Carbon Free Boston

Social Equity Report 2019

Boston Green Ribbon Commission

Boston University

Applied Economics Clinic
Economic and Policy Analysis of Energy, Environment and Equity

All Aces, Inc.
Dealing a Controlling Hand

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Dear Mayor Walsh,

On behalf of the Green Ribbon Commission and its Carbon Free Boston Working Group, we are pleased to present you with a detailed analysis of the social equity implications of the pathways to carbon neutrality laid out in our Carbon Free Boston report. We believe this is the most detailed analysis of the social equity challenges and opportunities linked to deep decarbonization done by any US city to date.

Socially vulnerable populations are part of the fabric of every neighborhood. They are exposed to the greatest risks—and have the most to lose—from new action taken to reduce GHG emissions. They also have the most to gain from those actions. Action taken toward carbon neutrality will fundamentally transform the city's buildings, transportation, waste, and energy systems. We believe Boston can use this unique, once in a lifetime opportunity to create a more equitable, inclusive, resilient and prosperous city.

This report provides a detailed analysis of the current social equity issues in each of the city's key emissions sectors – buildings, transportation, waste and energy – and identifies how intentional policy design can avoid unintended consequences and use the City's emissions reduction strategies to address historical social inequities. It ends with a synthesis of equity guidance that we hope will be useful to the City as it proceeds with the update of its Climate Action Plan this year.

We want to extend special thanks to three sets of partners in this process:

- To the Sherry and Alan Leventhal Family Foundation that provided critical grant support that made this report possible.
- To the team of Boston University's Institute for Sustainable Energy, All Aces and the Applied Economics Clinic who conducted the research and wrote the report itself.
- To the members of the Social Equity Advisory Group who put in many, many hours of volunteer time to provide feedback and assure the quality of the final product.

We look forward to continuing to work with you and your administration as you move into the difficult but exciting phase of implementing strategies for carbon neutrality. We hope that this report will help you convert the challenges of carbon neutrality into new infrastructure and cultural practices that will benefit all Bostonians in the generations to come.

Sincerely,

Amos B. Hostetter, Jr.
Co-Chair, Boston Green Ribbon Commission
and Trustee, Barr Foundation

Mindy Lubber
Vice Chair, Boston Green Ribbon Commission
and CEO & President, Ceres

"We have both the opportunity and the obligation to ensure that our growth benefits all, regardless of their race, class, or neighborhood."

Resilient Boston Report, 2017

Table of Contents

Executive Summary

Overview

In January 2019, the Boston Green Ribbon Commission released its *Carbon Free Boston: Summary Report*, identifying potential options for the City of Boston to meet its goal of becoming carbon neutral by 2050. The report found that reaching carbon neutrality by 2050 requires three mutually-reinforcing strategies in key sectors: 1) deepen energy efficiency while reducing energy demand, 2) electrify activity to the fullest practical extent, and 3) use fuels and electricity that are 100 percent free of greenhouse gases (GHGs). The *Summary Report* detailed the ways in which these technical strategies will transform Boston's physical infrastructure, including its buildings, energy supply, transportation, and waste management systems. The *Summary Report* also highlighted that it is ***how*** these strategies are designed and implemented that matter most in ensuring an effective and equitable transition to carbon neutrality.

Equity concerns exist for every option the City has to reduce GHG emissions. The services provided by each sector are not experienced equally across Boston's communities. Low-income families and families of color are more likely to live in residences that are in poor physical condition, leading to high utility bills, unsafe and unhealthy indoor environments, and high GHG emissions.[1] Those same families face greater exposure to harmful outdoor air pollution compared to others. The access and reliability of public transportation is disproportionately worse in neighborhoods with large populations of people of color, and large swaths of vulnerable neighborhoods, from East Boston to Mattapan, do not have ready access to the city's bike network.

Income inequality is a growing national issue and is particularly acute in Boston, which consistently ranks among the highest US cities in regards to income disparities. With the release of *Imagine Boston 2030*, Mayor Walsh committed to make Boston more equitable, affordable, connected, and resilient. The *Summary Report* outlined the broad strokes of how action to reach carbon neutrality intersects with equity. A just transition to carbon neutrality improves environmental quality for all Bostonians, prioritizes socially vulnerable populations, seeks to redress current and past injustice, and creates economic and social opportunities for all.

This *Carbon Free Boston: Social Equity Report* provides a deeper equity context for *Carbon Free Boston* as a whole, and for each strategy area, by demonstrating how inequitable and unjust the playing field is for socially vulnerable Bostonians and why equity must be integrated into policy design and implementation. This report summarizes the current landscape of climate action work for each strategy area and evaluates how it currently impacts inequity. Finally, this report provides guidance to the City and partners on how to do better; it lays out the attributes of an equitable approach to carbon neutrality, framed around three guiding principles: 1) plan carefully to avoid unintended consequences, 2) be intentional in design through a clear equity lens, and 3) practice inclusivity from start to finish.

Inequality is Pervasive and Growing

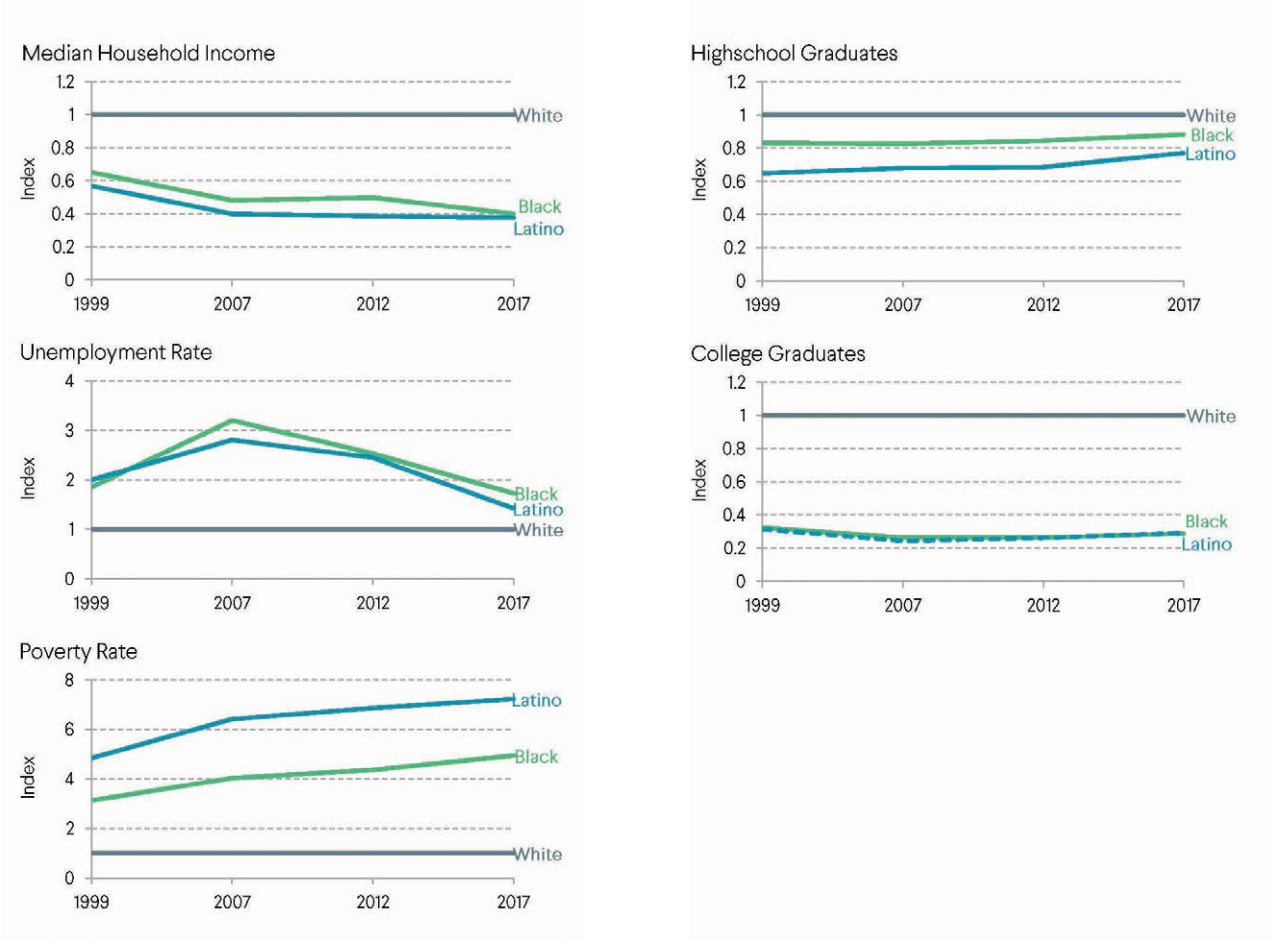
By most accounts Boston is among the most vibrant cities in the country. Strong economic growth has created nearly 100,000 new jobs over the past decade, and median household income jumped 17 percent from 2013 to 2017. The city gained 100,000 new residents since 2000. Boston's strong economy, rich history, environmental amenities, wealth of higher education, and reputation for walkability and bikeability make it one of the most popular cities in the country to visit.

But the quality of life for individual Bostonians is a much more complex mosaic than aggregate trends suggest. Like most cities in the country, recent economic gains are uneven. Corrected for inflation, the poorest 10 percent of households in Boston have *lower* real incomes today compared to 1980, while the richest 10 percent of households have experienced a 195 percent rise in income over the same period. The median income of Boston's Latinx/Hispanic families averages about one-quarter that of

1 We use the racial, ethnic, socioeconomic, and demographic terminology used in Resilient Boston, which is generally consistent with that used by the Census Bureau. Following Resilient Boston, we use the term "Latinx" for people of Latin American descent, whereas the Census Bureau uses the term "Latino." Sources: City of Boston. July 13, 2017. Resilient Boston: An Equitable and Connected City. Mayor's Office of Resilience & Racial Equity. Available online: https://www.boston.gov/sites/default/files/document-file-07-2017/resilient_boston_digital.pdf. Census Bureau, race & Ethnicity. Available online: https://www.census.gov/mso/www/training/pdf/race-ethnicity-onepager.pdf

Figure 1. Racial Equity across Income, Unemployment, Poverty, and Education

Black and Latino populations compared to White populations, where data is indexed to White population equal to 1.0. Source: Data from US Census Bureau, 1999/2000 Census Data: Profile of Selected Economic Characteristics and 2007, 2012 and 2017 American Community Survey Data: 1-Year Estimates, Selected Population Profile in the United States.



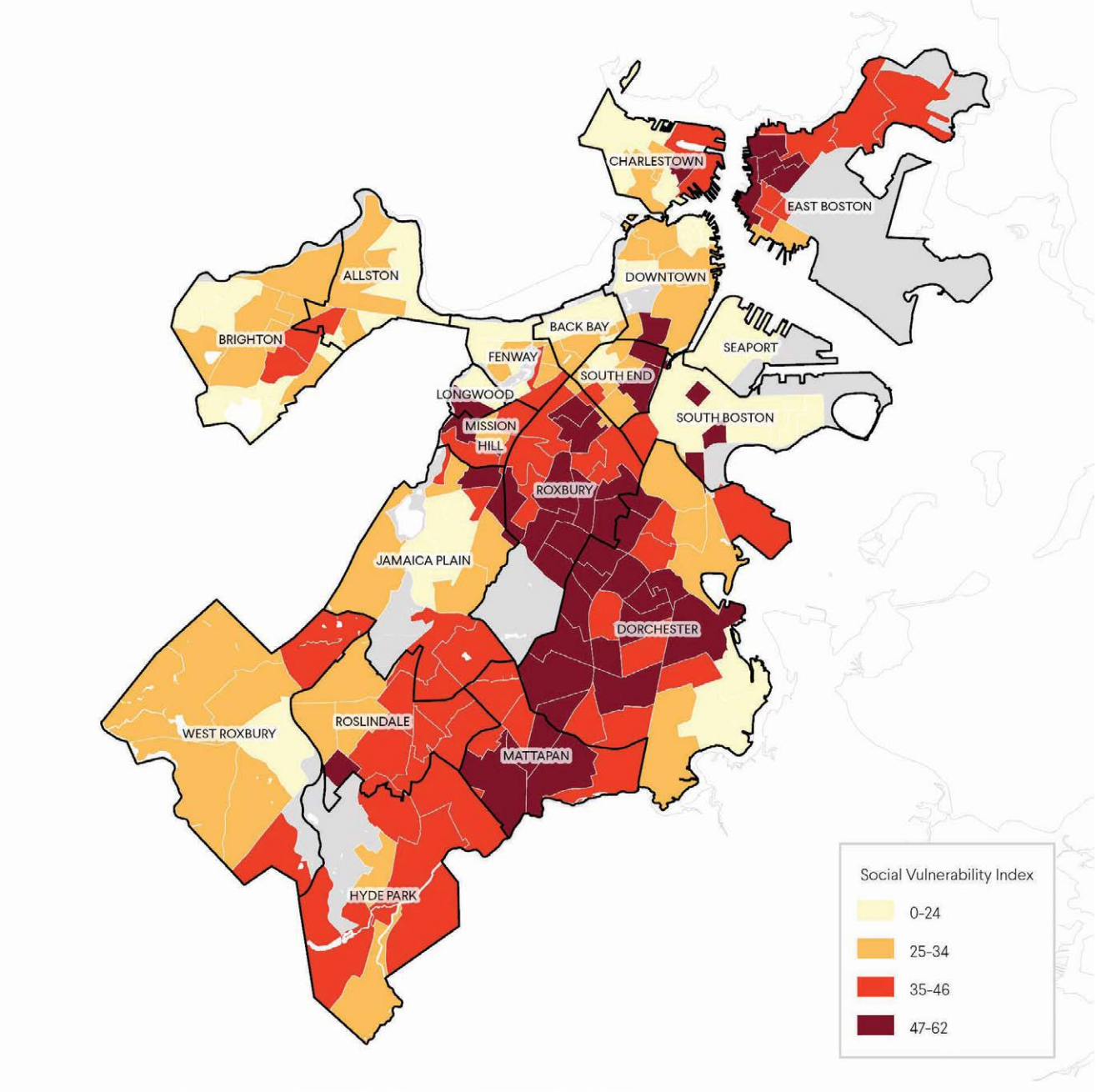
White families, a gap that has widened over time[2] (Figure 1). These current trends are layered on Boston's residential and homeownership patterns that were formed by decades of government-sanctioned systemic discrimination. Strong economic growth combined with stagnant or declining real incomes puts affordable housing beyond the reach of many residents. Health and educational outcomes fall along the same income, racial, and ethnic fault lines as affordable housing.

Social vulnerability is the lack of capacity to withstand hard times—that is, to prepare for, respond to, and recover from emergencies such as a missed paycheck, illness, a high utility bill, or the effects of a natural disaster. To inform the City's planning for carbon neutrality, this report sheds light on the challenges many Bostonians face on a daily basis, focusing on six of the socially vulnerable populations that were defined in *Climate Ready Boston*: children, people with limited English proficiency, people with low to no income, older adults, people of color, and people with disabilities (both physical and mental). In Boston, socially vulnerable populations are spread throughout the city and are part of the fabric of every neighborhood and every community (Figure 2). Neighborhoods with higher concentrations of socially vulnerable populations tend to have lower median incomes, higher proportions of renters, less energy efficient residences, and fewer transit stops per capita, and they tend to devote a larger fraction of their income to fuel and electricity.

2 Lima, A. et al. January 2017. Boston in Context: Neighborhoods. 2011-2015 American Community Survey. Boston Planning and Development Agency. Available online: https://bit.ly/2ubjqcV.

Figure 2. Social Vulnerability Index

The Index combines values from six measures of vulnerability, each expressed as a share of a census tract or neighborhood population. A higher score (darker color) indicates a greater degree of vulnerability. Population shares for the six vulnerable groups are converted into six component indices, each ranging from 0 to 100/6 (or 16.7) in value. If a census tract or neighborhood had the highest census tract share of all six vulnerable groups—receiving six component index values of 16.7—its Social Vulnerability Index would be 100.0. Calculated census tract indices range from 5 to 62, and neighborhoods from 13 to 49. Source: calculations by Applied Economics Clinic



Equitable Action Towards Carbon Neutrality

With a greater understanding of the challenges that socially vulnerable Bostonians experience, it is possible for the City and a diverse set of partners to design and implement planning processes, policies, and systems for accountability that ensure carbon neutrality, and its abundant benefits: improved health, lower or stable energy costs, new job opportunities, safer streets, and cleaner air. The selection and design of specific initiatives will require careful evaluation to avoid unintended consequences. For example, improving the energy efficiency of residential buildings will benefit socially vulnerable populations because they tend to live in poor quality buildings, and they devote a large fraction of their income to fuel and electricity. But improvements to the energy efficiency of buildings tend to increase property values, and thus could make the housing unaffordable to, and therefore lead to displacement of, historical communities.

The design of policies and programs needs to be intentional in its focus on equity outcomes. An intentional design to promote equity is made with awareness that socially vulnerable communities have the most to gain from action taken to reach carbon neutrality and are simultaneously exposed to the greatest risks. Intentional design also involves an awareness that Boston's actions have impacts that extend well beyond the city's borders.

Avoiding unintended consequences and intentionally pursuing equitable outcomes in the design of policies are best achieved through inclusive practices from start to finish. This means that socially vulnerable communities have meaningful participation in decision-making, policy planning and design, implementation, evaluation, and an enduring role as these policies evolve over time. For participation to be meaningful, people must have a right to participate in the decisions that affect them, including receiving balanced, objective information; consultation with affected communities for their input and feedback at every step in the process; a role in policy design, implementation and monitoring; and control over decisions that affect their well-being. This requires data and metrics to track progress and inform course corrections.

With these three principles as the foundation—avoid unintended consequences, intentional design, and inclusivity—the City can help ensure that actions taken to reduce GHG emissions help to close equity gaps and improve the lives of socially vulnerable communities, while avoiding unintended consequences that can exacerbate inequity. Energy efficiency in buildings addresses the largest source of GHG emissions, and can simultaneously reduce energy insecurity, increase family wealth, and improve living conditions and public health. Expansion of public transit and active transport can reverse some historical inequities and generate a wide range of public benefits. A zero-waste city can reduce emissions and lower the city's ecological footprint. The provision of GHG-free electricity to all residents creates universal participation in the clean energy transition. Every action discussed in the *Summary Report* has the potential to create good jobs in clean, safe working conditions that are equitably compensated.

The following chapters provide more specific equity guidance regarding the *Summary Report's* strategies. This guidance, summarized in Table 1, is intended to generate actionable insights for the design and implementation of carbon-neutral policy options in Boston.

Table 1. Carbon Free Boston Equity Summary Guidance

1. Include Socially Vulnerable Communities in Decision-Making

Enable socially vulnerable communities to have influence over critical decisions and processes, access to information and resources, and provides the ability to contribute more fully and effectively.

2. Set Priorities in the Context of Interactions Among Policies

Prioritizing the order and timing of policy implementation in ways that seek to avoid potential pitfalls is necessary to reduce negative impacts on socially vulnerable communities and all Bostonians.

3. Focus Workforce Development Efforts on Job Quality

The benefits of job creation are enhanced by a commitment to job quality, including living wages and benefits and job health and safety standards, to ensure that workforce development is beneficial for all Bostonians.

4. Training Today and Tomorrow's Workforce for Green Careers

Bostonians need green career training throughout their career pathways, from high school to four-year colleges and continuing education, that provides the new skills and knowledge to capitalize on the opportunities that arise on the path to carbon neutrality.

5. Sustainability Education for All

Public outreach and education to provide all Bostonians with the knowledge, skills, and opportunities needed for sustainability are critical to successfully and inclusively implementing carbon-neutral strategies.

6. Avoid Displacement

Intentional design and inclusive decision-making will avoid or reduce the displacement of Boston's most socially vulnerable households and communities.

7. Increase Access to Credit and Community Wealth

Action that builds community wealth and makes gains in individual household wealth accessible to as many Bostonians as possible will increase access to energy efficiency and clean fuels and electricity.

8. Allow for/Prioritize Neighborhood Planning for Equity and Sustainability

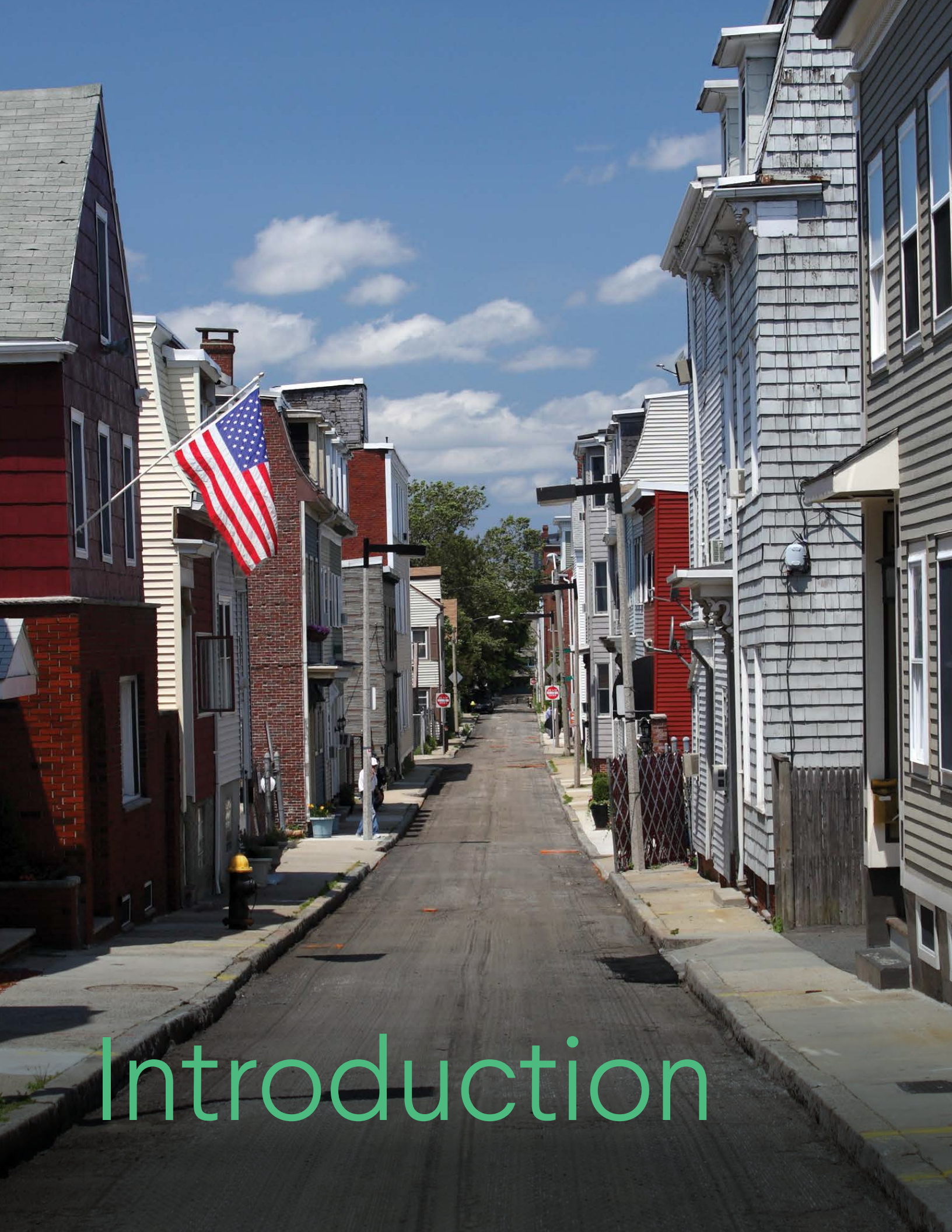
Climate action is a prime opportunity to leverage changes in neighborhoods' design to address historical disparities and to build the capacity of socially vulnerable communities.

9. Address Historical Disparities in Transportation Equity

Changes in the transportation sector are an opportunity to make public, private and active modes of transit work—and work better—for all Bostonians, particularly those facing barriers to access.

10. Improve Energy Security and Access to Clean Energy

Access to affordable, clean fuels and electricity reduces GHG emissions and has wide-ranging benefits to socially vulnerable communities.



Introduction

Main Findings

- Racial-ethnic gaps persist in Boston around income, poverty, housing quality and security, exposure to environmental hazards, the financial burden of fuel and electricity, access to transportation, and access to credit to acquire clean, energy efficient technologies.
- Socially vulnerable communities—those with diminished capacity to withstand hard times—are spread throughout the city and are part of the fabric of every neighborhood.
- Socially vulnerable communities are exposed to the greatest risks—and have the most to lose—from new action taken to reduce GHG emissions. They also have the most to gain from those actions.
- Action taken toward carbon neutrality will fundamentally transform the city's buildings, transportation, waste, and energy systems. Appropriate design, implementation, and monitoring will create a more equitable, inclusive, resilient, and prosperous city.
- Our equity analysis is organized around three principles:
  1. Careful planning to avoid unintended consequences
  2. Intentional design with a clear focus on equity outcomes
  3 Inclusive practices from start to finish in every action to reduce greenhouse gas emissions

The Equity Divide

In January 2019, the Institute for Sustainable Energy at Boston University and the Boston Green Ribbon Commission released the *Carbon Free Boston: Summary Report*, an assessment of the options available to reach carbon neutrality by 2050. Sweeping improvements in energy efficiency and deployment of clean fuels and electricity will transform the city's energy, transportation, buildings, and waste systems. The *Summary Report* emphasized that carbon neutrality is not merely about reducing greenhouse gas (GHG) emissions; it also is a public health, economic, and social equity imperative.

Race and income predict differential exposure to a wide range of environmental hazards linked to persistent health disparities in the US,[1] including the effects of climate change[2] and the effects of living in energy-inefficient housing.[3] Due in part to discriminatory zoning and lending practices and racial segregation in the US, Black families and Latino/x families are significantly more likely to live in regions with hazardous waste, experience 38 percent higher air pollution concentrations, and devote a much larger fraction of their household income to fuel and electricity, on average, relative to White families[4] (Figure 3). This includes a class of "hyper-polluters"—the worst-of-the-worst—that disproportionately expose communities of color and low-income populations to hazardous and toxic chemical released from industrial and commercial facilities.[5]

This differential exposure to environmental and economic risk explains in part why opinion polls reveal a racial/ethnic gap in environmental concern, including concerns about climate change: non-White respondents in the US express consistently higher

1 Pearson, Adam R., Jonathon P. Schuldt, Rainer Romero-Canyas, Matthew T. Ballew, and Dylan Larson-Konar. 2018. "Diverse Segments of the US Public Underestimate the Environmental Concerns of Minority and Low-Income Americans." Proceedings of the National Academy of Sciences 115 (49): 12429–34. https://doi.org/10.1073/pnas.1804698115.

2 USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. Available online at: doi: 10.7930/NCA4.2018

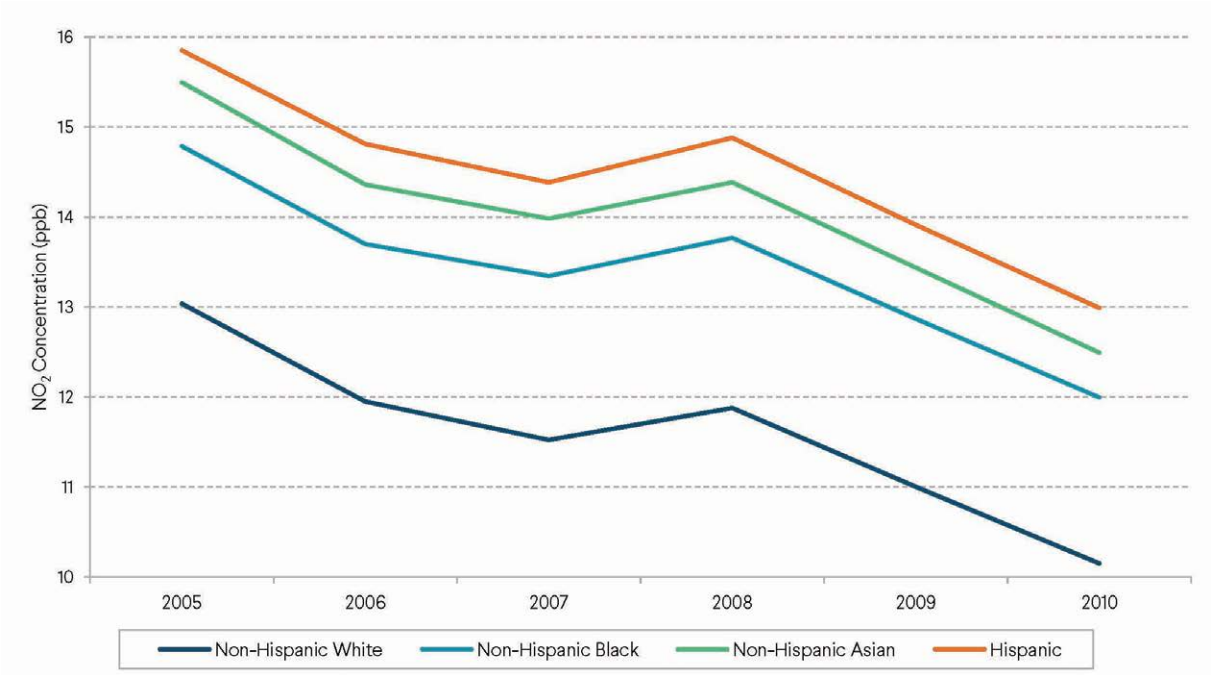
3 Jacobs, David E. 2011. "Environmental Health Disparities in Housing." American Journal of Public Health 101 Suppl 1 (Suppl 1): S115–22. Available online at: https://doi.org/10.2105/AJPH.2010.300058.

4 Pearson et al. 2018, op.cit.; U.S. Energy Information Administration (EIA). 2017. 2015 Residential Energy Consumption Survey (RECS). Available online: https://www.eia.gov/consumption/residential/index.php.

5 Collins, Mary B, Ian Munoz, and Joseph JaJa. 2016. "Linking 'Toxic Outliers' to Environmental Justice Communities." Environmental Research Letters 11 (1): 015004. https://doi.org/10.1088/1748-9326/11/1/015004.

Figure 3. Air Pollution Inequality in Massachusetts Cities

Annual average nitrogen dioxide (NO_2) concentrations urban areas (greater than 50,000 people) in Massachusetts by Census 2010 and ACS 2006–2010 demographic subpopulations. NO_2 impairs respiratory function and is regulated by the US Environmental Protection Agency under the Clean Air Act. Source: Data from Rosofsky, Anna, Jonathan I. Levy, Antonella Zanobetti, Patricia Janulewicz, and M. Patricia Fabian. 2018. "Temporal Trends in Air Pollution Exposure Inequality in Massachusetts." Environmental Research 161 (February): 76–86. https://doi.org/10.1016/j.envres.2017.10.028.



levels of concern than their White counterparts (Figure 4).[6] Despite this reality, people of color and low-income populations are noticeably underrepresented in environmental decision-making in the US, including climate policy.[7]

Most recent Census Bureau data indicate that 55 percent of all Bostonians are people of color, and one in five people lives below the federal poverty line.[8] As we explain throughout this report, these specific populations and others in Boston are exposed to the environmental and economic risks described above for the nation as a whole. As Boston embarks on an explicit transition to a carbon-neutral city, there is a remarkable opportunity to intentionally transform the ways that energy is used in buildings, transportation, and waste management to address historical inequities and improve the quality of life for all residents. Of course, the opposite is also possible. If equity considerations are not baked into every effort to reduce GHG emissions, then the historical inequities based on race and income will persist, and perhaps even worsen. By placing equity at the center of action to reach carbon neutrality, Boston has the opportunity to enhance its leadership in responding to climate change.

Why Income Inequality Matters

Income inequality is a defining issue of our time. Pope Francis declared that "inequality is the root of social ills," while former President Barack Obama described inequality as "the defining challenge of our age."[9] Income inequality is measured along many social and economic dimensions, but nearly every metric points in the same direction: the world is increasingly divided into

6 Pearson, A., Ballew, M., Naiman, S., & Schuldt, J. (2017, April 26). Race, Class, Gender and Climate Change Communication. Oxford Research Encyclopedia of Climate Science. Ed. http://oxfordre.com/climatescience/view/10.1093/acrefore/9780190228620.001.0001/acrefore-9780190228620-e-412.

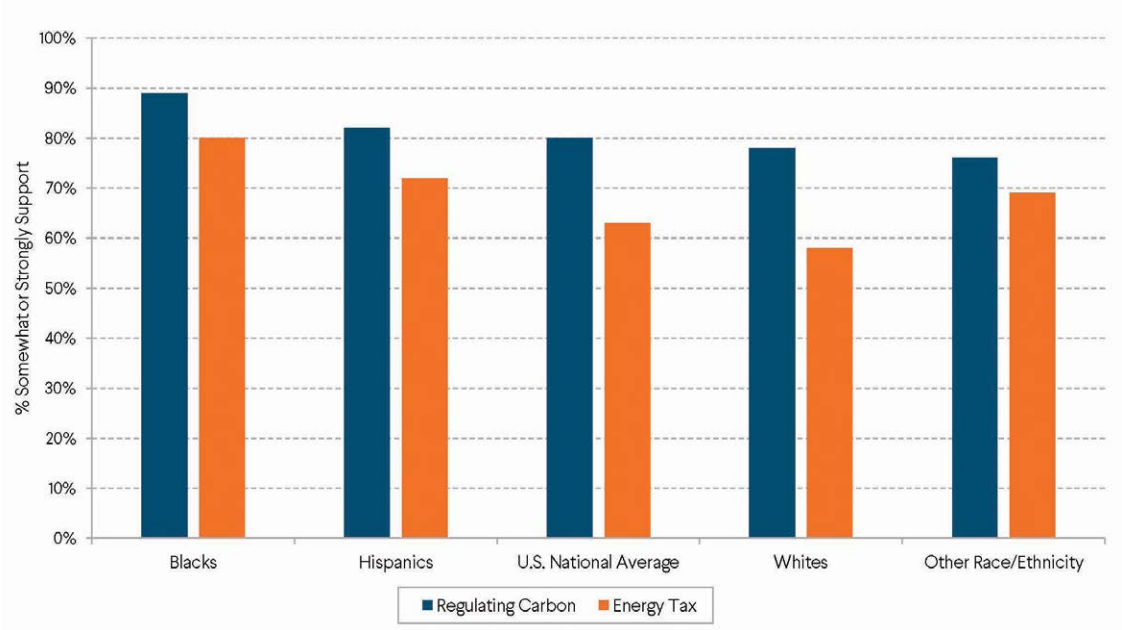
7 Simms, Patrice Lumumba. "On Diversity and Public Policymaking: An Environmental Justice Perspective." Sustainable Development Law & Policy 13, no. 1 (2012): 14-19, 57-59.

8 US Bureau of Census, Quick Facts for Boston Massachusetts, accessed April 2, 2019. The Census Bureau poverty definition is here: https://www.census.gov/topics/income-poverty/poverty/guidance/poverty-measures.html

9 Pope Francis. 2013. "Evangelii Gaudium." Vatican City.; President Barack Obama, Remarks on Economic Mobility, The White House, Office of the Press Secretary, December 04, 2013

Figure 4. Percentage of US Respondents Supporting Climate and Energy Policies by Race/Ethnicity

Data reflect support or opposition to (i) regulating carbon ("Regulating carbon dioxide (the primary greenhouse gas) as a pollutant"); and (ii) an energy tax ("Establish a special fund to help make buildings more energy efficient and teach Americans how to reduce their energy use. This would add a $2.50 surcharge to the average household's monthly electric bill"). Source: Reproduced from Pearson, Adam R., Matthew T. Ballew, Sarah Naiman, and Jonathon P. Schuldt. 2017. Race, Class, Gender and Climate Change Communication. Vol. 1. Oxford University Press. Available online: https://doi.org/10.1093/acrefore/9780190228620.013.412; Data from Leiserowitz, A., & Akerlof, K. (2010). Race, ethnicity, and public responses to climate change. Yale Project on Climate Change. New Haven, CT: Yale University and George Mason University. Available online: http://climatecommunication.yale.edu/wp-content/uploads/2016/02/2010_04_Race-Ethnicity-and-Public-Responses-to-Climate-Change.pdf.



the haves and have nots. The World Inequality Lab reports that since 1980, the global top one percent of earners have captured twice as much of income growth as the poorest 50 percent individuals. The global middle class, which contains all of the poorest 90 percent income groups in the EU and the US, has been severely squeezed.[10] Individual quality of life in the US is starkly segregated by income, race, and other measures of socioeconomic status.[11] It is not surprising that two-thirds of Americans report being dissatisfied with the way income and wealth are distributed.[12]

Inequality affects everyone, not just those with lower incomes. Income and wealth inequality slow economic growth, and thus lower overall prosperity and opportunity. A key channel between inequality and economic growth is investment in education. Income and wealth disparities depress skills development among individuals with poorer parental education background, both in terms of the quantity of education attained (e.g. years of schooling), and in terms of its quality (e.g. skill proficiency). Educational outcomes of individuals from wealthier backgrounds are not affected by inequality.[13] For this reason, countries with a higher degree of income and wealth inequality tend to have lower levels of social mobility between generations.[14]

10 Alvaredo, Facundo, Lucas Chancel, Thomas Piketty, Emmanuel Saez, and Gabriel Zucman. 2017. "World Inequality Report 2018." World Inequality Lab.

11 Alvaredo et al., op. cit; Kochhar, Rakesh, and Anthony Cilluffo. 2018. "Key Findings on the Rise in Income Inequality within America's Racial and Ethnic Groups." Washington, DC: Pew Research Center; Cingano, Frederico. 2014. "Trends in Income Inequality and Its Impact on Economic Growth." OECD Social, Employment and Migration Working Papers 163. https://doi.org/10.1787/5jxrjncwxv6j-en; Sullivan, Laura, Tatjana Meschede, Lars Dietrich, Thomas Shapiro, Amy Traub, Catherine Ruetschlin, and Tamara Draut. 2016. "The Racial Wealth Gap: Why Policy Matters." https://www.demos.org/sites/default/files/publications/RacialWealthGap_2.pdf.

12 Americans' Views on Economic Mobility and Economic Inequality in the U.S., Gallup Inc., January 2, 2018.

13 Cingano, Frederico. 2014. "Trends in Income Inequality and Its Impact on Economic Growth." OECD Social, Employment and Migration Working Papers 163. https://doi.org/10.1787/5jxrjncwxv6j-en.

14 Campos, Anna. 2017. "How Does Inequality Affect Economic Growth?" http://www.caixabankresearch.com/en/how-does-inequality-affect-economic-growth.

The impacts of inequity extend beyond income and wealth, and no one is inoculated from the social dysfunction caused by inequality. Crime rates, mental and physical health outcomes, life expectancy, imprisonment, environmental quality, and other measures of well-being are directly linked to income inequality.[15] Joseph Stiglitz, Nobel laureate in economics, summarized the social cost of inequality:

But perhaps the most invidious aspect of US inequality is the inequality of opportunity. America has become the advanced country not only with the highest level of inequality, but is among those with the least equality of opportunity—the statistics show that the American dream is a myth; that the life prospects of a young American are more dependent on the income and education of his parents than in other developed countries. We have betrayed one of our most fundamental values. And the result is that we are wasting our most valuable resource, our human resources: millions of those at the bottom are not able to live up to their potential.[16]

Equity and Inequity in Boston

Resilient Boston summarizes Boston's equity challenges:

[N]ot every resident has been able to share in [Boston's] recent prosperity. Many Bostonians are facing daily and compounded pressures of financial insecurity and lack of affordable housing. In addition, our aging transportation system does not serve all residents equally, and health outcomes continue to vary by neighborhood. The achievement gap in education is a persistent and vexing challenge, and climate change and extreme weather events pose increasing threats to our communities and infrastructure, with the greatest impacts often felt by our already most vulnerable residents. These challenges are further compounded by systemic racial inequity and the resulting harm it inflicts upon our communities and families.[17]

Boston's residential and homeownership patterns were formed by decades of government-sanctioned systemic discrimination. In the wake of the Great Depression, the federal government embarked on a strategy of expanding homeownership opportunities as a means of building wealth and achieving the American Dream. In the 1930s and 1940s, the US Federal Housing Authority (FHA), however, would not insure mortgages in neighborhoods that were home to communities of color,[18] nor in "White" neighborhoods that did not incorporate racially restrictive covenants. As a result, White families were able to build wealth, advance their economic status, and live in their choice of neighborhood (or suburb), while Bostonians of color were confined to neighborhoods experiencing crippling levels of disinvestment. FHA policies allowed bankers to devise a plan to provide low-interest loans to homebuyers who were people of color[19] but restricted them to Mattapan and parts of Dorchester, neighborhoods that to this day remain home to predominantly people of color.[20]

The Federal Housing Act of 1949 established a program of Urban Renewal, providing cities with funding to acquire parcels of land that were considered "blighted."[21] Cities used eminent domain to take privately owned land from residents, so long as it was put to "public use" and the government provided "just compensation."[22] This further restricted economic opportunities available to socially vulnerable populations because many residents were not duly compensated for their property,[23] and the interpretation of "blight" was infused with racial prejudice[24] and then used by governments to "relocate minority populations and entrench racial segregation."[25] In Boston, the impact of these policies led to large-scale displacement as the West End, a neighborhood of mostly working-class western European immigrants, gave way to Government Center,[26] and Chinatown

15 Wilkinson, Richard G., and Kate E. Pickett. 2009. "Income Inequality and Social Dysfunction." Annual Review of Sociology 35 (1): 493–511. https://doi.org/10.1146/annurev-soc-070308-115926.
16 Stiglitz, Joseph. 2014. Opportunity, Mobility, and Inequality in Today's Economy. Testimony before U.S. Senate Budget Committee, https://www.budget.senate.gov/hearings/opportunity-mobility-and-inequality-in-todays-economy.
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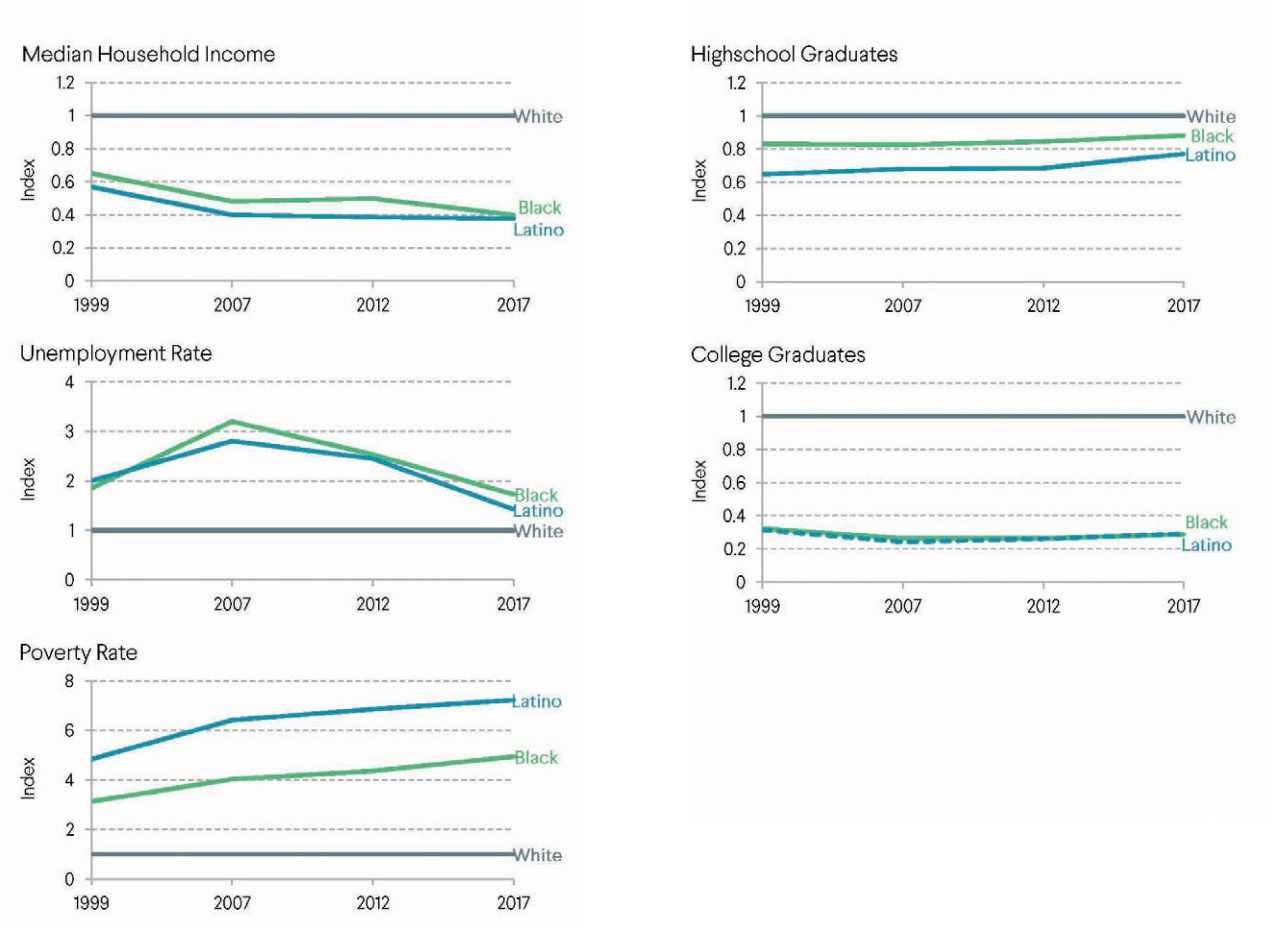
23 Jacobs, Jane. 1992. The Death and Life of Great American Cities. Vintage.
24 Pritchett, Wendell E. 2003. The "Public Menace" of Blight: Urban Renewal and the Private Uses of Eminent Domain. Yale Law & Policy Review, 21(1), 1–52.
25 Mock, Brenton. 2017. The Meaning of Blight. CityLab. Available online: https://www.citylab.com/equity/2017/02/the-meaning-of-blight/516801/.
26 The West End Museum. 2019. Urban Renewal. Available online: https://thewestendmuseum.org/history-of-the-west-end/urban-renewal/.

Figure 5. Racial Equity across Income, Unemployment, Poverty, and Education

Black and Latino populations compared to White populations, where data is indexed to White population equal to 1.0. Source: Data from US Census Bureau, 1999/2000 Census Data: Profile of Selected Economic Characteristics and 2007, 2012 and 2017 American Community Survey Data: 1-Year Estimates, Selected Population Profile in the United States.



ceded 1,200 units of housing to make way for a highway and other development.[27]

Today these historical injustices against socially vulnerable populations are visible in the persistent patterns of residential segregation, disparate rates of homeownership, discrepancies in building quality, and wealth inequity across Boston. The City's Economic Inclusion and Equity Agenda summarizes the situation as follows:

Boston is currently in the midst of one of the biggest building booms in the history of the city. Generations of inequity, however, have contributed to the fact that Boston's growth primarily benefits those who are already advantaged and excludes our most underserved populations. To attain a healthy economy that is generating more resources for the City and attracting diverse populations we must build an inclusive city with economic opportunity for all. The City must use its available tools to reach those who currently face barriers to participation: lack of qualifications for highly skilled jobs, lack of access to resources and capital for businesses, and rising living expenses which put homeownership out of reach.[28]

Racial-ethnic gaps persist in Boston around income, unemployment rates, poverty rates, and educational attainment (Figure 5). Boston has the sixth highest rate of income inequality of all US metropolitan areas; the top 5 percent of households earn

27 The Asian American Legal Defense and Education Fund. 2013. Chinatown Then and Now: Gentrification in Boston, New York, and Philadelphia. Available online: https://lawprofessors.typepad.com/immigration/2013/10/chinatown-then-and-now-gentrification-in-boston-new-york-and-philadelphia.html.

28 City of Boston. February 2016. Economic Inclusion and Equity Agenda. Available online: https://www.cityofboston.gov/pdfs/economicequityinclusionagenda.pdf. p.3.

incomes approximately 15 times higher than households in the bottom 20 percent.[29] In 2017, after adjusting for inflation, Boston's Latinx/Hispanic families had a median income of $37,000, Black families, $39,000, and White families $98,000.[30] This disparity has grown over time. Boston's Black and Latinx/Hispanic residents also face higher unemployment rates than White residents, and are less likely to have a high school or college degree. While the share of all families in Boston who live beneath the poverty line is shrinking, the rate of reduction is slower for Black and Latinx/Hispanic families.

