NHSaves Button Up 201: Advanced Home Energy Workshop

Pilot Dec. 2020

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NHsaves

Your Source for Energy Efficiency

EVERSOURCE

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New Hampshire Electric Co-op

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Button Up NH 201 Workshop Overview

- Button 101 Review
- Building Science and Heat Loss
- Air Sealing and Insulating
- Heating, Cooling and Ventilation Tips
- Other Tips and Resources
- Resources and Next Steps

Disclaimer: *This workshop is only designed to provide general information about residential energy efficiency. It is the responsibility of workshop attendees to determine the applicability of these energy saving activities. Any activities conducted outside this actual workshop are the sole responsibility of the individuals engaged in the activity. We strongly encourage attendees to seek the advice of a professional before engaging in any activity that can impact the building system and/or its occupants.*

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Plenty of Simple Steps to Save Energy

- LED lights: inside, outside, holiday – everywhere!
- Replace showerheads and faucet aerators with low-flow versions

- Install pipe insulation
- Use smart power strips to reduce phantom loads
- Turn down thermostats
- Remove window A/C units in winter
- Use dehumidifiers as little as possible

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And Some Bigger Actions

- Purchase ENERGY STAR Appliances
- Have that spare frig or freezer hauled away, and earn $30
- Install smart thermostats
- Add insulating window treatments
- Get an energy audit!
  - With NHSaves “Home Performance with ENERGY STAR” program
  - Professional weatherization installation
  - nhsaves.com

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NHSaves.com Energy Audits & Weatherization

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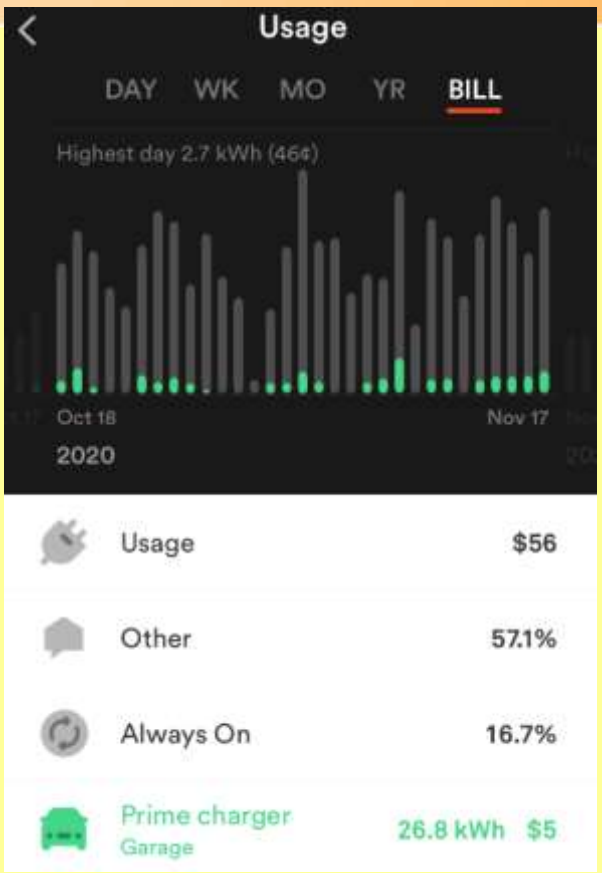
DIY Tips for Sleuthing Home Energy Use

Express your energy geekiness!

- Have fun with plug-in watt meters
- Whole house electricity monitor: TED, Engage, etc. Sense →
  - Real-time monitoring
  - May also ID specific circuits or devices
  - Electrician installation recommended
- NHSaves' Home Heating Index calculator
- ENERGY STAR'S Home Energy Yardstick →



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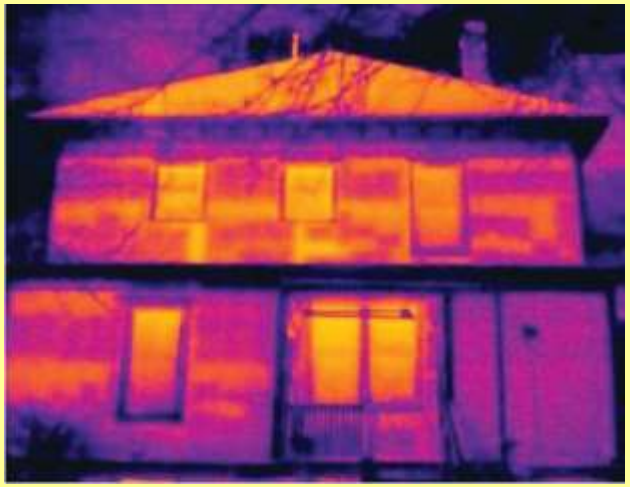
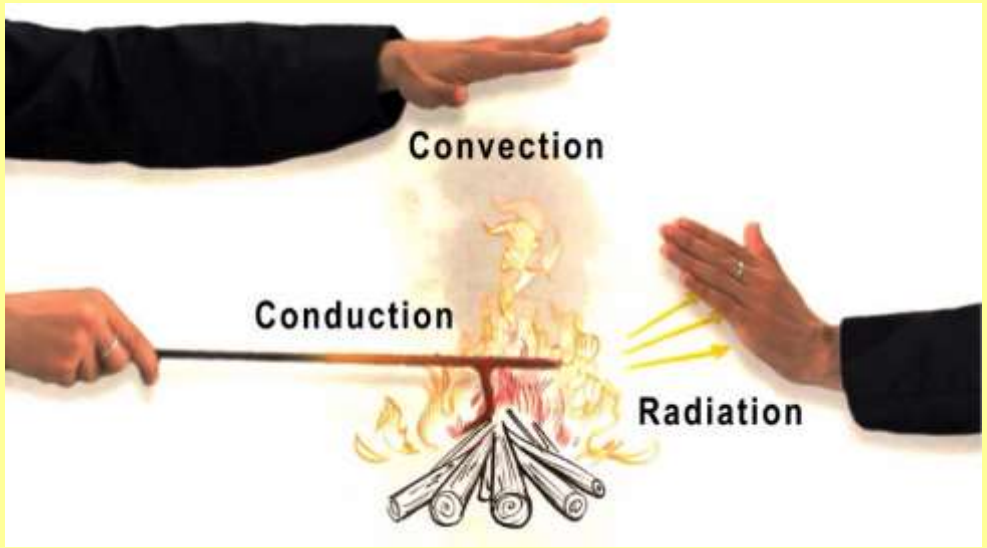
Building Science and Heat Loss

