There are two common types of heat pumps: air-source heat pumps and geothermal heat pumps. Either one can keep your home warm in the winter and cool in the summer. An air-source heat pump pulls its heat indoors from the outdoor air in the winter and from the indoor air in the summer. A geothermal heat pump extracts heat from the indoor air when it’s hot outside, but when it’s cold outside, it draws heat into a home from the ground, which maintains a nearly constant temperature of 50° to 60°F.

An air-source heat pump can provide efficient heating and cooling for your home, especially if you live in a warm climate. When properly installed, an air-source heat pump can deliver one-and-a-half to three times more heat energy to a home compared to the electrical energy it consumes. This is possible because a heat pump moves heat rather than converting it from a fuel, like in combustion heating systems.

**How They Work**

You might be wondering how an air-source heat pump uses the outdoor winter air to heat a home. Believe it or not: heat can be harvested from cold outdoor air down to about 40°F. And this can be accomplished through a process you’re probably already familiar with — refrigeration.

Basically, a heat pump’s refrigeration system consists of a compressor and two coils made of copper tubing, which are surrounded by aluminum fins to aid heat transfer. The coils look much like the radiator in your car. Like in a refrigerator or air-conditioner, refrigerant flows continuously through pipes, back and forth from the outdoor coils. In the heating mode, liquid refrigerant extracts heat from the outside coils and air, and moves it inside as it evaporates into a gas. The indoor coils transfer heat from the refrigerant as it condenses back into a liquid. A reversing valve, near the compressor, can change the direction of the refrigerant flow for cooling as well as for defrosting the outdoor coils in winter.

When outdoor temperatures fall below 40°F, a less efficient panel of electric resistance coils, similar to those in your toaster, kicks in to provide indoor heating. This is why air-source heat pumps aren’t always very efficient for heating in areas with cold winters. Fuel-burning furnaces generally can provide a more economical way to heat homes in cooler U.S. climates.

The efficiency and performance of today’s air-source heat pumps is one-and-a-half to two times greater than those available 30 years ago. This improvement in efficiency has resulted from technical advances and options such as:

- Thermostatic expansion valves for more precise control of the refrigerant flow to the indoor coil
- Variable speed blowers, which are more efficient and can compensate for some of the adverse effects of restricted ducts, dirty filters and dirty coils
- Improved coil design
- Improved electric motor and two-speed compressor designs
- Copper tubing, grooved inside to increase surface area.

**Summary**

This fact sheet provides an overview of air-source heat pumps for home heating and cooling.

More publications on related topics can be found in the Resources section.

**Types of Air-Source Heat Pumps**

You can use a central heat pump to heat and cool a whole house. Most central heat pumps are split-systems — that is, they each have one coil indoors and one outdoors. Supply and return ducts connect to a central fan, which is located indoors. The fan, often called an air handler or blower, circulates air throughout the house. The fan also usually contains electric resistance coils (some units now have a gas-fired furnace option). The heated or cooled air circulates from the fan to the supply ducts, and openings in the home called supply registers. Return registers and ductwork return the air to the fan to be heated.

Some heat pumps are packaged systems. These usually have both coils and the fan outdoors. Heated or cooled air is delivered to the interior from ductwork that protrudes through a wall or roof. Another packaged system is the ductless room heat pump. These pumps will efficiently heat or cool a room or small house with an open floor plan. They are much more common for apartments and motel rooms than homes. They can be installed in a window or through a hole in the wall — wall installations being preferable for appearances sake. Through-the-wall installations, however, sometimes aren’t well insulated from inside to outside and can have infiltration problems. When used, mini-split systems can solve these problems.

**Selecting a Heat Pump**

When selecting an air-source heat pump, consider the following three characteristics carefully: the energy efficiency rating, sizing and the system’s components.

**Energy Efficiency Rating**

In the United States, a heat pump’s energy efficiency is rated by how many British thermal units (Btu) of heat it moves for each watt-hour of electrical energy it consumes. Every residential heat pump sold in this country has an Energy Guide Label, which features the heat pump’s heating and cooling efficiency performance rating,
removal. Resulting in constricted ducts and inadequate airflow. Contractors complain that they often have to squeeze the proper amount of space they require. Check your home's heat pump. Regarding ducts, for example, it's important to have SEERs of at least 7 and a SEER of at least 12.

Many new heat pumps exceed these ratings, but looking for this label is a good way to start shopping for one.

Sizing
When selecting a new heat pump, it's important that you determine the proper size needed for your home. Bigger is not better. A heat pump system should be designed to start and stop more frequently, which is less efficient and harder on the components than letting it run for longer cycles. A properly sized heat pump also will provide you with better comfort and humidity control than an oversized one.

