

Homeowners DIY Energy Efficiency Tips for Older Buildings

White Paper, May 2021

Prepared in cooperation by the Preservation Trust of Vermont and Vermont State Historic Preservation Office.

Introduction

The sustainability of our communities relies heavily on the proper adaption of our older buildings to meet the growing and changing demands of the 21st century. The reuse, adaption, and protection of valued older buildings and the inherent embodied energy and character-defining features ensure an investment in the future of our homes, communities, and planet.

- ***Embodied Energy** is the amount of energy consumed in the process of creating building products. This includes harvesting, manufacturing, transporting, and installing. Measured in Megajoules per Kilogram (MJ/kg), the more processed a material is, the higher amount of energy needed to produce it. For example, plywood is 10.4 MJ/kg, cement is 5.6 MJ/kg, PVC is 80 MJ/kg, and hardwood is 2 MJ/kg. This energy usage can be converted to BTUs to show the energy equivalent, such as one gallon of gasoline is equivalent to the average production, transportation, and installation of eight bricks. More and more companies are now adding embodied energy/carbon to their new building product declaration labels.*

With roughly half of Vermont's housing estimated to date from before 1970, older buildings must be part of the plan to reduce our collective carbon footprint and our reliance on fossil fuels. Weatherizing and maintaining older houses should be the first step in reducing energy usage and lowering operating costs. These small, low-cost/low-impact measures can have large results. Start with the least intrusive and most cost-effective methods. It is important to remember that this work can be done in stages, monitoring progress, and assessing the potential impact of further action.

This guide offers a way to unite the collective need to lower energy usage while living comfortably, keep waste out of our landfills, and save the built environment that makes Vermont a unique and special place to live and explore.

Frame of Mind

When weatherizing for energy efficiency or renovating an older building, remember three main points—reversibility, drying potential, and maintenance:

Reversibility: Alterations made today should be evaluated to determine how and if they permanently impact the building and the materials. Explore the long-term effects and maintenance requirements of alterations and new products used in weatherizing to ensure such activities will not permanently alter the way the material breathes and dries. Such examples may include application of a waterproof sealant or spray foam to masonry, which could expediate decay and potentially cause health risks for occupants. Most materials in older buildings are infinitely repairable but adding irreversible treatments could limit continued repairs and quickly lead to only replacement options.

- **Explore alternatives before commencing the work.**
- **Consult with experience professionals.**
- **Always start with the least intrusive measure.**
- **Do a small test patch before applying throughout.**

Drying Potential: The movement of air through wall cavities ensures the drying of materials and proper circulation of healthy air for occupants. When vents, air leaks, gaps, and cracks are improperly sealed and done without investigation of indoor ventilation, water and humidity will commonly be trapped. This trapped moisture assuredly will expediate the decay of structural materials and cause mold to form, leading to what is commonly called **Sick House Syndrome**.

- **Before air sealing, covering/removing vents, or applying vapor barriers, explore and understand the building's existing drying process and indoor ventilation strategy.**
- **When in doubt, contact experts in HVAC and building construction.**

For more information on Sick Building Syndrome:

https://www.epa.gov/sites/production/files/2014-08/documents/sick_building_factsheet.pdf

Maintenance: When getting recommendations on weatherizing and energy efficiency upgrades, it is important to explore and question the appropriateness of specific products and how each will interact with (particular) older buildings. Recommendations for replacement windows and modern materials, for example, could merely be an attempt to sell a new product, which might not necessarily be better. A restored single-pane window with a properly installed storm window may be as efficient as a replacement double-pane window and can avoid expending the energy needed for manufacturing a new window unit. Cyclical maintenance, required for both restored and replacement windows, is the best path for longevity of the materials and maintain energy performance.

- **Learn to repair before replacing.**
- **Knowledge of how to properly care for older building will ultimately cost less, retain the building's historic features, save energy, and keep materials out of the landfills.**

A guide for maintenance: <https://www.nps.gov/tps/how-to-preserve/briefs/47-maintaining-exterior.htm>

Advice on when to repair or replace windows from Efficiency Vermont:

<https://www.encyvermont.com/blog/how-to/when-to-repair-or-replace-your-windows>

Planning

Before beginning any energy efficiency project, it is best to have a plan. Background information on the building's original construction date and design influences, structural system, subsequent alterations, and current conditions/maintenance needs will save on costs and time, as well as inform next steps. For example, a balloon-framed house, a platform-framed house, and a masonry dwelling each require different insulation techniques to ensure energy efficiency success and not cause unforeseen negative effects.

