Energy Advice for Owners of Historic and Older Homes

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Energy Advice for Historic and Older Homes

INTRODUCTION

Do you live in a historic home? Are you wondering how to lower your energy bills without losing features that give your house its character? Concerned about how your decisions might affect the long-term maintenance or condition of your home? Then this guide is for you! It is meant to be a homeowner's first step in mapping out a plan for how to be a good steward of both your historic home and the planet. This guide will be most helpful to people who are living in their house while making improvements, and is not necessarily appropriate for a home that is undergoing a substantial renovation.

Older homes like this one have a lot of character. Its wood windows with multiple glass panes, door hood, decorative window moldings, barge board, and other trim contribute to its charm. These don't need to be sacrificed to make your home more comfortable and energy efficient.
Photo: Adrian Scott Fine

This guide is designed to help you make decisions about how to increase your home's energy performance in a way that maximizes energy savings while preserving the historic character of your home. The more you know the better choices you'll make and the more money you'll save in the long run. While this guide is a great place to start, there are many options to learn more and these will be referenced along the way and at the end of the guide.

As you read through this guide, you may notice that many of these recommendations will work for a home of almost any age. With a little bit of planning, weatherizing your historic home is not much different than making improvements to any other building.

What's Special about Older Homes?

Why do historic and older homes need special consideration? One reason is that historic and older homes were constructed using different techniques and materials than most modern structures. For example, if your home dates to the 1850s or earlier and its frame is made of wood, there is a good chance that is has post and beam construction rather than balloon framing. This is an important consideration if you're thinking about adding insulation in the walls (more on this later).

One key difference between historic homes and their modern counterparts is the way in which historic buildings regulate temperature and moisture levels. For example, most historic buildings were not constructed with any or much insulation or with many mechanical devices. Some construction techniques, however, did provide some insulating properties. Thick masonry walls offered some insulation and the high thermal mass helped to regulate temperatures throughout the day. But for the most part, the concern of the occupants was for some reasonable thermal comfort in terms of heating in cold weather and ventilation and protection from the sun in warm weather. People naturally adjusted their clothing and activities to fit the weather. They did not have the expectation of precisely-controlled temperature and humidity. They lived within the natural environment with the shelter and technologies available to them.

Traditional homes were often built with environmentally-friendly features such as thick walls, light-reflecting finishes, wide eaves for shade, porches, operable windows, and locally-sourced materials. Functional shutters, vents, and awnings are also commonly found energy-savers.
Photo: Adrian Scott Fine

Without modern vapor barriers and insulation, air and moisture in the house moved more easily between inside and outside. Adding insulation to the wall cavities without understanding how the house functions as a system and without establishing new ways to circulate air through the home can cause moisture to accumulate. High moisture levels can result in mold and rot, creating serious problems for the home-owner as well as unnecessary expense. This does not mean that older homes cannot be made more energy efficient. They can. They simply need to be treated with a thoughtful, whole-house approach.

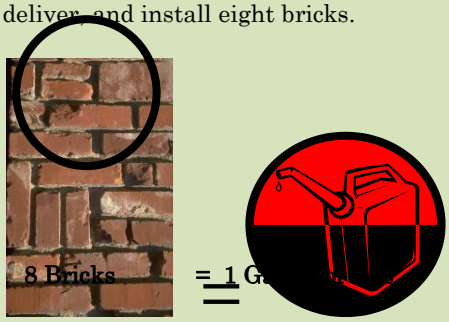
As the owner of an older or historic home, you can feel good about living in a building that has served well for 50, 100, or 200 years or more.

MAXIMIMIZE YOUR HOME'S ORIGINAL ENERGY SAVING FEATURES

Historic homes have many inherently sustainable features. Out of sheer necessity, historic houses were typically designed to be compatible with their environments. Before the middle of the twentieth century, most homeowners couldn't rely on comprehensive and fully automated, controlled, mechanized heating, cooling and ventilation systems, because they did not yet exist. Instead, these buildings incorporated a number of passive or manual features that responded to the need for heating, cooling, and ventilation. For example, trees were strategically planted to provide summer shade and windows had functional interior and/or exterior shutters to adjust solar heat gain.

WHAT IS EMBODIED ENERGY?

Embodied energy is the amount of energy, measured in BTU (British Thermal Units), represented by the production, delivery and installation of materials in a building. The BTUs are often expressed in equivalent gallons of gasoline. The energy equivalent of one gallon of gasoline is required to make, deliver, and install eight bricks.



A building's embodied energy is the energy used in its production and, eventually, demolition. This includes the energy required to extract, process, manufacture, transport, and assemble materials, as well as the energy required for related equipment, services, and administration. Materials associated with high embodied energy include aluminum, copper, plastics, and glass. Those with relatively low embodied energy include wood, gypsum, fiberglass, and stone.

When the decision is being made to demolish a building, replace historic windows, or gut a building's interior, not only do you lose the historic materials, but you are literally throwing away a significant amount of energy. This can add up very quickly. A typical brick house represents an average of 24,000 gallons of gasoline in just the building envelope alone.

Historically, in warm climates, buildings were often built to minimize the heat gain from the summer sun by introducing exterior balconies, porches, wide roof overhangs, awnings, and shade trees. Vents and shutters let air circulate while keeping out the hot sun. Exterior walls were also frequently painted with light colors in order to reflect the sun, helping to keep interior temperatures lower. On the inside, high ceilings allow hot air to rise and transom windows above doors promote air circulation. In the southeast where it is often hot and humid, homes were elevated off the ground and built with large porches and high ceilings to allow for air circulation and shade. In the northeast, positioning a saltbox-style house so that the long slope of the roof directed the cold north wind up and over the house helped keep the house warmer in winter. Likewise, grouping the house and outbuildings in an L or U-shape created a sheltered dooryard in which to work. In areas where the winter is cold, chimneys typically run through the center of the house to allow the heat to radiate into the rooms. In warm climates, chimneys are more commonly found on the outside walls. Thick masonry or adobe walls work in both warm and cooler climates. The walls provide thermal mass to absorb the sun's energy during the day and transfer it very slowly to the interior. This helps keep the interior cool during the day and warmer in the evening as the heat works its way through the walls.

Other regional variations are common. Take a look around your neighborhood or town to get a sense of the character of your local area. While features such as these were merely considered practical upon their construction, they are green by today's standards. Although these features are not present in all historic homes, most older houses incorporate at least one of these passive or manual systems, helping reduce the need for mechanized heating, cooling and ventilation. The good news is that owners of older and historic homes can continue to use these practical features as they were originally intended, or rediscover them, making use of their great energy-saving potential. For example, simply

closing the shutters on the hot sunny side of the house will keep the house cooler. For free air conditioning when the humidity is not high, open the windows and/or doors on the lower level of the cooler side of the house and then open the upper sash of the windows or an attic window to exhaust the warmer air at a higher level of the house. This creates a cooling, whole-house draft.

Using—or even restoring—these features as part of your efforts to go green can preserve the character of your home, *and* reduce your energy usage. If you're interested in learning more about traditional construction and regional differences, you might enjoy books such as A Field Guide to American Houses by Virginia and Lee McAlester, James Garvin's A Building History of Northern New England, or The Visual Dictionary of American Domestic Architecture by Rachel Carley. Videos such as *Buildings For All Seasons: Energy Conservation in Historic Structures*, produced by the Georgia Historic Preservation Division and Georgia Public Television, walk the viewer through common energy saving features of historic homes, businesses, and civic buildings. The National Park Service website has some online interactive guides such as "Walk Through Historic Buildings" and the National Trust for Historic Preservation's Weatherization page also has additional examples.

IMPROVE YOUR HOME'S ENERGY EFFICIENCY

Start with an Energy Audit

Energy audits provide the best way to identify air leaks in your home. While some utilities and local governments offer free energy audits, it may be worth the expense of hiring a professional energy auditor to do a comprehensive assessment. When done by a certified auditor, the comprehensive energy audit will go beyond identifying obvious energy upgrades. The auditor will create a roadmap of where and how best to make improvements in your home. This is even more critical with historic homes because air sealing can dramatically alter how moisture moves through the structure. Choose a company whose employees understand older buildings. Also look for companies that are not interested in also selling a product—such as new windows or an HVAC system. Although the audit might reveal these upgrades are warranted, product-centered companies are in the business of selling their products first. Your auditor's only interest in your home should be the energy audit. A typical audit will take about two or three hours and may cost several hundred dollars depending on the complexity of your home. This is usually money well spent, especially with more challenging homes that will require a systems approach in making upgrades. It is also a great way to learn about your house. The company will likely recommend that you collect some information in advance to share with the auditor, typically including the last twelve months of your utility bills.

