

GREATER PORTLAND LANDMARKS

The Energy Efficient Old House:

A Workbook for Homeowners



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**The Energy Efficient
Old House: A Workbook
for Homeowners**

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Taking advantage of your building's original "green" design

GREATER PORTLAND LANDMARKS is committed to helping people operate their homes more efficiently and economically, reducing our area's carbon pollution while preserving the region's history and architectural integrity. Founded in 1964, Landmarks' mission is to preserve and revitalize the architectural fabric, history and character of greater Portland – renewing our neighborhoods, spurring economic development and keeping Portland one of the most livable cities in America.

Many older buildings were built to be warmer in winter and cooler in summer than their modern counterparts, and much of the energy efficiency upgrades required in historic houses need only to boost this "climatic wisdom." The strategies to increase energy efficiency in older buildings differ from new construction, and when coupled with practical behaviors that accompany the changing seasons, they can achieve excellent results.

This workbook discusses energy efficiency improvements for older and historic homes in three tiers ranging from the simplest and most cost-effective, to those that are more complex. We would like to dispel myths about older buildings and energy use, and help homeowners make good choices to improve the performance and value of their buildings. Consider this workbook to be your guide as you seek information, explore alternatives and implement solutions.

Landmarks strongly believes that, with modest investment, older and historic houses can achieve significant improvements in energy performance while retaining their unique architectural features and intrinsic value. The reuse

A Note to Readers Living in Historic Districts

The guidelines in this book apply to all old houses, whether or not in historic districts. But if you are in a district, be sure to speak to your historic district commission well in advance of any energy projects to ensure that your project is in compliance with district guidelines.

and rehabilitation of existing buildings is one of the "greenest" approaches to energy conservation, which revitalizes neighborhoods, optimizes use of existing infrastructure, and reinforces our distinctive sense of place.

Greater Portland Landmarks would like to thank the Horizon Foundation and the Richard and Julia Moe Fund for Statewide and Local Partners of the National Trust for Historic Preservation for making this workbook possible. As our communities increasingly strive toward sustainability – a clean environment, economic well-being and community vitality – historic preservation stands as a very important means to achieving these goals.

We welcome your interest in preserving your old house and improving its energy efficiency! Landmarks offers information and resources, including our Preservation Services Advisor, to support your efforts. To become part of a broader community of people who share your interest in preservation and community revitalization, we invite you to become a Landmarks member and to visit our website at www.portlandlandmarks.org.

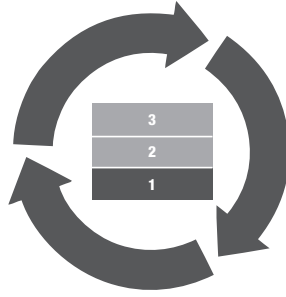
An energy audit is a useful first step in creating your plan for energy efficiency. The auditor will inspect visually all the energy features in the house, with a focus on moisture, building durability, and indoor air quality. They will evaluate existing insulation levels and air leakage by using a blower door and thermography (a camera that reveals areas of heat). The result is a prioritized list of recommended improvements based on their findings and a computer-generated energy model of the home. *(See page 12)*

PHOTO

1

(see page 7)

Images that refer to the text are indicated by the boxes and page references as shown above.



▶ *Don't begin energy improvement projects until you have resolved structural problems and/or water infiltration.*

Tier 1: Initial Investigations and Low Cost Solutions

Moisture Management and Building Durability

Why?

Energy conservation and building durability are inextricably linked in short- and long-term building performance. Energy performance problems often stem from deferred maintenance. Significant areas of heat loss often reveal the first symptoms of moisture-related structural damage, which develops over time.



Identify

Our Maine homes endure a range of temperature and humidity extremes. Although many houses have withstood 200 years or more of seasonal fluctuations, they still need periodic upkeep. An annual inspection of the exterior of your home is crucial to its successful stewardship. Is the roof leaking? Does the siding need repair or replacement? Is mold or mildew growth visible? Is there efflorescence on brick surfaces, peeling paint, or cracked masonry? Are there cracks in the basement walls? An annual inspection, with a particular focus on managing moisture intrusion or its inadvertent retention, is the most important way you can protect the function, performance, and energy efficiency of your home.

Where? And How?

Start by looking for moisture – including puddles, buckled siding, or mildewed clapboards.

Sources of Moisture in Buildings:

Interior or retained moisture sources may come from:

- High water table in the soil and prolonged periods of high humidity
- Lack of a vapor barrier beneath the basement floor
- Inadequate basement, bathroom, or laundry room exhaust ventilation
- Absence of attic and/or roof ventilation
- Inadequate air exchange
- Condensation from cold water pipes

Exterior sources that allow water infiltration include:

- Leaks in roof, wall, exterior trim, window and doors, and faulty mortar joints
- Blocked gutter systems, downspouts, or leaders
- Poor drainage of building site, including slopes pitched toward – rather than away from – foundations
- Absence of, or poorly designed or blocked foundation perimeter drains
- Exterior foundation walls that lack waterproofing and/or cracks in the foundation

Beyond checking these key water infiltration locations, we recommend using this excellent annual maintenance checklist from *This Old House* available at <http://img2.timeinc.net/toh/static/pdf/fall-checklist.pdf>. Many of the projects described on the following pages such as basement insulation, interior storms, and air sealing will require first managing interior and exterior sources of moisture.

Who?

If you'd like professional advice beyond the checklist, contact Greater Portland Landmarks' Preservation Services Advisor.



TIER 1: Initial Investigations and Low Cost Solutions

Indoor Air Quality and Healthy Living Environments

Why?

Americans spend up to 90% of their time indoors, and much of that indoor air is more polluted than the air outside. Passive ventilation in buildings can often be inadequate to protect residents from health problems stemming from pollutants. Even houses that have air leaks can have higher than usual amounts of indoor pollutants. Assessing your indoor air quality is an important first step before beginning any energy projects, especially air sealing.

Identify

The most dangerous indoor air pollutants include asbestos, biological pollutants (pets and pests), carbon monoxide, dust, mildew, mold, pesticides, radon, and volatile organic compounds.

Where?

Source control and elimination of indoor air pollutants is the most effective method of protecting the health of your family. First, walk through your home looking for pollutants – many of these like mold, mildew, asbestos, and volatile organic compounds – can linger in the basement or garage. Exhaust ventilation is the next best solution and needs to be functioning well in places of high moisture and pollution like bathrooms and kitchens. Installing carbon monoxide detectors on every floor is also a simple safeguard.

How?

The EPA has published a guide to assessing indoor air quality, identifying pollutants and recommending solutions. Download “Care for Your Air” here www.epa.gov/iaq/pubs/careforyourair.html. Reducing and managing pollutants inside your house will allow you to air seal without compromising the health of your family.

Who?

With help from the EPA guide above, you can conduct an indoor air quality assessment yourself. If you find mold, asbestos, or other toxins you’re not sure how to deal with, it’s time to call a professional. The Maine Association of Building Energy Professionals has a listing of indoor air quality technicians at www.encypro.org.



Low Cost Energy Saving Measures

Why?

Turn off, turn down. We hear it time and again – for good reason! There are a number of low-impact, no/low cost energy saving measures that reduce energy bills. Adopt these approaches first and consider the savings as a down-payment on the larger energy efficiency projects that will be more expensive down the road.