To aid in identifying and understanding of older buildings, please visit:

- Vermont Division for Historic Preservation <https://accd.vermont.gov/historic-preservation/identifying-resources>
 - For existing survey documentation, please refer to the Online Resource Center: https://orc.vermont.gov/Resource_MultiTown/Show-Resource-MultiTown-Table.aspx
- University of Vermont-Historic Preservation Program- https://www.uvm.edu/landscape/dating/residential_architecture/architectural_styles.php
- Historic New England- <https://www.historicnewengland.org/preservation/for-homeowners-communities/your-old-or-historic-home/architectural-style-guide/>
- *A Field Guide to American Houses: The Definitive Guide to Identifying and Understanding America's Domestic Architecture*- By Virginia Savage McAlester (New York: Alfred A. Knopf, revised 2013).
- Online overview of the more popular American architectural styles: <https://www.thisoldhouse.com/21018307/american-house-styles>

Home Energy Assessments: A roadmap to energy efficiency upgrade is one of the first steps. Contact a trained professional to perform an energy audit of the building. This technical audit will highlight the problem areas to tackle first.

Efficiency Vermont- <https://www.encyvermont.com/services/energy-assessments/home-energy-assessments>

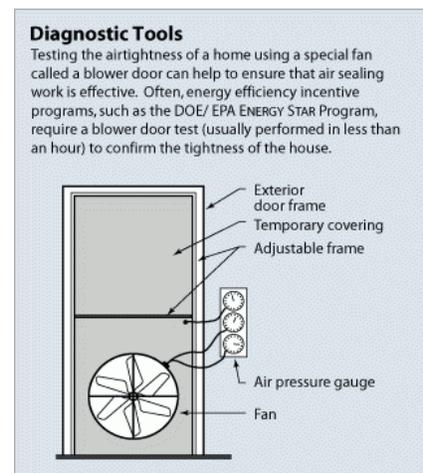
Weatherization

Weatherization or weatherproofing is the practice of protecting a building from the elements, particularly from sunlight, precipitation, and wind, and the act of modifying a building to reduce energy consumption and optimize energy efficiency.

- **Always start with the small and non-invasive steps and advance as needed.**
- **Always test a new material or product on a small section/sample before applying throughout.**

Sealing drafts and gaps is an easy way to reduce the loss of conditioned air and increase comfort. Simple tasks like applying a bead of caulking or adding weather stripping can save about 10% on heating and cooling bills.

- Apply caulking to gaps around frames of windows and doors, where the bottom sill meets the foundation, and around utility penetrations (gas, electric, dryer vents, cable,



A blower door test is conducted during an energy audit to quantify air circulation and heat loss. Courtesy of the US Dept. of Energy.

telephone, etc.). Spray foam should be used sparingly and in select situations due to its potential to cause irreversible damage to historic materials or diminish the drying potential in wall cavities.

- Install or replace weather stripping on exterior doors. Most weather stripping is intended to be replaced periodically; inspecting and replacing damaged or worn weather stripping should be part of a cyclical maintenance schedule.
- Seal chimney flues if not used.
- Add backer-rod or insert fiber insulation in larger gaps.
- Install foam socket seals behind electrical outlets.
- Insulate or block unused mail chutes.

