Rocky Mountain Institute's

Home Energy Briefs

#4 SPACE HEATING

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Space heating and cooling account for 45 percent of total home energy use and cost the typical family $677 a year.[1] Space heating alone costs the average homeowner $480 per year, or about 32 percent of the total energy bill.[2] In the Northeast, heating bills can reach $800 or more.[3] The good news is that everyone can take action to save on heating bills. The space heating philosophy among energy-efficiency advocates is that a well-insulated, tightly-constructed home requires little supplementary heating, and retrofit measures that minimize heat loss reduce heating requirements even in old, leaky homes.

Once you have properly insulated and sealed your home, there are several space-heating-related things you can do to make your home more efficient depending on your existing heating system, your climate, and the size of your home. First, although it is a non-renewable fossil fuel, natural gas remains the most economical fuel choice for furnaces, boilers, and in-space heaters. Second, new technology (e.g., active solar heating and geothermal heat pumps) might be an option if you live in certain climates. However, if you live in a small home or apartment, supplementing your heating needs with in-space heaters can also reduce energy costs. This Brief will guide you on these home-heating options and covers:

- **Heat loss and passive heating**;
- **The efficiency of various heating systems, their maintenance requirements, and their costs**;
- **Sizing and installation of new heating systems**; and
- **Considerations about when to replace your existing heating system**.

HEAT LOSS AND PASSIVE HEATING

Heat naturally flows from warmer spaces to cooler ones until the temperatures both in and between the two spaces are equal. Inside the home, warm air rises and leaks out the attic and roof while drawing cold air in through the basement. Your home's shell (walls, windows, doors, foundation, roof, attic, etc.) determines its rate of heat loss, and leaky shells can be responsible for 25–40 percent of the load on your heating system.[4] You can prevent this heat loss by implementing passive heating measures such as improving insulation, sealing leaks, and replacing or reglazing your windows to minimize heat transfer. For more information, see *Home Energy Brief No. 1: Building Envelope*.

Making your home climate-smart so that it naturally harnesses solar energy (also called *passive heating*) can be expensive as a retrofit measure, and is discussed in *Home Energy Brief No. 9: Whole System Design*. Recommended retrofit measures include installing large south-facing windows, adding south-facing thermal mass walls, and installing a sunroom.

SPACE HEATING SYSTEMS

The most common heating systems are furnaces, boilers, and space heaters. New technologies, such as geothermal heat pumps and active solar heating systems, are also available. This section will briefly describe these different heating systems, their efficiencies, maintenance issues, and costs.

Other titles in Rocky Mountain Institute's **Home Energy Briefs** include:

No. 1	Building Envelope
No. 2	Lighting
No. 3	Space Cooling
No. 4	Space Heating
No. 5	Water Heating
No. 6	Cleaning Appliances
No. 7	Electronics
No. 8	Kitchen Appliances
No. 9	Whole System Design

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Furnaces (air systems) and boilers (hot water or steam systems)

Furnaces and boilers are the most common types of heating systems. If you own a furnace or boiler you can save energy by improving the efficiency of your system through better maintenance and minor modifications. A typical gas furnace burns natural gas to heat air inside a winding pipe assembly called a heat exchanger. Cool indoor air mixed with some outdoor supply air is then blown across the heat exchanger with a fan, warming the air, which is then distributed via ducts throughout the home. As such, these systems are also called "ducted warm-air" or "forced warm-air" distribution systems. An electric furnace is similar to a gas furnace except it uses an electric coil or rods instead of a heat exchanger to warm incoming air.

A gas boiler heats water or steam instead of air, which is then circulated through pipes to radiators or baseboards in the home. Various controls such as thermostats and valves turn the system on and off to maintain comfortable indoor temperatures. The advantages of boilers include the ability to regulate the temperature in each room, the avoidance of heat loss through ducted air systems, and the use of the same boiler for domestic hot water (see *Home Energy Brief No. 5: Water Heating*). However, boilers can be slow to warm up and, unlike ducted air, cannot filter air or ventilate your home. Furnaces have the additional advantage of using existing air ducts for central air conditioning. The diagrams below show how conventional furnaces and boilers operate.

