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# THE HONEST BOOK OF HOME ENERGY SAVINGS

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guide for **New England**



**Helpful for Renters, Landlords and Homeowners**

HEET (Home Energy Efficiency Team) is an EPA-award-winning grassroots nonprofit.

We have worked in hundreds of buildings—from tiny homes to historic churches, from homeless shelters to apartment buildings. We have taught over 3,500 volunteers hands-on skills in saving energy and water and money while we fixed up actual buildings.

We know how to reduce energy and water use, as well as how to teach these simple but critical skills. This book is the result.

Written by: Audrey Schulman, Jason Taylor, Jeremy Marin, Bill Donaldson, Jesse Gorden and Rob Riman

Editing and research by: Jesse Gorden and Susan Altman

Reviewing help by (although all errors are still the writers'): Michael Blasnik, Kerry Koskinen, Zachary McArthur, Ninya Loeppky, Patricia McDonald, Chris Babcock, Kevin Bright, Jim Devine, Judy Diamondstone, Bill Donaldson, Katherine Fisher, Paula Garcia, Marin Goldstone, Jonathan Hunt, David Kelman, Patti Keville, David Levy, Vince Maraventano, Paul Markowitz, John Moore, Peg Preble, Susan Redlich, Harold Simansky, Jamie Simpson, Rachel Stevens, Matthew Schreiner and Fay Strigler

Advice offered by: Bill Donaldson, Michel Clapham, Michael Gineires, Barbara Taggart and Jade Mortimer

Design and layout by: Susan Altman

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# introduction



## efficient |i'fi sh ənt|

*adjective*

Achieving maximum productivity with minimum wasted effort or expense.

Working in a well-organized and competent way.

Preventing the wasteful use of a particular resource.

### **This book shows you how to:**

- Save on energy and water bills
- Reduce your reliance on fossil fuels
- Keep money in the local economy
- Reduce your impact on the planet
- Decrease drafts in your home
- Reduce the ways vermin can enter your home
- Decrease street noise in your home

### **Why Energy Efficiency?**

Because you're smart. Energy efficiency is financially savvy, environmentally good, benefits the local economy, and improves the comfort of your home.

### **Maximum productivity**

Efficiency means to get the work you want done using less energy.

Residential energy efficiency has come a long way. There are now a lot of off-the-shelf technologies that can help you radically reduce your energy use.

### **Great investment**

The average stock market investment returns between 4 and 10%. According to the Lawrence Berkeley National Lab, the average residential efficiency project [returns 16% interest](#).

And the money you spend on efficiency will probably go to a local contractor who will spend it in the local economy. That's way better than pumping the money overseas.

### **Wise and moral**

Efficiency reduces our climate-changing emissions. We live on a gorgeous planet,

the very best we know of in the universe. Help preserve the planet you want your children and grandchildren to grow up on.

Why wait passively for someone else to fix the problem, when you can accomplish something good today?

### **Join the community**

More and more people are reducing their energy bills and planetary impact through efficiency, because it is practical and easy to do. Join your neighbors in saving energy.

Amory Lovins (MacArthur Genius Award winner!) of the Rocky Mountain Institute calls energy efficiency the:

- largest
- least expensive
- most benign



- most quickly deployable
- most neglected way to provide energy services

Nega-watts (watts that are not used) are the greenest energy source we have. Energy efficiency is our first and least expensive renewable energy.

### **Why This Book is Better**

#### **Specific to New England**

Many energy-savings books report energy savings for the entire country, as though you'll save the same amount from installing an efficient furnace in New Mexico as in Wisconsin. That's ridiculous.

This book reports the specific energy, water and money savings for New England—given our climate, fuel costs, the types of fuels we use, and our building stock.

#### **Individualized**

We include easy-to-use calculators so you can enter your own fuel prices and energy use to get utterly individualized results that show what you'll save in money, water and carbon emissions for each work item.

#### **Accurate**

We give you accurate energy savings estimates so you can figure out what actions to prioritize.

We get the majority of our energy saving information from Michael Blasnik, the residential energy-efficiency expert who has analyzed more energy bills before and after upgrades than just about anyone else in the country. He's currently analyzing the energy bills for the evaluation of National Weatherization Assistance Program and has done research and evaluation work for many government agencies and utility companies. We're lucky he even answers our phone calls.

#### **Expert**

As an EPA award-winning nonprofit, we have worked in hundreds of buildings from small apartments to historic churches. We know what we're doing.

#### **Clear**

We tell you how hard each task is, how much time it will take and what tools you'll need. We give step-by-step instructions with clear photos and links to sites that sell the

materials. We even share with you any discounts we have with local manufacturers.

We are energy-efficiency zealots. We want to make this work easy to do so you can start saving today.

#### **Hiring professionals**

For those tasks that are best done by a professional, we'll explain how to figure out if your home needs the work, then how to find a good contractor and how to check the job was done right.

We even have links to the rebates and services available in your New England state. This will help you get the work you need done for the least amount of money.

#### **Good news**

Given our vast energy use, the U.S. could be the Saudi Arabia of energy savings. You literally have an energy gusher in your own home. With a little effort you can harvest that energy and money savings in your bathroom, your attic and your kitchen.

# how to use this guide

This is a practical how-to guide that ranges from the do-it-yourself work to more advanced tasks that you might need a contractor to do.

Most of these tasks cost less than \$50 to do and have a 100% return on investment in a few months. Imagine a bank account that had that sort of return.

There are four sections of the book:

- Saving Electricity
- Saving Water
- Saving Heat
- Professional Work

Each section starts with the easiest tasks and ends with the hardest ones.

The book will make the most sense if you start from the beginning and read straight through. If you choose instead to start working on a task without reading the whole book first, then make sure to look up any confusing terms, tools or materials.

## Renters

Over 30% of Americans are renters.

If you are a renter, look for this



moving box icon. These are the tasks you can perform to lower your energy use and bills without irking your landlord. In some cases, such as the Saving Water tasks, the landlord will appreciate you doing the work since it will decrease his/her water bills.

## Hungry for energy and money saving?

Look for this elephant icon next to a task. Each elephant means by performing this task you can save up to 10,000 pounds of CO<sub>2</sub> per decade (as well as all the money it takes to waste that energy). If you see more than one elephant next to a task, you can save more than 10,000 pounds.



## Calculators

Every place you see a calculator icon is a place where you can link to one of our web-based calculators. In these calculators, you can enter your fuel costs and lifestyle choices to figure out which tasks will save you the most.



## Information you need

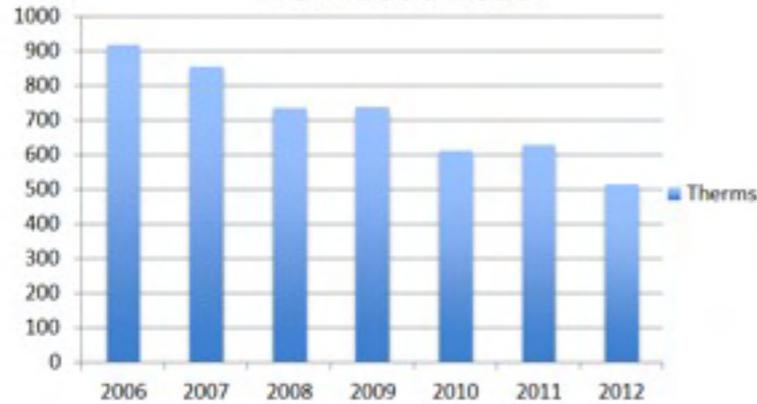
You know those lists you get in the mail called something like “Ten Actions to Fight Climate Change”?

Some of those tasks, like adding insulation, will save hundreds of dollars a year. Others, like unplugging your cell phone charger, will save you less than \$1 per year. We don’t want you to spend a year anxiously unplugging your cell phone charger, because—if you see no real reduction in your energy bills—you might grow discouraged and give up.

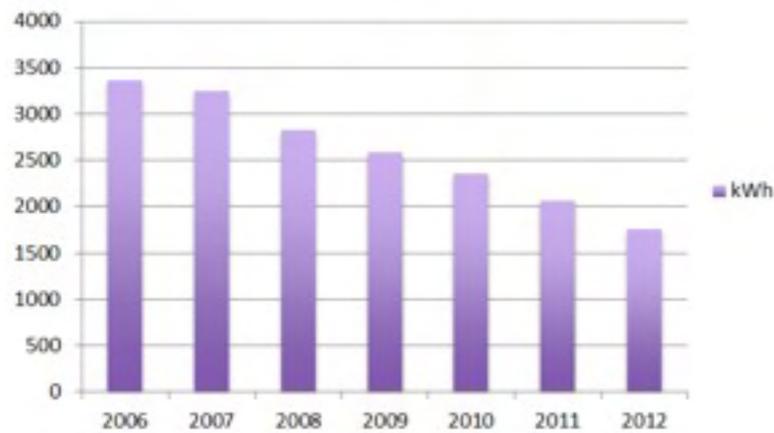
We want you to concentrate on actions that will save you energy—both fossil fuel energy and your own. We are giving you the information you need to figure out which are the most effective actions to take.

We want this book to be the start of your energy-efficient lifestyle.

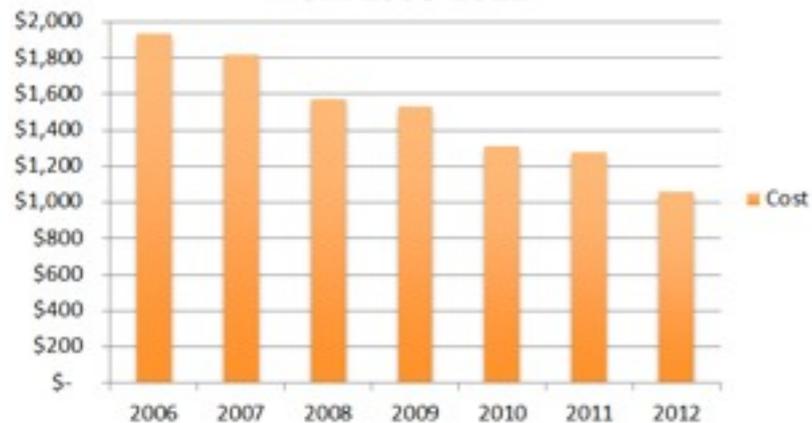
**Natural Gas Use at Audrey's House  
From 2006-2012**



**Electricity Use at Audrey's House  
From 2006-2012**



**Cost of Energy Use at Audrey's House  
From 2006-2012**



*When my husband and I moved into a 100-year-old house in 2000, it was so drafty we couldn't go into the dining room in the winter without wearing mukluks. Since I don't like being cold or wasting energy, I started sealing up holes in the basement with mortar, installed CFLs, had cellulose insulation blown into the attic, etc.*

*With a little work each year, I've reduced our energy use almost 50%. Now there are no drafts. The dining room is comfortable all year round, we can't hear as much street noise and there are no more creepy crawly creatures in the basement. Our annual heating and electricity bills total under \$1,100 for a family of four.*

*- Audrey*

## Good deals

In the Tools & Materials listed as needed for each task, we include web links to any unusual items so you can click on the link to buy what you need. Most of the links go to Energy Federation Incorporated ([EFI](#)), a New England nonprofit that supplies energy-efficiency tools and materials. If you want any of the EFI materials or tools, then contact EFI at 800 876 0660) and mention HEET. Whenever EFI can, it will give you HEET's 8% below wholesale rate and ship the item so it arrives the next day.

We don't make any money on these sales. Please use the money you save to do more energy efficiency work, or spend it on the people you love.

saving electricity



## **Kilowatt Hours (kWh)**

On your electricity bill you are billed for kWhs. Many people don't know what that means; they just pay the bill.

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A kWh (kilowatt hour) is 1,000 watts used for one hour. It's the amount of electrical energy you'd use if you turned on 10 light bulbs that each used 100 watts and left the bulbs on for one hour.

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Here in Massachusetts, one-kilowatt hour currently costs us 14 cents (if you add in all the surcharges including for generation and transmission). It also emits an average of 1.28 pounds of carbon dioxide at the power plant where our electricity is made. That doesn't sound like so much, but each of us uses a lot of kilowatt hours.

The average home in New England consumes 7,500 kWh per year, emitting 9,600 lbs. of carbon dioxide through our electricity use alone. This is almost as much as the average passenger car emits each year.

Altogether this much electricity costs \$1,125 per year per home. That's a chunk of change, and if you picture all the homes in New Eng-

land, you can imagine that's a lot of carbon being pumped into the sky. Along with the damages of climate change, pollution like this [increases the risk of heart disease, lung cancer and asthma attacks](#).

## **Electricity Production**



In [New England](#), electricity is created primarily by natural gas (43%), oil (22%), nuclear (16%), and coal (8%). The techniques used to process those fuels—ranging from hydraulic fracturing (a.k.a. fracking) to mountaintop removal to nuclear reactions—have problems associated with them. The less we can use of these problematic resources, the fewer problems we will cause.

Also at every step in the process of delivering electricity –from burning the fuels at the power plant to moving the power along transmission lines– there are inefficiencies that cause some of the power to be lost. The result: [60% to 70% of the original energy of the fuel is lost before it ever reaches your home](#).

## **Scale of the Problem**

It's hard to comprehend the scale of our household carbon dioxide emissions. A pound of carbon, a thousand pounds, what does it all mean?

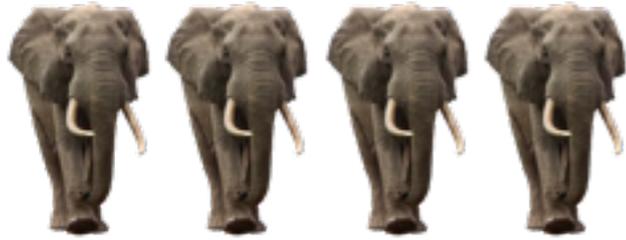
An African bull elephant weighs around 10,000 pounds.

Every year the average New England household emits roughly one African bull elephant in carbon through electricity use.

Each household emits another elephant through heating use, and another elephant per car the household owns. The average American household owns two cars.

That's a total of four elephants of carbon emissions per home.

Imagine those four elephants in your backyard or in your driveway.



Now add on the elephants from last year.

And the year before that and the year before that.

You've been producing that many elephants every year for decades. So has every one of your neighbors.

This book will help you reduce your energy use by as many elephants as possible over the next decade.

Throughout the book, since we don't know your particular fuel costs, we will use the current average kWh and therm costs in Massachusetts.

In our energy-saving calculators, you can input your own fuel costs to get your individualized saving estimates.

# your electricity price scanner



The way electricity use is billed is crazy.

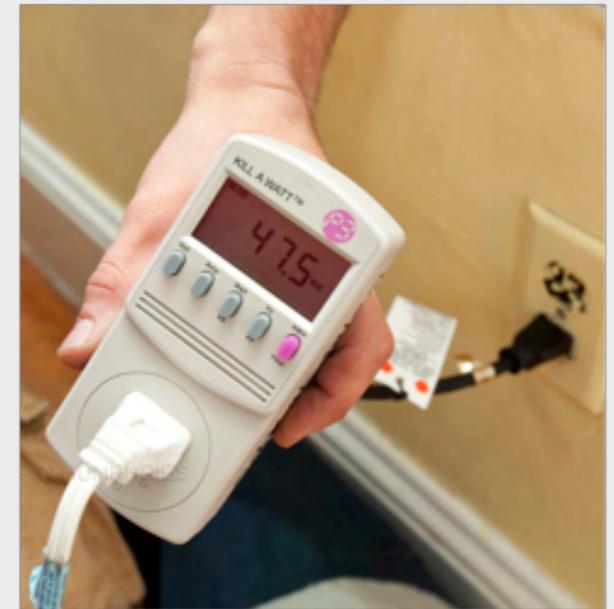
It's as though you go to a grocery store with no prices on any item. You fill your shopping cart with artichokes, macaroni, steak and Cheerios, and then leave without paying for anything. A month later the bill arrives at your home. The bill just shows the total amount owed; nothing is itemized.

Given this process, you have no idea how to reduce your bill effectively. You don't know how much the steak costs in comparison to the Cheerios. Through your lack of knowledge, you are made helpless.

Different types of appliances from your fridge to your printer will vary tremendously in how much electricity they use. And even the same type of appliance—say a TV—will vary a lot depending on many factors such as its age, size or model.

Luckily there is a price scanner for your electricity use.

## Your electricity price scanner



A [Kill A Watt electricity meter](#) allows you to learn how much electricity an appliance is drawing, both when the appliance is on and off.

By using the Kill A Watt meter on all of your appliances, you learn how much each is costing you, and you can figure out which appliances seem a bit greedy in terms of how much electricity they are taking versus the service they are providing you.

With the greedy appliances you have a variety of alternatives:

- Turn them off when you aren't using them.
- Choose a different appliance that uses less energy. For example, if you like background noise during the day, you might try leaving a radio on rather than that large-screen TV.
- Switch the appliance out for a more efficient appliance, for instance a TV that uses fewer watts.

For more information on these and other methods in reducing the use of your greedy appliances, keep reading.

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**Tip:** If you live near the Greater Boston area, you might be able to check out a Kill A Watt meter from the library and use it for two weeks for free. Request one now from the [Minuteman Library System](#). The librarians will notify you when it's available and have it at the front desk for you to pick up. If your local library isn't on the Minuteman System and doesn't have a Kill A Watt to borrow, talk to a librarian to suggest getting one. Most librarians will love the idea.

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### Calculating your kWh cost

Electricity bills are pretty confusing. There are so many different charges listed at different rates, it's hard to figure out how much you're actually paying per kWh.

In order to calculate the cost per kWh, ignore everything on your bill except the Customer Charge, the total number of kWhs you've used this month and the total amount of money you owe this month.

Subtract the Customer Charge from the total amount of money you owe this month and then divide the result by the number of kWh used:

$$\text{\$94.31 total bill} - \text{\$6.87 Customer Charge} = \text{\$87.44}$$

$$\text{\$87.44} / \text{624 kWh} = \text{14 cents per kWh}$$

How-to Section



### How to use a Kill a Watt electricity meter

- Benefit: **Knowledge to act**
- Level of difficulty: **Easy**
- Cost: **\\$19 or free from some libraries**
- How long it takes: **About a minute**
- Tools & materials: [Kill A Watt meter](#) and **an electric appliance**

The Kill A Watt link above takes you to Energy Federation Incorporated ([EFI](#)), a New England nonprofit that supplies energy-efficiency tools and materials. If you want any of the EFI materials or tools, then contact EFI (800 876 0660) and mention HEET. Whenever EFI can, they will give you HEET's 8% below-wholesale rate and ship the item so it arrives the next day.

1. First, unplug your appliance. Plug the Kill A Watt meter instead into the outlet,

then plug the appliance into the Kill A Watt and turn the appliance on.

2. Press the center button on the Kill A Watt that says *Watt*. (You might have to press it a second time so the screen says *Watt* rather than *VA*.)
3. The Kill A Watt screen will display how many watts the appliance is using while it is on.

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**Tip:** Some appliances like fridges, freezers or dehumidifiers will cycle on and off over time. For them, you will need to leave the Kill A Watt plugged in for 24 hours to get an accurate reading. For directions on how to do this see our “Old or Second Fridge” chapter.

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# “vampire” loads



Some appliances draw electricity from your wall even when they're not "on."

Frequently this "vampire" or "phantom" load is providing you a service you don't really need, such as the ability to turn on your TV with the remote control even when you're asleep or away.

If you have a lot of these vampires in the house, they can add up to [10% of your electricity use](#).

If you aren't okay with that waste, use a Kill A Watt meter to check your appliances for a vampire load.

The most likely vampires are the appliances that have large clunky plugs, use remote controls or have LED displays that are always on. These are the ones to check first.

Some of the most expensive vampire "services" that appliances provide to you are:

- The DVR patrolling the cable channels 24/7 for that that one weekly show you like to record.
  - The cable box always being on, even when you're at work or asleep.
  - The stereo and TV always ready to be turned on with the remote control.
- For more information, check out [Forbes' list of the 26 worst offenders](#).

To show how energy savings add up over time, our savings are calculated in terms of a decade. Thinking this way makes sense, since you probably want to have a bank account and be living on this planet then.

All our saving estimates use current Massachusetts therm and kWh costs and assume a 1.5% increase in energy costs per year.



## How to reduce vampire loads

- Energy savings per decade: **Up to \$602 and 4,800 lbs. CO<sub>2</sub>** assuming you cut your 10% vampire load in half
- Level of difficulty: **Easy**
- Cost: **\$60 to \$120** (assuming you need three power strips)
- How long it takes: **1 hour**
- Tools & materials: **Kill A Watt meter, your appliances, the appropriate power strips**

1. Unplug an appliance.
2. Plug the Kill A Watt meter into the outlet, and then plug the appliance into the Kill A Watt.
3. Press the center button on the Kill A Watt that says *Watt*. You might have to toggle it until the screen says *Watt* instead of *VA*.
4. Make sure the appliance is off.
5. If the Kill A Watt shows that the appliance is still drawing energy (i.e., the watts number shown on the screen

doesn't go down to 0.0), then the appliance is a vampire.

6. Use our [Vampire Load Calculator](#) to figure out how much it's costing you.



7. If the vampire load from an appliance is more than \$10 a year and you don't need the "service" the appliance is providing you when it's off, then it might be worth plugging the appliance into a power strip and the power strip into the wall. That way when you don't need the appliance, you can *really* turn it off by clicking off the power strip.

Any time the power strip is clicked off, the vampire appliance won't be able to suck any electricity at all.

There are a lot of great power strips for different applications, and companies are coming up with more every day. Here are some of our favorites:

- [Belkin Conserve](#) is helpful for entertainment centers. It automatically turns off the peripheral devices plugged into it (such as speakers and monitors) when you turn off the main device (such as the TV). This means you can click off the TV with your remote control as normal, and all the speakers and monitors will magically turn

off too. Here's a [video](#) explaining it. Costs about \$30.

- The [Belkin Conserve Remote power strip](#) comes with a switch that works as a remote to turn the



power strip on or off. The switch has an adhesive on the back, so you can stick it on the wall in some convenient location to flick off the power strip when you leave the room, the same way you'd turn off a light. This helps if the power strip is located somewhere that's difficult to reach or if you don't tend to remember to click off the power strip if the switch isn't handy. Costs about \$40.

- [Home Depot programmable power strip](#) allows you to program the power strip so it turns off automatically at night when you're sleeping or during weekdays when you're at work. You can program the power strip once and never have to remember to turn everything off again.

Smart. It works well with cable boxes and DVRs to turn them off for those hours you are not watching or recording shows. Program them to turn back on before you need them so they have enough time to warm up and reset.

- An [appliance timer](#) (OK, this isn't really a power strip) turns your appliances automatically on and off at different times during the day and night using simple green and red pins. It's not as slick as some of the other options and you can only plug one appliance into it, but it costs just \$11.

\* \* \* \* \*

It's frequently hard to figure how best to reduce our impact on the planet. How do we value the energy needed to make and transport the power strip (i.e., the embodied energy) versus the electricity we'd be wasting without it?

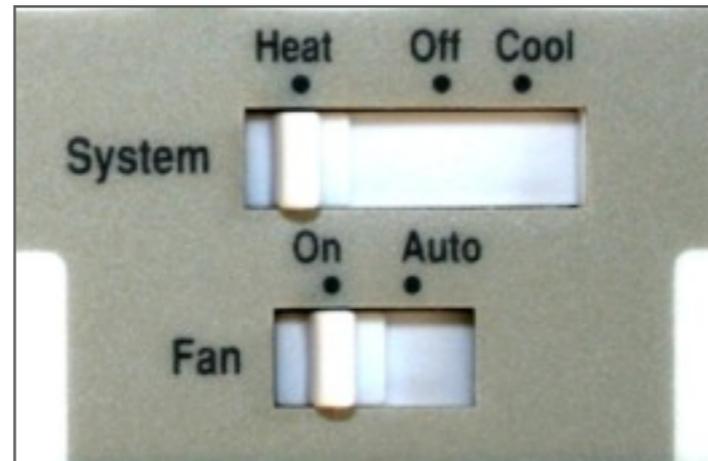
Let's consider money as a proxy for the planet's resources. If the cost of the power strip will return its investment within three years through a savings in fossil fuels, then not only our banker, but the planet and our children would probably all agree it's a wise action to take.

# set your furnace fan



Here's the easiest way to save energy ever.

Your thermostat probably has a little switch on it to control the fan in your heating system.

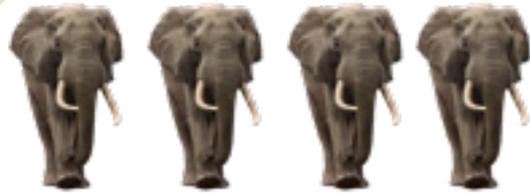


If you have forced hot air for your heating system, then turning that switch to *On* keeps the furnace fan whirring constantly every hour of the day every day of the year. That fan is then trying to circulate the heat from the furnace even when the furnace is off—even in the middle of the summer.

(The same is true if you have central air conditioning. The fan again will be on, even when the air conditioner isn't, trying to circulate the cool air).

To make matters worse, these fans tend to be wildly inefficient.

Switching it to *Auto* turns the fan on only when the furnace or air conditioner turns on.



## How to switch your furnace fan setting



- Energy savings per decade: **\$5,619 and 44,800 lbs. CO<sub>2</sub>**
  - Level of difficulty: **Easy**
  - Cost: **\$0**
  - How long it takes: **10 seconds**
  - Tools & materials: **Your finger**
1. If you have forced hot air heat (i.e., no radiators in your home, but those vents with metal grates), walk over to your thermostat now.
  2. See the button that says *Fan?* If it is set to *On*, switch it to *Auto*.
  3. You just saved \$525 in electricity per year.
  4. Check the thermostats at your neighbors', friends' and relatives' homes also. If any of them have forced hot air and the Fan switch set the wrong way, flip the switch to *Auto* and then ask

them to take you out for a nice dinner. They owe you.



**Myth buster:** Some people like to keep the fan on all the time. They believe:

- They are making their air cleaner by filtering it. Unfortunately normal furnace and air conditioning filters don't filter air very effectively unless you have some fancy filtration set up (that was installed well).
- The fan will keep them cooler in the summer or will mix air better in the winter. However, if the ducts run outside the heated and cooled part of the building (for instance into the attic or a crawlspace), then the air moving through the ducts will lose heat in the winter and cold during the summer making the home more uncomfortable and increasing the energy bill even more than we've estimated here. In addition, in the summer the fan power will add extra heat to your home you don't want.

# CFLs



## Modern technology

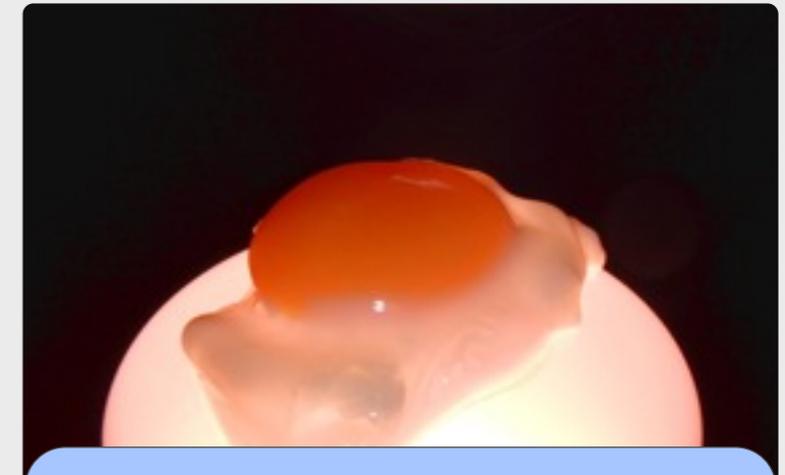
Incandescent light bulbs were invented in the 1800s, around the time people considered a horse and buggy a fast way to travel.

The out-of-date technology heats up a metal filament inside an incandescent to such a high temperature that light is emitted as a *byproduct*. You could cook an egg on top of most incandescents. All that heat is wasted fuel and money.

A compact fluorescent light bulb (CFL) uses a much more modern technology. CFLs use electricity and argon gas to excite phosphor to emit light. This is such an efficient process that CFLs only need about 25% of the energy to produce as much light as an incandescent. Touch a CFL bulb when it's on and you'll feel how little electricity it wastes: it's almost cool.

Since a CFL isn't being heated all the time to absurdly high temperatures, a well-made one will last eight times longer than an incandescent. Thus it also

You CAN cook an egg on an incandescent light!



Click on the link to see our [great photos](#) of cooking an egg on an incandescent light bulb.

wastes less of your time climbing a ladder to switch out your bulbs.

## Warm light

CFLs have come a long way since they first came to market. They now have the same warm light as the incandescent bulbs you are used to.

## Money-saving

Switching out an incandescent for a CFL is way better than money in the bank. The money you invest in a CFL—which you install in place of an incandescent—results in a nearly 600% annual interest rate at Massachusetts' kWh cost (assuming you leave the light on about 3 hours per day on average and the CFL costs \$1.25).

## Carbon-saving

By switching out an incandescent for a CFL that emits the same amount of light, you will save roughly as many pounds of CO<sub>2</sub> per year as the number of watts of the original incandescent. In other words, a 60-watt incandescent replaced by a CFL saves about 60 pounds of CO<sub>2</sub> per year.

Replacing 20 incandescents will save over a decade the same amount of CO<sub>2</sub> as taking a passenger car off the road for a year. If you like to drive but want to reduce your CO<sub>2</sub>, then trading out your incandescents is the first step you should take.

## Embodied energy

Don't wait for your incandescent bulbs to break before you replace them. Switching them out for CFLs will earn back the embodied energy within two months.

## Calculate your savings

To get a more accurate estimate of how much you can save given your kWh costs and lighting needs, use our [CFL Calculator](#).



## Buying tips

- If you want the warm soft light of an incandescent, buy CFL bulbs that say they have *soft light* (otherwise known as 2,700 to 3,000 Kelvin).
- In general, *divide the wattage of the incandescent by four* to get the right wattage of a replacement CFL. So if you have a 60-watt incandescent, you should buy a 15-watt CFL, which will give off light as bright as the incandescent. (Lumens are how lighting experts measure how much light a bulb produces, but the lumens-to-watts ratio is so complicated it would take a dissertation to explain.)
- Buy CFLs that have the *Energy Star label* on the box. These bulbs turn on quickly rather than taking a moment to warm up to their full brightness (unlike the previous generation of CFLs). In order to turn on fast, these CFLs get a short electrical burst of higher wattage to warm them up instantly. This burst of higher wattage is only for a fraction of a second so the bulb still uses much less than your old incandescent.

- Buy the right kind of CFL for your needs. There are nearly as many specialized CFLs as there are incandescent bulbs. If the application is specialized (a recessed or outdoor location, three-way switch or dimmer circuit), make sure the CFL will work in that application.



- If you want a CFL to work with a motion sensor, make sure to get a motion sensor that says it is CFL-compatible. Motion sensors designed for incandescent bulbs confuse the CFL ballasts and can cause strobe-like effects.

If you are having a hard time finding the right bulb, call EFI (a Massachusetts energy-efficiency nonprofit, 800-379-4121). They will advise you and deliver the right bulb to your doorstep the next day. If you don't like EFI, try any other supplier with on-staff experts.

## How-to Section



### How to install CFLs

- Energy savings per decade: **\$1,187 and 9,461 lbs. of CO<sub>2</sub>** (for 15 CFLs of 17 watts each)
  - Level of difficulty: **Easy**
  - Cost: **Under \$30**
  - How long it takes: **1 hour to buy and install bulbs**
  - Tools & materials: **The right kind of CFL for each fixture, potentially a ladder**
1. Turn off the light source and unscrew the old incandescent bulb.
  2. Throw it away.
  3. Screw the CFL into the socket.
  4. Turn it on to make sure it works.

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**Tip:** Keep the CFL on this first time for at least 20 minutes to let it “burn in.” This allows the ions to fully activate, giving you a brighter glow every time you turn on your new bulb in the future. If it’s a dimmable

bulb, give it a few hours at full light the first time before turning it off.

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**Tip:** When picking up or working with the CFL, hold onto the metal bottom as much as possible (not the glass part) to ensure you don't break the glass.

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#### If a CFL shatters

CFLs contain a pinpoint of mercury, a toxin that should be avoided, especially by children and pregnant women. However, a broken CFL is not a hazmat site, since mercury doesn't get airborne easily. If you leaned over a broken CFL, sucking in as much air as you could, you would only absorb about as much mercury as is in a single can of tuna. Just skip your tuna sandwich that week.

If a CFL breaks or cracks:

1. Air out the room.
2. Wipe up the area with wet napkins or paper towel.

3. Put the remains and paper in a plastic bag, tie it shut, and recycle it at a hardware store.
4. *Never vacuum it*, because that will put the mercury into the air where you could absorb it through your lungs.

Even though incandescents don't have mercury in them, they emit *more* mercury through the electricity they waste. Half of the electricity in this country is created by burning coal. Burning coal emits mercury (and a lot of other toxins) into the air. The airborne mercury rains down into the sea where it moves up the food chain into tuna (a predator). Since incandescents use more than four times as much electricity as CFLs, they pump more than four times as much mercury into the air.

If you can't stand adding an incandescent to a landfill, you could try making it into a Christmas ornament. Dip it in Elmer's glue, then roll it in sparkles and tie a wire around the base to hang it from. Sell all your old incandescent bulbs as ornaments to raise money for a good cause and to point out that incandescents should now only be used as ornaments.

Thus, you have a choice.

Either you can have your children eat your wasted energy as mercury in their tuna sandwiches, or you can use energy more efficiently, keeping the mercury in your CFL where you can recycle it at the end of its life.

### **When a CFL stops working**

Recycle the bulb by bringing it to a Home Depot, Lowe's, or most other hardware stores. Or check with your Department of Public Works to see if it will accept CFLs for recycling.

### **Possible problems**

If your CFLs are burning out quickly, you might be:

- using non-dimmable CFLs with a dimmer switch. Buy dimmable CFLs instead.
- using a standard CFL with a three-way switch. Buy a three-way CFL instead.
- using non-exterior CFLs outside. Buy CFLs meant for temperature extremes and wet locations if they are going outside.
- buying badly made CFLs. Buy CFLs with an Energy Star label. They have quality control.
- experiencing something wrong with your electrical system so that a low wattage is

constantly running through your wires. Get your electrician to take a look.

### **Don't get ripped off**

For non-specialized CFLs, don't pay more than \$1.50 per bulb. You can get deals at Home Depot and Lowe's. Save the money for all the other efficiency items you'll want.

For more info on CFLs:

- [Energy Star info on CFLs](#)
- [Rocky Mountain Institute report on CFLs](#)

# LEDs



Light Emitting Diode (LED) light bulbs use one-fifth the energy of incandescent bulbs to produce the same amount of light.

Using the same technology as the LEDs that display the time on your microwave or clock radio, LED light bulbs can use a combination of many diodes to create nearly any color you want, including the same “warm” light you are used to with an incandescent.

LEDs are preferred by many people who have a hard time finding CFLs for certain fixtures in terms of color rendition, fast start-up, etc. If you didn't like a CFL in a certain spot, you might find you like an LED there.

### **Dimmable, and with no mercury**

LEDs can dim about as well as incandescents (if you buy dimmable LEDs). Unlike CFLs, they contain no mercury. If the pinpoint of mercury in CFLs makes you nervous, then buy LEDs.

### **Lasts 30 years**

With the average use of three hours a day, an LED will last 30 years. That's 30 times longer than an average incandescent, and three times longer than the average CFL.

With this life span, LEDs would make a great wedding gift, because the gift could be passed down to the couple's children. Maybe even the grandchildren.

### **Less work**

Install them in all your hard-to-reach light sockets or where the light is on all the time, so you won't have to replace them for many years.

### **50% off sale**

Because LEDs are basically computers, Moore's Law applies. This means that, as with a computer, the same LED bulb this year will cost you roughly 50% less than it would have cost last year.

A warm light LED equivalent to a 60-watt incandescent cost \$30 in 2011, \$15 in

2012, and by 2013 it should be under \$8. If you don't like CFLs, rush out and get LEDs now. Each will save you a lot of money and carbon.

#### Different types of LEDs



#### Nega-watts are smart

Start off with the LEDs. Then, when you do install solar panels, you won't need as many since you've already reduced your electrical use enormously.

Also, with LEDs, you don't have to figure which solar installer to call, fill out lots of paperwork or wait months for the product to get installed. You can just do the work yourself today.

#### The inside of an LED



You currently can earn 400% more by *saving* a kWh with an LED (that you install in place of an incandescent), than you will by creating a kWh with solar electric panels. See our [LEDs versus Solar Panels calculator](#).

#### Calculate your savings

To get a more accurate estimate of how much you can save given your kWh cost and lighting needs, with our [LED Calculator](#).



How-to Section



#### How to install LEDs

- Energy savings per decade: **\$1,239 and 9,881 lbs. of CO2 (with 15 LEDs of 13-watts each)**
- Level of difficulty: **Easy**
- Cost: **\$225 for 15 LEDs**
- How long it takes: **1 hour to buy and install the LEDs**
- Tools & materials: **the appropriate [LEDs](#) and perhaps a ladder**

1. Find the right LED for your application.
- As with incandescents or CFLs, there are different bulbs for every application. If you want an LED for a dimmer switch, make sure to get a dimmable LED. If you want a warm light similar to the kind you're used to with an incandescent, look for a bulb labeled "soft" light (2,700 to 3,000 Kelvin).
- In general, divide the wattage of the incandescent by five (and then add a few watts) to get the right wattage for

the replacement LED. A 60-watt incandescent should be replaced by a 13 or 14-watt LED.

- Here are some good websites to find the bulb you need. You should be able to get someone who works there to advise you.

[EFI](#)

[Lowe's](#)

[Home Depot](#)

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**Tip:** You can also look for LED bulbs in your local computer store, because they basically are computers inside a glass.

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2. Unscrew old incandescent.
3. Screw in the new LED.

\* \* \* \* \*



# fridges and freezers

There's no need to keep your milk freezer solid in your fridge. Keeping your fridge this cold wastes energy and damages many foods.

- The ideal temperature for a fridge is 39°F.
- The ideal temp for a freezer is 0°F.

Type to enter text



Here's one handy fridge and freezer thermometer that has markings on it to show the correct temperature for both fridge and freezer.

## How to change your fridge or freezer temperature

- Energy savings per decade: **Up to \$289 and 2,304 lbs. CO2** (assuming you increase the temperature 6° on a 15-year-old side-by-side fridge)
- Level of difficulty: **Easy**
- Cost: **\$0**
- How long it takes: **A couple of minutes, over a day or two**
- Tools & materials: **A thermometer**

1. Put a thermometer in the fridge or freezer.
2. A few hours later check what the temperature is.

3. If your fridge or freezer is too cold, move the temperature dial to adjust the temperature upward and check again a few hours after that.



4. Repeat until your fridge and freezer are both the correct efficient temperature.

You will save about 2.5% on your fridge's electricity bill per degree you turn up the temperature.

\* \* \* \* \*

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**Tip:** On some older fridges there is a button labeled *Reduce Condensation* or *Energy Saver*. The button turns on a heating

coil on the outside of your fridge to stop condensation from building up. Heating up the outside of the box where you are keeping your food cold is crazy. If you have a button like that, turn it off. If you have that button, it probably means your fridge is decades old and inefficient. If so, you might want to pay extra attention to this next chapter.

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# old fridges or freezers



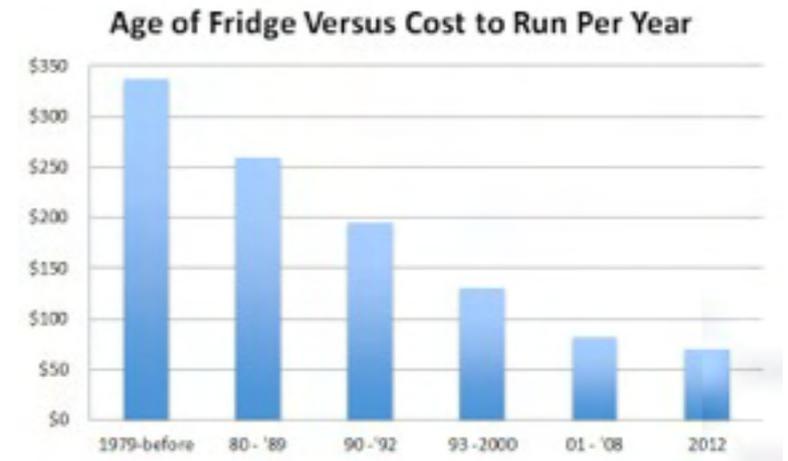
Since appliance standards are getting more efficient all the time, that old fridge or freezer in your basement might be costing you over \$330 per year to keep plugged in. That's nearly five times as much as a new fridge would cost to run per year. New fridges also have no freon, so they don't hurt the ozone layer.

The fridge can be the appliance in your home that uses the most electricity. If you have a fridge or freezer more than 10 years old, you should use a Kill A Watt meter to figure out how much energy it's drawing. Then you can decide if the time has come to upgrade or unplug it.

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**Tip:** The kWh/Hour button is a toggle switch. If you want to check how many hours have elapsed since you plugged it in, press it once. To toggle it back to how many kWh have been used since you plugged it in, press the button again.

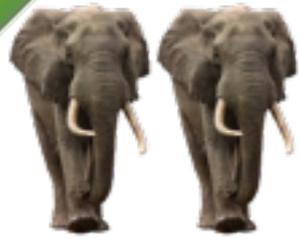
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This information comes from [Energy Star's fridge calculator](#) site and Consumer Reports (June 2012) at 14 cents per kWh for an average-size fridge with a freezer on the top.

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## How to reduce your fridge or freezer's electricity use

- Energy savings per decade: **Up to \$2,063 and 16,448 lbs. of CO<sub>2</sub>** (Assuming you unplug a 1991 fridge with a top freezer and 20 cubic feet of storage)
- Level of difficulty: **Easy**
- Cost: **\$0** (if you get rid of a second fridge you don't need)
- **\$400 to \$900** (on average if you need to buy a new fridge/freezer)
- How long it takes: **A day to check the fridge's electricity use, and a couple of hours shopping**
- Tools & materials: **A Kill A Watt meter, extension cord, a phone and maybe a Consumer Reports subscription**

Because a fridge or freezer's compressor cycles on and off—radically changing its electricity use—you need to measure how much electricity the appliance draws over a whole day to get an accurate idea of how much it actually costs.

1. Unplug the fridge/freezer, plug the Kill A Watt into the outlet, and then plug the appliance into the Kill A Watt.

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**Tip:** If the plug is hard to reach or see, you might want to plug a grounded (three-prong) extension cord into the wall socket first, and then plug the Kill A Watt and the fridge into that, so you can pull the Kill A Watt out to read it without having to crawl between the fridge and the wall.

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**Tip:** Don't unplug the fridge in the middle of the compressor running (i.e., when the fridge is making its humming noise). Unplugging it then can hurt the compressor. If you do, you should wait at least a few minutes before plugging it back in.

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2. Press the red button labeled *kWh/Hour* so the meter counts the kWh used by the appliance over time, as well as the number of hours that have passed.
3. 24 hours later (preferably exactly 24 hours), read the display. The number displayed is how many cumulative kWh the fridge/freezer used in one day. **DO NOT unplug the Kill A Watt** in order to get the meter close enough to read it. The kWh reading will disappear as soon as you unplug it.

4. Use our [Fridge/Freezer Calculator](#) to figure out how much the appliance costs to run and whether it's time for you to upgrade or unplug it.



If you need to buy a new fridge, consider one that:

- has the freezer on top and the fridge on the bottom
- doesn't deliver ice through the door
- is not a side-by-side model
- is the smallest you can manage with
- is labeled Energy Star

Keep in mind that the estimated cost of electricity for the appliance (as shown on the Energy Star label) is calculated using the *national* average cost for electricity. New England's rates are about 30% higher than the national average, meaning that the electricity use of any fridge you buy will cost you 30% more than the label says it will.

To predict the cost of running your new appliance, multiply how much you pay per kWh by the estimated annual kWh use displayed on the Energy Star Label.

If you don't have a Kill A Watt meter, a less accurate way to figure out how much elec-

tricity your fridge/freezer consumes per year is this [Energy Star fridge/freezer calculator](#). Enter your kWh cost, and the year and size of your appliance. Both year and size should be on a manufacturer's label on the inside or outside.

### **Recycling and rebates**

Here's an [Energy Star video](#) showing how your fridge or freezer can be recycled. Many stores (such as Best Buy) and some utilities will pick up and recycle your old appliance. Some will even pay you a rebate when you buy your new more efficient fridge.

Through Energy Star, you can get an updated local list of applicable [offers from utilities, retailers and manufacturers](#). Also check with your state energy office and municipal waste management office to see if they have any offers. Some will offer rebates for recycling or for buying a new Energy Star appliance.

If you live in Massachusetts, call Mass Save and they will pick up the appliance, recycle 95% of it and give you \$50.



# computer settings



Screen savers were not invented to save energy. They were invented to stop a monitor from burning out pixels in any one area of the monitor through showing the same image all day long.

Get rid of your screensaver and instead switch your computer's system preferences so your monitor sleeps after a few minutes. If your monitor doesn't go dark after two to five minutes of your not touching the keyboard or mouse, you are wasting energy.

While you're at it, set the Power Management preferences so your computer hibernates after 30 minutes of inactivity. When you touch a key again, the hard drive will cycle back up and the monitor turns back on so you can keep working.

In general the rules of energy use with computers are:

- Macs use less energy than PCs
- Laptops use less than desktop computers

- Flat-screen monitors use less than CRT monitors (non-flat screen monitors)
- Peripherals (such as speakers and printers) can suck up a lot of energy

## **Practices to keep in mind**

- Shut down your computer when you aren't using it.
- Use a smart power strip to turn off the peripherals when you aren't using the system.
- Reduce the brightness of your screen.
- if you find hibernate too slow to wake up from, try using sleep mode instead -- it's far better than leaving it on.



## How to change your computer's power management settings

- Energy savings per decade: **Up to \$642 per computer and 5,120 lbs. CO<sub>2</sub>** assuming your always-on PC that never hibernates is changed to hibernate after 5 minutes
- Level of difficulty: **Easy**
- Cost: **\$0**
- How long it takes: **Two minutes**
- Tools & materials: **A computer and your fingers**

Read through the up-to-date directions on the appropriate link below to learn how to change the Power Management settings.

- [Microsoft Windows 7](#)
- [Microsoft Windows XP](#)
- [Microsoft Windows Vista](#)
- [Macs](#)

Follow the directions to change your computer's settings so both the monitor and system hibernate after a few minutes.



Fear not; computers with power management features activated will still receive software updates such as new antivirus definitions and Windows security patches.

For individuals and organizations without centralized IT departments, computer software is generally pre-configured to automatically download. The updates will be applied shortly after your computer returns from hibernating/sleeping.

*We worked with the Cambridgeport School to reduce its energy bills. In the computer lab, all 50 computers were on eight hours a day. Even though the computers were used only when students were in the lab, the hard drives and monitors never hibernated.*

*We helped the IT person change the power management settings, explaining it wouldn't interfere with her ability to control or back up the computers.*

*The next year the entire school's electricity*

*bill was several hundred dollars less expensive—due to a few keystrokes.*

— Jesse

# buy efficient appliances

Sure, fridges generally use the most electricity in a home, but altogether the other appliances' use dwarfs the fridge's use. It's very worthwhile to make sure all your appliances are as efficient as they can be.

