BUILDING ENERGY 15

MARCH 3-5, 2015 AT THE SEAPORT WORLD TRADE CENTER

AIA Provider: Northeast Sustainable Energy Association

Provider Number: G338

Balancing Historic Preservation and Energy Performance

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March 3, 2015

HISTORIC NEW ENGLAND

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Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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Course Description

Historic New England's approach to weatherization emphasizes preservation over intervention. But as shown by the energy retrofit that achieved an over 60% reduction in energy usage at the Lyman House, a National Historic Landmark, energy performance and preservation can co-exist. This session will discuss HNE's preservation philosophy and how it guides the organization's energy conservation projects. We will share an energy usage analysis of all 36 HNE properties and discuss how that information is used to prioritize actions.

- Introduction to Historic New England
- Our Approach to Energy Efficiency
- Analysis of All Energy Usage
- Case Study: Lyman Estate Weatherization Project

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Learning Objectives

At the end of the this course, participants will be able to:

1. Be able to reference multiple case studies for energy use reduction strategies in historic buildings;
2. Be able to identify appropriate, non-destructive energy retrofits for historic properties and understand how to balance stewardship of heritage buildings with effective energy retrofits;
3. Have a prioritized list of actions for reducing energy use in historic buildings;
4. Have a working knowledge of Historic New England's preservation philosophy.

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Historic New England

We serve the public by preserving and presenting New England heritage

Collections

Archives and Publications

Educational Programs

Preservation Services

Historic Properties

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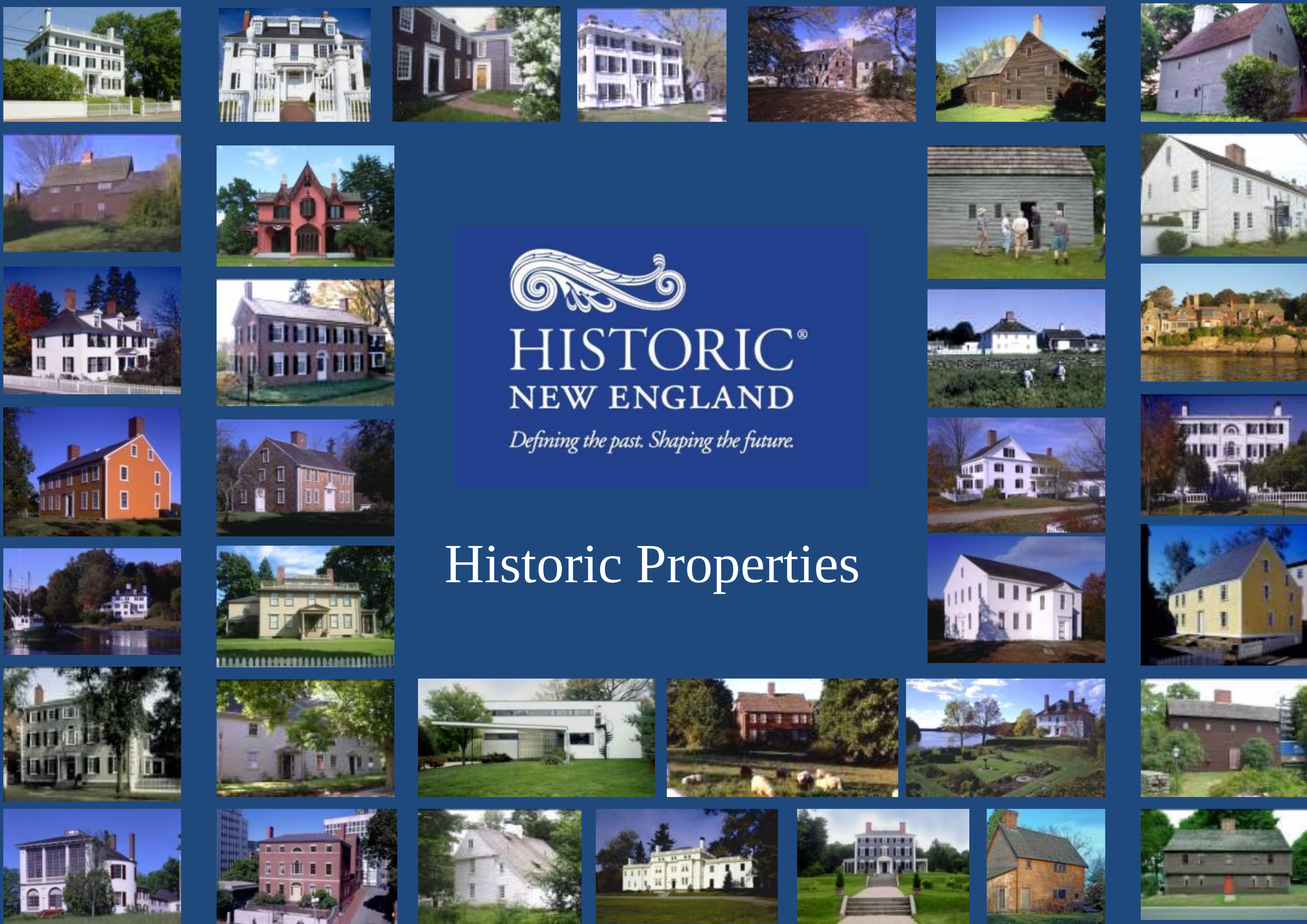
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Historic Properties

Program Areas: *Historic Properties*

We promise

You'll experience, in a real and personal way, the lives and stories of the individuals who made New England what it is today.

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Program Areas: *Historic Properties*

We offer

-House and landscape tours

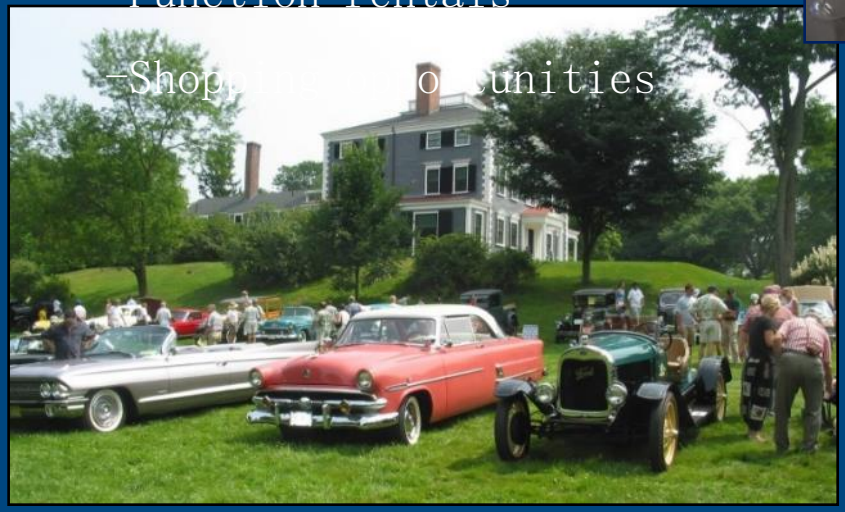
-Adult and family programs

-School programs

-Special events

-Function rentals

-Shopping opportunities



Program Areas: *Historic Properties*

36 Properties

140 structures

48 distinct metered entities

Building Uses

-Museum

-Museum and Administrative

-Administrative and/or Programming

-Greenhouse

-Support

-Tenant

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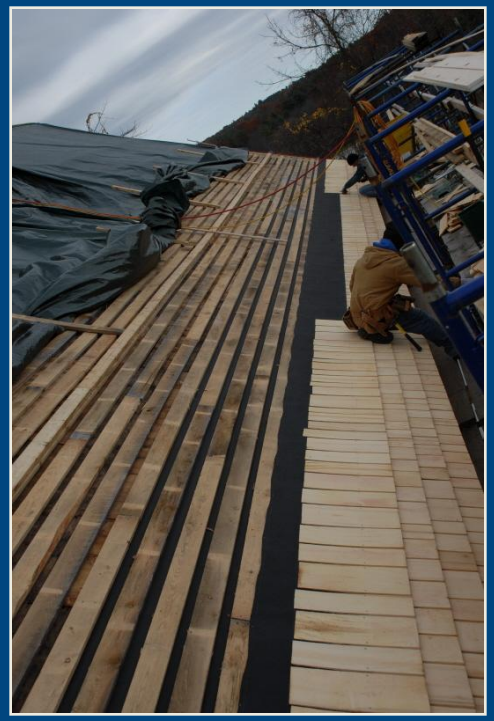
What is Property Care?

