pursuing equity requires work outside of the climate sphere. These outcomes were largely derived from those identified by the Carbon Free Boston report and Climate Ready Boston planning exercise—which respectively identified the core strategies needed to achieve the goals described above.

Boston's Big Lifts distills key areas in which we must focus resources to attain these outcomes. We identify four system-transforming actions which Boston—along with the broader region and state—needs to immediately accelerate. This list is not exhaustive, but it draws attention to areas that need to be more adequately acted on at the local level.

Figure 2.

OVERVIEW OF REPORT

Organization and focus areas.

KEY

Goals

Commonly accepted goals necessary to rise to the challenge of climate change.

Outcomes

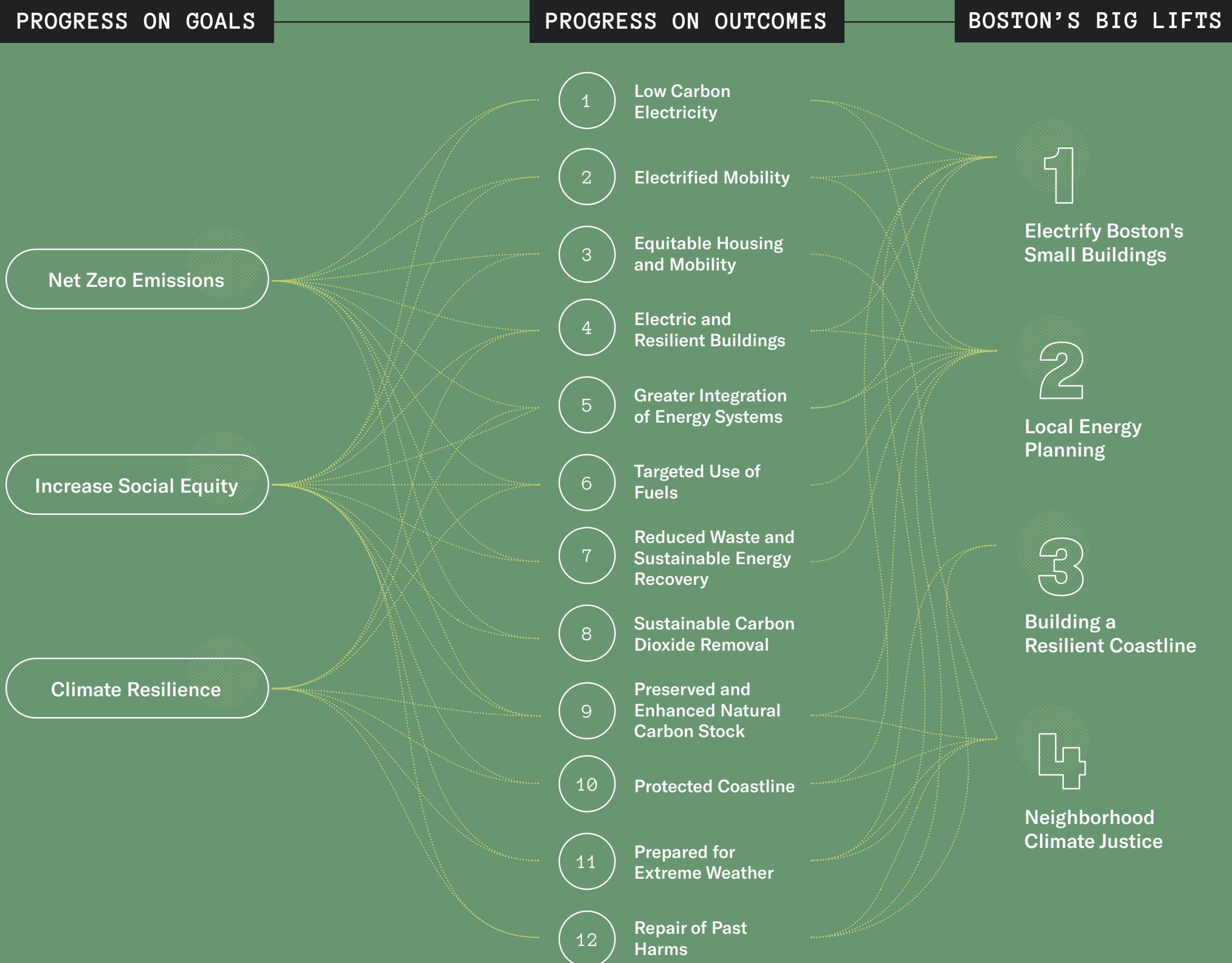
Results necessary to achieve the goals.

Big Lifts

Priority focus areas of this report that Boston must act on to drive forward outcomes under its influence.

SUMMARY

- ▶ Each outcome serves at least two and often three goals.
- ▶ All outcomes support increasing social equity.
- ▶ Nearly all outcomes can be advanced by the big lifts focused on in this report.



Each of the big lifts requires a systemic transformation:

1

Electrifying the small building stock means scaling up electrification retrofits that have been only applied to a few dozen buildings in the city so far to 70,000.

2

An electric city requires more local planning to accelerate and justly guide grid upgrades and other new energy infrastructure.

3

A new unified governance structure will be needed to ensure resilience for our entire coastline to avoid fragmentation of planning, financing, and implementation.

4

Climate action is an opportunity to undo past and ongoing harm imposed on communities of color by beginning a reparative planning process that finally delivers justice.

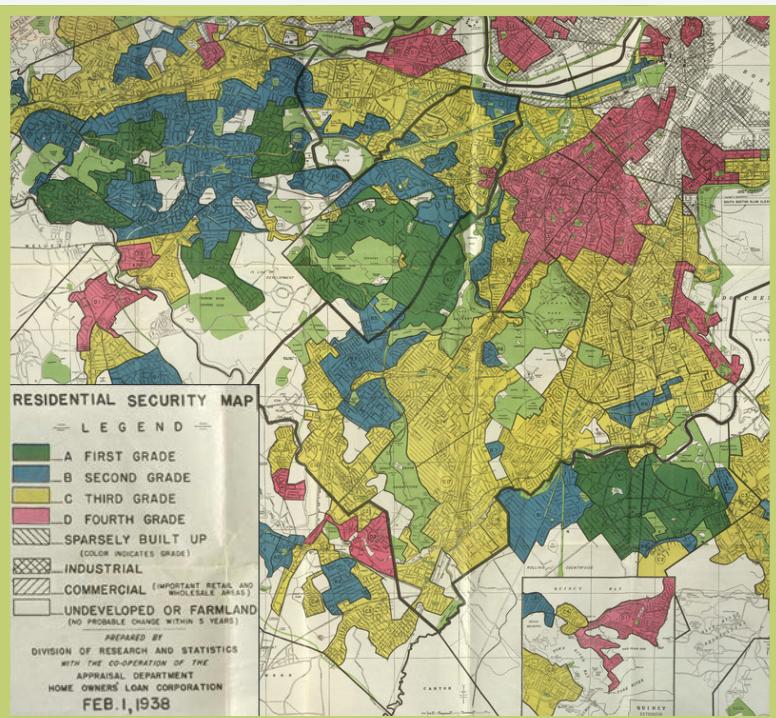
The understanding of how to become a net-zero, resilient, equitable city is evolving, as is the assessment of progress on the road to achieving these goals. By using the three-tiered framework of goals, outcomes, and big lifts, we hope to create a consistent approach to evaluating progress and sharing it with Boston's residents, workers, civic leaders, elected officials, practitioners, businesses, and nonprofit institutions to better empower them to accelerate progress toward these goals.

Integrating Equity

Increased social equity is connected to every outcome in our analysis and is central to each big lift. Boston has a shameful history of racial segregation and racism.

In 2014, Boston was ranked the worst city in the nation on income inequality by the Brookings Institution, with top income earners making 18 times as much as those in the bottom.

The gap has narrowed since then, dropping to the seventh most unequal city in 2016, a reflection of worsening conditions in other cities more than improvements in Boston. Earners in the 95th percentile make 10 times as much as the 20th percentile.⁸



The racial wealth divide is staggering. An analysis of median net worth in Boston estimated it at \$247,500 for White households and a mere \$8,000 for Black ones in 2015 (this study is currently being updated by the Boston Federal Reserve Bank).⁹ Deliberate government policy has limited Black financial advancement from slavery to \$8,000 in 400 years. Although this finding was based on a small sample, there is considerable additional evidence revealing a wide gap in wealth. Black Bostonians are not only less likely than White Bostonians to own homes (56 percent v. 33 percent), but those who do are more likely to have a mortgage. In addition, Black Bostonians are more likely to have student loans and medical debt.¹⁰

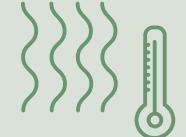
Income inequality is reflected in the city's neighborhoods and throughout the metropolitan area.¹¹ From 2014 to 2019, Boston ranked 14th for racial segregation of the 51 metropolitan areas with large Black populations.¹² While there has been slight improvement, high housing prices, inadequate supply, and exclusionary zoning practices maintain the pattern of highly segregated neighborhoods in Boston. Even though these disparities have been recognized for decades, rather than using the blank slate of the Seaport to create a diverse—to say nothing of green and resilient—community, Boston city government and developers built an almost exclusively White one.¹³

Redlining map of Boston, 1938.
(Source: Norman B. Leventhal
Map & Education Center)

Marginalized communities face greater environmental risks.



Exposure to Pollutants



Extreme Heat



Flood Risk



Poor Access to Nature



Poor Food Access



Poor Transit Options



Limited Healthcare Access

This glaring racial divide affects the economy of the Commonwealth. The Massachusetts Taxpayers Association in 2021 estimated that “gross state product would increase by approximately \$25 billion over five years if we were to close the racial divide in wages, housing, investments and wealth.”¹⁴ We see a connection to the impact of climate change as well.

Systems leading to segregation have exposed discriminated-against communities to environmental risk factors, including high exposure to pollutants, extreme heat, flood risk, or poor access to nature, food, transit, and healthcare. Living in such “frontline communities”—those neighborhoods that have experienced the first and worst effects of climate change—has health impacts that we saw so starkly during the COVID-19 pandemic. The correlation between communities with a high concentration of people of color and the confirmed COVID-19 case rate is striking.¹⁵

The 2018 *Fourth National Climate Assessment*, a congressionally mandated report on climate change and its impacts, warned that climate change disproportionately affects low-income communities and communities of color and emphasized that governments need to work closely with those communities to develop solutions. The COVID-19 pandemic, combined with our nation’s racial reckoning following the murder of George Floyd and others in 2020, has amplified the need to connect climate action to racial and social justice. Delivering that vision for the city’s frontline communities is an urgent priority.

While climate action cannot be expected to ameliorate such gaping racial inequality, a political commitment to doing so should be reflected in all climate mitigation and resilience plans. Seemingly, Boston already has made climate equity a priority. Addressing income and wealth inequality and climate are key priorities for Mayor Wu.

The 2019 *Carbon-Free Boston Social Equity Report* analyzes the social equity implications of carbon emission reduction strategies across four key sectors: buildings, waste, transportation, and energy.

The report reviews historical inequities in Boston and provides a detailed snapshot of present-day social equity concerns and challenges to inform the City’s actions toward carbon neutrality. The Carbon Free Boston social equity project team provides extensive guidance on how the City and its partners can integrate equity into their carbon neutrality planning and policy design. A central argument of the report is that assessing progress toward equitable policy design and implementation requires decision-makers to track and measure equity impacts.

“With bold leadership and vision, Boston has the potential to be a worldwide beacon for climate action and environmental justice. In partnership with community activists and organizations, [we can pursue] an ambitious policy roadmap for delivering the kinds of structural changes we need in order to provide our kids a future built on sustainable energy, good jobs, and healthy, connected communities.”

—Mayor Michelle Wu

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02

PROGRESS ON GOALS

NET ZERO GREENHOUSE GAS EMISSIONS BY 2050

To avoid the worst impacts of climate change, Boston—along with the rest of the world—must achieve net-zero greenhouse gas emissions by 2050.

Boston's progress toward this goal is being influenced by several overarching forces (Table 2), spanning soft policy, hard policy, voluntary action, and market forces.

Boston's emissions largely stem from its reliance on fossil fuels to heat buildings, to move residents and commuters, and to generate the electricity it consumes.

- ⟨ Achieving net zero is not simply about eliminating fossil fuel use in our current infrastructure, it is about rebuilding entire energy systems to operate with a near-zero reliance on fossil fuels.^{16,17}

This forces us to look beyond mere counting of emissions to understand the steps needed to dismantle and reconstruct the system while it is in use—and what outcomes will indicate progress as that happens. These outcomes will be reviewed later in Part II. The following subsections assess progress in planning and pivoting to comprehensive action aimed at eliminating emissions.

What is net zero?

The entire world needs to be net zero by 2050 to avoid the worst impacts of climate change.



By 2050 human and energy systems need to be transformed to:

- ✓ Reduce greenhouse gas emissions by 90% from peaks
- ✓ Balance residual emissions with carbon removals
- ✓ Be prepared to continue mitigation and increase removals past 2050

Governments, businesses, institutions, and households need to pursue the actions that they can best influence.

Table 2.

Influencing Forces Shaping Boston's Path to Net Zero by 2050

City of Boston Voluntary Commitment	In 2017 Mayor Walsh established a voluntary commitment of net-zero greenhouse gas emissions by 2050 with an interim target of cutting emissions in half from 2005 levels by 2030. ^{18,19}
Voluntary Community Leadership	Countless leadership actions by Boston's residents, businesses, and institutions to align their practices with net-zero goals.
State-wide Legal Target	In 2020, Governor Baker issued an executive order establishing a statewide goal of net-zero emissions by 2050. ^{20,21} The target was subsequently codified into law by the 2021 Next Generation Climate Roadmap Act. ²² A series of interim and sector-focused targets were defined by the 2025/2035 Clean Energy and Climate Plan. ²³
Market Forces	An unprecedented technological revolution—spurred in part by policy at all jurisdictional levels—will offer consumers enhanced products and services through zero emissions technologies such as e-bikes, electric vehicles, heat pumps, and local energy production, among others. The community must be prepared for these emerging technologies.

What Is Carbon Neutral & Net Zero?

The City of Boston uses the term **carbon neutral** to describe its decarbonization goals, which it defines in its 2019 CAP Update as, “Becoming carbon neutral means that in 2050 Boston will release no net carbon emissions into the atmosphere.” While the terms **climate neutral** and **net zero** are generally interchangeable, this report uses the latter as it is more commonly used in academic, state, national, and global (e.g., IPCC) circles.



City government and administration can advance climate work—but needs partnership and coordination at all levels to truly achieve its goals.
Boston City Hall. (Source: CDMA/Unsplash)

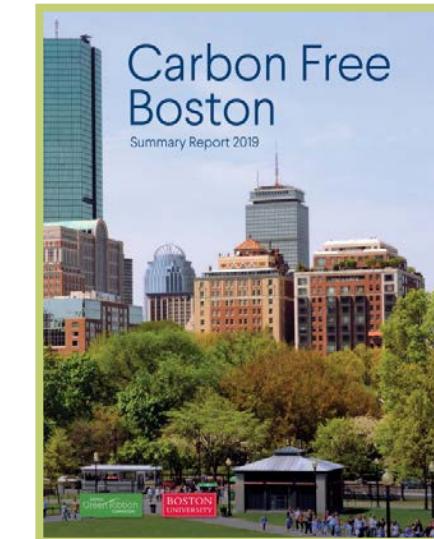
Progress and Plans So Far

The City's first steps on climate action came in 2007 when Mayor Thomas Menino committed to an 80 percent reduction in greenhouse gas emissions by 2050.²⁴ The following year, the Commonwealth of Massachusetts adopted the same target when it adopted the groundbreaking Global Warming Solutions Act. In 2017, Boston and 14 other neighboring cities and towns (Metro Mayors Coalition) committed to achieving net-zero greenhouse gas emissions by 2050.¹⁹ In 2019 the City of Boston updated its Climate Action Plan¹ based on this new goal and the technical analysis of the Carbon Free Boston report.⁶ Following this leadership from Boston and other communities, in 2020 the Commonwealth of Massachusetts released its 2050 Decarbonization Roadmap and commitment to be net zero by 2050.²⁵

Between 2005 and 2019, prior to the start of the disruptive COVID-19 pandemic, Boston's accounted greenhouse gas emissions declined by approximately 21 percent. This was largely driven by the decline in the carbon intensity of electricity supplied to Boston as a result of the near-complete elimination of coal from the New England electricity supply in favor of natural gas (Figure 3).²⁶ State clean electricity standards have contributed a modest, but steadily increasing amount to this progress.

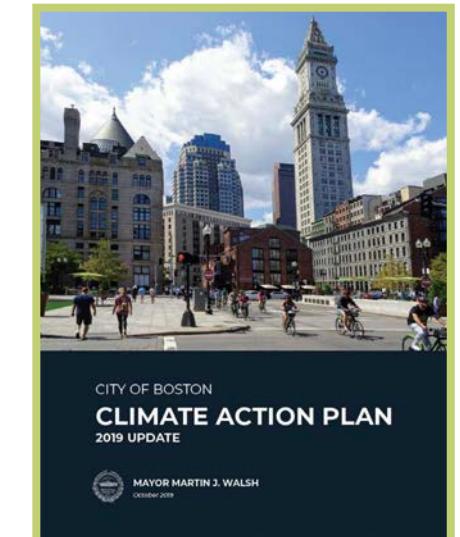
Building Blocks of Boston's Net-Zero Action

Scientific Understanding



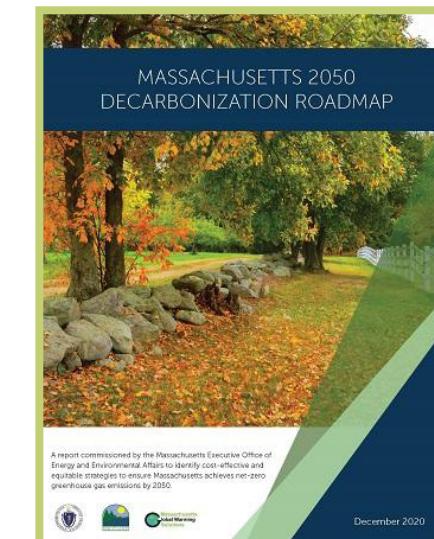
Carbon Free Boston

City Leadership



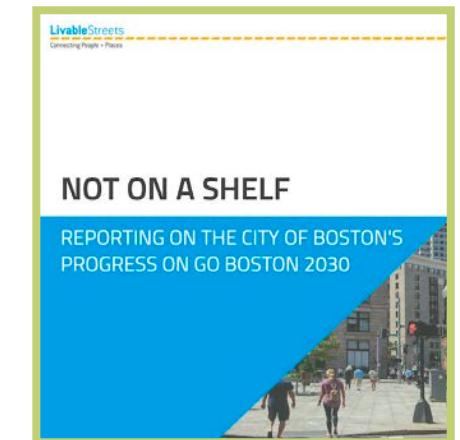
2019 Climate Action Plan Update

State Action



Massachusetts 2050 Decarbonization Roadmap

Nonprofit Advocacy



LivableStreets Report on Boston's transportation progress among others

The evolving landscape in Boston, 2005–2019

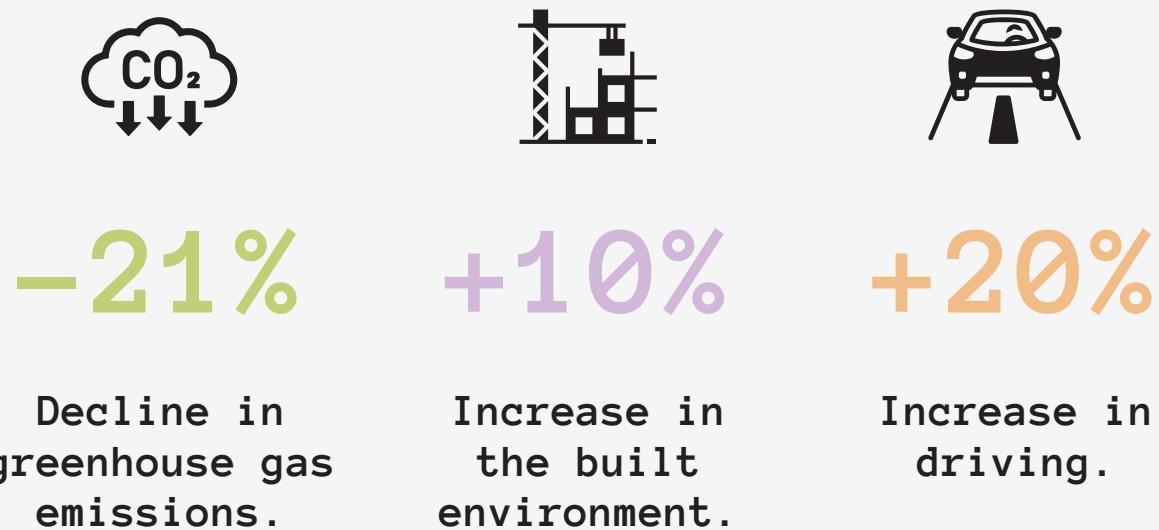
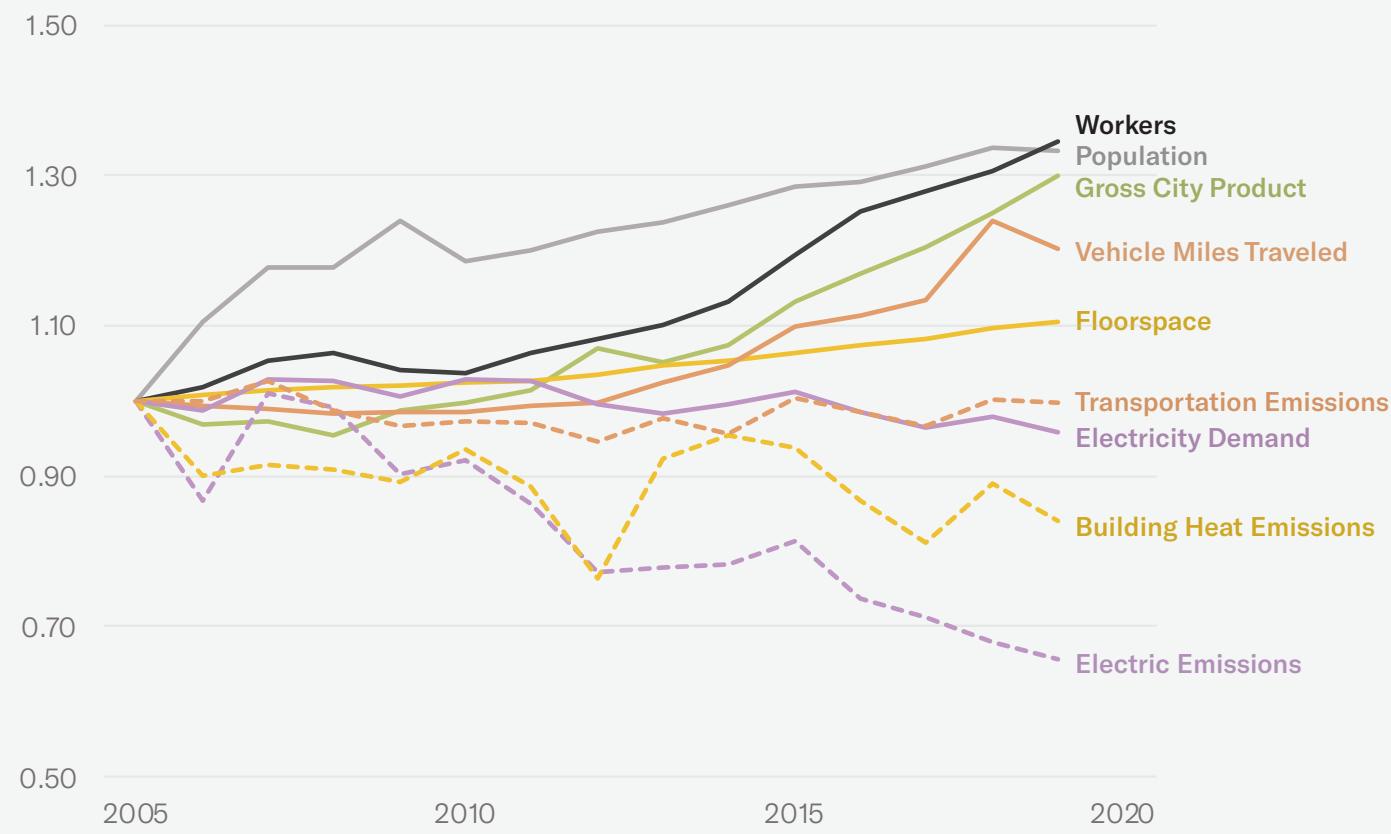


Figure 3. A growing city with declining emissions.

Selected socioeconomic and emissions indicators from 2005 to 2019 as indexed to 2005 values.



Source: City of Boston 2019 Inventory Data.²⁶

Over the past two decades, Boston has experienced unprecedented growth in population and economic activity, which has led to a 10 percent increase in the built floorspace²⁷ and a 20 percent rise in miles driven (Figure 3). Despite this growth, fuel consumption in buildings and transportation systems has remained flat, while electricity consumption has declined modestly.

This remarkable trend results from improved vehicle efficiency, the broad adoption of building energy efficiency measures from lighting to insulation, and oil-to-gas heating system conversions. While these accomplishments are impressive, these

incremental approaches have exhausted their ability to reduce emissions to the extent needed to reach Boston's goals. We have harvested all our low-hanging fruit. We now must tackle the transformative system changes necessary to get all the way to net-zero emissions.

The problem is that the needed transformations to achieve net zero have not been fully realized in policy and action: household, business, municipal, state, and federal. Further, as we discuss throughout the report, efforts to implement the needed transformations have run into barriers at all levels.

