

Zero Net Carbon Building Zoning

City of Salem, SERC Committee



boston planning &
development agency

Michelle Wu, Mayor
City of Boston

October 26, 2022

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Coastal Flood Resiliency Overlay District

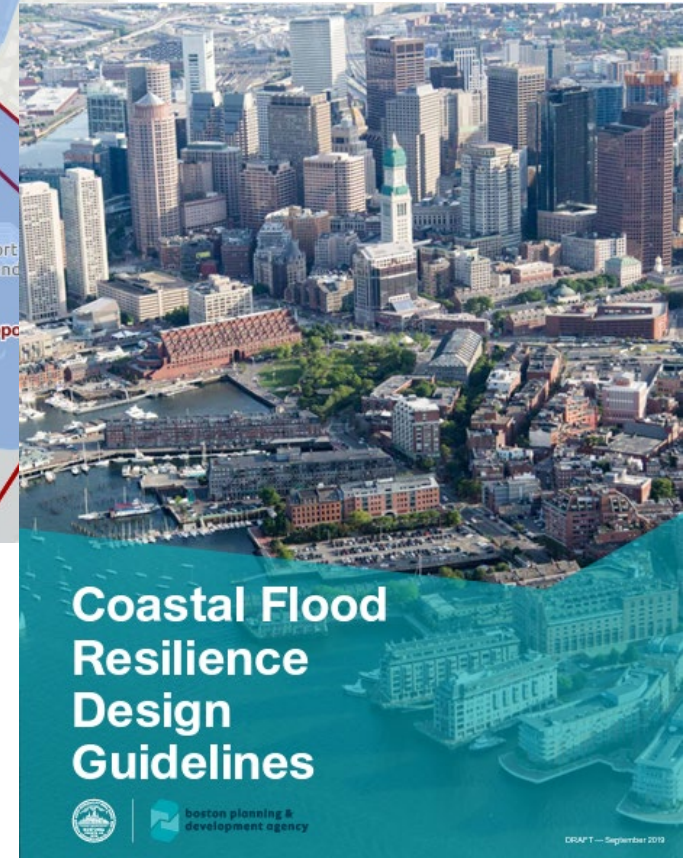
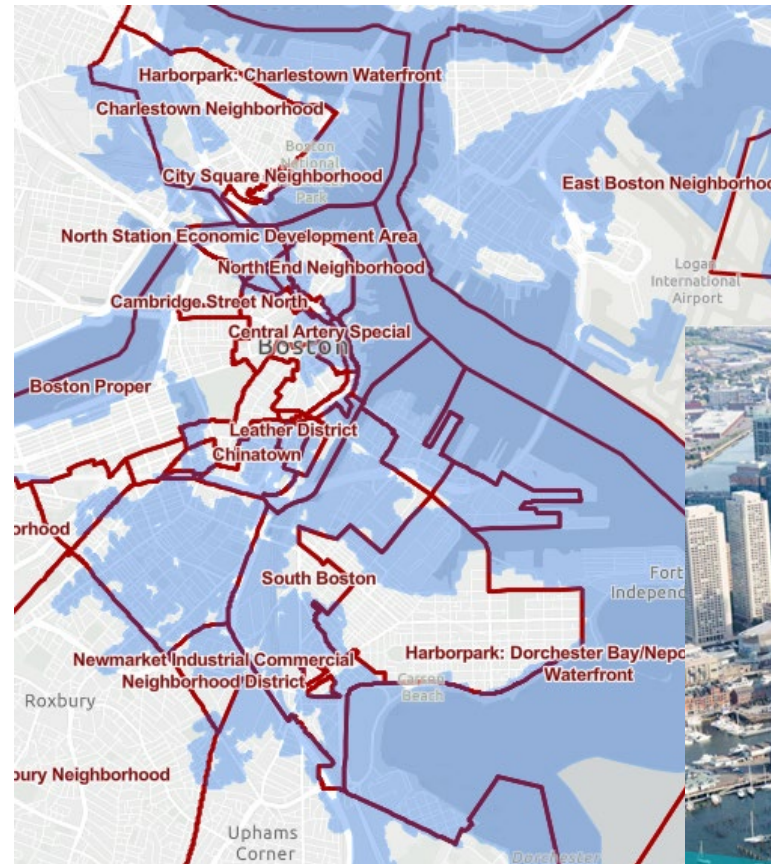
Zoning Article 25A

Resilience Review

- **Overlay = 2070 1% chance coastal storm event with 40" SLR**
- **Projects 20,000 SF+**
- **Compliance:**
 - Respond to SLR DFE
 - Coastal Resilience Guidelines
 - Use limitations
 - Dimensional allowances

Project Reviews:

- **67 projects - 19 approved**
- **30M - 3.5M SF approved**



Article 37 Green Buildings / IGBC Review

- Applicable to all 80B Large Projects (50k SF)
- Comprehensive sustainable development standards
 - LEED Gold typical / Certified is minimum
 - Carbon Neutral Building Assessment (CNBA) assesses inclusion of ZNC building strategies
- IGBC (Interagency Green Building Committee)
 - Oversees A37 compliance & conducts reviews
 - Staffing: BPDA 3+2, Environment Dept. 2
- Compliance Review Phases
 - Initial Filing Approval
 - Design Approval / Building Permit
 - Construction Approval / Occupancy Permit
- Building Review Activity
 - 2021 Reviews: 142 Buildings / 40 M SF
 - 2022 Reviews to date: 64 Buildings / 14.3 M SF

2021 Performance Average 26.8% below Code

- 7 Platinum (5%)
- 99 Gold (70%)
- 34 Silver (24%)
- 2 Certified (1%)

2022 Performance Average 32.7% below Code

- 1 Platinum (2%)
- 50 Gold (78%)
- 11 Silver (17%)
- 2 Certified (3%)

