SATURN
RESOURCE MANAGEMENT

Heat Pumps

Heat pumps are difficult to classify because they provide both heating and cooling for the home. Heat pump compressor systems use a refrigerant to move heat from the outdoors to indoors during the heating season, and from the indoors to out-

doors during the cooling season. A reversing valve changes the direction of the refrigerant flow depending on the need for heating or cooling.

Heat pumps are the most efficient type of electric heat, particularly for the southern United States. Heat pumps can deliver one-and-a-half to four times more heat energy to a home than they consume because heat pumps move heat rather than converting heat from a fuel. Unfortunately, the superior energy efficiency of heat pumps' is often reduced by poor installation, distribution losses, and neglected maintenance.

See "Heat-pump Efficiency Ratings" on page 184

Heat pumps are controlled by two-stage thermostats for heating. The first stage is the compressor of the heat pump; then, if the compressor fails to keep up with the home's heat loss, electric resistance coils (the second stage of heat), come on to assist the compressor. Heat pumps should have an outdoor thermostat that prevents the less efficient electric resistance heat from coming on until the outdoor temperature is below 40°F.

Classifying Heat Pumps

There are two common types of heat pumps, air-source heat pumps and geothermal heat pumps. Air-source heat pumps transfer heat between the home and the outdoor air. Geothermal heat pumps transfer heat between the home and the ground or an outdoor water source.

Another way to classify heat pumps is by their heat source and their heat sink. The heat source is where the heat-pump collects the heat. The heat sink is the indoor heat-distribution medium (water or air) that accepts the heat pump's collected heat. For example, an air-source heat pump that uses a forced-air distribution system would be classified: air-air (source = air; sink = air).

Types of Heat Pumps by Source and Sink

Source-Sink	Typical System Description
Air-Air	Outdoor air-heated evaporator with indoor condenser fan-coil (ductless mini-split)
Air-Water	Outdoor air-heated evaporator with indoor radiant slab
Water-Water	Ground coil (closed or open-loop) with indoor radiant slab
Water-Air	Ground coil (closed or open-loop) with forced-air ducts

Air-source heat pumps — Air-source is the most common type of heat pump, comprising more than 85% of residential heat pumps. Air-source heat pumps employ two coils, one outdoors and one that conditions indoor air. Both coils are made of copper tubing with aluminum fins to aid heat transfer. Fans blow air through these coils.

Electric heat pumps work like mechanical air-conditioning systems. In fact, a heat pump is almost identical to an air conditioner, except for a reversing valve that permits the reversal from heating to cooling.

In the heating mode, the outdoor coil refrigerates the air to harvest heat. The refrigerant brings the collected heat to the indoor coil and releases the heat to the circulating indoor air. In cooling mode, the process is reversed. The indoor coil collects heat from indoor air, and the outdoor coil releases the heat to outdoor air.

Like air conditioners, air-source heat pumps are available as centralized units with ducts or as room units. Most residential heat pumps are split systems with indoor and outdoor units. Room heat pumps are more efficient than central units because they have no ducts and are factory-charged with refrigerant. Mini-split heat pumps are a centralized air-source heat-pump system

without ducts. One outdoor unit serves the mini-split system, which has one or several indoor fan-coil units.