*To read interviews with energy auditors and **learn more about how an energy audit is done**, visit the National Trust for Historic Preservation's Weatherization page. For advice on how to select a professional audit company, see the Department of Energy's guidance on the Energy Saver's website.*

Two types of tests are commonly done during an energy audit, a blower door test and infrared imaging. The first, known as the blower door test, uses a strong fan being placed in an exterior doorway to depressurize the house and identify air leaks. Air leaks also can be found by using an infrared temperature sensor to detect changes in temperature near suspected leaking areas. [1]

Reducing air infiltration is one of the least intrusive, most reversible, and most cost effective retrofit strategies. *For more information on weatherizing, see the Department of Energy's online guide, Weatherize Your Home—Caulk and Weather Strip. For more on how air, moisture and vapor move through buildings, how your actions might change this, and how to avoid potential pitfalls, books such as George Nash's Renovating Old Houses is a good reference.*

Or, for a low-tech test, on a windy day use the smoke from burning incense to identify moving air from cracks and crevices by holding the incense near suspected leaks. If there is a leak, the smoke should be drawn toward it.[2] Or, you can simply use your hand and feel where the air is moving. The Energy Savers website has additional advice.

Even if you do your own basic energy audit, it's important to establish a baseline for your energy usage so that you know if the changes you make are effective, and to calculate your payback analysis. You can establish a benchmark for your energy usage by collecting your energy bills for the last twelve months (or longer if available). If you hire an energy auditor, this should be part of their analysis. For more on how to calculate a benchmark for your home's energy efficiency, see the worksheet at the end of this booklet.

Air Seal

Looking for just one thing you can do to improve your home's energy efficiency? Significantly reduce air infiltration. Gaps or cracks in a building's exterior envelope of foundation, walls, roof, doors, windows, and especially "holes" in the attic floor can contribute to energy costs by allowing conditioned air to leak outside.[3] Think small cracks don't matter? A gap of just 1/8 of an inch under a 36-inch door lets in as much air as having a 2.4 inch wide hole in the wall.[4] Furthermore, since people often adjust the thermostat and leave heat running longer when they feel a draft, preventing air infiltration can greatly reduce energy usage.[5] Remember that for every cubic foot of heated or cooled air (that you have paid to condition) that leaves your house, one cubic foot of outside air enters! Sealing up those cracks will make you feel comfortable and keep more money in your pocket. The Department of Energy estimates that you can save more than ten percent on your energy bills just by eliminating drafts using simple and cost effective techniques of caulking and weather stripping.[6] Additionally, the barrier created by caulking and weather stripping can prevent the intrusion of dust, moisture and even noise, making a building more habitable for its occupants.[7]

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[1] *Making Your Historic Home Energy Efficient: Volume 1, Principles and Approaches*, Office of Environmental Affairs, City of Boulder, 2007.
[2] Lord, N. "Co-Existing with Energy Efficiency," *Old House Journal*, October 2007.
[3] Air Infiltration National Park Service. http://www.nps.gov/history/hps/tps/weather/air_infiltration.html
[4] Koncius, Jura, "I need an Energy Audit, Stat!," *Washington Post*, January 22, 2009.
[5] English Heritage. *Energy Conservation in Traditional Buildings* (2008), p. 6. http://www.climatechangeandyourhome.org.uk/live/content_pdfs/94.pdf
[6] Lord, N. "Embracing Energy Efficiency," *Old House Journal*, October 2007.
[7] English Heritage. *Energy Conservation in Traditional Buildings* (2008), p. 6.

Most Common Sources of Air Infiltration

The most common sources of air infiltration in the average home are:[8]

- Bypasses (attic access door, recessed lighting, plumbing stacks, dropped soffits, open frame construction, duct penetrations, electrical penetrations, *etc.*) in the attic floor regardless of the presence of insulation, which by itself is not an air barrier. If you see dirty insulation, air is getting through.
- Between foundation and rim joist
- Crawl spaces
- Around the attic hatch
- Between the chimney and drywall
- Chimney flue
- Electrical and gas service entrances
- Cable TV and phone line service entrances
- Window AC units
- Mail chutes
- Electric outlets
- Outdoor water faucets entrances
- Where dryer vents pass through walls
- Under the garage door
- Around door and window frames
- Cracks in bricks, siding, stucco and the foundation
- Mudrooms or breezeways adjacent to garages

The Department of Energy estimates that just ***by reducing air leaks in your home, you can save 10% on heating and cooling bills****. The savings can be much higher—as much as 30% of conditioned air may be escaping through cracks, holes, and gaps. All that air movement costs you money and makes your home more uncomfortable.*

Sealing the Leaks

Once you know where the air is coming in, the good news is that you can probably seal the leaks yourself. The Environmental Protection Agency's *Energy Star* website has a Do-It-Yourself Guide to Sealing and Insulating with ENERGY STAR on how to do your own air sealing.[9] Some public utilities also have programs that can provide assistance and incentives for air sealing, so make sure you look into that option. For example, Mass Save in Massachusetts and New Jersey's Clean Energy Program offer free air sealing or offer credits of up to $1,000 in services. Attic air sealing and proper insulation is also the corrective action to stop ice dams.

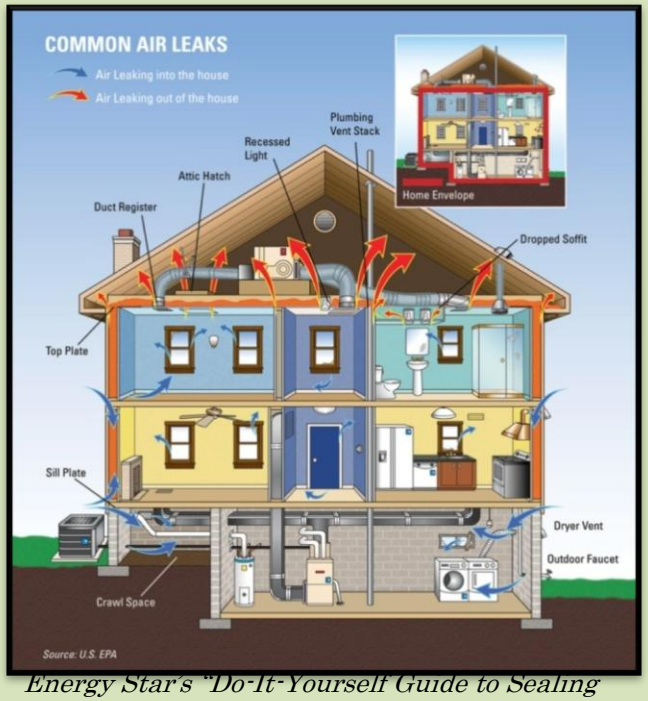
Drafts can also be reduced by simple measures such as:

- Closing curtains, blinds, shades, or shutters at night in cold weather.
- Use draft "snakes" at doors (or simply a rolled towel).
- Close fireplace damper and/or use an inflatable device that fills the flue opening (sold under a variety of names) when fireplace is not being used in winter.

[8] US Department of Energy, "*Energy Savers*," www.energysavers.gov/your_home/insulation_airsealing/index.cfm/mytopic=11250

[9] US Department of Energy, Energy Star, "*A Do-It-Yourself Guide to Sealing and Insulating with ENERGY STAR*" www.energystar.gov/index.cfm?c=diy.diy_index

Simple improvements to reduce air infiltration include caulking loose window and door frames where they join walls, sealing where the foundation meets the sill, and sealing cracks in masonry and foundations.[10] Other areas to target are where services such as electrical, plumbing, television cables, and phone lines enter a building.[11] On the interior, you can seal where the baseboard meets the floor, around window and door casings, where the ceiling meets the walls, and where plumbing goes through walls.



Energy Star's "Do-It-Yourself Guide to Sealing and Insulating With Energy Star" booklet provides practical information on where air leaks commonly occur and how you can help eliminate them. See the Energy Star webpage for more information and to download the booklet.
Image courtesy of Energy Star, EPA

There are many different types of caulks and sealants available, including latex, synthetic rubber, silicone, modified-silicone polymers, and acrylic co-polymers. There are also specialty caulks for specific materials, so make sure to match the caulk to the application and material(s) to which it is being applied. A paintable, flexible caulk works well for most applications. For temporary interior installations such as around window sash, "rope caulk" (often known as Mortite®) is inexpensive, works well, and it can be easily removed. Make sure the surfaces are clean and dry and use the highest quality caulk you can afford as it will last longer.[12] For wide gaps (greater than about 3/8"), fill the gap first with a foam backer rod before caulking. Your local hardware store should carry these backer rods in the same aisle as their other weather stripping or air sealing products. An added advantage to sealing from the exterior is that it will also reduce water infiltration, which in turn will prolong the life of the building materials and reduce the possibility of other problems with mold and/or insects.

Quick Reference Chart to Curbing Air Infiltration

Source of Air Infiltration	Solution
Attic hatch	Insulate the hatch opening. There are many DIY plans for this. See Energy Savers, Mother Nature Network, or the Old House Journal for ideas.