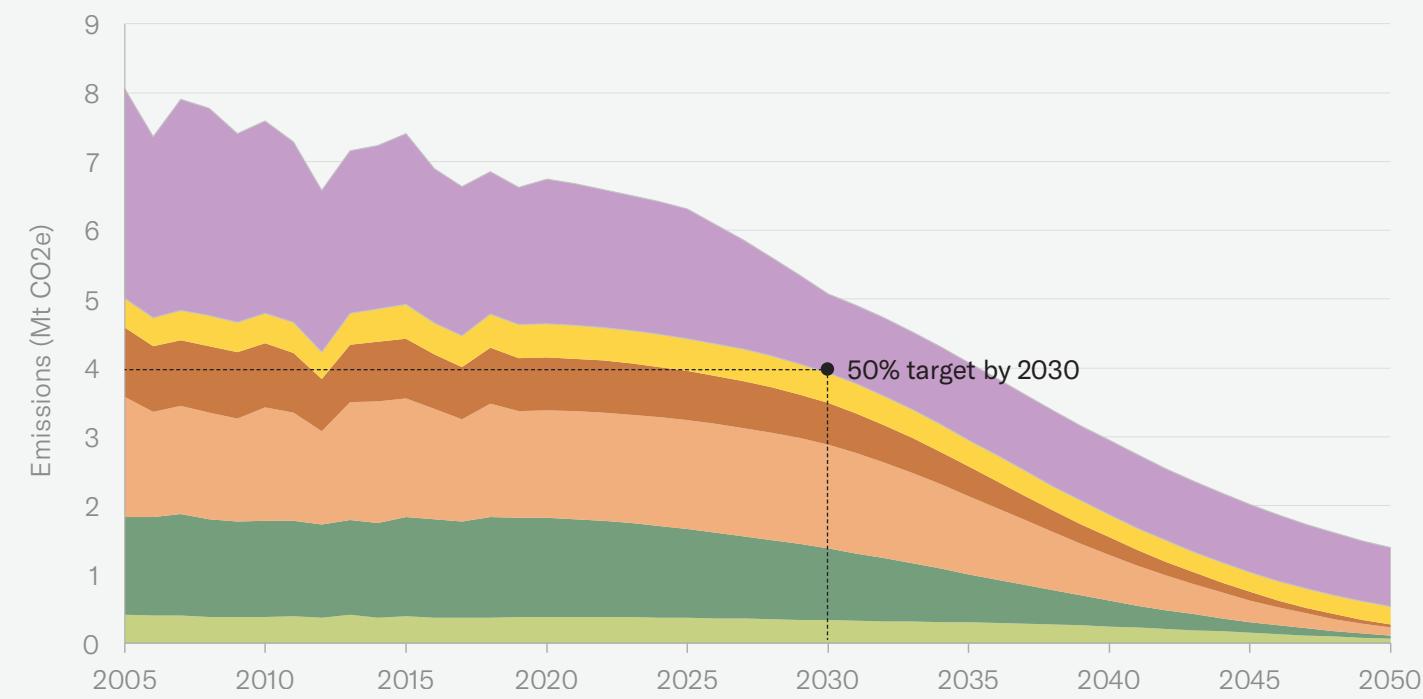
The collective delay—spanning individual to global responses—in implementing such systematic transformations has put Boston's 2030 emissions reduction targets out of reach. Continued delay places the net zero by 2050 goal at significant risk.

We use the City's community greenhouse gas accounting inventory²⁶ and Figure 4 and Figure 5 to illustrate why Boston's 50 percent reduction goal by 2030 currently exceeds its reach. We assume a steady decline in the emissions intensity of electricity provided to the city due to the Commonwealth's draft amendments to the Clean Energy Standard.²⁸ Despite carbon-free electricity comprising 80 percent of the city's supply in 2050, electricity sector emissions remain flat due to increasing demand from the electrification of heating and transportation, based upon forecasts used in the Massachusetts 2050 Roadmap.²⁵

Figure 4. Boston's Past and Future Emissions.

Forecast of Boston's emissions under an aggressive transportation and buildings electrification timeline and proposed Massachusetts Clean Energy Standard policy.^{28,29}

Legend: Trns. Other (green), Trns. Passenger (dark green), Commercial Heat (orange), Residential Heat (brown), Methane Leaks (yellow), Electricity (purple)



Source: Author calculations based on state forecasts and policy.

While the legislature's 2022 Act Driving Clean Energy and Offshore Wind^{30,31} has begun to align the transportation sector with this forecast, similarly aggressive policies to decarbonize the building sector have yet to be established. Subsequently, those forecasts should be considered optimistic.

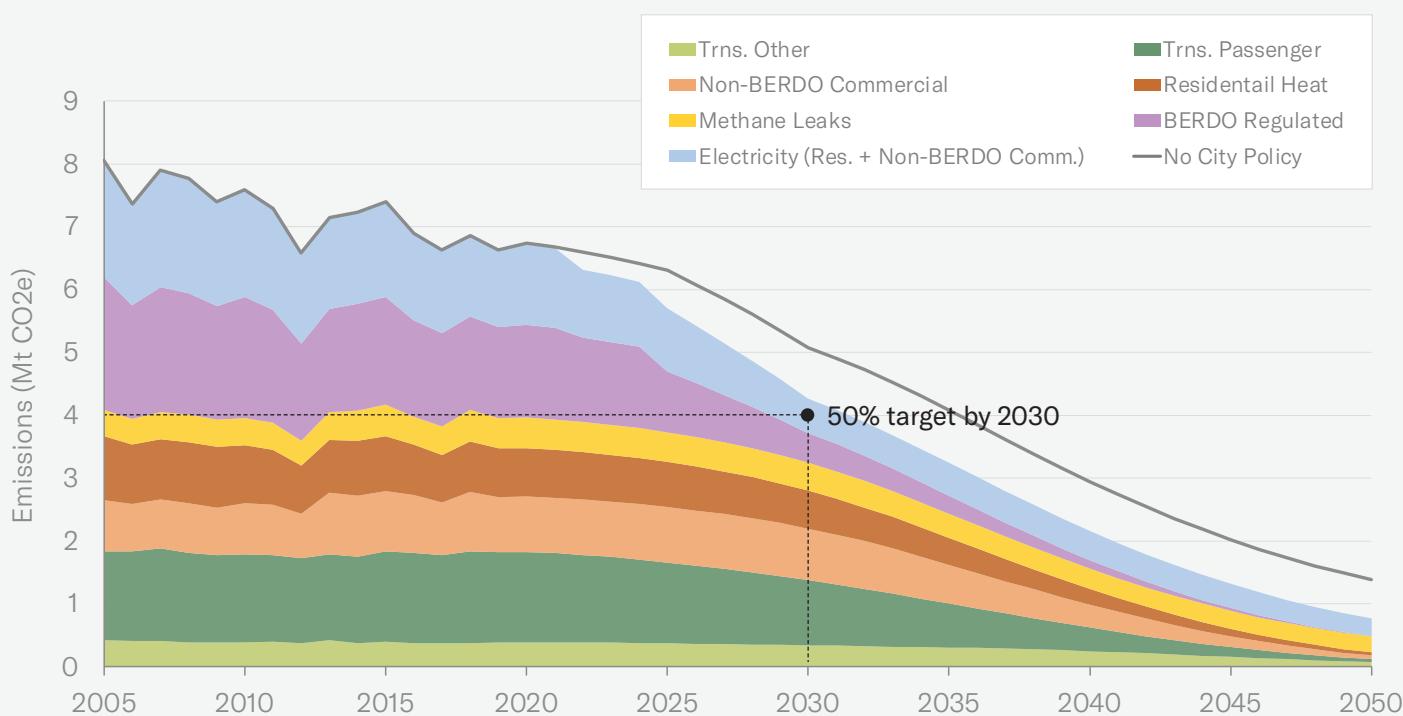
Approximately 2.5 percent of the methane entering the gas distribution system is leaked.³² As many as half of these leaks come from pipes and equipment inside the buildings. While the pipes under the streets are being modernized to little impact there is no effort mitigate leaks within buildings.

Given these factors and the lack of a current plan to right-size the gas system, we estimate that methane leaks will decline by half by 2050 to approximate some customer attrition and modest improvements to the distribution system.

2.5%
of the methane entering
the gas distribution
system is leaked.

Figure 5. Boston's Past and Future Emissions with City Policy.

Emissions trajectory for Boston using the same assumptions as Figure 4 but with BERDO-regulated buildings as a separate sector (including heat and electricity) guided by BERDO 2.0 emissions targets; and remaining electricity consumption reflecting a community choice energy portfolio with an additional 10% renewable electricity supply beyond the state's clean energy supply standard.^{23,26,34}



Note: The forecast includes Vicinity's steam electrification proposal³⁴; however, much of this impact is subsumed by the BERDO regulation. (Source: Author calculations based on state forecasts and policy.)

Under this forecast, the city would miss its 2030 50 percent reduction interim target by five to six years.

The City's two signature climate policies—Building Energy Reduction and Disclosure Ordinance (BERDO 2.0) and Boston Community Choice Electricity program³³—have the potential to cut the gap in half in both 2030 and 2050 (Figure 5).

This comparison shows the impact of City policy leadership. However, further City-level action faces significant challenges. Expanding BERDO to smaller buildings increases regulatory complexity for both the City and building owners. The City has little control over the thousands of vehicles entering it each day.

So, should everyone in Boston buy 100 percent renewable electricity to achieve its 2030 target? Figure 5 hints that doing so could achieve this goal. But it may not be the most effective use of resources to advance the necessary system changes.

Today, residents can opt in to 100 percent renewable electricity, and some institutions buy renewable electricity to claim that their electricity supply is "carbon free." Typically, this is done through the purchase of credits that represent the renewable nature of electricity generated from solar.

These purchases support the deployment of solar at a level that matches the electricity used by the resident or institution. On paper, this again allows entities to make the claim of 100 percent renewable electricity. However, because solar only generates electricity during the day, it is not a scalable strategy. Such procurements are thus incremental and in the absence of regional action to decarbonize the grid are insufficient to drive the necessary system transformation and pace of progress.

Mixing in wind electricity purchases would be an improvement—and some institutions do—but there will remain a significant number of hours during the year when wind and solar will still be insufficient. While modest gas-generation could cheaply support deep levels of wind and solar, 100 percent renewables would require substantially more solar, and many batteries. This would be prohibitively costly under today's technological outlook and require a large solar footprint.

The resulting high electricity rates would disincentivize heating electrification; the additional spending to go all the way to 100 percent renewable electricity could have been used for deeper building electrification. While this may not yield as immediate reductions per dollar spent, it would yield more durable reductions in emissions.

So, yes, under currently established practices, Boston could buy a lot of renewable energy certificates and maybe account its way to its interim 2030 net-zero target, but this strategy would involve various tradeoffs that need to be weighed.

Impact of State and Federal Policy

Carbon Free Boston and the City's 2019 Climate Action Plan were produced at a time when City leadership in climate action was essential to driving any progress a decade after Congress failed to pass the American Clean Energy and Security Act (Waxman-Markey). Carbon Free Boston mapped out what needed to be done and the City's 2019 Plan detailed actions that were within the City's power. However, even with the most ambitious City action a significant gap remains.

Over the past decade, federal action has not reduced emissions significantly although federal research and development drove some incremental change. The Trump administration intentionally stymied the permitting of offshore wind³⁵ and actively worked to hamper the Obama administration's efforts to reduce emissions.

State action has evolved slowly. The Massachusetts Senate's 2021 Act Creating a Next Generation Roadmap for Massachusetts Climate Policy²² was the Commonwealth's first major climate legislation since the landmark 2008 Global Warming Solutions Act.

Unfortunately, while this new iteration legislated the needed targets, it largely lacked transformative regulations necessary for creating systems change.

The record of the executive branch has been mixed. Notably the Baker administration's push to advance offshore wind development primed the industry to be ready when the permits were granted. Attempts by the administration to source low-cost, reliable hydroelectricity from Quebec were temporarily stymied by voters in Maine opposing the construction of a transmission line to deliver the power.

The administration supported the Transportation and Climate Initiative, a cap-and-invest program that would have generated substantial revenue to promote systems changes in vehicle electrification and alternative transportation. Unfortunately, while 12 states signed on to the initiative, all but Massachusetts backed out because fuel suppliers could pass on the cost of emission allowances by raising gas prices—always a politically unpopular outcome.

Subsequently the administration initiated rulemaking to align the state with the California Advanced Clean Trucks and Advanced Clean Car rules. Simultaneously, various state agencies have been working to strengthen clean energy,²⁸ waste,³⁶ and building efficiency and appliance standards.

By the end of the first half of 2022, it seemed that progress would continue to be incremental and Sisyphean. Then the comeback started.

In August, the federal Inflation Reduction Act created incentives and funding to advance renewable electricity and electrification with a portion of its funding dedicated to disadvantaged communities (termed "justice 40" communities).³⁷ This built on significant federal investments in infrastructure³⁸ and technology³⁹ earlier in the year. At the same time the Massachusetts legislature passed a bill³⁰ that sought to transform systems through increased incentives, electrification of the MBTA, building electrification, and increased state responsibility for natural gas planning. The legislation defines environmental justice populations and environmental burden. To top the month off, the Maine Supreme Court overturned the referendum blocking the transmission of hydroelectricity to Massachusetts.

Impact of the Private Sector

It is conceivable that the universities, laboratories, and incubators of Greater Boston will have catalyzed enough greenhouse gas reductions over the coming decades to dramatically reduce the city's community emissions. This possibility should inspire everyone and be an early mover on technology adoption to support their operations. Boston University has pushed the envelope by procuring renewable electricity to closely match its demand and by building a gas-free 19-story building heated and cooled by 1,500 feet deep geothermal wells. Boston's commercial district energy system

operated by Vicinity has instituted a steam electrification plan that is more ambitious than experts anticipated.* The effort of these entities to disseminate what they've learned from these system-transforming ventures will be impactful in and beyond Boston in accelerating progress.

When looked at as a whole, the private sector appears not to be innovating and is thus a major barrier to change. While many institutions have issued climate plans or commitments, most have been vague. Many that talk about climate action find ways to buy themselves to net zero using dubious renewable electricity procurement or offset strategies. These are incremental—not transformative—actions that fail to achieve the equity co-benefits of investing in direct and ideally local mitigation. Despite commitments to net zero, organizations and interest groups have lobbied to slow the pace of electrification, while blatantly advocating for more costly, inequitable, and debunked false solutions. This hinders the development of sound climate policy and planning approaches, putting the broadly espoused climate goals at risk.

*Carbon Free Boston and the State Decarbonization Roadmap anticipated that a system such as Vicinity's Boston district would be reliant on some level of fuels even beyond 2050. Neither envisioned a geothermal system in the city for a building the size of BU's new data science center.

RESILIENT TO A CHANGING CLIMATE

Recent climate disasters have underscored the need to enhance resilience significantly, especially for frontline communities—communities of color that have had disproportionate exposure to environmental harm and economic disinvestment.

Boston has the unfortunate distinction of being the eighth most vulnerable⁴⁰ city in the world to flooding due to sea-level rise. The sea around Boston rose nine inches in the 20th century, with another eight inches predicted by 2030.⁴¹ Relative sea-level rise is accelerating in Boston Harbor and is rising at a faster pace than the global average.⁴² Boston ranks third⁴³ in the nation for the number of multifamily buildings at risk from storm surges and is the most vulnerable state in New England for sea-level rise and storm surge.⁴⁴ If left unabated, the rising sea level will affect all Boston residents directly or indirectly, including many of our neighborhoods—East Boston, South Boston, Dorchester, the Back Bay—and employment hubs such as the Seaport, Logan Airport, commercial piers, port facilities, and our transit system.

What is resilience?

The capability to prepare for, withstand, recover from, and adapt to adversity.

As the climate continuously changes, Boston must strengthen its:

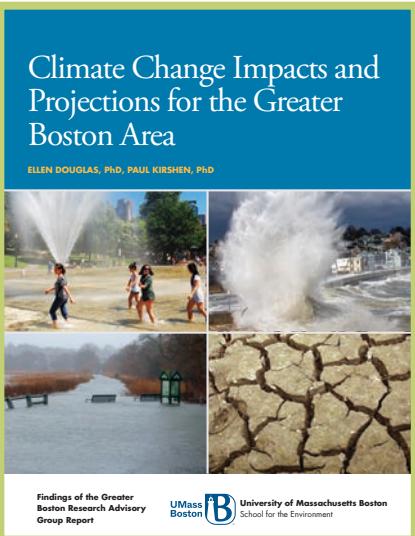
- ✓ Physical infrastructure to withstand extreme weather and sea level rise
- ✓ Social infrastructure by uniting residents and institutions to not just endure but thrive in the face of rapid change

Resilience is not only needed in response to sea-level rise, but also extreme heat. The “heat island” effect, the presence of higher temperatures in cities than in rural areas, is even more extreme in compact and dense older cities with taller buildings, like Boston. Despite its northern location, these features contributed to Boston's being ranked sixth among 158 cities in a recent study of urban heat island effect.⁴⁵ Heat waves are increasing in frequency and intensity in the region.

This year there were 21 days where the temperature exceeded 90 degrees Fahrenheit, a count that has crept up steadily since the 1980s and is predicted to more than double in the 2040–2060 period.⁵ Boston could have 8.8–11.7 heat-related deaths per 100,000 by 2050⁴⁶ (for context, Massachusetts has 4.9 traffic deaths per 100,000).⁴⁷ The urban heat island effect impacts the city's low-income neighborhoods of color much more intensely than other communities of the city because currently they have fewer trees, less green space, and less air conditioning.⁴⁸

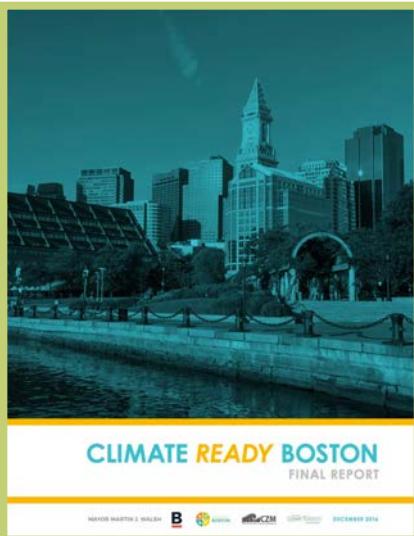
Building Blocks of Boston's Resilience Action

Scientific Understanding



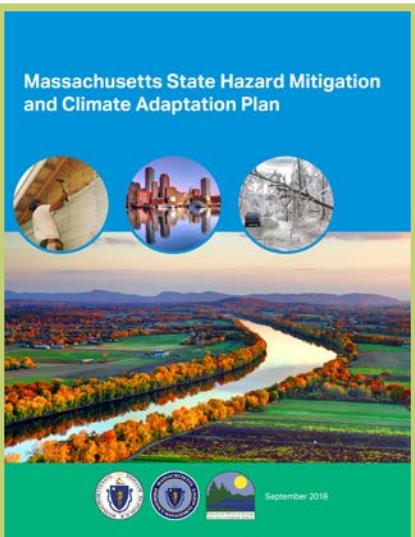
GBRAG Report

City Leadership



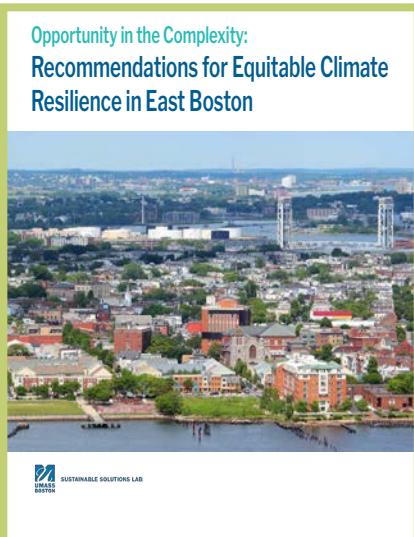
Climate Ready Boston

State Action



Hazard Mitigation and Climate Adaptation Plan

Nonprofit Advocacy



Recommendations for Equitable Climate Resilience in East Boston

Progress and Plans So Far

Boston's resilience efforts have been underpinned by comprehensive and regularly updated projections for the impacts of climate change on the Greater Boston area.^{42,49} This work has been led by local researchers and UMass Boston and critically evaluates and summarizes impacts from storms, sea-level rise, extreme temperatures, and energy system reliability.

Climate Ready Boston⁵⁰ is the City's ongoing initiative to address these risks. The city has completed coastal resilience reports for South Boston,⁵¹ Dorchester,⁵² the North End and Downtown,⁵³ East Boston,⁵⁴ and Charlestown.⁵⁵ Expansions of the East Boston and Charlestown planning efforts were released in an August 2022 report.⁵⁴

The modernization of Langone Park & Puopolo Playground in the North End employed the city's Climate Resilient Design Standards and is informing the design of other green spaces. Some actions have been taken by the MBTA to prevent flooding of T stations, including deployable seawalls at the Aquarium station. Private sector proponents of major new developments along the waterfront are now required to meet more stringent resilience/flood protection standards based on target elevations established in the Climate Ready Boston coastal resilience plans, and many are doing so. FEMA-funded protections for the Fort Point Channel are also underway.

Boston's Ongoing Resilience Efforts



From top to bottom: Seawall at New England Aquarium. (Source: bauhaus1000/iStock); Rose Kennedy Greenway. (Source: Richard Howard); Fort Point Channel. (Source: BPDA); Puopolo Park ribbon-cutting. (Source: Boston.gov.)

Much of Boston's action is characterized by protecting areas that should have been made resilient before development started, particularly in the Seaport. Retrofitting an existing landscape will be a more expensive and less effective approach.

The nonprofit GreenRoots and Boston University School of Public Health collaborated on a research project to build the capacity of Chelsea and East Boston communities to respond to extreme heat events.

C-Heat Project site in Chelsea, Mass.
(Source: Julia Howard)



Little has been done yet to protect smaller residential and commercial properties in older neighborhoods that are already built out. Several coastal resilience projects proposed by the City and others have had difficulty obtaining permitting from state agencies. There are conflicts evident in the mission of agencies protecting the environment and cities seeking to protect their coastline that need to be resolved.

The City of Boston has been developing programs to help people survive worsening heat waves and conducting studies to plan for the future. Many of these initiatives have not been implemented as planned, disappointing residents. The City's 2022 report *Heat Resilience Solutions for Boston*⁵⁶ focuses on the frontline communities of Chinatown, Dorchester, East Boston, Mattapan, and Roxbury. The city proposes to work closely with groups representing these communities to implement the plans. The City is also acting to reduce urban heat island effects, with efforts tied to stormwater management and expansion of green space to meet public health and recreation needs.

Impact of State and Federal Policy

The Commonwealth's main funding mechanism for resilience projects is the Municipal Vulnerability Preparedness program, which was created by an executive order signed by Governor Charlie Baker in 2017. The annual budget for the program for cities and towns to plan and implement climate resilience projects is about \$20 million. Most grants are less than \$30,000, meaning they cover only initial planning. During the FY23 application round, the maximum given per applicant was \$3 million for Action Grants.⁵⁷ This funding needs to be increased substantially (the cost of implementing all of the coastal resilience plans for Boston alone could approach several billion dollars). In addition, there is bipartisan support for increasing the current Deeds Excise Tax to create new revenue for affordable housing and climate resilience projects. This legislation, the HERO Act, will be re-introduced in the next session (2022). State policy to establish a governance structure for evaluating, coordinating, and financing coastal resilience should be a priority.

The federal Infrastructure Investment and Jobs Act (IIJA)³⁸ along with the Inflation Reduction Act³⁷ are about to infuse significant funding to cities and states to pursue resilience projects. The White House estimates that \$50 billion from the IIJA is dedicated to climate resilience infrastructure projects while \$4 billion in the IRA is dedicated to building resilience in environmental justice communities and low-income households.

Impact of the Private Sector

The last 15 years have seen an unprecedented growth in building development, particularly along the waterfront.

One only needs to recall the [floating dumpster](#) of the [2018 Bomb Cyclone](#)⁵⁸ to understand the inadequacy of the redevelopment of the Seaport and waterfront neighborhoods.

Boston Zoning Code Articles 37⁵⁹ and 80⁶⁰ have been important tools for guiding developers to factor in sea-level rise and extreme weather. A case in point: The Wharf District Council Climate Resilience Plan, a public-private partnership, is planning a district-wide barrier for Downtown Boston in the area surrounding Columbus Park to Fort Point Channel, as called for in Climate Ready Boston. Council members have contributed \$10,000 and the Commonwealth added \$250,000 to fund the plan. It has considerable public input. The influence of these Articles is growing, yet in the main, the city's developers have not risen to the challenge. The trouble here is that developers and property owners may see scant incentive for taking a long-term view of climate risks even though those risks are rapidly approaching.

INCREASING SOCIAL EQUITY IN BOSTON THROUGH CLIMATE ACTION

Equity, as it relates to urban climate action, often refers to efforts to ensure that environmental justice (or frontline) communities are prioritized in receiving the “goods” of climate action initiatives.

This approach to climate equity and justice reflects the view of reparations defined by Olúfemi O. Táíwò in *Reconsidering Reparations*.⁶¹ In this view, reparations and climate justice are inseparable, since the burdens of climate change disproportionately impact the most vulnerable communities. Although written from an international perspective, it resonates at the city level in its commitment to the idea that more of the goods of climate action should be distributed to those who have been the recipients of past injustices.⁶²

What is climate equity?

Repair the harms that have contributed to planetary warming and pollution that have burdened the most marginalized.

- ✓ Rapidly scale back the use of fossil fuels and the impact of harmful energy infrastructure.
- ✓ Repair past harms by ensuring historically marginalized communities benefit from the transition.
- ✓ Promote diverse representation in planning and implementation.

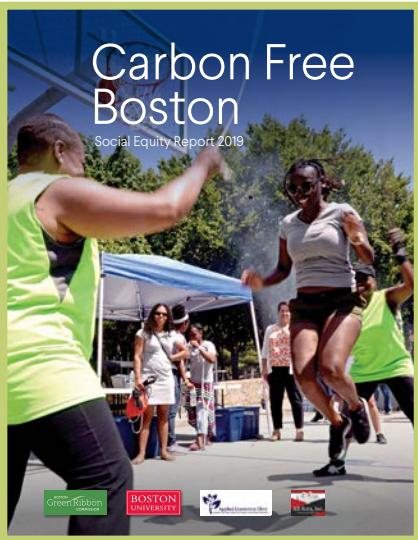
This aligns with the concept of reparative planning that has emerged in the urban planning field as a way to correct past economic, environmental, and social harms inflicted on Black and other communities of color. Some cities, for example, are beginning to address the racial wealth gap created by redlining and associated practices with reparations funds and by removing highways that isolated and polluted Black neighborhoods; cleaning up hazardous environmental sites; and creating new education, training, and job opportunities in the green economy.⁶³ Many see reparative planning as a moral imperative for creating climate-just cities.⁶⁴

Boston, like communities around the country, has begun to collectively understand that it has been failing to make sufficient progress in becoming an equitable and just city.

