HEAT PUMPS

WHAT IS A HEAT PUMP?

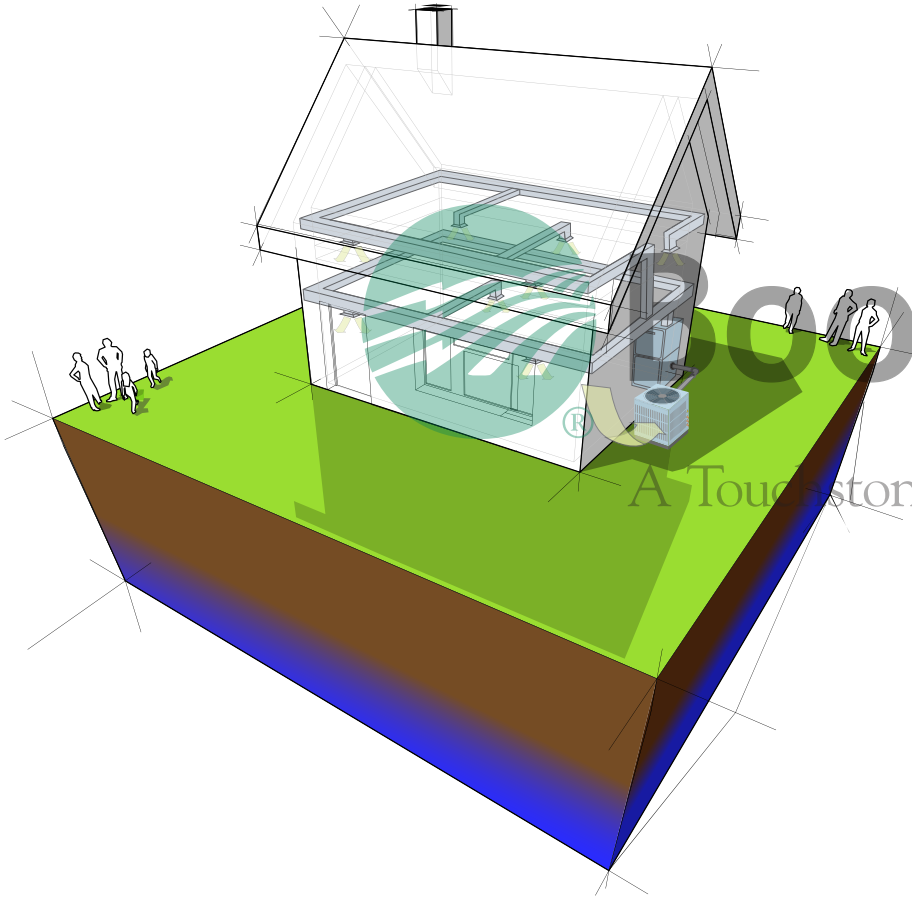
Heat pumps are innovative heating and cooling systems that extract heat from the outdoor environment and transfer it indoors in heating mode—and vice versa in cooling mode. They can provide up to three times more energy than the electricity they consume, leading to significant cost savings on energy bills. Compared to traditional gas or oil furnaces and air conditioners, heat pumps offer several advantages. They eliminate the need for separate systems, reducing installation and maintenance costs. Additionally, heat pumps are more energy efficient because they transfer heat rather than burn fuel, resulting in reduced energy loss and greater efficiency in achieving the desired indoor temperature.

As with any major appliance, proper sizing and installation are crucial to ensure optimal performance. And just as with a gas or oil furnace or an A/C system, regular maintenance by a professional HVAC technician is essential. This tip book goes over some of the basic considerations to help you determine if a heat pump is right for your home and the questions to ask during purchase, installation, and maintenance. The costs of installation, maintenance, and use will vary based on the size of your home and other factors, and asking questions and comparing your costs to savings and incentives will help you determine how a heat pump fits into your home and your finances.

