Do-It-Yourself Home Energy Audit Guide

BY

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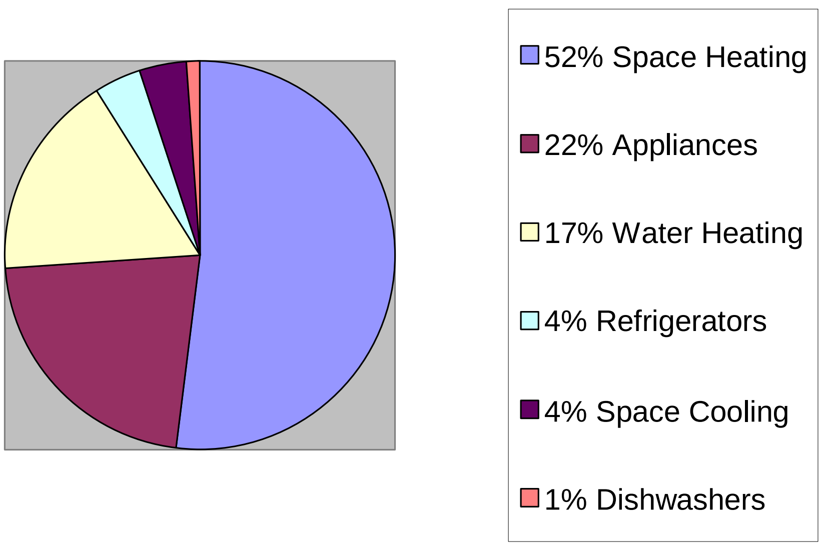
You can easily conduct a home energy audit yourself. With a simple but diligent walk-through, you can spot many problems in any type of house. When auditing your home, keep a checklist of areas you have inspected and problems you found. This list will help you prioritize your energy efficiency upgrades.

The graph below shows the national average of energy use in homes



Average Energy Use In Homes

Locating Air Leaks

First, make a list of obvious air leaks (drafts). The potential energy savings from reducing drafts in a home may range from 5 to 30% per year, and the home is generally much more comfortable afterward. Check for indoor air leaks, such as gaps along the baseboard or edge of the flooring and at junctures of the walls and ceiling. Check to see if air can flow through these places:

- Electrical outlets
- Switch plates
- Window frames
- Baseboards
- Weather stripping around doors
- Fireplace dampers
- Attic hatches
- Wall- or window-mounted air conditioners.

Also look for gaps around pipes and wires, electrical outlets, foundation seals, and mail slots. Check to see if the caulking and weather stripping are applied properly, leaving no gaps or cracks, and are in good condition.

Inspect windows and doors for air leaks. See if you can rattle them, since movement means possible air leaks. If you can see daylight around a door or window frame, then the door or window leaks. You can usually seal these leaks by caulking or weather stripping them. Check the storm windows to see if they fit and are not broken. You may also wish to consider replacing your old windows and doors with newer, high-performance ones. If new factory-made doors or windows are too costly, you can install low-cost plastic sheets over the windows.

If you are having difficulty locating leaks, you may want to conduct a basic building pressurization test:

1. First, close all exterior doors, windows, and fireplace flues.
2. Turn off all combustion appliances such as gas burning furnaces and water heaters.
3. Then turn on all exhaust fans (generally located in the kitchen and bathrooms) or use a large window fan to suck the air out of the rooms.

This test increases infiltration through cracks and leaks, making them easier to detect. You can use incense sticks or your damp hand to locate these leaks. If you use incense sticks, moving air will cause the smoke to waver, and if you use your damp hand, any drafts will feel cool to your hand.

On the outside of your house, inspect all areas where two different building materials meet, including:

- All exterior corners
- Where siding and chimneys meet
- Areas where the foundation and the bottom of exterior brick or siding meet.

You should plug and caulk holes or penetrations for faucets, pipes, electric outlets, and wiring. Look for cracks and holes in the mortar, foundation, and siding, and seal them with the appropriate material. Check the exterior caulking around doors and windows, and see whether exterior storm doors and primary doors seal tightly.

When sealing any home, you must always be aware of the danger of indoor air pollution and combustion appliance "backdrafts." Backdrafting is when the various combustion appliances and exhaust fans in the home compete for air. An exhaust fan may pull the combustion gases back into the living space. This can obviously create a very dangerous and unhealthy situation in the home.

In homes where a fuel is burned (i.e., natural gas, fuel oil, propane, or wood) for heating, be certain the appliance has an adequate air supply. Generally, one square inch of vent opening is required for each 1,000 Btu of appliance input heat. When in doubt, contact your local utility company, energy professional, or ventilation contractor.

Ventilation

When creating an energy-efficient, airtight home through air sealing techniques, it's very important to consider ventilation. Unless properly ventilated, an airtight home can seal in indoor air pollutants. Ventilation also helps control moisture—another important consideration for a healthy, energy-efficient home.

Purpose of Ventilation

Your home needs ventilation—the exchange of indoor air with outdoor air—to reduce indoor pollutants, moisture, and odors. Contaminants such as formaldehyde, volatile organic compounds, and radon can accumulate in poorly ventilated homes, causing health problems. Excess moisture in a home can generate high humidity levels. High humidity levels can lead to mold growth and structural damage to your home.

To ensure adequate ventilation, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) says that a home's living area should be ventilated at a rate of 0.35 air changes per hour or 15 cubic feet per person per minute, whichever is greater.

Ventilation Strategies

Natural Ventilation

Natural ventilation used to be the most common ventilation method of allowing fresh outdoor air to replace indoor air in a home. Today it's usually not the best ventilation strategy, especially for homes that are properly air sealed for energy efficiency. Natural ventilation also usually doesn't provide adequate moisture control.

Natural ventilation occurs when there is uncontrolled air movement or infiltration through cracks and small holes in a home—the same ones you want to seal to make your home more energy efficient. Opening windows and doors also provides natural ventilation. Because of central heating and cooling systems, however, most people don't open windows and doors as often. Therefore, air infiltration has become the principal mode of natural ventilation in homes.

A home's natural ventilation rate is unpredictable and uncontrollable—you can't rely on it to ventilate a house uniformly. Natural ventilation depends on a home's airtightness, outdoor temperatures, wind, and other factors. Therefore, during mild weather, some homes may lack sufficient natural ventilation for pollutant removal. Tightly sealed and/or built homes may have insufficient natural ventilation most of the time, while homes with high air infiltration rates may experience high energy costs.

Spot ventilation can be used to improve the effectiveness of natural ventilation. However, if both spot and natural ventilation together don't meet your home's ventilation needs, then you should consider a whole-house ventilation strategy.

Whole-House Ventilation

The decision to use whole-house ventilation is typically motivated by concerns that natural ventilation won't provide adequate air quality, even with source control by spot ventilation.

Whole-house ventilation systems provide controlled, uniform ventilation throughout a house. These systems use one or more fans and duct systems to exhaust stale air and/or supply fresh air to the house. There are four types of systems:

- **Exhaust ventilation systems**
  Force inside air out of a home.

- **Supply ventilation systems**
  Force outside air into the home.

- **Balanced ventilation systems**
  Force equal amounts quantities of air into and out of the home.

- **Energy recovery ventilation systems**
  Transfer heat from incoming or outgoing air to minimize energy loss.

Spot Ventilation

Spot ventilation improves the effectiveness of other ventilation strategies—natural and whole-house—by removing indoor air pollutants and/or moisture at their source.

Spot ventilation includes the use of localized exhaust fans, such as those used above kitchen ranges and in bathrooms. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommends intermittent or continuous ventilation rates for bathrooms and kitchens instead of using windows (natural ventilation): 50 or 20 cubic feet per minute for bathrooms, and 100 or 25 cubic feet per minute for kitchens, respectively.

Insulation

Heat loss through the ceiling and walls in your home could be very large if the insulation levels are less than the recommended minimum. When your house was built, the builder likely installed the amount of insulation recommended at that time. Given today's energy prices (and future prices that will probably be higher), the insulation level might be inadequate, especially if you have an older home.

If the attic hatch is located above a conditioned space, check to see if it is at least as heavily insulated as the attic, is weather stripped, and closes tightly. In the attic, determine whether openings for items such as pipes, ductwork, and chimneys are sealed. Seal any gaps with an expanding foam caulk or some other permanent sealant.