The emergence of the COVID-19 pandemic, alongside numerous global climate disasters and injustice-fueled unrest, has forced a recognition that broad system change is immediately needed.

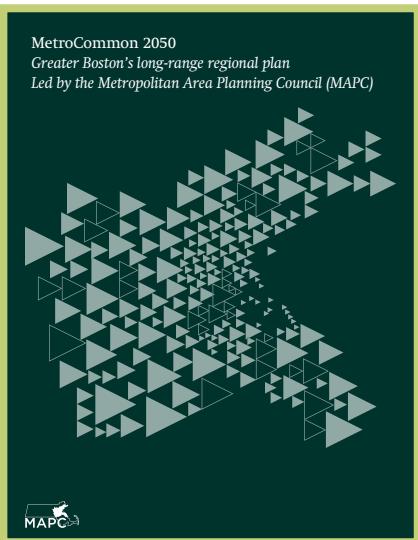
Building Blocks of Boston's Climate Equity Action

Scientific Understanding



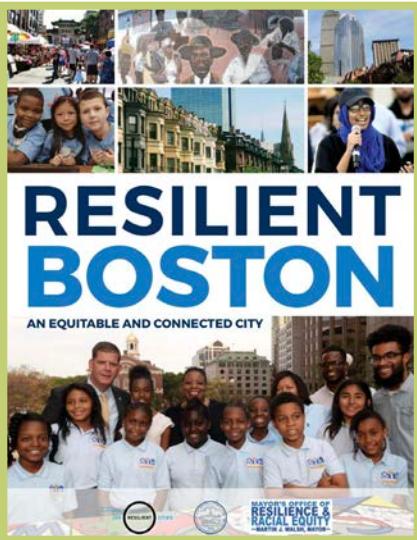
Carbon Free Boston: Social Equity Report

State Action



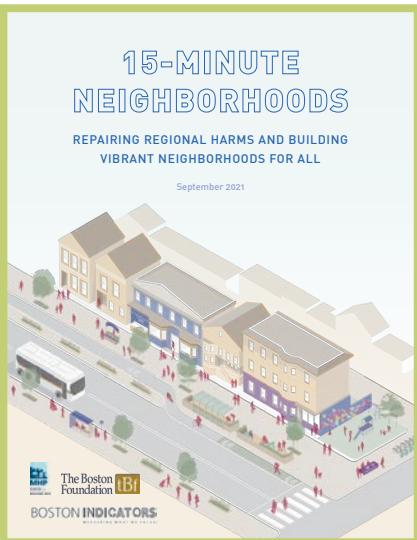
MetroCommon 2050 (MAPC)

City Leadership



Resilient Boston: An Equitable and Connected City

Nonprofit Advocacy



Boston Indicators' 15-Minute Neighborhoods

This report is being released following the 10th anniversary of Hurricane Sandy. Had its track moved and tides shifted by a couple of hours, Boston could have experienced what New York City did: flooded subway tunnels, widespread power outages, and public housing without basic services for over a month.

This report is also being published as Europe faces an unprecedented energy crisis resulting from the Russian invasion of Ukraine and the sharp reduction of Russian natural gas sales to Europe. Despite a concerted cross-ocean effort to shore up energy reserves, supplies are low and energy costs are skyrocketing. Bills for electricity and heat are expected to triple.

Recognizing the impacts of recent events, the big lifts we discuss in this report are largely focused on the intersection of energy and built environment systems with human systems.

We acknowledge substantial challenges in pursuing justice through accessibility in the transportation and housing systems. However, while such challenges and their solutions have been well documented elsewhere,^{65,66} the political will to change such systems is regrettably lacking.

Progress and Plans So Far

Housing and transportation are fundamental needs, yet Boston is struggling to provide them adequately, leaving those on the margins vulnerable to financial burdens, displacement, and further marginalization. Housing and transportation are also the two major sources of greenhouse gas emissions. Efforts that systematically and broadly lower emissions—such as comprehensive building electrification and efficiency retrofits and reduced societal reliance on vehicles—also deliver the greatest benefits for those on the margins.

Energy insecurity stemming from poverty is a real issue for many. It is exacerbated by a lack of capability for those without means to retrofit their homes to modern energy standards. The solution must be systemic: It requires both modernizing homes for climate and addressing the root causes of poverty.

While the city cannot fully address the root causes of poverty, it can help to reduce the cost of housing. To that end, Mayor Wu's unprecedented infusion of \$380 million toward affordable housing and home ownership is a significant step in the right direction.⁶⁸

Boston still needs to develop equity indicators that reflect the concerns, interests, and needs of socially vulnerable groups in the assessment process. To that end, city officials should convene with stakeholders representing Boston's frontline communities and their respective environmental justice, transit, housing, and labor organizations to co-create equity indicators. These indicators should then be used as part of the City's annual assessment of its progress.

The equity analysis should include three widely recognized aspects of climate equity:

- 01 **Procedural equity**—who participates and the extent to which the voices of residents of frontline neighborhoods are reflected in goals and actions.
- 02 **Distributional equity**—which groups and neighborhoods have access to the benefits of climate action.
- 03 **Structural equity**—correcting past harms to frontline communities and preventing future unintended consequences.

These elements correspond to two characteristics that define a just and equitable transition to a net-zero emissions city in the *Carbon Free Boston Social Equity Report*:

- **Fairness**—net zero is achieved by minimizing burdens and maximizing benefits for communities that have historically been burdened by the impacts of fossil energy systems.
- **Inclusion**—historically marginalized and burdened communities are empowered to participate and inform net-zero planning to ensure the transition is fair.

Fairness and inclusion define the transformational changes needed to establish a net-zero city. The pace at which they are implemented will influence Boston's greenhouse gas emissions. In all cases, we find insufficient progress to meet Boston's goals.

Impact of State and Federal Policy

Cities are limited in what they can do to address wealth and income inequality. Urban policy and planners cannot reduce inequality under pro-growth regimes.⁶⁹ As urbanist Susan Fainstein argues in *The Just City*, advocacy and equity planning, regardless of how participatory, cannot produce just outcomes because “they cannot resolve structural inequalities among actors, settle rival concepts of the public good, or account for progressive policies achieved in non-deliberative democratic societies.”⁶⁹ Still, there are actions cities can take to achieve greater equity, particularly when supported by federal and state policy.

Massachusetts is one of a few states that has explicitly established environmental justice laws.

The State's 2021 Climate Legislation—the Next-Generation Roadmap for Massachusetts Climate Policy²²—both codified the state's emissions targets and defined environmental justice principles to guide action. The law seeks to ensure that low-income groups and communities of color are no longer disproportionately exposed to environmental pollution and monitors air quality to verify that this is the case. It also raises the standards of what constitutes an environmental justice community to target the most overburdened places and increases access to solar for low-income residents. The legislation seeks to create an equitable clean energy workforce and market development program by providing

training and education as well as business start-up assistance in energy efficiency and clean energy industries, funded at the level of \$12 million annually.

The legislation also made efforts to promote procedural justice through an environmental justice advisory council and a low-income whole home energy retrofit task force to support MassSave efforts to increase participation among low-income households.

President Biden's Executive Order 14008 established the Justice40 Initiative, which commits 40 percent of the overall benefits of specific federal investments to communities that are marginalized, underserved, and overburdened by pollution.⁷⁰ The recent climate-oriented federal legislation of 2022 (the Infrastructure Investment and Jobs Act,³⁸ the CHIPS Act,³⁹ and the Inflation Reduction Act³⁷) puts this commitment into legislated practice.

Impact of the Private Sector

An economic system that extracts wealth from the less affluent rather than build wealth for all will struggle to solve shared climate goals. And economic imbalance continues despite a proliferation of efforts from the well-meaning to the cynical in the form of diversity, equity and inclusion officers, workplace trainings, slogans, and corporate social media campaigns.⁷¹ It continues because of a federal political system that was designed to disenfranchise some and benefit others. One can point to examples of leadership, but without political change—and leadership from the private sector—past harms persist.



03

PROGRESS ON OUTCOMES

WHAT ARE CLIMATE ACTION OUTCOMES?

Eliminating emissions, building durable resilience, and achieving climate justice require transforming a broad set of deeply ingrained energy, infrastructure, and human systems.

This section defines and assesses progress on 12 outcomes (Figure 6) necessary to achieve the three goals.

Despite incremental action across all 12, we do not find sufficient progress in these transformations to ensure that Boston achieves these goals.

These 12 outcomes are informed by Boston's prior work focused on climate action. *The Carbon Free Boston Summary Report*⁶ emphasized that a carbon-neutral city maximizes efficiency, electrifies activity, and runs on clean energy and focused on the sectors of buildings, transportation, energy supply (local and regional), and waste. Climate Ready Boston⁴¹ identified four layers of action: protected shores, resilient infrastructure, adapted buildings, and prepared and connected communities. The initiative has also emphasized the importance of focusing on neighborhoods, deploying district-level energy solutions, and expanding green infrastructure.

These outcomes have also been defined in leading net-zero^{72,73} and urban resilience scholarship,⁷⁴ which emphasizes the importance of integration of physical and human systems. Further, recent scholarship on climate justice has emphasized the importance of climate reparations aimed at redressing past harms.⁶²

Most, but not all, of the outcomes advance all three goals. The list is comprehensive with respect to mitigation and resilience but repairing past injustices and building a more equitable society will require efforts on many more fronts than climate-focused transformations. However, climate action can still be the catalyst for such society-wide change.

A comprehensive evaluation of progress in all 12 areas is beyond the scope of this assessment. Our summaries in each area are intended to provide the reader with a sufficient understanding of each outcome and where it stands. Each outcome is defined and linked to the goals of net-zero emissions, resilience, and equity.

Equity implications are summarized, or a potential indicator of progress is proposed where appropriate. This report set out to develop formal indicators to assess progress in advancing climate justice. However, the project team quickly found that data limitations and inaccessibility challenged our ability to create such indicators. In many cases indicators could be developed given improved data management and sharing by data owners (MassSave, City of Boston, utilities). Further, we realized that the most effective equity indicators are developed as part of a city-stakeholder process that establishes goals, not by a team of researchers external to that process.

Finally, we identified the essential areas in which effort has to be focused—we call these big lifts. They need immediate attention and action due to their scope, scale, and respective complexities. The big lifts are summarized in Part III and are detailed in supplemental reports.

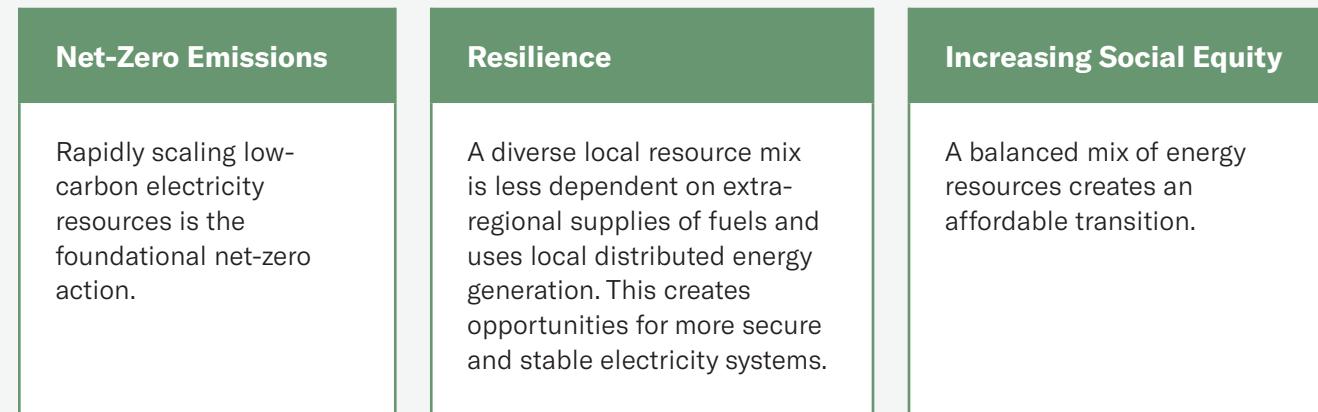
Figure 6. Outcomes needed to achieve the goals of net zero emissions, resilience, and reparative climate justice.



LOW CARBON ELECTRICITY

Boston must generate and be supplied with electricity sourced from renewable and other low-carbon generation resources.

Connecting Outcomes to Goals



Progress Assessment

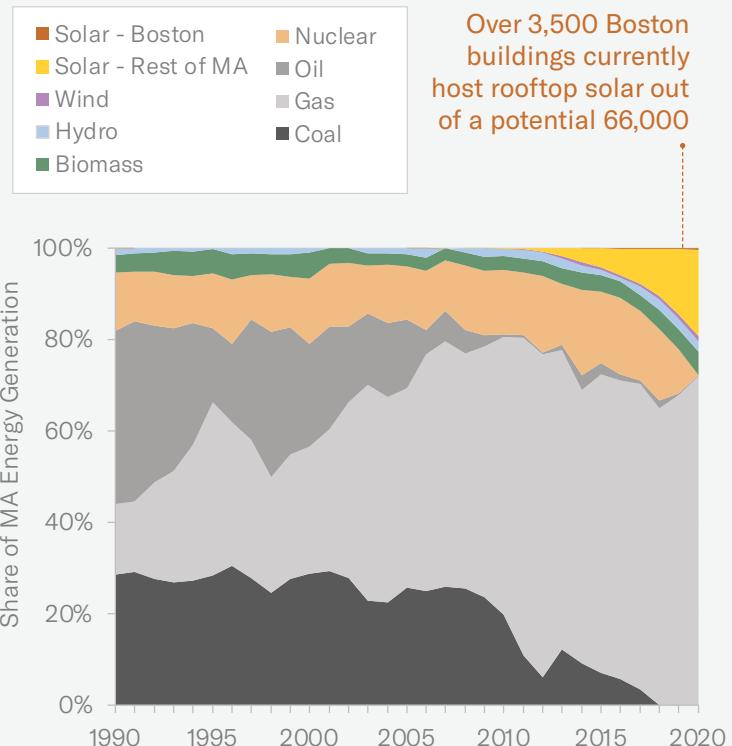
Recent state^{22,28,30,77} and federal^{37,38,38} policies have stepped up efforts to deploy wind, solar, and transmission resources, but it is yet to be seen whether scaling these activities can achieve a pace that aligns with the City's (or Commonwealth's) goals.²⁹ Boston's Community Choice Energy program helps to push this transition forward, but ultimately the jurisdictional control of electricity supply lies with the state and region.

The transformation is being challenged by the inertia of fossil fuel-focused market design,⁷⁸ supply chain constraints,⁷⁹ workforce limitations, and utility barriers.⁸⁰ Further, the growth of renewable energy in the Northeast region is dependent on the ability of many localities to scale and site solar and wind⁸¹—recent examples of local opposition highlight the challenge of conflicting interests that push back against renewable deployment.⁸² The adoption of rooftop solar in the city can support local resilience benefits while avoiding the need to build solar elsewhere, but is itself challenged by limitations on the distribution system (see outcome #5).

Figure 7. Solar in Boston can deliver local energy benefits but achieving net zero depends on regional action and coordination.

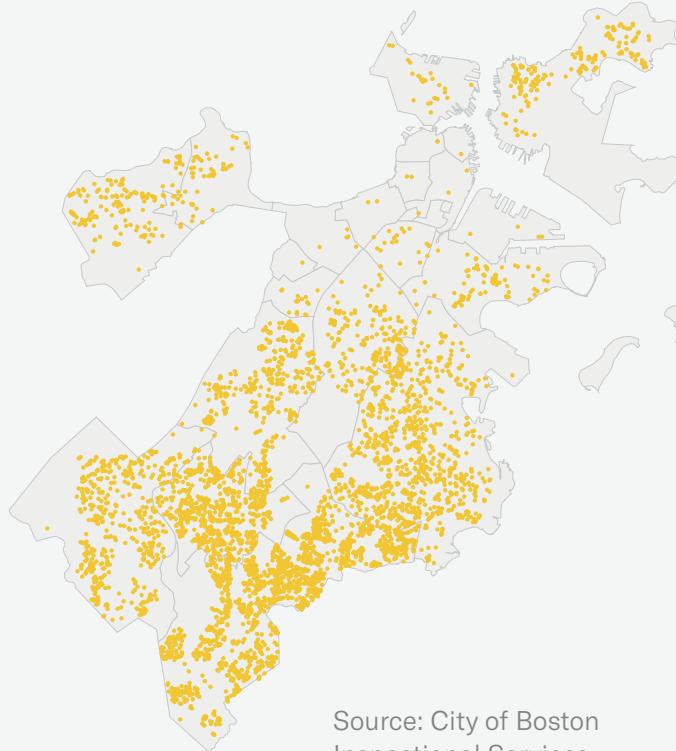
Twenty percent of the Commonwealth's electricity comes from solar. Boston's Community Choice Energy brings an extra 10% to participating homes and businesses. Solar (6 GW) and wind (1.5 GW) across the region will need to grow 10 and 20-fold respectively to decarbonize the grid and support electrification. More rooftop solar reduces the need for land-based solar.

Share of Massachusetts electricity generation by fuel or resource.⁷⁵



Source: U.S. Energy Information Agency Form EIA-860⁷⁵

Location of solar installations in Boston⁷⁶



Source: City of Boston
Inspectional Services
Department Permit
Database⁷⁶

Equity Implications & Indicators

Cost of Electricity: Policy and implementation strategy need to ensure that low-income households are not burdened by high rates.

Adoption of Rooftop Solar: Low-income and rental households currently lag in terms of rooftop solar adoption,^{27,76,83} which will put them at a financial disadvantage as the benefits of such systems grow.

Big Lifts

Retrofitting the Small Building Stock: 55 MW of solar has been installed on 3,500 buildings in Boston (Figure 7). As much as 1,100 MW could be installed on 66,000 buildings in the city—the vast majority of which are single-family and small multifamily homes.⁸⁴

Local Energy Planning: Scaling rooftop solar and the need to bring in renewable electricity to meet growing demand will require distribution system upgrades within the city.

ELECTRIFIED MOBILITY

Phase out the use of non-zero emissions vehicles and deploy accessible charging infrastructure.

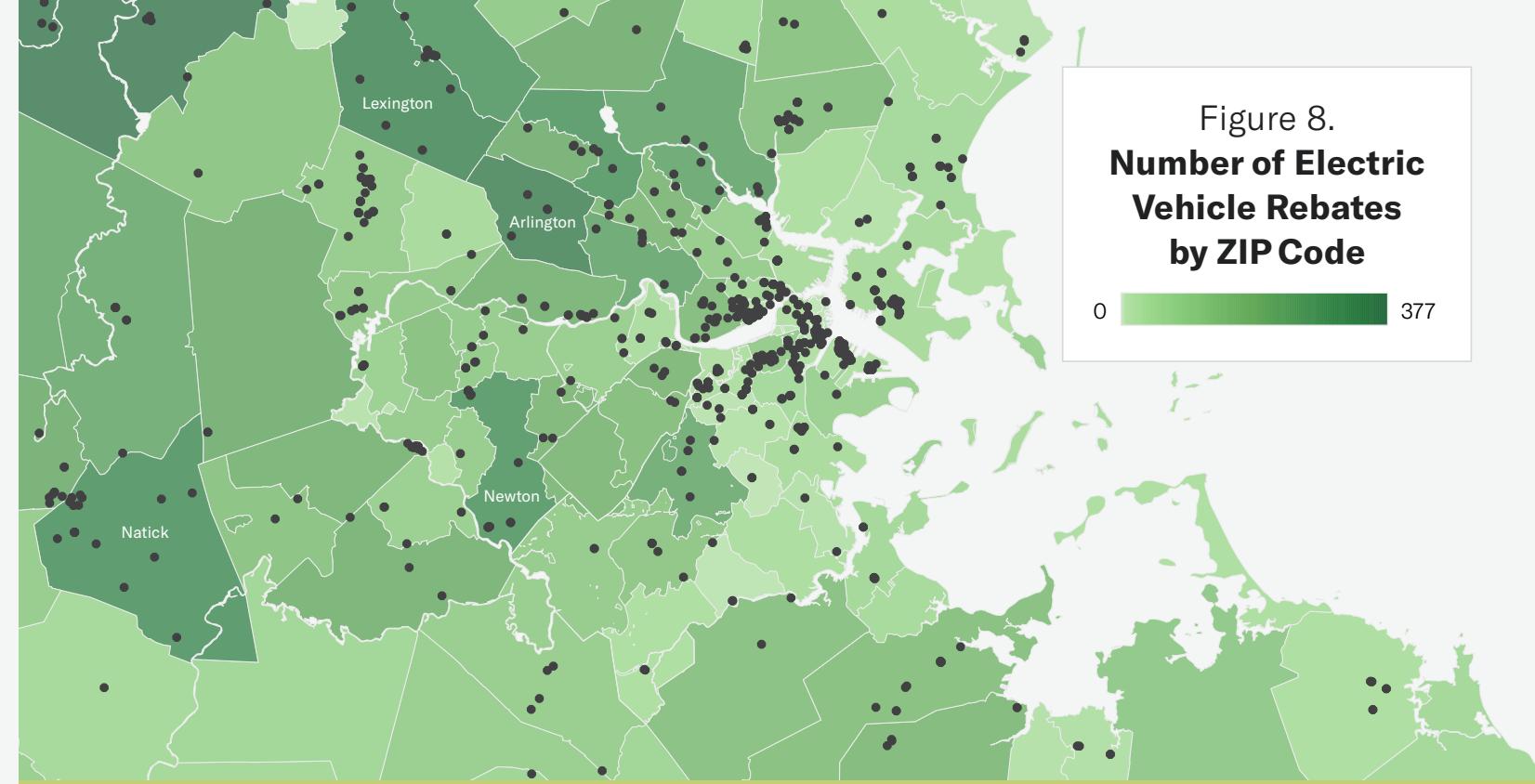
Connecting Outcomes to Goals

Net-Zero Emissions	Resilience	Increasing Social Equity
Increased electrification of private and public transportation reduces fossil fuel emissions.	The batteries of some vehicles can support grid resilience.	Tailpipe emissions are reduced in frontline neighborhoods, particularly if the transition is supported by actions focused on deployment in frontline neighborhoods.

Progress Assessment

The state will follow California's lead in phasing out gas light-duty vehicle sales by 2035 along with heavier vehicles over a slightly longer time horizon.^{30,31} Industry trends in vehicle costs and generous state³⁰ and federal³⁷ incentives are anticipated to ease the transition for vehicle owners—which may contradict efforts to reduce vehicle reliance. The state and City of Boston have begun efforts to electrify transit³⁰ and school bus⁸⁶ fleets. The city has been a hotbed of experimentation in innovative EV policy such as the MassCEC-sponsored Good2Go affordable EV carshare which has sought to expand access to EVs.⁸⁷

While these actions will accelerate the transition to EVs, the pace of change in Boston will be determined by the ability to build sufficient charging infrastructure. The City is partnering with Eversource's Make Ready program to install public chargers at municipal lots and has required large new developments with parking spaces to have some EV charging infrastructure.^{88,89} City, utility and property owner collaboration will be necessary to scale up street charging and charging in private lots. The City's *Zero-Emission Vehicle Roadmap*⁹⁰ lays out a robust plan for implementing this; however, the report notes that there are funding gaps along with technical and feasibility barriers to deploying charging in the public realm.



Electric vehicle rebates by ZIP Code (green shades) under the state's MOR-EV program,⁸⁵ public charging locations (black dots) as reported by the Alternative Fuels Data Center. (U.S. Dept. of Energy).

Equity Implications & Indicators

EV Adoption and Access to Charging

Resources by Location: MassDOT will begin to report annual vehicle class registrations and presumably rebates with neighborhood precision for more robust tracking and infrastructure planning.³⁰ These data sets should be used to understand how adoption in these communities is proceeding.

Big Lifts

Local Energy Planning: Ensuring access to charging for all residents is essential for widespread adoption. Further, the potential cost and delays in contracting the MBTA's Quincy bus garage project—built to support electric buses—is a concerning sign that deploying the necessary charging infrastructure and grid upgrades will be a serious challenge.⁹¹

By January 2022 EVs comprised:

0.5%
of Boston's cars

3%
of Lexington's cars

0.5%
of Massachusetts cars

EQUITABLE HOUSING AND MOBILITY

Build more housing near transit and within the urban core. Accelerate strategies to reduce vehicle reliance and ownership by growing alternative travel modes and reshaping the street to prioritize the needs of people over vehicles.