Understanding Social Vulnerability

Socially vulnerable communities contribute the least to GHG emissions and are the "first and worst" impacted by climate change.[31] Social vulnerability is a lack of capacity to withstand hard times—that is, to prepare for, respond to, and recover from emergencies such as a missed paycheck, illness, a high utility bill, or the effects of a natural disaster.[32] Some researchers use the term "insecurity" to describe this kind of vulnerability: energy, food, and housing insecurity threaten overall well-being, but particularly health, and especially the health of children.[33] Other scholars connect ideas of social vulnerability and insecurity to concerns of "environmental justice" pointing out that socially vulnerable communities are often disproportionately impacted by environmental hazards and have less access to goods and services that would enable their recovery and enhance their resilience.[34] Social vulnerability is also connected to "energy justice" because socially vulnerable communities often lack consistent access to a clean, affordable, and secure supply of energy needed for heating, cooling, lighting, and refrigeration.[35] These themes are reflected in a report to the Boston City Council which observed that "a resilient city is one that is both climate resilient and has intentionally created a resilient social and economic fabric to weather the coming storm."[36]

In Boston, socially vulnerable populations are spread throughout the city and are part of the fabric of every neighborhood and community (Figure 6). We use six of the socially vulnerable populations that were defined in *Climate Ready Boston* (see Appendix B for more detailed descriptions):

- Children (18 years and younger)
- Limited English proficiency
- Low to no Income (below 150 percent of the poverty line)
- Older adults (65 years and older)
- People of color (including Black or African American, American Indian and Alaska or Hawaiian Native, Asian, Pacific Islanders and all Latinx/Hispanic)
- People with disabilities (both physical and mental)[37]

Social vulnerability does not mean that individuals in these groups are victims. Social vulnerability should not be mistaken for weakness, lack of information, or powerlessness. To the contrary, the use of the term assesses and acknowledges deficiencies, policy failures, and historical disparities in our social, economic, and political systems that have made communities vulnerable; communities are not inherently or naturally vulnerable.[38]

29 Berube, A. February 5, 2018. City and metropolitan income inequality data reveal ups and downs through 2016. Brookings Institute. Available online: https://www.brookings.edu/research/city-and-metropolitan-income-inequality-data-reveal-ups-and-downs-through-2016/.

30 Lima, A. et al. January 2017. Boston in Context: Neighborhoods. 2011-2015 American Community Survey. Boston Planning and Development Agency. Available online: https://bit.ly/2ubjqcV.

31 Environmental Justice Foundation. November 2, 2017. Beyond Borders: Our Changing Climate – Its Role in Conflict and Displacement. Available online: https://ejfoundation.org/reports/beyond-borders.

32 Martin, S.A. June 2015. A Framework to Understand the Relationship between Social Factors That Reduce Resilience in Cities: Application to the City of Boston. International Journal of Disaster Risk Reduction, 12, 53–80. Available online: https://doi.org/10.1016/j.ijdrr.2014.12.001.

33 Hernandez, D. October 2016. Understanding 'energy Security' and Why It Matters to Health. Social Science & Medicine, 167, 1–10. Available online: https://doi.org/doi:10.1016/j.socscimed.2016.08.029.

34 Bullard, R.D. March 2000. Dumping in Dixie: Race, Class and Environmental Quality. Westview Press: Boulder, CO. Available online: https://we.riseup.net/assets/371526/Robert+D.+Bullard-Dumping+In+Dixie+Race%2C+Class%2C+And+Environmental+Quality%2C+Third+Edition-Westview+Press+%282000%29.pdf.

35 Sovacool, B.K. and Dworkin, M.H. March 2015. Energy Justice: Conceptual Insights and Practical Applications. Applied Energy, 142, 435–44. Available online: https://doi.org/10.1016/j.apenergy.2015.01.002.

36 Schlegel, Christina. 2018. Climate Justice for the City of Boston: Visioning Policies and Processes, Office of Boston City Council. Available online: http://michelleforboston.com/wp-content/uploads/2018/02/CJ-Report.pdf

37 U.S. Census Bureau. American Community Survey (ACS). 5-year Estimates. Available online: https://www.census.gov/programs-surveys/acs. See Methodology Appendix for more details.

38 Ibid. p.21.

Figure 6. Socially Vulnerable Populations in Boston

Populations are mapped by quartile to show relative concentrations in each census tract. Source: Data from US Census Bureau, 2012-2016 American Community Survey: 5-Year Estimates

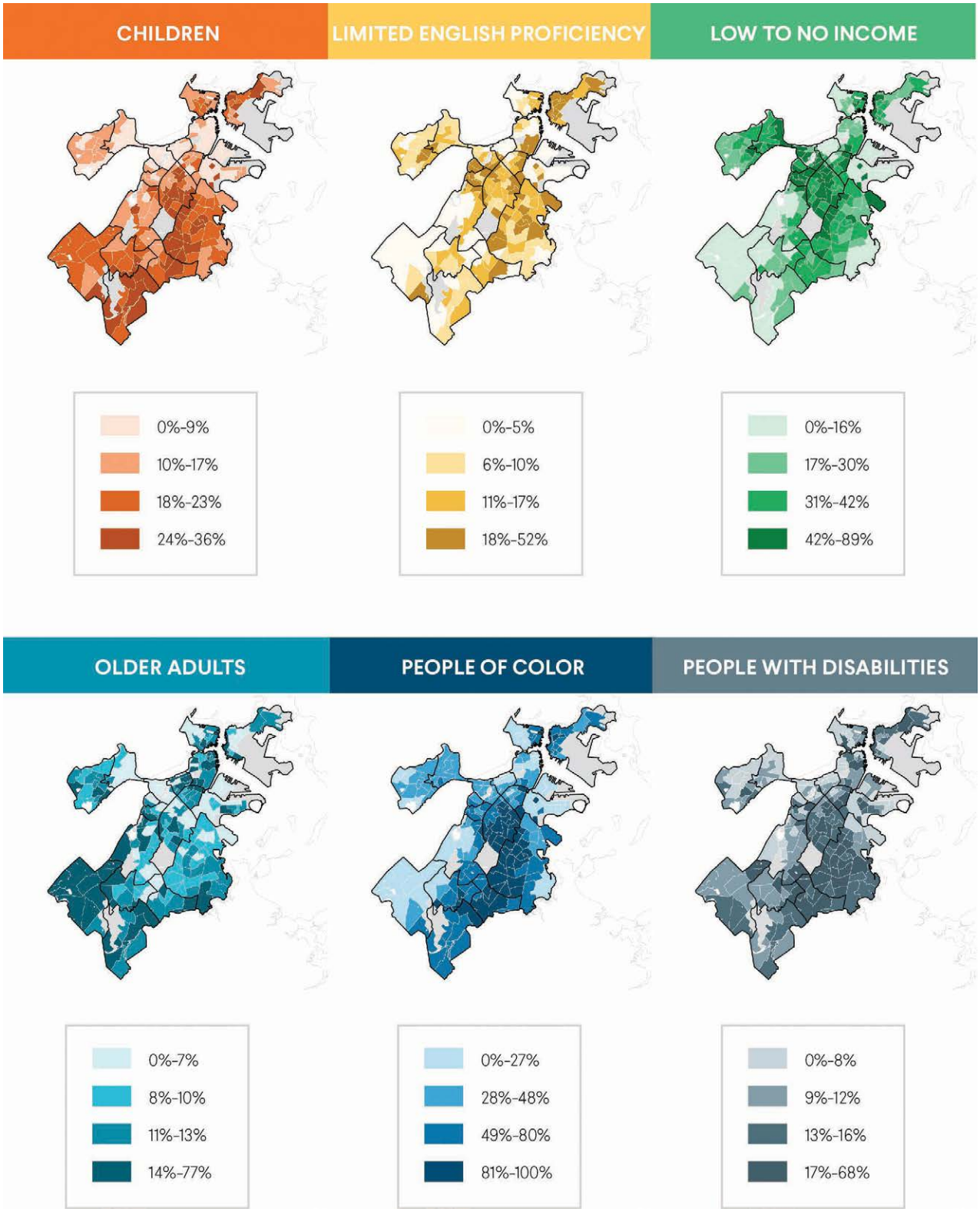
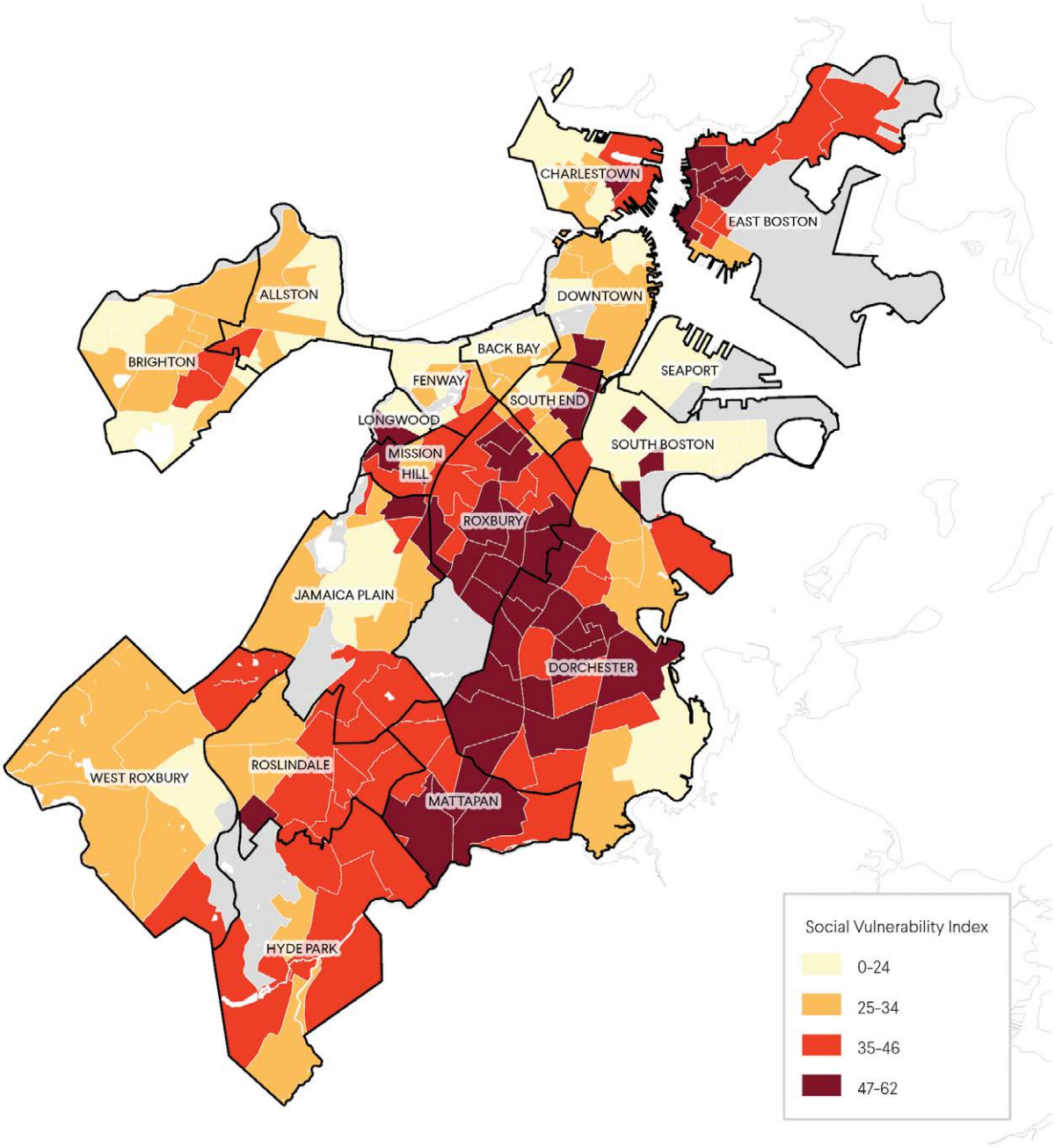


Figure 7. Social Vulnerability Index

The Index combines values from six measures of vulnerability, each expressed as a share of a census tract or neighborhood population. A higher score (darker color) indicates a greater degree of vulnerability. Population shares for the six vulnerable groups are converted into six component indices, each ranging from 0 to 100/6 (or 16.7) in value. If a census tract or neighborhood had the highest census tract share of all six vulnerable groups—receiving six component index values of 16.7—its Social Vulnerability Index would be 100.0. Calculated census tract indices range from 5 to 62, and neighborhoods from 13 to 49. Source: calculations by Applied Economics Clinic



Many families, communities, and neighborhoods face multiple social vulnerabilities. We represent this in a Social Vulnerability Index (SVI) that aggregates the six vulnerable groups into a single measure of vulnerability in each census tract (Figure 7). The six groups are equally weighted. See Appendix C for a detailed explanation of the SVI calculation.

Boston communities with a high SVI score— including Dorchester, East Boston, Hyde Park, Mattapan, Mission Hill and Roxbury—are more likely to face disproportionate impacts from both climate change and action to reduce GHG emissions, and they are less likely to have access to the resources that buffer those impacts. Communities with a low SVI score—including Back Bay, Longwood and Seaport—have greater capacity to respond to extreme temperatures and fluctuations in the costs of energy, and the means to pay for clean energy technologies such as heat pumps, electric vehicles, and building retrofits.

A City of Neighborhoods

Boston neighborhoods vary widely in terms of race/ethnicity, income, housing types (single-family vs. multifamily homes), building age, share of renters, types of fuel use for heating, and transit access. In Table 2, Table 3 and Table 4, Boston neighborhood names (on the left) are highlighted in three shades of blue that correspond to their SVI values: light blue indicates the lowest SVI results (less than 23); medium blue indicates the middle SVI results (23 to 34); and dark blue indicates the highest SVI results (35 and greater). The tables also show neighborhood characteristics in these three shades of blue indicating a low, middle or high vulnerability value for each characteristic presented. For example, in the "People of Color" column in Table 2, light blue indicates the lowest (less than 20 percent), medium blue indicates the middle (between 20 and 60 percent), and dark blue indicates the highest (over 60 percent). Appendix C provides information about the low, middle and high data ranges for each variable.

Neighborhoods with the highest levels of social vulnerability include: Dorchester, East Boston, Hyde Park, Mattapan, Mission Hill and Roxbury. Neighborhoods with the lowest levels include: Back Bay, Longwood and Seaport. The remaining neighborhoods—Allston, Brighton, Charlestown, Downtown,[39] Fenway, Jamaica Plain, Roslindale, South Boston, South End and West Roxbury—are somewhere in the middle. Neighborhoods with higher concentrations of socially vulnerable populations and higher social vulnerability indices tend to also have lower median incomes, higher proportions of renters, devote a larger fraction of their income to fuel and electricity, and they have fewer T stops per 10,000 residents—while the opposite is true for neighborhoods with lower concentrations of socially vulnerable populations.

Business-heavy neighborhoods—like Downtown, Back Bay and Seaport—and student-heavy neighborhoods—like Longwood, Mission Hill and Fenway—have high shares of renters, which presents the City with a distinct set of challenges as it works to decarbonize the building sector. The highest incidence of low-income households is also found in student-heavy neighborhoods (Allston, Fenway, Longwood, Mission Hill), with the exception of Roxbury (Table 2). Two of the three neighborhoods with the lowest social vulnerability indices (Back Bay and Seaport) also have the highest median incomes of any Boston neighborhood. The least vulnerable neighborhoods have high shares of renters, ranging from 78 percent in Seaport to 100 percent in Longwood (Table 3). They also have among the best transit availability and connectivity in the city (especially Seaport) (Table 4).

Among the neighborhoods with the highest social vulnerability indices (Dorchester, East Boston, Hyde Park, Mattapan, Mission Hill and Roxbury —Table 2), there are wide variations in median incomes (from as low as $27,000 in Roxbury to as high as $52,000 in East Boston—Table 3), shares of renters (from as low as 35 percent in Mattapan to as high as 84 percent in Mission Hill—Table 3), and solar panels per 10,000 residents (from as low as 3 in Mission Hill to as high as 123 in Hyde Park—Table 4). These differences mean that the City cannot use a "one size fits all" approach in its efforts to address social vulnerabilities as part of its larger effort to reach carbon neutrality.

39 "Downtown" includes Beacon Hill, Chinatown, West End, and the North End.

Table 2. Socially Vulnerable Populations by Boston Neighborhood

Neighborhood	SV Index*	People of Color	Children	Older Adults	People with Disabilities	Low-income	Limited English Proficiency
Allston	23	44%	4%	4%	7%	42%	9%
Back Bay	20	24%	7%	15%	6%	15%	6%
Brighton	27	34%	9%	12%	10%	31%	12%
Charlestown	28	29%	19%	10%	10%	24%	7%
Dorchester	43	78%	23%	10%	16%	34%	14%
Downtown	25	29%	7%	13%	9%	24%	12%
East Boston	45	68%	21%	9%	13%	34%	29%
Fenway	25	39%	3%	4%	7%	49%	15%
Hyde Park	39	74%	23%	14%	11%	17%	9%
Jamaica Plain	30	46%	17%	11%	10%	23%	9%
Longwood	20	30%	1%	1%	6%	40%	18%
Mattapan	47	93%	22%	12%	17%	34%	13%
Mission Hill	39	56%	12%	11%	12%	55%	18%
Roslindale	33	47%	21%	12%	11%	19%	10%
Roxbury	49	89%	23%	10%	16%	51%	17%
Seaport	13	17%	5%	7%	9%	9%	3%
South Boston	24	23%	13%	9%	12%	23%	8%
South End	34	48%	14%	11%	12%	33%	14%
West Roxbury	31	28%	22%	18%	13%	13%	6%
ALL BOSTON	35	55%	17%	11%	12%	31%	13%

Note: Refer to Appendix C for high, medium, and low variable cutoff definitions.

* The Index combines values from six measures of vulnerability, each expressed as a share of a census tract or neighborhood population. A higher score indicates a greater degree of vulnerability. Source: calculations by Applied Economics Clinic

Table 3. Income and Housing Information by Boston Neighborhood

Neighborhood	Median Income	Population Density (1000s per sq mile)	Single Family Unit	Small Multi Family Unit	Large Multi Family Unit	Average Year Built	Share of Renters
Allston	$41,706	12	19%	58%	22%	1926	75%
Back Bay	$99,110	29	12%	15%	73%	1936	88%
Brighton	$58,160	17	21%	55%	24%	1923	65%
Charlestown	$91,581	14	34%	52%	14%	1898	60%
Dorchester	$49,902	17	26%	67%	7%	1854	45%
Downtown	$85,547	29	12%	26%	61%	1923	82%
East Boston	$52,229	10	18%	73%	9%	1910	53%
Fenway	$30,801	37	3%	34%	63%	1926	95%
Hyde Park	$67,095	8	68%	30%	2%	1935	23%
Jamaica Plain	$77,339	11	34%	60%	6%	1916	49%
Longwood	$40,662	19	0%	45%	55%	1942	100%
Mattapan	$46,506	12	42%	52%	6%	1933	35%
Mission Hill	$32,857	31	8%	79%	13%	1936	84%
Roslindale	$74,660	11	52%	45%	3%	1922	31%
Roxbury	$27,301	16	24%	66%	10%	1918	57%
Seaport	$122,264	1	28%	48%	24%	1922	78%
South Boston	$85,301	37	24%	68%	8%	1909	67%
South End	$74,644	37	10%	38%	52%	1925	81%
West Roxbury	$79,620	6	84%	14%	2%	1938	18%
ALL BOSTON	$60,573	19	28%	52%	20%	1910	57%

Note: Refer to Appendix C for high, medium, and low variable cutoff definitions.

Table 4. Transit and Energy Access by Boston Neighborhood

Neighborhood	Miles of Bus Route	T Stops	Blue Bike Stations	Bike Network Miles	EV Charging Stations	Rooftop Solar Installations
	Per 10,000 Residents					
Allston	38.3	3.6	4.6	4.8	3.6	5.7
Back Bay	11.8	2.2	4.4	3.1	5.5	0.6
Brighton	6.5	1.8	2.0	2.4	0.8	19.8
Charlestown	25.6	1.1	6.0	2.2	0.0	7.6
Dorchester	16.4	0.9	1.5	2.0	0.4	26.2
Downtown	10.1	4.7	4.9	2.2	4.5	1.1
East Boston	17.5	0.7	2.4	2.0	1.1	10.7
Fenway	6.8	3.4	4.0	3.0	0.9	0.0
Hyde Park	17.7	1.1	0.0	1.8	0.3	122.7
Jamaica Plain	13.4	1.4	2.2	2.5	0.7	55.5
Longwood	44.3	0.0	9.3	3.0	5.6	0.0
Mattapan	13.7	1.2	1.6	2.0	0.4	90.7
Mission Hill	7.5	3.5	0.6	1.3	0.6	2.9
Roslindale	26.9	0.8	1.1	2.3	0.0	113.7
Roxbury	31.1	1.6	2.7	2.6	0.2	16.4
Seaport	156.4	13.8	41.5	10.5	34.6	0.0
South Boston	20.0	0.6	2.8	2.2	0.0	10.7
South End	10.9	5.5	2.9	1.4	1.5	1.8
West Roxbury	34.2	0.6	0.0	2.1	0.0	77.2
ALL BOSTON	18.4	1.8	2.6	2.3	1.2	32.0

Note: Refer to Appendix C for high, medium, and low variable cutoff definitions.

Our Approach

Our approach to the assessment of strategies to achieve a carbon-neutral city assumes that ignoring equity is not an option. A carbon-neutral city requires a major transformation of Boston's built infrastructure, regulatory frameworks, regional markets, and the behavior of its inhabitants. Every public action has an equity impact whether stated or unstated, and many new actions will be designed and implemented that embody choices about what to include and what to leave out. In this transition Boston will either lock in and exacerbate historical capacity gaps, or use this watershed moment to create a more equitable, inclusive, resilient and prosperous city.

Three principles guide our equity analysis: careful planning to avoid unintended consequences; intentional design with a clear focus on equity outcomes; and inclusive practices from start to finish in all decision-making.

Well-Meaning Policy Choices Can Have Unintended Consequences

Action to reduce GHG emissions can exacerbate or perpetuate inequity unless specifically designed to avoid unintended consequences. Examples (described in detail later in this report) include:

- Changes to property values and rents that can contribute to ongoing trends in neighborhood gentrification and displacement of communities that are predominantly poor, working class, and/or people of color
- Unfair burdens on socially vulnerable communities, families or individuals that raise their costs of living or exclude them from access to services and decision-making
- Cost increases that are unduly burdensome as a share of income (e.g. the same $100 annual cost increase has a very different effect on a family with low or no income than it does on an affluent family)
- Special benefits to more privileged groups, lowering costs or creating benefits that only they can access

Avoiding these and other unintended consequences requires not only forethought and inclusive decision-making, but also effective monitoring and evaluation procedures that enable course corrections.

Intentional Design Focuses on Equity Outcomes

Intentional design refers to policy design that explicitly attempts to avoid unintended consequences, promotes efforts to redress capacity gaps, and includes socially vulnerable communities in every step of the decision-making process. Intentional design has three tenants:

1. ***Socially vulnerable communities have the most to gain***: Socially vulnerable communities pay disproportionately more for rent, energy, and transportation; they may be served by poor performing public infrastructure; and their personal assets (vehicles, homes, appliances) tend to be old and inefficient. As *Climate Ready Boston* reported, socially vulnerable communities also are disproportionately impacted by the effects of climate change itself. It is self-evident, therefore, that socially vulnerable communities stand to gain the most from a reduction in GHG emissions. Intentional design looks for opportunities to direct benefits of carbon-neutral policies towards communities with such vulnerabilities and historical gaps in capacity.

2. ***Socially vulnerable communities face the greatest risks***: Socially vulnerable communities are exposed to the greatest risks—and have the most to lose—from new action taken to reduce GHG emissions. Intentional design plans for these risks and asks how they can be distributed equitably across the city. Potential burdens include mental and physical health, costs (in money and in time spent) of transportation, housing, waste management, energy, and the risk of neighborhood displacement.

The Boston Common Frog Pond. Photo credit: iStock/mediaphotos

Clean energy policies need not reduce overall employment opportunities,[40] but poor policy design could result in overall job loss in the worst-case scenario, or could result in job growth with an inequitable distribution of benefits. Workers in carbon-intensive sectors will need to transition to other work as fossil fuel-related jobs shrink and renewable energy and efficiency jobs grow.[41] This dynamic was recently highlighted at the federal level with US House Resolution 109 that proposed to create a "Green New Deal" that would "spur economic development…while prioritizing high-quality job creation and economic, social, and environmental benefits in frontline and vulnerable communities, and deindustrialized communities, that may otherwise struggle with the transition away from greenhouse gas intensive industries."[42] Intentional policy design ensures that workers are equipped and prepared for these transitions, and that job training and skill development are targeted at those workers who stand to lose the most in the transition.

These risks can be addressed by the policies discussed in this report, including:

- Prioritizing policies that benefit socially vulnerable groups and the neighborhoods in which they reside
- Policies that recycle revenue from fees to fund public and active transit investments that benefit socially vulnerable communities
- Redressing differential access to credit, technology, and information that are barriers to the realization of benefits generated in a carbon-neutral city
- Pairing policy mandates with protections for socially vulnerable populations
- Acknowledging different levels of capacity for investment in clean infrastructure and technologies

40 Kruse, T., Dellink, R. and Chateau, J. June 2017. Employment Implications of Green Growth: Linking Jobs, Growth, and Green Policies. OECD. Available online https://www.oecd.org/environment/Employment-Implications-of-Green-Growth-OECD-Report-G7-Environment-Ministers.pdf.

41 Altenburg, T. and Assmann, C (Eds.). 2017. Green Industrial Policy: Concept, Policies, Country Experiences. German Development Institute and UN Environment: Geneva, Bonn. Available online: http://www.greengrowthknowledge.org/sites/default/files/downloads/resource/Green%20Industrial%20Policy_Concept%2C%20Policies%2C%20Country%20Experiences.pdf.

42 Ocasio-Cortez, A. February 8, 2019. House Resolution 109: Recognizing the Duty of the Federal Government to Create a Green New Deal. U.S. 116th Congress (2019-2020). Available online: https://www.congress.gov/bill/116th-congress/house-resolution/109/text.

3. ***Action in Boston has regional equity impacts***: Action in Boston to reduce GHG emissions will ripple through socially vulnerable communities outside the city. For example, citywide transportation emissions include all trips that end in Boston, including socially vulnerable individuals that commute into the city for work. Boston's municipal solid waste is sent to incinerators located elsewhere in the region. Boston's electric supply is regional, and decisions about it have the potential to impact communities throughout New England and Canada. Similarly, choices regarding offset purchases will impact their communities of origin. Intentional planning looks at the whole picture, considering equity effects wherever they may occur.

Questions and Considerations for Integrating Equity

Key Questions	Considerations: does the strategy/is the strategy…?	
Is it green?		
Is it GHG-free?	Reduce GHG emissions: electrification, active transport, lower non-CO_2 emissions	Yes / No / Depends
Is it environmentally sustainable?	Use less energy or emit fewer GHGs to provide the same energy service; other environmental considerations: land and water use, pollution, etc.	Yes / No / Depends
Does it promote smart behavior?	Alter behavior or use in ways that accomplish more than GHG reductions: i.e., better timing or siting for congested resources, smarter use of resources, waste reduction	Yes / No / Depends
Is it fair?		
Is it accessible?	Available to and beneficial for all communities; addresses historical disparities and cultural differences	Yes / No / Depends
Is it affordable?	Affordable to all private residents; limits negative impacts on public sector	Yes / No / Depends
Are workforce opportunities just?	Balanced and fair in workforce and contractor diversity; addresses historical disparities	Yes / No / Depends
Who gets to decide?		
Is it inclusive?	Active and meaningful role in decision-making for impacted or socially vulnerable communities	Yes / No / Depends
Are values considered?	Decision-making processes go beyond dollars and cents to address shared values and cultural differences	Yes / No / Depends
Is it measurable?	Enable measurement of quantity and quality of service provided and community impacts in order to provide important performance feedback	Yes / No / Depends

Inclusive Policies Focus on Equity from Start to Finish

To reach carbon neutrality, the City will have to simultaneously achieve an inclusive and equitable Boston. "Communication to" socially vulnerable communities is not inclusivity. "Engagement" and "diversity" are not inclusivity. True inclusive policy making requires that those most impacted by new climate mitigation policies have a seat at the table and lead engagement efforts. Socially vulnerable communities must have meaningful participation in policy planning and design, implementation, evaluation and an enduring role as these policies evolve over time. For participation to be meaningful, people must have a right to participate in the decisions that affect them, including receiving balanced, objective information; consultation with affected communities for their input and feedback; a role in policies' design, implementation and monitoring; and control over decisions that affect their well-being.[43]

The Social Equity Advisory Group

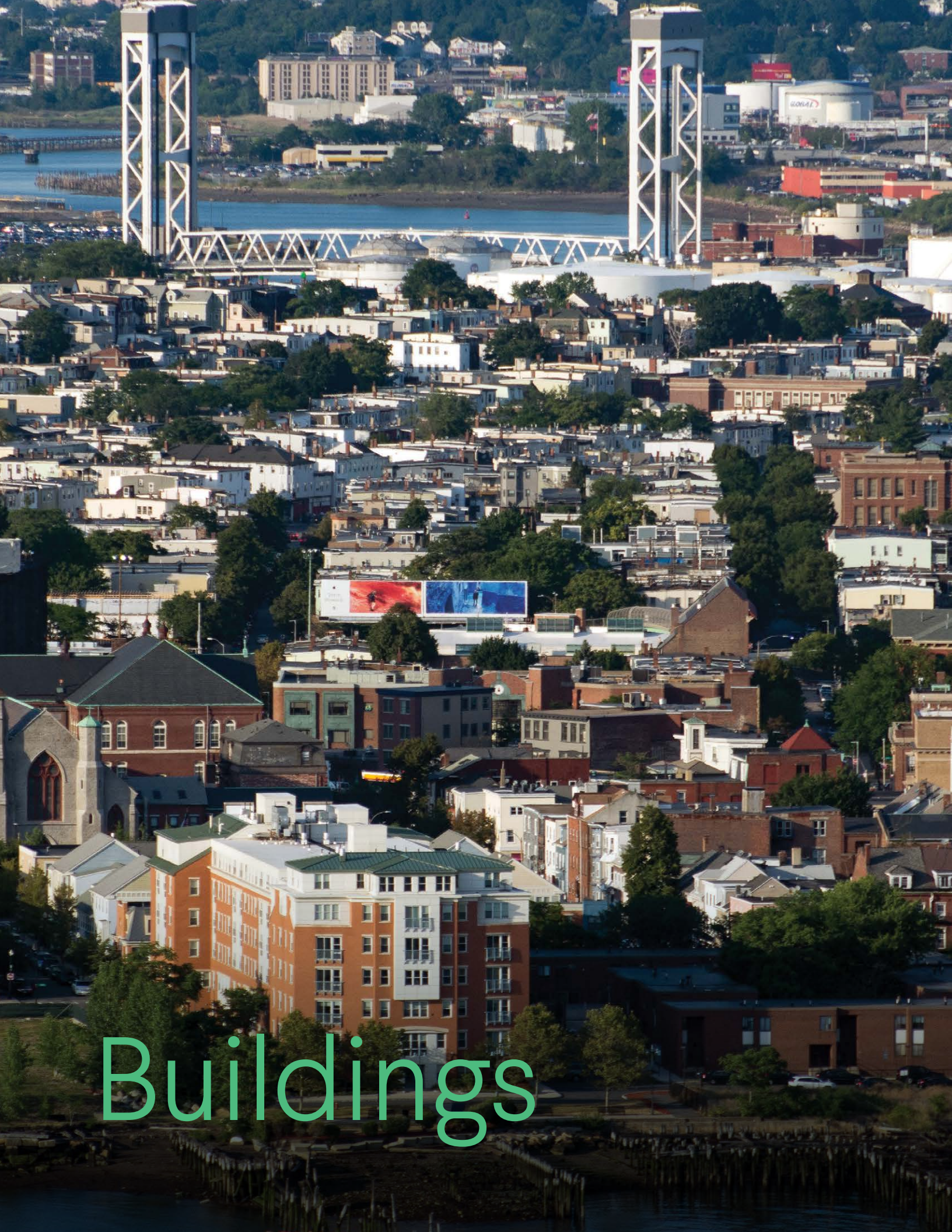
A group of leaders and community stakeholders formed an advisory group for the development of the *Summary Report*. The group consisted of experts in the area of social equity, representatives of several community groups, and members of the Technical Advisory Groups for Buildings, Transportation, Waste, and Energy. The Social Equity Advisory Group met four times in 2018-2019 to provide guidance and feedback on the integration of social equity into the assessment of options to reduce GHG emissions in Boston. The input and expertise of the members of the Social Equity Advisory Group was pivotal to the development of this report. The members are listed in Appendix A.

Organization of this Report

The chapters that follow address each of the five areas addressed by the *Summary Report* in turn: Buildings, Transportation, Waste, Energy Supply, and Offsets. A final chapter offers an overview of guidance from this report and synthesizes the lessons learned across all sectors for the City to consider as it develops its Climate Action Plan. Each sector chapter begins with a recap of the mitigation strategies assessed in the *Summary Report* and summarizes the social equity concerns that currently exist in that sector in Boston. Next, the framework presented above—how policy can address existing capacity gaps, avoid unintended policy consequences, benefit from intentional policy design, and provide examples of instances from elsewhere in the country and the world that illuminate these pitfalls and opportunities—is utilized to synthesize the existing body of knowledge on the social equity impacts relevant for that sector and its potential mitigation pathways. Each sector chapter includes a summary table of actionable insights regarding the results of the social equity analysis, and guidance regarding the implementation of climate policy in Boston. The summary table uses a criteria-based framework to evaluate mitigation strategies in the context of how each intersects with social equity.

43 World Health Organization. 2019. Gender, equity and human rights: Participation. Available online: https://www.who.int/gender-equity-rights/understanding/participation-definition/en/.

Dorchester Day Parade.
Photo credit: MJ Photography/Alamy Stock Photo



Buildings

Main Findings

- Boston has a very old housing stock and a shortage of affordable housing, both key equity concerns as Boston evaluates its options to retrofit 2,000 to 3,000 buildings per year.
- The affordable housing shortage makes many of Boston's neighborhoods—including South Boston, Seaport, Roxbury, the South End, Dorchester, Brighton, Allston, Jamaica Plain, and East Boston—vulnerable to gentrification and displacement.
- Renter-occupied, multifamily homes are harder to retrofit and are more common in neighborhoods with the highest concentrations of many socially vulnerable communities, such as Dorchester, Roxbury, Mattapan, East Boston, Allston, Mission Hill, and Hyde Park.
- Socially vulnerable households face multiple barriers to clean energy technologies and energy efficiency, including affordability, high up-front costs, access to credit, and split incentives between landlords and tenants.
- Socially vulnerable communities stand to benefit the most from energy efficient residences: improved health, safety, and comfort; cost savings; higher property values, and workforce development.
- The City's climate and equity goals will be simultaneously advanced with enhanced tracking of demographic data and metrics; building trust and participation in education and outreach; working with local and state partners to lower financial barriers, prioritizing multifamily affordable housing, intentionally expanding workforce diversity in the buildings sector, and by using new, net-zero homes to close the affordable housing gap.
- Boston's path to a carbon-neutral building stock will be fair and just when choices are made with input from those most affected, and when deliberate action is taken with inclusive decision-making at each step in the process.

Overview

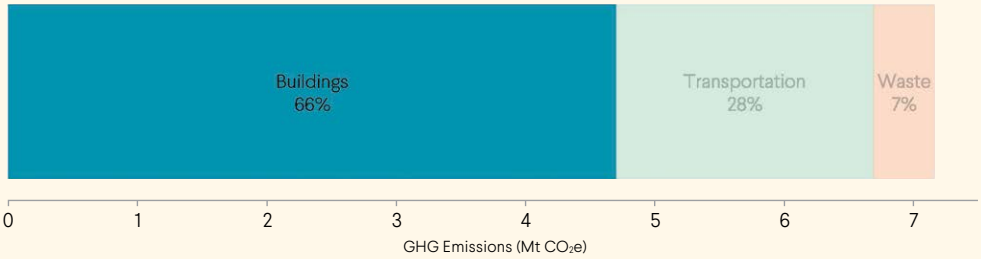
The *Summary Report* identified three main areas of action for buildings: (1) maximize energy efficiency, primarily through whole building and deep energy retrofits; (2) replace the natural gas and heating oil currently used to heat space and hot water with GHG-free electricity; and (3) establish strong energy performance standards for all buildings. According to the findings of our analysis, the focus of carbon neutrality in Boston should be on ensuring that (i) energy-efficient, affordable housing is expanded to slow the displacement of vulnerable Bostonians; (ii) the cost of fuel and electricity is not a burden, and (iii) the quality of life enhancements from energy efficient housing are shared equitably across the city.

The age, ownership, and type of Boston's buildings vary by neighborhood (Figure 8), but each neighborhood includes a broad range of building ages and types. For the most part, Boston's buildings are old, and even the neighborhood with the youngest residential building stock has an average home built year of 1942. In Charlestown and Dorchester the average residential building was constructed in the 1800s. Downtown, Charlestown, Back Bay, East Boston, Fenway, Longwood, Mission Hill and large parts of Roxbury and Dorchester are dominated by non-owner occupied, large residential, and small multifamily homes. Owner-occupied, single-family homes are more common in Jamaica Plain, Roslindale, West Roxbury, Hyde Park and parts of Mattapan and Dorchester.

Different neighborhoods face different challenges to retrofitting their heating systems (Figure 9). Neighborhoods with a large share of electric heating—like Downtown, Mission Hill, Back Bay, and South End—are in the best position to decarbonize as the electric grid becomes cleaner. The remainder of Boston neighborhoods have buildings that are largely reliant on heating oil and gas for heating and pose a greater challenge to decarbonize, as they require electrification retrofits.

Carbon Free Boston Strategies for Carbon-Neutral Buildings

The use of electricity, heating oil, natural gas, and steam in Boston's buildings currently accounts for approximately two-thirds of the city's total emissions (below).



To achieve carbon neutrality, the City of Boston will need to retrofit about 86,000 buildings by 2050—or between 2,000 and 3,000 retrofits per year—and ensure all new buildings are GHG-free. The retrofit challenge is significant because the Boston's building stock is old and thus relatively energy-inefficient. The *Summary Report* proposed three main areas of action for buildings: (1) maximize energy efficiency, primarily through whole building and deep energy retrofits; (2) replace the natural gas and heating oil currently used to heat space and hot water with GHG-free electricity; and (3) establish strong energy performance standards for all buildings.

	ACTION	DETAILS
Expand Efficiency	Incentive programs to promote early action	• Examples include windows and weatherization; individual actions have small impact
	Deep energy retrofit requirements and financial support	• Target 50% reduction in energy use
		• Required for about 3% of building stock per year
		• Create financing mechanisms to reduce cost burden
	Storage programs	• Battery, thermal, and demand response to reduce peak demand and time of use costs
		• Commercial focus
Electrification	Eliminate fuel oil for heating by 2030	• Replace with electric heat pumps and boilers
	Phase out natural gas where feasible	• Replace with electric heat pumps and boilers
		• Pair with retrofit requirements and expand incentives
		• Approximately 3% of buildings stock per year
	Use renewable natural gas or hydrogen from zero-carbon electricity for difficult to electrify heating services	• Near-term limits on supply of renewable gas
		• Hydrogen requires new infrastructure
Building Performance Standards	New construction performance targets	• Net Zero Emissions phased in for different building classes from 2023 - 2035
	Expand existing building disclosure and action requirements (BERDO)	• Include all commercial and large residential buildings
		• Target at least 1% reduction in energy use intensity per year

Figure 8. Building Age, Building Ownership and Building Type in Boston

Source: City of Boston Property Assessment FY 2018

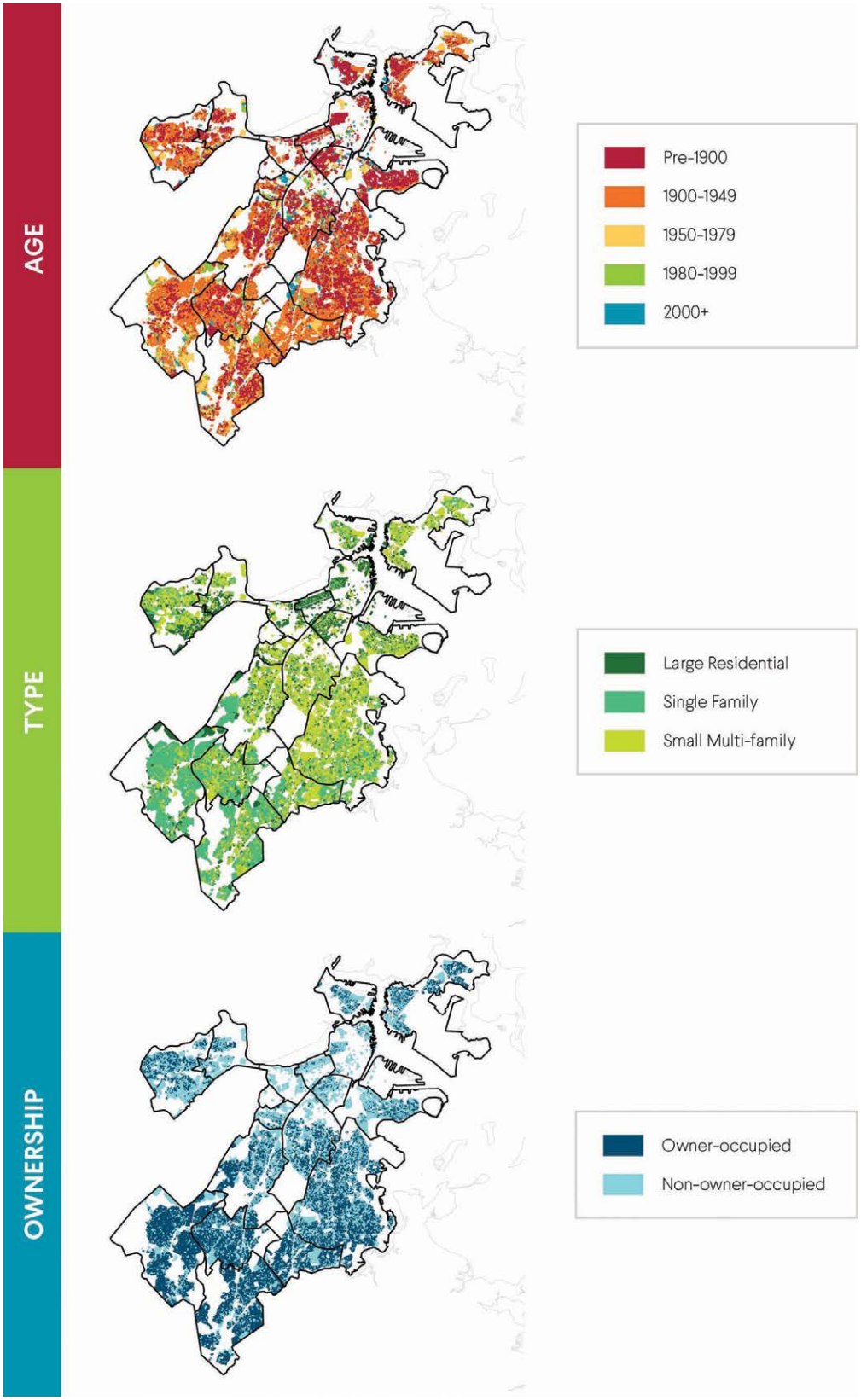


Figure 9. Home Heating Energy Use by Boston Neighborhood

Source: Data from US Census Bureau, 2012-2016 American Community Survey: 5-Year Estimates

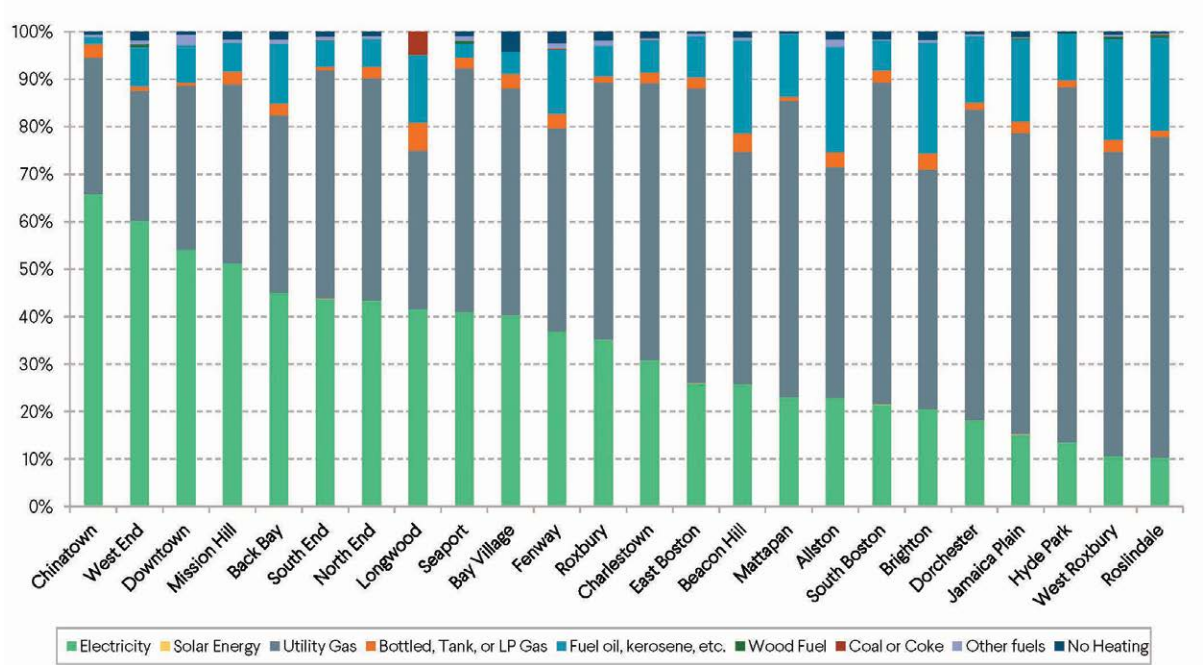
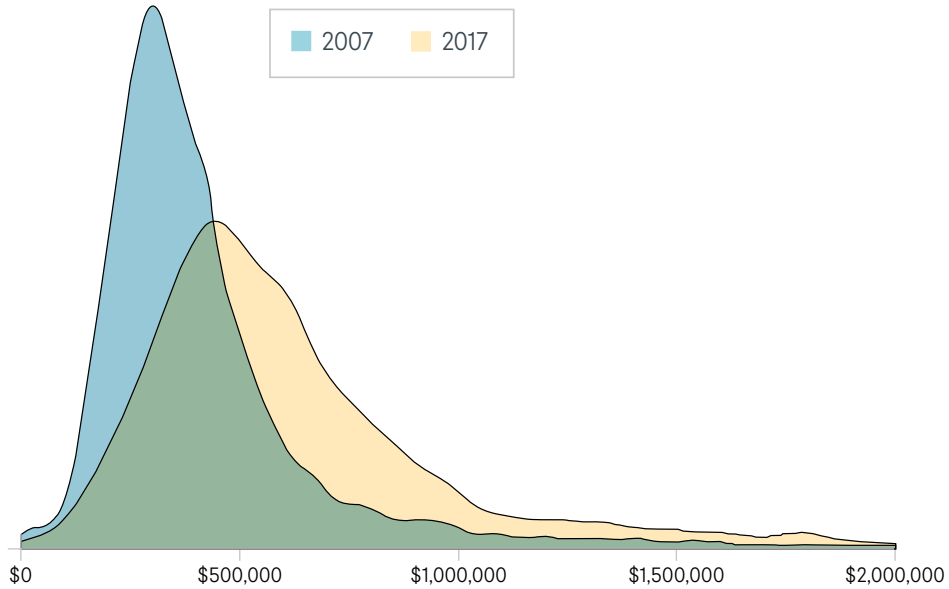


Figure 10. Distribution of Home Sale Prices in Suffolk County, MA

In 2007, the bulk of homes cost less than $500,000. By 2017 most homes cost between $500,000 and $1 million, with an increasing number moving closer to $1 million. Source: Data from Ganesh, B., Strochak, S. and Pardo, S. June 5, 2018. Boston's housing market, in three charts. Urban Institute. Available online: https://www.urban.org/urban-wire/bostons-housing-market-three-charts.



Housing Insecurity

Boston has a shortage of affordable housing. In 2007, most homes in Suffolk county (which includes Boston) cost less than $500,000. In 2017, most homes cost between $500,000 and $1 million (Figure 10). During the same period, the average home price in the Boston increased by 61 percent.[1] Between 2009 and 2015, the average price of a traditional triple-decker home in Boston grew by 85 percent.[1] Housing costs are the principal reason that metropolitan Boston is consistently ranked as one of the least affordable large metropolitan regions in the US.[2]

Housing costs are especially acute for renters: Boston has the fourth highest rents of any city in the country.[3] In 2018, the median rent in Boston was $2,480—the second highest in the state behind Cambridge.[4] From 2010 and 2014, Boston's median rent increased 13.2 percent per year, far outpacing the city's annual 2.4 percent rise in incomes in that period.[5] As a result, renters face the "toughest housing challenge in the region".[6] According to *The Greater Boston Housing Report Card 2017*, the percentage of "rent-burdened" Bostonians—meaning that they pay 30 percent or more of their income in rent—is more than 52 percent (Figure 11), "the highest percentage on record and up from 39 percent in 2000".[7]

Boston's scarcity of affordable housing increases the risk of gentrification and displacement for socially vulnerable communities. The Federal Reserve Bank of San Francisco (a city well-known for its rapid displacement of historic communities) defines gentrification as:

[A] form of neighborhood change driven by a complex interaction between historic practices that created and reinforced disinvestment in low-income communities and communities of color and modern investment patterns that are now radically reshaping the economic conditions in those same neighborhoods. As neighborhood economics change, long-time residents are frequently being pushed out, generating a range of consequences for children, families, and entire communities. For youth, displacement to far-flung reaches of a city can interrupt school attendance patterns and access to health care providers; for adults, these moves can interfere with access to jobs, social supports, and other daily necessities. At scale, these forces change the cultural, economic, political, and demographic make-up of neighborhoods, cities, and entire regions, with lower-income households often bearing more burden than benefit from those changes.[8]

Displacement, then, is a potential outcome of the gentrification process. But it is important to note that displacement is the result of more affluent households choosing to move in to affordable neighborhoods, largely populated by lower income residents, and by large-scale government policy and investment. This means that cities have an important role to play in addressing issues of gentrification and displacement.[9]

1 Maciag, M. November 2015. As Affordable Housing Shrinks, Where Can Families Live? Governing: The States and Localities. Available online: http://www.governing.com/topics/urban/gov-urban-affordable-housing-families.html.

