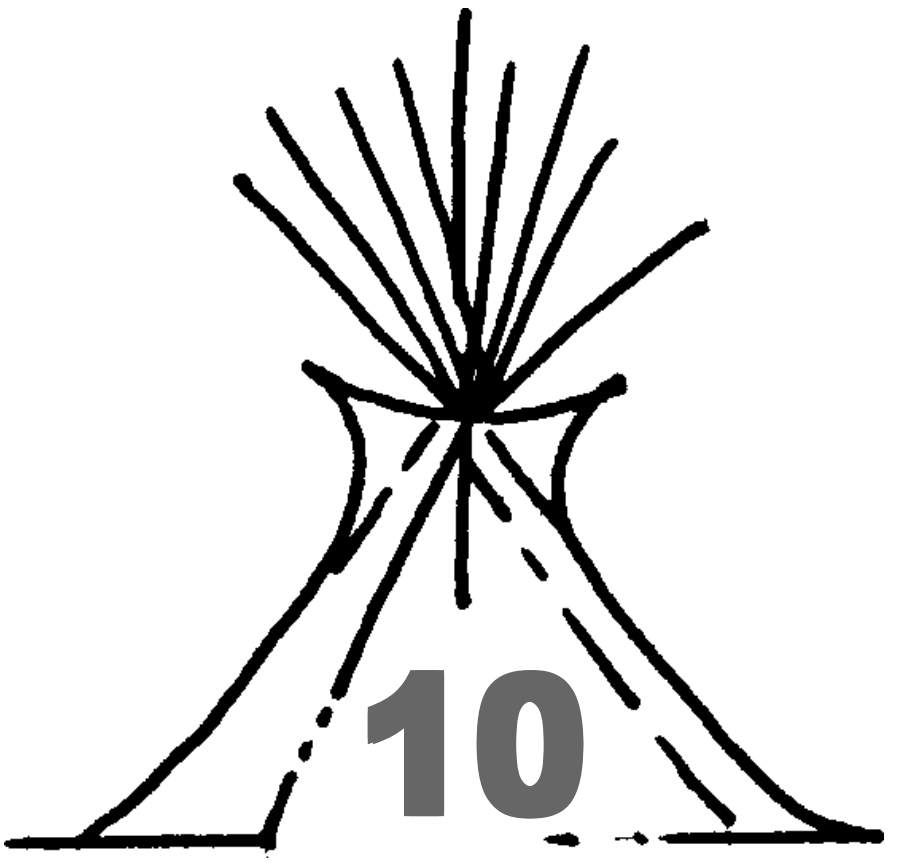
HEATING AND COOLING SYSTEMS

Saving Energy and Keeping Safe



Maintaining your heating and cooling systems can prevent health risks, reduce energy bills and prevent structural damage.

This section talks about your home heating system, duct system, and the foundation, floors, walls, ceilings and roof of your house.

1. Ventilation Safety for Fuel-Burning Appliances
2. Energy Use
3. Energy Efficiency *(heating/cooling systems, air-sealing, insulation and hot water)*

Important Note:

Before air-sealing your home, you must make sure that doing it will not cause air quality or moisture problems.
See page 8 of this section for important safety warnings and **read section 9 "Indoor Air Quality"** for more information.

Connected to the Earth

The environment is our religion. It is who we are.

—Jackie Warledo, Seminole

PART 1 • Ventilating Fuel-burning Appliances

If your furnace, wood stove, boiler, or water heater burns gas, oil, wood, or coal, the venting system, which carries toxic gases out of the house, must work properly. (This also applies to a gas clothes dryer.) This part explains how venting systems work and what will keep them safe. Use the table at the end of part 1 to identify potential risks in your home.

Fuel Burning Appliances

When fuel (gas, oil, coal, or wood) burns it gives off carbon dioxide and water vapor. If the burner isn't working perfectly, carbon monoxide and other harmful pollutants are also produced (See fact sheet 9 of this packet, "Indoor Air Quality."). Most fuel burning appliances have vents to remove toxic by-products from the home. But if you aren't careful, problems like blocked vents and cracked flues can be dangerous. Check vents and flues every year.