Responsible for the Preservation and Maintenance
of the 36 historic buildings and landscapes



William Sumner Appleton and SPNEA Preservation Philosophy

- Documentation
- Respect for change over time
- Repair materials in-kind rather than replace
- Reversibility

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Historic New England's General Approach to Energy Efficiency

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Approach to Energy Efficiency

- Baseline Measurements & Metrics
- Air Leakage
- Insulation
- HVAC and Utility Improvements
- Behaviors and Traditional Techniques

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Baseline Measurements and Metrics

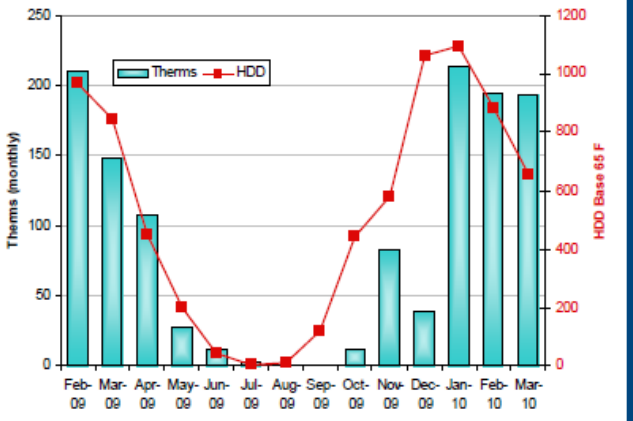

Figure 10: Gas use, 2009-2010, with heating degree days 65° F

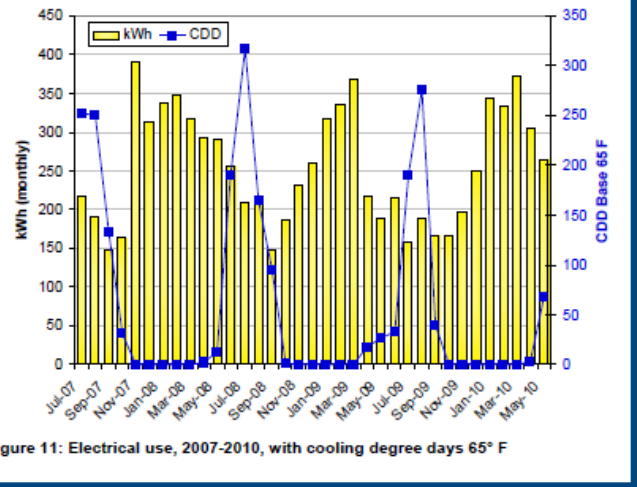

Figure 11: Electrical use, 2007-2010, with cooling degree days 65° F

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Air Leakage: Air Sealing

Holes in Foundation

Holes in building envelope

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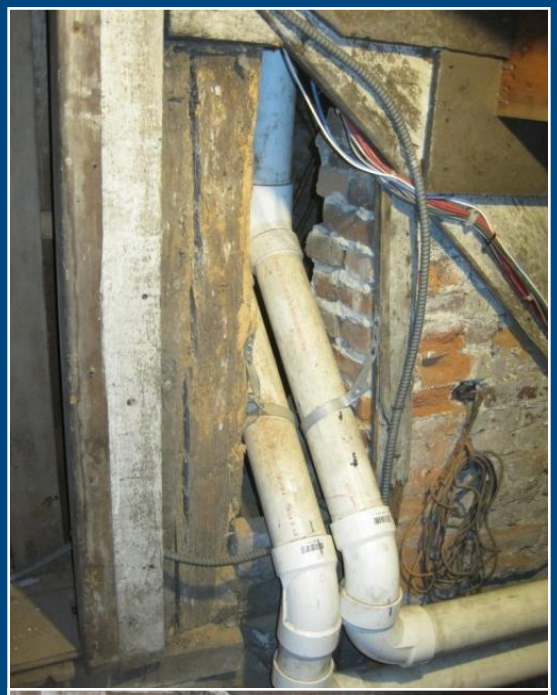
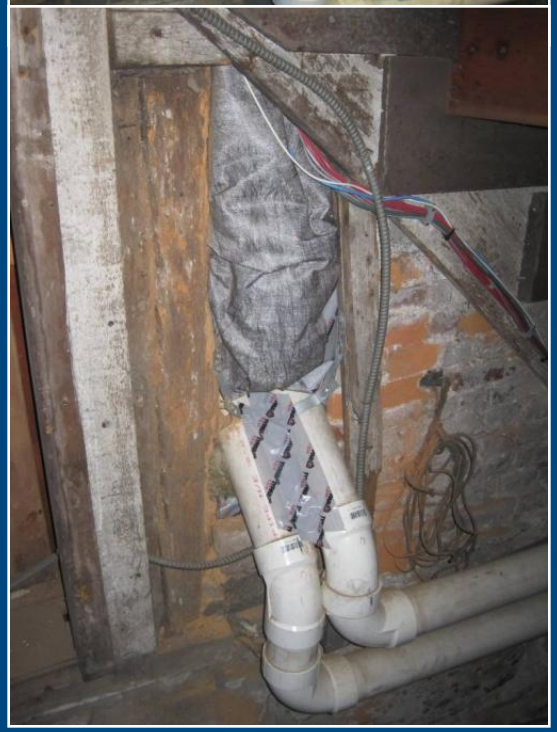
Air Leakage: Air Sealing





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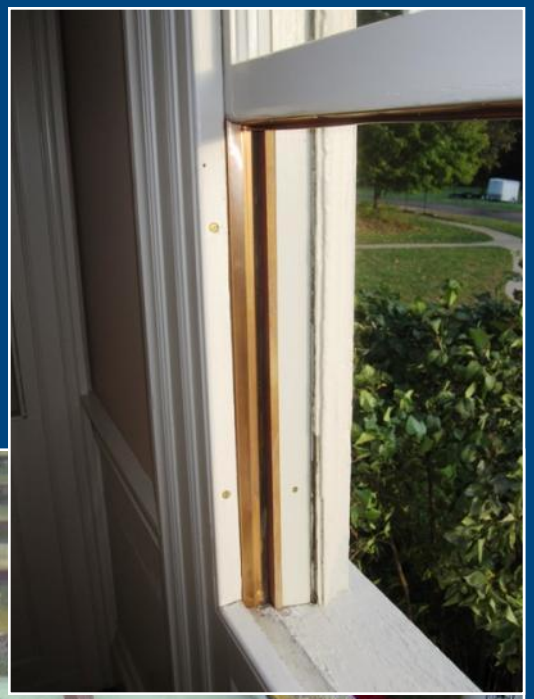
Air Leakage: Window Conservation