[10] Air Infiltration National Park Service.
[11] *Weatherize Your Home: Caulk and Weather Strip*, Energy Efficiency and Renewable Energy, US Department of Energy, June 2004.
[12] See articles such as "Making Sense of Caulks & Sealants" by Brian Pontolilo in *Fine Homebuilding*, April/May 2004, pp 97-101. Available at www.finehomebuilding.com/PDF/Free/021162097.pdf.

Source of Air Infiltration	Solution
	Companies also sell several styles of pre-made insulating attic hatch covers.
Attic floor	Air seal any penetrations (wiring, plumbing, etc), and insulate between the joists. Follow manufacturer's instructions when insulating around pot lights and chimney stacks.
Cable TV and phone line service entrances	Caulk around service line entry
Air conditioner units	If wall mounted, caulk around the opening and use a winter cover. If it is an in-window unit, remove during seasons when it's not needed. When in use, use insulating panels and caulk to seal around the AC unit if it does not fill the entire opening.
Outdoor water faucets	Caulk around pipe where it meets the wall.
Dryer vents passing through walls	Install a vent cover that closes when dryer is not in use.
Vents and fan openings	Cover vents and opening when not in use.
Cracks in bricks, siding, stucco, or foundation	Use appropriate caulk for the material. Your local hardware store staff can help you find the right kind. Do not caulk the underside of siding or stucco. This area needs to remain open to allow moisture to escape.
Between chimney and siding	Caulk
Electric outlets	Use foam gasket behind outlet cover. These are available from your local hardware store and are made of fire-retardant foam.
Recessed lights	Call a professional to insulate these safely. Lights that are not rated for being in contact with insulation pose a serious fire risk if insulated. See this Energy Star Guide for more details.
Chimney flue	Close the damper when the fireplace is not in use. If you don't have a damper, have one installed. You can also use glass doors or an inflatable device to stop air from going up your chimney.
Around windows	Caulk around the window frame on the exterior and the interior; make sure the sash lock is functional and draws the sash tight; use a storm window or even removable plastic film. For more on windows, see the windows section below.

Source of Air Infiltration	Solution
Between foundation and sill	Use an appropriate caulk or expandable foam.

Don't Make Your Home Too Air Tight

While energy can be saved by reducing the amount of air infiltration, it is important not to seal a historic home entirely, as historic buildings were designed to "breathe." The goal is to find a good balance. Without some air movement, these structures can develop problems associated with moisture accumulation including wood deterioration, mold growth and insect infestations.

Need help with your radiators? *Search for articles on old house websites such as the Old House Journal or books such as Dan Holohan's Greening Steam: How to Bring 19th Century Heating Systems into the 21st Century (and save lots of green!) available through www.heatinghelp.com.*

In warm, humid climates, historic homes were often constructed with vented crawl spaces beneath the first floor. This space allowed air to circulate and reduce moisture in this area. When air sealing your home, it is important to allow for this air circulation. If not, moisture can accumulate which will attract insects and will cause or accelerate the deterioration of wood components. Even in colder climates, it is important to promote air circulation and/or reduce moisture levels in crawl spaces and cellars with dirt floors, especially in the summer months. In basements and crawl spaces with earthen floors, installing a polyethylene vapor barrier and securing it to the foundation walls will also reduce the amount of vapor and moisture moving through your house. See the National Park Service's *Preservation Brief 39*, *Holding the Line, Controlling Unwanted Moisture in Historic Buildings*, for more information.

In addition, if your heating, cooking, water heating, or other appliances have a pilot light, it is imperative that they are properly supplied with air and are vented correctly. Your utility, appliance, or energy audit professional can help make sure your appliances are in good operating condition.

Relatively simple actions such as using a range hood when cooking and a bathroom vent when bathing can also help reduce moisture build up in your home. Several companies manufacture bathroom fans that operate automatically based on the ambient moisture levels.

HEATING, COOLING, AND VENTILATION SYSTEMS

The sources of heat, cooling, and ventilation in older and historic houses changed as the technology advanced. Early heating was with wood-burning fireplaces, although sometimes other fuel was used depending on geography. Later, coal was used in fireplaces. Cast iron stoves either inset into fireplaces or freestanding and burning wood or coal were used at a later stage; hot air furnaces with

either one large floor grate, and later ducted systems, arrived in the late 19th century. Steam or hot water radiators fed by a boiler were another advance.

Air conditioning as a mechanical solution did not advance into residential use until the mid-twentieth century. Previously, ventilation was achieved primarily by manipulating windows, doors, and vents. As discussed earlier, occupants relied on more passive and manual temperature-regulating features such as operable windows, interior and/or exterior shutters, vents, porches, wide eaves, awnings, thick walls, or siting to block cold winds or to take advantage of the sun or shading. These elements allowed the occupants of a historic home to moderate temperature without using an HVAC system.

Similar to other energy efficiency improvement strategies for your home, there is no one-size-fits-all solution for upgrading mechanical systems in your older or historic home. Instead, a more holistic approach is recommended. One that is specific to your home or building, its use, and the needs of its occupants. Considering a combination of systems might also be the best solution. It might be necessary to think of your home as a collection of several systems working together, rather than a single system designed to maintain comfortable temperatures. For example, it doesn't make any sense to upgrade your HVAC system if you haven't already done a comprehensive job of air sealing and adding insulation—these will reduce the heating load and allow for a smaller, less costly new system. Older homes with hydronic (radiator) heating typically have had to rely on window AC units for cooling. Today there are new options for cooling that do not require ductwork—these systems are called ductless mini-splits. These ductless mini splits can also provide heat via heat pump options.

Low-Cost or No-Cost Behavioral and Operational Energy-Saving Steps

The way a building is used, in conjunction with the inherent qualities of its materials and construction, play a large part in its energy efficiency. Taking advantage of these qualities and thinking about how the home is used are the first changes to improve energy performance. There are a number of measures you can take that cost little but will have a big payback.

- Lower the thermostat in the winter, raise it in the summer, and use a programmable thermostat to modify temperatures on occupancy patterns.
- Control the temperature in rooms that are used and establish climate zones throughout the building with separate controls so that unused rooms are not actively conditioned.
- Reduce the number of lights used, maximize natural light, and switch light bulbs to energy–saving fluorescent bulbs.

BUILDING ENERGY CODES

Energy codes set minimum requirements for energy efficiency for new construction as well as for major renovations of existing buildings. Building energy codes are adopted by states and/or individual communities. Typically either the International Energy Conservation Code (IECC) or the ANSI/ASHRAE/IESNA Standard 90.1 is chosen. Many communities have begun implementing additional programs, of which the stretch code is the most common. The name varies, but the purpose is similar: go beyond the baseline energy efficiency requirements to achieve increased building energy efficiency. For example, a city that uses the IECC could require that new construction comply with 10% above the current IECC energy efficiency goals.

There are two important things to remember: codes vary by state and sometimes by community, and in almost all cases, historic buildings are exempt from meeting the new energy efficiency requirements. Even so, home owners will typically be told they need to buy a new item or change something to "meet code." There are likely things you can, and should, do, but you may be exempt from meeting the same standards as new construction. Before you assume that is correct, it pays to do your homework first.

For more on energy codes, including a state-by-state summary of energy codes, see the information and resources available on the US Department of Energy's Building Energy Codes Program website: www.energycodes.gov.

- Use operable windows, shutters, awnings, and vents as originally intended to moderate the interior temperature.
- Clean radiators and forced air registers to ensure proper operation.
- Have your furnace and boiler cleaned and serviced at least once a year.
- Make sure the furnace filter is clean. Often, you can clean and/or replace the filter yourself.
- Make sure ducts and pipes are sealed and well insulated.
- Offset the use of electricity with the purchase of renewable energy (such as wind energy) through your local energy provider. For example, Pennsylvania's energy provider has a program that allows customers to pay an additional fee (as low as $3.00 a month) to help fund wind farms. In turn, this increases the amount of wind energy delivered to the electrical grid while reducing the need for energy from other sources.
- Monitor occupant behavior with regard to energy and modify if necessary. Simple things like turning off lights when leaving a room saves energy and money that can be invested in other energy-saving upgrades.

Advanced Energy Saving Measures

Once the homeowner has made all of the low-cost, no-cost, and low-impact changes, it may be time to make more substantial upgrades. These measures require more thought and planning and usually, more up-front expense. If you have not already had an energy audit done, that should be the first step. You may also want to consider working with a preservation professional or a contractor with experience working with historic buildings. Contact your local or state non-profit preservation organization, your state historic preservation office, local historic commission, or other trusted old-house friendly people to locate an appropriate person or company. Many of the above-mentioned organizations and agencies maintain directories of old-house friendly contractors. Lists of many of

these organizations can be found by going to www.preservationnation.org/.

From a heating standpoint, one of the simplest and most cost-effective options may be to replace your furnace with the highest-efficiency unit you can afford. Particularly if your existing furnace performs at less than 80% efficiency, it might be time for a new high-efficiency unit. The Energy Star website provides guidance on how to select an energy efficient system. The same theory can be applied to the cooling system.

