The Boston Climate Progress Report:

CONNECTING BOSTON: LOCAL ENERGY PLANNING FOR BOSTON'S CLIMATE GOALS

A big lift necessary for Boston's climate progress

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

SUPPLEMENTARY CHAPTER

2

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Boston Green Ribbon Commission

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1. EXECUTIVE SUMMARY

Achieving the goals of decarbonization, resilience, and enhanced social equity (in this document called energy justice) requires modernizing energy infrastructure to:

- support deep electrification of buildings and transportation
- develop new low-carbon energy resources
- share energy resources across electrical and thermal grids
- enhance energy reliability and resilience
- manage the costs of aging infrastructure,
- address past harms and neglect in energy infrastructure typically experienced by low-income, predominantly minority communities.

These changes will occur on every street across Boston. Some are happening now with little notice, while others, such as gas pipeline replacements, feel like they are happening everywhere because they are visible and often disruptive. The pace of energy infrastructure changes—seen and unseen—will need to increase to achieve the above goals.

The prolonged controversy around Eversource's proposed East Eagle substation in East Boston highlighted a disconnection between the benefits and the burdens of hosting infrastructure. Efforts to enhance and situate energy infrastructure in order to reliably meet growing electricity demands in the community seemed at odds with that community's sense of neighborhood preservation and safety.

Previous efforts by the City of Boston to lead in the development of modern energy infrastructure to support climate and resilience goals have been constrained by state regulation.

Rapidly building the energy distribution system and supporting the infrastructure necessary to achieve climate and equity goals requires the further development of local energy planning. Such planning seeks to:

1. Identify local decarbonization, resilience, and energy justice needs.
2. Identify opportunities to develop local alternative energy resources (e.g., geothermal, waste heat), build thermal networks, conduct batch retrofit buildings, and upgrade electric infrastructure.
3. Balance both local and non-local decarbonization, resilience, and energy equity needs.
4. Evaluate alternative scenarios for energy infrastructure development to identify opportunities and tradeoffs.
5. Have a long-term vision but be regularly updated to incorporate changing circumstances.
6. Be technically detailed but convey information to the general public via community groups, translation services, and alternative media outreach.

Such planning can be—but does not have to be—led by the municipal government in a similar fashion to how Boston currently does neighborhood-level resilience planning. The City has sought to identify opportunities for new networks and microgrids but has been limited in its power to drive forward such strategies. An increase in institutional capability in City Hall and new state legislation will be needed to enable local energy planning and action. Improved data availability will be necessary to support planning and tracking.

Navigating This Content

This chapter of the *Boston Climate Progress Report* is a summary of issues and key barriers relating to energy planning and development in Boston and the Metro Boston region. It begins by reviewing the role of upgraded and new energy systems furthering mitigation, resilience, and equity goals. It then reviews challenges in substation siting and in developing new shared infrastructure to highlight the difficulty of deploying new energy. It defines what such infrastructure could be, and offers some high-level action areas (summarized in the table below) for advancing more local involvement in energy planning by City Hall and the public. Major indicators are then reviewed. The chapter concludes with an assessment and several prompts for leaders in this space to consider as they advance energy planning for decarbonization.

These recommendations are intended to be high level and support the launching of more detailed work on several fronts to accelerate development of the energy system to support mitigation resilience, and equity goals.

Table 1.
Action Areas to Increase Local Involvement in Energy Planning

ACTION AREA	RESPONSIBLE PARTY/ PARTIES	DESCRIPTION	PROGRESS INDICATORS
Expand City of Boston planning powers	Legislature City of Boston, DPU, Utilities	The state should grant Boston more control over its energy planning given its unique situation and resources. There is a range of possible levels of control; expanding to any of these levels would require legislative action and coordination with the DPU and utilities.	Legislation expands planning powers.
Expand City of Boston planning capacity	City of Boston	The City of Boston should leverage federal IRA funds to scale up its energy planning office, with the aim of meeting energy transition support needs by the 2030s.	City planning budget, staff, and case load all increase.
Develop local energy planning processes that ensure positive outcomes for communities hosting energy infrastructure	City of Boston, DPU, Utilities	Empowering communities with knowledge about pending energy infrastructure has the potential to build support. Alerting communities to proposed energy plans, communicating through various channels, and providing multilingual support and resources for people who cannot make meetings supports better community engagement.	Community buy-in and support for energy projects increase.

2. BACKGROUND

Boston has established goals of achieving net-zero emissions by 2050, increasing resilience to a changing climate, and increasing social equity though climate action. These goals have been directly articulated with an increasing sense of urgency by Boston's last four mayors. They are also largely aligned with state policy and have been embraced by community.

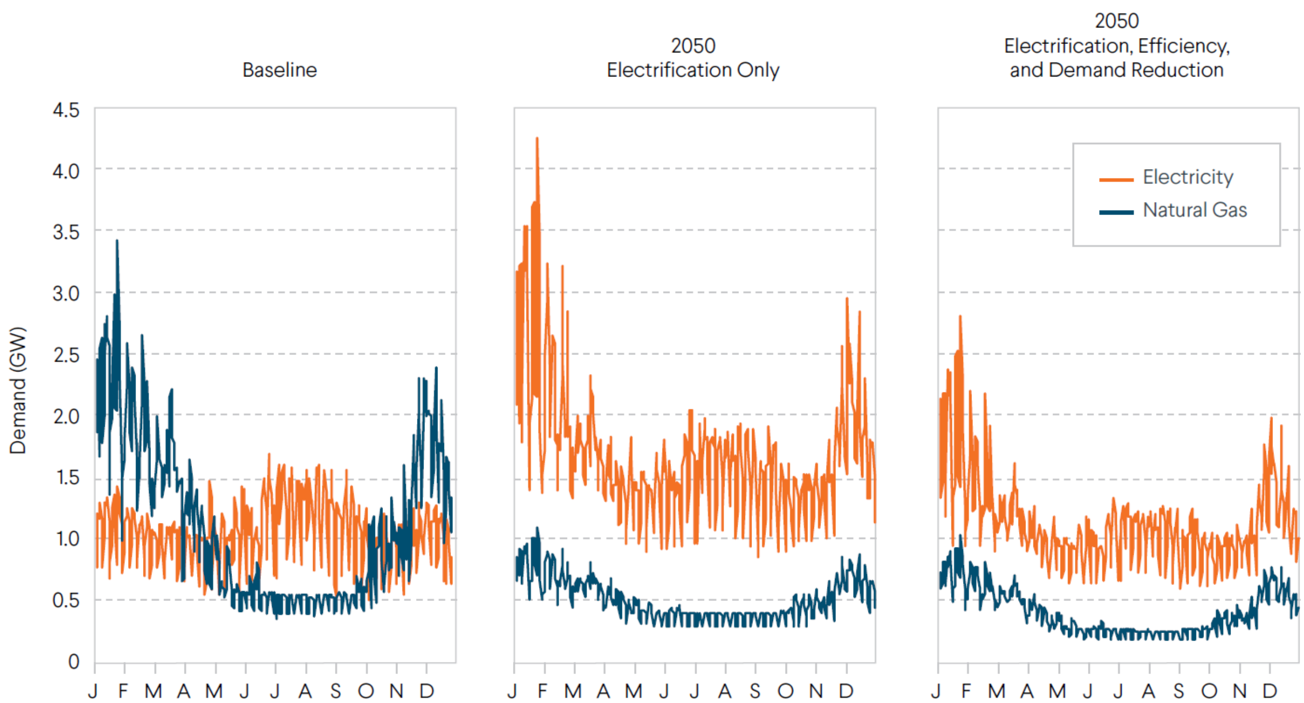
Boston's climate *mitigation*—greenhouse gas reduction—goals will put new pressures on existing electrical infrastructure and necessitate extensive upgrades to electricity generation, transmission, and distribution technologies. These pressures are not unique to the city of Boston or even Greater Boston. For example, ISO New England recently concluded that the entire New England grid would need to double in capacity (installed electrical generation) over the next two decades to accommodate higher shares of renewable energy sources and serve increasing levels of demand from electrification.[1] Within the city, the *Carbon Free Boston* report modeled a future net-zero energy system and found that total electricity demand in Boston could be 12 to 57 percent higher in 2050 compared to 2015.[2] The substantial range in future electricity demand growth is attributable to a range of projections in energy use efficiency across the heating and transportation sectors.