The heating and cooling capacity of heat pumps is measured in Btu per hour. The cooling capacity is commonly expressed in "tons" of cooling capacity — each one ton equaling 12,000 Btu per hour. Correct sizing procedures commonly involve complex calculations, which are best performed by an experienced contractor, who uses sizing methods accepted by the heat pump industry. Don’t employ a contractor who guesses the size of the heat pump you need.

Operating a Heat Pump
In ducted heat pump systems, you control heat pumps using thermostats. If you leave and return at regular times every day, you’ll save money by using automatic thermostats, which minimize energy use during the times the home is unoccupied. However, choosing an automatic thermostat’s reactivation time requires considering the duration of heat-pump operation necessary to restore a comfortable temperature. During the heating season, some homeowners also set their thermostats back 10°F, manually or automatically, when they leave home or go to bed.

A two-stage thermostat controls the heating. The first stage activates the refrigeration system. If it’s too cold outside for the refrigeration system to counteract the home’s heat loss, then the thermostat’s second stage activates the electric resistance coils. An outdoor thermostat will prevent the less efficient electric resistance heat from coming on until the outdoor air temperature is 40°F. An outdoor thermostat also will prevent auxiliary heat from activating when an automatic thermostat is warming the house after a set-back period. Use setback thermostats that are only for heat pumps.

Improving Performance
Poor installation, duct losses and inadequate maintenance are more of a problem for heat pumps than for combustion furnaces. A growing body of evidence suggests that most heat pumps have significant installation or service problems that reduce performance and efficiency. According to a report on research funded by Energy Star®, more than 50 percent of all heat pumps have significant problems with low airflow, leaky ducts and incorrect refrigerant charge.

Increasing Airflow in Central Heat Pumps
The capacity and the efficiency of a heat pump depend upon the airflow through the ducts. The airflow should be about 400 cubic feet per minute (CFM) per ton of the heat pump’s air-conditioning capacity. Efficiency and performance deteriorate if airflow is much less than 350 CFM per ton.

An ideal duct system has both a supply register and a return register for every room. Most homes, however, have only one or two return registers for the entire house. Air from the room being cooled flows its way back to these registers to be reheated or re-cooled. Obstructions in return air are a common air circulation problem, particularly from closed interior doors to rooms with no return-air register.

Blockade of supply or return air ducts and registers can prevent the dehumidification of the spaces the return air should serve. The most common problem is a duct blockage, caused by obstructions within 10 feet of the sides with openings and pathways back to a return register. You can install louvered grilles through walls or doors, ducts between rooms and/or additional return ducts and registers to improve air circulation.

Technicians can increase the airflow by cleaning the evaporator coil, increasing fan speed, or enlarging the ducts — especially the supply ducts. Enlarging ducts may seem drastic but in some cases, it might be the only remedy for poor comfort and high energy costs.

Air-sealing Ducts
Measurements of heat pump performance indicate that duct leakage wastes 10 to 30 percent of the heating and/or cooling energy in a typical home. It’s one of the most severe energy problems commonly found in homes because the leaks are generally around 20° to 70°F warmer than the indoor air in winter and 15° to 30°F cooler in summer. Duct leakage may cause some minor comfort problems when ducts are located in conditioned areas. But when leaky ducts are located in an attic or crawl space, the energy loss is often large. Some of the worst duct leakage occurs at joints between the air handler and the main supply and return air ducts. Some main return ducts use plastic or fiberglass boxes. These boxes frequently leak because their joints are exposed to the duct system’s highest air pressures. Heating and air-conditioning contractors often use wall, floor and ceiling cavities as return ducts. These building-cavity return ducts are often accidentally connected to an attic, crawl space, or even the outdoors, creating serious air leakage. Fiberglass ducts and flex ducts are often installed improperly. These ducts may also deteriorate with age, leading to significant supply-duct leakage.

The best heating and cooling contractors have equipment to test for duct leakage. Testing helps locate duct leaks and indicates how much duct sealing is necessary. Do use duct tape for sealing — its life span is very short, often less than 6 months.
Installing a New Heat Pump

A heat pump’s performance and energy efficiency depend on the selection and planning of the equipment but also on careful installation. Consumers and home builders alike tend to accept the lowest bid for heating and air-conditioning work. This unfortunate choice can often leave a system lacking 10 to 30 percent in the materials and labor necessary to optimize heat pump performance. Rather than just accepting the lowest bid, it’s best to research the size of the heat pump needed, and get involved in the planning and decision-making about your new heat pump system.

