

# Saving with Building Envelope Improvements

Weatherization Retrofit Opportunities  
April 26, 2023

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## Saving with Building Envelope Improvements



Massachusetts Energy Efficiency Partnership



nationalgrid EVERSOURCE



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# 01

## Introduction

Learning Objectives,  
Savings Opportunities



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## Saving with Building Envelope Improvements

### Learning Objectives:

- Identify opportunities to improve building envelope in a variety of small C&I facilities
  - **WHERE** to look
  - **WHAT** you may find
  - **WHAT** is recommended
  - **WHY** to improve weatherization
  - **HOW** this will save energy
  - **WHAT** incentives are available from utilities



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## Small C&I

### Small Businesses, as defined by Mass Save:

- Consume less than 1.5 million kWh and 40,000 therms annually. Contact your Mass Save Sponsor to schedule a no-cost assessment.
- Weatherization opportunities can be identified during no-cost assessment.
- Performing weatherization improvements can be key to “right-sizing” of heat pump equipment for electrification projects, as well as reducing operating costs for heat pump systems.
- Contact Mass Save to verify if you are unsure if you fall into this category.
- For buildings up to 8,000 SqFt in size, a prescriptive rebate program is available for Wall Insulation, Attic Insulation, and Attic Air Sealing.

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## Weatherization

### Weatherization Defined

- **Weatherization** or **weatherproofing** is the practice of protecting a building and its interior from the elements.
- **Weatherization** is distinct from building insulation.
- In the United States, buildings use over one third of all energy consumed and two thirds of all electricity.

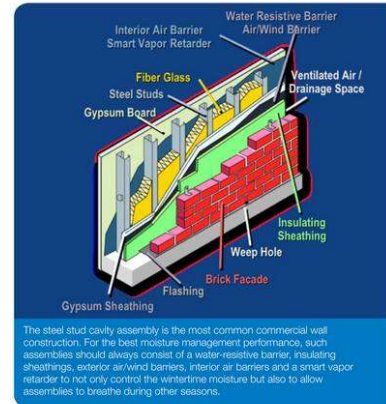


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## Weatherization

### The Building Envelope Defined

- The physical separator between the conditioned and unconditioned environment of a building
- The building envelope (or the more modern term, **building enclosure**) is all of the elements of the outer shell
- Building envelope design is a specialized area of architecture and engineering

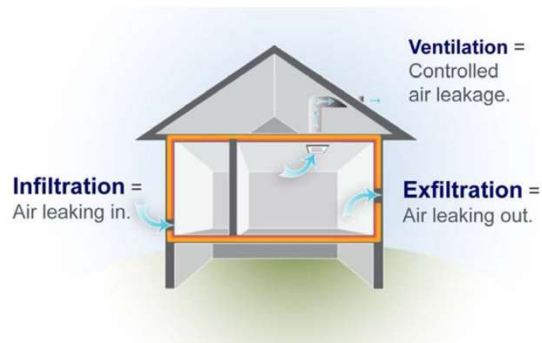


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## Thinking Holistically

### View The Building as a system

- Taking a holistic approach to retrofit strategies addressing the building envelope
- Understanding infiltration, exfiltration, and ventilation



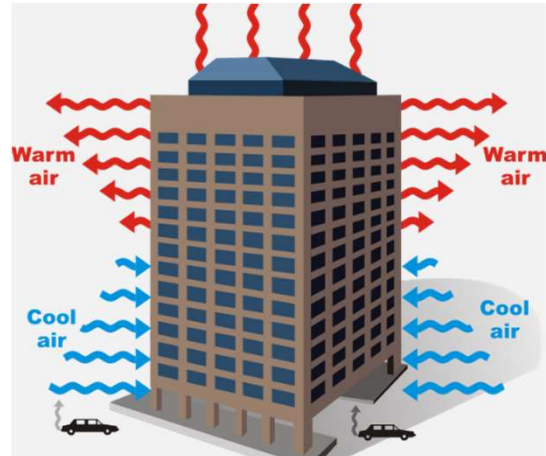
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## Stack Effect

### The Stack Effect

- A driving force for loss of conditioned air in building
- Two main factors controlling stack effect
- Ventilation Requirements