Connecting Outcomes to Goals

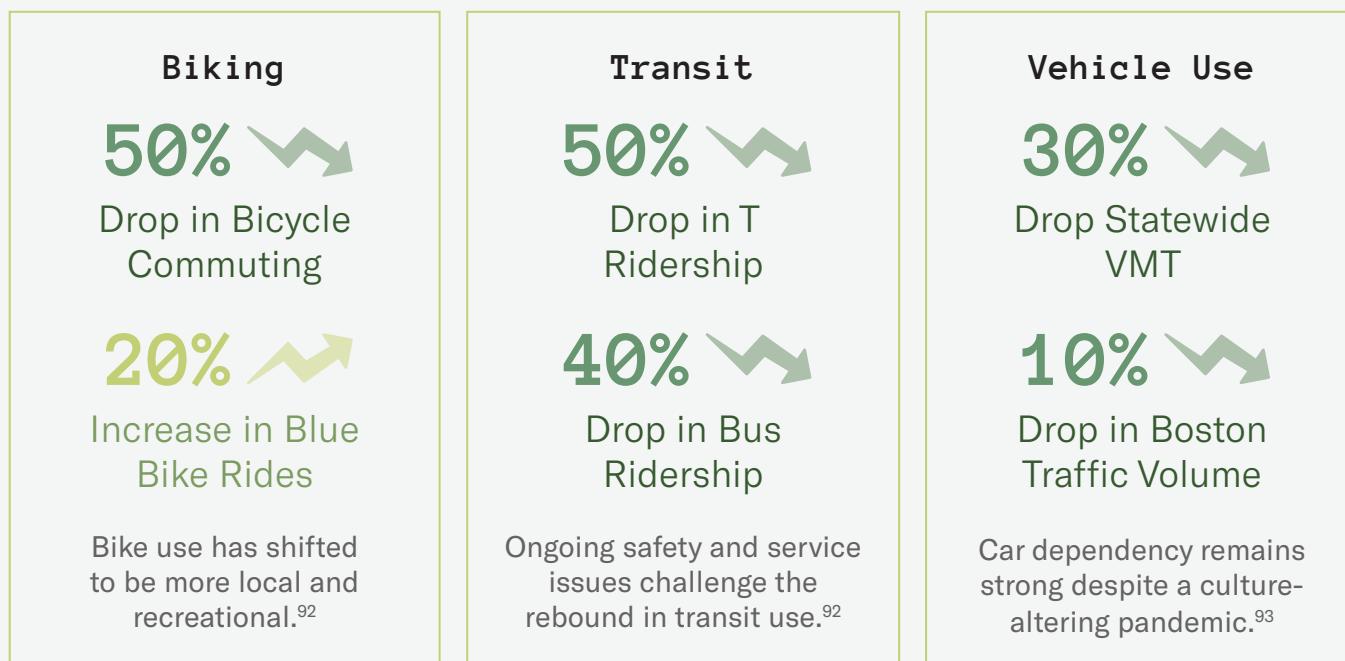
Net-Zero Emissions	Resilience	Increasing Social Equity
Urban lifestyles that are less dependent on personal vehicles have lower emissions and are more sustainable.	New construction can enhance resilience. Complete, people-focused streets help to make more connected and resilient communities.	Increased housing supports affordability and reduces displacement. Prioritizing moving people over cars improves access to mobility for those without cars.

Progress Assessment

The metro Boston region is not producing enough housing, nor does it have a functioning transit system that can reliably support efforts to reduce vehicle reliance. Between 2016 and 2020, the pace of housing construction was half that targeted by the Metropolitan Mayor's Coalition—a partnership of 15 urban core communities, including Boston.¹⁵ Community opposition has made it difficult to build housing outside the core despite many of these communities having access to the commuter rail system. This failure to provide housing for people in places they want to live is a primary driver of inflated housing costs and often pushes people further away from walkable, bike-able, or transit accessible areas.

Simultaneously, the state's historical under-investment in and inadequate management of the Greater Boston region's public transportation system undermines confidence in the system's ability to contribute to meaningful emissions reductions. Despite little progress in discouraging driving and providing adequate public transit, the region has seen applaudable but gradual progress in promoting "complete streets" and alternative mobility.⁶⁵ Notably, the deployment of rapid bus lanes has improved transit service, while several fare-free routes have resulted in increased ridership and

Figure 9. The shift to work from home has markedly changed commuting patterns.



Source: MassDOT Mobility Dashboard and Bluebikes system data.

lower transit burdens. The city is developing an e-bike incentive program, which, coupled with efforts to safely support riders, could potentially lead to a revolution in how people travel.

Equity Implications & Indicators

Develop Localized Indicators: Growing the housing stock to reduce vehicle reliance is likely to be the most impactful locally focused strategy for fighting climate change and increasing social equity. The annual Greater Boston Housing Report Card provides a rich set of indicators for evaluating progress on this front.

Mobility needs will vary by neighborhood, and measuring progress on meeting these needs calls for numerous location-specific indicators spanning transit access, vehicle reliance, and alternative mobility infrastructure, among others.

Big Lifts

Build More Housing and Address the Region's Transportation Crisis: This big lift goes far beyond the scope of this report, but cannot go without mention. Fundamentally, the pace of housing construction is too slow to fight climate change, and there is no concerted effort to evolve the region toward meaningfully reducing its reliance on private cars. The lack of progress in these overlapping areas is a lost opportunity to reduce emissions. This report acknowledges the importance of these actions, notes that the inability to do them is a systemic failure, but struggles to offer any recommendation beyond those made before and not acted on.

Prioritize Reparative Planning for Boston's Frontline Neighborhoods: In the absence of regional action on transit, the opportunity remains to reduce reliance on personal vehicles by improving neighborhood planning for complete and improving bus routes serving these neighborhoods.

ELECTRIC AND EFFICIENT BUILDINGS

Electrify buildings while updating them for energy efficiency, comfort, and resilience.

Connecting Outcomes to Goals

Net-Zero Emissions	Resilience	Increasing Social Equity
Electrification eliminates on-site fossil fuel emissions. Buildings with energy generation, storage, and flexibility serve as a grid resource.	Heat pumps provide cooling to homes that would otherwise not have an air conditioner. Well-insulated airtight buildings hold temperature longer in the event of a power outage.	Retrofits deliver health, safety, and comfort benefits to buildings that may have been otherwise neglected. Reducing the cost of housing can make electrification more affordable.

Progress Assessment

A historical emphasis on energy efficiency has kept building sector emissions flat over the past 15 years despite significant growth in the building stock (Figure 3, on page 38).²⁶ While this reflects Boston's and Massachusetts' recognized leadership in energy efficiency,⁷⁵ large scale electrification and deeper levels of energy efficiency are needed. These would bring various long-term benefits but have high up-front costs, a dynamic that results in a funding gap that needs to be filled. An unprecedented level of state and federally sponsored financial incentives and enabling programs in the 2022–2024 MassSave Plan⁹⁵ and the IRA³⁷ could close this gap; however, scaling requires overcoming inertia and addressing knowledge gaps with customers and contractors to build up supply chains and workforce.

The City's adoption of BERDO 2.0 created a framework to align large buildings with its net-zero goal to overcome this inertia. While this has prompted Vicinity, Downtown Boston's steam provider, to electrify its steam production, clear technical pathways for other buildings have yet to emerge. The City's application⁹⁶ to pilot a zero emissions new building code sends another important signal that will accelerate efforts to electrify the existing building stock—such action builds on the Boston Planning & Development Agency's success in integrating resilience into the development process.^{59,60}

Most historical efficiency gains have been in the large building stock, which includes most public housing. Various financing, incentive, knowledge, and access barriers make it hard for efficiency programs to achieve similar rates in single-family and small multifamily homes. Such barriers will continue to challenge efforts to electrify and attain deeper energy efficiency gains, such as the adoption of heat pumps (Figure 10).

Equity Implications & Indicators

Retrofits by Home: Electrifying homes may bring modest cost increases in the near term, but protect households from long-term increases in the cost of gas.^{23,97} Associated improvements bring health, safety, resilience and comfort benefits. Funding gaps can be alleviated by incentives that reduce the cost of housing or the cost of energy. Integrated data from utilities, MassSave, and the City could be used to track risk of potential energy cost burdens associated with transitioning away from oil and gas. Retrofits in flood prone areas also need to be resilient to climate risks.

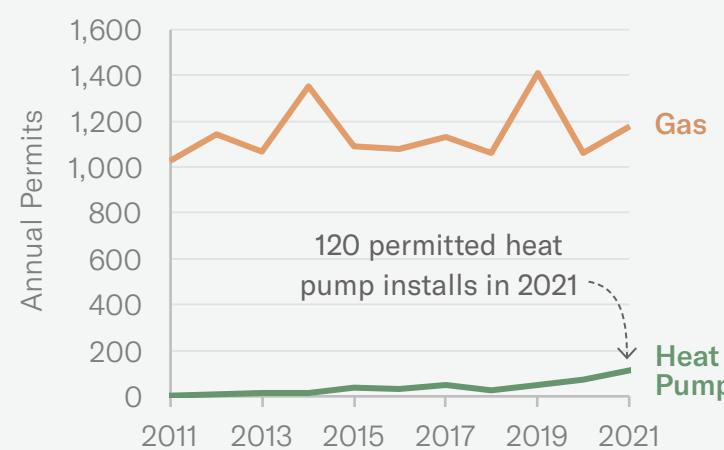
Big Lifts

Retrofitting the Small Building Stock: With BERDO 2.0 regulating the large building stock, attention must be given now to the challenge of the small building stock due to its volume, complexity, and dependency on an aging gas distribution network.

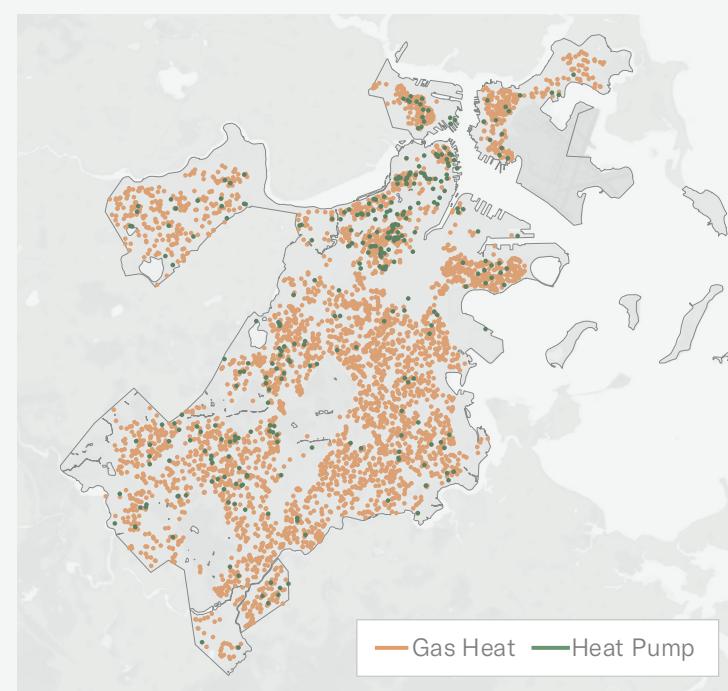
Figure 10. Heat Pump vs. Gas System Installations, 2011–2021

Heat pump installs dramatically lag gas furnace replacements, and are most often done in owner-occupied homes.

Permits granted for select energy system intervention by Boston's Inspectional Services Department from 2011–2021 for single families, two families, and three-family homes.



Gas heating system and heat pump permit for all residential buildings from 2018–2021.



Source: City of Boston Inspectional Services Department⁷⁶ and Property Assessment²⁷ databases

GREATER INTEGRATION OF ENERGY SYSTEMS

The utility-owned electric distribution grid must be modernized to support electrification, share the solar power generated on its roofs, and ensure resilience. Simultaneously, developing and sharing alternative thermal energy resources—such as the earth, nearby water bodies, and waste heat—can efficiently displace fuel-based heating.

Connecting Outcomes to Goals

Net-Zero Emissions	Resilience	Increasing Social Equity
Integrated energy systems shift energy supply and demand across time and space to more optimally serve energy needs with diverse resources.	Modernized and more deeply integrated energy systems better withstand disruptions such as extreme weather.	Modernized electricity systems will improve service to formerly neglected communities and provide opportunities for cost savings.

Progress Assessment

Boston's grid today cannot support the demands of electrification and the growth of distributed energy resources such as rooftop solar.⁹⁸ Some efforts to meet growing demand have faced community opposition.⁹⁹ Opportunities exist for sharing thermal energy and resources (e.g., ground and water); however, utility-led pilots have been evolving slowly¹⁰⁰ and innovative non-utility examples are non-existent. State regulatory law has limited the City's ability to drive forward such integrated solutions in new developments to demonstrate both the technology and partnerships necessary to create modern energy systems.^{101,102} Such action is limited by the conflicting interest of Boston's regulated utilities, the jurisdictional constraints that limit the City's ability to promote new integrated energy systems. While the City has an office that has been actively engaged in energy planning for some time, its capacity will need to be greatly scaled to meet the needs of a rapidly transitioning city.

Equity Implications & Indicators

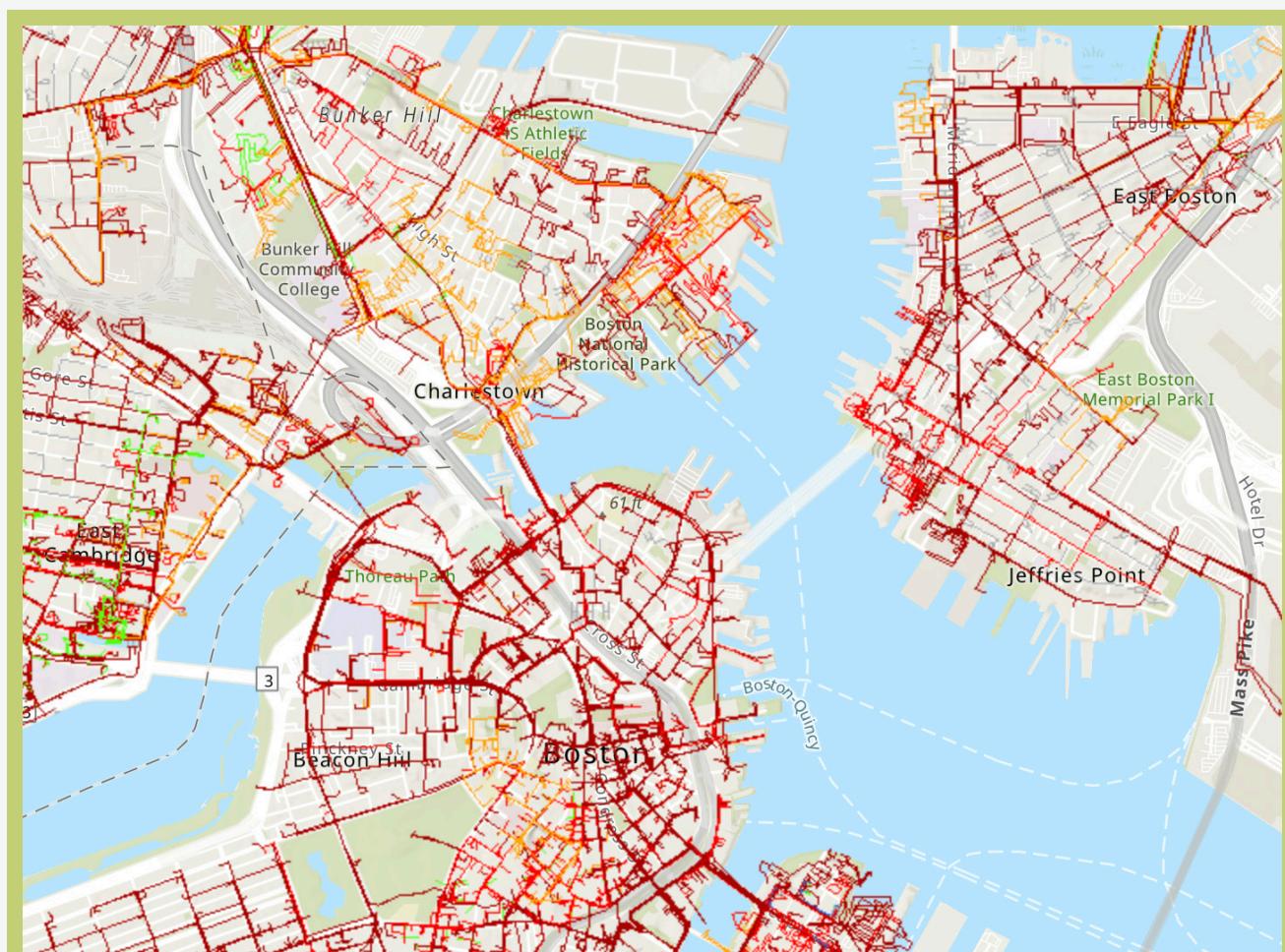
State of Energy Infrastructure by Neighborhood: A legacy of environmental burdens in frontline communities and underinvestment in energy systems requires restorative justice through planning that ensures that these communities receive the benefits associated with modernized infrastructure. More transparency from utilities on the state of energy supply systems across the city can help to shed light on potential disparities.

Big Lifts

Local Energy Planning: Integrating energy systems for net-zero emissions and resilience requires more active local planning to better meet local needs, leverage local energy resources, and build support for new infrastructure. Energy planning is currently conducted at the state level by the Department of Public Utilities. Providing more avenues, powers, and resources for local planning should aim to accelerate the integration of energy systems by better identifying opportunities and roadblocks to energy system modernization.

Figure 11. Much of Boston's distribution grid will need to be upgraded to support solar generation and increasing electricity demand.

Eversource distributed generation hosting capacity map⁹⁸ for Charleston, Downtown, and East Boston. Colors in bright or dark red reflect sections of the electricity distribution grid that do not have the capacity to accommodate a significant amount of rooftop solar or other distributed energy resources.



TARGETED AND MODEST USE OF FOSSIL AND ALTERNATIVE FUELS

Fossil fuel use must drastically decline by 2050; however, modest judicious use of fossil or alternative fuels (e.g. bioenergy) will be needed to support low-cost reliability and resilience.

Connecting Outcomes to Goals

Net-Zero Emissions	Resilience	Increasing Social Equity
Deploying wind, solar, and electrification achieves mitigation goals by displacing fossil fuel use. However, fuels are needed to support low-cost energy reliability when solar and wind production is insufficient.	Fuels can help support energy system resilience at the grid and local (or building) scales. ^{29,103}	Limited fuel use has a role to play in ensuring low-cost, low-burden, and high resilience. The siting of such use needs to factor in past harms and future impacts.

The iconic Corita Kent painting on a Dorchester LNG tank has survived 40+ years, three utility owners and two tanks. Infrastructure can be beautiful, but needs to be sited carefully. (Source: Imgur)



Progress Assessment

Fuel use across all sectors has not declined in a manner consistent with Boston's goals. Further, there is a tension among views that fuel consumption must drastically and rapidly decline, that some sectors (e.g., aviation) are unlikely to be fully electrified, and that modest use of some fuels is necessary to maintain reliability and resilience at low costs.^{29,103} In the transportation sector, the role of fuels relative to electrification will likely be defined by technological and market factors. In the electric sector the technical feasibility of moving to a predominantly renewable grid is a concern. ISO-NE is planning¹⁰⁴ to ensure that there will be sufficient fuel-based electricity generation to support the scaling of wind and solar to meet increasing electricity demands, but reliability needs should not be used to delay or disadvantage the growth of renewable resources. In the building heating sector, a DPU-led investigation¹⁰⁵ into the future of gas has yet to produce a viable plan for managing the transition away from gas. The legislature has since taken a more active role in this planning given the conflicting interests of the utilities in planning their future.³⁰ Rightsizing the gas system will be essential for managing costs¹⁰⁶ and fugitive methane emissions, which continue to be a pernicious problem despite efforts to reduce leaks.³²

Equity Implications & Indicators

Siting of Fuel Infrastructure in Frontline Communities:

Modest use of fossil fuels in a net-zero energy system reduces energy costs; however, continued combustion can impact frontline communities. While the scale of fuel use and infrastructure will decline by 2050, efforts to mitigate the impact of remaining infrastructure ensures equitable outcomes.

The development of a plan to right-size the gas system is essential for ensuring that those with the least agency to leave the gas system do not bear the burden of transition costs.

Big Lifts

Local Energy Planning: Local planning can improve outcomes surrounding existing and future fuel infrastructure, by more optimally using local resources and ensuring that such infrastructure does not unduly impact vulnerable communities.

SUSTAINABLE WASTE MANAGEMENT

We need to produce less waste while shifting to more sustainable waste treatment practices. These practices include locally sited material and energy recovery processes such as composting and technologies that convert organic waste to gas, electricity, or liquid fuels.

Connecting Outcomes to Goals

Net-Zero Emissions	Increasing Social Equity
Reducing waste incineration reduces emissions. Energy recovery from organic waste can provide a modest amount of renewable fuels that can be used to displace fossil fuels.	Reducing incinerated waste reduces pollution levels in impacted communities. Future waste processing facilities will need to consider past harms in siting decisions.

Figure 12. Boston's waste is shipped to incinerators adjacent to distant environmental justice communities. Future sustainable management may necessitate some treatment within Boston's boarders.

Locations of incinerators to which Boston sends its trash. Each incinerator is located in or is adjacent to an environmental justice community.¹⁰⁷ Boston's curbside-collected organic waste is shipped to Lawrence just to the left of the northernmost arrow.



Progress Assessment

Boston's municipal solid waste is another place's problem: It is shipped to incinerators located miles away to be inefficiently turned into emissions, ash, and electricity (Figure 12). Mounting regional waste production and reliance on aging incinerators will challenge this approach as costs and the need to ship further increase. Boston's Zero Waste Plan¹⁰⁸ and the state's 2030 Solid Waste Master Plan³⁶ both seek to avoid this outcome with ambitious targets for waste reduction and diversion. In the absence of a transformative state legislation to better manage single use plastics—such as that adopted in Maine and Oregon requiring manufacturers to bear some of the cost of waste management—Boston is unlikely to achieve its zero-waste goal¹⁰⁸ and the associated reductions in emissions from waste. Increased recycling and the City's plastic bag ordinance, although commendable, simply do not have the scalability to make an impact on waste sector emissions.

Still, Boston, with the help of its residents, can smartly manage a significant portion of its waste to support net-zero goals. The City is piloting residential food waste curbside collection,¹⁰⁹ building on the success of Cambridge and state-mandated¹¹⁰ commercial efforts to collect and sustainably treat organic waste. The increasing collection of organic waste across the region will require the development of composting and energy recovery facilities in a way that balances costs, siting constraints, transportation distance, energy needs, and community impact. Energy recovery may include: existing technologies such as anaerobic digestion, which has specific siting challenges; or emerging ones that may be more advantageous, but by being largely unknown will be viewed by the public as being more risky.

Continuing existing and pursuing new waste treatment pathways will involve tradeoffs between advancing progress and managing undesirable outcomes. Efforts to advance these approaches have faced conflicting interests among stakeholders, particularly with respect to siting new waste treatment infrastructure and transporting waste through communities.^{111,112} The City of Boston will soon be leveraging \$3 million in funding to explore municipal infrastructure for food waste disposal and a center for hard-to-recycle materials.

Equity Implications & Indicators

Waste Diversion: Diverting waste away from incinerators will demonstrate that Boston is lowering its impact on communities burdened by Boston's waste.

Future waste treatment facilities must be planned and sited in a way that does not unduly burden frontline communities.

Big Lifts

Local Energy Planning: Proactive local energy planning will be essential for siting future waste energy recovery facilities.

RESPONSIBLE CARBON DIOXIDE REMOVAL

Support the scaling of technologies to extract carbon from the atmosphere and permanently store it in geologic or natural stocks.

Connecting Outcomes to Goals

Net-Zero Emissions	Resilience	Increasing Social Equity
Removing carbon from the atmosphere mitigates the impact of unavoidable and historical emissions.	Removals are the final mitigation step to avoid catastrophic climate change. Some nature-based approaches enhance ecosystem resilience.	Removals are essential for fulfilling global climate equity once mitigation is exhausted, but premature efforts come at a cost of local climate equity.

Progress Assessment

Carbon dioxide removal (CDR) is not a substitute for a rapid reduction of greenhouse gas emissions from fossil fuel use. Eventually, CDR will be a necessary complement to Boston's greenhouse gas mitigation efforts to roll back the impact of past and unavoidable future emissions. Boston has been responsible for generating greenhouse gas emissions for two centuries and is locked in to doing so for years to come. CDR is a mechanism to eventually repair this legacy. Yet, there is no capability to directly facilitate CDR within the city.

Frameworks for meaningfully incorporating CDR into climate goals likely will evolve at state and national scales. Currently many organizations voluntarily procure offset credits from CDR projects to claim that they are a net-zero entity. Some Boston area institutions are regrettably pursuing this non-strategy to claim to be "climate neutral"¹¹³ or "net zero."¹¹⁴ This type of premature CDR—and especially that which relies on dubious offset crediting programs^{115,116}—misses opportunities to realize local co-benefits of emissions reductions by diverting investment away from local action. Leading organizations have instead sought to fill a gap in federal action by stimulating the development of high-quality CDR.^{117,118} These exemplars focus less on accounting and crediting and more on facilitating the growth of CDR.

Only when local emissions reduction efforts approach maturity can robust CDR practices contribute to global climate justice by repairing past harms. Society needs to be prepared to subsidize removals for the sake of achieving global climate justice.

By 2050, removals should match residual emissions. After 2050, removals will need to rise relative to residual emissions. This net negative phase is essential to rectifying past emissions in order to avoid the worst impacts of climate change;⁶¹ however, the ability of these strategies to cost-effectively scale is uncertain. All CDR strategies involve various cost, resource, energy, and ecosystem tradeoffs.¹¹⁹ Given tradeoffs associated with various CDR strategies, they must be deployed in a way that avoids exploitation of communities that will host CDR.¹²⁰

People understand the urgency; they need agency. Climate march. (Source: Li-An Lim/Unsplash)



Equity Implications & Indicators

Removals: When efforts to mitigate emissions are exhausted, Boston's investment in removals are an indicator of additional action to pursue global climate justice.

Big Lifts

There is no big lift at this time. Aside from appropriately supporting research and development of CDR, Boston should focus on direct emissions reductions first as they bring local and global benefits. Pursuing removals will require a lift that recognizes the need to repair the impacts of past and currently unavoidable harms that place the world's vulnerable at risk.

ROBUST AND RESILIENT URBAN FORESTS

Boston must better manage its trees and natural spaces to ensure they grow and provide enhanced benefits to their communities in a changing climate.