While you are inspecting the attic, check to see if there is a vapor barrier under the attic insulation. The vapor barrier might be tarpaper, Kraft paper attached to fiberglass batts, or a plastic sheet. If there does not appear to be a vapor barrier, you might consider painting the interior ceilings with vapor barrier paint. This reduces the amount of water vapor that can pass through the ceiling. Large amounts of moisture can reduce the effectiveness of insulation and promote structural damage.

Make sure that the attic vents are not blocked by insulation. You also should seal any electrical boxes in the ceiling with flexible caulk (from the living room side or attic side) and cover the entire attic floor with at least the current recommended amount of insulation.

Checking a wall's insulation level is more difficult. Select an exterior wall and turn off the circuit breaker or unscrew the fuse for any outlets in the wall. Be sure to test the outlets to make certain that they are not "hot." Check the outlet by plugging in a functioning lamp or portable radio. Once you are sure your outlets are not getting any electricity, remove the cover plate from one of the outlets and gently probe into the wall with a thin, long stick or screwdriver. If you encounter a slight resistance, you have some insulation there. You could also make a small hole in a closet, behind a couch, or in some other unobtrusive place to see what, if anything, the wall cavity is filled with. Ideally, the wall cavity should be totally filled with some form of insulation material. Unfortunately, this method cannot tell you if the entire wall is insulated, or if the insulation has settled. Only a thermographic inspection can do this.

If your basement is unheated, determine whether there is insulation under the living area flooring. In most areas of the country, an R-value of 25 is the recommended minimum level of insulation. The insulation at the top of the foundation wall and first floor perimeter should have an R-value of 19 or greater. If the basement is heated, the foundation walls should be insulated to at least R-19. Your water heater, hot water pipes, and furnace ducts should all be insulated.

How Insulation Works

You need insulation in your home to provide resistance to heat flow. The more heat flow resistance your insulation provides, the lower your heating and cooling costs.

Heat flows naturally from a warmer to a cooler space. In the winter, this heat flow moves directly from all heated living spaces to adjacent unheated attics, garages, basements, and even to the outdoors. Heat flow can also move indirectly through interior ceilings, walls, and floors—wherever there is a difference in temperature. During the cooling season, heat flows from the outdoors to the interior of a house.

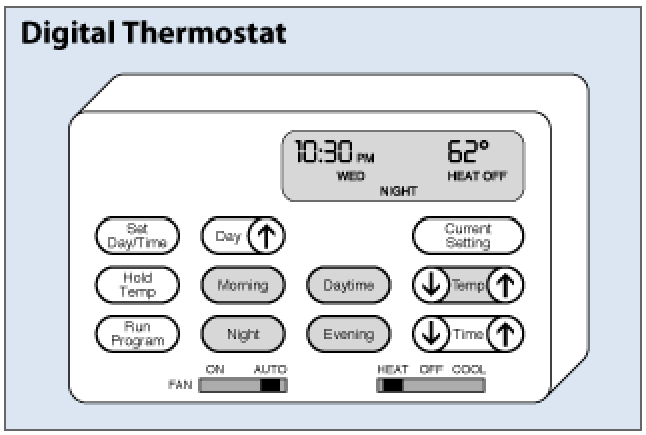
To maintain comfort, the heat lost in the winter must be replaced by your heating system and the heat gained in the summer must be removed by your cooling system. Properly insulating your home will decrease this heat flow by providing an effective resistance to the flow of heat.

Heating/Cooling Equipment

Inspect heating and cooling equipment annually, or as recommended by the manufacturer. If you have a forced-air furnace, check your filters and replace them as needed. Generally, you should change them about once every month or two, especially during periods of high usage. Have a professional check and clean your equipment once a year.

If the unit is more than 15 years old, you should consider replacing your system with one of the newer, energy-efficient units. A new unit would greatly reduce your energy consumption, especially if the existing equipment is in poor condition. Check your ductwork for dirt streaks, especially near seams. These indicate air leaks, and they should be sealed with a duct mastic. Insulate any ducts or pipes that travel through unheated spaces. An insulation R-Value of 6 is the recommended minimum.

You can save around 10% a year on your heating and cooling bills by simply turning your thermostat back 10°–15° for eight hours. You can do this automatically without sacrificing comfort by installing an automatic setback or programmable thermostat.



A programmable thermostat offers a lot of flexibility in its temperature settings.

Using a programmable thermostat, you can adjust the times you turn on the heating or air-conditioning according to a pre-set schedule. As a result, you don't operate the equipment as much when you are asleep or when the house is not occupied.

Programmable thermostats can store and repeat multiple daily settings (six or more temperature settings a day) that you can manually override without affecting the rest of the daily or weekly program. When shopping for a programmable thermostat, be sure to look for the ENERGY STAR label.

General Thermostat Operation

You can easily save energy in the winter by setting the thermostat to 68°F while you're awake and setting it lower while you're asleep or away from home. By turning your thermostat back 10°–15° for 8 hours, you can save about 5%–15% a year on your heating bill—a savings of as much as 1% for each degree if the setback period is eight hours long. The percentage of savings from setback is greater for buildings in milder climates than for those in more severe climates.

In the summer, you can follow the same strategy with central air conditioning, too, by keeping your house warmer than normal when you are away, and lowering the thermostat setting to 78°F (26°C) only when you are at home and need cooling. Although thermostats can be adjusted manually, programmable thermostats will avoid any discomfort by returning temperatures to normal as you wake or return home.

A common misconception associated with thermostats is that a furnace works harder than normal to warm the space back to a comfortable temperature after the thermostat has been set back, resulting in little or no savings. This misconception has been dispelled by years of research and numerous studies. The fuel required to reheat a building to a comfortable temperature is roughly equal to the fuel saved as the building drops to the lower temperature. You save fuel between the time that the temperature stabilizes at the lower level and the next time heat is needed. So, the longer your house remains at the lower temperature, the more energy you save.

Limitations For Homes With Heat Pumps, Electric Resistance Heating, Steam Heat, And Radiant Floor Heating

Programmable thermostats are generally not recommended for heat pumps. In its cooling mode, a heat pump operates like an air conditioner, so turning up the thermostat (either manually or with a programmable thermostat) will save energy and money. But when a heat pump is in its heating mode, setting back its thermostat can cause the unit to operate inefficiently, thereby canceling out any savings achieved by lowering the temperature setting. Maintaining a moderate setting is the most cost-effective practice. Recently, however, some companies have begun selling specially designed programmable thermostats for heat pumps, which make setting back the thermostat cost effective. These thermostats typically use special algorithms to minimize the use of backup electric resistance heat systems.

Electric resistance systems, such as electric baseboard heating, require thermostats capable of directly controlling 120-volt or 240-volt circuits. Only a few companies manufacture line-voltage programmable thermostats.

For steam heating and radiant floor heating systems, the problem is their slow response time: both types of systems may have a response time of several hours. This leads some people to suggest that setback is inappropriate for these systems. However, some manufacturers now offer thermostats that track the performance of your heating system to determine when to turn it on in order to achieve comfortable temperatures at your programmed time.

Alternately, a normal programmable thermostat can be set to begin its cool down well before you leave or go to bed and return to its regular temperature two or three hours before you wake up or return home. This may require some guesswork at first, but with a little trial and error you can still save energy while maintaining a comfortable home.

Choosing and Programming a Programmable Thermostat

Most programmable thermostats are either digital, electromechanical, or some mixture of the two. Digital thermostats offer the most features in terms of multiple setback settings, overrides, and adjustments for daylight savings time, but may be difficult for some people to program. Electromechanical systems often involve pegs or sliding bars and are relatively simple to program.

When programming your thermostat, consider when you normally go to sleep and wake up. If you prefer to sleep at a cooler temperature during the winter, you might want to start the temperature setback a bit ahead of the time you actually go to bed; you probably won't notice the house cooling off as you prepare for bed. Also consider the schedules of everyone in the household; is there a time during the day when the house is unoccupied for four hours or more? If so, it makes sense to adjust the temperature during those periods.

The location of your thermostat can affect its performance and efficiency. Read the manufacturer's installation instructions to prevent "ghost readings" or unnecessary furnace or air conditioner cycling. Place thermostats away from direct sunlight, drafts, doorways, skylights, and windows. Also make sure your thermostat is conveniently located for programming.

Lighting

Energy for lighting accounts for about 10% of your electric bill. Examine the wattage size of the light bulbs in your house. You may have 100-watt (or larger) bulbs where 60 or 75 watts would do. You should also consider compact fluorescent lamps for areas where lights are on for hours at a time. Your electric utility may offer rebates or other incentives for purchasing energy-efficient lamps.