Considering the fact that you probably have at least five major appliances (fridge, TV, dishwasher, clothes washer and dryer), choosing efficient appliances can have a dramatic effect on your wallet and on your impact on the planet.

## General tips when buying appliances

Do your research before you buy. Check out the [Energy Star appliance web-page](#) for overall buying guidelines on most major appliances. The site has lists of qualified models, how much energy they use, a store locator, and lists of special offers.

Once you get to a store, only look at appliances with the Energy Star label—



they are the most efficient ones in their class.

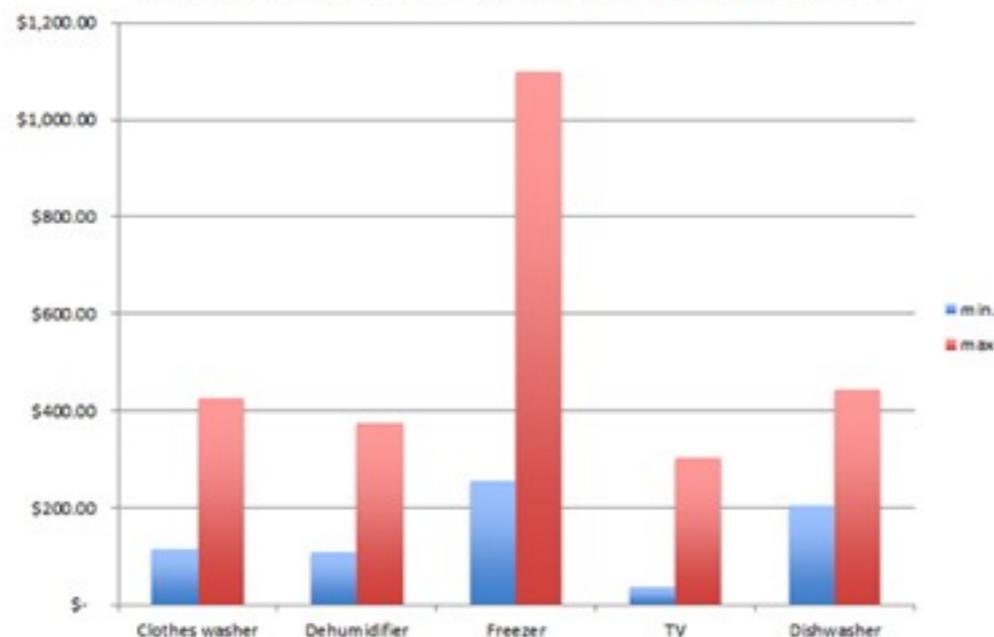
Use the information on the Energy Star label to buy the model that gives you all the services you want for the least amount of energy.

## Recycling

Here are some great sites to find the best way to recycle your old appliances:

- [Habitat for Humanity ReStores](#)
- [Appliance 411 Recycling Tips](#)
- [ARCA Appliance Recycling Centers of America, Inc.](#)

Max. vs. Min. 10-year Electricity Cost of Appliances





## How to buy an efficient appliance

- Energy savings per decade: **Up to \$902 per appliance and 7,194 lbs. CO<sub>2</sub>** assuming you switch out a freezer that uses 732 annual kWh for one that uses 170 kWh
  - Level of difficulty: **Easy**
  - Cost: **Generally the same as buying an inefficient appliance**
  - How long it takes: **A few hours of research and shopping**
  - Tools & materials: **A calculator to figure out lifetime costs of energy, and maybe a Consumer Reports to find a long-lasting appliance that meets your needs**
1. Check your appliances with a Kill A Watt to see how much energy each one draws. If your appliance also uses therms and/or water—such as in the case of a natural-gas clothes washer—then use the web to look up the

2. Go to the [Energy Star appliance web-page](#) and, for each type of appliance, click on Find a Model on the right side under Resources. Enter your search criteria to get a list of potential models and their annual energy use.
3. Use our [Buying a New Appliance Calculator](#) to calculate how much you could save if you upgraded to a more efficient appliance.
4. If it's worthwhile, buy a new appliance.

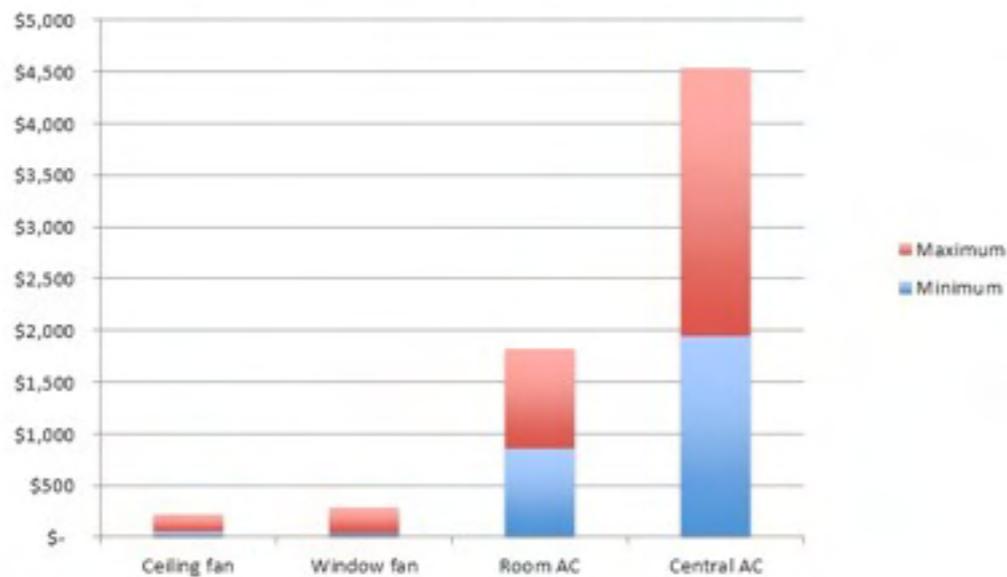


*When I buy a new appliance, I do my research first on [Consumer Reports](#) to make sure the manufacturer has a reputation for building durable and well-reviewed appliances. This increases the chance that I will buy a durable appliance that I like. You can always join Consumer Reports for just that one month when you are buying your new appliance(s).*

*-Audrey*

# fans

Annual Cooling Cost Comparison: Fans vs. ACs, 2012



An air conditioner (AC) pumps the heat out of a whole room—including the furniture—in order to cool you, the inhabitant.

A fan works by blowing the heat and sweat directly off of your body. This is smart, because after all, who cares if the side table is cool?

Since fans work to cool people instead of people and furniture, they use far less energy and money than ACs do.

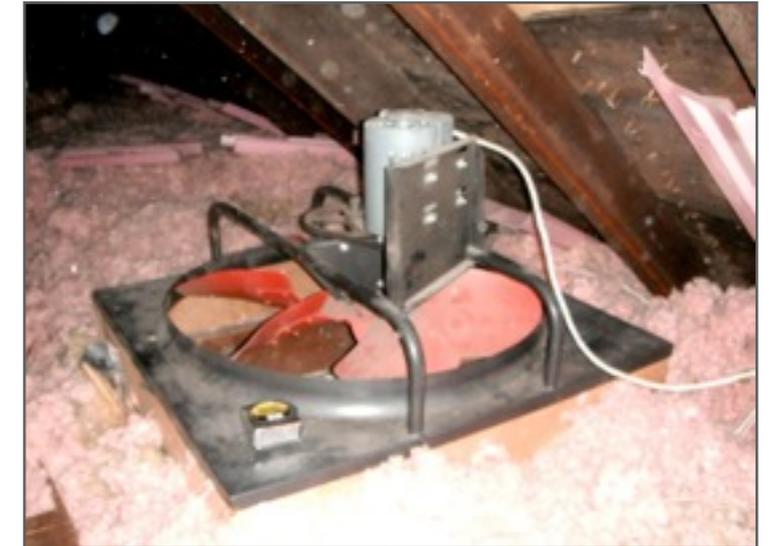
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**Tip:** Some new fans have timers that you can set to automatically turn off when you're not home.

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## Whole house fans

A whole house fan is a large fan mounted between the lived-in area of the house and the unlive area of the attic. During the summer the fan is used to pull the heat in the home out through the attic. To use one effectively, you wait until the outside air is cooler than the air in your home, then open up the windows



on the lowest floor in your home and turn on the fan.

The opening for the fan is a huge hole into the attic that loses enormous amounts of heat during the cold New England winter. If you have one or want to buy one, make sure it is well insulated and seals well.



## How to cool off efficiently

- Energy savings per decade: **Up to \$2,144 and 17,095 lbs. CO<sub>2</sub>** assuming you switch a central AC out for four efficient fans
  - Level of difficulty: **Easy**
  - Cost: **\$40** if you already have a few fans but need a power strip
  - How long it takes: **An hour to set up the fans**
  - Tools & materials: **A few fans, some patience and perhaps a [Belkin remote power strip](#)**
1. As much as possible, use fans rather than air conditioners.
  2. If the day is blistering and you feel you have to use AC, set it to a high temperature like 80°, then use the fan to cool you the little extra bit you might need.
  3. If the wind from the fan can't reach you or somebody else, it isn't doing any good. Place the fan nearby and point it at you and the other inhabitants.

4. When you leave a room, don't leave the fan on; it won't cool the empty room. It will just cycle the air around the room, while adding to the heat in the room from its hot whirring motor.
5. If your kids or spouse can't remember to turn off the fan when leaving a room, plug the fan into a Belkin remote power strip and install the remote switch on the wall by the door. You can then tape a note onto the switch to remind them.



# air conditioning



Air conditioners only came into common use in the 1940s. In a short period of time we've gotten very accustomed to them.

It's a pretty energy-intensive way to keep cool.

If you feel you have to use an air conditioner, here are some helpful tips to help it work efficiently.

### **Keep your home cooler naturally**

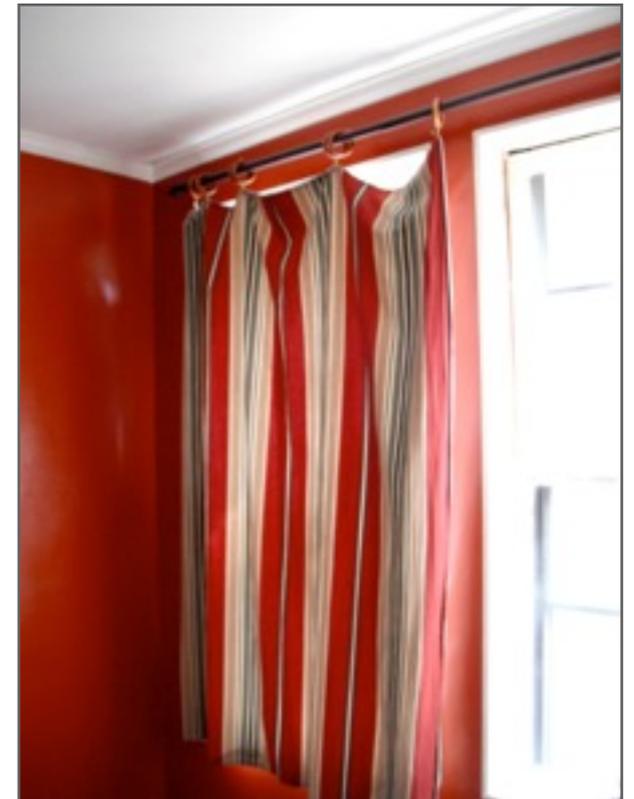
- Reduce how much the sun heats up your home (also called solar gain).
- Shade the east and west sides of your building with trees or awnings. The north side is the shady side so it doesn't matter. The south side doesn't make much difference during the summer because the sun is nearly directly overhead by the time it reaches that side. That angle dramatically reduces the solar gain.

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To locate the east and west sides of your home, look your address up on Google street view maps and zoom in to an overhead view of your home. The bottom of the map is always due south.

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- Shut the shades or drapes of sunny windows.



- Close all your windows in the early morning and open them again at night to fill your home with the cooler night air.

### Use an efficient, properly sized AC

That “free” AC your neighbor gave you isn’t all that free. It is old and inefficient and will cost you every time you turn it on. Use an efficient AC.

- Buy an Energy Star AC. Before you buy, check out Energy Star’s air conditioner spreadsheets and buying guidelines for a:
  - [Room Air Conditioner](#)
  - [Central Air Conditioner](#)
- Make sure the AC’s SEER (Seasonal Energy Efficiency Ratio) is as high as possible.
- Make sure the AC isn’t [oversized](#) for the space it is cooling; that reduces its efficiency. You don’t need an Indie 500 race-car to tootle up and down your driveway.

### Where to install your AC

- Don’t install your AC on the sunny side of the house if you can help it. It will heat up and have a harder time doing its job.
- Give the AC enough room to dump its hot air outside. An air conditioner exhausts the hot air from the inside of your home into the air just outside. If it’s

jammed in a corner of the building with walls on three sides, it will have a harder time keeping you cool.

- AC ducts: If your central AC is up in the attic or in a crawlspace (or any other place where its ducts will be exposed to the broiling heat of the summer), air seal (close up the holes) and insulate the ducts so they aren’t losing lots of cool air to the great outdoors. For more information, see our chapter on Sealing Ducts.

### Don’t cool the house when you’re not home

- Why keep your TV cool all day long when you’re not there? You don’t have to cool the house when everyone’s out. Every hour you don’t cool your house will save energy.
- If your AC comes with a programmable thermostat, set it to turn on half an hour before you get home. You can easily plug your window AC into a programmable power strip or an appliance timer to have it turn on and off at times of the day that match your schedule.

### Myth buster

It does **not** take more energy to cool down your home once you get back from work, than it would to keep it cool for all those hours while you’re at work.

You can save a lot on your electricity bill by turning off your AC when you don’t need it.

For more information see our [Program your Thermostat](#) chapter.

# humidifiers and dehumidifiers

## Humidifiers

Humidifiers use between \$10 and \$30 in electricity during the winter months, depending on what kind of humidifier you're using and how many hours per day you leave it on.

Most people who need to use a humidifier only have to do so during the winter. They usually need them because the house is drafty, and when the hot air escapes it takes moisture along with it.

If your home is so dry that when you scuff across the rug you could knock Frankenstein across the room with the static shock, you should bring in a professional to do some air sealing to prevent hot air from escaping through holes (especially likely in the attic).

Air sealing will keep your home more humid and less drafty during the winter and lower your heating and humidifying bills. Your home will be less expensive to run, more comfortable and take fewer resources from the planet.



How-to Section

## How to get rid of your humidifier

- Energy savings per decade: **Up to \$321 and 2,560 lbs. CO<sub>2</sub>** assuming you turn off your inefficient humidifier entirely
  - Level of difficulty: **Easy**
  - Cost: **\$300** for four hours of air sealing assuming there are no rebates in your area
  - How long it takes: **A few minutes to call an air sealer**
  - Tools & materials: **A phone and maybe access to [Angie's List](#) to find a good air sealer**
1. Call in some professional air sealers. For more information on this, see Attic air sealing.

In some areas, air sealing is free, provided by your utility company or the state. If you're low income, there are a variety of federal programs that will do the air sealing for you for free. For infor-

mation on this see our chapter on Rebates and Tax Credits.



### **Dehumidifiers**

Dehumidifiers can cost more than \$100 in electricity per year. Most of the time people use them because there is too much moisture in the basement.

Not only is using a dehumidifier expensive, too much moisture in the basement is a sign that something is wrong. Using a dehumidifier can frequently mask the symptoms, allowing you to ignore the problem.

Water coming in through the foundation is bad because it will expand and contract with the temperature during the winter, breaking down the foundation over time.

Excess moisture in your basement is also a health risk. Mold can cause respiratory difficulties, and running that humidifier costs a lot of money in electricity. Stop the moisture from getting into your basement and all these problems will go away. Then you can unplug the dehumidifier and use the money you would've spent on electricity to have fun with your family or friends.

**Water in the basement leads to mold**





## How to get rid of your dehumidifier

- Energy savings per decade: **Up to \$1,554 and 12,390 lbs. CO<sub>2</sub>** assuming you turn off your Energy Star dehumidifier entirely
- Level of difficulty: **Easy**
- Cost: **Hard to quantify without knowing the problem**
- How long it takes: **A few minutes to figure out the problem**
- Tools & materials: **An umbrella, a phone. Maybe access to [Angie's List](#) to find a good contractor, or some dirt and a shovel, or a downspout extender, a drill, a ladder and a few sheet metal screws**

Frequently the problem comes from the gutters, downspouts or the grading of the land near your home splashing or puddling rainwater right up against your foundation.

The next time it's raining hard, go outside and watch how the water moves around your home. Walk around the house, examining the gutters and downspouts for problems.

### Potential problems

- Do the gutters overflow so water is sheeting over the edge to land with force by the foundation or to cascade down the side of your home?

**Solution:** Clean and/or repair the downspouts and gutters.

- Are the gutters leaking anywhere?

**Solution:** Repair your gutters.

- Are your downspouts more than 30 feet apart?

**Solution:** Add downspouts.

- Does no water come out the bottom of a downspout?

**Solution:** Clean the downspouts and gutters.

- Is the water that pours out of the downspouts directed toward the foundation?

### Downspout problems



See our photos of [different downspout problems](#).

**Solution:** Add a downspout extender and direct water away from the foundation.

- Do you see water hitting the ground hard anywhere near the foundation?

**Solution:** Fix the gutter above.

- Is the water pooling up anywhere around your foundation?

**Solution:** Re-grade the land in this area so the ground slopes downward away from your home. That way the water will run away from your foundation. This work

might take just a few bags of dirt and/or gravel and some shoveling.

- Is the downspout not connected to the gutter, or has the downspout come apart anywhere?

**Solution:** Reconnect the gutter or downspout to seal the hole. Make sure to drill in sheet metal screws to connect the pieces more permanently.

- Is one or more of your downspouts missing its extender, letting water from the downspout hit the ground with force?

**Solution:** Install extenders. Make sure to use sheet metal screws to ensure the extender stays on.

Fix these problems and you might not need your dehumidifier anymore.

Downspouts and gutters are not our field of expertise, so we won't give you step-by-step directions on how to do this work. You're probably better off looking up more expert directions on YouTube, or finding a professional to do the task for you.



# security lights



An outside security light illuminating the front steps when you get home late at night is nice, but why leave the light on all night?

These outdoor lights are generally two honking-big reflector lights that are burning 10 hours per night. The cost of just these two lights can easily mount to over \$130 per year.

But you only need lights on when someone is in the area. To make this happen, just install a motion detector, which you can probably add to your existing security light.

Make sure the motion detector also has a photocell so it turns off the light automatically when the sun comes up. That way you don't have to remember to turn the light on or off.

The motion detector will also scare away any possible burglars better, since the light clicking on just when they come up the path will freak them out. If you use CFLs in the fixture, it will increase your

savings even more. However, you need to make sure the CFLs are intended for the outside locations and that the motion detector will work with CFLs.

Alternately there are some motion detectors that come with LED bulbs in them. If you want to install this fixture once and not have to worry about changing its light bulbs again, you might choose a fixture like this. The bulbs are designed for outside and are rated to last for 50,000 hours (with a motion detector, meaning the light will probably last 30 years).

Here's a [Security Light Calculator](#) to figure out how much a motion detector on your light might save you.





## How to install a motion detector

- Energy savings per decade: **\$1,336 and 10,652 lbs. CO<sub>2</sub>** assuming you replace two 120-watt bulbs with a motion-detector light with two 30-watt bulbs
- Level of difficulty: **Easy**
- Cost: **Around \$145** depending on the cost of the motion detector
- How long it takes: **One hour** to buy a motion detector and new bulbs and then call your electrician
- Tools & materials: **The motion detector, new efficient bulbs and a phone**

With electricity, it's always better to be prepared.



Working with electricity is something that scares a lot of people. Probably this is work you want your electrician to do.

If you know what you're doing with electricity, here's a [video](#) on how to do it yourself. The video is for the LED lighting, but the directions will work with most motion detectors. If the video doesn't cover all the information you need, then find a few others that do.

saving water



In most of the Greater Boston area, a gallon of water pumped into your house and then away down the sewer costs 1.5 cents. That seems inexpensive; however since the average household in Massachusetts uses 82 gallons per day, the yearly cost adds up to \$450.

Picture 82 gallon jugs. Think about how many gallons that is, the sheer weight of it.

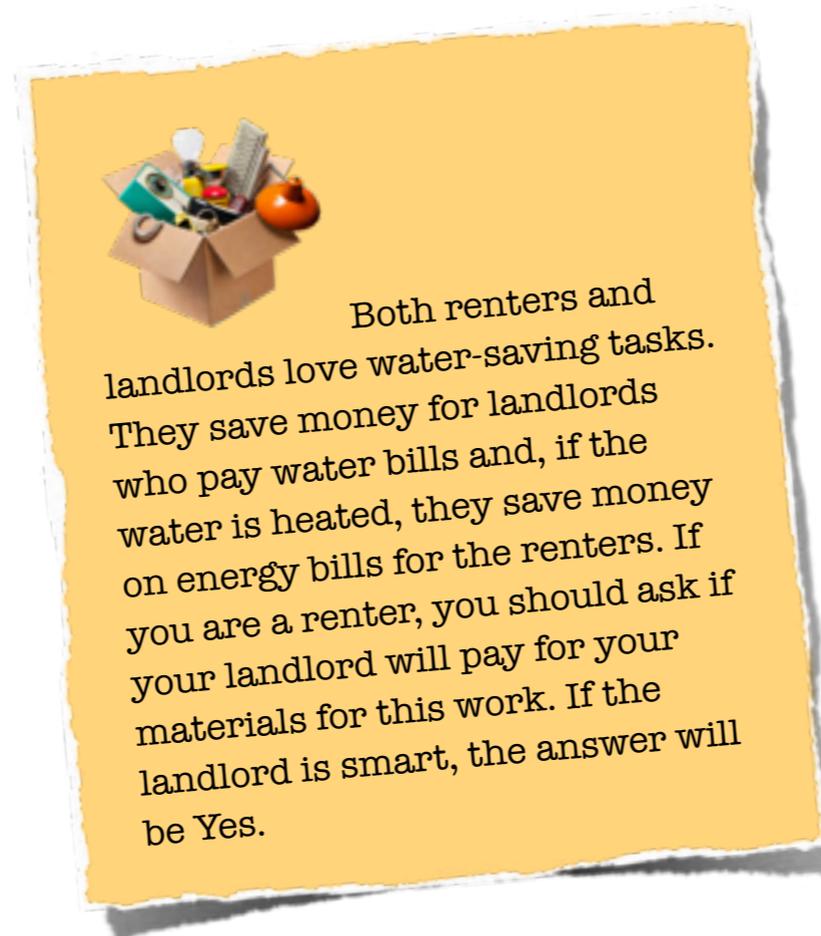
With five minutes of work, you can probably decrease your use 10%. This work will also reduce your heating bill because you have to heat less water. And you will have helped life on this planet.

### **Bigger picture**

Most climate change prediction models predict hotter drier summers. In New England, more droughts will result from a combination of these weather-related changes:

- More extreme downpours. Warmer air can hold more moisture. Think of tropical downpours. Extreme downpours mean the earth (and the aquifers beneath it) don't have time to absorb most of the water, allowing more of it to run off into streams.
- Increased evaporation from hotter summer temperatures.
- Earlier snowmelt from a warmer spring, resulting in the earth being drier by the time summer hits.

We should start saving water now so we have more water in our aquifers and lakes later on when we need it.



# measure water flow



In order to know what efficiency work you should do, you need to find out how much water each fixture uses (such as kitchen and bathroom faucets, as well as showerheads).

Many fixtures have a number on their side or front saying how many gallons per minute (GPM) they use. If you can't find a fixture's GPM number or it's hard to read, you can measure the fixture's flow instead.

## Recommended water flow for different fixtures

- **Showerheads:** 2 GPM or less
- **Kitchen faucets:** [1.5](#) to 2.2 GPM (choose the higher water flow rate if you fill up the occasional big pasta pots)
- **Highly used bathroom faucets:** 1.0 GPM aerator
- **Lightly used guest bathrooms:** [0.5 GPM aerator](#)



You can ignore tub faucets because they should have a high flow, since the point of them is to fill up the tub.



## How to measure water flow

### Using a water flow measurement bag

- Benefit: **Knowledge you can act on**
- Level of difficulty: **Easy**
- Cost: **\$0**
- How long it takes: **Five seconds per fixture**
- Tools needed: [Water flow measurement bag](#), stopwatch or a watch with a second hand

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**Tip:** If you live in Greater Boston, you can order as many free water flow measurement bags and 1.5 G.P.M aerators as you need from the Massachusetts Water Resources Authority. Fill out this [request form](#) and send it in via fax or snail mail. You can give the water flow measurement bags out to your friends, book club, church group, etc.

---

### Filling a water measurement bag



1. Put the mouth of the flow measurement bag around the fixture (showerhead or faucet) so it will catch all the water. Turn the water on high for five seconds.

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**Tip:** Use a watch with a second hand or a stopwatch app on your cell phone or count 1-Mississippi, 2-Mississippi, because most people count way too fast and then think they have a low-flow fixture.

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2. Once the five seconds are up, turn the fixture off and hold the bag up to see how full it is. The water level will show you how many gallons per minute (GPM) your fixture uses.

Repeat these steps on every showerhead and sink faucet in your home in order to figure out which fixtures need to be upgraded. See our recommended water flow requirements on the previous page for different fixtures.

### Using a quart container

If you can't get a free water flow bag or don't want to wait for it to arrive in the mail, then use any empty quart container.

- Benefit: **Knowledge you can act on**
- Level of difficulty: **Easy**
- Cost: **Free**
- How long it takes: **One minute**
- Tools needed: **Empty quart container, stopwatch or a watch with a second hand**

1. Turn the water on high. Make sure all the water goes into the container. (You might want to open the top of the container all the way.)
2. Time how long it takes for the container to fill up. If it takes 15 seconds,

it's a 1 GPM fixture. If it takes 7.5 seconds, it's 2 GPM. 3.25 seconds, it's 4 GPM. Etc.

If you don't like math, you can use our [Water Flow Measurement Calculator](#) to figure out the flow rate.



Repeat these steps on every showerhead and sink fixture in your home in order to figure out which fixtures need to be upgraded.

\* \* \* \* \*

# toilet tank banks



It does seem a bit crazy to flush drinking water down the toilet. If you want to reduce that use, you can buy and install a new low-flow toilet, but that will cost you upwards of \$400 which would take a long time to pay for itself.

There are also \$20 [dual-flush retrofit kits](#) that can save a lot of water. Dual-flush kits allow you to retrofit your toilet so you can press the lever down for a lighter flush to get rid of liquids and pull the lever up for a normal flush to get rid of any solids. Dual-flush kits say they can be installed in 10 minutes and will work on any toilet, but sometimes the reality doesn't quite meet the advertising.

An easier and less expensive option is a toilet tank bank. They cost under \$1 and can fit any toilet (as long as it doesn't have a pressurized-flush system. In this case the tank is filled with a plastic sealed container with no water visible).

A toilet tank bank is basically a water balloon that hangs inside the tank and dis-

places water with each flush. Every time the toilet tank fills up for the next flush, the water balloon takes up space so less water is needed.

This is the same as putting a brick in the tank to displace water; however bricks break down over time and can damage your toilet. Some people put a water-filled plastic jug instead in their tank, but those are big and inflexible and can interfere with the working mechanics of the toilet.

## Fun fact

At Consumer Reports the way they test a toilet's "flushability" is by stuffing firm tofu into nylon bags to make fake poops. Then they flush the tofu bags down the toilet.

A toilet tank bank can be filled just as much as you need for that toilet and hung in the corner out of the way.

If you're curious about how much water you might save, use our [Toilet tank bank calculator](#).



## How to install a toilet tank bank

- Water savings per decade: **Up to \$234 and 14,600 gallons** assuming the tank bank is filled 50% and the toilet is flushed 8 times daily
- Level of difficulty: **Easy**
- Cost: **Under \$1**
- How long it takes: **A minute**
- Tools & materials: [Toilet tank bank](#), **water**

1. Pop open the cap of the tank bank and fill it up with as much water as you think you will want.

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**Tip:** If your toilet uses 1.6 gallons per flush (generally the toilet will be labeled with how many gallons it uses per flush), then fill the tank bank about halfway. If your toilet uses more water, fill the tank bank more.

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2. Squeeze the air out of the tank bank so it doesn't float at the top of the tank. Close the cap.



3. Take off the top of the toilet tank, and hang the tank bank on the inside of the toilet out of the way of the flushing mechanism.



4. Flush the toilet a few times to make sure the tank bank doesn't interfere with the working mechanisms. Move

the tank bank if it seems to be in the way.

5. If your toilet now doesn't flush all the solids down with the tank bank, empty some water out of the tank bank to make the flush more powerful. If the toilet is working well, you can fill the tank bank up more and test the flush again.



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**Tip:** Another way to save water is to obey the rule, “If it’s yellow, let it mellow. If it’s brown, flush it down.”

If you follow this practice, every few years the minerals will build up in the main “siphon jet” (the siphon jet at the front bottom of the toilet bowl). You’ll realize that’s happening because the flush will get weaker over time. In this case take a screwdriver and gently knock the minerals out of the siphon jet hole. (If you have a problem finding this hole, stand facing the toilet, lean forward and look back down toward your feet. The two inch wide hole is at the very bottom in the front of the bowl).

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# faucet aerators



An aerator is that little doohickey at the end of most faucets. The aerator controls how much water comes out of the faucet per minute.

Switching an aerator out is easy to do and saves water. Most times the water flow feels and looks the same.

If you want to calculate how much you might save, here's our [aerator calculator](#).



How-to Section



## How to install a low-flow aerator

- Energy savings per decade per aerator: **\$56 and 442 lbs. CO<sub>2</sub>** assuming a 2.2 GPM aerator traded out for a 1 GPM aerator used 3 minutes per day
  - Water savings per decade per aerator: **Up to \$211 and 13,142 gallons**
  - Level of difficulty: **Easy**
  - Cost: **\$0 to \$5 per aerator**
  - How long it takes: **A minute**
  - Tools & materials: **Aerator (such as a [0.5 GPM aerator](#), [1.0 GPM aerator](#) or [1.5 GPM aerator](#)), rubber band, locking pliers or vise grips, rag**
1. Remove the old aerator by twisting it *clockwise* with your hand. (Although it's *Lefty Loosey*, in this case

you aren't facing the aerator, but standing above it).

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**Tip:** If the aerator is wet, wrap a rubber band around it for a better grip. If the aerator still won't come off, try using locking pliers or vise grips. If you're worried about scratching the aerator, you can cover it with a rag before tightening the pliers around it.

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2. Screw the new aerator on and hand-tighten it. Don't over-tighten.

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**Tip:** If it doesn't seem to fit, take out the top inside gasket and try to thread it on again, using the threads on the inside of the aerator.

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**Note:** Some commercial or specialty fixtures use a different size aerator. If your aerator seems to be the wrong size entirely, put the old aerator back on and call up the manufacturer of the fixture to figure out what size aerator will fit.

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3. Turn on the water. If the water spritzes or drips out the sides between the aerator and fixture, turn the water off and tighten the aerator a bit more.



# showerheads



Taking showers is one of the most water-intensive actions you do in your home. Unlike watering the lawn, water for the shower is heated.

A more efficient showerhead saves water *and* fossil fuels needed to heat the water.

Since the cost of a new showerhead starts at under \$15, the investment return is generally well over 200% per year.

You can figure out how much water you can save with a new showerhead by using our [showerhead calculator](#).



How-to Section



## How to replace a showerhead

- Energy savings per decade: **Up to \$258 and 2.060 lbs. CO<sub>2</sub> assuming a 2.2 GPM showerhead traded out for a 1.5 GPM one where 3 people take 8-minute daily showers**
- Water savings per decade: **Up to \$984 and 61,320 gallons**
- Level of difficulty: **Easy**
- Cost: **Under \$15**
- How long it takes: **5 minutes to order the showerhead and 5 minutes to install it**
- Tools & materials: **1.5 GPM [fixed showerhead](#) or [handheld showerhead](#), pliers or Teflon tape, locking pliers or vise grip, a rag, an old toothbrush**

**Note:** You can try using a wrench, but if you have a problem loosening the

showerhead, locking pliers or vise grips might make your life a lot easier.

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1. Use your tool to grab the nut where the showerhead connects to the arm.



**Tip:** If you don't want to scratch the fixture, wrap it with a thin rag first.

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1. Adjust the pliers to tightly grasp the showerhead neck using the bolt on the handle to tighten the jaws of the pliers. Remove the pliers from the showerhead and tighten the pliers' bolt so that it's just a hair tighter. Lock it back onto the showerhead neck. It should now be very tight.
2. You want to loosen the showerhead so go leftie or counter clockwise. Firmly grasp the showerhead neck with the pliers, and then turn the pliers counter-

clockwise. Remember the old saying: lefty loosey, righty tighty.

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**Note:** If the showerhead doesn't turn fairly easily, **DON'T FORCE IT**. You don't want to break the pipe that the showerhead connects to. If it looks like the pipe has rusted, then apply WD-40 to the joint. If you see the white gritty material of lime deposits, then use Lime-Away. Wait a few minutes and then try to loosen the showerhead again.

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3. Keep turning until the showerhead comes off.
4. If the threads—where the showerhead was screwed on—are dirty at all, use an old toothbrush to clean them off.
5. Wrap plumbers' tape around the now-clean threads. Make sure to wrap it on clockwise so that when you put the new showerhead on it doesn't unwrap the plumbers tape. The tape fills up any gaps between the threads of the arm and the showerhead so the connection doesn't leak. Keep the plumbers tape flat as you wrap it around the threads two or three times.



6. Install the new showerhead on the arm and hand-tighten it. Don't use so much force that you can't ever get the showerhead off again.



7. Get out of the shower stall and turn on the shower. If water spritzes out around the showerhead/arm connection, tighten the showerhead a bit more, or take it off and add a bit more plumbers' tape.

\* \* \* \* \*

Modern low-flow showerheads work beautifully. When I switched our showerhead out for a low flow showerhead, my husband—who is not a sustainability person—complimented me on the nice new showerhead. He did not know, even after showering, that it was low flow.

*Audrey*

# toilet leaks



Most moving parts of a toilet are made of rubber or plastic. They wear down over time and start leaking. These leaks can start off subtly and get worse each day.

You might notice thin streams constantly running down on the insides of the toilet bowl. Or perhaps late at night you'll hear the whine of water running through the pipes or the tank filling itself when no one has used it.

All too frequently, you don't notice anything until the water bill arrives three months later.

With most toilets, it's easy to check if it's leaking and then repair it.

**Note:** The following directions are not for a pressurized-flush toilet. You can tell you have a pressurized-flush toilet if the tank is filled with a plastic sealed container and no water is visible. If you have a toilet leak from a pressurized-flush toilet, call your plumber.

How-to Section



## How to check if the toilet is leaking

- Benefit: **Knowledge you can act on**
- Level of difficulty: **Easy**
- Cost: **Free assuming you have some food coloring**
- How long it takes: **30 minutes**
- Tools and materials: **Food coloring**

1. Put a few drops of food coloring into the toilet tank and wait 30 minutes. Make sure no one uses the toilet during this time.
2. If the water in your bowl is now the color of the food coloring you placed in the tank above, there is a leak from your tank into the bowl. The most likely culprit is the flapper (otherwise known as the flush ball or flap valve). Since replacing your flapper costs less than five dollars, try that first. If it doesn't work, call your plumber.

## How to replace the flapper

- Water savings per decade: **Up to \$839 and 52,560 gallons of water assuming the leak is a measly 1/100th a gallon per minute**
- Level of difficulty: **Easy**
- Cost: **Under \$5**
- How long it takes: **A trip to the hardware store and 10 minutes for the repair**
- Tools and materials: **A new flapper that fits, snips, rag**

1. Turn off the shut-off valve to stop the water to the toilet by cranking it clockwise. The shut-off valve is located beneath the tank on the left side as you face the toilet.
2. Take the top off the toilet tank. Put the top down somewhere safe. It is porcelain and can break easily.
3. Remove the old flapper.
  - \* If you don't know what the flapper is, then flush the toilet while watching what happens inside the tank. The flapper is the rubber or plastic flap at the bottom of the tank that is pulled

### Replacing an old toilet flapper



See our [photos](#) of how to replace an old toilet flapper.

up so the water can drain from the toilet tank into the bowl.

- \* Unhook and remove the flapper from the bottom of the toilet tank. Generally the flapper hooks onto the toilet with two arms. Also unhook the chain that connects the flapper to the flush handle at the flush handle, so the chain comes out with the flapper. Be careful not to damage the flapper, in case you can't find a matching one easily.

**Tip:** Don't feel grossed out about touching any parts inside the toilet tank; it's clean

water and never mixes with the water in the toilet bowl.

4. Take the old flapper to the hardware or plumbing store and buy an exact match.
  - \* If the toilet needs to be used while you're gone, take a photo of the flapper along with the name and brand of the toilet. In this case, you can replace the old flapper and turn the water to the toilet back on while you do the errand.
5. Once you have the new flapper (and the water is still shut off at the shut-off valve), install the new flapper by attaching it the same way as the old flapper was.



6. While you're at it, use a rag to scrub away any sediment that might have built up on the seal where the flapper sits. This sediment could cause a leak.
7. Clip the chain onto the flush handle with about an inch of slack on the chain.
8. Turn the shut-off valve on again (*lefty loosey*) and flush the toilet to check the chain length.
  - \* If you flush and nothing happens, decrease the slackness in the chain. Some chains are adjusted by clipping them into a different hole along the flush handle, others are shortened by changing where the clip is on the chain.
  - \* If the flapper can't close because the chain is too tight, increase the slackness in the chain.
9. Flush the toilet a few times watching to check that everything is working fine inside the tank.
10. When you have the chain at the right length, clip off the end of the chain with the snips so it can't get caught on any other working mechanism.
11. Repeat the food coloring test for leaks. If you still have a leak, call a plumber.

If there is no leak, congratulations, you fixed it.

12. Put the top back on the tank.

For more info check [this eHow video](#).

\* \* \* \* \*

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**Tip:** You get your water bill only once every few months. A leaking toilet can cost you hundreds of dollars by the time you find out about it. Some municipalities will send you automatic emails if your water use suddenly goes up. The email goes out the same day your water use increases. The change in water use does have to be dramatic to trigger the email, but it's far better than waiting weeks or months to find out. Check to see if your water department offers the free service. Sign up for it, or suggest your landlord sign up. Your landlord will love you for it.

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# other water leaks



If water leaks from a bathtub faucet—while you're taking a shower or when the tub and shower are off—you are wasting water. That water is never used to clean you.

If such a leak involves hot water, you are wasting not only water but also the energy to heat the water. Tub and sink leaks can be very expensive over time.

Get the leak fixed by a plumber.

If you want to figure out how much the leak is costing you, measure how many cups leak out in a minute. Then use our [water leak calculator](#) to figure out how much it's costing you per year.



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**Note:** This is something a smart landlord will want to fix. Use the calculator to figure out the savings, then call your landlord.

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How-to Section



## How to fix a water leak

- Energy savings per decade: **\$1,388 and 11,038 lbs. CO<sub>2</sub>** assuming the leak is a mealy 1 cup per minute
- Water savings per decade: **\$5,274 and 328,500 gallons**
- Level of difficulty: **Difficult, call a plumber**
- Cost: **\$50 to \$200**
- How long it takes: **A minute to call**
- Tools & materials: **The phone and your plumber's phone number**

Call a plumber to fix a water leak, because if you don't know what you're doing or you don't have the right gasket, you can suddenly find yourself in big trouble. When that happens, it always seems to be Friday night with no plumbers around.



# lawn and garden



Up to 30% of the water used by the average American household is not used in the home at all, but outside on the garden and lawn.

You can reduce this use in several easy ways.

## What to plant

- If your area doesn't get a lot of water, don't plant water-loving plants.
- Choose plants native to your area. Native plants are meant for your geography and you won't have to fuss over them as much to make them look great. Find a list of plants native to your area on [this EPA site](#).
- Don't plant more lawn than you need. Lawns were intended for damp Scotland, not dryer and hotter New England.
- If you do plant a lawn, choose a combination of several drought-tolerant species that need little to no watering, such as Zoysia grass, Bermuda grass, fescue or others. A combina-

tion of several insect-resistant grasses with a high percentage of fine fescues has the greatest chance of doing well no matter what the weather.

## Watering your lawn efficiently

- Don't water after it rains or just before it will rain.
- Don't water in the middle of the day when the sun's heat will evaporate more of the water.
- When you do water, put an empty tuna fish can (or other short can) out on the lawn. Stop watering once the can is full.





## How to water plants efficiently

- Water savings per decade: **Up to \$221 and 44,895 gallons assuming you save 12 gallons a day. These savings don't consider the cost of materials.**
  - Level of difficulty: **Easy**
  - Cost: **Up to \$500 assuming you need four rain barrels and 200 feet of soaker hose**
  - How long it takes: **Up to 3 hours**
  - Tools & materials: **Enough soaker hose to loop through your garden, a rain barrel per downspout**
1. Place a rain barrel under each of your downspouts so the barrels catch the rainwater from your roof. Rainwater is better for plants' health than the chemically treated water that comes from the water department.
  2. Connect the rain barrels to soaker hoses. A soaker hose is made from a material that allows the water in it to

gradually leak out, watering your plants at a slow rate the roots can absorb.



3. Roll the soaker hoses out from the rain barrels so they wind their way through your plants near the roots. The soaker hoses will stay here. If you don't like the look, you can always cover up the hoses with wood chips or bury them just under the surface of the soil.



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**Tip:** If you need to run the hose across a path or lawn and don't want to trip over it constantly, you can bury it underground inside a PVC tube so the hose isn't crushed by the weight of the dirt. Use a normal (non-soaker) hose for this length so you don't waste a lot of water inside the PVC tube.

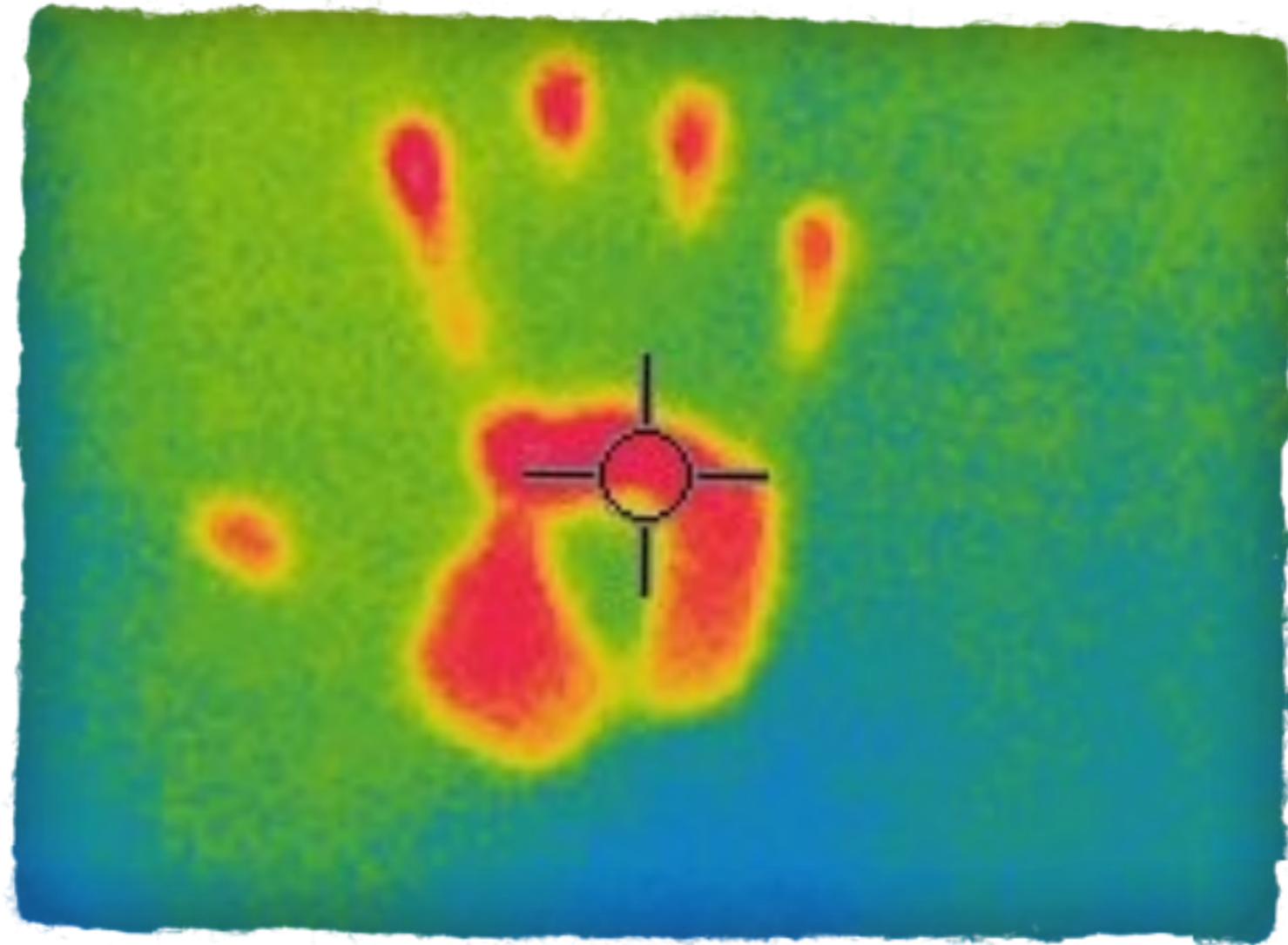
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4. Make sure the valve on the rain barrel is open so the rain barrel water runs into the soaker hose.

This system will water your plants gradually over the summer so you don't have to run outside all the time turning sprinklers on and off.

In the winter, you should disconnect the hoses from the barrels and make sure the barrels' valves are all the way open. This way water won't freeze and thaw inside of the barrels and hoses, which would break them down more quickly over time.

saving heat



Heat is often measured in terms of British Thermal Units or BTUs. A single BTU is the amount of energy necessary to warm up 1 pound of water one degree Fahrenheit.

The average home in New England uses about 79 million BTUs per year to keep it warm during the winter.

(This isn't counting the additional 21 million BTUs for "base load" energy used for cooking food, drying clothes, etc.)

If you use natural gas, just heating your home costs \$1,122 on average per year (at \$1.41 per therm) and creates 9,468 pounds of CO<sub>2</sub> (i.e., roughly one African elephant).

Luckily, not only is it fairly easy to reduce heat use, most of the changes we list in this section cost less than \$100 and have a higher annual interest rate than anything you can get in the bank. Many of the ways you can save on heat will also increase the comfort and health of your home, and help the planet.

### Calculating your heating cost per unit of fuel

In order to calculate how much you're paying per therm (or other unit of fuel), ignore all the surcharges on your bill. Pay attention only to the Customer Charge, the to-

tal number of units you've used this month and the total amount of money you owe for this month.