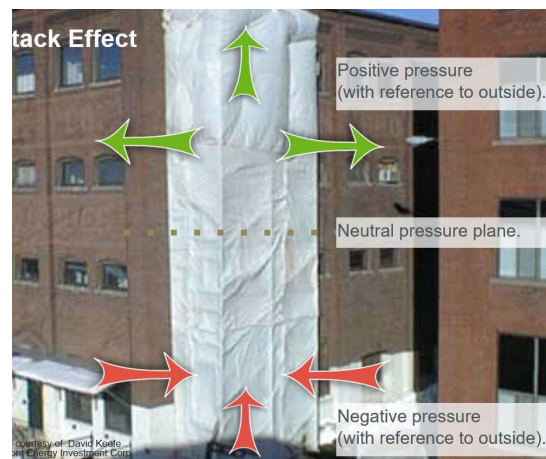


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## Stack Effect

### The Stack Effect

- Real life example
- Opportunities in basements and attics

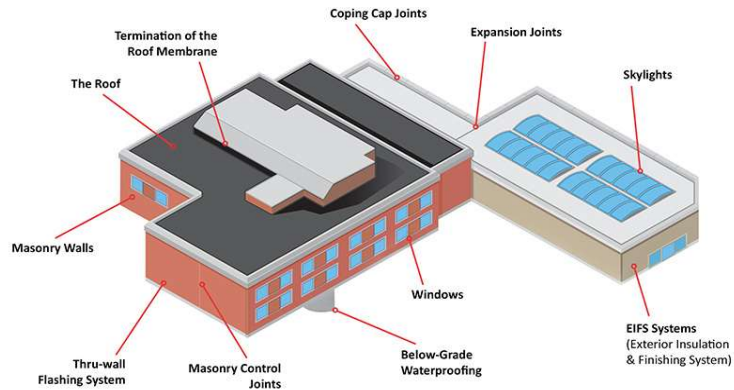


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## What areas should be evaluated/addressed?

### Key areas of the Thermal Envelope to evaluate

- Roof Insulation
- Exterior Walls
- Basements
- Crawlspace
- Fenestrations
- And More



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## Primary Air Infiltration Sites

- Ceilings, Floors, and Walls
- Ducts
- Plumbing Penetrations
- Doors
- Windows
- Fans and Vents
- Electrical Outlets

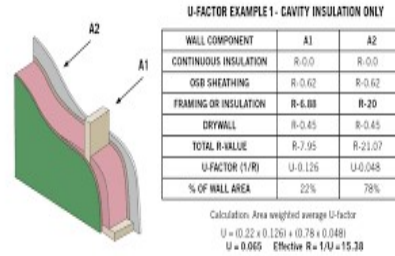
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## What are typical weatherization opportunities?

### Envelope Measures

- \*Installing insulation and air sealing in roofs & walls
- \*Installing new roofing, siding, flashing
- \*Installing insulation in floors & the foundation
- \*Replacing doors with EE doors
- \*Replacing older windows with double-glazed
- \*Weather-strip and seal doors, windows, skylights

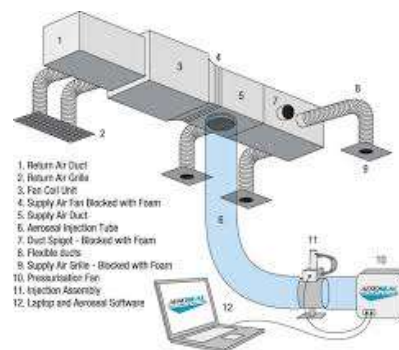


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## What are typical weatherization opportunities?

### Additional Measures

- \*Sealing air ducts, vents & exhaust fans which can account for 20% of heat loss
- \*Sealing bypasses (cracks, gaps, holes), especially around pipes & wiring that penetrate the ceiling & floor.
- \*Seal elevator shafts & stairways
- \*Sealing recessed lighting fixtures.



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## What are typical weatherization opportunities?