2 Boston ranks as the 16th most expensive out of 382 Metropolitan Statistical Areas in the Regional Price Parities index calculated by the Bureau of Economic Analysis. It ranks sixth among regions with more than 2 million residents.

3 McKim, J. and Serrano, A. February 19, 2019. As rents soar in Boston, low-income tenants try to stave off eviction. New England Center for Investigative Reporting and The Boston Globe. Available online: https://www.bostonglobe.com/magazine/2019/02/19/rents-soar-boston-low-income-tenants-try-stave-off-eviction/QddCq1bLrV3JQhaFTzYnGP/story.html.

4 RealEstate by Boston.com & Globe.com. December 5, 2018. Rent is up 15.7 percent in Worcester and Waltham. How did other Mass. cities fare? Available online: http://realestate.boston.com/news/2018/12/05/rent-15-7-percent-worcester-waltham-mass-cities-fare/.

5 Mayor Martin J. Walsh. September 2018. Housing a Changing City: Boston 2030 (2018 Update). City of Boston. Available online: https://www.boston.gov/departments/neighborhood-development/housing-changing-city-boston-2030. p.47.

6 The Boston Foundation, Northeastern University's School of Public Policy and Urban Affairs, and The Warren Group. November 2017. The Greater Boston Housing Report Card 2017: Ideas from the Urban Core—Responsive Development as a Model for Regional Growth. Available online: https://www.tbf.org/-/media/tbf/reports-and-covers/2017/2017-housingreportcard.pdf. p.8.

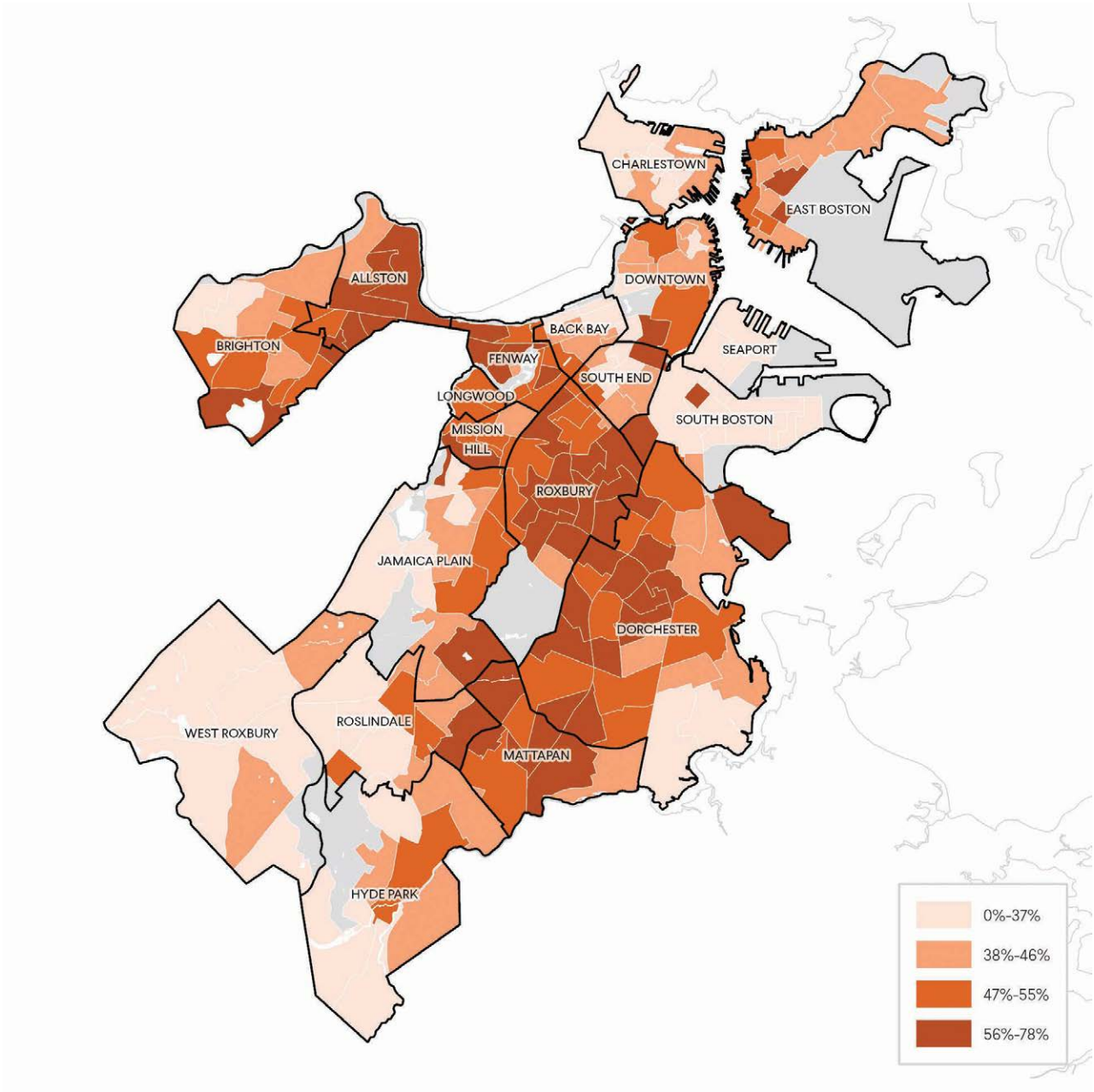
7 Ibid.

8 Cytron, N. November 21, 2017. Gentrification and Displacement. Federal Reserve Bank of San Francisco. Available online: https://www.frbsf.org/community-development/initiatives/gentrification-and-displacement/.

9 Zuk, M. et al. August 24, 2015. Gentrification, Displacement and the Role of Public Investment: A Literature Review. Federal Reserve Bank of San Francisco. Available online: https://www.frbsf.org/community-development/publications/working-papers/2015/august/gentrification-displacement-role-of-public-investment/.

Figure 11. Concentrations of Rent- and Mortgage-Burdened Households in Boston

The map indicates the share of household income spent on rent or mortgage. Source: Metropolitan Area Planning Council based on US Census, American Community Survey, 2012-2016 data, https://datacommon.mapc.org/browser/datasets/184



Massachusetts does not track evictions in the state, but the Eviction Lab at Princeton University found that:

[I]n 2016, there were roughly 15,708 forced removals in Massachusetts — an average of nearly 43 a day. That's about double the number of evictions in 2005, before the housing bubble burst, and it probably does not reflect how many people are displaced, since it does not include the number of renters who leave once they get their notice, and those who strike deals with their landlords to stay temporarily. Some legislators and activists say that evictions disproportionately affect the poorest, most vulnerable members of our society.[10]

Recent studies have warned of the negative impact that gentrification and displacement have on Boston's households and small and neighborhood-based businesses, and the potential for gentrification to negatively affect local economic development, economic diversity, employment, education and public health.[11] The overrepresentation of racial and ethnic minorities in Boston neighborhoods at the greatest risk of displacement[12] raises additional concerns regarding re-segregation in Boston along those dimensions.

The City is aware of its affordable housing shortage and has taken steps to facilitate community engagement and address the issues of displacement and gentrification. Boston's Inclusionary Development Policy closes some of the affordability gap by requiring developers that seek zoning relief to build and/or finance affordable housing.[13] In September 2018, Boston hosted the YIMBY ("Yes In My BackYard") town conference that convened community leaders from around the country to discuss solutions to affordable housing challenges.[14] The conference theme was equity and inclusion and focused on supporting local residents fighting displacement. Recommendations included promoting more mixed-income and affordable housing and advocacy around high-income development that is exclusionary. Affordable housing providers like the East Boston-based Neighborhood of Affordable Housing (NOAH)[15], Allston Brighton Community Development Corporation[16], Dorchester Bay Economic Development Corporation[17], Fenway Community Development Corporation[18], Jamaica Plain Neighborhood Development Corporation[19], and South Boston Neighborhood Development Corporation[20] lower the cost of housing, foster neighborhood connections and community, and promote economic development. Organizations like these are also critical partners for the *Summary Report's* housing, transportation, waste, and energy supply strategies.

In the context of climate change, it is noteworthy that displacement can be driven by environmental forces. A Better City's report *State of the Built Environment: Greater Boston's Infrastructure* notes that "[Boston needs] to focus on making large parts of Greater Boston near Boston Harbor and along the seacoast more resilient to expected sea-level rise and storm surge that could inundate large swaths of the region".[21] A large number of people of color in Roxbury, East Boston, and Dorchester, are exposed to the hazards of rising sea level (Figure 12). Similar climate risks are born by other vulnerable communities. Regardless of the reasons for potential displacement, Boston should seek to build resilience and provide protection for its most vulnerable residents.

10 McKim, J. and Serrano, A. February 19, 2019. As rents soar in Boston, low-income tenants try to stave off eviction. New England Center for Investigative Reporting and The Boston Globe. Available online: https://www.bostonglobe.com/magazine/2019/02/19/rents-soar-boston-low-income-tenants-try-stave-off-eviction/QddCq1bLrV3JQhaFTzYnGP/story.html.

11 Jennings, J. September 22, 2016. Gentrification as Anti-Local Economic Development: The Case of Boston, Massachusetts. Trotter Review: Black Culture, Race and Race Relations, 23(1), Article 4. Available online: https://scholarworks.umb.edu/trotter_review/vol23/iss1/4.

12 Miletsky, Z. and Gonzalez, T. November 28, 2017. How Gentrification and Displacement Are Remaking Boston. Black Perspectives. Available online: https://www.aaihs.org/how-gentrification-and-displacement-are-remaking-boston/.

13 Boston Planning and Development Agency, Creating Middle Income Housing through Inclusionary Development 2017 Annual Report, http://www.bostonplans.org/getattachment/91c30f77-6836-43f9-85b9-f0ad73df9f7c

14 YIMBYtown Homepage. 2018. Available online: https://yimby.town/.

15 Neighborhood of Affordable Housing, Inc. (NOAH) Homepage. Available online: http://noahcdc.org/.

16 Allston Brighton Community Development Corporation Homepage. Available online: https://allstonbrightoncdc.org/.

17 Dorchester Bay Economic Development Corporation Homepage. Available online: https://dbedc.org/about-us/mission/.

18 Fenway Community Development Corporation Homepage. Available online: http://www.fenwaycdc.org/.

19 Jamaica Plain Neighborhood Development Corporation (JPNDC) Homepage. Available online: https://jpndc.org/.

20 South Boston Neighborhood Development Corporation Homepage. Available online: http://sbndc.org/.

21 Bluestone, B., Huessy, J. and Tumber, C. 2016. State of the Built Environment: Greater Boston's Infrastructure. A Better City. Available online: https://www.northeastern.edu/csshresearch/dukakiscenter/wp-content/uploads/sites/7/2018/03/A-Better-City-State-of-the-Built-Environment.pdf. p.5.

Figure 12. Long-term Sea Level Rise (SLR) and Flooding in Boston

In the late century (2070s or later), a significant portion of Boston's current land may be inundated every month. Exposure to severe coastal and riverine flooding will expand to vast areas of the city, including inland neighborhoods like the South End and neighborhoods along the Charles River. Many vulnerable households will be affected by these changes in some neighborhoods in Charlestown, East Boston, the South End, South Boston, Dorchester, and Roxbury. Source: Data from Climate Ready Boston Map Explorer

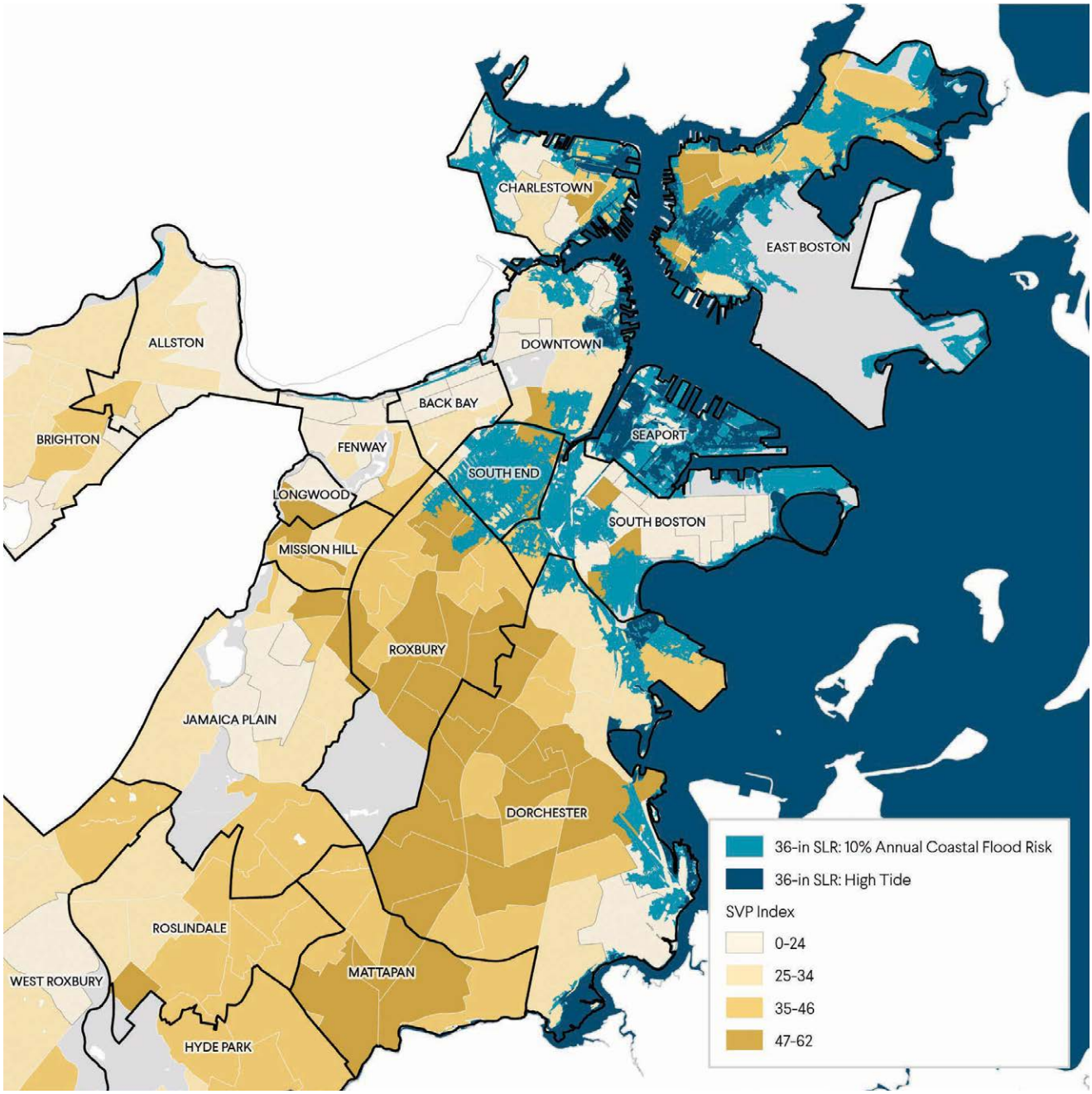


Table 5. Household Energy Insecurity in New England, 2015

Type of Household Energy Insecurity	Frequency of Household Reporting
Any household energy insecurity[1]	1 in 3
Reducing or forgoing food or medicine to pay energy costs	1 in 5
Leaving home at unhealthy temperature	1 in 7
Receiving disconnect or delivery stop notice	1 in 6
Unable to use heating equipment[2]	1 in 14
Unable to use cooling equipment[3]	1 in 14

Source: US Energy Information Administration, 2015 Residential Energy Consumption Survey (RECS)

[1] Household energy insecurity as defined in this table includes only those issues collected as part of the RECS questionnaire. Other factors, such as energy costs as a percentage of household income, could be considered as household energy insecurity, but are not included here. Respondents may report more than one energy insecurity issue.

[2] Includes inability to use main heating equipment because equipment was broken and household could not have it repaired; or electricity, natural gas, or bulk fuel disruption due to lack of payment.

[3] Includes inability to use air-conditioning equipment because equipment was broken and household could not have it repaired or electricity disruption due to lack of payment.

Energy Insecurity

Equity, social vulnerability, and climate change are connected to daily household energy use. Clean, affordable energy is essential to meet basic human needs (cooking, boiling water, lighting, refrigeration, cooling, and heating), and for good health and overall well-being.[22] Yet socially vulnerable populations tend to live in buildings that are in poor physical condition, which leads to poor housing quality as measured by air quality, thermal comfort, quality of illumination, home safety, space per individual, and the presence of mold, pests, asbestos, or lead.[23] The age of Boston's building stock contributes to all of these problems, especially energy efficiency: most buildings were constructed before codes that require insulation and other energy-saving features. A reduction in the combustion of fossil fuels will generate enormous health benefits because children, and especially the poor, bear a disproportionate burden of disease and developmental impairment from environmental pollution due to the combustion of coal, oil, gasoline, diesel and natural gas, and they are more vulnerable to the impacts of climate change.[24]

Affluent households may take these energy services for granted, but quality of life is seriously diminished for households who face energy insecurity: the inability to adequately meet basic household energy needs (See Box: What is Energy (In)security). Energy insecurity is pervasive in New England, with about one in three households—totaling two million households—reporting experiencing some type of energy insecurity in 2015 (Table 5).

Energy insecurity does not exist in isolation, but instead is part of a constellation of hardships that households face, including challenges related to energy, food, health, and housing.[25] Those experiencing energy insecurity are often those most at risk of multiple forms of social vulnerability. The transformation of Boston's energy system, and in particular the development of an energy-efficient, carbon-neutral housing stock, can help to alleviate the linked problems of energy insecurity and affordable housing in the city, or the building transformation can exacerbate these problems.

Dimensions of Energy Insecurity. Energy insecurity is manifested in three dimensions: physical, economic and behavioral.[26] *Physical energy insecurity* includes the physical infrastructure of the home that impacts thermal comfort, can induce harmful

22 (1) World Health Organization. 2006. Fuel for Life: Household Energy and Health. Available online: https://www.who.int/indoorair/publications/fuelforlife/en/; (2) The United Nations Development Programme. 2019. Sustainable Development Goal No. 7: Affordable and Clean Energy. Available online: https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-7-affordable-and-clean-energy.html; (3) Karekezi, S., McDade, S., Boardman, B., Kimani, J. and Lustig, N. 2012. "Energy, Poverty, and Development." In: Global Energy Assessment: Toward a Sustainable Future. Johansson, T.B., Nakicenovic, N., Patwardhan, A. and Gomez-Echeverri, L. (Eds.). Pages 151–190. Cambridge University Press: Cambridge, UK. Available online: https://doi.org/10.1017/CBO9780511793677.008.

23 Bonnefoy X. Inadequate housing and health: an overview. Int J Environ Pollut. 2007;30(3):411-429. 2. Krieger J, Higgins DL. Housing and health: time again for public health action. Am J Public Health. 2002;92(5):758-68.

24 Perera F. (2017). Pollution from Fossil-Fuel Combustion is the Leading Environmental Threat to Global Pediatric Health and Equity: Solutions Exist. International journal of environmental research and public health, 15(1), 16. https://doi.org/10.3390/ijerph15010016.

25 Cook, J.T., Ettinger de Cuba, S., March, E., Gayman, A. and Coleman, S. 2010. Energy Security Is a Major Threat to Child Health. Children's HealthWatch. Available online: http://childrenshealthwatch.org/wp-content/uploads/EnergyInsecurity_brief_February2010.pdf.

26 Hernandez, D. 2016. Understanding 'Energy Security' and Why It Matters to Health. Social Science & Medicine, 167, 1–10. Available online: https://doi.org/doi:10.1016/j.socscimed.2016.08.029.

What is Energy (In)security?

1. Energy insecurity is an inability to adequately meet basic household energy needs.
2. Household energy security is consistent access to enough of the kinds of energy needed for a healthy and safe life in the geographic area where a household is located. Members of an energy secure household are able to obtain the energy needed to heat/cool their home and operate lighting, refrigeration, and appliances while maintaining expenditures for other necessities (e.g., rent, food, clothing, transportation, child care, medical care). A household experiences energy insecurity (HEI) when it lacks consistent access to the amount or the kind of energy needed for a healthy and safe life for its members.
3. Energy insecurity occurs when a household has experienced at least one of the following conditions within the previous year: (i) a threatened utility shut-off or refusal to deliver heating fuel; (ii) an actual utility shut-off or refused delivery of heating fuel; (iii) an unheated or uncooled day because of inability to pay utility bills, or (iv) use of a cooking stove as a source of heat.
4. Fuel poverty is the inability to pay for the heating or cooling required to maintain a home at a reasonable temperature, and the loss of electricity through cessation of service due to nonpayment or other factors.
5. Energy insecurity is defined by a housed that reports one or more of the following: (i) reducing or forgoing food or medicine to pay energy costs; (ii) leaving home at unhealthy temperature; (iii) receiving disconnect or delivery stop notice; (iv) unable to use heating equipment; or (v) unable to use cooling equipment.

Sources:

1 Hernandez, 2016, op. cit.

2 Cook, John T., Deborah A. Frank, Patrick H. Casey, Ruth Rose-Jacobs, Maureen M. Black, Mariana Chilton, Stephanie Ettinger deCuba, et al. 2008. "A Brief Indicator of Household Energy Security: Associations With Food Security, Child Health, and Child Development in US Infants and Toddlers." Pediatrics 122 (4): e867. https://doi.org/10.1542/peds.2008-0286.

3 US Energy Information Administration, 2015 Residential Energy Consumption Survey (RECS), https://www.eia.gov/consumption/residential/about.php

4 United Kingdom Warm Homes and Energy Conservation Act 2000, chapter 31; https://www.legislation.gov.uk/ukpga/2000/31/contents

5 Child Health Impact Working Group. 2007. "Unhealthy Consequences: Energy Costs and Child Health." Boston, Massachusetts, http://childrenshealthwatch.org/unhealthy-consequences-energy-costs-and-child-health-a-child-health-impact-assessment-of-energy-costs-and-the-low-income-energy-assistance-program/

exposures, and increases energy costs. Examples include malfunctioning heating and cooling systems, outdated plumbing and electrical systems, poor lighting, inefficient appliances, and drafts from holes/cracks in floors, windows, and ceilings.

Economic energy insecurity refers to the impact that the cost of fuel and electricity has on household budgets. This cost impact is often measured as the energy burden; the percentage of household income that is spent on fuel and electricity. Low-income households often make partial bill payments to avoid service interruption, and thereby accrue debt that exacerbates their precarious finances.[27]

Behavioral energy insecurity is defined by the strategies people employ to cope, improvise and counteract the impacts of economic and physical energy insecurity. This dimension is marked by both positive and negative behavioral approaches.[28] On the positive side, a high energy burden often leads households to closely monitor energy use and address energy waste, thereby generating economic and environmental benefits. On the negative side, low-income households compensate in ways that reduce quality of life and can be dangerous, such as: using cooking stoves for heating, increasing the risk of carbon monoxide poisoning and burns; using space heaters and candles for lighting, increasing the risk of fires; setting temperatures at uncomfortable and dangerous levels; closing off rooms or entire sections of a residence; keeping curtains closed; and using tubs of ice instead of refrigerators.[29]

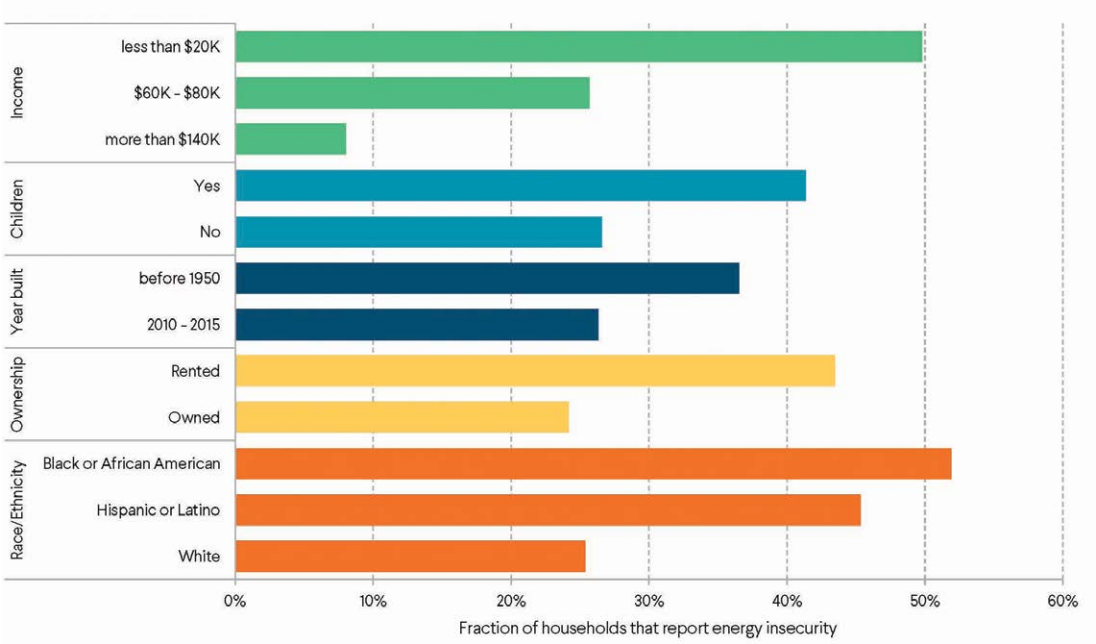
27 Heflin, C., London, A.S. and Scott, E.K. 2011. Mitigating Material Hardship: The Strategies Low-Income Families Employ to Reduce the Consequences of Poverty. Sociological Inquiry, 81(2), 223–46. Available online: https://doi.org/10.1111/j.1475-682X.2011.00369.

28 Hernández, D. 2016. Understanding 'Energy Security' and Why It Matters to Health. Social Science & Medicine, 167, 1–10. Available online: https://doi.org/doi:10.1016/j.socscimed.2016.08.029.

29 Emmel, J.M., Lee, H.J., Cox, R.H. and Leech, I. 2010. Low-Income Households' Response to Higher Home Energy Costs. Family and Consumer Sciences Research Journal, 38(4), 372–86. Available online: https://doi.org/10.1111/j.1552-3934.2010.00033.

Figure 13. Household Energy Insecurity in the United States

Source: Data from US Energy Information Administration, Residential Energy Consumption Survey



Populations Affected by Energy Insecurity. Access to energy is a fundamental aspect of social equity. The impacts of energy insecurity fall along many of the same fault lines of social equity: income, race, ethnicity, and the type and tenure of housing. In the US, low-income households and households that include children or people of color experience more energy insecurity (Figure 13). Households experiencing energy insecurity are more likely to live in older homes, live in rented, multifamily units, and have children under the age of 18. Black, Latinx/Hispanic, and Native American households are about twice as likely to experience energy insecurity compared to White households.[30]

Two studies shed light on the economic burden of energy insecurity Boston. The first found that the median energy burden for metro Boston is 2.8 percent, the ninth lowest burden of the 48 cities in the study. But the experience of vulnerable populations is very different[31] (Figure 14). For low-income households, the energy burden is twice as great, and for very poor households, it was four times as great—more than 12 percent of their income to pay utility bills. The poorest Black, Latinx/Hispanic, and renter households devote about twice as much of their income as the median household as a percentage of their income.

The second[32] study highlights several important features of energy use by Boston's households (Figure 15). Rich and poor households pay remarkably similar annual energy bills: $3,200 to $3,600 per year for owner-occupied residences and $1,700 to $2,200 per year for renter-occupied residences. Every household pays roughly the same price for fuel and electricity, and every household needs fuel and electricity for heating, cooling, lighting, and refrigeration of food. But the financial burden of energy varies dramatically by income class. Households earning less than 30 percent of the metro region's median income devote one-quarter of their income to pay for fuel and electricity. Owner-occupied households earning more than the region's median income

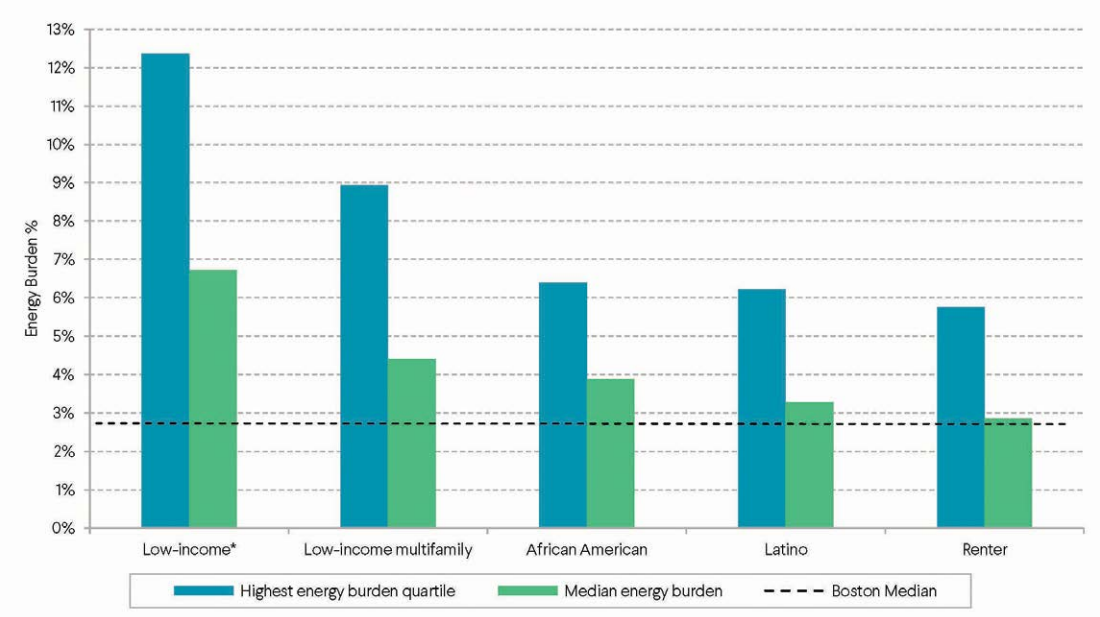
30 US Energy Information Administration. 2015 Residential Energy Consumption Survey (RECS). Available online: https://www.eia.gov/consumption/residential/index.php.

31 Drehobl, A. and Ross, L. April 2016. Lifting the High Energy Burden in America's Largest Cities: How Energy Efficiency Can Improve Low Income and Underserved Communities. American Council for an Energy-Efficient Economy (ACEEE). Available online: https://energyefficiencyforall.org/sites/default/files/Lifting%20the%20High%20Energy%20Burden_0.pdf. The study used data from the Census Bureau's 2011 and 2013 American Housing Surveys to determine the economic burden in 48 of the largest US cities and specific households in each city. Low-income households are defined as those who report an annual gross household income at or below 80 percent of the area median income, including both single- and multifamily households.

32 US Department of Energy. Low-Income Energy Affordability Data (LEAD) Tool. US Department of Energy (DOE) Open Data Catalog. Available online: https://openei.org/doe-opendata/dataset/celica-data. The LEAD tool is part of DOE's Clean Energy for Low Income Communities Accelerator that aims to lower energy bills in low-to-moderate income communities through expanded installation of energy efficiency and distributed renewables. It provides a breakdown based on fuel type, building type, and construction year, as well as average monthly energy expenditures and energy burden (percentage of income spent on energy).

Figure 14. Household Energy Burden in Boston

Energy burden is the percentage of household income that is spent on fuels and electricity. "Boston Median" is the median burden for all Boston households. "Low-income" includes both single- and multifamily households. Source: Data from Drehobl, Ariel, and Lauren Ross. 2016. Lifting the High Energy Burden in America's Largest Cities: How Energy Efficiency Can Improve Low Income and Underserved Communities. American Council for an Energy-Efficient Economy (ACEEE) (Washington D.C.)



pay less than two percent of their annual income; that's one-twelfth the energy burden of poorer households. The disparity is smaller in renter-occupied households, but the poorest renters still pay 11 times more than owner-occupied households with incomes above the median.

Surveys of energy insecurity in Boston corroborates the statistical evidence. One study interviewed 72 families living in Dorchester, the vast majority of which were headed by single mothers of color with median annual incomes below $32,000.[33] Participants were asked about the effect of housing and energy costs on family-well-being, and how they addressed such problems. The responses put a human face on the toll exacted by high utility bills (See Box: Quotes about Energy Insecurity in Dorchester, MA). Families reported financial stress, extreme indoor temperatures, increased debt, shut-off threats, choices between food and energy, and conflict with landlords over energy bills and poor quality of housing. Federal low-income subsidies for energy often do not adequately meet household energy needs in Dorchester.[34]

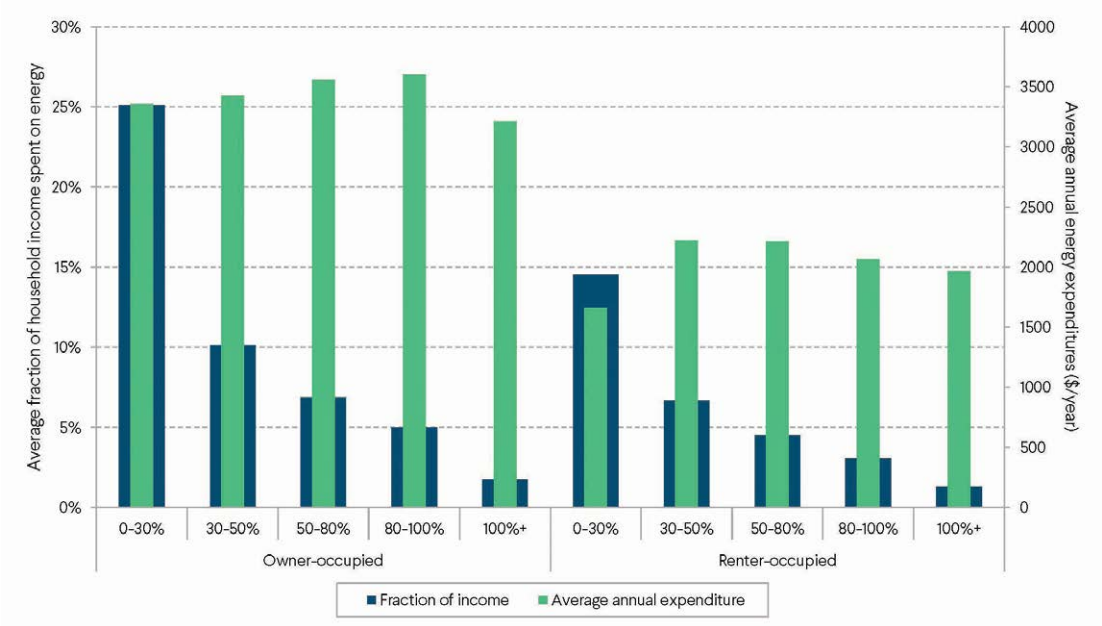
Impacts of Energy Insecurity. The economic and physical deprivation and negative social behavior associated with energy insecurity combine to exacerbate conditions of social disadvantage. Some impacts are tied directly to a single dimension of energy insecurity, such as the high cost of utility bills. Other impacts emerge from the "trifecta of insecurity," namely the housing, food, and energy costs that constitute the three largest expenditures within many monthly household budgets.[35]

One of the most significant impacts of energy insecurity is its impact on the health and well-being of children. Higher energy costs force budget tradeoffs that jeopardize health. The Department of Energy's Residential Energy Consumption Survey identified 25 million households that forwent food and medicine to pay energy bills; seven million faced that decision nearly every month.[36] The Boston Child Health Impact Assessment Working Group estimated that unaffordable home energy has

33 Hernández, D. 2016. Understanding 'Energy Security' and Why It Matters to Health. Social Science & Medicine, 167, 1–10. Available online: https://doi.org/doi:10.1016/j.socscimed.2016.08.029.
34 Bebinger, M. February 13, 2015. Many In Mass. Await The Next Blizzard With No Heat. WBUR News. Available online: https://www.wbur.org/news/2015/02/13/home-energy-help.
35 Hernandez, 2013, op. cit.
36 US Energy Information Administration (EIA). 2017. 2015 Residential Energy Consumption Survey (RECS). Available online: https://www.eia.gov/consumption/residential/index.php.

Figure 15. Energy Burden and Expenditures in Boston

The green bars (right axis) measure the total annual cost of household purchases of heating fuel and electricity. The blue bars (left axis) measure the fraction of household income spent on heating fuels and electricity. The horizontal axis categorizes households based on (i) what fraction of the median city household income they earn, and (ii) whether they live in owner- or renter-occupied buildings. Source: Data from US Department of Energy's Office of Energy Efficiency and Renewable Energy, Low-Income Energy Affordability Data (LEAD) Tool



preventable, potential consequences on the health and well-being of the more than 400,000 Massachusetts children living in low-income households.[37]

Perhaps the most pernicious health threat stems from the "heat-or-eat" choice that confronts vulnerable households. Heat and food are two expenditures that can be "squeezed" the most by low-income households. A small increase in energy costs can have a dramatic impact on the food budget of an energy insecure home: a 10 percent increase in energy costs equates to an amount equal to what the household would spend on groceries over a one to three-week period based on energy and food prices in 2014.

Cold spells put these households in a bind; decreased nutritional intake during and immediately after the coldest months is a common phenomenon.[38] A survey of about 10,000 children in five urban medical centers (including Boston) found that energy insecurity is positively and strongly associated with both household and child food insecurity. Indeed, other studies report that energy insecure households show a 10 percent reduction in caloric intake and weight loss during winter.[39] The impacts of the no-win, "heat-or-eat" situation are especially hard on children. Compared to those with no hardship, children experiencing dual food and energy hardship have significantly increased odds of being in fair or poor health, hospitalization, depression, somatic complaints, and deficits in cognitive and behavioral development that affect school performance.[40]

Energy-insecure households have a higher rate of health-related consequences such as respiratory problems, heart disease,

37 Child Health Impact Working Group. April 2007. Unhealthy Consequences: Energy Costs and Child Health. UCLA Health Impact Assessment Clearinghouse: Learning & Information Center. Available online: http://www.hiaguide.org/sites/default/files/ChildHIAofenergycostsandchildhealth.pdf.

38 Cook, J.T., Frank, D.S., Casey, P.H., et al. 2008. A Brief Indicator of Household Energy Security: Associations With Food Security, Child Health, and Child Development in US Infants and Toddlers. Pediatrics, 122(4), e867. Available online: https://doi.org/10.1542/peds.2008-0286.

39 Bhattacharya, J., DeLeire, T., Haider, S., and Currie, J. 2003. Heat or Eat? Cold-Weather Shocks and Nutrition in Poor American Families. American Journal of Public Health, 93(7), 6.

40 Fernández, C.R., Yomogida, M., Aratani, Y., and Hernández, D. 2018. Dual Food and Energy Hardship and Associated Child Behavior Problems. Academic Pediatrics, 18(8), 889–96. Available online: https://doi.org/10.1016/j.acap.2018.07.002.

Quotes about Energy Insecurity from Residents in Dorchester, MA

"If I go back to work he says that I will lose the food stamps. We'll lose the fuel assistance, and he feels like we really won't be any better off. So I feel like it's a catch-22."

"So the whole week [during a shut off], all we did was took a bucket like we were having a cookout. You know those buckets that you use to put sodas and stuff. Put some ice in it, it lasted for a week. Eating sandwiches, takeout. My kids said, 'Mommy, when they gonna put the gas back so we cook the fish?' I finally got two checks and turned the lights back on. You gotta sacrifice."

"One day I didn't have no money to pay my bill and they was gonna turn off my lights. When they turn off your lights people look at that and I didn't want nobody coming in here and take my children from me because I don't have my lights on."

"In the wintertime if something happens to the heat by chance, I turn the oven on, which is my electricity."

"We didn't have to pay for the heat, it was oil based and the landlords paid for it themselves. Then about a year later they changed it, without notice and they didn't even tell us. The bill just came."

"My bills started raising up and raising up and I went to the doctor's because they turned off my gas. So, I sent my kids to their aunt's house 'cause I didn't want them in the house since you can't cook or give them a bath or nothing. I didn't want them here. And then I went through my depression thing- it just went down for me."

Source: Hernandez, Diana. (2016). Understanding "energy security" and why it matters to health. Social Science & Medicine, 167, 1–10. https://doi.org/doi:10.1016/j.socscimed.2016.08.029.

arthritis, and rheumatism, especially in the winter.[41] The same households experience higher levels of mental stress that leads to anxiety and depression.[42] Mental stress is caused by worry over paying utility bills, physical deficiencies in housing and appliances, and thermal stress. A constant threat of service interruptions due to non-payment fuels parental fear and stigma; being unable to "keep the lights on" could be considered a marker of inadequate parenting and lead to intervention by social services agencies.[43]

Health and safety in energy insecure households are also jeopardized by the use of riskier sources of heat. Faced with high energy bills, some households often use portable space heaters, ovens, and fireplaces, especially in periods when they lose utility service due to an inability to pay their bill. About one in five households receiving federal fuel assistance use stoves or ovens to heat. Home fires involving heating equipment caused an estimated average of 490 civilian deaths and 1,400 civilian injuries each year from 2012 to 2016.[44] Unvented indoor combustion also raises the risk of carbon monoxide poisoning and serious burns.

Energy insecurity often leads to arrearages and debt accumulation when households are forced to skip payments or make partial payments to utilities. Of the 17 million households who reported receiving a disconnection notice in the Residential Energy Consumption Survey, two million reported that they received a notice nearly every month.[45]

41 Bird, S., and Hernández, D. September 2012. Policy Options for the Split Incentive: Increasing Energy Efficiency for Low-Income Renters. Energy Policy, 48, 506–14. Available online: hcccccc.

42 Gilbertson, J., Grimsley, M., and Green, G. October 2012. Psychosocial Routes from Housing Investment to Health: Evidence from England's Home Energy Efficiency Scheme. Energy Policy, 49, 122–33. Available online: https://doi.org/10.1016/j.enpol.2012.01.053.

43 Hernández, D. 2016. Understanding 'Energy Security' and Why It Matters to Health. Social Science & Medicine, 167, 1–10. Available online: https://doi.org/doi:10.1016/j.socscimed.2016.08.029.

44 Campbell, R. December 2018. Home Fires Involving Heating Equipment. National Fire Protection Association. Available online: https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/US-Fire-Problem/Fire-causes/osHeating.pdf.

45 US Energy Information Administration, op. cit.

Table 6. Energy efficiency benefits for low-income households, utilities, and communities

Benefit Recipient	Energy Efficiency Outcome	Resulting Benefit
Low-income program participants	Lower monthly utility bills	Lower household energy burden and greater disposable income
		Reduced stress and fewer trade-off between energy and other necessities
		Reduced exposure to risk from utility rate increases
	Improvements in the efficiency of the housing stock	Improved health and safety and greater household comfort
		Increased property value, more reliable equipment, and lower maintenance costs
		Greater satisfaction with the building/unit and improved household and neighborhood stability
Utilities and ratepayers	Demand-side management (both gas and electric)	Avoided excess costs of increased generation, capacity, and transmission investments
		Contribution toward compliance with energy efficiency portfolio standards and other environmental legislation
	Cost savings to utilities and ratepayers	Reduced arrearages and cost of shutoffs, which lower utility operating costs
		Improved customer service
Communities	Lower electric and gas demand	Reduced environmental pollutants and improved public health
	Lower monthly utility bills due to avoided utility costs	More money spent in the local economy due to greater household disposable income, with higher local multiplier effect
		Poverty alleviation and increased standard of living
	Improvements in the efficiency of the housing stock	Local job creation through weatherization programs and energy efficiency providers and trade allies
		Improved quality of life
		Increased property values and preservation of housing stock

Source: Drehobl, A. and Ross, L. April 2016. Lifting the High Energy Burden in America's Largest Cities: How Energy Efficiency Can Improve Low Income and Underserved Communities. American Council for an Energy-Efficient Economy (ACEEE). Available online: https://energyefficiencyforall.org/sites/default/files/Lifting%20the%20High%20Energy%20Burden_0.pdf.

Energy insecurity is a direct contributor to housing insecurity because families may not be able to fully pay their utility bill and their rent or mortgage. One-third of low-income US households who received federal assistance in 2016 to pay utility bills received shut-off notices, and 15 percent had their heat and light shut off before receiving grants from the federal Low-Income Home Energy Assistance Program (LIHEAP).[46] Massachusetts law allows a family whose utility service has been disconnected to be evicted for failure to maintain the habitability of their home. The Commonwealth provides protection against winter shutoff, but that ends in March or April. Energy insecurity thus contributes to housing instability, namely, involuntary moves that result from the inability to pay rent, utility bills, or other circumstances. Homelessness is the extreme end of housing instability.[47]

46 National Energy Assistance Directors' Association, http://neada.org

47 Child Health Impact Working Group. 2007. Unhealthy Consequences: Energy Costs and Child Health. Children's HealthWatch. Available online: http://www.hiaguide.org/hia/child-health-impact-assessment-energy-costs-and-low-income-home-energy-assistance-program-liheap.

Benefits of Energy Efficient Housing

A carbon-neutral building stock requires a large scale overhaul of the city's buildings to reduce energy use. This presents an enormous opportunity to improve the quality of life for thousands of households because improvements in the energy efficiency of a home simultaneously improves overall housing quality. Benefits for participants in energy efficiency go beyond the energy savings gained from installing energy efficient measures.[48] These benefits accrue to building occupants and owners, utilities and ratepayers, and to society at large (Table 6).

Improved Health, Safety, and Comfort

Energy efficiency programs can improve health and safety by directly addressing unsafe conditions in the home and by making improvements that indirectly lead to improved health and safety.[49] Enhanced energy efficiency reduces indoor air contaminants linked to chronic illnesses, controls environmental contaminants (dust mites, mold/moisture) that can trigger respiratory symptoms, and improves symptoms of asthma and other respiratory health conditions.[50] Studies of energy retrofits of existing homes reveal self-reported health improvements, fewer sick days from work and school, and fewer visits to health care providers.[51]

Cost Savings

Energy efficiency yields energy cost savings and thus helps preserve housing affordability. Those cost savings also mitigate energy insecurity by increasing disposable income, reducing the risk of arrearage and eviction, reducing reliance on federal fuel assistance programs, and greater protection from energy price increases.[52] In particular, improving the energy efficiency of the multifamily housing stock is identified as a key strategy to preserve housing affordability by major government agencies and organizations involved in affordable housing, such as the US Department of Housing and Urban Development, Fannie Mae, the Harvard Joint Center for Housing Studies, Enterprise Community Partners, and Stewards of Affordable Housing for the Future.[53]

Higher Property Values

Energy efficiency is capitalized in home prices, meaning that homes that are demonstrably energy efficient bring a higher selling price. In the US, homes can receive green labels from the LEED program of the US Green Building Council (USGBC), the Energy Star program of the EPA, and state programs such as California's GreenPoint Rated. An analysis of 4,231 single family homes with such certifications in California that were sold from 2007 to 2012 received a two to four percent premium relative to otherwise comparable, non-labeled homes.[54] A similar effect was found for single family home sales in Portland, Oregon and the Durham-Raleigh-Chapel Hill region of North Carolina.[55]

48 Caputo, Samantha. 2017. "Non-Energy Impacts Approaches and Values: An Examination of the Northeast, Mid-Atlantic, and Beyond." https://neep.org/sites/default/files/resources/NEI%20Final%20Report%20for%20NH%206.2.17.pdf.

49 Applied Public Policy Research Institute for Study and Evaluation. 2017. Low-Income Energy Efficiency Opportunities Study, https://www.edf.org/sites/default/files/APPRISE_Low-Income-Energy-Efficiency-Opportunities-Study-2017.PDF

50 Wilson, Jonathan, David Jacobs, Amanda Reddy, Ellen Tohn, Jonathan Cohen, and Ely Jacobson. 2016. "Home Rx: The Health Benefits of Home Performance - A Review of the Current Evidence." Columbia, MD: National Center for Healthy Housing.

51 Jonathan Wilson and Arnie Katz. 2010. Integrating Energy Efficiency and Healthy Housing. National Safe and Healthy Housing Coalition.

52 Drehobl and Ross, 2016, op.cit

53 Krukowski, Andrea, and Andrew Burr. 2012. "Energy Transparency in the Multifamily Housing Sector: Assessing Energy Benchmarking and Disclosure Policies." Washington, D.C.: Institute for Market Transformation. https://www.imt.org/wpcontent/uploads/2018/02/Energy_Trans_MFSector_IMT_Final.pdf; Deutsche Bank. 2012. "The Benefits of Energy Efficiency in Multifamily Affordable Housing." http://energyefficiencyforall.org/sites/default/files/DBLC_Recognizing_the_Benefits_of_Efficiency_Part_B_1.10%20%281%29.pdf.

