



# Capital Improvement Planning: From Concept to Implementation

THE CITY OF CAMBRIDGE MUNICIPAL FACILITIES IMPROVEMENT PLAN

**THE WORKS**  
CAMBRIDGE DEPARTMENT  
OF PUBLIC WORKS


**ARUP**

**E-ICON**  
ARCHITECTURE

# LEARNING OUTCOMES

- Define achievable large and small-scale **energy, maintenance, and accessibility goals** encompassing large building portfolios.
- Establish **strategies for collaborative design process** and understand how to prioritize projects over a long-term planning time-frame.
- **Set project energy targets** and understand planning for net zero emissions, and the difference between net zero energy vs. emissions.
- Identify areas for **building standardization** to reduce maintenance costs and understand how to develop metrics to define success and track progress.

# What do you do?

 When poll is active, respond at [PollEv.com/nedcollier051](https://PollEv.com/nedcollier051)

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New

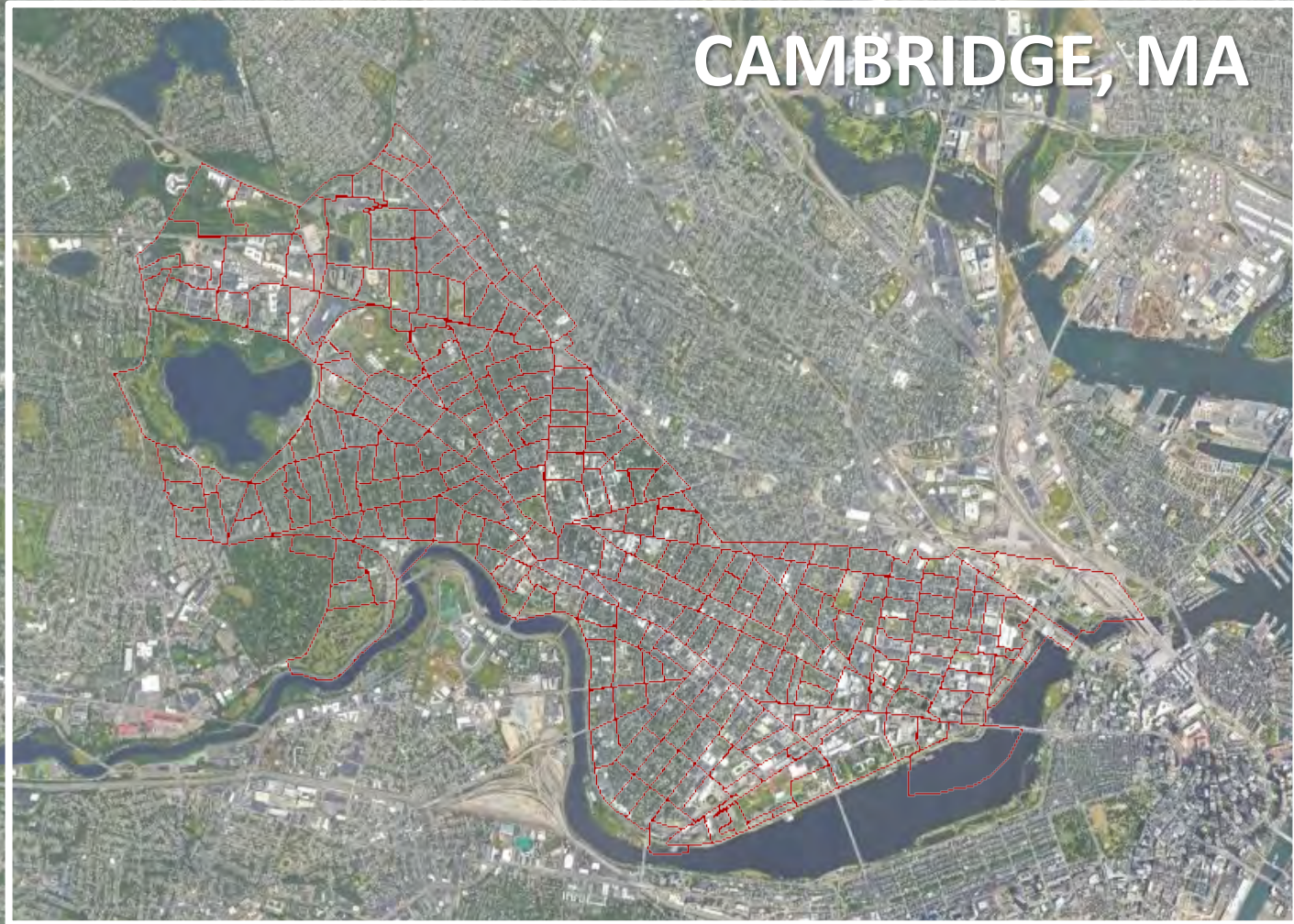
“The goal of the *Municipal Facilities Improvement Project* is to use **whole building thinking** to define a plan for the City of Cambridge to provide and maintain high-performance buildings for staff, occupants, the public and the environment.”

# WHOLE BUILDING THINKING

The philosophy of looking at a **building as a series of interrelated systems** and buildings as part of an integrated portfolio.

**A high performance building is not only low carbon and energy efficient**, but also provides a comfortable and healthy indoor environment, is resilient, easily maintained and responds to the larger community it serves.

# CAMBRIDGE, MA



# 1 Defining Net Zero

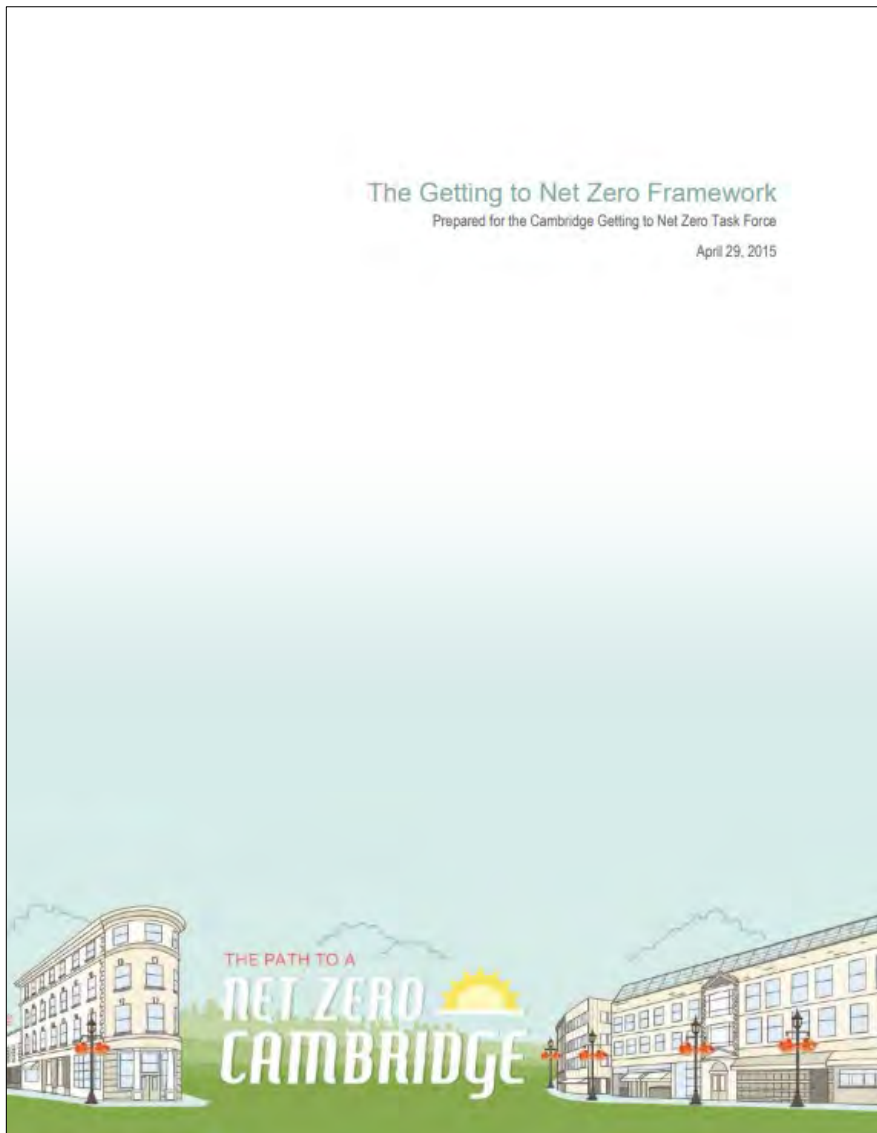
The Task Force defines net zero with respect to the city as a whole as: *A community of buildings for which, on an annual basis, all greenhouse gas emissions produced through building operations are offset by carbon-free energy production. Achieving the net zero objective relies on a combination of energy efficiency improvements, renewable energy production and, where necessary, purchase of carbon offsets or, potentially, credits (that meet specific criteria).*

## Key Actions

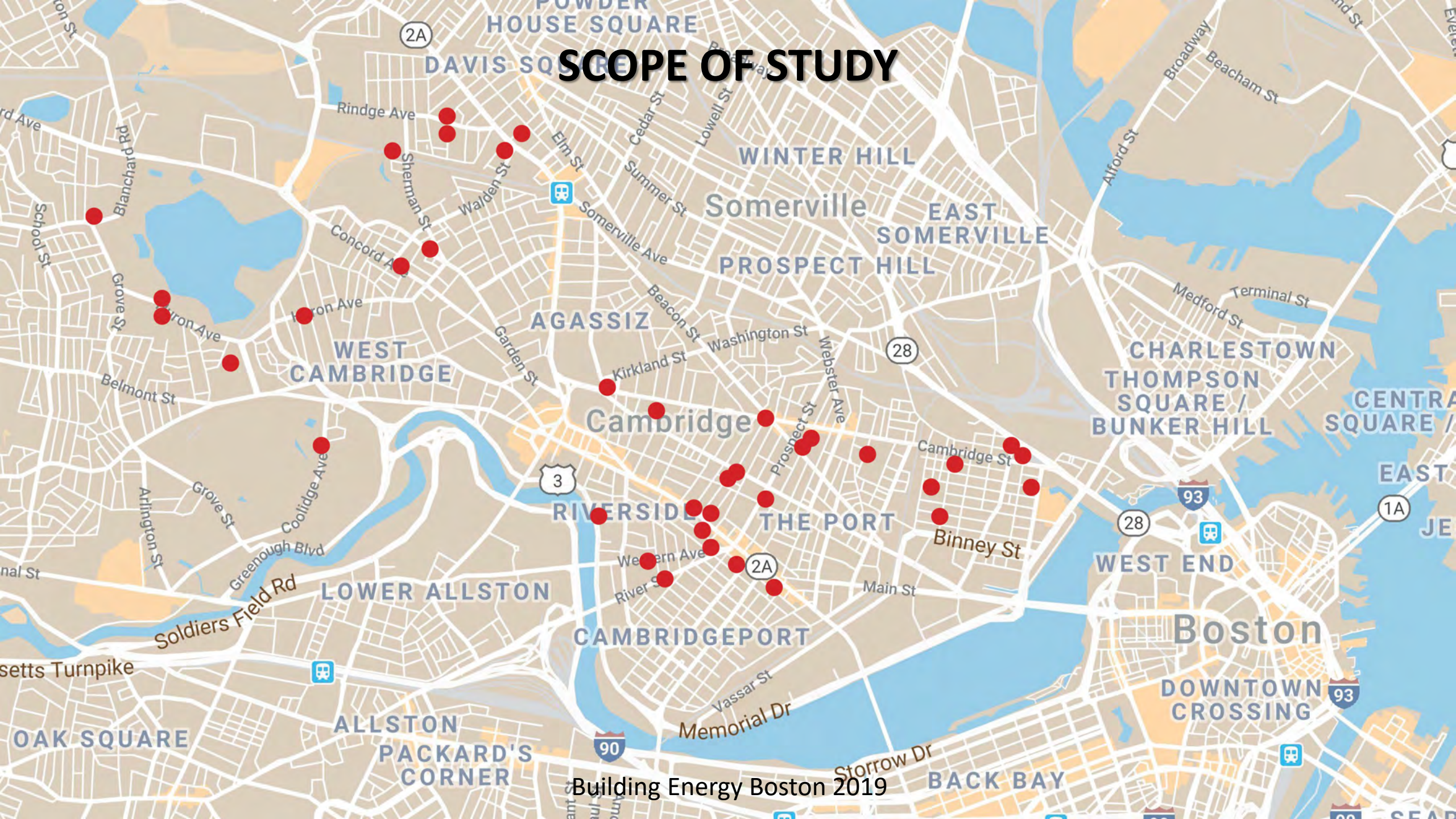
The proposed actions to meet the net zero objective are categorized into five key areas:

1. **Energy Efficiency in Existing Buildings**
2. **Net Zero New Construction**
3. **Energy Supply (low carbon and renewable energy)**
4. **Local Carbon Fund**
5. **Engagement & Capacity Building (communication and resources)**

Type:	Municipal	Residential	Multi-Family	Commercial	Institutional	Labs
Target Year:	2020	2022	2025	2025	2025	2030



# SCOPE OF STUDY





# **MUNICIPAL FACILITIES FRAMEWORK + ASSESSMENT**

## **Workshops**

to articulate priorities, assessment criteria, goals and metrics to develop a holistic assessment framework.

## **Framework**

scoring criteria and comprehensive building assessment form.

## **Assessment**

of City municipal building portfolio through document review, preliminary site visits, occupant survey, benchmarking & energy analysis.

# WORKSHOPS PHASE



## Workshop 1: Visioning & Goal Setting



## Workshop 2: Regulatory & Community



## Workshop 3: Environmental



## Workshop 4: Priorities



## ELEMENTS OF THE VISION

- LEAD IN LONG-TERM THINKING
  - EASY TO MAINTAIN/OPERATE
  - SIMPLICITY & PASSIVE DESIGN
  - CONSIDER LONG-TERM RESOURCE NEEDS
- COORDINATED APPROACH TO DESIGN
  - USE LISTS OF CRITERIA
- MAINTAIN COMMUNICATION BETWEEN PARTICIPANTS
  - CONTRACTING/OTHER TOOLS
- SET UP FRAMEWORK OF GOALS & BENCHMARKS
  - LONG-TERM STRATEGIC PLAN

**VISION**

## COMMUNITY VALUES

- #2 ADDRESS WHAT CITIZENS DESIRE IN THEIR MUNICIPAL POLICY
- #1 ACCESSIBILITY IN ALL WEATHER
- #1 USER FRIENDLY
- #2 VIRTUAL KIOSK/INTERACTIVE BY 2018
- #2 PROXIMITY TO CITIZENS
- MULTIPLE USES IN FACILITIES (SCHOOLS, CC's = PUBLIC RESOURCE)
  - 12 MONTH OCCUPANCY
  - RESILIENCY

**VALUES**

## Operations & Maintenance

- |   |  |   |
|---|--|---|
| <b>Good</b><br>Easy to request an O&M service and prompt response | <b>Better</b><br>Proventative Maintenance in all areas           | <b>Best</b><br>Advanced automated onsite reporting and dedicated onsite staff or resource |
| Give bldg occupants a one-time survey                             | Repeat survey regularly and set goals based on occupant feedback |   |
| Maintenance staff trained in current building systems             | Continuing training  | Maintenance staff be trained for building systems   |
|   | Consistent equipment specifications and standards                | Staff helps design, influence & implement specifications                                  |

**OPERATIONS & MAINTENANCE**

## INDOOR ENVIRONMENTAL PERFORMANCE

- |  |                              |
|--|------------------------------|
| <b>TEMP. HVAC</b>  | <b>COMFORT</b>               |
| * Comfort 100% Temp  | Work Space/Physical Space    |
| * More/Seperate zones for better control                           | INCREASE SECURITY AND SAFETY |
| By 2010 - All buildings have zone control                          |                              |
| By 2010 - All buildings have zone control                          |                              |
| <b>LIGHTING</b>  |                              |
| * Use planning to avoid glare                                      |                              |
| * Select lighting controls/technology                              |                              |
| * Dimmable - ZONES - Task lighting                                 |                              |
| * LED  |                              |
| By 2010 All buildings have zone control                            |                              |
| By 2010 All buildings have zone control                            |                              |
| * Look at lighting fixture, controls                               |                              |
| * Adjustable lighting controls                                     |                              |
| * Natural lighting   |                              |
| By 2010 All buildings have zone control                            |                              |
| By 2010 All buildings have zone control                            |                              |
| <b>ACOUSTICS</b>   |                              |
| By 2010 Design a specific standard for multiple building footprint |                              |
| * Critical spaces vs public spaces                                 |                              |
| * Public spaces  |                              |

**INDOOR ENVIRONMENT**

## FIRE

- Good**: All building occupants know exits
- Better**: All building occupants have a plan & resources
- Best**: Materials are safe for 1st Responders

