OFFICE OF GEOTHERMAL TECHNOLOGIES

Geothermal Heat Pumps Score High Marks in Schools

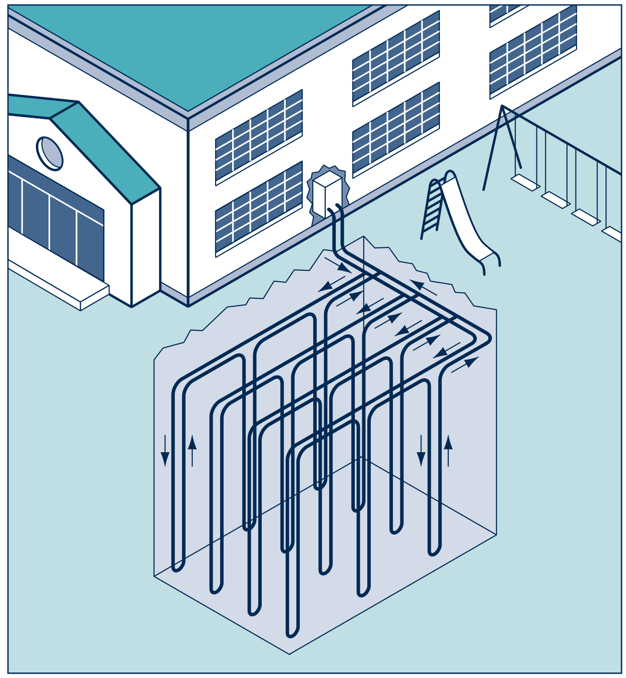
Nearly 500 schools nationwide have installed geothermal heat pump systems to provide their heating and cooling needs. With their proven lower operating and maintenance costs, energy efficiency, and superior classroom comfort, geothermal heat pumps are a great choice for school applications.

Hundreds of schools in the United States have already made the smart move and installed geothermal heat pumps (GHPs), as numerous school facility managers have recognized the overall comfort, economy, and energy efficiency of these systems.

What Are Geothermal Heat Pumps?

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. Like a cave, 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 fact by exchanging heat with the earth through a ground heat exchanger.

A major advantage of GHPs is their individual classroom heating/cooling controls or "zone space conditioning."



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.

Also known as a ground-source or GeoExchange[SM] system, a GHP moves the heat from the earth (or a groundwater source) into the building in the winter, and pulls the heat from the building 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. In essence, it's the same heat-exchanging process used by the common refrigerator or air conditioner, only it's underground.

GHPs come in either closed-loop or open-loop designs. Closed-loop systems circulate an environmentally friendly water/antifreeze solution through high density polyethylene pipes that are buried in the Earth. The solution absorbs heat from the ground during the winter and transfers it to heat pumps inside the building. In the summer, heat from the building is carried through the pipes and deposited in the cool ground. Open-loop systems operate in much the same way. They can be installed where a sufficient, predictable, and relatively clean supply of water (such as a pond, lake, or well) is available.

Benefits for Schools

Schools choose GHP systems for many reasons, some of which include aesthetics, zone control, energy savings and lower maintenance costs, decreased space requirements, and safety.

Aesthetics

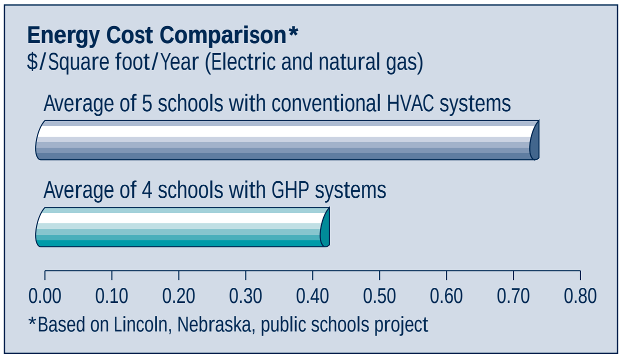
GHP systems allow for greater design freedom in schools. These systems can be installed nearly anywhere. Since there are no rooftop mechanical components, designs can allow for sloped roofs and minimize the space needed to contain less-than-attractive HVAC equipment.

> *"We have installed over 75 GHP systems in the Austin Independent School District alone. In addition to the savings, low noise, low maintenance, and numerous other benefits, these systems are also environmentally friendly and convenient to use."*
>
> Bob Lawson, Austin Independent Schools, Texas

Individual Room Controls

Because of the unique structure of school facilities and their many individual rooms, a major advantage of GHPs is their ability to heat or cool individual classrooms or other areas, known as "zone space conditioning." Each room can be kept as warm or cool as needed, rather than heating or cooling the entire building uniformly. "One of the greatest attributes to having this GHP system installed is the individual control in each space by the users," said David Anstrand, construction administrator for the Neff Elementary School GHP project in Lancaster, Pennsylvania.