- **Heat moves from Hot to Cold**



- **Heat moves via three methods:**
  - Conduction
  - Radiation
  - Convection



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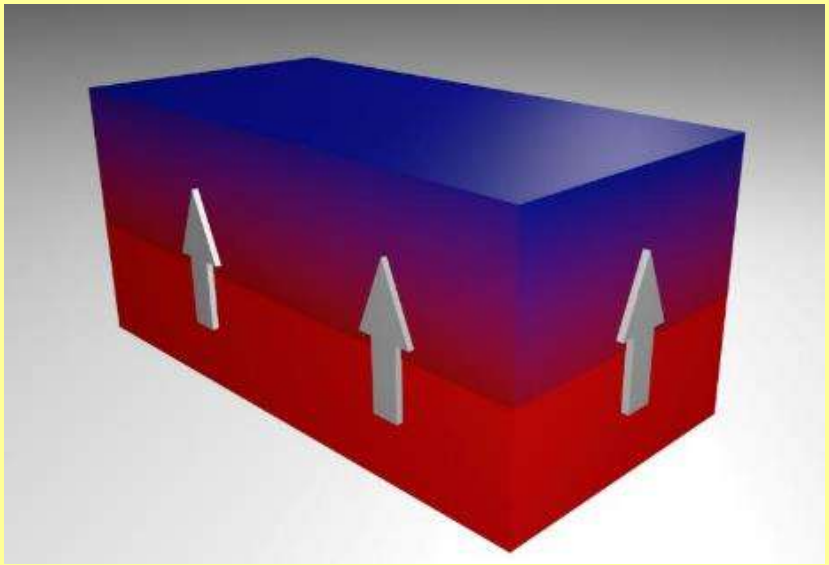
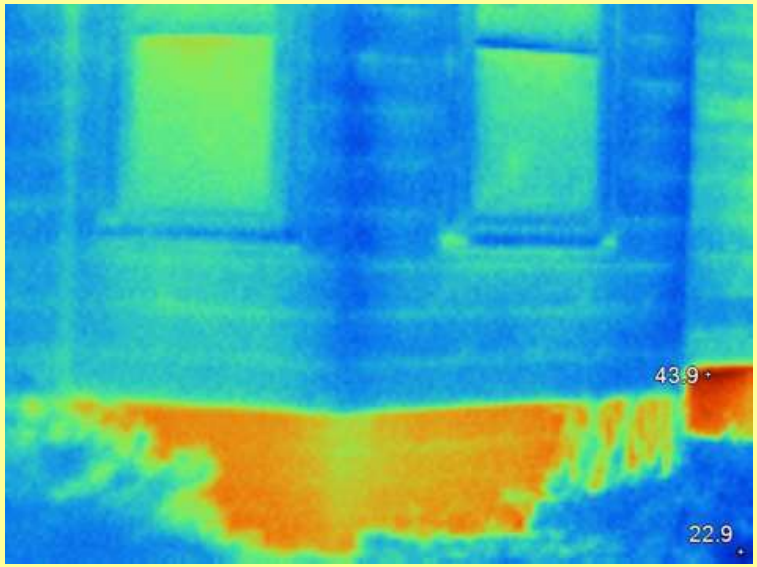
1. Heat Loss from Conduction

Conduction: movement of heat through materials

Counteract conduction with **insulation**

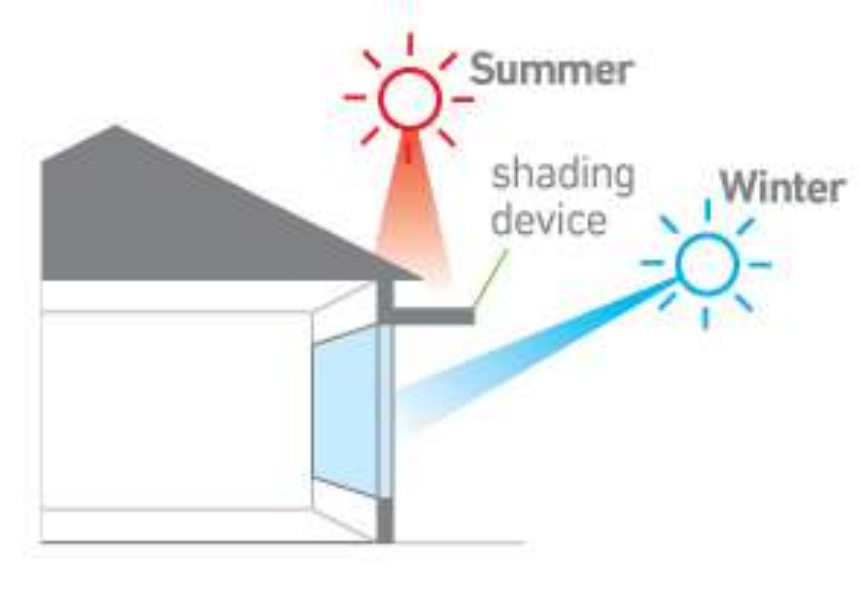




2. Heat Loss & Heat Gain from Radiation

Warmer objects **radiate heat** to cooler objects

Block the line of sight to reduce radiative heat gain/loss



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3. Heat Loss from Convection

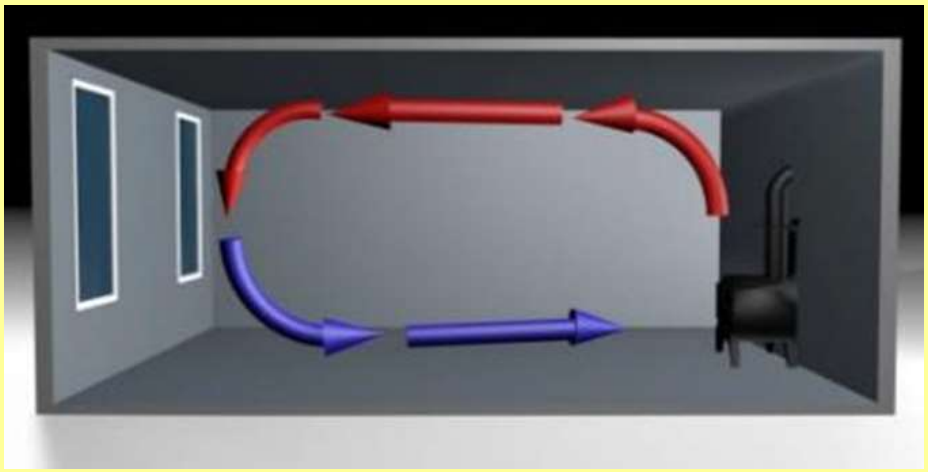
Heat moves in air currents

- Warm air is more buoyant than cool air

Convective air currents can be **inside** a building

Or between outside and inside:

- Buoyant **warm air escapes** up high
- Denser **cold air infiltrates** in down low



A Cozy House: Air & Thermal Barriers

"Continuous Building Envelope"

- **Air Barrier** – stops cold air leaking in, and warm air leaking out
- **Thermal Barrier** – insulation to resist conductive heat loss
- Buildings need both!
  - Continuous
  - Effective

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How to Sleuth for Heat Loss

General tips

- Cold, calm day best
- Look for clues: roof ice melt patterns, cobwebs, subtle ceiling staining, uncomfortable rooms, windows, frozen pipes, ice dams, etc.
- Professional sleuthing recommended
  - With a **blower door** and **infrared thermal camera**

DIY Techniques

- Sleuth for drafts with an incense stick or e-cigarette around the thermal envelope
- If accessible, closely inspect the attic for insufficient insulation and signs air leakage

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The Wild Card: Interior Moisture

Air exfiltration can lead to condensation

Warm air can hold more water vapor than cold air

Air leaking into attic cools and gives up moisture…

…and the moisture may condense in the attic

NOT a leaky roof

An (air) leaky ceiling!

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Reducing Interior Moisture Loading

- Mechanically ventilate bathrooms and kitchens to outside
  - With high quality fans, and short venting ducts
- Cover dirt basement / crawlspace floors with a moisture barrier (6 mil poly. sheeting, etc.)
- Move rainwater away from the house: landscaping, etc.
- Reduce interior moisture sources: firewood, wet laundry, humidifiers~, etc.
- (Last resort) Dehumidify

Don't let these "moisture bugs" invade your house!

