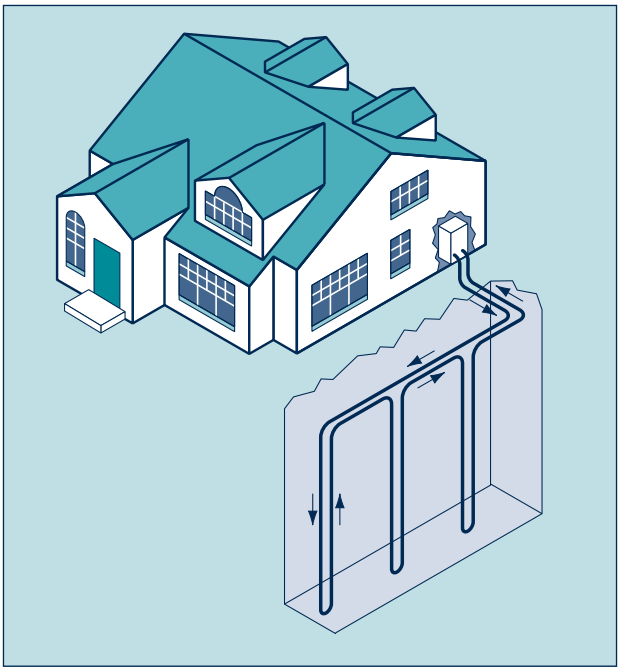
Geothermal Heat Pumps Make Sense for Homeowners

Geothermal heat pumps are one of the most efficient ways to heat and cool a home and provide hot water. More and more homeowners are discovering the benefits of these systems, which tap the relatively constant temperature of the Earth a few feet underground, for both new homes and retrofits in existing houses.

Why a Geothermal Heat Pump?

The installation of a heating or cooling system is a decision that will affect a homeowner's comfort—and pocketbook—for years to come. One option to think about is a geothermal heat pump (GHP), which is one of the most cost-effective and longest-lasting heating and cooling systems on the market. Plus, GHPs provide free hot water as a byproduct of air conditioning for the household in the summer.

Also known as ground-source heat pumps or GeoExchange℠ systems, GHPs provide many benefits to the homeowner in both new and retrofit situations. Surveys by utilities illustrate a high level of satisfaction with GHPs compared to conventional systems. In fact, more than 95% of all GHP users would recommend a similar system to their friends and family.



Geothermal heat pumps use the stable temperature of the ground (vertical boreholes typically are 100 to 400 feet deep) as a heat source to warm buildings in winter and as a heat sink to cool them in summer.

Warren Gretz, NREL/PIX06534

This house in Aurora, Colorado, uses a geothermal heat pump system that will provide all the heating, cooling, and hot water needs. For a home of 1,500 square feet with a good building envelope and a geothermal heat pump, energy costs are about $1 a day.

According to the Environmental Protection Agency (EPA), GeoExchange systems are the most energy-efficient, environmentally clean, and cost-effective space conditioning systems available (source: "Space Conditioning: The Next Frontier," EPA 430-R-93-004, April 1993).

Simply put, a GHP system moves the heat from the earth (or a groundwater source) into the home in the winter, and pulls the heat from the house and discharges it into the ground in the summer. The underground (or underwater) piping loops serve as a heat source in the winter and a heat sink in the summer.

While many parts of the country experience seasonal temperature extremes—from scorching heat in the summer to sub-zero cold in the winter—a few feet below the earth's surface the ground remains at a relatively constant temperature. Depending on latitude, ground temperatures range from 45°F (7°C) to 75°F (21°C). Like a cave, this ground temperature is warmer than the air above it during the winter and cooler than the air in the summer. The GHP takes advantage of this by exchanging heat with the earth through a ground heat exchanger rather than with the outside air as with air conditioners.

GHPs Offer Many Benefits

In even the coldest climates, geothermal heat pumps offer cost savings, durability, low maintenance, year-round comfort, and other benefits.