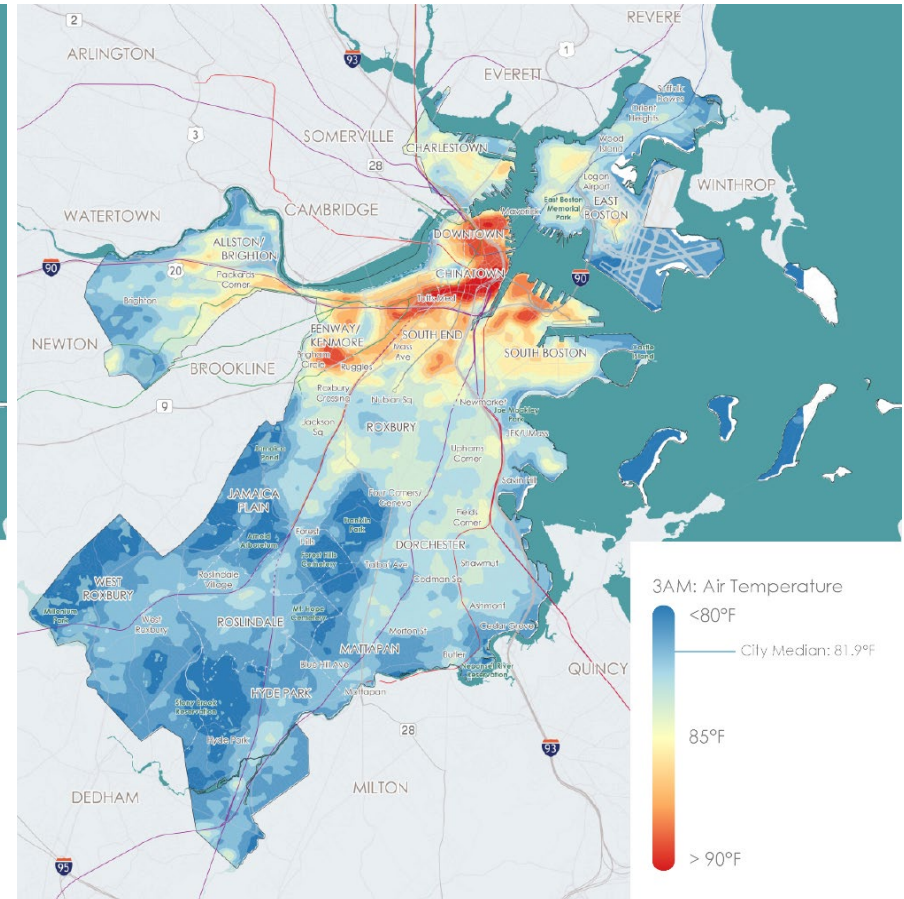
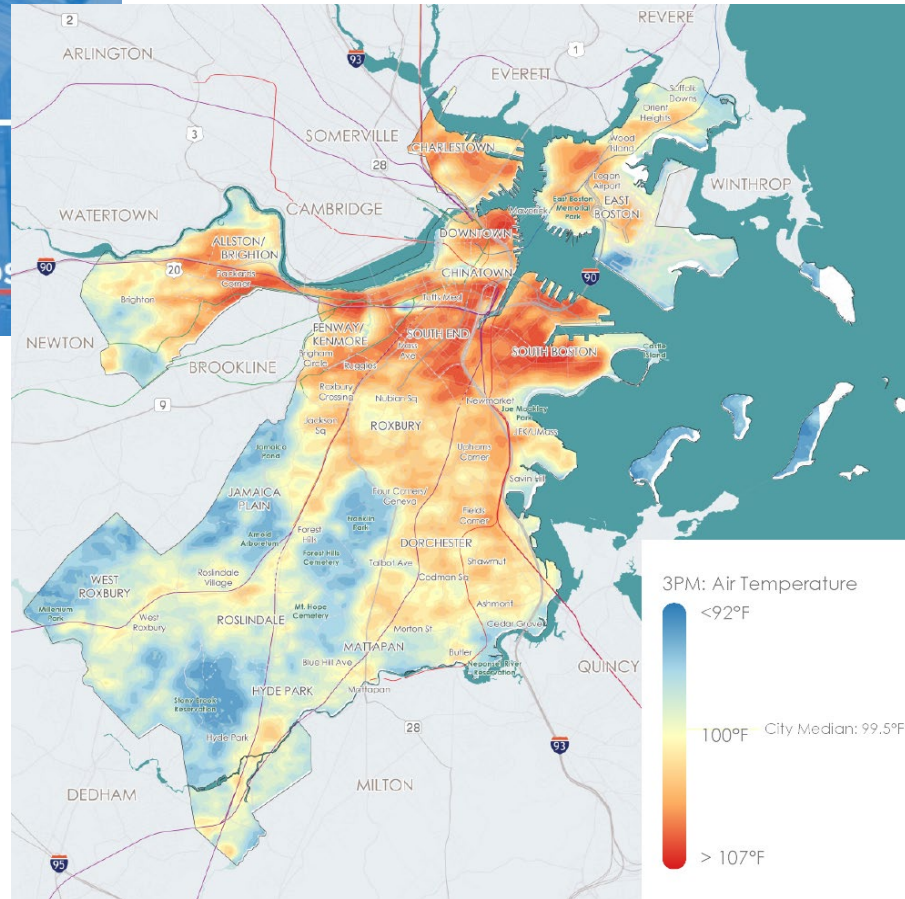
Smart Utilities Article 80 Policy

	Article 80 Size Threshold	Specifications
District Energy Microgrid	>1.5 million SF	Feasibility Assessment; if feasible, then Master Plan & District Energy Microgrid Ready design
Green Infrastructure	>100,000 SF	Install to retain 1.25" rainfall on impervious areas (Increase from 1" currently required by BWSC)
Adaptive Signal Tech.	All projects requiring signal installation or improvements	Install AST & related components into the traffic signal system network
Smart Street Lights	All Projects requiring street light installation or improvements	Install additional electrical connection & fiber optics at pole
Telecom Utilidor	>1.5M SF of Development, or >0.5 Miles of Roadway	Install Telecom Utilidor