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Review- Building Science & Heat Loss

- Conductive heat loss and insulation
- Radiant heat loss and gain
- Convective currents and heat loss
- A cozy house with an air barrier and thermal barrier
- How to sleuth for heat loss
- The interior moisture wildcard

Air Sealing and Insulating

- Air Sealing Priorities
- Button Up in the Attic
- Button Up Elsewhere
- Insulating
- Other Techniques

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Air Sealing Priorities

Common Leaks in New Hampshire Homes

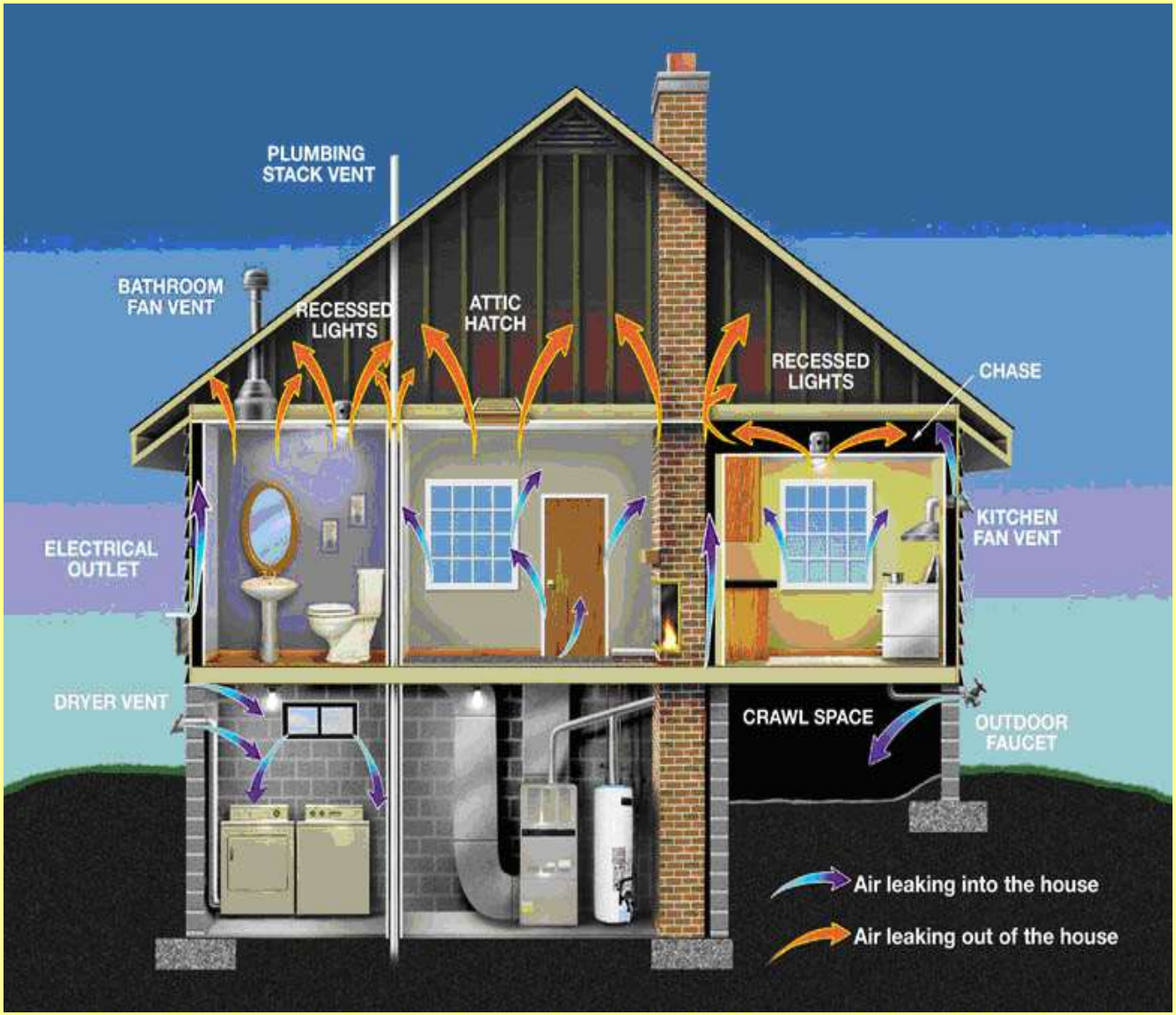

Image courtesy of US EPA

Priorities

Attic

Basement

Center

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Buttoning Up- Attic Air Leakage 1

Common Leaks into the Attic #1

Image courtesy of US EPA

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Buttoning Up- Attic Air Leakage 2

Common Leaks

Image courtesy of US EPA

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Buttoning Up- Basement Air Leakage