- Repair versus Replacement



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Air Leakage: Storm Windows

Exterior-Wooden

Exterior-Aluminum

Interior

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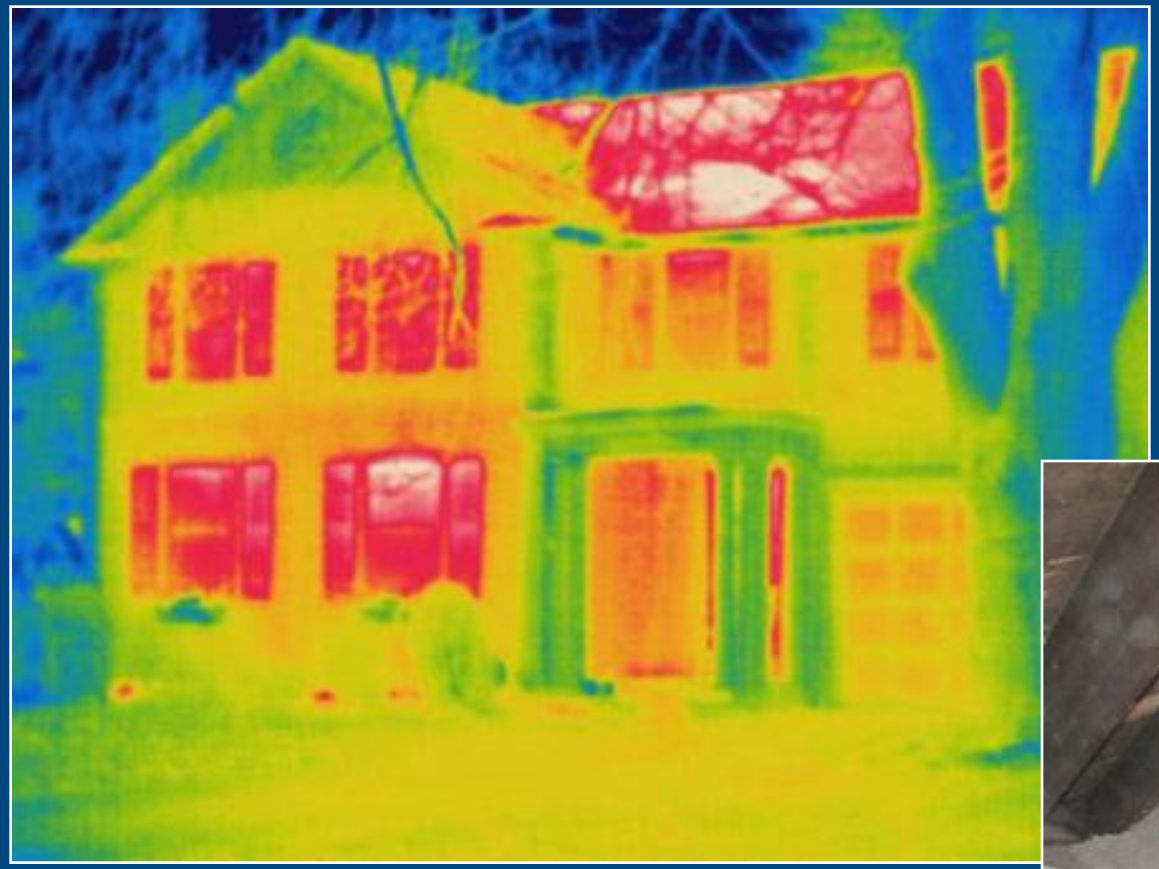
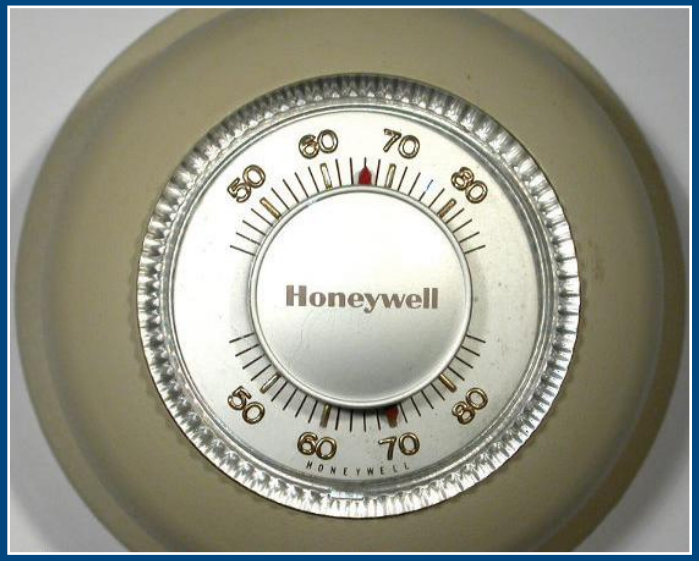
Insulation

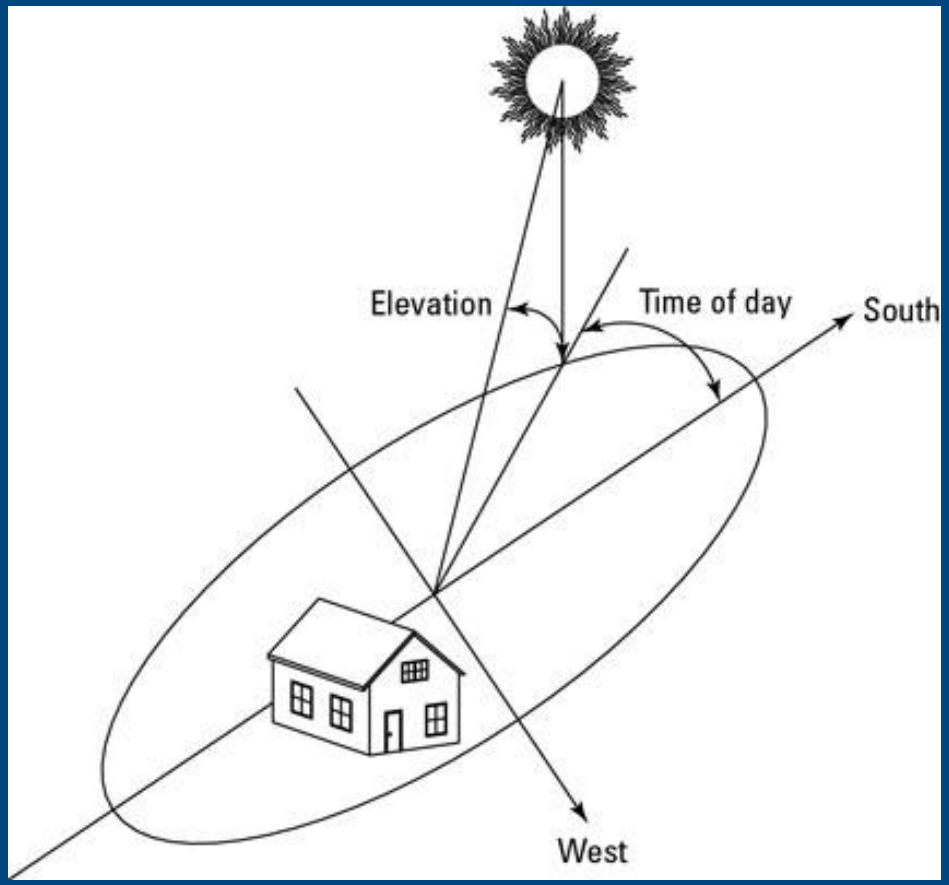


Insulation

HVAC and Utilities



Behaviors and Traditional Techniques



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Energy Use Analysis
36 Properties

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Energy Usage Analysis

- 2011 and 2012 utility data
  - oil, natural gas, electricity
- Converted all utilities to common factor
  - Gallons of Oil
  - Therms of Natural Gas
  - Kilowatt Hours of Electricity

To British Thermal Units (BTUs)

- Merged utility data per unique location
  - 48 Distinct Metered Entities

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Energy Usage Analysis

- Six calculations for each site:
  - Average BTU use per winter and summer
  - Average BTU use per HDD and CDD
  - Average BTU use per HDD and CDD per sf
- Seven rankings for each property
  - Six above PLUS a Compiled Total Ranking
- Analyzed performance by type