There are three types of venting systems: natural-draft, power-vented, and sealed-combustion. **Natural-draft** (or *atmospheric-vent*) systems rely on the tendency of warm gases to rise. They vent into a vertical flue (made of masonry or metal) and draw extra indoor air into the flue with a draft hood. ***Backdrafting*** is a danger associated with natural draft appliances. This can happen when exhaust equipment like a clothes dryer, central vacuum or exhaust fan draws air out of a house, creating a suction within. This can cause fuel exhausts to be pulled into the house instead of going out (figure 10.1).

Power-vented systems use a fan to blow exhaust from the house. Exhausts from power-vented appliances rarely backdraft.

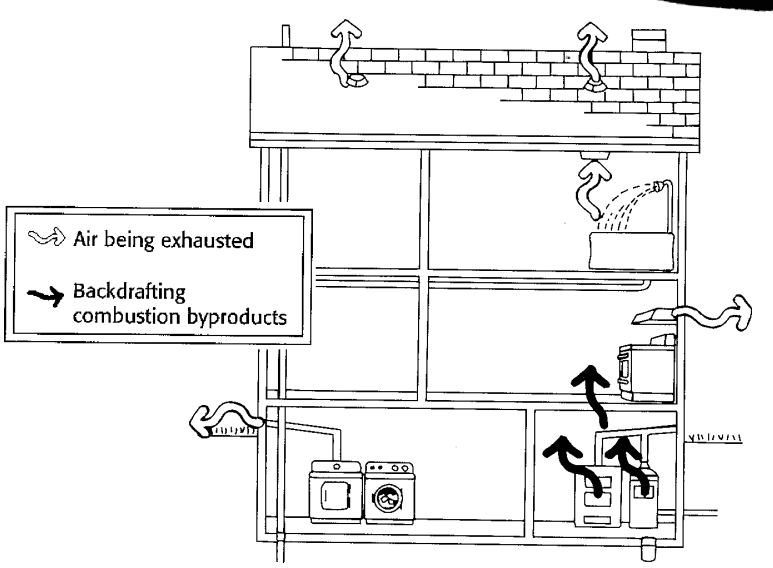


Figure I0.1 Backdrafting happens when exhaust fans lower air pressure inside the home.

Sealed-combustion systems are common in newer furnaces and water heaters. Air needed for combustion is drawn from outdoors through an intake pipe and exhaust gases are vented outside through a second pipe. No chimney is needed. These systems are completely isolated from inside air, and as long as the intake and vent pipes are not blocked or damaged, sealed-combustion appliances will not backdraft.

Unvented appliances, including gas fireplace logs, should only be used in well-ventilated areas. If you must use unvented appliances, open a window in the room at least 1 inch.

Table 1 - Ventilating Fuel-Burning Appliances

	LOW RISK	MEDIUM RISK	HIGH RISK	YOUR RISK
Vent system for combustion appliances	All combustion appliances have sealed-combustion venting systems.		Unvented space heaters or gas logs are used. -OR- Vent pipes are showing signs of damage. -OR- Rust or carbon is present on top of an appliance or below the draft hood.	❒ Low ❒ High
Condition of chimney or flue	The chimney or flue is inspected annually.	The chimney or flue has been inspected only once in the past five years.	The chimney or flue has not been inspected, or the inspection record is unknown.	❒ Low ❒ Medium ❒ High
Air for combustion (does not apply to sealed-combustion appliances)	Combustion equipment is in a well-ventilated space (for example, an attic or garage) or a basement with adequate combustion air.	Combustion equipment is in a well-sealed basement. (This is a higher risk if an exhaust, such as from a clothes dryer, is in the same space.)	Combustion equipment is in a small space (for example, a closet), and openings are blocked.	❒ Low ❒ Medium ❒ High

Fuel needs air to burn properly

Fuel burning appliances must have enough air to work safely. You must follow National Fire Protection Association (NFPA) codes (or more strict local codes) to safely install and operate fuel burning (combustion) equipment.