Efficiency: The federal minimum efficiency standards for furnaces took effect in 1992, requiring that new furnaces have an AFUE of 78 percent and new boilers have an AFUE of 80 percent. The most energy-efficient new furnaces rated by the U.S. Environmental Protection Agency (EPA) under the voluntary Energy Star® label have an AFUE of 90 percent or higher. Energy Star-rated boilers have an AFUE of 85 percent or higher. Electric furnaces convert 100 percent of electricity to heat.

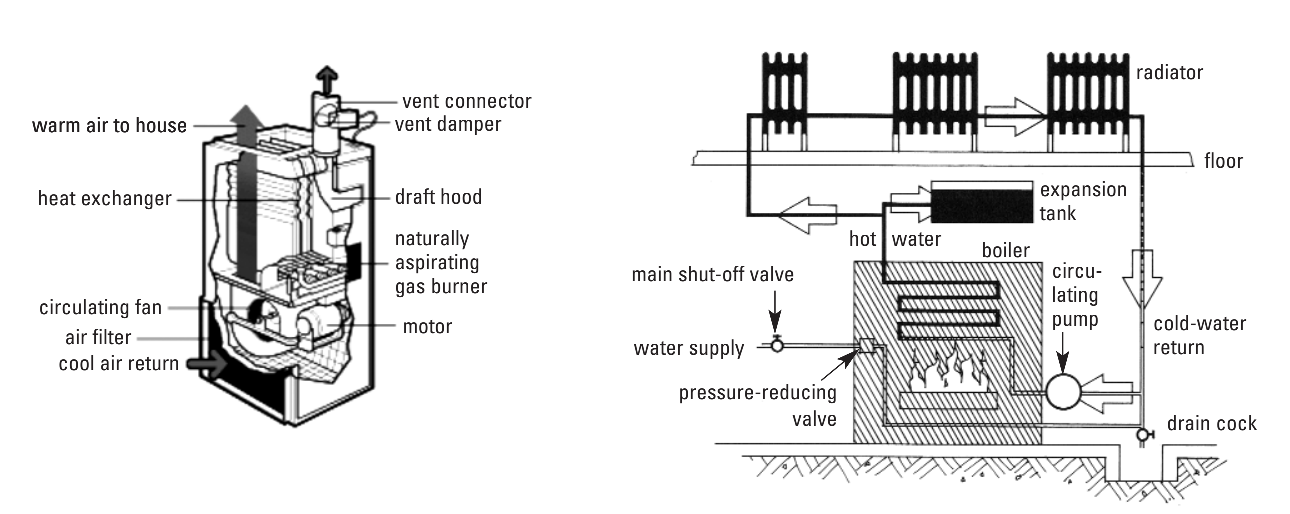
What is the AFUE?

The efficiency of a heating system is measured by the Annual Fuel Utilization Efficiency: the percentage of fuel that is converted to heat, factoring in combustion, seasonal use, and on/off cycling. A heating system technician can estimate the AFUE of your heater.

However, this entails converting non-renewable fossil fuels to electricity in power stations that are typically only 35 percent efficient, and this conversion combined with regular furnace inefficiencies, such as heat losses from ducts, makes electric furnaces an expensive option.

The table on the following page briefly describes the features of a highly efficient furnace and boiler. The aim is to reduce the amount of escaping heat, extract more heat from combustion by-products, and improve on/off cycles.

Figure 1: Typical gas furnace (left) and schematic (right) of a radiator boiler



Source: *Home Energy Magazine* Online, March/April 1996, http://homeenergy.org/archive/hem.dis.anl.gov/eehem/96/960309.html (left).
Pahl, Greg, *Natural Home Heating*, p. 21. Reprinted by permission of Chelsea Green Publishing (right).

Maintenance: There are a number of things you can do to improve the efficiency and life of your furnace or boiler:

- **Seal leaky ducts (furnaces):** Leaky ducts are notorious for decreasing the efficiency of warm-air furnaces and typically decrease their efficiencies by 20–30 percent.[6] Seal duct joints and seams with mastic, and insulate hot air ducts that pass through unheated spaces with fiberglass.
- **Insulate supply and return pipes (boilers):** Hot water and steam pipes passing through unheated areas should be wrapped with insulation. For steam pipes with wall thicknesses of at least three inches, use high temperature-rated pipe insulation, such as fiberglass. Foam insulation with a thickness of a half-inch is suitable for hot water pipes.
- **Manage the pilot light:** Newer gas furnaces and boilers are equipped with electronic ignitions, which save $30–40 annually in gas bills. If you have an older model and can safely turn the pilot on and off yourself, consider turning it off in the warmer seasons for additional savings ($2–4 per month).
- **Clean or change air filters (furnaces):** When dust blocks airflow, fans have to work harder which, in turn, drives up energy consumption and raises bills. For under $10 you can buy a reusable filter that lasts 1–2 years. It should, however, be vacuumed monthly. Disposable filters are also available from hardware stores.
- **Install radiator reflectors (boilers):** This avoids heat transfer from the radiator to the adjacent exterior wall. You can make reflectors from foil-covered cardboard, which is available at many building supply stores. The reflector should be installed behind your radiator and be the same size as it or slightly larger.
- **Clean registers (furnaces):** Warm-air registers should be cleaned regularly and not obstructed by drapes or furniture.
- **Ensure thorough servicing:** Gas furnaces and boilers should be tuned every two years while oil units should be tuned annually. Make sure the technician tests the vent for leaks; leaky vents can let combustion gases into the home. They may also recommend efficiency modifications such as reducing the nozzle (oil) or orifice (gas) size, installing a new burner and a motorized flue damper (see below), or replacing the pilot light with an electronic ignition. Ask them to explain and quantify AFUE improvements if possible.
- **Install a vent damper in the flue:** By shutting the vent during the off cycle, the damper prevents heat from being drawn up the flue and lost outside.
- **Install zone control radiators:** Your boiler distribution system can be retrofitted to provide zone control for different areas of large homes. The old, large cast iron radiators can be replaced with space conserving baseboard radiators, wall-hung radiators, or fan coils.
- **Install a programmable thermostat:** These cost $30–100 and allow you to pre-set a heating schedule while maintaining comfortable temperatures (remember, look for the Energy Star label). You can turn the heat down during sleeping hours and when the home or rooms are unoccupied. You'll shave 2 percent off your heating bill with every degree that you lower the thermostat. For example, turning it down from 70ºF to 65ºF at night and back up to 75ºF during the day can save $80–100 per year.[7]

Table 1: Characteristics of a high energy-efficient furnace or boiler

second heat exchanger	An additional heat exchanger through which hot flue gases pass after leaving the conventional heat exchanger, thus capturing more combustion energy from the source fuel
automatic vent damper	A device installed at the end of the draft hood of an appliance that automatically closes the vent when the furnace or boiler is off and restricts heated air from going up the vent
forced draft system	A mechanical system that moves flue gases through an appliance and creates more efficient heat transfer in the heat exchanger
intermittent ignition device (IID)	Replaces the constantly-burning pilot light used in older models. When the thermostat calls for heat, the device produces a spark to light the pilot, which in turn lights the heating system's main burner
ECM Fan blower motor (furnace)	Electronically commuted motors are more efficient than standard fan blower motors for pushing heated air through the ductwork. People who like to run their furnace fans all year long for comfort or air cleaning reasons would save about $250 a year with an ECM motor[5]

Source: RMI compilation

Cost: The cost of a furnace or boiler depends on the size of the system and the installation requirements. Most boilers and furnaces have a heating capacity of 40,000 to 300,000 Btus per hour, therefore you can expect to pay anywhere between $2,000 and $10,000, including installation. Highly efficient models will cost more to purchase (and possibly install). But because they will cost less to operate, are typically cheaper in the long run. To find out which manufacturers are making the most efficient furnaces and boilers according to size, heating capacity, and

What is a Btu?

Heating capacity in British thermal units per hour (i.e., the amount of energy needed to raise 1 pound of water 1 degree Fahrenheit). As a comparison, 1 Btu is the heat given off by completely burning a single match.

fuel source, and how much they cost, refer to either the Energy Star, website at www.energystar.gov or the American Council for an Energy-Efficient Economy's website at www.aceee.org.

In-space heaters

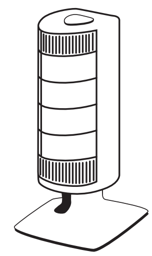
In-space heaters are designed to provide heating in small, specific areas. They are often considered a last resort in cases where central heating systems are inappropriate or unavailable. However, when in-space heaters are used in homes that are well-insulated or small, or in homes where only one or two rooms are occupied, they will allow you to lower the temperature of your central heating system, maintain comfort, and use less energy. For example, air temperatures can be lowered 6ºF to 8ºF in homes that have radiant spot heating. On mild days, central heating can be turned off altogether.