Currently, *peak energy demand* in Boston occurs on frigid winter days when heating demand is high. Still, this demand is currently met primarily by the direct combustion of natural gas (plus a small amount of fuel oil). *Peak electricity demand*, in contrast, occurs on hot summer afternoons, primarily driven by the demand for air conditioning. The summer peak in electricity demand is less than the winter peak in total energy. However, as space heating electrifies throughout the city, the Boston electricity grid will face a dramatically increased peak demand on cold winter mornings and evenings. This change in the timing of peak demand brings additional challenges for electricity infrastructure planning, as generator and grid infrastructure performance characteristics and availability can be different in cold weather than in hot. As illustrated below in Figure 1, *Carbon Free Boston's* analysis suggests that the future winter peak demand could be approximately 2.8 to 4.3 GW, whereas the 2015 summer peak demand was only about 1.6 GW. This massive increase in peak demand, and a substantial shift in timing, will necessitate a radical change and substantial investments in the city's electrical infrastructure. While overall electricity consumption may rise by 12 to 57 percent, peak demand—which primarily drives grid investments and costs—could rise more than 160 percent.

These sharp increases in total and peak electricity demand have been projected in other decarbonization studies focused on the state and local scale.[3]

Figure 1. **Impact of electrification on peak demand in modeling from Carbon Free Boston.**[2]

Source: Carbon Free Boston



The threat of more extreme storms and disparities in energy infrastructure across communities highlight the need to make the system more resilient and equitable. Boston's neighborhoods experience a notable variability in impact and response time to outages. Above-surface infrastructure is at risk of being impacted by a severe storm. Older transformers may be stressed by increasing temperatures while struggling to meet increasing electric demands driven by building cooling needs.

Efficiency, demand management (load shifting), energy storage, solar, alternative thermal resources (e.g., ground, water, and waste heat), and smart backup generation are all essential *local* tools (distributed energy resources) for reducing the impacts of growing electrical demand and making buildings and the grid more resilient. To leverage these resources wisely, energy distribution systems need to embrace an additional tool: integration or sharing energy across space and time. Integration is achieved by enabling two-way flows of electricity and heat between buildings and local energy resources. If planned well, these tools can be used to reduce the cost and footprint of the decarbonized and resilient energy distribution systems.

It is undeniable that equitable decarbonization and resilience will require the development of energy infrastructure across the city, particularly in marginalized communities where *community-serving infrastructure* has been historically underdeveloped. However, given a history of extractive planning associated with infrastructure that burdens more than benefits the community, there is a clear need to develop such infrastructure with inclusive community buy-in to minimize potential burdens and maximize benefits for such communities.

Planning, funding, and siting up the new energy infrastructure required for decarbonization is a significant challenge. Currently, the Boston city government has a limited role in energy infrastructure planning, as most of the decision-making power rests with the City's private utilities (Eversource for electricity and National Grid for natural gas) and the Massachusetts Department of Public Utilities (DPU), which regulates them.

Energy planning needs a more local focus to leverage opportunities for decarbonization and resilience that are beginning to emerge at the local level. Community-focused local energy planning can also serve as an opportunity to build community ownership of, interest in, and guidance of new infrastructure in a way that helps to accelerate its deployment to drive forward climate and equity outcomes.

This chapter reviews recent challenges surrounding energy planning by reviewing substation planning and efforts by City Hall to develop low-carbon and resilient infrastructure.

3. THE DISCONNECTION: A TALE OF TWO SUBSTATIONS

The East Boston Substation

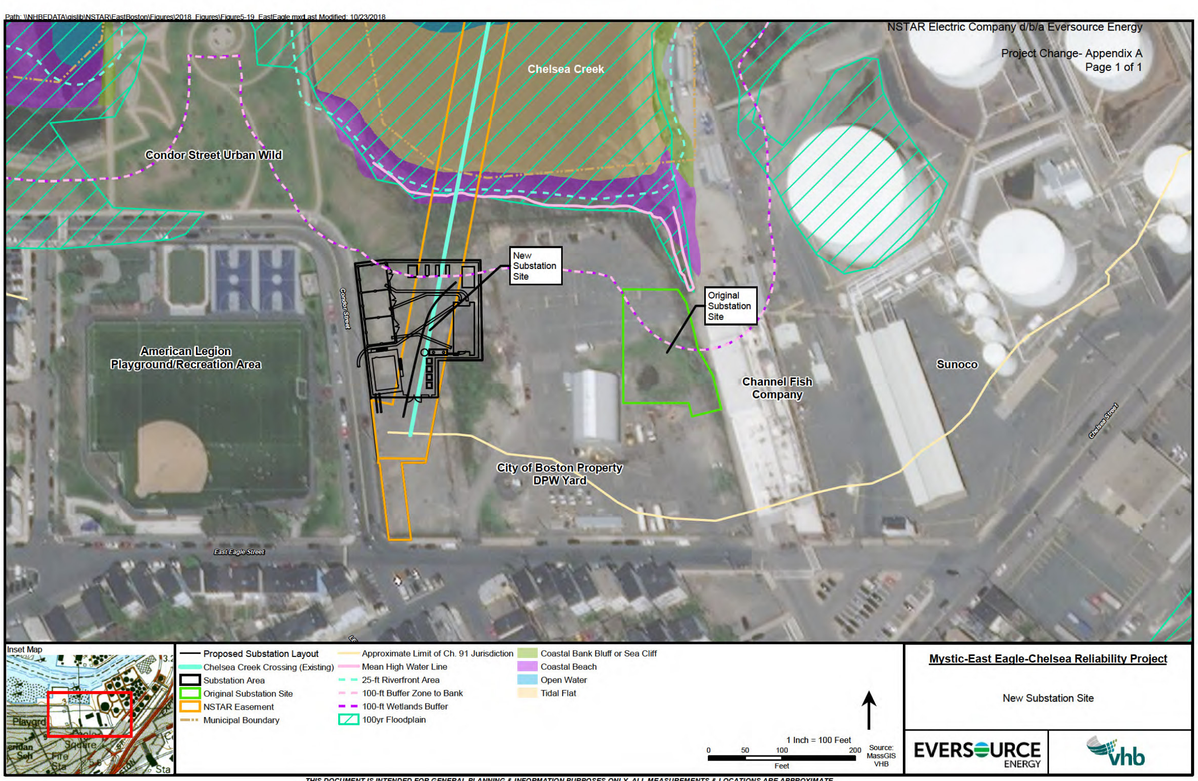
The development of a greenfield electric distribution substation in East Boston by Eversource is a now well-known controversy that illustrates the disconnect in energy infrastructure planning between the City government, residents, their utilities, and the Commonwealth. The ongoing saga of the East Boston substation is evidence of how increased energy infrastructure needs are challenged by antiquated planning frameworks that are inflexible and unresponsive to community interests. Ultimately, this threatens to slow the City's progress toward its climate goals.

Eversource first sought approval to build the East Boston substation (part of the Mystic - East Eagle - Chelsea Reliability Project) in 2014, arguing that the substation was necessary to meet future electricity demand growth in the neighborhood, driven by redevelopment and electrification in the area.[4] The East Boston neighborhood had been an “electrical island” not served by its transmission or distribution infrastructure. Instead, it connected to the grid through infrastructure in the neighboring city of Chelsea. In 2017, the Massachusetts Energy Facility Siting Board (EFSB) approved Eversource’s application for constructing the substation and associated transmission lines in East Boston. As of early 2022, the transmission lines have been completed, but the substation remains unconstructed, despite the project’s approval half a decade ago.

The East Boston substation project has faced opposition from various sources, including residents and environmental justice advocacy organizations. The opposition has taken two forms: substantive and procedural.

Figure 2. **East Boston substation engineering diagram showing proximity of the substation to a recreation area (left side); Chelsea Creek (top); and jet fuel depot (right).**

The proposed substation location was moved following a request by the Channel Fish Company (middle-right side) based on concerns regarding potential interference with its food processing equipment. Source: Eversource Energy Facilities Siting Board Filing (EFSB 22-01)



Substantive Concerns Surrounding the Substation

First, opponents of the project objected to the substantive need for the substation, arguing that Eversource's load forecasts were incorrect or that increases in local demand could be met entirely with distributed energy resources instead. These arguments tried to address a complex situation with simple-sounding and seemingly appealing solutions. However, these solutions would incur complex and potentially burdensome tradeoffs.

To achieve Boston's decarbonization goals, aggregate and instantaneous electric demand will need to rise with the electrification of buildings, transportation, and other high-energy end uses. A long line of studies ranging from *Carbon Free Boston*,[2] the Massachusetts 2050 Decarbonization Roadmap,[3] and long-range ISO-NE studies[1] all forecast a rise in electricity demand in the next decade and beyond to support the electrification of heating and transportation.