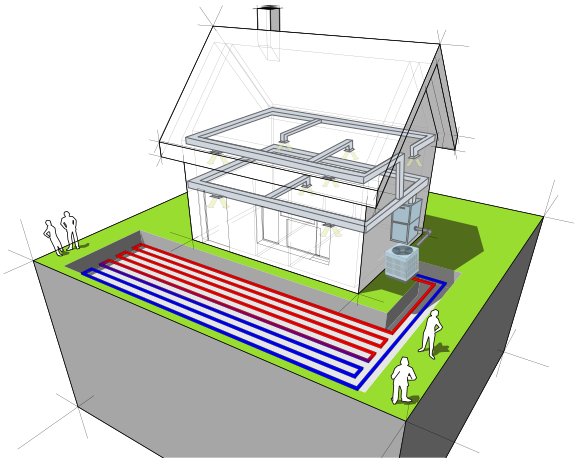
Heat pump technology has expanded in recent years to include cold-climate models that make heat pumps an option for consumers in cold-weather states. Check with your utility and local energy office to see if there are any incentives or programs for heat pumps in your area.

TYPES OF HEAT PUMPS

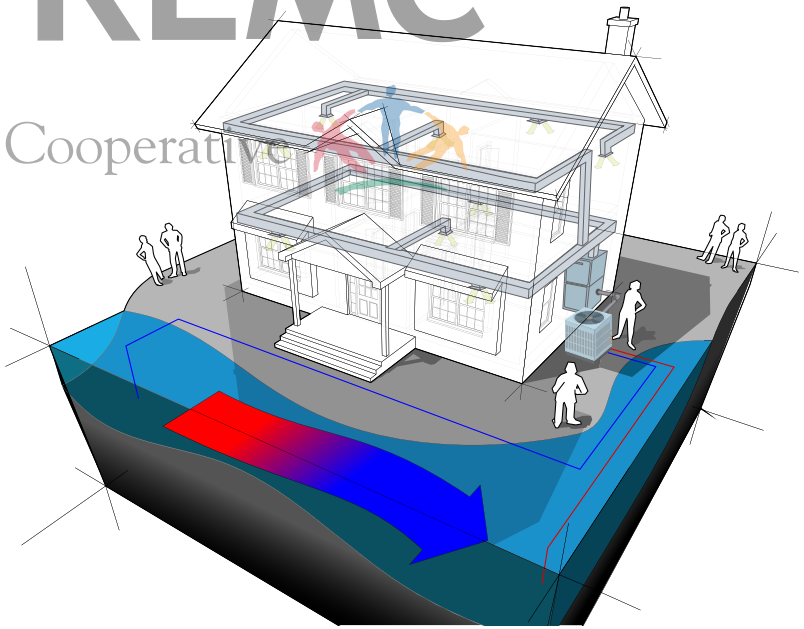
Three main types of heat pumps are available: air-source, ground-source (geothermal), and water-source pumps. Air-source heat pumps, by far the most common, extract heat from the outdoor air; ground-source heat pumps extract heat from the ground; and water-source heat pumps extract heat from a water source, such as a lake or pond. The three types use different environmental resources to provide heating and cooling.



Air-source heat pumps are the most common type. They absorb heat from outdoor air using an outdoor unit. Refrigerant circulates through the system, and as it passes over the outdoor coil, it absorbs heat from the air. Air-source heat pumps are relatively easy and cost-effective to install since they don't require extensive excavation.



Ground-source heat pumps use underground pipes, known as ground loops, to extract heat from the earth. These loops are filled with a heat-transfer fluid that absorbs heat from the ground and carries it to the heat pump. Ground-source heat pumps offer high efficiency and consistent performance since the ground temperature remains relatively stable throughout the year. However, they require more upfront investment because ground loops must be installed.



Water-source heat pumps work similarly but extract heat from a water source, such as a lake or pond. This kind of heat pump is efficient and is a viable option in areas with access to a nearby body of water.

HOW DO THEY WORK?