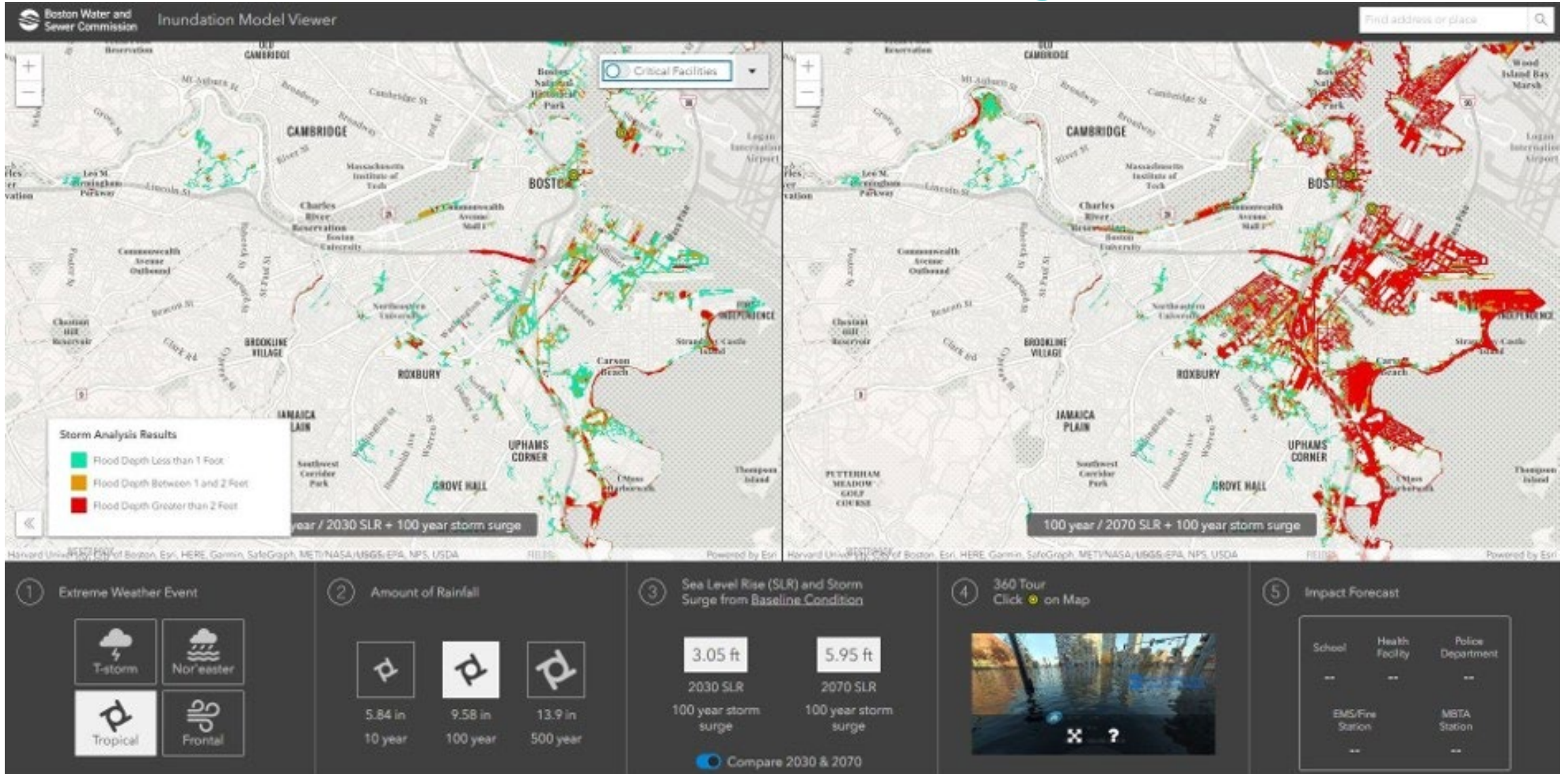
TOTAL GSF currently under BSU review = ~33 million GSF

44% or ~14 million GSF include District Energy Feasibility Studies

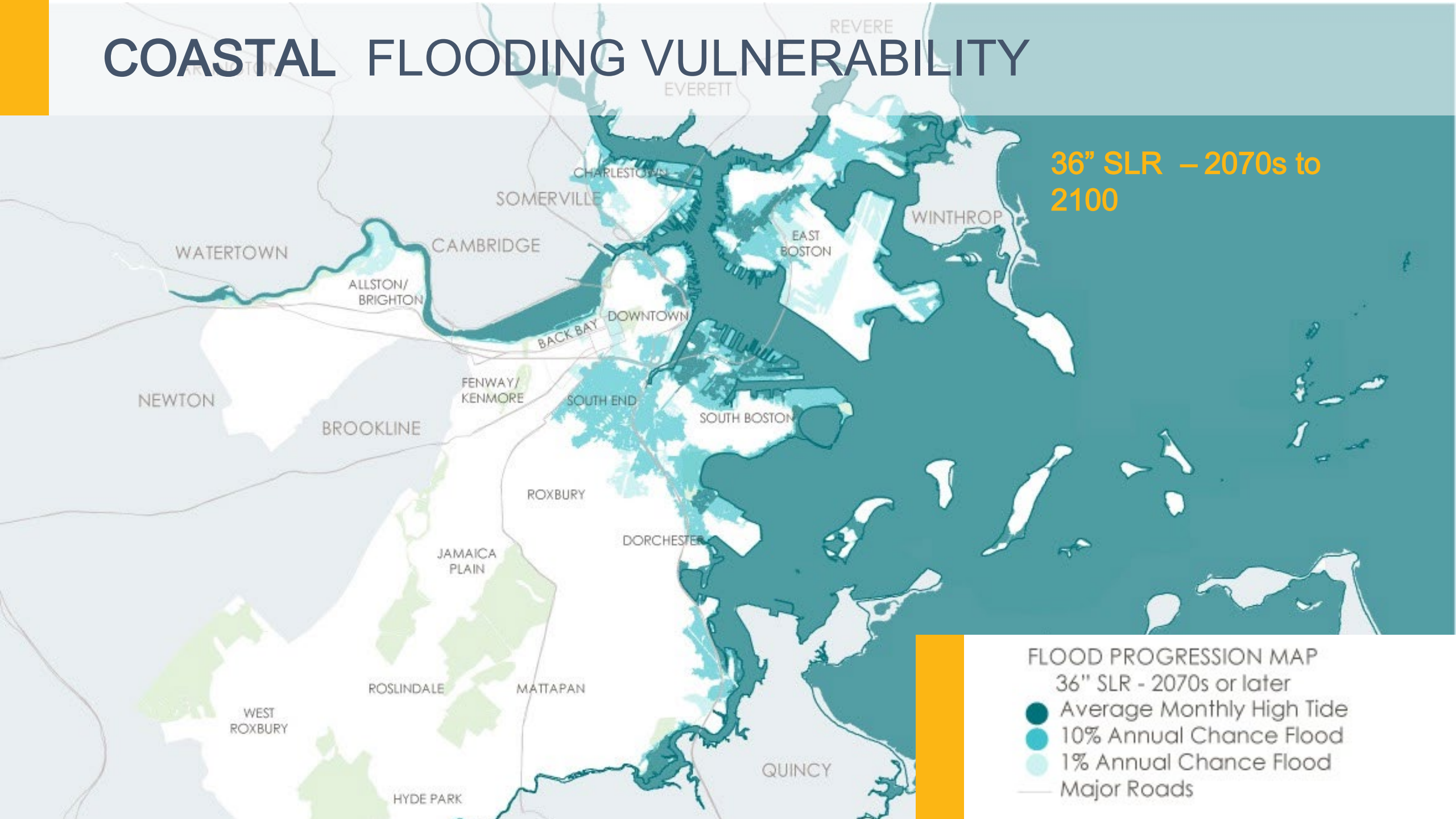
Heat Resiliency



Precipitation Stormwater Management



COASTAL FLOODING VULNERABILITY



36" SLR – 2070s to 2100

FLOOD PROGRESSION MAP

36" SLR - 2070s or later

- Average Monthly High Tide
- 10% Annual Chance Flood
- 1% Annual Chance Flood
- Major Roads

Article 37 & ZNC Policy - Overview

Covered Buildings:

- New construction buildings that are 20,000 SF or larger (excluding parking) or add 15 or more new housing units.