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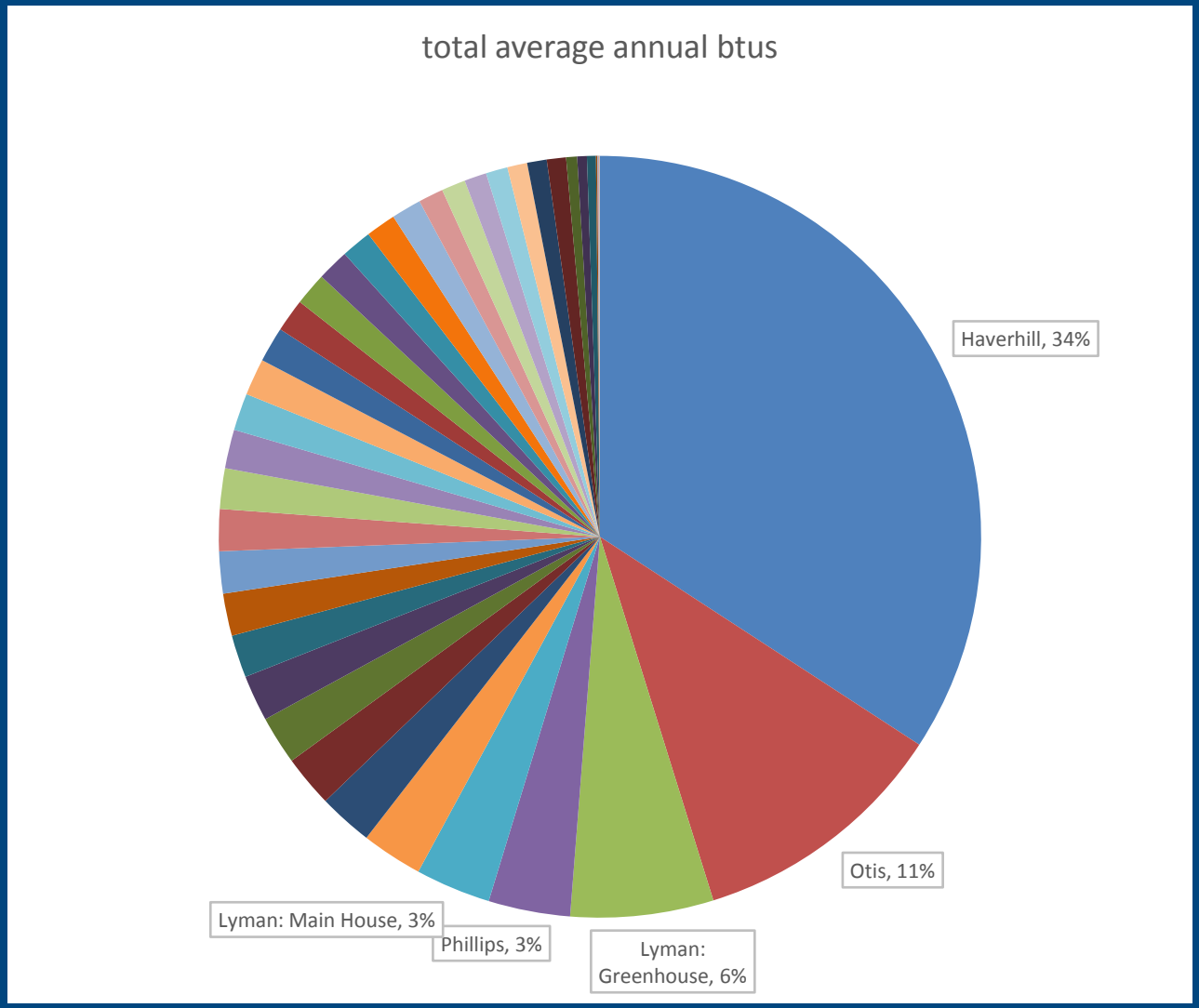
Energy Usage Analysis
Total BTU Usage



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Average Winter BTUs

Excluding Haverhill

Otis	**1,027,684,240**
Lyman Greenhouse	**702,209,794**
Phillips	**320,432,664**
Barrett	**296,639,820**
Lyman Main House	***289,105,739***
Jewett House	**268,892,146**

1 gallon oil = 140,000 BTUs
1 therm natural gas = 100,000 BTUs
1 kWh of electricity = 3412 BTUs

Typical residence = 72,000,000 BTUs

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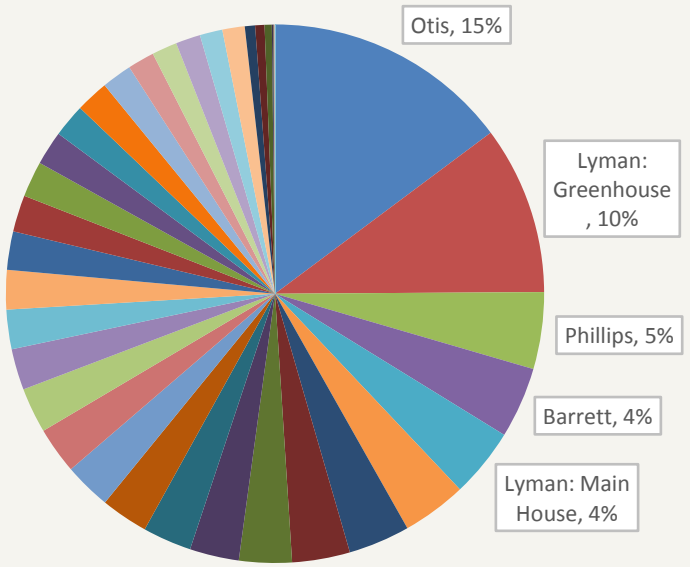
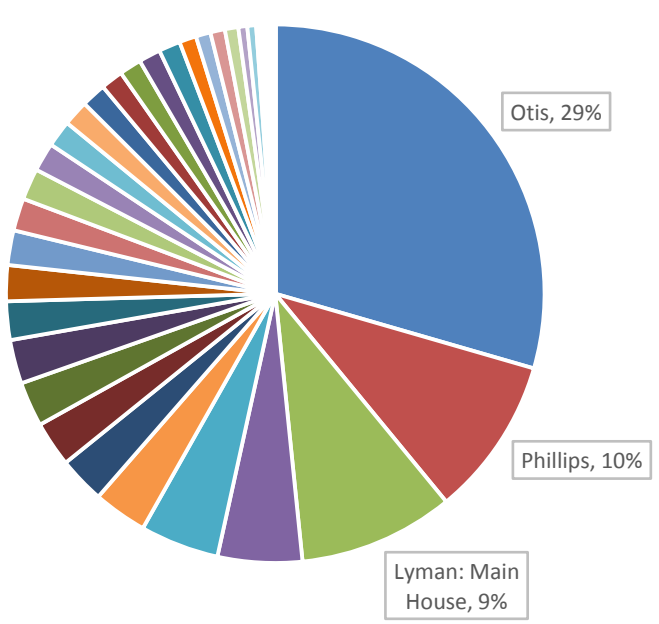
Average Winter BTUs

Excluding Haverhill



Average Summer BTUs

Excluding Haverhill



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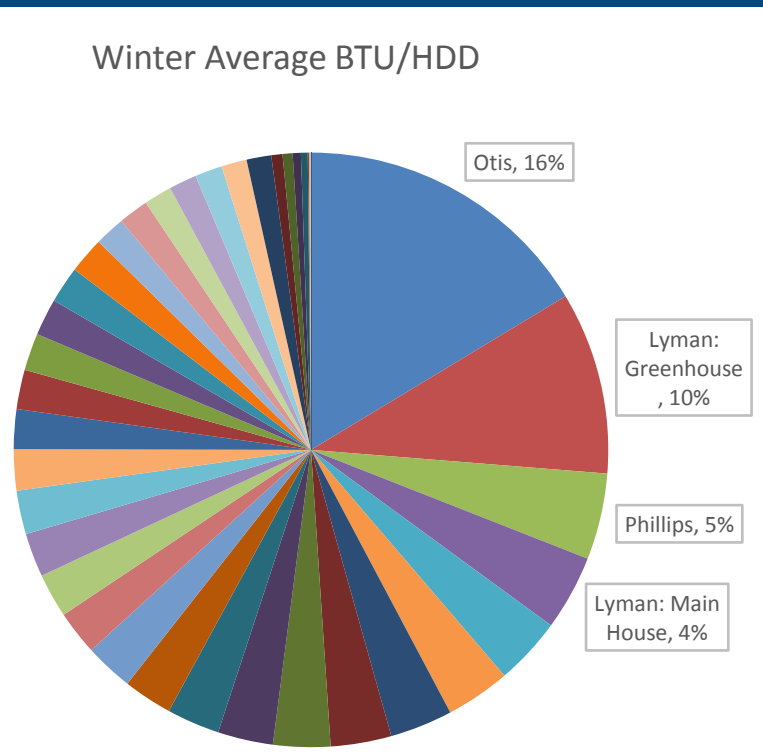
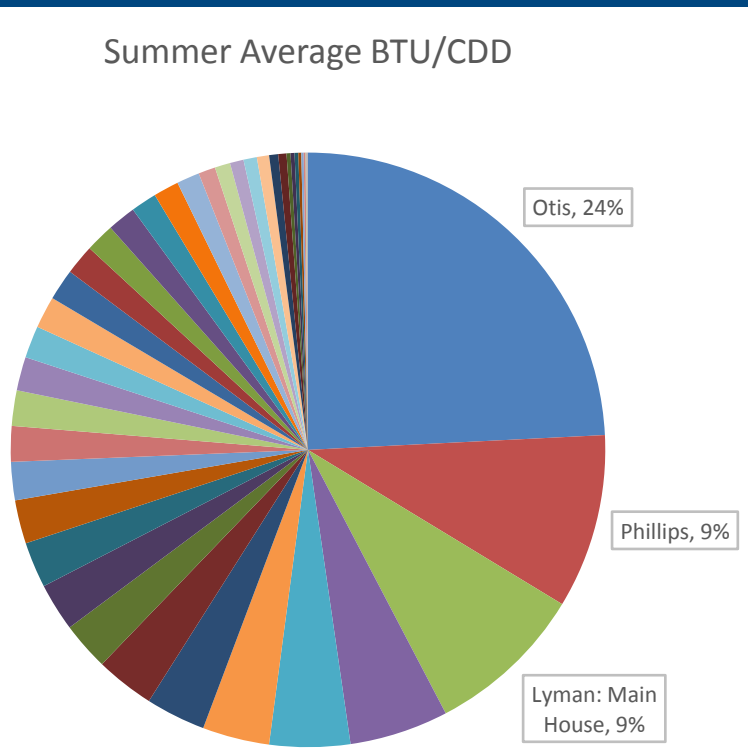
Average BTU per HDD