Subtract the Customer Charge from the total cost of the bill, then divide that by the number of units to get your cost per unit, for instance:

$$\begin{aligned} \$346 \text{ total bill} - \$20 \text{ Customer Charge} &= \\ &= \$326 \end{aligned}$$

$$\begin{aligned} \$326 \text{ divided by } 231 \text{ therms} &= \\ &= \$1.41 \text{ per therm} \end{aligned}$$

### Separating your heat use from your base load use

Since you want to calculate *accurately* how much insulating your home or other weatherization work is likely to save you, you need to know how much fuel you used for heat last winter. However in a lot of cases, your annual fuel use combines winter heat and base load use—for instance, you might heat your home with natural gas, but also use natural gas for your dryer and oven.

If your heat and base load use is combined, you need to separate them.

(Of course, if you don't mind approximations, don't worry. All of our heating calculators have the New England average winter heat use pre-inserted for you.)

Therms Usage History	
Date	Therms
08/23	11
07/25	14
06/23	17
05/23	19
04/24	39
03/24	66
02/23	92
01/24	115
12/21	64
11/22	48
10/22	17
09/22	14
08/22	12

Assuming you use natural gas or electricity to heat, pull out your last energy bill. Somewhere on your bill (or e-bill) should be a chart showing how many therms or kWhs you used per month over the last year.

Use our [Separating Heating Use](#) calculator to separate your heat from your base load energy use.



Once you've calculated your annual heat use with the calculator, write down the number of units used for heating, its cost and how many million BTUs that equals. You can use those numbers to calculate your potential savings from the actions described in the rest of this book.

# heating system

section 21

## choosing your heating fuel



New England doesn't have lots of oil like Texas, or mountains full of coal like Virginia. Mostly we have to import our fossil fuels, making heating (at least with natural gas) and lighting our homes roughly 30% more expensive than the national average (for both therms and electricity).

Perhaps you've been considering buying that wood stove, or switching from fuel oil to natural gas. In that case, try out our [Comparing Heating Fuels](#) calculator. Since different fuels have different units of measurement (therm, gallon, kWh and cord), the calculator compares them in terms of how much each costs to deliver one million BTUs of heat to your home.

Although your home might use more or less fuel than the average home—or your heating system might be more or less efficient than the average—this calculator can help you get a sense of each fuel's relative impacts on your wallet and the planet.



### Background info on each fuel

#### Natural Gas

In New England, use of natural gas for heating is far below the national average of 51%. Even in [Rhode Island](#) where the percentage is highest, only 46% use natural gas to heat.

Currently natural gas is generally considered the cleanest burning and least expensive heating fuel per BTU of heat delivered. Because of new natural gas deposit discoveries and new extraction techniques such as fracking, the price of natural gas in the US is not expected to go up [substantially](#) over the next decade. However, there are an increasing number of questions about how “clean” natural gas is—not only in terms of damage to groundwater but also in terms of carbon emissions.

Current natural gas extraction techniques only get about 30% of the natural gas out of a mine. When the extraction is finished, the mine is capped. There is the

possibility that these caps might continue to leak the remaining 70% of the gas into the atmosphere over the following decades. Un-combusted natural gas (i.e., gas that has not been burned to release its heat) is called methane and is over [20 times](#) more powerful as a climate-changing gas than is combusted natural gas.

If these mines do leak in this way, then the carbon emissions of mining and burning natural gas might be something equivalent to coal.

Until the scientists agree on the issue, we will assume that each therm burned for heat only creates 12 pounds of CO<sub>2</sub>.

### **Fuel Oil**

In New England states, between 39 and 80 percent of homes are heated with fuel oil—all much higher than the [national average of 9%](#).

Per million BTUs, oil is currently twice as expensive as natural gas and it creates 26% more CO<sub>2</sub> pollution. Over the last few years, the price of fuel oil has also been much more volatile, rising a lot faster than natural gas.

### **Electricity**

Few New England homes are heated with electricity—between 4% in Maine and 15% in

Connecticut—compared to the 30% national average. Electricity is by far the most expensive heating fuel, and it creates the most CO<sub>2</sub> per BTU of heat delivered to your home.

However you could take the long view, ignore the emissions and concentrate on the fact that the price of electricity increases historically only about 20% per decade.

### **Wood**

Very few homes in New England are heated entirely by burning wood (so few, we couldn't even find proper statistics on it).

Wood is much more difficult to quantify in terms of price and CO<sub>2</sub> emissions. If you can harvest this wood yourself (either from your own land or by scavenging it off [Freecycle](#)), then this is the one mainstream New England heating fuel that can cost nothing.

For the rest of us who can't rummage up enough free wood, the cost is about \$250 per cord. Although the cost might seem steep, per million BTUs, wood costs less than any of the other fuels and because the wood tends to be locally sourced, this money stays in the local economy.

Some people believe that since wood is a “renewable” resource, it has no carbon emissions. In order to assume this you have to believe that the trees cut down for your wood

are being replanted and that these saplings are certain to grow to adulthood—in spite of any future possibility of development, forest fire, Asian longhorn beetle infestations, etc.

Whether wood is harvested sustainably or not, burning it creates a lot more particulate matter than burning fossil fuels in a power plant. Your chimney at home does not have an emission scrubber the way a power plant does. Particulate matter causes 2,000,000 premature deaths worldwide every year and black carbon (created through incomplete combustion) is a strong [climate forcing agent](#). The pollution from your chimney will not only affect the [health](#) of your home, but your neighborhood.

In other words, although wood has many strong plusses as a heating fuel, it is by no means a perfect solution.

### **A Win/Win Solution**

If you want to reduce both your impact on the planet and your annual home-heating expense, then efficiency is the cheapest, fastest, and most effective technique - regardless of heating fuel you use. Making your home more efficient is an action that both Warren Buffet and the Dalai Lama would approve of.

# program your thermostat



In New England during the winter, every degree you turn the heat down for eight hours per day will decrease your heat use by 1%.

So if you turn your heat down at night from 70° to 60° while you are cuddled up under the covers, you will save 10% on your heating bill and reduce your heating emissions by the same.

If you have a programmable thermostat, you can program it to turn the heat up a half an hour before you wake up, so your home is warm and toasty for you. You will never even know the heat went down, until you see your bill has decreased.

If you don't have a programmable thermostat, our next chapter (Install a Thermostat) might be helpful. Once you have installed the thermostat, you can program it to turn down the temperature as much as possible at night and while you're at work.

## Myth buster

It does not take more energy to heat up a home than it does to keep that home at the same temperature for hours.

- **Reason #1:** Your home loses heat at a speed that increases the bigger the difference is between the inside and outside temperature. If it's 0° outside and your house is heated to 80°, your home will lose a lot more heat per hour than if it were heated only to 65°. When you lower the thermostat setting (the indoor temperature), you are decreasing the difference between the inside and outside temperature and thus decreasing the speed at which your home is losing heat.
- **Reason #2:** When you turn your thermostat down for a few hours at a time, your heater does not have to turn on and off and on and off throughout the night in short little bursts to maintain temperature. Most heaters don't run at their most effi-

cient in short bursts, similar to how most cars don't get their best mileage in stop-and-go traffic in the city.

- **Reason #3:** In the morning, when you turn the heat back up, the heating system gets to run full out for a while (like a car on the highway).

The only exceptions to this are heating systems with more than one speed, such as heat pumps and some of the newer high efficiency mod-con boilers. These two types of heaters can run at a much lower speed that is more efficient at warming up the home in short bursts.

All of our estimated energy savings for heat are calculated assuming your home is heated with natural gas and that the total annual cost is around \$1,122.

If you heat with oil or other fuel, your annual heating bill is probably much larger and your potential savings will be larger also.

## How-to Section



### How to program a thermostat

- Energy savings per decade: **Up to \$1,191 and 9,468 lbs. CO<sub>2</sub>** assuming you lower the heat 10° for 8 hours per night throughout the winter.
- Level of difficulty: **Easy**
- Cost: **\$0**
- How long it takes: **5 minutes**
- Tools & materials: **Your fingers, a piece of paper and pencil. Possibly also a computer and printer if you have to download directions.**

Determine the schedule you want:

1. Figure out your weekly household schedule. You can program most thermostats to up to four different temperature settings per day. For instance, your family might go to sleep every night by 10 p.m., wake up at 6 a.m., leave for work by 8 a.m., and return at 6 p.m. On Saturdays and Sundays,

they are home for most of the day and stay up until 11 p.m. Each time period for turning on or off the heat should start half an hour before needed to allow the home to get warm.

---

**Tip:** For instance, if the wake-up time is 6 a.m., the thermostat should turn on at 5:30 a.m. If bedtime is 10 p.m., then program the thermostat to turn the temperature down at 9:30.

---

2. Decide on what temperatures you want for each time period.

---

**Tip:** Remember the lower the temperature, the more you save. If you're cold, you can always over-ride the programmed temperature by pressing the Up button on the thermostat. This will increase the heat until the next programmed period begins.

---

3. Write the times and temperatures down before you start.

### Weekdays Settings

5:30 a.m.—68°

7:30 a.m.—55°

5:30 p.m.—65°

9:30 p.m.—55°

### Weekends Settings

6:30 a.m.—65°

10:30 p.m.—55°

Now you need to program the thermostat. If you don't know how to program your particular thermostat, a fairly cryptic version of the directions is sometimes printed on the inside of the thermostat's front panel. If these are a little too succinct, you can download the specific directions for your thermostat from the Internet (just search for the name and model of your thermostat).

---

**Note:** When choosing a thermostat for the home, most people choose the type that allows them to program one schedule for the weekdays and a separate

schedule for the weekend. This kind is called a 5-2 (for the five weekdays followed by the two weekend days).

---

Our directions below are for a Honeywell 5-2 and a LuxPro 5-2, the most popular thermostats in our neck of the woods. If you don't have either of these, the directions should still give you the general steps and important principals.

## Programming the LuxPro 5-2



1. Start by setting the current time and day—without knowing the right time, the thermostat will heat and cool your home at the wrong times. Open the front panel to show the controls. Rotate the dial to Set Day/Time. The day of

the week at the top of the screen will start blinking.

---

**Tip:** The text is rather small. If you have a problem seeing it, use a flashlight.

---

2. Press the Up arrow to change the day until the screen shows the correct day.
  3. Press the Next button. The time will start blinking.
  4. Press the Up or Down arrow to set the thermostat clock to the current time.
- 

**Tip:** Make sure the AM or PM setting is correct. If it's not, just hold down either the Up or Down arrow keys and the time setting will change a lot faster.

---

5. When the time is set correctly, turn the dial to Weekday Program.
6. Set the Temperature switch to Heat in order to program the winter settings. You will now program the weekday times and temperatures settings for your home.
7. The time will be blinking with the text Start At next to it and the screen will show Morn for the morning schedule. Press the Up or Down arrow to set the time at which you want the heat to start every weekday morning. For instance,

if you wanted the heat to turn on at 5:30 AM, then you'd set the time here to 5:30 AM.

8. When the time setting is correct, press the Next button.
9. The temperature will blink. Press the Up or Down arrow to program the temperature you want. For example, if you wanted the heat to warm the house to 68° every weekday morning, you'd set the temperature to 68°.
10. When you have this morning temperature setting correct, press the Next button. Repeat steps 7 through 9 to program your next weekday time and temperature setting. Probably this is the time when you leave for work or school. In our earlier example we wanted the temperature at 7:30 AM to go down to 55° for the time while the family was off at work. In order to do this, we would program the time setting to be 7:30 AM and then the temperature setting to be 55°.
11. Once you have this second temperature setting programmed, repeat step 10 to program the time and temperature for the next two scheduled settings. In our earlier example, we would press the Next button and then set the

temperature to 65° at 5:30 pm when everyone returns from work and then hit the Next button to schedule the temperature to go to 55° at 9:30 PM when everyone went to sleep.

---

**Tip:** So you don't lose track of where you are in the daily schedule, the LuxPro's screen shows a different word for each of the four daily settings: Morn, Day, Eve or Nite. Other companies use other names such as Wake, Leave, Return and Sleep.

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**Tip:** If you make a mistake and need to go back to a previous time or temperature setting, just twist the dial to Set Day/Time and then back to Weekday Program. You can then start again. With any time and temperature settings that are correct, you can just press Next and they will be saved. Keep pressing Next until you get to the setting you want to adjust and then use the arrow keys to adjust that setting.

---

12. When you're finished programming the weekday schedule, turn the dial to Weekend Program to set the programming for that.
13. Repeat the steps to program in the daily schedule for the weekends.

---

**Tip:** If you don't need all four daily temperature settings, just make sure the same temperature is requested for all the remaining time slots. For instance, let's say you only needed two temperature settings per day and the last one requested 55° at 10:30 PM. Since there are still two more settings you can program but don't want, you'd program the next temperature change to be a bit later, say 10:45 pm, but keep the temperature still at 55°. Then you would program the final daily setting to be a little later, say 11:00 pm, and still keep the temperature at 55°.

---

14. To check your program, simply turn the dial to either Weekday Program or Weekend Program and then press Next to scroll through each setting.
15. Turn the dial to Run or the heat won't come on.
16. Finally, make sure the thermostat is set to Heat, so it can turn the heat on as needed. If it's set to Off or Cool, it won't turn the heat on.

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**Tip:** If you have central air conditioning and want to program your summer schedule, when you finish the heat schedule, you can turn the switch to Cool to program your summer schedule.

---

## Programming the Honeywell 5-2



1. Start by setting the current time and day—without knowing the right time, the thermostat will heat and cool your home at the wrong times. Press the Set button. The time will start blinking.

---

**Tip:** The text is rather small. If you have a problem seeing it, use a flashlight.

---

2. Press the Up or Down arrows to adjust the time until the screen shows the current time.

---

**Tip:** Make sure the AM or PM setting is correct. If it's not, just hold down either the Up or Down arrow keys and the clock will adjust the time a lot faster.

---

3. Press the Set button. The day will start blinking.
4. Press the Up or Down arrow until the day shown is the current day.
5. Press the Set button. With the Honeywell thermostat, you can program four different daily time periods to different temperatures. The time periods are called Wake, Leave, Return and Sleep. You will now program each of these four periods for the time and temperature you want.
6. First the time will flash. Use the Up and Down arrow keys to change the time to when you want the heat to turn on for weekday mornings.

---

**Tip:** Make sure the AM or PM setting is correct.

---

7. Press the Set button to set that time. The temperature will now flash. Use the Up and Down keys to set the temperature to how warm you want your home to be on weekday mornings. For example, if you wanted the heat to warm the house to 68° every weekday morning, you'd set the temperature to 68°. Press the Set button to save that temperature setting. The screen will now show Leave, indicating you can

program the next time period (which is called Leave).

8. Repeat steps 6 and 7 to set the three other daily time periods to the time and corresponding temperature settings you want for the weekdays.
9. When you've finished, the screen should now show Sa Su for Saturday and Sunday. This means you can repeat steps 6 and 7 to set the four daily time and temperature settings you want for the weekends.

---

**Tip:** If you don't need all four daily temperature settings, just make sure the same temperature is requested for all the remaining time slots. For instance, let's say you only needed two temperature settings per day and the last one requested 55° at 10:30 PM. Since there are still two more settings you can program but don't want, you'd program the next temperature change to be a bit later, say 10:45 pm, but keep the temperature still at 55°. Then you would program the final daily setting to be a little later, say 11:00 pm, and still keep the temperature at 55°.

---

10. When you are finished, you can check your programming by pressing Set again and again as you scroll through

the entire program, checking that each time and corresponding temperature is what you want. If any of them are wrong, adjust it with the arrow buttons and then program the new setting with the Set button.

11. When you're sure the program is the way you want it, press Run or simply wait 60 seconds and the thermostat will automatically switch itself into the Run



mode.

12. Click the switch at the bottom to Heat or the thermostat will not heat your home.

---

**Tip:** Always slide the Fan switch to Auto. If your home heating system is forced hot

air, switching it this way can save you lots in electricity.

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\* \* \* \* \*

---

**Tip:** The Hold button overrides the entire program. If you're leaving town and the house will be empty, you can lower the heat and press the Hold button. This will hold the temperature 24/7 until you return. At that point, just press the Hold button once again and your normal heating schedule will continue. Be careful not to let the heat-crankers in your house know about this or they may Hold a temperature that is too high.

---

**Tech savvy, extra cash, and want to step it up a notch?**

If you hate the idea of programming your thermostat, you could install a fancy Nest thermostat instead. It learns over time how you use your home and adjusts the temperature accordingly.

And if you want you can control the Nest from your favorite wireless device (phone, tablet, laptop). Other thermostats do this too like EverSense, Filtrete, Lutron, Eco-bee, CEM24, etc. (Try the Internet search

“wireless thermostat control” to get started).

Fancy thermostats like these might be particularly handy if you occasionally are away longer than expected. If you find your dinner out has turned into a weekend away, you can easily adjust the temperature of your thermostat from your phone or other device.

---

*Of course wearing more layers (insulation for the body) is the least expensive way to keep warm. Keep a couple of blankets on the couch and try a little body heat by snuggling up with your honey. It works to keep you warm and may have some additional benefits.*

—Jason

# installing a programmable thermostat



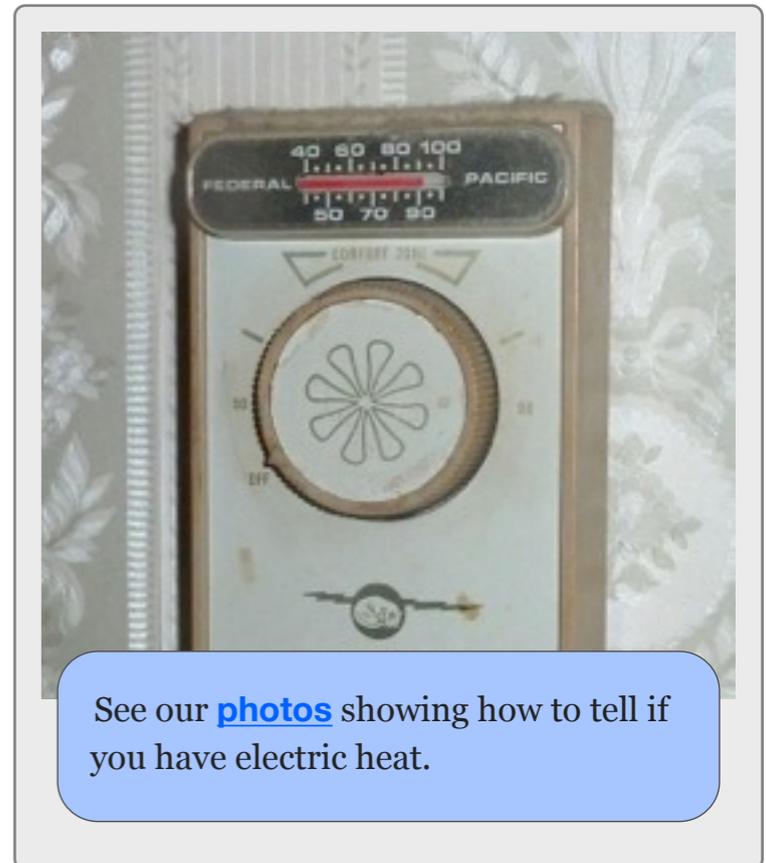
Now that we've taught you how to program a thermostat, we should teach you how to install one, just in case you don't have one yet.

**Warning: Do NOT install a programmable thermostat if your heating system is electric. You could electrocute yourself.**

## How to know if you have electric heat

Generally each room in your home will have low square baseboards along the floor, each with its own thermostat. You will also probably have no furnace or boiler in the basement and you will get a whopping huge electricity bill in the winter.

If you have gas or oil heat, then you don't need to worry about electrocuting yourself by using our directions to install a programmable thermostat. In this case the thermostat has DC current or only about as much electrical current as is in two AA batteries.



See our [photos](#) showing how to tell if you have electric heat.



## How to install a programmable thermostat

- Energy savings per decade: **Up to \$953 and 9,468 lbs. CO<sub>2</sub>** assuming you use the new thermostat to lower the heat 10° for 8 hours per night throughout the winter
- Level of difficulty: **Moderate**
- Cost: **\$25 to \$50**
- How long it takes: **20 minutes to 1 hour**
- Tools & materials: **Needle nose pliers, very small flathead screwdriver, Phillips head screwdriver, programmable thermostat, pencil, drill, a 3/16th drill bit, hammer, paper clips. Possibly also wire stripper or knife, batteries that fit the thermostat, screws, dry-wall anchors**

We give you these directions because sometimes thermostat-installation instructions can be fairly cryptic, translated badly from Urdu and may assume you're an HVAC professional. However please ig-

nore our directions if they disagree with the installation directions of your particular thermostat. If you've lost those directions, you can download new ones from the Internet by searching for the thermostat name and model.

---

**Tip:** Please don't start this project Friday night after 5 PM during the winter. If something does go wrong, you won't be able to reach an HVAC professional until Monday morning.

---

### Remove the old thermostat

1. Turn off the heating system (it's probably in the basement). Normally there's a switch on the side of the furnace or boiler that looks like a red light switch. Click it off.



2. Go back upstairs to where the old non-programmable thermostat is.
3. Unsnap the old thermostat cover from its base.
4. Remove the screws holding the thermostat mechanism to the thermostat base.



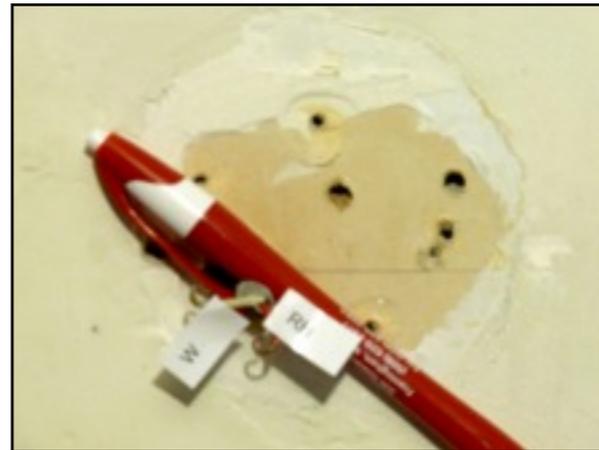
5. You can now see the flat base of the thermostat with the wires connected to different screws in it. These are the wires that connect your heating system to the thermostat. Take a photo or draw a picture of the wires and what screws they go to. That way, if you get in any trouble, you can at least re-attach the old thermostat.

**Tip:** If the wires are the same color, then put masking tape on them and label each in a way that explains which screw the wire was connected to.

6. Unscrew and remove the base of the thermostat from the wall.



Hold onto the wires as you do so. Secure the wires around a paper clip, pen, or other similar object to weigh them down enough so they don't slip backwards into the hole in the wall never to be seen again.

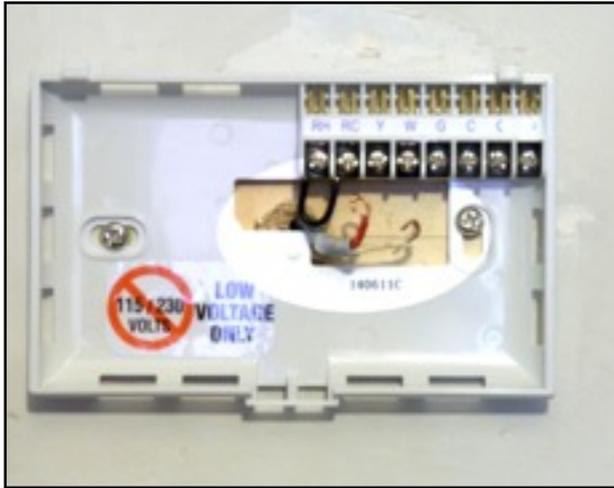


7. Stuff a few paper towels into the hole in the wall behind the thermostat. (This will protect your new thermostat from cold drafts so it doesn't crank the temperature up every time the wind blows.)

### **Install the New Thermostat**

1. Take the new thermostat out of its wrapping and unsnap the new thermostat from its base.
2. Unfurl the pen or other object you have used as a weight from the heating-system wires and push the wires through the hole in the new base so that they emerge under the terminal block (the area with all the screws for connecting the wires).
3. Reattach the weighted object to hold the wires in place.

4. Place the base against the wall. Try to line up the base with as many of the screw holes from the old thermostat as possible so you have less screw holes to drill. When you have the thermostat where you want it—holding it firmly in place—use a pencil to mark the location of each new screw hole.
5. Remove the thermostat base from the wall.
  - \* If the wall is drywall, you will need to use anchors. In this case use a 3/16th drill bit to drill the needed holes and then insert one anchor into each of these holes. Use a hammer to knock each anchor lightly into the wall until it is flush with the wall. (Both anchors and screws are normally included with the thermostat.)
  - \* If the wall is wood, you don't use the anchors. In this case, use a drill bit a fraction skinnier than the screws that came with the thermostat to drill the needed holes into the wall.

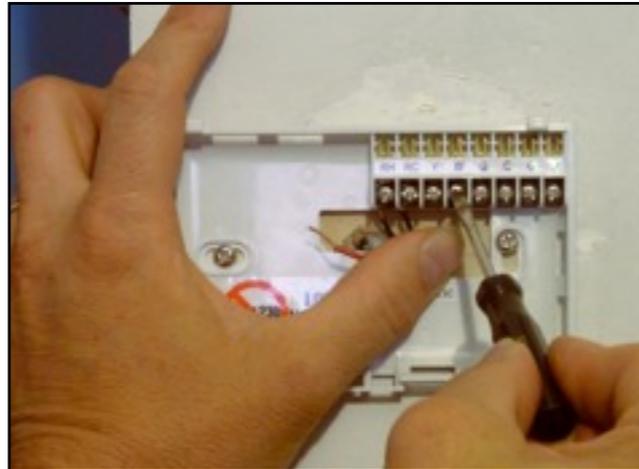


6. Place the thermostat base onto the wall and line it up with the holes. Screw it in. The holes in the base for the screws are a little elongated so you can shift the base around a bit to get it just where you want it, before you screw it in tight.
7. Follow the directions on your particular thermostat for where to connect the wires. If they are incomprehensible, then in general, you should do this:
  - \* Loosen the tiny screw marked Rh and the screw marked W.
  - \* With needle-nose pliers straighten the two wires that were connected to the old thermostat and insert the red wire into the hole marked Rh and the white wire in to the hole marked W.

---

**Tip:** If the exposed part of either wire is too short, you may need to pull off a bit of the plastic coating to expose more wire. A wire stripper is best for this. You place the wire into a wire stripper hole, give the stripper a bit of a turn to cut the coating and slide the coating off.

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**Tip:** If your wires have no color, try the left one with the RH screw and the right one with the W screw. Complete the last steps of these directions and then check that the thermostat works (as described below). If the thermostat doesn't work to control the heating system, then switch the positions of left and right wires and test the thermostat again. If you have a central cooling system, there might be more than just three wires. In this case, check the directions on the thermostat.

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- \* Then tighten the Rh and W screws so each wire is between the back of the thermostat and the head of the screw and is tightly held there. Make sure the bare part of each wire has a good contact with the metal of each screw.



8. Install batteries if they are needed.
9. Snap the front of the thermostat onto the base. Snap the top in first and then the bottom. Sometimes there is a screw at the bottom that must be tightened.

#### **Check New Thermostat**

1. Slide the Heat-Off-Cool switch to Heat. Sometimes the switch to do this is along the bottom of the thermostat.
2. Press the Up arrow on the thermostat until the thermostat read-out is asking for a temperature that is way over the

current temperature inside the home (90° or so).

3. Turn the furnace/boiler back on (using that switch you turned off on the side of the furnace/boiler down in the basement).
4. Stand by the furnace/boiler in the basement and listen. If you did everything right, the furnace/boiler should go on within three minutes. Listen for the whoosh of the flame going on. If you aren't sure the heat has gone on, lightly touch the metal flu above the furnace. Be careful; it could be hot enough to burn you.
5. After the heat goes on, go back to the thermostat and press the Down arrow until the thermostat is set to a reasonable temperature.
6. Program the thermostat to the temperatures and times you want. (See the earlier chapter, "Program your Thermostat," to do this).

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**Note:** Make sure to bring your old thermostat to a recycling center or hazardous materials center afterward. Each old thermostat contains enough mercury to poi-

son a small lake and many humans. Don't just throw it in the trash.

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**If the heat doesn't come on after five minutes**

1. Check that the switch on the furnace/boiler is on.
2. Check that the temperature on the thermostat readout is higher than the current temperature of the home.

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**Tip:** Click the Up arrow and it will show the temperature the thermostat is asking for. After a moment, it will return to showing the current temperature of the room. Make sure the first number is higher than the second.

---

3. Check that the red wire and white wire are in the correct holes and that the screws are tightened all the way.
4. Make sure the bare part of each wire is in tight contact with the metal of its screw. If necessary—using wire strippers—strip off a little more of the plastic casing on the wire, then re-screw the wire into the contact, making sure that the wire is held tightly against the metal of the screw.

---

**Note:** If the heating system does not go on, this is usually where the problem is.

---

5. Confirm the Heat-Off-Cool switch is on Heat.
6. See if the heating system is on now.
7. Repeat if necessary.



# furnace filters

Furnace filters clean the air of dust, dirt, pollen, pet hair and mites. Changing them occasionally will help keep your heating and cooling system last longer, keep your home's air cleaner, and allow your furnace's blower to run a tiny bit more efficiently.

However ignore all those fliers that say you have to change your furnace filters

once a month. There are no measured savings from frequent filter replacements. In the words of Michael Blasnik, the country's energy-saving Nostradamus, the idea is "hooey." The dirtier they are (up to a point) the better they work to actually clean the air, since the dirt particles are more likely to get caught in the filter.

## **When to change your furnace filter**

If you use the standard less-expensive filter, then change them once a season. If you use the thicker pleated filters, then twice a season is probably worthwhile.

If you use your furnace and central AC, then you have to change the filter during the heating season as well as during the cooling season.

### **Furnace filters: how clean should they be?**



See our [photos](#) showing how clean furnace filters should be and where they generally are located on the furnace.



## How to change your furnace filter

- Energy savings per decade: **Up to \$357 and 2,840 lbs. CO<sub>2</sub>**
- Level of difficulty: **Easy**
- Cost: **\$3 to \$35**
- How long it takes: **5 minutes**
- Tools & materials: **Your fingers, a flashlight, sometimes a screwdriver**

Ideally your furnace will have an instruction manual taped to its side. Look in the manual for directions showing where the filter (or filters) goes and how to change it. If there is no manual, you can always Google the furnace model to get directions.

**If you can't find directions, here are some generic directions.**

1. Open or slide the door panel on your furnace to get access to the furnace.

2. Normally the filter will be where the air returns to your furnace --in the duct itself or in the entrance to the blower chamber. Sometimes there is a filter in both locations.
3. If there is a cover on the filter, unscrew it.
4. Slide out the old filter.
5. Slide in the new filter with the airflow arrows pointing toward the blower.
6. Screw the cover back onto the filter if necessary. Close the furnace door(s) back up.

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**Note:** Energy savings will vary a lot depending on what type of filter, how dusty your home is, etc.

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# sealing ducts



There are many different types of heating systems for the home: forced hot water, electric baseboard, etc. One type is forced hot air. In this case, the winter heat is delivered in the form of hot air blown in through grates in the ceiling, wall or floor.

Forced hot air systems heat air in your furnace and then push that air with fans through ducts (metal tunnels) to your living space.

The ducts that supply your home with heat are called the supply.

As the air cools, other ducts return it to the furnace to be heated up again. Logically enough, these ducts are called the return.

The air in your home cycles from your furnace through the supply ducts to your living space and then back through the return ducts in a giant circle.

If there are gaps in those ducts, this circle doesn't work as well as it could, allow-

ing heat to escape, and possibly pulling dusty or moldy basement air—or even carbon monoxide—into your living space. Closing up the gaps increases the efficiency of the mechanical system by up to 15%, and potentially improves the air quality of your home.

To seal up ducts, most times all you have to do is apply mesh tape and then duct sealant (sometimes known as mastic). Duct sealant basically acts as a glue that closes the holes, while staying elastic enough to expand and contract with the temperature changes of the heating system. Mesh tape is used as reinforcement for the duct sealant.

Adding the duct sealant itself is easy and rather zen-like—a bit like finger-painting. If you're very proud of your work at the end, you can sign your name with the duct sealant on the side of a duct.

However some ducts do need more than just duct sealant. Because ducts come in many different forms and have many dif-



ferent associated problems, our directions below look a bit daunting. Don't worry. Probably you just need to check that your ducts don't have any of these other associated problems.

**Note:** We are assuming the ductwork for your home is in the basement. If your ducts and furnace are up in your unfinished attic, this work is even more critical to do because any escaping heat will rise out of your home without keeping you warm at all. Also, in this case you want to insulate the ducts as well as seal them, to make sure the air in them stays warm even if the attic is freezing. However, working in an attic can be dangerous and uncomfortable. It might be work you want a professional to do instead.

Read our "Inspecting Your Attic" chapter to learn about safety in an attic and to see if you feel up to the work. If you decide to hire a professional instead, then check our "Rebates, Services and Tax Incentives" chapter to find rebates available for this work in your area.

Average energy savings for sealing ducts are 8% of your heating use, if the ducts are in a vented crawlspace, and up to 5% if the ducts are in the basement.

## How to seal ducts

- Energy savings per decade: **Up to \$1,786 and 14,202 lbs. CO<sub>2</sub>**
- Closing off disconnected ducts
- Level of difficulty: **Difficult**
- Cost: **\$20** assuming you have to buy just the screws and metal flashing
- How long it takes: **45 minutes**
- Tools & materials: **Hexagonal self-drilling screws, work gloves, scissors, aluminum flashing, straight edge, drill, hexagonal drill bit, extension cord (if the drill isn't cordless), a work light, goggles, fiberglass mesh tape, duct sealant. Possibly flex duct, aluminum tape and zip ties instead**

Methodically follow each duct from your heating system to the point where it enters the living space of your home. Check to make sure each duct is enclosed on all sides with no gaps. Make sure the ducts

haven't slipped apart anywhere creating a hole between them.

If your ducts have any of these problems, you need to seal those holes up before you apply duct sealant.

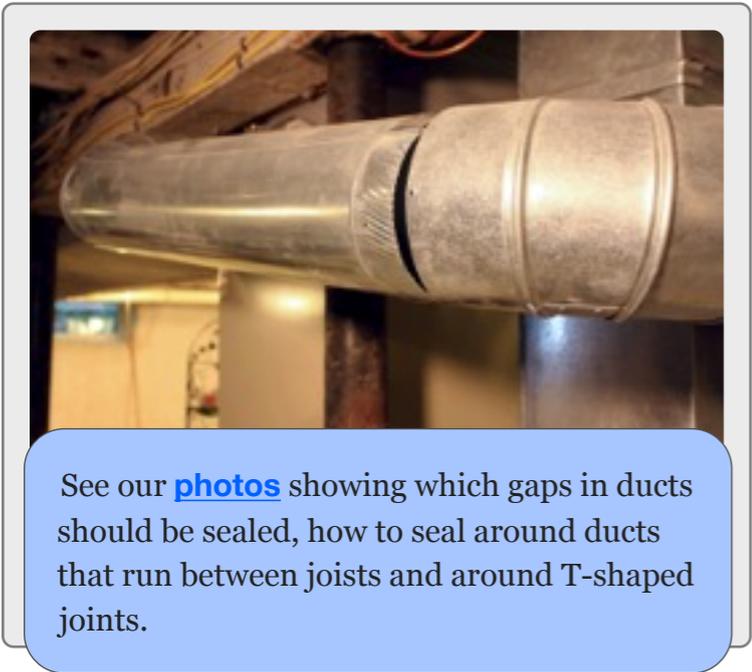
**Warning: Don't mistake the flue vent for a duct. The flue vent typically goes straight from the furnace into the chimney or out an exterior wall. The flue is always round. It is how the hot combustion gasses from the furnace—up to 600°—leave your home. Don't touch the flue. Don't put duct sealant or anything else on the flue.**

1. Pull together the disconnected ducts so they overlap (if ducts can't be brought together, jump ahead to step 3).
2. With a hexagonal bit on the screw gun, screw hexagonal self-drilling metal screws into the overlapping duct sections every three inches.

**Tip:** Self-drilling screws will drill their own hole into the metal, so you don't need to

pre-drill a hole. However, they need to spin quite rapidly before they pierce the metal. A little pressure helps too. Wear goggles.

3. If ducts won't come together or if there is a missing side, you can cut metal flashing to bridge the gap.
  - a. Measure the gap and add 4" to the width and height to allow for some overlap on all sides.
  - b. Flashing tends to come in a long roll. Pull the length of flashing you



See our [photos](#) showing which gaps in ducts should be sealed, how to seal around ducts that run between joists and around T-shaped joints.

need from the inside of the roll without undoing the roll. You don't want 20 feet of flashing to

unfurl across your basement. Cut the flashing with scissors or tin snips.



- c. Wrap the flashing in place so it overlaps itself and the pre-existing duct. Attach a corner of the flashing to the pre-existing duct with a screw. This screw should be placed so when the flashing is wrapped tightly around the duct, the screw won't be in the way of the overlapping flashing.
- d. Now wrap the flashing tightly all the way around that end of the duct and put a screw in to hold the circle of flashing in place.
- e. Do the same with the opposite side of the flashing where it overlaps with the duct on the other side of the gap. You should now have the

flashing in place at both ends of the gap. Add screws every 3 or 4 inches on both sides of the gap to hold the flashing firmly in place.

- f. When you are applying duct sealant to the ducts as described below, make sure to apply both duct sealant and mesh tape to these seams to seal this area well.



**Note:** If you are less experienced with metal flashing and self-tapping screws, creating a bridge across a gap in the ducts can be difficult. In this case, you can bridge the gap with a piece of flex duct. Just measure and cut with strong scissors a long enough section of flex duct to fit the gap (not so loose it droops) and then connect and seal at both sides as described in the Sealing Flex Duct section below.

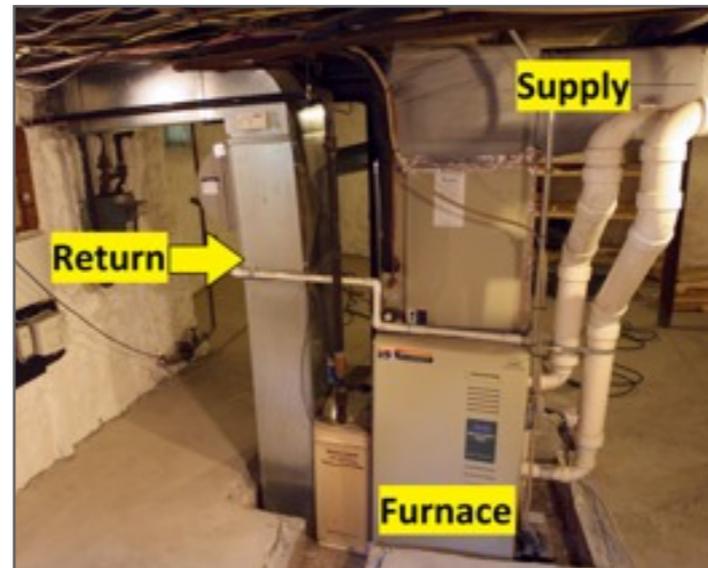
## Applying duct sealant

- Level of difficulty: **Easy**
- Cost: **\$25-\$50**
- How long it takes: **Up to a few hours depending on how many ducts you have**
- Tools & materials: **Toilet paper, tub of duct sealant, fiberglass mesh tape, dust brush or vacuum, work gloves, scissors. Possibly caulk tube of duct sealant, tube of 100% silicone caulk, caulk gun, spray foam and goggles, flex duct, plastic zip ties**

## Finding the leaks

1. First, you want to check to see if there are any leaks in the ducts. Turn the temperature way up on your thermostat until the furnace clicks on.
2. With air now moving through the ducts, let your hand circle the outside of each duct seam to feel for air leaks. You can also do this with a piece of toilet paper. If the paper is sucked toward or blown away from the seam, there is a leak.
3. Mark each leak with a piece of painters tape. You will fix the leaks with the following steps. You want to paint onto every seam so much gluey duct sealant that you seal the seam shut.

The return side is the most important to seal. Not only can the return ducts suck in dusty or moldy basement air that then gets delivered to your living space, but—if they have a lot of leaks—they can even depressurize your basement so much that the flue gasses trying to escape up your flue get pulled into your basement instead. These flue gasses include carbon monoxide, a poison. Sucking a poisonous gas into your home is not good, so you want to decrease the leaks.



Be sure to *start with the return* so that if you run out of duct sealant, the house safety has been improved (in the short term) until you can return and finish the job. Start with the return duct that butts up against the furnace because this is where the air pressure from the furnace is the

strongest. Then work backward applying duct sealant to every seam until you reach the ducts that dead-end in your living space.

Three ways to figure out which is the return duct:

1. The return duct usually enters the furnace at the bottom.
2. It always holds the filter.
3. By holding a square of tissue against a crack or hole in the return side, the tissue will be drawn to the sucking of the return. The tissue will be held in place. If it's the supply, the air will blow the tissue away. This only works—of course—when the furnace is running.

### How to seal around different types of boots



See our [photos](#) of how to seal around different types of duct boots.

### Fixing the leaks

1. Shut off furnace (usually the switch looks like a light switch attached to the furnace).



2. Clean all the seams with a dust brush or vacuum. You don't want the duct sealant to stick to the dirt or dust rather than the

ducts. You may also need to remove old duct tape or even insulation to get to the holes and cracks.

3. Insert your gloved hand into the duct sealant and pull out a handful of it. With your fingers, paint the duct sealant in the cracks all the way around each seam. The duct sealant should be about 1/8" deep.
4. If you come across a hole or crack that's bigger than 1/4", first cover the hole with mesh tape. Wrap the non-sticky side of the tape around the duct to measure how much you need. Cut it with scissors to the right length. Then apply the tape (sticky side down) all the way around the hole or seam to cover it. After the tape is in place, paint it with duct sealant to seal it.

### Branches: T's, Y's and L's

Where smaller ducts branch off the bigger ducts, you should add mesh tape that is cut to make a sort of "hula" skirt so the skirt can expand to fit smoothly onto the wider duct.

1. Determine the length of the mesh tape you need by wrapping the non-sticky side of the tape around the duct. Cut it with scissors to the right length.

2. Fold the mesh tape over itself and then in half again. Cut tabs halfway through the width of it, every inch or so.
3. Then apply the mesh tape to the seam, sticky side against the duct, so the notches spread out like a "hula" skirt onto the wider duct.
4. Cover the mesh tape with duct sealant (about 1/8" thick).

### Boots

Boots are the end of the ducts, where they reach the grate that enters the living space of your home.

1. Go to every room in your house and pull off the grate that covers the duct. The grate may be on the floor or it may be on the walls. If there is any crack around the duct between the duct and the floor or wall, then that crack needs to be sealed.
2. Clean the area first because boots tend to be very dirty.
3. You can seal the crack with duct sealant smeared on with your hands, or with 100% silicone caulk in a caulk tube, or even with aluminum tape.

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**Tip:** 100% silicone caulk is best for this job (If you don't know how to caulk, read

our Caulking chapter first. Either way, be careful you don't drip the caulk anywhere on the floor because 100% silicone can only be cleaned up with mineral spirits.

### Sealing flex ducts

Flex duct is a foil-covered flexible duct with a springy wire frame. It will remind you a tiny bit of those play tunnels from kindergarten.

If your flex duct has fiberglass insulation around it, you should wear gloves for this work. Fiberglass is a skin irritant.



3. Roll back the insulation layer from the flex duct so you can get to the inner flex duct layer. Fit this inner duct over the duct sealant on the rigid duct.
4. Encircle the flex duct joint with a zip tie. Next, insert the tail of the zip tie into the zip tie slot and pull tight. Cut the tail of the zip tie.
5. Cut a piece of mesh tape to fit around the flex duct seam and attach the mesh tape with the sticky side down.
6. Smear duct sealant over the mesh tape.
7. Pull the outer insulation layer over the inner flex duct until it meets the rigid duct.
8. Tape the insulation into place with aluminum tape. Seal the seam of the insulation all the way around the rigid duct.



### Checking your work

1. After three hours have passed you can turn on the furnace again with the furnace switch. This wait time will ensure the furnace's hot air won't blow holes in the duct sealant while it's drying.
2. Turn the temperature up with the thermostat until the furnace clicks on and starts blowing air through the ducts.
3. Feel for leaks on the supply and return sides. If you find any, add duct sealant where it's needed.

\* \* \* \* \*

### Insulation

If you have ducts in an unconditioned (unheated or un-cooled) area of your home such

as a crawl space or attic, insulating those ducts is critical work to do as well as sealing them. Otherwise whenever you most want hot air, it will be delivered through metal tunnels in a freezing space. Whenever you most want air-conditioned air, it will be moving through metal tunnels in a broiling space. Not too smart. Wrapping those ducts in a blanket of insulation will help keep your home more comfortable and lower your energy bills.

Insulating ducts in the attic will save 10 to 15% of your heating use and 15 to 20% of your cooling use.

Check out our later chapter on “Insulating Ducts.”

*While I was air-sealing an attic, the owner of the house asked me to check her bathroom ductwork. I crawled over and found the duct that delivered heat to her bathroom was completely unattached to the bathroom heat register. I pulled it over, secured it and sealed it.*

*The next day the homeowner told me that night was the first time she had had heat in her bathroom in 20 years.*

—Jason

# water temperature



When you turn on the water in your sink, you don't want the hot water to be so hot it nearly burns you. At its hottest, the temperature of the hot water delivered through any of the water fixtures in your home should be no more than 120° Fahrenheit.

If it's hotter than 120°, you are wasting heat, wearing down your water heater with increased mineral buildup and there is the chance someone could scald themselves.

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**Note:** Don't turn the temperature lower than 120°, because that could let bacteria grow.

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How-to Section



## How to lower the temperature on your water heater

- Energy savings per decade: **Up to \$166 and 1,320 lbs. CO<sub>2</sub>** assuming the temperature is lowered 10° on a natural gas heater
- Level of difficulty: **Easy**
- Cost: **\$0**
- How long it takes: **A minute**
- Tools needed: **A flashlight, a glass, a thermometer that goes up to 130°. Possibly a voltage tester and a medium-sized flat-head screwdriver**

### Check the water temperature

1. Go to the water fixture in your home farthest from your hot water heater (i.e., if your water heater is in the basement then the farthest faucet is the sink on the top floor on the oppo-

site side of the building from the heater).

2. Turn on the sink or tub all the way to the hottest temperature possible for two minutes.
3. Fill up a glass with the water after the two minutes is up.
4. Put a thermometer into the water to measure the temperature.
5. If it is hotter than 120°, you should turn down the temperature on your water heater.

### Generic directions for adjusting the temperature on a natural gas water heater



**Tip:** You can tell you have a natural gas water heater, because one of the labels on the front of it should mention gas or therms. Also, gas heaters have a metal or

plastic flue on top of the heater that vents into a chimney or out an exterior wall—this flue carries combustion gases out of your home.

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Often there is a temperature dial near the bottom of the heater.

On the temperature dial, there is generally a thick line showing the temperature most people set the heater to. If you have a large home—so the water has to travel further—you might need to set the temperature higher than normal. If you have a small home, you may be able to keep this



temperature lower than normal. Using our directions, you can learn how to adjust your dial.