Building Requirements:

- Reduce or mitigate adverse impacts.
- LEED Gold.
- Low carbon building practices and use renewable energy sufficient to annually achieve net zero carbon emissions.
- Annually report ZNC building performance using the BERDO portal.

ZNC Policy Framework

Prioritized Practices:

1. Low Carbon Building

- Embodied Carbon – Assess & include best practices, advance standards & practices
- Operational Emissions – Determine & meet building emission targets

2. Renewable Energy – Solar PV

Set Minimum Generation Standards

3. Renewable Energy - Procurement Multiple Options



Bunker Hill Housing – Building F

Residential - Affordable / Market Rate

271,844 SF - High Occupant Density / High Rise

Low Carbon Building - Operations

pCEI = 1.48 kg CO₂e / sf-yr (EUI 19.1)

Renewable Energy - Solar PV (82 kW = 104 mWh/yr)

pCEI 0.12 kg CO₂e / sf- yr (reduction)

Renewable Energy – Procurement

Boston Community Choice (optional)

ZNC Reporting

ZNC and BERDO are paired policies with aligned standards

Annual Reporting per BERDO 2.0

- Applicable to all ZNC permitted projects
- Applicable at building occupancy
- Carbon emissions limit is net zero
- Renewable energy procurement follows BERDO standards

ZNC Policy & Standards

CONSTRUCTION EMISSIONS MINIMIZATION MEASURES

Reduce Construction Operation Carbon Emissions

Include best practices for mitigation measures, including:

- Temporary Lighting
- Renewable Electricity - procure 100% renewable electricity.
- Low and no-carbon emission vehicles / equipment and sequencing

Minimize Demolition, Construction & Building Materials Embodied Carbon

Recognizing the emerging status of industry and practice standards, include best practices and LEED Materials & Resources prerequisites and credits:

- Construction and Demolition Waste Management;
- Building Refrigerant Management;
- Building Life-Cycle Impact Reduction;
- Building Product Disclosure and Optimization; and
- Low embodied carbon structural designs, materials, and systems.

ZNC Policy & Standards

Minimization Building Operational Carbon Emissions

Allows two approaches and sets “targets”:

Approach 1 - Predictive Performance Comparative Analysis

Projects attain a 40% carbon emissions reduction compared to modeled performance of the Stretch Code (ASHRAE 90.1-2013 with MA amendments) or LEED baseline (ASHRAE 90.1 version used for LEED credit determination).

Except:

1. Licensed healthcare facilities that are not medical office buildings, which should meet a **30% carbon emissions reduction target**.
2. Residential buildings that do NOT trigger stretch code AND the total area of any non-residential program is less than 40,000 GSF and does not exceed 50% of total GSF - these building must meet a **HERS score 38 or lower**.
3. Buildings committed to achieving Passive House certification via PHIUS+ or PHI.

ZNC Policy & Standards

Approach 2 - Use Specific Best Practice Performance

Projects attain the Best Practice pCEI for specific building uses. Buildings with multiple uses should calculate a blended pCEI target.

Primary Building Use Type	kg CO2e/sf-yr	Notes
Multifamily (low density)	1.1	Average Occupancy Density \geq 500 SF/Person
Multifamily (high density)	1.6	Average Occupancy Density btw 220 to 500 SF/Person
Residence Hall	1.6	
Hotel	1.9	
K-12 School	1.3	
Office - College or University	1.6	
Office - Commercial	1.8	
Retail & Service	1.6	
Dry Lab	4.3	
Wet Lab	6.4	
Hospital	7.4	Not including medical office uses

Article 37 & ZNC Review Process

A80 / A37 Building Planning & Review Sequence - *Unchanged*



Building Performance Planning & Modeling

- Project team determines planning and compliance pathways
- Selects preferred modeling platform
- Employs performance modeling in project planning
- Project team uses models to calculate CO₂e emissions

BERDO 2.0 Key Features

Building Emissions Reduction and Disclosure Ordinance

- **Covered buildings:**
 - *Non-residential buildings that are 20,000 ft² or larger (excluding parking)*
 - *Residential buildings that have 15 or more units*
 - *Any parcel with multiple buildings that sum to 20,000 ft² (excluding parking) or 15 units must report on all buildings*
- **Annual energy and water use reporting and disclosure.**
- **Covered buildings must achieve net-zero emissions by 2050.**
 - *Non-residential buildings that are 35,000 ft² + and residential buildings with 35+ units have to meet declining emissions standards starting in 2025.*
 - *Non-residential buildings that are 20,000 - 34,999 ft² and residential buildings 15-34 units have to meet declining emissions standards starting in 2030.*

Emissions Standards

Established in the Ordinance

- *Developed through the technical analysis process*
- *Based on existing buildings in Boston*
- *Aligned with citywide climate goals*
- *Multi-use buildings can adopt a blended emissions standard*

Building use	Emissions standard (kgCO ₂ e/SF/yr.)					
	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049	2050
<i>Assembly</i>	7.8	4.6	3.3	2.1	1.1	0
<i>College/ University</i>	10.2	5.3	3.8	2.5	1.2	0
<i>Education</i>	3.9	2.4	1.8	1.2	0.6	0
<i>Food Sales & Service</i>	17.4	10.9	8.0	5.4	2.7	0
<i>Healthcare</i>	15.4	10.0	7.4	4.9	2.4	0
<i>Lodging</i>	5.8	3.7	2.7	1.8	0.9	0
<i>Manufacturing/ Industrial</i>	23.9	15.3	10.9	6.7	3.2	0
<i>Multifamily housing</i>	4.1	2.4	1.8	1.1	0.6	0
<i>Office</i>	5.3	3.2	2.4	1.6	0.8	0
<i>Retail</i>	7.1	3.4	2.4	1.5	0.7	0
<i>Services</i>	7.5	4.5	3.3	2.2	1.1	0
<i>Storage</i>	5.4	2.8	1.8	1.0	0.4	0
<i>Technology/Science</i>	19.2	11.1	7.8	5.1	2.5	0

OPTIONS TO RETROFIT AND FUEL SWITCH

- Building owners may undertake measures to improve energy performance and reduce fossil fuel consumption within the building
 - *Envelope improvements*
 - *Appliance and mechanical upgrades and switches (heat pumps, solar, geothermal)*
 - *Building operations and controls*
- The City is expanding a [Retrofit Resource Hub](#) to connect building owners with appropriate technical assistance and financial resources.