The expectation that increased demand could be entirely offset by solar and storage projects in East Boston underestimates the magnitude of the challenge that the neighborhood and region face as they electrify. For example: meeting large electric heating demand peaks in the winter during cold, low-wind, and low-sun weather. Further, even if such distributed energy resources were rapidly scaled up to meet load growth from economic development and electrification, East Boston's wires and transformers would need to be upgraded just as rapidly to accommodate much higher levels of these distributed energy resources.

Delaying electric upgrades challenges efforts to rightsize the gas system and reduce the burden on the neighborhood from gas combustion and gas leaks—which have been disproportionately correlated with low-income, immigrant, and Black communities in Massachusetts.[5] Like much of rest of the city, East Boston is home to a considerable number of leak-prone century-old cast iron pipes with a handful having been installed in the 1890s.

National Grid has specifically named the challenge of siting new electric infrastructure—using Boston as an example—as a justification for its proposal to maintain the gas distribution system near its current scale: "Siting new electric infrastructure such as generation, substations, and transmission and distribution lines are likely to be more challenging and disruptive to the communities and environment compared to low-density areas."[6]

Dense areas offer challenges and opportunities for shared energy infrastructure and distribution systems. Seizing the opportunities and overcoming the challenges require creating shared knowledge to inform the collaborative reconciliation of potential tradeoffs. As the implementation actions needed to meet the climate and equity challenges become clearer, all stakeholders could benefit from a more holistic view and understanding of the challenges and opportunities to overcome barriers to implementation faster.

Procedural Concerns Surrounding the Substation

Second, opponents to the project have also made procedural arguments that the community should have a more significant role in energy infrastructure planning that affects the community. These arguments are more salient than the substantive concerns raised in the previous section. The design and siting of urban energy infrastructure vary widely across communities. For example, substations in cities like New York, Chicago, Toronto, and Berlin are often hidden from public view with false building facades or street art.[7] Meanwhile, the energy infrastructure in historically disadvantaged neighborhoods are often eyesores to the surrounding community, as can be seen in the obvious substations throughout the Greater Boston area. For the residents of East Boston, adding another industrial structure in the eyesight of homes can feel like a step backward, even if the outcome of such infrastructure is a step forward for the energy system beyond this neighborhood.

Many opponents' arguments against the substation were over community-focused siting concerns. First, the site is adjacent to Chelsea Creek. It has a small risk of modest flooding in the future as sea level rise progresses in the latter half of this century (Figure 3). However, the design of the site is currently consistent with development guidelines (Figure 4). Further, an assessment[8] of Boston's risk to sea-level rise and storm surge shows that the area only starts to be at risk near the end of its lifetime (beyond 2060). Second, the site had been previously promised as recreational land. Finally, an alternative site at Logan Airport would be preferable.[9] While the Energy Facility Siting Board is tasked with managing the siting process, opponents argue that it is not responsive to local concerns due to the institution's high-level state government control and focus, which had not been designed to handle significant complex changes in dense urban environments.

A legacy of injustice and extractive development in certain communities (that are now called environmental justice communities) has created an understandable degree of mistrust in the institutions that have evolved from those responsible for that injustice.

The local community should have been involved in the process from an earlier stage, particularly given evolving community expectations surrounding that land use. Some controversies may have been avoided with relatively minor changes to siting and design. In 2021, the DPU and the ESFB opened proceedings[10,11] to investigate how these two organizations could improve their efforts to support environmental justice and how to better engage the public.

Figure 3. **Map of East Boston substation showing a 1% annual probability flood scenario in 2070 under 36 inches of sea-level rise.**

The figure[9] was used by the organization, Extinction Rebellion, to highlight potential risk to the substation. Source: Extinction Rebellion Boston

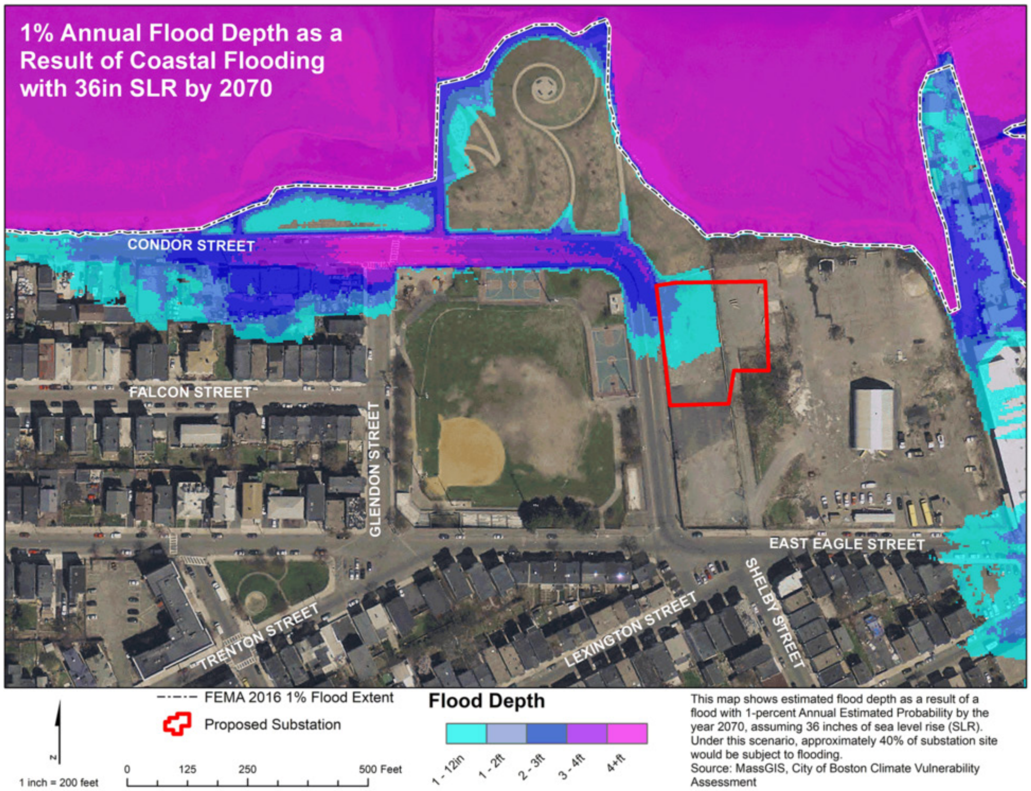
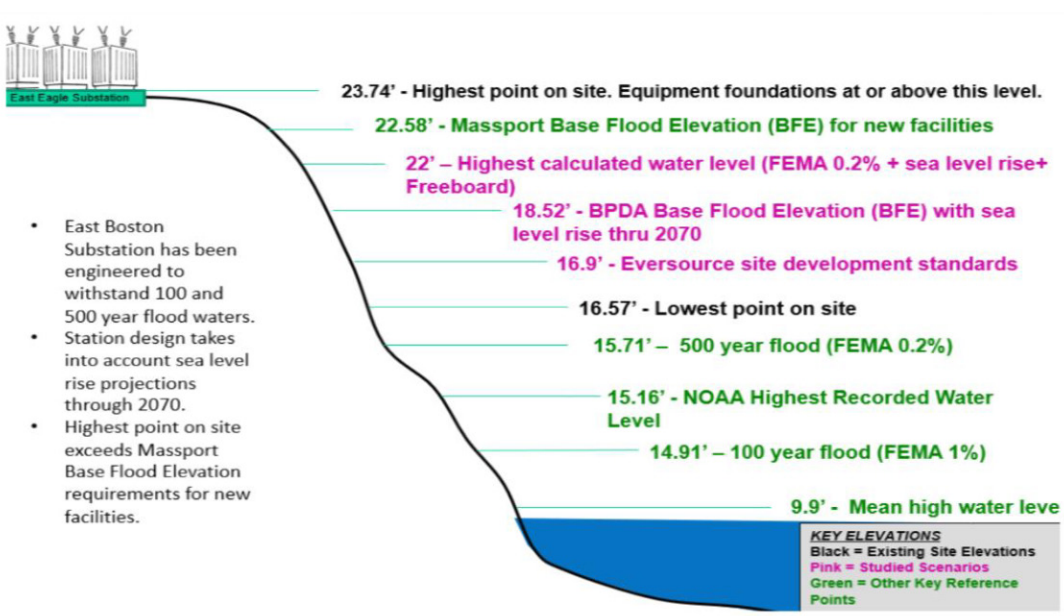


Figure 4. **Slide from Eversource presentation on substation design and sea-level rise.**[4]

Source: Eversource



Attempts to Halt the Substation

The opponents of the East Boston substation launched a non-binding referendum campaign in the Boston city elections in 2021, and nearly 84 percent of Boston voters voted against the project. The opponents have also launched three separate legal proceedings against the project, including federal civil rights complaints and appeals to the Massachusetts Supreme Judicial Court.[12] As of mid-2022, the project is subject to a new Energy Facilities Siting Board proceeding, in which Eversource is seeking a combined approval of several City permitting applications that have been delayed, including from the Boston Parks and Recreation Commission, the Boston Public Improvement Commission, and the Department of Public Works, among others.