For guidance on air sealing:

- <https://basc.pnnl.gov/checklist-focus/air-sealing>
- https://www.energy.gov/sites/prod/files/guide_to_air_sealing.pdf

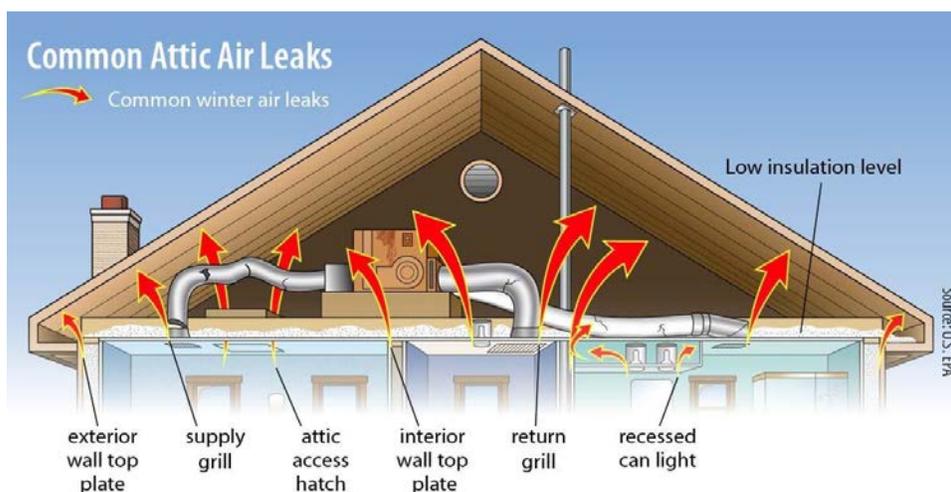


Diagram of common sources of air leaks and heat loss at the attic. Courtesy of US Dept. of Energy.

Insulation

Older buildings sometimes have no insulation or may be loosely insulated with anything from newspaper, corn cobs, or bricks. Properly insulating an older house can have the greatest impact on your energy loss, but there are several things to consider before starting an insulation project.

- **Always start with the small and non-invasive steps and advance as needed.**
- **Before adding insulation or a vapor barrier, be sure to know your building assembly's drying potential and where moisture will condense. The health of your building and your family depends on it!**
- Begin insulation projects in areas that are easily accessible and do not require cutting into materials like plaster, wallboard, or siding. Some of the easiest places to begin are in unfinished attics and crawl spaces.

- There are several types of insulation, each serving a different purpose.
 - Use cautious when considering spray foam insulation because of its permanence and possible negative effects on building materials.
- In attics, insulation alone will have little impact on comfort or reducing energy bills without addressing all the air leaks. Hot air rises so sealing the air leaks will stop the chimney effect of drafts rising through the house and out the attic.
 - Before insulating, seal all potential leaks between heated and unheated spaces such as an attached garage, porch, and attic. These air pathways carry moisture, as well as heated or cooled air, that affects comfort, increases ice damming, and raises operational costs.
 - Fibrous insulations such as cellulose and fiberglass do not stop the flow of air. To find air leaks under existing fiberglass insulation examine where the fiberglass is dirty, because that is where it is acting like an air filter.
- Contact a certified professional before adding insulation to walls, sealing vents, or adding vapor barriers, because of these actions could have serious repercussions.
 - Testing and modeling are available that can identify specific insulation and breathability solutions.
- Before removing or disrupting existing insulation, know what type of insulation it is. Many older houses can have vermiculite with asbestos or other harmful materials. Be aware of the local building codes and disposal requirements.
- Collect guidance on how much insulation is necessary to address energy efficiency needs specific to the building. Over insulating can be costly and create other maintenance issues.



Example of cellulose insulation in a timber-framed attic. Courtesy the Preservation Trust of Vermont.

For guidance on insulation types: <https://www.energy.gov/energysaver/weatherize/insulation/types-insulation>

Efficiency Vermont is a great resource for all weatherizing and insulation question:

<https://www.encyvermont.com/tips-tools/guides/a-homeowner-s-buying-guide-to-insulation>

A brief guide to insulating: <https://www.oldhouseonline.com/repairs-and-how-to/7-insulation-tips>