1. Turn the dial to lower the temperature. We can't tell you if that's clockwise or counterclockwise because it varies from heater to heater. In general, you want to turn it slightly toward the Vacation setting if there is one. Don't turn it far. A small adjustment can have a big effect.

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**Tip:** Most hot water heaters these days are made by Rheem/Ruud. On the dial for these, there are generally two lines. The longer line represents 130°. The shorter one to the right should set your heater to 120°.

2. Wait two days to allow the water to cool and measure the temperature again in the farthest fixture. Re-adjust the dial as necessary.

If these generic directions do not apply to your water heater, then look for a manual taped to your water heater. Obey its directions to change the temperature on your heater. If there is no manual, you can probably Google your water heater's model and download the manual.

## Generic directions for adjusting the temperature on an electric water heater

It's important not to waste heat with electric water heaters because heating with electricity is expensive.

Taped to your water heater should be a manual. Follow its directions to change the temperature on your specific heater. If there is no manual, you can Google your water heater's model to download the manual.

If you have a new electric heater, switching the temperature might be as simple as pressing some buttons on the front of the heater. If you have an older water heater, changing the temperature might be more difficult.

\* \* \* \* \*

**Warning: Electric water heaters have enough electricity running through them to kill you. Don't do this work unless you feel confident you know how to do each step safely. If you don't feel you can do**

**this work, have your plumber or electrician do the work.**

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**Tip:** If you go on vacation for a few days your hot water heater should be able to take a vacation too.

On most natural gas water heater temperature dials there is a Vacation setting. When you leave for vacation, turn the dial to Vacation (it will keep the water at a much lower temperature) so you save energy and money.

Leave a note by the front door reminding yourself when you get home to turn the temperature dial back to normal so the water will be nice and hot for the next morning's showers.

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**Tip:** One of our favorite plumbers, Barbara Taggart, points out many people have hot water tanks that are too big for their needs. The people have to pay to keep that water hot day after day. She recommends against installing anything bigger

than a 30-gallon water heater unless you have a Jacuzzi, take baths where you fill the tub, or have two or more people in your home who routinely take long showers right after each other.

She also recommends front-loading washing machines because they use a lot less water than top-loading washers. If your water bill or heating bill is high (especially during the summer) then buy a front loader next time you shop for a washer.

Barbara is wise. Considering a clogged toilet, she frequently quotes Camus, "Nothing human is alien to me."

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**Tip:** Finally, you can consider a solar hot water system. These systems can provide 70% or more of your hot water needs from the sun's heat.

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# insulating pipes



Ever notice how much colder it gets the deeper you swim into a lake? This temperature change is because water, like air, stratifies according to temperature.

In a water heater, this means that the hottest water will rise into pipes just above it. In those narrow metal pipes, the water will cool quickly and drift back down into the heater, cooling the water in the heater. Meanwhile, more hot water from the heater will rise into the pipes to be cooled down in turn.

Because of this convective loop (the movement of hot fluids rising and cooler fluids sinking) creating a constant dribble of cold water into the heater, the pipes in your basement that are most worth insulating are the ones connected to the top of the hot water heater. You can reduce this constant heat loss by insulating the first six feet of the hot-water supply pipe and the first three feet of the cold-water return.





## How to insulate pipes

- Energy savings per decade: **\$75 and 600 lbs. CO<sub>2</sub>**
- Level of difficulty: **Easy**
- Cost: **\$4**
- How long it takes: **5 minutes**
- Tools & materials: **9' of 3/4" foam pipe insulation, scissors, foil tape, measuring tape, flashlight**

Don't insulate the overflow pipe (the pipe that heads down and then dead ends about a foot from the floor) or the gas pipe (if your water heater uses natural gas, this pipe will enter the heater near the bottom where the burner is).

Insulate the two pipes that exit the top of your water heater. One is the hot-water outlet pipe (the one that is normally warm or hot to the touch). The other is the cold-water inlet pipe (the one that is not warm).

1. Measure the length of the pipe you want to insulate.

### Insulating a pipe



See our [photos](#) of how to insulate a pipe.

2. Cut a piece of insulation to that length with some scissors.
3. Open the insulation tube up by running your finger inside it and ripping open the pre-cut seam.
4. Place the insulation tube around the pipe.
5. Where the pipe takes a turn, cut the insulation to the proper length but make the cut at a 45° angle.
6. Install the angled piece on the first part of the pipe so the angled cut is at the corner, then use the rest of that cut

piece of insulation (spun around 180°) so the two angled pieces of insulation fit together neatly like the corner of a picture frame.

7. Tape the edges together with foil tape (lasts longer than duct tape).

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**Note:** Most water heater pipes are 3/4" pipes. If 3/4" pipe insulation fits loosely or can't close, then use the directions below to figure out what size pipe insulation you need.

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**Warning: If there is a metal flue vent at the top of your water heater, don't insulate any pipe within six inches of it. It will get very hot because it is the chimney for the hot combustion gasses. Pipe insulation is a foam petroleum product and can melt or catch on fire if exposed to high temperatures.**

### **Insulating non-water-heater pipes**

You probably don't want to bother with the expense or trouble of insulating other

pipes, such as the pipes that lead to your radiators. If these pipes are under the living space of the building, the vast majority of the heat from these pipes will rise into your living space to end up keeping it warm during the winter.

The only reasons to insulate non-water-heater pipes are if:

- You find your basement is warmer than the rest of your building.
- You spend a lot of time worrying about pipes freezing and breaking.
- The pipes are in your unheated attic or in an unheated crawlspace to the side of your home. Then, insulation will reduce the chance of your pipes freezing during the winter and help deliver the heat to your living space.

In case you have one of these exceptions, we include the following directions.

## **Other heating pipes**

- Energy savings per decade: **We couldn't find any reliable estimates**
- Level of difficulty: **Easy**
- Cost: **A few pennies to \$9 per linear foot** depending on the size of the pipe and the type of insulation
- How long it takes: **A few minutes for every 10 linear feet**
- Tools & materials: **The right length and width(s) of pipe insulation, scissors, foil tape, measuring tape, flashlight, string. Possibly a dust mask and gloves and baby powder**

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**Note:** Figuring out the width of the pipes is the most difficult part of this job.

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### **Figuring out the width of the pipes**

In order to buy the right-sized pipe insulation you need to start by figuring out the diameter of the pipe.

It's hard to get an accurate measurement by holding a straight ruler to the side of a round pipe. Instead wrap a piece of string all the way around the pipe, then mark with a pen the distance on the string. Measure the length of that part of the string against

a measuring tape to get the circumference of the pipe.

In order to derive the diameter from the circumference you need to divide the circumference by pi. (Don't worry about any uncomfortable flashback to middle-school; our calculator below will do this work).

Unfortunately that's only the first step. Pipes are referred to by their nominal width—the dimension of its inside channel rather than its outside girth. A pipe with an outside diameter of  $\frac{3}{8}$ " might be called a  $\frac{1}{4}$ " pipe because the channel inside where the liquid actually flows is only  $\frac{1}{4}$ " wide. To make matters worse—because different pipe materials need to be different widths

to adequately do their jobs—you can't just subtract a single standard amount from each pipe diameter to derive its inside diameter.

In general, the outside diameter of a copper pipe will be  $\frac{1}{8}$ " bigger than its nominal width. Plastic pipes will be  $\frac{3}{8}$ " bigger, and cast iron pipes will be  $\frac{1}{4}$ " bigger. To derive the nominal width, you need to know what the pipe is made of and then subtract the correct amount.

In case the very idea of doing all these calculations gives you the heebie-jeebies, we've included a [Nominal Width Calculator](#) to help.



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**Tip:** If all of this seems absurd, you can always buy a small amount of several likely sizes of pipe insulation and try them out to find the one that fits. You can return the other sizes. The right-sized insulation should fit snugly around the pipe, in contact on all sides and its seam should be shut (not gaping open). This snug fit will ensure the insulation works effectively.

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### **Lengths of pipes**

Once you've figured out the width of the pipe or pipes, eyeball or measure the length of the pertinent pipes to figure out how much you need of each width. Buy

about 10% more of each size than you think you need to ensure you have enough.

For example:

- 15 feet of  $\frac{3}{4}$ " pipe insulation
- 30 feet of  $\frac{1}{2}$ " pipe insulation
- etc.

### **Choose the type of pipe insulation**

Rubber pipe insulation has an R-value (resistance to cold) of 7.2 (a higher number means it's a better insulator). Generally rubber pipe insulation has an adhesive flap to seal itself so there's no need to use tape.

Foam pipe insulation has an R-value of around 2 per inch (not as good, but way better than nothing). It doesn't have the adhesive flap, so tape helps with the installation.

Fiberglass pre-slit pipe insulation has an R-value of 4.4 per inch. It tends to have an adhesive flap.

If you are installing fiberglass insulation, be sure to use gloves because fiberglass will irritate your skin. Also, rubbing baby powder on your forearms will decrease the itchiness by filling the pores so that the fiber-

### **Foam and rubber pipe insulation**



glass fibers can't get in. Wear a dust mask also to avoid breathing in the glass fibers.

### Steam Heat

**Warning: If you have steam heat, you must use fiberglass pipe insulation. Steam heat pipes can reach 250° – a temperature that will melt rubber and foam pipe insulation.**

You can figure out if you have steam heat by looking at your boiler down in your basement. A steam boiler will have a glass tube above it that shows the water level in the radiators.

Steam radiators will also have an air vent on the side that looks like a large bullet.



### Installing pipe insulation

Follow the directions above for installing insulation on hot water heater pipes. Remember to never place foam or rubber pipe insulation within 6" of the flue vent for the boiler. The vent is the metal flue that goes into the chimney.

Asbestos insulation on pipes generally looks like paper insulation except the "paper" has a honeycomb structure along the sides of it.



**Warning: Many steam pipes are or have been wrapped with asbestos. Do not remove old pipe insulation on steam pipes unless you know it is not made of asbestos. Breathing in asbestos has been linked with lung cancer. Asbestos particles can float in the air for hours. It is best to not disturb asbestos unless you are a professional asbestos abatement contractor.**



# reducing drafts

Living in a drafty home isn't pleasant; a small draft can make a home a lot less comfortable. It certainly makes your home more expensive to live in.

Reducing drafts is called air-sealing by the pros. It means to close up the holes in the interior envelope of the walls, foundation and ceiling of your building to keep the heated or cooled (conditioned) air in the area where you live rather than let it escape into the great outdoors.

The most important places to air-seal are in the envelope at the top and bottom of your building.

## **Attack the stack**

Think of steam or smoke from a fire. Hot air rises. This is called the chimney-stack effect, or stack effect.

During the winter heating season, the hot air in your home will also rise to sneak out cracks in the top of your building. As the hot air rises through your home to

leave through your attic, your basement will get depressurized.

Since nature hates a vacuum (and has a strong dislike of mild depressurization), any holes in the basement will then suck cold air in from outside. As this air warms up, it will be fed upward to the attic.

The stack effect makes it more likely that the majority of the air in your home is being pulled in through the basement during the winter heating season. Unfortunately the basement is likely to be where you keep most of your paints, solvents and cleaning products, not to mention it's where you're more likely to have mold, dust and other stuff you don't want to breathe.

Closing off the tiny gaps in the top and bottom of your house will reduce the amount of air being pulled in through the basement. This will also make you more comfortable in your home and reduce your energy bill.

## Hyperventilating homes

A lot of people worry their home might not be “breathing” enough. They don’t want to air-seal their home at all, because they believe they won’t get enough fresh air.

Luckily, you don’t have to guess how much ventilation is the right amount. With a great gadget called a blower door (see below), you can quantify how much outside air your home gets per hour.

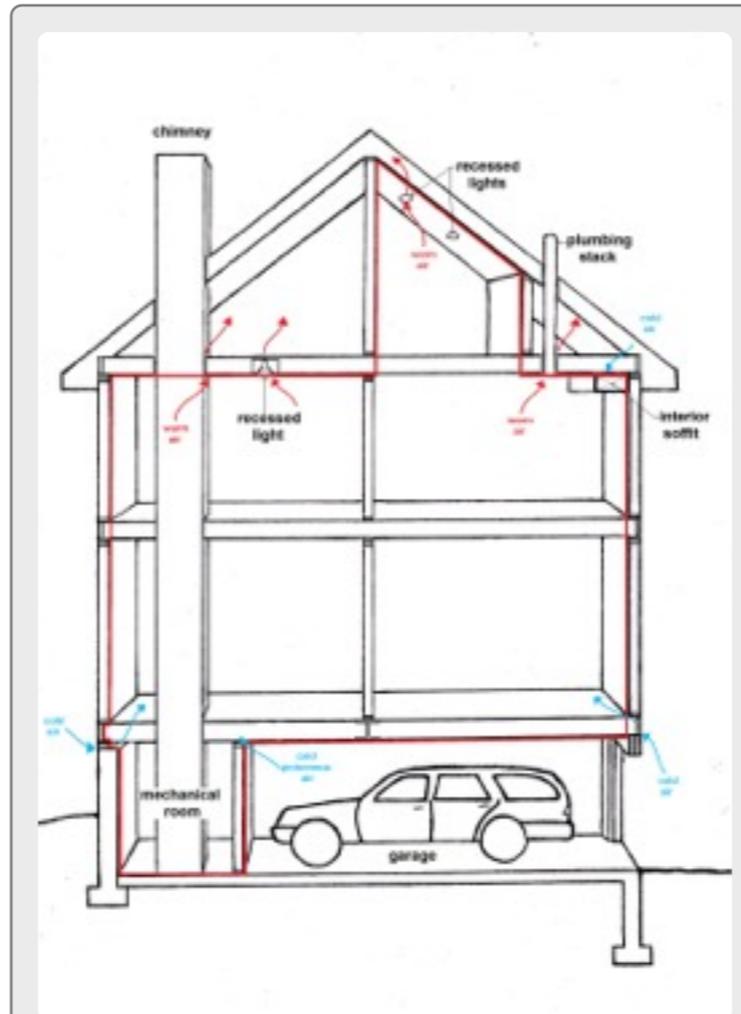
With our HEET blower door, we have tested over 160 different buildings in the Greater Boston area and never found a building that didn’t meet the minimum Building Airflow Standards; most were receiving *at least* double the needed ventilation.

American homes aren’t breathing; they’re hyperventilating.

## Blower Doors

Professional energy auditors use a blower door to find where the drafts in your home are coming from and to quantify how drafty your home is.

A blower door is basically a large fan that is placed in an exterior door. The fan sucks air out to slightly depressurize the building. The blower door tracks how many cubic feet per minute (CFM) of air it has to pump out of the building to keep the building depressurized.



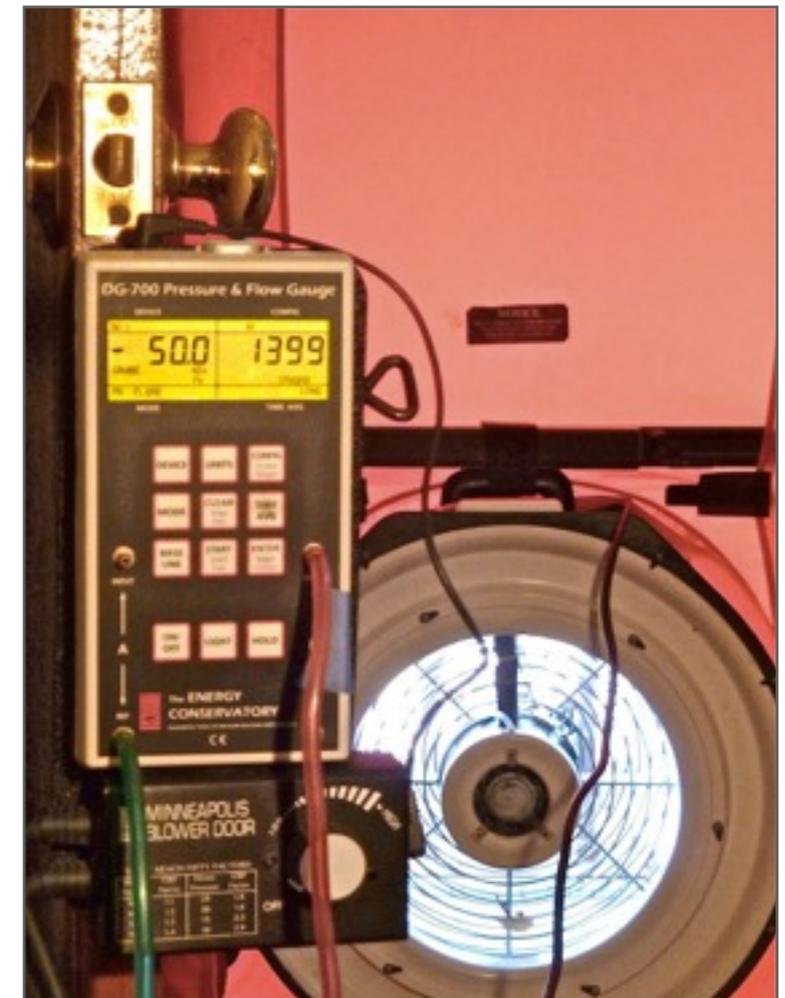
Letting warm air escape your home is a bad plan for comfort and your wallet. In some cases, the drafts can have even worse consequences, like when they pull in with them the gasses that “cold soak” out of your car when it is turned off inside your garage.

If the CFM number is high for the building’s size that means the building has lots of holes in its envelope letting air in (i.e., it is drafty). If the CFM is low for the building’s size, it’s less drafty.

From this CFM airflow, you can calculate the exact amount of ventilation your home receives and determine if it is adequate or not.

## Money and energy savings

Every 10-inch-square hole you close up in the envelope of your home saves between \$75 and \$120 in heating bills (assuming you heat with natural gas) over a decade. Because heat wants to sneak out the top of your home, closing up the holes at the top of



your building will save the most energy and money.

**Don't take granite for granted**

Radon is a gas produced by rock formations, such as granite, shale and limestone, that are high in certain radioactive elements. It is associated with lung cancer. If you worry about radon in your home, get a [\\$15 to \\$35 kit](#) to check radon levels in your basement.

# windows

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Most people believe the best way to save money on energy bills is to replace their windows.

Replacing windows does *not* save a lot of energy in a home. And it costs a huge amount of money to save that little energy.

You probably doubt this fact, so let's run through the numbers. The insulation value of a single-pane window without a storm window is about R-1 (i.e., almost none). Sure, that's not a lot of insulation, but—no matter what you do with glass—it's still a rotten insulator. Even if you install top-of-the-line triple-pane windows (with fiberglass frames and fancy gasses between each pane), you'll only raise the insulation value to R-5 at a cost of probably \$1,000 per window installed.

If you have 20 windows, that's \$20,000. A serious chunk of change.

And how much will you save for having spent all that money? Assuming the installation of the windows is done well (and this does not happen all the time by any means), then the maximum amount you can expect to save on your home's entire heating bill is \$476 in total *after a whole decade*. (The average energy savings for replacing all the windows in a home is less than 5% of the heating bill).

On the other hand, here in Massachusetts, pumping insulation into the average home's uninsulated walls costs under \$3,000 with the rebate and the work would reduce the heating bills by \$2,143 over a decade (assuming your home is 25' x 35' x 20', and you add dense-pack cellulose insulation at the present cost of \$2.06 per sq. ft. with a \$2,000 Mass Save rebate). That's

a 7% annual investment return for something that will keep you more comfortable and reduce your impact on the planet.

The residential-efficiency expert Michael Blasnik says don't expect your new windows to pay for themselves any time soon through energy savings. His advice is rather than replace your old windows, fix them up, take care of them and use them properly. If they are only one pane, add an extra layer through storm windows or interior storms.

Information on how to do that follows in the next chapters.

If you want to run through the numbers yourself for replacing your windows, check out our [Window Calculator](#).



# close & latch your windows

## Important window vocabulary

A sash is the movable part of a window. "Close the lower sash," means to slide shut the bottom part of the window.

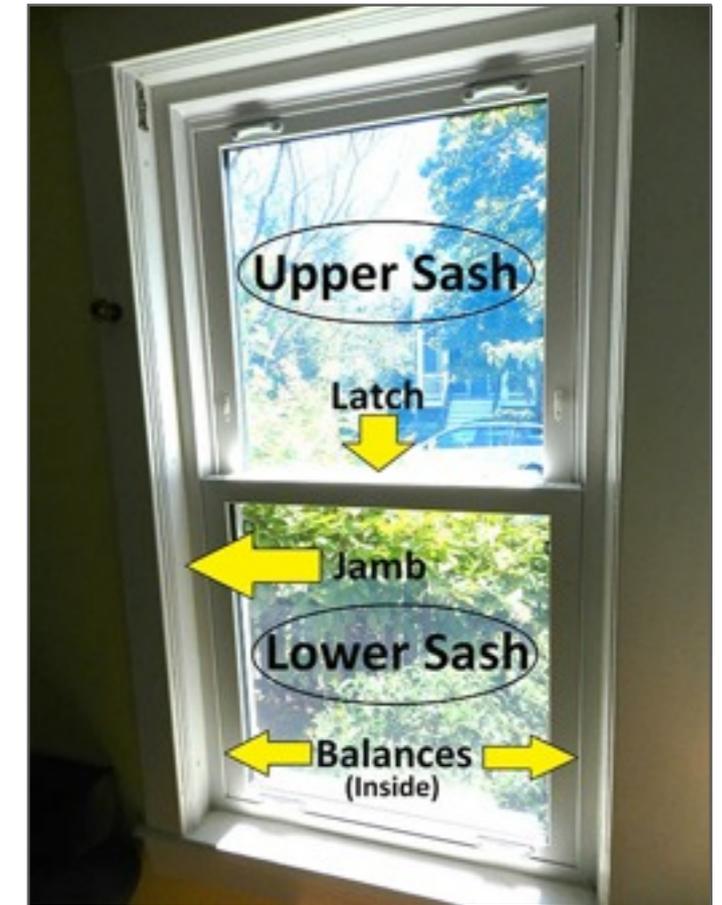
A double-sash window is the classic type New England window that has one sash on the top and one on the bottom. These two sashes open and close by sliding up or down.

Frequently while we're performing a home energy check-up, the residents tell us their windows are terribly drafty and they want to replace them. However when we examine the windows, we find the main problem is the windows aren't actually closed and latched.

This is somewhat equivalent to wanting to purchase a new car because, in your old car, you can't be bothered to turn the key in the ignition.

If, during the winter your windows seem drafty, make sure every one of them is closed and latched. Make sure the storm windows are also closed correctly. In many cases, the storms will almost double the R-value of your windows.

Because of the stack effect, the most important windows to close are the ones on the top heated floor of your home (i.e., if your attic is heated, check the windows on that floor. If your attic is not heated, check the windows on the floor below). These are the windows that will let your hot air escape.



The second most important windows to close are the ones in your basement. Because of the stack effect, they are the ones that will suck the cold air in from outside.



## How to close and latch a window

- Energy savings per decade: **Up to \$181 and 1,440 lbs. CO<sub>2</sub>** per window assuming a 1/2" gap along a 30" window on the top floor
- Level of difficulty: **Easy**
- Cost: **\$0**
- How long it takes: **1 minute per window**
- Tools & materials: **Your fingers and possibly a ladder**

1. Make sure the storm window is closed all the way.

**Tip:** If you have a double-sash window, then in order to get a good seal, the bottom sash of the storm window should be the one that runs along the “inside” channel in the frame. If the bottom sash is in the “outside” channel, you should push the outside sash to the top and the inside one to the bottom. Also, make sure the top sash is pushed all the way up so there

is no gap between it and the window frame.

2. Once the storm window is shut all the way, close the normal window sashes.
3. If the window is a double-sash window, check that the meeting rail (the area where the two windows sashes meet) are meeting and level.



4. No matter what kind of window it is, check that the latch is shut and actually engaged so it holds the window closed, even in the wind.
5. If the window won't close easily, the next few chapters should help you fix the situation.



Basement windows generally are the ones that are in the worst repair and everyone forgets to shut. It's hard to imagine—since they are so far away—that they are a large part of the reason you're shivering upstairs in your bedroom.



You should close them. Even if you have a hard time believing in the stack effect, think about vermin. You want to reduce the possibility of vermin getting in.

# sagging upper sashes



Okay, so you—or someone before you—got replacement double-sash windows, probably 10 to 15 years ago. When they were new, they looked so pretty and were effortless to move. Now they take such work to close and latch, you don't have shut the windows until December and then don't open them again until July.

The reason these windows are hard to shut is the balances have begun to fail. More specifically, the spring inside the balance has stretched and no longer has enough tension to hold the window up. When those balances begin to fail, the upper sash won't stay where it should anymore. Instead it slides down a bit or "sags," leaving a little gap open at the top of the window.

**To fix this problem you have four choices:**

1. Continue to have the windows shut once a year when ice starts forming on the kitchen sink.

2. Replace the windows again with new replacement windows, and then again in another 15 years when the balances fail again (expect the cost to be between \$500 and \$1,400 per window installed. Youch!).
3. Install sash props (a piece of wood on either side of the window to prop the upper sash up into the position it's supposed to be). This is an inexpensive and effective fix, although a trifle inelegant.
4. Replace the balances in your windows. This is harder and more expensive, but longer lasting and allows both sashes to move the way they should.

Assuming that options 1 and 2 aren't so attractive, we will explain options 3 and 4.



## How to fix a sagging upper sash

- Energy savings per decade: **Up to \$181 and 1,440 lbs. CO<sub>2</sub>** per window assuming a 1/2" gap along a 30" window on the top floor

### Sash Props

- Level of difficulty: **Easy**
- Cost: **\$4 per window**
- How long it takes: **10 minutes per window**
- Tools & materials: **Measuring tape, pencil and paper, saw, and two lengths of 3/4" lumber as long or longer than the height of your lower sash**

With this task, the upper sash is propped up in position while the lower sash opens and closes as normal, allowing you to shut the lower sash easily for the winter months. It's true that you can't open the upper sash anymore without taking out the wood props, but



Sash props prop the upper sash up into position so it doesn't sag.

you probably never opened that sash anyway.

We suggest 3/4" lumber for this (a square stick of lumber that measures 3/4" x 3/4"), but you can use any lumber strong and long enough to hold up the window and that fits unobtrusively in the jamb. Try finding some on [Freecycle](#) or [Craigslist](#). It's less expensive and it's recycling.

---

**Note:** This task is easier to do with two people.

---

1. Raise the top sash as high as it will go. Raise the bottom sash all the way up too.
2. On the right side of the window frame, measure the distance from the window-sill up to where the bottom of the upper sash should be—if it didn't sag.



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**Tip:** If you can, have a helper hold the upper window sash all the way up while you measure.

---

3. Cut a piece of the  $\frac{3}{4}$ " lumber to the length you just measured. If in doubt, make the piece a tad longer, because you can always cut it shorter. This will be the prop you use to hold up the sash in position.
4. After cutting, push the upper sash into the position it should be in if it didn't sag. Push the prop into place in the jamb (the channel that the sash slides up and down inside of). To do this, first put the top end of the prop under the corner of the sash, then slide the bottom end of the prop into place along the sill. You might need to lightly tap with a hammer to get it in. If it's too long to fit, cut off a little and then check again.
5. Repeat Steps 2 through 4 on the left side of the window.

### Replacing the Balances

- Level of difficulty: **Difficult**
- Cost: **\$4 to \$100 per balance** depending on weight and type of window
- How long it takes: **An hour to remove the balances, a week to get the parts, an hour to replace the balances**
- Tools & materials: **Flathead and Phillips screwdriver, vice grip or channel lock wrench, camera, pen and paper**



Sometimes the balances are covered by a face plate, and sometimes they aren't.

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**Note:** This is probably a two-person job.

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Contact the window manufacturer to see if they have the replacement parts for your window model. The model and window manufacturer company can sometimes be found on the window latches. You'll also need the window size along with the model number. They will be in a small, almost imperceptible triangular etching on the glass in the corner of the window sash. Write down the etched numbers to give to the manufacturer or parts supplier.

If the manufacturer doesn't know what kind of balances you need for that model, your first step is to pull out the balances to describe them.

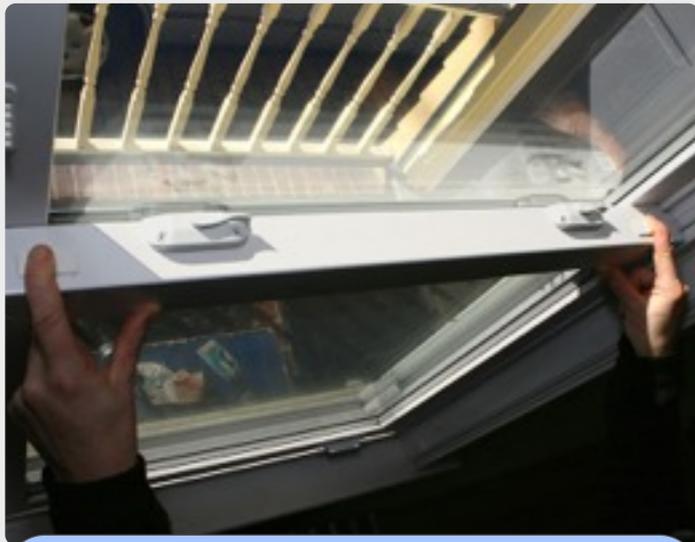
### Replacing tube balances on most vinyl replacement windows

1. First take the bottom sash out of the window:
  - \* Slide the sash up a couple of inches from the windowsill.
  - \* Holding the sash firmly so it doesn't fall, depress or slide the buttons or thumb latches on either side of the top of the sash in order to click the top part of the sash out of the win-

dow frame (the way you would to clean the inside of the window).

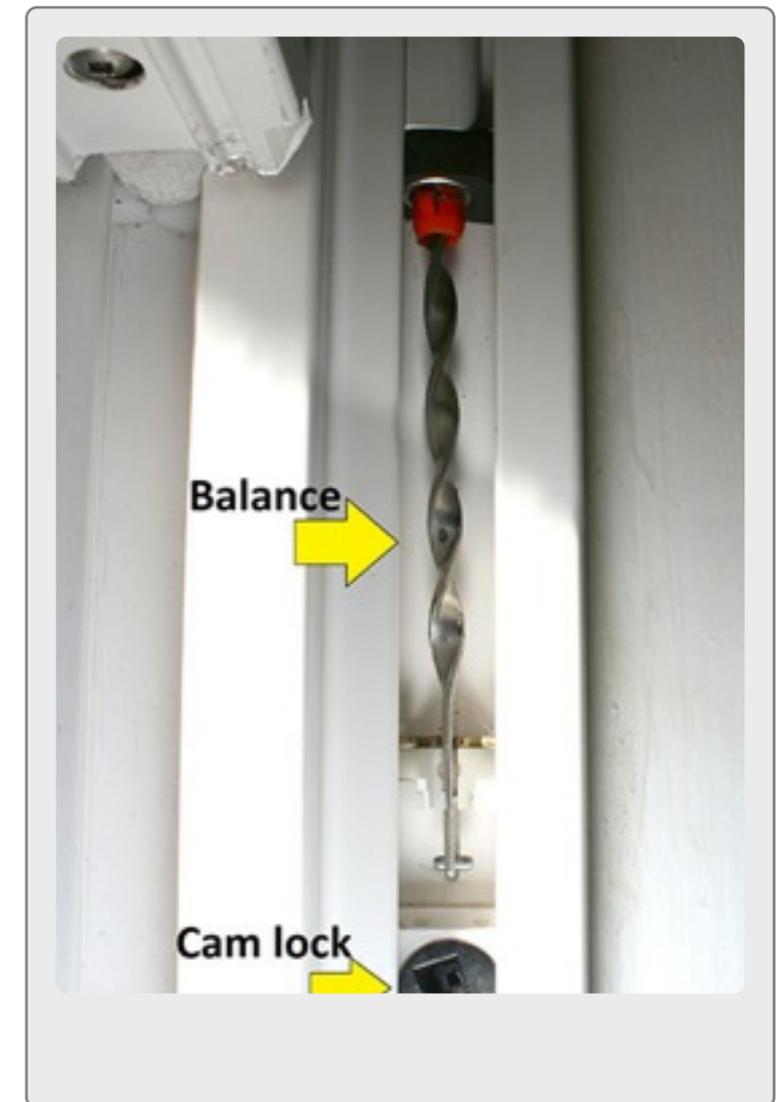
- \* Once the sash is parallel to the floor, delicately lift one side so that the bottom of the sash on that side angles up and unseats from the window frame.
  - \* Keeping the sash at an angle, pull the sash out of the frame.
2. In the same manner, remove the top sash. Only this time in step A, slide the sash down a few inches instead of up.

#### Removing a sash from a window



See our [photos](#) showing how to remove a sash from a vinyl replacement window.

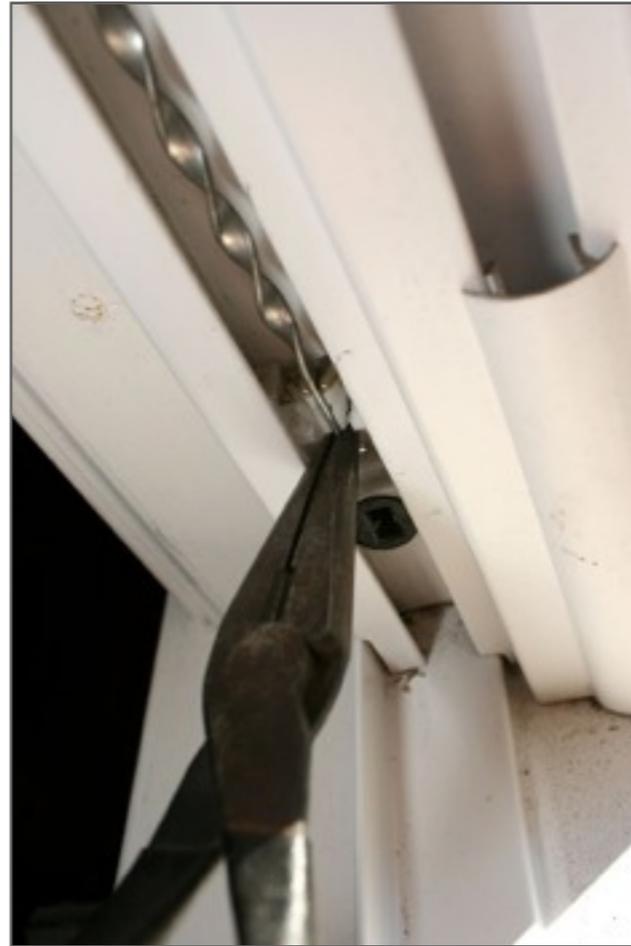
3. Vinyl replacement windows will have a plastic faceplate covering the metal balances on either side of the sash or on the inside of the window channel. Gently remove the plastic faceplate by inserting a finger or screwdriver at the bottom and prying it away from the jamb.
4. Inside you'll see a long metal balance (typically it looks like a long tube with a spiraled twisty piece of metal coming out of the bottom). Look to the bottom of the balance. There you will see the cam lock (the hardware the sash uses to click into the window frame).
5. If the balance is simply un-sprung and un-attached to the cam lock, the balance may not need to be replaced. In this case:
- \* Push the spiraling piece of metal back into the tube.
  - \* Use a vice grip or regular channel-lock wrench to hold the spring-loaded tip of the balance, while you re-seat the bottom of the balance back into the cam lock.
  - \* If the balance on the other side of the sash looks fine, then reinstall the plastic faceplates over the balances, reinstall the sashes and you are done. The window should be fixed.



Re-install the sashes to check if either still sags.

6. If the balance on either side of the sash or the cam lock to which it is attached is broken (usually the balance or cam lock is clearly damaged), then you have to replace the balance and/or cam lock.

- a. Take a vice-grip or pliers, and while holding the spiral piece of metal securely a couple inches from the bottom (remember, it is spring loaded), gently remove the bottom of the balance from the cam lock and allow it to slowly retract into the tube (unloading the spring).
- b. When the spring load is unloaded, remove the top of the balance from the top of the window frame.
- c. Measure the diameter and length of the balance tube and photograph it. Be sure to measure both the length of the unextended and fully extended balance. Measure the height and width of the visible glass in the sash. Taking and giving detailed measurements is critical because there are many types and sizes of tube balances and they relate to the size of the window.
- d. If the cam lock is broken, you'll have to take detailed pictures of it as well for replacement. Repeat steps A through D for the other side of the window sash.
- e. Provide this measurement information, along with the window identification information on the glass etch-



ing when you call the manufacturer and/or supplier to request the replacement parts.

- f. While you're waiting for the new parts, you can put the window sashes back in place. Have a second person *firmly* hold the upper sash in place until you can get the lower sash in place and use the window latch to lock the window shut. Without the balances in the side, *the upper sash will fall like a rock as soon as you let go* unless it is

locked securely in place. Tape a big note on it saying, "Don't open window. Broken."

- g. If the manufacturer doesn't make the balance anymore or if they have gone out of business, visit [Blaine Window](#) (708-345-8400.). They carry a lot of older window parts, and re-manufacture those parts they think people are going to need.

Once the new balances and/or cam locks have been delivered, reverse the above steps to reinstall the balances and/or cam locks.

---

**Note:** The tube balance must be spring loaded before it is newly installed. Otherwise, it will not hold up the sash. The cam locks typically screw into place.

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Thanks to Bill Donaldson for these directions.

\* \* \* \* \*

# window latches



If a window latch is missing, install a new one. Otherwise your window is more likely to rattle in the wind or slide open a bit, letting in cold air.

How-to Section



## How to install a new latch

- Energy savings per decade: **Up to \$81 and 720 lbs. CO<sub>2</sub>** per window assuming a 1/4" gap along a 30" window on the top floor
- Level of difficulty: **Moderate**
- Cost: **\$5 per window**
- How long it takes: **15 minutes per window**
- Tools & materials: **Drill, drill bits, sharp pencil, extension cord if you don't have a cordless drill, two window latches per window, wood screws**

If you want to decrease drafts the most, then you should install one latch on either side of the window to pull the window shut on both sides.

Make sure the latch you buy will fit on the wood sash, i.e., that from front

to back, it is not deeper than the frame of the sash.

1. Unscrew and remove the old latch.
2. Close the window. Place the new latch where you want it to be installed. Make sure it is centered in place and that the screws aren't so long they will pop through the wood on the other side or hit the glass. If there are already screw holes in the right place in the sash, skip to step 6.
3. Holding the latch firmly so it won't wiggle, run a pencil around the inside of the screw hole to mark where you will drill.
4. Remove the latch and drill the screw holes. Use a drill bit one size thinner than the screw. Make sure to center the drill bit in the center of the penciled circle. Don't drill deeper than your screw is long. Don't drill through window sash frame.
5. Repeat for the other holes.
6. Screw in the latch. If you are using any pre-existing screw holes and they are too big, stuff the hole with bits of a wooden matchstick (any part except the head of the matchstick). And then screw the latch in place. The wood from the matchstick will give the screw something to hold onto.

7. Latch the window and check your work.

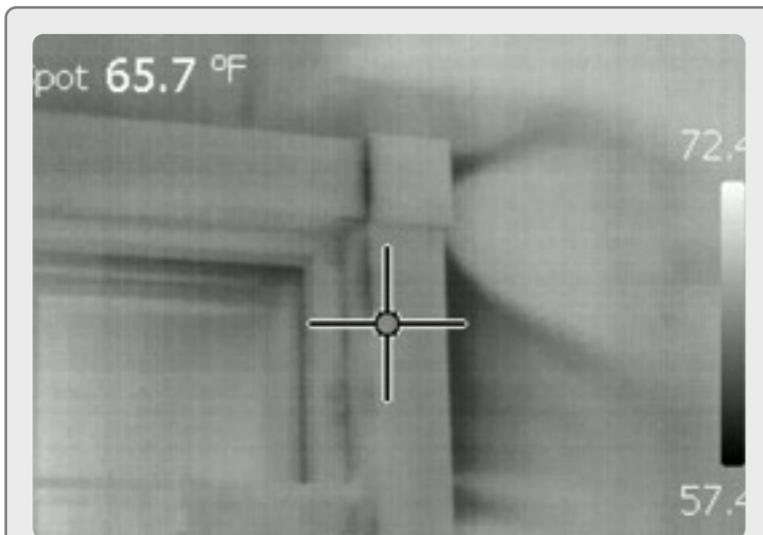


### **Broken windowpanes**

If you have a broken windowpane, replace the broken glass. You can do this work yourself if you're fairly handy or get the pane replaced at any window repair store. Just take the sash out of the window frame and bring it in to the store. If that seems like too much work and the window is somewhere you don't care about that much, you can close it off with a piece of wood or plexiglass caulked in place.

This work is critical to do, because a broken 9" x 14" windowpane will cost you \$124 on average per year in heating use.

# caulking



Thermal image showing air leaks (dark areas) around window. This window trim needs caulking.

Exterior doors and windows—even when they are closed—can let in a lot of air through cracks around their trim. Air can leak in or out of these small holes, cracks, and gaps.

Filling these cracks with caulk stops the airflow. Caulk is basically glue that fills up a crack, dries hard and still has a bit of elasticity for give and take. Caulk also makes the trim look neater (especially once it's painted) and without the crack, it's easier to keep clean.

### **Buying the right caulk for the job**

Caulk comes in many colors. If you can't find the exact right color, then use paintable white caulk and paint over it after it has dried thoroughly.

- White caulk should be used on white trim.
- Clear caulk should be used on bare wood trim (or brick or stone). Don't worry that the clear caulk comes out looking white. Once it's dry it turns clear and shiny. Don't use clear

caulk on anything you want to paint, because paint doesn't cover clear caulk very well and may require an extra coat.



### **Applications**

- Inside a building, use an acrylic/latex blend that is paintable.
- Outside a building, if you don't need to paint the area, use 100% silicone because it is more durable in temperature extremes.

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**Note:** You need mineral spirits to clean up 100% silicone caulk. Unless the tube says otherwise, 100% silicone is not paintable.

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- Fire-rated or intumescent caulk is used around anything that could get warmer than 140° (such as fireplaces, chimneys, or steam pipes). When heated, intumescent caulk expands to seal the gap and slow down the fire. Generally it is colored dark grey or brick red, so if it's visible you might have to paint it afterward.

There are other types of caulk as well. Check the caulk tube to make sure you have the right kind for your application, and make sure to check the temperature range in which it is best to apply (i.e., don't apply it outside on a 0° day if it shouldn't be applied below 40°).

## How-to Section



### How to caulk a window

- Energy savings per decade: **Up to \$91 and 720 lbs. CO<sub>2</sub>** assuming you caulk shut a 30" by ¼" gap by caulking all the windows in the home
- Level of difficulty: **Easy**
- Cost: **\$1 per window**
- How long it takes: **10 minutes per window**
- Tools & materials: **Caulk (probably 1/6 tube per window or door), caulk gun, rag, water, utility knife. Possibly a 3-inch nail and backer rod**

#### Opening a tube of caulk

1. Using a utility knife, cut off the end of the tip of the caulk tube at 45° to create a ¼" hole. Cutting a caulk tube takes a bit of force, so first place the tip of the tube against a floor or table so you don't end up cutting yourself. Making this cut at a 45° angle will allow you to get the angled tip of the caulk tube into corners.



Cut off the tip of the tube at an angle.

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**Tip:** Err on making the hole too small; you want a thin controllable stream of caulk, not the Rio Grande. If you need to, you can always cut the hole larger.

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2. Some brands of caulk have a membrane about 3" down inside the tube. Puncture the membrane by jamming a 3" nail or thick wire down the mouth of the tube.

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**Tip:** Some caulk guns have a thick wire that can be swiveled out to jam down the tube.

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Puncture the inside membrane with the wire on the caulk gun or a long nail.

### What to caulk

- You should fill any cracks between the wood trim and the drywall, between the different pieces of trim, and between the trim and the window, but don't caulk anything that needs to open or move (for instance don't caulk the window shut).
- Even if the crack is hardly visible, a little caulk will help seal it more.

### Applying caulk

1. Clean the area well so the caulk sticks to the surface rather than the dirt. If you need to use water to clean the area, don't leave the surface wet or even damp, or the water will dilute and weaken the

caulk. You will caulk all the way around the window or door, so make sure to clean the top and bottom of the frame.

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**Tip:** If the surface is really crumbly—for instance, if the mortar around a basement window is falling apart—then you might want to re-mortar the surface first. Check out our “Repairing Masonry” chapter.

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2. Put the tip of the caulk tube into the crack you want to caulk and depress the gun trigger.
3. As the caulk comes out, drag the tip to draw a bead along and into the crack you want to fill.
4. Whenever you need to stop, let go of the trigger and take the pressure off the caulk tube. Taking the pressure off is done in one of two ways depending on what kind of caulk gun you have. You can either



push the Off switch at the very back of the gun (near where your thumb is when you're holding the gun) or by pulling the metal plunger at the back out an inch.

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**Tip:** If you don't take the pressure off by doing one of these actions, the pressure will continue to push the caulk out so it dribbles all over that beautiful Oriental rug you're standing on.

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**Tip:** Always carry damp rags and keep the tip of the tube clean. Clean up any drips immediately. Unless the caulk is 100% silicone, it is water-soluble, so a little water and some elbow grease should work wonders.

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5. Once you've gotten a crack caulked, run your finger over the bead of caulk to press it into the crack and make it smooth.
6. Check carefully to see there are no gaps. If there are, add more caulk and smooth again.
7. Clean up any excess or messes with a damp—but not dripping—rag. (If you're using 100% silicone caulk, you will have to use mineral spirits).
8. Make sure to caulk the top of the window or door and the bottom of every window. This is where the biggest gaps normally are, since contractors know you probably won't ever see them.

In gaps bigger than ¼", you can stuff in some backer rod (a soft foam tube that comes in

#### Applying backer rod



See the large crack between the bricks and the curved metal at the top of the window? It should be caulked.

various diameters and can be cut to length) to fill the crack. Just jam the backer rod in with a screwdriver so its top is flush with the trim, then caulk over it.

9. After the caulk is dry, you can paint the area if you want to.



#### Things NOT to do

- Make a mess of an area you don't plan to paint.
- Forget to smooth the bead of caulk.

- Use too little to fill a crack.
- Smear caulk all around the crack instead of into the crack.