Geothermal heat pumps, also known as ground source heat pumps, might also be an option to reduce heating and cooling costs. Geothermal systems can typically be installed with minimal damage to historic fabric (provided that the house has an existing ducted system) and reduce both heating and cooling loads. An increasing number of people are finding it cost effective to install these systems, although as with any major system investment, it is important to calculate all the associated costs in advance to determine if investing in geothermal is warranted. A property may also need to be evaluated for possible archaeological resources or for important historic landscapes before the heat exchange system is installed. Check with your state historic preservation office to see what you may need to do.

into historic properties. When selecting a location, consider mounting them on a non-historic addition, a secondary façade, rear ell, an outbuilding or garage, or a use a free-standing ground-mounted unit. The goal is to preserve historic character by placing the panel in the least conspicuous location and minimizing the view of the array from the public right of way.
Photo: Chris Skelly

Using a whole-house approach will save trouble and money in the long run. For example, it doesn't make any sense to upgrade your HVAC system if you haven't done a comprehensive job of air sealing.

Hot Water Heaters and Going Solar

The hot water heater is an energy intensive system in most homes. According to the Department of Energy, heating water is responsible for about 13% of your utility bill and is the third largest energy expense.

Two low-cost actions to take are to insulate the unit and the hot water pipes, and to simply turn the thermostat down to 120°F. You will save 3-5% of your energy costs for every 10°F you reduce the water temperature of the tank.

With some additional investment, a next step would be to consider a tankless hot water system, often known as an "on-demand" system. Rather than pay to keep many gallons of water hot all the time, these tankless systems allow you to heat only as much water as you need when you need it. A second option for hot water heaters is to consider a solar hot water heater. These systems work in any climate and can be a cost-effective way to manage domestic hot water expenses—especially if water is heated by electricity and there are teenagers in the house! Typically, they can produce 65-

85% of domestic hot water needs with just the power of the sun. For more on this option, see the Department of Energy's *Energy Savers* webpage at www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12850.

In several areas of the country, the cost of installing these systems is reduced through co-ops, which have adapted the traditional "barn raising" model. Co-Op Power (www.cooppower.coop/index.php/home) and Solar Raisers (www.arlingtonenvironment.org/solar.htm) are two examples of this model. Typically, you help a team of professionals and other homeowners install the hot water system at your house. You also agree to help out at a set number of other homes. In this way, the labor costs are kept down and the systems pay for themselves more quickly.

Solar panels for domestic electricity may be another way to reduce your energy bills and reliance on fossil fuels. Increasingly, solar installations are more accepted in historic districts. For additional guidance on solar panels and historic buildings, see the National Trust for Historic Preservation's webpage on Solar Panels and Clean Air Cool Planet's booklet, "Energy Efficiency, Renewable Energy and Historic Preservation: A Guide for Historic District Commissions" available as a PDF on their website.

INSULATION

If you live in a historic house, you may find everything from corn cobs to newspaper to bricks in the walls for insulation. Fortunately, today there are higher performing options. If installed properly, the addition of insulation can reduce energy costs by as much as 50% in some cases[13] and make your house more comfortable. Simply adding insulation to the attic is one of the most cost-effective and energy efficient steps you can take. Yet always be sure to air seal the bypasses first. Not sure where these are? Dirty insulation is the tip off—where you see dirty insulation, air is passing through and the insulation is serving as an (unintended) air filter.

This section is not intended to answer every insulation question you have as there are already good sources of information on this topic. For example, see Energy Star's Air Seal and Insulate booklet, search online articles in the Old House Journal[14], the National Park Service's Weatherization page, or the book Renovating Old Houses by George Nash. Instead, the goal of this segment is to help you evaluate the wealth of insulation information with an eye towards the most preservation-friendly solution(s) and the best payback.

Because insulation may not have been included in your home originally, introducing insulation should be done carefully and with particular attention to ventilation.[15] If insulation is installed without appropriate ventilation and vapor barriers, insulation can become damp, causing it to lose its effectiveness at preventing heat loss. A vapor barrier is not a panacea however. One of the worst case scenarios is that the vapor barrier is installed in a way that causes vapor to condense inside the wall. Accumulated moisture causes decay by opening homes to a variety of problems including

[13] Lord, Noelle. "Co-Existing with Energy Efficiency." *Old House Journal*, October 2007.
[14] For example, the following two articles provide practical "how-to" information about insulating your historic house. Berry, Nancy E. "All Wrapped Up." *Old House Journal*, November/December 2004; Lord, Noelle. "Insulation from the Top." *Old House Journal*, March/April 2006.
[15] For example, fiberglass batt insulation was introduced by until 1938.

termites, rot, dry rot, and mold growth. [16],[17] The location of the vapor barrier depends on where you are installing the insulation and what type is being used. For guidance on this, see the Department of Energy's information on Moisture Control and Ventilation on the *Energy Savers* website.

Insulating a few key places in historic structures—attic spaces, crawl spaces, basements, around heating/cooling ducts, and around water pipes—provides the greatest benefit with the lowest risk of damage. How much insulation do you need? That depends on where you live and where you plan to install the insulation. Using your zip code and some basic information about your home, the calculator function on the Oak Ridge National Lab's website can help get you started.

There are many different types of insulation and the selection of what kind to use should take into account variables such as where it is being installed, budget, how moisture is being managed, and insulation goals. Although not always readily available, natural fibers such as sheep's wool, hemp, denim and even recycled paper provide good thermal efficiency. More common materials such as fiberglass, rigid foam board, and spray foam products are much more readily available.[18] Rock wool or mineral wool is made from waste products of iron manufacturing and in addition to being a good insulating material, it provides acoustical soundproofing, and is fireproof.

Both closed-cell (polyisocyanurate and polyurethane) and open-cell (policynene) spray foam insulation may not be appropriate for some buildings at all, and not in all applications as the foam has been known to cause wood decay because of their strong tendency to block the movement of moisture.[19] It also expands as it cures, which can cause damage to surrounding materials. Spray foam is also not easily reversible. If spray foam is going to be used, open-cell foams may be the better option as they allow water vapor to move more readily, thus reducing the possibility of trapped moisture.

Attic Spaces

According to ENERGY STAR, the most significant source of heat loss is through air infiltration and un-insulated or under-insulated attic floors and the basement[20], so insulating these areas is a priority.[21] With little expense and effort, attic insulation can provide dramatic energy use reductions.

Unfinished Attics

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[16] National Park Service, Weatherizing and Improving the Energy Efficiency of Historic Buildings, Install Insulation.
[17] National Park Service, *Preservation Brief 39,* "Holding the Line: Controlling Unwanted Moisture in Historic Buildings," Sharon Park, AIA.; Yapp, B., "Myths about Insulating Old House Walls," *About Your House* blog posting.
[18] English Heritage, *Energy Conservation in Traditional Buildings*, 2008, p. 4. www.climatechangeandyourhome.org.uk/live/content_pdfs/94.pdf
[19] Preservation Nation. Weatherization Tips & Strategies.
[20] Energy Star, "A Do-It-Yourself Guide to Sealing and Insulating with Energy Star." http://www.energystar.gov/ia/partners/publications/pubdocs/DIY_Guide_May_2008.pdf.
[21] Historic Scotland, Energy Efficiency in Traditional Homes.

In general, the easiest, most effective in terms of payback and energy savings, and least potentially harmful place for insulation in an attic space is below the floorboards. If present at all, these floorboards are usually laid loosely on top of floor joists, making insulation very simple to install. After checking for any gaps that need to be sealed, insulation can be laid between the joists.[22] Be sure to follow the manufacturer's instructions for insulating near chimneys, recessed (can) light fixtures, and wiring. Don't forget to insulate around the attic door or hatch. For more information on attic insulation, see Energy Star's Do-It-Yourself Guide to Sealing and Insulating and Seal and Insulate with Energy Star, and the *Old House Journal* article, "Insulation from the Top" (March/April 2006).[23]

Finished Attics

Even if your attic is finished and you don't have access to space under the floor or under the ceiling, you may still be able to access and air seal and insulate the kneewalls and adjoining unfinished spaces.