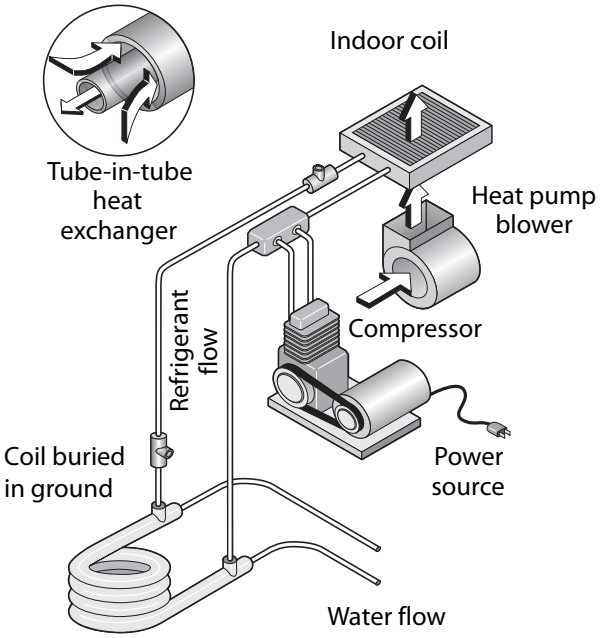
Geothermal heat pumps — Geothermal heat pumps use the refrigeration cycle to transfer heat between the home and the ground or an outdoor body of water to heat or cool the home. Geothermal heat pumps, like air-source heat pumps, work best in well-insulated and airtight homes because they provide heat at a relatively low temperature. Geothermal heat pumps are considerably more efficient than air-source heat pumps because of the ground's moderate and consistent temperatures. But they're also considerably more expensive to purchase and install than air-source heat pumps.

The two most common types of geothermal heat pumps are ground-source heat pumps (also called closed-loop geothermal heat pumps or ground-coupled heat pumps), and water-source heat pumps (also called open-loop ground-source heat pumps, or groundwater heat pumps).

Closed Versus Open Loops — Closed-loop heat pumps collect the earth's heat with a looped ground coil — a buried, sealed loop of pipe circulates a water-antifreeze solution between the ground and the heat pump. During the heating cycle, the heat pump removes heat from the circulating water and uses it to heat the home. The cooled water recirculates through the warmer ground, collects more heat, and then returns again to the heat pump to deliver its collected heat to the home. This process is reversed for the cooling cycle.

Open-loop geothermal heat pumps use water as their heat source. A pump moves water from a well or nearby water source and circulates the water through the heat pump, where the water is refrigerated, removing some of its heat. The cooler water is returned to the source as more water is drawn from the source.

Geothermal Heat Pump



Geothermal heat pumps circulate water from a well or recirculate a water-antifreeze solution through a ground coil. During the heating cycle, the heat pump moves heat out of the circulating water and into the home through the indoor coil.

Closed-loop ground-source heat pumps collect the earth's heat with a ground coil — a buried, sealed loop of pipe with water circulating to and from the heat pump. During the heating cycle, the heat pump removes heat from the circulating water. The cooled water recirculates through the warmer ground, collects more heat, and then returns again to the heat pump to deliver its collected heat.

Heat-pump Efficiency Ratings

Heat-pump efficiency is rated in a number of ways. The most common are Coefficient of Performance (COP), Heating Seasonal Performance Factor (HSPF), Energy Efficiency Ratio (EER), and Seasonal Energy Efficiency Ratio (SEER).

COP is oldest and most common rating. COP tells you how many times more efficient a particular heat pump is compared to electric resistance

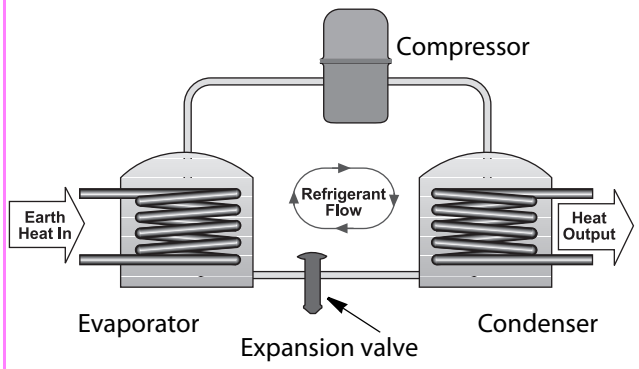
(100%). Heating COPs range from 1.5 to 4, depending on climate, design, and installation. A COP of 1.6 corresponds to 160% efficiency, and means that the heat pump delivers 1.6 kilowatt-hours (kWh) of heat for every kWh of electricity it consumes. An air-source heat pump's COP is less in the northern U.S. compared to the southern U.S. because air closer to the equator contains more usable heat.