54 Kahn, M. E., & Kok, N. (2014). The capitalization of green labels in the California housing market. Regional Science and Urban Economics, 47, 25–34. https://doi.org/10.1016/j.regsciurbeco.2013.07.001

55 Walls, M., Gerarden, T., Palmer, K., & Bak, X. F. (2017). Is energy efficiency capitalized into home prices? Evidence from three US cities. Journal of Environmental Economics and Management, 82, 104–124. https://doi.org/10.1016/j.jeem.2016.11.006

Winter in South Boston. Photo credit: iStock/DenisTangneyJr

Energy retrofits ensure the long term viability of affordable housing by:

- Increasing the net operating income of owners that in turn increases access to capital for the renovation, acquisition, and construction of affordable housing units[56]
- Improving the physical condition of the existing affordable housing stock
- Creating a visible investment in disadvantaged communities

Job Creation and Economic Impacts

Energy efficiency is a relatively labor intensive industry, so investment in efficiency spurs the economy. On average, $1 million spent in the US economy supports about 17 total jobs.[57] That figure includes direct jobs (a construction worker on a retrofit job), indirect jobs in the supply chain (home energy audit caused by a decision to retrofit), and induced jobs across the economy due to more disposable income. The overall effect on the economy is large. Every $1 million invested in residential energy efficiency retrofits generates about $1.3 million in Gross Domestic Product, which is about the same level of stimulus as the new construction of single-family and multifamily buildings.[58] The City can work with the Commonwealth and the private sector to steer some of the job creation to socially vulnerable populations in Boston.

56 Samarripas, Stefen, and Dan York. 2018. "Our Powers Combined: Energy Efficiency and Solar in Affordable Multifamily Buildings," American Council for an Energy-Efficient Economy, https://aceee.org/sites/default/files/publications/researchreports/u1804.pdf

57 American Council for an Energy-Efficient Economy (ACEEE). 2011. "How Does Energy Efficiency Create Jobs?" Available online: https://aceee.org/files/pdf/fact-sheet/ee-job-creation.pdf.

58 Booz Allen Hamilton. US Green Building Council Green Jobs Study. US Green Building Council, 2008.

Barriers to Energy Efficient Housing

Economic Barriers

Energy efficiency services are expensive and require a large up-front investment before payback is realized, often over a period of 10 to 15 years. Low-income households are much more likely to be denied credit or to be offered less credit than requested.[59] As a result, low-income households are unlikely to participate in energy efficiency programs that require a monetary contribution.[60] An analysis of Massachusetts participants in efficiency programs for low-income households revealed that census block groups with greater participation rates had higher median incomes, lower poverty rates, a lower percentage of renters, a lower percentage of older homes, and a lower percentage who do not speak English well.[61] As income disparities have grown over time more affluent households have a disproportionate capacity to acquire and use energy efficiency and clean energy technologies.[62]

Credit is a major hurdle for low-income households. Black, Latinx/Hispanic, and low-income households are:

- Less likely to have a bank account and more likely to use financial service products such as a check cashing service, money order, pawn shop loan, auto title loan, paycheck advance, or payday loan[63]
- More likely to be denied credit, or approved but for less credit than requested[64]
- Less likely to receive an offer for a credit card, and less likely to own at least one credit card[65]
- More likely to pay higher interest rates on loans, in part due to the use of higher risk lenders[66]

Access to safe bank products is a necessity to investing more in energy efficiency and clean energy. An awareness that credit is not an option for many Boston families is critical to the intentional design of climate mitigation policies that will build wealth and close gaps between socially vulnerable communities and their more privileged neighbors.

A large portion of Boston's low-income households are renters that live in multifamily housing, and thereby face another economic barrier: the landlord/tenant split incentive. Energy efficiency poses challenges for tenants because the landlord bears the cost of improvements but the tenant receives the benefit in terms of reduced energy bills (this would not be the case if the landlord was responsible for the utility bills). The split incentive problem is pervasive and requires explicit policies to overcome.[67] This is one reason why in the US, just 17 percent of rented properties have weather stripping (compared to 45 percent of owner-occupied), 43 percent have double-glazing (compared to 63 percent) and 28 percent are considered 'well-insulated' (compared to 40 percent).[68]

59 Access Denied. Low-income and Minority Families Face More Credit Constraints and Higher Borrowing Costs, Center for American Progress, August 2007.

60 Applied Public Policy Research Institute for Study and Evaluation (APPRISE). 2017. "Low-Income Energy Efficiency: Opportunities Study." https://www.edf.org/sites/default/files/APPRISE_Low-Income-Energy-Efficiency-Opportunities-Study-2017.PDF; US Environmental Protection Agency. 2018. "Energy Efficiency in Affordable Housing." https://www.epa.gov/sites/production/files/2018-07/documents/final_affordablehousingguide_06262018_508.pdf

61 Residential Customer Profile Study – Final Report, October 2, 2015, Cadmus. Prepared for the Electric and Gas Program Administrators of Massachusetts.

62 Curti, J., Andersen, F. and Wright, K. September 2018. A Guidebook on Equitable Clean Energy Program Design for Local Governments and Partners. Prepared for the Urban Sustainability Directors Group. Cadmus Group. Available online: https://cadmusgroup.com/papers-reports/a-guidebook-on-equitable-clean-energy-program-design-for-local-governments-and-partners/. p.6

63 Board of Governors of the Federal Reserve System. May 2018. Report on the Economic Well-Being of US Households in 2017. Consumer and Community Development Research Section of the Federal Reserve Board's Division of Consumer and Community Affairs (DCCA). Available online: https://www.federalreserve.gov/publications/files/2017-report-economic-well-being-us-households-201805.pdf.

64 Federal reserve, op. cit.; The report presents data for three income brackets: less than $40,000, $40,000-$100,000, greater than $100,000, and for all income levels.

65 Firestone, S. 2014. Race, Ethnicity, and Credit Card Marketing. Journal of Money, Credit and Banking, 46(6), 1205–1224. Available online: https://doi.org/10.1111/jmcb.12138.

66 (1) Bayer, P., Ferreira, F., and Ross, S. April 29, 2017. What Drives Racial and Ethnic Differences in High-Cost Mortgages? The Role of High-Risk Lenders. The Review of Financial Studies, 31(1), 175–205. Available online: https://doi.org/10.1093/rfs/hhx035. (2) Bocian, D., Ernst, K., and Li, W. January 1, 2008. Race, Ethnicity and Subprime Home Loan Pricing. Journal of Economics and Business, Financing Community Reinvestment and Development, 60(1), 110–124. Available online: https://doi.org/10.1016/j.jeconbus.2007.10.001.

67 (1) Melvin, J. April 1, 2018. The Split Incentives Energy Efficiency Problem: Evidence of Underinvestment by Landlords. Energy Policy, 115, 342–352. Available online: https://doi.org/10.1016/j.enpol.2017.11.069. (2) Gillingham, K., Keyes, A. and Palmer, K. October 5, 2018. Advances in Evaluating Energy Efficiency Policies and Programs. Annual Review of Resource Economics, 10(1), 511–532. Available online: https://doi.org/10.1146/annurev-resource-100517-023028. (3) Lang, G. and Lanz, B. May 2018. Energy Efficiency, Information, and the Acceptability of Rent Increases: A Multiple Price List Experiment with Tenants. IRENE Working Papers 18-04. IRENE Institute of Economic Research. Available online: https://ideas.repec.org/p/irn/wpaper/18-04.html.

68 Carroll, J., Aravena, C., Denny, E. September 2016. Low energy efficiency in rental properties: Asymmetric information or low willingness-to-pay? Energy Policy, 96, 617–629.

Social Barriers

Even if the cost of energy efficiency were free, other obstacles confront some households. The transaction costs of application, obtaining landlord permission, readying the home for services, and being at home during the weekday for service delivery are large. Additionally, households may not be aware of available options or understand the potential benefits of energy efficiency. There can be challenges in gaining acceptance and participation in no-cost efficiency programs, which may be related to language barriers, literacy, or immigration status. High crime rates are perceived as dangerous, making some contractors hesitant to provide services in these locations. These are often the neighborhoods with the poorest housing stock that is most in need of services.[69]

Technical Barriers

Home issues such as mold, asbestos, lead paint, knob and tube wiring, pests, clutter, and structural issues can prevent installation of energy efficiency measures. Some homes have roof leaks, foundation issues, grading issues, or other structural issues that prevent efficiency work. The prevalence of these issues in low-income homes can be high, reducing the energy savings that can be achieved, and their remediation requires additional funding.[70] As many as one in eight urban households in the US that are eligible to participate in low-income weatherization programs are disqualified for health and safety reasons.[71]

Data and Metrics for Program Evaluation

An information vacuum exists in regards to the reach and effectiveness of programs that aim to connect low-income and minority households with services for energy efficiency and fuel assistance. As a result, city agencies often have limited information about the extent their constituents needs are being met. The core of this challenge stems from the disparate actors involved. The federal government funds the Low Income Home Energy Assistance Program (LIHEAP), and disperses those funds to the states. Eversource, National Grid, and other utilities that serve Massachusetts provide most of the funding for energy efficiency. Nonprofit community development organizations such as the Action for Boston Community Development in Boston help households connect with these sources of funding. Multiple City agencies have responsibility for energy, climate, and housing programs. These actors collect different types of data and exhibit different motivations, abilities, and inclinations to share information. The Commonwealth's Affordable Access to Clean and Efficient Energy Initiative acknowledged this barrier when it concluded that "agencies and stakeholders should share program metrics, program data, and expertise to develop and implement effective policies and programs."[72]

The Retrofit Challenge in Boston

Every city has a unique combination of these challenges, all of which are connected to equity. Of Boston's approximately 70,000 residential buildings, 6,556 are owner-occupied, single-family homes in census tracts with a median household income above Boston's median household income of $85,691 in 2017. In the analysis presented here, these buildings are classified as "easier to retrofit" (Figure 16, Table 7). In contrast, 16,183 Boston buildings are in renter-occupied, multifamily homes in census tracts with a median household income below Boston's median household income. These are classified here as "harder to retrofit." Boston's remaining 45,356 residential buildings are combinations of these building types, ownership, and income levels that fall in between the easier and harder "edge" classifications.[73]

69 APPRISE, 2017, op. cit.

70 APPRISE, 2017, op. cit.

71 Green and Healthy Homes Initiative. 2010. Identified Barriers and Opportunities to Make Housing Green and Healthy Through Weatherization. Available online: https://www.greenandhealthyhomes.org/wp-content/uploads/GHHI-Weatherization-Health-and-Safety-Report1.pdf

72 Massachusetts Department of Energy Resources and Department of Housing and Community Development, Massachusetts Clean Energy Center and Meister Consultants Group. 2017. Affordable Access to Clean and Efficient Energy, Final Working Group Report, Available online: https://www.mass.gov/files/documents/2017/09/12/aacee-report.pdf

73 This analysis makes the simplifying assumption that the retrofit of a residential building can be represented by three factors: type of building (single vs. multifamily), type of ownership (renter vs. owner), and household income. Single-family, owner-occupied homes in high income areas face fewer hurdles than those in renter-occupied, multifamily homes in low income areas. Buildings in the "easier to retrofit" group requires updating only a single building and only a single occupant's participation, and these occupants will find a retrofit more affordable. Conversely, buildings in the "harder to retrofit" group require many occupants to be engaged and have owners with less stake in the improved performance of the building and occupants with less ability to pay.

Figure 16. "Harder" and "Easier" Homes to Retrofit in Boston

This classification is based on the assumption that the retrofit of a residential building can be represented by three factors: household income; type of ownership, or agency, (renter vs. owner); and type of building (single vs. multifamily). Harder = renter occupied, multifamily unit, and less than median income. Easier = owner occupied, single-family unit, and greater than median income. Source: City of Boston Property Assessment FY 2018

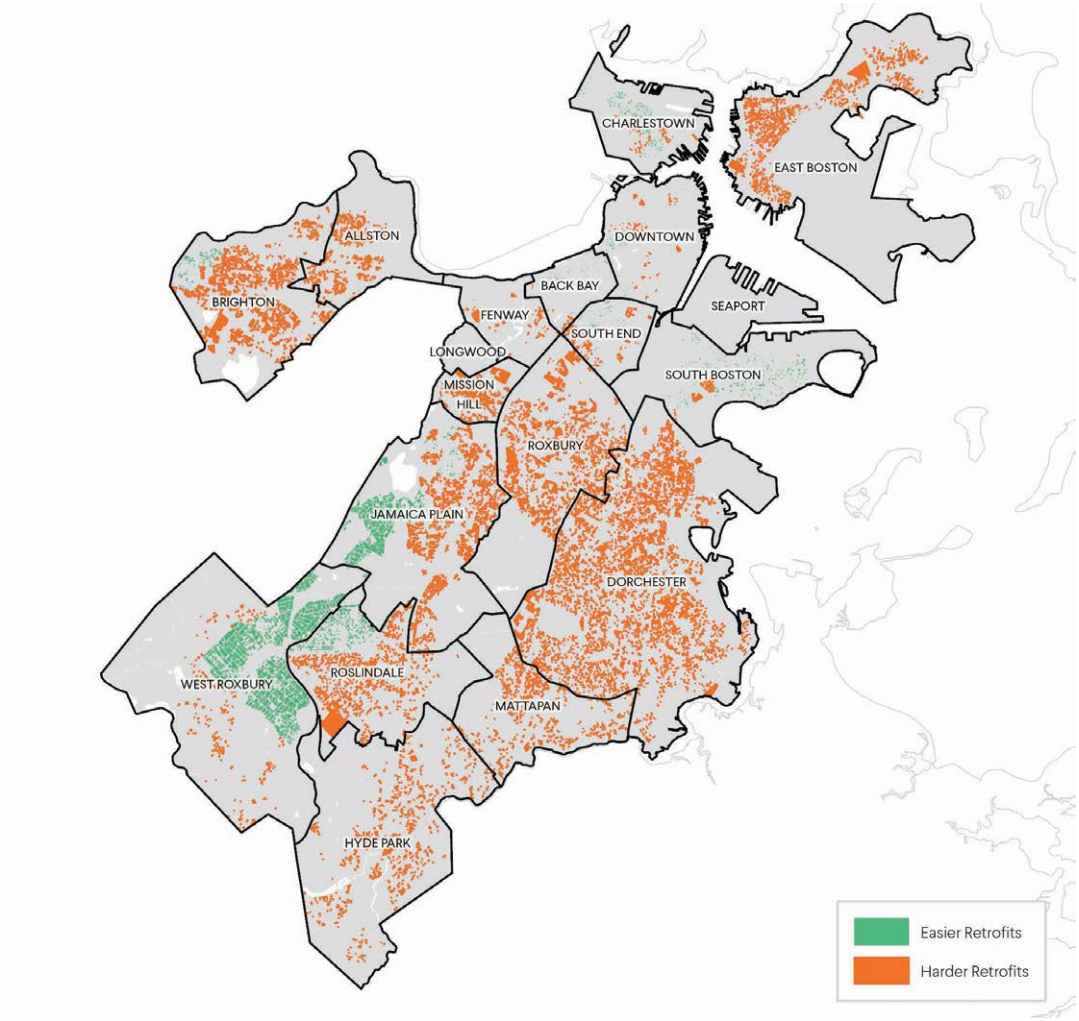


Table 7. Boston home ownership, building type, and household income

Single Family Buildings			Multifamily Buildings		
Owner Occupied (25,638)	**Greater than Boston median household income (easier)**	6,556	2,336	Greater than Boston median household income	Owner Occupied (16,775)
	Less than Boston median household income	19,082	14,439	Less than Boston median household income	
Non-Owner Occupied (4,843)	Greater than Boston median household income	1,164	4,656	Greater than Boston median household income	Non-Owner Occupied (20,839)
	Less than Boston median household income	3,679	16,183	**Less than Boston median household income (harder)**	
	Total	**30,481**	**37,614**		

The residential buildings that fall into the harder and easier to retrofit categories are displayed in Figure 16. The buildings in orange are the harder to retrofit while the buildings in green are the easier to retrofit. Neighborhoods with the highest concentration of harder to retrofit homes—Dorchester, Roxbury, Mattapan, East Boston, Allston, Mission Hill and Hyde Park—coincide closely with the neighborhoods with the highest concentrations of all socially vulnerable populations: people of color, children, elderly, people with disabilities, low to no income, and people with limited English proficiency. Socially vulnerable families have a lower ability to pay for retrofits, and face social circumstances that may limit full participation without inclusive accommodating practices.

A few dominant patterns emerge from these data. First, lower income neighborhoods have greater concentrations of buildings that pose obstacles for retrofitting than the wealthier census tracts as indicated by the density of orange in large parts of Dorchester, Roxbury, Mission Hill, Mattapan, and East Boston. These neighborhoods correlate exactly with the top five social vulnerability index results presented in the Overview section. The pattern is simple: many socially vulnerable families live in buildings that are harder to retrofit. The ones who need it most are the hardest to reach. Buildings with the fewest barriers to retrofit are concentrated predominantly in middle- and high-income neighborhoods like West Roxbury, Jamaica Plain, South Boston, Charlestown, the South End and Downtown, none of which have the highest social vulnerability index scores.

Strategies for Affordable, Energy-Efficient Housing

Boston and its local and regional partners form a strong base to launch a carbon-neutral building initiative with affordable, energy efficient housing as its centerpiece. The Boston Housing Authority (BHA) provides affordable housing to more than 58,000 residents in and around Boston, or about 1 in 11 city residents. BHA is the city's largest residential consumer of electricity, natural gas, heating oil, and water. The Authority's Strategic Sustainability Draft Plan reported a 15 percent decline in GHG emissions from its housing portfolio from 2008 to 2011, and set a goal to reduce energy use (from 2008 levels) by 25 percent by 2020, consistent with the City's climate action goal at that time.[74] The BHA's recent capital budgets included significant investments in more energy-efficient boilers, furnaces, HVAC, and building envelopes.

Other green buildings incentives in Boston have targeted underserved communities: for example, the City's E+ Green Building Program has sponsored energy-positive certified building in Jamaica Plain, Mission Hill, Dorchester and Roxbury, including several affordable housing units.[75] The Codman Square Neighborhood Development Corporation in Dorchester received funding from the US Green Building Council (USGBC) to continue development of Talbot Norfolk Eco-Innovation District, which includes affordable, low-emission homes.[76] In South Boston, USGBC has helped to fund the LEED certified Homes at Old Colony under the Affordable Green Neighborhoods Grant Program.

The Commonwealth is a strong partner. For eight years running, Massachusetts has ranked number one in the American Council for an Energy-Efficient Economy (ACEEE)'s state scorecard for energy efficiency due to its programs for utilities, buildings, transportation, state government, combined heat and power, and appliance standards. The Massachusetts Department of Energy Resources works closely with the natural gas and electric utilities and energy efficiency service providers in MassSave, a program that offers a wide range of services related to energy efficiency. Eversource Energy, the utility that supplies electricity to Boston, spent an average of $92 per low-income household in its service area in 2015, the highest of all metro regions in the US (Figure 17).[77] The Commonwealth Energy Tool for Savings (energyCENTS) provides a single entry point to all of the energy saving opportunities available to Massachusetts residents, businesses and institutions. Massachusetts' HEAT program provides zero percent interest rate

74 Boston Housing Authority. 2014. "Strategic Sustainability Draft Plan." Available online: https://www.bostonhousing.org/BHA/media/Documents/BHA-Sustainability_Feb18.pdf. At the time of the BHA sustainability plan, the City had set GHG reduction goals of 25 percent below 2005 levels by 2020 and 80 percent by 2050 for municipal operations. The target is now carbon neutrality by 2050.

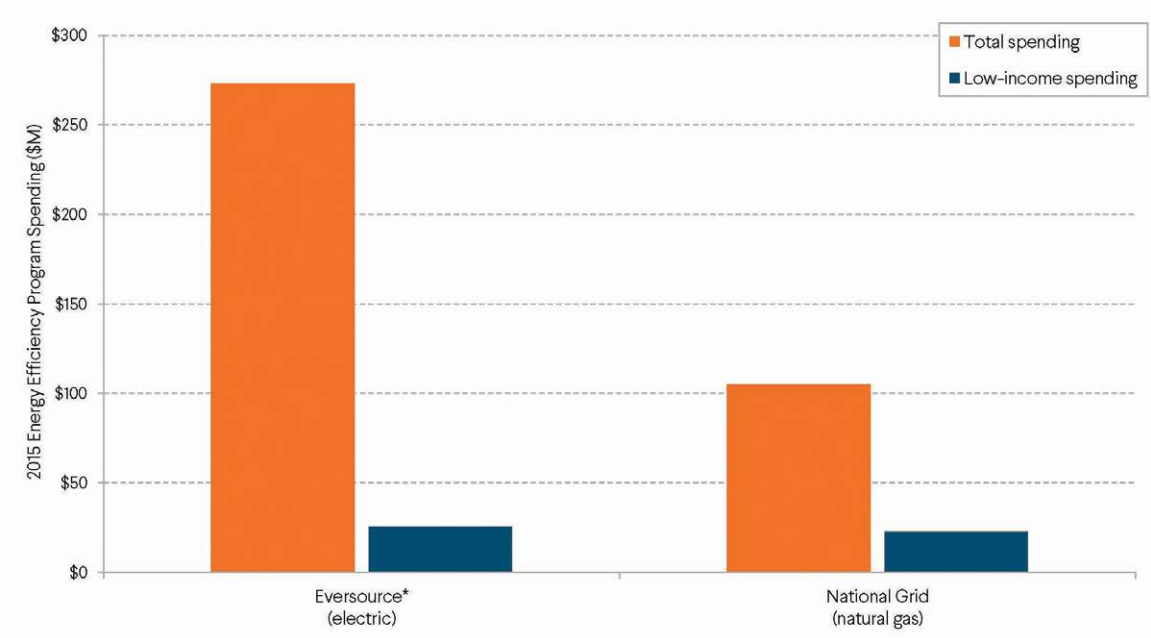
75 E+ Green Building Program Homepage. Available online: http://www.epositiveboston.org/.

76 Codman Square Neighborhood Development Corp. 2016. Eco-Innovation Initiative (EII). Available online: https://csndc.com/ecoinno.php.

77 Drehobl, Ariel, and Fernando Castro-Alvarez. 2017. "Low-Income Energy Efficiency Programs: A Baseline Assessment of Programs Serving the 51 Largest Cities." Washington, D.C.: American Council for an Energy-Efficient Economy (ACEEE).

Figure 17. Utility spending on energy efficiency in the Boston region in 2015

The data reflect electric and natural gas low-income efficiency program spending and total residential program spending in 2015. *The utility reported its low-income spending separately from its residential and commercial energy efficiency spending. An estimate of low-income spending was added to the 2015 total energy efficiency spending. Source: Drehobl, Ariel, and Fernando Castro-Alvarez. 2017. "Low-Income Energy Efficiency Programs: A Baseline Assessment of Programs Serving the 51 Largest Cities." Washington, D.C.: American Council for an Energy-Efficient Economy (ACEEE).



loans for families for energy efficiency investments, although it is not designed to specifically serve low or moderate-income families who are less likely to have the upfront capital or access to credit necessary to make such investments.[78]

ABCD is a nonprofit organization that helps low-income households connect with utility efficiency programs and LIHEAP. Its outreach program and neighborhood centers help about 15,000 households in Boston receive about $11 million per year in funding from LIHEAP. Over the last 18 years, ABCD has completed some combination of weatherization and heating system replacement in more than 16,000 housing units in Boston, averaging about $15 million per year on these improvements.[79]

These programs undoubtedly have reduced GHG emissions in Boston, but carbon neutrality requires a deeper and more expansive effort. Households with low-income and families of color will require more support to achieve larger GHG reductions. Additional opportunities to reduce emissions in buildings with equity in mind are discussed below.

78 Massachusetts Department of Energy Resources (DOER), Department of Housing and Community Development (DHCD) and Massachusetts Clean Energy Center (MassCEC). April 2017. Affordable Access to Clean and Efficient Energy. Available online: https://www.mass.gov/files/documents/2017/09/12/aacee-report.pdf.

79 John Wells, Action for Boston Community Development, personnel communication.

Equity Considerations: Retrofit and Electrify Existing Buildings

Key Questions	Considerations: does the strategy/is the strategy...?
Is it green?	
Is it GHG-free?	**Depends:** Delivers net-zero emission buildings over time when paired with 100% clean energy policies
Is it environmentally sustainable?	**Yes:** Enhances energy efficiency of buildings every year; reduces emissions associated with fuel combustion and harmful co-pollutants caused by fuel combustion
Does it promote smart behavior?	**Depends:** With intentional design, energy efficiency measures and electrification can facilitate integration with grid and shave peak demand; smart thermostats, appliances, and building design, together with behavioral changes, can reduce and improve building energy use, and give owners and occupants more control over their space
Is it fair?	
Is it accessible?	**Depends:** Deep reductions in energy use and electrification of thermal services may not be accessible to all; pairing this policy with subsidies, tax credits or rebates as well as a broad and accessible strategic communications strategy to address cultural and language differences offer a partial solution
Is it affordable?	**Depends:** While electrification of thermal services and deep reductions in energy use lower energy costs and customer bills, associated capital costs may not be affordable to all, even with financing mechanisms; pairing this policy with exemption options, public funding, and additional renter protections offers a partial solution
Are workforce opportunities just?	**Depends:** Opportunities for substantial local, diverse workforce development depend on policy design; careful planning will be necessary to identify training opportunities that expand this workforce beyond those with existing technical qualifications
Who gets to decide?	
Is it inclusive?	**Depends:** Opportunities for inclusive decision-making with intentional planning and prioritization; decision-making processes need to include renters as well as property owners
Are values considered?	**Depends:** Opportunities for values-based decision-making with intentional planning and prioritization
Is it measurable?	**Depends:** Easy measurement for energy usage, dollars, number of furnaces and boilers replaced, number of buildings addressed; more difficult for community and workforce impacts

Boston's North End nieghborhood. Photo credit: iStock/400tmax

Collect, Track, and Report Demographic Data and Metrics

Every assessment of how to get clean, affordable fuels and energy efficiency in households with low-income and families of color emphasizes the necessity of measuring the nature and magnitude of the needs of vulnerable populations, and how effectively these needs are being met. Most of the strategies discussed below depend on high quality data. Meeting Boston's equity and GHG goals will be facilitated with these types of information:

- Improve the parcel database maintained by the City's Assessing Department with a formal system of tracking the installation of new boilers, heat pumps, retrofits, solar panels, etc., such that their impact can be quantified at a granular level
- Quantify the energy and GHG benefits of City action to reduce emissions that accrue to socially vulnerable households
- Track the number of households within each socially vulnerable group that qualify for support from existing programs (e.g., LIHEAP and utility efficiency programs)
- Track rates of program participation within each socially vulnerable group
- Identify and track key non-energy and non-GHG benefits that accrue to socially vulnerable households (cost of fuels and electricity, health)
- Develop a method to identify which socially vulnerable neighborhoods that would benefit the most from specific clean thermal electrification and energy efficiency improvements
- Develop metrics to assess program effectiveness; for energy burden, this could include emergency calls related to energy insecurity, reduced arrearages, changes in property value, energy use, energy affordability, non-energy benefits, and health, safety and comfort
- In Allston and other student-rich neighborhoods, distinguish non-student low-income households

Build Trust in Education and Outreach

Vulnerable populations in Boston are connected to energy programs via a number of channels including Renew Boston, the BHA, MassSave, ABCD, Eversource, and National Grid, among others. There is a considerable amount of assistance available, but one must navigate a daunting maze of websites to find the right information. This poses a significant barrier to households that are challenged by language, income, time, culture, and access to technology. These households are better served by a single gateway that provides contextualized connections to resources, rather than simple click-throughs to other websites. The Commonwealth Energy Tool for Savings is a good template to adapt for city residents.

Realization of the benefits of clean fuels and energy efficient households ultimately requires "boots on the ground," that is people knocking on doors, answering phone calls, and entering residences to perform work. The effectiveness of person-to-person outreach is enhanced by "trusted messengers," people whose language, race, and ethnicity match the target population, and who present information that is tailored to specific needs.[80] This improves trust, communication, rates of program participation, and a sense of community around energy efficiency best-practices.[81] The City can work with its utility, non-profit, and Commonwealth partners to improve these channels of communication by tapping trusted parties, such as local leaders and local organizations, that extend existing relationships and networks.

Boston's policies need to be Boston-specific, and local stakeholders will have valuable input regarding how the City and its partners can best serve the needs of vulnerable Bostonians. Neighborhoods in Boston have very different energy efficiency needs. For example, neighborhoods with the greatest concentration of socially vulnerable populations—such as Dorchester, Roxbury, Mission Hill, Mattapan, and East Boston—also have greater concentrations of buildings that pose obstacles for retrofitting (see Figure 6 above).

80 Fuller, Merrian C. 2011. "Driving Demand for Home Energy Improvements: Motivating Residential Customers to Invest in Comprehensive Upgrades That Eliminate Energy Waste, Avoid High Utility Bills, and Spur the Economy." LBNL-3960E, 989852. Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory. https://doi.org/10.2172/989852.

81 Jansson-Boyd, C., Robison, R., Cloherty, R., Jimenez-Bescos, C. 2016. Complementing Retrofit with Engagement: Exploring Energy Consumption with Social Housing Tenants. International Journal of Energy Research, 41(8), 1150–1163. Available online: https://doi.org/10.1002/er.3698.

Case Study: Bay Area Urban Displacement Project

To help meet its transportation and sustainability goals, California's San Francisco Bay area is undertaking a rapid surge in transit-oriented development. Although intended to cultivate neighborhood economic vitality and improve public health, the new development that often accompanies transit planning and investment in low-income communities and communities of color can fuel displacement and gentrification. A 2015 report by the University of California Berkeley found that displacement is actively occurring in 48 percent of Bay area neighborhoods, while 10 percent had undergone complete transformation due to gentrification.

In response to this ongoing challenge, UC Berkeley initiated the Urban Displacement Project, a research and action initiative that has created a tool for mapping gentrification in the Bay Area and Los Angeles over time. With features such as an interactive map of anti-displacement policy measures across neighborhoods, this tool provides insights on the type of policies being adopted and areas of opportunity for advocacy and accountability purposes.

Boston has a similar tool called the Boston Displacement Mapping Project, which currently functions as a repository for data and story-sharing. Unlike the Bay area's academic and research institution backed initiative, Boston's project is reliant on volunteer effort and is narrower in scope. Support from City officials would strengthen marketing efforts and the tool's use among residents, advocates, and decision makers. Public or private funding for the project would aid sustainability and accountability efforts such as adding features for tracking local policy proposals and implementation information.

Sources:

University of California Berkeley. December 2015. Urban Displacement Project: Executive Summary. Available online: http://www.urbandisplacement.org/sites/default/files/images/urban_displacement_project_-_executive_summary.pdf.

Boston Displacement Project. 2017. Boston Displacement Mapping Project. Available online: http://www.bostondisplacement.org/.

Lower Financial Barriers

New financial assistance programs, and improvements to existing programs are emerging, including On-Bill Lending, Pay as You Save (PAYS), Property Assessed Clean Energy (PACE), Energy Saving Performance Contracts (ESPCs), Energy Service Agreements (ESAs), and financing from Community Development Financial Institutions (CDFIs). The City is already engaged with the Commonwealth and the utilities that deliver energy to insure that Boston residents will benefit from such programs. However, equity outcomes improve if new financial models explicitly target low-income and minority households, not just the "average" utility customer. Properly structured, PACE and On-Bill Financing programs can increase the acceptance of energy efficiency by households who are uncertain as to how long they will remain in their home.[82]

Prioritize Multifamily Affordable Housing

Rented multifamily buildings house many of Boston's socially vulnerable households, as they do in most US cities, and they are an important component of the supply of affordable housing. These households face the greatest energy and housing burdens, yet they typically have fewer energy-efficient features and they are under-served by efficiency programs compared to other modes of housing.[83] Purposeful action aimed at multifamily housing requires effective communication and collaboration among various departments in City Hall, BHA, BPDA, and other entities that design and implement redevelopment in Boston.

82 Leventis, Greg, Emily Martin Fadrhonc, Chris Kramer, and Charles Goldman. 2016. "Current Practices in Efficiency Financing: An Overview for State and Local Governments." LBNL 1006406, 1332131. Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory https://doi.org/10.2172/1332131.

83 Pivo, Gary. 2014. "Unequal Access to Energy Efficiency in US Multifamily Rental Housing: Opportunities to Improve." Building Research & Information 42 (5): 551–73.

Equity Considerations: Zero GHG New Construction

Key Questions	Considerations: does the strategy/is the strategy...?
Is it green?	
Is it GHG-free?	**Yes:** Delivers net-zero emission buildings
Is it environmentally sustainable?	**Yes:** Net-zero buildings use energy more efficiently while avoiding emissions associated with fossil fuel combustion and electric generation
Does it promote smart behavior?	**Yes:** While not an explicit goal, net-zero building design facilitates "smart" buildings technology and better integration with grid
Is it fair?	
Is it accessible?	**Depends:** Net-zero buildings may not be accessible to all; pairing this policy with subsidies, tax credits or rebates as well as strategic communications designed to address cultural and language differences offer a partial solution; careful planning will be necessary to avoid displacement of each neighborhood's existing residents
Is it affordable?	**Depends:** Net-zero buildings entail lower energy costs but depending on building type and timing, may not be always be affordable to purchase, rent, or build; intentional planning and financial support may be required to ensure affordability
Are workforce opportunities just?	**Depends:** Opportunities for substantial local, diverse workforce development depend on policy design; careful planning will be necessary to identify training opportunities that expand this workforce beyond those with existing technical qualifications
Who gets to decide?	
Is it inclusive?	**Depends:** Opportunities for inclusive decision-making with intentional planning and prioritization
Are values considered?	**Depends:** Opportunities for values-based decision-making with intentional planning and prioritization
Is it measurable?	**Depends:** Easy measurement for number of net-zero buildings and building energy use; more difficult for community and workforce impacts

Multifamily residences in East Boston. Photo credit: iStock/DenisTangneyJr

Best practices for programs that target multifamily housing include a combination of the following characteristics:[84]

- Provide a one-stop shop for program services
- Incorporate on-bill repayment or low-cost financing
- Integrate direct installation and rebate programs
- Streamline rebates and incentivize in-unit measures to overcome split incentives
- Coordinate programs across electric, natural gas, and water utilities
- Provide escalating incentives for achieving greater savings levels
- Serve both low-income and market-rate multifamily households
- Align utility and housing finance programs
- Partner with the local multifamily housing industry
- Offer multiple pathways for participation to reach more buildings
- Establish requirements for developers to incorporate energy efficiency and green features in affordable housing

Leverage and Integrate with Other Programs

The City will benefit from capitalizing on opportunities to advance social equity and reduce GHG emissions in buildings where they intersect many other City programs. Examples include:

- *Climate resilience and energy efficiency*: There is large overlap between the households at risk for flooding and extreme temperatures and those that face housing and energy insecurity. A strategy that couples energy efficiency improvements with resilience upgrades would lower costs relative to independent actions, and produce multiple benefits for households.

- *Rooftop solar and energy efficiency*: (i) require applicants for solar incentives to also install energy efficiency upgrades, and (ii) collaborate with manufacturers and trade associations to train building operators to operate, maintain, and monitor newer energy-efficient and solar technologies.[85]

- *Public health and energy efficiency*: Energy efficient homes are healthy homes.[86] Health professionals and community organizations can design and implement programs that improve building function, including GHG reduction, while also reducing health and safety risks. This approach uses building science knowledge to improve the way a building meets the needs of its occupants. Examples of this holistic approach are the Green & Healthy Homes Initiative® in Baltimore and EnergyFIT Philly in Philadelphia.[87]

- *Affordable housing and energy efficiency*: develop strategies to identify whole-building energy opportunities in subsidized multifamily housing at times where the building owner/developer is making decisions about investing in the building's structure or operation.[88]

- *Affordable housing and transportation planning:* locate energy efficient affordable housing near transit, jobs, and other infrastructure to reduce reduces costs and emissions.

84 Drehobl et al., 2016, op. cit.

85 Samarripas, Stefen, and Dan York. 2018. "Our Powers Combined: Energy Efficiency and Solar in Affordable Multifamily Buildings." American Council for an Energy-Efficient Economy, May 2, 2018. https://aceee.org/research-report/u1804.

86 Denson, Ronald, and Sara Hayes. 2018. "The Next Nexus: Exemplary Programs That Save Energy and Improve Health." Report H1802. American Council for an Energy-Efficient Economy (ACEEE). https://aceee.org/sites/default/files/publications/researchreports/h1802.pdf.

87 Ibid

88 Massachusetts Department of Energy Resources (DOER), 2017, op. cit.

Expand Employment and Workforce Diversity

Retrofitting 2,000 to 3,000 Boston buildings per year presents a significant opportunity to facilitate a fair and just workforce by ensuring that diverse local workers and contractors are trained and hired. Careful planning is necessary to identify training opportunities that expand this workforce beyond those with existing technical qualifications. Many of the job opportunities created will be local and span entry-level positions to upper management and representing a wide range of skills.[89] As demand for efficient technologies and building retrofits and upgrades increases, energy efficiency jobs will be created across many industries including construction, administration, manufacturing, building materials, lighting, design and installation.[90] With intentional design and targeted training and skills development programs, energy efficiency provides a unique opportunity to provide Bostonians with high-skill, well compensated jobs.[91] Not only do more skilled jobs tend to offer higher pay, research shows that green jobs require more high-level cognitive and interpersonal skills[92]—meaning that, should socially vulnerable Bostonians be targeted for these opportunities, they may reap benefits that are broader than employment and salary. One example is targeting job opportunities at women and people of color who are currently underrepresented in the city's construction workforce based on the City's own goals.[93] Diligence also is required to protect socially vulnerable workers (including subcontractors) from unfair labor practices.

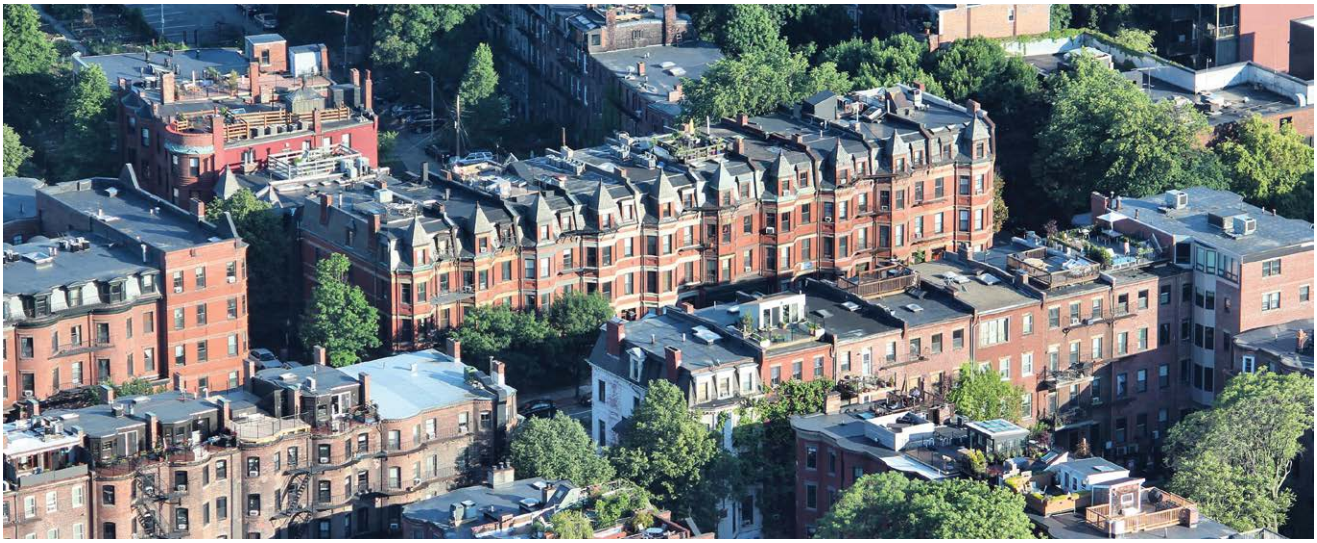
In 2017 the City significantly strengthened its "Resident Jobs" policy by requiring that at least 51 percent of workers on any public or large private construction project must be Boston residents, at least 40 percent must be people of color, and at least 12 percent must be women.[94] The stronger benchmarks currently are met by a small fraction of all eligible construction projects,[95] but there is notable progress. In 2017, people of color accounted for 51 percent of hours worked in public projects, surpassing the 40 percent requirement. In response to the new requirements construction companies and trade groups have increased apprenticeships, community outreach, and partnerships with schools to expand diversity. Action towards carbon-neutral buildings is an additional opportunity for the City to work with the private sector to enhance the diversity of Boston's workforce.

Experience in other cities demonstrate that Community Workforce Agreements can steer the benefits of energy efficiency investments towards disadvantaged communities and workers. They often include provisions for local hiring, living wages and benefits, and career development and training opportunities for employees. Clean Energy Works Oregon is a pioneer in using these agreements to achieve community benefits, a trained workforce, and high-quality efficiency projects. Organizations like the Emerald Cities Collaborative and Green for All are working with stakeholders in communities around the country to expand the use of such agreements.[96]

Use New, Net-Zero Homes to Close the Affordable Housing Gap

Net-zero, single-family homes currently are more expensive to build, although the costs of net-zero homes will continue to decline in the future.[97] Because of higher costs, new buildings of any kind tend to be less accessible to low-income families, and new carbon-neutral buildings may unintentionally exacerbate this disparity. New carbon-neutral buildings provide a unique

89 E4TheFuture. September 2018. Energy Efficiency Jobs in America. E2 and E4TheFuture. Available online: https://e4thefuture.org/wp-content/uploads/2018/09/EE-Jobs-in-America-2018.pdf.
90 United States Department of Energy (DOE). January 2017. US Energy and Employment Report. Available online: https://www.energy.gov/downloads/2017-us-energy-and-employment-report.
91 Christopher, D. May 10, 2017. 4 Technologies Driving Energy Efficiency Jobs. United States Office of Energy Efficiency & Renewable Energy. Available online: https://www.energy.gov/eere/articles/4-technologies-driving-energy-efficiency-jobs.
92 Consoli, D., Marin, G., Marzucchi, A., and Vona, F. July 2016. Do Green Jobs Differ from Non-Green Jobs in Terms of Skills and Human Capital? Research Policy, 45(5), 1046—1060. Available online: https://www.sciencedirect.com/science/article/pii/S0048733316300208.
93 Enwemeka, Z. June 13, 2018. Boston Is In A Building Boom — And Wants More Diverse Construction Workers. WBUR. Available online: https://www.wbur.org/bostonomix/2018/06/13/construction-industry-diversity.
94 City of Boston. March 2019. Boston Residents Jobs Policy on Construction Projects. Available online: https://www.boston.gov/departments/economic-development/boston-residents-jobs-policy-construction-projects.
95 Enwemeka, Z. June 13, 2018. Boston Is In A Building Boom — And Wants More Diverse Construction Workers. WBUR. Available online: https://www.wbur.org/bostonomix/2018/06/13/construction-industry-diversity.
96 Mackres, Eric. 2012. "Energy Efficiency and Economic Opportunity." American Council for an Energy-Efficient Economy (ACEEE). Available online: https://aceee.org/blog/2012/09/energy-efficiency-and-economic-opport.
97 Corvidae, J., Gartman, M., and Peterson, A. 2018. The Economics of Zero Energy Homes. Rocky Mountain Institute. Available online: https://www.rmi.org/insight/economics-of-zero-energy-homes/.



Apartment buildings in Boston's South End neighborhood. Photo credit: Marek Slusarczyk/Alamy Stock Photo

opportunity to address historical housing inequalities, particularly in neighborhoods that have experienced gentrification and displacement, or are a greater risk of gentrification and displacement. These neighborhoods include South Boston, Roxbury, parts of the South End, Dorchester, Brighton, Allston, Jamaica Plain, and East Boston.[98]

Learn From Others' Experience

Boston can benefit from the experience in other cities and countries who incorporate equity into building policy design (Table 8). From Oregon to New Zealand, energy efficiency program managers are working to create opportunities for low- and no cost upgrades to homes and businesses, and in California, New York, and Massachusetts, to direct the benefits of buildings policies to low-income households. California is targeting benefits to renters, while programs in New York, Washington, Tennessee and Georgia promote community education and work to address language and cultural barriers. A thorough review of other states' and cities' buildings policies may lead to new ideas and experiences in inclusive decision-making and workforce development.

Equity and Carbon-Neutral Buildings

Historically, when GHG reduction is the sole or principal goal in climate action, large energy consumers—typically, large commercial customers and more affluent families with larger homes—are targeted first and allocated the most resources, and large, multifamily affordable housing units are left behind. Boston's goal to achieve carbon neutrality can be paired with its social equity goals to ensure that a carbon-neutral building stock is built in a fair and just manner.

Action to reduce GHG emissions in buildings can avoid unintended consequences if it improves energy efficiency while also improving affordability and minimizing displacement. Intentionality in design requires that the multiple equity benefits of energy efficiency—lower utility bills, workforce development, and improved health, safety, and comfort—are used as organizing elements of policy design. Start-to-finish inclusivity requires that policy choices are made with input from those most affected and deliberate action taken for inclusive decision-making at each step in the process. An inclusive, value-based and equity-focused process is the only way to ensure that carbon neutrality is not achieved at the expense of social equity. An important way to accomplish this is to define equity goals and outcomes at the outset in order to provide a measurement stick by which to judge process equity, implementation equity, and outcome equity. When equity is approached intentionally in program design, planning, implementation and evaluation, Boston can build a carbon-neutral stock that is accessible and beneficial for all.

98 Jennings, J. September 22, 2016. Gentrification as Anti-Local Economic Development: The Case of Boston, Massachusetts. Trotter Review: Black Culture, Race and Race Relations, 23(1), Article 4. Available online: https://scholarworks.umb.edu/trotter_review/vol23/iss1/4.

Table 8. Examples of Intentional Design in the Buildings Sector

LOWER COST OF RETROFITS AND NEW HOMES	
Massachusetts	Solar Massachusetts Renewable Target (SMART) promotes cost effective solar energy projects, with incentives for projects that serve community solar, low-income, and public facilities
Massachusetts	HEAT loan MA provides 0% interest loans for 1-4 family homeowners and condos. Removes the barrier of credit
Cambridge (Massachusetts)	Custom retrofit program that offers cash incentives based on GHG savings
COST OF RETROFITS AND NEW HOMES DEPEND ON INCOME	
Massachusetts	LEAN/MassSave: energy efficiency measures installed through low-income programs
New York City (New York)	Equipment replacement rebates, affordable solar, and performance based cash incentives for low to medium income households, primarily multifamily homes
California	Affordable Housing and Sustainable Communities program invests in affordable homes and transit infrastructure in disadvantaged communities
California	Affordable, efficient homes to families making less than 50% of median income
Oakland (California)	0% interest loans for retrofits to low and moderate income home owners with no upfront cost
Georgia	Low Incoming Housing Tax Credit used to finance energy retrofits
Portland (Oregon)	REACH Community Development ensures new construction projects allow for an opportunity to build affordable housing with low energy needs
New Zealand	Warm Up New Zealand: Heat Smart provided energy efficiency retrofits to low-income households
PROTECTIONS FOR TENANTS FROM RENT INCREASES	
California	Affordable Housing and Sustainable Communities program targets funding to families earning less than 50 percent of their area median income
AVOIDS CITING DISAMENITIES IN SOCIALLY VULNERABLE NEIGHBORHOODS	
Buenos Aires (Argentina)	The Metropolitan Buenos Aires Urban Transformation Project is pursuing energy efficiency measures during construction of new homes and rehabilitation of existing structures in Villa 31 (an urban slum) to improve living standards
San Diego (California)	The San Diego Association of Governments sets goals and actions to ensure socially disadvantaged neighborhoods are not disproportionately affected by hazardous facilities
Seattle (Washington)	New building projects must address concerns related to equity, including potential negative impacts
PROMOTES COMMUNITY KNOWLEDGE, EDUCATION, SKILLS	
New York	Long Island Power Authority: Residential Energy Affordability Partnership Program provides energy education and counseling to low-income customers along with installation of electric energy efficiency measures
Washington	Oil-Free Washington toolkit for residential heating oil conversion provides resources, instruction, support for programs targeted to oil home conversions
ADDRESS LANGUAGE AND CULTURAL BARRIERS	
Knoxville (Tennessee)	Assistance to organizations that develop equitable energy transformation projects targeted at low and moderate income residents, including literature around equity and sustainability
Union City (Georgia)	Low-income Housing Tax Credit financing major renovations that all incorporated energy efficiency measures and green building certifications
PROMOTES WORKFORCE DEVELOPMENT	
New York City (New York)	Transform Don't Trash NYC is a campaign to transform the commercial waste industry and create good jobs and clean, safe communities
Portland (Oregon)	30% of the workforce of city wide retrofitting jobs must be made up of disadvantaged and underrepresented employees, and 20% minority
RAISES JOB SAFETY OR COMPENSATION STANDARDS	
Massachusetts	Laborer collective bargaining agreements to secure fair wages is protected among State, county and municipal employees
Boston (Massachusetts)	Mayoral ordinance sets labor employment standards for Boston residents, people of color, and female construction workers
California	New labor laws raise minimum wage, overtime pay and tighten sexual harassment regulations
Seattle (Washington)	2019 labor law raises minimum wage to $16/hour for large employers, $15/hour for small employers

Source: See Appendix D for a list of sources.

A multifamily residence in South Boston.
Photo credit: iStock/DenisTangneyJr

Transportation

Main Findings

- More privileged Boston residents enjoy greater access to, and a greater ability to afford, all modes of transportation.
- Proximity to public transportation and safe biking is unequally distributed across Boston neighborhoods. New transit and biking infrastructure and reduced-cost and free public transit have great potential to increase ridership and biking, thereby reducing GHGs and congestion, while also enhancing equity. Investment should target transit-poor areas.
- Proximity to public transit does not necessarily improve connectedness: reliability, frequency of service, hours of operation, connectivity and affordability are also very important.
- Intentional planning across housing and transportation should account for the connections among improved access to transit, higher property values, and neighborhood displacement.
- Road pricing can cause many drivers to change their mode of transportation, but such action should mitigate the disproportionate burden on low-income households. Fee revenues can improve access to active and public modes of transport.
- Care must be taken to ensure that socially vulnerable communities are not priced out of essential trips and have multiple transit options that are roughly equal in terms of time, distance, and cost.
- Community-specific outreach and education are crucial to make all Bostonians aware of walk and bike networks, bike-share systems, and how to access them.