Common Leaks

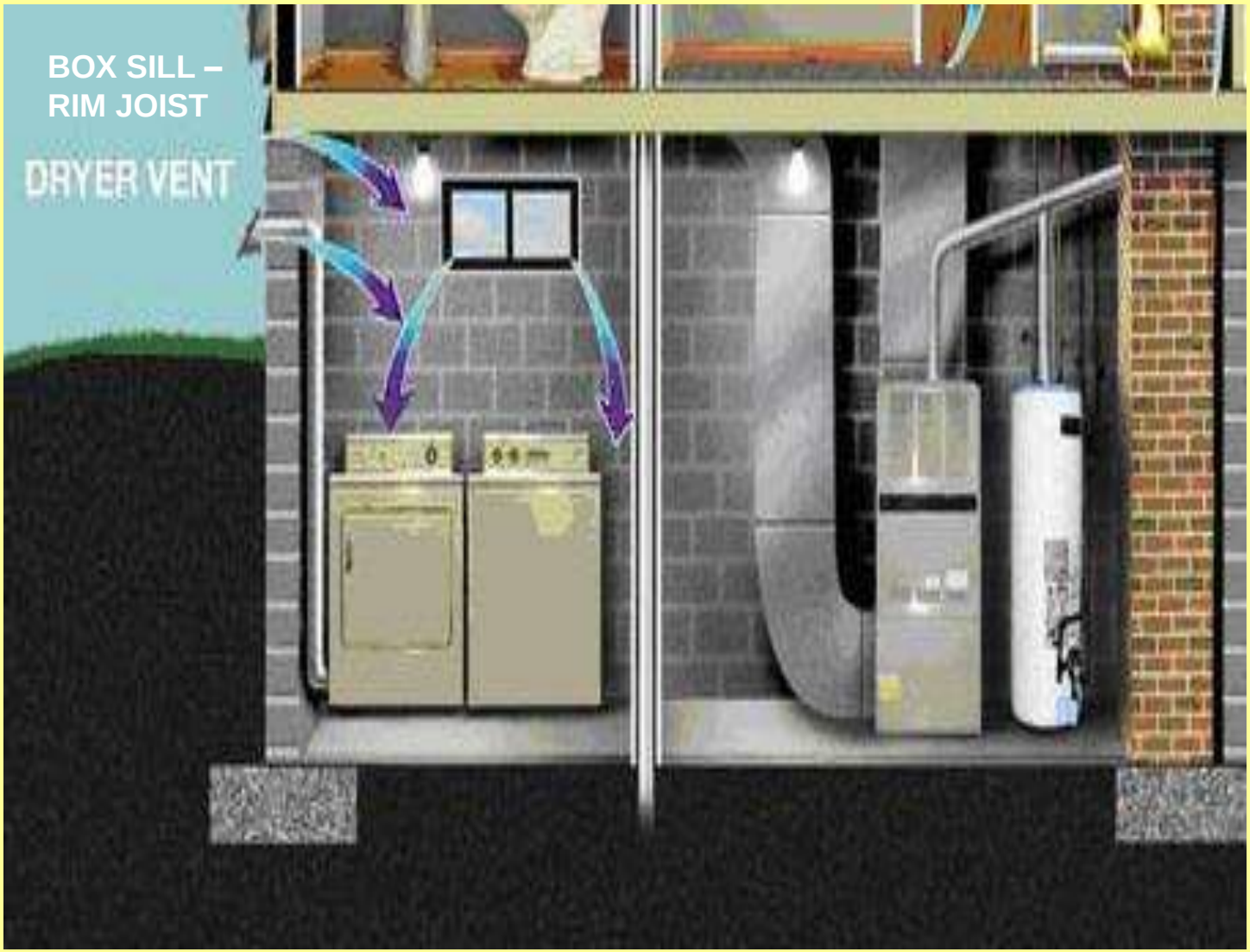

Image courtesy of US EPA

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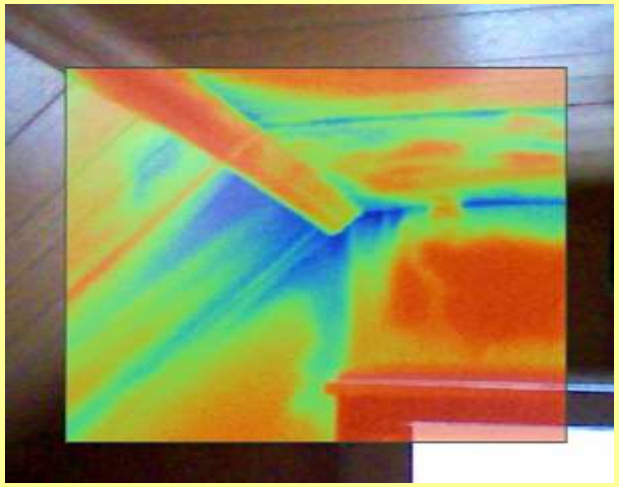
Using a Blower Door

How Professionals Find Air Leaks

- The blower door test is the primary tool
  - Quantifies air leakage -- "CFM_{50}"
  - Prioritizes air sealing opportunities
  - Also used to confirm air sealing
- Infrared imaging (thermography)
  - Can be used with a blower door
  - Also finds insulation voids
- Compare CFM_{50} results with "Building Tightness Limit"
  - ***Seal tight and ventilate right!***



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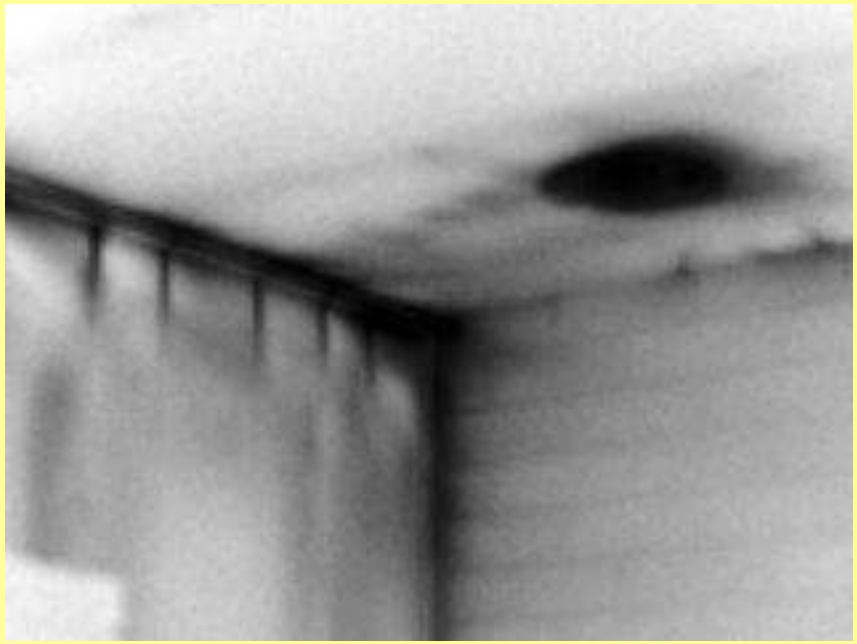
Infrared Thermography with a Blower Door

Using Infrared (IR) Thermography to Find Air Leaks

Digital Image



Infrared Image

IR image: light shades = warm; dark shades = cold
Cold air leakage at top of wall, corner and recessed light

DIY Air Sealing

Some of the following are projects you can do yourself. Other projects will require a professional or additional instruction. Even if DIY, an energy audit can help you pinpoint your efforts.

Excellent Resource:

A DO-IT-YOURSELF GUIDE TO SEALING AND INSULATING WITH ENERGY STAR®

SEALING AIR LEAKS AND ADDING ATTIC INSULATION

ENERGY STAR

BASIC

Do-it-yourself projects – possible projects for homeowners and renters

ADVANCED

Additional instruction needed or professional assistance required

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Air Sealing Materials

Basic Air Sealing Materials

- *Foam gun (with single part sealing foam)
- Caulk (silicone stays flexible)
- Rigid foam board, sheetrock (edges fully sealed)
- Weather stripping

Wear appropriate PPE- personal protective equipment:

- N95 mask or respirator
- Eye protection
- Gloves
- Coveralls or similar

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Attic Air Sealing: Electrical Boxes