Before moving on in this workbook, we recommend that you tackle the following low-cost projects:

Lights and Electricity:

- Turn off everything not in use and put significant plug loads on smart strips for easy turn-off.
- Activate “sleep” features on computers and office equipment so that they power down when not in use. Turn off equipment when you are not using it for long periods.
- Replace incandescent bulbs with more efficient bulbs such as compact fluorescents or LEDs.
- Hang clothes to dry outside, and when using the dryer, clean both the lint trap and the vent
- Clean the refrigerator coils below and behind the refrigerator to ensure proper function.

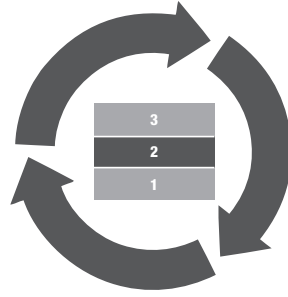
Heating and Cooling:

- Program thermostat settings to reduce heating at night or when the house is unoccupied. Install programmable thermostats if possible: they are inexpensive and simple to install.
- Check the furnace and air conditioner filters every month, and clean or replace as needed. Dirty filters block air flow.
- Heat your house efficiently – are there rooms that can be closed from heating or cooling? Radiators or zones to be turned on or off?
- Help your radiators and vents heat effectively by removing furniture, shoes, and other obstructions from them.

Hot Water Heating:

- Wash clothes in cold water
- Reduce hot water settings to 120°F.
- Install low-flow showerheads and sink aerators to reduce hot water consumption.





Tier 2: Projects of Moderate Investment

Air Sealing

Why?

Air sealing is one of the most cost-effective energy conservation measures; experts agree that about 1/3 of your energy costs are attributable to air leakage. Most air sealing can be done by a do-it-yourselfer with a little study and preparation.

Identify

Remember your ABCs: Start in the Attic, then move to the Basement, then the Center of the house. This allows you to take advantage of the natural physics of heat and air movement. First you'll stop the warm air leaking out; next you'll reduce incoming air.

The goal is to create a continuous air and thermal barrier for your home. Take a moment and draw a sketch of your house. Where is the inside? Where is the outside? Often there are spaces (mudrooms, eaves, and attics) that are a little of both. After determining the boundaries of the interior envelope of your home, consider the services and features that break it up. For example, if the attic floor is insulated, then you'd like the attic floor to also be the demarcation line between the inside and outside. But this plane is frequently penetrated by chimneys, plumbing vents, and recessed lights. **Effective air sealing targets those places where the line between inside and outside is broken, as well as those places inside the home where divisions between floors or stories are blurred.**

Where?

First, benefit from your experience – where do you feel drafts? Second, look for moving cobwebs – they're great indicators of air leaks. Third, do you have dirty patches of insulation? Dirty insulation is a good indicator because it acts as a filter for the air leaks. Fourth, walking around your home with a burning stick of incense in an incense holder may also help you identify air leaks as the smoke follows typical patterns of air leakage and movement. Use your common sense when using incense to discover air leaks. Exercise caution when moving around your home and manage embers to ensure that air leakage detection doesn't result in fire.

Take your incense and pay particular attention to the places indicated on this illustrative diagram created by the US Department of Energy.

PHOTO

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(see page 8)

How?

Each type of air sealing material -- weather-stripping, caulk, backer rod, spray foam -- has its best use. There is guidance on how to match materials with air sealing challenges available from the EPA at www.energystar.gov/index.cfm?c=diy.diy_index. Remember the preservation principle of *reversibility*. Backer rod is easily removed and replaced, as is latex caulk and most types of weather-stripping. Spray foam is permanent, messy, and difficult to remove! Proceed with caution when sealing. Ask yourself, "Will I need to be able to un-do this? Will the next homeowner?"





PHOTO 1
(from page 3)

An energy auditor uses a blower door to discover pathways of air leakage.
(Courtesy Peter Taggart)



PHOTO 2
(from page 4)

Water entering the basement in this corner of the house is likely caused by these rhododendrons which have grown too large to be so close to the foundation. (Courtesy Anne Stephenson)

This cross-section of a typical home identifies the most common indoor pollutants. (Courtesy Environmental Protection Agency)

PHOTO 3
(from page 5)

Asthma is a serious, sometimes life-threatening respiratory disease that affects the quality of life for millions of Americans.

Environmental asthma triggers: are found around the home and can be eliminated with simple steps.

- Don't allow smoking in your home or car.
- Dust and clean your home regularly.
- Clean up mold and fix water leaks.
- Wash sheets and blankets weekly in hot water.
- Use allergen-proof mattress and pillow covers.
- Keep pets out of the bedroom and off soft furniture.
- Control pests—close up cracks and crevices and seal leaks; don't leave food out.

Children are especially sensitive to secondhand smoke, which can trigger asthma and other respiratory illnesses.

Secondhand smoke: smoke comes from burning tobacco products such as cigarettes, pipes, and cigars.

- To help protect children from secondhand smoke, do not smoke or allow others to smoke inside your home or car.

Radon is the second leading cause of lung cancer.

Radon gas: enters your home through cracks and openings in floors and walls in contact with the ground.

- Test your home with a do-it-yourself radon kit. If the test result indicates you should fix, call a qualified radon mitigation specialist.
- Ask your builder about including radon-reducing features in your new home at the time of construction.

Mold can lead to allergic reactions, asthma, and other respiratory ailments.

Mold: can grow anywhere there is moisture in a house.

- The key to mold control is moisture control.
- If mold is a problem in your home, you should clean up the mold promptly and fix the water problem.
- It is important to dry water-damaged areas and items within 24-48 hours to prevent mold growth.

VOCs cause eye, nose, and throat irritation, headaches, nausea, and can damage the liver, kidney, and central nervous system.

Volatile organic compounds (VOCs): are chemicals that evaporate at room temperature. VOCs are emitted by a wide array of products used in homes including paints and lacquers, paint strippers, varnishes, cleaning supplies, air fresheners, pesticides, building materials, and furnishings. VOCs are released from products into the home both during use and while stored.

- Read and follow all directions and warnings on common household products.
- Make sure there is plenty of fresh air and ventilation (e.g., opening windows and using extra fans) when painting, remodeling, or using other products that may release VOCs.
- Never mix products, such as household cleaners, unless directed to do so on the label.
- Store household products that contain chemicals according to manufacturers' instructions.
- Keep all products away from children!

Carbon monoxide causes headaches, dizziness, disorientation, nausea and fatigue, and high levels can be fatal.

Nitrogen dioxide causes eyes, nose, and throat irritation, impairs lung function, and increases respiratory infections.

Sources include: indoor use of furnaces, gas stoves, unvented kerosene and gas space heaters, leaking chimneys, and tobacco products.