Sealed-combustion units draw air directly from outside the home. But natural-draft and power-vented units draw air from the inside the house. If you have fuel burning equipment in a closet or other confined space, make sure it gets enough air. This is often done using ventilated doors. Do not place anything inside or outside the confined space that might block air flow.

Do Table 1 - Ventilating Fuel-burning Appliances

Complete the table on the previous page. Rate your risks in the right-hand column. Some choices may not correspond exactly to your situation, so choose the response that best fits.

Responding to risks

Try to lower your risks. Transfer any high and medium risks you identified to the action checklist at the back of this fact sheet. Then make plans to reduce your risks.

PART 2 • Energy Use

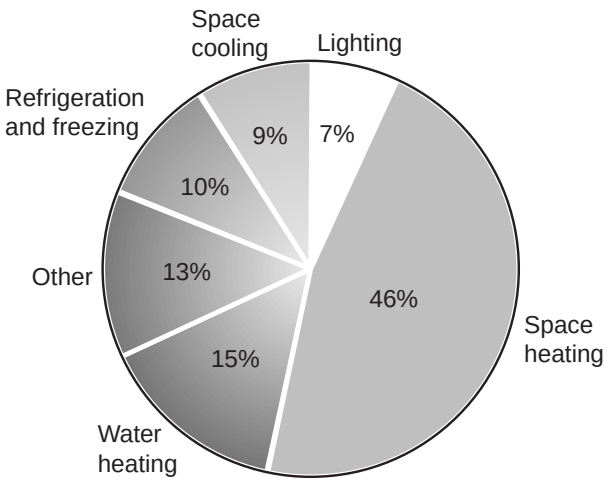


Figure 10.2 Energy use in the typical American Home.
Data taken from U.S. Congress, Office of Technology Assessment, Building Energy Efficiency, OTA-E-518, 1992.

How much energy you use depends on your home's insulation, the efficiency of your appliances, your area's climate and your lifestyle. This part tells how to find out if your energy use is high or low. If it is high, or if there are ways you could save energy (and money), Part 3 tells how.

Energy audits

Figure 10.2 shows how energy is used in the typical American home. Your family's lifestyle affects how energy is used in your home. A home energy audit done by a service professional is the best way to find out how energy efficient your home is. Without an audit, it's hard to know if your energy consumption is too high.

Contact your local utility to see if they offer a residential energy audit or can give you information on average energy use for houses like yours. You can also ask them to quote you a monthly payment plan based on the average energy consumption for a house in your area. Be sure to describe your energy and fuel uses: for example, if you have an all-electric home, if you heat with gas, if you cook with electricity, or if you have air conditioning. Make sure to make it clear that you are trying to find out what normal energy usage is for an average home the size of yours. Otherwise, they may quote you a monthly payment plan based on *your* past energy usage.

Calculate your energy use

Use the space below to figure whether your energy costs are higher or lower than average. Check your records or call your utility to see how much you spent on energy over the last year. Then divide your energy cost by 12 to get your average monthly bill.

Compare your answer with the monthly bill of an "average" home or a monthly payment plan amount for your area quoted by your utility company. If your actual average bill is much higher than the average the utility company told you, there are probably many ways to improve your home's energy efficiency. If your bills are lower than average, there may still be ways to make your home even more efficient.

ARE YOUR ENERGY COSTS HIGH OR LOW?

Use the equations below to calculate and evaluate your energy use.

1. Total of your heating/cooling bills for the past year (12 months)
2. Divide by 12

A. The answer is your average monthly bill

B. Compare to an average monthly bill for energy efficient houses similar to yours. (Contact your local utility company for an estimate.)

$ _____
÷12
= $ _____ (A)

$ _____ (B)

If **A** is larger than **B**, it may show that your home is using more energy —***and costing more money***—than it should. By increasing energy efficiency, you can cut your bills and save significant amounts of money over the long run.

PART 3 • Energy Efficiency

The average home in the United States wastes 30 to 50 percent of the energy it uses. If every home was well-insulated and had energy-efficient equipment, homeowners and the national economy would reap tremendous savings. This part tells how to find out where your home is losing energy and prevent it from losing more. The three key strategies to saving energy are air-sealing (leak-proofing) your home, adding insulation and efficient windows, and using more efficient appliances and equipment.