How Compact Fluorescents Compare with Incandescents

Many compact fluorescent light bulbs now carry the Energy Star label. These bulbs last up to 10,000 hours and save $25 to $45 over the life of the bulb. Compared to incandescent lamps, compact fluorescent lamps (CFLs), when used properly have the following advantages:

- Last up to 10 times longer
- Use about one-fourth the energy
- Produce 90% less heat, while producing more light per watt.

Table 1 below compares the wattage of commonly available incandescent lamps and the wattage of a CFL that will provide similar light levels.

Table 1. Comparable Wattage of CFLs and Incandescents	
Incandescent Wattage	**CFL Wattage**
25	5
50	9
60	15
75	20
100	25
120	28
150	39

Table 2 below shows how you can save money using CFLs. This table assumes the light is on for 6 hours per day and that the electric rate is 10 cents per kilowatt-hour.

Table 2. Cost Comparisons between CFLs and Incandescents		
	27-Watt Compact Fluorescent	**100-Watt Incandescent**
Cost of Lamps	$14.00	$0.50
Lamp Life	1642.5 days (4.5 years)	167 days
Annual Energy Cost	$5.91	$21.90
Lamps Replaced in 4.5 years	0	10
Total Cost	$40.60	$103.55
Savings Over Lamp Life	$62.95	0

Incandescent lamps have a few advantages over CFLs. The color rendition of incandescent lamps is superior to CFLs, though it has greatly improved in CFLs. Incandescents also project light further. This makes them more appropriate for some applications, such as for lighting in high ceilings. Compact fluorescent lamps, however, can also have advantages in high locations. CFLs can be more convenient for hard-to-reach places because they last longer and do not need to be changed as often.

How Compact Fluorescent Lamps Work

CFLs work much like standard fluorescent lamps. They consist of two parts: a gas-filled tube, and a magnetic or electronic ballast. The gas in the tube glows with ultraviolet light when electricity from the ballast flows through it. This in turn excites a white phosphor coating on the inside of the tube, which emits visible light throughout the surface of the tube.

CFLs with magnetic ballasts flicker slightly when they start. They are also heavier than those with electronic ballasts. This may make them too heavy for some light fixtures. Electronic ballasts are more expensive, but light immediately (especially at low temperatures). They are also more efficient than magnetic ballasts. The tubes will last about 10,000 hours and the ballast about 50,000 hours. Most currently available CFLs have electronic ballasts.

CFLs are designed to operate within a specific temperature range. Temperatures below the range cause reduced output. Most are for indoor use, but there are models available for outdoor use. You can find a CFL's temperature range on most lamp packages. You should install outdoor CFLs in enclosed fixtures to minimize the adverse effects of colder temperatures.

CFLs are most cost effective and efficient in areas where lights are on for long periods of time. You'll experience a slower payback in areas where lights are turned on for short periods of time, such as in closets and pantries. Because CFLs do not need to be changed often, they are ideal for hard-to-reach areas.

Types of Compact Fluorescent Lamps

CFLs are available in a variety of styles or shapes. Some have two, four, or six tubes. Others have circular or spiral-shaped tubes. The size or total surface area of the tube(s) determines how much light it produces.

Some CFLs have the tubes and ballast permanently connected. Other CFLs have separate tubes and ballasts. This allows you to change the tubes without changing the ballast. There are also types enclosed in a glass globe. These look somewhat similar to conventional incandescent light bulbs, except they're larger.

Sub-CFLs fit most fixtures designed for incandescent lamps. Although most CFLs fit into existing 3-way light sockets, only a few special CFL models can be dimmed.

Saving Water and Heating It Efficiently

Water heating uses 17% of the energy in U.S. homes. Solar water heating is one option for reducing the energy you use for water heating, but there are also several options for improved efficiency in non-solar water heating.

Water heating is the second largest energy expense in U.S. households. If your water heater is more than 10 years old, it probably has an efficiency no higher than 50%. An old water heater can operate for years at very low efficiencies before it finally fails. One way to reduce water heating costs is to replace your old water heater with a new, higher-efficiency model.

In addition, you should reduce your hot water use by buying appliances with low water usage, such as front-loading (horizontal-axis) washing machines, and by installing water-conserving plumbing fixtures.