Connecting Outcomes to Goals

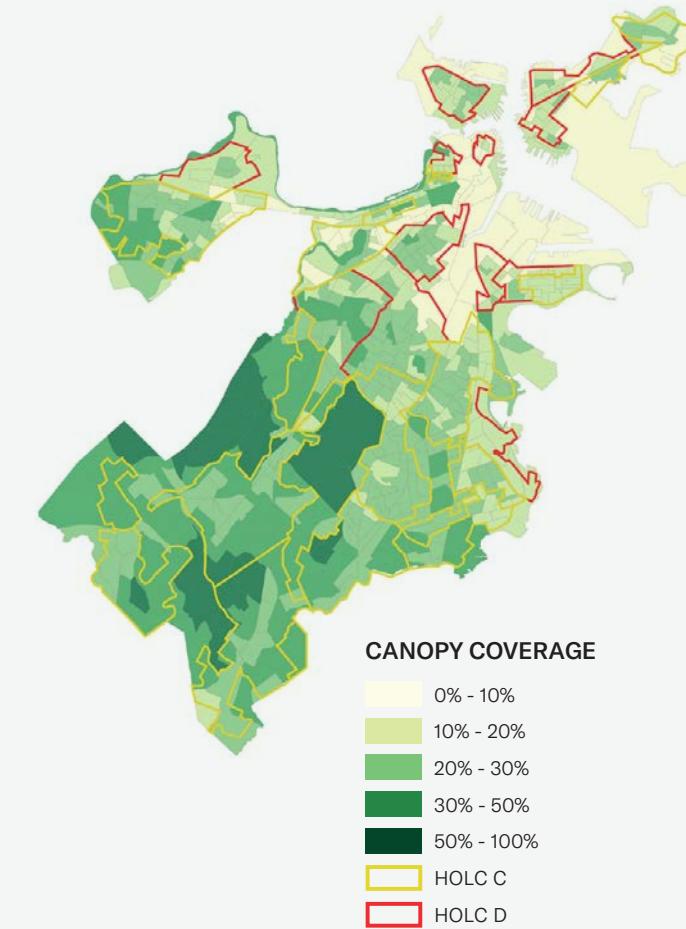
Net-Zero Emissions	Resilience	Increasing Social Equity
Planting more trees removes a modest amount of carbon from the atmosphere but is not a scalable net-zero strategy.	Trees provide a cooling effect while healthy soils can support stormwater management.	Expanding tree canopy and green spaces in frontline communities counteracts past neglect, improves air quality, and offers health benefits of proximity to nature.

Progress Assessment

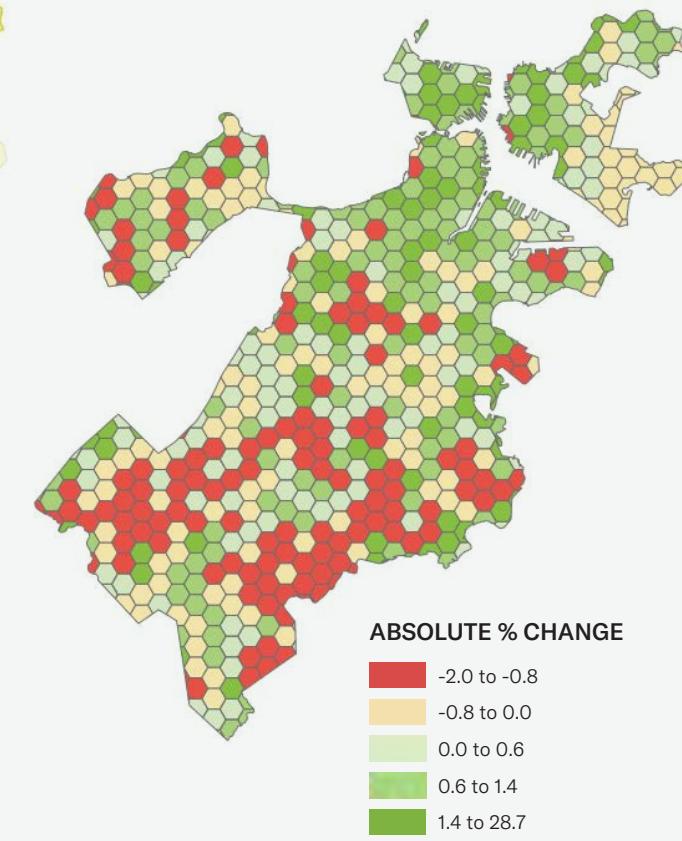
Boston's tree canopy varies by neighborhood. Historically redlined neighborhoods have lower average canopy coverage (Figure 13 left).¹²¹ Between 2014 and 2019 Boston's tree canopy experienced roughly the same amount of growth as losses.¹²² Changes were broadly distributed across the city (Figure 13 right), with losses concentrated in areas with significant tree canopy, and gains mostly realized in areas with low canopy. The City of Boston's Urban Forest Plan¹²¹ provides a needed strategic roadmap for expansion of the city's trees and natural spaces with a particular focus on neighborhood-level action. Despite the clear need to better manage the urban forest and the commitment from the City, tradeoffs in various land use priorities that reflect conflicting interests among community members will continue to emerge in parks, in housing communities, and along roads.^{123,124,125}

Figure 13. Preserving and enhancing the urban forest requires addressing past harms while building resilience and improving neighborhoods for future generations.

Tree canopy coverage by census tract with overlay of Home Owner's Loan Corporation ("redlining") map.¹²¹



Absolute tree canopy change, 2014-2019.¹²²



Equity Implications & Indicators

Tree Canopy Growth in Underinvested Neighborhoods: Areas that currently have low levels of tree cover should be prioritized for preservation and enhancement of the natural carbon stock to maximize benefits of heat reduction, soil repair, and air quality improvement.

Big Lifts

Prioritize Reparative Planning: Attention must be given to neighborhoods that have seen their urban forests languish by neglect.

PROTECTION OF THE COASTLINE

Maintain ongoing implementation of coastal resilience strategies across Boston's and the region's coastline. These include nature-based and hard engineered flood and sea-level rise infrastructure to reduce the risk of coastal and riverine flooding, with the aim to protect all neighborhoods.

Connecting Outcomes to Goals

Resilience	Increasing Social Equity
Coastal infrastructure effectively protects Boston from sea-level rise and storm surges.	Safeguarding the shores protects residents of all neighborhoods especially those who are often most at risk during an emergency. Sufficient safeguards reduce the risk and cost (e.g., insurance) of housing.

Progress Assessment

A study of barrier systems for managing sea-level rise recommended that the region focus on shore-based protection rather than more ambitious harbor-wide strategies. Local climate resilience plans have been developed for Moakley Park,¹²⁷ Charlestown,⁵⁵ South Boston,⁵¹ and Dorchester,⁵² and Phase II plans for East Boston and Charlestown were completed in August 2022. Other City-led initiatives, including community outreach, zoning policy, and frameworks for project prioritization have been adopted.

The private sector, which owns much of the coastline, is doing reasonably well in complying with Climate Ready Boston guidelines and providing some public benefits, mostly in the form of access to the water and open space. In some cases, private developers are providing flood protection that will protect adjacent inland properties, but responsibilities for integration between and across properties to provide a continuous line of defense are not always clear. Likewise, questions about who benefits and who pays for measures that protect both shoreline property and inland areas vulnerable to flood pathways through those properties need to be resolved.

Funding gaps have slowed progress in developing infrastructure; however, recent federal climate and infrastructure legislation will provide new funding streams.^{37,38,39}

Effective use of new federal and state resources will depend on having sufficient City staff support to overcome institutional inertia. To this end, the City has hired a director of green infrastructure to create a green infrastructure working group and focus on the resilience needs of Chinatown, East Boston, Mattapan and Roxbury.

Jurisdictional limitations challenge coastal resilience projects due to the need for approvals from various state agencies, while action on private property is largely out of reach. The City can only act on property it owns and much of the city's coastline is privately owned. Conflicting goals between the City and various state agencies granting permits is slowing progress, particularly for nature-based solutions.

Equity Implications & Indicators

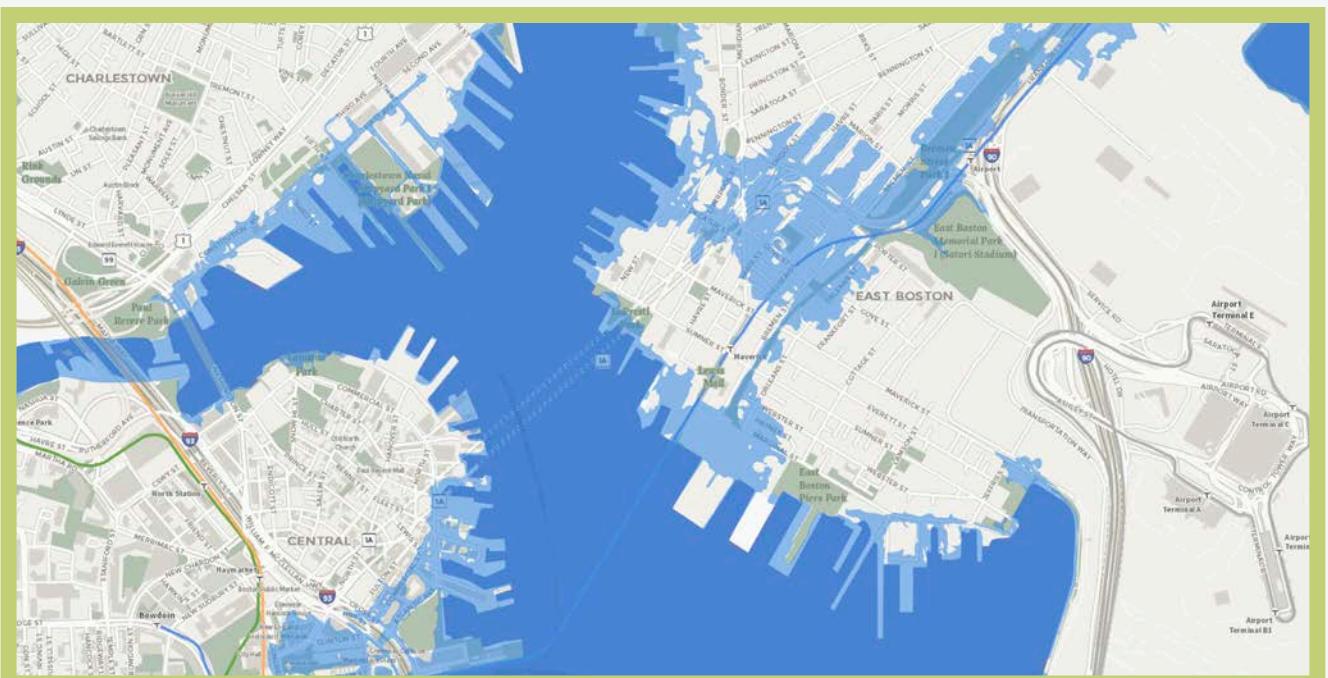
Investments and Community Input: Planning for resilience must ensure that frontline communities are protected, a priority of the Wu administration. Metrics detailing investments and progress toward meeting self-defined neighborhood needs should be used as indicators of equitable progress.

Big Lifts

Building a Resilient Coastline: Management of the coastline and a steady-but-insufficient stream of funding requires an agency that can fund and implement projects on the entire Massachusetts coast.

Prioritization of Reparative Planning: Represent and incorporate the various interests of frontline neighborhoods in developing and implementing neighborhood plans for emergencies.

Figure 14. Projection of the extent of high tide in 2070¹²⁶



Source: Climate Ready Boston Map Explorer

PREPARATION FOR EXTREME WEATHER

Plan and develop the storm-water, energy, transportation, and emergency support systems in both public and private spaces.

Connecting Outcomes to Goals

Resilience	Increasing Social Equity
Preparedness for extreme weather is a hallmark of resilience along with the abilities to withstand and recover from adverse events, using both physical and social measures.	Prioritizing the needs of frontline communities ensures they have access to the necessary protections to weather extreme events.

Progress Assessment

Boston has not experienced a recent catastrophic weather-induced event. However, the COVID-19 pandemic and recent challenges of the MBTA system serve as harbingers of large-scale climate challenges. The pandemic raised the importance of healthy buildings, which will become more important as temperatures climb and mold-inducing flooding increases in likelihood. The city has taken steps to improve ventilation interventions in some buildings such as schools with a proposed \$2 billion investment in school infrastructure.^{129,130} The recent MBTA Orange Line shutdown highlighted the value of proactive emergency action, but also underscored the near-failed state of the region's transit system.

The City can require new construction be built with resilience in mind,⁶⁰ but jurisdictional limitations hold Boston back from developing non-utility shared energy infrastructure such as microgrids to support resilience objectives.

Rebuilding existing infrastructure faces cost and institutional inertia barriers at the state, city and neighborhood scales. Responsibility falls on the Boston Water & Sewer Commission to evaluate and act on threats to existing infrastructure, which it cannot do without additional funding. While the recent federal climate and infrastructure legislation^{37,38,39} will provide new funding streams, staffing limitations may hinder the City's ability to fully take advantage of these funds.

Equity Implications & Indicators

Neighborhood-Focused Risk Projections:

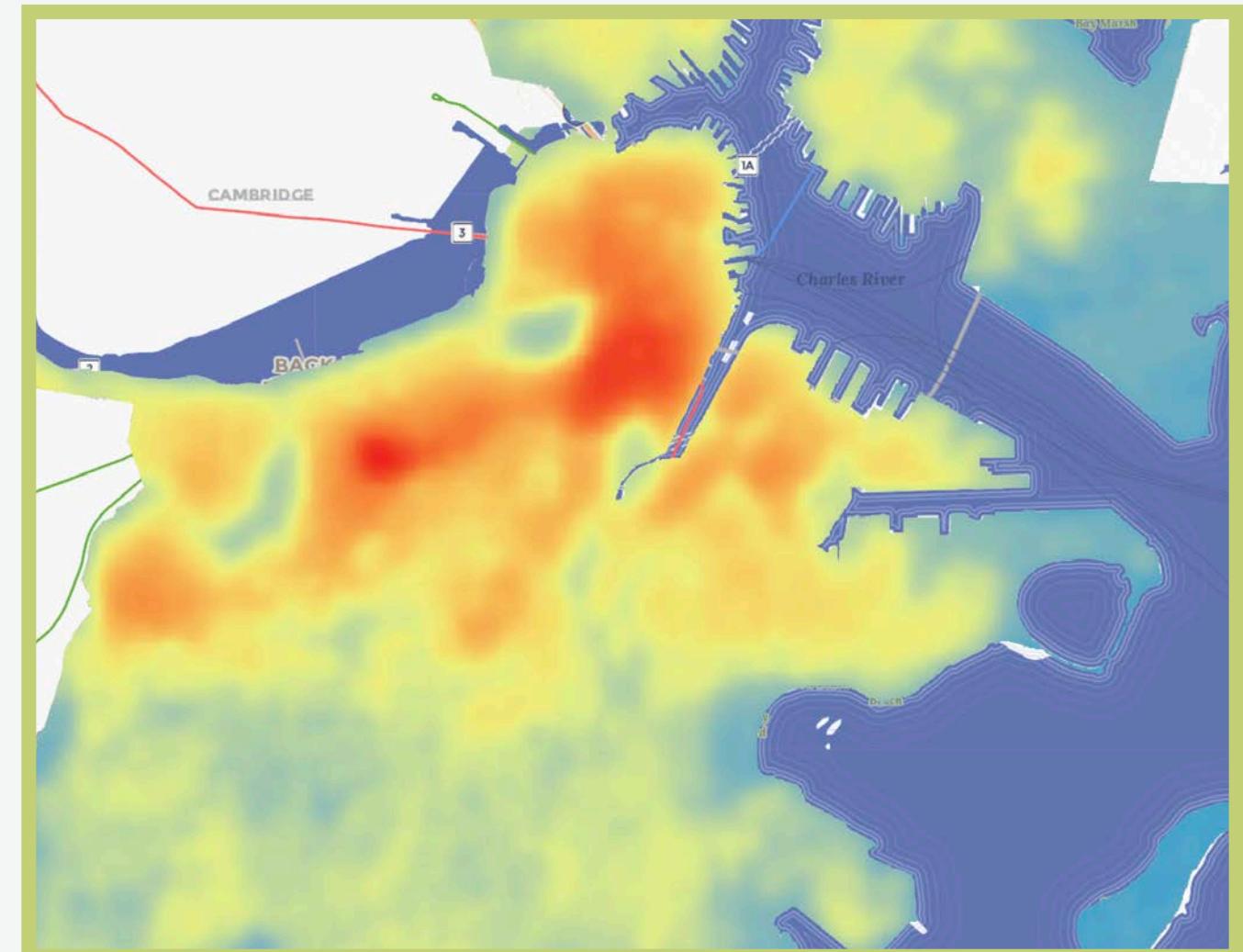
Regularly updating projections to reflect evolving risks, changing social needs, and infrastructure enhancements can help assess progress. These assessments occur through the City's ongoing Climate Ready Boston neighborhood plans, assessments, and updates.

Big Lifts

Local Energy Planning, Building a Resilient Coastline and Prioritization of Reparative Planning: All are necessary to prepare and protect Boston from the worst impacts of extreme weather with the aim of enhancing both physical and social infrastructure.

Figure 15. Urban heat island intensity

Urban heat island intensity—a metric combining the amount and extent of heat exposure—in central Boston experienced during extreme heat events in the 2010s.¹²⁸



Source: City of Boston

REPAIR OF PAST HARMS

Frontline communities have experienced a history of neglect and outright damage. To repair these harms, the City must initiate a planning process to mitigate emissions and make homes and neighborhoods more resilient.

Connecting Outcomes to Goals

Net-Zero Emissions	Resilience	Increasing Social Equity
Neglected housing stock is upgraded to be more energy efficient, healthy, and comfortable. Connected neighborhoods with sufficient access to services and transit reduce vehicle reliance.	All neighborhoods are protected from sea-level rise and storm surges. Green stormwater management and increased green space protect communities from flooding and urban heat island effect.	Residents are authentically engaged in establishing climate and related goals and metrics for assessing progress.

Progress Assessment

Mayor Wu has committed significant funding to increase the stock of affordable housing and improve public schools. Still, housing affordability,⁶⁶ disparities in the impact of the COVID-19 pandemic,¹³¹ and lingering environmental harms present barriers to bringing frontline communities to full health without displacement.

A lack of diversity in many sectors, particularly green technology, and a lagging career development pipeline means that full representation—and the trust that it brings—is years out. The private sector has been going through the motions of climate and diversity, equity, and inclusion work, but has failed to fully commit to fundamental political change at local, state, and federal levels necessary to repair past harms. Calls for more public engagement are increasingly common, but so is participant fatigue and inertia. Despite more transparent planning processes, monied nonlocal interests dominate in shaping the city. Communities are subsequently dissatisfied with outcomes. Boston's anchor institutions, particularly universities, also need to engage more in uplifting their surrounding communities.



Cooling an urban heat island in Chelsea, one block at a time. (Source: GreenRoots)

Equity Implications & Indicators

Reduced Burden of Past Injustices: This is the ultimate indicator, measured in climate terms by access to green affordable housing, increased mobility options, access to renewable energy, protection from sea-level rise, and overall neighborhood resilience.

Big Lifts

Prioritize Reparative Planning: A participatory reparative planning process is essential to creating a climate-just city aligned with Boston's climate goals.

Retrofitting the Small Building Stock: Electrify and reduce the energy burden of low-income small multifamily housing that has experienced decades of neglect.



04

BOSTON'S BIG LIFTS

WHAT IS A BIG LIFT?

A big lift is a multidecade mega-project that seeks to improve the city to align with its climate and equity goals.

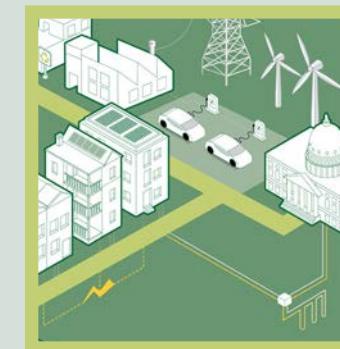
The assessment of outcomes needed to achieve Boston's climate goals identified several common and interlinked challenges. These are depicted at the start of this report (Figure 2, on page 24) and form the basis of what we identify as Boston's "big lifts" for this inaugural progress report.



Big Lift #1

Retrofitting the Small Building Stock

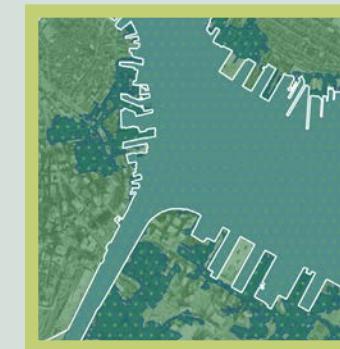
Not only do many small residential buildings need to be electrified, but they also offer opportunities to deploy rooftop solar and improve living conditions.



Big Lift #2

Local Energy Planning for an Electrified City

Developing low-carbon, resilient, reliable, and dynamic energy distribution systems requires new planning approaches for modernizing energy infrastructure.



Big Lift #3

Building a Resilient Coastline Through Improved Governance

Challenges in the governance of coastal protection and preparation for extreme weather events call for new frameworks for accelerating resilience investments.



Big Lift #4

Prioritize Reparative Planning for Boston's Frontline Neighborhoods

A century of marginalization based on race, income, and immigration status has given us neighborhoods where housing is inadequate, energy infrastructure is insufficient, residents are unduly exposed to unchecked fossil fuel and waste infrastructure, trees are few, cars are prioritized over people, and infrastructure unable to handle rising seas and intensifying storms.

A big lift requires funding, legislation at state and city levels, increased staff capacity at City Hall, coordination among community organizations, metrics and accountability frameworks, leadership by the private sector, and guiding support of residents. Those combined demands are a tall order, made more challenging by multiple barriers baked into the system (see table next page).

With federal funds starting to flow in and state climate policy starting to shape up, these big lifts are the local actions that are the most pressing and relevant for achieving the outcomes assessed in Part II.



President Joe Biden signs H.R. 5376, the Inflation Reduction Act of 2022, into law on August 16, 2022, which brings significant new resources to climate issues.

Bill signing in State Dining Room of the White House. (Source: Cameron Smith/The White House)

While these actions have not been neglected, they have not received the attention and effort needed to ensure adequate progress on achieving the goals reviewed in Part I.

Here, we give them that attention by summarizing and assessing the challenges that have hindered progress in these areas so far. Each section ends with proposed next steps for making the big lift. More comprehensive evaluations of each big lift are provided in supplemental chapters.

**Table 3.
Identified barriers to systematic action
needed to address climate change**

Barrier	Affected Outcomes
Conflicting interests	Transitioning to low-carbon electricity; electrifying transportation; integrating energy systems; strategic use of fossil and alternative fuels; reducing waste; carbon dioxide removal; protecting shores; neighborhood-based climate justice planning.
Contradictions	Transitioning to low-carbon electricity; neighborhood-based climate justice planning.
Jurisdictional limits	integrating energy systems; reducing waste; carbon dioxide removal; protecting shores.
Funding gap	Electrifying transportation; reducing vehicle miles traveled; integrating energy systems; protecting shores; extreme weather protection; neighborhood-based climate justice planning.
Misalignment of goals among policy or political actors	Transitioning to low-carbon electricity; electrifying transportation; extreme weather protection; neighborhood-based climate justice planning.
Unintended consequences	Strategic use of fossil and alternative fuels; neighborhood-based climate justice planning.
Technical feasibility	Transitioning to low-carbon electricity; strategic use of fossil and alternative fuels; reducing waste; carbon dioxide removal.
Knowledge gaps	Reducing vehicle miles traveled; neighborhood-based climate justice planning.
Inertia	Transitioning to low-carbon electricity; electrifying transportation; reducing vehicle miles traveled; protecting shores; extreme weather protection.

BIG LIFT #1

RETROFITTING THE SMALL BUILDING STOCK

70,000 single- and small multifamily homes need to be electrified by a new industry powered by a workforce that represents the communities it serves.

Many of Boston's homes have stood for almost a century, and while they were built to last, they were not built to keep in the heat and rely upon a sprawling and leaky natural gas system.

While that has been good enough for most residents, the continued use of natural gas for heating at current scales is inconsistent with achieving net-zero emissions. Recent geopolitical conflict and long-term investment needs also challenge it.¹⁰⁶ Those who have means can leave it behind, but in doing so may leave those without means holding the bill to maintain it.^{29,97}

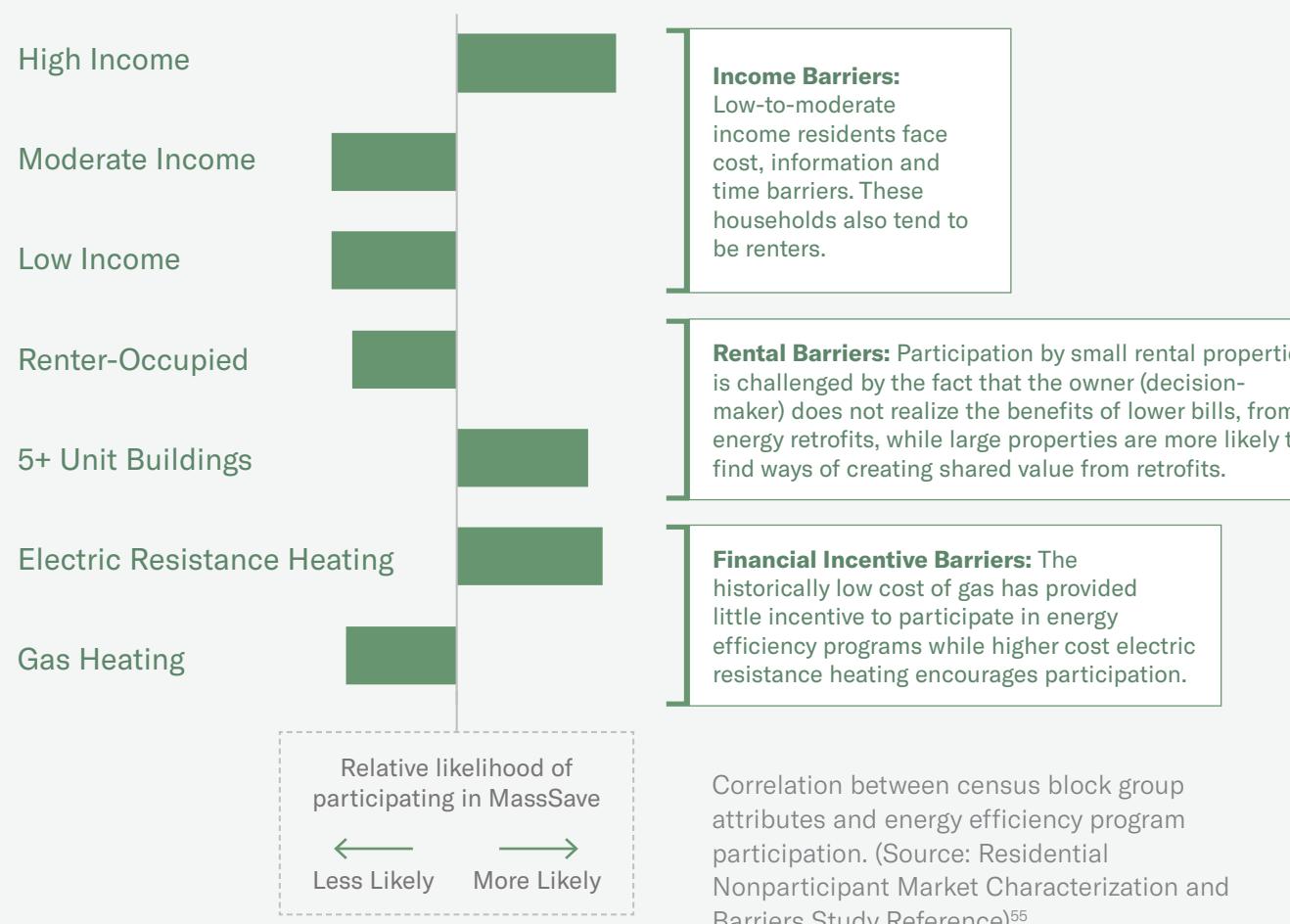
Figure 16. Changes to Boston's Small Residential Buildings



Retrofitting buildings can be achieved through the electrification of heat and cooking along with insulating and weatherizing the building envelope. Electrification does not need to happen all at once, but by 2050 most homes would need to be removed from the gas system using heat pumps, energy sharing, or some delivered fuel. It would also be beneficial to add EV chargers and solar panels along the way. Homes would be healthier, more comfortable, and more resilient.