Excluding Haverhill



Average BTU per CDD

Excluding Haverhill



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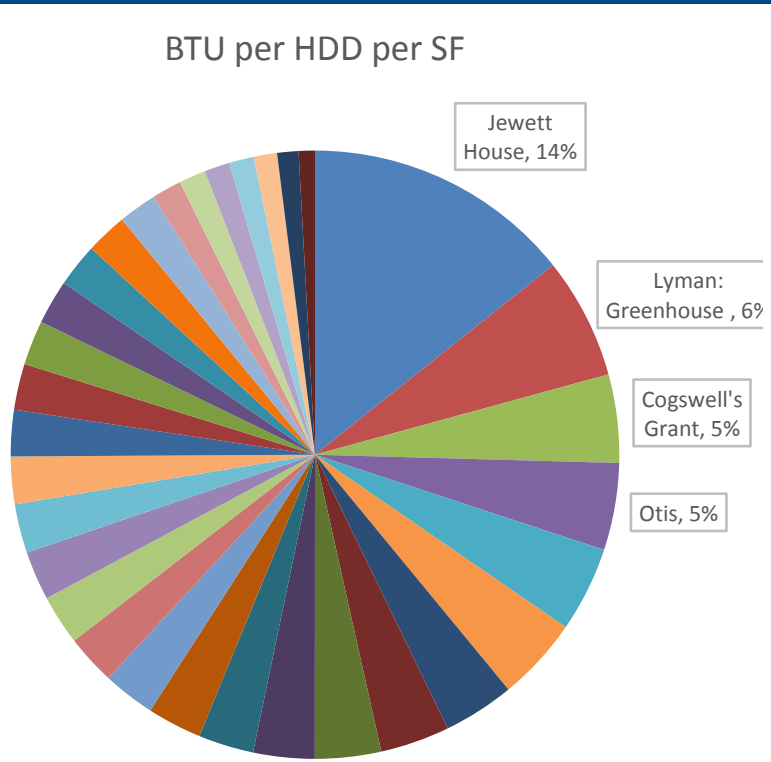
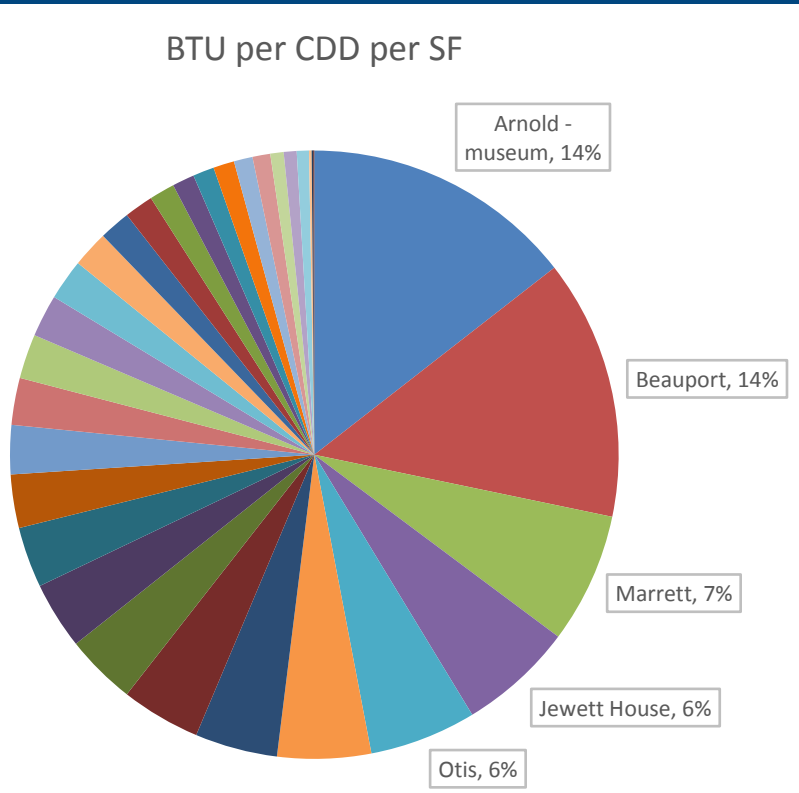
Average BTU per HDD per SF

Excluding Haverhill



Average BTU per CDD per SF

Excluding Haverhill



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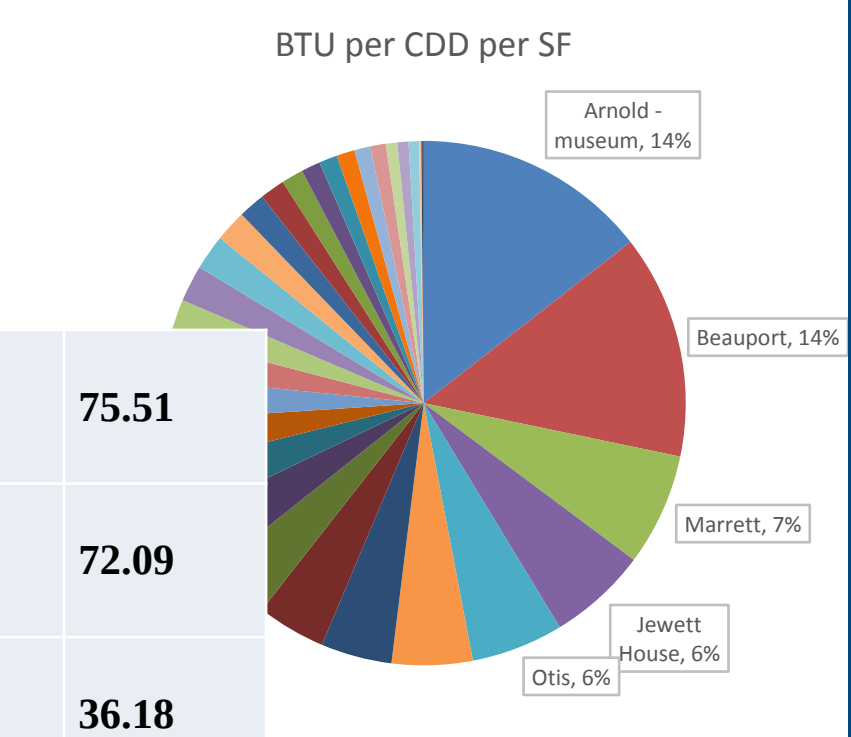
Average BTU per CDD per SF

Excluding Haverhill



Be Careful of Data Trickery!

Arnold - museum	**75.51**
Beauport	**72.09**
Marrett	**36.18**
Jewett House	**31.90**
Otis	**29.66**
Lyman Main House	***13.29***

Overall BTU Usage

- Arnold Ranks #30
- Beauport Ranks #28

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Energy Usage Analysis

Compiled Total Ranking

Property	
Otis	1
Lyman: Greenhouse	2
Phillips	3
Haverhill	4
Lyman: Main House	5
Jewett House	6
Casey Farm - Greenhouse & outbuildings	7
Cogswell's Grant	8
Barrett	9
Marrett	10
Castle Tucker	11
Lyman: CHSE	12
SPL: Visitor's Center	13
Gropius	14
Codman - CB	15
Rundlet-May	16
Langdon	17
Roseland Cottage	18
Beauport	19
Codman - Main	20
Merwin	21
Hamilton - museum, garden cottage, carriage barn	22
Arnold - museum	23
Casey Farm - office	24
Browne	25
Win-Thacher	26
Pierce	27
Sayward-Wheeler	28
Jewett-Eastman	29