BASIC

Seal small **Electrical Penetrations** with caulk

Before

After

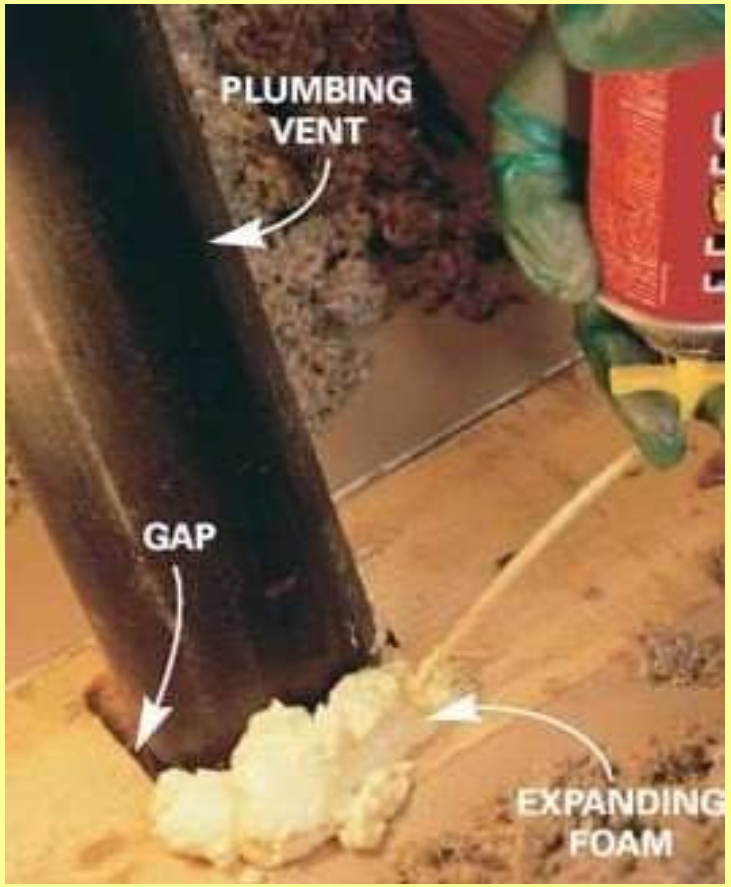
Images courtesy of Efficiency Vermont

Attic Air Sealing: Other Penetrations

BASIC

Foam Plumbing & Wiring Penetrations, and Top Plates

Cracks in top plates should also be sealed



Images courtesy of Efficiency Vermont

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Attic Hatches

BASIC

Attic Hatch

Weatherstrip to create an effective seal and ~6” foam board insulation – very cost-effective. Build a plywood dam around opening to keep insulation from falling.

Images courtesy of EnergySmart of Vermont

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Buttoning Up- Attic Air Sealing

Sealing a Pull-Down Stairs

ADVANCED

- Needs a well-sealed and insulated box in attic
  - 4-8” of foam board (R-30+)
  - Weatherstripping and method to keep box sealed
- “Thermodome” and other ready-made options
  - Easier but…
  - May not fit perfectly
  - Still needs a flat platform to seal onto

This approach doesn’t work well *Why?*

Stained insulation from air leakage

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Sealing Attic Chimney Chases

Sealing a Chimney Chase

ADVANCED

Images courtesy of Efficiency Vermont

Sheet metal or flashing
Sealed with non-combustible caulk
Non-combustible insulation dam at least 3” from chimney

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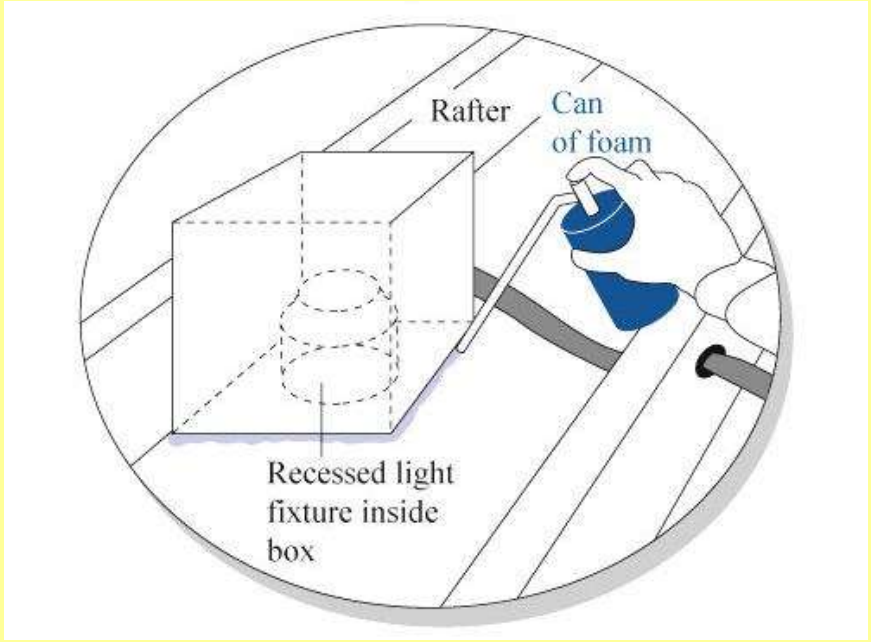
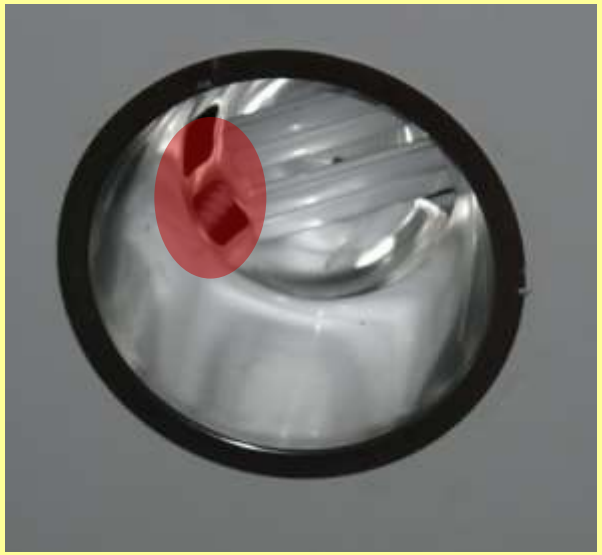
Air Sealing Around Ceiling Can Lights

ADVANCED

- Many older **ceiling can lights** are NOT rated for insulation contact (e.g., "Non-IC")
- Must be either replaced with IC-AT can
- Or boxed with 3+" clearance on all sides
- Air-sealed custom drywall box





Non-IC cans often are very leaky!

New LED can lights are very efficient

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Air Sealing the Basement

Bulkhead Door Air Sealing

BASIC ADVANCED

Highly cost effective

"Q-Lon" style weatherstrip

May need to build a vertical door -- requires carpentry skills to seal effectively

Image courtesy of EnergySmart of Vermont

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Air Sealing the Basement Rim Joist

Rim Joist / Box Sill and Foundation

BASIC

- Junction of framing and foundation -- leaky
- Seal with gun foam around rigid foam
- Other basement opportunities:
  - Foundation windows
  - Plumbing and wiring penetrations
  - Small cracks of the foundation

Images courtesy of EnergySmart of Vermont

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Air Sealing Fireplaces

BASIC ADVANCED

Fireplace

- Fireplaces often lose more heat than they generate (in cold weather)
  - Sucks in cold outside combustion air
  - Warm air leaks out the chimney
- Close off a fireplace to create a tight seal during cold weather
- Insert inflatable “chimney balloon” when not in use
- Consider installing a fireplace insert with sealed doors

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Air Sealing and Windows

Windows

BASIC ADVANCED

- Replacing windows – one of the least cost-effective strategies
- Most NH windows are Not very leaky
- Sealing around windows:
  - Caulk sash and trim (tube goo or rope type)
  - Air seal & insulate counter-weight cavities
  - V-seal between sashes and frames
- Window treatment options:
  - May help air seal windows: interior storms, exterior storms and plastic film
  - Does not air seal: cellular shades, most window quilts,

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Air Sealing Review

Air Sealing Action Plan:

- Find air leaks first – blower door very helpful
- **A**: Attic air sealing
- **B**: Basement air sealing
- **C**: Air sealing in the center