INSULATION TYPE / MATERIAL		COST	PERFORMANCE & COMMENTS
RIGID / BOARD	Polyiso (Polyisocyanurate)	High	High insulating value for relatively little thickness.
	EPS (Expanded Polystyrene)	High	Can block thermal short circuits when installed continuously over frames or joists.
	XPS (Extruded Polystyrene)*	High	An effective vapor barrier.
	Mineral wool (semi-rigid board, rock or slag)**	High	Foil-faced mineral wool and fiberglass when taped provide an interior vapor barrier.
BLOW-IN (loose or dense-fill)	Cellulose	Low to Moderate	Good for adding insulation to existing finished areas, irregularly shaped areas, and around obstructions.
	Mineral wool (rock or slag)**	Low to Moderate	Good for adding insulation to existing finished areas, irregularly shaped areas, and around obstructions.
	Fiberglass (formaldehyde-free recycled content)	Low to Moderate	Energy performance of cellulose fill is comparable to high-density fiberglass batts, and more effective than batts at controlling air leakage and convective and radiant heat. Cellulose can have high recycled content, very low embodied energy, and low/no-toxicity fire retardants.
SPRAY FOAM (low density)	Icynene™ Soy Cementitious foam (Aircrete) Polyurethane Foam (closed-cell)*	Moderate to High	Good for adding insulation to existing finished areas, irregularly shaped areas, and around obstructions.
BLANKET (batts & rolls)	Mineral wool (rock or slag)**	Low	Suited for standard stud and joist spacing, which is relatively free from obstructions.
	Cotton	Low	Suited for standard stud and joist spacing, which is relatively free from obstructions; low- or no-toxicity fire retardant.
	Cellulose	Low	Can have high recycled content, very low embodied energy, and low- or no-toxicity fire retardants.
	Fiberglass (formaldehyde-free recycled content)	Low	Does not provide the degree of air seal that blown cellulose does.

Source: Based on DOE EERE EnergySavers.gov

Determining the right insulation and where to apply it can be a difficult decision. The guide provides a brief overview of the options and where they are best suited. Courtesy of the US Department of Energy.

Windows and Doors

Windows and doors on many older buildings are important aspects of the architectural character. The design, craftsmanship/workmanship, and other qualities may make them worthy of preservation and, with some minor upgrading, can provide energy efficiency. As with all building materials, proper and cyclical maintenance are necessary. Consider repairing and improving before replacing, which sends most historic building features to the landfill.

Windows

Windows should be considered significant to a building if they are original, reflect the original design intent for the building, reflect period or regional styles or building practices, reflect changes to the building resulting from major periods or events, or are examples of exceptional craftsmanship or design. Once the evaluation of significance has been completed, it is possible to proceed with planning appropriate treatments, beginning with an investigation of the physical condition of the windows. Window repair and rehabilitation can range from routine maintenance, stabilization, or parts replacement. The best window repairs consider energy efficiency with appropriate weather stripping to reduce air infiltration.

- **Weather stripping is available in many different forms and styles. Some are applied seasonally while others are permanent. For more information on the pros and cons of the varying types of weather stripping, visit [The Department of Energy's website](#)**

Older wood windows require maintenance and can be infinitely repairable. Routine maintenance could include new weather stripping, reglazing where necessary, repainting (including removing excess and peeling/flaking paint), frame repairs, reinstallation of the sash, repositioning of the sash weights, and new sash cords/chains.

- Learning just a few basics of window maintenance can prolong the life of windows.
- Most heat loss occurs around the perimeter of a window, through infiltration rather than through the actual glass. Keep seals tight and in good repair, checking sealant at all window muntins as well.
 - Insulating the weight pockets, where the sash cord/chains and weight are housed, will have little energy efficiency effect as these cavities were designed to be open.
- Keep exterior surfaces painted, including putty. Recommend using durable, low VOC (volatile organic compounds), exterior grade paints.
- Add weather stripping to your windows to increase its energy efficiency as much as 50%.
- Check the window lock, an important element ensuring that the rails and sashes are held together tightly to reduce air infiltration.
- If glass in older windows needs to be replaced, consider Low-E glazing that reduces heat transfer and can be more energy efficient than regular glazing. It also helps with reduce the damaging effects of sunlight on fabrics.
- Window stops, wood on the sides of the jamb that abut the lower sash held in place by screws and washers, are intended to be moved in or out to allow the sash to move freely or to form a tight seal against the parting bead. In the winter, push the stop tightly against the sash to air seal the window.
- Draft blockers, window snakes, and curtains/blinds are a cheap way to limit air leaks and drafts.
- Always practice lead safety when working with older windows or painted materials.