This needs to happen in 70,000 single-family and small multifamily homes, and the collective ability to do so by 2050 has yet to be developed.

Figure 17. Boston's small homes face several barriers to participation in MassSave energy efficiency programs.



Massachusetts and Boston's nation-leading efficiency programs have been remarkably successful in reducing energy consumption in large buildings, including affordable public housing, but have faced significant challenges in touching the small residential stock (Figure 17). Boston's century-old iconic triple-deckers and small multifamily buildings face greater barriers⁸³ to accessing such programs; barriers that will continue to be problematic as the focus of energy efficiency programs shifts to electrification and deeper efficiency.

Slow adoption for energy efficient heating systems



100

Heat pump
installation permits.

1 dot = 100 permits. Source: 2021 Data Small Residential Buildings, Boston Inspectional Services Department Permit Database.⁷⁶

1000+

Gas system
replacement permits.

In 2021 just over 100 heat pump installations were permitted in Boston's single-family, two-family, and three-family homes (Figure 10, on page 67), continuing a steady—but still nascent—increase in adoption.⁷⁶ Most of these were owner-occupied. In most cases, the new electrified heating system was installed alongside, rather than displacing, the existing fossil fuel system. Between 2019 and 2021, only 17 whole home "electrofits" (electric retrofits) were completed.¹³²

These numbers stand in stark contrast to:

- ▶ The more than 1,000 permitted gas system replacements per year.⁷⁶
- ▶ The 70,000 small residential buildings that contain nearly 130,000 units, approximately half of Boston's households.²⁷
- ▶ The need to install 1,000,000 heat pumps across Massachusetts by 2030 to meet the state's climate targets²⁹—a pace that would require 10,000 heat pump installs per year across Boston's building stock.

While electrifying heating systems is an essential step, so too is the need to insulate and seal up these homes in the near term; replace gas appliances such as stoves, water heaters, and dryers; install vehicle chargers; and steadily upgrade electric panels and services to accommodate increased electric loads. Long term goals include deeper energy efficiency—applying passive house principles to existing buildings—and more efficient heating strategies such as geothermal.

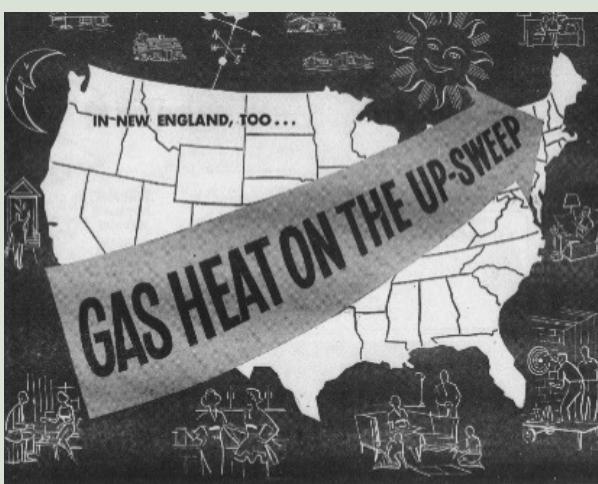
This task may sound daunting, but it is not unprecedented: The switch from manufactured to natural gas in the 1950s also necessitated transforming equipment in every gas-connected home (see next page).

Making Things Work: The Last Time Every Home Was Retrofitted

The transition from gas manufactured locally out of coal and biomass to natural gas piped in from the south required changes to every appliance to ensure compatibility. The effort was described by the former president of Boston Gas, John Bacon:

“We bought a company from the South. They were good at it. They had these trucks with lathes and machine shops, and they went from house to house and did the work. They hit Boston of course, which had some of the oldest appliances in the country. And we had to alter every range, every water heater, every single appliance. If we couldn’t get to a house on the list, we’d keep trying to get in it, until the end when we’d connect an area. If the houses weren’t converted, they were cut off. We had a couple of situations where he had to break in to get the appliances converted. We’d get a permit from the city, and we’d have an officer with us, and we’d go there and make things work.”

The transition made gas safer and cheaper, leading to its rapid adoption in the '50s and '60s. Early customers were incentivized by free appliances and marketed to aggressively. Eventually, in the words of a recent utility executive, gas began to “sell itself.”



**350% more New England Homes have Gas Heat now than in 1950
You will eventually... why not now?**

CHALLENGES

Making the massive switch this time requires overcoming four key challenges:

1

Household Barriers: Inertia & Funding Gaps.

Most of Boston’s building stock is old, leaky, and dependent on fossil fuels for heating. The costs of energy efficiency interventions are relatively high, and while the benefits are substantial, they tend to be diffuse and spread over long time horizons. Upfront costs can be hard to justify when full electrification costs more than remaining on gas—even though gas will become more expensive in the long term.^{23,29,97}

2

Supply-Side Barriers: Inertia.

Even when funding is available, the contracting and financing process can be cumbersome. The workforce will need to be drastically expanded, better trained, and represent the communities they work in. New supply chains and practices will need to be developed to streamline retrofits. This will be very difficult for an industry that is averse to risks associated with new approaches—one that too often dissuades customers from electrification strategies because they don’t understand them or don’t have the workforce to install them, and currently has year-long waiting lists for some interventions.

3

Entanglement Barriers: Conflicting Interests; Misalignment and Technical Feasibility.

An unmanaged exit of customers from an old gas system will burden those who cannot leave with the costs of maintaining it. While the cost of electrification is high today, the costs of gas will increase dramatically as utilities serve fewer customers on a system that is increasingly expensive to maintain. It is in Boston’s interest to strategically right-size this system, but the current regulatory framework and financial interests of investor-owned gas distribution companies challenge such efforts.



Policy Barrier: Knowledge Gaps

Current data resources and metrics are insufficient to effectively guide the transition to achieve steady emissions reductions, manage costs, and ensure equitable outcomes.

Progress Assessment

In the coming years, the pace of electrification and efficiency retrofits will accelerate, spurred by rebate and tax credit incentives offered by MassSave⁹⁵ and the federal Inflation Reduction Act.³⁷ Combined with growing customer preferences for electric alternatives, this will yield a gradual electrification—constrained in part by limits on the industry—that will be insufficient for achieving net zero and risk leaving behind those with less capability to upgrade their home. An equitable transition consistent with net zero by 2050 is currently out of reach for many homes across the city. In the small residential stock, Boston is currently not on pace for an equitable transition. The Inflation Reduction Act, along with efforts by the City, MassCEC and the Green Ribbon Commission to develop a green bank to finance projects all establish a potential pivot point for beginning to scale up efforts to make the building stock last for the next century.

Doing so is a big lift that requires:

- ▶ **Industrial policy** that establishes a consistent and ambitious pace of electrification as the core decarbonization strategy for the small building stock.
- ▶ **Market development** policy that reinforces industrial policy by developing workforce needs, supply chains, and business development.
- ▶ Proactive **transition planning** to manage costs and ensure optimal outcomes for ratepayers, particularly those with less ability to transition.
- ▶ **Improved data collection** and reporting to support these efforts.



Boosting installation of solar systems on small housing units throughout the city will help residents save money on electricity and spur new business and employment opportunities.

Rooftop solar installation. (Source: Akarawut Lohacharoenvanich /iStock)

Priority Actions

Industrial Policy Signal

Overview

The state needs to provide a clear signal that electrification is the foundational step of building decarbonization. DOER should accept Boston's application to become one of 10 communities to establish fossil fuel-free building codes.¹³³ DOER should evaluate a timeline for appliance and equipment standards, like California,¹³⁴ that drives the small residential market toward predominantly electric replacements by the late 2030s. The Commonwealth and City should prepare to leverage incoming federal funding to drive retrofits in Boston's small building stock.

Responsible Parties

- ▶ City of Boston
- ▶ MassSave
- ▶ Action for Boston Community Development (ABCD)
- ▶ MA Department of Energy Resources (DOER)
- ▶ State legislature
- ▶ Community groups

Indicators of Progress

The appropriately timely adoption of predominantly zero emissions and electric appliance and heating standards will be essential for establishing market signals on electrification. Better understanding the customer adoption of electric equipment is essential for ensuring progress. Data management recommendations are given in the rightmost column.

Market Development

Overview

Existing workforce development programs barely support industry needs. Green jobs should be seen as a rewarding career path that can help create durable wealth in low-income communities.

Supply chain improvements such as automation, standardization, and local manufacturing can be used to push down costs. Implementors can leverage pending funding from the IRA to promote these objectives.

New business models (e.g., performance contracting) should be encouraged.

Responsible Parties

- ▶ MassSave
- ▶ Industry Participants
- ▶ MassCEC
- ▶ MA Department of Energy Resources (DOER)
- ▶ Boston Public Schools

Indicators of Progress

MassSave and MassCEC should track and report the count and demographics of entrants into various green career paths.

MassSave should track and regularly report the cost of equipment and labor.

MassSave, MassCEC and DOER should evaluate the effectiveness of existing and emerging retrofit models.

Gas Transition Planning

Overview

The DPU should develop a framework for the ongoing rightsizing of the gas system by focusing on: (1) retirement of costly-to-maintain, leak prone infrastructure; and (2) long-term targeted electrification and transition to alternative heating strategies. The city, in partnership with its gas and electric utilities, should immediately pursue street and neighborhood-level implementation pilots to transition these areas off of the gas network.

Responsible Parties

- ▶ MA Department of Public Utilities (DPU)
- ▶ Eversource
- ▶ National Grid
- ▶ City of Boston
- ▶ MassCEC
- ▶ Affected residents
- ▶ State legislature

Indicators of Progress

Utilities should report¹³⁵ with geographic detail: gas system size, ongoing gas use, customers, changes to customer bills over time, and impact of pilot studies.

Improve Data

Overview

Tracking building energy assets can support city and household planning. The Massachusetts Division of Local Services should establish standards for tracking building energy assets for the small residential stock. City of Boston inspectional services and the assessor's office should implement such standards. MassSave is anticipated to improve its data tracking and reporting. A third party and stakeholders should evaluate and provide recommendations on preliminary improvements.

Responsible Parties

- ▶ Assessing Department (City of Boston)
- ▶ Inspectional Services (City of Boston)
- ▶ MA Division of Local Services
- ▶ MassSave

Indicators of Progress

The Division of Local Services and the City of Boston's Tax Assessor's Office should implement energy asset building performance tracking.

BIG LIFT #2

LOCAL ENERGY PLANNING FOR AN ELECTRIFIED CITY

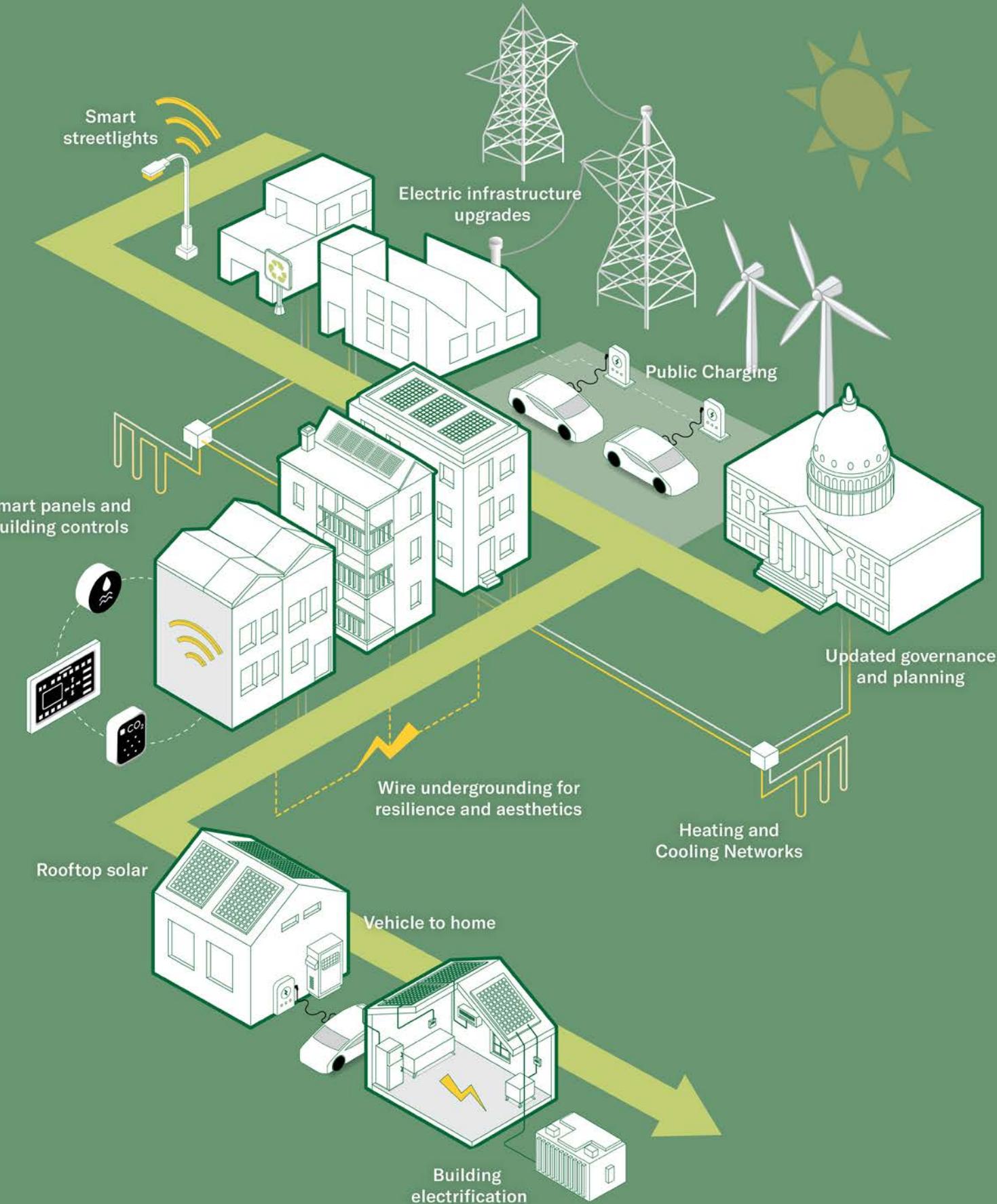
Energy planning must be modernized rapidly to meet the increasingly local needs of the energy transition and the communities that host energy infrastructure.

Proactive local energy planning can accelerate the transition by identifying local opportunities, managing costs and other impacts, and facilitating early community support for rapid change.

Every building in Boston will add to electricity demand with the growth of electric heating and cooling. With increased electric heating and cooling demand, electricity consumption will sharply peak on some of the coldest and warmest days of the year straining existing wires and transformers. On many sunny days, rooftop solar will generate more electricity than the building it rests on may consume, requiring the distribution system to be capable of storing or moving that surplus energy to buildings or vehicles that can use it.

There are approximately 300,000 vehicles registered in the City of Boston; around a quarter million of these are passenger vehicles, with half of them being parked on the city's streets.¹³⁶ Extension cords are now a regular sight on sidewalks as EV owners without a driveway charge their cars due to lack of public charging. New charging infrastructure will be needed, from rapid charging that fills up a battery while the driver gets her Dunkin's to service for large electric bus depots.⁹¹

Figure 18. Boston's Future Energy Infrastructure



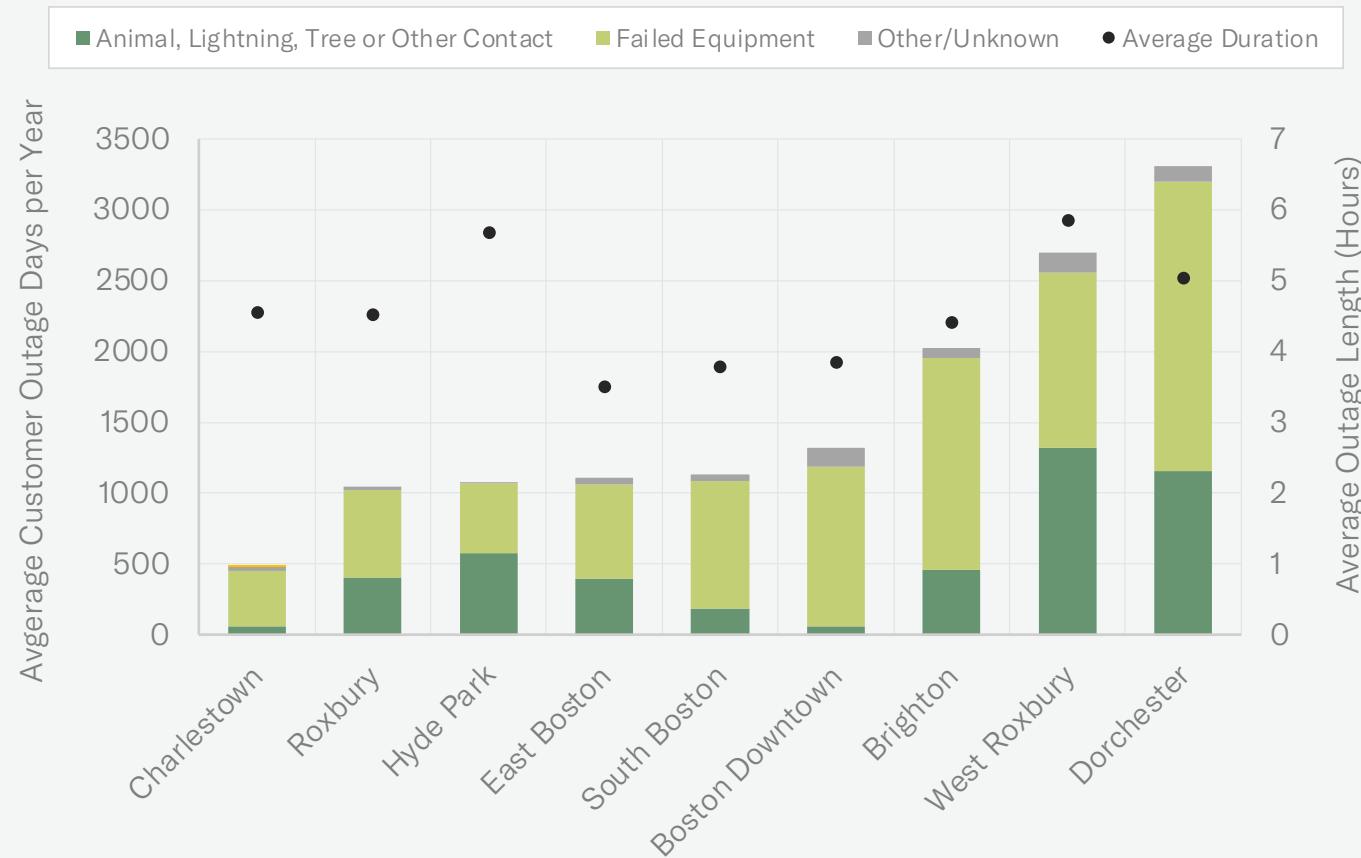
The figure below shows electricity outages in Boston's neighborhoods from 2018-2021, as reported by Eversource to the DPU. Limitations in data reporting make it difficult to draw comparisons among neighborhoods. However, this figure is useful for illustrating some points related to resilience. First, neighborhoods with more trees—and, sadly, critters—are more susceptible to power outages through the exposed nature of overhead wires. This is a reminder that such infrastructure is also vulnerable to increasingly extreme weather. Second, failures of aging equipment are quite common and will be exacerbated by increasing demand and warmer weather.

Addressing these challenges—especially in frontline communities historically underserved by electric infrastructure—requires an unprecedented effort to modernize Boston's utility-run electric distribution system to meet increasing demand and better share electricity across time and space within the city and with the broader grid.

Additionally, new thermal distribution systems can efficiently provide and exchange heat among buildings and ambient heat resources—ground, rivers, and the harbor. Dedicated microgrids will further assist resilience needs.

Figure 19. Variable Vulnerability in Boston's Electricity System

Electrical outages experienced by Boston neighborhoods.



Eversource reported electrical outage data¹³⁷ for select Boston neighborhoods for 2018-2021. Customer outage days indicate the total outage time experienced by all customers in the neighborhood.



City infrastructure will need to change to include charging stations of all kinds. Charging bank for electric vehicles. (Source: Joe Potato/iStock)

These upgrades—many of which are invisible—not only allow for the delivery of energy but also play a key role in energy system integration by allowing energy resources such as solar electricity, stored energy in a battery, and waste heat to be shared across space and time. This allows electrification to happen more efficiently and cost-effectively.

While many changes may be invisible, some will require changes to the public realm.

Some will be mundane such as the upgrading of transformers. Opportunities may arise for the undergrounding of wires and transformers to reduce the risk of wind damage from extreme storms, making the streetscape more appealing and leaving a bit more space for trees to grow. Some will require new visible infrastructure that has a footprint, sometimes in or near neighborhoods—backup-micro generation, waste energy recovery facilities, and substations.

In all cases there will be a lot of digging and disruption to the streets (perhaps a reason to invest in an e-bike rather than a car).

Completing upgrades and deploying new energy distribution systems will be difficult, given the current state of infrastructure planning processes, where decisions around grid modernization in Boston are made between the utilities and the Massachusetts Department of Public Utilities (DPU), with limited input from the City.

This has already stymied Boston's ability to modernize its energy system in pursuit of its climate targets. In 2017 the City of Boston sought to facilitate a public-private energy services partnership to develop a district energy system as part of the Flynn Marine Park redevelopment.¹³⁸ The partnership required legislative approval via a home rule petition that was passed by the City Council but went nowhere in the state legislature, effectively killing the project.

Developers have been reluctant to pursue such strategies on their own, despite efforts by the City and the Boston Planning and Development Agency (BPDA) to highlight potential opportunity sites (see Boston Community Energy Study)¹⁰² and encourage new district energy solutions (through Zoning Code Articles 37⁵⁹ and 80⁶⁰). This is not to say that innovative projects have not been completed—notably there have been some advances in geothermal use—however, new shared integrated energy is held back by the balance of power in energy planning being held by the Commonwealth. The City of Boston, given its unique context, should have a greater ability to influence the development of new energy services.

Doing so may enable more public buy-in for projects that are critical to climate and equity goals.

The East Boston Substation controversy (Page 104) exposed longstanding concerns among frontline communities excluded from decades of centralized energy planning that unduly burdened them. The controversy illustrates the need for proactive, responsive, and integrated energy planning. Constructing and upgrading physical electric infrastructure will be necessary to support electrification and emissions reductions, and the burden of hosting such infrastructure will need to be shared equitably across the region.

Many more of these projects will be required to meet the City's climate goals. Distribution systems are just the tip of the iceberg. Vicinity—Downtown Boston's district steam provider—has proposed “lifting heat” from the Charles River between Boston and Cambridge as part of its electrification of steam project. While the ecological implications of this are far less severe than Kendall Station's past dumping of waste heat, which ended a decade ago, it is conceivable that other district systems along the river may want to do the same.

From the need to dig up streets to install geothermal wells and thermal networks, to the planning of vehicle charger placement and the siting of waste energy recovery facilities, all energy infrastructure will have tradeoffs.

The current approach to energy planning is simply challenged by the increasingly local needs of net-zero emissions strategies and resilience.

CHALLENGES

We identify a pair of challenges for implementing these ideas that need to be resolved:

1

Limited City Control of Planning: Funding & Jurisdictional Limitations

The City of Boston's ability to influence energy infrastructure policy and planning is limited and constrains efforts to develop local resources to meet its net-zero goals. The City has an energy and infrastructure planning program but requires significantly more funding to guide grid modernization, gas transition, and the deployment of new energy distribution systems. Simultaneously, the utilities themselves, by legislative design, currently lack the directive to address local aspects of climate-focused energy planning.

2

Unintended Consequences and Conflicting Interests in the Siting of Energy Infrastructure

To achieve climate and justice goals, things need to change rapidly. The changes could impact communities in conflicting ways. An unintended consequence of poorly executed public participation has created mistrust that will impede the ability to implement climate projects in some communities. Projects that are important for providing access to low-cost renewable electricity are being blocked at all levels: generation, transmission, and distribution. We must reconcile the need for speed with the need for equitable participation and outcomes.

Progress Assessment

The current approach to energy planning cannot effectively facilitate the development of a modern urban energy distribution system to support the electrification, efficiency, and integrated planning needed to achieve net zero.

Climate Progress at the Ballot Box

On election day 2021, voters in Maine and Boston were given the chance to weigh in on the construction of energy infrastructure. For Maine, the choice pitted traditional conservation and regional incumbent electricity generators against climate mitigation, Canadian hydropower, and transmission builders. In Boston, the need to meet growing electricity demand in East Boston was challenged by a grassroots coalition concerned about safety and process.

Maine: Question 1

Do you want to **ban the construction of high-impact electric transmission lines** in the Upper Kennebec Region and to require the Legislature to approve all other such projects anywhere in Maine, both retroactively to 2020, and to require the Legislature, retroactively to 2014, to approve by a two-thirds vote such projects using public land?