Historic Properties

36 Properties

140 structures

47 distinct metered entities

Building Uses

-Museum

-Museum and Administrative

-Administrative and/or Programming

-Greenhouse

-Support

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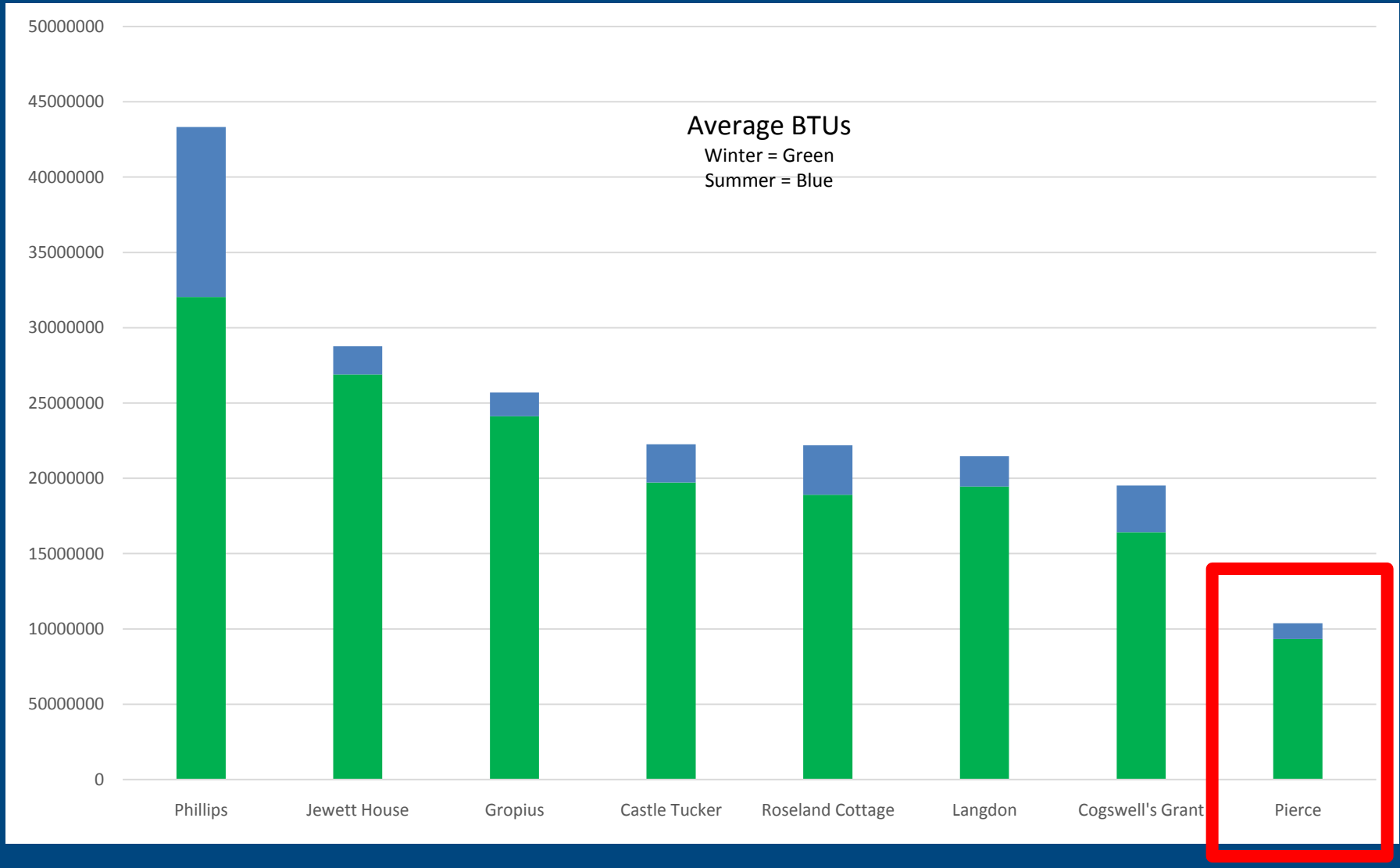
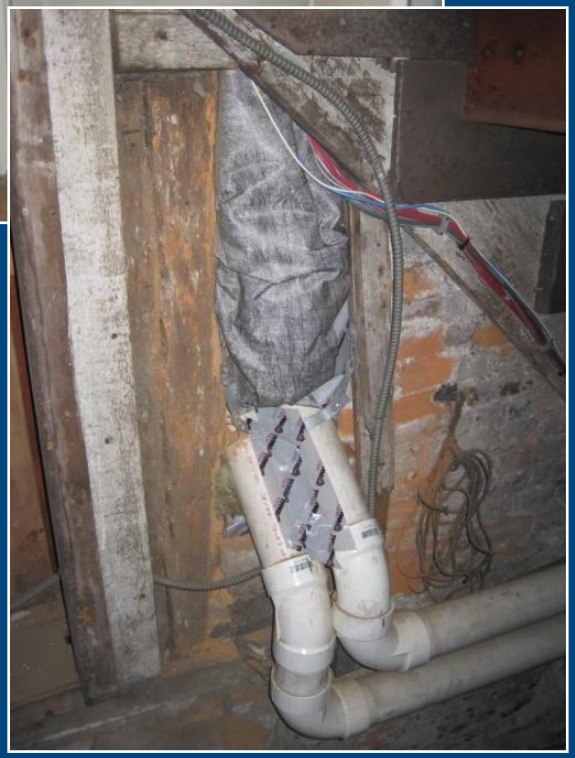
By Type: Museums and Admin



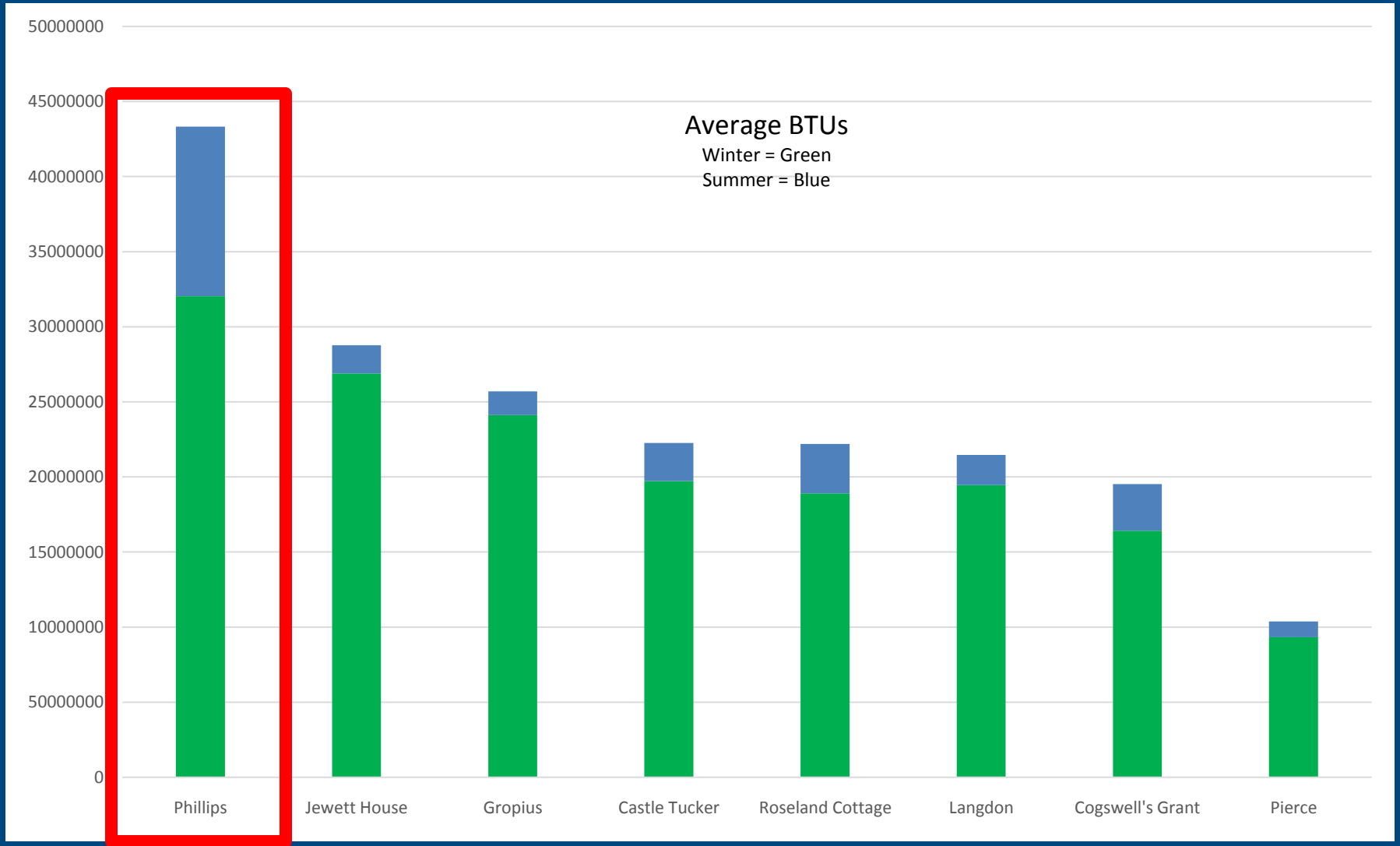
Museums and Admin

- Pierce House
  - *Interior shutters*
  - *Foundation pointing*
  - *Carpentry Repairs*
  - *Weatherstripping*
  - *Pillow Stuffing*