**FIRE**

## LIFE SAFETY

- Good**: Meet ADA code
- Better**
- Best**: Universal design - all can use all facilities
- Public should have easy access to info re: IT & city procedures

**LIFE SAFETY ACCESSIBILITY**

## CO<sub>2</sub>/GHG REDUCTION

2010 - 2030 - 2050

2008 - 2015 8% ENERGY REDUCTION

- 25-30% PLUG LOAD ENERGY USAGE
- 5% ENERGY CHANGES
  - UNPLUG/TURN OFF
  - HUMAN COMFORT "ACCESSORIES" - HEATERS PAWS
  - NEW EFFICIENT
  - DATA FEEDBACK CAPABILITY
- 30% LIGHTING LED/DIMMING SAVINGS (50%)
- 15% DESIGN TO NEEDED LIGHT LEVELS
  - TASK LIGHTING
- 40% HVAC
- HISTORIC FULL-ENVELOPE UPGRADE 170% city wide by 2010
- Renewable Energy Supply on site/off site
- Zero net energy - new buildings by 2020
- 170% city wide by 2010

**CO<sub>2</sub>/GHG REDUCTION**

## RESILIENCE

- GOAL 1: Adequate emergency shelter**
  - Good**: 1 Shelter
  - Better**: Strategically located shelters
  - Best**: All multi buildings emer. Shelter
- GOAL 2: Buildings withstand Climate Change + Natural Causes**
  - Good**: Disbanded Building codes (to withstand flooding, power outage)
  - Better**: Test for backup generator
  - Best**: Off-grid operation
- GOAL 3: Changing needs of City Buildings**
  - Good**: Open from possibility for change
  - Better**: Minor alterations for change (infrastructure included)
  - Best**: Changing one building's function to another

**RESILIENCE**

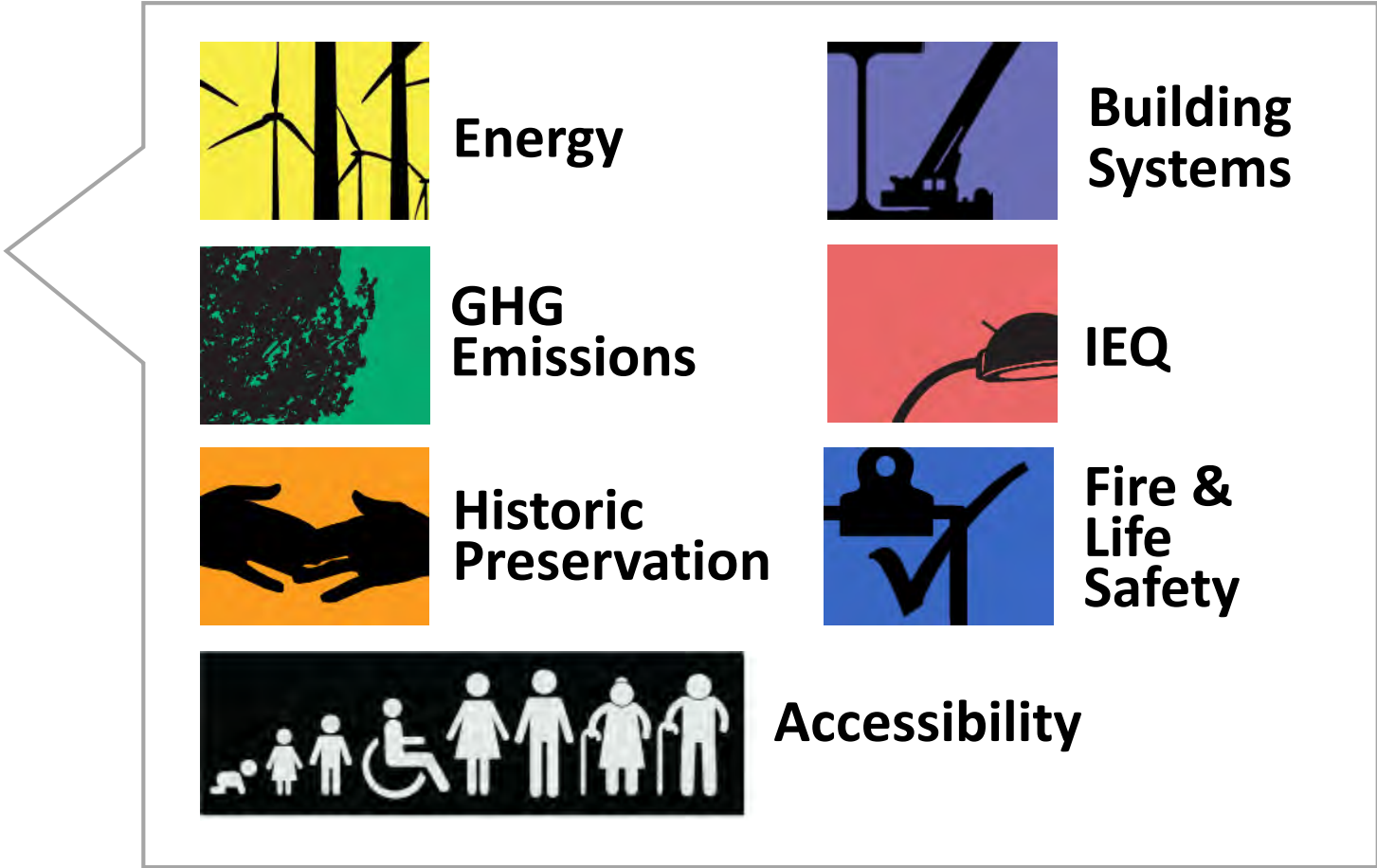
## HISTORIC

GOALS


- #1 PRESERVE EXT CHARACTER
- #2 ACHIEVE HVAC COMFORT 40% CHANGE IN EXT
- #2 IMPROVE ENERGY EFFICIENCY
- #1 IMPROVE INT ARCHITECTURE TO GREATEST EXT POSSIBLE
- #3 FUNCTIONAL INT. LAYOUT
- #1 INVENTORY OF BUILDINGS BY 2020
- #1 ESTABLISH STANDARDS OF MAINTENANCE FOR HISTORICAL FEATURES EXT + INT
- #2 SUSTAIN COMFORTABLE ENVIRONMENT

**HISTORICAL GOALS**

# ASSESSMENT FRAMEWORK



# Any questions on the FRAMEWORK?

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# BUILDING ASSESSMENT PHASE



ALICE K. WOLF CENTER



AREA IV YOUTH CENTER



CITY HALL



CITY HALL ANNEX



COFFON BUILDING



DPW GARAGE



CENTRAL SQUARE BRANCH LIBRARY



GREEN STREET GARAGE



FIRE DEPARTMENT HEADQUARTERS



FRESH POND GOLF GARAGE



CITY HALL



FRESH POND GOLF CLUBHOUSE



HEALY PUBLIC SAFETY BUILDING



INMAN STREET FIREHOUSE



NORTH CAMBRIDGE SENIOR CENTER



PORTER SQUARE FIRE HOUSE



KENNEDY LONGFELLOW SCHOOL



LOMBARDI BUILDING



MAIN LIBRARY



WEST CAMBRIDGE YOUTH CENTER



FRISOLI YOUTH CENTER



DPW ADMINISTRATION BUILDING



TAYLOR SQUARE FIRE HOUSE



BOUDREAU BRANCH LIBRARY



LEXINGTON AVENUE FIRE HOUSE



O'CONNELL BRANCH LIBRARY



MOORE YOUTH CENTER



RIVER STREET FIREHOUSE



DANEHY PARK COMFORT STATION



LAFAYETTE SQUARE FIREHOUSE



CEMETARY CHAPEL



CAMBRIDGE ELECTRICAL SHOP



CORPORAL BURNS BUILDING



PEABODY/RING AVE UPPER SCHOOLS



ROXBURY YOUTH CENTER



Building Energy Boston 2019



CEMETARY ADMINISTRATION



O'NEILL BRANCH LIBRARY



CEMETARY GARAGE


# SCORING SYSTEM

worst ← → best

Numerical Score:	-3	-2	-1	0	1	2	3
<b>Energy Efficiency</b> (kBtu/sf/yr) <b>GHG emissions</b> (m tCO <sub>2</sub> e/sf)	Performing > 75% above MFIP portfolio	Performing 50-74% above MFIP portfolio	Performing 25-49% above MFIP portfolio	Performing at median of MFIP portfolio	Performing 25-49% MFIP portfolio	Performing > 50% below MFIP portfolio	Carbon Neutral in operation (site)
<b>Historic Preservation</b>	Historic features in poor repair and/or covered up/removed	X	Limited Historic features in poor repair and/or covered up/removed	N/A - not a historic building/no historic features	Limited Historic features in good condition	Extensive Historic features in good condition	Historic designation & extensive features in good condition
<b>Accessibility</b>	Conditions prevent access to building or program	X	Conditions allow access by nonstandard means	Conditions allow access but program not fully accessible	Building and programs fully accessible	Fully accessible with aspects of Universal Design present	Universal Design
<b>Indoor Environmental Quality</b>	Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Very Satisfied
<b>Building Systems</b>	Immediate life safety risks or code compliance issues	High priority non-functional or immediate operational risks	Beyond design life, performance and/or system efficiency compromised	Operational and adequate for current use	Operational and adequate for current use; installed recently & in	Operational and functioning with efficiency and/or flexibility of use	Operating to the City's highest standards
<b>Fire and Life Safety</b>	Systems missing or hazardous condition in fire situation	Systems present but incomplete or non-functional	Systems present but not well maintained	Systems present and compliant	Systems present and maintained	Systems present and maintained + FP of emergency systems	Systems beyond what is required



# ASSESSMENT FORM

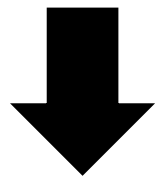
Cambridge Municipal Facilities Portfolio Assessment			
<b>Building Data</b>			
<b>Global Building Data</b>		<b>Responses</b>	
Building Name	Main Library		
Address	449 Broadway		
Facility Manager	Warren Pearson		
Building Image			
Year of original construction	1888		
Year of last major renovation	2006		
Area (gross square feet)	277,185		
Number of stories, total	4		
Number of stories, occupied	4		
Occupancy Category	Assembly		
Total occupants	78	current # of people	max # of people
Are there tenants other than government employees?	Yes	No	
Hours of operation	M-Th 9am Fr-Sa 9am Su 1pm (Sep-Jun)	Start Time	M-Th 9pm Fr-Sa 5pm Su 5pm (Sep-Jun) End Time
<b>Site Visit Information</b>		<b>Responses</b>	
Relevant existing drawings available?	Yes	No	
Does the surveying team have them?	Yes	No	
Survey to verify data completed?	Yes	No	
Date of visit	3/14/2018		
Estimated % of building visited	50-98 %		
Visit made by	Aaron Einck, Mike DiMascia, Alex Stockratm, Elhan Grossman, Thomas Shauler		
<b>Building History</b>			
Significant alterations or additions	Completed	Outstanding	None
Significant damage or repairs	Completed	Outstanding	None
Hazardous materials or abatement measures	Completed	Outstanding	None
<b>Observations</b>			

1. Building data
2. Façade and exterior structures
3. Interior finishes
4. Historic preservation
5. Accessibility
6. Structural systems
7. IEQ
8. Mechanical systems
9. Electrical systems
10. Plumbing systems
11. Fire & life safety systems

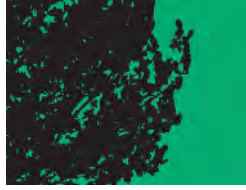
# METHODOLOGY



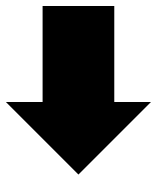
**Energy**



**2015 Data  
FirstView**



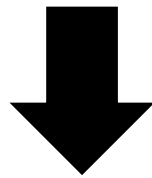
**GHG Emissions**



**2015  
Data**



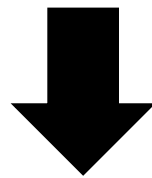
**Historic  
Preservation**



**Site  
Observation**



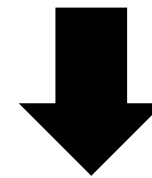
**Accessibility**



**Site  
Observation**



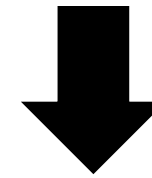
**Building  
Systems**



**Site  
Observation**



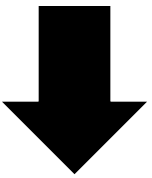
**IEQ**



**Occupant  
Survey**



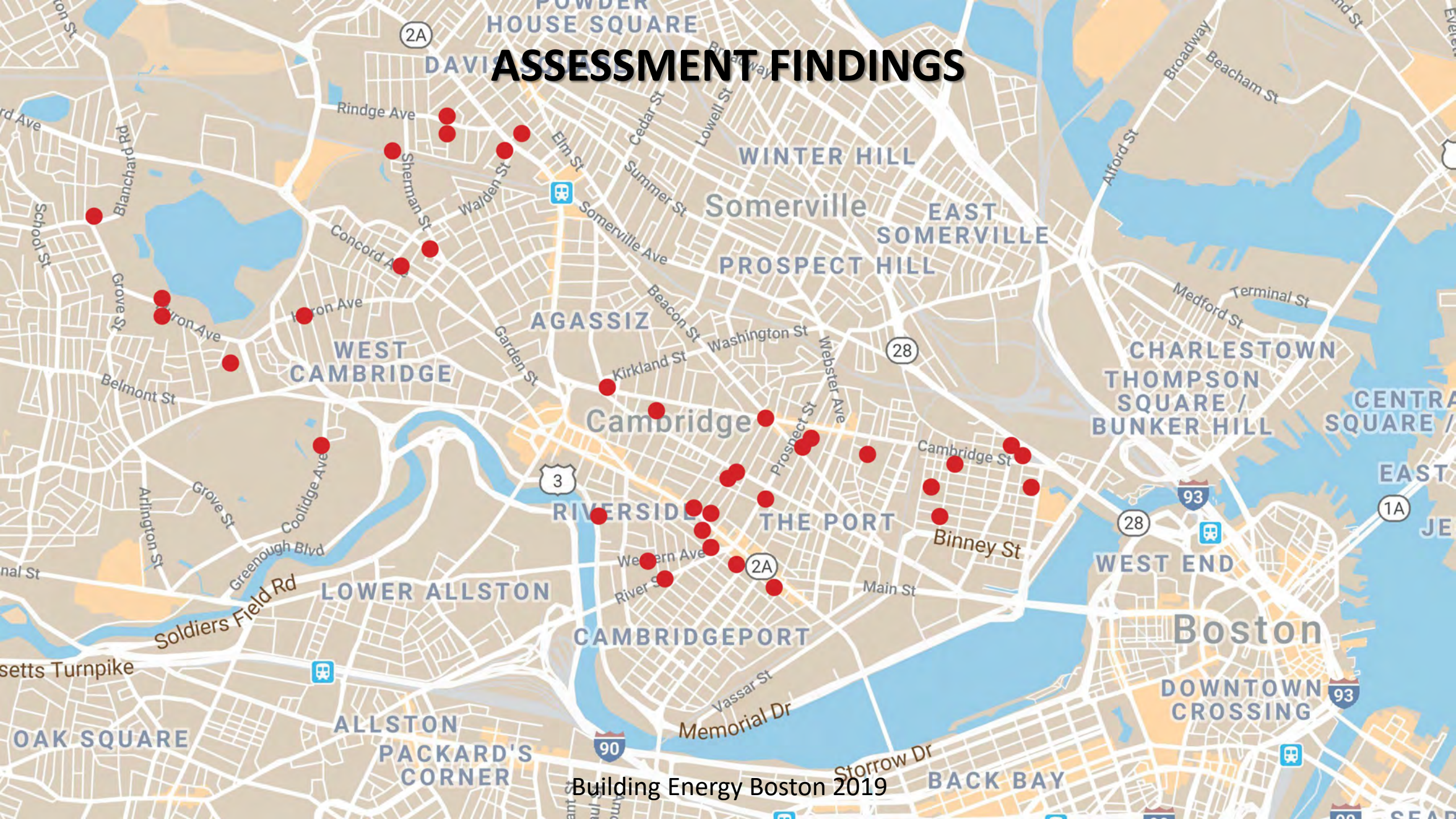
**Fire &  
Life  
Safety**



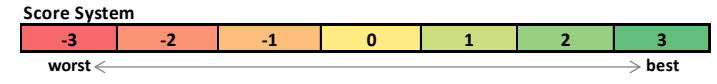
**Site  
Observation**

- **Site visits by Arup & ICON**
- **FirstView energy analysis by NBI**
- **Occupant surveys by Center for the Built Environment, Univ. of Berkeley**