Crawl Spaces and Basements

Insulating crawl spaces and basements can provide great energy savings as well, but special considerations should be taken to prevent the collection of moisture, as these areas can easily become damp. Insulation can be added relatively easily to newer basement walls, while older historic basements with rugged walls made from dirt, brick, or fieldstone may be more difficult. Simply ensuring that the foundation walls are in good repair and not in need of repointing will reduce drafts. If the walls are not suitable for insulating, it is recommended that basement or crawl space insulation be installed on the basement ceiling or between the first floor joists, with the vapor barrier facing up.[24] Exposed piping and ductwork in these locations can also be wrapped in insulation to gain further savings and to protect them from freezing.[25]

Wall Insulation

The question about whether or not to insulate the walls is probably one of the most challenging technical questions in preservation today. Wall insulation can be problematic in historic structures as it is difficult to install properly due to the unpredictable nature of historic wall construction. There may be old knob and tube wiring in the wall which would present a fire hazard. Blocking, fire stops, or obsolete and forgotten chases will result in cold pockets. And anywhere the insulation does not or cannot reach, such as the junction between the exterior wall and the floor joists, can create thermal bridging. These cold pockets and thermal bridges set up areas were moisture will condense. (Imagine a cold glass on a hot day and the beads of water than form on the glass to understand this concept.) Any time you have moisture in the wall, the possibility of decay and mold increase. In addition, pumping in dense pack cellulose insulation in the walls can also cause the keys that attach plaster walls to the supporting lath to break, necessitating repairs.

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[22] Zimmerman, S., Energy Costs in an Old House: Balancing Preservation and Energy Efficiency, in Sustainable Preservation: Greening Existing Buildings, by Jean Carroon. 2010, John Wiley & Sons, Inc. 401 pp.

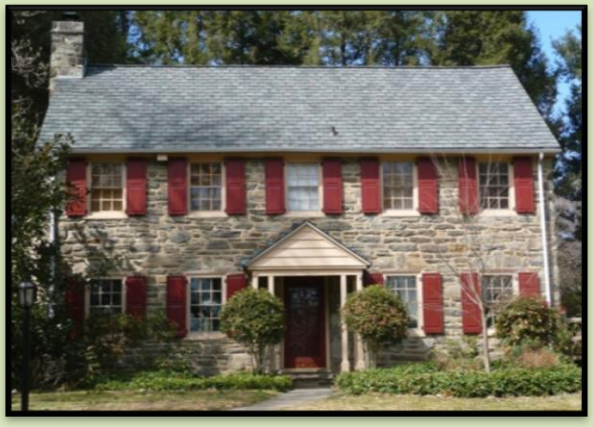
[23] Back issues of Old House Journals are available through www.oldhousejournal.com and through Google Books (http://books.google.com/books)

[24] Weatherization Tips & Strategies Preservation Nation.

[25] Forsyth, M. *Historic Building Conservation: Structures and Construction*, Blackwell Publishing, Oxford, 2007, p. 37.

Traditional construction in wood-framed wall systems generally includes a cavity to act as a thermal chamber, slowing the movement of heat through a wall. For masonry-walled structural systems, there may or may not be an internal cavity to provide a thermal break.

For those masonry structures without an internal cavity, some property owners have added insulation on the interior surface of the exterior masonry walls and have carefully relocated any decorative trimwork such as baseboards, door trim, and door and window casing to the new wall surface. It is important to save and reuse this historic trim to retain the historic character of the space. Adding insulation in this way will result in some loss of the overall floor area, but "furring" out the walls also provides an opportunity to install new electrical and other utility lines in this new space without having to dig into the historic masonry walls themselves. Owners must be careful, however, not to overly fur out walls and create a "shadow box" effect around windows or disrupt historic decorative finishes.



Windows give a building a great deal of character and provide clues to its history. Older windows are also made of high-quality, long-lasting materials. Although replacing them to improve energy efficiency is common, it is not necessary and is often not cost-effective.
Photo: Adrian Scott Fine

More importantly, the trouble and expense of insulating historic walls may not be the best bang for your buck. Once you have insulated your attic, air sealed, tuned up (or replaced your furnace), and completed some of the higher priority energy saving techniques, you might consider insulating your walls. But, by undertaking these other energy-saving measures first, you may find that your comfort level goes up and your energy expenses go down significantly without the need to insulate the walls.

Windows and Doors

Windows

Windows are often not given much thought, at least not until they start to feel drafty or need some maintenance. But they contribute a great deal to the look of your home, are important parts of your home's architectural history, and are often made from high-quality and valuable materials that are no longer available. In preservation language, they're called "character-defining features" of your historic home. In addition to adding to the visual appeal, wood windows built prior to about 1950 were constructed with individual parts, each of which can be repaired or replaced. This means that if a part gets damaged it can be repaired rather than having to purchase an entirely new window, which is inherently a greener option. The wood itself is likely to be valuable and now scarce old-growth wood, which is denser, more rot- and warp-resistant, and holds paint better than modern, plantation-grown wood. While historic windows have all of this going for them, they are often the first elements people look to change when trying to improve their home's energy efficiency. Fortunately, the decision to retain historic wood windows needn't get in the way of improving the efficiency of your home.

First, studies suggest that only about 10 to 15% of a home's energy is lost through its windows.[26] The U.S. Department of Energy reports that windows can be responsible for up to 25% of your heating bill.[27] For comparison, a hot water heater is typically responsible for about 13% of your utility expenses. Repairing older wood windows instead of replacing them can usually be done at a lower cost than replacing them, while achieving approximately the same level of energy efficiency. Even if an estimate to have your windows professionally repaired is in line with a new window, the end

Time for a Tune Up? Basic Window Maintenance

There are many good, practical books and magazine articles to guide a handy person in the basic maintenance of wood windows. Several publications are listed in the references section at the end of this tip sheet. To get you started, here are some of the keys to many years—and generations—of life with older wood windows.

Make Paint a Priority
Keep the exterior surfaces painted, including the glazing putty. Paint protects the wood and glazing putty from water and extends their service life. Be especially attentive to horizontal surfaces where water may collect.

Repair Sash Cord and Re-hang Weights
If your sashes are hung with cord, keep the rope free of paint. This will improve the window's operability. Cord will eventually dry out and break but can be replaced. When replacing the cord you can also re-hang the weights so that the sash will be balanced.

Eliminate Paint Build-up on Moveable Parts
Keep movable surfaces, such as the inside jamb and parting beads, free of paint build-up so that the sash can slide freely. You can apply a layer of paraffin or beeswax to the jamb or sash to make the sash move more easily.

Continued on page 19.

[26] Sedovic, W. and J.H. Gotthelf. "What Replacement Windows Can't Replace: The Real Cost of Removing Historic Windows." *APT Bulletin* Vol. 36, No. 4, 2005, p.27; Changeworks. "Energy Heritage: A guide to improving energy efficiency in traditional and historic homes." 2008. Available at www.changeworks.org.uk/projects/energy-heritage/579/; Government of Ireland, "Energy Efficiency in Traditional Buildings." 2010. Available at www.seai.ie/Grants/Better_energy_homes/contractor/Newsletter/Energy_Efficiency_in_Traditional_Buildings.pdf

[27] U.S. Department of Energy. "Energy Saver$: Tips on Saving Energy & Money at Home." Available at www.energysavers.gov/pdfs/energy_savers.pdf.

result will likely be a window that will last longer, therefore saving you money in the long run. Conserving your historic windows also can be far better for the environment. By repairing and weatherizing your existing windows, you are keeping their valuable material out of landfills and new materials are not required to manufacture new windows.

Many replacement windows, typically made from vinyl or aluminum, especially the lower cost ones, have an average life span of less than 20 years. This is much shorter than their payback period, which is anywhere from 40 to 250 years.[28] This means that it could take from 40 to 250 years to save in energy what it cost to buy the new windows. And given that the new windows will likely not be functional for 40 years, they will need to be replaced before they have paid for themselves.

The repair and weatherization of traditional windows can be completed either by a professional or by the homeowner. If completed by the homeowner, repairs can be done at a much lower cost, since most of the expense of window repair is derived from labor, not materials. For good references on how to repair your wood windows, see Terry Meany's book, Working Windows: A Guide to the Repair and Restoration of Wood Windows (3rd ed. Guildford, CT: The Lyons Press, 2008), the HistoricHomeworks website www.historichomeworks.com, the National Park Service's Preservation Brief #9, "*The Repair of Historic Wooden Windows*," or similar references. Be aware that older homes (prior to 1978) may have lead paint. Before digging into repair projects, including window repairs, make sure to learn how to work lead safe. A good reference is the EPA's "Healthy Indoor Environmental Protocols for Home Energy Upgrades." See also the Lead Safety page on the National Trust for Historic Preservation's website.

The simplest ways to gain more energy efficiency from historic windows are to add weather stripping

Basic Window Maintenance *continued*

Glazing is Meant to Be Refreshed
Glazing putty will eventually dry out and is meant to be periodically replaced. You can do spot repairs initially, but eventually it will be easier to re-glaze the whole sash. Make sure to prime with a good oil-based primer before painting.

Check the Weather Stripping
Check for wear and replace as necessary. Don't have weather stripping? Now may be the time to add some. Using spring metal weather stripping will be more durable and be more efficient.

Fill Cracks or Checks in the Sill
If there are cracks or checks in the window sill, fill them with an epoxy or wood filler, then prime and paint. This ensures that water won't pool on the sill and encourage rot, mold, or mildew.