Part 3a - Heating and Cooling

The biggest energy user in your home is the heating/cooling system (furnace, boiler, heat pump, wood stove, or air conditioner). It has three parts: (1) heating or cooling units such as furnaces and air conditioners, (2) ducts or other distribution method and (3) a thermostat to control output. You can save energy in all three areas.

Newer equipment can save money

If your heating or cooling unit is 15 or more years old, it is probably not very energy efficient. Even if it still works, you may be better off replacing it with a new energy-efficient model. A new system can pay for itself in fuel savings in only a few years. Or, if you can get long-term financing for it, the amount you save on energy each month may be more than the monthly payment for the equipment, and you may start saving money right away.

Maintain your system regularly

All systems work better and more safely if they are regularly inspected and maintained. Your furnace, air conditioner and other heating/cooling equipment should be checked and serviced every year by a qualified professional. Maintenance, such as inspecting and changing air filters should be done monthly during the heating or cooling season. In a forced-air system, the filter removes dust and debris before it reaches the air blower and heat-exchange coils. Dirt on the coils reduces efficiency, so change or clean the air filter regularly.

Use your thermostat to save energy

One of the easiest ways to save energy is to set thermostats lower in winter and higher in summer so that the heating or cooling system runs less. If your house is caulked and weather-stripped to prevent cold drafts, most people will be comfortable at 68 degrees Fahrenheit in the winter. To save more energy, you can turn your thermostat down to 50 or 60 degrees when you go to bed or when nobody is home. During the summer try setting the thermostat at 72 degrees or higher. When you are out of the house in summer, try leaving the setting at 80 to 85 degrees.

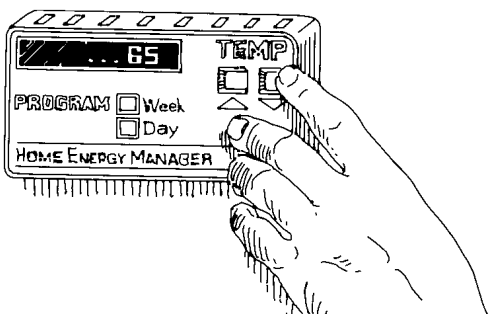


Figure 10.3 Digital or clock thermostats can be programmed to adjust automatically.

Digital or clock thermostats (also called automatic setback thermostats) can be programmed to adjust the temperature automatically (figure 10.3). For example, they can turn the heat down every night at 10 P.M. and bring it back up by 6 A.M. before you get out of bed. The newest kind of residential thermostat, a home energy manager, allows many settings throughout the week. Depending on your lifestyle, these set-back thermostats can pay for themselves in energy savings in as little as one or two years.

Distributing heated or cooled air

Unless you have a heating/cooling unit in each room, you probably have a way to distribute hot or cool air throughout your home. Most central heating and air conditioning systems have forced-air distribution, where air ducts move warm (or cold) air to the rooms. If the duct system leaks, it can waste a lot of energy.

Any ductwork in unheated spaces (like attics or crawl spaces) is likely to lose heat, so you should insulate it. Also, seal all joints in the duct system, everywhere in the house, to make sure all the warm or cool air gets where you want it to go.

Registers in each room deliver warm or cool air, but there should also be a *return duct* to allow air to get back to the heating/cooling unit. Instead of return ducts, many newer homes rely on the space under a closed door to allow air to return to a centrally located return. If you have a room that is hard to heat or cool when the door is shut but is fine when it's open, you probably have an air distribution problem. You can increase the space under the door or call a heating and cooling specialist to fix the problem.

Other heat distribution systems use hot water distributed through pipes to radiators. Pipes carrying hot water should be insulated everywhere—from boiler to radiator. Use a quality insulation material because cheap materials degrade over time. To allow effective air circulation, be sure registers and radiators are not blocked by furniture, curtains or other obstructions.

Do Table 3a - Heating and cooling

Use the table on the next page to see where you can save energy. Mark the potential energy-loss level in the right-hand column that fits best with your situation.