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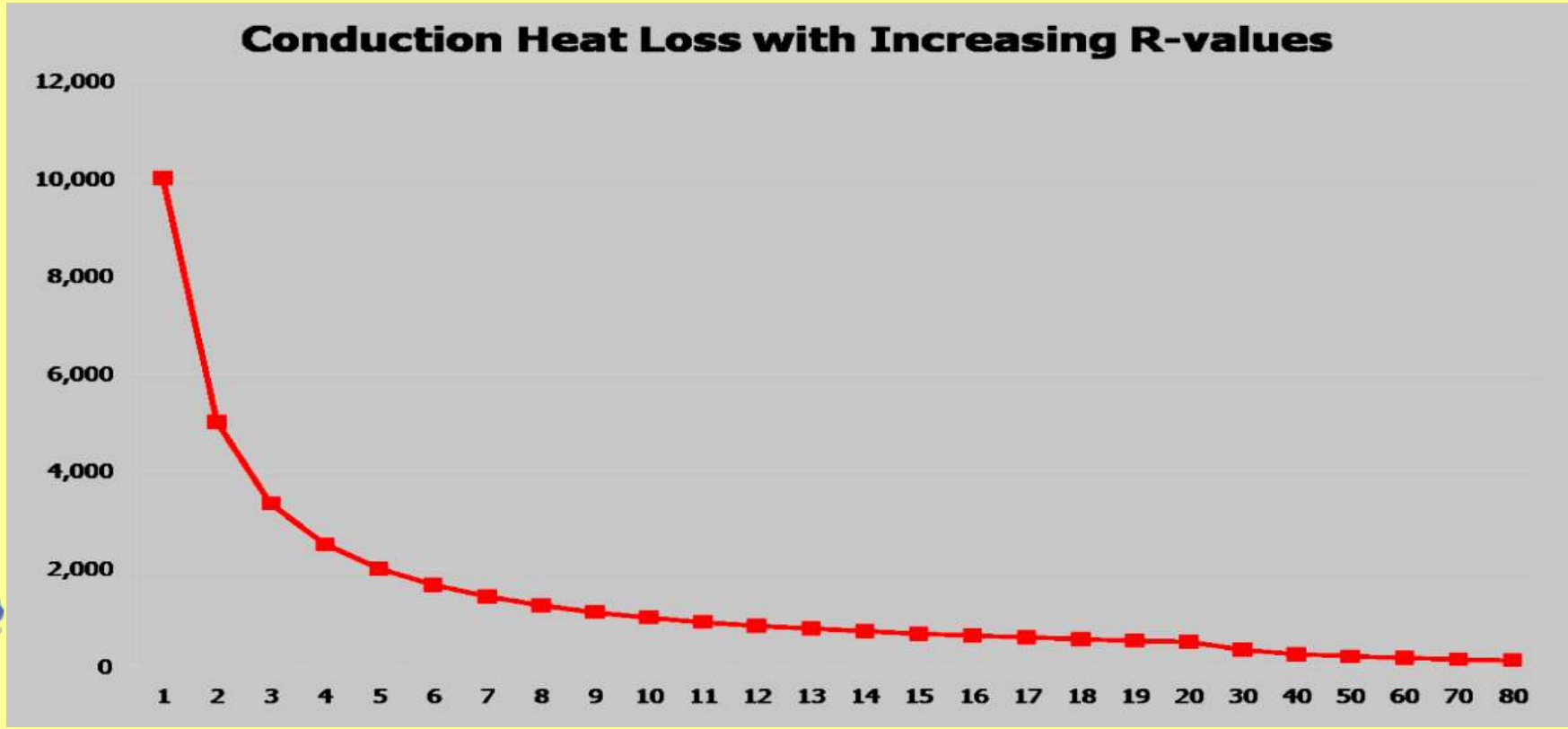
Buttoning Up- Insulating

- **Conduction** is the movement of heat through a material
- **R-values** measure a material's resistance to conductive heat transfer
  - Low R-value materials: metals, glass, concrete, stone, brick and wallboard



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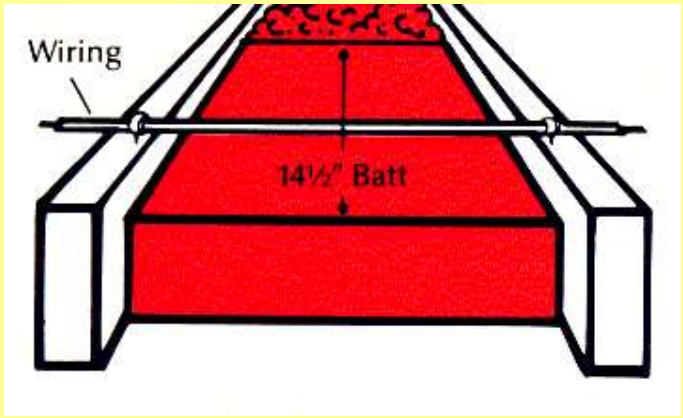
Installing Batt Insulation

Installing Batt Insulation

BASIC

ADVANCED

- Kraft vapor retarder on warm side
- Needs good contact with air barrier
- Fit around obstructions
- Careful installation is key – no gaps



<u>Scenario:</u> Attic 95% covered with R-38 insulation & 5% R-1 gaps

What is the average attic R-value?

<u>R-36</u> *<u>R-29</u>* *<u>R-20</u>* *or <u>R-13</u>?*

Tricky!

Lesson: Small areas with low R-values can have a big impact

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Installing Loose Fill Blown Insulation

AFTER Air Sealing…

ADVANCED

- Installing **Loose Fill Blown Insulation** in the Attic
  - Address conductive heat loss by adding insulation to achieve recommended R-values, where feasible
  - Loose fill insulation creates a uniform insulating layer

Attic blown-in cellulose

Photo courtesy of Efficiency Vermont

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Densepack Insulation in Wall Cavities

ADVANCED

- **Dense packing cellulose** fiber in closed cavities (wall, slope, floor) stops air movement and adds insulation in one step
- Densepacking uninsulated walls and attics – very cost-effective
- Must be a minimum density: 3.5 lbs./cubic ft.
- Fiberglass can also be dense packed

Image courtesy of Vermont Dept. of Children and Families

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Cape Homes: Insulating & Air Sealing

Most Cape Homes Have Knee Walls

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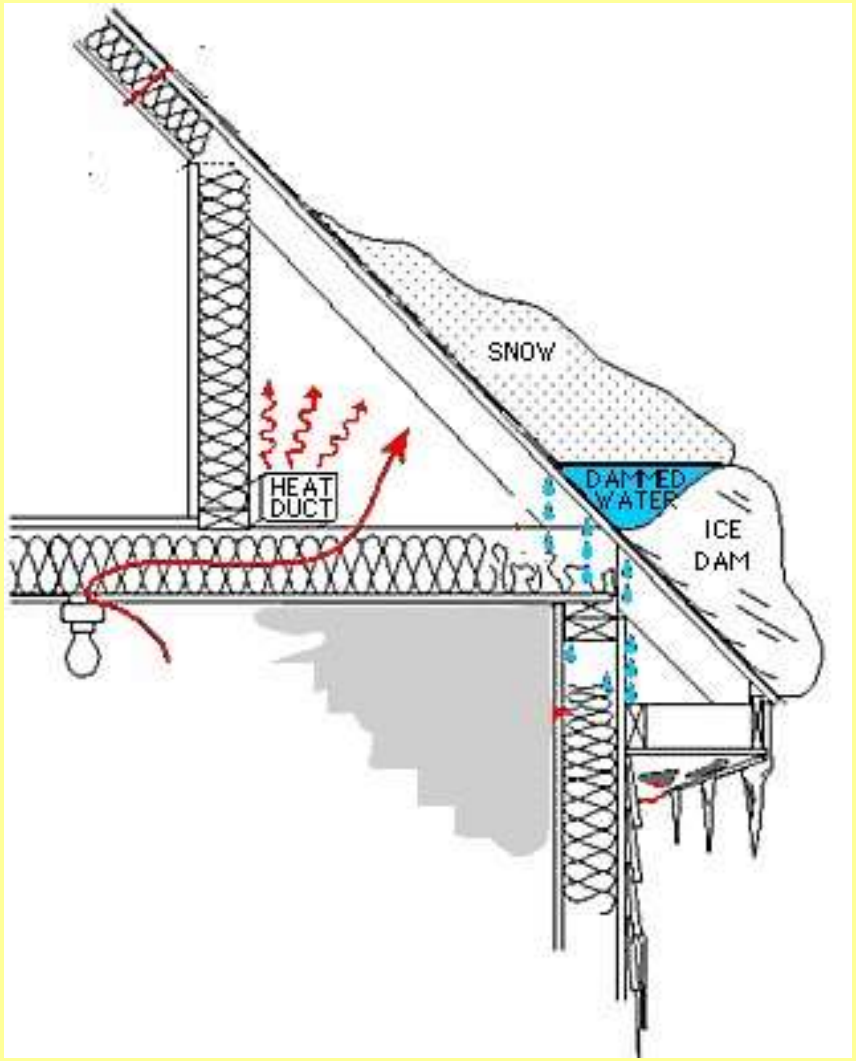
- A thermal weak link – lots of ice dams in Capes
- Address air leakage *and* conductive heat loss
- Professional assistance recommended