Reducing your water use in general saves you money and saves the energy used to purify the fresh water you use and the wastewater you dispose of. In arid climates, reducing your water usage can also help minimize your impact on the environment and help reduce the need for new dams and other water projects.

Insulating an Electric Water Heater Tank

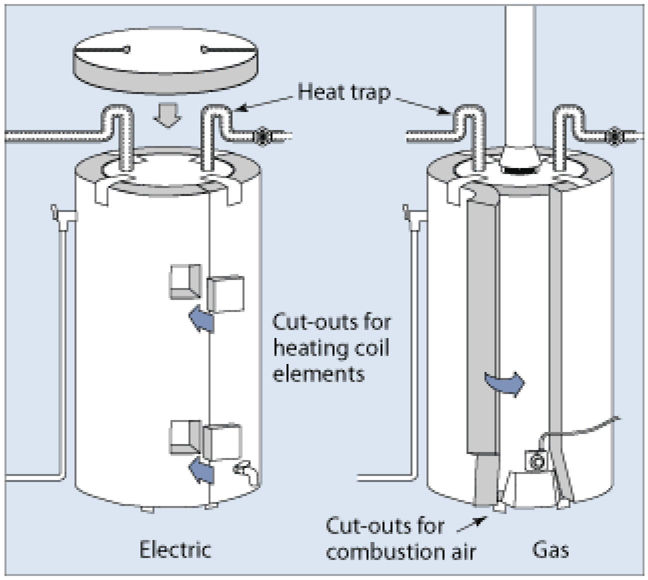
Unless your water heater's storage tank already has a high R-value of insulation (at least R-24), adding insulation to it can reduce standby heat losses by 25%–45%. This will save you around 4%–9% in water heating costs.

If you don't know your water heater tank's R-value, touch it. A tank that's warm to the touch needs additional insulation.

Insulating your storage water heater tank is fairly simple and inexpensive, and it will pay for itself in about a year. You can find pre-cut jackets or blankets available from around $10–$20. Choose one with an insulating value of at least R-8. Some utilities sell them at low prices, offer rebates, and even install them at a low or no cost.

You can probably install an insulating pre-cut jacket or blanket on your electric water heater tank yourself. Read and follow the directions carefully. Leave the thermostat access panel(s) uncovered. Don't set the thermostat above 130ºF on electric water heater with an insulating jacket or blanket—the wiring may overheat.

You also might consider placing a piece of rigid insulation—a bottom board— under the tank of your electric water heater. This will help prevent heat loss into the floor, saving another 4%–9% of water heating energy. It's best done when installing a new water heater.



Insulating a Gas Water Heater Tank

The installation of insulating blankets or jackets on gas and oil-fired water heater tanks is more difficult than those for electric water heater tanks. It's best to have a qualified plumbing and heating contractor add the insulation. If you want to install it yourself, read and follow the directions very carefully. Keep the jacket or blanket away from the drain at the bottom and the flue at the top. Make sure the airflow to the burner isn't obstructed. Leave the thermostat uncovered, and don't insulate the top of a gas water heater tank—the insulation is combustible and can interfere with the draft diverter.

Insulate Hot Water Pipes for Energy Savings

Insulating your hot water pipes reduces heat loss and can raise water temperature 2ºF–4ºF hotter than uninsulated pipes can deliver, allowing for a lower water temperature setting. You also won't have to wait as long for hot water when you turn on a faucet or showerhead, which helps conserve water.

Insulate all accessible hot water pipes, especially within 3 feet of the water heater. It's also a good idea to insulate the cold water inlet pipes for the first 3 feet.

Use quality pipe insulation wrap, or neatly tape strips of fiberglass insulation around the pipes. *Pipe sleeves* made with polyethylene or neoprene foam are the most commonly used insulation. Match the pipe sleeve's inside diameter to the pipe's outside diameter for a snug fit. Place the pipe sleeve so the seam will be face down on the pipe. Tape, wire, or clamp (with a cable tie) it every foot or two to secure it to the pipe. If you use tape, some recommend using acrylic tape instead of duct tape.

On gas water heaters, keep insulation at least 6 inches from the flue. If pipes are within 8 inches of the flue, your safest choice is to use fiberglass pipe-wrap (at least 1-inch thick) without a facing. You can use either wire or aluminum foil tape to secure it to the pipe.

Resources:

1: U.S. Department of Energy, Energy Efficiency and Renewable Energy