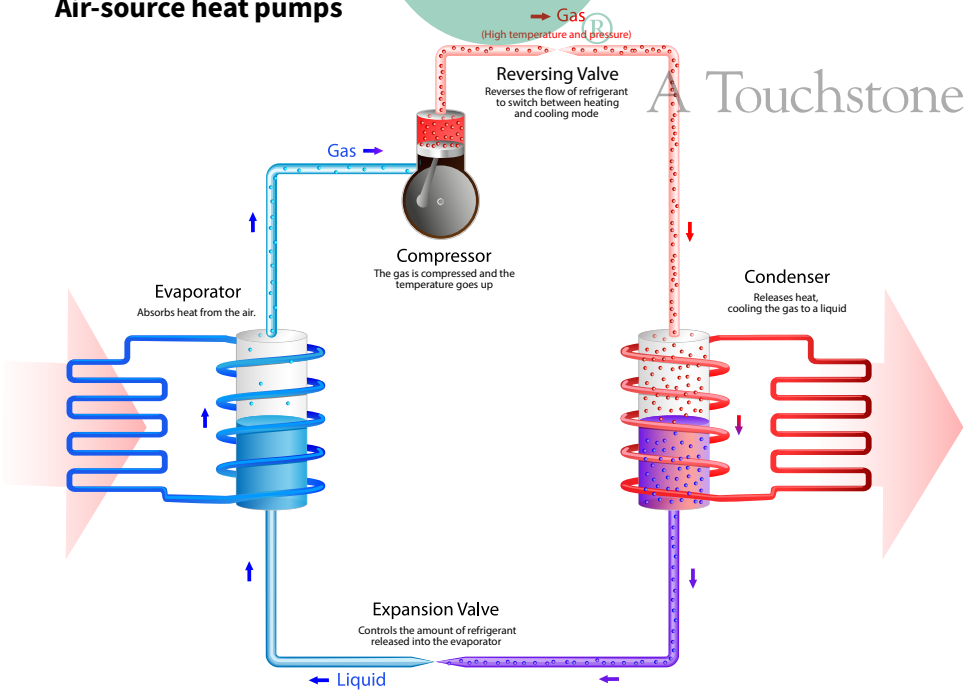
Heat pumps work on the principle of transferring heat from one area to another. In heating mode, the heat pump extracts heat from the outdoor air, the ground, or a water source and releases it indoors to warm the space. In cooling mode, the process is reversed, and heat is extracted from the indoor air and released outside, cooling the interior. This is achieved using refrigerant, which circulates through the system and undergoes changes in phase, pressure, and temperature to facilitate heat transfer.

The refrigeration cycle is the process that allows heat pumps to transfer heat. In heating mode, the cycle starts with the evaporator, where the refrigerant absorbs heat from the outdoors, causing it to evaporate into a gas. The compressor then increases the pressure and temperature of the refrigerant gas to produce a high-pressure, high-temperature gas that flows to the condenser, where it releases heat to warm the indoor space. The refrigerant then returns to the expansion valve, which reduces its pressure, and the cycle repeats.

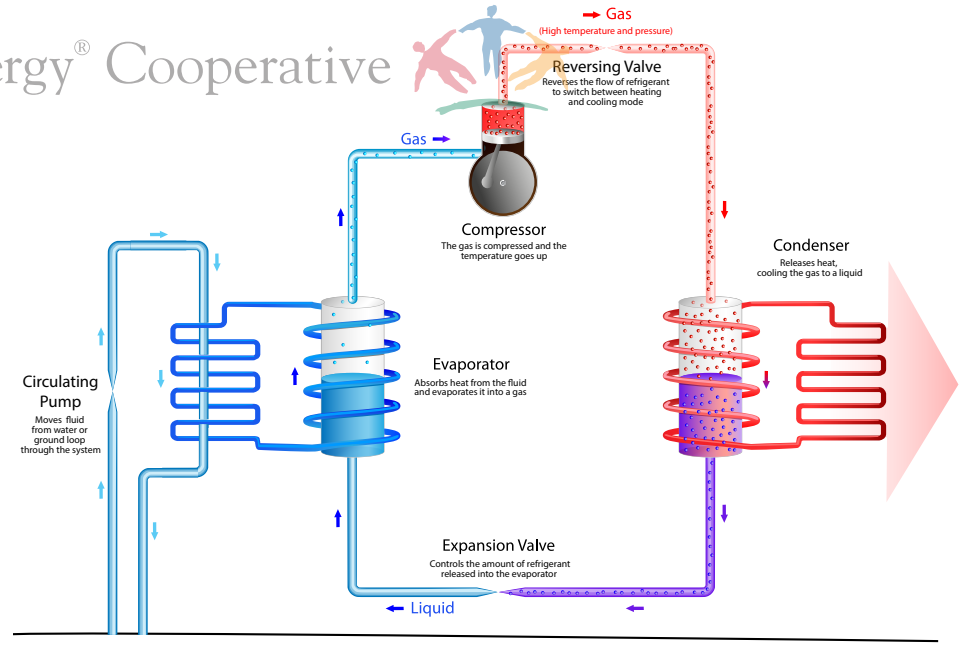
A heat pump system consists of several key components.