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Basement Insulation

ADVANCED

Need to first define where the home's thermal boundary is:

- Basement walls <OR>
- Basement ceiling

Then properly air seal and insulate that boundary

- Basement walls:
  - Spray foam with fire barrier
  - Rigid foam, fire barrier and sealing foam
  - Other options- not many
- *((Basement ceiling: air sealing and batt insulation))*

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Are Windows Good Insulators?

In a word: NO

- Window assemblies are typically R2 – R5
- Contrast: a well-insulated wall is R19

How to improve window insulation

- Window treatments are most cost-effective than replacement windows
  - Cellular shades
  - Window quilts
  - Check out: WindowDressers

- Some new / replacement windows are R-5 (U 0.20) – good for a window, but expensive

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Heating, Cooling & Ventilation Tips

- The building envelope and heating systems
- Cold climate air source heat pumps
- Duct insulation and sealing
- Mechanical ventilation

Building Envelope and Heating Systems

Which is more important: an efficient building envelope <or> a high efficiency heating system?

- Air and thermal barrier: A really good one means almost no extra heat needed
- Most heating systems are reasonably efficient: 80+%

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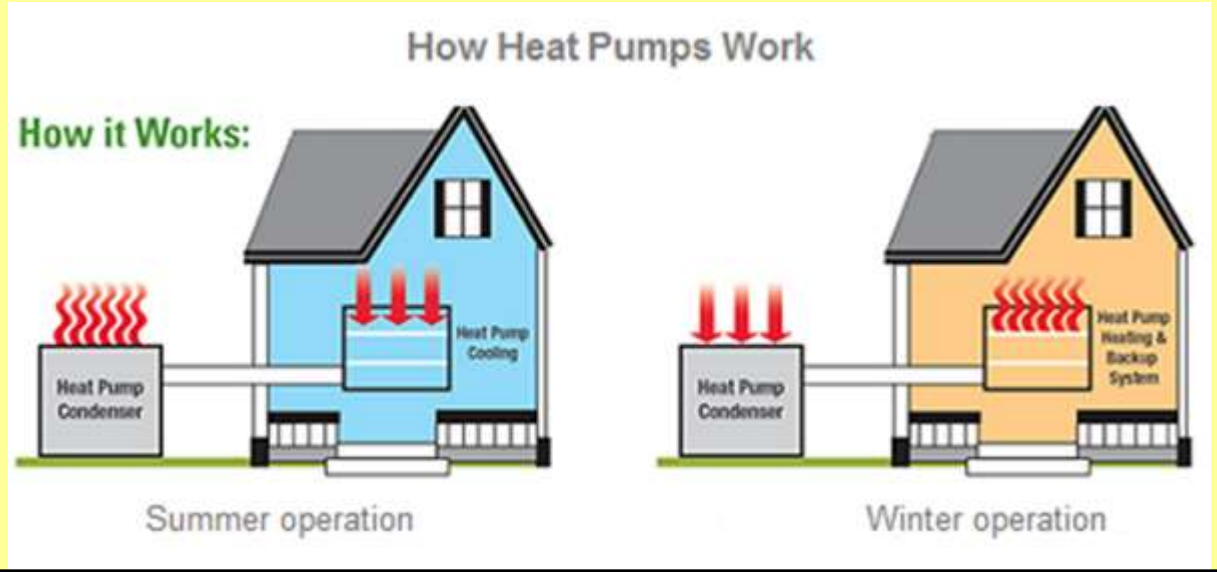
High Efficiency Heat Pumps

Ductless Cold Climate Heat Pumps for A/C & Heat

- "Mini splits" heat and cool air
- "Cold climate" models
  - Can extract heat from -20° air!

Heat Pump Hot Water Heaters

- More efficient than regular electric water heaters



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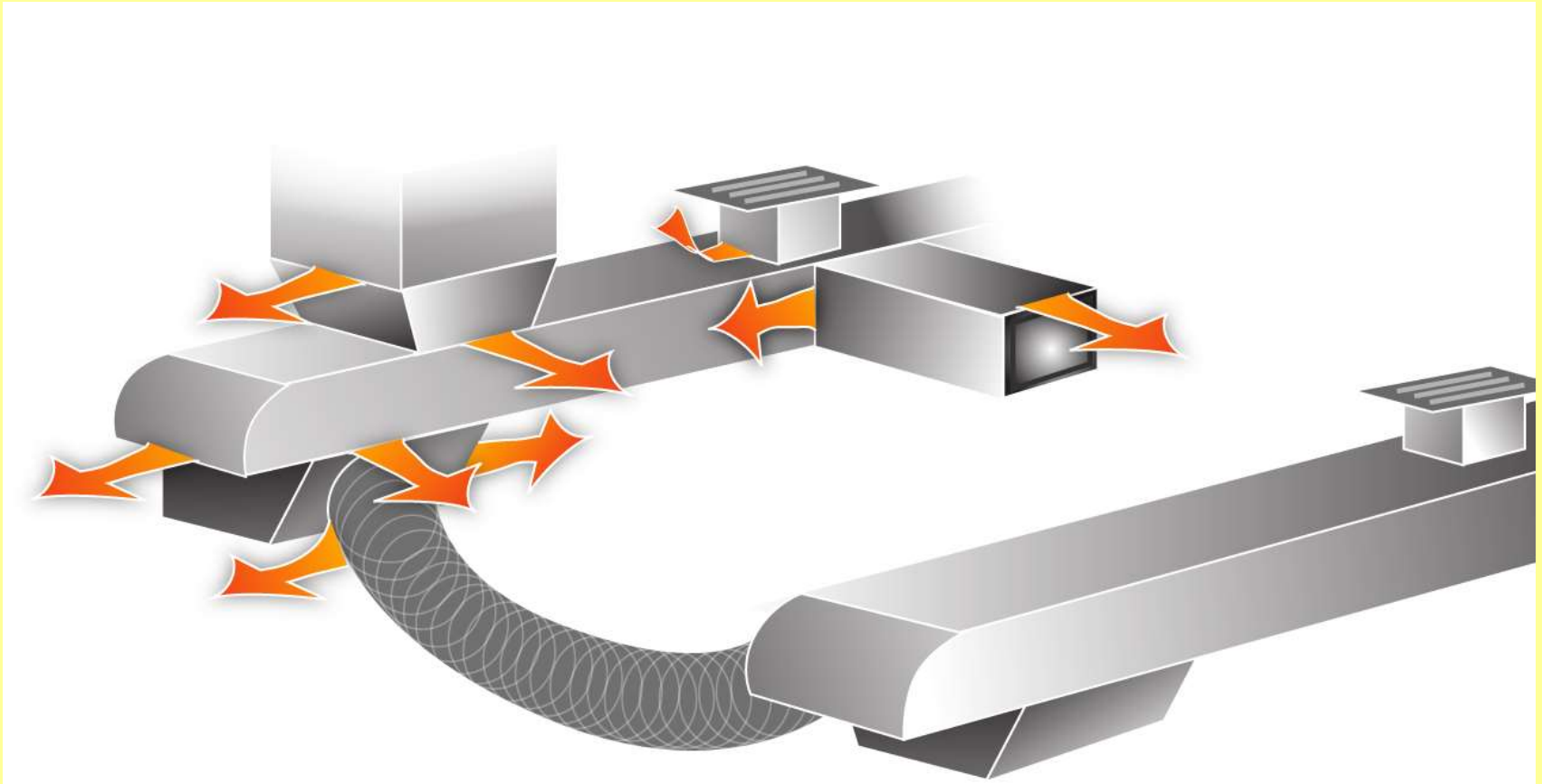
Duct Sealing and Insulation