Cost Effective

Geothermal heat pumps save money in operating and maintenance costs. While the initial purchase price of a residential GHP system is often higher than that of a comparable gas-fired furnace and central air-conditioning system, it is more efficient, thereby saving money every month. For further savings, GHPs equipped with a device called a "desuperheater" can heat the household water. In the summer cooling period, the heat that is taken from the house is used to heat the water for free. In the winter, water heating costs are reduced by about half.

State-of-the-art building envelope construction and highly efficient GHP systems allow some contractors and utilities to actually guarantee energy consumption costs of about $25 per month for each 1,000 square feet of living space.

On average, a geothermal heat pump system costs about $2,500 per ton of capacity, or roughly $7,500 for a 3-ton unit (typical residential size). In comparison, other systems would cost about $4,000 with air conditioning. When included in the mortgage, the homeowner has a positive cash flow from the beginning. For example, say that the extra $3,500 will add $30 per month to each mortgage payment. But the energy cost savings will easily exceed that added mortgage amount over the course of each year. On a retrofit, the GHP's high efficiency typically means much lower utility bills, allowing the investment to be recouped in two to ten years.

In addition, some electric utilities have financing packages that make the purchase of a GHP system even less expensive. Other utilities are providing special electric rates for homes with GHP systems installed

Durability

Because they use fewer mechanical components, and because those components are sheltered from the elements, leaves, dirt, and possible vandalism, geothermal heat pumps are durable and highly reliable. The underground piping used in the system often has 25- to 50-year warranties, and the GHPs themselves typically last 20 years or more.

Low Maintenance

Geothermal heat pump systems have fewer maintenance requirements than most other systems. When properly installed, the underground components are virtually worry free. The components in the living space are easily accessible, which increases the convenience factor and helps ensure that the upkeep is done on a timely basis.

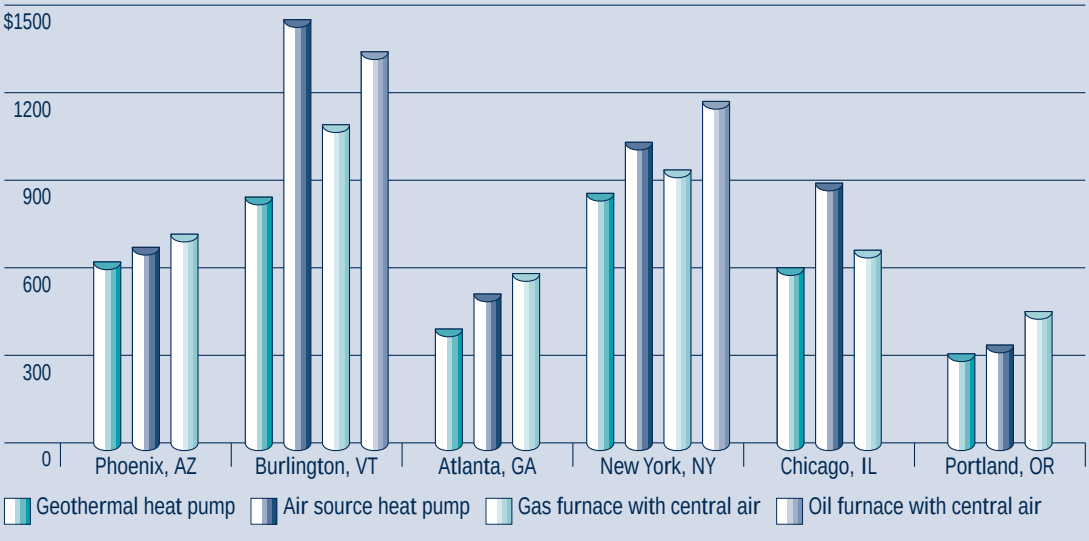
Year-Round Comfort

Like the typical forced-air furnace or central air-conditioning system, a GHP system uses ductwork. A two-speed GHP system is so quiet inside a house that users do not know it is operating because there are no telltale blasts of cold or hot air, depending on whether it's the heating or cooling season.

GHPs also improve humidity control by maintaining about 50% relative indoor humidity, making GHPs very effective in humid areas.