Responding to your risk of energy-loss

Try to reduce the amount of energy wasted in your home. Transfer any high and medium energy-loss potentials from table 3-a to the action checklist at the back of this fact sheet. Then use suggestions from this fact sheet and other resources to increase your energy efficiency.

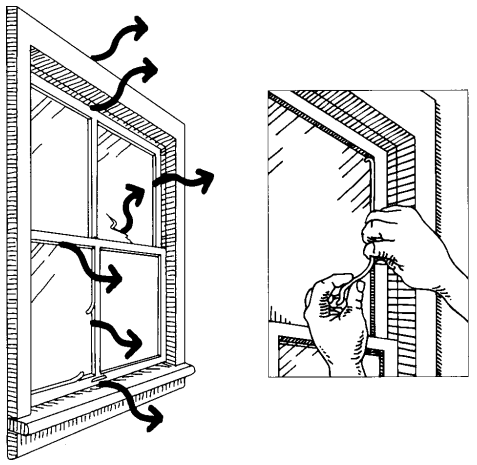
Table 3a - Heating and Cooling

	LOW ENERGY LOSS	MEDIUM ENERGY LOSS	HIGH ENERGY LOSS	YOUR LOSS POTENTIAL
Age of heating/ cooling equipment	Equipment is less than five years old.	Equipment is five to 15 years old.	Equipment is older than fifteen years.	❒ Low ❒ Medium ❒ High
Maintenance of heating/ cooling equipment	Air filters are changed every month during use, and equipment is serviced at least every two years.	Filters are changed occasionally, and the system is maintained on an irregular basis.	Filters are not changed or rarely changed, and the system is not maintained.	❒ Low ❒ Medium ❒ High
Air-temperature thermostat	A modern thermostat with variable temperature set-back is installed. It is routinely used to minimize energy consumption.	A newer thermostat is installed, but it is not used to regulate temperatures at night or when the house is empty.	An older thermostat is in use. It is set to maintain a constant temperature.	❒ Low ❒ Medium ❒ High
Duct location	All duct work is located in heated /cooled space.	Some duct work is located in unheated space.	All duct work is located in unheated space.	❒ Low ❒ Medium ❒ High
Ductwork in unheated space (if applicable)	All ductwork in unheated space is insulated.	Some ductwork in unheated space is insulated.	There is no insulation on ducts.	❒ Low ❒ Medium ❒ High
Return duct	There are air-return ducts in every room, or bedroom doors are left open.	There is one central air return. Bedroom doors are shut at night but there is a 2-inch or greater space under the doors.	There is one central air return. Bedroom doors are shut at night, and there is little space between the bottom of the doors and the floor.	❒ Low ❒ Medium ❒ High
Air-sealing ducts and registers	Seams in the duct system are caulked or sealed, especially where air registers enter rooms.	There are no visible gaps in the duct system.	Gaps are visible in the duct system or around room air registers.	❒ Low ❒ Medium ❒ High
Air intake or air handler	The intake/handler is located in heated space.	The intake/handler is located in unheated space (for example, a crawl space or attic).	The air intake/handler is located in a garage.*	❒ Low ❒ Medium ❒ High

***SAFETY NOTE:**

If your air handler is in your garage, NEVER leave your car running in the garage. The air handler can pick up car exhaust fumes and distribute them to the house through the duct system.

Figure 10.4
Air leakage is often the primary cause of heat loss from windows and doors. Seal leaks with caulking and weatherstripping.



Part 3b - Preventing heat/cold loss

Once you have reached a comfortable temperature, your aim is to keep it that way. Preventing unwanted air leaks and blocking heat transfer are two important approaches to making your home even more energy efficient.

Air-sealing your home

Every house has openings that let outside air get in. Some, such as open windows and doors, are obvious. Others, such as cracks around window frames, are unintended pathways for leaks (figure 10.4). This uncontrolled leakage of air can account for a large part of the total heat loss in a home: usually about 30 percent of your total heating bill. In most climates, air entering a home must be heated or cooled to keep you comfortable. Sealing your home against air leaks isn't hard, but it does require detailed information to be done right. For details, contact your local Cooperative Extension office or the U.S. Department of Energy's Energy Efficiency and Renewable Energy Clearinghouse (EREC). (See reference at the end of this fact sheet.)