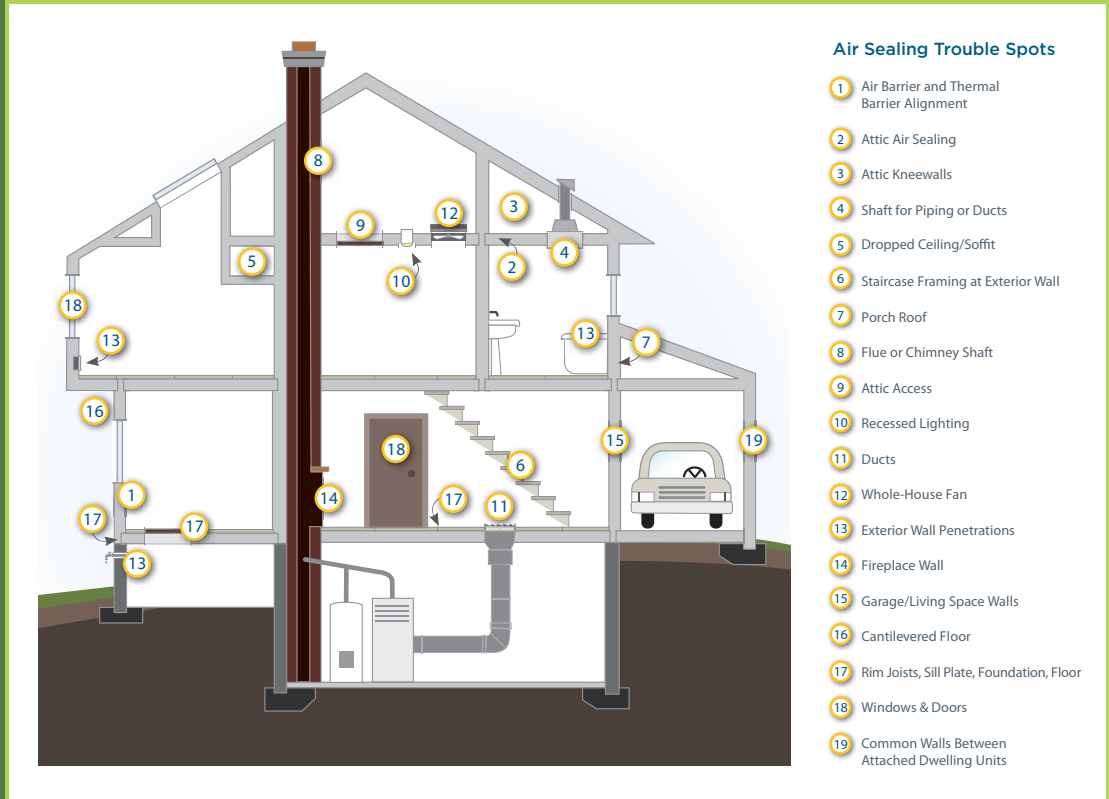
- Ventilate rooms where fuel-burning appliances are used.
- Use appliances that vent to the outside whenever possible.
- Ensure that all fuel-burning appliances are properly installed, used, adjusted, and maintained.

PHOTO

4

(from page 6)

A guide to the most frequent sites of air leakage. Reprinted with permission from US Department of Energy. Building America Best Practices Series, Vol. 10: Retrofit Techniques and Technologies: Air Sealing A Guide for Contractors to Share with Homeowners (Courtesy Pacific Northwest National Laboratory & Oak Ridge National Laboratory, 2010).



Air Sealing Trouble Spots

- 1 Air Barrier and Thermal Barrier Alignment
- 2 Attic Air Sealing
- 3 Attic Kneewalls
- 4 Shaft for Piping or Ducts
- 5 Dropped Ceiling/Soffit
- 6 Staircase Framing at Exterior Wall
- 7 Porch Roof
- 8 Flue or Chimney Shaft
- 9 Attic Access
- 10 Recessed Lighting
- 11 Ducts
- 12 Whole-House Fan
- 13 Exterior Wall Penetrations
- 14 Fireplace Wall
- 15 Garage/Living Space Walls
- 16 Cantilevered Floor
- 17 Rim Joists, Sill Plate, Foundation, Floor
- 18 Windows & Doors
- 19 Common Walls Between Attached Dwelling Units



PHOTO

5

(from page 11)

Knob and tube wiring is visible along the wall. (Courtesy Hilary Bassett)



The finished product. An older home with an effective R-60 of cellulose in the attic (Courtesy Peter Taggart)

PHOTO

6

(from page 11)

TIER 2: Projects of Moderate Investment

Who?

You! Most air sealing can be done by the handy homeowner with the help of publications listed in our bibliography.

There are also a number of professional air sealing contractors in Maine who can help you with the trickier air leakage challenges. A list can be found at www.encyclopedia.org.

Heating System Tune-up and Upgrades

Why?

Regular maintenance of your boiler or furnace will ensure its efficient operation and long life. Just as servicing your car increases your gas mileage, servicing your boiler or furnace can reduce your annual fuel costs by 5%.

Depending on your model, it might also be a candidate for low-cost upgrades that reduce fuel use even further.

Identify

When was the last time your boiler or furnace was serviced? Combustion appliances that burn oil should be serviced once a year; gas appliances once every two. Furnace filters should be cleaned or replaced every three months. Put a reminder on your calendar!

In addition to regular servicing, work with a local heating, ventilation and cooling contractor to evaluate if your boiler or furnace is a candidate for any upgrades.

How?

Boiler and furnace upgrades operate on a similar principle. Boilers typically respond uniformly to calls for heat, applying full force no matter the indoor or outdoor temperature. The solutions below help your boiler modulate its production based on call and temperatures. The result: a smart boiler that creates the amount of heat needed using far less fuel!

- ❑ **Modulating Aquastat (Outdoor Temperature Reset):** An aquastat measures the outdoor air temperature and regulates the boiler temperature accordingly. In colder months, for example, hot water can be delivered to the radiators at a lower temperature than might be required in the winter.
- ❑ **Cold-start Control:** This type of control allows the boiler to cool down when there is no call for heat or domestic hot water. This is especially helpful during the summer.

❑ Post-purge, Circulator, or Time-Delay Relay Controls:

A circulator pump upgrade allows the distribution water to circulate before or after the burner fires, which allows the system to create only the amount of heat needed. These kinds of controls can also slow down water movement based on the call for heat.

❑ Installing Separate Zones:

Separating your home into smaller heating zones can allow you to customize heating to space usage patterns. Historically we heated room-by-room. It made sense then and it does now!

❑ Limit Switch:

A great energy saving solution for your furnace, this switch allows for air circulation depending on the temperature of the air in the ducts. That means that warm air can be delivered long after the furnace turns off!

Who?

Only a licensed boiler or furnace technician is qualified to clean your boiler or furnace. Similarly, your HVAC contractor is the best person to speak with you about upgrading the boiler or furnace. To find one near you, consult www.encyclopedia.org.

Pipe and Duct Sealing and Insulation

Why?

Long lengths of un-insulated pipes and ducts often run through basements and crawlspaces where heat is lost. Although some of this heat warms the basement and the spaces above, it is far more efficiently delivered at the radiator or vent. Reducing duct leaks is especially effective because duct leaks can increase air leakage and air exchange through the building envelope; it's the perfect complement to other air sealing projects! Insulating your domestic hot water pipes can also significantly reduce your hot water costs.

Identify

How is heat delivered in your house? If you have a forced hot air system with vents, then you'll want to seal and insulate your ducts. If you have radiators or baseboards, then you'll want to insulate your pipes. Your heat delivery pipes are typically larger in diameter than your domestic hot water pipes. Different kinds of insulation are required for heating delivery and domestic hot water pipes, so be mindful of the difference.

STOP! If the pipes are already wrapped, they may contain asbestos! Hire a professional to encapsulate or remove asbestos pipe insulation.



TIER 2: Projects of Moderate Investment

Where?

Ducts: If you can't seal and insulate the entire system at once, try to identify leaks. With the furnace on, try to feel along as much of the duct work as possible, paying particular attention to elbows and joints. Seal leaks and joints first.

Pipes: Conventional wisdom dictates that the first ten feet of pipe from the boiler or hot water heater are the most important – these first few feet, after all, are where water is traveling at the highest temperature. But it is cost effective to insulate the whole length of pipe. Also be mindful of long stretches of pipe through crawl spaces or to distant bathrooms or additions. These are easily insulated and insulation will protect pipes from freezing!

How?

Ducts: Seal with mastic. It's messy... but fun! Mastic is available at all hardware stores. Be sure to wear rubber gloves! You can also use UL-181 approved foil tape, **but do not use duct tape**. Despite its name, it's not the right stuff for the job. After sealing, add vinyl-faced fiberglass duct wrap. Look for duct insulation rated to R-10 or higher.

Pipes: Pipe insulation typically comes in six-foot lengths and is easily cut to fit bends and elbows in the system. Many insulation types are already pre-slit to slide easily around the pipe and can be quickly taped in place. There are two types of pipes you are insulating: a) domestic hot water; and b) heating delivery pipes. Be mindful of the temperature range of the insulation for your heating pipes which must be rated up to 180°F, a higher temperature than domestic hot water. Follow manufacturer instructions regarding the best tape for the insulation.

Rated R-10 or higher?

An R- number on insulation refers to the material's resistance to thermal conduction. The higher the R-value per inch, or total R-value, the slower the rate of energy loss.

Who?

You! Pipe and duct sealing is manageable for even the novice homeowner. Because it can be time consuming, it is typically more cost-effective to tackle yourself than to hire a professional. That said, building performance or HVAC contractors can easily include duct and pipe insulation in their scope of work.

Attic Insulation

Why?

Attic insulation is one of the most cost effective energy measures for New England homes. Almost all houses in the greater Portland area have inadequate amounts of attic insulation compared to the recommended cost-effective levels for our climate.

Identify

Attic insulation is a straightforward energy solution but demands answers to challenging space utilization questions:

- Is my attic used for storage and does it need to be? If you can use insulation as an excuse to get rid of stuff, do so! Dedicating the attic exclusively to insulation means you can insulate more, and more cheaply.

But what about the walls?

The short answer is that walls are challenging! It is difficult to ensure good insulation coverage without damage to the exterior cladding or interior plaster. In general, adding wall insulation systems makes the most sense during a major renovation that also includes re-siding or the removal of interior plaster finishes. Wall cavity insulation requires an expert plan because of the movement of moisture through the wall cavity. Because about 12% of energy loss is through walls, it is a low priority.

- If I need storage, how much? If storage can be limited to one area of the attic, insulating will be simpler and more effective. If your attic space is finished or you hope to finish it, you might consider insulating the rafters rather than the attic floor. When installed, rafter insulation should be reversible and meet a minimum energy threshold. We encourage you to schedule a Greater Portland Landmarks Preservation Services Advisor visit before working with an insulation contractor.
- What kind of insulation do I have and how much of it? If it's in good shape, your existing insulation may be left in place and added to. If you have vermiculite insulation in place, some contractors recommend removing it before supplementing with a different product.
- What condition is it in? If your insulation has been home to mice or squirrels, or has become wet from ice dams or other water damage, it should be removed. Look carefully for "dirty" looking insulation. These places are signs of air movement from the floors below and should be sealed before beginning the installation process.



TIER 2: Projects of Moderate Investment

- ❑ What kind of venting is present? If you have soffit vents, baffles should be installed to protect the insulation from wind intrusion.
- ❑ Lastly, is there knob-and-tube wiring and if so, is it live? Insulation contractors will not install additional attic insulation if there is live knob and tube wiring.

PHOTO

5

(see page 8)

Where?

Many homeowners don't have an accessible attic. Whether cathedral ceiling, eave, or full attic, the principle remains the same – just as in the air sealing assessment, ask, “Where is the boundary between living spaces and outside, and how can that boundary be more effective?” This might require some time thinking about the relationship between spaces in your house.

How?

PHOTO

6

(see page 8)

There are countless insulation materials out there but the one that makes the most sense for the majority of Maine attics is cellulose. Because of its consistency, it can settle between floor joists and in between crooks and crannies unaddressed by the original insulation. It is also entirely removable and reversible, allowing access to utilities and accommodating future changes.

Reversibility is a key tenet of preservation and a hard learned lesson from past mistakes.

Modern materials often interact with older ones in ways we can't anticipate, and in ways that only become apparent years after a renovation. Current preservation standards require that projects are undertaken in such a manner that the essential form and integrity of the historic property and its environment remain unimpaired.

Who?

A professional insulation installer. While cellulose and other insulating materials are available at home improvement stores, insulation is only effective when installed properly. The more loft it has, the more resistant to heat transfer, and loft is easily lost each time you crawl through the attic dragging a bag of insulation behind you! It's difficult to achieve the full-coverage and reinforced air-sealing that's possible with a well-done professional job. The money you'll save in heating costs is well worth hiring a professional. Consult www.encyclopedia.org for an insulation contractor near you.

Storm Windows and/or Thermal Window Treatments

Why?

Windows are not as significant a source of heat loss as most homeowners think, but they are one of the biggest contributors to our sense of comfort, or discomfort, in the home. This is because we lose our body heat as it radiates out the window on a dark, cold, winter evening, and cold windows in a warm room increase convection currents and air movement. Window treatments, in conjunction with other energy saving measures, can reduce heat loss and air movement. Treating windows from the inside, rather than outside, significantly reduces the expense, although exterior storms might also be a solution for your home as part of your long-term energy plan.

Identify

What are your goals? Do you need to reduce air leakage, or to stop feeling cold when you sit next to the window? What kinds of window treatments do you have in place and do you want to keep them? How much light do you need? Could you leave something sheer in place that allows light to pass through? Evaluate what is already in place and determine what you would like to achieve, then, customize solutions room by room. Interior storms might not work if you have venetian blinds installed, for example. And if you love your curtains, interior storms might be a better fit than adding thermal window treatments.

Where?

Treating every window in your home can be a lengthy and expensive – but highly effective – process. Prioritize rooms where you spend the most time, and work from there.

How?

Windows primarily lose heat two different ways: air leakage and radiation. The solutions below address these two principles differently:

- ❑ **Exterior Storms:** Adding exterior storms to your home is a large-scale investment, but one that will repay you in dividends of reduced air leakage as well as the prolonged longevity of your windows. When well maintained, storm windows can last for decades. There are many frame and pane materials to choose from and all have different durability, energy performance, and aesthetic characteristics; contact the Greater Portland Landmarks Preservation Services Advisor for advice



TIER 2: Projects of Moderate Investment

about how to pick the best combination of materials for your exterior storms. If you live in a historic district, your exterior storm choices will need to be reviewed by your historic district commission.