# ASSESSMENT FINDINGS



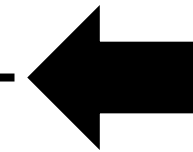
Typology	Area (sq ft)	Historically Significant?	Community Use?	Weighted Overall Score	Assessment Categories						
					2015 EUI (kBtu/sf/yr)	2015 GHG (CO2e/sf/yr)	Historic Preservation	Accessibility	IEQ	Building Systems	Fire and Life Safety
Other	1,923	Yes	No	-2	-2	-2	1	-3		0	-3
Office	2,874	Yes	Yes	-2	-2	-2	1	-3	1	0	-3
Office	3,591	Yes	No	-2	1	0	-1	-3		-1	-3
Garage	1,830	No	Yes	-2	-2	-2	1	-1		0	-3
School	127,302	No	Yes	-2	0	0	0	-3	-1	0	-3
Other	8,418	Yes	No	-2	2	2	-2	-3	-1	-2	-3
Office	11,542	No	No	-1	-1	0	0	-3	1	0	-3
Public Safety	17,093	No	No	-1	-1	0	0	-3	-1	0	-1
Public Safety	11,213	Yes	No	-1	0	0	1	-3	0	0	-3
Public Safety	30,389	Yes	Yes	-1	0	0	0	-2	0	0	-3
Other	4,610	Yes	Yes	-1	-2	-1	-1	0	0	0	0
Other	1,696	No	Yes	-1	-1	-2	0	-2	2	1	-2
Office	12,550	No	Yes	-1	-1	0	0	-2	0	1	-2
Public Safety	19,080	Yes	No	-1	0	0	1	-3	-1	0	-1
Public Safety	6,525	Yes	No	-1	0	0	1	-3	2	0	-3
Office	21,808	Yes	Yes	-1	-1	-1	1	0	0	0	-2
Garage	44,547	No	No	-1	-1	0	1	-2	-1	0	0
Library	3,300	Yes	Yes	-1	0	0	2	-1	0	0	-3
Youth Center	19,405	No	Yes	-1	-1	-1	0	-1	0	0	1
Public Safety	9,643	Yes	No	0	0	1	2	-3	1	0	-2
Public Safety	16,728	Yes	No	0	1	2	2	-3	-1	0	-2
Youth Center	20,059	No	Yes	0	-1	-1	0	0	1	0	1
Office	31,240	Yes	Yes	0	1	1	1	0	0	0	-3
Office	33,909	Yes	Yes	0	0	0	1	-1	0	1	-1
School	108,989	Yes	Yes	0	0	0	0	-1	1	1	0
Public Safety	16,187	Yes	No	0	-1	0	2	-3	1	1	1
Library	277,185	Yes	Yes	0	-1	-1	2	1	1	1	-2
Office	61,731	Yes	Yes	0	0	0	3	-1	0	0	-1
Public Safety	162,547	No	Yes	0	0	-1	0	1	0	1	0
Other	8,909	No	Yes	0	2	2	1	-1	-1	0	-2
Library	6,427	Yes	Yes	1	0	1	2	0	2	0	-3
Library	1,955	No	Yes	1	2	2	0	0		0	-2
Youth Center	10,537	Yes	Yes	1	0	0	0	1	0	0	1
Youth Center	31,586	No	Yes	1	0	0	0	1	1	1	-1
Garage	378,000	No	Yes	1	2	2	1	-1		0	-2
Library	15,447	No	Yes	1	2	2	1	-2	0	0	-1
Senior Center	27,999	Yes	Yes	1	-1	-1	1	1	1	1	1
Youth Center	14,837	No	Yes	1	2	2	1	-2	1	0	0
Library	4,566	Yes	Yes	1	0	1	0	0	1	1	1
Senior Center	3,623	No	Yes	1	2	2	0	0	1	0	-1
Other	4,319	No	No	1	2	2	0	1	2	0	-1
Garage	110,884	No	Yes	1	2	2	0	1		0	1
Office	58,318	Yes	Yes	1	1	1	2	1	1	1	0
<b>Average Score for City of Cambridge Portfolio</b>				<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>-1</b>	<b>0</b>	<b>0</b>	<b>-1</b>



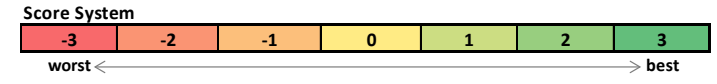
**30 of 43 bldgs (70%)  
 scored negative or  
 neutral**

**13 bldgs scored +1**

**0 bldgs scored +2 or +3**

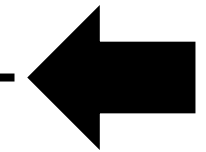


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Garage	110,884	No	Yes	1	2	2	0	1		0	1
Office	58,318	Yes	Yes	1	1	1	2	1	1	1	0
<b>Average Score for City of Cambridge Portfolio</b>				<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>-1</b>	<b>0</b>	<b>0</b>	<b>-1</b>



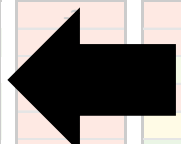
There is work to be done to achieve the City's goals of providing and maintaining high performance buildings & goals for ghg emissions, renewable energy, accessibility, and resilience

30 of 43 bldgs (70%)  
scored negative or neutral  
13 bldgs scored +1  
0 bldgs scored +2 or +3

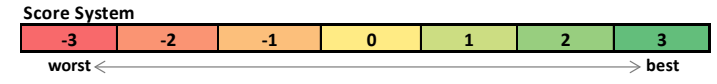


Typology	Area (sq ft)	Historically Significant?	Community Use?
Other	1,923	Yes	No
Office	2,874	Yes	Yes
Office	3,591	Yes	No
Garage	1,830	No	Yes
School	127,302	No	Yes
Other	8,418	Yes	No
Office	11,542	No	No
Public Safety	17,093	No	No
Public Safety	11,213	Yes	No
Public Safety	30,389	Yes	Yes
Other	4,610	Yes	Yes
Other	1,696	No	Yes
Office	12,550	No	Yes
Public Safety	19,080	Yes	No
Public Safety	6,525	Yes	No
Office	21,808	Yes	Yes
Garage	44,547	No	No
Library	3,300	Yes	Yes
Youth Center	19,405	No	Yes
Public Safety	9,643	Yes	No
Public Safety	16,728	Yes	No
Youth Center	20,059	No	Yes
Office	31,240	Yes	Yes
Office	33,909	Yes	Yes
School	108,989	Yes	Yes
Public Safety	16,187	Yes	No
Library	277,185	Yes	Yes
Office	61,731	Yes	Yes
Public Safety	162,547	No	Yes
Other	8,909	No	Yes
Library	6,427	Yes	Yes
Library	1,955	No	Yes
Youth Center	10,537	Yes	Yes
Youth Center	31,586	No	Yes
Garage	378,000	No	Yes
Library	15,447	No	Yes
Senior Center	27,999	Yes	Yes
Youth Center	14,837	No	Yes
Library	4,566	Yes	Yes
Senior Center	3,623	No	Yes
Other	4,319	No	No
Garage	110,884	No	Yes
Office	58,318	Yes	Yes

Weighted Overall Score	Assessment Categories						
	2015 EUI (kBtu/sf/yr)	2015 GHG (CO2e/sf/yr)	Historic Preservation	Accessibility	IEQ	Building Systems	Fire and Life Safety
-2	-2	-2	1	-3		0	-3
-1							
-1	-1	0	0	-3	-1	0	-1
-1	0	0	1	-3	0	0	-3
-1	0	0	0	-2	0	0	-3
-1	-2	-1	-1	0	0	0	0
-1	-1	-2	0	-2	2	1	-2
-1	-1	0	0	-2	0	1	-2
-1	0	0	1	-3	-1	0	-1
-1	0	0	1	-3	2	0	-3
-1	-1	-1	1	0	0	0	-2
-1	-1	0	1	-2	-1	0	0
-1	0	0	2	-1	0	0	-3
-1	-1	-1	0	-1	0	0	1
0	0	1	2	-3	1	0	-2
0	1	2	2	-3	-1	0	-2
0	-1	-1	0	0	1	0	1
0	1	1	1	0	0	0	-3
0	0	0	1	-1	0	1	-1
0	0	0	0	-1	1	1	0
0	-1	0	2	-3	1	1	1
0	-1	-1	2	1	1	1	-2
0	0	0	3	-1	0	0	-1
0	0	-1	0	1	0	1	0
0	2	2	1	-1	-1	0	-2
1	0	1	2	0	2	0	-3
1	2	2	0	0		0	-2
1	0	0	0	1	0	0	1
1	0	0	0	1	1	1	-1
1	2	2	1	-1		0	-2
1	2	2	1	-2	0	0	-1
1	-1	-1	1	1	1	1	1
1	2	2	1	-2	1	0	0
1	0	1	0	0	1	1	1
1	2	2	0	0	1	0	-1
1	2	2	0	1	2	0	-1
1	2	2	0	1		0	1
1	1	1	2	1	1	1	0

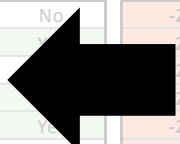


**30 of 43 buildings (70%) have community use**

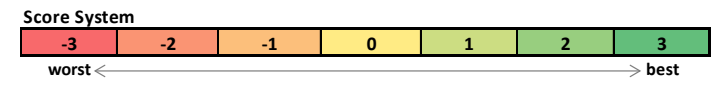


<b>Average Score for City of Cambridge Portfolio</b>	0	0	0	1	-1	0	0	-1
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Typology	Area (sq ft)	Historically Significant?	Community Use?	Weighted Overall Score	Assessment Categories						
					2015 EUI (kBtu/sf/yr)	2015 GHG (CO2e/sf/yr)	Historic Preservation	Accessibility	IEQ	Building Systems	Fire and Life Safety
Other	1,923	Yes	No	-2	-2	-2	1	-3		0	-3
Office	2,874	Yes		-2	-2	-2	1	-3	1	0	-3
Office	3,591	Yes		-2	-2	-2					
Garage	1,830	No		-2	-2	-2					
School	127,302	No	Yes	-2	-2	-2					
Other	8,418	Yes	No	-2	-2	-2					
Office	11,542	No	No	-1	-1	-1					
Public Safety	17,093	No	No	-1	-1	-1					
Public Safety	11,213	Yes	No	-1	-1	-1					
Public Safety	30,389	Yes	Yes	-1	-1	-1					
Other	4,610	Yes	Yes	-1	-1	-1					
Other	1,696	No	Yes	-1	-1	-1					
Office	12,550	No	Yes	-1	-1	-1					
Public Safety	19,080	Yes	No	-1	0	0	1	-3	-1	0	-1
Public Safety	6,525	Yes	No	-1	0	0	1	-3	2	0	-3
Office	21,808	Yes	Yes	-1	-1	-1	1	0	0	0	-2
Garage	44,547	No	No	-1	-1	0	1	-2	-1	0	0
Library	3,300	Yes	Yes	-1	0	0	2	-1	0	0	-3
Youth Center	19,405	No	Yes	-1	-1	-1	0	-1	0	0	1
Public Safety	9,643	Yes	No	0	0	1	2	-3	1	0	-2
Public Safety	16,728	Yes	No	0	1	2	2	-3	-1	0	-2
Youth Center	20,059	No	Yes	0	-1	-1	0	0	1	0	1
Office	31,240	Yes	Yes	0	1	1	1	0	0	0	-3
Office	33,909	Yes	Yes	0	0	0	1	-1	0	1	-1
School	108,989	Yes	Yes	0	0	0	0	-1	1	1	0
Public Safety	16,187	Yes	No	0	-1	0	2	-3	1	1	1
Library	277,185	Yes	Yes	0	-1	-1	2	1	1	1	-2
Office	61,731	Yes	Yes	0	0	0	3	-1	0	0	-1
Public Safety	162,547	No	Yes	0	0	-1	0	1	0	1	0
Other	8,909	No	Yes	0	2	2	1	-1	-1	0	-2
Library	6,427	Yes	Yes	1	0	1	2	0	2	0	-3
Library	1,955	No	Yes	1	2	2	0	0		0	-2
Youth Center	10,537	Yes	Yes	1	0	0	0	1	0	0	1
Youth Center	31,586	No	Yes	1	0	0	0	1	1	1	-1
Garage	378,000	No	Yes	1	2	2	1	-1		0	-2
Library	15,447	No	Yes	1	2	2	1	-2	0	0	-1
Senior Center	27,999	Yes	Yes	1	-1	-1	1	1	1	1	1
Youth Center	14,837	No	Yes	1	2	2	1	-2	1	0	0
Library	4,566	Yes	Yes	1	0	1	0	0	1	1	1
Senior Center	3,623	No	Yes	1	2	2	0	0	1	0	-1
Other	4,319	No	No	1	2	2	0	1	2	0	-1
Garage	110,884	No	Yes	1	2	2	0	1		0	1
Office	58,318	Yes	Yes	1	1	1	2	1	1	1	0

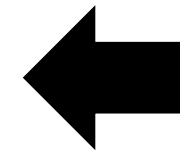
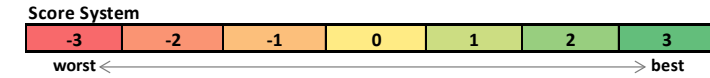


**24 of 43 buildings (56%) are identified as historically significant which speaks to the age of the building stock**



<b>Average Score for City of Cambridge Portfolio</b>	0	0	0	1	-1	0	0	-1
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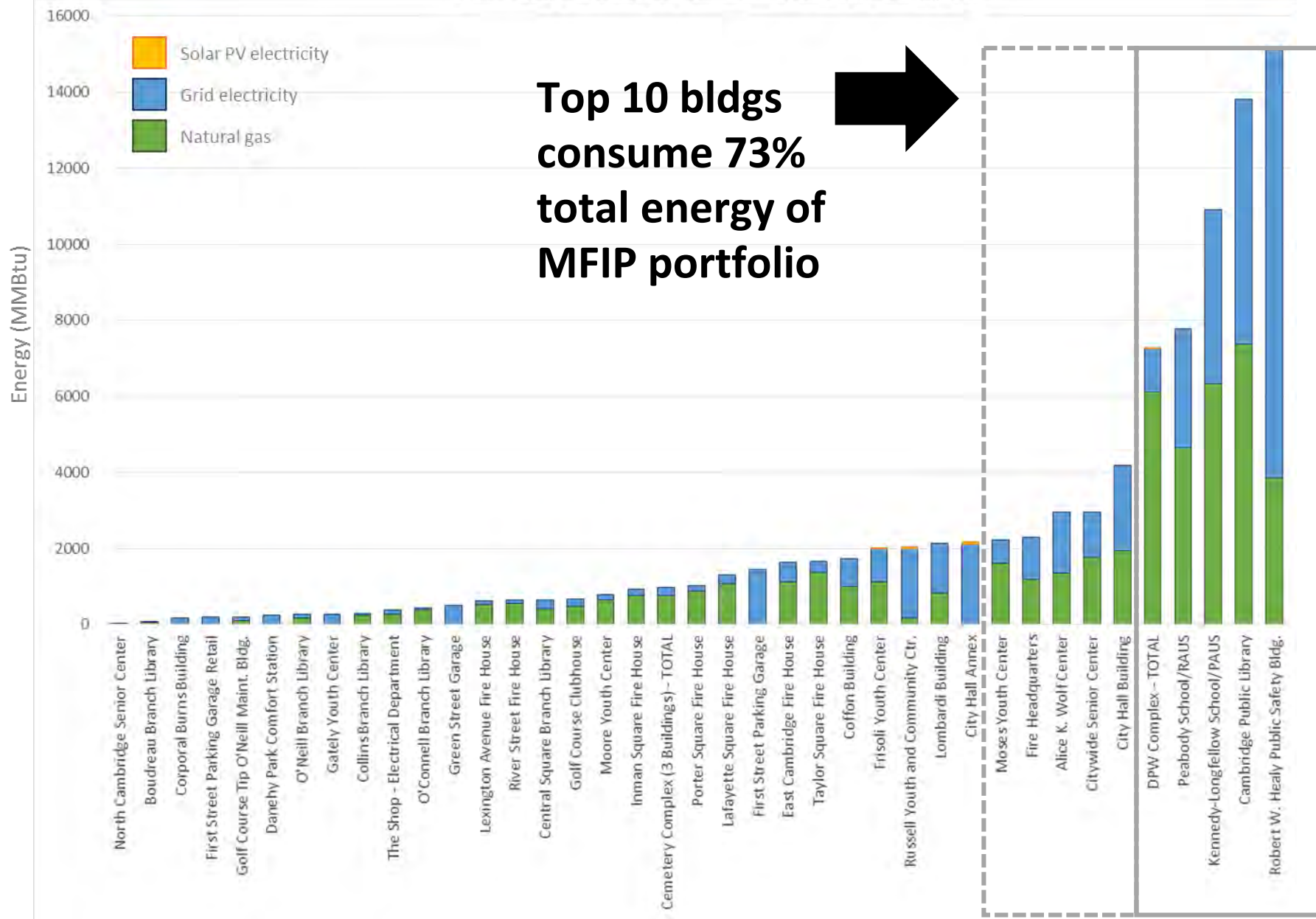
Typology	Area (sq ft)	Historically Significant?	Community Use?	Weighted Overall Score	Assessment Categories						
					2015 EUI (kBtu/sf/yr)	2015 GHG (CO2e/sf/yr)	Historic Preservation	Accessibility	IEQ	Building Systems	Fire and Life Safety
Other	1,923	Yes	No	-2	-2	-2	1	-3		0	-3
Office	2,874	Yes	Yes	-2	-2	-2	1	-3	1	0	-3
Office	3,591	Yes	No	-2	1	0	-1	-3		-1	-3
Garage	1,830	No	Yes	-2	-2	-2	1	-1		0	-3
School	127,302	No	Yes	-2	0	0	0	-3	-1	0	-3
Other	8,418	Yes	No	-2	2	2	-2	-3	-1	-2	-3
Office	11,542	No	No	-1	-1	0	0	-3	1	0	-3
Public Safety	17,093	No	No	-1	-1	0	0	-3	-1	0	-1
Public Safety	11,213	Yes	No	-1	0	0	1	-3	0	0	-3
Public Safety	30,389	Yes	Yes	-1	0	0	0	-2	0	0	-3
Other	4,610	Yes	Yes	-1	-2	-1	-1	0	0	0	0
Other	1,696	No	Yes	-1	-1	-2	0	-2	2	1	-2
Office	12,550	No	Yes	-1	-1	0	0	-2	0	1	-2
Public Safety	19,080	Yes	No	-1	0	0	1	-3	-1	0	-1
Public Safety	6,525	Yes	No	-1	0	0	1	-3	2	0	-3
Office	21,808	Yes	Yes	-1	-1	-1	1	0	0	0	-2
Garage	44,547	No	No	-1	-1	0	1	-2	-1	0	0
Library	3,300	Yes	Yes	-1	0	0	2	-1	0	0	-3
Youth Center	19,405	No	Yes	-1	-1	-1	0	-1	0	0	1
Public Safety	9,643	Yes	No	0	0	1	2	-3	1	0	-2
Public Safety	16,728	Yes	No	0	1	2	2	-3	-1	0	-2
Youth Center	20,059	No	Yes	0	-1	-1	0	0	1	0	1
Office	31,240	Yes	Yes	0	1	1	1	0	0	0	-3
Office	33,909	Yes	Yes	0	0	0	1	-1	0	1	-1
School	108,989	Yes	Yes	0	0	0	0	-1	1	1	0
Public Safety	16,187	Yes	No	0	-1	0	2	-3	1	1	1
Library	277,185	Yes	Yes	0	-1	-1	2	1	1	1	-2
Office	61,731	Yes	Yes	0	0	0	3	-1	0	0	-1
Public Safety	162,547	No	Yes	0	0	-1	0	1	0	1	0
Other	8,909	No	Yes	0	2	2	1	-1	-1	0	-2
Library	6,427	Yes	Yes	1	0	1	2	0	2	0	-3
Library	1,955	No	Yes	1	2	2	0	0		0	-2
Youth Center	10,537	Yes	Yes	1	0	0	0	1	0	0	1
Youth Center	31,586	No	Yes	1	0	0	0	1	1	1	-1
Garage	378,000	No	Yes	1	2	2	1	-1		0	-2
Library	15,447	No	Yes	1	2	2	1	-2	0	0	-1
Senior Center	27,999	Yes	Yes	1	-1	-1	1	1	1	1	1
Youth Center	14,837	No	Yes	1	2	2	1	-2	1	0	0
Library	4,566	Yes	Yes	1	0	1	0	0	1	1	1
Senior Center	3,623	No	Yes	1	2	2	0	0	1	0	-1
Other	4,319	No	No	1	2	2	0	1	2	0	-1
Garage	110,884	No	Yes	1	2	2	0	1		0	1
Office	58,318	Yes	Yes	1	1	1	2	1	1	1	0
<b>Average Score for City of Cambridge Portfolio</b>				<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>-1</b>	<b>0</b>	<b>0</b>	<b>-1</b>