In most school facilities, one GHP is used for one or two classrooms. The heat pumps may be in the classrooms as stand-alone consoles, in closets, or above hallway ceilings. Larger heat pumps are used for such areas as cafeterias and gymnasiums, each operating only as needed. Still others may be used to provide hot water for kitchens and locker rooms.



Energy Savings

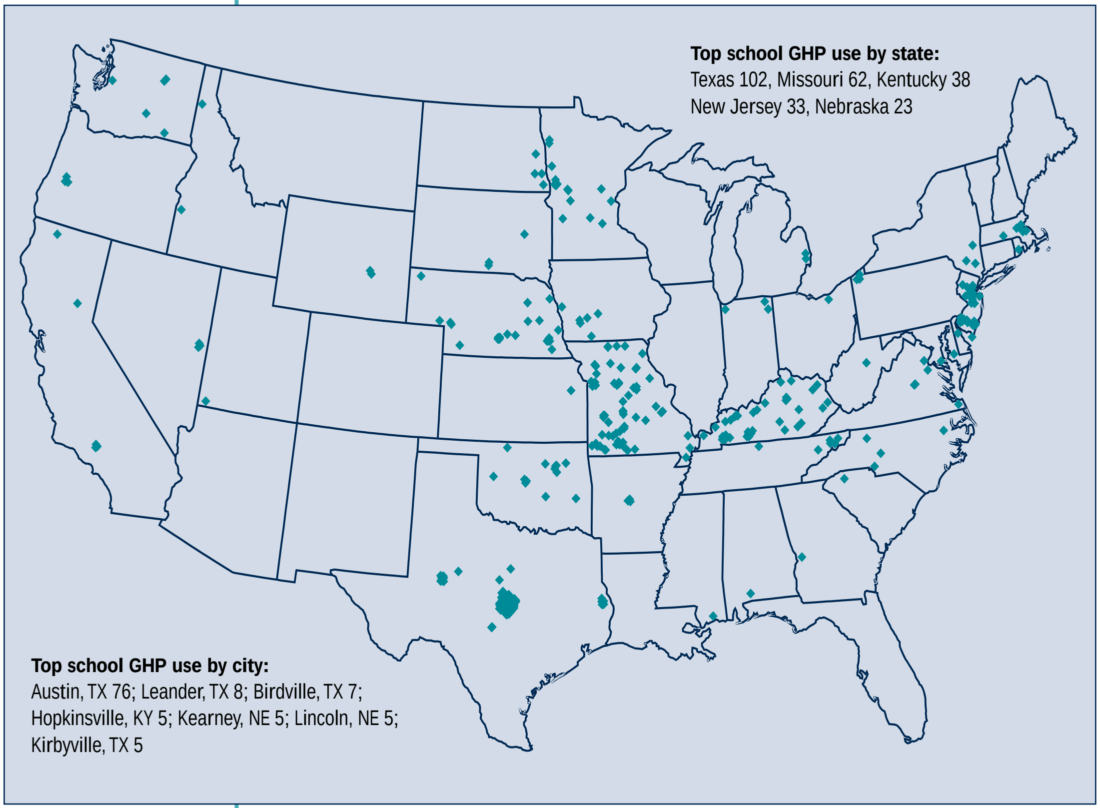
Energy savings are a significant advantage of GHP systems. Instead of *creating* heat by burning a fuel, GHPs *move* heat from one place to where it's needed. Therefore, consumption of electricity is reduced 25% to 50% compared to traditional heating and cooling systems, allowing a payback of system installation in two to eight years and a life expectancy of 20 to 30 years.

Smaller Space Requirement

A GHP system eliminates the need for boilers and cooling towers, which reduces the need for mechanical space. "We have a decrease in the need for space because only pumps are needed. This translates to $100 per square foot of building savings," says Anstrand. In addition, because the components of a GHP system can be installed anywhere, they eliminate the need for rooftop equipment. Since the GHP equipment is housed indoors, it lasts much longer than conventional HVAC systems that are exposed to harsh outdoor weather or vandalism.

Safety

GHPs are proven to be safe for schools. Since the piping and connections are buried, there is no dangerous outdoor equipment that children might be tempted to play on or vandalize. Polyethelene ground heat exchangers—essentially the same as used for natural gas distribution—are often guaranteed for 25 to 40 years.



Hundreds of schools in the United States reap the benefits and savings of geothermal heat pump systems to provide heating, cooling, and hot water.

Case Study—Nebraska Schools Benefit from GHPs

In Lincoln, Nebraska, not only is the school district benefitting from the savings of GHP systems, but the taxpayers are, too. With cooperation from Lincoln Electric Systems and Lincoln Public Schools, four elementary schools recently installed GHP systems. The heating and cooling costs are about $144,000 a year less (for 1996–1997) than they would have been if those schools installed more traditional heating and cooling systems. These savings will reach about $3.8 million over just 20 years, allowing for other capital improvements to be realized.