- ❑ **Interior Storms:** In addition to caulking and weather-stripping, interior storms which fit snugly in the frame can greatly reduce air leakage and are a less-expensive investment compared to exterior storms. Interior storms are a good solution for those windows where you've previously installed plastic in the winter, and they are reusable year-to-year. No more fighting plastic sheets with one hand and hair dryers with another!



- ❑ **Cellular Shades:** Cellular or honeycomb shades trap air in their folds creating a more significant thermal barrier between you and the outside. They bounce radiant heat back in in the evening, and can be easily opened to allow for sunlight in the daylight hours. Although more costly, cellular shades which sit in tracks on either side of the window also reduce convection currents up and around the window and can reduce condensation.
- ❑ **Solar Shades:** These semi-sheer shades are black on one side and silver on the other and are great for rooms with southern exposure and/or rooms where windows can be covered for most of the day. The black side allows the shade to better capture solar radiation and augments the window and home's passive heating. The silver side reflects radiant heat back into the room so none is lost to the outside. In the summer, the shades can simply be turned around to reduce solar gain during the sunny months.

Who?

Exterior storms must be custom fit and installed by a professional. The National Trust for Historic Preservation has a database of "Old-Building Friendly Contractors" in the area available at www.preservationnation.org/resources/homeowners/map.html. As for the other solutions – you can do them yourself! Cellular and solar shades are available at most home improvement and window treatment stores and are easily installed if cut to the right size. Interior storms are available from some on-line vendors but can also be custom-built. Newer models made of Lexan are often affixed with magnets which creates a tight seal. However, because your windows are likely all slightly different sizes, building and installing interior storms yourself can ensure a tight fit for effective air sealing. There are a number of designs for interior storms available through the bibliography. Building gasketed frames out of wood and Mylar is particularly cost-effective.

Working with Preservation and Energy-Savvy Auditors and Contractors



Finding an Auditor and Contractor:

Most auditors and energy-savvy contractors in Maine are members of the Maine Association of Building Energy Professionals and are listed in the database at www.encypropros.org. In that database, you'll be able to sort by location and areas of expertise.

Efficiency Maine Trust also keeps a list of auditors and contractors who are qualified to work with homeowners as part of the PACE loan program. That list may be found at www.encypropros.org/at-home/hesp_program/find_an_energy_advisor

Certifications:

When consulting the two databases above keep in mind that your energy auditor should be a BPI Building Analyst or a HERS Rater. Most contractors specializing in energy retrofits also have these certifications, but they also might be listed as a BPI affiliate and/or an Energy Star contractor.

Questions to Ask Your Auditor or Contractor:

The following questions are recommended by Efficiency Maine Trust:

1. What kind of information will I receive from you following my home energy audit?
(Expect a list of recommended energy efficiency improvements, along with the cost and the projected energy savings of each measure.)
2. What percentage of your audits includes recommendations for heating system replacement or controls?
(Best practice is close to 100%)
3. Do you offer all the energy-efficiency services I may need following my audit? If not, do you have professionals you can recommend?
(Some homeowners are happy to manage subcontractors and prefer an independent advisor who has no financial interest in the work. Other homeowners prefer to have their advisor do the general contracting for them.)
4. What do you charge for an audit?
5. What do you charge for incentive rebate or loan processing?
6. What do you charge for the required final inspection/test-out at the completion of the job?
7. If I hire you to do the audit, and someone else to do the installation, will you still do the test-out?
8. Do you charge for air sealing by the hour or by leakage reduction?
(Efficiency Maine suggests paying for air leakage reduction, not an hourly rate.)
9. Do you have references I can contact?

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PHOTO

7

(from page 12)

Interior Storms can be home-made or purchased.
(Courtesy Innerglass Window Systems)

PHOTO

8

(from page 15)

These vinyl-faced fiberglass batts were installed against a rubble foundation after basement moisture had been eliminated.
(Courtesy Peter Taggart)



PHOTO
9
(from page 16)

Header

Casing

Pulley

Weight Pocket

Muntin

Pane

Weather Stripping

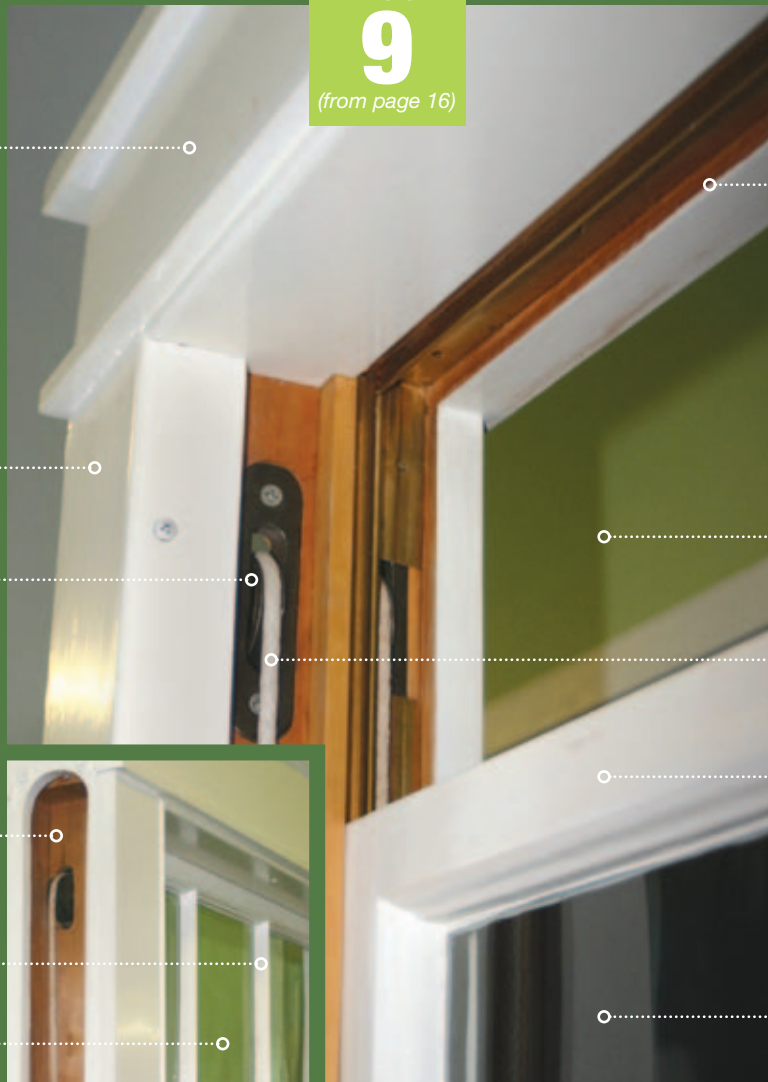
Applied to both the sash and window frame to reduce air infiltration.