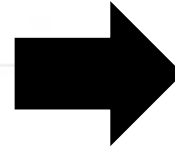
**TOP 13**  
**5 Youth/Community Centers**  
**4 Libraries**  
**3 Garages**  
**1 Office**



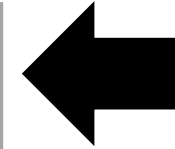
Cambridge Municipal Facilities – 2015 Total Energy Use



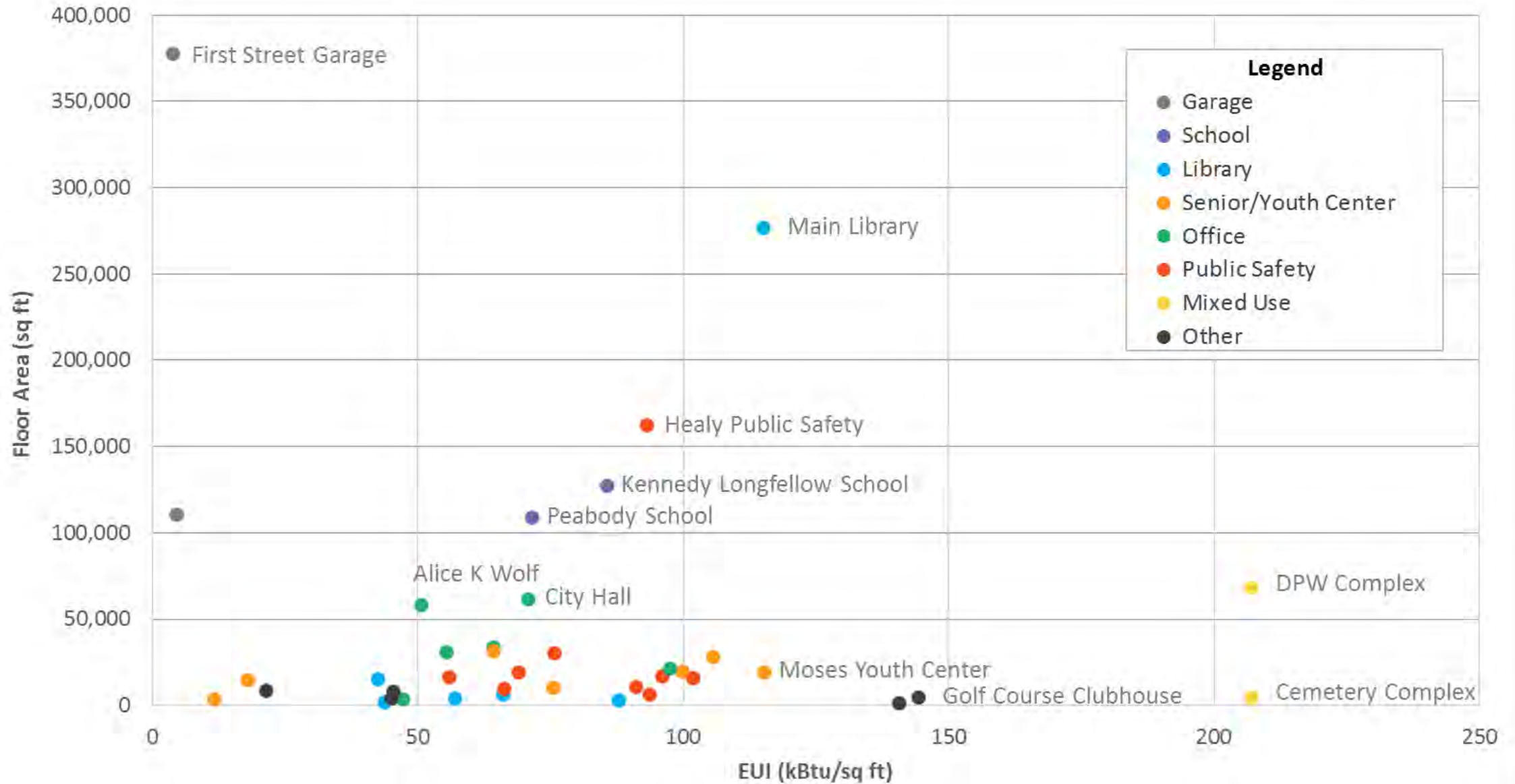
**Top 10 bldgs  
consume 73%  
total energy of  
MFIP portfolio**



**Top 5 bldgs  
consume 58%  
total energy of  
MFIP portfolio**

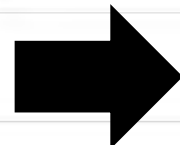


# Energy (EUI) & Square Footage

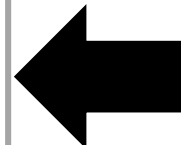


Total GHG Emissions (tCO2e)

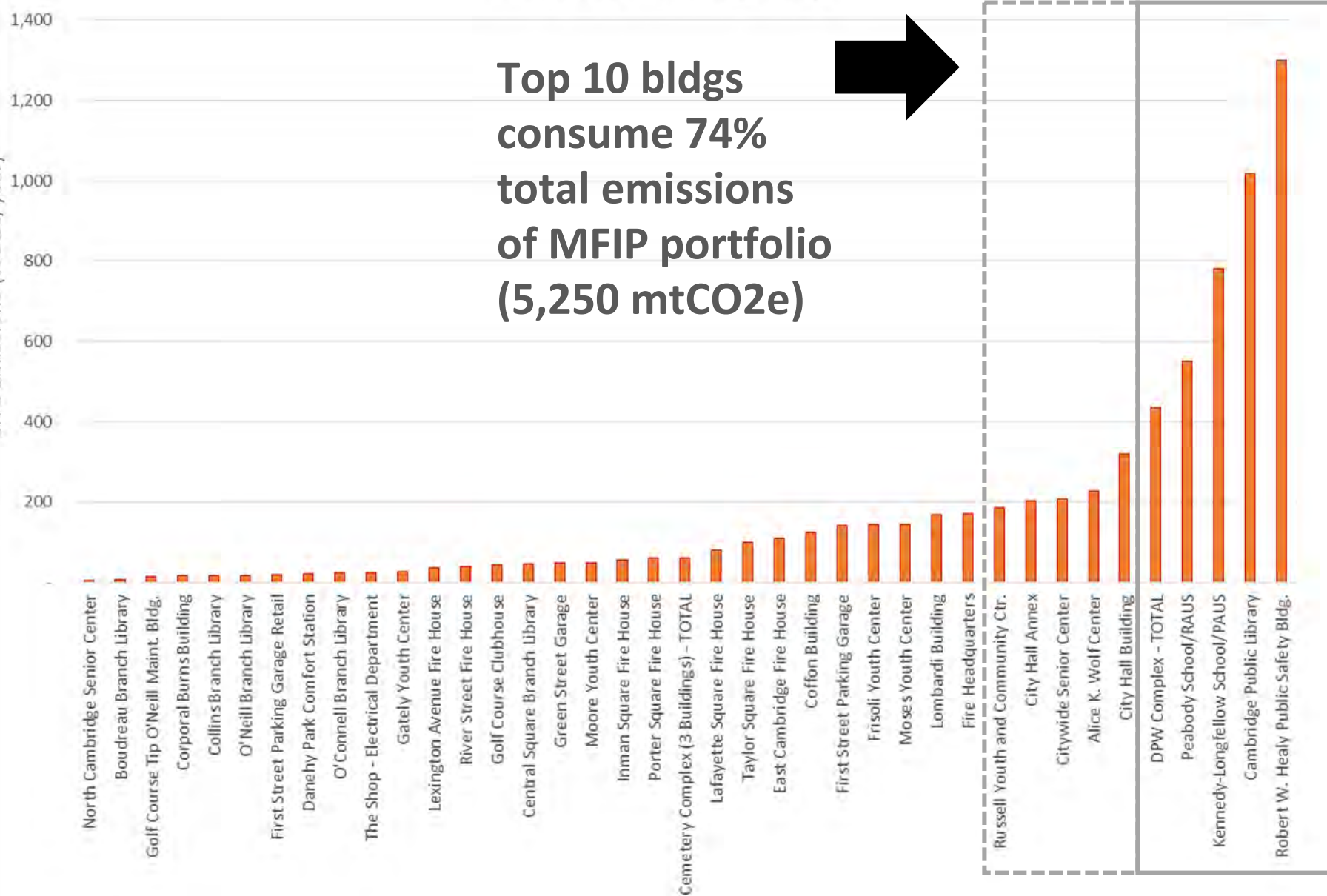
**Top 10 bldgs  
consume 74%  
total emissions  
of MFIP portfolio  
(5,250 mtCO2e)**



**Top 5 bldgs  
consume 58%  
total emissions  
of MFIP  
portfolio  
(4,100 mtCO2e)**

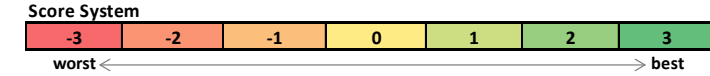


GHG Emissions (tCO2e/year)



Typology	Area (sq ft)	Historically Significant?	Community Use?
Other	1,923	Yes	No
Office	2,874	Yes	Yes
Office	3,591	Yes	No
Garage	1,830	No	Yes
School	127,302	No	Yes
Other	8,418	Yes	No
Office	11,542	No	No
Public Safety	17,093	No	No
Public Safety	11,213	Yes	No
Public Safety	30,389	Yes	Yes
Other	4,610	Yes	Yes
Other	1,696	No	Yes
Office	12,550	No	Yes
Public Safety	19,080	Yes	No
Public Safety	6,525	Yes	No
Office	21,808	Yes	Yes
Garage	44,547	No	No
Library	3,300	Yes	Yes
Youth Center	19,405	No	Yes
Public Safety	9,643	Yes	No
Public Safety	16,728	Yes	No
Youth Center	20,059	No	Yes
Office	31,240	Yes	Yes
Office	33,909	Yes	Yes
School	108,989	Yes	Yes
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Library	6,427	Yes	Yes
Library	1,955	No	Yes
Youth Center	10,537	Yes	Yes
Youth Center	31,586	No	Yes
Garage	378,000	No	Yes
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Senior Center	27,999	Yes	Yes
Youth Center	14,837	No	Yes
Library	4,566	Yes	Yes
Senior Center	3,623	No	Yes
Other	4,319	No	No
Garage	110,884	No	Yes
Office	58,318	Yes	Yes


Weighted Overall Score	Assessment Categories						
	2015 EUI (kBtu/sf/yr)	2015 GHG (CO2e/sf/yr)	Historic Preservation	Accessibility	IEQ	Building Systems	Fire and Life Safety
-2	-2	-2	1	-3		0	-3
-2	-2	-2	1	-3	1	0	-3
-2	1	0	-1	-3		-1	-3
-2	-2	-2	1	-1		0	-3
-2	0	0	0	-3	-1	0	-3
-2	2	2	-2	-3	-1	-2	-3
-1	-1	0	0	-3	1	0	-3
-1	-1	0	0	-3	-1	0	-1
-1	0	0	1	-3	0	0	-3
-1	0	0	0	-2	0	0	-3
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0	2	2	1	-1	-1	0	-2
1	0	1	2	0	2	0	-3
1	2	2	0	0		0	-2
1	0	0	0	1	0	0	1
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1	2	2	1	-1		0	-2
1	2	2	1	-2	0	0	-1
1	-1	-1	1	1	1	1	1
1	2	2	1	-2	1	0	0
1	0	1	0	0	1	1	1
1	2	2	0	0	1	0	-1
1	2	2	0	1	2	0	-1
1	2	2	0	1		0	1
1	1	1	2	1	1	1	0



**Use the assessment TOOL to develop the MFIP, a 13 year improvement plan**

Average Score for City of Cambridge Portfolio	0	0	0	1	-1	0	0	-1
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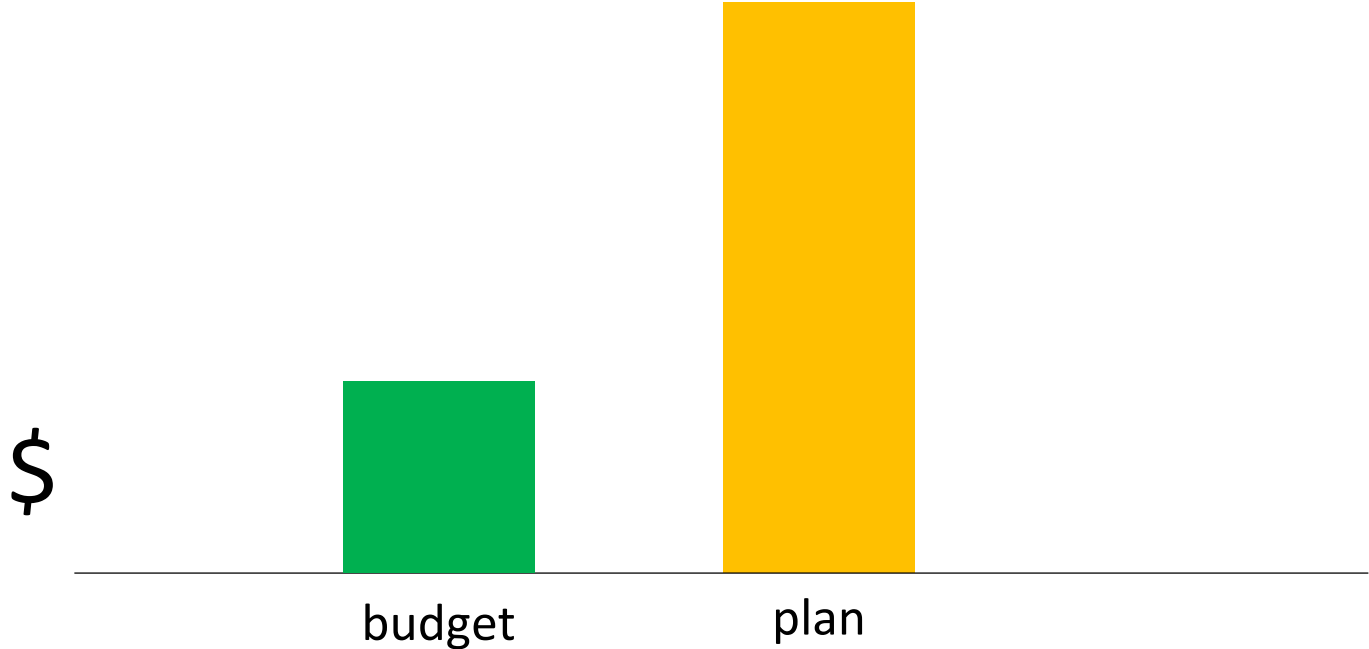
# Any questions on the ASSESSMENT PHASE/TOOL?

 When poll is active, respond at [PollEv.com/nedcollier051](https://PollEv.com/nedcollier051)

Top

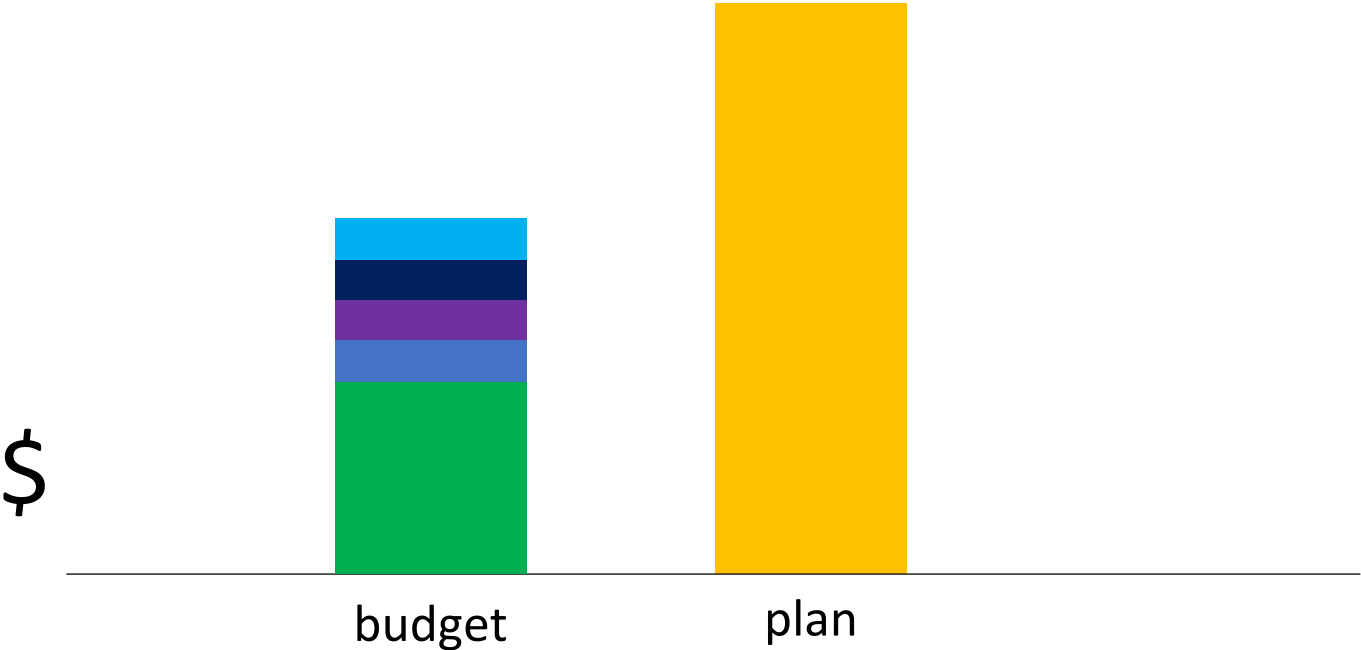


# The preliminary plan identified exceeds the budget.



# The preliminary plan identified exceeds the budget.

Get creative on funding





**The preliminary plan identified exceeds the budget.**

**How do we prioritize?**

**Will we achieve our goals?**

## GUIDING PRINCIPLES

Get our **newest construction** operating optimally, as designed.

Bring our **worst performers** up to better standards.

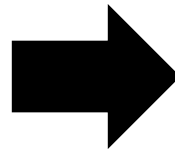
Manage our buildings to **minimize future needs** and investments.

**Demonstrate leadership in NZE**, show it can be done.

# GUIDING PRINCIPLES

Get our **newest construction** operating optimally,  
as designed.

- Alice K Wolf Center
- Russell Youth & Community Center
- Cambridge Public Library
- Healy Public Safety
- City Hall Annex

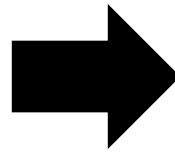


- Energy Audits
- RCx
- Monitoring performance
- Ongoing maintenance
- Training & education

# GUIDING PRINCIPLES

Bring our **worst performers** up to better standards.

- The Shop
- Cemetery Complex
- Fire Houses
- Ryan Garage
- Kennedy Longfellow School

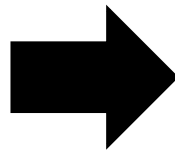


- Life safety projects
- Deferred maintenance
- Accessibility
- Training & education

# GUIDING PRINCIPLES

Manage our buildings to **minimize future needs** and investments.

- Youth & Senior Centers
- Libraries
- Office buildings
- Garages



- RCx
- Deferred maintenance
- Upgrade projects
- Ongoing maintenance



## Achievable number and scale of projects;

- Large/major renovation: 2020 NZE requirement
- Medium: System or equipment replacements
- Small: RCx, study, windows, metering, etc...
- Operational: policies, maintenance, etc...
- Cross sectional: lighting, controls, etc...
- Renewable energy

## Tracking & Monitoring Progress



# MFIP approach

3 project classifications developed around funding;

## Large Scale Renovations

Greatest need  
ZNE requirement applies

## Small Scale Renovations

Improvement projects to address accessibility, fire & life safety, standards, renewables, controls, electrification, RCx, etc...

## Deferred Maintenance

Projects to address envelope and equipment that are at or beyond useful life such as roofs, sealants, equipment, and unforeseen issues

# MFIP approach

3 project classifications developed around funding;

Large Scale  
Renovations

Significant Financial Investment

\$2 to \$30M

Small Scale  
Renovations

\$3M - \$5M Annual Budget  
Range of Financial Investment

\$5,000 - \$3.5M

Deferred  
Maintenance

\$2M Annual Budget  
Range of Financial Investment

\$50,000 - \$2.5M



# HOW ARE WE MOVING FORWARD?

Projects

Tools

Standards

Advocacy & Communication



# PROJECTS UNDERWAY

## Newer Construction

- City Hall Annex
- Healy Public Safety
- Cambridge Public Library
- Russell Youth & Community Center
- Alice K Wolf Center

## Deferred Maintenance

- Citywide Senior Center
- Moore Youth Center
- Lombardi building
- The Shop
- Ryan Garage
- Golf course clubhouse
- Portfolio projects

## De-carbonization

- Solar PV (350 kW):  
Kennedy Longfellow School, Fletcher Maynard Academy & Cambridge Public Library
- Electrification at Engine 3 & Taylor Square Firehouses



# Tools & Standards: Capital Planning

eline

## Project Type Key

Large Scale Renovation	HVAC 5 YR Plan
Deferred Maintenance	Resident Sticker Fund
Small Scale Renovation	School Dept

FY19 Annual Costs		FY2 Annual Costs		FY2 Annual Costs		FY2 Annual Costs		FY2 Annual Costs	
MFIP Total	\$8,386,109	MFIP Total	*****	MFIP Total	*****	MFIP Total	*****	MFIP Total	*****
Non-MFIP T	\$345,650	Non-MFIP Tot	\$189,829	Non-MFIP Total	*****	Non-MFIP Tot	*****	Non-MFIP Tot	*****
Large Scale	\$1,271,351	Large Scale F	\$3,171,622	Large Scale Reno	#REF!	Large Scale F	#REF!	Large Scale	#REF!
Deferred M.	\$5,834,142	Deferred Mair	\$2,462,329	Deferred Maintena	#REF!	Deferred Mair	#REF!	Deferred	#REF!
Small Scale	\$1,934,679	Small Scale R	\$2,249,716	Small Scale Renov	#REF!	Small Scale R	#REF!	Small S	#REF!

Project Name	Project Type	Category	Bond C	Design? Construction? Both	Total Project Cost	Start Date	Completion Date	FY19 Annual Costs												FY2 Annual Costs												FY2 Annual Costs												FY2 Annual Costs												FY2 Annual Costs											
								Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23
Solar PV System 61kW	Small Scale R		19625	Construction		7/1/2018	8/1/2018	[Green bar]																																																											
Admin Building: Repla	Small Scale R	Building System	19625	Design		2/1/2019	4/1/2019	[Green bar]																																																											
Roof Replacement - G	Deferred Main	Building System	21625	Design/Construction	\$195,586	7/1/2020	6/30/2022	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											
Windows - Chapel St	Small Scale R	Energy & GHG	21625	Design/Construction	\$488,964	7/1/2020	6/30/2022	[Green bar]												[Green bar]												[Green bar]												[Green bar]												[Green bar]											
LED retrofit & controls	Resident Sticker	Energy & GHG	20625	Design/Construction	\$106,090	7/1/2019	4/1/2020	[Grey bar]																																																											
Window Replacement	Small Scale R	Building System	20625	Design/Construction	*****	7/1/2019	6/30/2021	[Green bar]												[Green bar]												[Green bar]												[Green bar]												[Green bar]											
Window Replacement	Small Scale R	Building System	21625	Construction	*****	6/30/2020	6/30/2021	[Green bar]												[Green bar]												[Green bar]												[Green bar]												[Green bar]											
ADA Upgrades; Wayfir	Deferred Main	Accessibility	19625	Design/Construction	\$275,000	7/1/2018	6/30/2020	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											
Entry Accessibility Upg	Deferred Main	Accessibility	19625	Design/Construction	\$500,000	7/1/2018	9/1/2019	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											
n.	Small Scale R	Building System	19625	Design/Construction	\$562,500	7/1/2018	9/1/2019	[Green bar]												[Green bar]												[Green bar]												[Green bar]												[Green bar]											
Sealant & Repointing	Deferred Main	Building System	19625	Design/Construction	*****	8/1/2018	1/1/2020	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											
Sealant & Repointing	Deferred Main	Building System	20625	Construction	*****	7/1/2019	1/1/2020	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											
Emergency Egress Up	Deferred Main	Fire & Life Safe	19625	Design/Construction	\$200,000	7/1/2018	6/30/2020	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											
Roof replacement 2	Deferred Main	Building System	20625	Design/Construction	\$200,290	7/1/2019	8/1/2020	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											
Roof Replacement - S	Deferred Main	IEQ	21625	Design/Construction	\$135,000	7/1/2020	6/30/2022	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											
Major Alteration 2	Large Scale F	Condition - All	20625	Design/Construction	*****	7/1/2019	7/1/2021	[Red bar]												[Red bar]												[Red bar]												[Red bar]												[Red bar]											
Major Alteration 2	Large Scale F	Condition - All	21625	Construction	*****	7/1/2020	7/1/2021	[Red bar]												[Red bar]												[Red bar]												[Red bar]												[Red bar]											
Fire Alarm Systems - 1	Small Scale R	Fire & Life Safe	19625	Design/Construction	\$145,000	1/1/2018	11/1/2018	[Green bar]												[Green bar]												[Green bar]												[Green bar]												[Green bar]											
Major Alteration 1	Large Scale F	Condition - All	19625	Design/Construction	*****																																																														
Ventilation - Apparatu	Small Scale R	Fire & Life Safe	19625	Design/Construction	\$200,000	1/1/2018	1/1/2019	[Green bar]												[Green bar]												[Green bar]												[Green bar]												[Green bar]											
Window AC Replacem	Deferred Main	Building System	20625	Design/Construction	\$20,000	7/2/2019	6/30/2021	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											
Destratification Fans 1	HVAC 5 YR Plan	IEQ	21625	Design/Construction	\$30,000	7/1/2020	6/30/2022	[Grey bar]												[Grey bar]												[Grey bar]												[Grey bar]												[Grey bar]											
HVAC - DayCare VRF	Small Scale R	Building System	19625	Design/Construction	\$220,000	7/1/2018	6/1/2019	[Green bar]												[Green bar]												[Green bar]												[Green bar]												[Green bar]											
LED retrofit & controls	Resident Sticker	Energy & GHG	21625	Design/Construction	\$100,000	7/1/2020	1/1/2021	[Grey bar]												[Grey bar]												[Grey bar]												[Grey bar]												[Grey bar]											
Roof Repair - Slate Rd	Deferred Main	Building System	21625	Design/Construction	\$100,000	7/1/2020	6/30/2021	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											
Window & Door Replad	Small Scale R	Energy & GHG	19625	Design/Construction	\$528,530	7/1/2018	6/30/2019	[Green bar]												[Green bar]												[Green bar]												[Green bar]												[Green bar]											
Heating replacement	Deferred Main	Building System	21625	Design/Construction	\$150,706	7/1/2020	6/30/2022	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											
Fire Sprinkler System U	Deferred Main	Fire & Life Safe	19625	Design/Construction	\$500,000	7/1/2018	6/30/2019	[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]												[Blue bar]											

# Tools & Standards: Capital Planning

Summary Cash Flow				Print Sheet											
Budget Code	Budget Amount	Total Cost	Cash Flow Analysis Start Date	Required Expenditure	Total Expended	Difference	Required Expenditure	Total Expended	Difference	Required Expenditure	Total Expended	Difference	Required Expenditure	Total Expended	Difference
TARGETS →				7/16-3/17			3/17-8/17			8/17-3/18			3/18-8/18		
				10%			45%			75%			95%		
17625	\$ 4,670,000	\$ 10,320,850	7/1/2016	\$ 467,000	\$ 449,534	\$ 17,465.82	\$ 2,101,500	\$ 2,010,639	\$ 90,861.50	\$ 3,502,500	\$ 5,090,058	\$ (1,587,558.36)	\$ 4,436,500	\$ 7,141,367	\$ (2,704,866.78)
TARGETS →				7/17-3/18			3/18-8/18			8/18-3/19			3/19-8/19		
				10%			45%			75%			95%		
18625	\$ 4,670,000	\$ 4,025,850	7/1/2017	\$467,000	\$1,652,339	\$ (1,185,338.57)	\$2,101,500	\$2,779,682	\$ (678,182.14)	\$3,502,500	\$3,285,000	\$ 217,500.00	\$4,436,500	\$3,310,350	\$ 1,126,150.00
TARGETS →				7/18-3/19			3/19-8/19			8/19-3/20			3/20-8/20		
				10%			45%			75%			95%		
19625	\$ 5,000,000	\$ 25,557,180	7/1/2018	\$ 500,000	\$ 3,526,445	\$ (3,026,444.79)	\$ 2,250,000	\$ 5,645,537	\$ (3,395,537.05)	\$ 3,750,000	\$ 6,824,263	\$ (3,074,263.33)	\$ 4,750,000	\$ 6,923,430	\$ (2,173,430.00)
TARGETS →				7/19-3/20			3/20-8/20			8/20-3/21			3/21-8/21		
				10%			45%			75%			95%		
20625	\$ 5,000,000	\$ 9,317,995	7/1/2019	\$ 500,000	\$ 3,542,852	\$ (3,042,852.29)	\$ 2,250,000	\$ 5,573,706	\$ (3,323,706.36)	\$ 3,750,000	\$ 7,841,534	\$ (4,091,533.92)	\$ 4,750,000	\$ 9,317,995	\$ (4,567,994.75)
TARGETS →				7/20-3/21			3/21-8/21			8/21-3/22			3/22-8/22		
				10%			45%			75%			95%		
21625	\$ 5,000,000	\$ 2,674,488	7/1/2019	\$ 500,000	\$ 1,092,896	\$ (592,896.00)	\$ 2,250,000	\$ 1,610,060	\$ 639,939.83	\$ 3,750,000	\$ 2,287,423	\$ 1,462,576.67	\$ 4,750,000	\$ 2,674,488	\$ 2,075,512.00
TARGETS →				7/21-3/22			3/22-8/22			8/22-3/23			3/23-8/23		
				10%			45%			75%			95%		
22625	\$ 5,000,000	\$ 5,513,636	7/1/2019	\$ 500,000	\$ 3,320,279	\$ (2,820,278.55)	\$ 2,250,000	\$ 5,177,027	\$ (2,927,026.91)	\$ 3,750,000	\$ 5,513,636	\$ (1,763,636.00)	\$ 4,750,000	\$ 5,513,636	\$ (763,636.00)
TARGETS →				7/22-3/23			3/23-8/23			8/23-3/24			3/24-8/24		
				10%			45%			75%			95%		
23625	\$ 5,000,000	\$ 14,639,475	7/1/2019	\$ 500,000	\$ 8,474,650	\$ (7,974,650.00)	\$ 2,250,000	\$ 11,514,788	\$ (9,264,787.50)	\$ 3,750,000	\$ 13,503,225	\$ (9,753,225.00)	\$ 4,750,000	\$ 14,639,475	\$ (9,889,475.00)
TARGETS →				7/23-3/24			3/24-8/24			8/24-3/25			3/25-8/25		
				10%			45%			75%			95%		