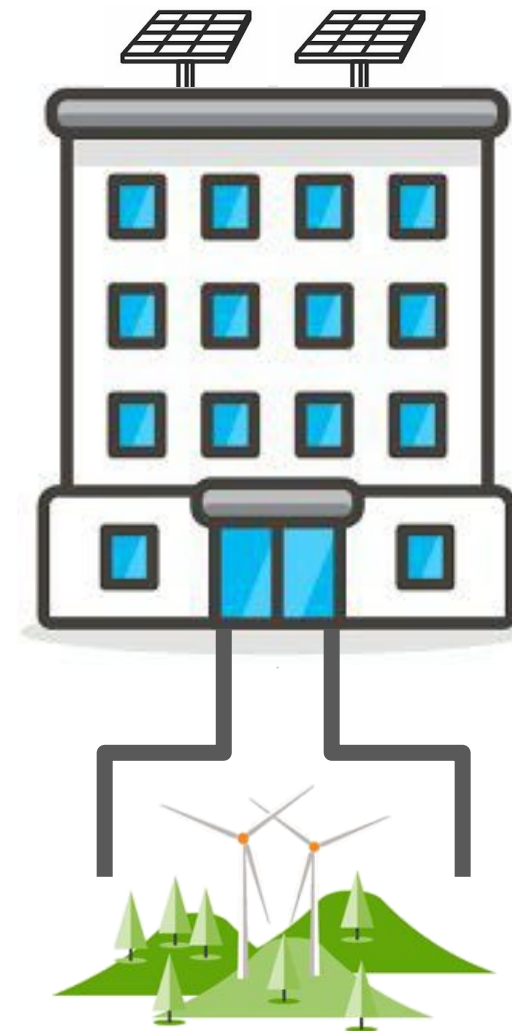


Credit: Indiana Public Media

OPTIONS TO PURCHASE RENEWABLE ELECTRICITY

Renewable energy can be used to reduce emissions from a building's electricity use.

1. Deploy renewable energy onsite;
2. Purchase renewable electricity that is generated offsite.
 - Boston community choice electricity (cityofbostoncce.com)
 - MA Class I Renewable Energy Certificates from non-emitting renewable sources
 - Power purchase agreements, including virtual PPAs, for RECs from non-emitting renewable sources



ALTERNATIVE COMPLIANCE PAYMENT

- Additional option to meet emissions standards
- Tied to average retrofit cost per metric ton of CO₂e, estimated at \$234/mtCO₂e
- Paid into a new Equitable Emissions Investment Fund



ZNC Building Programs

BOSTON MASS TIMBER ACCELERATOR

MTA Round Two Now Open!
Second and Final Funding Round

- Buildings 9 to 18+ Stories Tall
- Funding & TA to assess benefits of Mass Timber practices

Apps Due: 5pm, October 28th



THANK YOU!

- Stop in during our Office Hours & Feedback Meeting
- Submit [online comments](#)
- Email: John.Dalzell@boston.gov



Article 37 Zoning Updates

Proposed Zoning Changes – Part 1/3:

- Applicability Threshold
- LEED Gold
- Removes “Boston Green Building Credits”
- Establishes annual net Emissions performance standard of zero kg of Carbon Dioxide Equivalent (CO₂e) / sf-yr.

Article 37 Zoning Updates

Proposed Zoning Changes – Part 2/3:

- Construction Emissions Minimization Measures
 - Construction site activities
 - Building construction materials, products, and waste
- Operational Emissions Minimization Measures
- Operational Emissions Mitigation Measures
 - Generate on-site renewable energy
 - Purchase renewable electricity
 - Alternative Compliance Payments for on-site fossil fuel emissions

Article 37 Zoning Updates

Proposed Zoning Changes – Part 3/3:

- Modifies building height to exclude solar PV panels from building height (up to 48” above roof) and parking structures (up to 10’ plus 48” above parking deck).
- Updates the Article 80E Small Project Application & Review Standards
 - Adds Sustainability Component and references to Article 37

ZNC Policy & Standards

Sets Energy Emission Factors for calculating CO₂e emissions

Greenhouse Gas Emission Factors for Common Energy Sources

- 2035 Grid Electricity: 392 lbs CO₂e / MWh = 177.8 kg CO₂e / MWh = 52 kg CO₂e / MBtu
- Natural Gas: 117 lbs / MBtu = 53.11 kg CO₂e / MBtu = 5.31 kg CO₂e / therm
- District Steam^{3, 4}: 193 lbs / MBtu = 87.5 kg CO₂e / MBtu

Notes:

1. All GHG emission factors will be reviewed on an annual basis and may be amended from time to time by the BRA.
2. The forecasted Grid Electricity emission factors are design standards.
3. As calculated by Massachusetts DOER for determining CO₂e emissions from Vicinity provided District Steam to Mass General Hospital's recent building project
4. Alternative distributed thermal energy system GHG emission factors, with supporting analysis and reporting, may be consider.

ZNC Policy & Standards

Operational Mitigation Measures

1. Mitigation of electricity emissions: On-site production of Renewable Energy

If needed as a mitigation measure, the minimum area cumulatively equals:

- 50% of the building roof area(s)
- 90% of the area of any uncovered parking structure deck(s); and
- 5% of unoccupied paved or hardscaped site areas.

With exceptions and exclusions for:

- Building mechanical and structural systems
- Areas are shaded for more than 30 percent of daylight hours annually.
- Uses and/or mature trees of environmental or aesthetic value
- Historic preservation, building, fire, or environmental requirements
- Grid interconnection standards.

And an Installation Time Extension for equipment supply, and changes in incentives, and interconnection standards.

ZNC Policy & Standards

Operational Mitigation Measures

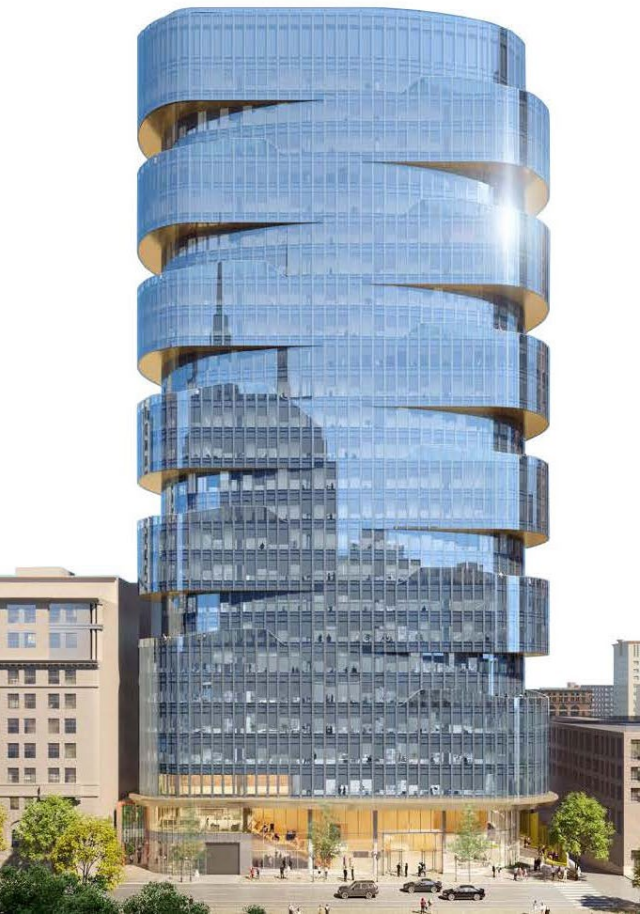
2. Mitigation of electricity use emissions: Renewable Electricity Purchases

If needed as a mitigation of electricity-use Emissions, projects shall: (a) purchasing renewable electricity, (b) purchasing Renewable Energy Certificates, (c) entering into a Power Purchase Agreement, or (d) any other Compliance Mechanism identified in BERDO.