- **The compressor is responsible for compressing the refrigerant gas, increasing its pressure and temperature.**
- **The condenser receives the high-pressure, high-temperature refrigerant from the compressor and releases heat to the indoor air in heating mode or to outdoors in cooling mode.**
- **The evaporator is where the refrigerant evaporates by absorbing heat from outdoors during heating or from indoors during cooling.**
- **The expansion valve controls the flow of refrigerant by reducing its pressure and temperature before it enters the evaporator.**

Air-source heat pumps



Ground- and water-source heat pumps



HEAT PUMP INSTALLATION

Professional installation and proper sizing of heat pumps are crucial for optimal performance, energy efficiency, and long-term reliability. A professional installer has the knowledge and expertise to assess the specific heating and cooling needs of a space by considering factors such as the climate, insulation, building size, layout, airtightness, and ventilation. They can accurately determine the appropriate heat pump size and capacity to meet those needs. Undersized or oversized heat pumps can lead to inefficiencies, inadequate heating or cooling, increased energy consumption, and premature wear and tear on the system. Therefore, it is essential to engage a qualified HVAC professional to size and install heat pumps.

Installation of a heat pump typically involves several key steps, including the following:

1. Site assessment: An HVAC professional evaluates the space and assesses factors such as insulation, layout, and available outdoor space. They determine the most suitable location for the outdoor and indoor units on the basis of accessibility, noise reduction, efficiency, and other factors.

2. Ductwork inspection and installation: If the building has existing ductwork, it is inspected to ensure that it's in good condition and compatible with the heat pump system. If necessary, the installer designs and installs new ductwork to distribute conditioned air throughout the building, ensuring proper airflow and efficiency.

3. Electrical considerations: Heat pumps require a dedicated power supply, so the electrical requirements of the system are evaluated. A licensed electrician may be involved to ensure that the correct wiring and electrical connections are in place.

4. Mounting and connection: The outdoor unit is mounted on a stable surface, such as a concrete pad, and securely fastened. The indoor unit is typically installed in a central location to optimize airflow. The refrigerant lines and electrical connections between the indoor and outdoor units are carefully connected following manufacturer guidelines and local building codes.

5. System testing and start-up: Once the installation is complete, the HVAC professional performs thorough testing to ensure that the heat pump is functioning properly. This includes checking refrigerant levels, verifying proper airflow, and testing the heating and cooling modes. They also program and calibrate the thermostat to optimize performance and energy efficiency.

6. Customer education: The installer provides the homeowner with information on how to operate and maintain the heat pump system effectively. They explain the thermostat settings, filter cleaning and replacement, and any specific maintenance tasks required. They also address any questions or concerns the homeowner may have to make sure they have a good understanding of their new heat pump system.

RETROFITTING A HEAT PUMP

When considering retrofitting a heat pump into an existing home, it's important to ask your contractor the following key questions:

- **Is sufficient space available for both the indoor and outdoor units?** Assess whether the proposed locations are accessible for installation and future maintenance.

- **Will ductwork installation or modification be necessary?** If there is existing ductwork, determine if it can be used or if new ductwork needs to be installed. If not, inquire about the feasibility of a ductless mini-split system.

- **Can the electrical system support the power requirements of the heat pump?** Discuss the electrical capacity of your home and ensure that it complies with specifications for heat pump installation.

- **Are any additional upgrades needed for optimal performance?** Inquire about the need for insulation upgrades, air sealing, or window improvements to enhance energy efficiency and maximize the heat pump's performance. If upgrades of this kind are made, the space may require a smaller heat pump.

- **What are the estimated costs and timelines for the retrofitting process?** Discuss the overall project costs, including equipment, installation, and any necessary upgrades, as well as the anticipated timeline for completion. Make sure to include installation costs in your savings calculations.

- **Are any specific permits or certifications required?** Inquire about any permits or certifications needed for the installation to ensure compliance with local building codes and regulations.

- **Can your contractor provide references or examples of retrofitting projects?** Request information on retrofitting projects the contractor has completed to gauge their expertise and experience with similar installlations.