Annual Heating and Cooling Costs by Region

Source: EPA, 1993



Quiet Operation

With GHPs, there are no outside condensing units like air conditioners, so there's no concern about A/C noise near patio areas or decks, or bothering the neighbors with the constant hum of a conventional air conditioner.

Geothermal Heat Pumps Are Highly Efficient

A study by the Environmental Protection Agency (source: "Space Conditioning: The Next Frontier," EPA 430-R-93-004, April 1993) analyzed six locations representing major climate zones in the U.S. These cities (Burlington, VT; Chicago, IL; upper New York City; Portland, OR; Atlanta, GA; and Phoenix, AZ) were chosen to compare the performance and costs of emerging high-efficiency space-conditioning equipment with equipment already on the market.

For all locations, the findings named geothermal heat pumps as the most efficient heating and cooling systems over other types of space-conditioning equipment including high-efficiency gas furnaces and air conditioners. Geothermal heat pump installations in both new and existing homes can reduce energy consumption 25% to 75% compared to older or conventional replacement systems. Annual operating costs were also lowest with geothermal heat pumps. Add in the benefits of the desuperheater for hot water savings, and it's easy to see how a GHP system is the most efficient available.

> *"This home has no hot spots or cool spots. It [the heat pump unit] is good and quiet. And it is every bit as economical as I thought it would be."*
>
> Ray Mosher, homeowner, Louisiana

GHPs Have Low Environmental Impact

Because a GHP system is so efficient, it uses a lot less energy to maintain comfortable indoor temperatures. This means that less energy—often created from burning fossil fuels—is needed to operate a GHP. According to the EPA, geothermal heat pumps can reduce energy consumption—and corresponding emissions—up to 44% compared to air-source heat pumps and up to 72% compared to electric resistance heating with standard air-conditioning equipment.

Financing a GHP System

Many geothermal heat pump systems carry the DOE and EPA ENERGY STAR® label. ENERGY STAR®-labeled equipment can now be financed with special ENERGY STAR® loans from banks and other financial institutions. The goal of the loan program is to make ENERGY STAR® equipment easier to purchase, so these loans were created with attractive terms. Some loans have lower interest rates, longer repayment periods, or both. Ask your contractor about ENERGY STAR® loans or call the EPA's ENERGY STAR® toll-free hotline at 1-888-STAR-YES for a list of financing options.

Design and Installation

Installing a geothermal heat pump system is not a project for the do-it-yourselfer. Because the pipes are underground, they need to be designed and installed correctly, and properly pressure tested.

The consumer should insist that a qualified and experienced contractor, who has received training at a recognized institution, install the system. For a list of installers and training locations, contact the International Ground Source Heat Pump Association and Geothermal Heat Pump Consortium (see *For More Information* section).

Homeowners should also check with their utility and ask if they offer any rebates or special electric rate programs. Another way to help finance the purchase of a GHP system is to roll the cost into an "energy-efficient mortgage" that would cover this and other energy-saving improvements to the home. The additional cost can be combined into the mortgage and will produce a positive cash flow. Banks and mortgage companies can provide more information on these types of loans.

DOE Spreads the Word about GHPs

In 1994, the U. S. Department of Energy (DOE), working closely with the EPA, Edison Electric Institute, Electric Power Research Institute, International Ground Source Heat Pump Association (IGSHPA), National Rural Electric Cooperative Association, and industry, helped to create the Geothermal Heat Pump Consortium (GHPC). The GHPC launched the National Earth Comfort Program, designed to foster the development of a fast-growing, self-sustaining, national GHP industry infrastructure. DOE has also supported research and development activities, especially through IGSHPA; the American Society of Heating, Refrigeration, and Air-Conditioning Engineers; the National Ground Water Association; and DOE's national laboratories. The work has targeted several areas of GHP technology, lowering the cost of ground heat exchangers, and developing advanced design software.