Yes 59% No 41%

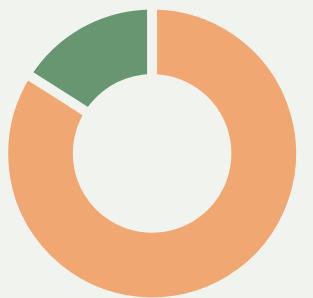


OUTCOME & STATUS: Measure passed. Construction on the project halted. On August 30, 2022, the Measure was found to be unconstitutional by Maine supreme court, removing a significant roadblock.

Boston: Question 2

Should a **high-voltage electric substation be built** at 400 Condor Street in East Boston, along the Chelsea Creek, near homes, parks, playgrounds, jet fuel storage, and in a flood risk area rather than in a nearby alternative safe and secure location such as non-residential Massport land at Logan Airport?

Yes 16% No 84%



OUTCOME & STATUS: Non-binding referendum approved. Construction is proceeding despite some permitting delays.

Despite their different location and scale, both are intensely relevant to Boston's goal of net-zero emissions as they were intended to modernize the grid to deliver clean, reliable electricity that can support deep electrification. Years ago, both projects would have been mundane energy infrastructure projects and hardly garner attention. Indeed, in East Boston, the project commenced in 2014 and flew under the radar for several years. With a different lens—and an effort to ensure that an energy structure seen by the community could be shaped by the community—its completion could be viewed as an essential element of restorative justice for East Boston by rectifying years of underinvestment and neglect of existing energy infrastructure.

These examples illustrate the communication challenge of explaining the nuances of a complex energy transition.

Early outreach, inclusion, and two-way education are essential to turn stakeholders into well-informed decision-makers.

Both projects have their footprint—each a reminder of how our energy demands mark our natural lands and our neighborhoods. Both have their benefits and are required for net zero and resilience. Moving them will shift human and ecological tradeoffs, possibly for the worse. Delay adds to residents' energy bills and threatens climate goals with the most catastrophic of consequences.

An unprecedented pace and scale of change are necessary to avert the worst impacts of climate change. Future projects cannot face the same time and resource drain as these cases did. What kind of process is needed to accelerate change and maximize benefits while minimizing burdens? For interstate transmission, it requires reform at the federal level that speeds up the review timeline and removes opportunities for parties to stall the process. For energy planning in Boston, it may mean proactive community-focused communication and engagement. The substation controversy highlighted legitimate problems with utility planning at the city scale. Given the density, opportunities for integration and innovation, legacy of environmental injustice, and a more local sense of ownership, more local involvement in energy planning could—if designed correctly—accelerate progress.

PRIORITY ACTIONS

Expand City of Boston Planning Powers

Overview

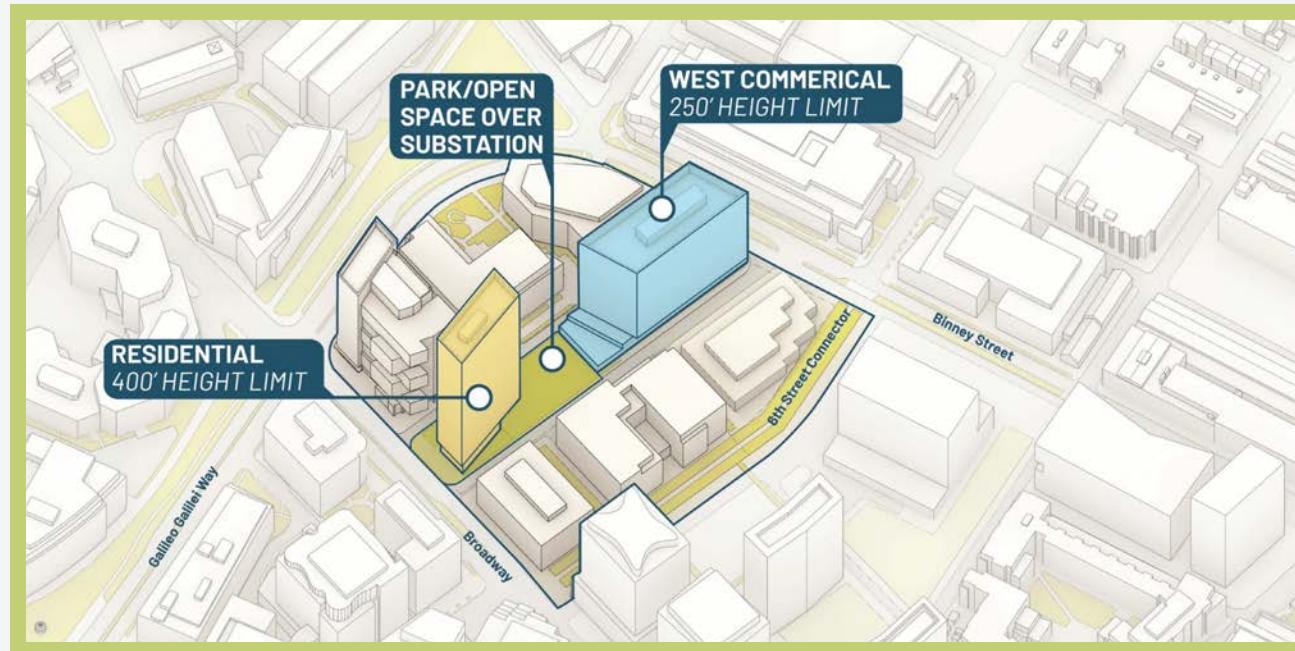
The State should grant the City of Boston more influence over the planning and development of energy resources. Expanding Boston's influence would require legislative action and coordination with the DPU and utilities.

Responsible Parties

- ▶ Legislature
 - ▶ City of Boston
 - ▶ MA Department of Public Utilities
 - ▶ Utilities

Progress Indicators

Legislation expands planning powers.



Expand City of Boston Planning Capacity

Overview

The City of Boston should leverage IRA funds to scale up its energy planning office, with the aim of fully meeting and accelerating energy transition support needs by the 2030s.

Responsible Party

- ## ► City of Boston

Progress Indicators

City planning budget, staff, and case load all increase.

Develop Processes That Ensure Positive Outcomes for Communities Hosting Energy Infrastructure

Overview

Empowering communities with knowledge about pending energy infrastructure has the potential to build support. Alerting communities to proposed energy plans, communicating through various channels, providing multilingual support and resources for people who cannot make meetings supports better community engagement.

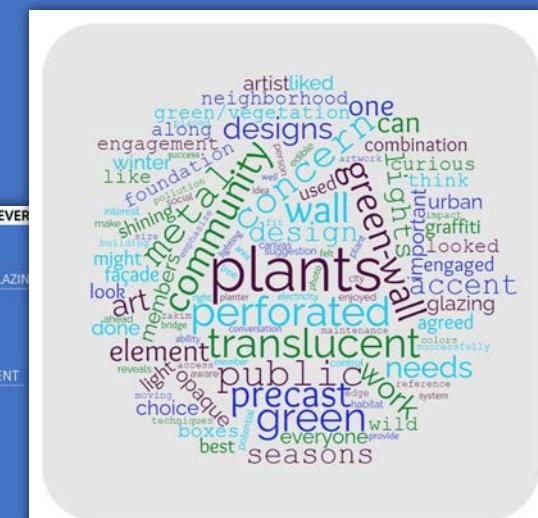
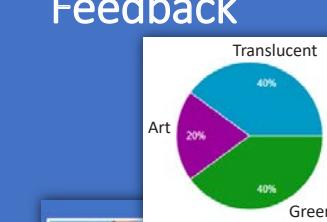
Responsible Parties

- ▶ City of Boston
 - ▶ MA Department of Public Utilities
 - ▶ Utilities
 - ▶ Public interest organizations
 - ▶ The public

Progress Indicators

Community buy-in and support for energy projects.

Community input into building design can ensure that new infrastructure adds to the local environment.
Eagle Hill Substation Design Focus Group. (Source: Eversource)



BIG LIFT #3

BUILDING A RESILIENT COASTLINE THROUGH IMPROVED GOVERNANCE

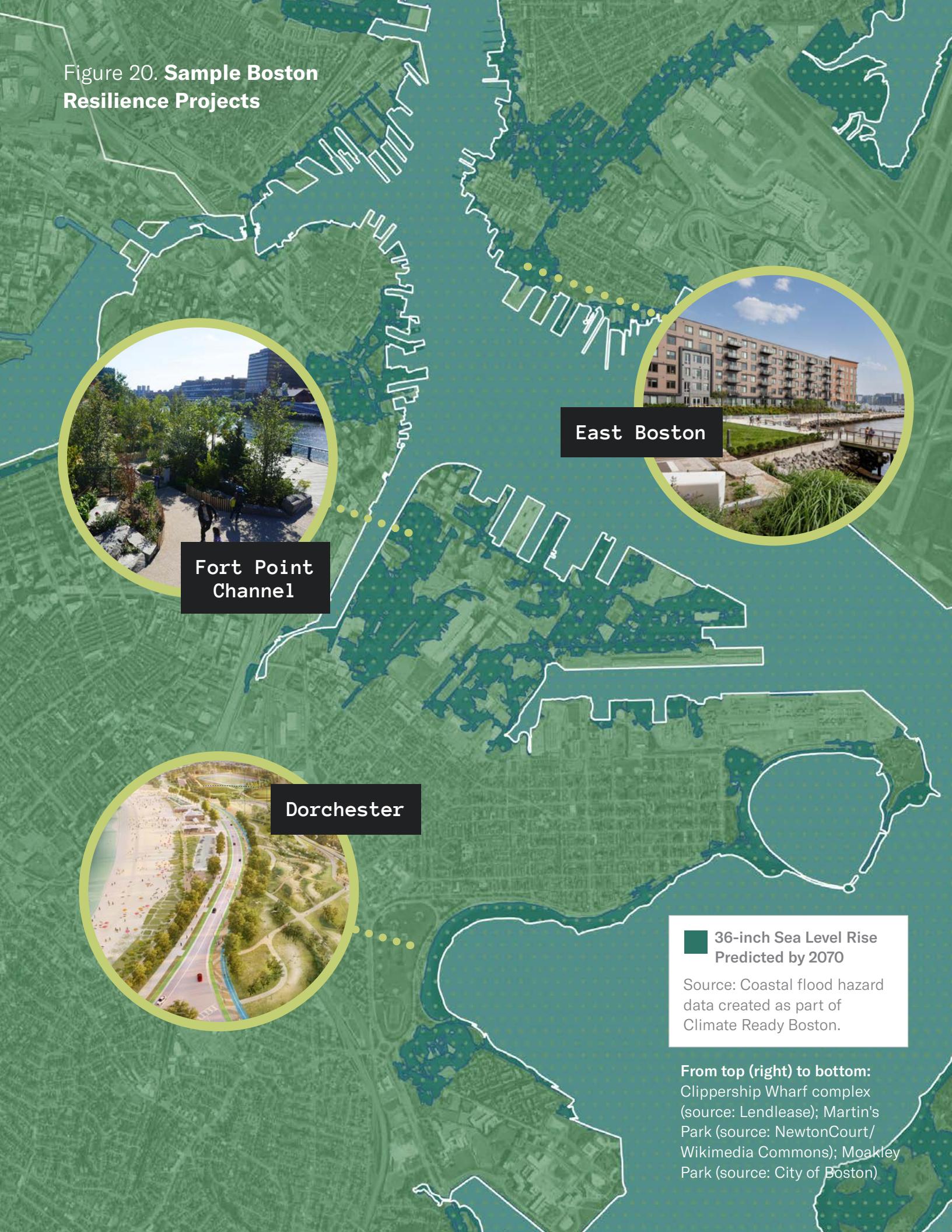
Boston needs to be part of a decision-making process to create a governance structure for managing the Massachusetts coastline.

Boston has 47 miles of coastline and has prepared a plan to address coastal resilience for all of it. The cost of implementing the city's coastline plans is between \$862.2 million and \$1.6 billion. It's a task complicated by the lack of a consistent funding stream and an effective and efficient governance structure. Further, because many coastal properties are privately owned, city government cannot drive resilience to the extent needed.

While Boston has billions of dollars in infrastructure and buildings to protect, resilience must prioritize people.

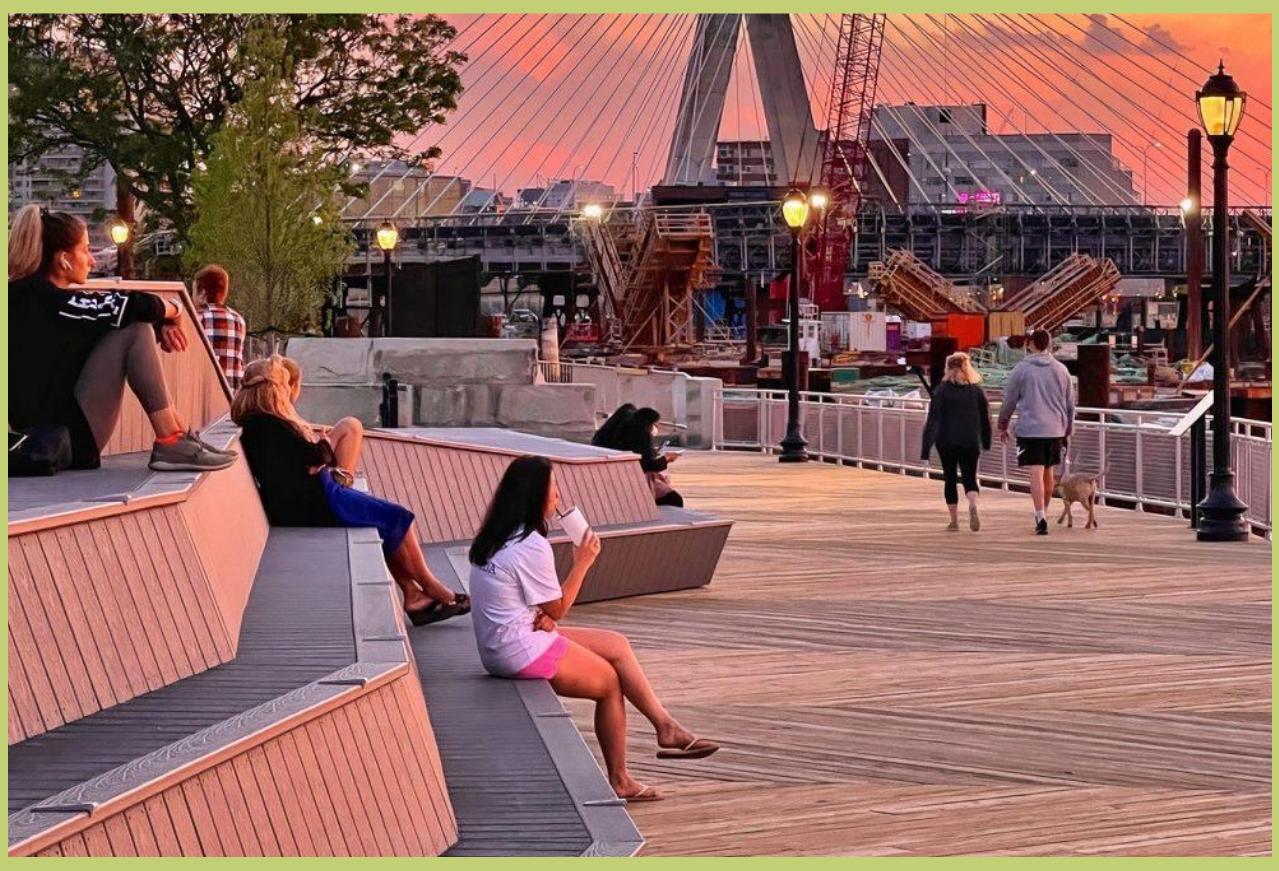
It matters that Mayor Wu is concentrating on East Boston; she has signaled that equity is at the forefront of decision-making. The dilemma is that East Boston and downtown are part of one coastline—we need to protect all of it at the same time.

Figure 20. Sample Boston Resilience Projects



The City of Boston and several other private and nonprofit groups are focusing on nature-based solutions to protect the shoreline.

Nature-based solutions are adaptation measures designed to protect, restore, and manage ecological systems while providing economic, social, and ecological benefits.



Making the city climate ready can make it more pleasant and enjoyable too.
Boston Harborwalk. (Source: City of Boston)

Nature-based solutions, because they often extend from land into the water, require permitting by various state agencies. Those seeking permits are frustrated by the difficulty of obtaining the permits needed to advance their resilience projects.

The first park project to be designed under Boston's Climate Resilient Design Standards and Guidelines improved the resilience of the North End's Langone Park and Puopolo Playground by raising the Harborwalk along the edge of the park and integrating seating with flood barriers (referred to as a "seatwall") (photo below).

CHALLENGES

Boston's big lift for coastal resilience is to work with the governor, the state legislature, and key stakeholders to create a governance structure and a steady funding stream to protect the city's people and infrastructure from sea-level rise and storm surge. There are several options and several challenges.

1

Need for a Coordinating Agency: Jurisdictional Limits and Conflicting Interests

Some coastal property owners are creating their own resilience measures, but isolated solutions cannot protect the entire coastline. A coordinated solution is needed. Further, multiple jurisdictional authorities slow progress. Coastal Resilience Solutions for Dorchester illustrates how in the example of Joe Moakley Park, which is designed to give water a new pathway in the waterfront space connecting Dorchester and South Boston by combining land-use planning and nature-based solutions (image below). The redesign of the space has been an ongoing priority and project for the city since 2018. Building this resilient park will require collaboration and coordination among city, state, and federal officials. The proposed removal of Day Boulevard introduces other entities into the decision-making process that will create a prolonged approval process.

Joe Moakley Park Design. (Source: City of Boston)



Depending on the scope, coastal resilience projects need to acquire permits from the Massachusetts Department of Environmental Protection (MassDEP), which enforces the federal Wetlands Protection Act. Projects that discharge dredged or fill material into waters, including wetlands, must apply to the Army Corps of Engineers for permits. Charged with protecting natural systems, nature-based solutions that extend into the water can be denied even though they provide substantial coastal protection.

Overall, there is considerable confusion about which projects are reviewed by MassDEP, Chapter 91, the Clean Water Act, Massachusetts Office of Coastal Zone Management, or the Massachusetts Wetlands Protection Act. Many argue that water protection laws developed in the 1980s are out of date, creating conflict over protecting infrastructure and people on land and protecting water-based ecosystems and marine life.

2

Complying with Existing Regulations: Conflicting Goals

Conflicting goals are evident in several proposed projects. Boston's plans for coastal protection in East Boston's Border Street are illustrative.⁵⁴ In 2017, the City released a vision for coastal resilience solutions for this area, including nature-based solutions with open areas, a waterfront plaza, floating green and grey interventions, and docks that would improve maritime connectivity.¹³⁹ While Boston is able to move ahead with some plans such as Lewis Mall, Carleton Wharf, and the Greenway entrance, others are on hold as they do not comply with regulatory restrictions on Designated Port Areas (DPAs), which were established in 1978 to protect coastal areas that support water-dependent industrial and commercial uses.¹⁴⁰

3

Who Pays for Resilience Projects? Funding Gap

Cities do not have the resources to pay for all the needed coastal resilience projects. Moakley Park illustrates the problem. The City estimates the cost of the 60-acre park to be \$240 million. To date, the project has \$2.2 million in federal and state funds. The City must compete for additional funds that could take years to amass. This is just one of several examples of the resilience funding gap.



Need for more transparency: Misalignment of Goals

To the interested public in frontline communities, there is a lack of clarity on how resilience planning unfolds within the city. To various stakeholders, it isn't clear which departments of the City are responsible for implementing climate readiness measures. Planning seems to be the responsibility of the Environment Department, but it doesn't have the authority or the responsibility for implementing recommendations. Implementation is undertaken by other departments and organizations. The City has several tracking systems in place, including an online map tracker. Still, community members are calling for more accountability in explaining why benchmarks are not being met. In addition to the online progress tracker, community members would like more explanation from the City on why benchmarks are not being met.

Progress Assessment

The City has identified 70 priority projects to build resilience in all neighborhoods with an estimated cost of \$3 billion. These will need to be funded and permitted. Several stakeholder groups have offered proposals for streamlining the permitting and implementation of resilience projects. Various solutions and legislative fixes have been suggested. A stakeholder group comprising key actors will release a report in November 2022 detailing possible solutions.

Numerous options for a governing body are being promoted, including existing agencies such as the Massachusetts Water Resources Authority. Others call for creating a Massachusetts Coastal Defense Agency that would have engineering and finance expertise and even the power of eminent domain to protect the Commonwealth's coastline (Figure 21). Another option is to replicate the Resilience Authorities enabled by recent legislation in Maryland that can fund and implement coastal and stormwater infrastructure projects (detailed in Big Lift 4 "supplementary chapter"). The governor needs to open a discussion with all stakeholders on what the governance structure should be and work with the legislature to act on it quickly.

Figure 21. Proposed Governance Agency.



Source: John Sullivan, BWSC

In January 2020, the BPDA requested that the Massachusetts Office of Coastal Zone Management de-designate four parcels of the East Boston DPA that are included in the Climate Ready Boston plan for the area.¹⁴¹ The BPDA argues that the DPAs make it impossible for the city to incorporate coastal resilience into development, but many argue that the problem really is that the city is forced to fund resilience by leveraging private development, and market-based development is not allowed in the DPAs.

While Mayor Wu supports removing the DPA designation, there is considerable opposition to doing so. Some groups argue that although water-dependent industrial uses have declined during the past 20 or 30 years, there may be need for deep water access for the offshore wind industry.

Equity concerns loom large as well. Some East Boston residents are concerned that de-designating the port areas will pave the way for expensive new housing developments that will add to ongoing gentrification and displacement.¹⁴² Although an industrial use on the East Boston waterfront may not be ideal, many residents see it as the only thing preventing them from being priced out of their neighborhood.

Boston has developed an online progress tracker for neighborhood plans.¹⁴³ This tool is important to keep residents informed of progress in their neighborhoods. Still, a more inclusive planning process is needed to resolve these issues.

Local options for filling the funding gap are limited. Proposition 2½ makes it difficult for municipalities to raise property tax rates. The state legislature has yet to act to raise multi-year funding for large infrastructure projects. So competitive funding pools are what is left.

The distribution of coastal resilience funds must move beyond competitive grants to prevent extraordinary inequity across differently resourced communities. Coastal resilience will have to be funded with a mix of public and private funds.

New federal funding streams will soon be available to support Boston in protecting its coastline. The 2021 American Rescue Plan Act (ARPA) included dedicated funding for states. Of the \$8.7 billion allocated for Massachusetts, \$5.3 billion is for the state government to allocate and \$3.4 billion for municipalities to allocate. The 2022 Inflation Reduction Act will invest \$47 billion to help communities prepare for extreme fires, floods, storms, and droughts caused by climate change³⁷. How much Massachusetts and Boston receive is yet to be determined, but it will be enough to jumpstart delayed projects.

The Commonwealth's Municipal Vulnerability Preparedness Program provides small grants (\$15,000–\$430,000) to cities and towns. Grants of that size typically can cover planning, but not implementation. The current funding level and distribution structure is insufficient to address existing coastal resilience needs.

The Housing and Revenue Opportunities (Hero) Act has bipartisan support for increasing the current Deeds Excise Tax to create new revenue for affordable housing and climate resilience projects. The bill was first filed in 2019 by Governor Baker.¹⁴⁴ It was stalled in that session (191st). It was filed again in the most recent legislative session and sought to double the Deeds Excise Tax (from \$4.56 per \$1,000 to \$9.12 per \$1,000), using the additional \$300 million annual new revenue for affordable housing and climate resilience projects. The bill was not enacted but will be refiled in the upcoming session (193rd).

Boston has made a good start on protecting the coastline and projects are being implemented now. There are several viable options for resilience governance and funding. It should be a priority of the Wu administration and the new governor to act quickly on both. In the interim, the City must develop a better process for frontline communities to co-create the plans for making resilience equitable.

PRIORITY ACTIONS

Create statewide (or other) governance agency to coordinate and finance coastal resilience

Overview

Misalignment and conflicting goals argue for a state agency or resilience authority that considers the needs of the Commonwealth's entire coastline. The agency would need to have engineering, design, construction management, finance, contract administration, program management, and environmental planning expertise.

Responsible Parties:

- ▶ Governor
- ▶ State legislature, with input from relevant stakeholders

Progress Indicators

The governor meets with relevant stakeholders to discuss options for agency and makes recommendation to legislature.

Review existing neighborhood resilience plans to address equity concerns

Overview

Although the City has attempted to obtain community input, many groups in frontline communities are concerned that low-income areas are not adequately protected. The Wu administration focus on East Boston, reflected in the complementary plan released in August 2022, attempts to address this problem.

Responsible Parties:

- ▶ City of Boston
- ▶ Neighborhood organizations

Progress Indicators

Neighborhood representatives and the City are in agreement on resilience priorities.

Pass the HERO Act

Overview

The HERO Act has bipartisan support and would provide much-needed funding for both resilience and affordable housing.

Responsible Party:

- ▶ State legislature

Progress Indicators

Early take-up and passage in the 193rd session.

Parts of Boston that have seen less investment in the last hundred years may be particularly vulnerable to climate events.

East Boston. (Source: Denis Tangney Jr./iStock)



BIG LIFT #4

PRIORITIZE REPARATIVE PLANNING FOR BOSTON'S FRONTLINE NEIGHBORHOODS

Boston must run with its “Green New Deal” vision to integrate climate action with reparative planning (and become a national leader in the process).

Residents will support the radical changes identified throughout this report only to the extent they can see them improving their neighborhoods and creating economic opportunity, particularly in frontline communities that have a history of environmental pollution, substandard housing, and few transportation options. As noted earlier, apart from the practical imperative our climate future imposes, there is a moral obligation to counteract past economic, environmental, and social harms inflicted upon these communities and create neighborhoods that are accessible, affordable, vibrant, and connected.

This obligation is at the forefront of an emerging planning framework called reparative planning.

- ↳ Reparative planning acknowledges the role urban planning has played in oppressing Black people and other people of color and seeks to undo past harms.