OPERATING AND MAINTAINING A HEAT PUMP

To maximize the performance and efficiency of your heat pump, consider the following tips:

- **Maintain a consistent temperature.** Frequent adjustments can strain the system and increase energy consumption. The start-up of a heat pump takes the most energy and heat pumps operate most efficiently when they're running for long periods at steady-state conditions, so frequent cycling will consume unnecessary energy. (This is different from gas systems, which allow for more adjustments without a significant energy penalty.)

- **Make sure your home is properly insulated and air sealed to minimize heat loss or gain.** Well-insulated and air-sealed walls, ceilings, doors, and windows create a thermal barrier that reduces the transfer of heat between the inside and outside of your home, allowing the heat pump to operate more efficiently.

- **Use interior zoning if it's available.** This innovative feature allows you to divide your home into separate zones, each with its own temperature control. By independently adjusting the temperature in these areas, you can customize comfort levels to meet the specific needs of each space. This not only enhances your overall comfort but also provides the flexibility to prioritize heating or cooling in areas where it's needed most, further optimizing energy usage and reducing operating costs.

- **Consider using ceiling fans to enhance airflow and distribute conditioned air effectively.** This will reduce the workload on the heat pump. Promoting better air movement allows you to rely less on the heat pump to adjust the temperature, leading to improved energy efficiency and potentially lower energy costs.

- **Understand the "emergency heat" setting.** When you have a heat pump installed, your thermostat has an additional setting, EM for "emergency heat." It should be used sparingly (really just for emergencies). In those situations, the system will bypass the heat pump and turn to a backup system, typically electric heat strips, to heat the home. These are inefficient compared to heat pump mode and should be used only when necessary or as or recommended by your manufacturer.

- **Setting the right temperature and programming your thermostat effectively can significantly affect the performance and energy efficiency of your heat pump.** During the heating season, it's recommended that you set your thermostat to a moderate temperature, around 68–72 degrees Fahrenheit, for optimal comfort and efficiency. During the cooling season, set your thermostat to a comfortable temperature, typically around 72–78 degrees Fahrenheit. Sharp swings in the temperature settings (2 degrees or more in heating mode) could cause the backup heat strips to kick in, reducing efficiency.

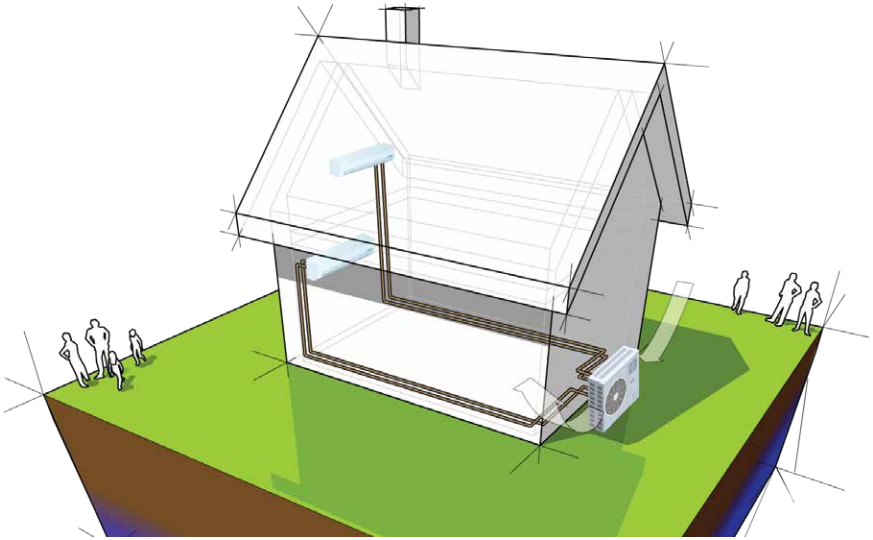
- **Clogged or dirty filters restrict airflow, reducing efficiency and straining the system.** Clean or replace air filters every one to three months, depending on usage.

- **Regular maintenance plays a vital role in preserving the performance and longevity of your heat pump.** Professional inspections at least once a year are essential. A trained HVAC technician will inspect and clean the indoor and outdoor units, check refrigerant levels, tighten electrical and mechanical connections, and ensure optimal system performance. Routine maintenance can prevent potential issues, improve efficiency, and extend the life-span of your heat pump.