Meanwhile, State Sen. Lydia Edwards, who represents East Boston, has filed a home rule petition that would give the city government more power to block projects that pose environmental risks and make the zoning review process of utility projects significantly stricter.

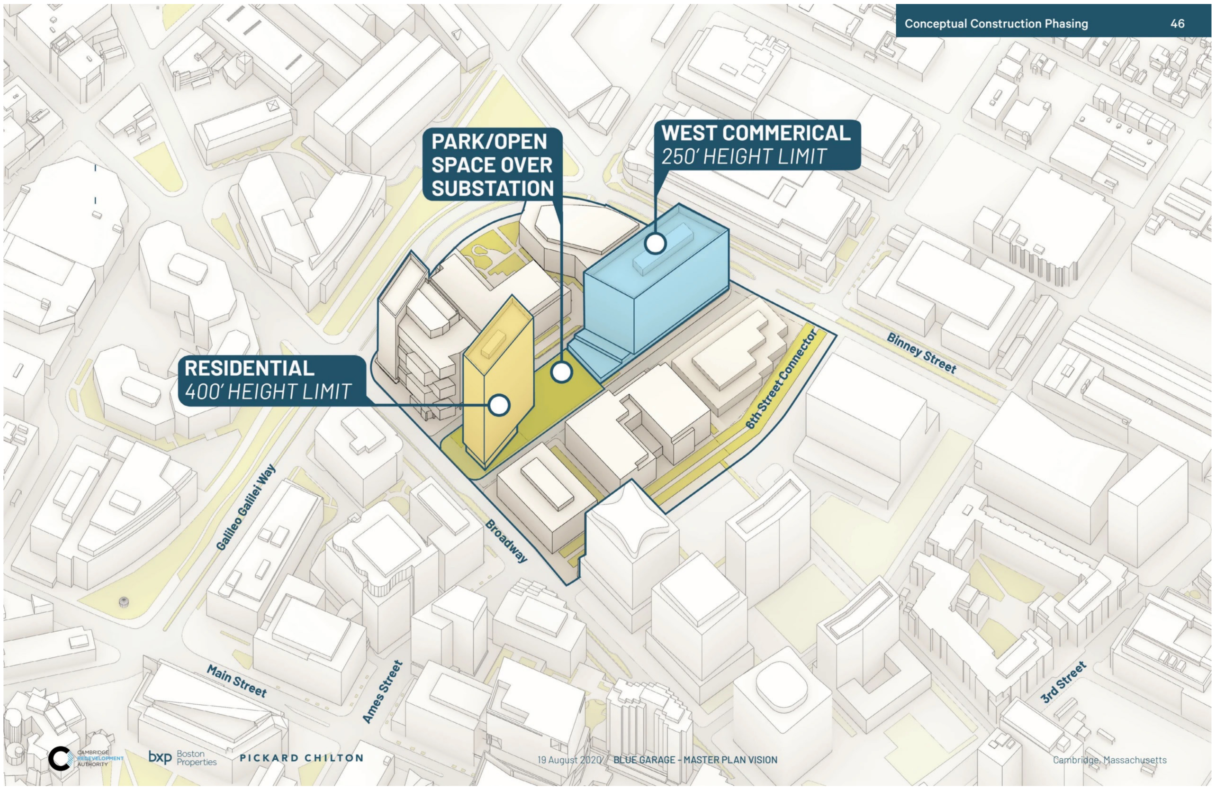
The concerns and opposition to the East Boston substation project illustrate a worrying barrier to future climate progress in Boston. Under a deeply decarbonized, highly electrified future, much more electrical infrastructure—more substations in more neighborhoods—will need to be constructed in the city. Due to the inherently location-specific nature of electricity distribution infrastructure, there will be limited flexibility in siting and design of this infrastructure. Frontline communities need to be prioritized in the development of infrastructure to recover from past underdevelopment and underinvestment.

Regrettably, and in a similar vein to a wide variety of other energy infrastructure projects (offshore wind, solar farms, transmission), local aversion to new infrastructure places Boston's shared climate goals at risk. Nonetheless, aspects of the East Boston substation controversy reflect legitimate problems with utility planning at the local level. Achieving ambitious climate and equity goals requires learning from the these past mistakes and quickly applying lessons to the next project.

Kendall Square Substation

Figure 5. **Underground substation with mixed-use development in Kendall Square, Cambridge.**[13]

Source: Cambridge Redevelopment Authority



With Kendall Square booming and experiencing increasing development in residential, office, and laboratory space, the need for greater electricity supply and support infrastructure resources became apparent in 2014. Eversource subsequently proposed the Greater Cambridge Energy Project to build a new substation and to connect the substation to existing resources via underground transmission lines crossing Cambridge.

The Initial proposed location for the substation was directly adjacent to a residential community on the northern end of the Kendall business district. Following community concerns and a call for alternative ideas, Boston Properties offered to house the substation in a subsurface vault as part of a redevelopment of one of its parking garages into a new commercial and residential development with a beautified outdoor community plaza (Figure 5).

Such integration with the urban landscape will likely have cost and other tradeoffs. Cost increases will be borne by ratepayers across the state, which will disproportionately burden low-income households. Such approaches should be analyzed and selected for cost-effectiveness. In some cases, moderate additional costs may be justified by the time value of the project completion and savings realized by avoiding extended litigation or regulatory delays. However, excess granting of aesthetic concessions may set a precedent that more affluent or politically influential stakeholders could exploit.

In part because of the lessons learned from the East Boston substation controversy, Eversource has been more proactive with public engagement on the siting of the substation and of connecting transmission lines. Such engagement includes a website with resources in multiple languages, presence at various community events, and virtual public open houses scheduled at accessible times. Even Boston Properties has launched a website focused on public engagement providing project information, e-mail signup for project news, and a feedback form.[14]

Eversource has also been more transparent and up-front with its examination of alternative strategies and their impacts on costs, level of disruption, and environmental footprint. Providing alternative proposals and assessing their impact educates the public on the complex tradeoffs associated with constructing new energy infrastructure in an urban environment. It also gives the public alternatives to consider and provide feedback on rather than create a situation where the only alternatives are to build or not.

Synthesis

The desire for public participation to guide planning decisions stems from genuine democratic values. Historically, low-income, minority, and other marginalized populations have been shut out of planning processes to their severe detriment. Society cannot become more equitable without working to fix the legacy of exclusionary planning and ensure that all stakeholders have a voice in the process to promote balanced outcomes.

However, public participation as it is widely practiced now has the potential to lead to undemocratic and inequitable outcomes. A longstanding body of evidence demonstrates that the “citizen voice” increases costs and lengthens the time to build infrastructure projects.[15,16] Further, participants in the process are not representative of their communities and often advocate for positions that are not necessarily in the best interest of their communities.

Research on Massachusetts public meetings has shown that participants in public processes tended to be older, Whiter, and much more likely to be homeowners than the general population of their municipality, and generally oppose new projects such as home construction.[15] Follow-up research during the COVID pandemic found that efforts to make meetings more accessible led to a more significant bias in participation toward old and White residents.[17]

The benefits of energy infrastructure projects can be significant—lower rates, decarbonization, cleaner air—but such benefits are diffusely realized by a large group of people, while the downsides of projects are more localized. The outcomes of infrastructure upgrades, in general, have broad support. However, it is hard to translate such broad support to single projects where opposition can readily coordinate to stymie a project. This dichotomy challenges the energy transition at both the local and the regional level (e.g., interstate transmission).

To address our region's housing crisis, there is a clear need to remove power from localities and shift it to the state. With interstate transmission, there is also a movement to reduce the ability of local entities to hold up a project—but certainly not remove public input. The recently overturned citizen referendum in Maine to block the transmission of low-cost, low-carbon electricity from Quebec to lower New England is another example of how projects that are essential to achieve our climate goals can face opposition by strange bedfellows, such as a combination of grassroots conservationists and entrenched fossil interests.[18] Climate and energy burden mitigation goals will be at risk if the pace of transmission construction cannot double relative to current trends.[19] Streamlining such regional planning is essential.

