HSB

A Munich Re company

# Home heating systems – 101

HSB, a Munich Re company, is a technology-driven company built on a foundation of specialty insurance, engineering, and technology, all working together to drive innovation in a modern world.

## Energy use and fuel costs of heating systems

Space heating is the largest home energy culprit, accounting for over 40% of your total energy consumption, according to the U.S. Energy Information Administration. There are two major cost components of the heating systems: the energy efficiency of the heating equipment and the fuel costs. When we discuss efficiency, which may have differing measurement systems, they all are based on a ratio of input energy to output energy. A general description of five mainstream heating systems can improve your understanding of the annual operating costs of these systems.

### 1. Forced-air systems

Furnaces create warm air by burning fuel inside a heat exchanger. The outside of the heat exchanger is surrounded by air, which is circulated through the house by ductwork. Historically, these have been the most common and usually least expensive heating systems in homes. Furnaces can last 15 to 20 years, but by 15 years, replacement with a newer, higher-efficiency furnace is often a better investment. These are “fired” with natural gas, propane, or various types of fuel oil. Gas-fired furnaces (propane or natural gas) have the lowest maintenance costs. Oil furnaces will likely have an annual maintenance cost for oil residue removal.

### 2. Hot-water boilers

Hot-water boilers are the second most common heating systems for homes. The hot water is pumped through the house to radiators throughout the house. This type of heating system, used in homes, is second in popularity to forced-air systems. Hot-water boilers are “fired” with natural gas, propane, or fuel oil. Gas-fired units need minimal service. Oil-fired boilers will likely have an additional annual cost for oil residue cleaning of the cast iron sections.

## 3. Steam boilers

Steam heating is one of the oldest heating technologies. The process of creating steam in this type of system is less efficient than more modern hot-water systems because of the higher temperatures and heat losses. Steam systems need regular maintenance, usually by a professional, to maintain proper water quality and corrosion resistance, as some amount of air is always present in the piping. This can add a significant maintenance cost. Gas-fired units need minimal burner service. Oil-fired boilers will usually have an additional annual cost for oil residue cleaning of the boilers.

## 4. Electric heat

Baseboard electric resistance heating is 100% energy efficient, as all the incoming electric energy is converted to heat. Zoning room by room is readily achieved, and rooms with less use can have slightly lower temperature set-points. Response time to load changes is slightly longer than "fired systems." Professional maintenance costs of this equipment are minimal. A general homeowner vacuum cleaning during the summer, like hot-water systems, is usually all that is required. If electricity is the only choice, heat pumps are preferable in most cases. (See topic 5 heat pumps.)

**Boilers and furnaces – understanding efficiency ratings**

Boiler and furnace energy efficiencies can be reviewed as a percentage (of the quantity of fuel to heat ratio), as identified below.

a. Older, low-efficiency heating systems: operate between 56% and 70%.

b. Mid-efficiency heating systems are the most common and operate between 80% and 83%.

c. High-efficiency heating systems operate as high as 90% to 98.5%. Condensing boilers and furnaces are recent entries into the residential heating market. There are wide-ranging preliminary life expectancies, and many have been requiring major repairs or replacement between seven and 12 years (on average), due to how they operate. This equipment may require a professional service every year.

## 5. Heat pumps

Like a refrigerator, heat pumps use electricity to transfer heat from a cool space to a warm space. Because there is no burning of fuel, the efficiency is measured as a percentage of the amount of electrical energy input compared to the energy output, a ratio known in this application as the Coefficient of Performance (COP).

Sizing of the heat pumps is determined by the heating requirements of the residence. The best application for heat pumps is in well-insulated homes with double-pane windows. Note that heat pumps also provide air conditioning capacity. (Air conditioning costs and savings are not reflected in the heating estimates.)

There are two basic types of heat pumps for residential use, termed "Air Sourced" (ASHP) and "Ground Sourced" (GSHP). Both have an average ENERGY STAR required minimum COP requirement of 3.6. For every unit of energy consumed, 3.6 units of energy are released, which means these have an efficiency of 360%, almost too good to be true.

Air-sourced heat pumps remove heat from cold outdoor air and have a high efficiency in moderate climates but lower efficiencies as outdoor air temperatures drop. In extreme cold temperatures (below zero Fahrenheit). the COP can drop to 1. At this point, you are essentially using electric heat; so, the efficiency is 100%, but the energy cost is high.

Ground-sourced heat pumps are more energy efficient due to the use of more constant underground temperatures to provide heating (and cooling). Installation involves drilling deep wells down to approximately 500 feet or burial of hundreds of feet of piping at depths greater than 5 feet. As a result, these are more costly to install. A general cost estimate, depending on system size and location, should be in the range of $20,000 to $35,000. These can be installed in severely cold climates as far North as Southern Alaska, providing heat without large variations in COP (not recommended in permafrost locations).

Either type of heat pump is ideal for three-season room additions or cottages (spring, summer, fall). However, if the location is intended for winter season use (like a ski retreat), GWHP are generally preferred.

Regular maintenance by a professional is recommended twice a year for the best equipment performance.

Because both types of heat pumps transfer rather than generate heat, they can efficiently provide comfortable temperatures for a home without any on-site fuel burning Green House Gas (GHG) emissions.

Current regulations in many states and large metropolitan cities have embraced heat pump systems to reduce GHG creation. In the state of California, new home construction does not allow installation of fuel-fired equipment for heating. Energy Contractors will install these on a lease basis. Manufacturers will provide financing for these systems. There are many subsidies available from energy providers and state and local governments to reduce installation costs. In addition, the Federal Government provides a tax credit of 22% of the installation costs (IRS Form 5695). Evaluation of heat pumps at your residence should be on your radar in the future.

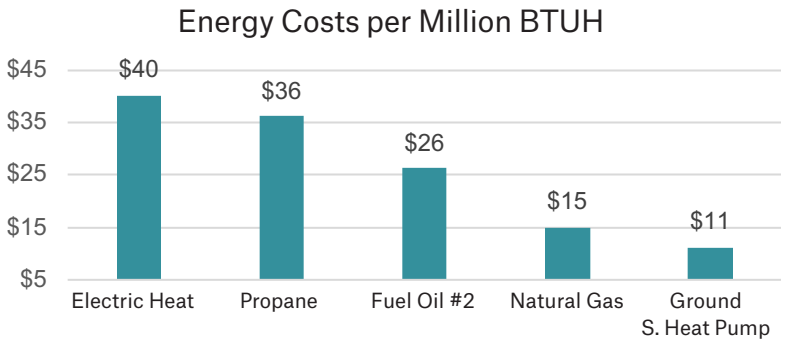
## Energy savings and fuel costs

Using ENERGY STAR heating appliances is the simplest method to ensure the home is using high-efficiency heating equipment. High-efficiency heating systems will, on average, reduce the operating costs by approximately 20%.

## National average fuel cost residential

For comparative information: an estimated average of U.S. homes uses approximately 32 million BTU per year for Heating by the U.S. Energy Information Administration (https://www.eia.gov/tools/a-z/index.php?id=r).

Additional information is available at (https://www.energy.gov/energysaver/furnaces-and-boilers).




Watch for additional articles that further examine equipment servicing requirements and failure modes of the most common home heating systems.



**HSB**
One State Street
P.O. Box 5024
Hartford, CT 06102-5024
Tel: (800) 472-1866

HSB.com



2022-031 (Revised 9/22)