IDENTIFYING HIGH-RISK RESIDENCES FOR CLIMATE-RESPONSIVE TECHNOLOGIES

BOSTON UNIVERSITY

Campus Climate Lab

Overarching Question

Where should BU consider implementing energy-efficient heating/ cooling infrastructure for on-campus housing residences in response to recent climate extremes?

MISSION

The purpose of this research is to investigate the impact of recent climate crises (specifically extreme heat waves) on more vulnerable Boston University residents and propose housing units of interest for climate-responsive renovations. An in-progress study was conducted over the course of the Fall 2023 Semester to (a) analyze disproportionate urban heat island effects on BU housing residences, and (b) evaluate opportunities for implementing energy-efficient cooling appliance infrastructure. To achieve our data analysis objectives, we inspected recent trends in extreme Boston weather patterns and compared on-campus housing locations by their facilities' needs. Our mission is to provide BU with a more cost-effective and energy-efficient solution to meeting the growing demands for in-unit cooling.

METHODS

Our project employs a comprehensive analytical approach to assess the impact of climate change on Boston University's (BU) housing infrastructure and to identify high-priority residences for climate-responsive renovations. We commenced with data sourcing, gathering Boston's historical climate data, alongside housing infrastructure data and renovation cost predictions. A pivotal component of our analysis is data modeling, which includes a spatial analysis for evaluating the heat burden across BU residences and a yearly average temperature analysis for understanding trends in climate extremes. This aids in forecasting future cooling infrastructure needs. Additionally, we integrated public data sources, such as Boston's Building Energy Reporting and Disclosure Ordinance (BERDO) data and USGS hazard maps, to enrich our analysis.

Interim Report

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Heat Burden Analysis:

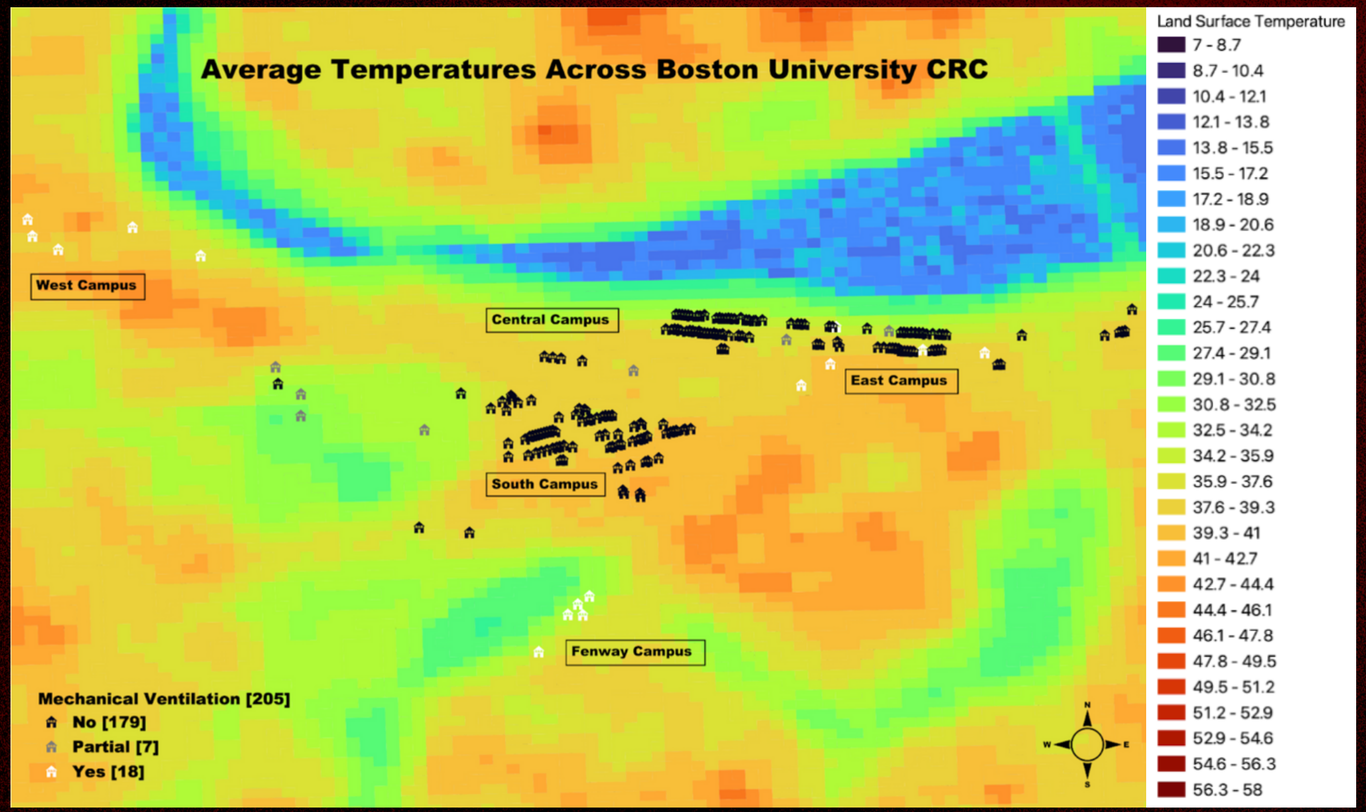
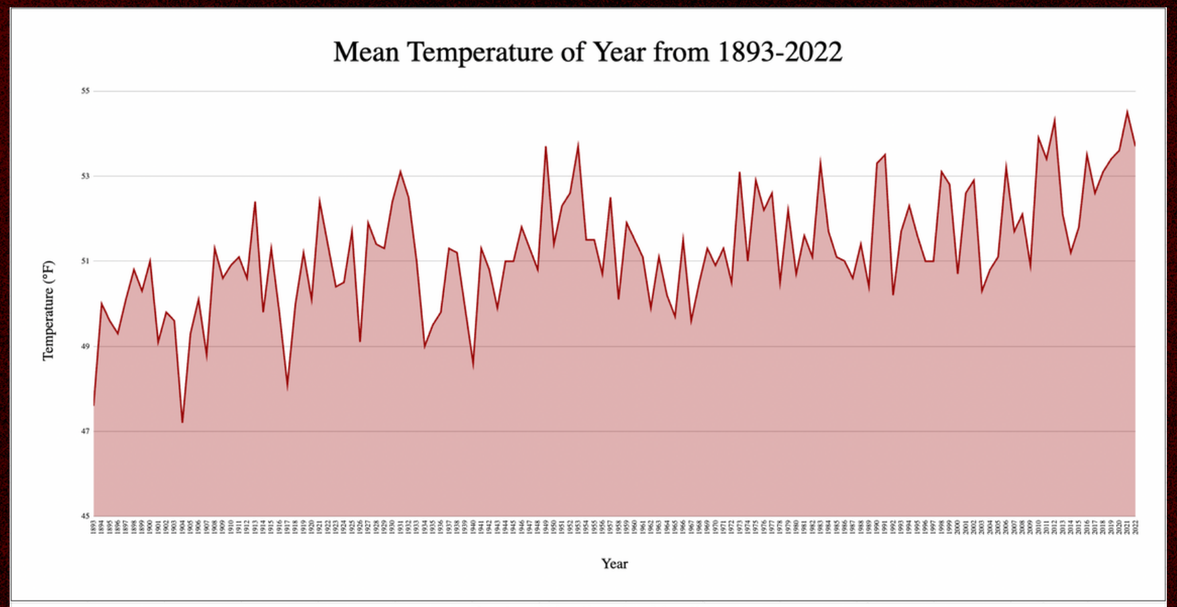


Fig 1: This GIS-generated map displays the residential buildings on Boston University's Charles River Campus, whether they have mechanical ventilation installed, and the average temperature in the area of and around BU. It indicates which buildings should be prioritized in terms of installing mechanical ventilation as they are more vulnerable to extreme heat.



Boston Weather by Month

Averages based on the years 1991–2020

Month	Average (°F)		Record (°F)		Average (inches)	
	High	Low	High	Low	Precipitation	Snow
January	37.2	23.3	74	-12	3.4	14.3
February	39.4	24.8	73	-18	3.2	14.4
March	45.8	31.3	89	1	4.2	9
April	56.6	40.9	94	13	3.6	1.6
May	66.7	50.4	96	33	3.2	0
June	76.4	59.9	100	41	3.9	0
July	82.3	66.3	104	50	3.3	0
August	80.7	65.3	102	46	3.1	0
September	73.4	58.4	100	34	3.6	0
October	62.4	47.7	90	25	4	0.2
November	51.9	38	83	8	3.7	0.7
December	42.5	29.4	76	-17	4.3	9.1
Entire year	59.7	44.7	104	-18	43.5	49.3

Fig 2.1 & 2.2: These illustrate the trend in monthly average temperatures in the Boston area spanning from 1893 to 2022. Specifically, within the last 100 years, the period from 2000 to 2020 has seen unprecedented temperature highs, with 7 out of the top 10 warmest years occurring within this timeframe. This pattern underscores a clear and concerning acceleration in temperature increases, signaling a significant shift in the Boston area's climate dynamics.