Insulating your home

Even if you air-seal your house, you still need to prevent heat or cold air from going through walls, floors or ceilings. Insulation acts like a blanket to keep the heat or cool air inside. Insulation materials are rated by their *R-value*, a measure of how well they resist the flow of heat energy into or out of your home. The higher the R-value, the more heat (or cool air) is kept where you want it.

The amount of insulation you should use varies. If you have extreme temperatures in your area, you will need more insulation. A building supplier should be able to help. The EREC publication "Insulation Materials and Strategies" tells about insulation products and gives recommendations for all areas of the United States by zip code. It also helps you decide if you should attempt the job yourself or have it done professionally.

Table 3b - Preventing heat/cold loss

	LOW ENERGY LOSS	MEDIUM ENERGY LOSS	HIGH ENERGY LOSS	YOUR LOSS POTENTIAL
Attic	All potential leak points are sealed or weather-stripped.	Only some potential leak points are sealed.	Most potential leak points are not sealed.	❒ Low ❒ Medium ❒ High
Windows and doors	All windows and doors are sealed with caulk and weather-stripping and tested for leaks. Newer, well- sealed, double-paned windows are installed.	Only some windows and doors are caulked and weather-stripped. Older or leaky storm windows are used. Some windows are sealed in winter with plastic sheets.	Windows are older and not sealed. Storm windows may be absent.	❒ Low ❒ Medium ❒ High
Basement or crawl space	Sill plates, service entrances, windows, and wall cracks are sealed with caulk or foam.	Leaks have been detected but are not fully sealed.	No sealing has been attempted.	❒ Low ❒ Medium ❒ High
Attic insulation	Insulation is equal to or greater than levels recommended for my region.		Insulation is well below the recommended levels—OR—attic is not insulated.	❒ Low ❒ High
Insulation in walls (above-ground)	Wall cavities are insulated with loose fill or 3-inch to 5-inch batts.		There is no insulation in wall cavities.	❒ Low ❒ High
Insulation in walls (heated basements)	Walls are insulated with rigid foam or bats, according to the regional recommendations.		Walls are not insulated.	❒ Low ❒ High

IMPORTANT SAFETY NOTE

Your home gets outside air from all its small holes and cracks, including any holes in the duct system that are outside the heated or cooled space (such as an attic or crawl space).

Sealing a leaking duct system reduces the amount of outside air that leaks into the home. While this reduces energy loss, you should also be aware of how it might affect fuel-burning appliances and your air quality. The precautions listed under the "Safety Note" on the back page apply here also. Duct sealing is a job best left to a professional.

Do Table 3b - Preventing heat loss or cold loss

Mark the energy-loss level in the right-hand column that best fits your situation.

Responding to your energy-loss potentials

Try to reduce the amount of energy you use. Transfer any high and medium energy-loss potentials from table 3-b to the action checklist at the back of this fact sheet. Then use the suggestions you've read here and ideas from other sources to increase your energy efficiency.

Part 3c - Hot water

After heating and cooling, heating water is your home's biggest energy user. The simplest thing you can do to save energy is to turn down the water heater temperature. Each 10 degrees will save you three to five percent on your water heating bill. Lowering the water temperature will also increase the lifetime of your water heater and reduce the risk of someone being burned. Children and the elderly are most at risk of being scalded by hot water.

Most water heaters come set at around 140 degrees F. For most people, this is higher than necessary. Usually, 120-degree water is fine unless you have a dishwasher without a temperature booster.

Wrapping your water heater with insulation can reduce water heating energy use by four to nine percent. Adding insulation usually pays for itself in less than one year, but some new water heaters come well insulated with foam and don't need any more. Water heater insulation blankets are available at hardware stores. They come in standard sizes to fit 40-, 60-, and 80-gallon water heaters. Be sure to follow the manufacturer's installation instructions.