# windows that rattle in the wind

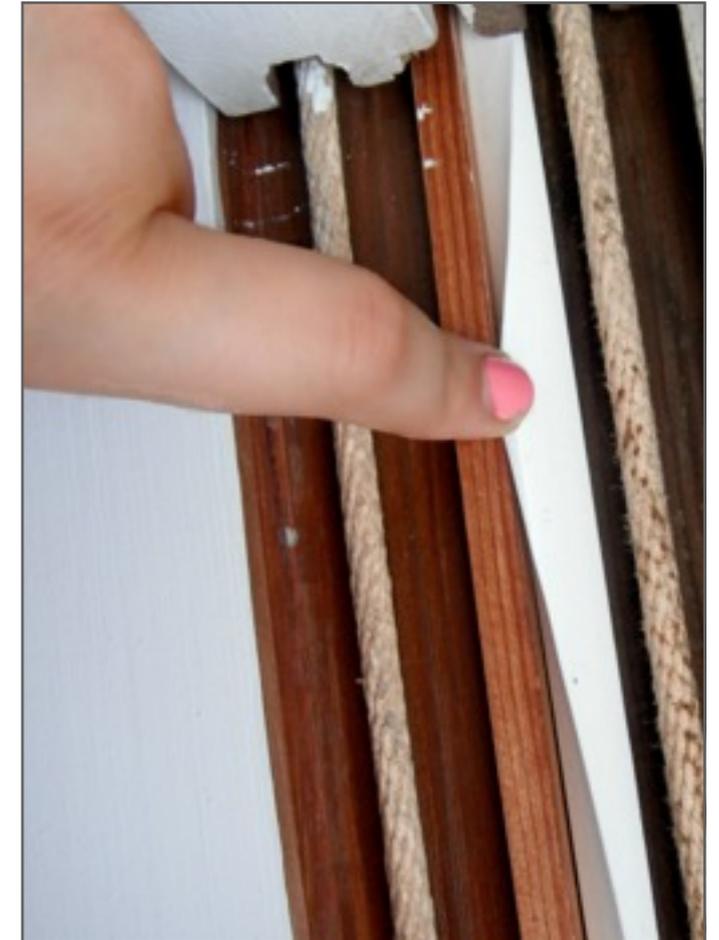


Over time, the sashes of wooden double-hung windows can get a little loose in their jambs and begin to rattle in the wind, letting in cold air.

Air leakage around rattling windows can be decreased substantially using a V-shaped polyethylene weatherstripping called V-Seal (otherwise known as V-shape Fin, Vflex, etc.).

V-Seal is a long strip of plastic that is folded in half along its length, so in cross-section it looks like a V.

Install each piece in the space between the jamb and the sash, with the arms of the V open toward the outdoors. When the wind blows in from the outside, the plastic V opens wider, sealing against the jamb and sash to stop the air from entering. Simple and cheap, but surprisingly effective.





## How to fix rattling double-hung windows

See this [V-Seal installation video](#). The visuals make our written directions easier to grasp.

- Energy savings per decade: **Up to \$91 and 720 lbs. CO<sub>2</sub> assuming you close up a 30" by 1/4" gap by installing V-seal in all the windows in a home**
- Level of difficulty: **Easy**
- Cost: **\$3 per average-sized window**
- How long it takes: **10 minutes a window**
- Tools & materials: **[V-Seal](#), scissors, either tack cloth and vacuum or rag and rubbing alcohol**

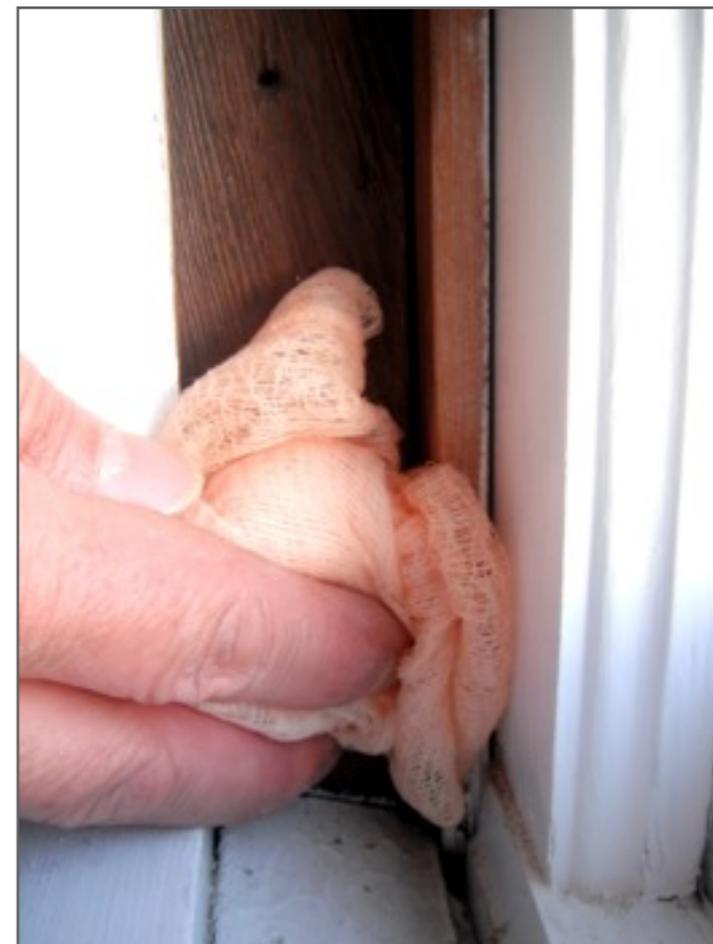
Old windows are likely to vary considerably in their degree of rattle. You should assess each one individually.

Start with the side of a window that seems to have the biggest gap for air to sneak through. After adding the first section of V-Seal to the jamb on this side of the window, the sash should still slide easily. If it

still rattles when shaken, add another section of V-Seal to the jamb on the other side. Don't add so much V-Seal that it becomes hard to open and close the window.

### Preparation

1. Clean the jambs on both sides of the window, as well as the top and bottom (if you might apply weatherstripping here as well), so the V-Seal's adhesive will stick to bare wood rather than caked dirt. Open the bottom sash all the way to clean the lower part of each jamb, and then open the top sash all the way to clean the upper parts.



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**Tip:** If the jamb is just dusty, you can vacuum and use a tack cloth. More likely, you'll need to clean with denatured or rubbing alcohol, which will dry very quickly. The adhesive on the V-Seal won't stick well to wet wood, so any cleaning with a water-based solution must be done well ahead of time and allowed to dry completely.

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## Application

1. Most people want to start with the lower sash, since that tends to be the one that rattles the most. Measure the height of the lower sash (let's say it's 36"), add 2" (to get 38"), then cut the V-Seal to this length. Fold the V-Seal in half as though it were a very long hot dog bun (a 1/4" wide by 38" long hot dog bun).
2. Raise the window's bottom sash as high as it will go.
3. Orient the V-Seal so the open part of the V (i.e., the open top of the bun where the hot dog would go) is facing the outside of the window, with the adhesive facing the jamb.
4. In this orientation, peel away all of the paper that covers the adhesive except the two inches at the very top.
5. Holding these top 2" of V-Seal closed, ease it up between the bottom sash and the jamb until you reach the part of the V-Seal that has no paper covering the adhesive.
6. Holding the V-Seal in this position, make sure it's the right length so the bottom of the V-Seal dead-ends at the bottom of the jamb. If not, adjust its position.
7. Begin to press the adhesive firmly onto the jamb starting at the bottom of the jamb, keeping the V-Seal straight in the jamb. The V-seal

### Applying V-seal



See our [photos](#) showing how to apply V-seal.

- can be installed along either side of the sash rope.
8. When you reach the paper covering the rest of the adhesive, tug it gently off while keeping the V-Seal still in position between the jamb and sash. You may want to slide a narrow, blunt instrument in between the sash and jamb to hold the V-Seal down while you do this. (This 2" extra length keeps the edge of

the V-Seal from getting caught or ripped out of place by the bottom corner of the sash when a window is closed.)

9. Close the window to check if the sash still moves easily in its frame and if it rattles at all. If it does rattle, repeat steps 1 through 8 for the other side.
10. When you finish, if the upper sash is loose in its frame and both sashes still move easily, you can repeat steps 1-8 to install V-seal around the upper sash. In this case, start off by lowering the top sash as far as it will go.

### Top and bottom

1. If you want to seal the bottom sash's lower rail against the sill or where the top sash's top rail meets the head (top of the window), then measure the full width of the sill or head between the jambs.
2. Next, cut the V-Seal to that exact length (not 2" longer this time).
3. Finally, expose the adhesive face of the V-seal and install it in the same plane as the V-seal you applied to the jambs, such that the two meet cleanly at each corner, top and bottom. Again the 'V' should open toward the outdoors.

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**Note:** Don't install V-Seal along the meeting

# interior storm windows



Perhaps this past fall, in hopes of decreasing the drafts from your windows, you used a hair dryer to install plastic sheets over the inside of your windows. This is one type of interior storm window.

Interior storm windows reduce drafts and create a dead air space between the window glass and the interior plastic sheet. The air space acts a bit like insulation. The combination decreases the amount of heat lost out of a window and will generally save as much energy as installing a new window.

The problems with the hair-dryer-installed plastic sheets are that the plastic tears easily, the adhesive is weak and the plastic is thrown away every spring..

Tyz-All storm windows allow you to attach a thin frame around your window. You can then use the frame to “zip” (zip-lock style) a plastic sheet into place across the window. This way you can unzip the plastic sheet each spring, so you can use the window normally during the

summer. Every fall you can re-install the same plastic sheet in the frame. This reduces the amount of plastic being thrown away each year into a landfill.

Also, Tyz-All uses a thicker grade of plastic, so the plastic doesn't rip easily.

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**Note:** The Tyz-All plastic sheets are made from PVC, the same material as some shower curtains. If you have allergies to PVC or want to avoid the VOCs and the damage to the environment from using a material linked to atmospheric degradation, you can use a different and thinner plastic. Just make sure the sheet is transparent so you don't end up feeling like you're living in a tupperware container.

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## How to install interior storms

[See this video showing the installation.](#)

The visual makes written directions easier to grasp.

- Energy savings per decade: **Up to \$353 and 2,880 lbs. CO<sub>2</sub> assuming you install interior storms on all the windows in your home**
- Level of difficulty: **Moderate**
- Cost: **\$7 to \$11 per window**
- How long it takes: **20 minutes per window**
- Tools & materials: **Rag, pencil, screwdriver, a [Tyz-All window kit](#) big enough for your window, scissors, utility knife, measuring tape**

1. First clean off the window casing of all dirt and loose paint, etc.

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**Tip:** The adhesive backing the lengths of channel won't stick well to wet surfaces, so any water-based cleaning should be

### Installing an interior storm window



See our [photos](#) showing the parts of a Tyz-all kit, as well as the parts of a window.

done well ahead of time and allowed to dry completely.

2. Use a pencil to lightly draw where the frame will go. You can install the Tyz-All frame on the front face of the window casing (as in the video linked to above) or on the inner surface of the sash stop (the inside of the window frame next to the window jamb). Either way, the frame must have a straight and continuous line, 360° around the window.

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**Tip:** To decrease convective looping (the movement of cold air sinking and warmer air rising within the insulated space allowing more cold to transfer into the home), it is best if the plastic sheet is installed within one half inch of the window. Since this is normally not possible, just try to install it as close to the window as you can.

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3. Remove any obstructions (blinds, latches or handles, etc.) that are going to get in the way of the plastic sheet once it's pulled tight, but leave any handles used to open the window nearby, in case an emergency exit is needed.
4. Peel the paper cover off the backside of a two foot frame piece to expose the adhesive and press the frame's adhesive side firmly into place along the penciled line. Make sure to press it exactly into place; the adhesive is sticky and it will be hard to move. Also it won't stick as well the second time.
5. Peel off the paper cover and place the next piece tightly butted up to the first end, following the penciled line.
6. Continue all the way around the window, building a frame for the plastic sheet on the window trim, along the penciled line.

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**Tip:** If you need a window frame piece shorter than two feet, you can cut the piece with a utility knife or scissors. Once you have the surface cut started, you can bend the frame piece back and forth along the cut to break it. It is easier to unzip the spline from the frame piece first and cut them separately.

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7. When you have the whole frame in place, unzip the spline from all of the frame pieces.
8. Cut out a piece of clear plastic that is at least four inches taller and wider than the frame.
9. Zip a half an inch of the plastic into the very center of the topside of the frame.
10. Zip a half an inch in at the center of the bottom of the frame, making sure to pull the plastic tight so there is no slack.
11. Zip half an inch in on the center of the left side.
12. Zip half an inch on the center of the right side, making sure to pull the plastic sheet so there is no slack.
13. Now that you have the center of each side in place, zip each side's plastic and spline into place by moving outward from these center spot to the corner. With the

centers correctly in place you can easily press all the creases out of the plastic as you go, resulting in a flat nearly invisible plastic sheet.

14. When it's in place, you can use a utility knife or scissors to cut off some extra plastic from the edges. If you're planning on removing the plastic sheet each summer, then don't cut too close to the edge or when you try to zip the sheet in next fall, you'll have a hard time getting it exactly right.

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**Tip:** Label the plastic sheet in an unobtrusive corner so you know which window it belongs in next fall when you zip it back into place.

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If you want an even more effective, longer lasting, professionally constructed window insulation system, [Advanced Energy Panels](#) sells a great one.

Advanced Energy Panels (AEPs) are a double glazed, light, interior panel custom-made for each window. They are easy to install and remove, and they can be reused year after year.



AEPs insulate and air-seal more than most replacement windows, yet they are a fraction of the cost. Sometimes you can even get rebates for them

# repairing wood windows



If your wood windows are pre-1950, then the wood is probably old-growth wood with hand-made beautiful joinery no Taiwanese window factory is going to attempt now. You couldn't buy such well-crafted windows on the market today.

These windows will last for hundreds of years with some paint and care. In double-sash windows, the mechanism that allows the sash to slide smoothly open when you pull up—and then not to slam shut as soon as you let go—is a simple rope pulley with a weight, a technology that hasn't changed since long before Columbus. You will always be able to find the parts to repair it.

Pulling out wood windows to install replacement windows is like ripping out your teeth because you want shiny dentures.

Repair and weatherize your old windows instead.

The cost for the work could be as little as \$20 per window if they just need a little

weatherizing. If they are in bad shape because they've been ignored for decades, fixing them up could cost as much as installing top-of-the-line vinyl windows, especially if your windows need to have lead paint stripped off them. However they will then work well with little care for the next 100 years.

## How to find a window-restoration person

- Search for “window restoration” or “window preservation” on Google.
- Make sure the contractor has completed at least three recent window restoration projects.
- Check the references to make sure the contractor is knowledgeable, on time, friendly and repairs the windows well.
- Check the price is right. If you want a full restoration (repairing the window so it is well weatherized, moves like new with fresh parting beads and ropes, and looks like new with all lead paint and putty removed and fresh paint and putty applied) expect to pay over \$700 per double-sash window. If you just want to repair the window so it moves like new and is well weatherized, then \$125 to \$200 per window is a more reasonable price.
- Also, ask for recommendations from friends and acquaintances you trust or try [Angie’s List](#).

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**Note:** Homes built before 1978 are likely to have lead paint in them. Lead paint dust is a toxin that especially children and pregnant women should avoid. Even a tiny amount of the dust in food and on hands can really harm a child’s developing brain.

If you want to know if your windows have lead paint, you can buy a \$10 lead paint test kit and test the wood around your windows. If there is lead there, you need to make sure the repairperson is aware of this fact and takes the necessary precautions. There are now strong lead laws with fines of over \$30,000 for contractors who break this law.

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# weatherizing a door



If an exterior door has even a small gap all the way around it, the result can add up to a lot of heat loss. Because of the stack effect, the heat loss will be worse if the door is in the basement or on the top heated floor.

Even if the door is in one of the middle floors of the building, if it's near the couch where you watch TV, the draft can make you crank up the thermostat.

During daylight hours, examine every exterior door in your home from inside with the door closed. Look carefully for light sneaking through cracks around the door. Stand up on your tippy toes, move from side to side and get down on your knees to check under the door.

If you can see light sneaking through the crack between the door and the frame on the sides or top of the door, you should install Q-Lon. If there's light under the bottom of the door, then you should install a door sweep.

Q-Lon is a door weatherization strip installed around the sides and top of the door. It has a half-inch soft gasket that is very forgiving of the possible imperfections in a door or frame. It lasts longer than most other brands.

There are a few different kinds of Q-Lon. Pick the kind that works best for you and will look good on your door. For older doors, we recommend the kind with the vinyl backing. The vinyl is flexible so if your door is less than perfectly square the vinyl will bend to conform to the frame.

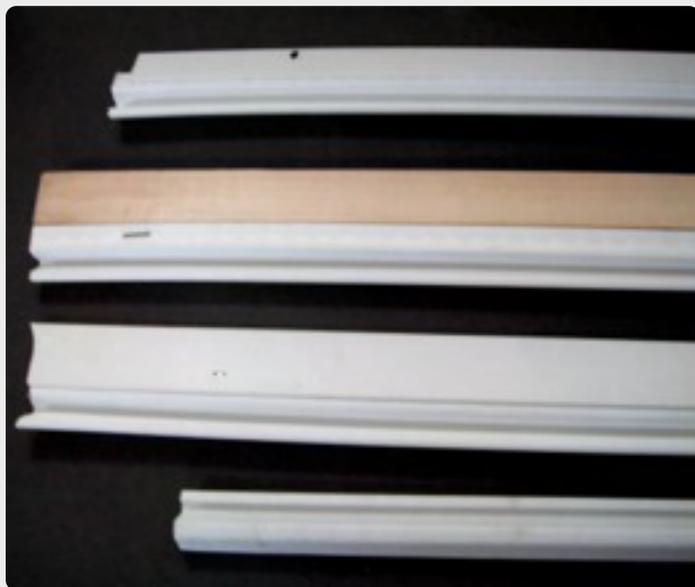


## How to weatherize a door

### Installing Q-Lon

- **Energy savings per decade: Up to \$169 and 1,344 lbs. CO<sub>2</sub> per door**
- **Level of difficulty: Moderate**
- **Cost: \$12 per door**
- **How long it takes: One hour per door** if you haven't done it before

There are many different kinds of Q-lon.



- **Tools & material: Vinyl Q-Lon door kit** (call EFI, 800-379-4121, to order the Q-Lon and ask for the HEET discount), **4D stainless steel finish or galvanized nails with heads, acrylic/latex caulk, hammer, measuring tape, pencil, coping saw or chop saw, caulk gun, utility knife, short ladder or chair, possibly also two pry bars or flat edge screwdrivers**

When you open your Q-Lon kit, you will have 3 pieces of Q-Lon. Each piece is a wood or vinyl strip with a foam gasket running along it.

You want to stand on the side of the doorway such that the door will swing away from you as it opens. Standing on this side, when you shut the door, the door will stop when it hits that narrow shelf of wood

that runs along the sides and top of the inside of the doorframe. This shelf of wood is called the doorstop.

You will cut and nail the Q-Lon to the doorstop in such a way that, when the door is shut, it closes firmly and evenly against the gasket. The gasket will work somewhat like the gasket around a fridge door to create an air-seal.

**Note:** If your doorstop is metal, follow the directions below, but instead of nails, use self-drilling metal screws and pre-drill all needed screw holes in the Q-Lon. Use metal-backed Q-Lon because it won't crack if the screws go in too far. Use a hack saw or chop saw to cut the metal backed Q-Lon.

### Prep work

1. With a putty knife or pry bar, remove any obstructions that might get in the way along the doorstop, such as nail heads or large paint lumps.

### Install the top piece.

1. Measure the length of the doorstop that runs along the top of the doorway, from the left doorstop to the right doorstop. Then, measure it again to double-check.

### Installing the top of Q-Lon



See our [photos](#) showing how to install the top Q-lon piece.

2. You have three pieces of Q-Lon in your kit. Use the shortest piece. Cut the vinyl with a saw to the length of the top doorstop, but cut the gasket ½" longer with a utility knife in case your cut isn't exactly right.
3. Check to be sure the Q-Lon fits. If not, re-cut it. It should fit neatly into the top of your doorway along the doorstop and butt up on either end against the left and right doorstops.
4. Figure out where this piece of Q-Lon should go. With the door shut and locked, slide the Q-Lon in tight against the door, compressing the gasket about 30%. You want a tight seal without making the door impossible to close. Getting this placement right is the whole point of installing the Q-Lon, so take a little while to make sure you have it perfect. Use a pencil to trace the back edge (the edge without the gasket) along the doorstop, so you know exactly where the piece should sit.
5. Put the Q-Lon strip on a flat surface (so the rounded edge of the Q-Lon is facing up) and partially hammer one nail into the Q-Lon every 10". Don't hammer the nails all the way through; you just want to get each nail started. Hammer into the center

of where the Q-Lon is the thickest to avoid cracking the vinyl.

6. Run a thin, continuous bead of caulk along the opposite flat side of the Q-Lon. If you don't know how to caulk, read our caulking chapter. The caulk will act as a glue to make sure no air gets in between the Q-Lon and the doorstop.
7. Open the door and put the Q-Lon in place (with the caulk squished against the doorstop) with its edge along the pencil line.
8. Holding the Q-Lon in place, hammer nails in partway, but not all the way in.
9. Close and lock the door to confirm that gasket is compressed and that the door is still easy to close. If necessary, adjust the position of the Q-Lon by pushing it (remember vinyl bends a bit) and tapping the nail to hold it in that position.

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**Tip:** Locking the door will frequently shift its position a tiny bit. In order to make sure the Q-Lon is really in the correct position, make sure you get the final placement for it with the door locked.

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10. Hammer nails in completely.

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**Note:** Q-Lon installation is a bit confusing. If you are having trouble, you can also check out [Arlington HEET's directions](#).

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### Installing the sides

1. Start with the hinge side first. Measure the height of the doorstop along the side that the door shuts against.

**Note:** Frequently the threshold is sloped so the doorstop will be longer on the threshold side. Measure it again just to double-check yourself.



2. There are two pieces of Q-Lon remaining that you could use. Each of them has one coped (a.k.a. curved) end. That cope will, when installed, fit perfectly around the piece you've installed at the top of the door. To confirm you have the correct Q-Lon piece, hold the Q-Lon in the position it will be installed so that the gasket is facing the door. If the coped end is on the top (and not on the threshold), that's the correct piece.
3. Measure the Q-Lon from the very tip of the cope to the length you need and cut. *Don't cut off the coped end by mistake.* Cut the gasket so it's a ½" longer at the non-coped end.
4. Slip the hinge-side Q-Lon in place to make sure it is the correct size. Adjust if necessary (see below).
  - a. If necessary cut the end of the gasket at the coped end to 45° so horizontal and vertical gaskets meet but don't interfere with each other.
5. Once the size is correct, you should close and lock the door, and use the pencil to trace where the strip should go.

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**Tip:** The placement of the Q-Lon on this side can easily make the door difficult to close. Take your time to get it right.

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6. Add caulk to the backside of the Q-Lon and nail it in partway the way you did the top piece.
7. Again, close and lock the door to make sure the fit is correct before you nail in the piece all the way. If the fit isn't quite right, adjust the Q-lon by pushing it and giving the nail a tap to secure it. It is quite pliable. You can make adjustments even when parts of the Q-lon are nailed into the doorframe.
8. Repeat the steps to install Q-Lon along the non-hinge side.

#### Installing the sides of Q-lon



The coped end will fit neatly against the curve of the top piece.

### Fixing mistakes

#### If you need to remove a piece of Q-Lon once it's nailed all the way in:

The vinyl backing has quite a bit of flexibility, however it's hard to remove without snapping it. Wood Q-Lon on the other hand can be removed more easily but it isn't quite as flexible during installation.

1. Using at least two pry bars or at least two flat-head screwdrivers, start at one end and gently pry the Q-Lon up, away from the door. Ease a section out a tiny bit, then move to the next section.
2. Do not try to pull the bottom end of the Q-Lon off the doorstep while leaving the middle and top attached. Q-Lon will not bend like a piece of tape. You need to pry a little bit at a time, going up and down the length of the Q-Lon. If you don't, you will almost certainly snap the piece.

#### If you cut a piece too short (try not to):

Cut a piece of scrap Q-Lon to fit into the hole. Caulk and nail or staple the piece in place.

#### Installing a door sweep

- Energy savings per decade: **Up to \$190 and 1,512 lbs. CO2 per door**

- **Level of difficulty: Moderate**

- **Cost: \$6 per door**

How long it takes: **15 minutes per door**

- **Tools & materials:** [Door sweep](#) (comes with screws), **drill, drill bits, Phillips head drill bit, hack saw, utility knife**

We prefer the door sweep linked to above, because it's got two tongues (or flanges) of different lengths so if your door or threshold is uneven, at least one of the tongues will still meet the threshold all the way along its length.

Stand on the side of the doorway where there isn't a doorstop and close the door. This side of the door is called the trailing edge.

1. Measure the width of the trailing edge of the door.

**Note:** When measuring for the Q-Lon, you measured the door opening but for the sweep you measure the door.

2. Cut the door sweep to the width of the door. Use the hacksaw to cut the aluminum and a utility knife to cut flanges (or a chop saw if you want to cut through both at the same time). Tip: If you don't want to see the scratches from the hacksaw on

your installed door sweep, then start the cut on the face of the door sweep that has the shortest flange (this is the face that will be against the door) and along the end of the sweep that will be installed on the hinge side of the door. This is the side and end that you will not see.

3. Close the door and line up the door sweep along the bottom of the door so the longest flange just touches the threshold all the way across, covering the gap but high enough to travel easily across the floor, i.e., not pressed hard against the floor.
4. With a pencil, make a mark at each screw hole so you know where to drill.
5. Remove the door sweep and drill a pilot hole at each pencil mark using a drill bit one size thinner than the screws. Don't drill deeper than the length of the screws.
6. Line up the door sweep with the holes, hold it, and screw in each screw.
7. Check that the door closes easily and the door sweep touches the threshold all the way across when the door is closed.
8. If there is a problem, unscrew the screws a bit and adjust door sweep up or down, then tighten the screws again.

#### Installing a door sweep



See our [photos](#) showing how to install a door sweep.





### **Bulkhead doors**

Bulkhead doors are really leaky. Don't even try to weatherize them. The best solution is to install an interior door as an air-seal barrier.

# electric outlets and light switch gaskets

Most electrical boxes for light switches or outlets have several holes in the front and back of them, creating an easy way for unheated air to sneak into your home. Installing foam gaskets underneath the outlet and light switch covers can cut the airflow down a bit. Especially if your home is older than 1950, has balloon framing and/or lacks insulation, these gaskets can help a bit.

The gaskets only cost about 10 cents each and are easy to install.



How-to Section



## How to install gaskets on outlets and light switches

- Energy savings per decade: **Small**
- Level of difficulty: **Easy**
- Cost: **10 cents per outlet or light switch**
- How long it takes: **One minute per outlet or light switch**
- Tools & materials: **Flat head screwdriver, appropriate number and kinds of [outlet gaskets and switch gaskets](#)**

1. Unscrew and take off every outlet and light switch cover (aka face-plate) along the exterior walls (since that's where the cold air tends to sneak in through).



lets and gaskets on the interior walls too. With balloon framing, the cold can possibly sneak in anywhere.

2. Choose a foam gasket that matches the type of outlet or light switch.
3. Poke out the pre-cut parts in the center so the gasket will fit over the working parts of the outlet or switch.
4. Place the flat side of the gasket against the metal box inside.



.....  
**Warning: Remember the current will be live, so don't stick a screwdriver or your wet tongue inside the metal box. Or you can turn off the power to your whole house at the electrical panel before starting this work and use a flashlight to see your work.**  
.....

**Tip:** If you have balloon framing, you might want to install gaskets on the out-

5. Put the cover plate back on over the gasket (keep gasket corners tucked in under the plate) and screw it back into place.

# drywall holes



Not only do holes in your walls look unsightly, they also can let in cold air, especially if they are along exterior walls and your house has no wall insulation or balloon framing.

How-to Section



## How to patch drywall holes

### Patching 2" diameter or smaller holes

- Energy savings per decade: **Up to \$48 and 384 lbs. CO<sub>2</sub> per 2" hole**
- Level of difficulty: **Easy**
- Cost: **\$7**
- How long it takes: **20 minutes**
- Tools & materials: **3" wide putty knife, 2" wide putty knife, Plaster of Paris, a plastic container you're okay with destroying, and water in a portable container**

1. Combine two parts Plaster of Paris dry compound with 1 part water in an old plastic container you are okay with recycling afterward. Start by making a little less plaster than you think you'll need, so you can adjust the mixture as needed.
2. Mix the water and powder together to get a peanut-butter-like consistency. If you need to, add either more powder or water. Work quickly to blend the mixture so there are no dry pockets because the plaster will dry in a few minutes.

#### Mixing plaster



See our [photos](#) of how to mix plaster.

#### Patching a 2" hole in drywall



See our [photos](#) showing how to patch a 2" drywall hole.

3. Push the plaster into the hole with the putty knife so the hole gets filled. Indent the plaster slightly with your putty knife so that it mushrooms inside the wall to create a better bond.
4. Wait five minutes until the first coat is dry enough to hold the second.
5. Mix a second batch of plaster up because the first batch is probably too dry to work with.
6. Use the plaster to fill the indent and create a flat smooth surface. You can't sand plaster, so make sure you scrape off any excess plaster while it is still soft. Use a wide clean putty knife to scrape the area flat. A moist rag will also clean off small plaster remnants.

7. Wait 12 hours before painting.

---

**Note:** Alternately, you can use joint compound instead of plaster. Joint compound is nice in that it won't dry for a long time, allowing you more time to work and you can sand the compound afterward to create a flat surface. However the joint compound is mixed with so much water that if it's layered more than 1/2" thick, it can crack as it dries.

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#### Cleaning up and repairing a medium-sized drywall hole



See our [photos](#) showing how to repair a medium-sized drywall hole.

### **Patching holes with diameter of 2-5"**

- Energy savings per decade: **Up to \$121 and 960 lbs. CO<sub>2</sub>** per 2" to 5" hole
  - Level of difficulty: **Easy**
  - Cost: **\$12**
  - How long it takes: **Five minutes each day over five days**
  - Tools & materials: **3" and 6" putty knives, a quart of joint compound, an aluminum wall patch big enough to fit over the hole, 150 or 180 grit sand paper**
1. Prep the hole: Gently knock any loose plaster or drywall pieces out of the hole. Make sure nothing protrudes that could interfere with the aluminum patch. Wipe off the dust really well with a dry cloth.
  2. Peel the adhesive backing off the aluminum mesh and apply this wall patch smoothly over the hole.
  3. With a 3" wide putty knife, apply a very thin and even coat of joint compound over the mesh tape.

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**Tip:** Use the 6" putty knife to pull the joint compound to the tip of the 3" putty knife. This will give you the best control of the compound. It tends to ride up toward the

handle of the knife but the tip is where you can best apply it.

---

4. Wait overnight for the first coat to dry.
5. Scrape the 6" putty knife over the coating to scrape off any bumps or ridges. Then apply a second thin and even coat that is a bit bigger on all sides than the first coat. Try to taper the coat so that it gets thinner past the patch. This is to create a smooth transition from the patch to the drywall.
6. Wait overnight for the second coat to dry.
7. Again, scrape the 6" putty knife over the coat to scrape off any bumps or ridges. Then apply a third thin and even coat that is a bit bigger and is feathered out a bit to make a perfectly smooth transition to the normal drywall.
8. Wait 24 hours. Sand with fine sand paper to get rid of any ridges and bumps.
9. Clean off the dust and it's ready to paint.

### **Patching holes larger than 5"**

- Energy savings per decade: **Up to \$435 and 3,456 lbs. CO<sub>2</sub>** per 6" hole
- Level of difficulty: **Moderate**
- Cost: **\$15 to \$45 depending on if you have spare paint and lumber**

- How long it takes: **90 minutes spread out over 5 days**
  - Tools & materials: **Pencil, 1 quart joint compound, a piece of 1/2" or 5/8" drywall that is bigger than the hole, a piece of 1"x 3" lumber or strapping at least three times taller than the hole, saw, measuring tape, 150 or 180 grit sand paper, fiberglass drywall mesh tape, drywall square or a flat edge, utility knife, drywall saw, a few 2" coarse drywall screws, 3" wide putty knife and 6" putty knife, drill and Phillips head drill bit**
1. Most holes this size have very uneven sides. To fix a hole this big, you need to make the hole into a neat rectangle. Use a drywall square to draw a rectangle around the hole in the wall. Make sure the rectangle you draw is bigger than the hole on all sides and that the sides of the rectangle are straight and the corners are 90°.
  2. Cut out the rectangle carefully with a drywall saw.

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**Tip:** You can use a drill to make a hole for the point of the drywall saw to fit into in order to start cutting the rectangle.

---

3. Cut two pieces of the 1" x 3" wood to be a few inches taller than the new hole.
4. Feed one of the pieces of lumber into the hole and hold it in place along the left

#### Repairing a large drywall hole



See our [photos](#) showing how to repair a large drywall hole.

side of the hole so its upper and lower ends are behind the wall and the middle of the lumber is just peeking out, half visible all the way along the left side of the hole.

5. Drill the lumber into place through the drywall using two drywall screws, one screw at the top above the hole and one at the bottom, below the hole.

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**Tip:** Drill the screws in slowly so their heads are slightly below the surface of the drywall, but not so far they crack the drywall.

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6. Install a piece of lumber on the right side in the same way.
7. Measure how wide the hole is, going from drywall edge to drywall.
8. Cut a piece of spare drywall to be that wide.
  - a. Use a pencil and measuring tape to mark the width at the top and bottom of the spare drywall.
  - b. Draw a straight line connecting the two marks.
  - c. Hold a straight edge to the line, and run the utility knife along the drywall two or three times to score the line.
  - d. Move the drywall to the edge of the table so the line you scored is right on top of the edge of the table. Press downward on the piece of the drywall that's off the edge of the table to snap the piece along the edge. With a utility knife cut the paper holding the pieces together.

9. Follow the same steps to cut this new piece of drywall to be as tall as the hole.

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**Tip:** Rather than guess what is exactly 90°, use a drywall square or some other object with a 90° angle to trace the corner.

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10. Check to make sure the drywall piece fits in the hole. If it's over-sized, cut down the edges with the drywall saw.
11. Put the drywall piece into the hole and screw it into the lumber pieces on either side with drywall screws every few inches. Drill the screws in slowly at the end so their heads are slightly below the surface of the drywall.
12. Apply mesh tape all the way around the hole to cover the crack between the wall and the patch.
13. Cover the mesh tape with a thin and even layer of the joint compound, pressing the compound into the mesh tape and the crack beneath.

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**Tip:** Use one knife to pull the joint compound to the tip of the other knife. This will give you the best control of the compound as you apply it. It tends to ride up toward the handle of the knife but the tip is where you can best apply it.

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14. Wait overnight for the first coat to dry.
15. Scrape the 6" wide putty knife over the coat to scrape off any bumps or ridges. Then apply a second thin coat that covers a bit more area than the first coat. This second coat will ease out the transition from the wall to the drywall patch. If the patch is slightly inset from the existing wall, apply a thin even coat over the patch.
16. Wait overnight for the second coat to dry.
17. Scrape the 6" wide putty knife over the coat to get rid of any bumps or ridges. Then apply a third thin and even coat that is a bit bigger and is feathered out a bit to make a perfectly smooth transition to the normal drywall.
18. Wait overnight.
19. Sand with fine sand paper to get rid of any ridges and bumps.
20. Clean off the dust and it's ready to paint. Wash your hands, and pat yourself on the back.

*Before you seal up large holes in a home, you might want to count all the animals in the home. Once I sealed up a large hole under a bathtub. The hole led to a space that turned out to be the cat's favorite hiding place. After I was done, the homeowners didn't see their cat for two days, until one of them was taking a bath and heard a muffled meow. The cat was fine, but I'm still traumatized.*

—Audrey

\* \* \* \* \*

# fireplaces



Tape a sheet of plastic over a fireplace with the damper open in order to see how much an open damper literally sucks.

A fireplace damper is the metal flap inside the chimney. The damper must be open when there's a fire in the fireplace so the smoke can rise up the chimney, leaving the house. For the rest of the winter though, when there is no fire in the fireplace, the damper should be shut so the heated air in the house can't exit in the same way.

Leaving your fireplace damper open is like leaving a window open all winter long—maybe worse since hot air loves to rise and the chimney is a straight shot up. Without the damper shut, chimneys literally suck.

However since the damper isn't visible, many people leave it open all winter by mistake. Sitting on the living room couch, they feel a cold draft through the winter and end up buying new windows or a bigger furnace out of desperation.

How-to Section



## How to close off a fireplace flue

- Energy savings per decade: **Up to \$724 and 5,760 lbs. CO<sub>2</sub>** assuming you close a 12" x 5" damper

### Closing your damper

- Level of difficulty: **Easy**
- Cost: **\$0**
- How long it takes: **Two minutes**
- Tools & materials: **Clothes that can get dirty, a flashlight, incense**

Most often, the way to close and open the damper is with a metal lever on the front or side of your mantelpiece.

1. If there is such a lever, twist it all the way to one side.
2. Stick your head and a flashlight into your fireplace to check if you have successfully shut the damper. Don't do this wearing your favorite white

linen suit. The damper is generally located within sight just above the fireplace in the flue. If it's closed, you will most likely see a metal flap or grate that's closing off the flue. Check that the flap or grate is shut well without obvious gaps or cracks.

3. If the metal flap or grate doesn't seem to be closed entirely, then twist the mantel-piece lever the other way to check to see if that works better.

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**Note:** Sometimes the damper is shut instead by reaching up inside the fireplace flue to pull a metal flap down. Other times there is a lever on the metal grate itself;

#### Opening a flue



See our [photos](#) showing how to open a flue.

sliding the lever will slide the grate shut. Experiment with your damper to see what works best. Either way, the flap or lever will be within easy reach, no need to try to climb up the inside of your chimney.

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#### Checking if your damper is closed well

Sometimes there is no damper visible no matter how far you look or grope your way up the flue. Don't panic. It's possible there's a damper somewhere further up inside your flue or even on the very cap of the chimney.

Other times, even if there is a damper and you've shut it as well as you can, the whole thing looks warped and corroded, leading you to wonder if it's functioning as an air-seal.

Either way, here's how to check if the damper is stopping hot air from leaving your home.

1. Light some incense and hold it inside your fireplace to study the smoke. If the smoke slides straight up the flue to disappear from sight, your damper literally sucks. If instead the smoke hangs there for a moment, the same way it does if the

incense is held in the middle of your living room, your damper is closed.

## Creating your own damper

If your damper doesn't exist, or doesn't close effectively, here are four possible ways to create or buy your own. The solutions range from the inexpensive to the expensive.

### Make a damper out of tinfoil and foil tape

- Level of difficulty: **Easy**
- Cost: **\$30 if you need to buy the tin foil and foil tape**
- How long it takes: **20 minutes over two days**
- Tools & materials: **Clothes that can get dirty, a flashlight, incense, a wet rag, aluminum foil, foil tape.**

This is a good solution if you aren't terribly handy and you use your fireplace once a year or less.

1. Figure out where you want your homemade tinfoil damper to go. Generally you'll want it somewhere inside the fireplace where you won't be able to see it. Probably the best place is on the ledge inside the fireplace where the fireplace officially turns into the flue.
2. Wash the area with soap and water well, so the tape will stick to the masonry

rather than to the dirt. If the area isn't clean, the damper will fall out of the flue and won't work.

3. Wait a day for the area to dry all the way (otherwise the tape will stick to the water).
4. Tape a sheet of tinfoil neatly over the hole onto the area you cleaned, to create a seal at the top of the fireplace. Use foil tape (sold at hardware stores). Foil tape is not only highly resistant to fire; it also is very very sticky and endures extreme temperatures. If your chimney is wider than one sheet of tinfoil, overlap two tinfoil sheets and tape the sheets together. Take care with all the taping. Air will sneak through the tiniest hole.
5. When you're done, test the result with the incense. If you did your work well, you will have an unobtrusive homemade damper that should work effectively for years.

If you want to use the fireplace for that rare holiday party, you can peel the tinfoil off and use the fireplace as normal. Afterward, repeat these directions to re-install a new tinfoil damper. This time at least you don't have to buy the foil tape.

## Make a plywood faceplate for the fireplace

- Level of difficulty: **Easy**
- Cost: **\$25**
- How long it takes: **45 minutes**
- Tools & materials: **½" thick plywood, table saw, ½" foam pipe insulation, measuring tape, utility knife, 2 wood knobs with screws that fit, paint, paint brush.**

You can make a plywood faceplate for the front of the fireplace to air-seal it.

When you want to close off your fireplace, you push the faceplate into position, slightly inset into the fireplace. The pipe insulation around the edge of the faceplate air-seals it against the uneven brick or mortar of the fireplace. When you want to use the fire, you grab the knobs on the faceplate to pull the faceplate out of the way.

Here's a great [how-to video from A-HEET](#) that shows you how to create the faceplate. It's easy. Afterward you can paint a pretty picture on the plywood or just paint it an unobtrusive color.

1. Measure the width and length of your fireplace at a spot half an inch inset into your fireplace. Subtract 1" from the height and width.

2. Cut the piece of plywood to that height and width.

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**Tip:** If you don't have a table saw to cut the plywood to the right size, buy the plywood at Home Depot and ask them to cut it to your measurements.

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3. Cut two pieces of pipe insulation to the height of the plywood. Cut their edges to 45° angles.
4. Stick a finger in one piece of the cut pipe insulation and rip open its pre-cut seam, then install it on one side of the plywood to function as a gasket. Install the other piece on the other side.
5. Repeat steps 3 and 4 to install pipe insulation along the length of the plywood. Make sure the pipe insulation is installed so the 45° corners meet like the corners of a picture frame to leave no gaps.
6. Try the plywood out in the fireplace to make sure it is the right size and that the pipe insulation will function to air-seal the faceplate into the front of the fireplace.
7. Drill screws into the backside of the plywood in the places you want the knobs. Drill all the way through.
8. Screw on the knobs.

9. If you want, paint the faceplate. (Don't forget to take the pipe insulation off while you paint. Then put it back on once the paint is dry.)
10. Press the faceplate firmly into your fireplace to block it off and enjoy the increased comfort of your home.

### **Buy a chimney balloon**

- Level of difficulty: **Easy**
- Cost: **\$30 to \$55**
- How long it takes: **20 minutes**
- Tools & materials: **Clothes that can get dirty, a flashlight, measuring tape, chimney balloon.**

A chimney balloon inflates to block off your flue when you don't have a fire going. The balloon is located far enough up your flue that you can't see it. A cord hangs down from the balloon with a visible warning so



people know there is a balloon there that they need to deflate before they start a fire.

Once the fire is over and the flue has cooled down, you can put the balloon back in position and re-inflate it. If someone by mistake starts a fire with the balloon still inflated in the flue, the balloon simply bursts.

The most difficult parts of installing a chimney balloon is figuring out if a balloon will work in your flue and then buying the right-sized balloon. Read through the directions on the website that you order your chimney balloon from to make sure you know what you're looking for and what you're measuring. Then examine the flue just above your fireplace to see if a balloon will work. Measure the inside of the flue, according to the chimney balloon's directions. Talk to the salesperson for a few minutes to make sure you did it right. If you need to, send digital photos of the flue.

1. Order the balloon.
2. When it arrives, hold the chimney balloon where you want it to go inside the flue.
3. Blow into the nozzle until it's inflated and held firmly in the flue.

## **Install glass doors on the front of your fireplace**

If all else fails, you could install some glass doors on the front of your fireplace. The doors should be able to close tightly. Call a chimney specialist for this. This work will cost several hundred dollars.



# basement holes



Most times when we do an energy checkup in a home, we don't even have to step into the home to be pretty certain it has mice or other vermin. We can tell just by examining the foundation.

A foundation with holes tends to be a home inhabited by more than humans, since these holes are easy entrances to a warm place with lots of food.

Closing off these gaps will decrease the amount of vermin in your home, your heating bill and the amount of dusty moldy basement air being pulled into the lived-in parts of your home by way of the stack effect.

## **Find the problems**

First do a careful survey of your foundation to find every hole, gap or crack that goes all the way through the foundation from the inside of your house to the outside. Likely spots include around wires, pipes, fans, vents, doors and windows.

It's best if you do this survey from both the outside of your building, as well as from the inside. When you're outside, pull back any foliage, garbage cans or other items against the house to examine every inch. Get down low and look everywhere.

From inside the basement, bring a flashlight and examine every inch of the basement walls, concentrating on the parts above ground level. Sometimes it's easier to find the gaps if you turn off the flashlight so you can see sunlight peaking through the wall.

Alternately, you can turn all the basement lights on at night and examine the foundation from the outside. Look for pinpricks of light coming through the foundation -those are the holes. In order to see these pinpricks, make sure to turn off all the outdoor lights (but bring a flashlight so you don't trip over anything).

Mark every hole with painters tape so you don't forget about it.

### Dryer flap

When you're surveying your foundation for holes, don't forget to check the dryer flap. If it's propped open by old lint, clean it out so the flap can close.

### Spider webs

When you're looking for holes in the basement walls, look for spider webs. Spiders love to build webs in drafty areas because the draft blows insects their way. If you see a spider web, examine that area carefully for a hole or gap to the outside.

## How to fill a foundation hole

### Choose your materials for filling the hole (or gap or crack)

In general, if the area involves:

- Only masonry (i.e., is in brick, mortar, cement or stone), repair it with mortar.
- More materials than just masonry and is smaller than 1/4" wide, use caulk.
- More than just masonry and is bigger than 1/4", use spray foam.

Don't bother closing up the holes in the basement ceiling because:

- Closing off that many holes in your basement ceiling (around wires, pipe, chimneys, stairs and framing) would be really difficult.
- Probably you have a heating system in the basement emitting lots of stray heat. Since hot air rises, sealing off the base-

### Basement holes



See our [photos](#) showing which holes to seal and which ones not to seal.

ment would only slow that hot air from rising up into the lived-in part of your home.

- It's much easier and more effective to close up the holes letting cold air into your basement from outside. That will save more energy for both you and your heating system.

**Note:** If you have mold and active water leaks, then you should stop the water from coming into your basement before you do a lot of air-sealing. The air-sealing can exacerbate the mold. Mold is everywhere on this planet. Most of it is fine to breathe, but occasionally mold can turn into a variety that isn't so good for humans. It's best to keep large active mold colonies out of your home by not having water leaking into your

basement. Water helps mold grow. Once you've stopped the water leak, you can get rid of the mold.

1. Stop the water from entering your home. For more information on this, please read our Humidifier/Dehumidifier chapter.
2. Dry out your basement as well as you can, using fans and/or a dehumidifier.
3. Use detergent and water to clean up the mold you can get to.
4. Once the mold is gone, you can do the air-sealing. Then your home will be drier, healthier and cheaper to heat.

For more information, see this [EPA mold guide](#).



**Warning: Make sure you have a working Carbon Monoxide detector in your basement. If the detector goes off a lot, don't take the batteries out of it. The alarm means there's carbon monoxide in your home. It's an odorless toxin that will start off just giving you a headache or flu-like symptoms and can result in**

**death. Call your utility company to have them come to check out the situation. Most utility companies will do this lickety-split and for free.**

**Combustion equipment and ventilation: Any room that has combustion equipment such as your furnace or boiler and/or water heater has specific ventilation needs. These appliances have combustion (a.k.a. fire) inside of them. Fire needs air to breathe. It is dangerous to seal a vent that was deliberately put there for combustion air supply. If you have a vent near any combustion equipment, don't seal it.**

# repairing masonry



Mortar is easy to work with, like play dough, but it will dry into something far more permanent. It is great for sealing up holes in foundations.

Mortar, unlike spray foam, will deter vermin for decades and, if it's done well, adds to the beauty and durability of the home.

**How-to Section**

## How to repair masonry

- Energy savings per decade: **Up to \$68 and 540 lbs. CO<sub>2</sub>** assuming the holes you fill add up to a 3" x 3" hole
- Level of difficulty: **Easy**
- Cost: **\$4**
- How long it takes: **1 hour for the average foundation**
- Tools & materials: **Trowel, a plastic container you're okay with destroying, pre-mixed mortar mix, some water, work gloves, dust mask, a spray bottle and maybe a few bricks**

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**Note:** Use mortar only on masonry, not on wood or other non-stone-based materials. It won't bond well to other materials.

