



Image courtesy of ClimateMaster.

*Residential ground-source heat pump (GSHPs) take advantage of the naturally occurring, relatively stable year-round temperature of earth's shallow crust to condition indoor air. GSHPs use earth as a heat sink to cool the air or as a heat source to heat the air in living spaces. They are an energy-efficient alternative to air-source heat pumps (ASHPs).*

## HOW IT WORKS

Heat pumps operate much like refrigerators. They transfer heat from one place to another using refrigerant coils, in lieu of burning fuel.

Whereas an ASHP transfers heat between ambient air and an indoor space, a GSHP transfers heat to or from the earth via fluid circulating in pipe coils underground, as illustrated, left, by the red coils representing warm fluid and blue coils representing cool fluid. The ground acts as a heat source in winter and a heat sink in summer.

To heat a living space, the fluid flows from the underground pipe coils through a heat exchanger above ground. The heat pump's refrigerant absorbs heat from the fluid at the evaporator, where the refrigerant vaporizes. A compressor applies pressure to this vapor and the resulting high-temperature gas gives up its heat in the condenser inside the home. An air-handler fan pushes the warmer air into the living space. The high pressure refrigerant exiting the condenser is cooler and in a mixed liquid and vapor state. As it passes through an expansion valve on its way to the evaporator, it becomes a cool gas and the cycle continues. To cool a living space, the process is essentially reversed.

## DID YOU KNOW?

GSHPs have been in use in the United States since the late 1940s. Properly equipped systems also can provide hot water to the home.

## APPLICATIONS

Though not typically used in mobile homes or high-rise buildings, GSHPs can be used in other residential and small commercial applications, regardless of climate, including:

- Single-family homes
- Office buildings or retail shops
- Low-rise multifamily buildings
- Schools and military housing

## BENEFITS

**Energy-saving performance over their lifetimes.** GSHPs are more effective and efficient than traditional air conditioners or electrical resistance heaters. Their coefficient of performance, 6, is double that of traditional ASHPs. In heating mode, GSHPs are much more effective than simple electrical resistance heaters using the same amount of electricity.

**No backup heat source required.** If sized properly, GSHPs typically do not need a backup heat source and are highly efficient in a broad range of climates. They offer a convenient, turnkey solution that delivers the same or improved comfort-control over ASHPs.

**Potential for savings during summer peak demand.** A GSHP offers both space cooling energy and summer peak demand savings. Customers on demand-based or time-of-use plans that reflect the value of reducing peak energy usage can benefit more than those on simple kWh pricing plans.

**Simple design, durable equipment.** GSHPs are quiet, need no fans or defrosting systems, and the above ground equipment can be housed entirely indoors; it also is simpler than comparable ASHP components and reported to have almost double the life at 25 years. The underground coils, made of high-density polyethylene (HDPE) pipe, typically have a 50-year warranty but are thought to have a 100-year lifetime.

## LIMITATIONS

**High initial cost.** Installation costs are considerably higher for GSHPs than ASHPs. For that reason, GSHPs cost roughly \$6,000/ton installed. Furthermore, few companies currently specialize in GSHP installation. Government incentives can offset these higher installation costs, and energy savings are considerable.

**Unique installation needs.** GSHPs require earth excavation, exterior plumbing, and adequate underground space for the buried fluid coils.

**Construction limitations.** GSHPs are more suited to new construction than to retrofits, and to residential locations that have sufficient land around the construction site to accommodate the system. Soil conditions must also be taken into consideration. GSHPs cannot be installed on rooftops.

**Environmental considerations.** Like most heat pump systems, GSHPs contain refrigerants, which may have environmental impacts.

**Perception and education needs.** Some may perceive GSHPs as risky, with unknown durability. These perceptions must be addressed through education of consumers, sales representatives, technicians, and installers about the technology, the systems, and their established benefits.