Top Sash

Sash Cord

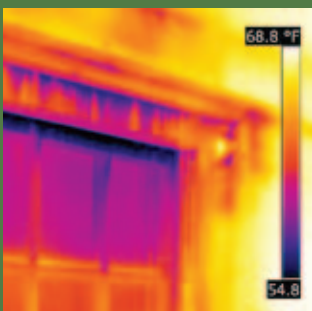
Meeting Rail

Bottom Sash

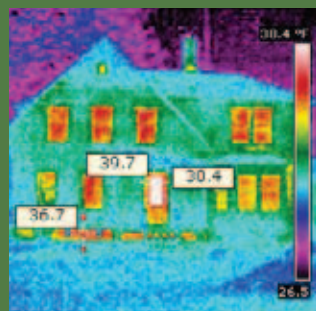


Leaky windows can often be remedied after the underlying cause or part is identified. Older windows are made of a number of different parts, allowing homeowners to undertake simple window repair projects rather than costly replacement. See the thermal image below for an example!
(Courtesy Bagala Window Works)

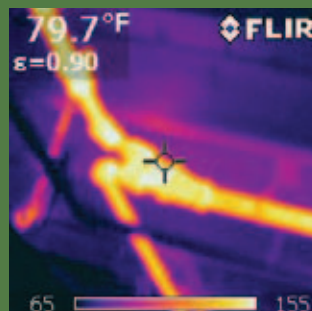
PHOTO
10
(from page 16)



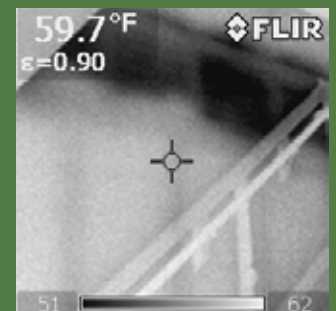
This thermal image reveals significant air infiltration where the window sash meets the head jamb.
(Courtesy Monroe Infrared Technology)



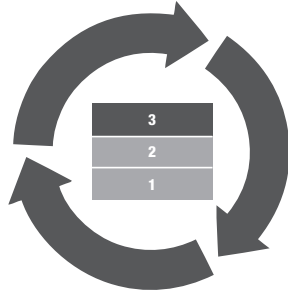
Heat loss through windows without storms is shown in red in this thermal image of an 1890s farm house.



Uninsulated pipes lose a significant amount of heat as shown here in yellow. The temperature difference between the basement and pipes is 90° F.



This thermal image reveals that the older insulation in this house has settled almost two feet down the wall cavity since it was installed.



Tier 3:

Projects Requiring Professional Guidance

Basement Insulation

Why?

A significant amount of heat is lost from the basement, in particular the several feet of foundation exposed above grade. When done properly, insulating basement walls, especially the sills and floor joist end cavities, also reduces air leakage and air movement between floors.

Yet basement walls are one of the most complicated areas of the house to insulate and seal, especially in existing homes. Careful research and consideration is required before embarking on basement insulation; basement insulation solutions must be customized to an individual house.

Identify

Do you have a full basement with a poured concrete floor? An unfinished crawlspace with a dirt floor? The solutions available will depend on your particular basement configuration and in particular your basement's moisture history. First, complete your building identification and moisture management homework from page 4.

Do not proceed with any of the insulation measures discussed below without first mitigating moisture intrusion through the foundation walls and/or floor.

Where?

Walls or Ceilings?

Many homes already have fiberglass batt insulation installed in the basement ceilings. Although this insulation can help to make the first floor above a bit warmer, insulating the

basement walls is typically a more effective solution. When paired with targeted air sealing, it creates both a thermal and air leakage boundary. This boundary is far more challenging to achieve with ceiling insulation because of the many electrical, plumbing, and other utilities extending between the basement and upstairs.

Inside or Outside?

It is possible to insulate on the exterior of the foundation, but for older homes, it is discouraged since the above grade treatment could fundamentally change the appearance of the building's exterior. However, there are opportunities to install rigid foam below grade as a way of reducing heat loss through the basement and channeling water away from the foundation. On archaeologically-sensitive sites, property owners should first consult with the Maine Historic Preservation Commission before commencing with exterior installations.

How?

Vinyl-faced fiberglass batts are draped along the foundation wall. This product is less expensive, reversible and more easily installed than the rigid foam described above, but is more subject to moisture intrusion and mildew.

Rigid foam board is a suitable basement insulation material, especially concrete foundations, and can be installed on vertical strapping applied to basement walls. Installed in this way the basement wall remains intact and



TIER 3: Projects Requiring Professional Guidance

any moisture intrusion penetrating the foundation can drain down the cavity between wall and insulation. Like spray foam, rigid foam board must be installed with a fire barrier. **Spray Foam (or Closed Cell Insulation)** is a popular basement insulation product because it acts as an excellent air sealing material as well as an insulator, and achieves a far higher R-value per inch than any other material. In general, however, spray foam insulation is not compatible with historic preservation standards, largely because it is irreversible and adheres permanently to foundation materials. In order to protect and preserve the integrity of the foundation wall construction, spray foam should be installed over a drainage mat that protects the wall behind. Spray foam must be treated with a fire retardant paint or enclosed behind drywall.

Who?

Because of the quadruple challenge of moisture management, fire codes, preserving historic fabric, and air sealing while insulating, we recommend working with an experienced insulation contractor. A list of insulation and energy professionals working in Maine is available at www.encyclicpros.org.

The Greater Portland Landmarks Preservation Services Advisor can also help you identify basement or crawlspace construction type, prioritize needs, and help prepare you for interviewing insulation contractors.

Repairing Windows and Doors

Why?

Replacement of windows and doors is typically an ineffective strategy since new windows and doors are expensive and save little energy when compared to repaired originals. Repairing windows and doors is a far more cost-effective and preservation-minded approach.

Identify

Can you locate specific windows and doors that seem drafty? A burning stick of incense in its holder may help you find sources of drafts and opportunities for repair.

Such close examination reveals that a leaky window typically requires only a minor repair: air leaks are often found around the window trim, which can easily be remedied with caulk or paint. The meeting rails of the upper and lower sashes might no longer meet tightly and the

hardware can be replaced or re-invigorated to create a tighter latch. The parting bead may be worn or missing, and is readily replaced. The window diagram might help you to better locate the particular issue with your leaky window.

Where?

Doors: Sometimes doors are seated poorly in their jambs, or unevenly if the door frame is out-of-square. Use incense or look for daylight around the door to identify opportunities for sealing or repair. Doors may perform better if re-hung. Weather-stripping around the jamb and installing a door sweep is always effective.

Windows: Windows, especially historic windows, consist of multiple components. The beauty of this is that when one part fails it is easily replaced without the expense of an entirely new window. The downside?

It might be challenging to know where to begin addressing air leaks and window repair. The National Trust for Historic Preservation recommends beginning with caulk around the window opening on the exterior; caulking around the window trim on the inside; and adding weather stripping to the window sash.

How?

Fortunately, there are countless resources for homeowners to select preservation-appropriate materials and do-it-yourself guides. We especially like the video clips available from *This Old House* at www.thisoldhouse.com/toh/windows.

Weather-stripping, rope caulk, and other basic weatherization materials are available from all hardware stores, but most conventional weather-stripping relies on adhering to one side to the window itself – a solution that sometimes removes paint when it's time to open the windows again in spring. Bronze v-type weather-strip, or zinc channel with standing flanges, are attached by brads rather than adhesive and better protect interior finishes. Whenever weather-stripping is applied to lower sash rails, be certain that several weep holes are drilled or notched to allow moisture to drain out and prevent rot.

Who?