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1. If the area you'll be working on is at all dirty, clean it off first. You don't want the mortar to stick to the dirt rather than the foundation. You can use water to clean it. Mortar sticks better to a damp foundation.
2. Mix three parts mortar powder with one part water in a container. Wear a dust mask while pouring the mortar powder and stirring up the mixture because you don't want to breathe in the dry cement dust. It's bad for you.

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**Tip:** Mix up a little less mortar than you think you'll need so you can adjust the mixture to the right consistency by adding more mortar powder or more water.

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3. Use a trowel to stir the mixture to a peanut butter consistency, until a ½" glob of mortar sticks to a trowel when held vertically. Adjust the mixture as necessary to get the right consistency. Make sure to stir the contents thoroughly including in the corners of the container.
4. Let the mixture slake or sit for a few minutes, so any dry pockets of mortar pull the water in.
5. Mist down the area to be repaired so the dry masonry doesn't wick all the moisture out of your mortar. That will make your new mortar crack.

6. Press the mortar into place with the trowel or your hands. Wear gloves, because mortar is basically tiny pieces of glass and the mix is alkaline (the opposite of acidic, equally damaging). Working with your bare hands will burn and scrape your skin.

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**Tip:** Don't fill a hole more than ½" deep with mortar. You are just creating a barrier, not building a castle. Mortar more than ½" has a tendency to crack. If it's a big hole (more than a half inch deep), break up a brick with a hammer and fill up the majority of the hole with the brick pieces. Then fill the remaining pocket with mortar to seal it shut.

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7. Wait until the mortar is dry enough that you can't easily make a thumb print in it, then smooth it down with a trowel and clean up any dribbles in the area before the mix hardens.

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**Tip:** Hydraulic cement is cement that expands as it dries, helping to ensure it fills a crack well. Although it is sold as a way to stop water leaks, it doesn't work well at this long term.

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If you have a water leak, you should fix the problem, not try to hide the result. Stop

the water leak before it gets into your foundation, because once it's in the foundation it will expand and contract with the weather, breaking your foundation down (a seriously expensive problem to fix). Additionally, hydraulic cement is more rigid than other types and doesn't bond well with older mortar, making it crumble over time.

It is, however, good for anchoring railings or bolts.

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Information thanks to Michel Clapham of Restoration Masonry—aka Mike the Mason.

The [New York City Rat Academy](#) (oh yes, such a place does exist) is the place where all top-of-the-line pest-control professionals go to figure out how to deal with vermin. It's basically the Ivy League for exterminators.

Mortar is the only product the Academy recommends for sealing up a foundation so rodents can't get in.

# spray foam



Spray foam was originally invented to keep vermin out of a home. Only after it was used for a while, did people figure out it was great at air-sealing holes too.

It is fast and easy to use, somewhat similar to spraying out whip cream—only it solidifies.

## Important Safety Issues

- Spray foam is highly flammable for about an hour after it's first sprayed. Turn all water heaters, furnaces, etc. down to pilot setting while the foam is curing. Have no ignition sources nearby.
- Wear protective goggles. Make sure to wear protective goggles at all times. Spray foam is the stickiest substance known to humans. If you were spraying above your head and it spattered or dripped into your eye, you could lose your sight.
- Wear gloves. Long sleeves and a hat are helpful too. If it gets on the

skin, it will turn into a dark blobby stain that lasts about three days.

- Foam in clothing or hair? Don't touch it until it dries, because it just smears everywhere. After it's dry, you can cut the foam blob off without taking as much of your hair or clothing with it.
- Don't use within 2" of steam pipes or anything else that can get warmer



than 200°. Spray foam is made of a petroleum product and will melt or potentially catch fire.



- Open all windows and doors to the area. Spray foam has VOCs that aren't good to breathe.
- Read the instructions and warnings on the can before using.
- Practice on some scrap material before spraying anywhere permanent.

#### What kind of spray foam to use

- [Great Stuff spray foam](#) or other similar foam is fine for most applications around wires and pipes etc.
- Minimally expanding foam should be used in the casings around windows or doors so the foam doesn't grow so big it overflows the area.
- "Green" or "soy" spray foams, unfortunately, aren't worth buying. They use only 10% soy or other products. The remaining 90% is exactly the same as in

non-green foams (composed of petroleum products and propellant gasses) and the foam doesn't tend to spray out as well.

- [Professional spray foam](#) has a lot of pluses. If you have a fair amount of air-sealing to do, try it out. You need to have both the pro spray foam can and a [pro spray foam gun](#). The pro guns have a long nozzle and a control valve allowing you to control exactly where the foam goes and how fast it comes out. This decreases the amount that drips everywhere and it makes the work go faster.

### How to close up basement gaps with spray foam

- Energy savings per decade: **Up to \$68 and 540 lbs. CO2** assuming the holes you fill add up to a 3" x 3" hole

#### Using Great Stuff spray foam

- Level of difficulty: **Easy**
- Cost: **\$8 to \$12; 3 cans of Great Stuff are enough to do touch-up work in most basements**
- How long it takes: **3 hours in an average basement assuming your basement is easy to move around in**
- Tools & materials: **Long sleeved shirt, pants and a hat you don't like, dust pan or vacuum, protective goggles, ladder, [spray foam](#), latex gloves, head lamp or other light source, dust mask, possibly some Brillo pads**

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**Note:** The spray foam needs to be room temperature (70° for 24 hours) to work

right. Otherwise it will dribble out in a lazy and unhelpful manner.

#### Tips for using spray foam



The correct way to hold the spray foam gun is with the can on top.

4. Spray with the can held upside down, the same way you'd use a whipped cream can. The propellant gases then work well to push the foam out.

**Tip:** If the can starts to make a hissing noise when you press the trigger and no foam comes out, try shaking the can for a minute again and—when you spray—hold the can in an upside-down position.

5. You don't want to hide the hole from view; you want to solidly fill it. Stick the nozzle right into the crack or hole as you spray out the foam.

**Tip:** Apply lightly. Foam doubles in size as it cures. (Minimally expanding types expand less.) Spray a light application at first, then check back after 20 minutes to see if you need to add more.

6. If the foam is exposed to sunlight, it will turn yellow or orange over time. If it is outside, or if you want to clean up the look a bit afterward, let it dry for a day, then cut it back to a flat surface and paint it.

**Tip:** If you're trying to keep vermin out of your home, jam a Brillo pad deep into any vermin-sized entry hole first, then use spray foam over the Brillo pad to seal it. This will do wonders at reducing the num-

ber and diversity of unwanted wildlife in your home.

**Note:** If a wad of foam at the end of straw dries and blocks any more foam from coming out, you can snip off a half inch of the straw end in an attempt to fix the problem. Wear goggles while doing this. You really don't want the foam to spray into your eyes by mistake.

1. Clean off the area with a vacuum or dustpan so the foam has a clean surface to stick to. Wear a dust mask for this.
2. Put your goggles on.
3. Shake the can well for at least 60 seconds before using it in order to mix up the propellant gasses with the foam. If you don't mix it up well enough, the foam won't come out.

## Using a pro spray gun

- Level of difficulty: **Moderate**
- Cost: **\$15 per spray foam can, \$25 for a pro gun**
- How long it takes: **An hour in an average basement assuming your basement is easy to move around in**
- Tools & materials: [Spray foam \(pro can\)](#), [pro gun](#), latex gloves, long sleeved shirt and pants and a hat you don't like, protective goggles, ladder, head lamp or other light source, dust mask, garbage bag, utility knife

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**Tip:** Foam needs to be at 70° for 24 hours to work right.

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1. Clean off the area so the spray foam has a clean surface to stick to. Wear a dust mask for this.
2. Put your goggles on.
3. Shake the can for at least 60 seconds to mix the propellant gasses with the foam.
4. Pop the cap off the can of spray foam (if it has a cap).
5. Connect the can to the gun by seating the top of the can into the steering wheel type do-hickey at the top of the gun. Turn the can counterclockwise a half turn until

the can finds the threads, then gently twist the can clockwise into its seat so it is firmly attached. Do not force it. If it goes in unevenly, you haven't found the threads and need to back up (counterclockwise) until you find the threads. Forcing it could mess up the threads and make the gun useless.

6. Open the valve at the back of the gun five or six complete rotations counterclockwise. This valve controls how fast the foam flows out whenever you touch the trigger. The wider you open it up, the bigger the bead of foam you will be able to draw.
7. Hold the can upside down, the same way you'd use a whipped cream can. Touch the nozzle to where you want the foam to be and gently press the trigger. You can control the volume of the foam by changing the pressure on the trigger. Pull the nozzle along to draw the foam inside a crack.

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**Tips:** If the can starts to make a hissing noise when you press the trigger, but no foam comes out, you need to hold the can in a more upside down position.

Put the nozzle right into the crack you are trying to fill.

Apply lightly. The foam will double in size.

To adjust how fast the foam comes out, adjust the valve at the back of the gun or change how much you press the trigger.

To fill up a large hole, start at the bottom and apply the foam in a side-to-side motion to build up a wall of it. If the hole is bigger than 3" square, you might want to fill it with rigid insulation cut to the right size, then use spray foam to seal the edges of it.

When you are finished spraying, leave the can on the gun. Close up the valve at the back of the gun. Store it until you need it again. *Always leave a can on the gun*, even if the can is empty. Otherwise the foam will cure inside the gun and the gun will be ruined.

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**Note:** If the foam at the end of gun cures, you can run a knife blade gently over the tip of the gun to clean it. There is a little ball-point-pen-like ball that retracts to make the foam come out. When it gets covered up, the foam can't escape until you scrap off the foam that is blocking the little hole. Make sure to close up the

valve at the back before you do this. Wear goggles while doing this. The can might spray foam at any moment.

### Switching the foam can on a pro gun

Pro spray foam cans contain a lot more foam than Great Stuff cans, but you will run out of foam sooner or later and need to put a new can of foam on the gun. If you think you are running low on foam but—when you shake the can it feels like it still has foam inside—then first try fixing the problem:

#### Cleaning the tip of a spray gun.



Run the utility knife gently over the tip of the spray gun nozzle. Be SURE to wear goggles.

a. Run a knife over the gun's nozzle to make sure a chunk of dry foam isn't blocking it (wear goggles).

- b. Shake the can for a while, open up the valve a bit more and then try to spray again.
- c. Was the foam at 70° for 24 hours or did you just pull it out of the freezer?

If you are sure you need a new can, then make sure you have everything you need right there: the new spray foam can, a garbage bag, an old wire hanger and a utility knife. Make sure your goggles and gloves are on. *You only have a few seconds* to get the new can on before the old foam inside the nozzle of the gun will start to dry, ruining the gun.

1. Prepare the new can to be attached: shake it for 60 seconds and pop the cap off the can (if it has a cap).
2. Close off the valve at the back of the gun.
3. With the empty can still connected to the gun, place an empty garbage bag loosely over the gun and can. (Sometimes the can isn't totally empty and having the garbage bag over it will reduce the chance of spray foam going everywhere.)
4. Put your goggles on. This is the moment when foam might spray everywhere.
5. Untwist the empty can and unseat it from the gun.

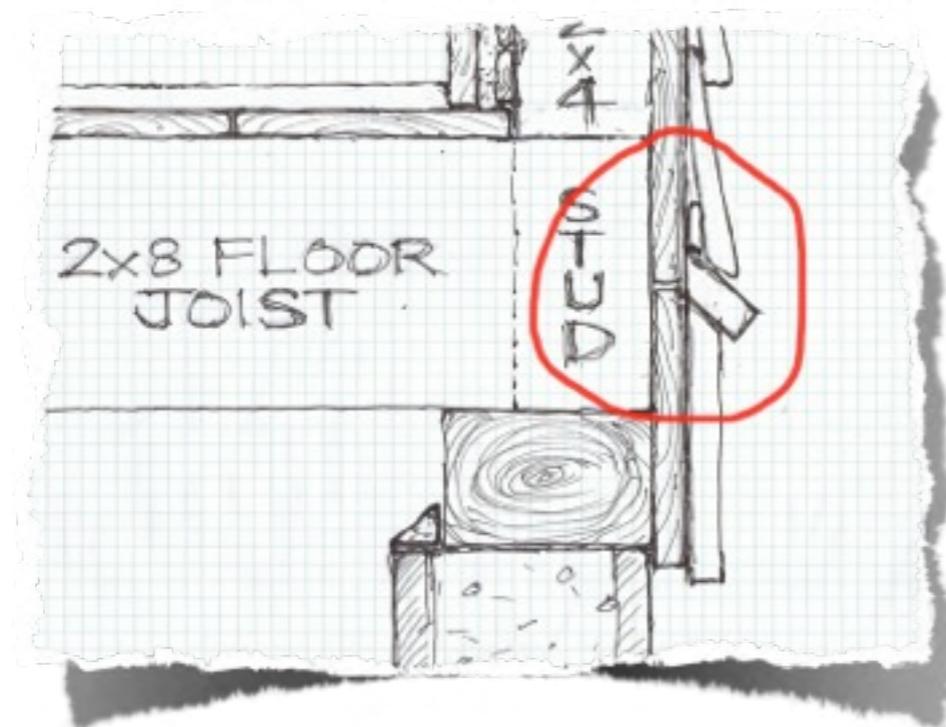
6. Put the new can on and twist it gently into its seat until it's firmly in place.
7. Open up the valve and test that foam is coming out by spraying it into the garbage bag. If foam doesn't come out, check that the can is seated well, scrape off any spray foam on the nozzle, shake the foam can and try again. If it's still not working, close up the nozzle again, untwist the can, reseal it and twist in. Be gentle.
8. If the foam doesn't come out, then as a last resort, untwist the can and use a wire to probe around in the hole where the can connects to clean out the mechanism. There is a little ball that can get stuck and you can sometimes push it in to get the gun working again. Wear goggles! Probably this won't work, but it's worth a try.

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*One winter I was contacted by a woman who said she had mice coming into her home during the cold weather. I had a pretty good idea what the problem was once I found a hole in her foundation large enough for a D-Cell battery to fit through. With \$5 of expanding foam (and a bit of steel wool for*

*good measure) the hole was sealed. No  
more mice, no more wind through the  
basement.* —Jeremy

# air-sealing the sill plate/ band joist



If you stand in the basement and look up at the basement wall to where the wood of your home sits on top of the masonry of your basement, you will probably see a big horizontal wood beam that runs all the way around your building. This beam is the sill plate.

The band joist is the joist that runs horizontally just on top of the sill plate.

- The reason to air-seal around the sill plate/ band joist area is:
- Unlike the rest of your home, this area has no interior air barrier (such as drywall) to act as a second layer.
- The gap between the masonry and wood will expand during the winter—when the air is dry—letting in cold air.

It's best to thoroughly close off the cracks in this area.

You can choose to air-seal these cracks, or, if you're feeling energetic, you can also add insulation at the same time. Wood only has an R-value of 1 per inch,

and your rim joist is only a few inches thick. Adding a layer of 2" rigid insulation will triple the R-value of this area.

## **Balloon framing**

Balloon framing is a type of house framing used back when there were still lots of huge trees for lumber. The builders would use long single pieces of lumber to frame the outside of the house. Since the wall framing was continuous, the floor plates for each floor don't go all the way to the exterior walls, but stop where they intersect the interior wall.

If your home has balloon framing, the wall cavity in your home is uninterrupted from the basement up into the attic, creating a fast and easy passage for heat to leave your home, and for any potential fire in the basement to quickly take over the whole building.

Generally if your home was built after 1950, it won't have balloon framing. If your house is older than this and you want to know if it has balloon framing, go

to the basement and examine a few joist bays on at least two sides of your home. Sometimes it's hard to see what's going on back there, so you might try running your hand along the ceiling of the basement, following it back into the bay. You have balloon framing if at any point there is no ceiling to the bay, so that you can stick your hand into the wall cavity above.

#### Do you have balloon framing?



See our [photos](#) showing how to figure out if you have balloon framing.

Sometimes there will be fiberglass at the back of the bay or a few bricks stacked in the way. In this case, move these to the side to see if the basement ceiling ends before it hits the outside wall. If it does and you can reach

your hand into the wall cavity of the floor above, you have balloon framing.

#### If your home has balloon framing:

- Your home is probably really cold and drafty. You should have the pros fill the walls with insulation and air-seal the top of the wall cavities in your attic. Your home's heating and cooling bills will go down significantly and you will be a lot more comfortable in your home.
- Also, before your basement band joist gets air-sealed and insulated, it's a good idea to stuff rock wool into the opening above each joist bay. This way if—God forbid—there is a fire in your basement, it will be stopped from running up inside the walls of your home. Fires that travel this way move much faster and tend to be more catastrophic.

## How to reduce heat loss from the band joist

### Air-seal the band joist

- Energy savings per decade: **We couldn't find any solid energy-saving estimates for this work**
- Level of difficulty: **Moderate**
- Cost: **\$30 to \$65 for the average-sized basement**
- How long it takes: **3 hours**
- Tools & materials: **Ladder, vacuum or dust brush, [spray foam \(pro can\)](#), [pro gun](#), latex gloves, long-sleeved shirt and pants and a hat you don't like, protective goggles, utility knife, trash bag, headlamp**

Read the earlier chapter about how to use spray foam. For this job you want to use a pro spray gun and can, rather than Great Stuff, because you can reach into each joist bay with the pro gun's longer nozzle

and you can draw a thinner more exact bead.

1. With a vacuum or a dust brush, clean off the top of the foundation and around the band joist, so there isn't any loose dirt. Make sure to clean out even the areas you can't see in the recesses of the each bay. This part is important to do well or the spray foam will just peel off after a while and all your work will be for naught. Sometimes you can find handfuls of dirt and debris need to be removed from each bay.
2. Draw a bead of spray foam carefully around the rectangle at the back of each bay, basically "picture-frame" the back of each bay, carefully filling in the thin crack where the joists on either side connect to

#### Cleaning out a joist bay



See the dirt at the top of the joist bay? You need to clean that out.

the band joist and where the band joist sits on the sill plate and where the basement ceiling sits on the band joist. The secret with this work is to get the foam into the crack all the way around the bay. Use a headlamp to light what you're doing (that way the shadow of your head won't get in the way) and stand on a ladder so you can see what you need to.

3. Do the same for every joist bay in the basement.

#### Air-seal and insulate the band joist

- Level of difficulty: **Moderate**
- Cost: **\$95-127 for the average-sized basement**
- How long it takes: **Five hours for the average basement**
- Tools & materials: **Ladder, vacuum or dust brush, pro spray gun and can, latex gloves, long-sleeved shirt and pants and a hat you don't like, protective eye wear, utility knife, trash can, a box of 3" nails, one or two sheets of 2" thick rigid insulation, headlamp**

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**Note:** If you have balloon framing, you probably should air-seal and insulate the band joist to reduce the amount of warm

basement air running up the wall cavities to exit your house by way of the attic. And before you do this work, rock wool (sometimes known as mineral wool) should be added as fire-block. Rock wool is made from power-plant slag and won't catch on

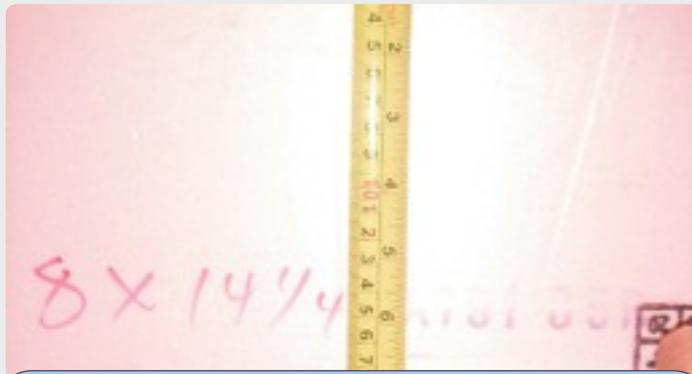
**Mineral wool requires lots of safety precautions.**



fire, but it has all sorts of heavy metals that can become airborne with handling. Rather than do this work yourself, we recommend you call in the pros to do this job. They have the appropriate safety equipment. Check out our chapters on "How to Find a Good Contractor" and on "Rebates and Tax Services."

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### Sealing a joist bay



See our [photos](#) showing how to insulate a joist bay.

Read our chapter about how to use “Spray Foam.” Probably for this job you want to use a pro spray gun and can, rather than Great Stuff, because with the pro gun’s longer nozzle you can reach into the area and draw a thinner more exact bead.

1. Clean off the top of the foundation and around the band joist, so there isn’t any loose dirt. Make sure to clean out the areas you can’t see. You can use a vacuum or a dust brush. This part is important to do well or the spray foam will just peel off after a while and all your work will be for naught.
2. Measure the back of each joist bay (with old houses, each bay might be a different size). Use a steak knife or saw to cut a block of rigid insulation to be 1" shorter in height and width than each joist bay.

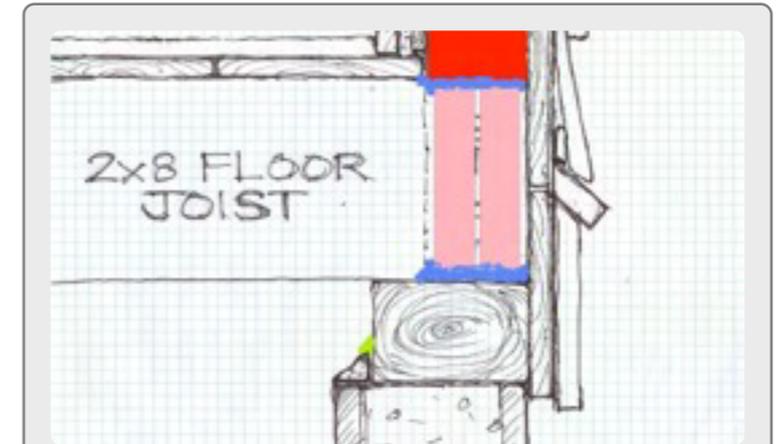
3. Nail the insulation block into the back of the bay, in the center, so there is 1/2" on all sides.
4. Use the spray foam to fill that 1/2" gap all the way around the insulation with a continuous bead of foam. The cured foam works both as glue to hold the insulation in and to seal the gaps around. Stick the nozzle of the gun as far as possible into the crack between wood and rigid insulation as you spray so the foam goes into the crack to air-seal better. Keep any doors and windows open while you work to air out the fumes. Leave the windows and doors open for a while afterward.

### Pipes or electrical wires

You can make your own decision about what to do about any pipes or wires that might get in your way. You can cut the insulation to go around them, bury them under the insulation or try to move them out of the way. Don’t fret too much about which to do. Foam is easy to cut through, so if an electrician/plumber ever did need access, s/he could get to the pipe/wire.

### Steam pipes and flue vents

If there is anything that gets over 200° F, such as steam pipes or flue vents, don’t install insulation or foam within 2" of the



The red at the top is rock wool, the blue is spray foam, and the two pink blocks are two levels of rigid insulation.

object(s). The foam will melt, releasing VOCs and it could be a fire hazard.



# insulating the basement ceiling



When you wonder if you should insulate your basement ceiling, you first have to figure out if your basement is really a cellar.

- Are you scared to go down there because lord knows what is living there?
- Is there no interior staircase leading down into the area? Instead do you enter through a bulkhead around the side of the home?

If you answered yes to both, then insulating the ceiling might be worthwhile. And don't forget to air-seal it too or the insulation won't work as effectively.

If not—if there is an interior staircase, if you store stuff down there and go down there regularly—then you will be much more effective at saving energy and increasing comfort by air-sealing the exterior penetrations in the basement to stop the cold air from getting in.



This is because:

- There's normally heating equipment in the basement. You want the waste heat from that equipment to be able

to rise into the lived-in part of the building

- It's nearly impossible to insulate and air-seal an interior staircase perfectly. Think of trying to air-seal and insulate each one of those treads and rises as well as the sidewalls and the door at the top. If you don't get this right, the insulation you put along the flat part of the basement ceiling is rendered useless as the drafts wander as they please up and down the staircase.
- You've got pipes in the basement. If you do manage to do a great job and keep the basement a lot colder than the rest of the house, these pipes may freeze.

These are Michael Blasnik's points. We just parrot his points while stealing his best lines.

## How to insulate the basement ceiling

1. Don't do it. If you have a basement instead of a "cellar," then just air-seal the exterior of it. If you really want to insulate something in the basement, do the basement wall or floor. Both air-sealing and insulating the perimeter of the basement will save you more money in the end by keeping the cold air out of your home altogether.

If you do have a "cellar," then you already admitted you're scared to go down there. This is probably a job for the professionals.

Check out our chapters on finding a great contractor and rebates.



*When we first moved into our home, the fieldstone basement was a mess. The mortar in some places had been water damaged and turned to sand (although not enough to damage the structure of the foundation). Rather than trying to insulate the ceiling, I re-mortared the damaged areas, sealed the band joist with spray foam, built stud walls and filled the area between the studs with rigid insulation. I dry-walled the stud walls, rolled out across the floor a thin foam layer as a thermal break, and installed flooring on top.*

*All this work dropped my heating 10%, made my whole home more comfy and gave me 400 square feet more livable space.*

—Audrey

# professional work



# problems in the attic

## **Snowmelt**



If snow melts off your roof unevenly like in this photo—or God forbid, your roof never has any snow on it at all—you have problems in your attic.

The snowmelt means your roof is kept warm from the heat loss from your home. The result is you are generously donating more money than necessary to the fossil fuel companies.

## **Ice dams**

Ice dams are another sign of problems in your attic. Ice dams tend to occur because the snow melts off your warm roof and then refreezes once it hits your chilly gutters, creating long icicles.

If the melting water ends up trickling down into your walls, repairing the damage can cost thousands of dollars. Not to mention the danger of having sharp ice daggers hanging from the edge of your home.



## Don't endure it. Fix it.

Get your attic air-sealed and insulated.

Because hot air rises toward your attic, air-sealing and insulating an attic properly are two of the most effective actions you can take to keep your home more comfortable in the winter, lowering your heating bills and your impact on the planet. As a side benefit, this work will also keep you cooler in the summer.

Since work in the attic is generally unpleasant, potentially dangerous and demands a greater skill level than most do-it-yourselfers have, our directions from here on are geared toward helping you find a professional to fix the problems.

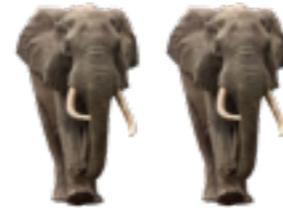


## Energy Savings

We wouldn't be very accurate if we tried to estimate the energy savings for each of the

separate tasks we list in the rest of the book, but we can say on average, air-sealing and insulating your attic (if it has not been previously air-sealed and insulated) will save 21% of your heating bill.

Average energy savings per decade: **\$2,500 and 19,883 lbs. CO2**



If you heat with oil and need more heat than the average home, your savings will be much larger than this.

## The rest of the book will explain:

- How to figure out what problems your home has
- What steps the professionals should take to fix each problem
- How the pros should check their work to ensure they've done a good job
- How to find a great contractor
- Where to find the available rebates, tax incentives and free services

At the end we include a calculator to estimate your probable costs, rebates and savings.

## Four Important facts

If the topics of attics, air-sealing and insulation bore you to tears, simply take away these four important facts.

- **Fact #1:** Air-sealing and insulating your attic, if it hasn't been done, is one of the biggest energy-saving acts possible to perform in your home, and the work will last a lot longer than efficient light bulbs or showerheads.
- **Fact #2:** If you don't know if your attic has been air-sealed and insulated, there's a very good chance it hasn't.
- **Fact #3:** In many New England states, there are rebates and free services available to access the efficiency help your home needs and then to get the work done.
- **Fact #4:** You don't have to know dinky about any of the technical terms we use from here on. Just follow these steps.

Use our "Rebates, Services and Tax Incentives" chapter to get the services you need for the least amount of money possible.

Use our information in our "How to Find a Great Contractor" chapter.

While the contractors are there, make sure they check their work the way we suggest to be sure they've done their job well.

If you follow these rules, then you will have increased your home's efficiency while wasting the least amount of your own money or time.

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**Note:** If you are a semi-pro in terms of home repair, you can use our directions to do the work yourself. However we should warn you, the directions are a lot more cryptic than the ones in the earlier parts of this book, and most buildings have unique variations that will require some tweaking of our basic instructions when in practice. You should research each task to figure out any safety and building issues and any potential problems. You are responsible for using common sense around what you can handle and what will benefit your home.

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# inspecting your attic

Performing a careful inspection of your unfinished attic will help you figure out if you need professional work, as well as what some of the likely problems are. Since you know your home best and care about the results the most, you might be able to find problems the contractors can't. In this way you can help guide them, so they can find and fix as much as possible.

If wandering around in your unfinished attic seems unwise to you because you aren't all that nimble or balancing on joists makes you nervous, don't do it. Instead, read through the rest of the book while thinking about which problems are *likely* to be in your attic. This way you can point out potential problems to the contractor and be an informed consumer.

If you are going to inspect your attic, read the rest of the book first to make sure you know what to look for. Then head on up there.

## **Exploring your unfinished attic**

### **What to wear:**

- A long shirt
- Long pants
- Socks
- Comfortable flat shoes
- Possibly kneepads

### **What to bring:**

- A headlamp (like miners wear) or flashlight. A headlamp is best because it will light up what you're looking at while leaving your hands free.
- Gloves (latex or otherwise) for pawing through fiberglass
- A P95 dust mask if you have breathing issues or want to be extra careful
- Duct tape to mark any problems with so the contractors can find them later
- Possibly a fairly hardy camera or cell phone to take photos of important items

- A pen and piece of paper to write any notes to yourself

### Where to stand

First off, be careful where you stand. If there isn't a true floor in the attic, you have to stand on the *joists*. Balance on them in a mindful Zen way. If your cell phone rings, ignore it.



When in the attic, stand on joists and wear protective gear. Don't answer your cellphone!

If you step by mistake into the area between the joists, you are likely to put your foot through the drywall ceiling and fall through onto the next floor. Nobody wants that.

You can bring a wide board to stand on if you want. Place it centered across the joists, at 90° to the joists, so the board is well balanced. Make sure you don't step on the far end of the board and seesaw off the end.

**If the insulation is higher than the joists** and it is not fiberglass batts that you can easily tug out of the way, you should probably not inspect your attic because:

- You don't want to step all over the insulation; that will compress it and make it lose its R-value.
- It will be harder for you to figure out where the joists are to walk on, making your inspection a little more hazardous.

If you still feel your home is drafty, you can still get a good air-sealer to do the work. They will move the insulation out of the way as they work and then put it back.

### Potential problems to watch out for

Below is a list of different problems to watch out for while you inspect your attic for air-sealing opportunities. These problems are potentially dangerous to either you and/or your home, and they can stop or delay effi-

ciency work from being performed in your attic.

If your attic is heated, the attic ceiling is the top of your home's envelope and that ceiling is what you should inspect for holes. Since you probably can't get above that ceiling to see what the problems are, your inspection is less likely to be as fruitful.

However even a finished attic can have an attic hatch heading up into an attic cap, some knee walls or recessed lights. Page through the next few chapters to see if any of the problems we list are in your attic. If so, then the solutions we suggest will probably fix the problem.



### **Vermiculite**

Vermiculite looks a bit like the shiny mica chips that you sometimes see in potting soil. It was used frequently as insulation before the 1950s.

All vermiculite on the East Coast came from one of two mines. One of these mines was in Libby, Montana where the vermiculite turned out to be contaminated with asbestos. Asbestos when airborne can cause cancer of the lungs. 70% of the vermiculite on the East Coast comes from that Libby mine. You can do a lab test to check if your vermiculite contains any asbestos, but it costs \$42 to test one piece. If you tested 2,000 pieces, all the results could come back negative, but your attic could still have 10,000 other pieces that were contaminated. We would suggest testing is not worth it.

The United States Department of Energy and the Environmental Protection Agency suggest that much of the vermiculite found in homes today contains only trace amount of asbestos. They recommend taking safety measures mostly if you plan to disturb the insulation by adding more on top of it. In these cases, your contractor ought to be properly trained in handling asbestos just in case.

Instead, unfortunately, the action most professional insulators suggest is to clean out all the vermiculite from your attic, then add new insulation. (Certainly don't do this work yourself; this is a pro job because you really don't want to breathe the particles that get stirred up from the work. The contractors will have the correct breathing equipment to do this work safely.)

If you see vermiculite in your attic, leave the attic and close up the hatch well. Then call in the professionals and figure out what to do.

In the meantime, please head to [the EPA's page on vermiculite](#) to learn more.

### **Knob and tube wiring**



## Knob and tube

Knob and tube wiring is an old electrical wiring system from the early 1900s. Generally it looks like porcelain thimbles with wiring strung between. The negative wire is separated from the positive wire.



At this point any existing knob and tube wiring is over 100 years old and likely a bit worse for the wear. The casing of the wires could be worn away or nibbled off by vermin. Anything metal, wet or living can then make a connection between a bare spot on the positive wire and a bare spot on the negative wire.

If there is knob and tube wiring in your attic, you don't want your body to form that connec-

tion. As with getting shocked by any wire in the house, it could kill you. Even if it doesn't, it's no fun to be shocked, especially while you're balancing on a joist in bad light. Keep your eye out for knob and tube and, if you find any, don't touch it.

Never use any metal flashing or *Reflectix* (basically bubblewrap faced with aluminum - it's used as an air-sealer) around knob and tube wiring because the metal could become the connection, either shocking you or causing an electrical fire over time.

Insulation contractors will not add insulation to a building with active knob and tube wiring for fear the insulation might form an electrical connection that could cause a fire. If you (or a contractor) see knob and tube wiring anywhere in your home, you will have to get an electrician to certify it inactive before you can get insulation added.

## Rock wool

Rock wool (sometimes referred to as "mineral wool" by contractors) is a type of non-flammable insulation made from power plant slag. It contains a lot of heavy metals that can become airborne if the insulation is moved.

### Appearance:

- Yellowish, whitish or greyish cotton candy
- Won't usually have a paper backing or come in long rolls like fiberglass batts
- Similar to cellulose insulation, but with a more matted heavier look

**Mold on the rafters can have a variety of different appearances.**



See our [photos](#) showing different types of mold on rafters.

If you suspect the insulation in your attic is rock wool, then make sure you are wearing a P-95 mask (if not a P-100 respirator) and don't handle the insulation except with gloves on. If particles of rock wool get in your lungs they won't ever leave.

If your attic does have rock wool, be sure to remove your clothes in a place close to your

washing machine and put them right in the wash to get rid of the particles. To prevent itchiness, before you touch any of the insulation, rub an ample dash of baby powder on your exposed skin (mostly your forearms). If you do this, after a shower, the itchiness should end.



A bathroom fan where the vent isn't connected to the outside can dump a lot of water into your attic.

## Mold and water issues

If you see any obvious signs of leaks, mold, dampness or water in the attic, you will need to get the leak fixed before you should do any air-sealing. Otherwise you could be trapping the moisture into your living space. Long-term, moisture isn't good for homes or building materials, and mold (although it is everywhere and part of the planet) can sometimes be bad for humans, especially in enclosed spaces.

Mold growth requires four things: a spore, warmth (50 to 120°), food and moisture.

The spores and warmth are everywhere. Food is fairly plentiful too since mold can digest most organic objects such as dust, the paper backing of batts and wood rafters. Moisture is the ingredient that is normally lacking. Keep moisture away and your home won't get moldy. Take it away and the mold will go away.

Contractors will not air-seal or add insulation to an attic with mold or water issues.

Signs of moisture in an attic:

- Grey streaks from a long-term water leak running down the chimney
- Round mold colonies on the rafters above or damp wood
- Mold on the insulation or damp matted down insulation

If you find this, then figure out where the moisture is coming from.

The likely spots are:

- Leaks through the roof
- Leaks through the chimney
- A bathroom fan or dryer that dumps its moist air into the attic rather than outside through a wall or roof vent

If there are signs of moisture but you can't find an unvented fan or dryer vent, and the chimney doesn't have water streaking down it, then the problem could be a leak in the roof.

Whatever the problem is, get the problem taken care of. This isn't something to stall off for years. Water damage and mold will end up costing you much more if you wait until you can't ignore the damage anymore.

Once the moisture problem is fixed, you will have helped stop long-term expensive damage to your home and you will be able to reduce your energy bill through air-sealing.

# finding treasure in an attic



Assuming your attic is unheated, the ceiling of the floor below your attic is the barrier that should stop the hot air in your home from escaping. The plane of that ceiling is a barrier you want to make sure has no holes in it.

Unfortunately most of the holes that might be in that ceiling plane are likely to be in places you can't see by standing on the floor below and staring up at the underside of the ceiling. They will be hidden inside of walls cavities, behind soffits and other detailing. Any of the people who built or renovated your home over the years might have cut—or never closed off—all sorts of large holes in this ceiling plane and then hidden these holes behind pretty veneers.

Therefore the best way to find these holes is by doing a careful inspection of this ceiling from above it in the attic.

## **Attic flooring**

If your attic does have a floor, remove the floor planks (if it's easy to do) to see

what holes there might be in the ceiling of the floor below. Look below the floor joists. You will see the topside of the ceiling below; it will be made of drywall, or plaster and lathe, and wood. (This is the barrier that keeps heat from leaving your home and should have no holes or you're wasting heat.)

## Problems to look for

### Dirty insulation

Air conditioner filters are made from fiberglass. The air will pass right through leaving obvious dirt smears. If your attic is unfinished and the floor's insulation is fiberglass batting, then pull the batts back. If the fiberglass appears dirty anywhere, there is a nearby hole letting in a lot of air. Examine the nearby area to find the hole where the air is coming from.

#### Dirty fiberglass insulation



### Cracks, gaps, holes or canyons

While you are pulling back the insulation, examine the ceiling below you. Look for holes through to the next level below. Be system-

atic in your search, making sure you examine the whole surface.

Since you know the layout of your home well, think about what is below you as you look through the attic. Search especially in the areas around or above:

- Recessed lights
- Whole house fans
- Pipe stacks
- Chimneys
- Wet walls
- Gable ends
- Balloon framing

#### Soffits



See our [photos](#) of soffits.

- Changes in ceiling height
- Bathroom fans

If you don't know what some of these items are, don't panic. Each of these items is described in the following chapters.

### Mark the problems

Mark any gaps or holes you find with duct tape on the rafter above so the contractors can locate the problem. You can also take photos with your cell phone to show them.

### Put the insulation back neatly

Make sure to put the insulation back. If it's fiberglass, make sure each batt is not crumpled or jammed in anywhere. Make sure it's actually flush against the floor of the attic. Like a sweater, insulation works better when it is in contact with what it's trying to keep warm and when it's fluffed up rather than compressed (and this is especially true of fiberglass).

### Insulation problems

Imagine wearing a thick sweater outside on a cold winter day. The sweater is keeping you warm, until you catch the sweater on the edge of a fence and two of the buttons pop off. The sweater gaps open a bit, the wind is brisk and suddenly you find you are freezing even though the sweater hasn't changed at all in terms of how thick it is.

The same is true with the “sweater” for a home. If there is even a 5% hole in the insulation of your attic, it can reduce the efficacy of your insulation by 50% (there’s a long and complicated mathematical way to prove this, but trust us, it’s easier to imagine yourself in that damaged sweater). If your attic doesn’t have a thick blanket of insulation everywhere along the attic floor (or on top of the attic ceiling if that’s your envelope), then your sweater is damaged - but it’s easy to fix.

While you’re up in your attic, notice if there are any holes in your insulation.

Also measure the depth of the insulation in several spots. Write down how thick it is on average.

Write down what kind of insulation it is. If you aren’t sure, take a photo of it so you can figure it out later. Later in the book, this information will help you figure out if you have enough insulation.

Problems to notice:

- No insulation
- Uneven spots in the insulation
- Gaps in the insulation—if you can see the floor anywhere in your attic, that’s a problem.
- Wet insulation—wet insulation conducts cold faster than air and can grow mold. If insulation gets wet, it needs to be removed and replaced.

#### Ceiling height changes



See our [photos](#) showing ceiling height changes.

# big numbers

An air-sealing contractor we work with—Roger Ouellette—loves doing his job well. He loves to make homes less drafty because that helps people and the planet. When a blower door pre-work versus post-work test shows a large reduction in a home’s CFM number, he feels he’s put in a good day’s work.

It’s no surprise then that one of the things that makes him happiest in an attic is when he comes upon one of the problems we list in this chapter. He’ll call out to his crew, “Big numbers, big numbers,” because air-sealing these holes will result in big changes in the blower door number, showing the house is much less drafty afterward.

If you find any of these problems in your attic, you really should get professionals in to fix them now. The work will make a huge difference in how comfortable your home is year round and how expensive your energy bills are.

**Open wet wall as seen from the attic**



**Wet walls** are structural walls designed to have a larger than normal space inside the wall so the plumbing pipes from a bathroom and/or kitchen can be hidden in the wall. When the top of a wet wall dead-ends in an unfinished attic, the builders sometimes don’t close off this gap, leaving an open chasm that can be several inches wide by several feet long.

**Gable ends:** A gable roof is the classic type of triangular roof all children draw for a home. The front and back of this

type of home rise into a triangular peak; this front and back are the *gable ends*. The framing in the gable-end where it intersects with the attic floor plane is sometimes not capped, creating two huge holes at the top of the wall cavity that is several inches wide and the width of your home.

**Balloon framing** is when the floor plates don't go all the way to the exterior wall. Instead the floor stops where it reaches the interior framing. Balloon framing results in open wall cavities several inches wide along the entire length of all four sides of your building, creating a fast and easy passage for heated air to leave your home in the winter.

**A change in ceiling height** is any sort of architectural detailing that results in the ceiling not being an utterly flat and dull plane in between your walls and doorways. It's something to worry about in terms of your home's draftiness if it's on the top heated floor.

A change in ceiling height might be from:

- A cathedral ceiling
- A skylight
- A *bathroom soffit* (a rectangular box built usually into the ceiling of a bathroom or kitchen—generally above the tub or sink)
- A height change inside a split level home

- A lowered ceiling in a closet or other small room

Frequently these architecturally pretty details aren't capped off on the top, creating large holes in your home's envelope.

The second likely problem is that the sides of the ceiling-height change might not be insulated. For instance, you might have a cathedral ceiling that is six feet taller than the rest of the ceiling and 20-feet long. From up in the attic, the back wall of that cathedral ceiling is likely to be utterly bare of insulation, resulting in a giant void in your home's sweater.

### What to look for

#### Wet walls

If you have a bathroom on your top heated floor, then in the general area above the bathroom ceiling in the attic, search for an open wall cavity.

Even if you never knew the term “wet wall” before today, you will instinctively recognize it when you see it (picture a long narrow canyon you could drop your wallet into and never see it again). Take care looking. Pull back the insulation and look in the shadow of joists. Also cast a bigger circle than you think you need to, because being up in the attic can be a bit disorienting.

### Gable ends

If you have a gable roof, then walk to the side of the house where the attic wall rises in a triangle. Pick a spot between two studs and dig through the floor's insulation within an inch or two of the exterior wall to see if there is a big hole into the wall cavity below. If so, you have a problem you need to solve (and this also means that you probably have balloon framing). If you don't find a hole, then dig around at a few places at both gable ends to double check the framing at both ends was thoroughly capped.

#### Reflectix in gable end



A gable end closed off with Reflectix stapled in place and air-sealed with spray foam in every crack. If you look closely, you can see the contractors missed the gap just below the floor joist.

## Balloon framing

We discussed how to check for this in your basement already; now let's talk attics. If your house is older than 1950, then go to the edge of the attic (any side will do) and dig around through the insulation within an inch or two of the exterior wall to see if there is any hole into the wall cavity between each stud. Try it in few places on at least two different sides of the roof. If you can't find any cavities, you don't have balloon framing.

## Changes in ceiling height

Generally these problems will be large and obvious from a distance. When you're up in the attic, if the ceiling plane (attic floor) goes down or up, that's a change in ceiling height. Examine the framing carefully around this "canyon" or "mesa top." If you can see any holes or gaps through the ceiling plane below, then that's a hole an air-sealer should fix.

Also, if there isn't insulation on the sides and bottom or top of the canyon/mesa top section, then insulation should also be installed. Whatever type of insulation is chosen, it should be thick enough to be at least R-30 and should be installed evenly across all the faces of the ceiling change.

## What the pros should do

### Air-sealing

There are many ways to seal large holes, but using Reflectix is one of the most common.

The steps are:

1. Clean the surface nearby so the spray foam will stick to the surface rather than the dirt.
2. Cut Reflectix or other material to cover each hole.
3. Staple the material in place.
4. Spray foam all the cracks around the material to seal every crack. The seal will be better if the foam is sprayed *into* a crack, rather than *onto* a crack.

Tip about gable ends: If the contractors are sealing up the gable ends, make sure they check below the floor joist closest to each gable end. There can be a second access to the gable end beneath the joist where the wood strapping creates a gap between the joist and the ceiling below. Contractors in a rush sometime seal the top of the gable end and miss the gap below the joists. The heat can still escape out this smaller gap.

If you want to avoid this whole problem, just fill the walls in your home with dense-packed cellulose. It will stop the heat leaking out, can

### Gable end cap



The gap in the framing for a gable end is sometimes quite obvious.

reduce the risk of a catastrophic fire, and will insulate a large part of your home.

### How to know the pros did a good job

They should check any air-sealing work with the blower door and a smoke puffer. A smoke puffer is a device that when you squeeze it, a small puff of visible smoke comes out.

The blower door will increase any drafts so much that any remaining crack will have a

**Smoke coming from puffer**



tiny tornado of wind rushing through it toward the blower door. If a crack remains from the air-sealing work they did, the wind will whip the smoke from the puffer away. If this happens, the contractors should turn off the blower door and fix the crack, then re-check their work.

If there are no cracks remaining, the smoke from the puffer will hang in the air for a moment above the area that has been air-sealed before dissipating. In this case, thank the contractors. They did a great and honest job and helped you a lot.

If you don't want to go into the attic to see the puffer test results or examine their work,

the contractors instead could take cell phone photos to show you what the problem was like before and what their solution looked like afterward. Make sure they photograph all four sides (if it's possible).

These types of holes are big holes. If the air-sealers do a pre-work and post-work blower door test, then the post-work CFM number should drop by several hundred (see below for more info).

### **Insulation**

If they install insulation along the side of a change in ceiling height, you could check their work in two ways:

- You could go up into the attic to check the insulation is installed evenly and neatly. Make sure there are no holes in it, that it is contiguous with the air barrier, that the insulation is fluffy and not crumpled. If the insulation is installed on more than one side of your attic's topography, check that the insulation is evenly installed across every side. For more information on insulation, check out our "Attic Insulation" chapter.
- They could take photos of the insulation on every face they install it so you could check the photos rather than going up to the attic.

### **Five important points about blower doors**

Blower door technicians will throw around a lot of terms with great confidence as though of course you understand them.

To understand the essential concept of a blower door, think of a water pump in a boat. If the boat is really leaky, the water pump will have to pump harder to keep up with the incoming water.

The blower door is basically an air pump. How hard it has to pump to keep up with the air whistling into your drafty home is measured through CFM (cubic feet per minute).