Make Sure Weep Holes Are Clear in Storm Windows
The small weep holes at the bottom of your storm window are there to reduce condensation and allow any trapped moisture to escape. These are often accidentally painted over. Unclog them to improve the storm window's performance and ensure that water is not trapped on the sill.

Don't want to tackle this kind of work yourself? Hire a local window repair contractor. Ask your neighbors, local hardware or paint store, or preservation organization for recommendations, or visit www.PreservationNation.org for an interactive map of window repair companies.

[28] Repair or Replace Old Windows, a visual look at the impacts. National Trust for Historic Preservation; "Should Your Old Wood Windows Be Saved?" *Fine Homebuilding*, April/May 2010, pp 40-43.

to the sash, make sure that the sash lock holds the meeting rails tightly together, and to caulk the window's interior and exterior casing to stop air leaks.[29] For more information on how to select and install weatherstripping, see articles such as "Strips and Storms Windows: Techniques for tuning up sash windows for winter" in the Old House Journal.

Traditional storm windows are hung from hooks and can be removed or propped open for ventilation. They provide excellent thermal protection and help protect the primary window. They can be heavy and cumbersome to remove seasonally. Fortunately, many styles and types of storm windows are available today, with or without insect screens. Several companies now make traditional-style storms with stationary frames and interchangeable screens and glass. These systems give you the look of a traditional storm but are much more manageable.
Photo: Adrian Scott Fine

Not every window can be saved, but before it is assumed that replacement windows are the best option, careful consideration should be given to the quality of the materials, the payback period, and performance. For more on how to make informed decisions about your windows, you can read the information and technical studies available on the Windows page of www.PreservationNation.org and articles such as "Should Your Old Wood Windows Be Saved?" in the April/May 2010 issue of *Fine Homebuilding* magazine.

As a general rule of thumb, before changing anything that might alter a building's historic character, you might first consult with your local historic preservation commission, your local or state historic preservation non-profit, or your state historic preservation office. To find a list of many of these, visit the National Trust for Historic Preservation's webpage www.preservationnation.org/about-us/regional-offices/, select the region in which you live, and then click on the "Find More Contacts" link in the box on the right.

Storm Windows

Storm windows, which can be affixed to either the exterior or interior of a window, offer additional energy savings. Much like traditionally-constructed cavity walls, snugly fitted storm windows create a void that slows the transfer of heat. [30]

In contrast to double-glazing, this technique allows the original windows to remain intact, while providing added insulation and reducing air infiltration.[31] Adding a storm window to a weather stripped historic window can achieve essentially the same, and sometimes better, energy performance as

[29] Weatherization Tips & Strategies Preservation Nation.
[30] "Seven Ways to Weatherize," *Old House Journal,* online publication.
[31] *Technical Note No. 48: Windows and Doors.* Environmental and Heritage Services, Department of Environment, Northern Ireland, 2006.

a new insulated dual-pane window.

Storm windows are manufactured in multiple sizes and are reasonably priced. In addition to the ubiquitous "triple track" storms with storm and screen combinations, there are many options available. Wood is becoming increasingly popular as it has better thermal properties than aluminum and can be painted any color. Custom sizes for unusually-shaped or sized windows can be made in aluminum or wood. Custom work will likely cost more but should pay for itself sooner than replacing the entire window. If you don't want the hassle of switching out a traditional storm for the screen every year but don't like the look of the triple track, there are a growing number of companies that make systems with interchangeable storms and screens that can be manipulated from inside the house.

Besides providing thermal insulation, storm windows have the added benefit of providing sound insulation as well as protecting the original window from the elements.[32] Interior storm windows allow the historic windows to be easily viewed from the outside, can be easier to take off when not needed, and provide excellent insulating properties. If interior storms are used, it's especially important to make sure that the small weep holes at the bottom of the storm window remain open. These weep holes are there to reduce condensation and allow any trapped moisture to escape. If you find moisture trapped between your primary window and the storm, the first course of action is to check that the weep holes are open. These are often accidentally painted over. Unclog them to improve performance and ensure that water in not trapped on the sill.

U-Value and R-Value: What's the Difference?

A fundamental property of heat is that it will flow from a warmer area to a colder area.

The rate at which heat is transferred through a material is its **U-value**. The rate will be affected by a number of factors, including the type of material or assembly, the thickness of the material, by the difference in the interior and exterior temperatures, and by dampness. Wet or damp material will not insulate as well as a dry material. This is why people feel colder if their clothes get wet, even if the air temperature remains constant. Materials are assigned U-values based on how slowly they transfer heat, which, in practical terms, is a measure of how well they insulate. **The lower the U-value, the better the material insulates.** U-value is typically used to rate windows and storm windows.

The **R-Value** is largely the inverse. It is a measure of how well a material resists the flow of heat through it. **The higher the R-value, the better it will insulate.** When shopping for insulation, buy the type with the highest R-value that you can afford and that is appropriate for the intended use.

Regardless of location, during mild months, all storm windows should be opened to allow original windows to fully dry and help prevent moisture damage.

For additional energy savings, noise reductions, and/or security, storm windows that use low-E or laminated glass are also an option. While these will cost more than standard glass, the energy saving and comfort may make it worth the added expense. A historic window with a low-E storm

[32] "Storm Windows, A Report from the Field" *Traditional Building* March/April 2001.

window has been shown to perform just as well as a replacement window.[33] A 2009 study commissioned by English Heritage found that using a low-E storm window reduced the amount of heat lost through the window by 58%.[34] The same English Heritage study found that closing heavy curtains at night reduced heat loss by 41%, closing well-fitted interior shutters reduced heat loss by 58%, and a honeycomb insulating blind reduced loss by 51%. Many of these insulating shades also qualify for a tax credit. A quick internet search on "honeycomb insulating shade" will result in many different options. Low-E storm windows may make more sense in warmer climates than very cold climates. In cold climates, greater benefit may be achieved by allowing heat gain during the day rather than by limiting it, particularly in winter months. In some areas of the country, the advantage of solar heat gain can be significant, particularly if blinds, shutters, curtains, or shades are drawn when the sun sets to retain the heat. This does not mean that low-E storms aren't an option. You might consider using the low-E glass for some elevations, but not on others where the solar heat gain would be welcome (on the north side for example). Laminated glass has excellent sound dampening qualities and its strength provides an extra measure of security.

A study by English Heritage found that using a storm window reduced the heat loss through the window by 58%. Simply closing heavy curtains at night reduced heat loss by 41%, and closing interior wood shutters saved 58%. Using an insulated honeycomb blind reduced heat loss by 51%.

Doors and Storm Doors

Original wooden doors are likely to have excellent thermal properties without alteration thanks to the old growth wood used to build them. Regular maintenance of caulking and the addition of weather stripping will ensure the thermal efficiency of the doorframe and prevent air leaks when the door is closed.

Buildings in extremely cold climates may benefit from the installation of storm doors that are well matched to the building's original architectural features and colors. A storm door can help improve upon the thermal performance of the original door by adding an extra barrier between the interior and exterior. Just like installing storm windows, this step makes most sense colder climates. Buildings in milder climates, by contrast, are unlikely to enjoy enough energy savings to justify the cost.

Removal of Hazardous Materials

If necessary, materials such as lead paint and asbestos can safely be removed from your home.

Lead-Based Paint

[33] Klems, Joseph H. "Measured winter performance of storm windows." Lawrence Berkeley National Laboratory, University of California, 2002, Paper LBNL 51453. Available at https://repositories.cdlib.org/LBNL-51453.

[34] English Heritage, "Research into the Thermal Performance of Traditional Windows: Timber Sash Windows." Research Report. October, 2009. Available to download as a PDF from www.english-heritage.org.uk/publications/thermal-performance-traditional-windows/thermal-performance-traditional-windows.pdf.

Most buildings with paintwork before 1978 likely have some lead paint present. When completing renovation, paint may be disturbed, causing particles to spread throughout a building. This does not mean that historic features should be removed for fear of spreading lead paint particles. What it does mean, though, is that work should be completed by EPA-certified professionals, according to the EPA's Renovation, Repair and Paint Rule.

For buildings where children are likely to be, regulations now require lead paint to be handled by professionals whether the scope of building works includes paint removal or other renovations that come in contact with the paint. Remedial action may be as simple as applying a protective, clear coating to painted areas that are actively used (such as a window jamb) or have been damaged.[35] For more information see the EPA's Renovation, Repair and Paint Rule and the National Trust for Historic Preservation's page on lead paint. For more information about lead paint in historic housing, see the National Park Service's Preservation Brief 37, *Appropriate Methods for Reducing Lead-Paint Hazards in Historic Housing,* available online as a PDF at www.nps.gov/history/hps/tps/briefs37.pdf.