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Housing Renovations Candidates:

			Heat Pumps by Type		
Type	**Average System Cost***	**Average Installation Cost***	**Groundwork?**	**Ductwork?**	**Rebates Offered?**
Water-source	$1,500-3,000	$2,500-6,000	not required	required	$10,000/home
Air-source (Ductless Mini-split)	$1,000-3,500	$500-1,500	not required	not required	$1,250/ton
Gas-engine (VRF)	$3,000-6,000	$1,300-2,000	not required	required	Currently none found
Ground-source	$3,000-6,000	$10,000-$30,000	required	required	$2,000/ton

Fig 3: The table is a qualitative overview of the 4 heat pumps we will be investigating. Of the 4 types, the air-source ductless mini-split emerged as a strong candidate for recommendation. In addition to the ductless mini-split's popularity, its installation costs are low due to the system's low infrastructural requirements, and rebates are an additional factor in its cost-effectiveness. Above data is compiled from online sources.

Continued Analysis Objectives

- Building Renovations Capabilities Assessment
- Cost-Benefit Analysis of Heat Pump Renovations
- Per Capita Heat Burden Evaluation
- Refined Consderations Priority List

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Claflin Hall
273 Babcock Street
BERDO ID: 107089
Large Dormitory Style
Mechanical Ventilation: yes
Residential Capacity: 610
Square feet: 130,604
Height: 125'
Stories: B+13+P+PM
Construction Date: 1963
Renovation Date: 2008

Sleeper Hall
275 Babcock Street
BERDO ID: 101270
Large Dormitory Style
Mechanical Ventilation: yes
Residential Capacity: 612
Square feet: 160,505
Height: 136'
Stories: SB+B+13+P+PM
Construction Date: 1963
Renovation Date: 2008

Rich hall
277 Babcock Street
BERDO ID: 101271
Large Dormitory Style
Mechanical Ventilation: yes
Residential Capacity: 629
Square feet: 156,736
Height: 136'
Stories: B+13
Construction Date: 1964
Renovation Date: 2008

'1019'
1019 Commonwealth Ave
BERDO ID: 106323
Large dormitory style
Mechanical Ventilation: yes
Residential Capacity: 274
Square feet: 66,485
Height: 70'
Stories: B+6+P
Construction Date: 1989
Renovation Date: 1997

Towers Residence Hall
140 Bay State Road
BERDO ID: 101245
Large Dormitory Style
Building Code: 522
Mechanical Ventilation: partial
Residential Capacity: 521
Square feet: 127,815
Height: 79'2"
Stories: B+9
Construction Date: 1958
Renovation Date: 2010

Whitestones
726 - 728 Commonwealth Ave
BERDO ID: 101264, 101263
Apartment Style
Building Code: 996, 997
Mechanical Ventilation: no
Residential Capacity: 87, 81
Square feet: 28,278, 29,574
Height: 51'
Stories: B+5
Construction Date: 1911
Renovation Date: 1975

Warren Hall
14 (10-18) Buswell Street
BERDO ID: 101260
Apartment Style (Graduate)
Building Code: 584
Mechanical Ventilation: no
Residential Capacity: 89
Square feet: 67,049
Height: 68'
Stories: 6
Construction Date: 1924
Renovation Date: 2001

167-169 Bay State Road
BERDO ID: NA
Small Dormitory Style
Building Code: 530
Mechanical Ventilation: no
Residential Capacity: 51
Square feet: 13,948
Height: 50', 40'
Stories: B+4
Construction Date: 1903
Renovation Date: 1957

210-212 Bay State Road
BERDO ID: NA
Small Dormitory Style
Building Code: 573
Mechanical Ventilation: no
Residential Capacity: 45
Square feet: 12,664
Height: 45', 45"
Stories: B+4
Construction Date: 1901
Renovation Date: 1998

6 Buswell Street
BERDO ID: 101279
Apartment Style
Building Code: 742
Mechanical Ventilation: no
Residential Capacity: 70
Square feet: 25,818
Height: 46'
Stories: B+4
Construction Date: 1914
Renovation Date: 1995

48 Buswell Street
BERDO ID: NA
Small Dormitory Style
Building Code: 586C
Mechanical Ventilation: no
Residential Capacity: 60
Square feet: 16,337
Height: 60'
Stories: B+5
Construction Date: 1911
Renovation Date: 1998