**Point #1:** Bigger CFM numbers are bad. The larger the CFM number, the draftier your home is.

The average home has so many gaps and cracks in it that if they were all pulled together into one big hole, that hole would be the size of an open window.

You can divide your CFM number by 10 to figure out how many square inches your "window" is open (i.e., if the CFM is 3,000, then your window is 30" by 10". If it's 5,400, it's 54" x 10").

Your air-sealing contractors will work to close your window a bit.

**Point #2:** If your contractors are high quality, after they finish their work, they will turn the blower door on and check their work with the puffer.

Using the blower door and a puffer to check their work is the minimum you should expect from an air-sealing contractor.

**Point #3:** If your contractors are very good, before they even start their air-sealing, they will perform a pre-work blower door test. That way they will have the pre-work CFM number that they can compare with their post-work CFM to make sure they succeeded in closing your “window.”

(If they do this pre-work blower door test, check out the CFM number shown on the control panel of the blower door. Write down the number so you can check our point #5.)

**Point #4:** If your air-sealers are excellent, during this pre-work blower door test, they will search through your attic with a puffer to locate the very worst holes. Every home is different and surprising. Without this systematic search, they might make logical and experienced assumptions about where the leaks are in your home but still be wrong in their assumptions.

**Point #5:** During the post-work blower door test, the CFM number should be smaller than the pre-work test.

A 10% CFM reduction (i.e., from pre-work 3,000 CFM to a post-work 2,700 CFM) is a reasonable amount for a few hours of air-sealing work in a normal home.

#### Blower door



Here's a blower door installed in the exterior doorway, blowing air out of the house. The circled number on the manometer is the CFM number.

# knee walls



If you have a finished attic, you probably have a knee wall. A knee wall is one of those short walls (generally four feet tall or less) nestled into the slope of the attic ceiling. Frequently there will be some cupboards or a door the right size for a munchkin built into the knee wall so the residents can use the space behind for storage.

Sometimes a knee wall closet will exist that has an average-height door, but the back end of the closet slopes down precipitously into the slope of the roof.

Unfortunately, while contractors and residents generally remember the ceiling of a finished attic needs to be insulated, they frequently forget to insulate behind the knee wall. Since a knee wall can make up a significant portion of most attics, this oversight can have a large effect on your energy bills and comfort. During the winter, all that is between you and howling winter winds is some drywall and wood sheathing. During the summer, the attic heat transferring into your living

**Knee wall melt on roof**



space through this wall can make you miserable.

To make matters worse, there are vents built into the underside of most roofs to ventilate the attic. These soffit vents can allow outside air into the space on the other side of your knee wall. If the space between the floor of the knee wall and the ceiling of the level beneath is not blocked, that unconditioned air will then whistle through the joist bays for the

### Half-insulated knee wall



whole length of the attic floor to chill or heat the attic floor, as well as the ceiling of the level below.

Properly insulating a knee wall and air-sealing the area just under the knee wall (between the knee wall floor and the ceiling below it) is a very important task in terms of comfort and energy savings all year round.

### How to air-seal and insulate a knee wall

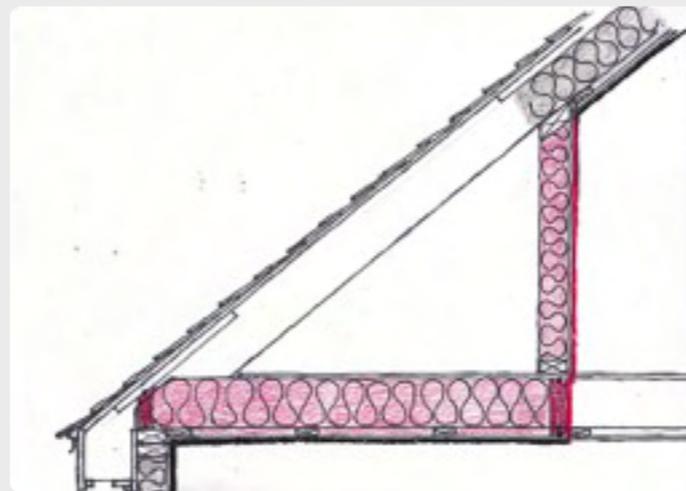
Building scientists will argue themselves silly about which air-sealing and insulation strategy is best with knee walls. The choices are either:

1. Insulate the knee wall and the floor of the knee wall space.

2. Insulate the roof slope down to—and including—the point where the slope connects to the exterior top plate. Also the gable ends (the triangular walls on either end) need to be insulated.

In general, without knowing the specifics of your particular attic, we prefer the first option since having the air barrier of the drywall contiguous with the insulation helps both insulation and air-seal barrier work more effectively.

### Knee wall cross-section



Here's how to insulate a knee wall.

### General steps to doing the work of the first option:

- The backside of the knee wall should be insulated. The insulation could be any

type of insulation (although we don't recommend fiberglass because wind from the soffits vents can wash right through it), but whatever type it is, it should have no gaps in it. Every bit of wall, no matter how hard to access should have insulation on it.

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**Tip:** If fiberglass batts are used, they should be installed with the paper backing facing the living space. This paper backing is an additional vapor barrier. A lot of contractors end up instead installing the batts with the paper facing toward the great outdoors, because handling the batts by the paper side is easier for them.

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- The door or hatch opening should have a gasket running around the frame to air-seal it when closed.
- The back of the door or hatch should be insulated.
- There should be a working latch that shuts the door or hatch tightly against the gasket.
- The floor cavity needs to be filled with insulation from the exterior wall of the house to the point where the floor meets the interior of the knee wall.
- Each bay between the joists under the knee wall must be blocked so it is airtight.

This can be done with any of these options:

- \* A garbage bag partly filled with fiberglass pressed into each joist bay and then air-sealed with spray foam
  - \* Dense-pack cellulose *tightly* filling the mouth of each joist bay (the contractor has to be conscientious to do this right)
  - \* Reflectix stapled across the face of each bay and then air-sealed in place with spray foam
  - \* Rigid insulation cut to size and pressure-fitted in place with the edges sealed with spray foam
  - \* Open cell or closed cell spray foam sprayed into the floor cavity
- If there is any hole in the framing at either gable end leading down into the conditioned space, these holes should be sealed also.

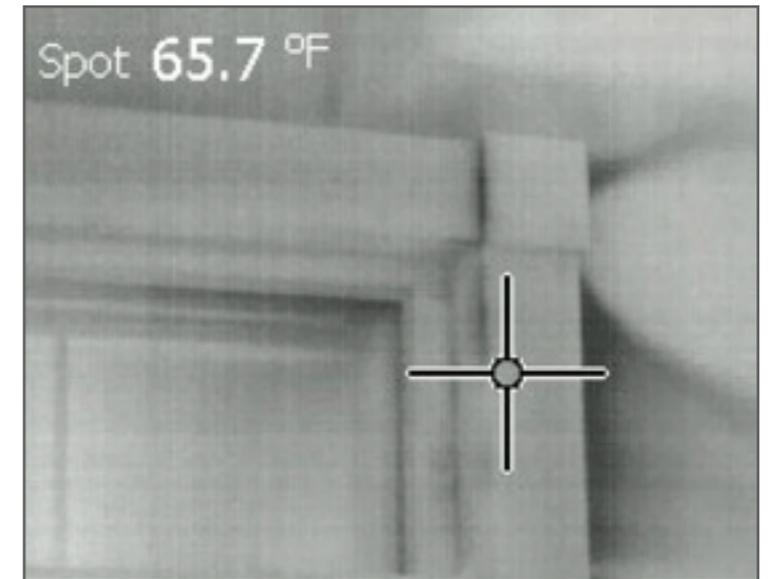
### How to know the pros did a good job

The contractors should check the seal around the knee wall hatch or door by turning on the blower door and using the puffer as described in our “Big Numbers” chapter. The smoke should not be blown away by any leaks around the door/hatch.

They should also test the joist bays under the knee wall are sealed tight with the puffer and the blower door on.

If you can, crawl behind the knee wall to inspect that the insulation has no gaps and that the joist bays beneath the knee wall are well sealed.

If you don’t want to—or aren’t able to—crawl behind the knee wall, then using a thermal camera to check the contractors’ work is another possibility. If the temperature outside is at least 15° different from the inside of your home and the contractors have a thermal camera, borrow the camera to inspect their work. If they have a blower door, have them turn it on while you examine the knee wall and the floor. The blower door accelerates any drafts. Through the thermal camera, these drafts will look like dark wisps of cold (unless it’s hot outside, in which case the wisps would be light).



If any part of the knee wall or floor nearby is a lot lighter or darker than the rest of the wall or floor, or if it has those dark wisps of cold trailing across it, then they might not have done a perfect job.

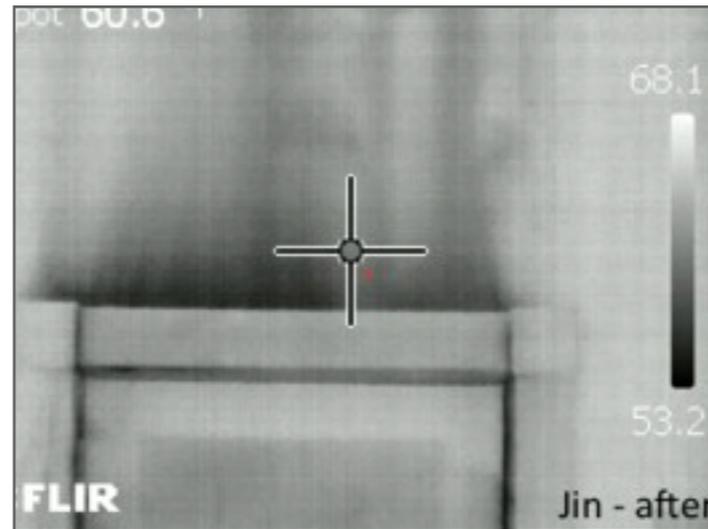
### About thermal cameras

There has to be at least 15° temperature difference between the inside and outside of a building to allow the thermal camera to show anything useful.

- The camera shows the temperature of the surfaces you look at. Anything dark is cold. Anything bright is warm.
- It’s important to remember the temperatures are shown *in comparison to each other*. So if you looked at the wall as well as a part of your hot radiator, the radiator will glow super hot and the wall will look

so dark you might assume it had no insulation behind it at all. If you adjust the camera so you don't see the radiator, the wall will suddenly look much warmer. If you want to be sure that you're seeing real cold, check the temperature bar shown along the side or bottom of the thermal image. It will give you the temperatures associated with the colors.

- A properly insulated wall will all be one uniform color except for the wood framing. Since wood has an R-value of only 1 per inch, it will transfer the outside temperature quickly making it darker if it's cold outside and lighter if it's hot outside.
- Once the sun has had a chance to hit a house for a while, the heat from the sun will reduce the thermal camera's usefulness. Try to use the thermal camera early in the morning or late at night before the sun's heat can soak into a wall.



### **Thermal cameras and ceilings**

Thermal cameras aren't very effective at checking the insulation job above a ceiling. Often the image is muddy and hard to read, because the warm air pools up at the ceiling. Thermal cameras are more effective at checking the wall insulation or the insulation in roof slopes.

If you had insulation blown across the floor of the attic, just have the contractors take a photo of it from inside the attic. They could take the photo with a measuring tape stuck into it so it's easy to tell the depth of the insulation. The insulation should look uniform and fluffy like a big field of snow and preferably you should see no joists at all.

# chimneys

**Chimney gap**



By code, nothing flammable can be within two inches of the masonry of a chimney. This is to ensure—in the unlikely event the chimney has large cracks in it—a fire inside the chimney can't set your home on fire.

This code means that the wood framing of your home has to be set back from the chimney on all sides. Since the chimney runs through every floor of your home and out into the unheated attic, this two-inch gap running all the way around the chimney is a superhighway for hot air to exit your home. On the average-sized chimney, this adds up to a two-foot by one-foot hole at the top of your home open all year round.

This gap is a lot of the reason why the snow on some roofs melts away from the base of the chimney long before it melts anywhere else on the roof.

Contractors can close this “window” with metal flashing and fire-rated caulking, to

stop the heat loss without causing a fire hazard.

## **What to look for**

If your chimney runs through the interior of your home, head up into the attic and pull back any insulation from the base of the chimney to look for a gap between the masonry and the wood framing.

If there is any type of flooring there, you won't be able to see or seal the gap at the point where it counts, which is at the ceiling of the story below.

You have to do your “sealing at the ceiling,” because floorboards have gaps between them. If you caulked the seams perfectly between all the floorboards for two feet around the chimney, the hot air would just leak out between the floorboards a few feet over. The heat loss would be inconvenienced, but not stopped.

In order to find and seal the gap, you or a contractor will have to pull back or cut away the floor enough to see the top of the ceiling of the floor below you.

#### Cutting flooring in attic



#### Flashing with small hole cut for wire



#### How the pros should air-seal around your chimney

The basic idea is to air-seal from the chimney to the ceiling. Since there can be a variety of immovable obstacles in the way (such as joists), these objects need to be incorporated into the seal.

When the joists run parallel with the side of the chimney, there are two gaps that must be sealed: the one *above* the joist and the one *below* the joist.

Because it's close to the chimney, the gap along the top part of the joist has to be sealed only with fire-rated materials: metal

flashing and fire-rated (intumescent) caulk. The flashing should butt up against the chimney.

Trying to be even safer than building codes, the Dept. of Energy requires that no flammable substance be used to air-seal within three inches of a chimney. Most gaps below the floor joist can be sealed with spray foam since they are generally more than three inches away from the chimney.

When the joists dead-end inside of the chimney, the flashing has to be bent neatly and tightly to create a continuous seal around the joists.

#### Sealing chimney gap



A joist running parallel with the side of the chimney. The top of the joist is sealed with metal flashing and fire-rated caulk. The gap below the joist is sealed with spray foam.

### Joist butting into flashing



Joist dead-ending in the side of the chimney means the flashing has to be bent around the joists to get a continuous seal.

3. Run a continuous bead of fire-rated caulk onto the joist before installing the flashing.
4. Staple the flashing to the joists. Since staples won't go into masonry, the flashing can only be butted neatly up against the chimney.
5. Caulk all seams and cracks within three inches of chimney with fire-rated caulk. Use enough caulk to fill the gap.
6. Spray foam or other non-fire-rated air-sealing materials can be used three inches or further from the chimney.

### Finished product: caulked and sealed chimney gap



Figuring out a plan to use all joists and obstructions to get a perfect seal takes patience and thought.

### Steps your contractor should take

1. Clean the surface with a dust brush to make sure caulk sticks to the surfaces rather than to the dirt.
2. Cut pieces of metal flashing to bridge the gap between the chimney and the joists. If there are any wires, cut small holes in the flashing for the wires to run through.

7. Spray foam below the floor joists if there is a gap between joists and ceiling.

### How to know the pros did a good job

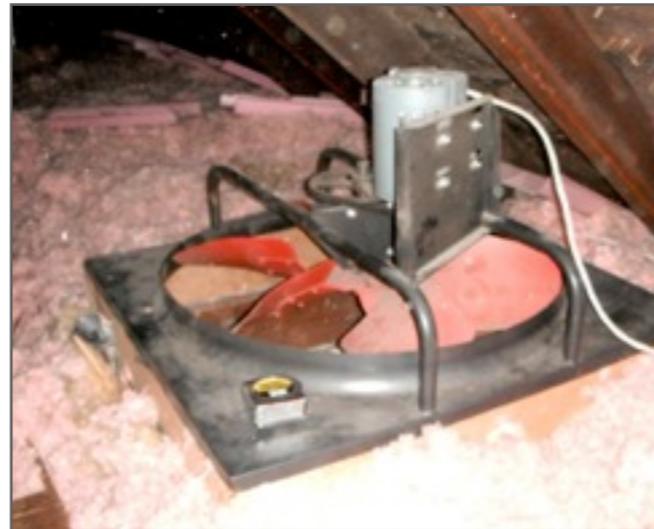
They should check the seal by turning on the blower door and using the smoke puffer.

If they show you photos of their work, make sure you get photos of what it looked like before they started, as well as after they finished, on all four sides of the chimney. Check that the crack below the floor joists has been sealed since it's the most likely thing to be missed by a new worker.

If the contractors do a pre-work and post-work blower door, the CFM number will generally (although not every time) go down by a hundred at least for sealing around a chimney.

# whole house fans

A whole house fan is a large fan mounted in the ceiling between the lived-in area of the house and the un-lived-in area of the attic. On a cool summer night turning the fan on can quickly pull the day's heat out of your home.



However in the winter, if your whole house fan is not sealed and insulated, it is a giant hole in the top of your home letting heat escape.

If you have a fan like this, air-seal and insulate it either by:

- Having contractors build a box out of rigid insulation to fit on top of the fan (up in the attic)  
OR
- Buying a damper (aka cover) that you install yourself on the underside of the fan (inside the living space)

From then on, every fall you will have to seal off the fan with the box or the damper. And every spring, in order to use the fan when the temperatures start to soar, you will have to remove the box or the damper.

A damper is easier to install and remove, because you can do it from inside the living space of your home. Unfortunately it doesn't insulate quite as well as the box.

To install or remove the box, you will have to go into the attic and walk across the attic to wherever the fan is. If your attic is hard to move around in, or you aren't comfortable standing on

joists, the box might not be the best method for you.

Make sure you choose a method that will actually work for you. The box or damper will do no good if you don't install it each winter.

### **How the pros should install a whole house fan box**

- The box is built of rigid insulation, with the sides of the box fixed in place by being screwed into the joists (of course how the box is built and secured depends on the configuration of the attic and the space available). The seams of the box are then sealed with spray foam from the inside and taped on the outside with foil tape.
- The lid is cut to be larger than the box so there is at least a 1" overhang on all sides. On the inner lip of the lid or on the inside of the box, a gasket is installed to air-seal the lid.

### **How to know the pros did a good job**

They should check the seal by turning on the blower door and puffing smoke out of a smoke puffer from inside the living space just below the whole house fan. If the fan isn't sealed well, the smoke from the puffer will be whisked away quickly. If this happens, they should fix their work and recheck it afterward with the blower door and puffer.

The post-work CFM number on the blower door should go down by a hundred or two at least.

### **How you can install a whole house fan damper**

- You can buy a whole house fan damper from [ConservationStrategies.com](http://ConservationStrategies.com). It will cost you somewhere between \$95 and \$110 and offers R-10 worth of insulation.
- Or here's a [slightly less expensive one](#) from BatticDoor that offers the lower R-value of R-8.

Follow the directions to install whichever model you choose. It will take just a few minutes to install.

### **Checking your work**

If you want to check your work after you install the damper, close all the windows and exterior doors in your home and then turn on every bathroom and kitchen fan, as well as the dryer, in order to slightly depressurize your home (the effect is akin to a weak blower door test).

Then wet your hands a bit and hold them around the edges of the damper to feel for a draft. Wetting your skin helps you feel air movement better. If you feel a draft, shift the

damper to seal that area a bit better, and then recheck your work.

# attic hatches and ladders



An attic hatch is a hatch through the ceiling up into an unfinished attic. Almost every building has one. Sometimes they are hidden in a closet.

Because attic hatches are at the top of your home, hot air loves to sneak out of them. Most times they aren't air-sealed or insulated and that small drafty hole in your attic insulation can have a large impact on how comfortable your home is during the winter and summer.

If instead of a hatch, you have an attic ladder—the kind where the ladder pulls down on a spring from the attic ceiling—then it's even more critical to get this attic access air-sealed and insulated. The plywood flaps that cover attic ladders are several times larger than hatches and tend to be very leaky.



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**Tip:** If you have a normal door and a real staircase leading up to your unheated attic, then keep the door shut. Weatherize it with Q-Ion and a door sweep, and insulate the attic side of the door with rigid insulation screwed

on with large washers (so the insulation doesn't rip off the screws over time). Professionals will do this work for you if you want. In several New England states, this work is free or rebated. Also, contractors should make sure the staircase walls and stairs are fully insulated.

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### **How a contractor should air-seal and insulate an attic hatch**

1. Install two layers of 2" rigid insulation on the attic-side of the attic hatch (so the insulation is not visible from the inside your living space). The added height of the insulation should not get in the way of the hatch being opened. Secure the insulation with screws and large washers.
2. Staple a gasket onto the frame that the attic hatch sits on, so that when the hatch is closed it firmly presses against the gasket air-sealing it.
3. Install a hook and eye on either side of the hatch to hold the attic hatch shut with pressure against the gasket.
4. On the attic-side of the hatch, use spray foam and/or caulk to seal any gaps between the framing of the attic hatch and the drywall below.

5. On the living-space side of the hatch, use caulk to seal any gaps or cracks in the trim around the hatch.

### **How the pros should check they did a good job**

They should turn the blower door on and, with the attic hatch closed, they should check for cracks they might have missed by squirting smoke out of their smoke puffer in several different spots just below the hatch.

If they find any drafts with the puffer, they should seal the crack and then recheck their work.

### **How to air-seal and insulate attic ladders**

Insulating and air-sealing an attic ladder is one job that you might be able to do for yourself or have a professional do. Here are directions on how to do the work yourself.

### **Order the item that will work best for your attic**

First measure your attic ladder opening and examine the area above the opening (from inside the attic) to see how much room there is for the operation of either a [Laddermate](#) or [Therma-dome](#). Order the item that will fit and will work best for your attic.

### **Installation**

To install it, follow the directions that come with the product to install it. The Therma-dome takes 30 minutes to assemble and install. The Laddermate takes about an hour to install and is a bit trickier.



### **Checking your work**

Close all the windows and exterior doors in your home and then turn on every bathroom and kitchen fan, as well as the dryer, in order to slightly depressurize your home. Wet your hands a bit and hold them around the edges of the flap covering the ladder to feel for a draft.

If you feel a draft, shift the Laddermate or Therma-dome to seal that area a bit better, and then recheck your work.

*The Therma-dome is a blast to install. It's like playing with Legos except it saves serious money. I put it in and did a blower door test to find it cut my CFMs by 10%. A huge difference. And it doubles the effective R-value.*

*If you have some insulation in your attic and a pull-down folding stairway, get one of these kits today. It could easily save you 10% of your heating bills.*

*- Jason*

# pipe stacks



Every home has a *pipe stack*. This is a pipe that exits the top of your building to allow air into the plumbing system. Without this incoming air, the fluids in your toilets and sinks would not be able to drain—in the same way that liquids don't drain out of a straw if you put a thumb over the top.

The pipe stack is important because it is in a pipe chase—a vertical tunnel for pipes that runs inside the walls of your building straight down to the basement.

**Pipe stack coming through minimal insulation**



This chase is connected to your bathrooms and kitchen.

The plumber who installs the pipe stack in your unheated attic will frequently cut a big hole in the floor of the attic, right through the ceiling below to allow him or her to install the pipe easily. The plumber then does not seal the hole. This hole allows the hot air in your home to run straight up the pipe chase into the unheated attic. This is bad.

### **What to look for**

Look around the attic for large pipes heading up through the roof. Generally the pipe stack will be above the kitchen or bathroom. Sometimes there is more than one pipe stack in a home.

Pull back the insulation around any pipes to see if there are any gaps or giant holes around them.

If you find a hole around the pipe's base, you should get the hole sealed.



Large wire chase shown from the attic looking down into the recesses of the building. Standing above it, it was easy to feel the heat gushing out of the building.

### Can't find the pipe stack?

If you are in the attic and can't see the pipe stack, it might be in a part of the attic you cannot get to or see. One way to locate the pipe stack is by walking around the outside of your building while looking up at the roof. It will be a metal or plastic pipe sticking up a foot or two out of your roof. Walk all the way around your home, because sometimes there is more than one pipe stack. When you see where the pipe stack(s) is (are), go back into the attic to figure out if you can access that area and check for holes around the base of the pipe.

### How the pros should air-seal around the pipe stack

There are many ways to do this, but using Reflectix and spray foam is one of the most common. Generally the steps are:

1. Clean the surface nearby so the spray foam will stick to the surface rather than the dirt.
2. Cut Reflectix or other material to cover the hole.
3. Staple the material in place.
4. Spray foam all the cracks around the material to seal every crack. The seal will be better if the foam is sprayed *into* a crack, rather than *onto* a crack.

### How to know the pros did a good job

They should depressurize house using the blower door and while the blower door is on, check that the patch is well sealed by using a smoke puffer. Because they probably can't access the bottom of seal around the pipe stack, they will have to check the seal from inside the attic.

If the smoke hangs out above the patch, the patch is working. If the smoke is sucked down into the patch to disappear, the patch needs work.

If you don't want to crawl into the attic to watch the results of the puffer test, then they could take cell phone photos to show you the pipe stack before and after their work.

Or if they did a blower door test before they started their work, compare the CFM number

of the pre-work blower door with the CFM number from their post-work blower door test to make sure the CFM number goes down afterward.

### Before and after sealing a pipe stack



See our [photos](#) showing how to seal around a pipe stack.

# recessed lights



Recessed lights on the top heated floor of your home are a bad idea. Don't install them if you have the option.

The lights are recessed because their electrical cans are actually inset into the space above—in this case into the unheated attic. Unless these cans are rated as *Air Tight*, they have small gaps or cracks all around the can, letting heated or cooled air from your home escape into the attic.

When the light is on, the heat from the light bulb will actually speed up the stack effect, becoming a tiny engine to remove heat from your home.

Also the metal cans of many recessed lights get so hot when the light is on, they can be a fire hazard, so by code most recessed lights can't have insulation within three inches of them. This means not only that they are drafty little chimneys, but they also create a sizable hole in the insulation around each of them. A few, called *Insulation Contact*

are designed well enough that insulation can be right up against them without any danger.

If you have any recessed lights in the top heated floor of your home, you need to check if they have a label showing they are rated as ICAT (insulation contact, air tight). If your lights aren't labeled this way, you have a problem.



A recessed light can from the attic. The smoke from a red and black puffer is being sucked into the wiring hole during a blower door test.

To search for the ICAT label:

1. Take out the light bulb.
2. If you can't see the labels and information printed inside the can, gently remove the interior trim of the light. Generally it will twist off or just pull down on a spring. Be gentle; the spring or hook can break.
3. Examine the labels and information printed on the inside of the can to see if the light is rated as ICAT (or potentially just as IC or AT) or if instead there are warnings about fire risks.
4. If you aren't sure what the can is rated for, you can always search the manufacturer and model on Google to double check.

If your recessed can is not ICAT, there are several possible solutions ranging from partial solutions that you can do yourself, to more comprehensive solutions that you might need a contractor for.

- Install an [air-tight collar](#) inside the fixture. To install, just unscrew the light bulb, put the collar in around the socket and screw the light bulb back in. No need for any tool or electrician. Make sure to get the right-sized collar for your recessed can; i.e., if you have a six-inch can, get a collar for a six-inch can. This will make the light fixture airtight, but

won't solve any problem with insulation if the can isn't rated IC for insulation contact. Still, the collar is better than nothing and costs between \$3 and \$20 each.

- You can also install an [LED retrofit kit](#). To install them, mostly you just screw them into the light-bulb socket. If you caulk the trim to the drywall, you have an air-tight can. Again this won't do anything about solving the potential insulation contact problem with the lights, but at least with an LED your electricity use will decrease as well as the draft through the recessed can. LED retrofit kits cost between \$53 and \$66 each. If you like these kits but they seem pricey, check their prices every once in a while. Sometimes, especially near the end of the year, the utility companies will rebate them a lot.
- Install these [can hats](#). They can just be dropped on top of the recessed lights from within the attic. They air-seal the fixture and are fireproof, allowing insulation to be piled up on top of the hat.
- Hire a contractor to build a five-sided box around the light from 1/2" sheet rock and seal it to the attic floor with spray foam. The box must have a three-inch space from all sides of the light.



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**Note:** These hats are so good at insulating that they can result in heat build-up in the fixture, which can cause some temperature-sensitive LEDs or CFLs to flicker off. If this happens, install LEDs or CFLs that are rated for temperature extremes.

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- Hire an electrician to switch out your recessed can lights for ICAT recessed cans. If you have a lot of recessed cans on your top floor, this is the best solution but can get rather expensive. Prices per ICAT recessed cans are between \$7 and \$80 each, not counting the installation cost.
- Hire an electrician to take your recessed cans out and install light fixtures that are flush with the ceiling. Then you don't have to worry about the stack effect or insulation voids. Light fixtures that are flush with the ceiling can cost as little as \$10 each.

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**Note:** Many utility programs won't perform this work because rewiring lights is so expensive.

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# insulating ducts



You wouldn't wear a metal sweater in the winter. It wouldn't keep you warm.

You shouldn't send your heated air through metal tunnels in a freezing attic or crawlspace, either. You will lose a lot of the heat.

Of course the converse is true also. During the summer, don't send air-conditioned air through a metal tunnel in a sweltering attic or crawlspace.

The new National Building Code requires R-8 insulation around ductwork in unconditioned spaces whether those ducts are for heat or air conditioning. Make sure the ductwork in your attic and crawlspaces is insulated.

And of course, before the insulation is installed, make sure the ductwork is sealed perfectly.

This can save you **up to \$714 and 5,681 lbs. of CO<sub>2</sub>** over a decade.

Please note that these energy savings assume you don't have central air condi-

tioning and that your ducts are in a crawlspace. If you have central air and/or your ducts are in the attic, your savings from doing this work are likely to be larger than our estimates.

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**Tip:**

From all we can learn, Reflectix (tin-foil covered bubble wrap) doesn't deliver the R-8 rating it promises. However it's hard to find R-8 fiberglass duct insulation. If your contractor wants you to choose between R-8 Reflectix and R-6 fiberglass insulation, our suggestion is to go for the fiberglass.

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## **What the pros should do**

### **Air-sealing ducts**

The ducts should be well sealed to help the insulation work effectively. Make sure the contractors first:

- Close up all gaps between the ducts
- Install duct sealant on all seams

See our “Sealing Ducts” chapter for more information on how and what should be done.

### **Insulating ducts**

- Every duct in an unconditioned space in your home should have a foil-wrapped sleeve of insulation all the way around it.
- Each foil sleeve should fit snugly around the duct, have no holes or gaps in it and be taped tightly to the metal duct at both ends.
- If the insulation is made of fiberglass, the fiberglass should be completely covered by the foil sleeve.
- The insulation should be at least R-6 and preferably R-8.

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**Note:** In a retrofit duct insulation job, it may not be possible to get insulation on all sides of the duct in which case the contractors can only nail the insulation in on three sides.

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### **How to know the pros did a good job**

#### **Air-Sealing**

They should check their air-sealing work afterward by turning on the furnace and using a puffer or toilet paper to search for leaks. The toilet paper or smoke from the puffer will

be blown away or sucked toward any seam that is leaking.

Alternatively if they have a duct-blaster (a tiny blower door especially for checking out ducts) they can use that to check that the ducts are leaking less than they were before.

Remember they can take cell phone photos to show you their work before and afterward.

#### **Insulating**

If you can get into the area where the ducts are you should visually inspect them, especially the sides of the ducts that are harder to get to.

If that isn't possible, then the contractors can take cell phone photos to show you their work before and afterward.

# attic insulation

Because humans can see only the visual spectrum (i.e., colors) and not the infra-red spectrum (i.e., heat), they are literally blind to the problems of having no insulation. They don't understand that adequate insulation could dramatically slow down heat loss in their homes.

Many New Englanders especially think winter is supposed to be uncomfortable. They pay huge heating bills to live in drafty homes where some rooms are cold and some overheated, and the air throughout is uncomfortably dry from the heating system roaring constantly.

They could get insulation instead!

## **Energy savings**

When you look at the stock market, a great investment will generally get you a 10% annual return. The average Dow Jones return is about 5%.

If your attic has not been air-sealed and has no insulation, then an investment in air-sealing and insulating will earn 14%

## **Roof insulation problems**



See our [photos](#) showing roof insulation problems.

per year and that investment --unlike the stock market-- will keep you more comfortable in your own home while hurting the planet less. (This price is assuming you have an average heating bill of \$1,112, your attic is 1,000 square feet and the air-sealing and R-38 of cellulose insulation costs \$1.67 per square foot).

If you're lucky enough to live in Massachusetts, a state with an instant rebate for insulation, the total bill for that work

and materials would cost you only \$396 --a 56% return per year.

Be one of the smart ones. Use whatever rebates exist in your state before they go away. It's what Warren Buffet would do.

### **Benefits of insulation**

- Reduces drafts and increases comfort
- Keeps your home a more consistent temperature
- Keeps the air in your home less dry during the winter
- Reduces street noise (if the insulation is installed in the walls)
- Reduces your carbon footprint
- Means you don't have to wear mukluks all winter long to keep your toes warm

And after all what would you rather do with your money?

1. Give it to foreign fossil fuel dictators
2. Improve your home by hiring local green-job contractors

Make sure before you get your attic insulated that you get it air-sealed. Even if the insulation is supposed to air-seal as well as insulate, it's better to ensure all the big holes are sealed first. Once the insulation is added, everything is buried under piles of insulation

and finding a problem, much less fixing it becomes more difficult.

### **How to inspect attic insulation**

In New England, you should have at least R-38 (and R-50 would be better) in the attic. If you haven't already, read about how to inspect insulation in our "Inspecting Your Attic" and "Finding Treasure in Your Attic" chapters. Then go up into your attic to see the thickness of your home's sweater for yourself.

You want to make sure you have at least R-38 worth of insulation, that there aren't large holes in the insulation or big uneven spots and that it isn't wet.

### **Possible problems**

**Uneven insulation** can be raked or moved so it lies more evenly. Wear a P95 dust mask and gloves to do this work.

If you suspect the insulation might be rock wool or vermiculite, you shouldn't do the raking. Get a professional. They have the proper safety equipment to take care of the situation.

**Wet insulation** will transfer cold into your home faster than if there were no insulation there. Imagine how fast you'd get cold wearing a wet sweater. If insulation gets wet, you need to get it removed and replaced, as well

as solve the problem that made the insulation wet in the first place.

**Not enough insulation** is the simplest concept here. Think of the difference between wearing thin pajamas versus a full-body parka outside on a windy winter night.

Like clothing, different types of insulation offer different amounts of warmth. This is measured through their R-value per inch.

Measure the thickness of the insulation and figure out what kind of insulation it is. Then consult the chart below to figure out if you have a thick enough sweater for your attic. If there isn't enough insulation, you should have more added.

### **Attic insulation - recommended thicknesses**

For a lot more information about the different types of insulation, see the next chapter.

### **If your heating or cooling system is in your unfinished attic**

You probably want to insulate the attic ceiling above your heating or cooling system. This keeps your heating and/or cooling system inside the comfortably heated or cooled space, allowing the mechanicals to run much more efficiently.

In this case, you probably want to use spray foam for the insulation, since it sticks easily to rafters.

Spray foam is also usually the better solution in tight finished attic spaces such as you find in Victorian homes or homes with Gambrel roofs.

### Attic insulation - recommended thicknesses

Material	Recommended thickness	Appearance	Notes
Fiberglass	15" – 54"	Pink cotton candy	The effective R-value depends enormously on how it's installed. Make sure it isn't crumpled or compressed.
Cellulose	10" – 12"	Fluffy hamster cage bedding, generally grey in color	Non-flammable, nontoxic, unattractive to vermin, made from recycled newspaper
Open-cell spray foam (such as <u>Icynene</u> )	10" – 11"	Melted blobby foam	Great air-sealer and good insulator. Flame resistant, but not non-flammable. In any inhabited or occasionally used space, needs an ignition barrier such as drywall or intumescent paint.
Closed-cell spray foam	6.5"	Melted blobby foam	Great air-sealer and the best insulator per inch. In any inhabited space, needs an ignition barrier.
Rock or mineral wool	13"	Slightly matted yellow, white or grey cotton candy	Nonflammable



Here spray foam was installed along the underside of the roof, but the installers didn't sweep the old cellulose along the attic floor out of the way first. This meant there was an eight-inch gap in the foam all the way around the roof.

### How to check whether the insulation was installed well

- **Fiberglass** should not be wrinkled or jammed in or compressed. There should be no holes. It should be flat against the surface being insulated. If there is a paper side to the batt, the paper side should be facing the lived-in space of your home.
- If several layers of fiberglass are installed so that the level of insulation rises above the joists, then instead of running the layers from the front of the attic to the back, run them from one side of the attic to the other across the joists, to ensure the joists get covered.

- **Cellulose** should be installed evenly and look like a flat field of greyish snow. It should not be squished flat by boxes sitting on top of it or footsteps through it. There should be no holes or lower spots.
- **Foam** should be sprayed on so no voids get created as the foam expands.

### Types of insulation



See our [photos](#) showing different types of insulation.

If possible, the bottom face of each wood rafter should be covered too, to create a thermal break (i.e., stop the cold or heat from outside being able to be transferred along the wood into the inside of the house). The R-value on the rafters should be brought up to at least R-10.

The thickness of the foam can be confirmed by poking it with a wire made from a wire clothes hanger.

The most likely place a contractor will cut corners is where the slope of the roof meets the space between the floor joists. The foam *must* continue all the way to the ceiling of the story below. If there is old insulation (or dirt) in the way, it must be removed before the spraying begins.

Make sure there is no foam within two inches of the chimney.

To reduce the risk of fire, if the foam is installed in an occupied space, (rather than in an un-lived-in attic) any foam that isn't covered with drywall should be painted with flame-resistant spray paint.

### Problems to fix before you insulate Knob and Tube

Insulation contractors won't add insulation in homes with active knob and tube wiring for fear the insulation could get wet and form a connection and burn the house down. If you have knob and tube and want to add insulation, get an electrician to certify the wiring is inactive and show the certification to the insulator.

### **Mold or moisture issues**

If your basement floods or you have mold in the house or an unvented bathroom fan, you need to deal with these issues before adding insulation. You don't want to make your home more airtight if it has mold, or the potential for mold in it. And you don't want to get insulation wet because wet insulation doesn't work to insulate anymore (only closed-cell foam is resistant to moisture).

### **Crawl spaces**

If you have a crawl space in your basement that has a dirt or gravel floor (or if part of your basement has dirt or gravel) then you need to install a vapor barrier over the earth or gravel so the ground doesn't constantly emit moisture into your home. Some utility companies will do this work for you. The vapor barrier should be 6-mil thick plastic. Any seams should overlap 6" and be taped shut. The plastic should go up the walls of the crawlspace at least 6" and be sealed to the walls.

### **Vermiculite**

Most professional insulators will demand that all vermiculite is cleaned out from your attic, before they will add new insulation. Make sure, if you agree to this, the person is licensed to do it, has the proper equipment and keeps your living space sealed off from

their work area. You don't want to potentially spread cancer-causing asbestos throughout your home.

### **Flat roof**

If you live in a house with a flat roof, your attic cap is probably sloped so that the far short end is only one to two feet tall. For contractors, it's very hard and claustrophobic to get in there to insulate, much less air-seal.

You might have to search hard to find a contractor to do this work since most contractors don't want to take this on.

If you can't find someone to air-seal your flat-roofed building, then at least install insulation in there. We recommend open- or closed-cell foam since it both insulates and air-seals. Alternately you could install at least 12" of cellulose, since as it settles over time, it air-seals.

Or next time you replace your roof, you can have the contractors add six to eight inches of polyisocyanurate foam board under the roof.

### **Estimate your savings**

Use our [attic insulation calculator](#) to estimate your potential savings. The calculator assumes you have no insulation and air-sealing in your attic at the moment. If you do have insulation or air-sealing, your

energy savings are likely to be less than this calculator predicts.



# wall insulation

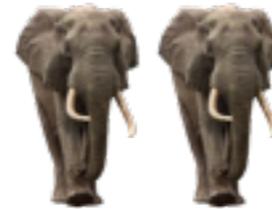
Although a few homes in New England have no insulation in the attic, many of them have no wall insulation at all.

If you don't have wall insulation, installing some will reduce your heating bill by 18% on average, decrease drafts and cold spots, increase your comfort a lot and reduce street noise.

*Average energy savings per decade:*

**\$2,143 and 17,042 lbs.**

(of course if you heat with oil or other expensive fuel, your savings would be much larger).



## **Different ways to check if your walls are insulated**

- A thermal camera is the most thorough way to check if you have insulation. Using one you can see right through the walls to check for insulation. You can rent thermal cameras now from Home Depot, but a professional energy auditor will cost almost

the same amount and be able to explain the camera's images. If you suspect you have spotty insulation, this is the best way to learn the truth.

- Email [Sagewell](#) to see if they will take a drive-by thermal image of your home. This will not give you information on every wall in your home, but the information can be extrapolated to the probable condition of the rest of your home.
- You can cut a small hole in the dry-wall running along an exterior wall in your home and peer into the hole looking for any fluffy insulation. (Probably you should cut this hole in the back of a closet somewhere so when you patch over the hole later on with plaster the patch isn't so visible.) Spot-check a few places in your exterior walls this way and hope that these spots are representative of the insulation status of your exterior walls. If you've had parts of your house remodeled, it is quite likely

that some parts will have insulation while others will be empty.

- Take the faceplates off a few outlets or light switch covers on exterior walls to see if there is a gap between the electrical box and the drywall that will allow you to reach into the wall cavity. If there is any gap there, then use a wood skewer to see if you can hook out any insulation. *Don't* use metal in case the electrician left any code violations that might end up shocking you. If you can't hook out any insulation from any of the exterior walls in your home, you probably have no wall insulation.

### **Thermal Imaging**

Thermal images show you clearly where your home is lacking wall insulation or proper air-sealing. Having an energy auditor with a ther-



mal camera come by to photograph your home costs a few hundred dollars, but there is now a way to get thermal photographs of your home for free.

[Sagewell](#) (and perhaps [Essess](#) soon) will drive by with very high-resolution cameras to take a thermal image of your home from the street, Google-street-view style. It will send you the image through a password-protected website.

The image is only of the front and sides of your home as they are visible from the street, but images (as they say) are worth 1,000 words and some of these images are worth even more than that.

Did we mention the service is free? (If Sagewell hasn't yet reached your area, request that it do so through its website. The company gets paid through a referral fee from any services you might request after seeing your image).

### **Installing wall insulation in a pre-existing home**

If your walls have no insulation, the contractors can generally add cellulose insulation by:

1. Taking off a few clapboards or a bit of siding at the bottom and top of your home.

2. Drilling a small hole through the sheathing at the top and bottom of the home into every stud bay.
3. Feeding a hose in and pumping insulation in to fill each stud bay from the bottom to the top.
4. Filling the holes they drilled with plugs.
5. Putting back on the siding or clapboards they removed.

In an average-sized home, the contractors will be gone at the end of the day and generally you will not even know they were there except your home will be a lot warmer in the winter and cooler during the summer.

### **Potential difficulties**

- Sometimes if the plaster in your home is uneven, thin or old, the contractors will have to take care they don't crack or break some of the plaster.
- If you have balloon framing, they will have to block the bottom of each bay in the basement to make sure they don't fill your basement with a sea of insulation by mistake.
- If the paint job on your wood sided home is old, they might chip flecks of the paint off when they remove some of the siding.
- If you already have some insulation, the existing insulation will block the cellulose from being added.

This technique of blowing insulation into an existing wall cavity (i.e., not having to first rip off the drywall to add insulation) is most common with cellulose insulation. Although we always hear rumors of [injection foam](#) or [airkrete](#) that can be poured into pre-existing walls, in our experience in the Boston area, it's hard or impossible to get contractors to do this work who really know what they are doing.

### How much is enough?

The Oakridge National Laboratory recommends R-21 for new construction. The Passive House standard is R-40.



Cellulose is made of shredded newspaper treated with borate.

If your home is already constructed, the width of the wall cavity is pre-determined. Some have as little as 3" of space inside the wall. You want to add as much R-value as possible into a limited area. Choosing the insulation with the highest R-value is definitely worth it in the walls.

### What kind of insulation to get

#### Cellulose

Material	R-Value per inch	Cost to fill in a 4" wall cavity
Cellulose (dense pack)	3.5	\$2 to \$3.18 per square foot

Cellulose is our favorite in general because it's safe for you and the planet, inexpensive and effective when applied competently. Also it can be added to existing buildings easily by pumping it into the wall, generally from the outside as described above. Thus there is no demolition or discomfort, or cost for rebuilding a wall or repainting.

Cellulose is made of shredded recycled newspaper treated with chemical borate so vermin won't nest in it and so it is nonflammable. Borate is a safe inert chemical used in toothpastes and laundry detergents. The resulting insulation is something mice will avoid and that will not catch fire.

Cellulose insulation is less expensive. If it's installed in an enclosed area—such as a wall or roof slope—it should be “dense-packed” at 3.5 pounds per square foot so air can't get through it and so it won't settle. Then it is not only an insulator, but also an air-sealer. Imagine wearing a worsted-wool sweater that's several inches thick; it will keep you warm.

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**Tips:** The best cellulose is the one that doesn't have ammonia sulfates.

Dense-packing cellulose in the walls might create dust, so people with asthma should stay away till the dust settles—which is generally by the end of the day.

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### Jason and the blowtorch

*A cellulose manufacturer once asked Jason, “Did you ever see me use a blow torch to melt a penny?”*

*“No,” Jason replied, a little hesitantly.*

*“Watch this.” He scooped about a two-inch-thick clump of cellulose into his bare hand and put a penny on top, like a cherry on a sundae. Then he lit his blowtorch.*

*“What are you doing?”*

*“Watch.” He turned the flame on the penny sitting in the palm of his hand.*

*“Hey, don't...”*

"Don't worry," The penny began to melt, but the cellulose just charred and didn't catch on fire.

"Jeez, turn off the..."

"Tada," he announced. The penny had turned to a liquid puddle—the penny sitting on his hand with only 2 inches of cellulose to protect his hand. The heat never made it to his hand. Cellulose is very fireproof.

If you want to see this yourself, Google ["Scorch a penny."](#)

## Fiberglass

Material	R-Value per inch	Cost to fill in a 4" wall cavity
Fiberglass	0.7 to 2.5 (depending on how well it's installed)	\$1.20 per square foot

Fiberglass is the worst.

It can't be added to a pre-existing building without taking down the drywall (unless it is loose fill fiberglass, a product currently so rare, we have never seen it). With conventional fiberglass batts, removing and then replacing the drywall adds enormously to the price of the job.

Also, vermin and mice love to nest in fiberglass. For instance, if you ever find mouse poop under your dishwasher, it's probably be-



Fiberglass batts should fit neatly in between the joists to fill up the space entirely. This is a very bad insulation job.

cause they are nesting in the fiberglass in the bottom of your dishwasher. Then they have a comfy bedding material and get rocked to sleep each night by the warm working of your dishwasher.

Fiberglass, as was said earlier, is what air conditioner filters are made of. Air moves right through it. Imagine wearing a sweater made of cotton candy on a windy winter day and you get the idea of the possible problems with this.

If it isn't installed well, it's R-value decreases *dramatically*. Make sure it isn't crumpled, wrinkled or jammed in. Make sure it's fluffed up. If it's on a paper-backed batt, the paper side should face toward heated space. Many

times, it is installed the other way around and that reduces its effectiveness.

Fiberglass is fire resistant.

## Foam

Material	R-Value per inch	Cost to fill in a 4" wall cavity
Open-cell foam	3.7	\$1.75 per square foot
Closed-cell foam	6	\$3.50 per square foot

Basically foam is a whip-cream dollop of petroleum lathered across the sides of your home. Although it is treated with flame-retardants, it catches on fire a lot more easily than fiberglass or cellulose.

