Fort Polk
Fort Polk, LA

Commercial Case Study

Fort Polk Demonstrates Potential for GHP Systems

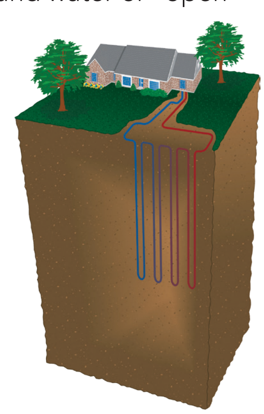
Geothermal Systems at Fort Polk

A recent independent study prepared for the U.S. Department of Energy by Oak Ridge National Laboratory demonstrates that geothermal heat pumps (GHPs) provide substantial benefits to the end user (the government in this case), the electric utility industry and the environment. A 4,003-home retrofit of GHPs (also called ground-source heat pumps, water-source heat pumps and GeoExchange) at Fort Polk, Louisiana reduced electrical consumption by 26 million kWh (33%) while altogether eliminating consumption of 260,000 therms (27,429 mega joules) of natural gas. Peak demand was reduced by 7.5 MW (43%), and the power factor was increased from 0.52 to 0.62. Emissions of CO^2 have been reduced by 22,400 tons (20,320,922 kg) per year.

World's Largest Geothermal Installation

Fort Polk, the world's largest installation of geothermal heat pumps, was funded by $18.9 million in private capital, with no investment by the federal government except for procurement and administrative costs. Private investors, through an ESCO (Energy Services Company), realized that GHPs inherently pay for themselves. The U.S. Army and the ESCO share the cost savings over the life of a 20-year contract, allowing Fort Polk to exceed the mandate for 35% reduction in energy use by 2010, outlined in the Energy Policy Act of 1992. With heating, air conditioning, and water heating responsible for 74% of residential energy use (and 50% of commercial energy use) on a national basis, widespread use of GHP systems could generate significant savings for energy utilities and end users.

GHP systems consist of simple, proven components. The technology is not new. The first recorded system was shown in a 1912 Swiss patent. Ground water or "open loop" heat pumps have been used successfully since the 1930s. The Edison Electric Institute (EEI) sponsored closed loop research (like the Fort Polk application) in the 1940s and 1950s, although the lack of suitable material for closed loop piping slowed interest. Swedish researchers began investigating geothermal closed loop systems again in the 1970s with the advent of plastic pipe,



which is ideal for the application. GHP systems have been gaining in popularity every since.

In general, GHP systems consist of three components, (1) a geothermal (or water source) heat pump, (2) a heat source/sink (closed loop piping system) and (3) a distribution system (forced air ductwork or hydronic piping). A geothermal heat pump "moves" energy to or from the ground, instead of to or from the air like traditional heat pumps, giving the GHP system the advantage of working with a very mild heat source/sink – the ground.

The heat source/sink consists of polyethylene pipe (usually 3/4 - 1 in. diameter – 1.91 cm or 2.54 cm diameter), arranged according to the geography of the land. One loop piping system is not better than another; the loop is tailored to the available land space, with loop length adjusted accordingly (e.g. horizontal loops require more piping than vertical loops, due to the more shallow burial depth). A water and antifreeze solution is pumped through the piping system. The water/antifreeze solution transfers heat from the earth to the heat pump refrigeration circuit (or from the heat pump refrigeration circuit to the earth), which transfers heat to or from the distribution system.

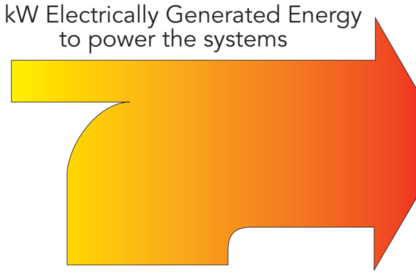
The distribution system consists of forced air ducting or hydronic piping. A forced air ducted system uses a fan and ductwork to deliver heated or cooled air via registers and grilles to the structure being conditioned.

GHPs offer warmer air temperatures in heating for forced air systems than traditional air-source heat pumps due to the milder heat source they use (the ground). In cooling, GHPs provide excellent dehumidification and cool, refrigerated air. A hydronic distribution system may be used instead of a forced air system. Some examples include radiant floor heating, fan coil units and snow melt.

Diverse Applications for GHPs

Almost any building can benefit from a GHP system. Schools, assisted living communities, office buildings and residential homes are but a few examples. Any building that has an available space for loop piping of 100 to 225 ft^2 per ton of cooling (1,150 to 2,600 cm^2 per kW) is a good candidate for a GHP system, even if the available space is under a parking lot or under the building. Where a retention pond is required for parking lot runoff, a GHP system can become not only the most efficient HVAC system, but may even be the lowest first cost (installed) system.