# Net Zero Definitions

## 1 Defining Net Zero

The Task Force defines net zero with respect to the city as a whole as: *A community of buildings for which, on an annual basis, all greenhouse gas emissions produced through building operations are offset by carbon-free energy production. Achieving the net zero objective relies on a combination of energy efficiency improvements, renewable energy production and, where necessary, purchase of carbon offsets or, potentially, credits (that meet specific criteria).*

City of Cambridge Net Zero Action Plan



### Net Zero Energy<sup>1</sup>

- May use fossil fuels or electricity for heating
- Generates as much energy on site or nearby as it uses on an annual basis

- Still emits carbon pollution if using gas on site
- Not all buildings have solar potential
- Generation may not match demand; fossil fuel burning power plants may still be needed during peak hours, leading to higher electricity rates



### Net Zero Carbon<sup>2</sup>

- May use fossil fuels or electricity for heating
- Fossil fuel use (on-site or on the grid) is offset with the purchase or generation of low-carbon energy

- Still emits carbon pollution if using gas on site
- Carbon offsets are achieved only if purchased clean energy displaces high-emissions energy
- There are multiple definitions of when carbon balance is achieved



### Zero Carbon

- No fossil fuel burned on site
- Only uses clean electricity or low-carbon fuels

- Increased demand on clean electricity grids
- Biofuels still emit carbon pollution and can only be considered carbon neutral if feedstocks are sustainably managed and fugitive emissions are addressed

Infographic courtesy of Pembina institute

# Tools & Standards: Capital Planning

Print Sheet

Project Name	Project Type	Budget Code	Design? Construction? Or both?	Design Start Date	Construction End Date	MFIP budget (\$)	Total Project Cost (all included + escalation)
Solar PV System 61 kW - CO19625	Small Scale Renovation	19625	Construction		8/1/2018		
Admin Building: Replace window AC with energ	Small Scale Renovation	19625	Design	2/1/2019	5/1/2019		
ADA Upgrades; Wayfinding	Deferred Maintenance	19625	Design/Construct	7/1/2018	6/30/2020		\$275,000.00
Entry Accessibility Upgrades	Deferred Maintenance	19625	Design/Construct	7/1/2018	9/1/2019		\$500,000.00
n.	Small Scale Renovation	19625	Design/Construct	7/1/2018	9/1/2019		\$562,500.00
Sealant & Repointing	Deferred Maintenance	19625	Design/Construct	8/1/2018	1/1/2020		\$2,500,000.00
Emergency Egress Upgrades	Deferred Maintenance	19625	Design/Construct	7/1/2018	6/30/2020		\$200,000.00
Fire Alarm Systems - 13 buildingsLafayette Fire	Small Scale Renovation	19625	Design/Construct	1/1/2018	11/1/2018		\$145,000.00
Major Alteration 1	Large Scale Renovation	19625	Design/Construct				\$18,618,750.00
Ventilation - Apparatus Bay replacement & Kitc	Small Scale Renovation	19625	Design/Construct	1/1/2018	1/1/2019		\$200,000.00
HVAC - DayCare VRF	Small Scale Renovation	19625	Design/Construct	7/1/2018	6/1/2019		\$220,000.00
Window & Door Replacement - Operable Wood	Small Scale Renovation	19625	Design/Construct	7/1/2018	6/30/2019		\$528,530.00
Fire Sprinkler System Upgrade	Deferred Maintenance	19625	Design/Construct	7/1/2018	6/30/2019		\$500,000.00
Hazardous Abatement/Flr. Finishes	Deferred Maintenance	19625	Design/Construct	7/1/2018	6/30/2020		\$100,000.00
Roof replacement 3	Deferred Maintenance	19625	Design/Construct	7/1/2018	7/1/2019		\$460,000.00
Daycare space HVAC Repair Feasibility Study	Resident Sticker Fund	19625	Design/Construct	12/1/2018	7/1/2019		\$300,000.00
Daycare space HVAC Repair Feasibility Study	Resident Sticker Fund	19625	Construction	12/1/2018	7/1/2019		\$250,000.00
Patio Roof - Phase 2- ramping stair	Deferred Maintenance	19625	Construction	7/1/2018	12/1/2018		\$155,500.00
Pole Compartmentalization	Deferred Maintenance	19625	Design/Construct	7/1/2018	6/30/2020		\$20,000.00
RTU-1 Redundancy, dry coolers + upgrades + chi	Deferred Maintenance	19625	Design/Construct	8/1/2018	8/1/2019		\$392,400.00
RTU-1 Redundancy, dry coolers + upgrades + chi	Deferred Maintenance	19625	Construction	8/1/2018	8/1/2019		\$300,000.00
HVAC, Controls, Water infiltration upgrades	Deferred Maintenance	19625	Construction	5/1/2018	1/1/2020		\$350,000.00
BMS Upgrades	HVAC 5 YR Plan	19625	Design/Construct				\$15,000.00
<b>FY Total:</b>						<b>\$0.00</b>	<b>\$26,592,680.00</b>

# Tools & Standards: GHG Emissions Tracking

Main Summary Tables and Charts

Partially Protected Worksheet

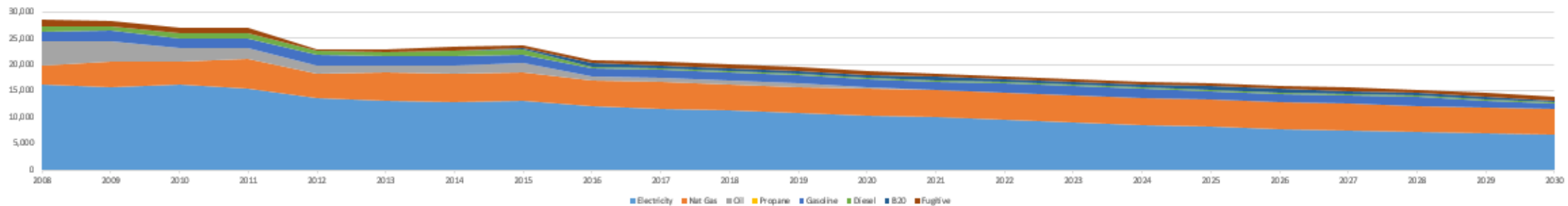
Select Electricity Scenario -----> Scen 2: ISO NE Grid Aligns with RGGI and RPS by 2030

By Fuel Type (metric tons CO2)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Electricity	16,178	15,740	16,118	15,563	13,706	13,028	12,833	13,131	12,014	11,712	11,256	10,811	10,440	10,021	9,656	9,109	8,532	8,276	7,864	7,531	7,320	7,056	6,732	
Nat Gas	3,670	4,760	4,568	5,575	4,645	5,430	5,566	5,452	4,365	5,042	5,012	5,004	4,382	5,081	5,079	5,079	5,077	5,050	5,002	4,932	4,862	4,860	4,856	
Oil	4,543	4,000	2,418	2,029	1,583	1,343	1,422	1,606	803	680	668	536	232	66	66	66	66	61	0	0	0	0	0	
Propane	3	4	3	3	3	3	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Gasoline	2,005	1,908	1,871	1,833	1,857	1,770	1,919	1,675	1,620	1,620	1,620	1,620	1,620	1,620	1,620	1,620	1,620	1,620	1,620	1,620	1,620	1,336	1,053	
Diesel	1,029	969	927	908	850	834	937	1,106	286	286	286	286	286	286	286	286	286	286	286	286	286	286	236	186
B20	0	0	0	0	0	0	2	60	581	581	581	581	581	581	581	581	581	581	581	581	581	479	377	
Fugitive	1,058	1,058	1,058	1,058	209	375	648	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	
<b>Total</b>	<b>28,487</b>	<b>28,459</b>	<b>26,963</b>	<b>27,055</b>	<b>22,853</b>	<b>22,903</b>	<b>23,338</b>	<b>23,694</b>	<b>20,870</b>	<b>20,523</b>	<b>20,025</b>	<b>19,500</b>	<b>18,742</b>	<b>18,258</b>	<b>17,691</b>	<b>17,544</b>	<b>16,825</b>	<b>16,476</b>	<b>15,956</b>	<b>15,613</b>	<b>15,271</b>	<b>14,570</b>	<b>13,866</b>	

By Fuel Type (%)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Electricity		-3%	0%	-4%	-15%	-19%	-21%	-18%	-26%	-28%	-30%	-33%	-35%	-38%	-40%	-44%	-47%	-43%	-51%	-53%	-55%	-56%	-58%
Nat Gas		30%	24%	52%	27%	50%	52%	43%	35%	37%	37%	36%	36%	38%	38%	38%	38%	38%	36%	34%	32%	32%	32%
Oil		-12%	-47%	-55%	-65%	-70%	-63%	-65%	-82%	-85%	-85%	-87%	-95%	-93%	-93%	-93%	-93%	-93%	-100%	-100%	-100%	-100%	-100%
Propane		27%	9%	-5%	9%	9%	27%	38%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Gasoline		-5%	-7%	-6%	-7%	-12%	-4%	-16%	-19%	-19%	-19%	-19%	-19%	-19%	-19%	-19%	-19%	-19%	-19%	-19%	-19%	-33%	-47%
Diesel		-6%	-10%	-12%	-17%	-13%	-9%	7%	-72%	-72%	-72%	-72%	-72%	-72%	-72%	-72%	-72%	-72%	-72%	-72%	-72%	-77%	-82%
B20		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fugitive		0%	0%	0%	-80%	-65%	-33%	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%
<b>Total</b>		<b>0%</b>	<b>-5%</b>	<b>-5%</b>	<b>-20%</b>	<b>-20%</b>	<b>-18%</b>	<b>-17%</b>	<b>-27%</b>	<b>-28%</b>	<b>-30%</b>	<b>-32%</b>	<b>-34%</b>	<b>-36%</b>	<b>-37%</b>	<b>-39%</b>	<b>-41%</b>	<b>-42%</b>	<b>-44%</b>	<b>-45%</b>	<b>-46%</b>	<b>-49%</b>	<b>-51%</b>





Individual Project Input

Project Co	Asset Name	Project Name	Solar PV Project	Fuel Type	Related Spreadsheet	Most Recent Annual Fuel Type Use	Units	Fuel Savings Input Type (% Or Absolute)	Annual Percentage Change (%)	Annual Energy Change (Absolute)	Start Date	Completion Date
1		Major Alteration		Electricity	Elec_Grid	46,978	kWh	Absolute		67,503		
1		Major Alteration		Nat Gas	Nat_Gas	6,086	therms	%	-100%			
1		Major Alteration	Yes	Electricity	Elec_Grid	46,978	kWh	Absolute		(21,798)		
2		Major Alteration		Electricity	Elec_Grid	73,652	kWh	Absolute		80,835		
2		Major Alteration		Nat Gas	Nat_Gas	8,842	therms	%	-100%			
2		Major Alteration	Yes	Electricity	Elec_Grid	73,652	kWh	Absolute		(7,056)		
6		Major Alteration		Electricity	Elec_Grid	43,920	kWh	Absolute		61,607		
6		Major Alteration		Nat Gas	Nat_Gas	8,004	therms	%	-100%			
6		Major Alteration	Yes	Electricity	Elec_Grid	43,920	kWh	Absolute		(9,042)		
3		Major Alteration		Electricity	Elec_Grid	23,580	kWh	Absolute		31,303		
3		Major Alteration		Nat Gas	Nat_Gas	2,898	therms	%	-100%			
4		Major Alteration		Electricity	Elec_Grid	309,162	kWh	Absolute		32,655		
4		Major Alteration		Nat Gas	Nat_Gas	10,105	therms	%	-100%			
502		PV	Yes	Electricity	Elec_Grid	520,860	kWh	Absolute		(271,743)	7/1/20	9/1/21
11		Major Alteration		Electricity	Elec_Grid	10,319	kWh	Absolute		20,416		
11		Major Alteration		Nat Gas	Nat_Gas	2,001	therms	%	-100%			
11		Major Alteration	Yes	Electricity	Elec_Grid	10,319	kWh	Absolute		(8,064)		
5		Major Alteration		Electricity	Elec_Grid	30,884	kWh	Absolute		36,025		
5		Major Alteration		Nat Gas	Nat_Gas	4,614	therms	%	-100%			
5		Major Alteration	Yes	Electricity	Elec_Grid	30,884	kWh	Absolute		(8,084)		
12		Major Alteration		Electricity	Elec_Grid	23,618	kWh	Absolute		36,880		
12		Major Alteration		Nat Gas	Nat_Gas	4,132	therms	%	-100%			
12		Major Alteration	Yes	Electricity	Elec_Grid	23,618	kWh	Absolute		(10,332)		
7		Major Alteration		Electricity	Elec_Grid	212,320	kWh	Absolute		46,137		
7		Major Alteration		Nat Gas	Nat_Gas	8,831	therms	%	-100%			
7		Major Alteration	Yes	Electricity	Elec_Grid	212,320	kWh	Absolute		(22,131)		
10		Major Alteration		Electricity	Elec_Grid	135,200	kWh	Absolute		57,946		
10		Major Alteration		Nat Gas	Nat_Gas	8,647	therms	%	-100%			
10		Major Alteration	Yes	Electricity	Elec_Grid	135,200	kWh	Absolute		(23,346)		
8		Major Alteration		Electricity	Elec_Grid	168,720	kWh	Absolute		107,162		
8		Major Alteration		Nat Gas	Nat_Gas	13,839	therms	%	-100%			
8		Major Alteration	Yes	Electricity	Elec_Grid	168,720	kWh	Absolute		(26,388)		
9		Major Alteration		Electricity	Elec_Grid	335,520	kWh	Absolute		(27,198)		
9		Major Alteration		Nat Gas	Nat_Gas	5,335	therms	%	-100%			
9		Major Alteration	Yes	Electricity	Elec_Grid	335,520	kWh	Absolute		(16,920)		
153		Window Replacements		Electricity	Elec_Grid	48,667	kWh	Absolute		(49)	1/1/19	1/1/20
153		Window Replacements		Nat Gas	Nat_Gas	4,317	therms	Absolute		(9)	1/1/19	1/1/20
153		Window Replacements		Electricity	Elec_Grid	48,667	kWh	Absolute		0	1/1/19	1/1/20
14		Major Alteration		Electricity	Elec_Grid	48,667	kWh	Absolute		33,425		
14		Major Alteration		Nat Gas	Nat_Gas	4,317	therms	%	-100%			



# Advocacy & Communication



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### A - C

- Animal Commission
- Assessing
- Auditing
- Budget
- Cambridge Arts
- City Clerk's Office
- City Council
- City Manager's Office
- Commission for Persons with Disabilities
- Community Development
- Consumers' Council

### D - F

- Election Commission
- Electrical
- Emergency Communications
- Equity & Inclusion
- Family Policy Council
- Finance
- Fire Department

### G - L

- Historical Commission
- Human Rights Commission
- Human Service Programs
- Immigrant Rights & Citizenship (CIRC)
- Information Technology
- Inspectional Services
- Law
- LGBTQ+ Commission
- Library
- License Commission

### M - P

- Mayor's Office
- Peace Commission
- Personnel
- Police Department
- Police Review and Advisory Board
- Public Health
- Public Works (DPW)
- Purchasing

### Q - Z

- Retirement Board
- School Department
- Tourism Office
- Traffic, Parking, and Transportation
- Veterans' Services
- Water Department
- Weights & Measures
- Women's Commission