With local energy planning, however, the situation is more nuanced. A history of environmental harms levied on minority communities has eroded trust in the institutions responsible for siting new infrastructure. Leveraging a local energy resource such as a water body or earth for heating and cooling merits a more local focus in energy planning to build interest and willingness to pursue such a resource.

The East Boston substation controversy illustrates the need for proactive, responsive, time-sensitive, and integrated energy planning by the City of Boston and among its energy consumers. Many more such projects will be required to support electrification and emissions reductions, particularly in transportation and space heating.

And distribution system upgrades are just the tip of the iceberg: Even more ambitious energy infrastructure projects, including distributed energy resources, district heating systems, and next-generation waste treatment, may be required to achieve Boston's climate goals.

4. THE MISSED CONNECTION: A CASE STUDY AT FLYNN MARINE PARK

Recognizing a growing need for modern integrated energy infrastructure that supports both resilience and climate goals, the City of Boston and the Boston Planning Development Agency have been attempting to improve microgrid development and related infrastructure for nearly a decade.

Notably, the Boston Community Energy Study[20] was conducted to identify and highlight opportunities for new district energy systems and microgrids. The City has used its findings to prod developers through Articles 37[21] and 80[22] of the Zoning Code to pursue opportunities for integrated energy networks.

In 2017 a real opportunity arose to develop such a system and microgrid served by a combined heat and power system at the redevelopment of the Raymond Flynn Marine Park at the eastern end of the Seaport District. The project would have served municipal and private buildings via an energy savings performance contract.

Unfortunately, state law restricts such arrangements to serve only publicly-owned buildings, typically leaving systems that serve the private sector to be under the purview of the regulated utilities. This was despite Eversource's being brought on as a stakeholder early in the process and the Department of Public Utilities largely blessing the project.[23]

The City attempted to circumvent this via a home rule petition.[24] However, the petition languished in the state legislature, and the project has gone nowhere.

This missed connection highlights a significant challenge: **Existing regulation is not designed for deployment of new technologies.** Specifically, the current regulatory regime is a product of an era focused solely on providing energy through regulated utilities to keep the cost of energy low.

New technology, the impetus to decarbonize, and the need to become more resilient—while rectifying institutionalized disparities—add layers of complexity that the existing regulatory structure is not set up to scale.

Opportunities to decarbonize, build resilience, and achieve more equitable outcomes while keeping costs low will evolve from *local* opportunities to deploy new technology and solutions: solar, vehicle-to-grid, thermal networks and resources, microgrids, storage, etc. This requires a more local focus on local opportunities—as opposed to the historical top-down energy planning—in assembling stakeholders to support and conceptually buy into such projects.

5. THE CONNECTIONS: TECHNOLOGY AND INFRASTRUCTURE CHANGES

This section discusses four critical dimensions of integrated energy system planning that need to be addressed:

- Upgrades to the electricity distribution system
- Heating and cooling networks
- Vehicle charging
- Waste treatment facilities

We examine the coordination of gas transition planning or gas system rightsizing in a separate chapter focused on retrofitting 70,000 small residential homes in Boston. Gas system rightsizing will require many of the same regulatory changes and coordination support being discussed here. Given how gas system rightsizing intersects with economic and planning aspects of the small buildings stock, the authors chose to discuss this topic in the other chapter.

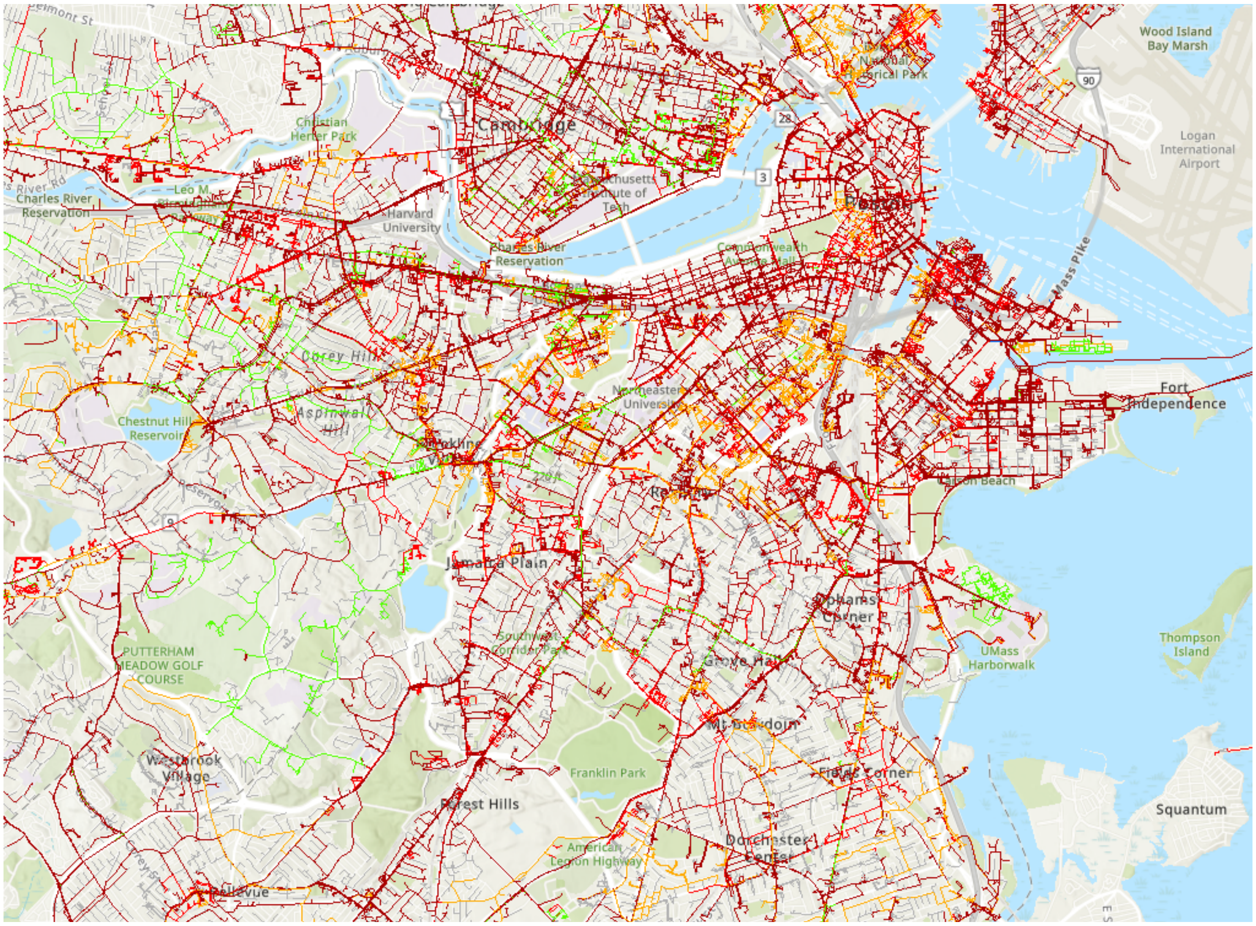
Electric Distribution System Upgrades

Increasing electric demand and deployment of solar will require substantial upgrades to the local electric distribution system.

The electrification of Boston's buildings and transportation economies will pressure existing electrical infrastructure and necessitate upgrades to the city's electric distribution system. These upgrades will include traditional technologies like substations, transformers, wire undergrounding, and other network hardening improvements, in addition to new technologies that enable "smart grid" monitoring and control of network elements. Furthermore, improving the grid in Boston will promote the integration of more distributed energy resources around the city, such as rooftop solar, battery storage, and micro-generation.

Figure 6. **Eversource Eastern Massachusetts hosting capacity map.**

Colors in bright or dark red reflect sections of the Boston electricity distribution grid that cannot accommodate a significant amount of distributed generation safely (<2 MW).[25]
Source: Eversource



The current state of the electricity distribution network in Boston can be assessed visually by referencing Eversource's Hosting Capacity Map (Figure 6).[25] This map illustrates the location-specific hosting capacity and the estimated maximum amount of distributed generation (such as rooftop solar) that can be safely accommodated on different parts of the grid within Boston. Hosting capacity is commonly analyzed and discussed in developing new rooftop solar resources. Boston is unlikely to ever meet a significant portion of its electricity demand through rooftop solar. Due to building type and geographic space constraints, the total potential of rooftop solar in Boston is estimated at 1 TWh, or 15 percent of current electricity demand, according to Google's Project Sunroof.[26] However, the growth of distributed energy—and the continuing reliable and resilient operation of the existing grid in Boston—depends upon investing in electricity distribution infrastructure to alleviate the stressed areas and bottlenecks seen in the dark red lines on the hosting capacity map.