Some doors and windows might require more than basic weatherization measures and might need more significant



TIER 3: Projects Requiring Professional Guidance

repair. Beyond the normal standard of repair, they may need to be replaced in kind. To find an old-window- and door-friendly contractor near you, consult the National Trust for Historic Preservation's map of historic repair specialists at www.preservationnation.org/resources/homeowners/map.html or contact the Preservation Services Advisor at Greater Portland Landmarks for an updated listing of qualified window repair shops in Maine.

Renewable Energy Installations

Why?

Consumption within the house can be offset by renewable energy production to reduce a home's energy and carbon footprint. That said, renewable energy installations are costly and only make sense after significant investment in energy conservation and efficiency.

Identify

Consider what kind of renewable energy solutions might be the right fit for the house and its site. There are incentives for small-scale wind installations in Maine but unless you are in a particularly windy and open spot, a wind turbine installation might not be possible or cost effective.

Geothermal heat pump systems are another option, but can be expensive for a single residential application. Many sites in Maine are candidates for solar energy installations, including solar hot-water and solar photo-voltaic, but only if the roof or yard has favorable southern exposure unobstructed by trees.

Where?

Historic homeowners should first consider ground-mounted solar arrays or locating arrays on rear additions so that the installation won't disturb historic resources like original roofing materials or framing. If that isn't possible, the primary roof is an option. Guidelines for historically-sensitive placement of solar panels are available from the National Trust, The National Park Service, and Clean Air-Cool Planet.

How?

With the help of a professional! A renewable energy installation professional will help determine if your property is a candidate for solar, geothermal, or wind energy.

Who?

Efficiency Maine provides a list of qualified installers of small-scale wind, solar thermal and photovoltaic panels at www.energymaine.com/at-home/renewable-energy.

Working with Preservation and Energy-Savvy Auditors and Contractors



CONTINUED FROM PAGE 12

10. How soon can you begin? And how quickly will my work be completed?
11. Do you provide a standard contract when finalizing my upgrade work schedule?
12. What are your payment terms and conditions?
(For example, do you require a deposit and when is final payment due?)
13. Do you require your employees to sign a Contractor Code of Conduct committing to professional conduct at the worksite?

Greater Portland Landmarks also suggests adding the following questions:

14. Have you worked in older homes before? If yes, what age and style? Were any located in a historic district?
(Finding a contractor or auditor with experience in older buildings, and/or older buildings like yours is a plus and

is particularly important for property owners with masonry houses).

15. Do you change your approach for older homes, if so, how?
(There's no right answer to this one, but your auditor should describe that many solutions, like air sealing, are universal to all homes, but that wall cavity and basement insulation will be treated a little differently in your older home.)
16. Are there specific measures that you do not recommend in older or historic homes? If so, what are they and why?
(Your auditor and contractor should be aware that window replacements are not appropriate unless in extreme cases of disrepair or energy loss, and that wall and basement insulation should be handled with extreme care. If you live in a historic district, be sure to speak with your contractor and auditor about any changes that might need historic district review.)

Consider contacting Greater Portland Landmarks' Preservation Services Advisor before hiring a contractor or auditor. This initial preservation walk-through and analysis will prepare you for any specific preservation opportunities or challenges.

For More Information:

The National Trust for Historic Preservation has a number of interviews with home energy auditors posted on their website. These are a great resource to learn more about what to expect, www.preservationnation.org/issues/weatherization/audits/

Clean Air-Cool Planet's guide "Energy Efficiency, Renewable Energy, and Historic Preservation: A Guide for Historic District Commissions" includes a number of frequently asked questions about working with an auditor and working with your historic district officers. Available at: www.cleanair-coolplanet.org/for_communities/HDCGuide.pdf



Fuel Conversion Worksheet



BTU, or British Thermal Unit, is the typical measure of energy content in fuels. Fuels are measured many different ways (gallons, cubic feet, bags of pellets) so fuel comparison relies on comparing BTUs rather than comparing the units in which the fuel is delivered.

To calculate a fuel conversion, consider the following steps:

Step 1. I currently burn _____ to heat my home. I am interested in how much energy and money I might save if I switched to _____.

Step 2. How much are you currently consuming to heat each year? This will require examining your bills. Collect as many years as possible and attempt to get an average annual fuel usage number. Average fuel consumed annually is _____.

Step 3. Determine the average price per unit for your region. This may come from your oil, natural gas, or electricity bill. You can also go to the Maine Governor's Office of Energy Independence and Security (www.maine.gov/oeis/data.html) or the United States Energy Information Administration (www.eia.gov/state/state-energy-profiles.cfm?sid=ME) or Unitil (www.unitil.com/energy-for-residents/gas-information/rates) for historic and current energy prices in Maine. How much would you spend next year at the current prices? Of course, this number doesn't get at fuel price volatility, inflation, or other changes in prices. If you would like some guidance on predicting future prices, the US Energy Information Agency has predictions for future fuel costs at this site, www.eia.gov/analysis/projection-data.cfm

$$\text{Answer from Step 2} \times \text{Cost per unit} = \text{_____}$$

Step 4: Use the table below to determine your heat consumption

Fuel	BTUs per Unit	Unit*
Home Heating Oil	138,690	Gallon
Natural Gas	100,000	Therm
Natural Gas	102,000	Cubic foot (ccf)
LPG	91,690	Gallon
Wood Pellets	16,500,000	Ton
Wood (Dried, Mix of hard and soft)**	20,000,000	Cord
Electricity	3,412	kWh

in BTUs.

$$\text{Answer from Step 2} \times \text{BTU/unit from table} = \text{BTUs}$$

*The content per unit may depend on additives or your location. This is an average BTU content.

**The weight and heat content value for a cord of wood both vary by tree species and moisture content. This is an average number.

Step 5: How efficiently am I currently burning fuel? (Get this answer by reading the efficiency number from last performed service call on your furnace or boiler. It's typically listed on a flyer hanging above or a

sticker stuck on the side. Multiply Step 4's answer by the efficiency (convert the % to a decimal). This is how much of the fuel burned gets delivered to the distribution system (i.e. the radiators or ducts).

$$\text{Answer from Step 4} \times \text{Efficiency of Current System} = \text{BTUs Delivered to Distribution System}$$

Step 6. How efficiently will you be burning your new fuel? This is a big question and will likely require some research. Efficiency ranges quite a bit depending on how much you spend on your new system. Talk to your heating contractor to see what might work for your home in your price range. You can also look at efficiency ratings for major combustion appliances at www.energystar.gov. After you get a number, divide step 5 by your new efficiency number. This will give you how many BTUs will be required to produce the same amount of heat as was delivered with the old system. If you buy a more efficient system, the answer to step 6 should be smaller than the answer to step 5:

$$\text{Answer from Step 5} \div \text{New Efficiency} = \text{BTUs Required by the New System}$$

Step 7. What does this mean new BTU number mean in terms of fuel units?

$$\text{Answer from Step 6} \text{ BTUs} \div \text{BTU/unit from Table} = \text{_____}$$

Step 8. How much money will I spend next year if I convert?

$$\text{Answer from Step 7} \text{ price/unit} \times \text{_____} = \$ \text{_____}$$

Step 9. Have I saved any money from my conversion? Subtract Step 8 from Step 3.

$$\text{Step 3} - \text{Step 8} = \text{Dollars saved in Annual Energy Expenses}$$

Step 10. How do my annual energy savings compare to the cost of installing a new unit?

$$\text{Cost of new appliance} \div \text{Step 9} = \text{Years to Pay off Investment}$$

If fuel prices remain at current year prices, I would recoup the cost of my fuel switch and appliance upgrade in _____ years.