Overview

Boston cannot achieve carbon neutrality by 2050 without public and private transportation options that all Bostonians can access and afford. The *Summary Report* evaluated a number of strategies to achieve carbon neutrality by shifting modes of transportation, reducing the number of vehicle trips, and electrifying most vehicles. The social equity analysis that follows demonstrates that the implementation of more equitable access to less GHG-intensive modes of transport requires concentrating efforts in communities that are currently underserved by clean energy infrastructure, applying fees in ways that equitably distribute those burdens, and recycling fee revenues into modes of transit that are beneficial to all.

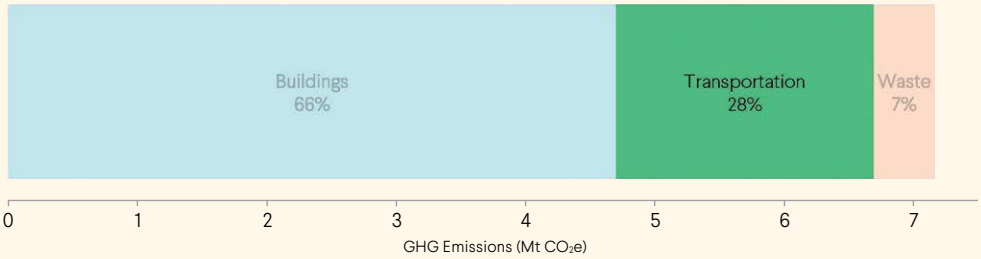
Transportation accounted for about 28 percent of the city's greenhouse gas emissions in 2016. Some of those emissions stem from traffic congestion in Boston, which is among the worst in the country. Commuters who drive during peak times spend an average of 164 hours longer in traffic than if they were to drive at non-peak times.[1] Without intervention to increase housing supply close to activity hubs and transit, and to expand regional transit, congestion is likely to worsen due to the projected increase in commuters.[2]

1 Vaccaro, A. February 12, 2019. The worst gridlock in the US is right here in Boston. The Boston Globe. Available online: https://www.bostonglobe.com/metro/2019/02/12/bragging-rights-boston-now-has-worst-rush-hour-traffic-country-report-says/wMNdRAIrEV7svwShY80NaJ/story.html.

2 Bluestone, B., Huessy, J. and Tumber, C. 2016. State of the Built Environment: Greater Boston's Infrastructure. A Better City. Available online: https://www.northeastern.edu/csshresearch/dukakiscenter/wp-content/uploads/sites/7/2018/03/A-Better-City-State-of-the-Built-Environment.pdf.

Carbon Free Boston Strategies for Carbon-Neutral Transportation

Boston's transportation system currently accounts for about 28 percent of the City's total GHG emissions. More than two-thirds of the city's transport emissions are from private vehicles.



The *Summary Report* proposes three overarching actions to reach a carbon-neutral transportation system: (1) shift trips away from private vehicles towards transit, walking, and biking, (2) reduce the demand for private vehicle trips, and (3) electrify all modes of transport to the extent practicable. If all private vehicle commuters shifted to transit, biking and walking, transportation GHG emissions would be 70 percent lower than they are today. It is important to note that the City cannot address these transportation emissions on its own and will need to collaborate with regional partners: three-quarters of private vehicle emissions are generated by trips that begin or end outside of Boston.

	ACTION	DETAILS
Shift people out of private vehicles	Reduce demand for vehicle trips	• 75% of future population growth in transit-rich, walkable, and centrally-located neighborhoods
		• 20% increase in travel demand management market penetration
	Expand and improve biking	• 250 new miles of protected bike facilities, covering entire City with routes spaced a half-mile apart
	Expand and improve walking	• Walk and bike friendly main streets; Vision Zero priority corridors and safe crossings
	Expand and improve public transportation	• Improve speed and reliability
		• 42 new miles rapid bus + 35 new miles urban rail
	Free and reduced-cost public transportation	• Free for walk-access transit, including rapid transit and local bus
		• 50% fee reduction for drive-access commuter rail and ferry
	Private travel pricing	• $5 parking fee /trip ending in non-home location in Boston
		• Cordon fee: $10 to $15 per trip within cordon
		• VMT fee: $0.20/mile for all vehicle trips
	Smart mobility incentives	• $1/mile increase for ride-alone
		• $1/mile decrease for shared-ride
Electrification	Shift automobiles, trucks, buses, and trains to zero-GHG electricity	• Early action to electrify buses and fleet vehicles
		• Upgrade commuter rail when feasible
		• Strategically install EV charging infrastructure that avoids prioritizing EVs over other uses of the urban landscape
		• Prohibit fossil-fuel based transport: 100% of trips in light/medium duty vehicles and 100% of transit

Transportation Inequity and Insecurity

More privileged city residents enjoy greater access to, and a greater ability to afford, most modes of transportation. For example, access to reliable public transportation is disproportionately worse in neighborhoods with large populations of people of color: Black and Latinx/Hispanic Bostonians have longer commutes than their White counterparts, particularly on public transit.[3] Black bus riders spend 64 hours more per year in transit than White riders—even though White and non-White Bostonians use the bus system in approximately equal numbers—due to systemic differences in reliability and frequency of service.[4]

Meanwhile, many who can afford to avoid the bus have simply opted out. Nearly half of bus riders surveyed between 2015 and 2017 by the Metropolitan Planning Organization reported household income below $58,000 a year. Another 17 percent declined to answer the question.[5]

In Boston, ride-hailing and active transit options have emerged as important alternatives to public transit with distinct equity impacts. In the US, ride-hailing is more commonly used by younger, wealthier people,[6] and a study conducted in Boston revealed that, "the cancellation rate for African American sounding names was more than twice as frequent compared to white sounding names".[7] Nationally, Uber drivers are predominantly young (49 percent under 40), white (37 percent), male (86 percent) and college-educated (48 percent).[8]

There is a strong gender component to transportation equity. Female ride-hailing passengers tend to be driven farther than their male counterparts, and there is a strong correlation between commute length and life expectancy for low-income, less educated women. This suggests access to efficient transportation (or lack thereof) has an impact on health, with "lower social position and demographic factors affecting health outcomes".[9]

Most residents in East Boston, Downtown, Back Bay, South End, Seaport, Fenway, Longwood, Mission Hill, and Roxbury can reach a transit stop, bus stop or blue bike station within 5 to 10 minutes. In South Boston, Allston, Brighton, Dorchester, Mattapan, Jamaica Plain, Roslindale, West Roxbury and Hyde Park, only those sections of these neighborhoods clustered around existing transit infrastructure are able to reach a transit stop, bus stop or blue bike station within 5 to 10 minutes (Figure 18).

Disparities in access is a growing concern for electric vehicles and active transportation. There is a far higher rate of EV ownership in wealthier Massachusetts counties (Table 9), and a far higher rate of EV charging station installations located at single-family homes than multi-unit buildings[10], where more residents have lower average incomes than single-family home residents. Investments in active transit—like biking and walking infrastructure—have historically been made first in city centers, slowly working their way outwards like spiderwebs.[11] Those initial investments tend to be in higher-income communities and more predominantly White neighborhoods, and underserved communities are not necessarily better served as infrastructure moves outward.[12]

3 (1) Metropolitan Area Planning Council and Dukakis Center for Urban and Regional Policy. 2016. 2016 MAPC Regional Indicators of Sustainable Transportation in Metro Boston. Available online: http://www.regionalindicators.org/topic_areas/2%23improved-equity. (2) Pollack, S., Williams, L., Lopez, R., Luna, I. November 2013. The Toll of Transportation: Final Report. Dukakis Center for Urban and Regional Policy. Available online: https://www.northeastern.edu/csshresearch/dukakiscenter/wp-content/uploads/sites/7/2018/03/The-Toll-of-Transportation-Final-Report.pdf.

4 Ramos, N. February 6, 2019. If Rosa Parks rode a bus in Boston today, she'd see nearly the same segregation she fought. The Boston Globe. Available online: https://www.bostonglobe.com/metro/2019/02/06/rosa-parks-rode-bus-boston-today-she-see-nearly-same-segregation-she-fought/P4gg5mXpYZu9ZRywDIJAhK/story.html.

5 Ibid.

6 Smith, A. May 2016. Shared, Collaborative and On Demand: The New Digital Economy. Pew Research Center. Available online: http://www.pewinternet.org/2016/05/19/the-new-digital-economy/.

7 Yanbo, G., Knittel, C., MacKenzie, D., Zoepf, S. October 2016. Racial and Gender Discrimination in Transportation Network Companies. National Bureau of Economic Research (NBER). Available online: https://www.nber.org/papers/w22776.

8 Clifford C. 2015. Who Exactly Are Uber Drivers? Entrepreneur. Available online: https://www.entrepreneur.com/article/242096.

9 Wray, R. October 2013. The Spatial Trap: Exploring Equitable Access to Public Transit as a Social Determinant of Health. Wellesley Institute. Available online: https://www.wellesleyinstitute.com/wp-content/uploads/2013/10/The-Spatial-Trap.pdf. p.10.

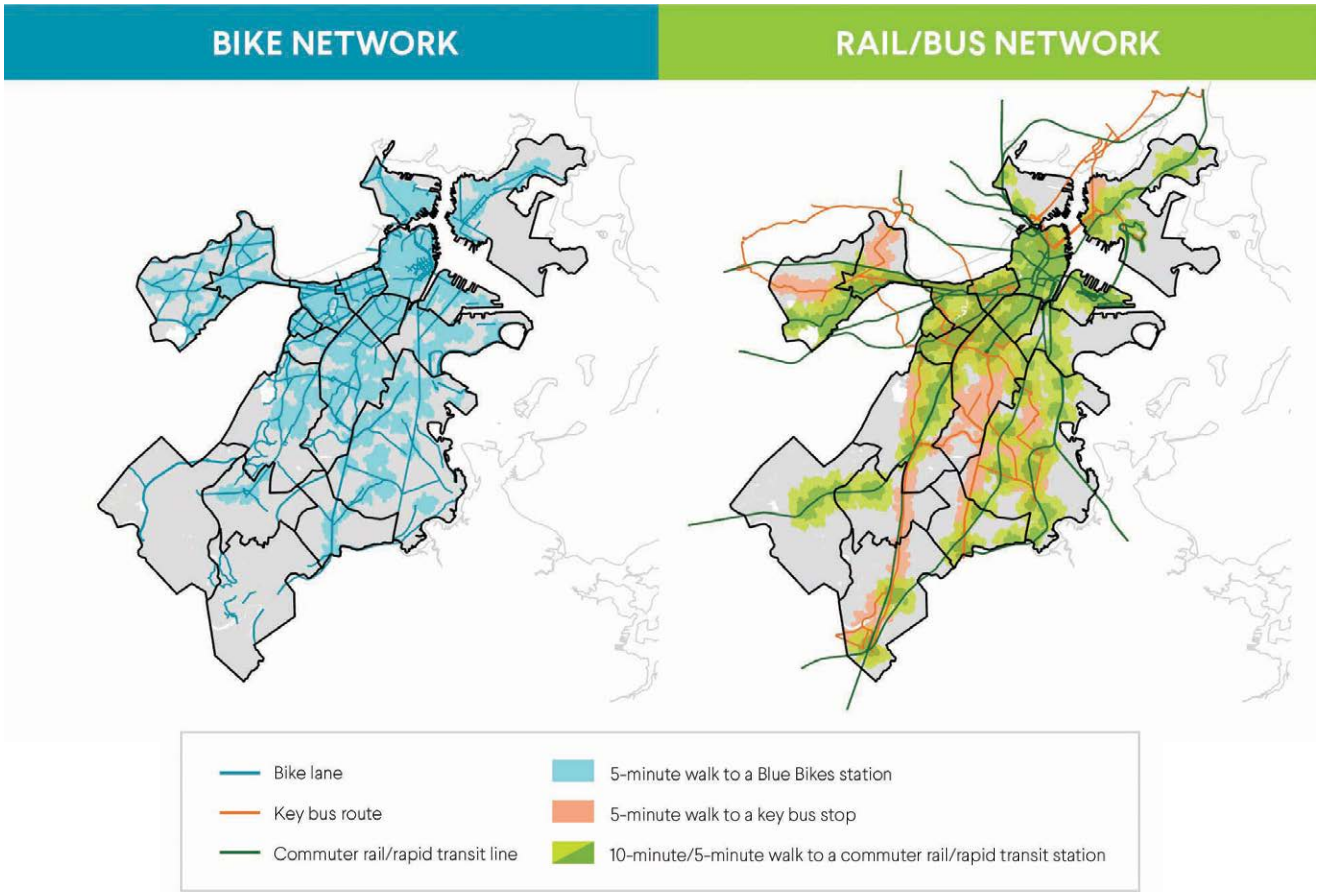
10 Eversource Energy. November 2018. Eversource Energy - Eversource Energy and Envoy Technologies Team up to Promote Increased Electric Vehicle Access at Massachusetts Apartment Buildings. Electric Energy Online. Available online: https://electricenergyonline.com/social/fnjg/article/energy/category/energy-storage/143/730348/Eversource-Energy-and-Envoy-Technologies-Team-up-to-Promote-Increased-Electric-Vehicle-Access-at-Massachusetts-Apartment-Buildings.htm.

11 Howland, S., McNeil, N., Broach, J., Rankins, K., MacArthur, J., Dill, J. May 2017. Breaking Barriers to Bike Share: Insights on Equity from a Survey of Bike Share System Owners and Operators. Transportation Research and Education Center (TREC). Available online: https://doi.org/10.15760/trec.173.

12 Wintersmith, S. July 2018. Bike-Share Equity In Boston, A Work In Progress. WBGH. Available online: https://www.wgbh.org/news/local-news/2018/07/24/bike-share-equity-in-boston-a-work-in-progress.

Figure 18. Boston Residents within 5 and 10-minute Walks to Bike and Rail/Bus Networks

Source: Data from Blue Bikes Trip Data 2018 and MBTA



The MBTA Green Line at Park Street station. Photo credit: MBTA

Table 9. Summary of Massachusetts EV Counts by County through 2015

County	Charge Points	PEVs	EVSE per 1,000 PEVs	Median Income
Barnstable	43	181	238	$68,048
Berkshire	22	82	268	$55,190
Bristol	28	236	119	$62,514
Dukes	3	60	50	$67,535
Essex	66	657	100	$73,533
Franklin	10	86	116	$57,307
Hampden	34	213	160	$52,205
Hampshire	40	267	150	$64,974
Middlesex	300	2,366	127	$92,878
Nantucket	10	13	769	$91,942
Norfolk	123	759	162	$95,668
Plymouth	53	318	167	$82,081
Suffolk	189	665	284	$61,242
Worcester	75	632	119	$69,313
State Total	996	6,535	152	$74,167

Note: EVSE = Electric Vehicle Supply Equipment; PEV = Plug-in Electric Vehicle

Source: EV data adapted from Wood, E., Raghavan, S., Rames, C., Eichman, J. and Melaina, M. January 2017. "Regional Charging Infrastructure for Plug-In Electric Vehicles: A Case Study of Massachusetts." National Renewable Energy Laboratory (NREL). p.16. Available online at: https://www.nrel.gov/docs/fy17osti/67436.pdf. Median income data from US Census Bureau, American Community Survey, 2013-2017 ACS 5-Year Data Profiles. Available online at: https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2017/

Neighborhood Impacts of Transportation Decarbonization

The *Summary Report* evaluated a wide range of options to move the city's transportation system towards carbon neutrality. Such changes will have sweeping impacts across the city's neighborhoods. Decarbonization of Boston's transportation may increase the costs of some modes of transportation while lower the costs of other modes (Figure 19). While reductions in transit cost may be similar in most neighborhoods, changes to the cost of private vehicle and ride-sharing vary greatly. Among the most socially vulnerable neighborhoods, Mission Hill stands out as risking the greatest increases to non-transit transportation costs, followed by Roxbury.

A carbon-neutral transportation system would fundamentally change the way Bostonians get around by 2050. Compared to the base case—a scenario in which the City takes no additional action, including none of the options in *Go Boston 2030* (Figure 20)— the transportation pathway presented in the *Summary Report* (Figure 21) greatly decreases the share of commuters driving ("drive anywhere" in the Figures below) and greatly enhances the share of commuters taking shared rides (a trip that utilizes a ride-share service), public transportation and active commutes ("walk access" to public transit and "walk/bike"). The neighborhoods furthest away from downtown—West Roxbury, Hyde Park, Roslindale, Mattapan and Jamaica Plain—have the highest 2050 driving rates both in the base case and the carbon-neutral scenario, although under the latter strategy they experience the largest drop in driving rates among all neighborhoods. Across all neighborhoods, the greatest difference between the scenarios is in shared rides, which are substantially higher due the cross subsidy from single occupant to multiple occupant trips via ride-hailing.

Figure 19. Change in Transportation Costs in Pathway to 2050 Scenario

The change compares the price of a trip in 2050 if the City took no new action to the price under the carbon-neutral transportation pathway in the *Summary Report*. Source: Institute for Sustainable Energy model calculations.

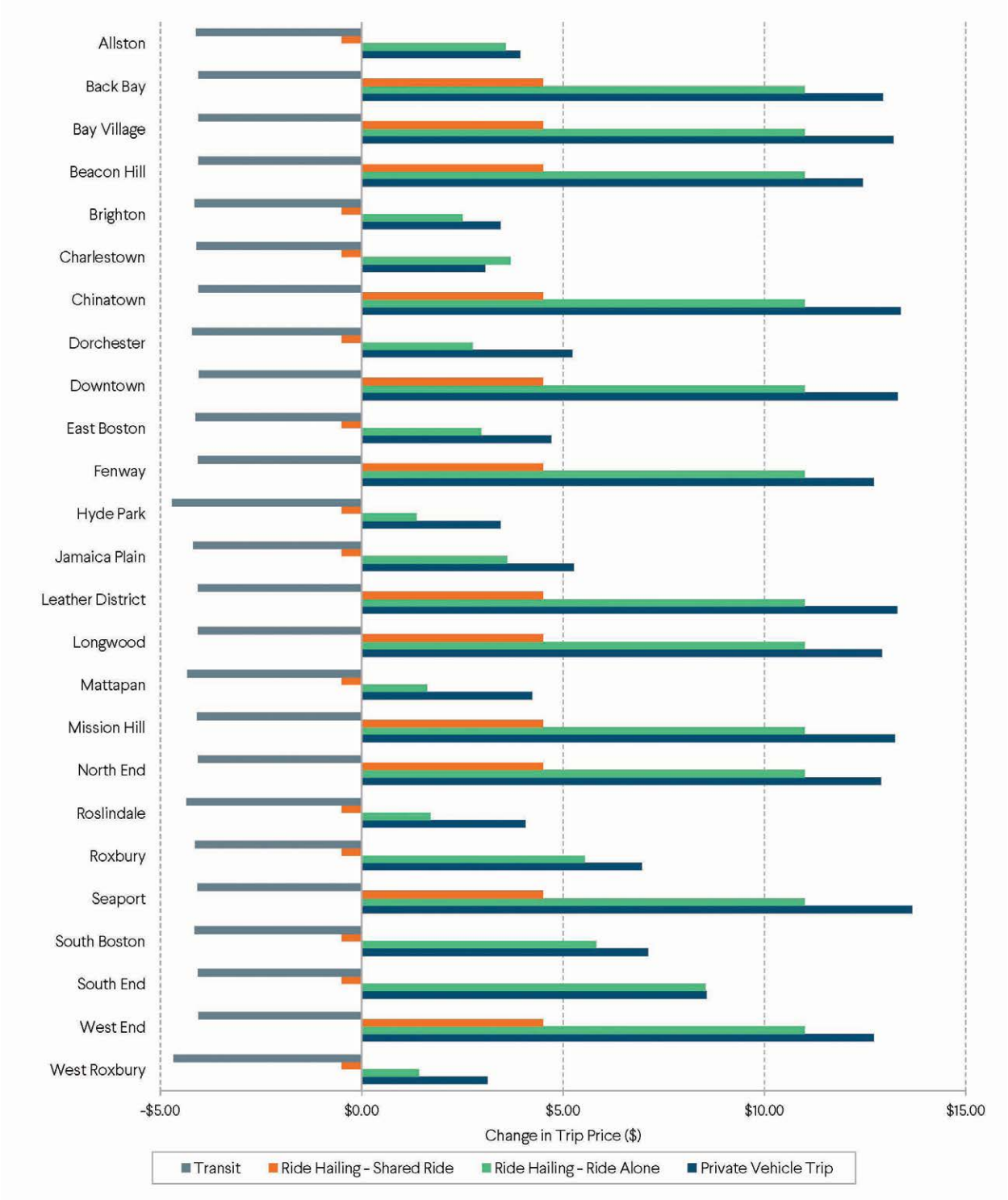


Figure 20. Boston Auto Trips by Mode, 2050, in Baseline Scenario

The Baseline Scenario assumes no new action by the City of Boston. Source: Institute for Sustainable Energy model calculations.

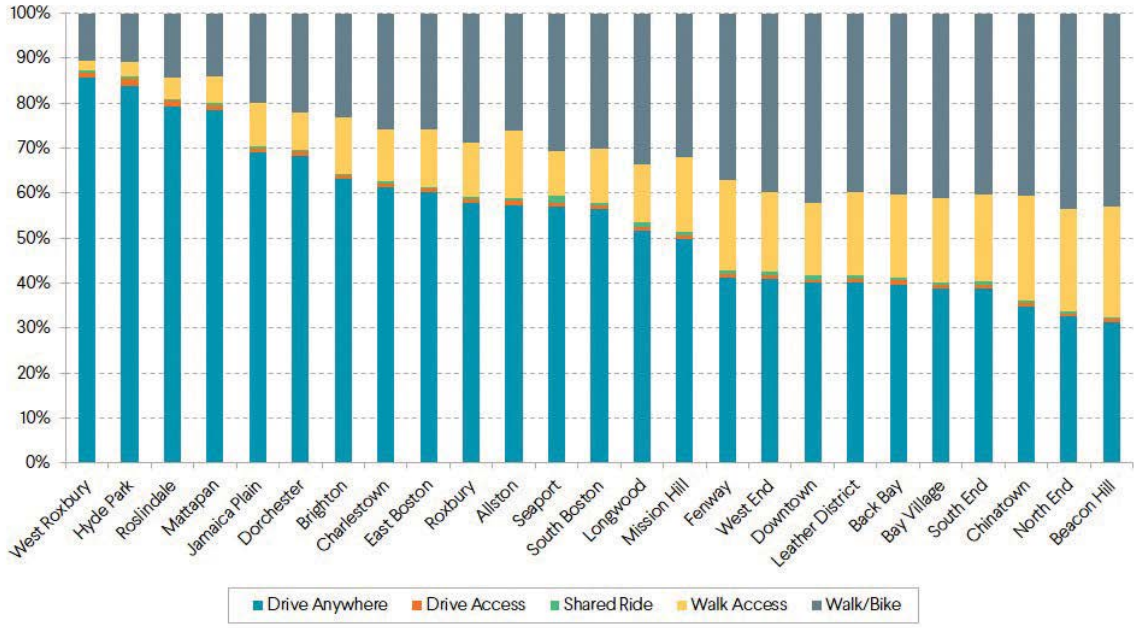
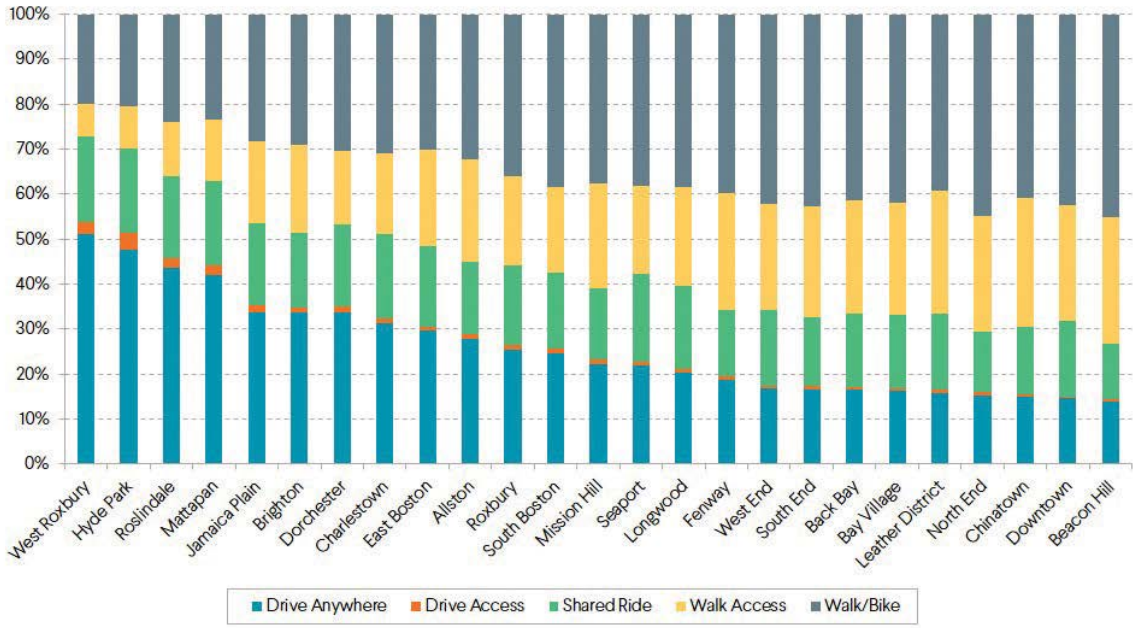


Figure 21. Boston Auto Trips by Mode, 2050, in Pathway to 2050 Scenario

Source: Institute for Sustainable Energy model calculations.



Note for Figures 20 and 21: *Drive Anywhere*: A trip in a car (not including shared ride services), driving to some destination from start to finish; *Drive Access:* A multimodal trip that begins in a car and drives to a transit stop; *Shared Ride:* A trip that utilizes a shared ride service to get to a destination. This includes shared rides where the person requesting is alone, as well as pooled rides; *Walk Access:* A multimodal trip that begins by walking to a transit stop; *Walk/Bike:* A trip by walking or biking from start to finish.

Benefits of Equitable, Carbon-Neutral Transportation

Improved Health and Safety

The *Summary Report* described the health benefits that flow to residents from a clean transportation system, and especially to some socially vulnerable groups. A carbon-neutral transportation system has the potential to improve people's health and safety. The physical activity resulting from the big increase in the number of miles people travel by biking and walking will lower health care costs in Boston by $52 million in 2050. Expanding the quality and quantity of active transport modes in currently underserved neighborhoods could close the gap in health inequities that characterize the city's minority and low-income populations.[13]

Deep vehicle electrification reduces air pollution from fuel combustion, which reduces health care costs by another $8 million. In Massachusetts urban regions, air pollution disproportionality burdens people of color, individuals with lower educational attainment, and households with an annual income of less than $20,000.[14] It follows that a cleaner transportation energy system in Boston will benefit those populations.

Job Creation and Economic Impacts

Building a carbon-neutral transportation system will generate substantial new employment opportunities. For an investment of $1 million, bicycling infrastructure creates 11.4 jobs, pedestrian-only infrastructure creates 10 jobs, multi-use trails create 9.6 jobs, and road-only construction creates 7.8 jobs. The average job creation per $1 million investment across 58 different projects was 9 jobs—that increased to 12 jobs when the study accounted for indirect employment effects.[15]

Many of the new job opportunities associated with the transportation transition will be local,[16] and—with intentional design—can be targeted to socially vulnerable communities and areas of high unemployment. A combination of labor policies, social protections, and worker training is necessary to ensure that new transportation jobs both created and eliminated by the transition to a carbon-neutral city are equitably distributed. Training and skills development programs are particularly important in the short run to allow workers to shift within and between sectors, and are of particular importance for those workers in fossil fuel and energy-intensive sectors that are likely to shrink or change first, such as car mechanics.[17]

Table 10 shows the current distribution of jobs in Boston by industry. Jobs will shift as the green transportation transition gets underway: some may be eliminated, substituted, adapted, or created.[18] Intentional policy forecasts the distribution of job creation and elimination, and the ability for workers in at-risk or eliminated jobs to adapt or substitute their skills. Intentional policy ensures that the transition has an overall positive effect on employment and that opportunities be targeted at particularly vulnerable segments of the workforce as needed.

13 Boston Public Health Commission, Health of Boston 2016-2017, http://www.bphc.org/healthdata/health-of-boston-report/Pages/Health-of-Boston-Report.aspx

14 Rosofsky, Anna, Jonathan I. Levy, Antonella Zanobetti, Patricia Janulewicz, and M. Patricia Fabian. 2018. "Temporal Trends in Air Pollution Exposure Inequality in Massachusetts." Environmental Research 161 (February): 76–86. https://doi.org/10.1016/j.envres.2017.10.028.

15 Garrett-Peltier, H. June 2011. Pedestrian and Bicycle Infrastructure: A National Study of Employment Impacts. University of Massachusetts Amherst: Political Economy Research Institute. Available online: https://www.peri.umass.edu/publication/item/427-pedestrian-and-bicycle-infrastructure-a-national-study-of-employment-impacts.

16 World Health Organization. 2011. Green and Healthy Jobs in Transport: Launching a New Partnership under the PEP. Available online: https://thepep.unece.org/sites/default/files/2016-10/THE.PEP_.Green_.Jobs_.e.pdf.

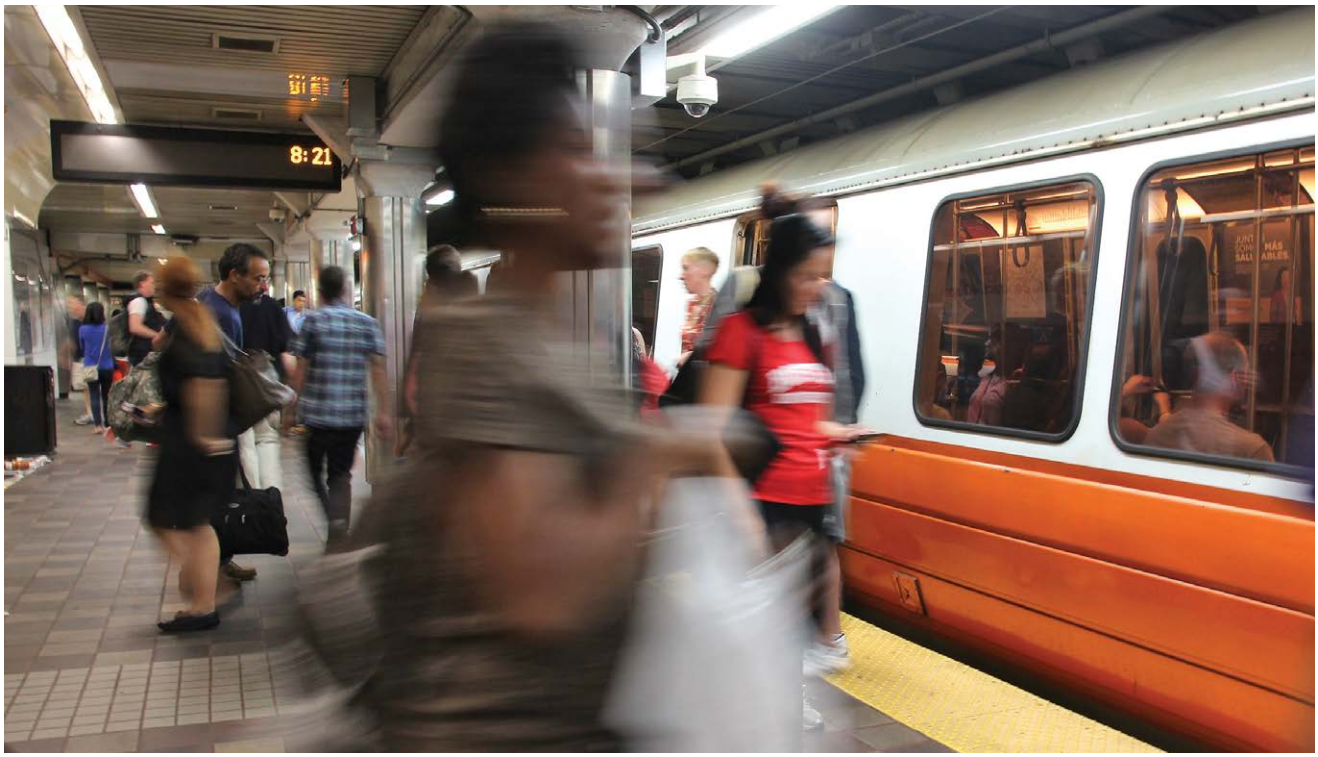
17 Kruse, T., Dellink, R. and Chateau, J. June 2017. Employment Implications of Green Growth: Linking Jobs, Growth, and Green Policies. OECD. Available online https://www.oecd.org/environment/Employment-Implications-of-Green-Growth-OECD-Report-G7-Environment-Ministers.pdf.

18 World Health Organization. 2011. Green and Healthy Jobs in Transport: Launching a New Partnership under the PEP. Available online: https://thepep.unece.org/sites/default/files/2016-10/THE.PEP_.Green_.Jobs_.e.pdf.

Table 10. Boston's Total Payroll and Non-Payroll Jobs by Industry

Industry	2015	%
Health Care and Social Assistance	139,911	18.5%
Professional, Scientific, and Technical Services	91,858	12.1%
Finance and Insurance	86,971	11.5%
Government	76,708	10.1%
Accommodation and Food Services	59,910	7.9%
Educational Services	57,534	7.6%
Administrative and Waste Services	37,274	4.9%
Real Estate and Rental and Leasing	34,591	4.6%
Retail Trade	34,142	4.5%
Other Services	32,762	4.3%
Transportation and Warehousing	26,037	3.4%
Construction	17,478	2.3%
Information	16,861	2.2%
Arts, Entertainment, and Recreation	16,805	2.2%
Wholesale Trade	9,862	1.3%
Management of Companies and Enterprises	8,390	1.1%
Manufacturing	7,969	1.1%
Utilities	1,894	0.3%
Natural Resources and Mining	387	0.1%
Total	**757,344**	**100.0%**

Source: Reproduced from The Boston Planning & Development Agency. Boston's Economy Report 2017. Available online: http://www.bostonplans.org/getattachment/d835ad4c-e8a9-4f17-b342-468f02301c58



The MBTA Orange Line at Downtown Crossing station. Photo credit: iStock/tupungato

Strategies for Affordable, Accessible and Clean Transportation

Promote and Expand Access to Public Transportation

The *Summary Report* identified free or reduced cost public transit coupled with investment in transit infrastructure as an important strategy to reduce GHG emissions and shift travel out of private vehicles. Reduced-cost and free public transit have great potential to increase ridership—as they have in places like Portland (Oregon), Contra Costa (California)[19], Bonn (Germany)[20] and Estonia[21]. Such action would also improve the safety, reliability and accessibility of public transit for all.

Intentional planning should consider the connections between improved access to transit, higher property values, and neighborhood displacement. Often called the "transit premium," houses and apartments with nearby access to public transportation tend to have higher property values:[22]

- A review of ten US cities found higher property values closer to light rail, subways, and rapid bus lines.[23]
- In Cleveland, Ohio, adding new access to transit raised property values by 3.5 percent.[24]
- A study of Boston home sales found that the price of properties close to rapid transit was growing at more than double the pace of other properties.[25]
- A study of transit justice in Colorado found that Denver's new light rail opening resulted in higher rents, putting a burden on low-income residents.[26]

The connection among gentrification, displacement, and improved transportation infrastructure highlights the need to coordinate planning and decision-making across the multiple City agencies, and their partners, with responsibilities across these dimensions of city life.

Pair Equitable Travel Pricing with Investment in Public and Active Transportation

The *Summary Report* evaluated a suite of potential road pricing strategies to reduce GHG emissions: a congestion (cordon) fee, a fee on vehicle miles traveled (VMT) by private vehicles, a parking fee, and a cross subsidy from single- to multiple-occupant trips via ride-hailing. Table 11 describes some of the important equity considerations for both Boston residents and commuters in the context of the congestion, VMT, and other road pricing fees. Recent studies of the policy impacts of road pricing indicate that congestion charges are successful in causing drivers to change their mode of transportation, but place a disproportionate burden on low-income households.[27]

19 Pollack, S., Bluestone, B., and Billingham, C. October 2010. Maintaining Diversity In America's Transit-Rich Neighborhoods. Northeastern University. Available online: https://www.northeastern.edu/csshresearch/dukakiscenter/wp-content/uploads/sites/7/2018/03/TRN_Equity_final.pdf.

20 Delhaes, D. June 2018. Urban Mobility: Five German Cities to Slash Public Transport Fares to Fight Pollution. Handelsblatt Today. Available online: https://www.handelsblatt.com/today/politics/urban-mobility-five-german-cities-to-slash-public-transport-fares-to-fight-pollution/23582564.html.

21 Gray, A. June 2018. Estonia Is Making Public Transport Free. World Economic Forum. Available online: https://www.weforum.org/agenda/2018/06/estonia-is-making-public-transport-free/.

22 National Association of Realtors. June 16, 2014. Public Transportation Boosts Property Values. Available online: https://www.nar.realtor/articles/public-transportation-boosts-property-values. Pollack, S., Bluestone, B., and Billingham, C. October 2010. Maintaining Diversity In America's Transit-Rich Neighborhoods. Northeastern University. Available online: https://www.northeastern.edu/csshresearch/dukakiscenter/wp-content/uploads/sites/7/2018/03/TRN_Equity_final.pdf.

23 Diaz, R.B. 1999. Impacts Of Rail Transit On Property Values. American Public Transportation Association. Available online: http://reconnectingamerica.org/assets/Uploads/bestpractice083.pdf.

24 Lendel, I., Pasha, O., Sohrabian, D., and Ellerbrock, M. 2019. GCRTA Economic Impact and Contributions to Local Economy: Main Findings. Urban Publications. Available online: https://engagedscholarship.csuohio.edu/urban_facpub/1593.

25 Mooney, J. May 7, 2013. Home Values Near Transit Outperform. UrbanLand. Available online: https://urbanland.uli.org/industry-sectors/infrastructure-transit/home-values-near-transit-outperform/

26 Mahajan, N., and Williams, Z. January 2014. Left at the Station: A Civil Rights Perspective on Transit Justice in the Front Range. 9to5 Colorado. Available online: http://milehighconnects.org/wp-content/uploads/2014/10/Left-at-the-Station.pdf.

27 (1) Amelsfort. D., and Brundell, K. March 2018. Congestion Charging: Policy and Global Lessons Learned. WSP. Available online: https://www.wsp.com/-/media/Insights/Canada/Documents/doc-Congestion-Charging-Report.pdf?la=en-CA&hash=1A44EC2D1A1E5683F77F6F2B5A2EC8EA50F74976; (2) Levinson, D. January 2010. Equity Effects of Road Pricing: A Review. Transport Reviews, 30(1), 33–57. Available online: https://www.tandfonline.com/doi/full/10.1080/01441640903189304.

Table 11. Equity Considerations with Road Pricing (Congestion and VMT Fees)

Impact	Questions
Environmental	Will road pricing divert traffic through a SV community, and if so, what are the air quality and noise impacts?
Mobility and Safety	Will road pricing cause some individuals to be "priced-out" of certain trips? Are there reasonable alternative modes available to those that cannot afford the fee? Will individuals be forced to use less desirable (to them) modes of transport? Will traffic diverted through a SV community increase the safety risk to bicyclists and pedestrians? Will road pricing alter transit routes and schedules in the SV communities?
Social and Economic	Are the non-tolled alternatives equitable in terms of travel time and distance? How will road pricing affect property values in SV communities? How will road pricing affect access to schools, work, hospitals, etc.? How will road pricing impact business access for customers and deliveries?
Cultural/Historic	Will road pricing impact or discourage access to cultural and recreational resources (historical sites, parks)?

Source: Adapted from Jolanda Prozzi, Isabel Victoria, Gerald Torres, C. Michael Walton, and Jorge Prozzi. Guidebook for Identifying, Measuring and Mitigating Environmental Justice Impacts of Toll Roads, Center for Transportation Research, The University of Texas at Austin, TxDOT Project 0-5208, September 2006

Equity Considerations: Invest and Improve Public Transit

Key Questions	Considerations: does the strategy/is the strategy…?
Is it green?	
Is it GHG-free?	**Yes:** Operational improvements and free/reduced-price transit lowers emissions, even more so when transit electrification is done with GHG-free electricity
Is it environmentally sustainable?	**Yes:** Public transit is more energy efficient than travel by private vehicle
Does it promote smart behavior?	**Yes:** Encourages a large-scale transition to mass transit, reducing the length of commutes and road congestion
Is it fair?	
Is it accessible?	**Depends:** New, free, and reduced-price transit reduce obstacles to accessibility; operational and infrastructure improvements have the potential to greatly increase transit accessibility depending on decisions made regarding type and location of investments
Is it affordable?	**Depends:** New, free, and reduced-price transit are more affordable for low-income communities; New investment in public transit may impact public budgets. Pairing with policies that generate revenue (e.g., private travel pricing) can limit this impact
Are workforce opportunities just?	**Depends:** Opportunities for diverse new workforce and contractors depend on policy design
Who gets to decide?	
Is it inclusive?	**Depends:** Opportunities for inclusive decision-making with intentional planning and prioritization
Are values considered?	**Depends:** Opportunities for values-based decision-making with intentional planning and prioritization
Is it measurable?	**Depends:** Easy measurement for trips, dollars; more difficult for community and workforce impacts

While road pricing will raise costs for drivers and entail equity concerns, they can be designed to minimize cost and redistribute benefits to socially vulnerable populations. For example, in the proposed pathway to carbon neutrality presented in the *Summary Report* transportation analysis, the research team evaluated a road pricing scheme that charges $5 per trip in a congested area in a private vehicle (Figure 22), with a congestion area that covers 4.4 square miles and approximately 100,000 residents living in Downtown, Back Bay, Longwood and Seaport—the Boston neighborhoods with the four lowest social vulnerability index results (see Table 2 above). The revenues from the charge can be leveraged to improve access to active and public modes of transport in such a way as to achieve desired equitable outcomes. Several cities have implemented or planned to implement similar schemes. London, Norway, Singapore, Milan, and San Diego use revenues from private travel pricing schemes to improve public transit and equity outcomes.[28] Seattle's Transportation 2040 plan[29] aims to reduce vehicle miles traveled through pricing schemes that simultaneously support broader regional economic development.[30] Revenues from the proposed congestion fee in New York City are intended to be secured in a "lockbox" designated only for investment in public transportation.[31]

In addition to potential cost burdens, private travel pricing schemes must be designed to ensure they do not result in increased mileage and emissions. That is what happened in Singapore where drivers altered their routes to avoid paying fees.[32] The design of pricing schemes must also address other unintended consequences, such as concentrated traffic burdens or disincentivizes to strategies that can reduce the number of cars on the road, like shared ride-hailing or ride-sharing.[33] Program design also needs to acknowledge all economic barriers, not just the means to pay tolls. Accessing toll roads with electronic pricing depends on the ability to acquire a transponder, and large transponder deposits, initial prepayment amounts, minimum balances, monthly fees, account replenishment options, and use of credit cards could put transponder usage outside the reach of many Bostonians and commuters. Private vehicle pricing schemes should also be designed with care to ensure equitable and consistent enforcement[34] and avoid disincentivizing private vehicle options that could reduce the number of cars on the road, like shared ride-hailing or ride-sharing.[35]

Collect, Track, and Report Demographic Data

Similar to the carbon-neutral building pathway, ensuring an equitable transition to a carbon-neutral transportation system requires tracking both the nature and magnitude of vulnerable populations' needs and the equity impacts of the strategies. This will allow for an honest assessment of how effectively the needs of the socially vulnerable populations are being met. This will entail the City and partners to:

- Update on an ongoing basis the travel characteristics of socially vulnerable households that were established in *Go Boston 2030*.
- Quantify the energy and GHG benefits of action to reduce transportation emissions that accrue to socially vulnerable households.
- Identify and track key non-energy benefits that accrue to socially vulnerable households (cost of transportation, health).
- Develop a method to identify socially vulnerable neighborhoods that would benefit the most from specific transportation strategies.

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32 Chu, S. July 2015. Car Restraint Policies and Mileage in Singapore. Transportation Research Part A: Policy and Practice, 77, 404–12. Available online: https://doi.org/10.1016/j.tra.2015.04.028.
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34 Liang, J. January 2015. Unmasking Covert Injustice? A Multilevel Analysis of Environmental Inequities and Regulatory Enforcement in the United States. PhD Dissertation, American University. Available online: https://dra.american.edu/islandora/object/auislandora%3A12521.
35 Jeekel, H. 2017. Social Sustainability and Smart Mobility : Exploring the Relationship. Transportation Research Procedia, 25, 4296—4310. Available online: https://doi.org/10.1016/j.trpro.2017.05.254.

Equity Considerations: Private Travel Pricing

Key Questions	Considerations: does the strategy/is the strategy…?
Is it green?	
Is it GHG-free?	**Depends:** Has the potential to reduce private vehicle GHG emissions to the extent that: EVs are widely adopted, electrification is powered by clean energy, and fees shift commuters from private to public transit
Is it environmentally sustainable?	**Depends:** Has the potential to reduce VMTs and reduce energy use per VMT to the extent that fees shift commuters from private to public transit
Does it promote smart behavior?	**Yes:** Reduces peak road congestion, encourages more efficient modes of transportation
Is it fair?	
Is it accessible?	**Depends:** Private vehicle travel would not be accessible to all; pairing this policy with more accessible public transit along with policies addressing ride-hailing and autonomous vehicle developments may be a partial solution
Is it affordable?	**Depends:** Private vehicle travel would not be affordable to all but these fees generate revenue for the public sector; individual affordability depends on revenue recycling choices
Are workforce opportunities just?	**Depends:** Opportunities for diverse new workforce and contractors depend on policy design
Who gets to decide?	
Is it inclusive?	**Depends:** Opportunities for inclusive decision-making with intentional planning and prioritization
Are values considered?	**Depends:** Opportunities for values-based decision-making with intentional planning and prioritization
Is it measurable?	**Depends:** Easy measurement for trips, VMT, dollars, pollution emissions; more difficult for community and workforce impacts

Figure 22. Modeled Congestion Zone

Congestion pricing refers to charging a fee to enter or drive within a congested area. The area of the assessed cordon covers 4.4 square miles and approximately 100,000 residents. For comparison, London's congestion fee covers 8 square miles and 136,000 residents. The *Summary Report* assessed a fee of $5 per trip in this zone. At current rates of driving, this equates to $10 to $15 per day to drive within the zone. Source: Institute for Sustainable Energy.

Make Biking Accessible and Safe

The *Summary Report* evaluated a significant expansion of the city's bike network. Many US bike-sharing programs are characterized by inequitable access for disadvantaged neighborhoods; a requirement for credit cards or online payments that some socially vulnerable families cannot meet; and bike-sharing stations that tend to be sited in Whiter and more affluent neighborhoods. Relative to many other cities, Boston's bike-sharing stations are more equitably distributed across neighborhoods, although there is room for improvement (Figure 23).[36] As part of their ongoing efforts to improve bike share access among underserved communities in the greater Boston area, BlueBikes partnered with the cities of Boston, Brookline, Cambridge and Somerville to introduce the Income-Eligible Program. Under this program, qualifying residents of the four municipalities can enjoy significant discounts on their membership fees, provided they can show proof of participation in any one of 12 pre-identified public assistance programs.[37]

The expansion of biking requires action beyond building protected bike lanes; people must feel secure to use them. An analysis of Black and Latinx/Hispanic residents in thirty-four neighborhoods across New Jersey revealed that the fear of being robbed and assaulted while bicycling ranked as the number two barrier to bicycling, second only to the fear of a traffic collision.[38] Black participants stated directly that concerns about police harassment serve as a barrier to biking, and both Black and Latinx/Hispanic residents said they occasionally change their routes within their communities due to concerns about police profiling. Studies in Tampa Bay and Minneapolis also reported that Black cyclists were stopped and cited more frequently than White cyclists, and that Black cyclists were more likely to be perceived as confrontational by police when compared to other racial and ethnic groups.[39]

Learn from Others' Experience

Metropolitan areas around the world are making public transit, walking, and biking more accessible (Table 12). Cities have taken action to make public transit less expensive than private transit, and more affordable for low-income commuters. Many municipalities are also working to make their streets and sidewalks more accessible for walking and biking with dedicated walkways and bike paths together with bike-sharing services. Boston's Complete Streets program aims to put pedestrians, bicyclists, and transit on equal footing with motor vehicle traffic.[40] The program aims to design roadways for shared use for all modes of travel, and incorporates trees, rain gardens, and permeable paving materials to manage flooding and pollution. Projects have included safety improvements and bike lanes in Fenway, sidewalks and greenspace in East Boston, congestion mitigation in Jamaica Plain, and a new "neighborhood friendly corridor" in the South End and Roxbury.

Ensure Access to Electric Vehicles

The transportation transition will inevitably occur faster in some areas than in others, creating the potential for uneven gains.[41] This is of particular concern for Bostonians who rely primarily on private vehicles. The price of EVs is expected to fall in coming years.[42] However, fossil fuel vehicles—particularly used fossil fuel vehicles—will remain the most affordable private vehicles for many Bostonians (even if they are far less affordable on a per-mile basis). This could exacerbate existing inequities such as differential access to transit infrastructure.[43]

36 Barajas, J. 2018. How Equitable Is Bikesharing? Exploring Population Characteristics and Access to Employment. University of California, Berkeley. Available online: http://www.jmbarajas.com/wp-content/uploads/2018/12/Barajas_Bikeshare_equity_20170801.pdf.

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40 Boston Complete Streets Homepage. Boston Transportation Department. Available online: http://bostoncompletestreets.org/.

41 Wells, P. November 2012. Converging Transport Policy, Industrial Policy and Environmental Policy: The Implications for Localities and Social Equity. Local Economy: The Journal of the Local Economy Policy Unit, 27(7), 749–763. Available online: https://doi.org/10.1177/0269094212455018.

42 McKerracher, C. May 2018. Electric Vehicle Outlook 2018 | Bloomberg New Energy Finance. Bloomberg New Energy Finance. Available online: https://about.bnef.com/electric-vehicle-outlook/.

43 Altenburg, T. and Assmann, C (Eds.). 2017. Green Industrial Policy: Concept, Policies, Country Experiences. German Development Institute and UN Environment: Geneva, Bonn. Available online: http://www.greengrowthknowledge.org/sites/default/files/downloads/resource/Green%20Industrial%20Policy_Concept%2C%20Policies%2C%20Country%20Experiences.pdf.

Table 12. Examples of Intentional Design in Transit and Active Transportation Policies

ELECTRIFY PUBLIC TRANSIT, TAXIS, RIDE-HAILING/SHARING	
Washington DC, CA, MA, NY, RI, WA (USA), Santiago (Chile)	Commitments to fully or partially electrify state vehicle fleet and/or public transit
GA, OH, RI (USA)	VW settlement funds used for electric transit
Medellin (Colombia)	1,500 electric taxis by 2020
TRANSIT PRICES DEPEND ON CUSTOMER INCOME	
Fort Worth (Texas)	Bikeshare offers $10 annual memberships to low-income
Paris (France)	Plan in place to make public transit free for low-income residents
PRIORITIZE PUBLIC/SHARED TRANSPORT OVER PRIVATE VEHICLES	
CA, OR (USA), Austria, Belgium, Estonia, Germany, Luxembourg	Programs offering partial or complete free public transit
San Francisco (California)	Vehicle Sharing Parking Permit Policy includes equity and access highlighted in definition and pricing of each zone
TX, WA (USA)	Special parking rules/fees for carsharing spaces
Chicago (Illinois)	Transportation funding and jobs targets for disadvantaged areas
Santa Clara (California)	Increasing ridership by residents of transit-rich neighborhoods by selling discounted passes to housing developers for free distribution to their residents
Los Angeles (California)	Park-and-ride parking fees generates revenue while having minimal cost burden on low-income households
Washington DC (USA)	Cordon system revenue used to fund transit improvements
CA, MN, TX (USA)	HOT lanes typically collect revenue with small impact on low-income drivers
Singapore	Investment in transit and affordable housing close to transit using congestion price revenue
PRIORITIZE ACTIVE TRANSPORT OVER PRIVATE VEHICLES	
Boston (Massachusetts)	Boston's Hubway provided more than 550 annual memberships to qualified low-income recipients at a cost of $5 each, along with longer than normal free trip durations (26)
Chicago (Illinois)	Protected bike lanes (increase number of cyclists and reduce injuries)
Philadelphia (Pennsylvania)	Reserve fund to cover bikeshare damages or theft; allows for expanded access to those without credit cards linked to their account
Minnesota	NiceRide Minnesota placed 30 biking stations (approximately 20 percent of their system) in areas identified by the community as necessary for equity
Canada	Investing in biking infrastructure contributed to the safety of bike riders, and resulted in a substantial decrease in biking accidents
Switzerland	SwitzerlandMobility - sustainable mobility for tourism through publicized routes for walking, cycling, mountain biking, skating and rafting.
Bogota (Colombia)	City efforts to promote walking and cycling

Source: See Appendix D for a list of sources.

With regard to private EV purchases, common policy tools include financial incentives—such as vouchers, rebates, tax exemptions and tax credits—to accelerate the transition to GHG-free private vehicles and to enable lower-income residents to participate. An EV subsidy or cash incentive designed to vary based on the customers income may be preferable from an equity standpoint to a tax refund, which many low-income (and therefore low tax paying) customers cannot collect.[44] About 90 percent of federal EV tax credits for Massachusetts' EV charging infrastructure to consumers with annual incomes of $75,000 or more. Similarly, caps on tax exemptions based on the cost of EVs directly benefits more affluent families that can afford higher cost EVs.[45]

Financial incentives for GHG-free private vehicles can leverage private and public capital. For example, California funds its EV vouchers and rebates with revenue collected from polluters in its cap-and-trade program.[46] Other cities, states and countries have made substantial progress in incorporating equity measures into EV policies, including rebates, tax credits, and fee reductions that lower the price of EVs to all customers, or by opening up high-occupancy or bus lanes to EV drivers (Table 13). With intentional design to maximize benefits in socially vulnerable communities, these programs can better meet the needs

44 Skerlos, S., and Winebrake, J. February 2010. Targeting Plug-in Hybrid Electric Vehicle Policies to Increase Social Benefits. Energy Policy, 38(2), 705–708. Available online: https://doi.org/10.1016/j.enpol.2009.11.014.

45 The Greenlining Institute. 2016. Electric Vehicles for All: An Equity ToolKit. Available online: http://greenlining.org/publications-resources/electric-vehicles-for-all/#tab3-section12.

46 Ibid.

Figure 23. EV Charging Stations, Blue Bike Stations, and Bike Network

Source: Open Charge map (https://openchargemap.org/site), Blue Bikes Trip Data

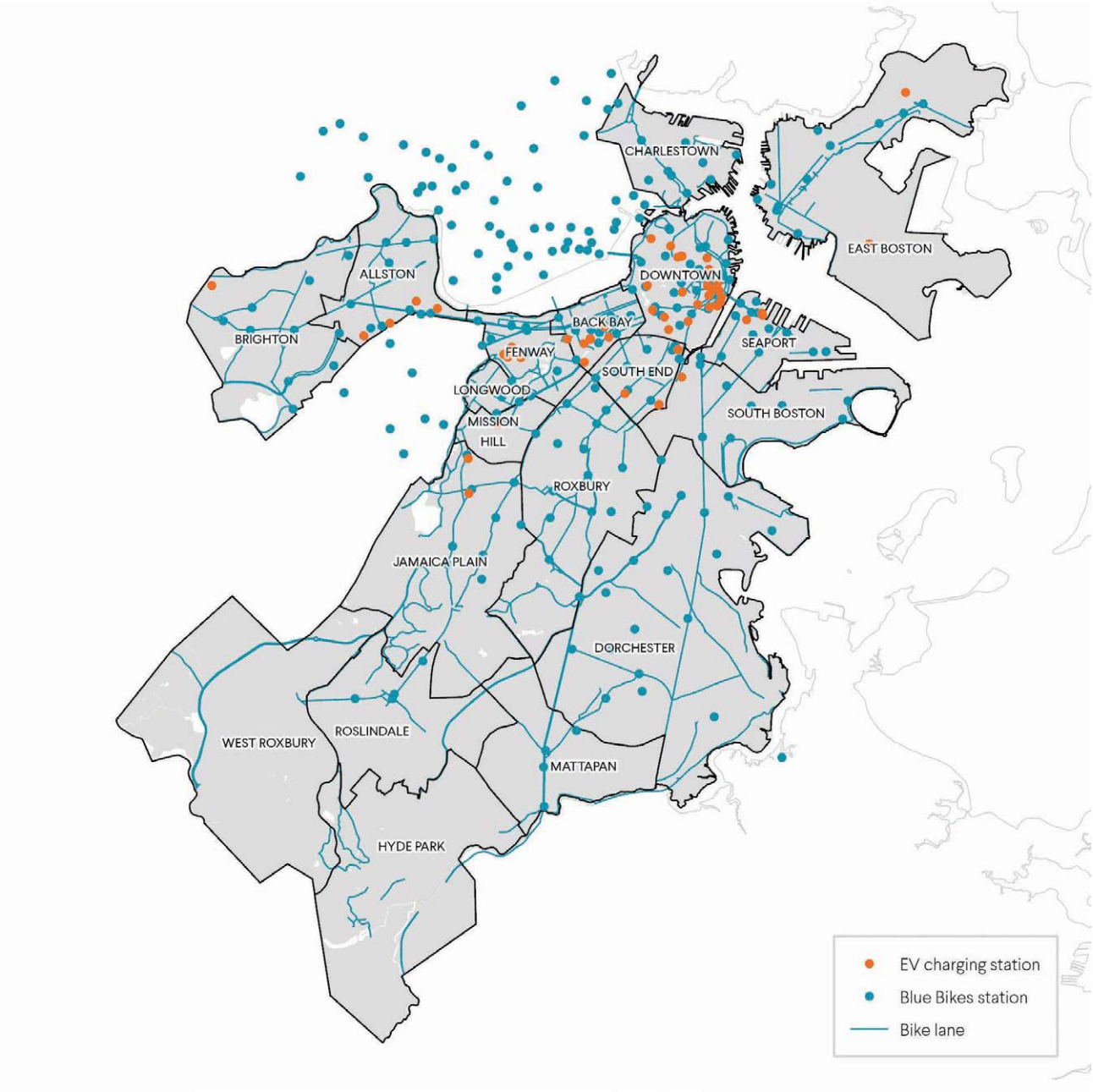

Table 13. Examples of Intentional EV Policy Designs

LOWERS PRICES OF EV TO ALL CUSTOMERS	
CA, CT, DE, MA, NY, OR, CO, MD (USA)	Rebates or tax credits for EVs (source provides small description for each policy)
CT, DC, IL, IA, VT (USA)	Waived or reduces vehicle registration fees for EV drivers
New Jersey (USA), Costa Rica, Norway	Tax exemption or reduction for EVs
Brazil	Elimination of tariffs on EV imports
BENEFITS TO EV DRIVERS (FREE CHARGING OR PARKING, DEDICATED LANES)	
AZ, FL, GA, HI, NJ, TN (USA), Norway	HOV or bus lane access for EVs
EV PRICES OR ACCESS DEPENDS ON INCOME	
California	Clean Cars 4 All program: incentive for low-income applicants; EV vouchers for low-income residents; EV car-sharing programs in disadvantaged communities; low-income EV financing assistance programs, and low/moderate income rebates with Clean Vehicle Rebate program
Los Angeles (California)	BlueLA EV car-sharing program geared towards low-income residents
Los Angeles (California)	Shared mobility project locates electric car share vehicles in underserved communities and provides an important new model for increasing access to clean vehicles
California	The California Air Resources Board has a program focused specifically on getting electric vehicle car sharing into disadvantaged communities
Oregon	Rebates for Low-Income EV drivers

Source: See Appendix D for a list of sources.

of lower income families as California and Oregon have done. The City can work with partners to urge the Commonwealth to adapt similar policies.

The reliance on state and local general funds runs the risk of unintentionally cutting low-income safety net services that are often first on the chopping block during budget cuts.[47] Incentives to purchase EVs alone will not result in higher adoption rates; it is equally important to ensure that charging infrastructure is available to all Bostonians. This is currently not the case (Figure 23). The City has allocated new funding to expand public charging infrastructure in municipal parking lots, and now requires new private garages to have chargers in 25 percent of their spaces, and to be 100 percent wired for future capacity.[48] Decisions about where to place infrastructure should intentionally include access for socially vulnerable communities. One example is the intentional placement of infrastructure in neighborhoods with limited access to transit and cycling infrastructure and/or in neighborhoods with high concentrations of minority-owned businesses.

At the same time, it is critical to carefully consider the location of charging infrastructure so that it does not unintentionally preclude alternative, more beneficial curbside community developments, such as walking paths or bike lanes. Even if the shift from fossil fuel vehicles to EVs is accomplished in the most inclusive, equitable fashion, there will still be Bostonians that cannot participate, such as disabled persons, or those who cannot afford or choose not to own and maintain a private vehicle.

Expand Employment and Workforce Diversity

Getting policy design correct from the beginning is critical because cleaner modes of transport will present new job opportunities.[49] As demand grows to improve and expand public transit or install and maintain electric charging, biking and walking infrastructure, new employment and entrepreneurship opportunities will arise. However, just as green growth creates new job opportunities, jobs will be eliminated in other sectors.[50] Careful consideration of how transport demands will shift and change as Bostonians alter where they work and how they commute is integral to the drafting of transportation policies to achieve an equitable transition to a carbon-neutral city.

47 Ibid.

48 Mayor's Office, City of Boston, March 7, 2019, https://www.boston.gov/news/municipal-research-bureau-speech-mayor-walsh-highlights-transit-climate-plan-updates

49 Altenburg, T. and Assmann, C (Eds.). 2017. Green Industrial Policy: Concept, Policies, Country Experiences. German Development Institute and UN Environment: Geneva, Bonn. Available online: http://www.greengrowthknowledge.org/sites/default/files/downloads/resource/Green%20Industrial%20Policy_Concept%2C%20Policies%2C%20Country%20Experiences.pdf.

50 Kruse, T., Dellink, R. and Chateau, J. June 2017. Employment Implications of Green Growth: Linking Jobs, Growth, and Green Policies. OECD. Available online https://www.oecd.org/environment/Employment-Implications-of-Green-Growth-OECD-Report-G7-Environment-Ministers.pdf.

Equity Considerations: Electric Vehicles

Key Questions	Considerations: does the strategy/is the strategy…?
Is it green?	
Is it GHG-free?	**Depends:** EVs reduce GHG emissions; when paired with 100% GHG-free energy they reach zero emissions
Is it environmentally sustainable?	**Yes:** Electric vehicles use energy more efficiently than internal combustion-engine vehicles and reduce tailpipe emissions and other harmful pollutants
Does it promote smart behavior?	**Depends:** Smart timing of EV charging can store energy and stabilize the grid. Dedication of public space to charging stations needs intentional design to ensure access and must balance competing demands for space
Is it fair?	
Is it accessible?	**Depends:** Banning fossil-fuel based transport limits access for anyone relying on these vehicles; careful policy design is needed to ensure that socially vulnerable communities are not left out of this transition. Public charging must be available to all communities
Is it affordable?	**Depends:** Purchase price of EVs is higher than conventional vehicles, but operating costs are lower. Electrification of transit and fleet vehicles may impact their affordability. Intentional planning and financial support may be required to ensure affordability
Are workforce opportunities just?	**Depends:** Opportunities for diverse workforce development depend on policy design
Who gets to decide?	
Is it inclusive?	**Depends:** Opportunities for inclusive decision-making with intentional planning and prioritization. Decisions regarding public charging infrastructure need to include people beyond drivers and car owners as EVs will impact the urban landscape and may come at the cost of other curb-use options
Are values considered?	**Depends:** Opportunities for values-based decision-making with intentional planning and prioritization
Is it measurable?	**Depends:** Easy measurement for infrastructure changes, EV adoption, dollars spent; more difficult for community and workforce impacts

The construction of new public transit infrastructure and the repair of existing infrastructure presents an opportunity to facilitate a fair and just workforce by ensuring that diverse local workers and contractors are trained and hired. The MBTA is already a source of well-compensated jobs—one in three MBTA workers earned $100,000 or more in 2017[51] —and the City can work to ensure that additional MBTA job opportunities create a more diverse workforce. MBTA labor unions and other unions are important stakeholders that need to be engaged during this transition to ensure that workers have input into structural changes and workers' rights.

51 David, H. February 2018. 1 in 3 MBTA Workers Earned More than $100,000 Last Year. Boston Business Journal. Available online: https://www.bizjournals.com/boston/news/2018/02/16/1-in-3-mbta-workers-earned-more-than-100-000-last.html.

Case Study: Sacramento, California Car-Share Program

As Sacramento, California works toward carbon-neutral transportation options, socially vulnerable populations in the area face rising transit costs alongside broader socioeconomic challenges like job growth, household income disparities, and educational gaps. Without intentional efforts to address the social and financial challenges faced by its vulnerable populations, Sacramento risks exacerbating the environmental challenges that decision makers have identified as priorities across all communities in the state.

In collaboration with Zipcar, the Sacramento Metropolitan Air Quality Management District has launched California's first zero-emission vehicle sharing program to expand the transportation options available to residents and address the area's transit equity issues. A designated number of electric vehicles have been made available to the residents of three specific neighborhoods to use for free. Two vehicles are housed at a public housing complex within each neighborhood and two vehicles are available at Sacramento train station.

The car share program is currently being funded by the Sacramento Housing and Redevelopment Agency, the Sacramento Municipal Utility District and other local partners through its first year.

This type of car share program carries significant potential for the City of Boston. Low-income Boston residents would benefit from reliable and carbon-neutral transportation options to access critical health services, grocery shop, and tend to family needs. This kind of program could be particularly beneficial during periods of transit expansions and improvements that may temporarily affect transit service in socially vulnerable communities. Boston would benefit from a pilot that begins with neighborhoods furthest away from the center of the city, considers a diverse mix of options to house the vehicles, such as public libraries or well-known community-based organizations, and ensures community input during research and strategizing efforts to help ensure the adoption and implementation of an effective pilot program.

Sources:

Parilla, J., Liu, S., and Gootman, M. April 30, 2018. Charting a course to the Sacramento region's future economic prosperity. Brookings Institute. Available online: https://www.brookings.edu/research/charting-a-course-to-the-sacramento-regions-future-economic-prosperity/.

Moffitt, B. May 5, 2017. Electric Car Share Program Launched In Sacramento Public Housing Complexes. Capital Public Radio. Available online: http://www.capradio.org/94932.

Zipcar. May 5, 2017. sacramento aqmd launches state's first electric vehicle car share program for disadvantaged communities, powered by zipcar. Available online: https://www.zipcar.com/press/newsroom/communitycarshare.

Sacramento Metropolitan Air Quality Management District. No Date. Community CarShare Program. Available online: http://www.airquality.org/residents/incentive-programs/community-carshare-program.

Equitably Achieving a Carbon-Neutral Transportation System

Boston's regional transportation system supports a vibrant city, but at great cost: severe traffic congestion, health impacts from air pollution, and inequitable access to public transit, biking, and walking infrastructure and services. The transportation strategies evaluated in the *Summary Report* offer the potential to make transport more accessible, affordable, safer, less polluting, and healthier for all Bostonians. This requires the pairing of Boston's goal to achieve carbon neutrality with its social equity goals to ensure that a carbon-neutral transportation system is built in a fair and just manner. Action to simultaneously reduce GHG emissions and improve equity can be achieved when disadvantaged and socially vulnerable communities are at the forefront in every stage of the process. This means that decision-making must be inclusive and transparent, and input must be solicited from those most affected (Table 14). Intentional planning will not only address historical disparities in the access, quality, and cost of transportation, but also reduce GHG emissions and improve the health and economic opportunities for Boston's most vulnerable residents.

Table 14. Examples of Intentional Design in Inclusionary Transportation Policies

AVOIDS CITING DISAMENITIES IN SOCIALLY VULNERABLE NEIGHBORHOODS	
Boston (Massachusetts)	Minimize burdens associated with MPO-funded transportation projects in low-income and minority areas
PROMOTES COMMUNITY KNOWLEDGE, EDUCATION, SKILLS	
Boston (Massachusetts)	Fairmount Line CDC Collaborative works to promote transit equity, securing funding for new stations and reduced fares
San Francisco (California)	Great Communities Collaborative ensures residents participate in land use planning around transit
WA, OR, CA (USA)	Uniform signage requirements for EV charging stations
Minnesota	Community benefits agreements with developers of transit-oriented projects which ensures community support
Atlanta (Georgia)	BeltLine Community Engagement Framework ensures community participation in transit development
Austria	Regional mobility centers which improve public transit and provide training and support for mobility management in communities, businesses, schools and the elderly
ADDRESSES LANGUAGE AND CULTURAL BARRIERS	
Boston (Massachusetts)	MBTA service plan updates: giving special consideration to impacts on commuters and households of color, especially in regard to commute times
USA	Americans with Disabilities Act required transit agencies to offer paratransit service to people with disabilities that live along bus routes
MN, CA, GA, MA (USA)	Policy tools to counteract transit-induced gentrification and shape transit projects as they develop to address language and cultural diversity
Arlington County (Virginia)	Spanish-language outreach program for all of the county's sustainable transportation programs, including Capital Bikeshare
Los Angeles (California)	Plans to introduce new names of lines that use a combination of colors and letters or numbers to reduce visual and language barriers
Mexico City (Mexico)	Transportation system uses words, symbols, and colors to identify stations and lines which improves accessibility for all languages or illiterate passengers
WORKFORCE DEVELOPMENT	
Denver (Colorado)	Denver B-Cycle partnered with a local Goodwill Industries nonprofit agency to recruit employees from low-income communities
Montgomery County (Maryland)	Partnered with Capital Bikeshare, and gave a preference for minority-owned small businesses in subcontracting procurement
Atlanta (Georgia)	Relay Bikeshare hired ten bikeshare ambassadors from targeted low-income neighborhoods through the Atlanta Bike Champions program
Austria	Austrian Action Programme for Mobility Management created and saved about 3000 green jobs; goal is to create 100,000 additional green jobs by 2020
Bogota (Columbia)	TransMilenio bus rapid transit system has created 40,000 direct and 55,000 indirect jobs; female workforce participation increased
RAISES SAFETY OR COMPENSATION STANDARDS IN TRANSPORTATION SECTOR JOBS	
Boston (Massachusetts)	OSHA teams up with MBTA to deliver job safety and health training programs
Los Angeles (California)	New bill introduced aimed at protecting bus drivers from assaults, authorizes $25 million over 5 years for implementation
New York City (New York)	MTA worker union demands body cameras to capture assaults on bus and subway drivers
Toronto (Canada)	Ventilation and HVAC system is installed in subway to combat particulate matter pollution; subway workers demand to be allowed to wear protective face masks
USA	Uber partners with Hertz and two other car rental agencies to allow drivers to use rental/leased vehicles, including electric vehicles

Source: See Appendix D for a list of sources.

Crossing the finish line at the 2019 B.A.A. 5K.
Photo credit: City of Boston

Waste

Main Findings

- Boston has committed itself to be a "waste- and litter-free city," and currently recycles 21 percent of residential waste and 25 percent of industrial and commercial waste.
- Boston neighborhoods that produce the highest amounts of waste also have the lowest recycling rates; they also tend to be the neighborhoods with the greatest shares of socially vulnerable communities.
- Massachusetts' communities of color and low-income communities are far more likely to be sites of hazardous waste disposal, landfills, trash transfer stations, and incinerators. Disproportionate exposure to waste-related hazards puts socially vulnerable communities at higher risk of poor health outcomes.
- There are substantial job creation benefits of moving from waste disposal to recycling and composting initiatives: recycling can create 5 to 100 times as many jobs as waste disposal.
- Waste policies should focus on training opportunities to broaden engagement, job safety to ensure healthy workers, and fair compensation to ensure an adequate standard of living and avoid displacing socially vulnerable households.

Overview

As Boston moves towards its zero-waste goals—enhancing opportunities for source reduction, reuse, recycling, and composting in the city—careful planning is needed to bring equity into policy design and bring the voices of socially vulnerable communities into decision-making. In 2014, as part of its *Climate Action Plan*, the City committed itself to become a "waste- and litter-free city"[1] and in 2018 launched a zero-waste planning process that assessed options to boost the overall recycling rate from to 80 percent or more by 2050, and to reduce the overall volume of waste generation.[2] Our equity analysis highlights the need for Boston to prioritize equitable waste, recycling, and composting facility siting, and the creation of safe jobs with living wages as it moves towards zero waste.

Boston recycles 21 percent of all residential waste and 25 percent of all industrial and commercial waste.[3] *The State of the Built Environment: Greater Boston's Infrastructure* report projects that there will be an additional 130,000 tons of waste generated per year from 2010 to 2030.[4] Increasing waste diversion—by avoiding the creation of waste or redirecting waste flows to be reused, recycled or composted—offers an opportunity to improve environmental, social and economic outcomes. The move towards zero waste can eliminate harmful emissions associated with incineration; provide community outreach; assist and educate; ensure equitable siting of material and waste handling facilities; and foster good, green employment and entrepreneurship opportunities.

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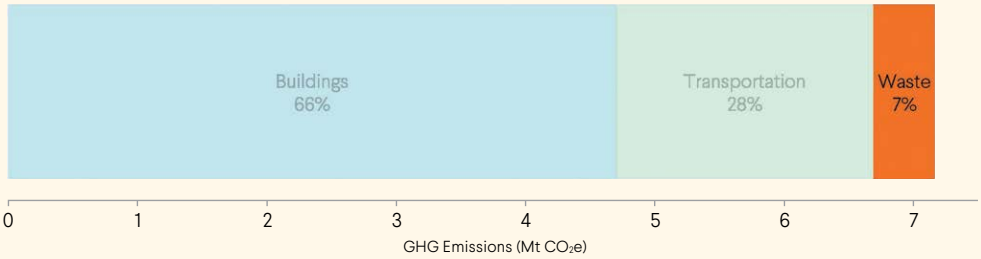
2 Zero Waste Boston: https://www.boston.gov/departments/environment/zero-waste-boston

3 Anthony, R., Engel, P., and Hendrick, M. February 2018. Boston Zero Waste Planning. Zero Waste Advisory Committee. Available online: https://www.boston.gov/sites/default/files/zwac_presentation.pdf.

4 Bluestone, B., Huessy, J. and Tumber, C. 2016. State of the Built Environment: Greater Boston's Infrastructure. A Better City. Available online: https://www.northeastern.edu/csshresearch/dukakiscenter/wp-content/uploads/sites/7/2018/03/A-Better-City-State-of-the-Built-Environment.pdf.

Carbon Free Boston Strategies for Zero Waste

The combustion, recycling, and composting of Boston's municipal solid waste accounts for approximately seven percent of the city's total emissions (below). Nearly 80 percent of the city's solid waste emissions are from the commercial sector.



The zero-waste roadmap comprises 30 strategies that fall into four core categories: reduce and reuse, recycle more, increase composting, and inspire innovation. Not only do these strategies aim to encourage Boston's residents and businesses to increase their waste diversion, they also establish the framework and infrastructure that is necessary to accelerate their transition to zero waste equitably and manageably. These strategies were assessed in the *Summary Report*.

	ACTION	DETAILS
Increased Waste Diversion	Reduce and Reuse	• Reduce problem products and packaging
		• Divert more reusable goods
	Recycle More	• Expand and enforce state and local recycling requirements
		• Make recycling more available in public places
		• Create new commercial hauler and generator rules
	Increase Composting	• Expand residential yard waste options
		• Implement residential food scrap collection programs
		• Increase commercial compost capacity
	Inspire Innovation	• Expand the City's environmentally preferable purchasing practices
		• Set zero waste reduction goals and metrics for the city as a whole and municipal operations specifically
		• Fund, explore, and research new ideas and approaches to achieve zero waste

Current Equity Context

Massachusetts' socially vulnerable communities are adversely affected by the waste industry in their neighborhoods. Across the Commonwealth, communities of color and low-income communities are far more likely to be sites of hazardous waste disposal, landfills, waste transfer stations, and incinerators. Hazardous waste dumps were four times more likely to be sited in lower income neighborhoods than those with higher average incomes, and 23 times more likely to be sited in neighborhoods with the highest concentration of people of color.[5] Boston's waste, composting, and recycling facilities are spread across a number of communities (Table 15).

5 Faber, D., and Krieg, E. April 2002. Unequal Exposure to Ecological Hazards: Environmental Injustices in the Commonwealth of Massachusetts. Environmental Health Perspectives, 110(2), 277–288. Available online: https://doi.org/10.1289/ehp.02110s2277.

Table 15. Waste processing facilities in the City of Boston

Category	# in Boston	Neighborhood	Facility
Landfills	0	N/A	N/A
Combustion Facilities	0	N/A	N/A
Handling Facilities	2	Roxbury	Reenergy Roxbury LLC
		Roxbury	Howard Transfer Station
Materials Recovery/Recycling	1	Charlestown	Casella Recycling
Composting	2	Central Boston	Department of Conservation and Recreation
		Mattapan	Boston Compost Site
Diverted Food Material	1	Charlestown	Waste Management Boston CORe

Source: Mass.gov. 2019. Massachusetts Landfills, Transfer Stations, Compost Sites & Recycling Facilities. Available online: https://www.mass.gov/lists/massachusetts-landfills-transfer-stations-compost-sites-recycling-facilities

Implementation of zero-waste strategies in Boston will bring equity and public health benefits within and beyond the boundaries of the city, including Saugus and Haverhill—communities that receive and burn waste from Boston (Figure 24).[6] Boston neighborhoods that produce the highest amount of waste—District C in Figure 24 below, which includes Dorchester and Mattapan (two of the most socially vulnerable Boston neighborhoods)—also have the lowest recycling rates, while Boston neighborhoods that produce the lowest amount of waste—District B in Figure 24 below, which includes Allston, Brighton, and Jamaica Plain—also have the highest recycling rates.

Disproportionate exposure to waste-related materials puts socially vulnerable communities at higher risk of poor health outcomes due to the harmful emissions from these facilities. According to a study published by the Boston Public Health Commission:

Building waste plants in low-income areas, for instance, could potentially expose residents who live there to toxic environmental exposures. This difference in health risk exposure is socially produced, modifiable, and unjust. Resulting poorer health outcomes related to this increased risk for these low-income residents, therefore, are considered health inequities.[7]

The siting of these facilities often occur in socially vulnerable communities for two reasons. First, it is often easier for waste companies to get the necessary permissions to site and operate in socially vulnerable communities, due to the fact that these communities are less likely to have access to attorneys, hydrologists, engineers, or other experts they would need to present an alternative expert viewpoint to that being offered by the waste company. Second, waste companies pay host fees to the communities in which they are sited. For example, Wheelabrator (the oldest incinerator in the country) pays Saugus $2.5 million per year,[8] and some companies also provide free waste disposal and collection.

Strategies for an Equitable, Zero-Waste City

The City is exploring the benefits of curbside composting as part of their zero-GHG and zero-waste strategies. Boston's Project Oscar Composting Program—a collaboration between the Department of Public Works, the Mayor's Office of Food Initiatives, Greenovate Boston, and the Mayor's Office of New Urban Mechanics—provides composting bins in East Boston, the North End, Brighton, Jamaica Plain and City Hall Plaza.[9] The program started with just two locations and has since expanded to five locations where bins are available for people to dispose of their organic waste around the clock. Many additional opportunities can benefit socially vulnerable communities.

6 Mass.gov. 2019. Municipal Waste Combustors. Available online: https://www.mass.gov/guides/municipal-waste-combustors.

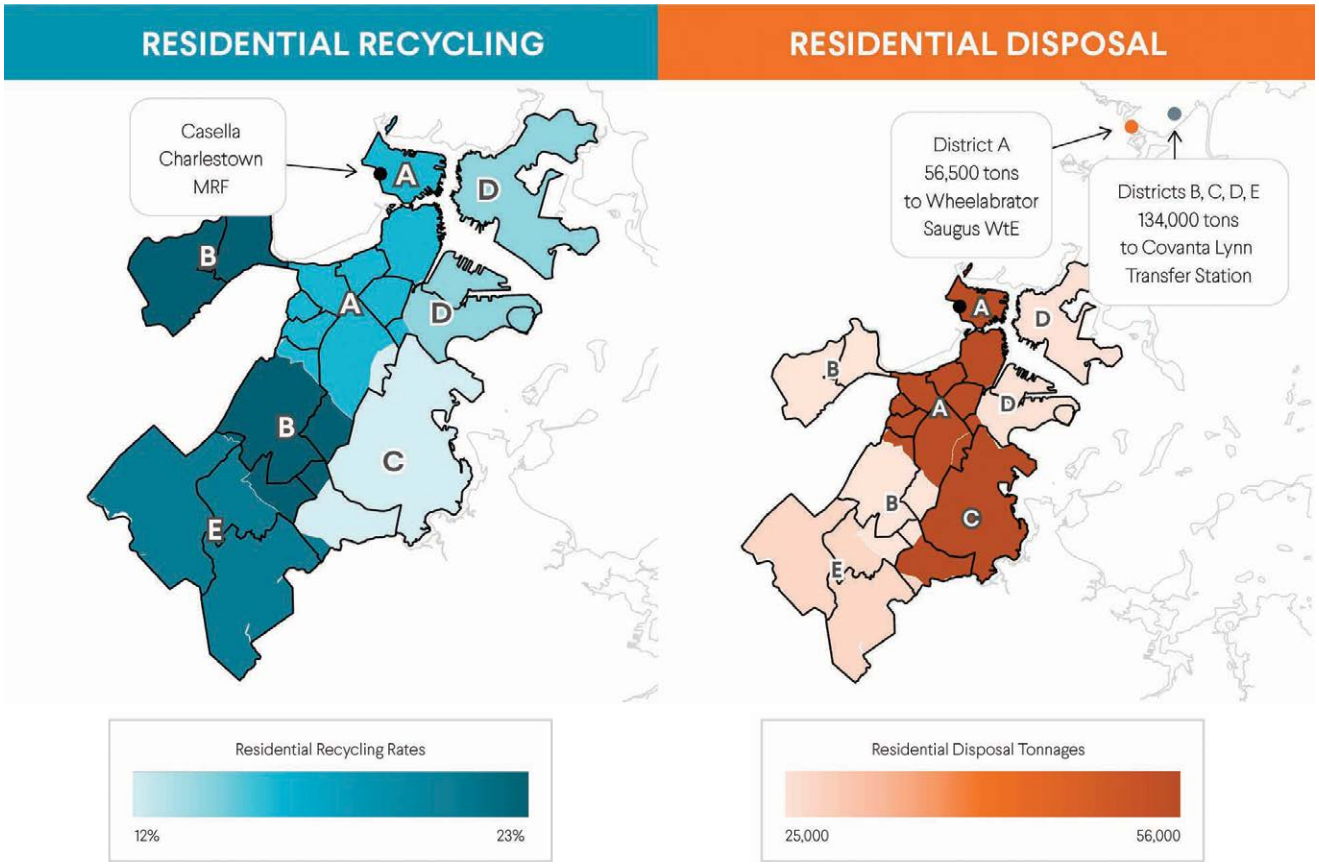
7 Boston Public Health Commission. 2015. Health of Boston 2014-2015. City of Boston. Available online: http://www.bphc.org/healthdata/health-of-boston-report/documents/hob-2014-2015/fullreport_hob_2014-2015.pdf.

8 Halloran, P. and Casey, M. 2009. New Deal Could Net Community $350,000. Wheelabrator Saugus News. Available online: http://www.grantgroup.com/wp-content/uploads/2009/06/wheelabrator-saugus_spring-09.pdf.

9 Greenovate. 2018. Project Oscar Composting Program. City of Boston. Available online: http://www.greenovateboston.org/project_oscar_composting_program.

Figure 24. Boston Residential Recycling and Disposal by Collection District in 2017

Boston's waste collection districts can be roughly defined as: (A) Charlestown, Chinatown, Downtown, Bay Village, Back Bay, Beacon Hill, South End, North End, Roxbury, Fenway, Mission Hill, Financial District; (B) Jamaica Plain, Allston/Brighton; (C) North & South Dorchester, Mattapan; (D) East & South Boston; and (E) West Roxbury, Hyde Park, Roslindale. Source: Data from Boston Department of Public Works



Expand Employment and Workforce Diversity

Transitioning from a system focused on waste disposal to one that fosters recycling and composting can create jobs.[10] The disposal route creates 1 job per 10,000 tons of waste disposal compared to 5 to 20 jobs per 10,000 tons for recyclables processing, and 40 to 100 jobs per 10,000 tons for manufacturing using recycled materials. The US Environmental Protection Agency estimates 16 jobs per 10,000 tons of recycled material, and an average wage of $76,000 for these recycling jobs.[11]

Moving towards a zero-waste Boston will create substantial employment and entrepreneurship opportunities that—to be equitable—should maximize the potential benefits for Boston's socially vulnerable communities. Employment opportunities range from large-scale industrial recycling to local community waste diversion, repair and reuse programs, but care needs to be taken to ensure that adequate training, living wages, and safe working conditions are prioritized on equal footing with job creation. The City is already working towards these goals by requiring that workers at the recycling and trash haulers and processing facilities that the City hires are employed with a livable wage.

10 Goldstein, J. November 2014. More Jobs, Less Pollution: Growing the Recycling Economy in the U.S. Tellus Institute. Available online: https://www.nrdc.org/sites/default/files/glo_11111401a.pdf.

11 United States Environmental Protection Agency. October 2016. Advancing Sustainable Materials Management: 2016 Recycling Economic Information (REI) Report. Available online: https://www.epa.gov/sites/production/files/2017-05/documents/final_2016_rei_report.pdf.

One zero-waste policy option is the creation of a long-term zero-waste economic development strategy that would:

Support development of new reuse, recycling and composting processing, manufacturing and retail businesses and robust markets (including collection, repair, resale, and manufacturing) for reusable, recyclable and compostable materials. Develop job training programs that support waste-reduction activities. Support measures to improve the safety, health, and jobs of workers in waste-reduction activities.[12]

For workforce development to be equitable, waste policies should focus on training opportunities to broaden engagement, job safety to ensure healthy workers, and fair compensation (including for contractors and subcontractors) to ensure an adequate standard of living.

Guaranteeing living wages and safe working conditions for waste and recycling workers is one of the four primary goals of the zero-waste plan, along with increasing recycling and composting rates while establishing "a citywide zero-waste planning process that prioritizes meaningful community engagement and emphasizes the creation of good, green jobs."[13] The plan also emphasizes the importance of ensuring that the City's living wage ordinance apply to recycling contract workers, including subcontractors.

The Boston metro region employed 710 refuse and recycling workers in 2017 (out of a total 1,550 refuse and recycling workers in Massachusetts), with an average wage of $21 per hour (the average wage for all workers in the greater Boston area was $33 per hour).[14] A 2009 Northeast Recycling Council study using much more specific definitions of job categories and looking across all industries found 10,700 recycling jobs in Massachusetts and an additional 3,200 jobs in manufacturing and reuse of recycled materials.[15]

Employment in recycling can be poorly paid and unsafe. The Casella recycling facility in Charlestown has five OSHA violations since 2010, and employs workers who have been made exempt from state living wage laws,[16] some of whom testified in 2005 about poor working conditions and intimidation during a $80,000 backpay settlement proceeding.[17] In California, recycling drop-off centers have been the target of wage theft investigations, and wages around the country for these workers can be as low as $7 or $8 an hour.[18] In 2014, the fatality rate at scrap yards—one of the largest recycling sectors—was 20.8 deaths per 100,000 workers, higher than the overall manufacturing sector's fatality rate, but lower than the rate for waste collectors.[19] Both traditional waste workers and recycling workers face a deadlier job than police officers or firefighters.[20] According to a 2016 exposé published in Mother Jones, recycling work can be hazardous in other ways, too:

It involves heavy machinery, including conveyor belts, shredders, and grinders that can pose a serious risk of injury or death, especially if they're not properly serviced or lack basic safety features. Unlike many industrial processes, recycling cannot be completely systematized because it deals with an ever-changing flow of materials in all manner of shapes and sizes. Workers may have to personally handle most of the scrap passing through recycling facilities, potentially exposing them to sharp objects, toxins, carcinogens, or explosives.[21]

12 Zero Waste Boston: https://www.boston.gov/departments/environment/zero-waste-boston

13 Zero Waste Boston: https://www.boston.gov/departments/environment/zero-waste-boston

14 Bureau of Labor Statistics. March 2018. May 2017 Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates. Available online: https://www.bls.gov/oes/current/oes_71654.htm#51-0000.

15 Boston Zero Waste Task Force. March 2014. Don't Waste This Opportunity: Policy Recommendations for a Path to Zero Waste and Good Jobs for Boston. Clean Water Action. Available online: http://www.cleanwateraction.org/files/ZWTF%20recommendations.pdf.

16 Rosengren, C. July 2018. SPECIAL INVESTIGATION: LIVING ON SCRAPS. DigBoston. Available online: https://digboston.com/special-investigation-living-on-scraps/.

17 Office of the Attorney General. 2017. Request for Public Records. Overtime Complaint, Restitution, and Citation. Available online: https://drive.google.com/file/d/1pfY4OmiZY6NP_FT_b_C5ZYvzEy0M1EWV/view?usp=sharing&usp=embed_facebook.

18 Joseph, B. April 2016. Dangerous Work for Crap Money: The Dark Side of Recycling. Mother Jones. Available online: https://www.motherjones.com/environment/2016/04/recycling-junkyard-dangerous-job/.

19 Lam, B. September 2016. The Dangerous Life of a Trash Collector. The Atlantic. Available online: https://www.theatlantic.com/business/archive/2016/09/trash-collector/498233/.

20 Feldman, K. January 2018. Why Private Waste Management Is One of the Nation's Most Hazardous Jobs. PBS NewsHour. Available online: https://www.pbs.org/newshour/nation/why-private-waste-management-is-one-of-the-nations-most-hazardous-jobs.

21 Joseph, B. April 2016. Dangerous Work for Crap Money: The Dark Side of Recycling. Mother Jones. Available online: https://www.motherjones.com/environment/2016/04/recycling-junkyard-dangerous-job/.

A study of working conditions at recycling facilities in Los Angeles found that workers were exposed to toxic or otherwise hazardous materials and that most employees are people of color, immigrants, women, and temporary workers earning poverty-level wages.[22] Massachusetts' Solid Waste Master Plan flags the need to address problem sites that pose "significant risk or harm to public health, safety, welfare or the environment or when a significant public nuisance warrants state intervention."[23] Careful policy design, oversight, and accountability help to avoid outcomes that exacerbate or perpetuate inequity, such as inequitable burden-sharing, unsafe working conditions, or poor wages.

Make Zero Waste Affordable for All

Any new fees associated with action to reach a zero-waste city should avoid creating unnecessary burdens on vulnerable residents by ensuring that monetary costs are accompanied by adequate communication, outreach, warning systems, and renter protections—and consider the diversity of languages and cultures among Bostonians. Recycling and composting programs that require an opt-in from the residents may be a barrier to non-English speaking residents even when the service is free.[24] New fees could be accompanied by discounts for low-income households, as is common for US cities with waste disposal fees. In San Francisco, low-income households may be eligible for a 25 percent discount.[25]

Learn from Others' Experience

Policies that bring equity into waste reduction, reuse, recycling, and composting are in progress around the world (Table 16). There are several zero-waste cities in the US that Boston can look to for inspiration and lessons. Some of the large cities with the highest recycling rates are San Francisco (83 percent), Los Angeles (76 percent), Seattle (59 percent), and Austin (42 percent).[26] With Boston's current recycling rate at about 25 percent, substantial opportunities exist to reduce waste sent to incinerators. Other cities have policies to avoid siting waste facilities in socially vulnerable communities, and programs designed to include all residents in waste reduction through community education and outreach that allows for language and cultural barriers. Many cities see waste reduction as an opportunity for workforce development, and some have paired these policies with explicit protections for vulnerable workers.

Support Producer Responsibility Laws

Even as households learn to reduce, reuse, recycle and compost their own waste, product manufacturers are under no such obligation,[27] meaning that the burden of dealing with product packaging, for example, falls to Bostonians. Producers typically use low-value materials in their packaging, reducing any incentive to reuse, recycle, or change these materials.[28] While progress has been made towards a more circular economy, further policy effort, a shift in business practices, and reduction of the financial gap is needed for lasting change.[29] For example, under extended producer responsibility (EPR) laws, producers are required to take responsibility for the end use of their products. These policies reduce the burden to consumers and the disposal costs faced by municipalities.[30] During the current legislative session, there is potential for EPR in Massachusetts related to both the

22 Owens-Wilson, S. July 2013. Transforming Trash in Urban America. The Partnership for Working Families. Available online: http://www.forworkingfamilies.org/resources/publications/transforming-trash-urban-america.

23 Massachusetts Department of Environmental Protection. April 2013. Massachusetts 2010-2020 Solid Waste Master Plan: Pathway to Zero Waste. Available online: https://www.mass.gov/files/documents/2016/08/nw/swmp13f.pdf.

24 Davis, M. 2014. Examining The Efficiency And Equity Of Solid Waste Service Production At The City Level. University of Colorado. Available online: http://www.ucdenver.edu/academics/colleges/SPA/PhD/Documents/Davis,%20Dissertation.pdf.

25 In San Francisco, low-income households may be eligible for a 25% discount. Participation in the Pacific Gas and Electric (PG&E) CARE program qualifies a resident for Recology's low-income rate program. https://www.recology.com/recology-san-francisco/rates/

26 City of Boston. 2018. Boston Zero Waste Recommendations. Boston Zero Waste Advisory Committee. Available online: https://d12v9rtnomnebu.cloudfront.net/diveimages/BostonZWReport-121218Draft.pdf.

27 Spiegelman, H., and Sheehan, B. March 2005. Unintended Consequences: Municipal Solid Waste Management and the Throwaway Society. Available online: http://dx.doi.org/10.13140/RG.2.2.18205.15842.

28 Davis, T. July 13, 2017. Unpacking the evolving role of producers in the US Recycling System (Part 1). Waste 360. Available online: https://www.waste360.com/recycling/unpacking-evolving-role-producers-us-recycling-system-part-1.

29 World Economic Forum. 2018. Platform for Accelerating the Circular Economy (PACE). Available online: http://www3.weforum.org/docs/WEF_PACE_Platform_for_Accelerating_the_Circular_Economy.pdf.

30 Nash, J. and Bosso, C. 2013. Extended Producer Responsibility in the United States: Full Speed Ahead? Harvard Kennedy School, M-RCBG Associate Working Paper Series No. 10. Available online: https://www.hks.harvard.edu/sites/default/files/centers/mrcbg/files/Nash_Bosso_2013-10.pdf.

Table 16. Examples of Intentional Design in the Waste Sector

TIMING OF MANDATE DEPENDS ON INCOME OR SIZE OF BUSINESS	
Boston (Massachusetts)	Ban on plastic bags: Allows exemptions for businesses that have "no reasonable alternatives to plastic bags that your business could use and provide to customers"
Chile	Ban on plastic bags: Allows small businesses allows more time to find an alternative to plastic bags
LOWER COST OF DISPOSAL	
Boston (Massachusetts)	City provides residents with free recycling bins and curbside recycling pickup
Milford & Cambridge (Massachusetts)	Disposal ban on construction and demolition materials has resulted in increased reuse and recycling as well as lower costs
San Francisco (California)	Composting comes with financial incentives and funding for modernized composting facilities
COST OF DISPOSAL DEPENDS ON INCOME	
King County (Washington)	Solid waste disposal rate includes a discounted fee for qualifying low-income customers
AVOIDS CITING DISAMENITIES IN SOCIALLY VULNERABLE NEIGHBORHOODS	
GA, MA, ME, MN, NJ, PA, TN, WI (USA)	Require private landfills to compensate hosting communities with at least $1 per ton of waste received
Massachusetts	MassDEP strategy to reduce the impact of emissions from diesel vehicles, including trash and recycling trucks, in environmental justice communities
PROMOTES COMMUNITY KNOWLEDGE, EDUCATION, SKILLS	
San Francisco (California)	Residents offered support, tools and education together with recycling and composting mandates
King County (Washington)	Zero Waste of Resources 2030 policy emphasizes education and encourages policies that will stimulate the local economy
Mexico City (Mexico)	A 2013 law promotes the separation of waste into four groups: organic, recyclable inorganic, non-recyclable inorganic, and special handling/bulky
Taiwan	Grassroots anti-incinerator movement led to adoption of zero waste policy
Austin (Texas)	Held over 100 community meetings in development of community zero waste plan
ADDRESSES LANGUAGE AND CULTURAL BARRIERS	
San Francisco (CA)	Composting policies have built in considerations to educate and reach out to non-English speaking and disabled communities
Mexico City (Mexico)	A 2013 law promotes the separation of waste into four groups: organic, recyclable inorganic, non-recyclable inorganic, and special handling/bulky
WORKFORCE DEVELOPMENT	
Massachusetts	The Waste Master Plan aims to increase recycling and composting by businesses and institutions through technical assistance to small businesses, among other interventions
CA, CT, HI, IA, ME, MA MI, NY, OR, VT (USA)	Laws requiring a minimum refundable deposit on drink containers provide 11-38 times more jobs for handling bottles compared to curbside collection
Reading (Pennsylvania)	New type of recycling mill will use recycled paper and cotton to produce goods; expected to create 100 jobs at $14 per hour (plus 20 jobs in distribution and warehousing)
Seattle, Kansas City and Chicago (USA)	Incentivize deconstruction (taking buildings apart and reuse/recycling remaining parts) over recycling in permitting
Austin (Texas)	75% recycling by 2020 expected to create 1,000 new jobs
Eugene (Oregon)	St. Vincent De Paul (SVDP) has created over 400 jobs in reuse, refurbishing and repair. Wages start at $14 per hour and include health insurance
Alameda County (California)	Mandatory recycling ordinance for the commercial sector expected to create up to 1,500 local jobs
India	Sustainable composting site provides job opportunities to impoverished citizens in areas of high unemployment
RAISES SAFETY OR COMPENSATION STANDARDS IN WASTE SECTOR JOBS	
Austin (Texas)	Requires all jobs created from Zero Waste to pay at least $11/hr plus benefits
Dhaka (Bangladesh)	Workers in the Mirpur composting plant benefit from safe, regulated and flexible working conditions compared to most low-income waste jobs in India

Source: See Appendix D for a list of sources.