As illustrated by the map, a significant portion of the city of Boston has physical constraints to deploying additional distributed generation on the current network. Furthermore, many areas of the city, especially around the North End, Downtown, and Back Bay neighborhoods, have an antiquated design of electricity distribution infrastructure called an “area network,” in which distributed generation additions are viewed to be especially technically tricky, costly, or even infeasible.[27] These areas may require additional investment in smart grid technology or radical improvements in grid infrastructure to modernize the distribution network and enable the integration of distributed energy resources.

These electricity distribution system upgrades will be challenging, given the current infrastructure planning processes. Most of the decisions around grid modernization in Boston would be made between the utilities and the state Department of Public Utilities, leaving the Boston city government with a limited role. As discussed in an earlier chapter, in the case of the East Boston substation, this process has not been well suited to public engagement. It engenders an oppositional dynamic between community members and energy infrastructure projects.

To achieve Boston’s climate goals, planning and permitting for electrical distribution projects should be fundamentally reformed to involve the city and its residents earlier to facilitate expedited progress on these climate-critical infrastructure projects. The City should be empowered with more significant resources to convene community meetings, enter dialogue with regulators and utilities, and ultimately have a substantive role in balancing community interests with state, utility, and climate plan pressures on energy infrastructure planning.

There are several concrete examples of how Boston’s procedural policy and planning structures could be improved to facilitate necessary upgrades to the city’s electrical distribution infrastructure, many of which are discussed in elsewhere in this chapter. There are also potential solutions that blend technology and planning in creative ways. The planned technologies could include alternative thermal networks, expanded district energy systems, and microgrids that combine distributed generation with battery energy storage to improve resilience. Furthermore, energy infrastructure projects can be “beautified” with design and art competitions, false facades, recreational or educational facilities, and other community benefits to ease the aesthetic and cultural burden on communities from the building and hosting of them.

Heating and Cooling Networks

New thermal networks can leverage previously untapped heating and cooling resources.

The density of cities is a characteristic that has allowed for cost and energy savings in delivering heat to small and tall buildings in an urban core. District steam systems enabled the growth of Downtown Boston in the late 1800s and early 1900s and supported the development of the Back Bay in the 1960s and 1970s. Boston and Cambridge's large universities have similarly relied on district heat to support their operations.

In these systems, fuel is burned at a central facility to generate heat to boil water into steam. The steam is piped underground to nearby buildings. The centralization of heat generation in a dense area reduced the costs at the building. But the production, delivery, and use of steam for heat are relatively inefficient.

More recent district systems employed two technological advances, sometimes used separately, sometimes together. First, hot water has largely replaced steam in many systems as it is a more efficient energy carrier. Second, combined heat and power (CHP) allows for the cogeneration of heat and electricity, increasing energy use efficiency and cost-effectiveness. Such systems also can be valuable for supporting resilience goals. CHP requires a fuel source, such as gas or oil, and thus faces some decarbonization challenges.

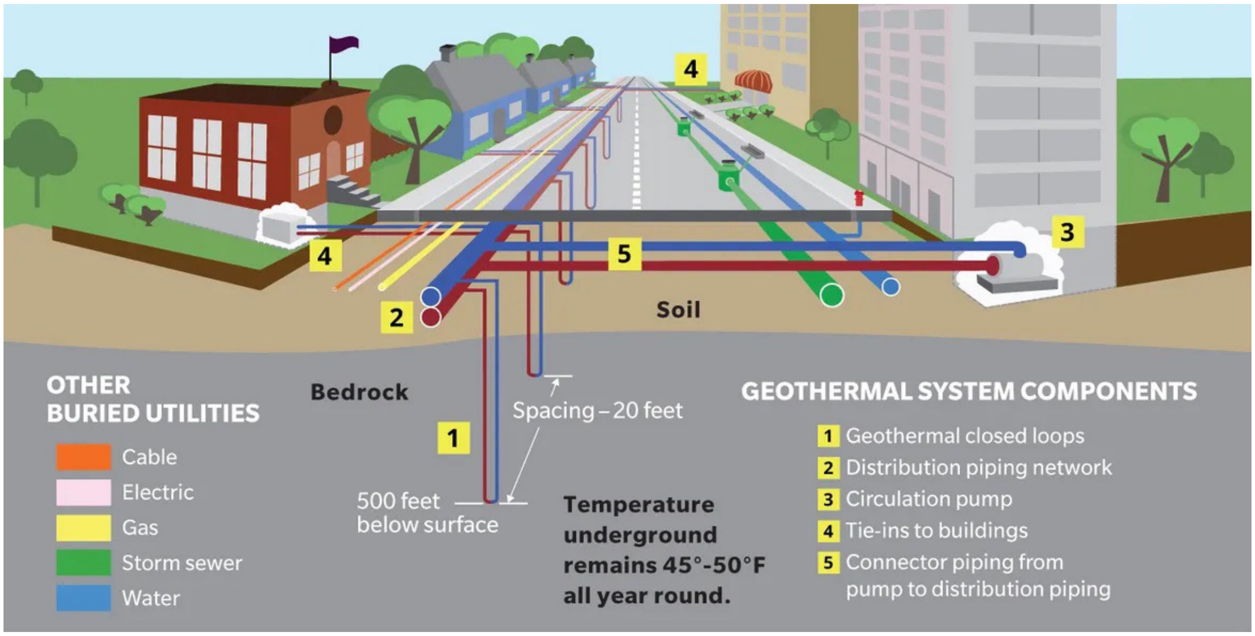
Vicinity Energy, the district energy provider with a network serving parts of Boston and Cambridge, will be transitioning from CHP to a combination of water-source heat pumps (lifting heat off the Charles River), thermal storage, and electric resistance to generate steam for Boston's downtown steam network.[28] It hopes to expand its network to new customers—large buildings that would otherwise have challenging pathways to decarbonization.

Lower (ambient) temperature heating and cooling networks are emerging as a new type of district energy system (Figure 7). These leverage the temperature of the earth, nearby water bodies, and waste heat to provide heating and cooling to connected buildings. Relative to air source heat pumps, these networks are anticipated to have a much lower electrical demand, reducing the impact on electric heating peaks, but are generally more expensive to deploy.

Eversource is currently piloting this approach in a mixed-use neighborhood in Framingham. National Grid is in the process of identifying sites for pilots in its territory, including Boston. These systems could also be operated privately. Several colleges and universities across the Commonwealth are already installing networks on their campuses.

Figure 7. **Illustrative diagram of a geothermal network.**

Source: Eversource



Electric Vehicle Charging Infrastructure

A rapid technological transition will require the deployment of charging infrastructure in the public realm to support vehicle uptake. Its siting needs to be guided. Electrification of larger vehicles presents both opportunities and challenges given the state of the electric distribution system.

Deploying electric vehicle chargers across the city is essential for supporting the anticipated growth in demand from residents (particularly renters who often lack private garages or parking spaces), commercial and municipal users like delivery drivers, and commuters into the city.

In 2020, the Boston city government published a Zero-Emission Vehicle (ZEV) roadmap, which sets several specific targets for EV charging infrastructure deployment, including for medium-duty vehicles to be emissions-free by 2050.[29] One example of how the City is leading with its fleet is with school buses. Mayor Michelle Wu is working with state and federal partners to seek additional funding to electrify Boston's school bus fleet. In a spring 2022 statement, the Mayor committed to fully replace the fleet by 2030. The first step to move in this direction is the purchase of 20 electric buses for the cost of $7 million, which is part of an 8- to 10-month pilot program.[30] The City has yet to identify potential partnerships it can make with the local private sector, suppliers, and electric bus experts. Electric school buses are a unique opportunity for energy system integration; their predictable use patterns and daily cycles make them an ideal pairing with solar and a potential vehicle-to-grid battery resource.

Simultaneously, the MBTA has taken initial steps toward electrifying its bus fleet by 2040.[31] This will require the development of new bus facilities that can charge and support electric vehicles. Challenges rose already as the MBTA had to restart a search for a contract to build a new facility in Quincy due to contractor bids exceeding the budgeted amount.[32]

Finally, the future of personal vehicle charging in Boston is obscure. It is now common in several neighborhoods to see extension cords crossing the sidewalk to charge cars. With approximately half of cars in Boston not having a dedicated space (e.g., driveway or garage), new solutions for vehicle charging will need to be developed and sited. Both chargers on sidewalks and in private lots will be needed; however, if fast charging rapidly scales, it may obviate the need for sidewalk chargers. Still, owners of private lots may be reluctant to adopt new technologies, given the high cost of fast charging. The City and Commonwealth have an essential role to play in encouraging the deployment of charging in the public realm, while leaving room for the private sector to scale.

