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Engineering for a sustainable future...

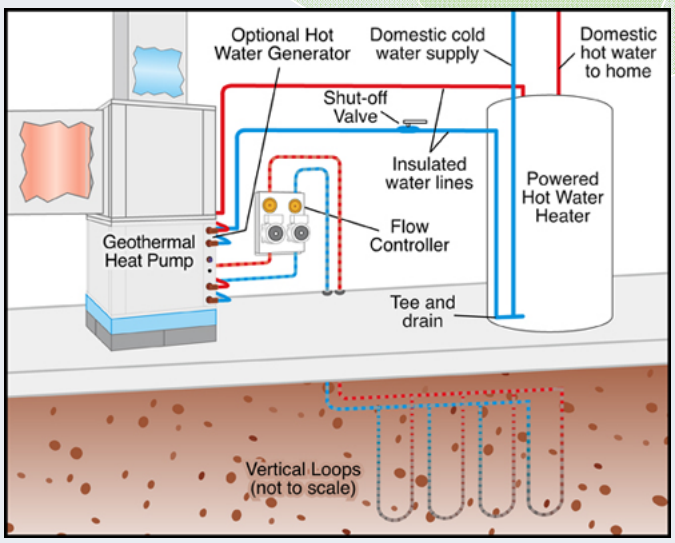
What Architects Need to Know About:

Geothermal Heat Pump Systems

Overview

Geothermal heat pumps (GHPs), sometimes referred to as Geo-exchange, earth-coupled, ground-source, or water-source heat pumps, have been in use since the late 1940s. They use the constant temperature of the earth as the exchange medium instead of the outside air temperature. This allows the system to reach fairly high efficiencies (300% to 600%) on the coldest winter nights, compared to 175% to 250% for air-source heat pumps on cool days.

Even though the installation price of a geothermal system can be several times that of an air-source system of the same heating and cooling capacity, the additional costs are returned to you in energy savings in 5 to 10 years. System life is estimated at 25 years for the inside components and 50+ years for the ground loop.



Geothermal Heat Pump System

Types of Geothermal Heat Pump Systems

There are four basic types of ground loop systems. Three of these; horizontal loop, vertical loop, and pond/lake are closed-loop systems. The fourth type of system is the open-loop option. Which one of these is best depends on the climate, soil conditions, available land, and local installation costs at the site. All of these approaches can be used for residential and commercial building applications.

Vertical Loop System

Horizontal Loop System

Pond Loop System

Open Loop System

Images courtesy of McQuay International

Energy Efficiency

The biggest benefit of geothermal heat pumps is that they use 25% to 50% less electricity than conventional heating or cooling systems. This translates into a GHP using one unit of electricity to move three units of heat from the earth. So while a standard electric heater or natural gas-fired combustion furnace can provide no more than 100% of the energy it uses, GHPs in heating mode can offer efficiencies of 400% percent and even more.

In cooling mode, GHPs have significantly higher energy efficiency ratings than competing air-source heat pump systems.

Aesthetics

Geothermal heat pump systems have two primary components, the heat pump unit and the fan coil unit. Both of these units can be located in equipment rooms within the building. In addition, fan coil units can be located above the ceilings, in closets or other small spaces.

Heat Pump Unit

Fan Coil Unit

Specific Architectural Issues

There are a number of architectural considerations for geothermal heat pump systems which should be discussed with your engineer.

Pros:

1. High system efficiencies will improve Title 24 scores, add LEED points and lower energy bills.
2. Fan coils require a minimal amount of ceiling space which may allow higher ceilings.
3. Small equipment footprints maximize building usable space.
4. System reliability due to few moving parts, which translates into reduced life cycle costs.
5. Reduction in greenhouse gas emissions a a result of significantly reduced energy consumption.

Cons:

1. May be more significantly more expensive that more traditional systems by approximately 30%, depending on site conditions.
2. Requires a detailed site investigation and analysis of ground, and ground water, conditions as well as careful engineering by a qualified professional.
3. Requires either multiple deep wells, or a large horizontal field for ground loop system that can present various challenges.
4. Presents certain liabilities and risks that are not normally associated with building systems. The architect must become knowledgeable on the system to ensure the risks are managed appropriately.

See the Department of Energy Geothermal Heat Pump 101 here:
http://www.youtube.com/watch?feature=player_embedded&v=y_ZGBhy48YI