In-space heaters can be divided into *convectors* and *radiant* heaters. *Convectors* transfer heat from the heating element or burner into the air and circulate it throughout the room. Baseboard heaters, wall furnaces, floor furnaces, and most gas and oil room-heaters are examples of convectors. *Radiant heaters* predominately heat only the objects (including people) at which they are directed and not necessarily the air in the room. An easy way to understand this concept is to stand in direct sunlight on a cold day. The radiant energy from the sun warms you even though the air temperature stays the same. Surface combustion radiant heaters include radiant ceilings and floors and surface combustion room heaters. Low-intensity electric and gas infrared heaters, and high-intensity electric and gas infrared heaters, are examples of reflector-focused radiant heaters.

In-space heaters come in a range of shapes, sizes, and heating capacities, and they use a variety of fuels. The AFUE of electric heaters is 100 percent whereas combustion heaters range from 56 to 71 percent for standard models, and up to 82 percent for those with efficiency features such as induced vents and automatic pilot lights. Most portable electric heaters, such as electric quartz heaters (pictured), generate up to 5,000 Btu per hour, the maximum allowed by industry safety standards. This is enough heat to warm mid-sized rooms. Baseboard electric heaters are often installed in the wall or along the floor and can generate up to 50,000 Btu per hour.

Figure 2: In-space heaters

Electric quartz heaters are reflector-focused heaters. They cost $40–70, and dual wattage allows two heat settings.



A free-standing gas heater (below) can heat several rooms. A 30,000 Btu model would cost about $1,000 plus installation.

Source: World Marketing (bottom)

Table 2: Opportunities for improving the efficiency of in-space heaters

regular maintenance	Built-in heating facilities (connected to gas or oil pipe) should be regularly serviced to maintain working order
programmable thermostats	Choose modulating thermostats to reduce overshooting and provide better comfort with less energy
combustion efficiency	Induced draft on vented systems to move flue gases through the appliance and create more efficient heat transfer in the heat exchanger
reset central thermostat	Reduce thermostat by 3–8ºF when using an electric or gas radiant heater for comfort
timers and occupancy detectors	Control radiant heaters with occupancy detectors and/or timer settings to minimize on-time while satisfying comfort needs
sizing	Minimize quantity and size of heaters by choosing heaters that focus the heat appropriately for the task area geometry and surface temperature requirements
pilot light	Gas appliances should be installed with an automatic pilot light
positioning	Orient portable heaters to provide optimal heating

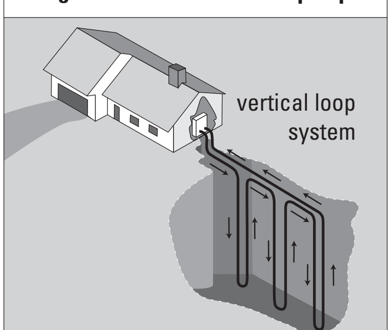
Source: RMI compilation

What is Energy Star®?

Energy Star® is an EPA-backed program that sets strict efficiency guidelines for home products. For products that meet these guidelines, an Energy Star label, shown below, is often placed on the product. Look for this label on the product or in its specifications to ensure you are purchasing a high-efficiency product.

Although they are cheap to install, they are expensive to run, which makes them a less desirable option. Natural gas in-space heaters are self-contained heating appliances that draw in combustion air and discharge the by-product through a vent to the outside. Note that unvented combustion heaters should be avoided because their exhaust can leak indoors. Gas units are generally mounted on the wall or are free standing, and both types are connected to a gas line. Most combustion heaters do not require electricity unless they operate fans for better convective heat distribution. Natural gas heaters range in size from 5,000 to 60,000 Btu per hour.

Figure 3: Geothermal heat pump



Source: Adapted from Tool Base Services, Geothermal Heat Pumps, www.toolbase.org/tertiaryT.asp?TrackID=&DocumentID=2093

Newer technology: electric air-source and geothermal heat pumps

A heat pump is an electrical device that extracts heat from one place and transfers it to another. It transfers heat by circulating a refrigerant through a cycle of alternating evaporation and condensation. In winter, a heat pump removes heat from the outside air and transfers it inside the home. In summer, the process is reversed. Heat pumps are an economical and energy-efficient way to provide space heating and cooling. You can even retrofit your existing distribution system (ducts or pipes) with a heat pump. Residential heat pumps can be air-source (air-to-air) systems, which draw heat from the air, and ground-source (earth energy) systems, that draw heat from the ground or ground water. Although both systems use electricity, more than three times the energy they consume is converted into heating or cooling output. For additional information on heat pumps, see *Home Energy Briefs No. 3: Space Cooling* and *No. 5: Water Heating*.

The efficiency of an air-source heat pump is measured by its heating season performance factor (HSPF) and seasonal energy efficiency ratio (SEER). Federal standards require air-source heat pumps to have a minimum HSPF of 6.8 and a minimum SEER of 10. However, heat pumps with SEERs around 14.0 and HSPFs around 9.0 are usually available. Look for heat pumps with an Energy Star label. Air-source heat pumps typically cost $1,500–5,000, depending on the size and installation, and have a heating output of up to 120,000 Btu/hr. Air-source heat pumps are only effective in moderate climates, however. Where temperatures fall below freezing, air source heat pumps typically require a back-up heating system.

Geothermal heat pumps

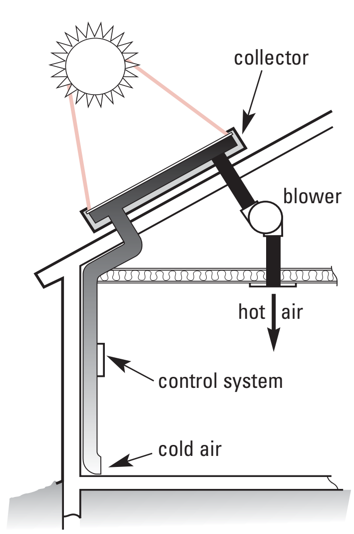
According to the EPA, geothermal heat pumps can save the average homeowner 30–70 percent in heating costs and 20–50 percent in cooling costs. This could save some homeowners up to $400 per year or more. Geothermal efficiency is measured by a coefficient of performance (COP) for heating and energy efficiency ratio (EER) for cooling. Geothermal systems with Energy Star labels will have a COP between 3.3 and 3.6 and an EER of 14.2–16.2.

Geothermal systems operate effectively in any climate, but the greatest operational savings are realized in climates that have extreme heating and cooling loads and generate high energy bills. They are typically twice as expensive to install as other central heating options, and can cost anywhere from $7,500 to $15,000. The heating capacity can reach up to 130,000 Btus per hour. Many utilities offer cash rebates to help lower these high initial costs.

New technology: active solar heating systems

In contrast to passive solar systems, active solar systems use supplemental electrical equipment, such as pumps or fans, to move heat around your home. In an active system, solar collectors harvest the sun's energy to heat either liquid or air that is then pumped or blown through pipes or ducts to your living space.[8] Liquid systems are similar to boilers in that they can provide space heating and hot

Figure 4: Active solar hot-air systems
An active solar hot air system uses air as the medium for collecting and distributing solar heat for your home.



Source: Adapted from Pahl, Greg, *Natural Home Heating*, p. 69.
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water, and some models combine these systems. Hot air systems operate much like furnaces. Active systems can be expensive to install and require electricity to operate. An active system will not provide all your heating needs, especially in cold, cloudy, northern climates where a backup heating system is required. In fact, solar heating systems are often designed to work in combination with other heating systems, which offers a lot of flexibility. Active solar heating systems are good choices in climates that have long heating seasons with high proportions of sunny days and above average utility and fuel prices. Active solar heating systems cost between $5,000 and $18,000 and, as with geothermal heat pumps, the operational savings are exceptional. There is also the option of installing a one-room solar heater for about $800. To find out more, contact an experienced solar heating designer.