Waste Treatment Facilities

While the people of Boston send their waste to other communities—out of sight and out of mind—will they mind now treating waste in the city properly with new technologies?

Although not immediately obvious, there are a number of parallels and a growing intersection between waste and energy planning. Boston currently ships its waste to several waste-to-energy incinerator electricity generation facilities outside the city. Each of these is in or adjacent to an environmental justice community. While single-use plastics in this waste stream are a pernicious problem that will need action at the state level to remedy, there is a near-term opportunity to collect and treat organic food waste to reduce the impact of incinerators and promote some other sustainability outcomes.

Landfilling food waste results in methane emissions. Burning food waste at an incinerator makes the incinerators operate less efficiently. Directly collecting food waste—through a curbside program—opens up three options: composting, the production of biogas, and production of renewable liquid fuels. Each of these strategies has benefits and drawbacks.

Composting food waste generates a soil amendment that can be used to improve soil quality but results in some modest methane emissions. More practically, there are simply too few sites to treat compost in the Metro Boston area for several towns, let alone the whole region, and the costs of transporting it longer distances are impractical.

The City of Cambridge quickly realized this constraint as the region's first implementor of curbside food waste collection. Instead, Cambridge—and now Boston as part of its curbside food waste collection pilot—hand their food waste over to Waste Management, which has a processing facility in Charlestown that consolidates (dewaters) the food waste before it is trucked up to the Greater Lawrence Sanitary District's anaerobic digestor. Here the organic material in the waste is converted to a gas which is then used to generate electricity.

Such waste could have been treated much closer to home at the Metropolitan Water Resource Authority's Deer Island Wastewater Treatment Plant, where anaerobic digestors today treat the wastewater at about 50 percent of their working capacity. However, efforts to do so were stymied by pushback from residents of Winthrop, who objected to the trucking necessary to bring the waste to Deer Island through primarily residential neighborhoods.[33]

Collecting and treating food waste is low-hanging (indeed, overripe!) fruit for pursuing decarbonization goals while reducing the impact of incinerators on environmental justice communities. However, it may need to be treated in Boston, which raises the question of where to site the needed facilities.

Anaerobic digestion has a large and visible land footprint and has some undesirable air quality impacts. Emerging technologies that produce liquid fuels from waste could be more economical, energy saving, and climate favorable while having a smaller footprint;[34] however, as new methods, they may not be as easily welcomed by the public.

6. HOW TO CONNECT THINGS: POLICY AND PLANNING NEEDS

The Boston city government currently has a limited ability to influence energy infrastructure policy and planning. These limits are imposed by state law and state policy strictures, self-imposed by city budgeting and staffing priorities, and exist as a legacy of dated, non-inclusive planning. This section discusses the concept of localizing energy planning before reviewing the City of Boston's current energy planning capabilities and finishes with potential paths forward for the City of Boston.

Localizing Energy Planning and Engagement

In energy planning activities such as substation development, the primary stakeholders typically are the utility system operator (as implementer) and the state (as regulator). In theory, the regulator also represents the broad, statewide public interest that acts responsively to utility proposals. It has a role to play in terms of balancing local needs with state-wide energy needs. While organizations such as the Energy Facilities Siting Board are charged with ensuring that the interests of localities are protected, the public and localities are in a *responsive position* to energy planning. This makes it hard for impacted communities to feel they are benefiting from such projects.

State-level energy planning processes have been driven by concerns for ensuring safety, consistency, low energy prices, reliability, and energy justice—and has largely been sufficient in most of those areas. However, the current model is challenged on two complementary fronts:

New solutions struggle to gain traction in old regulatory frameworks: Decarbonization requires the rapid deployment of new technologies and business models (geothermal, harbor and river-based cooling and heating, district systems, microgrids, etc.) that may face multi-jurisdictional legal and other institutional barriers to their deployment. There is a need to build coalitions and customers to support and use such infrastructure. Independent development of these projects can—but may not always—run counter to the financial objectives of regulated utilities. In the absence of utility interest, their diffuse nature means that they do not typically have a champion to build a coalition to develop such a project. This is not to say that there have not been champions; as noted above, the City of Boston has been attempting to act within its powers to catalyze such planning and infrastructure.

Local opposition grounded in an understandable skepticism of energy infrastructure: A lack of confidence in the existing planning process by historically marginalized communities stems from a history of unjust and inequitable planning practices that have resulted in low-income, often minority, communities bearing the burdens of energy infrastructure—even if such infrastructure has delivered broad social benefits.

Localization of energy planning may help to overcome these barriers. It may not mean a complete departure from state-level regulation, but it does require more empowerment of local interests and initiative. At a minimum, state regulation must seek to enable development of alternative energy infrastructure outside the utility realm, particularly in the near term, as new technologies need development and experimentation. Such a framework would have allowed for the development of the microgrid system at the Flynn Marine Park, as noted in the case study above, which was supported by the DPU in concept but was prohibited by existing regulations.

Early communication with stakeholders and the public on the benefits and tradeoffs of decarbonization and resilience-focused energy infrastructure projects will be essential for building support. Further, communities should feel like they have a voice in guiding infrastructure projects in their communities to ensure good integration of the infrastructure with the community, minimize disruptive impacts of construction, and create buy-in to projects via increased awareness. The engagement process of localized energy planning can also help identify customers for district energy systems.

Localities—cities, neighborhoods, and business districts—should be empowered to develop energy resources to suit the needs of their community and the broader energy system. One model for how this could work is for such planning to be led by the municipal government. For example, the City of Boston currently takes the lead on climate resilience planning at the neighborhood scale; a similar approach could be applied to energy planning, as currently being institutionalized in several European countries.[35,36] Such planning includes new developments, redevelopments, and existing districts or neighborhoods.

A local energy planning exercise should seek to:

1. Identify local decarbonization, resilience, and energy justice needs.
2. Identify opportunities to develop local alternative energy resources (e.g., geothermal, waste heat), build thermal networks, conduct batch retrofit buildings, and upgrade electric infrastructure.
3. Evaluate alternative scenarios for energy infrastructure development to identify opportunities and tradeoffs.
4. Have a long-term vision but be regularly updated to incorporate changing circumstances.

5. Be technically detailed but convey information to the general public via community groups, translation services, and alternative media outreach.
6. The ultimate goal of such an exercise is to create broad buy-in and community ownership of an energy transition that rapidly meets decarbonization, resilience, and energy justice needs.

Boston's Current Energy Policy and Planning Powers and Capabilities

To understand Boston's energy policy and planning capabilities, it is helpful to remember that American energy policy and planning have a long tradition of federalism. The U.S. federal government has asserted limited control over the energy system in interstate wholesale power markets, interstate transmission, federal tax policy, and nuclear energy. The remainder of the energy system is primarily left to the control of the states. In particular, due to the lack of a comprehensive federal climate policy, most climate programs are created and maintained by subnational government entities. States like Massachusetts primarily control electric utilities, rate design, infrastructure development, clean energy incentives, and planning considerations. Massachusetts restructured its electric sector in the 1990s, forcing most state-regulated electric utilities to divest their generation assets. As a result, Massachusetts state regulators today have limited control over electricity generation. However, the General Court has intervened with legislation to promote the growth of low-emissions generation, primarily through the Renewable Portfolio Standard, net metering incentives for rooftop solar, and ongoing offshore wind procurements.

Currently, most critical decisions on energy infrastructure planning in Boston are made at the level of the utilities, Eversource and National Grid, and state agencies. The Department of Public Utilities (DPU) regulates the utility monopolies for electric and natural gas services within the state government. The DPU is a quasi-judicial body with commissioners appointed by the governor. Several other state agencies also play essential roles in energy infrastructure planning and policy development. These agencies include the Department of Energy Resources, the Executive Office of Energy and Environmental Affairs, and the Attorney General's Office (which serves as the state's public advocate at the DPU). These agencies actively participate in the Department of Public utility proceedings, including the Energy Facility Siting Board (ESFB), an independent state agency that sits within the DPU. While a significant portion of DPU and ESFB decisions affect the City of Boston, our research suggests that the City does not have sufficient staffing and funding resources to intervene regularly at the DPU and ESFB. One glaring policy and planning need for the City to advance its energy and climate priorities, therefore, is to increase the staffing and funding levels required to participate in crucial energy planning and policy decision-making processes at the state level.