17% reduction in energy

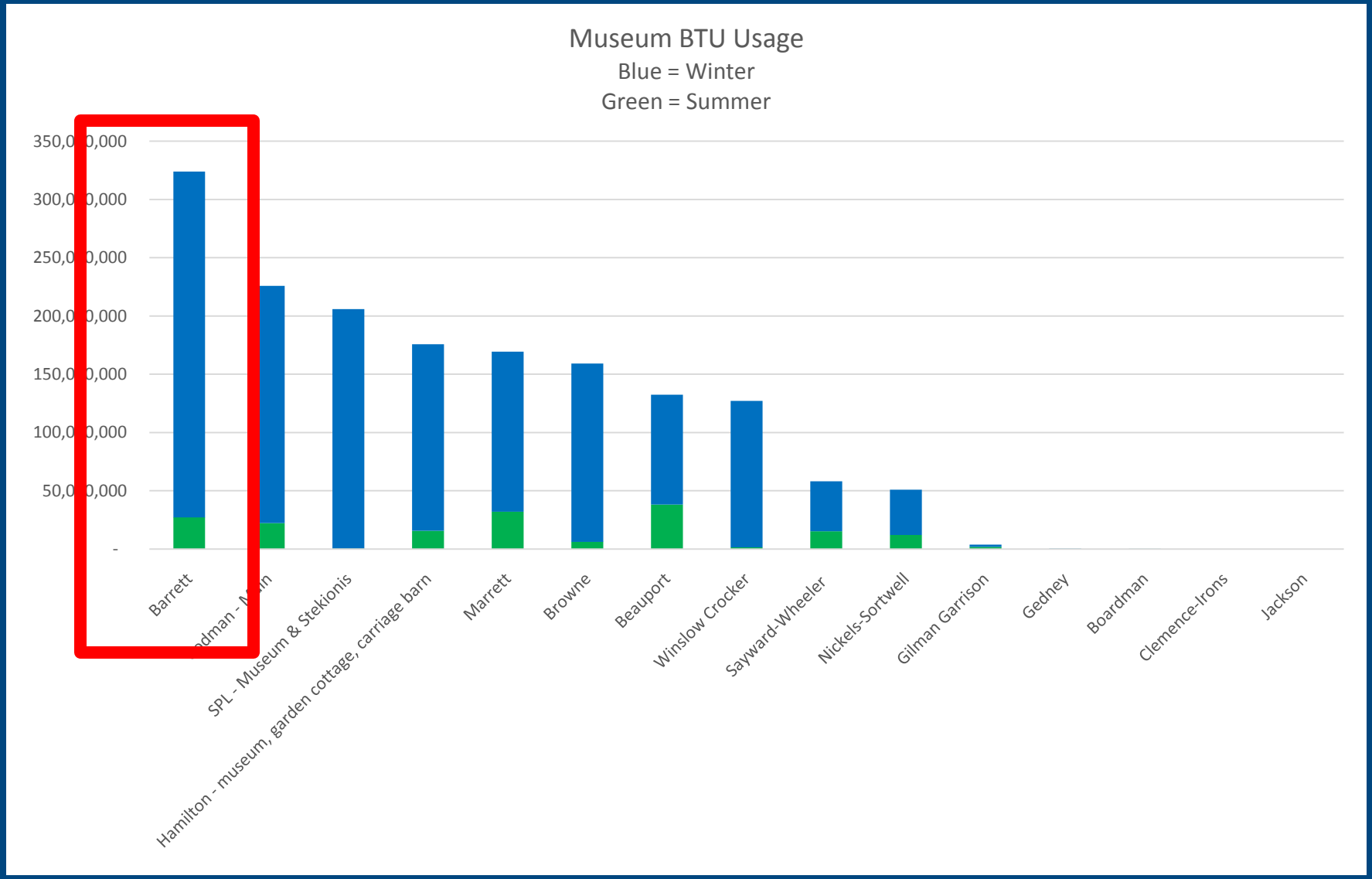
By Type: Museums and Admin



Museums and Admin

- Phillips House
  - *Deeper analysis of energy usage*
  - *Review museum conditions and environmental needs*
  - *Air infiltration testing and simple air sealing*
  - *Duct sealing and insulation*
  - *Better thermostat/zoning controls*
  - *Additional insulation in attic*

By Type: Museum Environmental Systems



Museum Environmental Systems

- Barrett House
  - *Deeper analysis of energy usage*
  - *Review museum conditions and environmental needs*
  - *What is actually going on?*

Case Study

Lyman Estate Weatherization – 2011/2012

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Project Background

- Massachusetts Department of Energy Resources
  - Architectural Heritage Foundation
  - Trustees of the Reservations
  - Historic New England: $311,000

- Goal: Reduce Energy Consumption by 50%!

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Preservation Philosophy

- Research and document the history, evolution, features, materials, integrity and areas of significance of resources prior to undertaking any repair or conservation work.
- Monitor usage to prevent irreparable loss of historic fabric;
- Choose maintenance and conservation treatments that reflect a commitment to retaining and preserving historic material;
- Recognize and preserve the design and craftsmanship that has uniquely shaped a resource over time;
- Disseminate the experiences and information associated with resources to internal and external audiences; and
- Follow or exceed nationally-accepted professional standards and guidelines, as appropriate for each discipline, in order to ensure the longevity of resources and maintain a reputation for innovation and the highest quality of work.

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Approach to Energy Efficiency Efforts

- Don't damage historic fabric
  - Energy Efficiency measures should be reversible

- Think about the interpretation
  - Trade-offs between efficiency and authenticity

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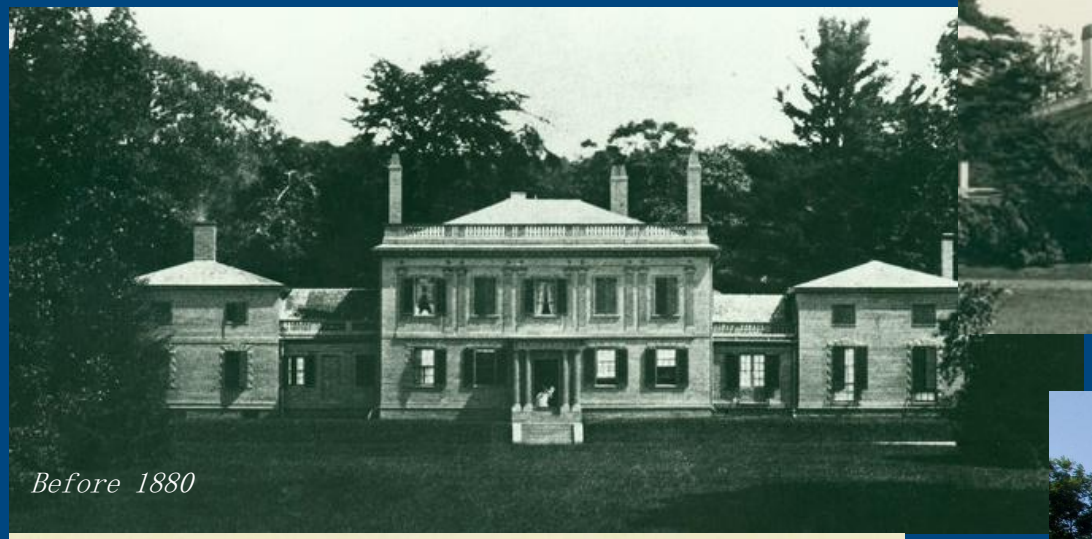
The Lyman Estate, 1793

Waltham, MA



Before 1880

After 1917

Between 1880 and 1917

2013

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Approach to Energy Efficiency