Compared to natural gas HVAC systems (air-cooled, variable air volume systems) that were installed in two other schools at the same time, the schools had a total energy cost savings of 57%. There were also 42% and 20% reductions in electrical demand and electrical energy consumption, respectively. Not only will the school district taxpayers save approximately $3.8 million over the next 20 years, but the GHPs also help reduce peak demand for electricity compared to alternative systems.

> *"Once we began to study the different types of heating, it became very obvious to me that the geothermal plan was going to be the least expensive."*
>
> Nan Droz, board member of Manheim Township School District (Neff Elementary School project), Pennsylvania

Case Study—GHPs Popular with Kentucky School District

Paint Lick Elementary School in Garrard County, Kentucky, was the first newly constructed school in Kentucky to be heated and cooled by a GHP system. Thirty-five separate GHPs throughout the school allow the library, cafeteria, offices, gymnasium, and each classroom to have individual thermostats and optimal zone control. The GHP construction cost of $9.60 per square foot was very reasonable considering there are individual temperature controls in every room. "The GHP system provides a financial cost savings in terms of service, because other systems are more labor intensive and require continual custodial care," said Dr. William Wesley, superintendent of the Garrard County School District.

One manufacturer even offered an unconditional guarantee on the system for two years. "By guaranteeing this system, we took the risk away from the school board, and we believed once they saw what the system could do, awareness and acceptance of the technology would be our reward," noted the company's head of marketing. The system did its job in convincing people—Kentucky now has over 40 schools with GHP systems.

Case Study—Texas Schools Favor GHPs

Austin (Texas) Independent School District was the nation's first school district to install GHP systems on a large scale. Since 1989, the majority of heating and cooling systems that have been installed are GHP systems.

Before installing GHPs, the school district was facing problems maintaining and upgrading their heating and cooling systems because of the large number of schools. One maintenance supervisor for the school district said, "Stocking parts for the numerous heating and cooling systems in our schools was a nightmare. By standardizing on the GeoExchange units, we eliminate chillers, boilers, convectors, etc., and all the chemicals, parts, and maintenance associated with them."

Installation Methods

GHP systems can be used in virtually any area of the country—from Alaska to Florida—because of the way they rely on the thermal stability of the Earth to heat and cool. The type of installation best for each school depends on a number of factors, such as climate, property layout, and geologic conditions. The best economics are gained by installing the ground heat exchanger when a building is under construction. Piping may be arranged as a few wells per classroom or as a series of vertical wells for the entire school. GHPs are a particularly viable heating and cooling option in areas where stringent air emissions standards are difficult to meet using conventional systems. For school facilities, GHP systems can be the lowest first-cost option when competing with four-pipe boiler and cooling-tower systems. In most other situations, GHP systems have lower life-cycle costs when considering overall energy and maintenance costs.

> *"For our current students and thousands that will take their place in the next century, one of the best means of achieving true, lasting energy efficiency in our schools is to convert them to GeoExchange heating and cooling."*
>
> Secretary of Energy Bill Richardson

Schoolchildren Learn by Example

Judged solely on the efficiency and durability of GHPs, it seems a smart choice for schools to incorporate them. But besides these advantages, there are more reasons to incorporate them into schools. With GHPs, the money saved on energy costs can be invested in educational resources.

GHPs in schools can teach children early in their lives to start thinking about cost efficiency and their environment. They can learn about conserving natural resources and that they can be part of helping to protect and save our environment—all of this right in their own school.

> *"The schools with geothermal systems have energy costs about half those of the schools with conventional heating and cooling equipment."*
>
> Doug Bantam, Chief Engineer, Lincoln Electric Systems, Nebraska

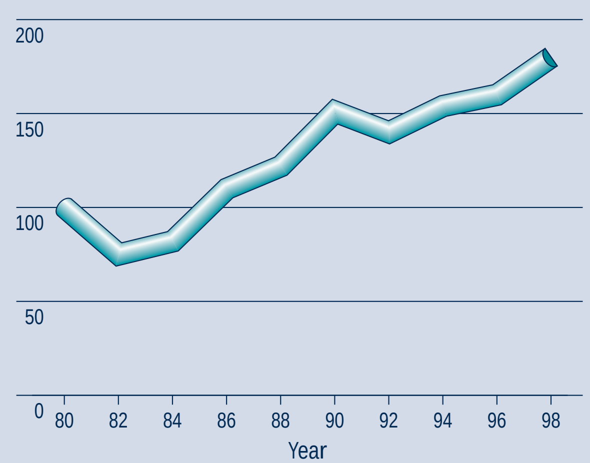
DOE Spreads the Word about GHPs

In 1994, the U.S. Department of Energy (DOE), working closely with the Environmental Protection Agency, 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.

> *"Our GHP system was a retrofit. Over a seven-month period, we have saved over 40% on heating plus the added benefits of cooling and hot water."*
>
> David Grubb, Schyler R-1 Schools, Missouri

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.

Construction Growth in Educational Buildings
Millions of square feet



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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