Cutting down how much hot water you use will also reduce the amount of energy needed. Fix any leaking pipes and consider installing low-flow shower heads. Using the cold water settings when you do laundry can also save energy. Insulate hot water pipes wherever you can with preformed foam insulation or wraparound fiberglass.

Do Table 3c - Hot water

Mark the energy-loss level in the right-hand column that best fits your situation.

Responding to your energy-loss potential

Try to reduce the amount of energy you use. Transfer any high and medium energy-loss risks from table 3-c to the action checklist at the back of this fact sheet. Then use the suggestions you've read here to increase your energy efficiency.

TAKE ACTION

Go back over the tables to make sure that you have transferred all high and medium risks to the checklist on the next page. Then list the improvements you plan to make. You can use suggestions from this fact sheet or from other sources. Write down a date to keep you on schedule. You don't have to do everything at once, but try to eliminate the most serious problems as soon as you can. Often it helps to tackle the inexpensive actions first.

Table 3c - Hot water

	LOW ENERGY LOSS	MEDIUM ENERGY LOSS	HIGH ENERGY LOSS	YOUR LOSS POTENTIAL
Thermostat setting	Thermostat is set at 120° F.	Thermostat is set at 143° F.	Thermostat is set at 140° F or higher.	❒ Low ❒ Medium ❒ High
Insulation	A new, highly insulated water heater or water heater blanket is installed.		An older water heater with no added blanket is in use.	❒ Low ❒ High
Water conservation	Low-flow shower heads are installed, and there are no leaking faucets. A conscious effort is made to conserve hot water.	There are no leaking faucets. Some effort is made to minimize hot water use.	There are leaking faucets, and no low-flow fixtures are installed.	❒ Low ❒ Medium ❒ High
Pipe insulation	All accessible hot water pipes are insulated.	Some accessible hot water pipes are insulated.	There is no insulation.	❒ Low ❒ Medium ❒ High

For More Information

Energy Efficiency and Renewable Energy Clearinghouse (EREC)

The U.S. Department of Energy's EREC will send detailed information on the topics covered here and much more. Call toll-free: (800)-363-3732, Monday-Friday, 9A.M. to 7P.M., EST.

American Council for an Energy Efficient Economy

For information on energy-efficient appliances, ask for a current list of publications. 2140 Shattuck Avenue, Suite 202, Berkeley, CA 94704

Acknowledgments

Figures 10.1, 10.3, and 10.4 were adapted from Ned Nisson and Alex Wilson, The Virginia Energy Savers Handbook: A Guide to Saving Energy, Money, and the Environment, 1993.

This fact sheet has been revised from the original written by Lori S. Marsh, Associate Professor and Extension Engineer, Department of Biological Systems Engineering, Virginia Polytechnic Institute and State University.

IMPORTANT SAFETY NOTE

****PROCEED WITH CAUTION!**** Air-sealing may save energy, but it can also trap deadly pollutants. Air-sealing can cause a dangerous situation by reducing the air available for fuel-burning appliances. ***Do not*** attempt to air-seal your home until you have taken care of these problem areas:

- Unvented gas or kerosene heaters or unvented gas fireplaces/ logs must be removed or vented outdoors.
- If you have a gas cook stove that is not vented to the outside by a power-vented hood, ***do not*** extensively air-seal your home. Alternatively, open a kitchen window 1/4 inch while cooking and run an exhaust fan.
- If you have a high level of radon in your home, properly air-sealing can help reduce the problem. However, you should monitor radon levels carefully and contact a professional if the problem is not fixed. (See Section 9 of this publication, "Indoor Air Quality," for more information about radon.)
- If you have natural-draft appliances, do not extensively air-seal your home without seeking the advice of an energy services professional.

ACTION CHECKLIST: Heating and Cooling Systems

Write all high and medium risks below.	What can you do to reduce the risk?	Set a target date for action.
Sample: Water heater is not insulated	Buy ready-made insulation blanket at the hardware store.	One week from today: March 8

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To obtain additional fact sheets in the *Connected to the Earth* series, contact your local Extension office or call Montana State University's Extension housing program at (406) 994-3451.