### #

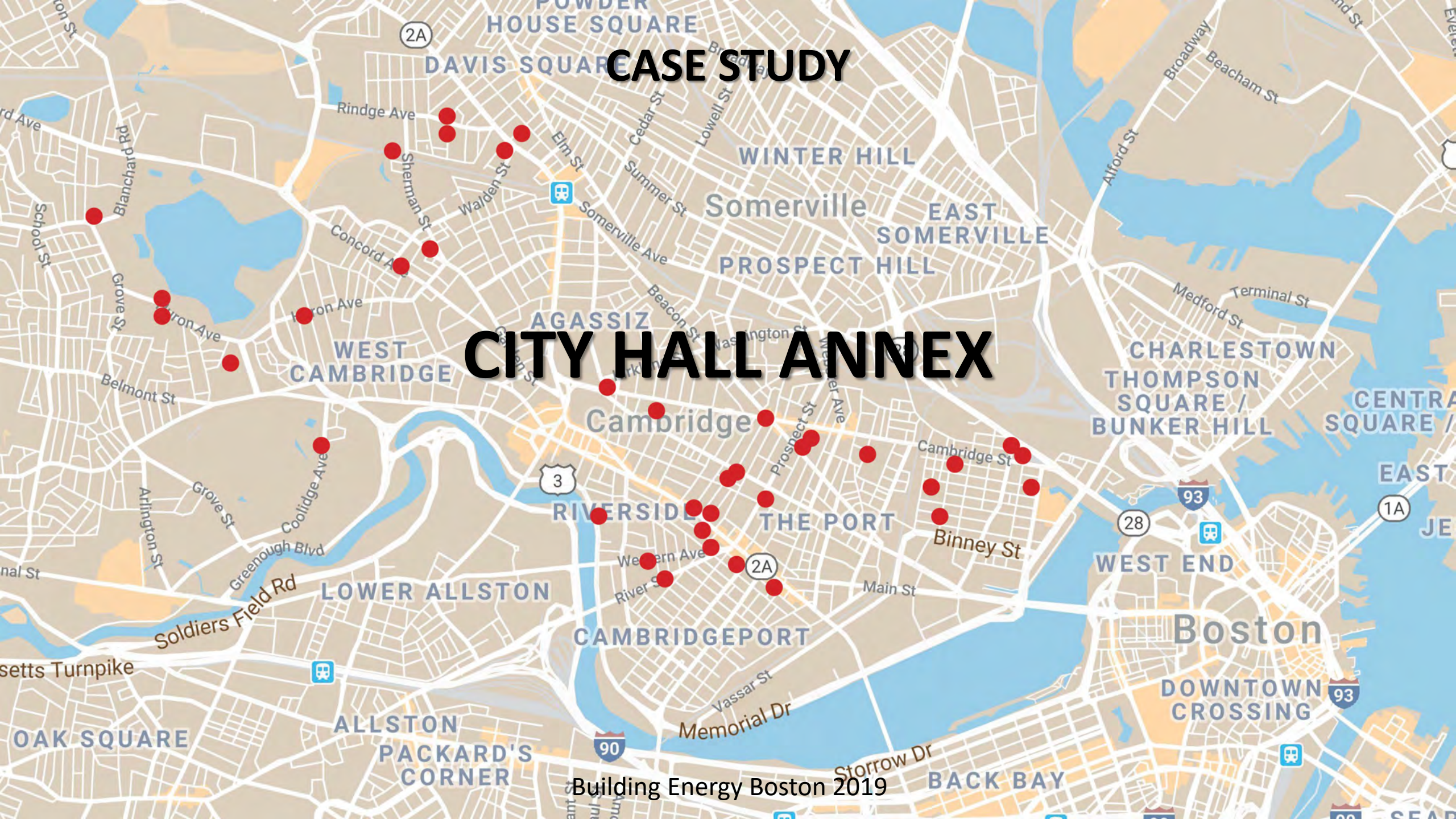
22-CityView

**DEPARTMENT DIRECTORY**



# CASE STUDY

# CITY HALL ANNEX



# Cambridge City Hall Annex : LEED Historic Buildings

iar 411-02 : fall 2011 : interior architecture department : group v : city hall investigation : jeff linn



Historic structure - repurposed to become a city hall



Observant and respectful of existing structure, while still achieving a modern feel.





*The staircase immediately lures you up to the second level if you do not already know where you are going.*



*Sequence of visitor entering building intuitively taking the stair and then backtracking down the stairs again looking confused. When asked he said he was looking for the elevator.*





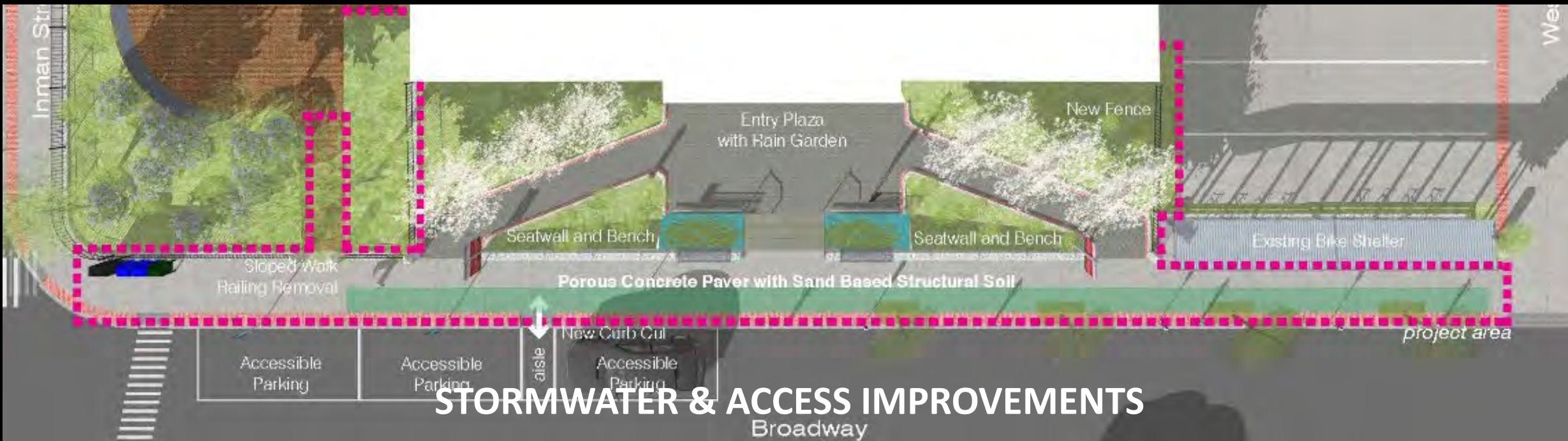
**ENVELOPE IMPROVEMENTS**



**INCLUSIVE DESIGN**



**WAYFINDING**

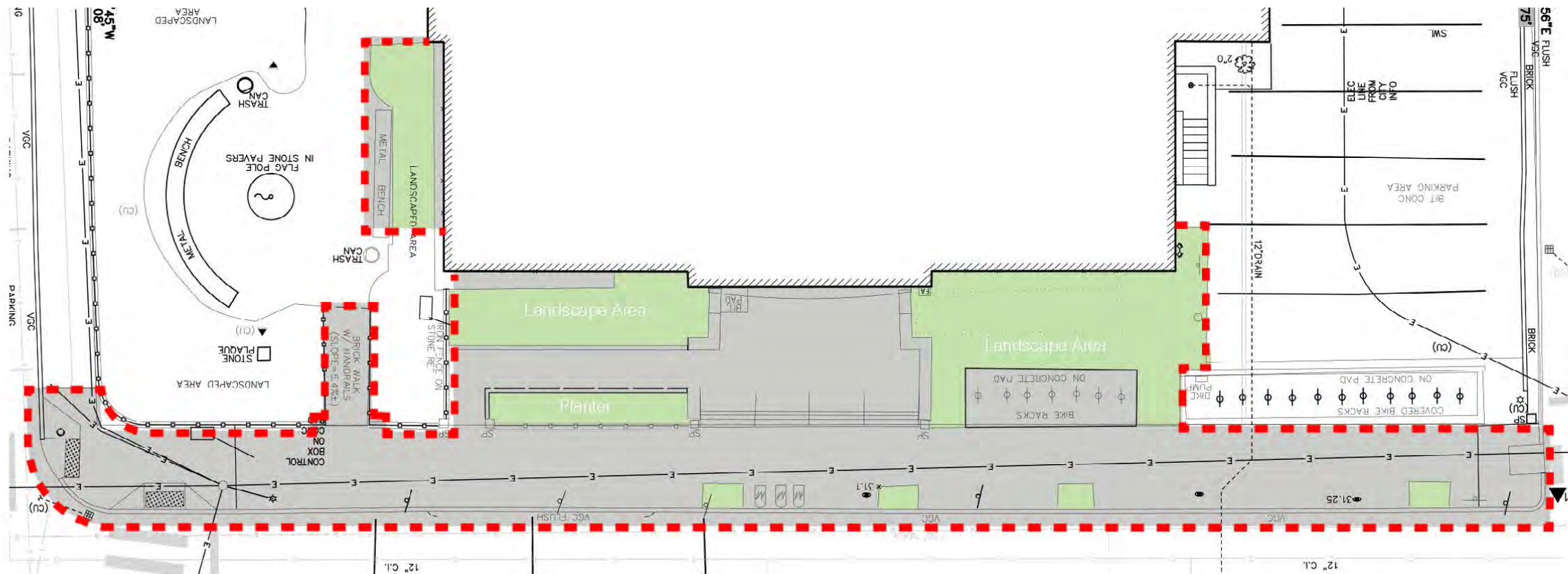


**STORMWATER & ACCESS IMPROVEMENTS**



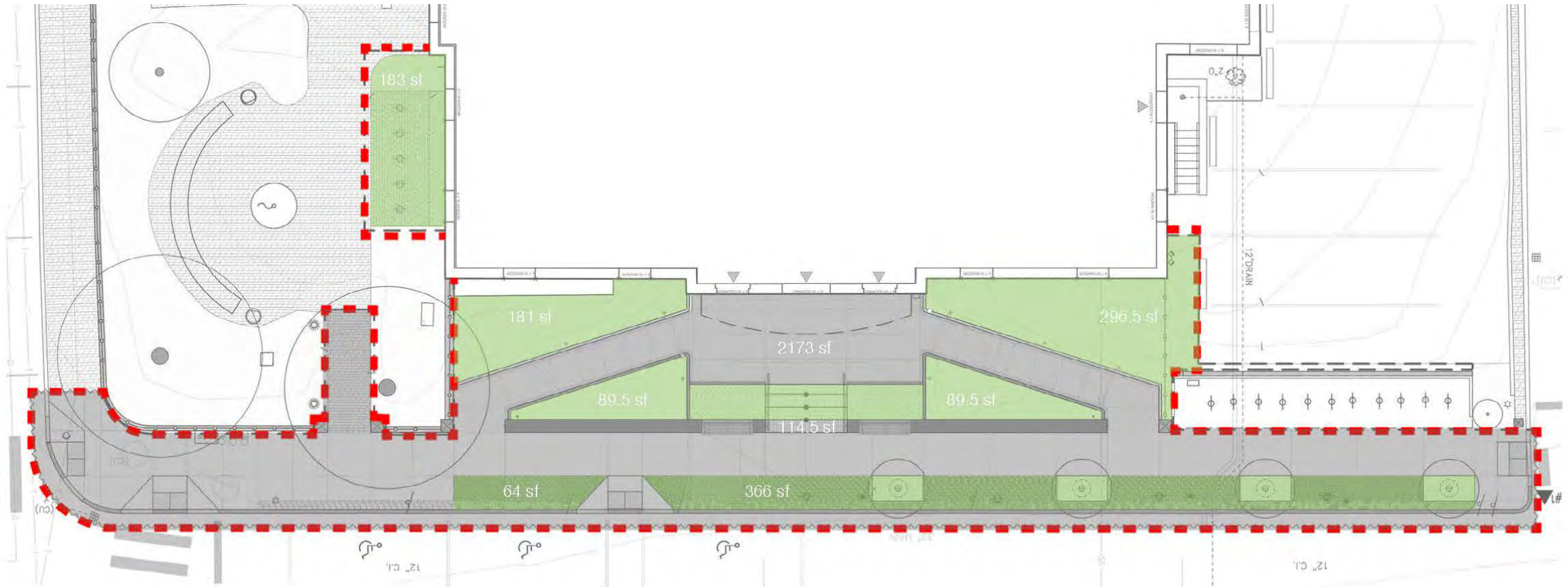
Building Energy Boston 2019





Pre-development:

- Total Area: 3557 sf (100%)
- Impervious Area: 2689 sf (76%)
- Pervious Area: 868 sf (24%)

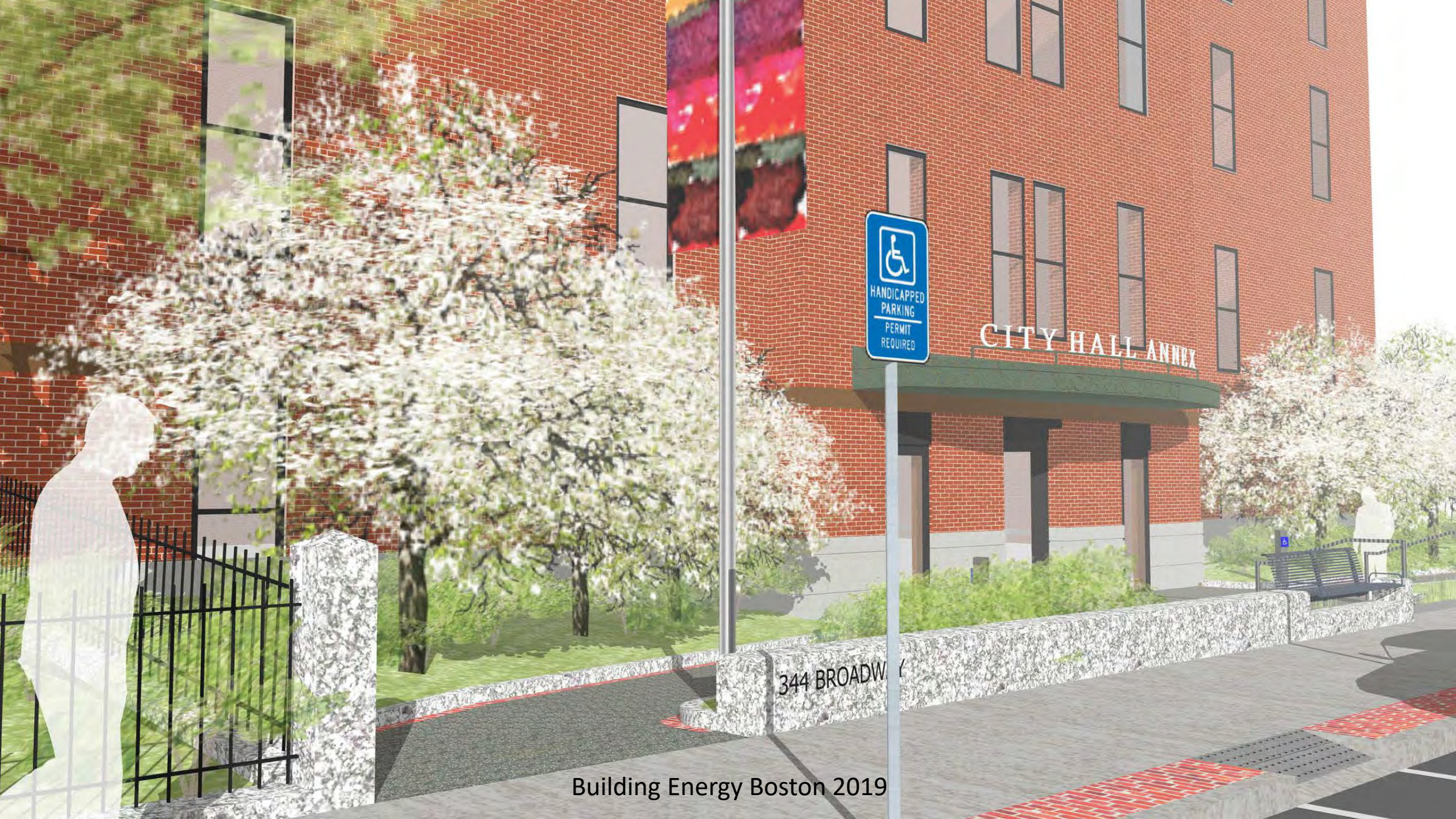


Post-development:

- Total Area: 3557 sf (100%)
- Impervious Area: 2173 sf (61%)
- Pervious Area: 1384 sf (39%)