Common Spots for Duct Leakage

- Ducts need sealing *and* insulating
- Especially ducts in attics and crawlspaces



Other Tips- Duct Sealing

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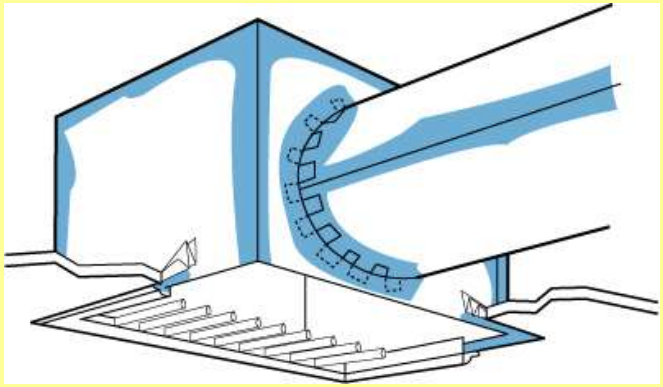
Mastic!

- Goop on to seal ducts
- Reinforce with drywall joint tape
- NOT duct tape!



Other Tips- Mechanical Ventilation

"Seal Tight & Ventilate Right"

- Mechanical ventilation provides fresh air and reduces interior moisture problems
  - Particularly important for houses that have been air sealed
  - Energy professionals calculate a building tightness limit
- Mechanical ventilation includes:
  - Bathroom fans
  - Kitchen exhaust hoods
  - Heat recovery ventilators (HRVs)

- How?
  - High quality bathroom fans with intelligent controls
  - Properly ducted to outdoors
  - And other more sophisticated systems…

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Health and Safety Issues

- **Carbon Monoxide** – caused by incomplete burning
  - Keep heating systems tuned up
  - Install a carbon monoxide detector on each floor
- **Back Drafts** – combustion gases coming back into the house
  - Get heating systems combustion safety tested
- **Moisture** – causes health and building problems
  - Control the source
  - Mechanical ventilation
- **How to assess?** *Best to involve an energy professional*

Carbon monoxide detector

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Other Button Up 201 Tips

- Clothes dryer venting
- Working with professionals
- A sneak peak at 2021+ NHSaves programs
- Resources

Clothes Dryer Venting

Over 12,000 clothes dryer lint fires per year in the U.S.

- Easily avoidable

Clothes Dryer Venting

Use metal venting

- With a well built exterior vent hood
- Clean out lint regularly

Best: Rigid Metal

OK: Flexible Metal

No: Aluminized Flex

Bad: Plastic Flex

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Why Use a Professional?

Call a professional when…

- You may have difficult health and safety issues
- You need specialized diagnostic tools and experience
- You are not sure how to do the installation
- You would rather *not* explore attic eaves & crawl spaces
- The project is bigger than you have time for

Do you really want to do this work yourself?!

Working with Professionals

Energy Auditors and Installers – What to Look for:

- House-as-a-system experience
  - Understanding how their recommendations or work affects other components in a home
- The right tools and materials
  - Blower door, combustion analyzer, infrared camera, etc.
  - Densepack insulation blower, spray foam systems, etc.
- Credentials and certifications (BPI, REPA, HERS, WAP, etc.)
- References and reputation
- Detailed written proposal – based on an energy audit
- Polite and pleasant, not hard-sell

Finding Energy Professionals

Finding a Qualified Energy Auditors & Contractors

- Qualified contractors with the NHSaves Home Performance with ENERGY STAR program
  - nhsaves.com ("Test your home")
- NH Residential Energy Performance Assoc. (REPA) – *www.repa-nh.org*
  - Full, voting members have been vetted for energy auditing skills
- BPI "Building Analyst" certified energy auditors and contractors
  - www.bpi.org
- Income-eligible Weatherization Assistance Program Call 211 to find the local CAP office

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Sneak Peak: NHSaves 2021 Programs

Theme: More programs and more pathways

- Expanded Home Performance with ENERGY STAR
  - Higher $8,000 cap on utility contribution
  - At least 50% utility contribution
- Expanded ENERGY STAR New Homes program
  - Emphasis on net zero homes with solar and heat pumps
- More ENERGY STAR Products incentives
  - Freezers, heat pump hot water heaters, appliance recycling rebates
- More emphasis on air source heat pumps for heating & cooling

Do-It-Yourself Resources

- ENERGY STAR -- www.energystar.gov
  - "DIY Guide to Air Sealing and Insulation"
  - "Home Energy Yardstick"
  - ENERGY STAR labeled appliances
- Weatherization TV -- wxtvonline.org
  - Great how-to weatherization videos

- Air Sealing & Insulation Supplies
  - Local hardware and building supply stores
  - J&R Products, Inc. -- jrproductsinc.com
- Book: *Insulate and Weatherize* by Bruce Harley

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Button Up!

What to Do Now:

- Develop an **Home Energy Action Plan**
  - What air sealing, insulation and other activities need to be done and why?
  - Know when to enlist professional help
- Materials: What is needed, where to get it and cost?
- Tools & Techniques: What will it take to do the job right?
- Labor: How long will it take, who will do it, and when?
- Safety: Know your limits and plan for worst case
  - What you don't know *can* hurt you!

Save energy, save money, help the planet and have fun!

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Thank You!

Presenter:

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Button Up NH is coordinated by the Plymouth Area Renewable Energy Initiative with support from the NHSaves' utilities.

Visit **www.plymouthenergy.org** for a copy of the presentation

Support future workshops …let your utility know.

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