The HSPF rates the heating efficiency of a heat pump and is listed on the Energy Guide label of every heat pump sold in the United States. The HSPF includes both the very efficient heating done by the compressor and the less efficient heating done by the electric resistance elements. The HSPF gives the number of British thermal units (BTUs) that the heat pump delivers for each watt-hour of electricity it consumes. The most efficient heat pumps have an HSPF of around 10.

EER rates the cooling efficiency heat-pumps at specific temperature and humidity conditions. SEER is similar to EER but is measured over a range of outdoor temperatures to account for seasonal variations. EER and SEER are measured in roughly the same way as HSPF, but they rate the number of BTUs removed from the home for each watt-hour of electricity they consume.

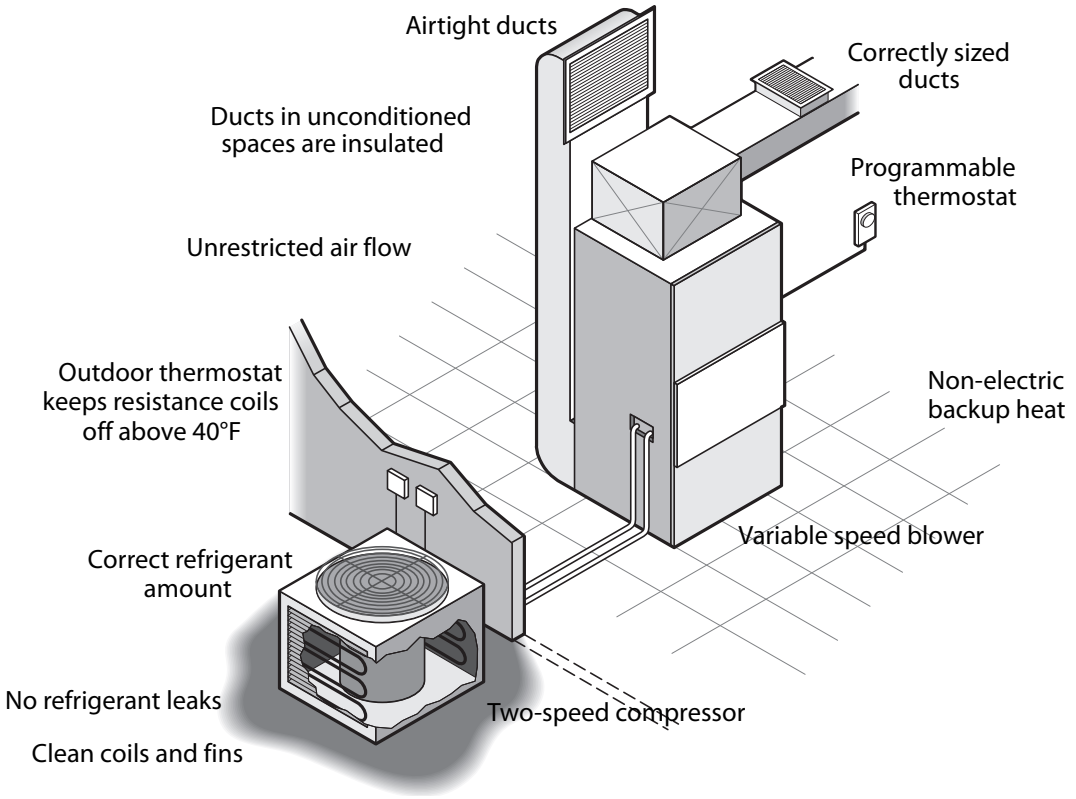
Use heat-pump efficiency ratings to compare the efficiency between different units. Because of the wide variety of operating conditions, efficiency ratings aren't useful to estimate the actual amount of energy the unit consumes.

Heat Pump Refrigeration Cycle



Heat from a ground loop or water source is transferred to indoors by a refrigeration system.

Heat-Pump Performance Enhancements



The COP or SEER of heat pumps varies depending on their type, the quality of their installation, and enhancements like programmable thermostats and variable speed motors.