3. Mitigation of non-electricity use emissions: Alternative Compliance Payments

If needed as mitigation measure for non- electricity emissions, projects shall make then Alternative Compliance Payments pursuant to BERDO.

THREE EIGHTY STUART



BY THE NUMBERS

- 625,000 SF Office Building
- 22 Terraces + 1 Roof Deck
- 100% Outside Air with High Efficiency Filtration
- Modeled CEI: 1.35 kgCO₂e/ft²
- Modeled EUI: 25 kBtu/ft²-yr
- Zero Net Carbon from Operations

THE APPROACH

- Reduce energy consumption by maximizing envelope performance and efficiency of systems
- Utilize heat pumps as the tool to electrify the HVAC system
- Purchase green power directly or through the purchase of RECs

DESIGN FEATURES

- High-performance envelope with triple pane glazing
- Heat recovery chiller
- Air source heat pumps
- DOAS with highly efficient energy recovery wheel
- Backup electric resistance boiler
- Chilled beams in lieu of VAVs

THE CHALLENGES

- Cost
- Systems implementation & limitations
- Green power purchase

[Home](#)

RESIDENTIAL

Bartlett Station - The Kenzi

Bartlett Station Drive, Roxbury

Team:

Developer: POAH (Preservation of Affordable Housing)
Architect: DREAM Collaborative
MEP Engineer: Petersen Engineering Inc.
Civil Engineer: Devellis Zrein Inc.
Structural Engineer: RJ Farah
Landscape Architect: Deborah Myers Landscape Architects
Passive House Consultant: Building Evolution Corporation
Contractor: NEI General Contracting

Status: Under Construction

RESILIENCY

Extreme Temps

SUSTAINABILITY

Green Building, Carbon Reduction

Kenzi energy usage

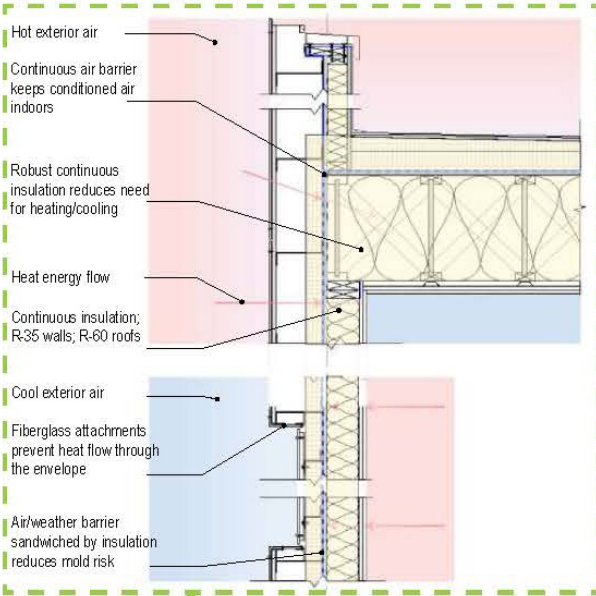
14.07
kBtu/ft²/yr

Base code energy usage

55.74
kBtu/ft²/yr

Home





Resilient Infrastructure

- Generator/battery power on roof of building
- Passive House envelope slows any heat loss/gain in the event of a utility outage, allowing the generator/battery to be downsized
- ~90kW of solar PV array on roof to minimize dependence on external utilities for power
- Rear of site features a bioswale to collect and filter water runoff from adjacent site above

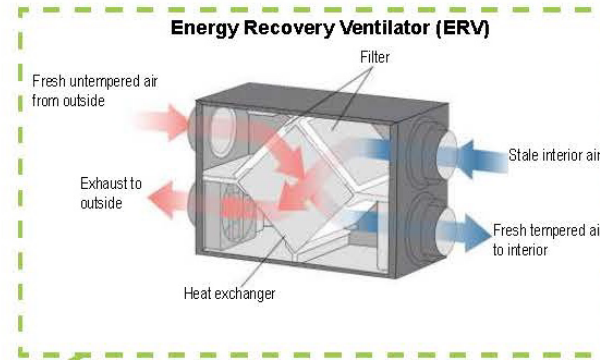
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- Passive House enclosure mitigates extreme temperature swings and will provide a healthy, efficiently conditioned interior environment.
- Habitable landscaped garage roof mitigates heat island effect, producing an oasis of cooled area on a southern exposure.



Carbon Reduction

- Aim toward lower embodied carbon materials, and much less Greenhouse Gas (GHG) emitting materials
- Operational carbon reduced via renewables on the roof and energy efficient Passive House enclosure
- High efficiency ERVs paired with air source heat pumps take advantage of existing energy in the air to control interior air and domestic water temperatures.
- Predicted EUI: 14.07 kBtu/SF/yr (75% reduction from baseline code)



RESIDENTIAL

Bartlett Station - The Kenzi
Bartlett Station Drive, Roxbury

Battery backup

System designed and permitted for emergency use and grid peak demand offset

TOTAL SYSTEM 100%

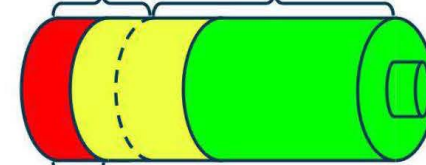
440 kWh



GRID BUY BACK 68%

140 kWh

300 kWh



2 HR LOAD 16%

70 kWh

Glavel

Foam glass gravel used under PH boundary slabs



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Net Zero Carbon BPDA Case Study