- Baseline Measurements & Metrics
- Air Leakage
- Insulation
- HVAC and Utility Improvements
- Behaviors and Traditional Techniques

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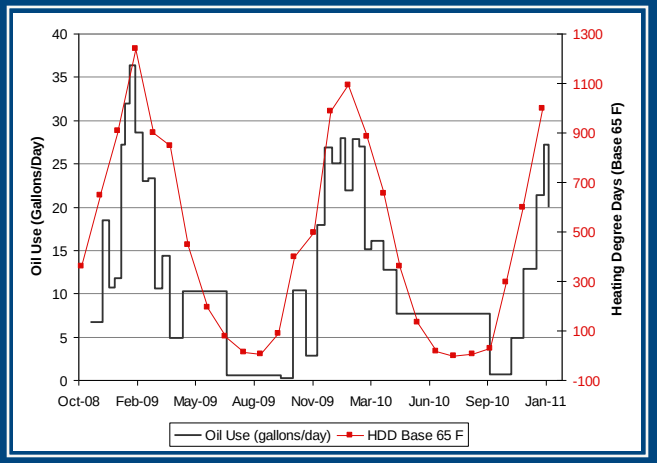
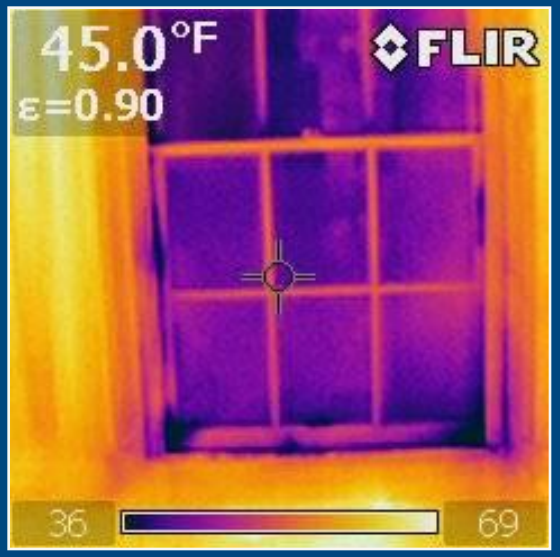
Performance Testing





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Baseline Metrics (2009/2010)

- Oil
  - ~ 3,100 gallons No. 2 Fuel Oil per year
  - 429 MMBTU

- Electricity
  - ~ 65,000 kWH per year
  - 221 MMBTU

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Window Conservation

~ 120 Window Openings

- Includes 3rd floor and basement
- Glazing, paint, structural repairs, weather

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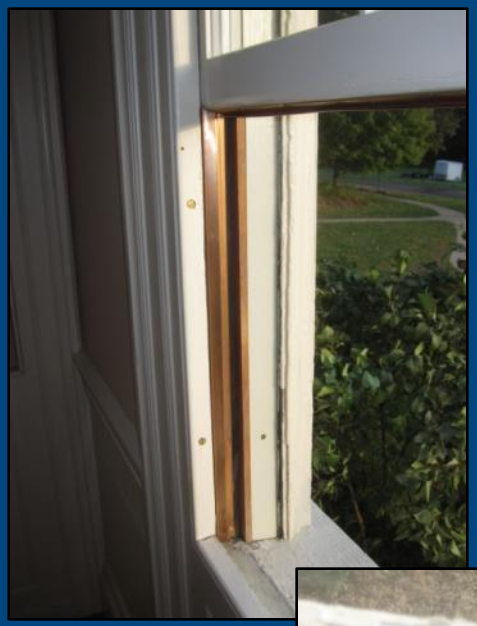
Window Conservation



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Interior Storm Windows

- ~ 70 Window Openings
  - Includes basement
  - No exterior visibility
  - Low E glass

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Exterior Storm Windows

Wood storms with screens

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Exterior Storm Windows

Aluminum storms with custom color matched to trim

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Storm Window Installation

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Window Treatment Metrics

Conservation:

Air Infiltration Reduction	5-10%

Interior Storm Windows:

Air Infiltration Reduction	20%
Window and Storm	25-30%

Exterior Storm Windows:

Air Infiltration Reduction	10%
Window and Storm	15-20%

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Air Sealing

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Air Sealing

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Air Sealing

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Insulation

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Insulation - *The Ballroom*

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Insulation

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Heating Plant

- Change fuel source Natural Gas
- High Efficiency Furnaces
- Ductwork modifications
- Digital controls

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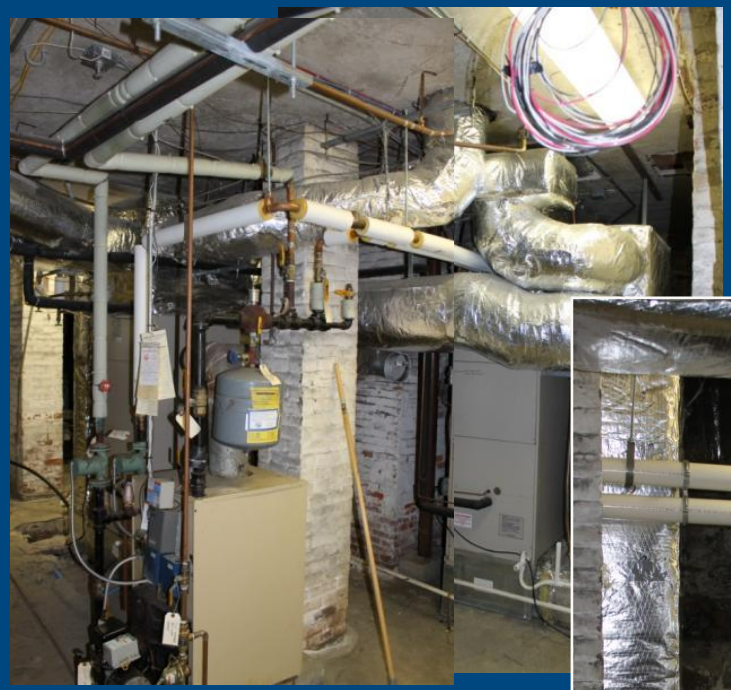
New HVAC



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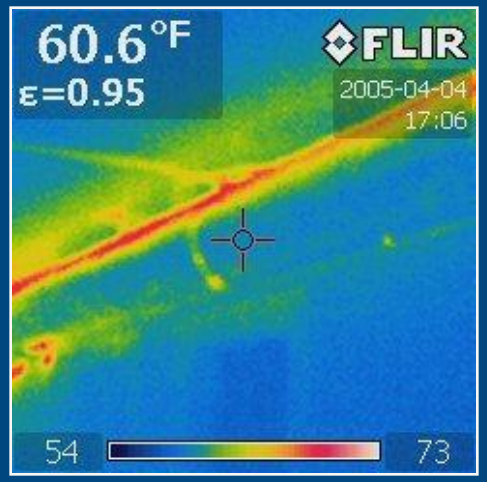
Ductwork



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Ductwork

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Lighting

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Lighting

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Heating Component

- Change from oil to natural gas
- Four condensing, modulating gas furnaces / heat pumps
- Room level zone controls

- Pre-work – 429 MMBTU (2009/2010)
- Post-work – 175 MMBTU (2012-2014)

59% reduction

Doubled site utilization (Nov – Apr)

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Electricity Component

- Newer air conditioning / heat pump technology
- Room level zone controls
- LED and CFL lighting

- Pre-work - 221 MMBTU (2009/2010)
- Post-work - 172 MMBTU (2012-2014)

22% reduction (overall)
68% increase in utilization (May - Oct)
40% reduction on a per event basis

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Energy Metrics

- Pre-work – 2009/2010
  - Average of 650 MMBTU

- Post-work
  - 2012 – 310 MMBTU (52% reduction)
  - 2013 – 360 MMBTU (45% reduction
  - 2014 – 370 MMBTU (43% reduction)
  - Average of 347 MMBTU

47% reduction

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Lessons Learned

- Efficiency can be achieved while respecting historic fabric
- Mechanical system and ductwork improvement resulted in best gain
- Insulation contractors were the least willing to work with us on different approaches

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Opportunities for Improvement

- Human behaviors
  - 68° heat
  - 75° cool
  - Use of shades for solar gain control
- Additional air sealing
  - Air barrier behind clapboards
  - 3rd floor access
- More advanced building controls

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This concludes The American Institute of Architects Continuing Education Systems Course

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