Building Energy Boston 2019



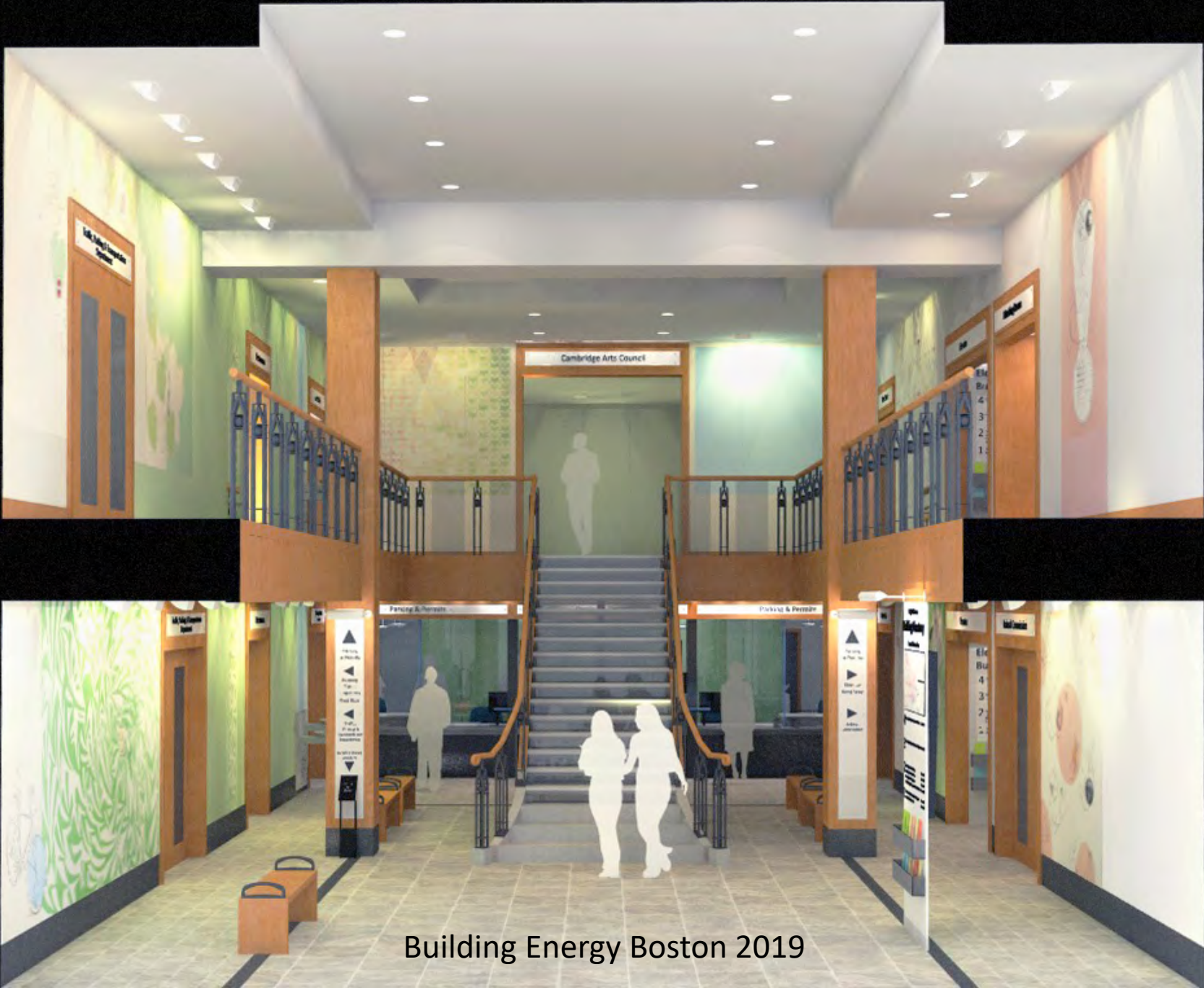
CITY HALL ANNEX

HANDICAPPED  
PARKING  
PERMIT  
REQUIRED

344 BROADWAY



Building Energy Boston 2019



Building Energy Boston 2019



Traffic, Parking & Transportation Department

Cambridge Arts Council

Animal Commission

City Hall Annex  
**Building Directory**  
 Transit Information



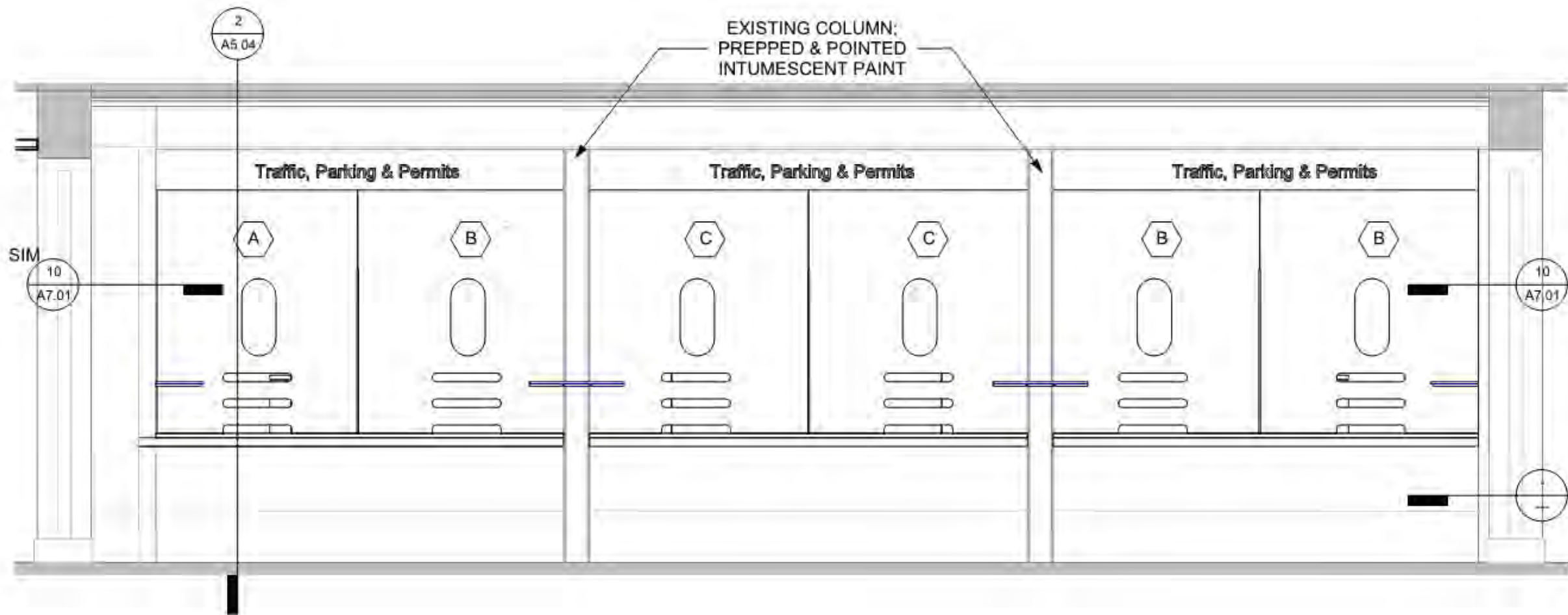
- 4 Community Development Department Offices Room 401
- 3 Community Development Department Reception Room 301
- 2 Cambridge Arts Council Gallery Room 201  
 Cambridge Arts Council Offices Room 204  
 Planning Board Meeting Room Room 205  
 Traffic, Parking & Transportation Administration Room 206
- 1 Traffic, Parking & Transportation Reception Room 101  
 Animal Control Commission Room 103

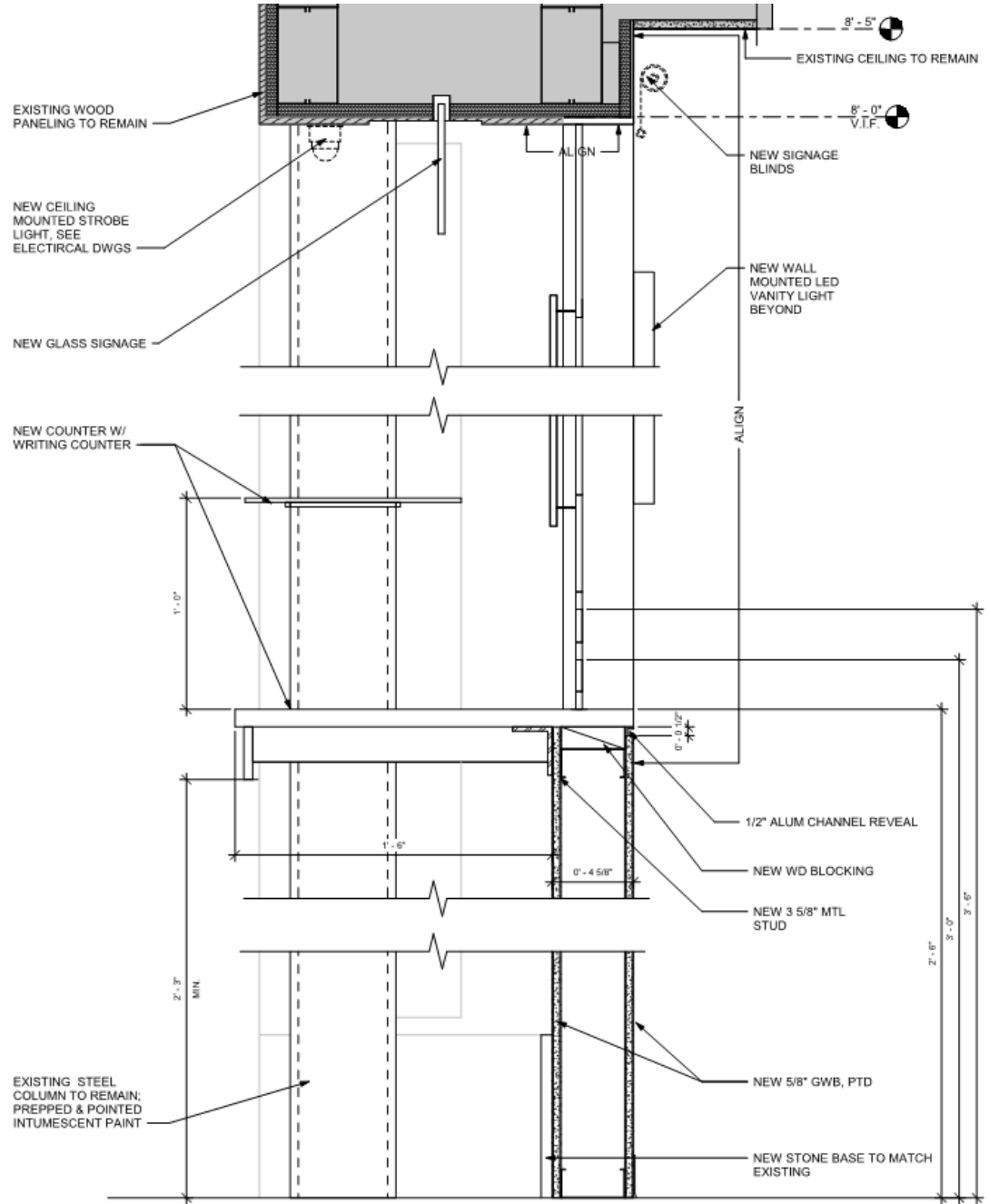
Building Energy Boston 2019











**HOW ARE WE MOVING FORWARD?**

**Projects**

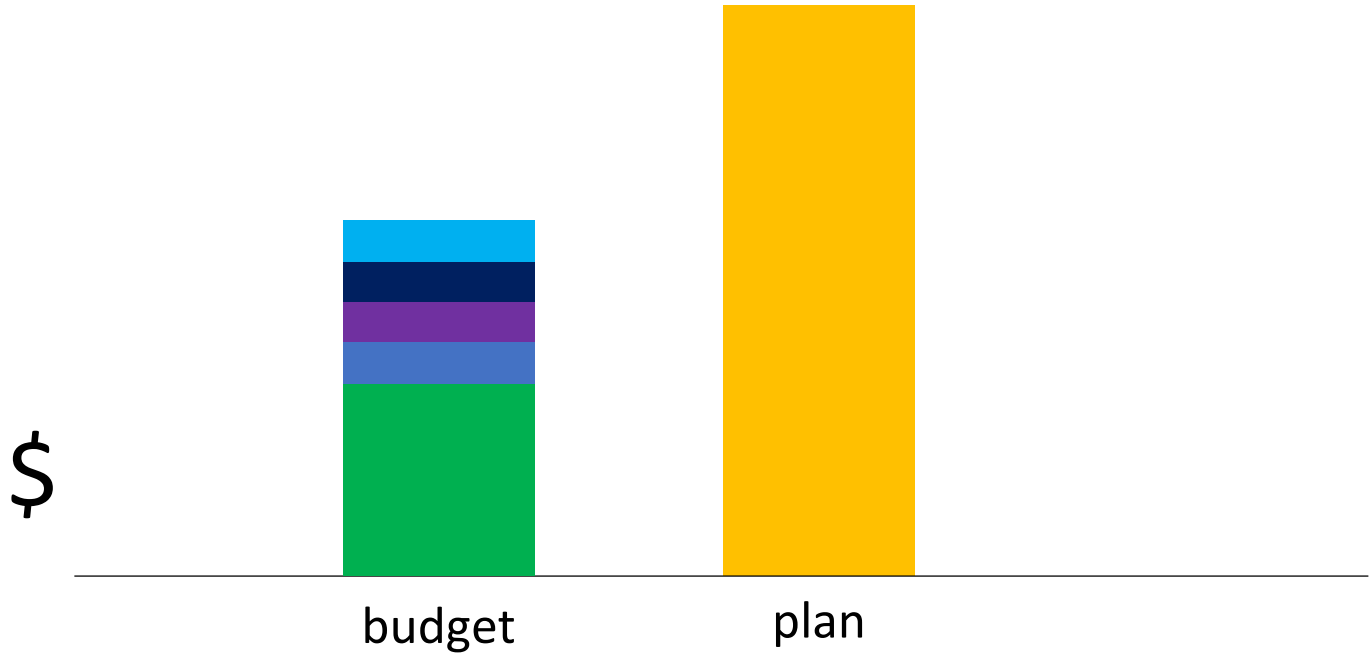
**Tools**

**Standards**

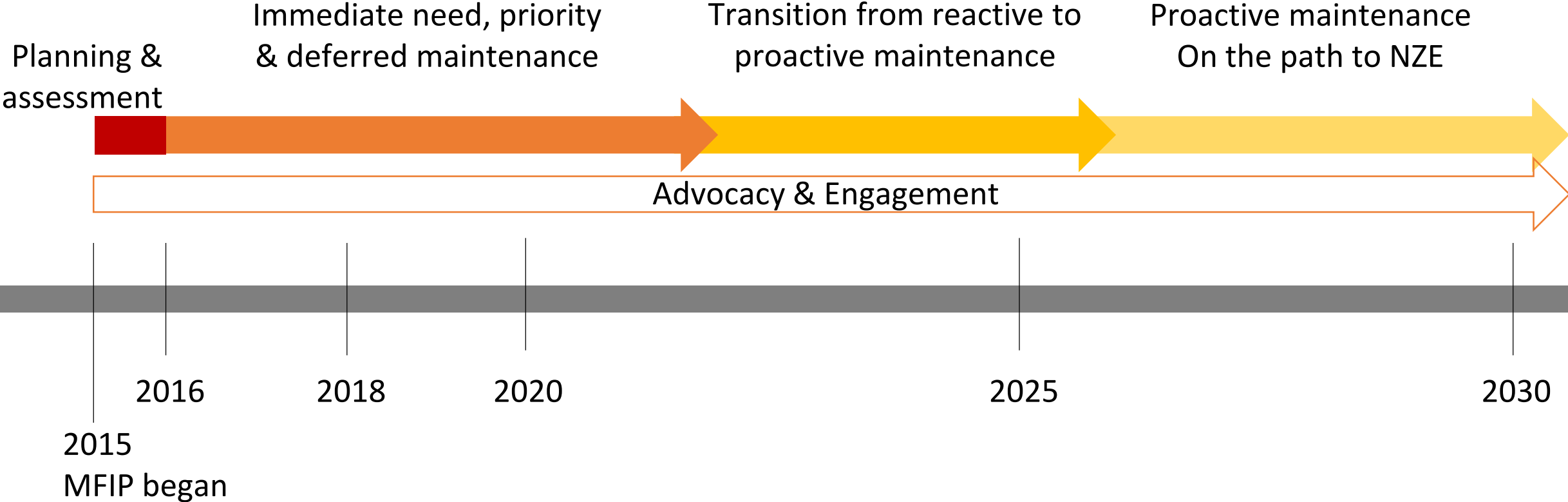
**Advocacy & Communication**




# The plan identified exceeds the budget.



# Municipal Facilities Improvement Plan



# Questions?

 When poll is active, respond at [PollEv.com/nedcollier051](https://PollEv.com/nedcollier051)

**Top**

# LEARNING OUTCOMES

- Define achievable large and small-scale **energy, maintenance, and accessibility goals** encompassing large building portfolios.
- Establish **strategies for collaborative design process** and understand how to prioritize projects over a long-term planning time-frame.
- **Set project energy targets** and understand planning for net zero emissions, and the difference between net zero energy vs. emissions.
- Identify areas for **building standardization** to reduce maintenance costs and understand how to develop metrics to define success and track progress.





# THANK YOU!

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