Net Zero Carbon - Life Science Approach

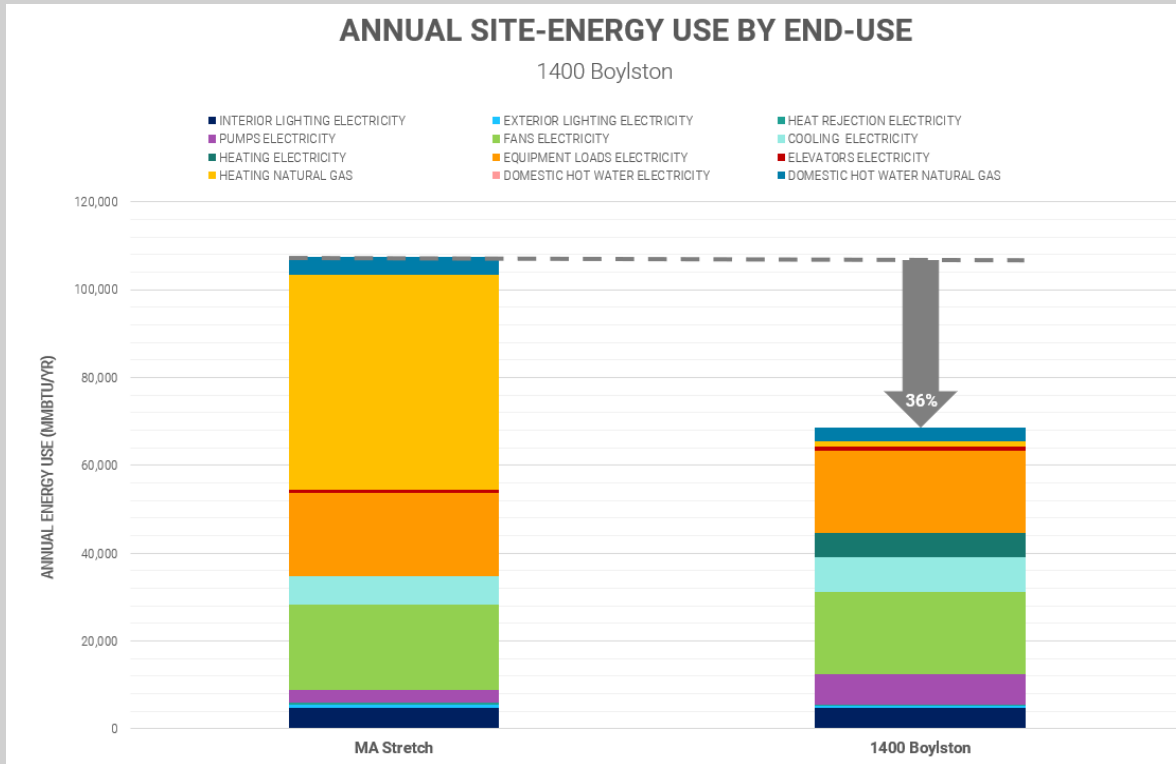
Several Hybrid Electric Projects Under Development

Highlights:

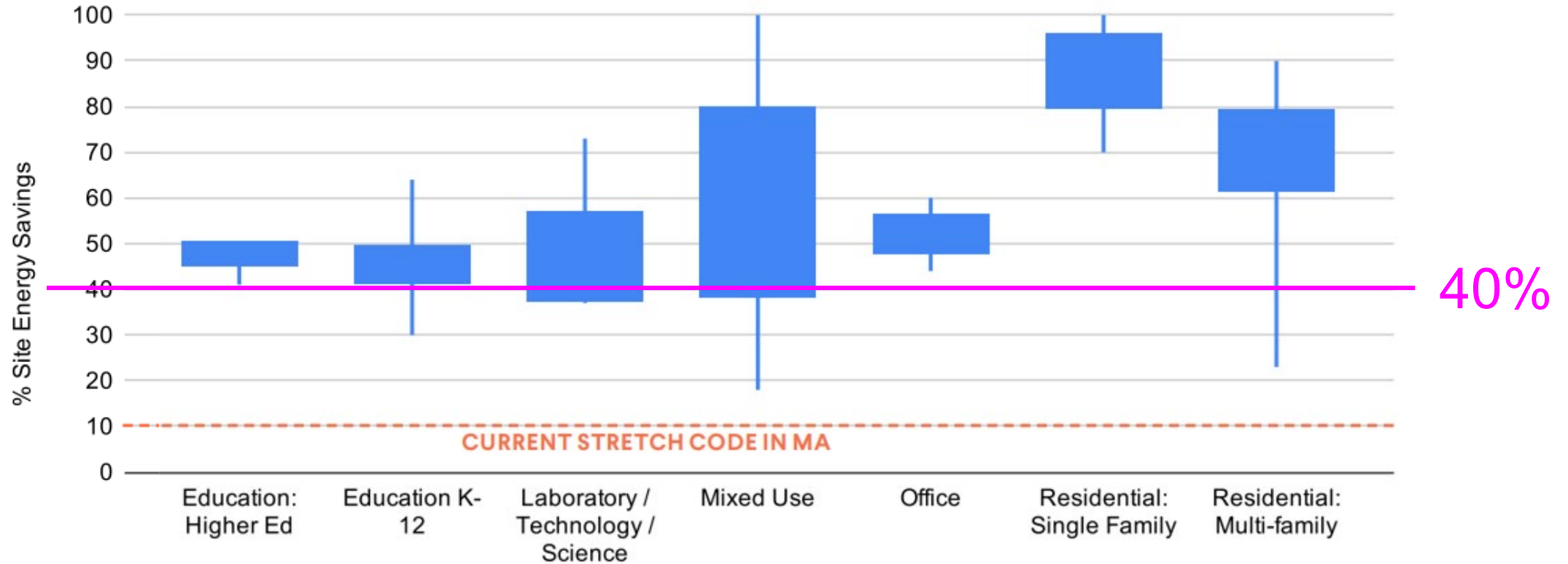
- 95%+ reduction in fossil fuels; shift energy use to electric
- Carbon emissions reduction of up to 40+%
- Renewable sources/RECs
- Thermal envelope; high performance systems

Considerations for future implementation:

- Cost
- Implications for penthouse size/height



Percent Carbon Reduction



Source: Built Environment Plus - Massachusetts is Ready for Net Zero 2021 report

Recommended Pathway

Low Carbon Emitting Building - Carbon Emission Intensity (CEI) Targets

The following building typologies must aim to meet CEI targets below:

Building Typology	CEI Targets [kg CO ₂ e/sf] Recommended	All electric site EUI [kBtu/sf-yr] (for reference only)
Office	1.6	30
College / University Office	1.6	30
K-12 School	1.3	25
Hotel	1.9	35
Residence Hall	1.6	30
Low Density Multifamily	1.1	20
High Density Multifamily	1.6	30
Dry Lab	4.3	80
Wet Lab	6.4	120
Hospital	7.4	139

- Targets are calculated using predicted 2035 carbon emission factors for electricity of 52 kg/MMBtu and current carbon emission factors as published by BERDO.
- Projects that are composed of more than one listed building typology should use a target based on area weighted average.
- Projects with unique conditions (e.g. schedules, loads, etc.) meeting the 40% carbon emissions reduction but not meeting the CEI target should have an opportunity to make a case for an adjusted value.

