

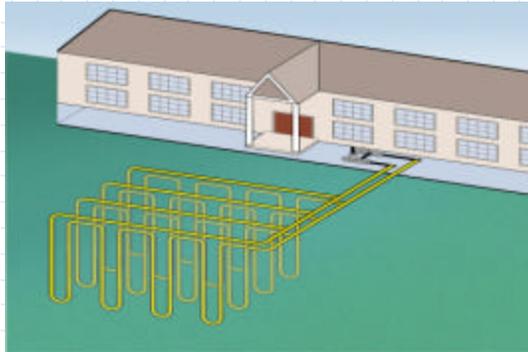
Geothermal Rocks!

The U.S. Fish and Wildlife Service
Experience

What is it?

- ◆ A Geothermal (ground-source) heat exchanger is loop of pipe circulating through the ground that rejects heat to or extracts heat from the earth.
- ◆ It may be vertical or horizontal.
- ◆ It may be an open loop or closed loop.

Commercial Vertical Closed-Loop System



Courtesy Geothermal Heat Pump Consortium

What are its major parts?

- ◆ A geothermal heat pump.
- ◆ The ground loop.
- ◆ A distribution system (air ducts).
- ◆ A supplemental heater (optional).

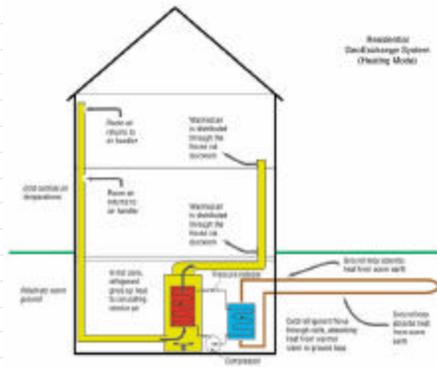
How does it work?

- ✦ GHP systems work by moving heat, rather than by converting chemical energy to heat like in a furnace.
- ✦ It has a summer cycle and a winter cycle.
- ✦ Systems are sized in “antiquated” units of tons (how many tons of ice that would make)
- ✦ 1 ton = 12,000 BTU/hr.

How about the winter?

- ✦ In heating mode, heat is extracted from the earth by the GHP and distributed to the building through a system of air ducts.
- ✦ Cooler air from the building is returned to the GHP, where it cools the fluid flowing back to the earth.
- ✦ The fluid is then re-warmed as it flows through the earth.

Winter Cycle

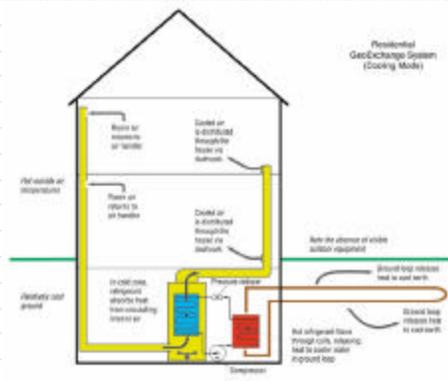


Courtesy Geothermal Heat Pump Consortium

How about the summer?

- ◆ In cooling mode, the process is reversed.
- ◆ The ground loop releases heat to the cool earth.

Summer Cycle



Courtesy Geothermal Heat Pump Consortium

What makes it better?

- The most common GHP system is the vertical loop.
- The horizontal loop requires a trench and more land.
- More moisture in the soil increases performance (GHP use is questionable in arid areas such as the Desert Southwest due to high cooling demand and lack of groundwater.)

What ensures cost effectiveness?

- ◆ Do a feasibility or SAVEnergy Study.
- ◆ Need land for bore holes or trenching.
- ◆ Depth of vertical bore.
- ◆ High energy use and demand rates.
- ◆ Reusable old components in renovations (piping, duct work, etc.).
- ◆ Experienced contractors.

How do you estimate costs?

