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Geothermal or Ground Source Heat Pumps Part III: Advantages and Disadvantages of Geothermal Heat Pumps and Lessons Learned

ADVANTAGES & DISADVANTAGES

As with any alternative energy system, there are advantages and disadvantages to Ground Source Heat Pump (GSHP) Systems and they are usually type-specific. In general all GSHPs are cost efficient and because they do not burn fossil fuels; are powered by renewable energy and are all electric, and they are very environmentally sustainable. GSHPs are quiet to operate. Since there is no outdoor equipment there is little or no maintenance to the piping which is often guaranteed to last 25-50 yrs. and is virtually worry-free. Overall GSHPs have a lower life cycle cost than conventional systems.

The disadvantages in general are that the first cost can be significantly higher than conventional systems; not all system types are feasible in all locations and there is a limited pool of qualified designers and installers in many locations; In addition, there is a lack of awareness and a lack of uniform standards; thus design and installation accreditation has yet to receive nationally standardized accreditation.

An overview of some of the advantages and disadvantages of the various systems are provided here. [1,2]

The advantages of the *Vertical Ground Coupled Heat Pump System* include:

- Requires less land than other closed loop systems
- Requires smaller amounts of pipe and pumping energy
- Likely to yield the most efficient performance of closed loop systems

The disadvantages are:

- Higher initial cost due to the drilling of boreholes
- Problems in some geological formations
- Limited availability of experienced drillers and installers

The advantages of the *Horizontal Ground Coupled Heat Pump System*, in which placement of straight or "slinky" piping installed in shallow (6-8ft) horizontal trenches, include:

- Likely less expensive to install than vertical closed loop because trenching is generally less expensive than drilling
- Requires less specialized skill and equipment to install, so contractors are more widely available

The disadvantages are:

- Requires more space; Horizontal systems generally require 1500-3000 ft^2 of land area per ton of heating or cooling
- Requires more piping hence use of the 'slinky' formation typical slinky configurations require 150 ft. of three-foot-wide area per ton. A slinky configuration can require one acre per 90 tons of peak block load, and the entire area must be excavated or filled to a depth of 6-8 ft.
- Ground temperature and thermal properties fluctuate with season, rainfall, and burial depth
- Lower efficiency than vertical GSHP
- Problems in some geological formations

The advantages of the *Surface Water Heat Pump Lake Loop System* where the piping is anchored to the bottom of a nearby body of water are:

- Low cost due to reduced excavation costs
- Low maintenance
- Low operating costs
- Can use stainless steel or titanium plate heat exchangers instead of piping.

The disadvantages are:

- Possible damage to piping in public bodies of water
- Significant temperature variation if lake is small/shallow

The advantages of the *Groundwater Heat Pump System* which uses groundwater as heat sink and source include:

- lowest installed cost, especially in larger applications
- Uses less space
- Well water contractors are widely available
- Long track record in large commercial applications

The disadvantages are:

- Local water and environmental regulations may restrict use
- Limited water availability
- May need anti-fouling precautions
- High pumping energy required if system is poorly designed or water is pulled from deep aquifer

A Hybrid System uses several different geothermal resources, or a combination of a geothermal resource with outdoor air such as a cooling tower. It is particularly effective where cooling needs are significantly larger than heating needs. The cooling tower is used to reject excess heat. The main benefits of this system include:

- Reduces loop field size, and thus costs, by allowing for the ground loop to be undersized for the cooling load, but sized for the smaller heating load
- Off peak Operation
- Avoids increase in ground temperature due to load imbalances

The most common mistakes made in the design and installation of GSHPs are typically a result of not adhering to International Ground Source Heat Pump Association (IGSHPA) standards and recommendations by: [3]

- Using standard instead of extended range water source heat pumps
- Using unnecessary boiler/chiller or boiler/cooling tower type mechanical room and heat pump connection components and accessories
- Using "utility" class trenching specifications for loop field header piping
- Using "hard" (metal, PVC) loop pipe testing criteria on the flexible, expansive (under pressure) high density polyethylene piping specified in IGSHPA Standards
- Ignoring or misinterpreting state or local well drilling/casing and well sealing regulations
- Inappropriate loop design approach resulting in incorrect loop length, pipe size, grout, header design, etc
- No reverse return header connections to balance flow through each borehole in a multi-borehole grid
- No "step-down" of loop field header piping sizes to facilitate purging
- No accommodations in the mechanical room for high volume flushing/purging.

[1] DOE/CE/15095-6/ Dec. 1983
[2] 2003 ASHAE Applications Handbook
[3] Earth Insights Phil Rawlings
http://www.igshpa.okstate.edu/pdf_files/geothermal/earth_insights/earth_vol1_no3.pdf