Carbon Emissions Factors

- Consistent Emission Factors should be used for BERDO and ZNC Zoning
- 2035 Grid Electricity emission factors should be used to more accurately represent the average mid-point lifespan of MEP system equipment

BERDO Aligned Carbon Emissions Factor

Fuel type	Emission factor (kg CO ₂ e/MMBtu)
Natural Gas	53.11
Fuel Oil (No. 1)	73.50
Fuel Oil (No. 2)	74.21
Fuel Oil (No. 4)	75.29
Diesel Oil	74.21
District Steam	66.40
District Hot Water	66.40
Electric Driven Chiller	52.70
Absorption Chiller using Natural Gas	73.89
Engine-Driven Chiller Natural Gas	49.31

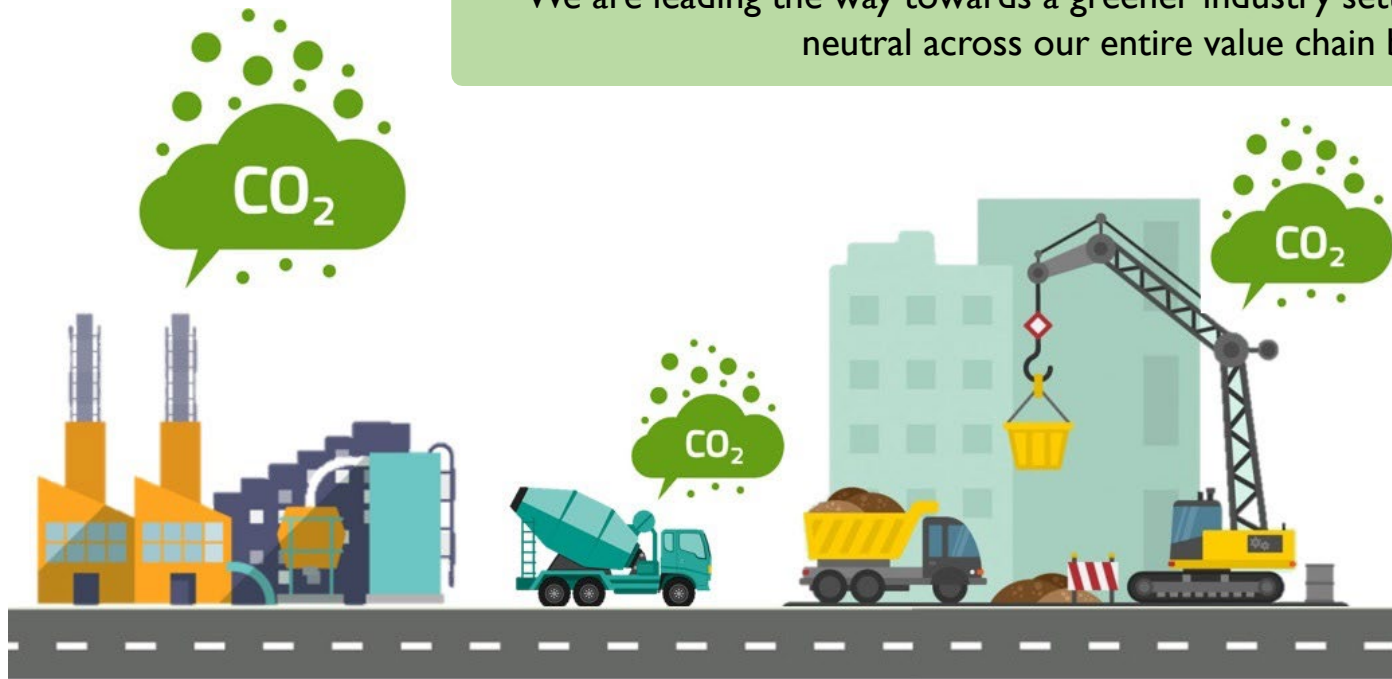
Notes:

1. For service in Boston, DOER has recently calculated the District Steam Emission Factor to be 87.54 kg CO₂e/MMBtu
2. For Grid Electricity, the 2035 Emission Factor is 52 kg CO₂e/MMBtu

SKANSKA

Skanska is a 135-year-old global real estate development and construction company founded in Stockholm, Sweden.

We are leading the way towards a greener industry setting the goal to be carbon neutral across our entire value chain by 2045.



Embodied Carbon

Use Embodied Carbon in Construction Calculator (EC3) tool to inform material supply decisions to reduce embodied carbon

[Home](#)



Operational Carbon

Design our buildings to minimize energy consumption and achieve meaningful reductions in carbon emissions.

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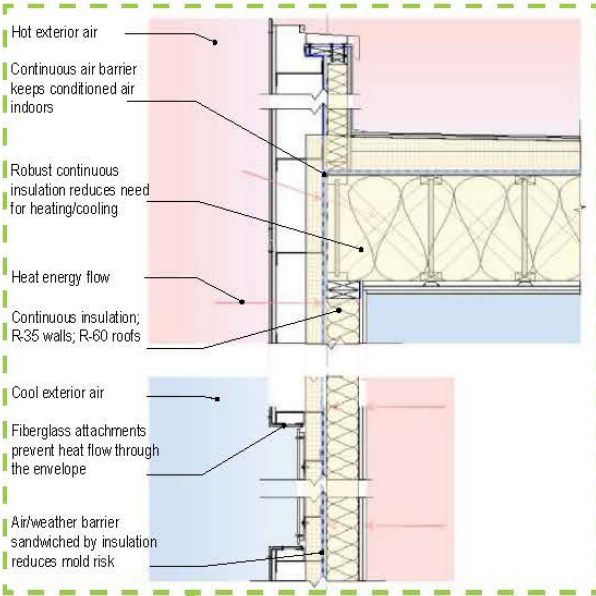
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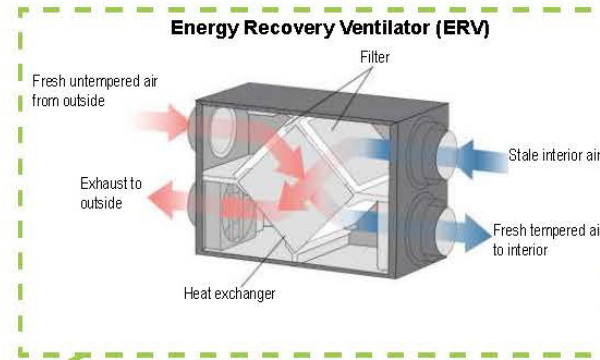
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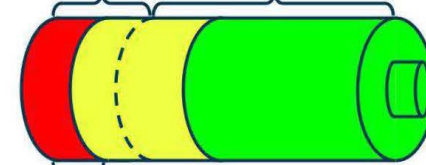
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