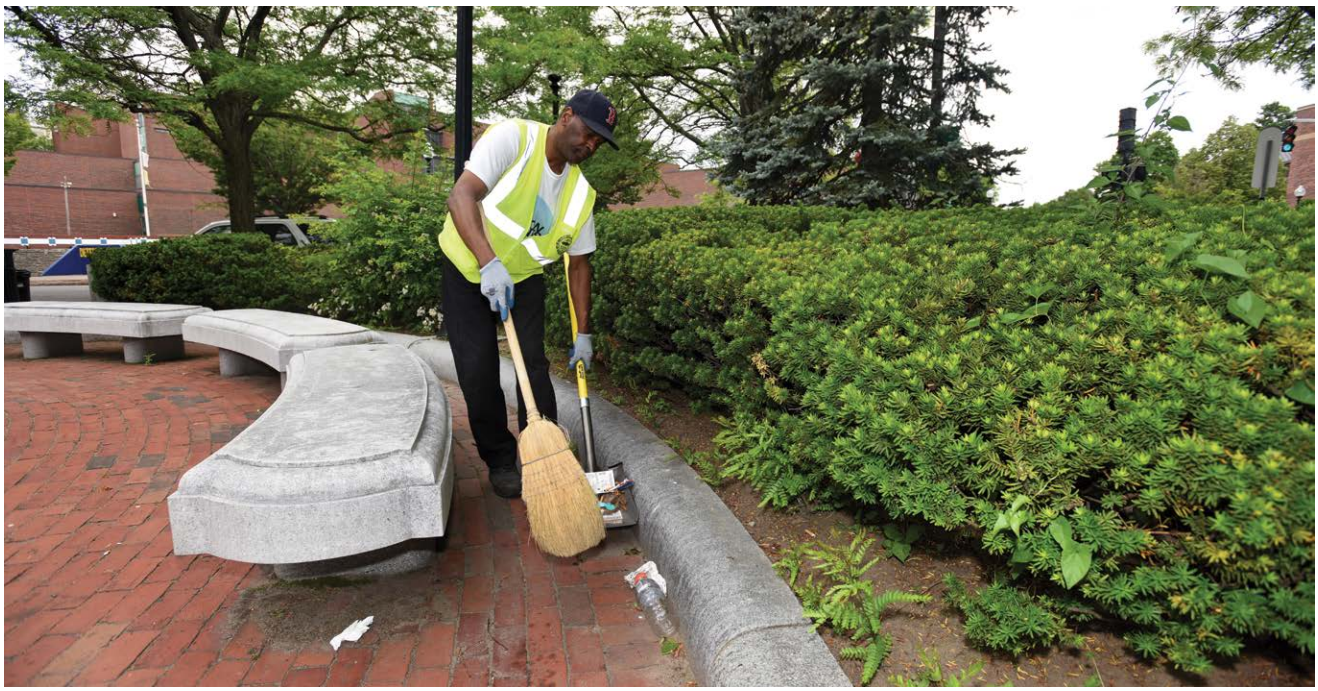
manufacture and post-consumer management of products.[31] Massachusetts currently has three EPR laws in place.[32] The City could "lighten its load" by working with the Commonwealth and other partners to expand such efforts.

Equitably Achieving a Zero-Waste City

A zero-waste city is cleaner, greener, more efficient, and—if equity concerns are prioritized at every stage—more educated, employed, and healthy. Boston's forthcoming zero-waste plan emphasizes that the transition to zero waste should be sustained through cultural change, including:

- Engaging meaningfully with all stakeholders in a zero-waste planning process
- Embracing industry workers, communities of color, low-income communities, and youth as critical zero-waste partners
- Conducting large-scale, linguistically and culturally appropriate public education
- Growing the next generation of zero-waste leaders by developing youth specific programs

The implementation of equitable waste policies will be most successful if they involve inclusive, value-based and equity-focused processes. This includes robust public outreach and education around recycling, composting, and other diversion activities. It also involves improving working conditions and wages of workers in the waste industry and prioritizing local job creation, with particular focus on recruitment and training in low-income or high unemployment communities. The safety and well-being of workers should be intentionally emphasized along with recycling and GHG reduction targets,[33] and measurement and evaluation methods should provide information on program performance to facilitate changes that will steer Boston's waste policies towards their fullest potential.



Litter cleanup at Hayes Square in Charlestown. Photo credit: City of Boston

31 MA House Docket No. 2124. MA H810. 2019. An Act relative to extender producer responsibility. Presented by Bradley H. Jones, Jr. Available online: https://trackbill.com/bill/massachusetts-house-bill-810-an-act-relative-to-extender-producer-responsibility/1703546/.

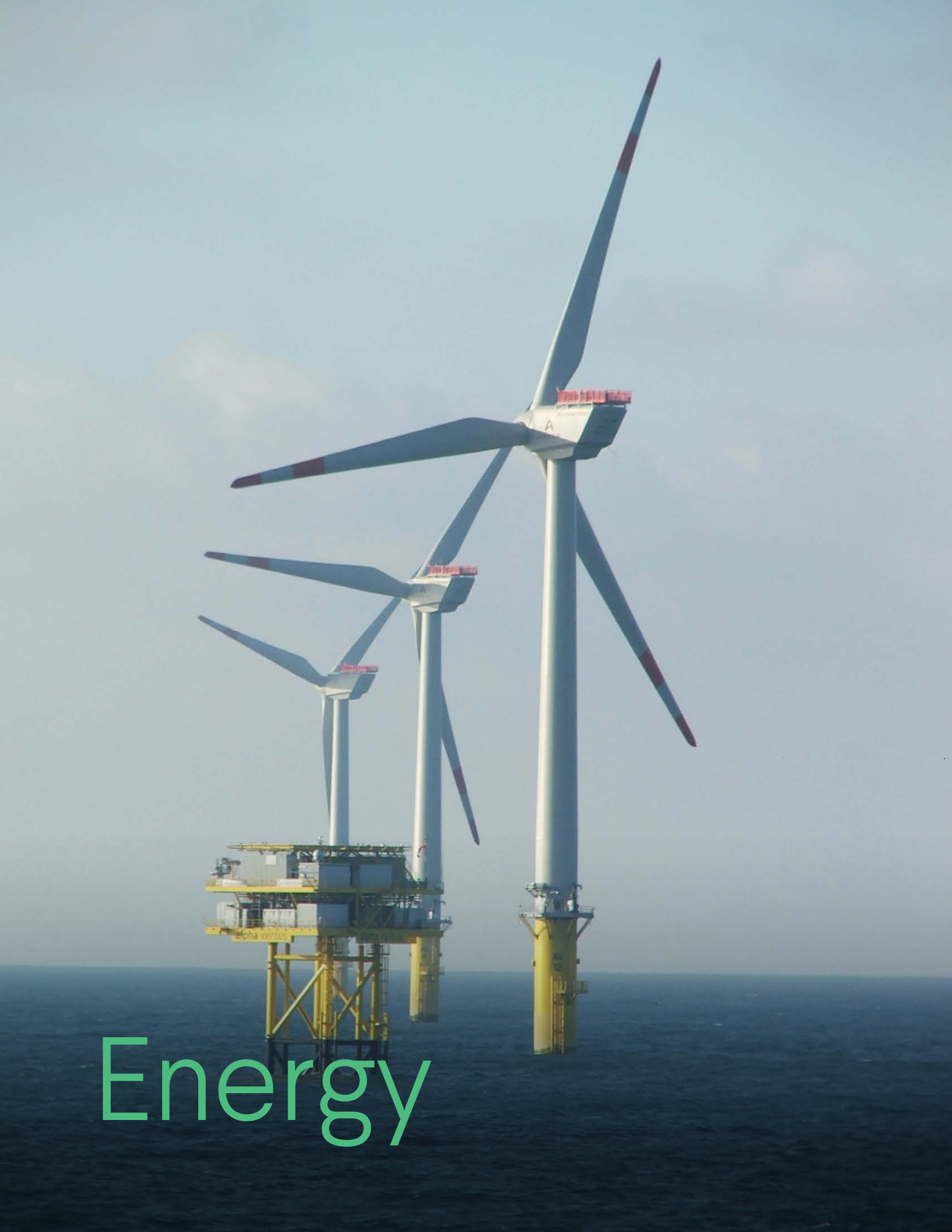
32 Product Stewardship Institute. 2019. US State EPR Laws. Available online: https://www.productstewardship.us/page/State_EPR_Laws_Map.

33 Allen, C. et al. June 2012. On The Road to Zero Waste: Successes and Lessons From Around the World. Global Alliance for Incinerator Alternatives. Available online: http://www.no-burn.org/wp-content/uploads/On-the-Road-to-Zero-Waste.pdf.

Equity Considerations: Increasing Waste Diversion and Source Reduction

Key Questions	Considerations: does the strategy/is the strategy…?
Is it green?	
Is it GHG-free?	**Depends:** Source reduction and recycling avoid emissions associated with waste treatment and disposal, and emissions from new product manufacturing; but they produce emissions when treated. Composting can increase emissions compared with waste combustion under certain conditions
Is it environmentally sustainable?	**Yes:** Avoids harmful pollutants associated with combustion, reduces demand for virgin materials, ensures a more sustainable use of organic waste, and delivers energy savings in the form of avoided energy
Does it promote smart behavior?	**Depends:** While not an explicit goal, wide adoption of source reduction, composting and recycling can encourage more responsible consumption and use of materials and avoid the creation of waste
Is it fair?	
Is it accessible?	**Depends:** Intentional planning and information campaigns are necessary to ensure equal access to GHG-free waste infrastructure
Is it affordable?	**Depends:** New investment in waste management may impact public budgets; opportunity for realized cost-savings to be passed onto households; fines must be structured to accommodate low-income households
Are workforce opportunities just?	**Depends:** Opportunities for diverse new workforce and contractors depend on policy design
Who gets to decide?	
Is it inclusive?	**Depends:** Opportunities for inclusive decision-making with intentional planning and prioritization
Are values considered?	**Depends:** Opportunities for values-based decision-making with intentional planning and prioritization
Is it measurable?	**Depends:** Easy measurement for waste streams and costs; more difficult for community and workforce impacts

Cleaning the streets in Bay Village. Photo credit: City of Boston



Energy

Main Findings

- Through mid-2018, about 2,500 rooftop solar panels were installed in Boston funded by Massachusetts Clean Energy Center programs. Neighborhoods with the highest share of home-owners—Hyde Park, Jamaica Plain, Mattapan, Roslindale and West Roxbury—have the most solar installations per capita.
- Many socially vulnerability communities do not have the same access to rooftop solar panels that more privileged groups due to housing circumstances, lack of capital, or access to credit. Without intentional design and inclusive decision-making, solar panel incentives risk exacerbating the gap between less and more privileged neighbors.
- Installing rooftop solar creates local, well-paying jobs that are available to diverse segments of the population.
- Municipal energy aggregation (if designed to prevent electric price increases) can bring cost savings and emission reductions to all Boston residents and is of particular benefit to those with the least financial resources, who pay a disproportionate share of their income in energy costs.
- Socially vulnerable communities have the most to gain from local solar installation and municipal aggregation policies that are designed to be affordable, inclusive, and create jobs with livable wages.

Overview

A carbon-neutral Boston requires that efficiency gains and thermal electrification in buildings and transportation be paired with GHG-free electricity and fuels. The *Summary Report* evaluated two principal ways to supply clean electricity. The first is to generate electricity in the city with rooftop solar panels. The second is to purchase electricity from another entity. Most of the city's electricity currently comes from the ISO New England regional grid (the "grid"). We assume that carbon intensity of electricity that Boston purchases from the grid will decline to 80 percent of levels in 2018 by 2050 due to the requirements of the Massachusetts Clean Energy Standard. Obtaining a 100 percent GHG-free supply of electricity will require procurement of GHG-free electricity from sources other than what is provided from the regional grid.

Our equity analysis assumes that all Bostonians should be included in the clean energy transition. This includes the opportunity for many households and businesses to directly produce and/or purchase renewable electricity with rooftop solar panels. Every kilowatt-hour of electricity produced by these panels is a kilowatt-hour that will not be imported into Boston from the grid. The costs of these panels—whether purchased or leased—are mostly borne privately, as are the benefits, such as the potential for lower electricity costs, more stable electricity prices, higher property values, and access to clean electricity.

Boston's clean energy transition goes beyond local solar installations to allow all to have access to the benefits of electricity from renewable sources. Boston is developing a municipal aggregation program (often called Community Choice Aggregation (CCA) or Community Choice Energy (CCE)) that will supply all households that do not opt out with renewable electricity. Municipal aggregation allows local governments (the City of Boston) to procure electricity on behalf of their residents and businesses from an alternative supplier while still receiving transmission and distribution service from their existing utility provider (Eversource).

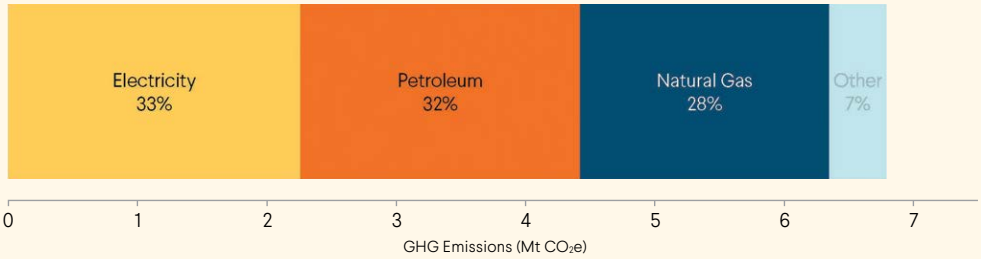
Municipal aggregation is a form of investment by the community. Other municipal aggregation programs in Massachusetts—including Dedham, Lexington, Somerville, Acton, Sudbury, Arlington, Winchester and Natick[1] —have successfully negotiated for both more GHG-free electricity and lower electricity prices.[2] Municipal aggregation programs have the additional potential

1 Woods, B., Comings, T., and Stanton, E. March 2018. Boston Community Choice Energy Aggregation and Electric Costs. Applied Economics Clinic. Available online: https://aeclinic.org/publicationpages/2018/3/15/the-abcs-of-boston-cce.

2 Woods, B., Comings, T., and Stanton, E. March 2018. Boston Community Choice Energy Aggregation and Electric Costs. Applied Economics Clinic. Available online: https://aeclinic.org/publicationpages/2018/3/15/the-abcs-of-boston-cce.

Carbon Free Boston Strategies for Carbon-Neutral Energy

Boston's energy demand system currently accounts for about 93 percent of the emissions assessed in the *Summary Report* resulting from the use of electricity, natural gas, and oil.



Transitioning Boston's energy supply to become carbon neutral will largely be achieved by successful implementation of the *Summary Report's* buildings, transportation and waste strategies. Indeed, the *Summary Report's* energy supply strategy relies on it, treating energy supply not as a separate emission category but instead counting these in the sectors in which this energy is used: buildings, transportation, and waste. The large-scale electrification of private vehicles and public transit combined with thermal electrification in buildings will make Boston heavily reliant on electricity. The goal of carbon neutrality by 2050 can only be met if electricity is generated by GHG-free sources of energy. Residual fossil fuel use in heavy-duty transportation and some building systems must be replaced with clean fuels to the extent feasible.

To address the emissions associated with electricity and direct fuel consumption, the *Summary Report* assessed two options: (1) install private rooftop solar panels on all suitable roofs, and (2) implement municipal aggregation that enables the City to procure GHG-free electricity on behalf of residents and businesses.

	ACTION	DETAILS
Rooftop solar	Incentivize rooftop solar PV	• Realize the full rooftop PV potential in Boston of about 1 TWh or 15 percent of current electric demand—will require up to 2,000 installations per year.
Municipal aggregation	Implement a municipal aggregation (also called community choice energy) program for Boston	• Negotiate a procurement of electric supply that, combined with electricity purchased from the grid, will lead an effectively 100% GHG-free supply.

Boston's historic North End neighborhood. Photo credit: Rene Schwietzke

benefit to customers of more stable electricity prices as compared to purchases from utilities.[3] A working group composed of environmental justice, affordable housing, public health, and neighborhood-based community groups is advising the City on the development of Boston's municipal aggregation program.

Boston has experience developing clean energy projects in its socially vulnerable communities. For example, in 2018, the Massachusetts' Clean Energy Center awarded funding to RUN-GJC—a collaborative of nine Boston environmental justice groups dedicated to environmental justice and energy democracy—to conduct a feasibility assessment of reliable renewable energy for low-income communities.[4] RUN-GJC's feasibility assessment will focus on community engagement led by GreenRoots in Chelsea and the Chinese Progressive Association in Chinatown. The program emphasizes a neighborhood focus that gives a voice to community members and prioritizes workforce development and indoor air quality as well as the resiliency benefits of microgrids. The Boston Planning and Development Agency's 2016 *Boston Community Energy Study* identified existing district heating networks and mapped out potential sites for future district energy microgrid infrastructure.[5]

Strategies for Rooftop Solar

The largest potential source for in-city renewable electricity is solar photovoltaic (PV) installations on building rooftops ("rooftop solar"). Rooftop solar is gaining a strong foothold in Boston, spurred by falling prices and financial incentives. Through mid-2018, the Massachusetts Clean Energy Center funded 2,450 solar systems in Boston. Recent residential rates of installation hover around 300 per year. This is a large increase from just a few years ago, but is well below the installation rate needed to realize the city's full rooftop PV potential of about 1 TWh, equivalent to about 15 percent of current electricity demand.

Eighty-six percent of these were residential solar installations, and most installations occurred on owner-occupied units subsidized by the Federal 30 percent tax credit and the Massachusetts Solar Renewable Energy Credits. Commercial building-heavy neighborhoods like Back Bay, Downtown, Fenway, Longwood, Seaport and the South End have less solar capacity (and the fewest number of solar installations per 10,000 residents as shown in Table 4) than more residential neighborhoods do (Figure 25). Neighborhoods with the highest share of home-owners—including Hyde Park, Jamaica Plain, Mattapan, Roslindale and West Roxbury—also have the most solar installations (per 10,000 residents), except for Dorchester, which has one of the highest rates of home-ownership but is not among the top solar neighborhoods.

Develop the Solar Workforce

Realizing the city's solar potential requires expanding the workforce, which is an opportunity for equity-targeted workforce development. Of the approximately 39,000 electric power generation workers in Massachusetts, solar installation and maintenance alone accounts for approximately 20,000 workers, while fossil fuel generation only accounts for approximately 6,000 workers.[6] Installing rooftop solar holds particular promise for the creation of good paying, local jobs, due to the on-site nature of this work, the lack of stringent educational requirements,[7] and the industry's living wages (in 2017, solar industry wages were above the national average and were competitive with similar industries).[8] Median wages in the industry in 2017 ranged from $20 per hour for installers to $38 per hour for supervisors.[9]

3 Woods, B., Comings, T., and Stanton, E. March 2018. Boston Community Choice Energy Aggregation and Electric Costs. Applied Economics Clinic. Available online: https://aeclinic.org/publicationpages/2018/3/15/the-abcs-of-boston-cce.

4 GreenRoots. May 2018. RUN-GJC to Conduct Studies for Microgrid Projects in Boston and Chelsea. Available online: http://www.greenrootschelsea.org/news/2018/5/29/run-gjc-to-conduct-studies-for-microgrid-projects-in-boston-and-chelsea

5 Davila, C., Reinhart, C., and Bemis, J. 2016. Boston Community Energy Study. Massachusetts Institute of Technology. Available online: http://www.bostonplans.org/getattachment/c73e69ff-dd4c-4096-aefc-9c14a1377bd8

6 United States Department of Energy (DOE). January 2017. U.S. Energy and Employment Report. Available online: https://www.energy.gov/downloads/2017-us-energy-and-employment-report

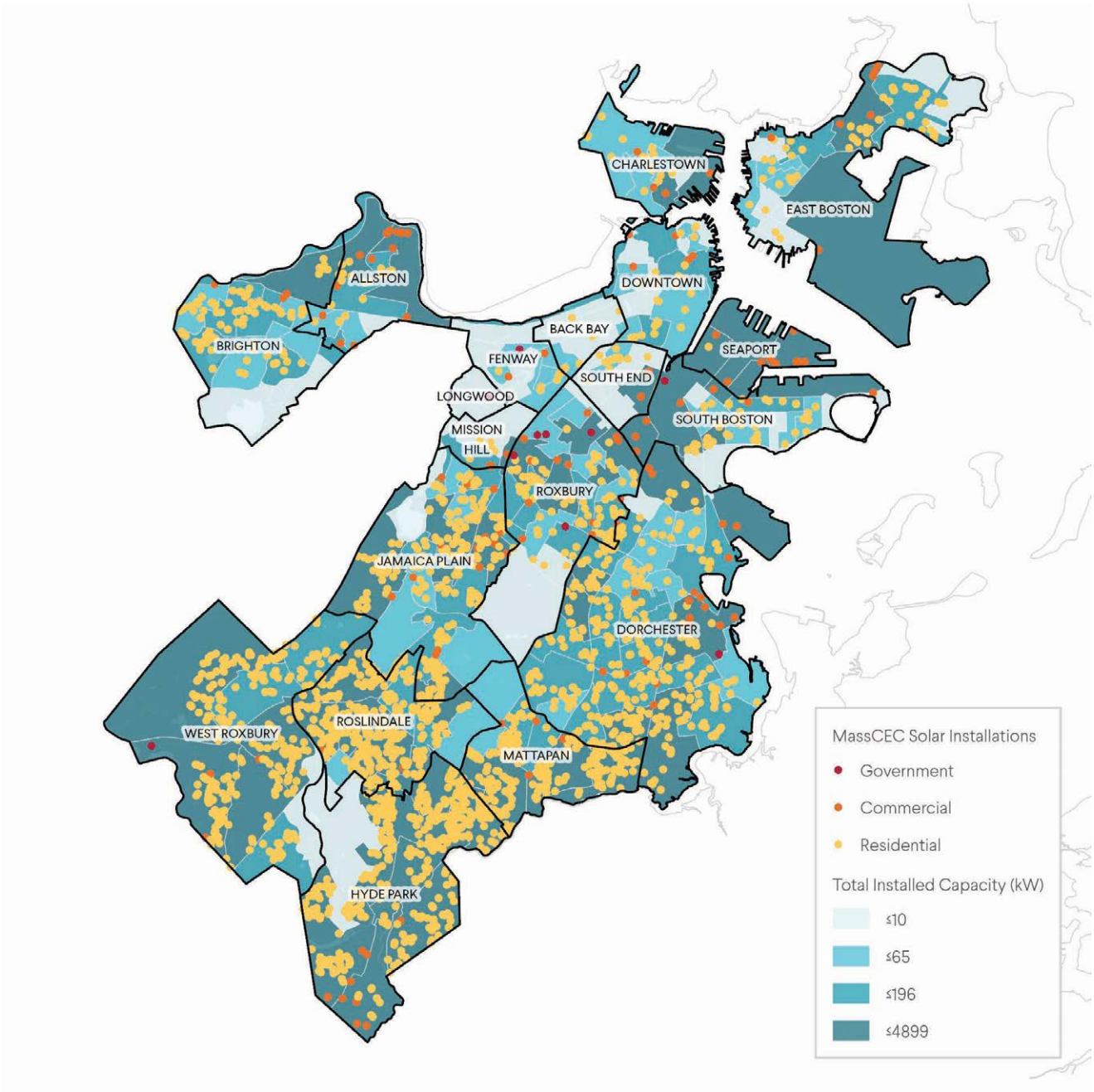
7 Gessesse, E. et al. 2017. Now Hiring: The Growth of America's Clean Energy & Sustainability Jobs. Environmental Defense Fund (EDF) & Climate Corps. Available online: http://edfclimatecorps.org/sites/edfclimatecorps.org/files/the_growth_of_americas_clean_energy_and_sustainability_jobs.pdft

8 The Solar Foundation. 2017. National Solar Jobs Census. Available online: https://www.thesolarfoundation.org/national/

9 Ibid.

Figure 25. Rooftop Solar in Boston

Solar installations and total installed capacity by census tract in Boston through 2018 that were funded by Massachusetts Clean Energy Center programs. Source: Data from Massachusetts Clean Energy Center



Equity Considerations: Private Rooftop Solar

Key Questions	Considerations: does the strategy/is the strategy…?
Is it green?	
Is it GHG-free?	**Yes:** Creates GHG-free energy supply
Is it environmentally sustainable?	**Yes:** Reduces air pollution and resource depletion associated with fossil fuel generation
Does it promote smart behavior?	**Depends:** Enhances storm resiliency and energy island effects; as penetration of solar and wind generation increases pairing with energy storage may become necessary
Is it fair?	
Is it accessible?	**No:** Private clean energy procurement would not be accessible to all for technical reasons (e.g., roof siting or state of repair); pairing this policy with the purchase of clean energy is a partial solution
Is it affordable?	**No:** Private clean energy procurement would not be affordable to all; pairing this policy with public funding, lease options, and virtual net metering is a partial solution
Are workforce opportunities just?	**Depends:** Opportunity for diverse new workforce and contractors depends on program design
Who gets to decide?	
Is it inclusive?	**Depends:** Opportunity for inclusive decision-making with intentional planning and prioritization
Are values considered?	**Depends:** Opportunity for values-based decision-making with intentional planning and prioritization
Is it measurable?	**Depends:** Easy measurement for dollars, installed capacity; more difficult for generation, community and workforce impacts

The *2017 National Solar Jobs Census* report notes that, in 2017, the solar industry workforce was 27 percent female, 17 percent Latinx/Hispanic, 8 percent Asian, 7 percent Black, and 2 percent Native American, Native Hawaiian or Other Pacific Islander.[10] While the solar industry is more diverse than other comparable industries, more can be done to ensure that it is inclusive and more broadly representative of the general population.

Equitable workforce development requires access to training and employment opportunities to a greater diversity of local workers.[11] With intentional policy design that targets training and new job opportunities for socially vulnerable communities, areas of high unemployment, and those who have historically been underrepresented in employment opportunities, the growth of solar in Boston has the potential to provide new, well-paying jobs to those who need it most.

As Boston expands its solar job opportunities, it is important to be mindful of the sensitivity of this sector to price fluctuations and the short-term nature of solar installation jobs. The number of solar jobs may drop as installations grow, although maintenance jobs are long-lasting. In 2018, prior to the federal government's imported solar panel tariff announcement, the US Bureau of Labor Statistics predicted that solar industry jobs would grow by 105 percent (equal to 11,800 jobs created) between 2016 and 2026.[12] The Solar Energy Industries Association estimated that the tariff could entail the loss of 23,000 solar jobs in 2018 alone.[13]

10 The Solar Foundation. 2017. National Solar Jobs Census. Available online: https://www.thesolarfoundation.org/national/.

11 World Health Organization. 2011. Green and Healthy Jobs in Transport: Launching a New Partnership under the PEP. Available online: https://thepep.unece.org/sites/default/files/2016-10/THE.PEP_.Green_.Jobs_.e.pdf.

12 Bureau of Labor Statistics. 2017. Occupational Outlook Handbook: Solar Photovoltaic Installers. United States Department of Labor. Available online: https://www.bls.gov/ooh/construction-and-extraction/solar-photovoltaic-installers.htm.

13 Hobson, A. January 2018. President's Decision on Solar Tariffs Is a Loss for America. Solar Energy Industries Association (SEIA). Available online: https://www.seia.org/news/presidents-decision-solar-tariffs-loss-america.

Overcoming Barriers to Rooftop Solar

Intentional planning is needed to avoid the potential for rooftop solar to exacerbate existing inequities in access to clean energy. First, installing solar panels requires a substantial capital outlay or access to bank loans or adequate credit to support a long-term power purchase agreement with a solar provider; these are not currently available to all Bostonians.[14] Second—with some notable exceptions—private solar investment is only available to property owners (not renters), single-family homes (not multifamily homes), and newer homes or homes with roofs in good repair (not roofs with structural issues or building code violations). Third, rooftop PV raises home prices. An analysis of 4,000 sales of solar homes in eight states (including Massachusetts) between 2002 and 2013 showed a clear premium for solar-powered homes. For each kilowatt of installed solar, sale prices increased by about one percent relative to comparable non-solar homes.[15] If that observation holds for Boston, then the average size of installation from 2015 to 2018 (6.1 kilowatts) equates to a demonstrable price premium for PV homes in the city. A number of additional studies demonstrate the PV price premium in US metro regions.[16] Actions taken to expand rooftop PV to reduce GHG emissions must include parallel action to ensure that higher property values do not make housing less affordable to low-income households, and/or accelerate displacement.

Public funding spent on incentives for solar installations requires equity-focused policy elements.[17] Possible policy designs include:

- ***Free solar:*** cover all costs of panels, installation and maintenance
- ***Financial incentives that vary by income:*** offer tax rebates and other incentives that depend on family income or business revenue
- ***Solar loan guarantee:*** work with financial institutions to make credit for solar investments accessible to a wider segment of the population
- ***Solar options for renters:*** mandate or provide incentives to building owners to encourage solar installations on rental properties
- ***Solar leasing:*** provide incentives to third-party solar leasing firms
- ***Virtual solar:*** encourage households and businesses to invest in "virtual" net metering—owning or leasing solar panels located elsewhere
- ***Community solar:*** support community solar projects in vulnerable communities by siting installations on City property; provide incentives for solar panels on community centers, schools, and other government buildings that would be owned or leased by Boston residents and businesses; be a major subscriber to community solar to help lower prices

Socially vulnerable communities have the most to gain from programs to promote rooftop solar that are inclusive, and create jobs with livable wages. They stand to lose if public funds are allocated to policies that are only accessible to wealthy families and large businesses, or if workforce development does not intentionally aim to attract workers from their communities.

Learn from Others' Experience

Municipal and national governments around the world have begun to account for equity in their rooftop solar policies (Table 17).

14 Board of Governors of the Federal Reserve System. May 2018. Report on the Economic Well-Being of U.S. Households in 2017. Consumer and Community Development Research Section of the Federal Reserve Board's Division of Consumer and Community Affairs (DCCA). Available online: https://www.federalreserve.gov/publications/files/2017-report-economic-well-being-us-households-201805.pdf.

15 Hoen, B., Adomatis, S., Jackson, T., Graff-Zivin, J., Thayer, M., Klise, G. T., & Wiser, R. 2017. Multi-state residential transaction estimates of solar photovoltaic system premiums. Renewable Energy Focus, 19–20, 90–103. Available online: https://doi.org/10.1016/j.ref.2017.05.006.

16 (1) Dastrup, S., Zivin, J., Costa, D., & Kahn, M. 2012. Understanding the Solar Home price premium: Electricity generation and 'Green' social status. European Economic Review, 56(5): 961–973. Available online: https://doi.org/10.1016/j.euroecorev.2012.02.006; (2) Hoen, B., Cappers, P., Wiser, R., & Thayer, M. 2011. An Analysis of the Effects of Residential Photovoltaic Energy Systems on Home Sales Prices in California. U.S. Department of Energy. Available online: https://doi.org/10.2172/1013074; (3) Colorado Energy Office. 2013. The Impact of Photovoltaic Systems on Market Value and Marketability: A case study of 30 single-family homes in the north and northwest Denver metro area. Available online: http://hermes.cde.state.co.us/drupal/islandora/object/co%3A25819.

17 Sen, B. April 2017. How States Can Boost Renewables, with Benefits for All. Institute for Policy Studies. Available online: https://ips-dc.org/report-how-states-can-boost-renewables-with-benefits-for-all/.

Table 17. Examples of Intentional Design in Rooftop Solar

FREE SOLAR PANELS	
Colorado	Low-income solar programs, including free panels for low-income families in Arapahoe County, community solar for low-income customers (available for renters)
Berkeley (California)	Solar installations for low-income communities
Honduras	Free rooftop solar panels in rural areas
LOWER COSTS FOR SOLAR	
Massachusetts	Community-based Solarize program, Mass Solar Loan, the Schools and Public Housing Integrating Renewables and Energy Efficiency (SAPHIRE) grant program, and the MassCEC Clean Heating and Cooling rebate program (higher rebates for low/moderate incomes) all aim to lower solar costs
California	Households installing PV have been eligible for a 30% federal tax credit on the cost of the PV system; financial incentives for installation of PV systems on multifamily affordable housing properties throughout the state
Austin (Texas)	Provides cash incentives to owners, developers and property managers of multifamily properties for making energy efficiency upgrades and for Solar PV and water heat
NY, NC, OR (USA)	Income-tax credits for renewable energy technologies
FL, NY, IL (USA)	Buy-down programs, in the form of rebates or other cash incentives, for renewable energy technologies
IA, NY, OR (USA)	Low-interest loan programs for renewable energy technologies
Italy	Tax deduction equal to 50% of the expenses incurred to purchase and install a PV system + storage
Bangladesh	Incentives with different financing structures provided to rural communities for installation of solar in homes and businesses which improves income and quality of life
Western Australia	Government provides subsidies to households opting to install solar systems
COST OF SOLAR VARIES BY INCOME	
California	Small users and poorer households were charged less for solar systems
Chile	Subsidies to low-income families to install solar panels
SOLAR LEASING	
Florida	Leasing for solar panels made legal, opening the door for low-income adoption
SOLAR OPTIONS FOR RENTERS	
California	The Multifamily Affordable Solar Housing program uses financial incentives including up-front rebates and a virtual net metering tariff to lower electricity bills for all; also provide incentives and innovative billing arrangements to overcome the "split incentive" problem
VIRTUAL SOLAR	
USA	The Center for Sustainable Energy (CSE) is working to break down barriers to solar for multifamily housing—for example, CSE is leading a project to expand use of virtual net metering and has developed a set of toolkits for tenants and multitenant property owners that guide owners and residents through the solar process
PROMOTES COMMUNITY KNOWLEDGE, EDUCATION, SKILLS	
Duluth (Minnesota)	The Hartley Nature Center hosts youth educational programs to explain the basics of resilient solar
WORKFORCE DEVELOPMENT	
Baltimore (Maryland)	Living Classrooms Foundation is installing resilient solar in Baltimore community centers and training local residents to become certified solar installers

Source: See Appendix D for a list of sources.

The Charles River and Boston's Skyline as viewed from Cambridge. Photo credit: Soe Lin

Case Study: Solar PV Ordinance in Watertown, MA

In November 2018, the town council of Watertown, Massachusetts (population 36,000) passed an ordinance that requires most new commercial buildings to install solar panels, becoming the first town in New England to do so. The compact town (4 square miles) is in the midst of a major development and redevelopment boom, and took that as an opportunity to reduce its carbon footprint. The ordinance requires new commercial construction greater than 10,000 square feet, retrofits of sites that are greater than 10,000 square feet, and all new residential structures with ten or more units to include solar power. Single-family homes and duplexes are exempt, as are buildings lacking feasible solar-zones. Parking garages will also be required to install solar. Town officials believe the ordinance will help provide local jobs for local companies, and that renewable energy generation will offset the money previously spent on fossil fuels and electricity.

Sources:

Watertown Becomes 1st Town In New England To Require Solar Panels On New Commercial Constructions, https://www.wbur.org/news/2018/12/09/watertown-commercial-buildings-solar-panels

Solar required on new commercial buildings in Massachusetts town, https://pv-magazine-usa.com/2018/12/10/if-commercial-construction-then-solar-required-in-massachusetts-town/

Rooftop solar on the Epiphany School in Dorchester. Photo credit: Resonant Energy

Solar Installation on Bethel AME Church in Jamaica Plain. Photo credit: Resonant Energy

Strategies for Municipal Aggregation

The *Summary Report* assumed that the Massachusetts Clean Energy Standard will cause 80 percent of electricity supplied to Massachusetts from the New England grid to be generated by renewable sources by 2050. That means that 20 percent of electricity would come from other sources, presumably natural gas. As a result, there will be GHGs remaining in Boston's emissions inventory even if the City aggressively acts in the buildings, transportation, and waste sectors. Achieving carbon neutrality will require one additional important action: the procurement of 100 percent GHG-free electricity and fuels.

The procurement of GHG-free electricity by the City on behalf of all residents could significantly enhance equity by giving all Bostonians access to affordable, clean electricity. However, such programs have the potential to either decrease or increase energy costs for households, and in the past a number of towns in Massachusetts abandoned aggregation due to unfavorable market conditions.[18] Massachusetts aggregation programs are designed to protect consumers from increased costs in two ways.[19] First, municipalities renegotiate energy prices every one to three years, and can choose not to sign an aggregation contract if prices are unfavorable compared to base utility electric prices. Second, individual electric customers can opt out and return to the base utility electric price at any time.

18 Commonwealth of Massachusetts Municipal Aggregation, https://www.mass.gov/info-details/municipal-aggregation

19 Comings, T., Stanton, E., and Woods, B. 2017. An Analysis of Community Choice Energy for Boston. Applied Economics Clinic. Available online: https://aeclinic.org/publicationpages/2017/9/29/an-analysis-of-community-choice-energy-for-boston.

Table 18. Comparison of Local CCE Program Electric Rates to Eversource for 2019*

	Supply Rate (cents/kWh)	Residential CCE Savings (%)	Small Commercial CCE Savings (%)
Eversource Basic Service (cents/kWh)		12.49	12.29
CCE Program			
Dedham	10.58	15.3%	13.9%
Lexington	11.62	7.0%	5.5%
Somerville	10.54	15.6%	14.3%
Acton	10.72	14.2%	12.8%
Sudbury	10.75	13.9%	12.6%
Arlington	10.76	13.9%	12.5%
Winchester	10.90	12.7%	11.3%
Natick	11.43	8.5%	7.0%
Average	**10.91**	**12.6%**	**11.2%**

Eversource Basic Service is the average price posted for January 1 through June 30, and July 1 through December 31 (https://www.eversource.com/content/ema-c/residential/my-account/billing-payments/about-your-bill/rates-tariffs/basic-service). Note that the Massachusetts Department of Public Utilities prohibits any guarantee of lower pricing by an aggregator. Source: Reproduced from Comings, T., Woods, B. and Majumder, M. February 2019. Updated Costs of Community Choice Energy Aggregation in Boston. Applied Economics Clinic. Available online: https://aeclinic.org/publicationpages/2019/2/28/updated-costs-of-community-choice-energy-aggregation-in-boston

Aggregation has the potential to stabilize electricity prices by reducing or eliminating exposure to volatility in fossil fuel prices. This would benefit households living paycheck to paycheck or, as with many elderly Bostonians, subsisting on a fixed income.[20] Table 18 compares rates negotiated by local towns' municipal aggregation programs to base Eversource electric rates for 2019, showing cost savings for the listed towns.

City communications will need to adequately explain the program, including residents' opt-out and alternative options, in ways that consider differences in education, language, sources of information, and culture. All Bostonians should be able to distinguish between the City's municipal aggregation programs and promotional materials and/or home visits from predatory third-party electric distributors.[21] To realize the opportunities presented by municipal aggregation, socially vulnerable populations should be represented in decision-making throughout the planning, design, procurement, and implementation phases.

Strategies for Affordable, Clean Fuels

The *Summary Report* discussed the potential for renewable natural gas (RNG). Also known as biomethane, RNG is methane manufactured from biological sources that is fully interchangeable with conventional natural gas. Renewable natural gas could be distributed to buildings via the existing gas grid and used with existing equipment (gas stoves, furnaces, and hot water heaters). The *Summary Report* concluded that RNG has a very modest near-term potential, but that sources and conversion pathways for biomethane are active research areas and should be closely monitored by the City.

On the path to carbon neutrality, it is essential that the cost of fuels and electricity do not increase income inequality or reduce economic fairness or opportunity. Even if RNG can be substituted for natural gas with no relative price changes to end users, it is still important that RNG be produced by a process and in a location that does not disadvantage vulnerable communities, the environment, or the climate. Such communities must have meaningful participation in decision-making, policy planning and design, implementation, evaluation, surrounding possible new infrastructure, such as pipelines and anaerobic digesters.

20 Comings, T., Stanton, E., and Woods, B. 2017. An Analysis of Community Choice Energy for Boston. Applied Economics Clinic. Available online: https://aeclinic.org/publicationpages/2017/9/29/an-analysis-of-community-choice-energy-for-boston. .

21 Commonwealth of Massachusetts. May 2018. AG Healey Calls for Shut Down of Individual Residential Competitive Supply Industry to Protect Electric Customers. Available online: https://www.mass.gov/news/ag-healey-calls-for-shut-down-of-individual-residential-competitive-supply-industry-to-protect.

Important equity issues surround the natural gas distribution system itself, whether it carries methane from fossil or biological sources. Many communities feel that decisions regarding new pipeline construction are made without sufficient input from the local population. In addition to exposure to methane leaks and explosion hazards, residents in some communities feel that such decisions lock in an infrastructure that is not compatible with the community's values. Equitable infrastructure decision-making requires that affected communities are empowered to have meaningful influence in all energy planning.

If the supply of biomethane is significantly constrained by resource supply or cost, there may be a managed shutdown of some or all of the gas distribution system in the City as action unfolds to reach carbon neutrality. The technical, economic, and social characteristics of the equitable retirement of the gas distribution system in Boston have not been rigorously assessed. That analysis, and the resultant decision-making process, should ensure that vulnerable communities are intentionally and actively engaged, that their concerns are substantively reflected in decisions, and that they have uninterrupted access to secure and affordable energy.

Equitably Achieving a Carbon-Neutral Energy Supply

The existing supply of electricity to most Bostonians—the regional power grid—probably will not decarbonize fast enough to reach carbon neutrality by 2050. Similarly, the current rate of deployment of rooftop solar will not realize the city's full potential by 2050. Efforts to reduce GHG emissions via municipal aggregation and the expansion of rooftop solar cannot increase the cost of energy or concentrate access to renewable energy in the hands of more affluent families. Instead, policies and programs should be designed to avoid negatively impacting socially vulnerable populations and to specifically target those who will especially benefit from clean, affordable fuel and electricity.

Socially vulnerable communities do not have the same access to rooftop solar panels that more privileged groups do due to housing circumstances, lack of capital, or access to credit. However, the increasing affordability of rooftop solar offers the potential for all Bostonians to benefit from lower utility bills and to participate in the clean energy transition. Municipal aggregation—if designed to provide relatively stable prices through the contracting process—could bring cost savings and emission reductions to all Boston residents.[22] It is important to remember, however, that aggregation cannot guarantee lower prices.

To succeed in closing historical equity gaps, decisions regarding the best allocation of City resources to bring more GHG-free electricity to Boston must be made intentionally and inclusively at every step. From planning to implementation to evaluation, socially vulnerable communities need a seat at the table to ensure the best equity outcomes.[23] This includes input regarding the structure of the municipal aggregation program, the choice of electricity supply, and clear communication that reaches all households. The City could follow the lead of California's municipal aggregators and advance equity and diversity through its procurement, policy, and program activities.[24] Clean energy policy design can also support building a more diverse workforce to build out the rooftop solar resource, while ensuring workers receive living wages and safe working conditions that are consistent with City policy. When equity is approached intentionally in program design, planning, implementation and evaluation, Boston can create and implement energy policies that benefit all residents and businesses.

22 Enright, N., Kaneene, T., McKay, H., Perry, D. March 2018. Resilient Solar: Powering and Empowering Communities. Institute for Sustainable Communities. Available online: http://us.iscvt.org/wp-content/uploads/2018/03/Resilient-Solar_Powering-and-Empowering-Communities.pdf.

23 Sen, B. April 2017. How States Can Boost Renewables, with Benefits for All. Institute for Policy Studies. Available online: https://ips-dc.org/report-how-states-can-boost-renewables-with-benefits-for-all/.

24 California Community Choice Association, Beyond Supplier Diversity Report, October 4, 2018. Available online: https://cal-cca.org/wp-content/uploads/2018/10/CalCCA-Beyond-Supplier-Diversity-Report.pdf

Offsets

Main Findings

- Some emissions are very difficult to eliminate completely. To reach carbon neutrality by 2050, Boston may have to purchase rights to emission reductions that are implemented elsewhere.
- Offsets can be purchased from emission reductions that take place inside or outside of Boston and often are reductions from: energy efficiency, renewable energy, carbon sequestration (biological and geological), or methane and industrial gas mitigation.
- If not done thoughtfully, purchasing offsets introduces a potential "moral hazard," or potential negative impacts on communities that produce offsets.
- The City should establish offset principles and standards that ensure all offsets are:
  - **Permanent:** emission reductions are non-reversible and last in perpetuity;
  - **Additional:** goes beyond what would have been done otherwise in a business-as-usual scenario;
  - **Verifiable:** emission reductions are measurable, confirmed, and monitored;
  - **Enforceable:** what counts as an emission reduction and offset purchase is clearly defined to avoid double counting;
  - **Real:** emission reduction being purchased does not lead to emissions increases elsewhere, i.e., the offset program generates net emission reductions;
  - **Co-benefit generation:** offset projects should be designed to facilitate emission reductions that also entail social, health, economic, or environmental benefits; and
  - **Contemporary relevance:** emission reductions being purchased should commence during the present time-period to ensure that they are real and verifiable.

Overview

The *Summary Report's* buildings, transportation, waste and energy supply strategies are unlikely to result in actual net zero emissions because some emissions are very difficult to eliminate (e.g. wastewater treatment). As a result, by 2050, the rights to some emission reductions implemented elsewhere may be necessary to achieve the 100 percent GHG-free goal. These emission reduction rights are typically called "carbon offsets."[1] These offsets could be emission reductions from energy use outside of Boston, or other types of emission reductions (for example, tree planting) that could take place either inside or outside of Boston. Potential categories of offsets that might be purchased by Boston include emission reductions from energy efficiency, renewable energy, carbon sequestration (biological and geological), or methane and industrial gas mitigation.[2] As Boston develops its offset strategy, our equity analysis indicates that the City should establish offset standards that ensure all offsets are permanent, and additional to what would have been done otherwise, verifiable, enforceable, and real.

1 Broekhoff, D. and Zyla, K. December 2008. Outside the Cap: Opportunities and Limitations of Greenhouse Gas Offsets. World Resources Institute. Available online: http://pdf.wri.org/outside_the_cap.pdf.

2 Barreto, V. et al. May 17, 2018. A Study of Carbon Offsets and RECs to Meet Boston's Mandate for Carbon Neutrality by 2050. Boston University Institute for Sustainable Energy. Available online: http://sites.bu.edu/cfb/files/2018/06/MIT-S-Lab-Final-Report.pdf.

Carbon Free Boston Offsets Strategies

The *Summary Report's* buildings, transportation, waste and energy strategies will deliver enormous emission reductions but cannot bring Boston's emissions to zero. Assuming the successful realization of other strategies, the City will still have approximately 500,000 tons of emissions in 2050, equal to about 10 percent of current emissions. To address residual emissions—those that are too costly or impossible to address directly, such as emissions from wastewater treatment or composting—the *Summary Report* suggests a final action: the purchase of carbon offsets.

	ACTION	DETAILS
Purchase carbon offsets	Purchase carbon offsets in accordance with set criteria	Offsets should be from verified projects that provide GHG reductions that are:
		Permanent: non-reversible, lasts in perpetuity;
		Additional: beyond business as usual (uneconomical, not policy driven);
		Verifiable: measurable, must be confirmed and monitored;
		Enforceable: clearly defined, exclusive ownership to avoid double counting; and
		Real: not subject to leakage (do not force emissions elsewhere), generates a physical, net reduction in GHG emissions

The traditional use of offsets—buying emission reductions achieved elsewhere—raises three main equity considerations for Boston:

- Offset projects include those that result in GHG reductions from energy efficiency, renewable energy, carbon sequestration (biological and geological), or methane and industrial gas mitigation.[3] Boston's offset strategy should establish clear principles and standards that ensure all the GHG reductions are permanent and additional to what would have been done otherwise, verifiable, enforceable, and real. The strategy should also ensure that carbon offsets do not lower the incentive to directly reduce GHGs.[4] An equitable offset program ensures social inequities are not exacerbated by allowing polluting facilities, typically located in disadvantaged communities, to continue to emit harmful pollution.[5]
- The mechanism to raise and allocate revenue for the purchase of offsets does not exacerbate existing income inequality in the city.
- Offset purchases are socially responsible and enhance equity. This includes offsets from local or global projects.

3 Barreto, V. et al. May 17, 2018. A Study of Carbon Offsets and RECs to Meet Boston's Mandate for Carbon Neutrality by 2050. Boston University Institute for Sustainable Energy. Available online: http://sites.bu.edu/cfb/files/2018/06/MIT-S-Lab-Final-Report.pdf.

4 Center for Resource Solutions. April 9, 2012. Renewable Energy Certificates, Carbon Offsets, and Carbon Claims. Available online: https://resource-solutions.org/wp-content/uploads/2015/08/RECsOffsetsQA.pdf; (2) Kotchen, M.J. Spring 2009. Offsetting Green Guilt. Stanford Social Innovation Review. Available online: https://ssir.org/articles/entry/offsetting_green_guilt.

5 Bushnell, J.B. August 2010. The Economics of Carbon Offsets. National Bureau of Economic Research Working Paper. Available online: https://doi.org/10.3386/w16305.

Pairing Better Equity with Lower GHG Emissions

The equity impacts of offset purchases will depend on the design of these programs and the criteria established for offset purchases. The criteria described above are known by the acronym PAVER: permanent, additional, verified, enforced, and real.[6] A 2018 report from the MIT Sustainability Lab expands these basic criteria in what they call the PAVER+ framework, which adds two criteria: co-benefit generation and contemporary relevance:[7]

- **Co-benefit generation:** Offset projects should be designed to facilitate emission reductions that also produce social, health, economic, or environmental benefits, for example: better living standards; cleaner drinking water; lower energy costs; and cleaner air or reduced soil erosion. At a minimum, offset projects should not have adverse effects on the community in which they take place.
- **Contemporary relevance:** Emission reductions should commence during the present time-period (as opposed to a promise of future reductions) to ensure that the emission reductions being purchased are real and quantifiable.