Asbestos

Until its production was banned in 1978, asbestos was commonly used as insulation, as a fire retardant, and used to strengthen material for a variety of products such as ceiling and floor tiles. In addition, almost all vermiculite insulation used from 1919 to 1990 was contaminated with naturally-occurring asbestos. Like lead paint, asbestos poses little risk if undisturbed. The first rule of thumb with asbestos is to leave it alone. If damaged or disturbed, however, the fibers can become friable and airborne and pose significant risks to health. When inhaled or ingested, it can eventually lead to cancer of the lungs and organ tissues, as well as other diseases that impair lung function. Removing asbestos from your home is

WHAT ABOUT FINANCIAL INCENTIVES?

Grants are uncommon for privately-owned homes, but that doesn't mean that finding financial assistance is impossible. Incentives vary from state to state and even by city. Federal tax incentives also exist, so it is worth spending time investigating your options. Here are some places to look for financial incentives:

1. **Energy Star** www.energystar.gov/

2. **Database of State Incentives for Renewable Energy** www.dsireusa.org

3. **Your town or city's website.** Look here for local incentives.

4. Your **state historic preservation office** (SHPO) may be aware of incentives available in your area, including possible state homeowner tax credits for rehabilitation. To find your SHPO, visit www.ncshpo.org/.

5. **Federal tax incentives** of 10% or 20% are available for qualified income-producing rehabilitation projects. Visit www.nps.gov/history/hps/tps/tax/ to see if the work you are planning might qualify. You can also call your SHPO office.

Final thought: When making energy efficiency improvements, the old adage, "A penny saved is a penny earned" is applicable. The money you save by reducing energy usage all goes back into your pocket. So even if you can't find incentives to do this work, you, and the environment, still win.

[35] Lead Paint: What's at Stake? www.PreservationNation.org.

possible, though not always easy.[36] If you suspect that a material in your home might have asbestos in it (white pipe wrap or 9" x 9" floor tiles for example), call a local qualified company to have it tested. If the material is damaged or will be disturbed during a renovation project, have it professionally removed. For more information or to find a qualified professional, see the Environmental Protection Agency's article, Asbestos in Your Home.

Maintenance

Keeping an older or historic building in good condition does wonders for its energy efficiency. Regular, diligent monitoring of its condition—whether making sure windows and doors open and close as tightly as they should, or checking for gaps in masonry that might be causing drafts or letting in pests—can make a tremendous difference in your home's performance over time. A little time and effort every now and then can add up to a significant environmental benefits by keeping building materials out of landfills, not to mention a substantial financial savings for the homeowner. An ounce of prevention can truly save a pound of cure. For a user-friendly guide on maintenance, see the National Park Service's Preservation Brief #47, *"Maintaining the Exterior of Small and Medium Size Historic Buildings."* Request a free copy here.

The National Park Service has a practical series of booklets on a wide range of topics, from plaster repair to porches to barns, called Preservation Briefs. *All of these are available to download or order for free from their website at www.nps.gov/history/hps/tps/publications.htm.*
Additional free technical assistance publications can be found at www.cr.nps.gov/hps/freepubs.htm

A Word on Reversibility

One of the key concepts in historic preservation is reversibility. Essentially what this means is that when making a decision about your home, take a moment to ask yourself the following question: If I do this, will the person living in my home in 15, 25, or 50 years be able to "undo" it, if necessary, without harming the building or a part that contributes to its character?

The concept of reversibility is taken from a set of guidelines known as the *Secretary of the Interior's Standard for the Treatment of Historic Properties*. These common-sense concepts were developed by the National Park Service and they provide a treatment framework for historic buildings. Technically, they only apply to properties listed in the National Register of Historic Places or when adopted by a local historic preservation review board, but they are useful as a point of reference for all older buildings. There are different standards depending on whether you are rehabilitating, restoring, preserving, or reconstructing your property. The most frequently used standards are those for Rehabilitation.[37] This set of ten flexible principles help people adapt an older building for new or continued use while protecting the parts of the building that make it special. For more information about the Secretary of the Interior's Standards for the Treatment of Historic Properties

[36] Asbestos, US Environmental Protection Agency.
[37] Rehabilitation is defined by the National Park Service as "the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values."
http://www.nps.gov/history/hps/tps/standards/rehabilitation.htm

and the accompanying Guidelines, visit the Technical Preservation Services website of the National Park Service.

How does this relate to lowering my energy bills?

When making changes to your historic home that may affect key features such as windows or structural elements such as your walls, if those alterations are reversible the more options you'll have later. Once you throw out the historic windows, unless you've stored them somewhere onsite, you won't be able to put them back in later. If you add insulation in your walls without air and vapor sealing, you could end up with a rotting frame. [38] Another advantage to making your energy efficiency improvements reversible is that future technologies are likely to improve upon current practices and materials. If the changes you make now cannot be easily or inexpensively undone, you may end up kicking yourself later. An example of a reversible change, with a quick and substantial payback, is the reduction of air infiltration. Almost all caulk and weather stripping can be easily removed or replaced when needed. Or, you can add storm windows to your historic windows. Though it can and does make a big difference in energy savings, storm windows can be removed and new storms incorporating high-performance materials can be added.

Conclusion

All of the recommendations listed on these pages are meant to offer guidance on how to make your older or historic building more energy efficient. They may not apply to your specific building, so if you have any questions, please contact your local preservation planning commission or your state historic preservation office. It is also important to note that some of the recommendations may require a building permit as well as planning permission from local historic districts. It is always best to check to see whether or not a permit needs to be granted before investing in any supplies or proceeding with any work. The good news is that a lot can be done to save energy and money for little or no cost, while protecting the features of your home that give it character. You can feel good about living in a home that has served well for fifty or one hundred years or more and that you are stewarding it for the next generation.

Looking for More?

While this guide is an excellent place to start, we encourage you to learn more. Here are some good places to look for more specific information:

Association for Preservation Technology

www.apti.org/

[38] Forsyth, M. *Historic Building Conservation: Structures and Construction*, Blackwell Publishing, Oxford, 2007, p. 7.

The Association for Preservation Technology International (APT) is a cross-disciplinary, membership organization dedicated to promoting the best technology for conserving historic structures and their settings. The APT Bulletin can be a great resource for case studies and informative articles.

Athena Institute
www.athenasmi.org/
For more than a decade, the Athena Institute has been helping architects, engineers and others to evaluate the environmental impacts of new and existing buildings through life cycle assessment (LCA). A non-profit organization, Athena seeks to improve the sustainability of the built environment by meeting the building community's need for better information and tools. Through offices in Canada and the United States, the Athena Institute furthers the use and science of LCA through groundbreaking software, world class databases and customized consulting services, and by working collaboratively with the international research community.

Boulder, Colo. Historic Building Energy Efficiency Guide
www.bouldercolorado.gov/index.php?option=com_content&task=view&id=8217&Itemid=22

Carley, Rachel. **The Visual Dictionary of American Domestic Architecture**. New York: Henry Holt & Company, 1994.

Carroon, Jean. Sustainable Preservation: Greening Existing Buildings. John Wiley & Sons, Inc. 2010, 401 pp.

Do It Yourself Energy Assistance Analyzer
www.energyguide.com/audit/baintro.asp

Energy Efficiency, Old House Web
www.oldhouseweb.com/how-to-advice/energy-efficiency-in-historic-buildings.shtml#7

Energy Efficiency Tips, City of Albany
www.cityofalbany.net/comdev/historic/energyefficiencytips.pdf

Energy Efficient Rehab Advisor (home owner tool)
http://pathnet.org/sp.asp?mc=techtools

Energy Modeling Forum
http://emf.stanford.edu/
EMF is an international forum for sharing and facilitating discussions on energy policy and global climate issues among experts. The Forum Seeks to: improve understanding of an important energy/environment problem by harnessing the collective capabilities of participating experts, explain the strengths, limitations and caveats of alternative analytical approaches, and identify high priority directions for future research. The value of their approach has been widely recognized by business and government leaders in the energy and climate change areas.

Energy Star
www.energystar.gov
Performance rating for appliances and equipment as well as home energy tools.

Garvin, James. **A Building History of Northern New England**. Dartmouth: University Press of New England, 2001.

HistoricHomeworks
www.historichomeworks.com
This website has books, free webinars, a user forum, and more, all dedicated to the care, restoration, and the maintenance of older buildings.

Holohan, Dan. **The Lost Art of Steam Heating**. Bethpage, NY: Dan Holohan Associates, 1992.
www.heatinghelp.com/.

Home Energy Saver
http://hes.lbl.gov/
The First Web-Based Do-It-Yourself Energy Audit Tool

MacAlester, Virginia and Lee. **A Field Guide to American Houses**. New York: Knopf, 1984.

Meany, Terry. **Working Windows: A Guide to the Repair and Restoration of Wood Windows**. 3rd ed. Guildford, CT: The Lyons Press, 2008.
A practical, hands-on guide for the repair of wood windows. It also includes products lists and sources.

Myths about Insulating Old House Walls, Bob Yapp
bobyapp.com/blog/2009/06/myths-about-insulating-old-house-walls

Nash, George. **Renovating Old Houses: Bringing New Life to Vintage Homes**.
This book, published by the Taunton Press is a practical, hands-on guide to assessing, repairing, and maintaining historic homes.