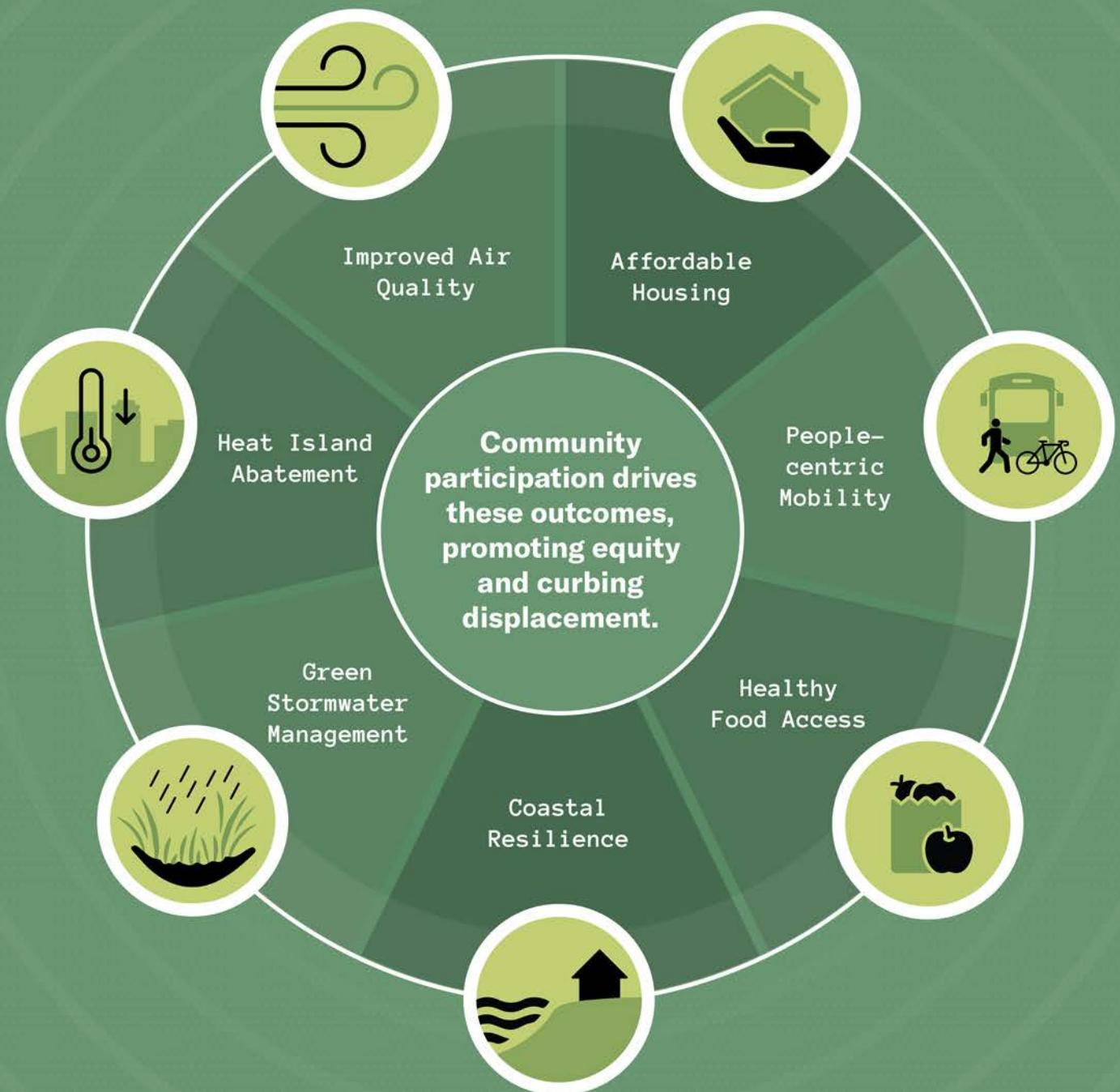
Figure 22. Boston's Frontline Communities



What Is a Frontline Community?

Frontline communities are those that have been exposed to more economic and environmental harm than other communities that have more power and wealth. They are often composed of racially and culturally distinct groups and diverse people of color who have limited financial and elective power. Frontline communities were hit hardest by the COVID-19 pandemic, for instance, and experience the most immediate and worst impacts of climate change. According to the NAACP, they are directly affected and have fewer resources and protections to adapt, pass legislation, and implement policies to their benefit.¹⁴⁶

Figure 23. **Elements of Reparative Planning**



Reparative planning defines success by outcomes, not intentions.¹⁴⁵ Authentic participation is essential to achieving reparative outcomes.⁶⁴

Linking reparative planning to climate action creates the imperative that communities that have experienced the “first and worst” of climate change impacts—frontline communities—should be the first to receive the benefits of climate action.

We see this linkage between reparative planning and climate action in the “green justice zones” several cities are establishing in frontline communities. They ameliorate past environmental harms such as high levels of pollution, neglected infrastructure, or substandard housing while increasing resilience and creating economic opportunity in the green economy. Central concerns in creating a green justice zone are that the planning for it is co-created with residents and that throughout planning and implementation measures to prevent gentrification and displacement are in place. We adapt a model used by Minneapolis for its green zones to illustrate what we call neighborhood-based reparative planning (figure 23). Its ultimate goal is climate justice.

These efforts can inform Boston as Mayor Wu’s green new deal vision is realized in planning. But Boston’s checkered history of developer-led planning suggests it won’t be easy.

Historically, the practice of planning in Boston has deferred to developers in the private sector (see next page). The need to expand the tax base means that City Hall is in a constant balancing act between wanting to ask more of developers and asking for so much that it scares them away. The profits made from private development, however, suggest that the City has much more leverage than it has been willing to use.

Many of Boston’s developers are from other places and do not share a reparative vision for the city. They will build to the specifications the City requires for reducing emissions and building resilience. And through the BPDA neighborhood planning process, they will negotiate concessions that community residents seek. They are unlikely partners in reparative planning, however, unless the City puts more pressure on them to do so.

Contrast that with Chicago developer A.J. Patton, the founder and CEO of 548 Development, a full-service development and construction company with a mission of creating more sustainable and equitable communities of color. All the housing Patton builds is energy efficient to keep utility bills low for tenants. Patton uses minority-owned contractors to the extent possible on his projects. He helps these small businesses network by introducing them to bankers, elected officials, and others who can help their businesses grow. Boston needs a strategy for developing a cadre of community-minded developers to link social, economic, and environmental goals.

The Failure of Developer-Led Planning



Boston's Seaport District. (Source: Rhododendrites/Wikimedia Commons)

Boston has a large percentage of nonprofit-owned real estate that generates limited tax revenues. And there is no city income tax or other taxes as the basis of its revenue structure. Thus, developer-led planning is what got us the Seaport. In the late 1990s the area of the Seaport was almost nothing but parking lots—a 600-acre clean slate on which a vibrant and sustainable neighborhood could have been developed. Indeed, Boston developed a comprehensive plan for the area in 1999, The Seaport Public Realm Plan, with the intention of defining a vision that could be used as leverage when negotiating with developers. Since then, several more plans have been released addressing different foci and sub-neighborhoods.

From the Municipal Harbor Plan in 2001 to the Fort Point District 100 Acres Master Plan in 2008 to the South Boston Waterfront Sustainable Transportation Plan (2015) to Coastal Resilience Solutions for South Boston (2018). All these plans have been largely ignored. Instead, as in the rest of Boston, planning occurs at a parcel level, not at a district level. While some broad requirements are applied to developers, most resilience or community benefit decisions are made at the negotiation table. The result: the Seaport, criticized by many as sterile, a traffic nightmare, and vulnerable to sea-level rise. It was dubbed by the *Boston Globe* as “A Brand New Boston—Even Whiter Than the Old.”

Planning in Boston needs a better process for community engagement. Although planners have tried, residents of Boston’s frontline communities (East Boston, Roxbury, Dorchester, Mattapan) are not satisfied that their input is acted upon and sometimes feel it is even deliberately ignored.

Changing that requires creating official stakeholder institution/community/public official working groups to guide neighborhood environmental improvement and development. Enabling communities to define and organize themselves, linked to capacity-building training for the newly formed coalitions, could lay the groundwork for neighborhood-based reparative planning (The Reparative Planning supplemental chapter reveals that there is a precedent for this in Boston).

Finally, Boston’s nonprofit anchor institutions—mainly universities and hospitals—are tax exempt and do not pay their fair share in payments-in-lieu-of-taxes. They should be pressured to invest in their surrounding communities to create a greener future.¹⁴⁷ The Green Ribbon Commission has encouraged members in these sectors to reduce emissions and build more resilience but has not done enough to add advocacy for climate justice in communities to their missions.

Reparative Planning Strategies

- ▶ Build healthy and climate resilient frontline communities
- ▶ Address root causes of inequities faced by residents of frontline communities
- ▶ Build education and training pathways for residents
- ▶ Cultivate and build community leadership across issues to advance reparative planning
- ▶ Commit to building authentic participation in planning processes

Source: Derived from Williams, the Greenlining Institute, Fitzgerald.

CHALLENGES

We identify several challenges for implementing these ideas that need to be resolved:

1

Limited City Influence on Developers: Inertia.

Developers need to be more responsive to city and community needs. As we see from the Seaport example, the BPDA hesitates to make big demands on developers (e.g., mandatory inclusionary housing onsite rather than paying into pool; investment in transit infrastructure; public green space) for fear of scaring them off and losing the associated tax base. Many of Boston's developers are from out of town and don't have a vested interest in community improvement beyond their project.

2

Need for Governance Structure on Development: Competing Interests.

What communities want is sometimes quite different from what developers plan. Communities have some political clout to vote against plans they don't like but often lack the planning and financial resources to implement the plans they would prefer. Instead, through the BPDA approval process, they provide input on developer proposals and negotiate for amenities that offer immediate and tangible results, such as funding a small park or a cash gift to a youth group. The process is reactive—residents are not part of the planning and design process, but only respond to the plans and designs presented to them.

3

Need to Diversify Boston's Development and Construction Field: Knowledge Gap.

Boston has few Black, Latino or Asian developers, construction companies, or workers in real estate development who can operate at the scale of current development projects nor is there a pipeline within the vocational, community college, and university system for creating more of these development professionals. Development entities, environmental organizations, professional associations, schools at all levels, unions, policy makers, and communities must work together to create these environmental justice workforce development pipelines, as was the case in the early stages of planning for the Big Dig project.

That project failed to achieve long-term diversity penetration in the real estate development and environmental fields due to budget cuts. Similar cuts must be avoided now as new federal funds become available to train workers to mitigate past environmental injustices.

4

Anchor Institutions Minimally Engaged in Reparative Justice: Inertia.

As the City begins comprehensively implementing elements of the green new deal and the reparative planning it suggests, all stakeholders need to support the agenda. The city's anchor institutions—colleges and universities, cultural institutions, and hospitals—all have a key role to play in neighborhood-based reparative planning. Each has programs that invest in communities, but connecting them to each other and to reparative planning principles is needed to leverage greater impact.

Progress Assessment

In August, at the direction of Mayor Wu, the City took a step in increasing accountability to community needs.

⟨ A new planning process requires that developers lay out their plans for being more inclusive in their neighborhood impact plans, and that they specify their diversity, equity, and inclusion plans.

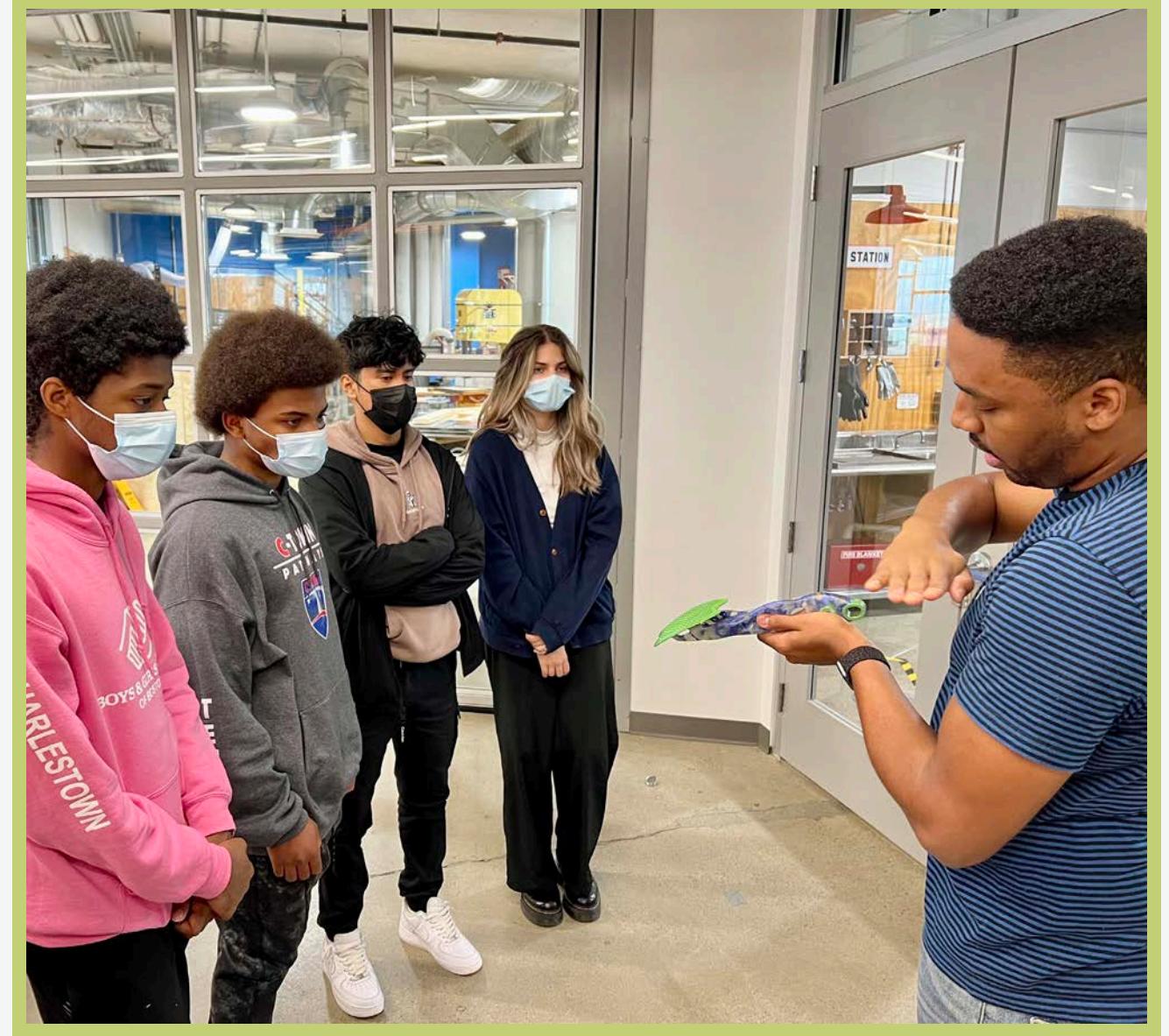
To date, clear metrics of success and timetables and sanctions that hold invested parties accountable for achieving measurable results have not been put in place. Doing so should be a priority. Without metrics and sanctions, there is little motivation for change.

The new requirements for developers to create more inclusive neighborhood impact plans is laudable. But not much has changed in how Boston empowers residents to participate in determining the needs of their communities. It is essential to have an officially recognized structure for engaging with community members. For example, residents should be on formal advisory groups and be paid for their participation in neighborhood-based reparative planning.

Reparative climate justice planning is very much aligned with Mayor Wu's Green New Deal (Table 1). and we have seen the beginning of its implementation in such actions as: prioritizing the needs of East Boston in coastal resilience; committing \$2 billion into improving school facilities, and investing approximately \$380 million into affordable housing and home ownership. The transformative reorganization of the priorities of the BPDA along with the hiring of a Green New Deal Director are additional steps that signal that Boston is moving away from the market-driven, developer-led planning that got us the Seaport.

The green technology and related careers pipeline starts with high schools. More education and training programs that prepare residents of frontline communities for the range of occupations and professions comprising real estate development and green technology need to be developed and linked to the city's community colleges, universities, and employers. Students need mentoring so they can create new businesses in these and related areas. Boston also needs a strategy to promote more minority-owned businesses and bring them to the attention of developer procurement managers.

Few anchor institutions are investing substantially in frontline community initiatives to improve environmental conditions, create career-ladder employment opportunities, or promote community health. Such initiatives would enhance neighborhood-based reparative planning. The Green Ribbon Commission has been an effective mechanism for encouraging these institutions and the real estate sector to reduce their individual carbon footprints. It now needs to focus its members on climate justice, and motivate all anchor institutions—colleges and universities, hospitals, and cultural institutions, as well as real estate developers—to integrate community outreach and reparative justice into their missions.



Training and early exposure to opportunities in climate-conscious development and construction professions should be ramped up.

Charlestown students on STEM field trip. (Source Kellyanne Mahoney/Autodesk)

PRIORITY ACTIONS

Hold developers accountable

Overview

The Mayor and the City's Chief Planner need to set timelines for the analysis and assessment of developer plans for incorporating environmental justice remedial measures into development plans. If data on current and pipeline developments were to be collected, assessed, and analyzed over the coming 18 months for their measurable positive outcomes, then new guidelines and recommendations could be prepared for implementation by mid-2024, with fairly negotiated and implementable sanctions incorporated into the guidelines as development mandates.

Responsible Party

- ▶ Mayor's Office
- ▶ Boston Planning & Development Agency

Progress Indicators

A timeline is established for analyzing developer plans.

Guidelines for developers are established.

Develop structures and processes for community engagement

Overview

Create a structure for engaging with community members (formal advisory groups, ad hoc relationships, community partnerships on specific issues, etc.).

Bring community stakeholders into the process in early stages so that they are co-creators of the engagement strategy.

Define and be transparent about how community input will influence organizational actions on climate change.

Collaborate with community partners to raise mutual awareness about climate change and actions that organizations and community members can take.

Responsible Parties

- ▶ Mayor's Office
- ▶ Boston Planning & Development Agency
- ▶ Community & environmental justice organizations

Progress Indicators

Formal advisory groups are created.

The City issues a statement on how community input will be used in defining and implementing climate action.

Motivate key institutions to promote climate justice initiatives in their communities

Overview

Request/require that Green Ribbon Commission member organizations place a client or community advocate member on their Boards or establish advisory groups on environmental justice (with paid members) to help develop specific strategies to address how the stakeholder institutions can best focus their resources on achieving measurable results in this area.

Responsible Party

- ▶ Green Ribbon Commission

Progress Indicators

Members are appointed and strategies developed within one year.

Create linked secondary and higher ed programs to prepare young adults for green technology careers

Overview

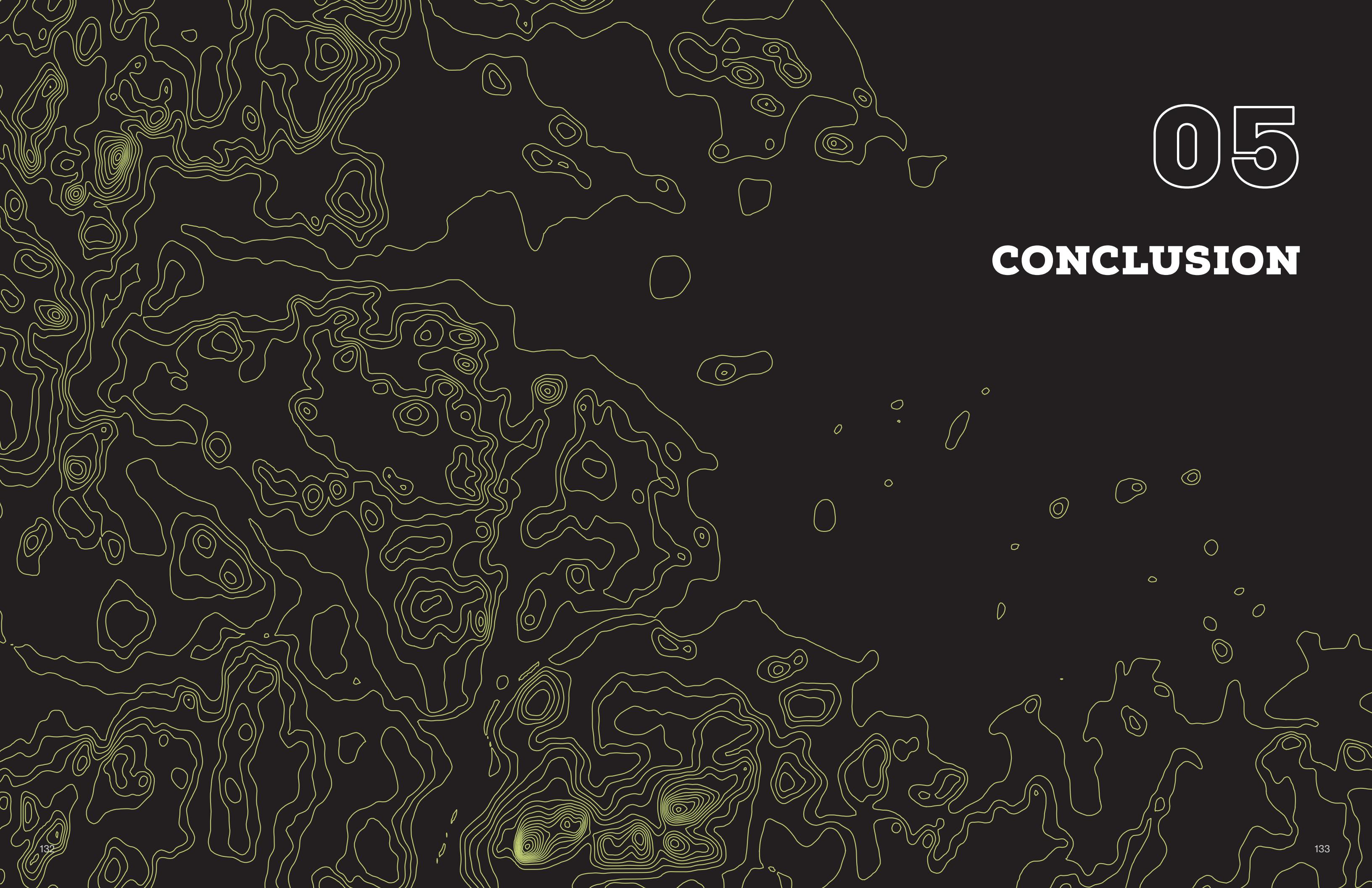
Assess employment needs related to implementing Boston's climate and resilience plans. Conduct an inventory of existing programs, paying particular attention to availability of opportunities for residents of frontline communities. Create a planning committee with representation from each of the responsible parties for program planning.

Responsible Parties

- ▶ Boston Public Schools
- ▶ Regional community colleges
- ▶ Boston Planning & Development Agency
- ▶ Green Ribbon Commission

Progress Indicators

Programs and initiatives are identified with input from frontline communities.

The background of the slide features a complex pattern of yellow contour lines on a black background. These lines represent elevation or density, creating a topographic map-like effect. The lines are more densely packed in the lower-left quadrant and become more sparse towards the upper-right quadrant.

05

CONCLUSION

BOSTON'S BIG PIVOT

Boston is still far behind on its three climate-focused goals. The good news is that the city and the region have been in tough binds many times before and rebounded or course corrected.

Its history is filled with underdog and adapt-and-persist stories, from its revolutionaries, abolitionists and marriage equality leaders to its immigrants, students and scientists, with its postindustrial decline and resurgence, and even its epic come-from-behind sports victories.

In this report we have homed in on barriers to change and highlighted some of the big lifts needed to drive progress forward. We have established that inertia limits our ability to cut emissions and address inequality. And we have attempted to create a data-informed framework for assessing and filling knowledge gaps with each outcome. Unfortunately, data is too siloed today to better formalize that framework, but the Commonwealth, City and utilities can use this report to better leverage data to drive progress.

We find that improvements in vehicle efficiency, adoption of building energy efficiency measures, and oil-to-gas heating system conversions have all provided incremental improvement to counter increased activity. But reductions to date mostly represent the proverbial low-hanging fruit.



Boston is at a big pivot point, similar to others throughout its history that have led to the rebounds that have pushed it forward.

Federal and state legislation have now aligned to provide a tailwind for the city's efforts by addressing an important barrier highlighted by this report: funding gaps.

There is a mayor in City Hall with climate at the core of her agenda, but jurisdictional limitations mean that the City cannot act alone, although it still must lead. An incoming governor, also focused on climate and energy justice, brings an opportunity to overcome some of these jurisdictional barriers.

This pivot point is the time to engage the entire community of Boston—city and state government, businesses, civic leaders (including cultural and education institutions, environmental justice and community organizations), and residents.

Progress requires:

- ▶ Civic leaders to speak publicly about the bold action needed and call out those actors who are blocking progress.
- ▶ Implementors to continue and boost their ongoing work by leveraging the incoming federal and state funding to go big and experiment. Learn from successes and failures using data to better understand the drivers of progress and ensure equitable outcomes.
- ▶ The private sector to align every aspect of their mission and operations with climate needs. They need to support—not stymie—transformative policy on climate and climate justice.
- ▶ Residents to support climate action by preparing for changes in their home and neighborhood. While understanding these changes—and how to retrofit one's home—can be daunting, active participation in shaping the change will create better homes and neighborhoods.

Transformative change happens by the rapid diffusion of ideas through social networks. The expansion of the gas network across the city happened in part because of neighbor-to-neighbor interaction over the experience of cooking. So too can the exodus from the gas network, and not just by an induction cooking party. Such interactions will happen in homes, virtual workspaces, responsible boardrooms, electric buses, and resilient playgrounds. While the pandemic temporally challenged interaction, the climate challenge calls Boston to engage and participate to accelerate climate progress.

This moment in history can be used to link climate action explicitly with equity and justice. That means more green affordable housing; more reparative home ownership programs; better mobility options; protecting all communities from sea-level rise, storm surges, and urban heat; and a new way of planning that goes beyond individual parcels and the designs of developers.

Boston can now follow this pivot with a comeback. Every emission avoided, degree of heat island effect lowered, and person treated justly matters. It is time to bring all stakeholders together to make Boston work as a climate-just city.



Community engagement is essential, especially early in planning phases for development, infrastructure siting, and electrification programs. (Source: The Boston Foundation)

The background of the page features a complex pattern of yellow contour lines on a black background, resembling a topographic map or a stylized ocean floor map. The lines are irregular and wavy, creating a sense of depth and movement.

06

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ACKNOWLEDGMENTS

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The background of the slide features a complex pattern of yellow contour lines on a black surface. These lines form various peaks, valleys, and ridges, creating a topographic map-like effect across the entire page.

07

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