Equitably Achieving Carbon Offsets

Carbon offsets that meet the criteria above will also improve equity if they avoid unintended consequences. Offsets should not create what is known as moral hazard: polluting at home, buying offsets elsewhere. The purchase of carbon offsets from elsewhere raises equity concerns about the "fairness" or "justness" of a wealthy locale, like Boston, purchasing the right to pollute from less affluent and privileged areas of the country or the world. The offset strategy must be used carefully to avoid outsourcing Boston's emission reduction responsibility. With careful selection and verification of projects and locations, offsets may produce real, beneficial emission reductions in locales elsewhere in the state, country, or the world. For example, a study demonstrated net emission reductions resulting from California's forest offset, with emission reductions created in selected sites within the US.[8]

Carbon offsets also should avoid potential negative impacts on the communities that produce the offsets. For example, US-funded carbon offset projects in Guatemala and Sri Lanka have caused unanticipated social costs, including resources being redirected away from poverty alleviation.[9] Careful planning, monitoring and verification of offset programs should ensure that the locales from which offsets are being purchased, whether they be local, national or international, do not suffer adverse consequences as a result of the program.

For projects outside the region, the City can work with project creators and voluntary carbon market standards that seek to support the United Nations Sustainable Development Goals in order to find offset projects that supports new skills, livelihoods, and/or infrastructure for impoverished individuals, families and communities. Working with a respected broker or standard can help ensure the offset projects the City supports align with its core values and achieves the impacts it desires.

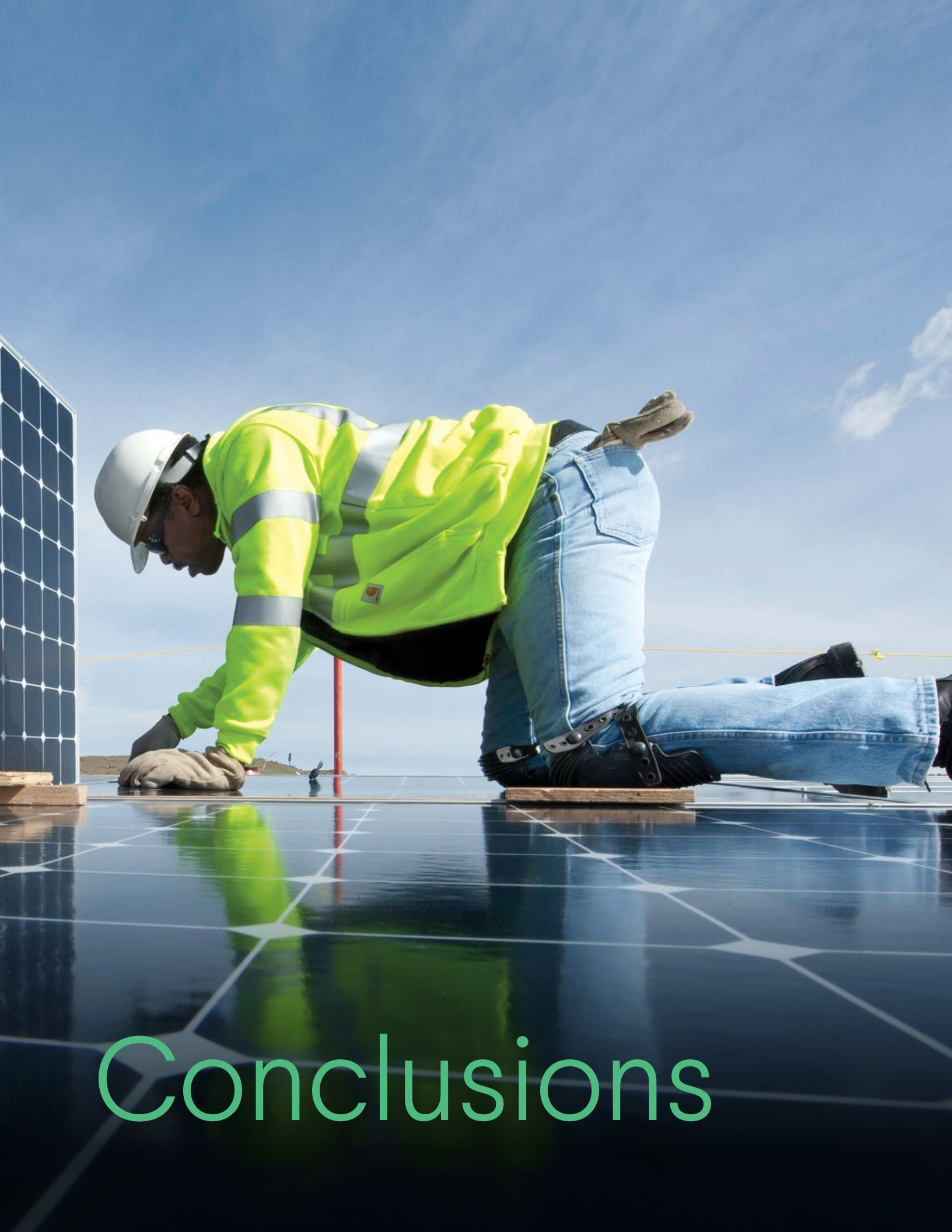
Intentional design from the outset can ensure that vulnerable communities—local and/or global—benefit from the purchase of carbon offsets. These communities must have a voice in every stage of the process, from design to implementation, monitoring, evaluation and communication. This means that decision-making should be inclusive and transparent, and input should be solicited from those most affected, even if they are outside of the city. A carbon offset program that combines the best purchase strategies with the best equity practices can be an important component of Boston's climate action plan.

6 Center for Resource Solutions. April 9, 2012. Renewable Energy Certificates, Carbon Offsets, and Carbon Claims. Available online: https://resource-solutions.org/wp-content/uploads/2015/08/RECsOffsetsQA.pdf. p.6.

7 Barreto, V. et al. May 17, 2018. A Study of Carbon Offsets and RECs to Meet Boston's Mandate for Carbon Neutrality by 2050. Boston University Institute for Sustainable Energy. Available online: http://sites.bu.edu/cfb/files/2018/06/MIT-S-Lab-Final-Report.pdf.

8 Anderson, C.M., Field, C.B. and Mach, K.J. August 15, 2017. Forest Offsets Partner Climate-Change Mitigation with Conservation. Frontiers in Ecology and the Environment, 15(7), 359–365. Available online: https://doi.org/10.1002/fee.1515.

9 Wittman, H. and Caron, C. 2009. Carbon Offsets and Inequality: Social Costs and Co-Benefits in Guatemala and Sri Lanka. Society & Natural Resources, 22(8), 710—726. Available online: http://dx.doi.org/10.1080/08941920802046858.



Conclusions

The commitment to carbon neutrality, in tandem with the commitment to resiliency in the face of climate change, presents Boston with the opportunity to demonstrate comprehensive and sustained climate leadership. That leadership is defined by two types of action: redressing historic environmental and energy injustices, and converting the challenge of carbon neutrality into new benefits—embedded in public policy—that will flow to benefit all Bostonians in the generations to come.

Intentional design is necessary to ensure that action taken to reduce GHG emissions closes equity gaps and improves the lives of socially vulnerable communities, while avoiding unintended consequences that can exacerbate inequity. Energy efficiency in buildings addresses the largest source of GHG emissions, and can simultaneously reduce energy insecurity, increase family wealth, and improve living conditions and public health. Expansion of public transit and active transport reverse some historical inequities and generate a wide range of public benefits. A zero-waste city will reduce emissions and lower the city's ecological footprint. The provision of GHG-free electricity to all residents enables universal participation in the clean energy transition and the resulting health and economic benefits. Many actions discussed in the *Summary Report* have the potential to create good paying jobs in clean, safe working conditions.

Indeed, the confluence of *Climate Ready Boston* and *Carbon Free Boston* offers a historic opportunity to address historical inequities, and to leverage new action to reduce GHG emissions in ways that benefit the city's most vulnerable residents. A carbon-neutral city requires a major transformation of Boston's built infrastructure and the behavior of its inhabitants, as well as new regulatory, institutional, and financial systems. Every public action has an equity impact whether stated or unstated, and many new actions will be designed and implemented that embody choices about what to include and what to leave out. In this transition Boston will either lock in and exacerbate historical capacity gaps, or use this watershed moment to create a more equitable, inclusive, resilient and prosperous city.

This synthesis of equity guidance regarding the *Summary Report's* strategies is intended to generate actionable insights for the design and implementation of carbon-reduction policies in Boston as part of its Climate Action Plan and beyond (Table 19).

1. Include socially vulnerable communities in decision-making

Equitable outcomes begin with equitable decision-making. In both its internal planning and public outreach as part of *Carbon Free Boston*, the City can help build this capacity around these principles of inclusion: [1]

- **Influence over decisions and critical processes:** Inclusive decision-making goes beyond invitations for public comment. Boston residents deserve an opportunity to have their perspectives and experience guide the formation and implementation of carbon-neutral policies.
- **Access to information and resources:** Important information on climate action needs to be accessible to all Boston residents and commuters. Special attention should be paid to language-based barriers, and communication strategies should recognize the value of a multicultural society.[2] This includes the opportunity to participate in decision-making, information on financial assistance for energy efficiency and renewable energy, basic educational materials on sustainable actions, and critical instructions on technology adoption and other opportunities to participate in the transition to a clean and efficient energy system.
- **Ability to contribute fully and effectively:** Achieving a carbon-neutral Boston by 2050 will require active and enthusiastic participation by all residents, business owners, and other stakeholders in the city.

There is a crucial distinction between inclusion on the one hand, and diversity or public engagement on the other. Inclusion is the embrace of genuine consideration and integration that allows for the full benefit of different voices and perspectives to be

1 Roberson Q. June 1, 2004. Disentangling the Meanings of Diversity and Inclusion. Cornell University, Center for Advanced Human Resource Studies (CAHRS) Working Paper. Available online: https://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1011&context=cahrswp.

2 Piller, I. and Takahashi K. July 2011. Linguistic Diversity and Social Inclusion. International Journal of Bilingual Education and Bilingualism, 14(4), 371–81. Available online: https://www.tandfonline.com/doi/pdf/10.1080/13670050.2011.573062?needAccess=true.

incorporated into public policy.[3] Confusing diversity or public engagement with inclusion can lead to public dissatisfaction and disengagement from public processes. The pitfalls of superficial engagement are summarized here:

While public participation is often a mandated part of decision-making processes, how public participation is implemented can exacerbate tensions between government organizations and members of the public. Public bodies may go to great lengths to create forums for the public to provide input on policy choices, only to have the public decline to take part because they do not feel their participation will make a difference, or protest after having participated that the discussion was somehow inauthentic or unsatisfactory. The consequences include participation burnout by well-meaning members of the public, government organizations, and politicians.[4]

2. Set priorities in the context of interactions among policies

The pace of equitable action towards carbon neutrality is accelerated by careful consideration of the order and timing ("phasing") of action because strategies interact with each other across sectors. Transportation, housing, and clean energy illustrate this point. The capacity of public transit must expand at a pace that mirrors any shift away from private vehicles. Improvements in service and accessibility, an equity-focused broadening of the MBTA network, and overall infrastructure upgrades and repairs are needed to support an uptick in ridership. Revenue from road pricing may need to be prioritized in order to finance other policies—such as free or reduced cost transit—that require new sources of funding. Simultaneously, closing neighborhood gaps in public transit will raise property values and diminish affordable housing; rooftop solar and efficiency upgrades have the same effect. Housing policy thus needs to connect with transportation and clean energy policy. Careful planning will avoid spending misallocations and strategically funnel investment to new infrastructure that not only reduces GHG emissions, but also benefits all Bostonians over the long run.

3. Focus workforce development efforts on job quality

The *Summary Report* described potential employment opportunities afforded by climate action. Creating new jobs in Boston is a starting point for workforce development efforts, but an equity-focused employment plan for carbon-neutral policies requires a commitment to job quality, including living wages and benefits, and job health and safety standards. New jobs from climate action will include workers employed by the City, the Commonwealth, contractors working for the city or state, and independent private employers. Strategies for improving job standards must account for this diversity of employers.

4. Training today and tomorrow's workforce for green careers

Building new bike lanes and net-zero buildings, installing rooftop solar, managing building energy use, repairing electric vehicles, recycling and reusing waste, and designing software to integrate wind and solar energy into the grid are just a few examples of new opportunities that will unfold on the path to carbon neutrality. New, well-compensated jobs in green public services and industries are a pathway towards building income and wealth for socially vulnerable communities.[5]

Training for green careers must go beyond retraining programs for displaced workers in emissions-heavy lines of work who will need to learn new—although often closely related—skills (contractors, HVAC specialists, auto mechanics, gas station attendants, waste facility workers). Partnerships with local high schools, technical schools, two-year and four-year colleges are critical to providing a new kind of labor force to meet growing demand. Making sure that Bostonians are well represented in this new green workforce requires public services that help residents throughout their career pathway, from high school through college or technical school, to finding jobs and advocating for fair compensation and safe work environments.

3 Miller, F.A. June 1998. Strategic Culture Change: The Door to Achieving High Performance and Inclusion. Public Personnel Management, 27(2), 151–160. Available online: https://doi.org/10.1177/009102609802700203; (2) Quick, K. and Feldman, M. 2011. Distinguishing Participation and Inclusion. Journal of Planning Education and Research, 31(3), 272–90. Available online: https://doi.org/10.1177/0739456X11410979; (3) Jaeger, P. and Bowman C. 2005. Understanding Disability: Inclusion, Access, Diversity, and Civil Rights. Praeger. Available online: https://books.google.com/books?hl=en&lr=&id=36JTzUCh9v0C&oi=fnd&pg=PA3&dq=inclusion+vs.+diversity&ots=GRqonPRdZT&sig=2CRFUF77jGGdkgPI7Z-EJmhi9Ao#v=onepage&q&f=false. p.123; (4) Chavez C. and Weisinger, J. June 2008. Beyond Diversity Training: A Social Infusion for Cultural Inclusion. Human Resource Management, 47(2), 331–350. Available online: https://doi.org/10.1002/hrm.20215.

4 Quick, K. and Feldman, M. 2011. Distinguishing Participation and Inclusion. Journal of Planning Education and Research, 31(3), 272–90. Available online: https://doi.org/10.1177/0739456X11410979.

5 Green for All. 2009. Green Pathways Out of Poverty: Workforce Development Initiatives. Available online: http://www.issuelab.org/permalink/resource/5794.

Table 19. Carbon Free Boston Equity Summary Guidance

1. Include Socially Vulnerable Communities in Decision-Making

Enable socially vulnerable communities to have influence over critical decisions and processes, access to information and resources, and provides the ability to contribute more fully and effectively.

2. Set Priorities in the Context of Interactions Among Policies

Prioritizing the order and timing of policy implementation in ways that seek to avoid potential pitfalls is necessary to reduce negative impacts on socially vulnerable communities and all Bostonians.

3. Focus Workforce Development Efforts on Job Quality

The benefits of job creation are enhanced by a commitment to job quality, including living wages and benefits and job health and safety standards, to ensure that workforce development is beneficial for all Bostonians.

4. Training Today and Tomorrow's Workforce for Green Careers

Bostonians need green career training throughout their career pathways, from high school to four-year colleges and continuing education, that provides the new skills and knowledge to capitalize on the opportunities that arise on the path to carbon neutrality.

5. Sustainability Education for All

Public outreach and education to provide all Bostonians with the knowledge, skills, and opportunities needed for sustainability are critical to successfully and inclusively implementing carbon-neutral strategies.

6. Avoid Displacement

Intentional design and inclusive decision-making will avoid or reduce the displacement of Boston's most socially vulnerable households and communities.

7. Increase Access to Credit and Community Wealth

Action that builds community wealth and makes gains in individual household wealth accessible to as many Bostonians as possible will increase access to energy efficiency and clean energy fuels and electricity.

8. Allow for/Prioritize Neighborhood Planning for Equity and Sustainability

Climate action is a prime opportunity to leverage changes in neighborhoods' design to address historical disparities and to build the capacity of socially vulnerable communities.

9. Address Historical Disparities in Transportation Equity

Changes in the transportation sector are an opportunity to make public, private and active modes of transit work—and work better—for all Bostonians, particularly those facing barriers to access.

10. Improve Energy Security and Access to Clean Energy

Access to affordable, clean fuels and electricity reduces GHG emissions and has wide-ranging benefits to socially vulnerable communities.

Boston is in a good position to capitalize on new green job opportunities: it ranked fifth in green job density (green jobs per 10,000 jobs) among all US cities (Table 20). Green employers in the city include General Electric, Boston University, Ceres, Enernoc, and the Dana Farber Cancer Institute.[6]

6 The Boston Planning & Development Agency. June 2018. Boston's Economy 2018. Available online: http://www.bostonplans.org/getattachment/4c9b4906-bf32-4933-a20a-b6180a610f10.

Table 20. 2017 Green Job Postings by Occupation Category

Occupation	Boston	National
Architecture and Engineering	20%	21%
Management	27%	19%
Installation, Maintenance, Repair, Cleaning	9%	13%
Sales, Office, Administrative	13%	11%
Production, Construction, Extraction	6%	11%
Life, Physical, Social Sciences	8%	8%
Business, Financial, Legal	10%	6%
Other	8%	11%

Source: Adapted from Figure 14 in The Boston Planning & Development Agency. June 2018. Boston's Economy 2018. Available online: http://www.bostonplans.org/getattachment/4c9b4906-bf32-4933-a20a-b6180a610f10.

Green career training programs and policies provide the best opportunities when they are designed in the context of Boston's diverse workforce. Boston's women and people of color are not proportionately represented in construction trades[7] and many relevant technical fields. At the national level, Black workers comprise 6.6 and 8.0 percent of the workforce in the solar and wind industries, respectively;[8] just one in three workers in those industries are women.[9] To promote workforce diversity and bring new economic opportunities to the widest cross-section of Boston society, training and education opportunities must be made in consultation with and targeted towards different genders, cultures, neighborhoods, and language groups.

5. Sustainability education for all

A transition to a carbon-neutral city will require lifestyle changes that simultaneously reduce GHG emissions and improve the quality of life for all Bostonians. The City can support these changes through public outreach and education. To ensure that no community is left behind, outreach and education need to be linguistically and culturally appropriate and emphasize inclusivity alongside quality.[10]

Boston has an excellent foundation on which to build this communication. The Greenovate Boston Leaders Program trains individuals to lead conversations about climate change among people and groups working at the intersections of climate, health, equity, and justice in Boston's neighborhoods. The program provides individuals with the information, materials, and logistical support to engage their friends, families, and neighbors as part of the collective action needed to advance citywide initiatives. The launch of the Greenovate Leaders program has included strong outreach in socially vulnerable communities in Dorchester, Jamaica Plain, and Roxbury, among others. The Greenovate Ambassador program is an extension of the Leaders program with a greater emphasis on focused community projects on the interconnections among climate change, housing, food access, and other important issues.

As the City's action on GHG reduction evolves, the Greenovate Leaders program will be strengthened if it extends its reach to all socially vulnerable communities, and continuously works to connect people to the new technologies and programs that will emerge in building energy efficiency, transportation, clean energy, and waste management. The Leaders Program also is an opportunity to coordinate outreach with other organizations such as Action for Boston Community Development and the Boston Housing Authority who also have extensive outreach programs that align directly with climate action.

7 Enwemeka, Z. June 13, 2018. Boston Is In A Building Boom — And Wants More Diverse Construction Workers. WBUR. Available online: https://www.wbur.org/bostonomix/2018/06/13/construction-industry-diversity.

8 The Solar Foundation. 2017. National Solar Jobs Census. Available online: https://www.thesolarfoundation.org/national/.

9 United States Department of Energy (DOE). 2017. U.S. Energy and Employment Report. Available online: https://www.energy.gov/downloads/2017-us-energy-and-employment-report.

10 City of Boston Zero Waste Advisory Committee. 2018. Boston Zero Waste Recommendations. Available online: https://d12v9rtnomnebu.cloudfront.net/diveimages/BostonZWReport-121218Draft.pdf.

6. Avoid displacement

As the City develops carbon-neutral buildings strategies, equity outcomes are advanced when vulnerable households are prioritized from the outset to counter forces that make it impossible for many Bostonians to remain in their historical neighborhoods. Best practices include:

- **Built-in flexibility for vulnerable populations in new policies:** Action to reduce GHG emissions can protect socially vulnerable populations in two ways. First, incentives and mandates for landlords can be paired with protections for renters. For example, landlords can be incentivized to reduce renters' energy use that can deliver energy savings, generate financial returns for investors, expand affordable housing, and improve renters' health and well-being.[11] Second, consumers can be protected from increased costs that could limit their ability to continue to live and work in their communities by (i) prioritizing incentives and limiting the use of fees (e.g., waste, travel pricing),[12] (ii) providing fee exemptions for certain households or populations, and/or (iii) recycling revenue from fee collection to fund public investments that benefit all.

- **Acknowledging different levels of capacity for investment in carbon-neutral housing:** Low-income residents have unique barriers to investing in energy efficiency and clean energy, and programs that address financial barriers—including access to credit and capital—can most effectively increase access. The buildings chapter described specific ways that the affordability gap can be narrowed.

- **Build broad coalitions:** There is substantial overlap between desired social equity outcomes and the potential for broad coalition-making to enact community-focused changes that will help Bostonians live and work safely and sustainably in their communities. Effective programs include: diverse sets of stakeholders getting involved in community development;[13] environmental cleanup being paired with technical assistance and training programs;[14] and pairing housing development with public health initiatives or microgrid resiliency efforts.[15]

- **Predict, measure, verify, and reassess as necessary:** Portland State's Urban Studies Faculty developed a strategy to identify families at risk of involuntary residential displacement.[16] The risk assessment method they developed anticipates market changes at different stages of gentrification, and then looks at neighborhood dynamics to design a policy response.[17] At-risk neighborhoods would then be monitored on an ongoing basis to understand how these factors change over time. This and other early warning systems are essential to preventing displacement.[18]

7. Increase access to credit and community wealth

Consumer credit, bank loans, and credit or debit cards facilitate financial transactions and confer a benefit to those with access. Many socially vulnerable Bostonians live paycheck to paycheck—or, for many retired community neighbors, within the means of their Social Security payments. They cannot get a loan for a new electric vehicle or heat pump. They cannot front the capital to purchase energy-efficient appliances and apply for a rebate. They will not qualify to lease solar panels, or benefit from an EV charging station in their neighborhood if they cannot afford the vehicle itself. They do not have a credit or debit card to use to sign up for Blue Bike or to get most Charlie Card machines to work. Estimates indicate that approximately 50,000 Boston

11 Samarripas, S., and York, D. May 2, 2018. Our Powers Combined: Energy Efficiency and Solar in Affordable Multifamily Buildings. American Council for an Energy Efficient Economy. Available online: https://aceee.org/research-report/u1804.

12 Amelsfort. D., and Brundell, K. March 2018. Congestion Charging: Policy and Global Lessons Learned. WSP. Available online: https://www.wsp.com/-/media/Insights/Canada/Documents/doc-Congestion-Charging-Report.pdf?la=en-CA&hash=1A44EC2D1A1E5683F77F6F2B5A2EC8EA50F74976; (2) Levinson, D. January 2010. Equity Effects of Road Pricing: A Review. Transport Reviews, 30(1), 33–57. Available online: https://www.tandfonline.com/doi/full/10.1080/01441640903189304.

13 Ishimatsu, J. and Matsubayashi, D. 2017. Sustainable Little Tokyo: Resisting Gentrification and Displacement Through Holistic Community Engagement and Development. Community Development Investment Review, Federal Reserve Bank of San Francisco. Available online: https://www.frbsf.org/community-development/files/sustainable-little-tokyo-resisting-gentrification-and-displacement.pdf.

14 United States Environmental Protection Agency. 2018. Overview of EPA's Brownfields Program. Available online: https://www.epa.gov/brownfields/overview-epas-brownfields-program.

15 AZ Housing Coalition. November 13, 2018. Gentrification, Appropriation, and Displacement in Barrio Neighborhoods: Policies and Practices. Available online: https://azhousingcoalition.org/resources/Documents/Innovative%20Housing_1.pdf.

16 Bates, L. May 2013. Gentrification and Displacement Study: Implementing Equitable Inclusive Development Strategy in the Context of Gentrification. Urban Studies and Planning Faculty Publications and Presentations, Portland State University. Available online: https://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1082&context=usp_fac.

17 Ibid, p.5.

18 Chapple, K. and Zuk, M. 2016. Forewarned: The Use of Neighborhood Early Warning Systems for Gentrification and Displacement. U.S. Department of Housing and Urban Development. Cityscape, 18(3), 109–130. Available online: https://www.jstor.org/stable/pdf/26328275.pdf?refreqid=excelsior%3Aff775cd890b0fb701b28ca0921e33a50.

households do not have an internet connection.[19] These are formidable barriers to participating in, and benefiting from, nearly every strategy to decarbonize the city.

The City can improve access to credit, electronic payments, and online communications by:

- Designing policies to broaden access to credit, while providing protections from predatory lenders
- Working with local banks to make bank cards available to lower-income families and individuals
- Working within Boston's wealth of computing and information technology innovators and entrepreneurs to find a technical solution to making electronic payment and identification available to all Bostonians
- Working towards universal internet or wi-fi access in the city (The City has established a Digital Equity Fund that "supports programs that advance digital equity in Boston").[20] This divide is narrowed by creating or enhancing community resources rather than focusing on individual households. For example, a focus on community wealth prioritizes policies that benefit all families regardless of their access to credit, bank cards, or identification, such as allocating public funding for energy efficiency improvements, expanded and improved transit, bike, and walking networks, and community choice energy. These kinds of policies improve the local housing stock, make it easier and less time consuming to get to work, school and shopping, make neighborhoods safer, and reduce energy bills.

8. Neighborhood planning for equity and sustainability

Dorchester has large number low-income families that pay rent in multifamily buildings that are difficult to retrofit. Mission Hill has very few rooftop solar systems. Large areas of East Boston lack bike networks. Many residents of Mattapan have poor access to bus and rail transport. Households in many areas of Roxbury spend a large percentage of their paycheck on fuel and electricity. These are examples of wide-ranging differences across Boston's neighborhoods in affordable housing, access to transportation, energy burden, and access to energy efficiency and clean energy.

Action to reduce GHG emissions is a tremendous opportunity for planning the design, look, accessibility, flow and mode of transportation, and the conceptualization of public space that is tailored to neighborhoods. Agencies across City Hall have the opportunity to pool their financial and human capital to integrate access to safe walking and biking routes to get residents to transit and schools, fresh food, green space, clean energy, and composting facilities.

The City has a strong base to launch this type of planning. *Imagine Boston 2030*,[21] *Go Boston 2030*,[22] and *Climate Ready Boston*[23] strategies call explicitly for a more inclusive and equitable pathway to growth. *Imagine Boston 2030* recommends setting priorities for affordable housing, reducing transportation access disparities, and improving educational opportunities for all, and sets the following goals:[24]

- Provide quality of life in accessible neighborhoods
- Drive inclusive economic growth
- Promote a healthy environment and adapt to climate change
- Invest in infrastructure, open space, and culture

The engagement process for *Imagine Boston 2030*, the BPDA's PLAN initiatives in neighborhoods such Roxbury, Mattapan, and East Boston, and other initiatives are excellent starting points to bring all Boston communities together to participate in making the critical choices that will transform the city in the next few decades.

19 Governing the States and Localities. 2013. Internet Connection Data for Cities. Available online: http://www.governing.com/gov-data/city-internet-connection-household-adoption-rates-data.html.
20 City of Boston. 2019. Broadband and Digital Equity. Available online: https://www.boston.gov/departments/broadband-and-cable/broadband-and-digital-equity#digital-equity-fund.
21 City of Boston. 2018. Imagine Boston 2030: A Plan for the Future of Boston. Available online: https://www.boston.gov/sites/default/files/imce-uploads/2018-06/imagine20boston202030_pages2.pdf.
22 City of Boston. March 2017. Go Boston 2030: Vision and Action Plan. Available online: https://www.boston.gov/sites/default/files/go_boston_2030_-_full_report_to_download.pdf.
23 City of Boston. 2016. Climate Ready Boston: Executive Summary. Available online: https://www.boston.gov/sites/default/files/02_20161206_executivesummary_digital.pdf.
24 City of Boston. 2018. Imagine Boston 2030: A Plan for the Future of Boston. Available online: https://www.boston.gov/sites/default/files/imce-uploads/2018-06/imagine20boston202030_pages2.pdf.

9. Address historical disparities in transportation equity

Boston has a transportation equity problem because many neighborhoods with large socially vulnerable populations lack access to, and/or pay proportionately more for transportation. Action to reduce GHG emissions in transportation should include equity in transportation planning along four dimensions:[25]

1. **Accessibility:** Improve accessibility to key destinations (work, school, groceries, transit) with a focus on socially vulnerable families
2. **Travel time equity:** Track and improve equity in travel time to work, school and essential services across multiple modes of transport (cars, public transit, bikes, walking)
3. **Income group equity:** Track and improve equity in transport expense across different income groups
4. **Safety:** Track and improve traffic injuries and deaths across car users, cyclists, and pedestrians on a per trip basis

At its most basic level, transportation equity requires affordable housing near rapid transit (subway or dedicated bus lanes), and/or the expansion of rapid transit network into affordable neighborhoods.[26] Broader policy reforms include improving the walkability and bike-ability of neighborhoods, improving the quality of public transit and the provision of special mobility services, and targeting ride-sharing incentives to low-income commuters.[27] Policies addressing transportation equity will also need to focus on the cost of public transportation, the reliability and frequency of service (especially bus routes), hours of operation, and connectivity (how difficult or easy it is to change lines).[28] Better access to public transit in socially vulnerable communities will only serve to address existing inequities if the public transit is able to affordably and reliably take Bostonians to the places they need and want to go.[29] *Go Boston 2030* provides an excellent blueprint because it is founded on the principle of accessible mobility, with a specific goal of having every resident live within 10 minutes of transit, bikeshare, and carshare.

10. Improve energy security and access to clean energy

Energy efficiency in buildings addresses the largest source of GHG emissions, and simultaneously could reduce energy insecurity, increase family wealth, and improve living conditions and public health. Similarly, equity goals reinforce emission reductions in energy when new jobs associated with rooftop solar are aimed at socially vulnerable communities, areas of high unemployment, and those who have historically been underrepresented in the energy and building sectors workforce. Affordable, clean electricity that is available to all residents via municipal aggregation or another procurement mechanism enables all residents to benefit from the clean energy transition. Effective energy efficiency and clean electricity programs include communications that consider differences in language and culture.

These guiding principles stem from a fundamental premise: burdens, barriers, and vulnerabilities are simultaneously opportunities as well. Seizing those opportunities rests on the collective ability of the City and everyone who live and works in Boston to remain mindful of what connects climate mitigation and equity policy: careful planning to avoid unintended consequences, intentional design with a clear focus on equity outcomes, and inclusive practices from start to finish in all decision-making. Meaningful participation in decision-making, policy planning and design, implementation, and evaluation ensures that all Bostonians will benefit from action to be a carbon-neutral city in 2050.

25 Chipello-McGill, C. January 8, 2015. 4 Ways to Include Social Equity in City Planning. Futurity. Available online: https://www.futurity.org/social-equity-city-transportation-833992/; (2) Manaugh, K., Badami, M.G. and El-Geneidy, A.M. January 2015. Integrating Social Equity into Urban Transportation Planning: A Critical Evaluation of Equity Objectives and Measures in Transportation Plans in North America. Transport Policy, 37, 167–176. Available online: https://doi.org/10.1016/j.tranpol.2014.09.013.

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Appendices

Appendix A: People and Organizations

Social Equity Advisory Group

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Metropolitan Area Planning Council

Mariama White-Hammond
New Roots AME Church

Appendix B: Socially Vulnerable Populations

Source: Data from US Census Bureau, 2012-2016 American Community Survey: 5-Year Estimates.

CHILDREN

(108,939 people)

Description: Children and adolescents are especially vulnerable to both indoor and outdoor air pollution. Reduced fossil fuel combustion in transportation will improve health outcomes for this population. Transit, biking, and walking produce safer streets, improve children's navigation skills and knowledge of their neighborhood, and increase physical activity. Energy-efficient buildings reduce mold and allergens that cause asthma and other respiratory illnesses.

Data: B01001 Sex by Age - Below 18 Years of Age

LIMITED ENGLISH PROFICIENCY

(31,796 households)

Description: Thirteen percent of Boston's population have limited English proficiency. This population will need targeted information on proposed actions to reduce GHGs. Among those with limited English proficiency, the most common languages spoken in Boston are Spanish or Spanish Creole (17%), Chinese (5%), French Creole (4%), and Vietnamese, Portuguese, and Portuguese Creole (3%). Linguistically appropriate and culturally relevant training and education materials will support efforts on waste reduction, increased residential energy efficiency, and active transportation.

Data: S1602 Limited English Speaking Households - Limited English Speaking Households

LOW TO NO INCOME

(187,515 people)

Description: People with low to no income spend a large fraction of their household income on energy and rely heavily on public transit. Energy-efficient buildings will lower household energy bills. Action to improve building energy efficiency should help this population pay for the upfront costs of building retrofits. Investment in transit will reduce GHG emissions and benefit low-income populations. Fees levied to reduce GHG emissions in transportation must be accompanied with action to offset the impact on this population. Equitable access to electric vehicles, smart mobility, and other new technologies should be prioritized.

Data: B06012 Place of Birth by Poverty Status in the Past 12 Months - Below 100% of the Poverty Line + Between 100-149% of the Poverty Line

OLDER ADULTS

(70,229 people)

Description: People over the age of 65 have physical and social vulnerabilities in the context of climate change and mitigation. They suffer from higher rates of medical illness than the rest of the population, are often socially isolated, and can have functional limitations that impede mobility. Energy efficient buildings will improve indoor air quality and reduce thermal stress in winter and summer. Investments in transit, biking, and walking directly address this population's mobility and access challenges, and improve health outcomes via more physical activity.

Data: B01001 Sex by Age - 65 Years of Age and Older

PEOPLE OF COLOR

(359,738 people)

Description: A majority of people of color (55.3%) make up Boston's residential mix; 19.5% of residents are Latino/x, 22.9% are Black, 9.5% are Asian, and 2.5% are multiracial. Action to reduce GHG emissions has the potential to decrease the burdens these communities bear on a daily basis by establishing pathways to equitably distribute benefits and increase resilience. This requires an intentional effort to remove historical barriers and include people of color in the decision-making that impacts their lives.

Data: B03002 Hispanic or Latino Origin by Race - (Non-Hispanic)[Black or African America + American Indian & Alaska Native + Asian + Native Hawaiian & Other Pacific Islander + Some Other Race Alone + Two or More Races] + Total Hispanic or Latino

PEOPLE WITH DISABILITIES

(80,101 people)

Description: One in 10 people in Boston has a disability and may face challenges around mobility, resources, and social connection. Investment in public transit and active transport can simultaneously reduce GHG emissions and improve mobility for this population. Similarly, building retrofits can simultaneously increase energy efficiency and increase access to buildings.

Data: B18101 Sex by Age by Disability Status - All Ages Male with a Disability + All Ages Female with Disability

Appendix C: Methodology

Part A: Social Vulnerability Index

Created for the *Carbon Free Boston: Social Equity Report*, the Social Vulnerability Index provides an estimate of census tracts and neighborhoods' cumulative concentration of communities thought to be at particular risk of energy, food, medical, or financial insecurities. As is discussed more fully in the report, socially vulnerable communities often lack the capacity to withstand hard times—that is, to prepare for, respond to, and recover from emergencies such as a missed paycheck, illness, or the effects of a natural disaster.

The Social Vulnerability Index combines values from six measures, each a share of census tract or neighborhood population composed of a given group:

- Children (18 years and younger)
- Limited English Proficiency
- Low to No Income (below 150% of the poverty line)
- Older Adults (65 years and older)
- People of Color (including Black or African American, American Indian and Alaska or Hawaiian Native, Asian, Pacific Islanders, and all Latinx/Hispanic)
- People with Disabilities (both physical and mental)[1]

Appendix Table 1 presents high and low values shares of each vulnerable group by census tract and neighborhood. For example, the census tract with the highest share of children (36 percent) compared to that with the lowest (0 percent), and the neighborhood with the highest share of children (Hyde Park with 23 percent) compared to that with the lowest (Longwood with 1 percent).

Appendix Table 1. Socially vulnerable groups and index, by census tract and neighborhood

		SV Index	People of Color	Children	Older Adults	People with Disabilities	Low-income	Limited English Proficiency
By Census Tract	Highest	62	100%	36%	32%	68%	89%	52%
	Lowest	5	3%	0%	0%	0%	0%	0%
By Neighborhood	Highest	49	93%	23%	18%	17%	55%	29%
	Lowest	13	17%	1%	1%	6%	9%	3%

1 U.S. Census Bureau. American Community Survey (ACS). 5-year Estimates. Available online: https://www.census.gov/programs-surveys/acs. Census tracts with n ‹ 50 were dropped. All SVP were normalized to the total population (individuals or households) of each Census tract. Data variables include: B01001 Sex by Age; S1602 Limited English Speaking Households; B06012 Place of Birth by Poverty Status in the Past 12 Months; B01001 Sex by Age; B03002 Hispanic or Latino Origin by Race; and B18101 Sex by Age by Disability Status.

Population shares for the six vulnerable groups are converted into six component indices, each ranging from 0 to 100/6 (or 16.7) in value. For example, the component index for children ranges from 0.0 (for the census tract with 0 percent children to 16.7 for the census tract with 36 percent. The conversion of population share to component index values is as follows:

$$Component\ Index = \left[\frac{population\ share - minimum\ census\ tract\ share}{maximum\ census\ tract\ share - minimum\ census\ tract\ share}\right] * \left(\frac{100}{6}\right)$$

These six component indices are summed to calculate the Social Vulnerability Index. If any census tract or neighborhood had the lowest census tract share of all six vulnerable groups—receiving six component index values of 0.0—its Social Vulnerability Index would be 0.0. Likewise, if any census tract or neighborhood had the highest census tract share of all six vulnerable groups—receiving six component index values of 16.7—its Social Vulnerability Index would be 100.0.

In Boston, actual census tract Social Vulnerability Indices range from 5 to 62, and neighborhoods from 13 to 49.

Part B: Neighborhood Characteristics (Tables 2, 3 and 4)

In Table 2, Table 3 and Table 4, Boston's neighborhoods names are highlighted in three shades of blue that correspond to their Social Vulnerability Index value: light blue indicates the lowest (least vulnerable) Social Vulnerability Index results (less than 23); medium blue indicates the middle Social Vulnerability Index results (23 to 35); and dark blue indicates the highest (most vulnerable) Social Vulnerability Index results (greater than 35). Similarly, Table 2, Table 3 and Table 4 use three shades of blue to indicate low, middle or high values for each neighborhood characteristic presented.

Appendix Tables 2-4 below show the first two neighborhoods shown in Table 2, Table 3 and Table 4, respectively, and the ranges bounding the low, middle, and high groups for each variable. Light blue indicates the lowest results, medium blue indicates the middle results, and dark blue indicates the highest results. Note that in some cases, low values are worse (more vulnerable) than high: median income, single-family home share, population density, and transit infrastructure per capita or per 10,000 residents (Table 3). For these characteristics, the lower/better values are shaded in dark blue and the higher/worse values are shaded in light blue. In all cases, dark blue coloring indicates greater vulnerability and light blue coloring indicates less vulnerability. For each neighborhood characteristic, low, medium and high ranges were selected to create three balanced groupings that are representative of the range of values across all Boston neighborhoods.

Appendix Table 2. Table 2 color coding examples and data ranges

TABLE 2 DATA EXAMPLE							
Neighborhood	**SV Index***	**People of Color**	**Children**	**Older Adults**	**People with Disabilities**	**Low-income**	**Limited English Proficiency**
Allston	23	44%	4%	4%	7%	42%	9%
Back Bay	20	24%	7%	15%	6%	15%	6%
DATA RANGES							
Low:	‹22	‹20%	‹5%	‹5%	‹10%	‹20%	‹10%
Medium:	23-34	21-59%	6-19%	6-9%	11-14%	21-39%	11-14%
High:	›35	›60%	›20%	›10%	›15%	›40%	›15%

Appendix Table 3. Table 3 color coding examples and data ranges

TABLE 3 DATA EXAMPLE							
Neighborhood	Median Income	Population Density (1000s per sq mile)	Single Family Unit	Small Multi Family Unit	Large Multi Family Unit	Average Year Built	Share of Renters
Allston	$41,706	12	19%	58%	22%	1926	75%
Back Bay	$99,110	29	12%	15%	73%	1936	88%
DATA RANGES							
Low:	›$80,000	‹10	›30%	‹30%	‹10%	1930+	‹50%
Medium:	$50-$79,999	11-19	16-29%	31-59%	11-49%	1911-1929	51-79%
High:	‹$49,999	›20	‹15%	›60%	›50%	1854-1910	›80%

Appendix Table 4. Table 4 color coding examples and data ranges

TABLE 4 DATA EXAMPLE						
Neighborhood	Miles of Bus Route	T Stops	Blue Bike Stations	Bike Network Miles	EV Charging Stations	Rooftop Solar Installations
	Per 10,000 Residents					
Allston	38.3	3.6	4.6	4.8	3.6	5.7
Back Bay	11.8	2.2	4.4	3.1	5.5	0.6
DATA RANGES						
Low:	›50.0	›3.0	›4.0	›3.0	›2.0	›30.0
Medium:	10.1-49.9	1.1-2.9	2.1-3.9	2.1-2.9	0.5-1.5	7.1-29.9
High:	‹10.0	‹1.0	‹2.0	‹2.0	‹0.5	‹7.0

Appendix D: Example Table Citations

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Glossary

active transport
The movement of people and goods via walking, biking, and other non-motorized modes of transportation.

biomethane
A form of biogas that has been processed to meet pipeline quality standards by increasing the fraction of methane via the removal of carbon dioxide, hydrogen sulfide, and other trace constituents. Such processing produces a gas that can shipped in gas pipelines and used interchangeably with conventional (fossil or geologic) natural gas. Also called "biogenic" gas.

carbon dioxide (CO_2)
A naturally occurring gas, and also a byproduct of burning fossil fuels and biomass, as well as land-use changes and other industrial processes. It is the principal human caused greenhouse gas that affects the Earth's radiative balance.

carbon offset
A credit for greenhouse gas reductions achieved by one party that can be purchased and used to compensate (offset) the emissions of another party. Offsets are typically measured in tons of CO2-equivalents, and are bought and sold through a number of international brokers, online retailers, and trading platforms. Common forms are included investments in renewable energy, energy efficiency, and forestry.

climate change
A change in the state of the climate that can be identified by changes in the mean or the variability of its properties and that persists for an extended period, typically decades or longer.

climate justice
The movement to address climate change that recognizes that socially vulnerable populations both contribute the least to climate change and also suffer "first and worst."

congestion fee
A fee paid by drivers who enter a specific geographic area, typically a city center. Also known as a cordon fee.

decarbonization
(i) The declining average carbon intensity of primary energy production over time;
(ii) the reduction of carbon emissions from energy supply chains and industrial processes;
(iii) the process by which countries or other entities aim to achieve a low-carbon economy, or by which individuals aim to reduce their consumption of carbon.

displacement
The immediate result of gentrification. This outcome is typically involuntary and occurs when residents can no longer afford to live in their neighborhoods/communities.

energy burden
The percent of household income spent on fuels and electricity.

energy efficiency
Using less energy to provide the same service (lighting, mobility, cooling/heating, etc.)

energy insecurity
The lack of consistent access to affordable and clean fuels and electricity.

energy justice
The concept of an energy system that equitably distributes the benefits and burdens of providing energy.

environmental justice
A framework recognizing that socially vulnerable populations are often disproportionately impacted by environmental hazards and are less likely to have access to the political power and tools necessary to rectify these disparities, yet have the right to a clean and healthy environment in which to live, work, go to school, play, and pray.

ethnicity
The national origin(s) of one's parents, grandparents, and other ancestors. People within an ethnic group may share beliefs, language, culture, traditions, religion, etc.

greenhouse gas (GHG)
Any gas that absorbs infrared radiation in the atmosphere. GHGs evaluated in this study include carbon dioxide, methane, and nitrous oxide. Other GHGs include ozone, chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride.

justice
The state or quality of being fair, equitable, or moral. It exists when people are not treated unfairly on the basis of race, gender, sexuality, religion, political affiliations, age, belief, disability, location, socioeconomic circumstances, or any other characteristic(s).

mitigation (of climate change)
A human intervention to reduce the sources or enhance the sinks of greenhouse gases.

municipal solid waste (MSW)
Residential solid waste and some non-hazardous commercial, institutional, and industrial wastes.

natural gas
Naturally occurring mixture of principally methane and small fractions of hydrocarbon and non-hydrocarbon gases found in porous geologic formations beneath the Earth's surface, often in association with petroleum (oil). It is sometimes referred to as "geologic", "fossil", "conventional", or "thermogenic" natural gas to distinguish it from biomethane ("biogenic" gas).

oppression
Unjust use of power and authority that adversely impacts groups and individuals that have historically and system been disadvantaged.

people of color
A political term used to describe non-White, oppressed populations in the US.

prejudice
A negative, preconceived opinion about an individual or group formed without actual knowledge or fair and just reason.

race
A false classification of human beings that consciously and unconsciously uses "white" as the norm, as the model of humanity which establishes and maintains the oppression of people of color.

racism
A historically rooted system of dehumanizing assumptions, behavior, and actions by individuals and institutions based on ideologies that reinforce the superiority and power of white people and the inferiority and powerlessness of people of color, while harming both. A system of prejudice and discrimination based on how one looks ("race").

renewable natural gas
See biomethane.

rent-burdened
The state of financial stress caused by a large portion of household income devoted to rent.

resilience
The ability to respond to and recover from stress.

social isolation
A state of physical and/or physiological distance from an individual's desired or necessary network of relationships with other people. Whether voluntary or imposed, the survival needs of socially isolated individuals are often compounded by other social circumstances, go unmet on a daily basis, and are further exacerbated in cases of crisis/emergency.

social vulnerability
The condition resulting from social factors and circumstances that create a lack of capacity or capability to prepare for, respond to, and recover from emergencies. These social circumstances are associated with age, gender, race, medical illness, disability, literacy, and/or English proficiency and are the basis of unjust, disproportionate burdens of environmental impacts.

split incentive
A situation in which the landlord bears the cost of energy efficiency improvements but the tenant receives the benefit in terms of reduced energy bills.

transportation justice
The idea that the transportation options and costs offered by a city or region are fair only if they provide a sufficient level of accessibility to all residents under most circumstances.

Abbreviations

ABCD	Action for Boston Community Development
ACEEE	American Council for an Energy-Efficient Economy
BHA	Boston Housing Authority
CCA	Community Choice Aggregation
CCE	Community Choice Energy
EPA	US Environmental Protection Agency
EPR	Extended Producer Responsibility
EV	Electric Vehicle
FHA	US Federal Housing Authority
GHG	Greenhouse Gas
HVAC	Heating, Ventilation, and Air Conditioning
ISE	Boston University's Institute for Sustainable Energy
LEED	Leadership in Energy and Environmental Design
LIHEAP	Low-Income Home Energy Assistance Program
MAPC	Metropolitan Area Planning Council
MBTA	Massachusetts Bay Transportation Authority
NO_2	Nitrogen Dioxide
PV	Photovoltaic
SLR	Sea Level Rise
SMART	Solar Massachusetts Renewable Target
SV	Socially Vulnerable
SVI	Social Vulnerability Index
USGBC	US Green Building Council
VMT	Vehicle-Miles of Travel

Additional Photo Credits: Front cover, Mayor Martin Walsh joined Councillor Ayanna Pressley at her 3rd Annual Jump Into Peace Event at Malcolm X Park in Roxbury. Mayor's Office photo by Don Harney; Page 3, Boston Public School students display there winning artwork at the annual opening of the Swan Boats on the Boston Public Gardens, Mayor's Office Photo by Jeremiah Robinson; Page 4, The Food Project's Roxbury garden. Photo credit: City of Boston; Page 6, Boston's North End neighborhood. Photo credit: Huntstock, Inc/Alamy Stock Photo; Page 12, Boston's South Boston ("Southie") neighborhood. Photo credit: Denis Tangney Jr/Getty Images; Page 30, East Boston from the Custom House Tower. Photo credit: user joswr1ght/Wikimedia Commons; Page 62, The annual Hub on Wheels Bike Ride in Boston. Photo credit: City of Boston; Page 84, iStock/mediaphotos; Page 94, National Renewable Energy Laboratory; Page 106, Global Warming Images/Alamy Stock Photo; Page 110, National Renewable Energy Laboratory; Page 118, The annual Puerto Rican Pride Festival at City Hall Plaza. Photo credit: City of Boston; Page 131, City of Boston; Back cover, Mayor Martin Walsh attends the Unity Park ribbon cutting, Mayor's Office Photo by John Wilcox.


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BOSTON Green Ribbon COMMISSION

BOSTON UNIVERSITY

Applied Economics Clinic
Economic and Policy Analysis of Energy, Environment and Equity

All Aces, Inc.
Dealing a Controlling Hand