Currently, the City employs several energy policies and planning specialists. The Boston Smart Utilities Program administered by the Boston Planning and Development Agency supports the development of five smart utility technologies in Boston: district energy microgrids, green infrastructure (focused on street-level projects like permeable pavers and stormwater retention), intelligent traffic signals to improve opportunities for multimodal travel, smart street lights, and telecom "utilidors" that allow utility wires and fiber optics to be consolidated into single banks of ducts underground to streamline network utility work.[37] The projects in the Smart Utilities Program only cover a small portion of Boston's core emissions reduction policy priorities. While these existing programs all deliver clear value, it is doubtful that they alone are sufficient to facilitate the disruptive energy transformations required to meet the city's climate goals.

Pathways for Expanding the City of Boston's Energy Planning Powers and Capacity

Given the limited resources and structural focus on energy policy and planning within the City of Boston, there is a clear need for creative thinking about how Boston's capabilities in this area could grow. For this purpose, we have presented two energy planning approaches for the City of Boston. This section simultaneously discusses the state-level policy changes and City Hall staffing and programmatic changes needed to support each policy scenario discussed below.

Broaden Existing Programs (No Gain in Powers from the State)

Boston could incrementally expand its existing energy policy and planning programs to ramp up the capacity of the city government to promote clean energy and emissions reductions. For example, the City could fund and authorize additional hires for staff members in the Office of Environment, Energy, and Open Space dedicated to energy programs. By hiring additional staff with specialized expertise in utility regulation (e.g., attorneys, engineers, or financial analysts), the City could begin to regularly intervene in state regulatory proceedings at the DPU and EFSB on cases that affect climate and energy priorities. Given the recent controversies around the development of greenfield electricity infrastructure in Boston, as discussed in the section on the East Boston substation project above, these hires could help make future siting and approval processes faster and more responsive to community concerns. By increasing the funding and staffing levels for the Smart Utilities Program, Boston could increase the number of technologies that the program supports, for example, by exploring the addition of geothermal, river- or ocean-source heat pump pilot projects to the program's district energy microgrid portfolio.

Major city-specific planning needs (e.g., a new district energy system) would likely be handled on an ad hoc basis and perhaps require a home rule petition.

Create a Boston Energy Policy and Planning Division with New Powers from the State

Many other large cities, including New York City, have dedicated divisions within city government that are focused entirely on energy policy and infrastructure planning. Boston, in contrast, has an energy policy team that is a relatively small portion of its Office of Environment, Energy, and Open Space. By creating a dedicated energy policy and planning division, Boston could receive more administrative support for achieving its energy and climate goals. Dedicated staff could create a self-sustaining programmatic emphasis on energy policy and planning, including more specialization within the department that could focus on operationalizing individual sectoral objectives to advance progress on Boston's climate action plan.

The creation of a dedicated energy division may have the side effect of improving the administrative efficiency and focus of the city's energy and climate programs since the current fit of Boston's energy policy staff within the Office of Environment, Energy, and Open Space is uncertain due to the majority of that office's budget being dedicated to other priorities like recreation and historic preservation.

Ensuring Inclusive Local Energy Planning

Meeting the climate challenge is an opportunity to ensure that energy infrastructure—new or existing—can better meet the needs of the communities it serves while imposing less burden on the communities that host it.

Inclusive energy planning is an opportunity to accelerate the adoption of net-zero strategies by achieving early buy-in, spurring participatory interest in potential solutions, and identifying barriers and opportunities through shared learning.

Local energy planning exercises should identify key stakeholder groups and reach out to key representatives at the outset to determine engagement needs. Identifying best practices for local meetings, offering accessibility services such as translation, and leveraging multiple communication channels can support outreach as the planning exercise progresses.

Making it easier to participate in public meetings and platforming the loudest voices is insufficient to serve diverse communities. Depending on the context, more targeted efforts may need to be employed to prioritize communities' needs. While this is a time and resource investment, early action here has the potential to accelerate adoption of low-carbon and resilient solutions in communities that would otherwise be slow to adopt such solutions.

Most importantly, the public should be confident that its representative government can represent its interests. This requires the makeup of advisory boards and commissions to reflect the communities they serve.

7. HOW TO CHECK THE CONNECTIONS: INDICATORS

Whatever the pathway, there needs to be a transparent, data-driven accountability framework to ensure progress on energy system modernization and energy equity goals. To measure progress in developing an energy system to support the goals of decarbonization, resilience, and energy justice, it is essential to identify concrete indicators and data streams that can guide data collection, analysis, and evaluation of existing and proposed programs. In particular, indicators for energy policy and planning should directly relate to energy infrastructure that will be used to reduce emissions, promote beneficial electrification, and ensure a resilient energy system that works for all Boston residents.

We suggest several indicators that could be used by staff, managers, and politicians (such as the mayor) to analyze and summarize the trends on critical outcomes for the city's energy and climate-relevant infrastructure.

The Boston city government should seek to have a sufficiently developed and technically capable energy policy and planning staff to track more detailed and technical indicators through modern data management methods that can create a "digital twin" of Boston's large and complex energy system.

Some examples of this more detailed data collection include street-level electrical data (similar to the hosting capacity map in Figure 6, which displays the grid constraints on distributed generation deployment); data on EV adoption and large building energy use that will be made publicly available under recent state climate legislation;[38] potential alternative energy resources such as geothermal; other energy infrastructure; system performance indicators (such as data on blackouts or interruptions) to monitor the overall health of the grid and customer service.

Several data types are publicly available through the utilities' proceedings at the state DPU. Others, such as EV charging data, may be available now in a "messy" or incomplete fashion. Still, future improvements in "smart" energy infrastructure that can track and report high-resolution data should make this data easier to collect and process.

Geospatially resolved data is essential for assessing progress and equity of outcomes. Data owners and regulators should weigh the benefits of improved data use for planning and accountability with privacy concerns.

Below, we present an outline of potential indicators, starting with high-level indicators and ending with more detailed or technical indicators. The reader is encouraged to review a complementary section in the small building retrofit chapter focused on buildings-sector specific metrics. Other identified indicators for this chapter include:

- Energy resource potential and development maps to track rooftop solar, geothermal, water body, waste heat, and thermal network potential.
- Climate-smart infrastructure deployment
    - District heat systems capacity, emissions, customers, performance, financials
    - EV chargers installed
- Geospatial disaggregation of electricity generation, transmission, and distribution
    - Hourly-level emissions of generation serving Boston, incorporating ISO-NE, BCCE contracts, municipal-owned generators, and any other RECs or PPAs
    - Transformers in need of upgrades or new construction
    - Hosting capacity for distributed generation on distribution circuits
    - Transmission capacity and contracts serving Boston (electricity and natural gas constraints, LNG imports)

8. IS BOSTON BECOMING CONNECTED? SUMMARY OF PROGRESS

The rapid modernization of energy infrastructure is essential for driving emissions reductions, resilience, and enhanced social equity but such infrastructure has historically been an afterthought and largely removed from the public eye. When change does happen, it can be disruptive and disconcerting, despite the potential benefits it may bring.

Decarbonization drives a shift from reliance on imported energy to investment in local energy resources—insulated building envelopes, electric heating systems, distributed solar energy, ambient thermal energy in nearby water and earth. This brings with it enormous economic and social benefits ranging from more comfortable buildings to improved air quality and more jobs and businesses opportunities.

Levering this transition requires local energy planning and action to gain political and economic buy-in and accelerate progress. Despite some notable efforts by City Hall, advocacy organizations and some members of the private sector, the inability to take ownership locally and drive the energy transition means Boston is not on track to reduce emissions, become more resilient to the climate threat, and ensure energy equity.

With this finding and the detailed assessment levied by this chapter, we propose three key questions to the Boston community. The answers will significantly influence its energy and emissions future. These questions have no correct answers, but they should be considered through open and vigorous dialogue to resolve profound differences on critical issues:

1. Can Boston and state regulators cooperate on infrastructure upgrades, siting, timelines, and funding for electrification, resilience, and equity? Can the City and the Commonwealth develop the necessary administrative capacity?
2. What resources are needed to develop robust local energy planning practices in Boston? What communities should be targeted first for such plans?
3. How can the public, given time and resource constraints, be empowered to shape their energy future to help ensure that the energy transition occurs at the necessary pace to achieve climate and equity outcomes?

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