(Answer from Step 10)





Example: Older model oil boiler conversion and upgrade to a new gas boiler

This is a very typical example. In general, you can burn gas more efficiently than oil, but a gallon of oil has more BTUs in it than a therm or ccf of natural gas. A conversion like the one below will gain in combustion efficiency, but you might end up delivering more fuel to the appliance.

Step 1. I currently burn oil to heat my home. I am interested in how much energy I might save if I switched to natural gas.

Step 2. I currently burn an average of 850 gallons of oil to heat my home as well as provide domestic hot water.

Step 3. At the current price of \$3.60 a gallon I am projected to spend \$3,060 on heating my home next year.

Step 4. Step 2 x BTU/unit

850 gallons oil x 138,690 BTU/gallon

117,886,500 BTUs annually

Step 5. Step 4 x Efficiency

117,886,500 BTUs x .83 = 97,845,795

BTUs delivered to my DHW and heating system.

Step 6. I am planning on upgrading to a 91% efficient gas boiler. (A 91% efficient gas boiler is not as efficient as they get, but I only have around \$8,000 to spend on my upgrade so it's the best fit for my budget.)

97,845,795 BTUs ÷ .91 = 107,522,851

input BTUs required for the new system

Step 7. What does this mean in terms of gas consumption (I live in Portland, gas is delivered in CCFs)?

$107,522,851 \text{ BTUs} \div 102,000 \text{ (BTUs/CCF)} = 1,054 \text{ CCFs}$

Step 8. How much money will I spend next year if I convert to gas? This is more complicated than Step 7 x current prices because the rate changes depending on how much gas I buy a month. Let's just assume that my fuel is evenly distributed over the course of the year (1054 CCFs ÷ 12 months = 88 CCFs a month). That of course is a simplification but allows us to estimate fuel usage at the higher delivery rate. The first 40 CCFs purchased every month are about \$1.20 (including delivery and supply); after the first 40, the rate is about \$1.03 a CCF.

Unitil in Portland charges a \$4.96 delivery rate. 12 months (\$4.96) + 12 months (40 CCFs x \$1.2) + 12 months (48 CCFs x \$1.03) = \$59.52 + \$576 + \$593.28 = \$1,228.80 annual cost for 2012 after switch

Step 9. How does this compare with my fuel costs if I stay with oil?

Step 3 – Step 8

\$3,060 – 1,228.80 = \$1831.20 in savings

Step 10. What's my simple payback?

Cost of new appliance ÷ Step 9 = _____ years to pay off investment

\$9,000 (including installation costs) ÷ \$1,831.20 in annual savings = 4.9 years simple payback.

If fuel prices remain at current prices, I would recoup the cost of my fuel switch and appliance upgrade in 5 years.

What if I live in a Historic District?

None of the suggestions or best practices in this document change if you live in a historic district – it is our belief that every home has a history, and has historic elements worth preserving whether or not located in a historic district.

But some of your energy improvements may require discussion with the local historic district commission. Some might require both a building permit and historic district commission approval. While there are a number of home renovation projects requiring review, the projects listed here are most likely to come up during an energy retrofit.

Please contact your local historic district if you are undertaking:

- Installation or replacement of siding
- Masonry repointing and repair
- Installation or replacement of gutter systems
- Installation of renewable energy systems and/or rooftop mechanicals
- Installation or alteration of exterior lighting
- Installation or alteration of awnings
- Re-grading and other non-vegetative alterations to the exterior
- Any demolition of the building

For an exhaustive list of those projects requiring historic district review, please contact your local planning department. For Portland residents, information is available at www.ci.portland.me.us/planning/default.asp

The Nantucket Island Historic District published guidelines for the historically-appropriate installation and siting of sustainable materials (like permeable pavers and rain barrels) and renewable energy installations (like solar panels and geothermal heat pumps). Reading their design guidelines might give you some ideas to discuss with your contractor and the review committee. Those guidelines are included in a larger document “*Energy Efficiency, Renewable Energy, and Historic Preservation: A Guide for Historic Districts*”, published by Clean Air-Cool Planet, and available for download at www.cleanair-coolplanet.org/for_communities/HDCGuide.pdf

Room by Room Checklist



Exterior

- Install motion sensors on exterior lights.
- Complete an exterior inspection every year looking for signs of water damage and drainage issues including obstructed gutters and disconnected downspouts, peeling paint, mildew, and cracked masonry.
- Remove all vegetation and roots a minimum distance of 24" from the building walls.
- Caulk all gaps in siding, and at door and window trim. Re-fasten loose siding.
- Weather-strip all exterior doors and windows. Consider adding exterior storm doors and windows if they're not already in-place.

Basement and Utility Room

- Set water heater to 120°F.
- Install a water heater wrap and wrap all domestic hot water pipes.
- Insulate heat pipes or seal and wrap heating ducts.
- Clean dryer lint trap and exhaust vent regularly.
- Air dry clothes when possible.
- Wash clothes with cold water.
- Inspect the oil furnace or boiler every year and service a gas combustion appliance every two.
- Change your furnace filters every three months.
- Inspect for water intrusion through the foundation walls, pay particular attention to efflorescence and mildew. Do not consider basement insulation until basement moisture has been controlled.
- Install a carbon monoxide detector.
- Speak with your HVAC Contractor about boiler or furnace upgrades like a modulating aquastat or limit switch.
- Air seal basement windows and add storm panels.
- Air seal pathways between the inside and outside including penetrations where utilities enter the basement.
- Air seal pathways between the basement and upstairs including utility and chimney chases.

Attic

- Insulate the attic and consider removing stored items from the attic to allow for more insulation.
- Air seal penetrations between the attic floor and the floors below including the chimney chase, plumbing vents and recessed lights.
- Insulate and weather-strip attic access point, whether door or hatch.

Kitchen

- Rinse dishes in cold water and use the "energy saver" no-heat setting on the dishwasher.
- Install an aerator on the kitchen sink faucet.
- Vacuum the refrigerator coils to ensure efficient functioning.
- Consider ENERGY STAR models when replacing any home appliances.
- Ensure kitchen exhaust fan is working properly and exhausting outside.
- Install a carbon monoxide detector if cooking with gas or propane.
- Ensure that radiators and vents heat effectively by removing furniture and other obstructions.
- Install interior storms or thermal window treatments.
- Air seal windows.

Living Spaces

- Install programmable thermostats.
- Change incandescent bulbs for more efficient bulbs like compact fluorescents or LEDs.
- Ensure that radiators and vents heat effectively by removing furniture and other obstructions.
- Install thermal window treatments.
- Air seal windows.
- Install interior storms if exterior storms are missing.
- Close chimney flue and add chimney balloon when not in use.
- Put electronics on a smart strip and turn off when not in use.
- Take advantage of the energy settings on your computer and printer.
- Consider ENERGY STAR models when replacing any home electronics.
- Install a carbon monoxide detector on every floor with a bedroom.

Bathroom

- Install a low-flow shower head and an aerator.
- Ensure the bathroom fan is functioning properly and exhausting outside.
- Air seal windows.
- Air seal plumbing chases between the bathroom and basement.