You can avoid most of the common comfort and performance problems from improper installation by following these guidelines:

• Make your home as energy-efficient as possible. Improving the efficiency of your refrigerator, and your entire home, will result in lower utility bills. The higher the SEER, the lower the operating cost. This is particularly true if your heat pump will be used during the summer.

• Insulate your ducts with R-8 or better. A properly insulated duct system can increase the life of your heat pump by at least 30 percent. Properly insulated and sealed ducts can reduce your energy costs by up to 30 percent.

• Seal your ducts tightly. A small duct leak can reduce your energy efficiency by up to 30 percent. A duct system with a leakage rate of 20 percent or less is considered to be well-sealed.

• Use the right size of ducts. Ducts that are too small can reduce your heat pump’s efficiency by up to 30 percent. Ducts that are too large can increase your energy costs by up to 30 percent.

• Install your system properly. Installing your system properly is crucial to its performance. A poorly installed system can reduce its efficiency by up to 30 percent.

• Check your system regularly. Regular maintenance of your heat pump system is essential to its performance. It is recommended that you have your system checked at least once a year.

Installing and Insulating Ducts

Insulation is one of the most important factors in determining the efficiency of your heat pump. Ducts that are not properly insulated can lose up to 30 percent of their heat. Insulating your ducts will reduce this loss and improve the efficiency of your heat pump.

The most efficient heat pumps have a SEER of at least 13 and a HSPF of at least 10. Many new heat pumps exceed these ratings, but looking for this label is a good way to start shopping for one.

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temperature defrost controls activate defrost at regular time intervals for set time periods, whether there is ice on the outdoor coil or not.

A demand-defrost control senses coil temperature or airflow through the coil and only activates defrost if it detects the presence of ice. Obviously, choosing a heat pump with demand-defrost will pay a significant efficiency dividend.

For greater efficiency, don’t locate a thermostat near a heat source or cold draft because they can cause a heat pump to operate erratically. This includes shading thermostats from direct sunlight. Also, do not turn the thermostat beyond the desired temperature. It will not make the heat pump heat or cool your home any faster. It will only waste energy. Residents who duel one another over the thermostat settings, moving it up and down to suit their different comfort levels, cause heat pumps to operate erratically and inefficiently.

Maintaining and Servicing
Heat pump performance will deteriorate without regular maintenance and service. The difference between the energy consumption of a well-maintained heat pump and a severely neglected one ranges from 10 to 25 percent.

Regular Maintenance
Either the homeowner or service technician can perform the following routine maintenance tasks:

• Clean or replace filters regularly (every 2 to 6 months, depending on operating time and amount of dust in the environment).
• Clean outdoor coils as often as necessary (when dirt is visible on the outside of the coil).
• Remove plant life and debris from around the outdoor unit.
• Clean evaporator coil and condensate pan every 2 to 4 years.
• Clean the blower’s fan blades.
• Clean supply and return registers and straighten their fins. Professional Service You should have a professional technician service your heat pump at least every year.

The technician can:
• Inspect ducts, filters, blower and indoor coil for dirt and other obstructions.
• Diagnose and seal duct leakage.
• Verify adequate airflow by measurement.
• Verify correct refrigerant charge by measurement.
• Check for refrigerant leaks.
• Inspect electric terminals and if necessary, clean and tighten connections and apply nonconductive coating.
• Lubricate motors and inspect belts for tightness and wear.
• Verify correct electric control, making sure that heating is locked out when the thermostat calls for cooling and vice versa.
• Verify correct thermostat operation.

Resources
The following are sources of additional information on heat pumps. This list is not exhaustive, nor does the mention of any resource constitute a recommendation or endorsement.

Air Conditioning Contractors of America [www.acca.org](http://www.acca.org)
Air-Conditioning and Refrigeration Institute [www.ahrinet.org/default.aspx](http://www.ahrinet.org/default.aspx)
Consortium for Energy Efficiency [www.ceeformt.org](http://www.ceeformt.org)
Eastern Heating & Cooling Council [www.eh-cc.org](http://www.eh-cc.org)
Energy Star® [www.energystar.gov](http://www.energystar.gov)
Home Energy Magazine [www.homeenergy.org](http://www.homeenergy.org)

Related Information
Ductless, Mini-Split Air Conditioners and Heat Pumps [www.eere.energy.gov/basics/buildings/ductless_mini_split.html](http://www.eere.energy.gov/basics/buildings/ductless_mini_split.html)