Geothermal Renewable Energy Concept



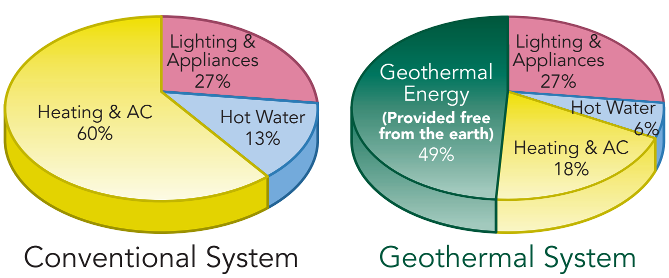
GHP systems can drastically reduce utility power generation requirements when compared to other systems. At Fort Polk, 1.14 kW peak demand reduction was realized for every installed ton of cooling (0.32 kW peak demand reduction for every kW of cooling). This equates to peak demand reduction of 285 kW for every 100,000 ft^2 (9,290 m^2) building or for every 71 homes. If GHP systems were implemented on a widespread basis, power companies could avoid building new power plants. Using the figures from Fort Polk, a 400 MW gas turbine generator could be redirected for use elsewhere for every 99,500 homes or for every 1,400 buildings of 100,000 ft^2 (9,290 m^2) converted to GHP. In the past ten years since Fort Polk was started, heat pumps have become even more efficient, some with almost twice the efficiency, further enhancing generating capabilities (peak reduction). The increase in load factor with GHP systems helps level peaks and increase generating efficiency.

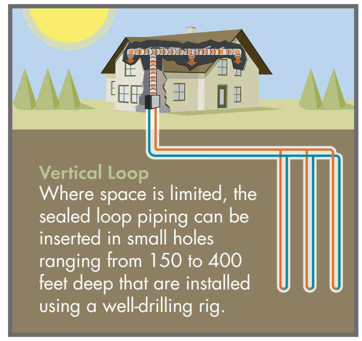
GHP systems are environmentally friendly. Based upon data supplied by the U.S. Department of Energy and Environmental Protection Agency, a typical 3 ton (10.5 kW) residential GHP system produces an average of about one pound (0.45 kg) less CO^2 per hour of use than a traditional system. If just 100,000 homes converted to a GHP system, the country could reduce CO^2 emissions by 880,000,000 pounds (39,916,096 kg).

Residential GHP systems generally cost more to install than other HVAC systems. The additional cost is primary the ground loop piping system, since the heat pump and distribution system are similar in cost to other technologies (e.g. furnace/air conditioner or air source heat pump). Initial cost for commercial GHP systems really depends upon a base system comparison. For example, GHP system initial cost is higher than a constant volume packaged rooftop unit, but the same or less than a 4-pipe VAV (variable air volume) system. Depending upon a base system comparison, peak demand and kWh savings will vary. However, GHP systems still have the most favorable operating cost and load profile of any HVAC system.

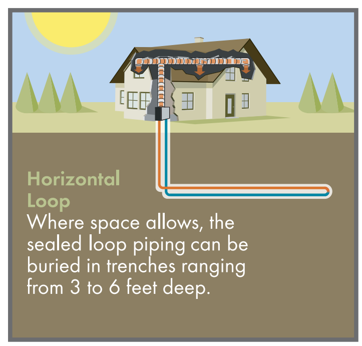
GHP systems have a proven track record for reducing operating costs for end users, lowering peak demand/ improving load factor for utility companies and creating a more environmentally friendly heating and cooling system for society in general. The independent study of the Fort Polk GHP retrofit installation provides a benchmark for the endless possibilities of applying the technology on a widespread basis.

Residential Energy Use

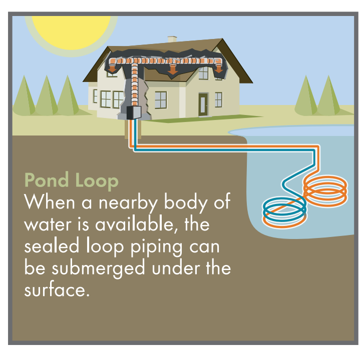




Vertical Loops are used extensively where land area is limited or soil conditions prohibit digging the more economical horizontal loops. A pair of pipes with a special U-Bend assembly at the bottom are inserted into a bore hole that averages between 150 to 250 feet deep per ton of equipment. These holes are then backfilled with a special grout solution to ensure good contact with the earth.



Horizontal Loops are installed in areas where the soil conditions allow for economical excavation. Taking up more land area than any other loop type, they are used where space permits. Trenches are normally about five foot deep with multiple pipes placed in the trench at different depths. Normally, several hundred feet of trench is required, but where space permits these loops are considered desirable.



Pond Loops are usually very economical to install. If a pond or lake at least eight feet deep is available, pond loops can utilize the water (rather than soil) to transfer heat to and from the pond. A coiled pipe is placed in the water, which should cover about 1/2 acre. An average home would require about 900 feet of pipe. Reduced installation costs and high performance are characteristic of this type of loop.

Fort Polk

World's largest geothermal installation

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Eliminated consumption of 260,000 therms (27,429 mega joules) of natural gas

Emissions of CO^{2} reduced by 22,400 tons (20,320,922 kg) per year

ClimateMaster is the world's largest and most progressive manufacturer of geothermal heat pumps. The company is committed to innovation and dedicated to environmentally clean, economically sound and superbly comfortable home and business environments.

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