The gases used to spray the foam out of the container can be horrible greenhouse gases that cause more harm to the climate than the savings in energy use will ever make up for. If you get foam installed, make sure to ask for water expellers instead. They should have this option for most types of open-cell foam and at least one version of closed cell foam.

However, in spite of all these negatives, it does offer the best R-value per inch and closed-cell foam is resistant to water. In a tight space such as a narrow wall cavity, or in the basement where it might get wet occasionally, there is nothing better.

Foam is a fantastic air-sealer. Imagine wearing a form-fitting beer cooler. You will stay warm.

Although you might be able to find a contractor who can install an injection foam that can be poured into an existing wall, most contractors prefer to apply spray foam once you've pulled the drywall off the inner face of a wall, adding to the cost of the job.

You can't be in the house without an organic gas respirator until the foam has cured for at least an hour. The foam will continue to off-gas for at least the next 24 hours but most of the dangerous fumes will be around for the first hour of installation.

To decrease the chance of fire in any living space, the entire surface of foam must be covered with an ignition barrier, such as intumescent paint or drywall. In a utility space (i.e., one that is rarely entered), open cell foam must have an ignition barrier. We recommend, no matter what kind of foam you use or in what kind of space, to use an ignition barrier.

### How to check the insulation

You can check that the insulation was installed well by looking at it with a thermal camera on a day when the inside of the home is at least 15° warmer or colder than the outside (and has been for a few hours). Make sure there are no voids in the insulation.

Check the areas especially above and below windows, bays and doors; many contractors will skip these areas.

### Homes with brick walls

If your building has brick walls, those walls will be very hard to insulate. The walls will wick moisture in through them, potentially wetting any insulation in contact with it.

Also it's prohibitively difficult to drill through brick, so you generally have to drill in through the drywall inside the house. Although these holes are filled with drywall plugs at the end of the work, the plugs are unpainted so most of the rooms need to be repainted.

In general, unless you are doing a major retrofit to your brick-walled home, installing insulation in brick walls is difficult to do.

### Basement insulation

#### Walls

Since basement foundations can leak, insulation below grade must be able to work both as an air-sealant and a vapor barrier. This can be accomplished with two to three inches of closed cell foam on the walls, since it is vapor resistant.

Closed-cell foam is especially useful if the basement is made of fieldstones (which are notoriously leaky when it comes to both air

and water). People who have gotten their basements foamed with closed-cell foam are able to get rid of their dehumidifiers.

The contractors should vacuum and dust the walls well before they foam. Otherwise, the foam will stick to any dust or cobwebs creating air pockets. These air pockets can let in cold air, decrease R-value and allow for condensation.

### **Band joists**

If a contractor is doing this work, make sure they spray the band joists too.

Make sure the band joists are completely free of dust and gravel. Stick your hand into the bay to check. Many contractors won't clean before they apply the foam, telling you the dust will be blown out of the way by the foam. It won't. The spray will stick to the dirt and then lift upward as it sets, leaving an air pocket that lets cold air sneak in. Cleaning out the bottoms of dirty band joist bays before the contractors begin to spray is important preparation for spray foam. If you have to, do this part yourself. Wear a dust mask and vacuum it out.

The foam must fill the entire rectangle at the back of each joist bay (see picture for how to spray a band joist badly). The correct technique is to "picture frame" the back of the rectangle so the foam gets into the cracks, then fill in the middle of the rectangle.

Ideally you want R-20 in the band joist bays and in the basement walls.

### **Floors**

If you have the money to do it right, you can spray an inch and a half of closed cell foam onto the floor and then cover it with a couple inches of cement.

### **Estimate your savings**



Use our [wall insulation calculator](#) to estimate your potential savings.

Unfortunately, the calculator is only accurate if you have no insulation in your walls at the moment. If you do have insulation, your energy savings will be less than predicted by this calculator.

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**Important tip:** If you need wall insulation, you might hesitate after seeing the price. Here's a way to make it a lot easier on the pocketbook.

If you have rebates for insulation in your area and there is a cap on how much any home can get per year, find out if you can get the rebate every year. If so, fill in two walls in your home this year, then on January 1st, fill in the other two walls. You will have doubled the amount of rebate you can get and actually accomplished the work that you would not have been able to afford otherwise.

Wait another year and then insulate your basement too. This is a great way to achieve energy efficiency in an economically efficient way.

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# how to find a great contractor

## **Before you hire**

Before you hire a contractor, make sure to check out the rules and process in your state for receiving the available rebates and services.



Sometimes the service is rebated in your state, but in order to get the rebate you have to choose a contractor from a pre-approved list. Before you get the work done, learn what the rules are to ensure your energy-efficiency dollar goes as far as possible.

Here are some general principles to consider when selecting your contractor.

## **Your checklist for hiring an air-sealer**

- Do they have a blower door and smoke puffers and will they check their work afterward using the blower door and puffers?
- Will they show you photos of the work before and afterward so you don't have to crawl into the attic to inspect what they did?
- Ask them why they went into air-sealing. They might not be highly motivated to do the best job if they answer something along the lines of, "Because my cousin offered me the

job,” or, “Because it pays better than working at the 7-11.” They are more likely to do good work if instead they answer something that suggests they get satisfaction from their job, for instance, “Because I like to save folks money,” or “Because I want to fight climate change,” or, “Because each home is a mystery that I love to solve.”

- ☑ If your contractors are very good, before they even start their air-sealing they will perform a pre-work blower door test. That way they will have the pre-work CFM number that they can compare with their post-work CFM to make sure they succeeded in closing up gaps that matter.
- ☑ If your air-sealers are excellent, during this pre-work blower door test they will search through your attic with a puffer to locate the very worst holes.

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**Note:** Some contractors are what are called *groundhogs*. They stick their heads up into the attic like a groundhog looking out of its burrow, take a glance around and then come down to say everything is fine. Make sure they go up there to check around and do the work.

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### **How to choose a good insulator**

- ☑ Do they have a thermal camera and will they use it before and afterward?
- ☑ Can you look through their thermal camera too to check the work?
- ☑ Do they mind if you get an independent auditor to inspect the work afterward? (You might have no intention of doing so, but even suggesting this as an option is an effective way of helping your contractors to do their best.

### **How to help a contractor do a good job**

- ☑ Tell them where it's drafty or cold.
- ☑ Show them a year's worth of energy bills.
- ☑ If you can, have the attic holes marked with duct tape on the rafters and/or have photos of any problems in the attic to show them.
- ☑ If you can, get the work done off-season. Weatherization contractors are very busy from September to April. By asking for the work anytime from May to August, you will get grateful contractors who can take the time to do it all right. The only downside is because the temperature inside and outside of the home is likely to be the same, it's harder to

check the insulation work with a thermal camera.

- ☑ Clean up the areas where they will be working so they can work easily.
  - If it's hot, give their workers water and let them use the bathroom.
- ☑ In the hot season, let them start early in the morning while the attic is cool.

### **When they've finished**

Working in an attic is hard and uncomfortable work. They don't get paid very well.

If they did a good job, don't forget to say a warm thank you. Let them know they've helped you. That will help motivate them to do a good job for the next customer too.

# rebates, services and tax credits



Rebates, services and tax credits change frequently. In the list below, we explain the basics about each program and then give you contact information so you can get the up-to-date information.

First we list the federal offers, then the state programs for New England.

## Federal programs

### Low-income

There is free energy-efficiency work available to those who are considered low income. You can potentially get free insulation, air-sealing, furnace upgrades, free appliances, and/or other work. There are some rules attached, but the rewards are intense.

Check with your local Community Action Agency (strangely abbreviated to CAP agency) to see if you are eligible. You can look up your CAP agency [by state](#).

The CAP agency will explain the rules and how you can best access the programs. Generally you have to prove you are low income through already being qualified for either:

1. Fuel assistance or
2. A discounted rate on your utility bill.

If you have the choice, apply for the discounted rate through the utility company.

It's often an easier process than getting qualified for fuel assistance.

If you apply for fuel assistance through your CAP agency, then when you apply, please bring as much of the following as you can:

- Names and social security numbers of all people living in your household
- Proof of gross household income for the last 3 or 12 months. (Household income includes, but is not limited to: wages, social security, unemployment, pension, and disability payments)
- Proof of present address (for example, a rent receipt, lease, deed, or property tax bill)
- A recent copies of your electricity and heating bills
- Proof about the type of fuel used to heat your home (natural gas, heating oil, propane, wood, etc.)

#### **Other federal low-income programs**

- [LIHEAP](#) (Low Income Home Energy Assistance Program)

The program is for buildings with 4 households or less in it.

- [LEAN Multifamily](#) (Low Income Multifamily Retrofits)

The program is for buildings with 5 units or households or more. The building must be owned by a non-profit, a non-profit-controlled entity, or by a public housing authority.

## **Connecticut**

Check the DSIREUSA website for the most up-to-date information on Connecticut's [residential incentives and services](#).

#### **Low-income programs**

Your [local CAP agency](#) can help you through the process of qualifying for the programs. The income-eligible program in CT has a simple name: Home Energy Solutions – Income Eligible ([HES-IE](#)). HES-IE is wonderful because income-eligible applicants not only get the below-described energy assessments and weatherization for free, but they also may get insulation and upgrades to energy star appliances! Opportunities this awesome should be sung from the rooftops. You can of course also qualify for LIHEAP and WAP.

---

#### **NOT low-income programs**

[Home Energy Solutions](#) is funded by the Connecticut Energy Efficiency Fund, through a surcharge on utility bills of all citizens of CT. The most you should have to pay for one of their assessments is \$75 (non-subsidized assessments normally cost between \$300 and \$500).

## Services

Home [Energy Assessments](#) which include a blower door test, work to reduce drafts (air-sealing) and installing low-flow showerheads, faucet aerators and CFLs. Connecticut has a separate program for buildings with five or more homes in them: the [Multi-family program](#). For more than the normal Home Energy Solutions assessment, there is the [Home Performance with Energy Star](#) program component.

## Rebates/Incentives

Sometimes hundreds of dollars are available for new construction, as well as some high-efficiency cooling and heating systems, various heat pumps, and gas-powered tankless water heaters. Also see rebates for replacement of certain inefficient appliances with qualifying energy-efficient models, and for multi-family clothes washers. To reduce your taxes, take advantage of some 100% property, sales, and use [tax exemptions](#) for renewable energy technologies including solar, biomass, landfill gas (!), wind, geothermal, hydroelectric, and others. Up to 50% of your project cost may be covered if you install a [solar hot water system](#) that produces over half of your household's hot water needs.

## Loans

Local [PACE loans](#), sometimes 0% interest loans, low interest loans of \$2,500-\$20,000 for improvements from the [Residential Energy Efficiency Financing Program](#). Between \$400 and \$60,000 loans available from the [Energy Conservation Loan Program](#) for 0-6% interest with repayment of up to 10 years, all dependent on location, building, family size, and income.

---

### T i p

You can choose your contractor, or they will pick one for you from this [list](#).

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## Contact

- Home Energy Solutions at 1-877-947-3873 to ask questions or schedule an appointment, or [sign up](#) online.
- Also see [CTenergyinfo.com](#) and [CTSavesEnergy.org](#).

## Maine

Check the DSIREUSA website for the most up-to-date information on Maine's [residential incentives and services](#).

### Low-income programs

Your [local CAP agency](#) can help you figure out if you qualify, and help you apply:

- The [Weatherization Program](#) (provides insulation, air-sealing, and/or safety related repairs)
- 

### Not low-income programs

[Efficiency Maine](#) is the state-wide program funded mostly by the Efficiency Maine Trust through a surcharge on utility bills, renewables, as well as some grants, the American Reinvestment and Recovery Act (ARRA) and the Regional Greenhouse Gas Initiative (RGGI). It started out as closely related to the Public Utility Commission, but in recent years transitioned to its current existence as a department of the State of Maine. Efficiency Maine works through hundreds of qualified private contractors.

### Services

Efficiency Maine has a lot of options to talk about; their funding is sometimes reduced,

but they spread out what they do have. The program starts with an energy assessment which may be free, or may cost you some, depending on which contractor you choose. There is also a program for buildings with five or more homes (households or units), the pretty all-encompassing [Multifamily Efficiency Program](#).

### Loans

[PACE](#) loans of \$6,500 to \$15,000 for energy efficiency, weatherization, and solar hot water, PowerSaver loans of up to \$7,500, and between \$7,500 and \$25,000 –all with 4.66% fixed rate. Not every town has passed a PACE ordinance, but you have options to circumnavigate that. There are some other “local” loan programs you should also take a look at, on the [DSIRE website](#).

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### Tip

Here’s a [nice video](#) showcasing a special project in Maine that will give you an idea of how energy assessments work out. (You probably won’t have a community-wide week-long event or an open house afterward, but if you feel inspired, you sure can!)

---

### Contact

Efficiency Maine at [efficiencymaine@efficiencymaine.com](mailto:efficiencymaine@efficiencymaine.com) or 866-527-7283 to ask questions.

## Massachusetts

Funding is often flux. For the most up to date information, please go to the DSIREUSA website for [Massachusetts residential incentives and services](#).

### Low-income programs

Your local [CAP agency](#) can help you figure out if you qualify, as well as help you to apply. If you qualify for these programs (see the income chart when you follow these links), you can get a bunch of work done for free! There is the Weatherization Assistance Program ([WAP](#)). WAP provides up to \$7,500 of air sealing, attic insulation, wall insulation, floor insulation, pipe and duct insulation, and some other services - free of cost to you. The Heating Emergency Assistance Retrofit Task Weatherization Assistance Program ([HEART-WRAP](#)), is a support service for income-eligible people’s heating systems; used during the winter as an emergency program, it operates all year long to repair or change out faulty systems). Call the HEATLINE at 1-800-632-8175.

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## NOT low-income programs

[Mass Save](#) is the state-wide program run by utility companies (not always available for municipal power customers). It is funded by an energy efficiency surcharge on everyone's utility bills. You have already paid for this program. You might as well use the funds, right? Get your home energy assessment ASAP – even if you're a renter, even if you've had one in previous years. You can do this every single year, and should definitely do it at least once every 4 years because technologies and programs shift.

## Services

No-Cost Energy Assessments which include the assessors performing air-sealing, installing no-cost programmable thermostats, CFLs, and water saving measures like aerators and showerheads (maybe even an LED). There is also an electrical efficiency [program for commercial buildings](#) and a program for [buildings with five homes in it or more](#) (also known as a Multi-Family program, as buildings with five or more homes are considered “multi-family”).

## Rebates/Incentives

You can get rebated an amazing 75% of the cost of weatherization up to \$2,000. You can get these rebates every year, so get the maxi-

mum rebate you can every year. Get your attic insulated Dec. 31st, then your walls insulated on Jan. 1st. Lots of other energy efficiency and renewable rebates and tax incentives can be found on [dsireusa.org](#). Your energy assessor will also provide you with information about which are available for your needs.

## Loans

Mass Save 0% interest HEAT loan - for installing insulation and changing out inefficient fridges or other appliances (our favorite MA loan), PACE loans, other state loan programs, local loan programs.

## Tips

When you sign up for an assessment, you can choose your contractor from a pre-qualified list, or you can just get assigned one.

Either way, if you are a Massachusetts resident, *we hope you'll tell them HEET sent you*, because sign-ups help our small non-profit stay in good standings with our Mass Save partners, and sometimes those sign-ups even generate some funds to help keep us afloat.

The best way to do this is to sign up for

your assessment through [our webpage](#). If you are in charge of a building with five or more units, you can instead email [heet.cambridge@gmail.com](mailto:heet.cambridge@gmail.com) with your information (contact phone number, address, number of units in building) to sign up and we will ensure you get the help you need.

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## Contact

MassSave at 866-527-7283 to ask questions or schedule an appointment.

## New Hampshire

For the most up to date information, please go to the DSIREUSA website for [New Hampshire residential incentives and services](#).

### Low-income programs in NH

Your local CAP agency can help you figure out if you qualify, and help you through applying. Here is the list for [NH agencies](#).

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### NOT low-income programs

[New Hampshire Saves](#) is the over-arching energy efficiency organization that unites NH utility companies and the Public Utility Commission, which is funded by a usage-correlated energy efficiency charge on utility bills throughout the state. The website for NH Saves will give you a basic understanding of the program, but mostly you'll need to go through your own utility company to see the intricacies of the program in your area (see the contact paragraph at the end of this here NH section – we did our best to direct you to their energy efficiency departments).

### Services

NH Saves' Home Energy Solutions program consists of home [energy assessments](#) through Home Performance with Energy

Star, which are offered with first priority to those buildings with higher than average heating fuel bills, who are likely in need of weatherization. They only cost the low fee of \$100 across the board in NH, which is great compared to the \$400-500 that some other states require. Alternatively, the [Energy Star Homes](#) program exists to help those who are building homes do so with the most effective efficiency in mind, with technical and project support of an Energy Star contractor, and incentives. [Energy Star Lighting](#) program works with local retailer to reduce the cost of efficient lighting; see the next section for details. If you want or need help shopping for electrical efficiency items, you can check out NH Saves' new [online catalogue](#).

Small businesses with monthly usage of less than 100kW of electricity can take part in NH Saves' [Small Business Energy Solutions](#) program which basically involves an energy assessment, and then help paying for any electrical improvements they'd like to make. New Hampshire Electric Co-Op has a [Large Business Energy Solutions](#) program. More comprehensive for all businesses is the NH Electric Co-op's [SmartSTART program](#), in which businesses can get weatherization, lighting measures, and other approved savings measures, and then pay for them with

the savings generated (See SmartSTART in the loan section below). The NH Division of Economic Development [provides further info](#) for businesses about programs and loans

### Rebates/Incentives

If they determined that you qualify for the Home Performance with Energy Star program, you can get 50% of your suggested projects' cost paid for, up to \$4,000 – an enormous help! Some Energy Star appliances are [rebated](#) for a limited time in NH: \$30 for clothes washers and fridges. Between \$1 and \$10 per package [is available](#) for different efficient lighting types, \$10 toward Smart Strips, and \$15 for [air purifiers](#). Liberty Utilities offers a [rebate of \\$25 each](#) for up to two programmable thermostats, and between \$100 and \$800 for a variety of efficient [water heaters](#). Liberty Utilities gas customers can get some [pretty great rebates](#) (\$800-\$1500) for installing qualifying boilers, furnaces, and/or water heater combos or \$250 for installing a [boiler reset control](#) on the outside of a home with an existing forced hot water heater. To help cut costs and fuel used for heating water, Liberty Utilities customers can also receive between \$100 and \$800 depending on the type of [efficient water heater](#) they'd like to purchase. NH Electric

Co-op customers can receive incentives of [up to \\$4,500](#) toward geothermal and high efficiency heat pumps for new construction, or [35% of costs to convert](#) existing construction to these systems, up to \$2,000. Fifty percent of project costs, equal to up to \$7,500 to small businesses and \$15,000 to large commercial operations [is offered](#) for efficiency via better equipment and/or insulation and weatherization. Some other rebates and tax incentives can be found on [dsireusa.org](#), at the above links. Your energy assessment professional will provide you with information about which are available for your needs, too.

### Loans

Unitil customers have an [amazing loan option](#). You can borrow between \$500 and \$7,500 with no interest, to cover up to 100% of your energy efficiency project, and pay back over between two and seven years – as long as you own the building the work is to be done in. PACE loans are also available in New Hampshire.

The NH Electric Co-op has a loan program for businesses called [SmartSTART](#) which allows you to pay back via utility bills and to still have your energy efficiency savings by simply paying back in amounts slightly lower than the total savings generated. Big busi-

ness loans (more than \$100,000) [can be taken from](#) the Energy Conservation revolving loan fund for energy efficiency improvements. Even city governments in NH are able to access a revolving loan of [up to \\$400,000](#) for a wide variety of costs, and use PSNH's [Municipal Smart Start program](#) for support. See [DSIREusa.org](#) for any other options.

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### T i p s

No matter who your utility company is, you'll need to have a year's worth of utility bills (which you can usually get online) and know the square footage of the parts of your house that are lived in when you check to see if you're qualified for an energy assessment from New Hampshire Saves. PSNH has some [energy saving tips](#), and even [calculators](#) you can use if you'd like to compare and contrast with the ones we made for you! Unitil also has some [great resources](#). If you don't want to use the internet, NH Saves offers a free Energy Star lighting catalogue: call 1-877-647-2833. Public Service of New Hampshire sometimes holds seminars or other worthwhile [events](#).

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### Contact

To see if you qualify for an energy assessment, use New Hampshire Saves' [online form](#). Also see [www.NHSaves.com](#) and their resources [page](#).

Talk to your utility company:

- [Public Service of New Hampshire](#), 800-662-7764
- [New Hampshire Electric Co-Op](#), 800-698-2007, [solutions@nhec.coop](mailto:solutions@nhec.coop)
- [Liberty Utilities](#) (a.k.a. National Grid in NH), 866-691-1707
- [Unitil](#), 800-852-3339

## Rhode Island

For the most up to date information, go to the DSIREUSA website for [Rhode Island residential incentives and services](#).

### Low-income programs

Your [local CAP agency](#) can help you figure out if you qualify for [Rhode Island low income energy programs](#), and help you apply. If you qualify for LIHEAP, you qualify for the [Appliance Management Program](#) which involves an energy assessment by a CAP agency professional who provides free CFLs and water saving devices, as well as potential replacement of inefficient appliances like fridges and freezers. The [Heating System Repair Program](#) will assist with faulty heating systems, especially in an emergency, and may even replace irreparable ones.

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### NOT low-income programs

The major program in Rhode Island is National Grid's [Energy Wise](#), which is funded by a surcharge on utility bills of National Grid customers.

### Services

Energy Wise encompasses a wide variety of services and rebates that can help most residents in various ways. They offer the classic [no-cost home energy audits](#) to any homeowner, condo association, or apartment building owner. Pascoag Utility District customers [can also receive](#) these services.

Several services exist to help with new construction. There is a [Deep Energy Retrofit program](#) that was successful in 2012 and may pick back up for 2013 and the foreseeable future. It provides funding and expert collaboration for deep energy retrofit projects like major insulation and equipment upgrades.

Net metering in RI allows for extra unused energy generated by renewable energy technologies to be [sold back to the grid](#).

Energy Wise offers a great [small business program](#) that pays up to 70% of the costs of

energy improvements after an energy audit, and allows easy financing for the remaining 30%. Resources are available for [all sized businesses](#).

### Rebates/Incentives

Rebates in RI are robust; see the [DSIRE list](#).

Efficient lighting rebates include between \$6 and \$25 for [bulbs and fixtures](#). For a 7-day programmable thermostat, [\\$25 is available](#), but if you want a fancier [Wi-Fi programmable thermostat](#) they'll rebate 50% of the cost up to \$100. Choose Energy Star and get between \$20 and \$50 to [update your fridge or freezer](#); get [rid of your old fridge](#) at the same time and receive \$50. Energy Star [air purifiers or cleaners](#) can qualify for a \$40 mail-in rebate. National Grid offers \$10 off (which is sometimes the whole cost) [Advanced Power Strips](#) aka Smart Strips.

If you've got a pool, you can receive up to \$300 back on a purchase of an [efficient pool pump](#), which could save you 70% of pool energy costs each year!

NGrid [offers a mail-in rebate](#) of \$300 or \$500 for efficient [central air conditioning](#) systems or heat pumps, and up to \$200 for

qualified heating equipment. For high efficiency [natural gas heating](#), get up to \$450 for efficient furnaces, or \$1,500 for a boiler, and up to \$800 for an efficient [natural gas hot water heater](#). Unspecified rebates can be rewarded for [heat pump water heaters](#) under specific conditions. If you only want to make your old boiler more efficient, you can get \$225 for a weather-sensitive [boiler reset heating control](#) that will keep your boiler at the appropriate operating level for the season's needs. Between \$200 and \$400 is available for updating [propane or oil furnaces or boilers](#).

The State of Rhode Island allows a local [property tax exemption](#) and a [sales tax exemption](#) for some. There's a special property tax exemption for solar panels, in that they [may not be taxed at a higher value](#) than a conventional system. In 2013, the Rhode Island Economic Development Corporation set aside a \$1.5 million fund for small-scale [solar PV and solar hot water projects](#).

### Loans

Energy Wise offers a [0% interest HEAT loan](#) to RI customers, as well, which can pay for 75% of costs of energy improvements re-

sulting from an energy assessment up to \$2,000.

### Contacts

- Rhode Island Office of Energy Resources at 401-574-9100
- Energy Wise at 1-888-633-7947 or [sign up directly](#) for an energy assessment.
- National Grid's [My Energy Services](#)
- Pascoag Utility District at 1-888-772-4242

## Vermont

For the most up to date information, please go to [Vermont residential incentives and services](#).

### Low-income programs in VT

Your local CAP agency can help you figure out if you qualify, and help you through applying. Find the list for [VT](#). Vermonters can qualify for WAP, which is the national program that was discussed early on in this chapter. In [addition to WAP](#), Vermont residents with income below 80% of VT's median income can be eligible for replacement of inefficient major appliances. Efficiency Vermont recommends you call one of the [Weatherization offices](#) in VT to determine whether you qualify. They have a second section of information for landlords of buildings with low income residents, but [the program](#) is pretty similar to the other.

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### NOT low-income programs

[Efficiency Vermont](#) is the over-arching energy efficiency utility for all of Vermont run by Vermont's Energy Efficiency Corporation. [Burlington Electric Department](#) (BED) manages efficiency programs for the City of Burlington. Both Efficiency Vermont and BED

are funded by an energy efficiency charge on utility customers' bills. Vermont Gas also offers a [few extra programs](#) for qualifying customers.

### Services

Efficiency Vermont manages the [Home Performance with Energy Star](#) for Vermont - – a program where private contractors conduct audits and perform comprehensive home efficiency services. These [energy audits](#) include a blower door test, a walk-through, and an infrared camera to check your home for air leaks and lack of insulation. Your heating system will be checked for efficiency and any potential health and safety issues. Free instant measures (replacement light bulbs and water saving measures) are included.

As usual, the assessment is the gateway through which you qualify for rebates and incentives. In addition to rebates mentioned below, a number of financing institutions provide low-interest home energy loans. These audits typically cost between \$300-500. In 2013, Efficiency Vermont is offering a \$100 discount off the cost of all audits. Shop around for your best deal, but remember that sometimes better service comes with a little more money. In the end the up-front costs

should be outweighed by the benefits of energy efficiency.

Judging by the fact that you picked up this book, you may be interested in doing the assessment yourself with the guidance of a contractor. If so, Efficiency Vermont has a program for you. The [DIY Home Performance with Energy Star program](#) is worth a couple of minutes of your consideration.

If you're building a new home, [Vermont Energy Star Homes](#) will provide an advisor to you, for free, to guide you and/or your builder.

Efficiency Vermont's program for small businesses and multifamily buildings of 4 homes or more is called the [Building Performance Program](#). If a business is large enough that it pays \$5,000 or more in Energy Efficiency Charges (EEC) on utility bills, the [Energy Savings Account program](#) may actually allow the business to use some of those funds for energy efficiency improvements on their facilities. How great is that? A step up from simply using the programs your EEC pays into, but actually wielding the money.

### Rebates/Incentives

Up to [\\$2,000 is available](#) for recommended home improvements for Vermonters who have energy assessments by Home Performance with Energy Star certified contractors. The \$2,000 is broken down for you in a neat table, based on the projects completed for your home. Up to \$5,000 is available for Building Performance Program participants.

Heating and cooling [rebates](#) are available, including between \$100 and \$1,000 for swapping different home components from electricity to natural gas power, and even \$1,000 for a pellet heating stove.

[Several](#) Energy Star appliances are lightly rebated in Vermont. \$50 is available for purchase of certain Energy Star clothes washers and refrigerators, and \$25 is available for dehumidifiers seasonally.

Through Efficiency Vermont, you can find retailers in Vermont that reduce the cost of [Advanced Power Strips](#) (what we call "smart strips" in this book) dramatically. There is even a possible [\\$200 rebate](#) for owners of swimming pools who want to purchase a qualifying efficient pump.

Residential, commercial, industrial, and agri-

cultural land harboring certain renewable energy technologies may be able to [become tax exempt](#) from portions of their municipal property taxes (state taxes would still apply no matter what). Until January 1st, 2023, solar PV systems are considered [100% tax exempt](#) from VT state property taxes, up to a 10 kilowatt system, after which a \$4/kWh standard is enforced. The Vermont Small Scale Renewable Energy Incentive Program offers a [variety of incentives](#) for renewables on most types of buildings, but may not be offered after early 2013. If you are looking to install solar there are options in VT, like [Co-op Solar](#), that can reduce your upfront costs to zero, while helping you through the process of receiving the state and federal funds available.

Lots of other energy efficiency and renewable rebates and tax incentives can be found on dsireusa.org, at the links in our first bullet point for VT. Don't forget that your energy advisor (or contractor, or whatever your energy assessment professional calls themselves) will provide you with information about which are available for your needs, too.

### Loans

A nice deal, [0%-3% interest loans](#) for home repair or weatherization are available from

the [NeighborWorks Alliance of Vermont](#) in what they call the Save Energy Assistance Loan program. Vermont Gas actually offers a [similar option](#), with re-payment time periods correlated to % interest (e.g. 0% if you pay back within 3 years, 2% for up to 5 years, and 4% for up to 10 years of payback period). Efficiency Vermont offers [PACE loans](#) for up to \$30,000 or 15% of the value of the property, whichever is lower. Vermont's Energy Investment Corporation offers [further guidance](#) on VT PACE loans. For businesses, there are [huge loans](#) for energy efficiency efforts available.

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### Tips

A lot of the Efficiency Vermont website's content is laid out for you in multiple formats. You might think you're looking at new information by following a different menu to get there, but you end up learning the same info from another page that looks different but says the same stuff you already read. This can get overwhelming, if not confusing. If you start to get lost, perhaps try to start with [this page](#), which we found has pretty much every component of the residential programs you may need leading off of it.

Information about Vermont's energy use

and savings from 2006 to 2010, by town, is [publically available](#).

There are so many [resources for Vermont](#) residents, we can't possibly touch on them all.

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### Contact

Efficiency Vermont at 1-888-921-5990 between 8am and 5pm weekdays. Also visit [EfficiencyVermont.com](#) for tons of resources.

## Financing Lingo

### PACE Loans

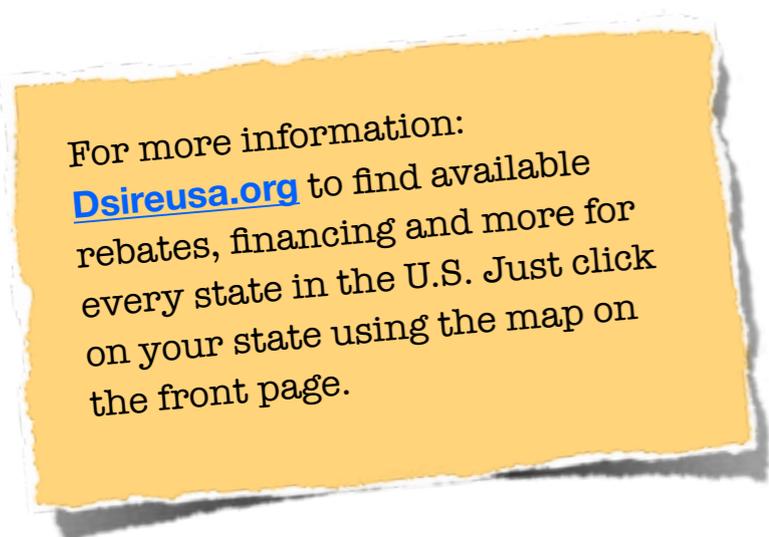
These Property Assessed Clean Energy loans are paid back at a fixed rate as an addition to your property taxes, or another municipal bill. They must be used for energy improvements, which must be predicted by an energy assessor to result in an overall home energy savings of 25% to qualify. In some states (like NH) only some towns have passed a PACE ordinance. PACE loans are considered a junior mortgage and are "assumable" which means they go to new owners if you sell your home.

### **Instant rebate**

This is a rebate where the money never leaves your pocket; the price is just immediately dropped as if you had used a coupon. These may come from government or other institutions.

### **Tax incentive**

A tax incentive is a reduction in the taxes you have to pay, specifically meant to boost an economy. Not the same thing as “incentive” which is a word used for lots of other things, too.



For more information:  
[Dsireusa.org](https://www.dsireusa.org) to find available rebates, financing and more for every state in the U.S. Just click on your state using the map on the front page.

### **Tax credit**

A tax credit is the amount of money you can subtract from the whole sum of taxes you owe. If you get a \$50 tax credit, you owe the government \$50 less. Tax credits are particularly tasty if they are refundable, because those can even exceed the amount of taxes you owe, and result in a reimbursement to you.

### **Tax exemption**

Tax exemption means either freedom from taxes, reduced taxes, or the need to pay only a portion of normal taxes. Residentially, this sometimes applies to renewable energy technology, and/or the land that it is built upon.

# other information



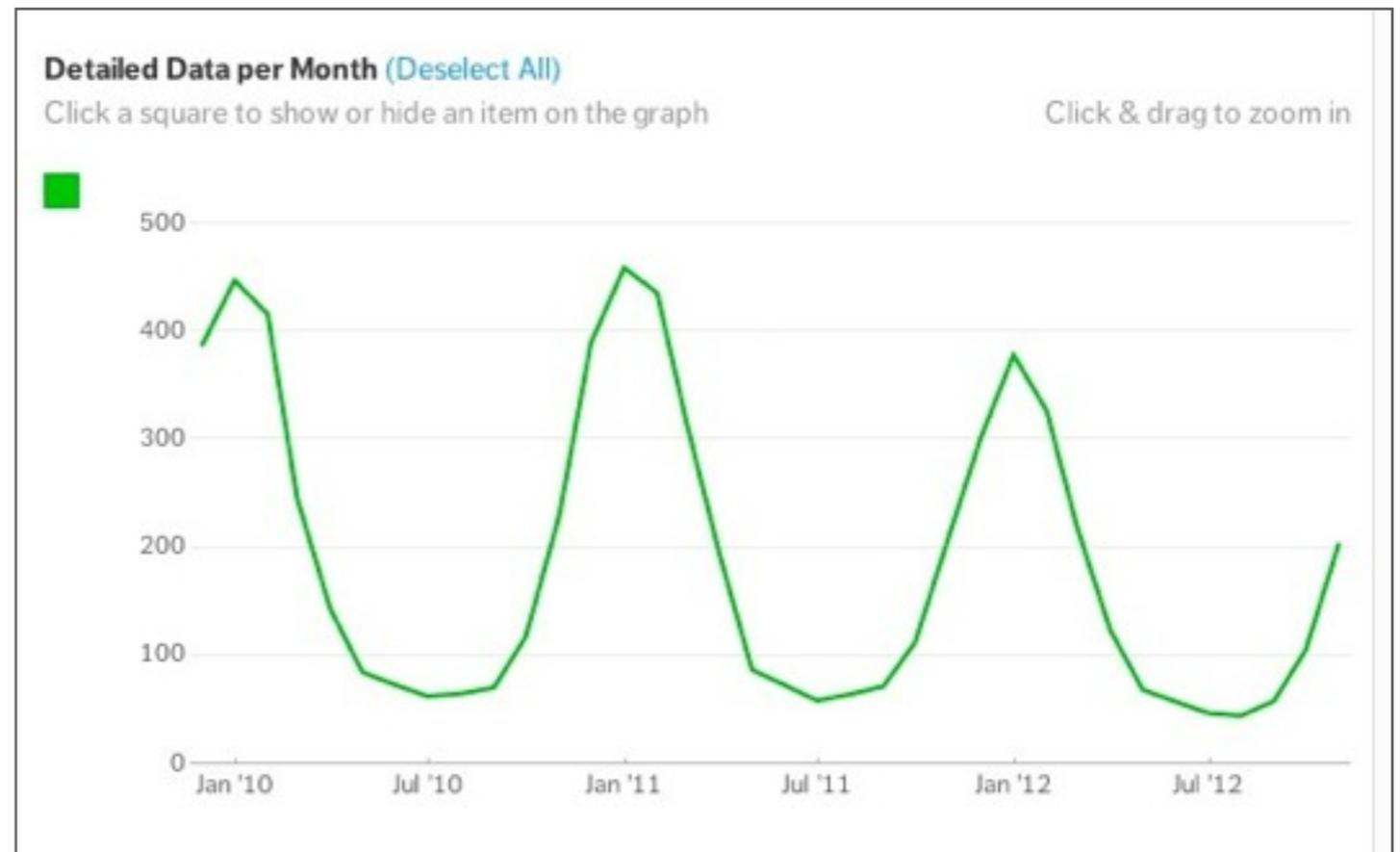
# how to monitor energy bills

You've done or are doing all this work; it would be great to be able to track your energy bills to learn how much your energy use has gone down.

**Try joining [WegoWise](#).**

WegoWise is a web-based energy tracker. In most cases it can automati-

cally download your electricity, natural gas and water use, and then analyze that use while adjusting for how cold the weather is (this allows you to accurately compare the efficiency of your heating system across two different winters).



If you use oil to heat, you have to enter that data by hand.

WegoWise is originally developed to help landlords and property management companies compare and improve the energy and water efficiency of different properties. However there's no reason it can't help you with your home's energy use too. You can even use WegoWise if your home is a single apartment in a large multifamily building, so long as you have your own electricity and gas meters.

### **It's free.**

Tracking your data through WegoWise costs nothing so long as you view the energy use of only one building at a time. Since you probably only care about your one home, this basic type of account will work fine. If you do want more than this, WegoWise costs just \$5 per month per building.

### **Understanding your results**

We should caution you that working with a sample size of one will result in a lot of variability in terms of your results. Energy use is always changing (your teenage son starts taking daily 30-minute-long showers or your roommate moves out with her huge flat-screen TV).

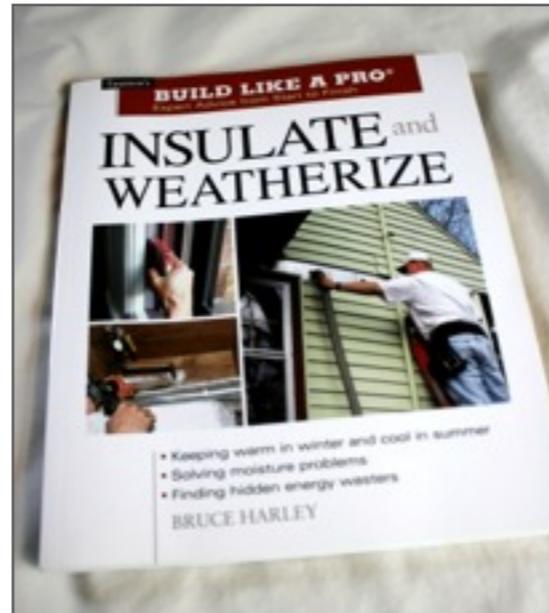
Since you only have one home, your individual savings may skew smaller or larger than you expected. (This is why we base our energy-saving estimates on the results from the same action in thousands of homes.)

Keep at it. Your son will start showering at his girlfriend's. Your energy use *will* go down.

Thank you for your work.

# further reading

## Great books



[Insulate and Weatherize](#) by Bruce Harley (\$19.95)

[Cut Your Energy Bills Now](#) by Bruce Harley (\$12.95)

## Websites

### [Resilience](#)

Wide-ranging current news about energy use and sustainability.

### [Post-Carbon Institute](#)

Think tank researching life using less energy.

### [350.org](#)

The campaign to limit CO<sub>2</sub> concentration in the atmosphere.

### [Dmitri Orlov](#)

Hysterical and mordant look at the fragility of industrial life.

### [Culture Change](#)

Other ways of living than consumerism.

### [Lowtech Magazine](#)

Debunks technical solutions to energy/pollution issues.

## Articles

### [The WeatherBook: Weatherization Standards and Field Guide for Pennsylvania](#)

Michael Blasnik was one of the technical contributors to this 268 page document that contains a wealth of in-depth information.

[Myth Busters: What Works, What Saves](#)

Slide Presentation (slides only) by Michael Blasnik.

[Weatherization Assistance Program](#)

[Effective Insulation for Flat Roofs, a Contractor's Guide](#)

**See other topics at the DOE site:**

[Air Sealing](#)

[Do-It-Yourself Energy Audits](#)

[Energy.gov](#)

# the authors

***Audrey Schulman, HEET co-founder***

Audrey has audited over 150 buildings and weatherized her own home to lower its carbon emissions over 50%. She is a registered thermographer who assesses houses prior to barn-raising and manages the work at barn-raising. She was on Cambridge's Blue Ribbon Panel to Green the Schools. Also she's published four novels that have been translated into 11 languages and been reviewed by the New Yorker and many other impressive periodicals. You can buy them on Amazon or better yet at [IndieBound](#) (the independent bookstores' version of Amazon).

***Jason Taylor, HEET team leader and evaluator, Treasurer***

Jason works at Byggmeister (a preeminent remodeling and design firm) and teaches air-sealing at ABCD (Action for Boston Community Development) WAGE program, Weatherization Bootcamps, Train the Trainer events, SMOC Green

Jobs Academy, Mass Green Initiative, and at Roxbury Community College. He has written air-sealing and insulation curriculum for MassCap and the SMOC Green Jobs Academy.

***Jesse Gorden, HEET Outreach Manager and team leader***

Jesse has team-lead at various HEET barn-raising. Miss Gorden has been critical to HEET's outreach since October 2011, handling big projects and managing community partnerships like NStar's Community Challenge and HEET's house of worship program; CARES. Before HEET, Gorden was an Outreach Coordinator for the Cambridge Energy Alliance, during which she spoke to thousands, managed small business and residential canvasses, headed a city-wide rebate program, and created countless print and online outreach materials. In 2010 she earned a B.S. in Environmental Science from the University of Connecticut.

***Jeremy Marin*, HEET team leader and evaluator**

Jeremy has more than 15 years' experience working for local, regional and national environmental organizations and political candidates. After weatherizing his own home, he became active in HEET and started an affiliate in his hometown of Arlington, MA. He also sits on the Massachusetts Sierra Club political committee.

# thank you

If you've found this book helpful, please tell others about it. If you have a moment, write a nice Amazon review or blog about this book.

Share this book and its information with all your friends and family, especially with those who complain about their energy bills, drafts or vermin or those who want to help the planet.

Tell others about what you've learned so you can help them lower their energy and water use. Explain how easy energy efficiency is to do and how many benefits come with it.

And please, talk to others about climate change and how much you really like this planet just the way it is.

Thank you for living an energy-efficient lifestyle,

From all of us at HEET.

# about HEET

HEET ([Home Energy Efficiency Team](#))

## [Video about HEET](#)

In 2008 a small group of us tried out organizing an energy-upgrade work party we called a “barn-raising.” We wanted to reduce the energy bills of one building as well as to teach the party-goers (aka volunteers) about how to make their homes more efficient.

The day we chose for the work-party turned out to have terrible weather, close to a monsoon. We figured we’d get five people if we were lucky.

Instead 40 bedraggled but excited volunteers crowded into the building and we realized we had stumbled onto a format people craved.

Since then we’ve helped organize over 100 events—in every kind of building from homes to historic churches, from a public school building to homeless shelters. We’ve also helped over 20 sister groups to start up, and trained over

3,000 volunteers in hands-on skills in saving energy.

Over 70% of our surveyed volunteers take their skills back to use in their own homes, multiplying our savings.

We call these events barn-raising because historically Amish barn-raising events were events in which the whole community pooled skills and strength to complete tasks too big for any one person. Fighting climate change is a big task we need to work together on.

## **Community**

At our events, neighbors meet each other and work together, helping neighborhoods to function more as communities. The work parties also socially market energy-efficient behavior, since all the volunteers see lots of other people like themselves working on these tasks, helping convince them this work is something they should do.

### **Savings versus costs**

Now we work primarily on the buildings of nonprofits (and we specialize in churches, synagogues and other houses of worship), saving money for the non-profit so it can provide more core services for the community it serves.

Since the work is through volunteers, it is free to the nonprofits. They only pay for materials, which range between \$200 and \$900 depending on the size of the building. This work generally returns an investment of about 700% over the lifetime of the work measures.

### **We'll help your Boston-area nonprofit or house of worship**

We do a thorough audit before each event to make sure we pinpoint the work that will effectively lower energy use. Our audits include a blower door test, combustion analysis, and more.

We write up a comprehensive report, explaining in easy-to-understand language the professional and do-it-yourself work that will help lower your bills and reduce your impact on the planet.

For the professional-level work, we will help you find the rebates and services you need

and might even be able to help you finance the work.

For the do-it-yourself work, we will help organize the energy upgrade work party, specifying and sourcing the materials, finding team leaders and volunteers.

### **Awards**

We've won a 2010 EPA Regional Environmental Merit award, a Massachusetts Climate Action Network Climate Superstar award and the City of Cambridge's GoGreen Award. Our events have been the subject of over 20 articles by publications that include *The Boston Globe*, *The Boston Phoenix* and *Boston Metro*.

We are always looking for more nonprofits to work with. We want to reach out to every community to teach people how to start reducing energy use now. If you're within an hour's drive of Boston, contact us and we'll help you too.

Thanks,

[HEET.Cambridge@gmail.com](mailto:HEET.Cambridge@gmail.com)

# photo credits

All photos in this book were taken by Jesse Gorden, Jason Taylor, Jeremy Marin, Tess Faraci or Audrey Schulman unless otherwise noted.

The remaining photo credits are below.

## **Cover**

- Photo of HEET volunteers holding up efficiency supplies: Marilyn Humphries

## **Introduction**

- Photo of young woman holding up caulk gun: Marilyn Humphries
- Photo of man holding thermal camera: Marilyn Humphries
- Image of moving box, elephant, and calculator icon: all purchased from iStock photo, Inc.

## **Your Electricity Price Scanner**

- Photo of someone holding Kill-A-Watt meter to read: Marilyn Humphries

## **“Vampire” Load**

- Photo of someone pointing at a Kill-A-Watt meter: Marilyn Humphries

## **Saving Water**

- Photo of water drops on a leaf: Susan Altman.

## **Toilet Tank Bank**

- Photo of inserting toilet tank bank: Nathan Gauthier
- Photo of filling a toilet tank bank: Nathan Gauthier

## **Lawn and Garden**

- Photo of a garden: Susan Altman.

## **Reducing Drafts**

- Diagram of whole house air-flow: Kerry Koskinen

## **Caulking**

- Thermal image: Kerry Koskinen
- Photo of piercing membrane seal inside caulk tube: Stanley Sagov
- Photo of applying bead of caulk below window: Nathan Gauthier
- Photo of man installing backer rod: Nathan Gauthier

### **Interior Storm Windows**

- Photo of woman installing an interior storm window: Nathan Gauthier

### **Air-sealing the Sill Plate/Band Joist**

- Both diagrams of sill plate: Kerry Koskinen

### **Professional Work**

- Photo of professionals: Stanley Sagov

### **Knee Walls**

- Diagram of knee wall cross-section: Kerry Koskinen
- Both thermal images of window trim: Kerry Koskinen

### **Wall Insulation**

- Thermal image of the front of a home: Sagewell, Inc.

### **How to Monitor Energy Bills**

- Model of energy bill data detailed per month: WegoWise, Inc.