### Additional Considerations

- \*Installing/replacing dampers in exhaust ducts.
- \*Installing insulation around ducts, boilers
- \*Installing foundation waterproofing membranes
- \*Protecting pipes from corrosion and freezing with insulation and thermal blankets



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# 02

## Attic Insulation



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## Attic Insulation

### The Low-Hanging Fruit

6" or less of existing insulation = Opportunity

- Identify Existing Insulation Material/Thickness
- Identify location of existing thermal boundary (attic floor or rafter slopes)
  - We will cover insulating rafter slopes in the next section
- Determine type, quantity, and thickness of insulation required to be added
- Be on lookout for uninsulated attic access panels, doors

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## Attic Insulation

### The Low-Hanging Fruit: Retrofit Opportunities

Town Halls



Police Stations



Fire Stations



Court Houses



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## Attic Insulation

### The Low-Hanging Fruit: Retrofit Opportunities

College Dorms



Office Buildings



K – 12 Schools



Country Clubs



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## Attic Insulation

### The Low-Hanging Fruit: Retrofit Opportunities

DPW Garages



Libraries



Senior Centers



Recreation Centers



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## Attic Insulation

### The Low-Hanging Fruit: Retrofit Opportunities

Hotels and Motels



Medical buildings



Banks



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## Attic Insulation

### The Low-Hanging Fruit: Retrofit Opportunities

Dunkin Donuts



Gas stations



General Stores



Specialty stores



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## Evaluating Existing Attic Insulation

### Measure existing thickness and determine type

- Rockwool
- Fiberglass
- Cellulose
- Other



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## Example of Uninsulated Attic

### Excellent Savings Opportunity

- Thermal boundary is in attic floor
- No mechanical equipment present



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## Cellulose Insulation

### A cost effective solution

- R-3.7 per inch in open areas
- R-3.5 per inch in enclosed cavities
- Easy to install, blown from a truck
- Can be densely packed to resist air flow
- Air Sealing generally required as preliminary step



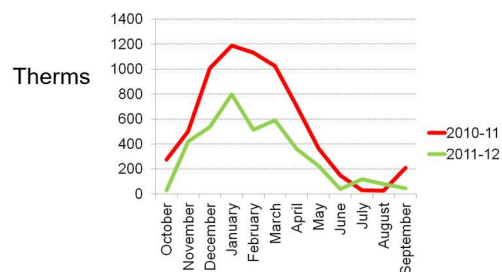
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## Incentives and Savings

### Real Life Example of Savings

- Building footprint: 8,244 sq ft
- Annual usage: 6,600 therms
- Comprehensive attic weatherization project generated savings of 36% of site usage
- Often a cost effective improvement that can be made to improve efficiency of facility

### Savings Example: Police Department

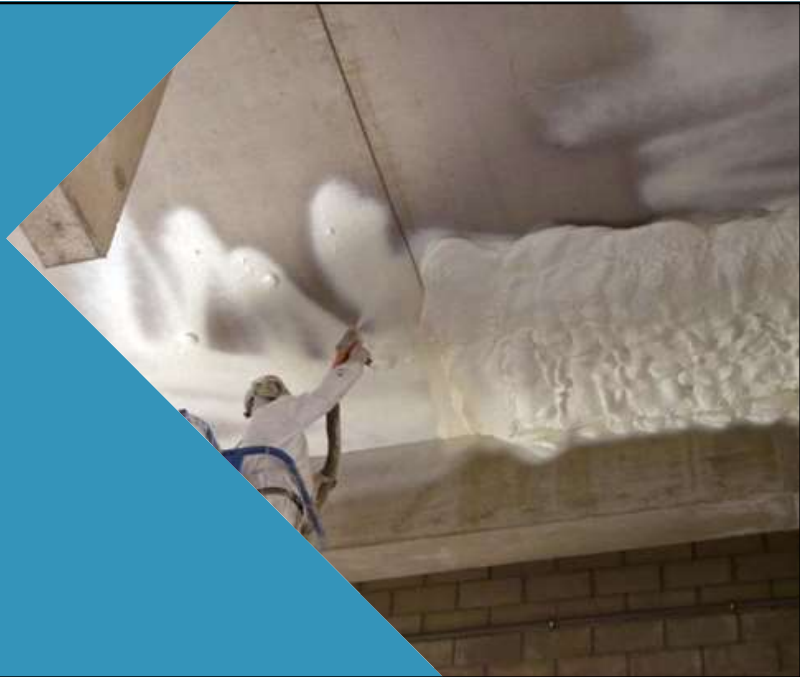


Weather-adjusted savings = 2394 ann. therms  
(36% of total usage.)