Original character-defining windows and doors. Courtesy of the Vermont Division for Historic Preservation.

http://www.leadSAFEvermont.org/download/Field_Guide.pdf

For a step-by-step guide to window repairs:

- <https://www.nps.gov/tps/how-to-preserve/briefs/9-wooden-windows.htm>
- <https://www.popularmechanics.com/home/interior-projects/how-to/a8043/how-to-reglaze-a-window/>.
- <https://thecraftsmanblog.com/how-to-restore-old-windows/>

Storm Windows

Storm windows create dead air space between the window and storm, which improves energy efficiency by reducing air flow through the window glass and around the window frame. Moreover, storm windows provide protection for older and historic windows. When properly installed, storm windows on the exterior or interior of single-pane windows can last longer and be just as energy efficient as double-pane replacement windows. Storm windows can come in a variety of types, styles, materials, colors, and prices.

- Custom wood storm windows with weather stripping provide increased protection and are in keeping with the historic character of 19th-century buildings.
- High-quality metal storms designed with low profiles and clean lines for better aesthetics.
- Multi-track storm windows can provide more benefits in the long run with energy cost savings, noise reduction, control of dust/allergens, and provide a level of security.
- Interior storm windows need to be monitored at the start of winter for trapped humidity.

For a guide to installing storm windows:

- <https://www.energy.gov/energysaver/services/do-it-yourself-energy-savings-projects/savings-project-install-exterior-storm>
- <https://www.encyvermont.com/tips-tools/guides/how-to-choose-and-install-storm-windows>

Doors

Older doors should be treated similarly to windows, attended to with cyclical maintenance plans and storm doors to ensure longevity and energy efficiency.

- Wood stops on door jambs should be adjusted to properly sit against door.
- Install or replace existing weather stripping to form an airtight seal.
- Adjust striker plate and tab/tang to ensure a solid close.
- Add a sweep at the bottom of door to decrease draft.

Appliances and Technology

Upgrading to energy efficient appliances and heating units is an effective way to lower energy usage and maintain occupant comfort.

- Before spending money to insulate, first consider investing in an efficient heating unit or water heater.
- Smart technology like thermostats and lighting can help monitor and lower energy usage.
- Install water-saving fixtures that lower energy and water usages.
- Replace florescent light bulbs with LED bulbs.

For appliance and technology options, explore Efficiency Vermont:

- <https://www.encyvermont.com/products-technologies/smart-homes>
- <https://www.encyvermont.com/products-technologies/heating-cooling-ventilation>

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HOMEOWNER DIY ENERGY EFFICIENCY CHECKLIST

Date: _____

Air Sealing-Caulk

- Door and Window Trim-Interior
- Door and Window Trim-Exterior
- Utility Penetrations (gas, electric, cable, etc.)
- Outdoor Faucets and Sillcocks
- Soffit Trim
- Seam of Sill and Foundation

Air Sealing-Other

- Foam Pad on Electrical Outlets behind Plates
- Repointing Small Holes in Foundation
- Gaps in Attic
- Closed Fireplace Damper when Not in Use/Cover Chimney if Not in Use

Windows and Doors

- Applied Weather Stripping and/or Sweeps
- Tightened Window Stops
- Made Window Hardware Operational
- Installed Storm Windows Tightly with Weather Stripping
- Reglazed Windows or Door Glazing

Insulation

- Installed Insulation in Unfinished Attic or Crawlspace
- Insulated Rim-Joist in Basement

Appliances and Technology

- Installed Energy Efficient LED Bulbs, Smart Thermostat, and Appliances
- Upgraded Heating Unit or Water Heater

Safety and Preservation Considerations

- Identified the Style, Age, and Condition of Building
- Conducted Energy Audit of Building
- Utilized Inherently Efficient Building Features (shutters, storm windows, shade trees, etc.)
- Ensured Roof or Soffit Vents are Not Sealed
- Contacted Certified Professional Before Insulating Building
- Explored Alternatives to Application of Damaging Products to Existing Materials
- Contacted Certified Professional Before Applying Vapor Retarder or Waterproof Shield