- ◆ GHP systems are not yet mainstream HVAC options.
- ◆ Cost estimating guides such as R.S. Means are not very useful.
- ◆ Get quotes from manufacturers.
- ◆ Small project costs vary widely due to differences in GHP design, site demands, and available contractors.

What are the energy savings?

- ◆ FWS experience shows that GHP systems use approximately 25% less energy than a conventional HVAC system.
- ◆ The simple payback is approximately 5-10 years.

Is technical info available?

- ◆ DOE/FEMP.
- ◆ Geothermal Heat Pump Consortium (GHPC).
- ◆ The International Ground Source Heat Pump Association (IGSHPA).
- ◆ The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
- ◆ Oak Ridge National Laboratory.
- ◆ Geo-Heat Center, University of Alabama.

Where's the Beef?



- ◆ The Service is the DOI leader in GHP.
- ◆ 9 GHP projects have been installed since 1993 at FWS field stations.
- ◆ 3 are Federal Energy-Saver Showcases.

Creston NFH, MT



Hatchery



Residence

What's Creston NFH's system?

- ◆ Projects were done since 1993.
- ◆ 5 closed-loop GHP systems for the residences, and
- ◆ 2 open-loop GHP systems at the hatchery, where they have the potential of flowing water.

Creston's Heat Pump Units



Cusano Environ. Ed. Center, John Heinz NWR, PA



- ✦ Federal Energy-Saver Showcase.
- ✦ Ribbon Cutting December 2000.
- ✦ 14,000 ft²
- ✦ Difference between GHP and standard HVAC is \$70,000-\$80,000.

What's Cusano's GHP system?

- ✦ 30 vertical closed-loop wells @ 350 ft.
- ✦ Costs increased due to former fill area (we had to drill through huge chunks of concrete!)
- ✦ 1-1/2" polyethylene (PEX) U-tube in each well, filled with water.
- ✦ Groundwater @ 55° F for pre-cool/pre-heat
- ✦ To minimize environmental impact: ran wells along road, and used PEX instead of PVC.

Courtesy Bruce Brooks & Assoc.,
Philadelphia

Cusano Performance

- ✦ Cooling = 560,000 BTU/hr = 46.7 tons
- ✦ Heating = 481 MBH = 40.1 tons
- ✦ Savings are estimated at 35,000 kWh and \$3,900 annually (20-year payback).
- ✦ 6,600 BTU/ft²/year (1/3 lower than most conventional systems)
- ✦ e.g. November 2001 electric bill = \$330!

Courtesy Bruce Brooks & Assoc.,
Philadelphia

Cusano Geothermal Well Field



Cusano Well Field Trench



Wichita Mountains WR Visitor Center, OK

- ◆ Federal Energy-Saver Showcase.
- ◆ Although GHP cost more, it was installed to save energy and reduce environmental impact.
- ◆ Two separate systems provide ventilation air per the new code (need more O.A.).
- ◆ Relatively easy O&M.

Wichita Mountains VC



Prairie Learning Center at Neal Smith NWR, IA



- ✦ Federal Energy-Saver Showcase.
- ✦ The 42,000 ft² education building and office is heated and cooled by GHP.

Lostwood NWR, ND



- ✦ The 4-ton GHP closed-loop system for the office was completed in 1994.
- ✦ \$5,000 utility rebate.
- ✦ 8" insulation in the ceiling.
- ✦ Supplemental heating not needed!

Long Lake NWR, ND



- ✦ The 9-ton closed-loop GHP system for the HQ completed in 1994.
- ✦ Two heat exchangers are on the 2nd floor.
- ✦ No problems with noise or vibration.

Madison Wetland Management District, SD



- ✦ Ongoing \$35,000 HVAC/GHP project.
- ✦ The heating system is being replaced with a GHP and rehabilitate the Office.

Lake Andes NWR, SD

- ✦ 3-ton GHP open-loop system for the residence completed in 1994.
- ✦ Uses 70° F well water.
- ✦ Turn system off in summer!

Teawaukon NWR, ND

- ✦ The project was completed prior to 1994.
- ✦ A GHP system for the headquarters building.