Old House Journal
www.oldhousejournal.com
The go-to magazine and website for people to live in, are restoring, or love historic buildings.

Preservation Briefs, *National Park Service*
The NPS offers a practical series of booklets called Preservation Briefs that provide guidance on preserving, rehabilitating and restoring historic buildings. They cover a wide range of topics, from plaster repair to porches to barns. All of these are available to download or order for free from their website at *www.nps.gov/history/hps/tps/publications.htm*. Additional free technical assistance publications can be found at www.cr.nps.gov/hps/freepubs.htm. Of note are the following briefs:

- Preservation Brief 2, *Repointing Joints in Historic Masonry Buildings,* Robert C. Mack, FAIA, and John P. Speweik
- Preservation Brief 3, *Improving Energy Efficiency in Historic Buildings*, Jo Ellen Hensley and Antonio Aguilar
- Preservation Brief 9, *The Repair of Historic Wooden Windows*, John H. Myers
- Preservation Brief 24, *Heating, Ventilating, and Cooling Historic Buildings: Problems and Recommended Approaches,* Sharon C. Park, AIA
- Preservation Brief 35, *Understanding Old Buildings: The Process of Architectural Investigation*, Travis C. McDonald, Jr.
- Preservation Brief 39, *Holding the Line, Controlling Unwanted Moisture in Historic Buildings,* Sharon C. Park, AIA
- Preservation Brief 47, *Maintaining the Exterior of Small and Medium Size Historic Buildings,* Sharon Park, FAIA

Preservation Trades Network
www.iptw.org/
The Preservation Trades Network (PTN) is a 501(c)3 non-profit membership organization founded to provide education, networking and outreach for the traditional building trades. PTN was established on the principle that conservation of the built environment is fundamentally dependent on the work of skilled people in all of the traditional building trades who preserve, maintain and restore historic buildings, and build architectural heritage for the future.

The Secretary of the Interior's *Standards for Rehabilitation with Guidelines on Sustainability for Rehabilitating Historic Buildings*.
National Park Service
www.nps.gov/history/hps/tps/download/guidelines-sustainability.pdf
These are the first set of official guidelines on how to make changes to improve energy efficiency and preserve the character of historic buildings. The *Guidelines* are an important addition to current discussions about sustainability and achieving greater energy efficiency, which have focused primarily on new buildings to date.

Smart Energy Design Assistance Center (University of Illinois)
http://smartenergy.arch.uiuc.edu/index.html
http://smartenergy.arch.uiuc.edu/pdf/ECRMHandout.pdf
http://smartenergy.arch.uiuc.edu/html/residential.html

Target Finder
Energy Star tool to benchmark building efficiency.
www.energystar.gov/index.cfm?c=new_bldg_design.bus_target_finder

Tusculum Institute at Sweet Briar College
www.tusculum.sbc.edu/
The Tusculum Institute is a historic preservation resource center, dedicated to preserving and studying the region's historic assets within a context of environmental stewardship. Their website features an interactive Preservation House www.tusculum.sbc.edu/toolkit/default.shtml to help homeowners learn about energy saving strategies in historic buildings.

Weatherization, *National Trust for Historic Preservation*
www.preservationnation.org/issues/weatherization/
For information on energy audits, windows, insulation, mechanical systems, roofing, an extensive bibliography, a window repair contractor map, and more.

Weatherizing and Improving the Energy Efficiency of Historic Buildings, *National Park Service*
www.nps.gov/history/hps/tps/weather/index.html
Weatherization means implementing cost-effective measures to make a building's envelope more energy efficient. Learn how to undertake those measures in ways that have minimal impact on the historic building's design and materials.

Zimmerman, Sally. **"Energy Costs in an Old House: Balancing Preservation and Energy Efficiency**."
http://committees.architects.org/hrc/Zimmerman%20insulating%2010_08.pdf
This paper explains some of the challenges of insulating the walls of historic buildings.

Also available in Sustainable Preservation: Greening Existing Buildings, by Jean Carroon. 2010, John Wiley & Sons, Inc. 401 pp.

Top 10 List

Here are ten items that you can do that will bring you a quick return on your energy efficiency upgrade dollar.

1. **Air seal.** Use caulk and weather stripping to close any cracks near your baseboards, ceilings, around window and door openings, and foundation. The goal is to reduce the amount of air leaking into, or out of, your home. This saves energy and improves comfort levels.

2. **Adjust your thermostat**. When heating, turn it to 68°F (or lower) during the day when no one is home and to 65°F at night. For AC, set the thermostat no lower than 78°F. Install a programmable thermostat to manage this automatically.

3. **HVAC tune up.** Maintain your heating and cooling systems so that they can run efficiently and make sure the air filters are clean. Depending on the age of the unit and its efficiency rating, you may want to consider replacing it for a higher efficiency model.

4. **Turn your water heater thermostat down.** Many water heaters are set to 140, which is warmer than most people need. Turning it town to 120 can save you between 6% and 10%. While you're at it, consider giving your water heater an insulating jacket.

5. **Close the curtains.** In winter, use insulated curtains, blinds, shades, or shutters (or a combination of these) at night to keep heat in your room. In the summer, close them during the day to keep out the hot sun.

6. **Insulate that attic space**. Don't forget to air seal first.

7. **Seal and insulate your heating ducts**.

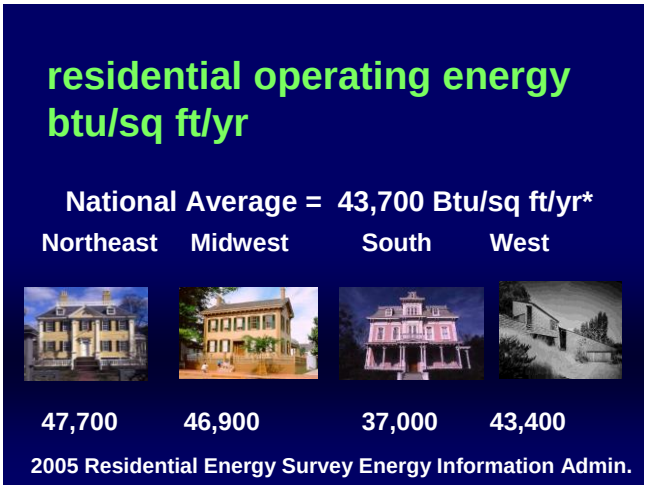
8. **Close fireplace damper and/or use an inflatable device that fills the flue opening** when fireplace is not being used in winter.

9. **Insulate hot water pipes**.

10. **Tune up and weatherize your historic windows**. Well-maintained windows will work well and keep you more comfortable. Adding weather stripping will also reduce drafts. In many climates, **storm windows** will reduce heating and cooling loads. If they are already in place, make sure that they are in good repair. If your storm windows are no longer performing well, consider replacing them with more efficient models or ones that are more compatible with the historic character of your home.

Worksheet: Calculating Your Home's Operating Energy

Used with permission from Mike Jackson, FAIA, Illinois Historic Preservation Agency



Widespread use of posted mileage ratings on new cars has made everyone familiar with the relative energy efficiency of automobiles. A similar familiarity does not exist for homes. This knowledge can help home owners when purchasing a house or deciding what energy efficiency upgrades to make. Whole house energy performance measures can also be used to calculate some financial incentives. Calculating the whole house energy efficiency is not that complicated, but does require a years' worth of utility bills and a little knowledge of common energy conversion factors.

Step 1: Determine Unit of Measure: BTU

The energy that is being measured is the site "metered" energy, which are the values reflected on the typical home utility bills. One universal measure of energy is the British Thermal Unit (BTU), which is the amount of heat it takes to raise one pound of water by one degree Fahrenheit. There are only a few major energy sources used by most home owners, so the math is not that complicated.

- **Natural Gas** One Therm = 100,000 BTUs
- One Kilowatt Hour (Kwh) of **Electricity** = 3, 412 BTU/Kilowatt
- **Liquefied Propane** (LP) Gas = 91,000 BTU/gallon
- **Heating Oil** = 139,000 BTU/gallon

Step 2: Calculating the area of your house:

The area calculation is based upon the gross area included in a real estate listing. This excludes unfinished basements, attics and garages.

Step 3: Calculate the BTU/sq ft/yr:

The final figure of this equation is given in BTUs per square foot of habitable space per year. The national average is 43,700 BTU/sq ft/yr.

Step 4: Measuring Efficiency

The goal of improving energy efficiency is often expressed as a percentage improvement in reduction below regional averages. In other words, a goal might be expressed as achieving a 30% energy efficiency reduction over the statistically average (or code required) house in your region. For a typical Midwestern home that utilizes 46,900 BTU/sq ft/yr, a reduction of thirty percent would change the annual consumption to 32,800 BTU/sq ft/yr.