SIZING AND INSTALLATION OF HEATING SYSTEMS

Properly sized equipment and installation optimizes the benefits of new or modified heating systems. Oversized systems lead to overuse of on and off cycles, surges in air or water pressure, and the accumulation of moisture in the heat exchanger, which can damage the unit over time. Undersized systems won't adequately heat the home. When requesting a size and installation quote for furnaces, boilers, permanently mounted in-space heaters, and heat pumps, choose a contractor that follows ASHRAE (www.ashrae.org) and Air Conditioning Contractors of America (www.acca.org) guidelines. This will help ensure that climate, size, and orientation of the home, as well as heat loss from the building shell and occupant lifestyles are considered in the contractor's calculations. Specifications and industry standards for correctly selecting and installing equipment are set out in Manual J (*Residential Load Calculation*) and Manual S (*Residential Heating and Cooling Equipment Selection*). Make sure your contractor is familiar with these manuals and is licensed in your state, and expect to pay more for good service.

REPLACING A HEATING SYSTEM: SOME CONSIDERATIONS

When is the right time?

If your furnace is older than 10–15 years, and your boiler is older than 20 years, then a new heating system will be at least 30 percent more efficient and will pay for itself in 5–10 years. If you have electric furnace or electric baseboard heating throughout your home, then switching to natural gas can save you money. Finally, if your annual heating and cooling costs are astronomical, then con-

Table 3: Guidelines for estimating AFUE of gas heating systems

Type	Description	AFUE
conventional, older furnaces and boilers	• Natural draft that creates a flow of combustion gases • Continuous pilot light • Heavy heat exchanger	68–72%
mid-efficiency furnaces and boilers	• Exhaust fan controls the flow of combustion air and combustion gases better • Electronic ignition (no pilot light) • Compact size and lighter weight to reduce cycling losses • Small-diameter flue pipe	80–83%
high-efficiency furnaces and boilers	• Condensing flue gases in a second heat exchanger for extra efficiency • Sealed combustion	90–97%[9]
direct vent wall heater	• Vent • Sealed combustion • Pilot light or electric ignition	73–82%
free standing room heaters	• Vent • Pilot light or electric ignition	65–71% or 82%*

* With induced vent.

Source: RMI compilation

sider augmenting your heating system's capabilities with in-space heaters or looking into heat pumps and active solar heating. Remember, your best investment choice is to properly insulate and seal your home.

What fuel to use?

Natural gas is the most popular fuel for heating systems for several good reasons, including the following:

- Natural gas is generally cheaper than other fuels. For example, in California, where utility and fuel is more expensive than in most other states, a small gas furnace would cost $16–40 per month to operate, whereas an electric furnace would cost $110 per month to operate.[10]

Equation 1: Annual savings by upgrading to a higher AFUE
Annual Savings = (A – B)/A × C
Where, A = AFUE of new (or upgrade) equipment B = AFUE of existing equipment C = Annual heating cost For example: Annual heating cost = $480 AFUE of existing conventional gas furnace = 68% (0.68) AFUE of new mid-efficiency gas furnace = 82% (0.82) Annual Savings = (0.82 – 0.68)/0.82 × 480 = $82/year
If would like to calculate expected savings from switching between fuels and/or between systems, the following websites are useful: • *Home Energy Magazine*: http://hem.dis.anl.gov/eehem/96/960309.html • Heating with Gas EnerGuide: http://oee.rncan.gc.ca/publications/infosource/home

- When the entire cycle of producing, transporting, and using fuel is considered, natural gas is delivered to the consumer with a total energy efficiency of about 90 percent, compared with about 20 percent for electricity.
- Natural gas heating systems and appliances, such as stoves and water heating systems, can be among the most efficient available, and natural gas burns cleaner than oil and wood.

Should you upgrade to a new system with a higher AFUE?

If you are thinking of converting to a more efficient heating system, you can calculate expected savings by using Equation 1. To complete the equation, you will need to know your annual heating costs (look at your gas and electric bills during the last few heating seasons), the AFUE of your current heating system (ask a heating system technician or use the guidelines in Table 3 on previous page), and the AFUE of the new heating system you are considering (ask a retailer or heating system technician or use the guidelines in Table 3). Then plug all three numbers into Equation 1 to estimate your annual savings.

What do I need to know when changing heating systems?

When comparing heating systems, you should consider safety (i.e., propensity to leak gases, catch alight, etc.), and costs to install, maintain, and operate the system. To simplify the selection process, these factors can be combined into the total cost of ownership over a period of years. Table 4 compares a selection of central heating systems. Note that it does not include in-space heaters or active solar heaters. Rather, it illustrates where one can expect costs and savings for certain heating systems. Geothermal heat pumps are the most cost-effective option in some cases.

Will you save by supplementing central heating with an in-space heater?

The energy efficiency of in-space heaters is more a function of their ability to deliver heating when and where it is needed, rather than merely the conversion efficiency of fuel to heat (AFUE). Energy savings from in-space heaters are derived from only heating the rooms you occupy regularly and allowing you to lower your thermostat. If your central heating system is an electric furnace, it is almost certain you will save money by using in-space heaters. However, if you have a large family and need more than three in-space heaters operating at one time, a central heating system may be as cost effective as using in-space heaters.

Table 4: Typical life-cycle costs of three central heating systems[11]

	Safety	Installation cost	Operating cost	Maintenance cost	Life-cycle cost
combustion-based	A Concern	Moderate	Moderate	High	Moderate
air-source heat pump	Excellent	Moderate	Moderate	Moderate	Moderate
geothermal heat pump	Excellent	High	Low	Low	Low

Source: Geothermal Heat Pump Consortium, www.geoexchange.org/about/compare.htm

SUMMARY

Investing in space heating systems is an expensive and long-term decision. Think carefully about your options. The first step is to determine whether (and where) your home loses heat through its building shell. The second step is to improve the efficiency of your existing heating system, especially if it is a furnace, a boiler, an installed in-space heater, or a heat pump. When purchasing a new heating system, think about your climate, the size of your home, your budget, and local utility and fuel costs; and make sure you weigh the cost of investment against the long-term costs to operate the system.

ADDITIONAL RESOURCES

Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE) — Comprehensive and useful selection of fact sheets on all aspects of space cooling, including a complete Home Energy Booklet that can be downloaded for free (www.eere.energy.gov/consumerinfo/factsheets.html).

American Council for an Energy-Efficient Economy (ACEEE) — A nonprofit organization that focuses on advancing energy efficiency. They list today's most efficient home appliances on their website (www.aceee.org/consumerguide/mostenef.htm).

Natural Home Heating: The Complete Guide to Renewable Energy Options, Greg Pahl, Vermont: Chelsea Green Publishing, 2003. www.chelseagreen.com

NOTES

1–3. EIA (Energy Information Administration), "Residential Energy Consumption Survey: Consumption and Expenditure Data," (Washington, DC: EIA, 2001), www.eia.doe.gov/emeu/recs/recs2001/detailcetbls.html#total.

4. Minnesota Department of Commerce, "Saving Money With Trees" (St. Paul, MN: MN DOC, Undated), p.1, www.state.mn.us/cgi-bin/portal/mn/jsp/content.do?subchannel=-536881511&id=-536881350&agency=Commerce.

5. Pacific Gas and Electric Company, "Selecting a Heating System for Your Home," (Undated), www.pge.com/res/energy_tools_resources/heating/select.

6. A.C.S. Hayden, "Choosing a Heating System that Saves Energy," *Home Energy Magazine* (March/April, 1996), http://hem.dis.anl.gov/eehem/96/960309.html.

7. DOE (Department of Energy), "Thermostats and Control Systems," (Washington, DC: EERE, 2004), www.eere.energy.gov/consumerinfo/heatcool/hc_thermostats.html.

8. Greg Pahl, *Natural Home Heating: The Complete Guide to Renewable Energy Options*, (Vermont: Chelsea Green Publishing, 2003).

9. DOE, "Energy Efficient Gas Heating for the Home," (Washington DC: EERE, 2004), www.eere.energy.gov/consumerinfo/factsheets/nb3.html.

10. Flex Your Power (California Statewide Energy), "Energy Usage Costs for Household Appliances," (Undated), http://fypower.org/res/energy_costs.html.

11. Geothermal Heat Pump Consortium, "Comparing Systems," (Undated), www.geoexchange.org/about/compare.htm.

Contact your local utility or energy office for information on rebates that may be available in your area on the purchase of new energy-efficient appliances. This publication is intended to help you improve the resource efficiency of your home. You should use your best judgment about your home, and seek expert advice when appropriate. Rocky Mountain Institute does not endorse any products mentioned and does not assume any responsibility for the accuracy or completeness of the information in this Brief. Written by Ramola Yardi, Andy Smith, and Katherine Wang.

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