MINI-SPLIT SYSTEMS

Mini-split heat pumps are innovative heating and cooling systems that provide efficient and customizable comfort in residential and commercial spaces. Unlike traditional HVAC systems, mini-split heat pumps consist of two main components: an outdoor unit that houses the compressor and condenser and one or more indoor units that deliver conditioned air directly into rooms. The indoor and outdoor units are connected by refrigerant lines, enabling zoned heating and cooling. Each indoor unit can be independently controlled to maintain different temperatures in different zones, which offers personalized comfort and energy efficiency. Mini-split heat pumps, ideal for spaces without existing ductwork, allow for easy installation and flexibility.

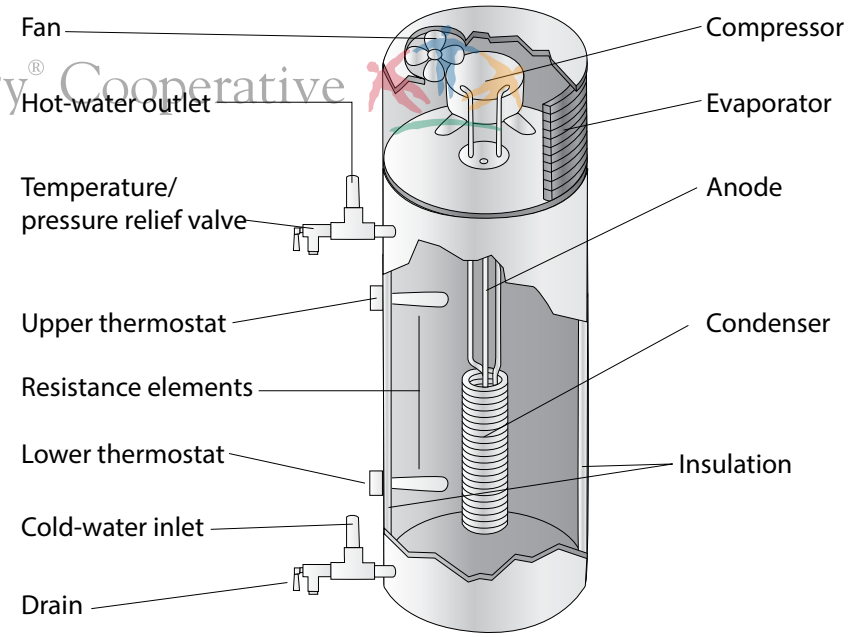
With their compact size, quiet operation, and customizable zoning capabilities, mini-split heat pumps are a versatile and efficient heating and cooling solution. The absence of ducts eliminates energy losses associated with duct leakage, improving overall system efficiency. These heat pumps are suitable for retrofitting older buildings or using in new construction where ductwork installation is challenging or costly. By dividing the space into zones, mini-split heat pumps allow for targeted heating or cooling in specific areas according to individual preferences and occupancy. These features make mini-split heat pumps a practical and effective choice for achieving personalized comfort in a wide range of applications.



HEAT PUMP WATER HEATER

Heat pump water heaters are energy-efficient alternatives to conventional electric or gas water heaters. They work by extracting heat from the surrounding air and transferring it to the water stored in the tank. This is achieved with a refrigeration cycle; it's similar to how heat pumps operate for space heating and cooling. The heat pump extracts heat from the ambient air and transfers it to the refrigerant, which then heats the water in the tank.

By using heat from the environment rather than relying solely on electrical resistance heating, heat pump water heaters can deliver hot water more efficiently, resulting in reduced energy consumption and cost savings. Heat pump water heaters, which are available in various sizes and configurations to suit most households' needs, provide reliable and energy-efficient hot water for daily use. Additionally, heat pump water heaters produce cool air as a byproduct of the heating process, which can be beneficial for cooling and dehumidifying the surrounding space.



RESOURCES

Visit these sites for additional information:

ENERGY STAR

www.energy.gov/energysaver/heat-pump-systems

AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY

www.aceee.org

U.S. DEPARTMENT OF ENERGY

www.energy.gov

U.S. DEPARTMENT OF ENERGY'S OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY

www.eere.energy.gov