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# 03

## Roof Insulation



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### Roof Insulation

#### Establishing thermal boundary on rafter slopes

- In most cases, thermal boundary should be established on the attic floor
- In cases where the attic contains heating/cooling mains, ductwork, mechanical equipment, it may make sense to insulate the rafter slopes

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## Roof Insulation

**This attic is a good candidate for roof insulation**

- Also known as a “hot roof”
- Note the presence of mains, ductwork, and mechanical equipment
- Example of closed cell foam



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## Roof Insulation

**This attic is a good candidate for roof insulation**

- Another example of an attic containing mechanical equipment
- Example of closed cell foam
- Note the extensive bypasses from living space to attic area



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## Roof Insulation

### Insulation Types

- Fiberglass Batt Insulation
- Spray Foam more expensive, but effective. Two types:
  - Open Cell Spray Foam
    - R-3.6 per inch
    - Requires vapor barrier, ignition barrier
  - Closed Cell Spray Foam
    - R-6.5 per inch
    - Requires an ignition barrier

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## Roof Insulation Types (cont'd)

### Spray applied mineral wool



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## Roof Insulation Types (cont'd)

### Densely Packed Cellulose



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## Flat Roofed Buildings

### Flat Roofed Buildings may require a different approach

- Some have an accessible, vented, attic space, but these are uncommon
- If so, air seal and insulate attic floor



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## Flat Roofed Buildings

### Flat Roofed Buildings require a different approach

- Most have air and insulation boundaries right at the roof surface
- Best time to insulate is when re-roofing
- Likely would not be an ideal candidate for a retrofit, due to the significant cost
- Re-roofing a flat roof also opens up the opportunities for addressing other energy conservation measures, such as rooftop HVAC units or solar PV arrays.



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## 04

### Air Sealing



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## Air Sealing

### What is air sealing?

- Installation of foam, caulking, and other sealants to seal air leaks in building envelope
- Minimizes the “stack effect” in building, which drives loss of conditioned air from the building
- Must be prior to installation of additional attic insulation
- Eliminate “bypasses” from conditioned to unconditioned spaces
- Blower door testing can be used to determine air leakage rates and potential savings

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## Air Sealing

### Where to recommend air sealing

- Attic
  - Wall top plates, plumbing/wiring penetrations, open chases
  - Preliminary step before adding additional insulation
- Basements/Crawlspaces
  - Band joist, sill, open chases
  - Ducts in unconditioned spaces should also be sealed

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## Air Sealing

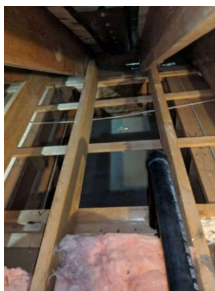
### Examples of bypasses



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## Air Sealing

### Examples of bypasses



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## Air Sealing

### Applications



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## Air Sealing

### Applications



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# 05

## Exterior Walls

Divider subtitle



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## Exterior Wall Insulation

### Applications

- Wood, vinyl, and aluminium sided buildings with empty wall cavities
- Cellulose insulation can be blown into exterior wall cavities by temporarily removing sections of siding from exterior
- Masonry, stucco walls, sometimes can be added from interior of building depending on presence of a vapor barrier
- Thermal imaging, wall probes can be used to determine presence, absence of exterior wall insulation.

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## Exterior Wall Insulation

### Applications



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# 06

## Basements and Crawlspaces

Divider subtitle



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## Basements and Crawlspaces

### Applications

- Building sill and band joist
- Bulkheads
- Crawlspace walls
- Materials include spray foam, rigid board, and fiberglass products
- Pay attention to vapor barrier on earthen crawlspaces
- Pipes/Fittings: Steam, Heating Hot Water (HHW), Domestic Hot Water (DHW)

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## Basement and Crawlspaces

### Applications



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## Basement and Crawlspaces

### Applications



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# 07

## Windows and Doors



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## Windows and Doors

### Overview

- Single Pane Windows and uninsulated doors may warrant replacement
- Often less cost effective than other envelope measures, but worth investigating
- Weather stripping of doors and replacing worn fuzz style weather stripping on older windows often a viable cost effective alternative to replacement
- Re-sealing window frames can also significantly reduce infiltration

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### Applications



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## Questions?

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