> *"The most unique part of it is the energy savings that you're going to get from a ground source heat pump—the advantage of using the earth rather than a propane tank or a natural gas line.... It makes your property worth more."*
>
> Bill Dugan, GeoExchange system installer, Kansas

In partnership with the GHPC, DOE's Office of Geothermal Technologies seeks to increase annual installations of GHP systems to about 400,000 by 2005 and reaching about 2 million installed (cumulative) that same year. Achieving the goal of 400,000 annual installations by 2005 will save consumers over $400 million per year in energy bills and reduce U.S. greenhouse gas emissions by over 1 million metric tons of carbon each year.

The System for the Future

With their high efficiency and user satisfaction, geothermal heat pumps are one option homeowners should consider. Not only will they save energy and money, they'll reduce emissions and provide indoor comfort at less cost to the environment.

Case Study—Minnesota

Located in the middle of Minnesota—where temperatures can range from 90°F (32.2°C) with 95% humidity in the summer to -18°F (-27.8°C) in the winter—Dennis Eichinger's 3,400-square-foot home averages a little over $44 per month in electricity bills.

The owner has been very satisfied with the unit's quietness, high quality, reliability, and low maintenance. House guests also marvel at the comfort level of the house—they don't feel any drafts, just an even temperature throughout the house.

> *"In the winter when the wind chill was 50°F below zero, I know other people in new homes were cold, and we were not. We didn't have any trouble with drafts and we were real comfortable."*
>
> Stacey Burger, homeowner, Kansas

The five-ton ground source heat exchanger connects to five horizontal Slinky™ loops, totaling 3,000 feet of pipe, buried next to the home at a depth of eight feet (2.4 meters).

GHP technology heats and cools as well as, or better than, conventional systems, even in Minnesota's extreme temperatures.

Case Study—Florida

Panama City, Florida, homeowner Keith Swilley partnered with his builder and local electric utility to create a 2,000-square-foot home that's a model of efficiency. It saves so much energy that the home won the 1997 Energy Value Housing Award for the custom home category for hot/humid climates at the National Association of Home Builders Conference in Houston.

Mr. Swilley used energy-efficient features from ceiling to floor, with cellulose insulation in the walls and attics, sealed ductwork, and efficient doors, windows, and lighting. However, the feature that saves the most energy is the GeoExchange system.

The geothermal heat pump heats and cools the house and provides hot water for the residents with a desuperheater, which takes waste heat from the air-conditioning process and uses it in the water heater. The desuperheater actually helps the GeoExchange unit reach heightened levels of efficiency.

The system was metered separately and has proven to be a valuable investment, as the home's total energy bill for 1996 was $906. Amazingly, only $253 of the total annual energy bill was used for heating and cooling the 2,000 square feet of conditioned space. "The energy bills are even lower than I anticipated," said Mr. Swilley, "and the comfort level in the winter and summer is much greater than expected. I never dreamed I could heat and cool my home for 69 cents a day!"

For More Information

The following organizations serve as excellent resources for information on geothermal energy and its various applications.

U.S. Department of Energy (DOE)
Office of Geothermal Technologies, EE-12
1000 Independence Avenue, SW
Washington, DC 20585-0121
(202) 586-5340
http://www.eren.doe.gov/geothermal/

The Energy Efficiency and Renewable Energy Clearinghouse (EREC)
P.O. Box 3048
Merrifield, VA 22116
(800) DOE-EREC (363-3732)
Fax: (703) 893-0400
http://www.eren.doe.gov/consumerinfo/
E-mail: doe.erec@nciinc.com

Geo-Heat Center
Oregon Institute of Technology
3201 Campus Drive
Klamath Falls, OR 97601-8801
(503) 885-1750
http://www.oit.osshe.edu/~geoheat/

Geothermal Heat Pump Consortium, Inc. (GHPC)
701 Pennsylvania Avenue, NW
Washington, DC 20004-2696
(888) ALL-4-GEO (255-4436)
http://www.geoexchange.org/

International Ground Source Heat Pump Association (IGSHPA)
490 Cordell South
Stillwater, OK 74078-8018
(405) 744-5175
(800) 626-4747
http://www.igshpa.okstate.edu/

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Produced for the U.S. Department of Energy (DOE) by the National Renewable Energy Laboratory, a DOE national laboratory

DOE/GO-10098-651
September 1998, Reprinted April 1999

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste