INFORMATION SERIES

Geothermal Heat Pump

What if we told you there is a way that your home can be heated and cooled for a fraction of what it is currently costing you? What if we told you this technology is not new but has been in use for many years? This article is about stealing heat from deep in the ground and pumping it into your house to keep you warm in the winter, then pumping the heat out of your house in the summer, again using the ground to your benefit. The technology is called a ground-source heat pump or a geothermal system.

TEMPERATURE GRADIENT

Temperature gradient is a preliminary concept that one needs to understand before the benefits of a geothermal heat pump can be fully appreciated. It's all about heat flow. There are two parts to this concept:

Direction of heat flow: It should be no surprise to you that heat will move from hot to cold all by itself. It does not need any encouragement (energy). If it is hotter outside than it is inside, heat will move from outside to in and heat the home until the temperature inside is the same as out. The natural direction of heat flow is hot to cold. If heat is flowing in the direction it wants to go, you have a positive temperature gradient.

Temperature difference: If it is very hot outside and very cold inside there is a big difference in temperature and we have a big temperature gradient. Heat will move very quickly.

WHAT'S A HEAT PUMP?

Heat will move on its own from hot to cold, but what if we want it to move heat the other way? For example, it's hot in your house and you want to get the heat out, but it's even hotter outside. Heat won't flow naturally in this direction, but we can force it using a heat pump. Using a compressor, refrigerant and two heat exchanging coils, the heat from the house gets pumped outside into the outdoor air and thus the inside gets cooler. This kind of one-way heat pump is commonly known as an air conditioner. When the system is capable of both moving heat from the house into the outside or and moving heat from the outside air into the house, we call this an air-source heat pump.

Heat pumps are nothing new and lots of people in moderate climates have air-source heat pumps. They don't work in climates that get cold because as the temperature outside drops, there is so little heat in the outdoor air that the heat pump has to work very hard to absorb that heat. This adversely affects the efficiency of the heat pump. In cold climates, air-source heat pumps are just not that effective or efficient.

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GEOTHERMAL HEAT PUMP

The reason an air-source heat pump is inefficient in cold climates is that it has to pump heat against a very large temperature gradient. For example, it might be 20˚F outside and 75˚F inside. That's a temperature gradient (difference) of 55˚F. Heat naturally wants to flow out of the house but the heat pump is pulling heat against this large gradient. This takes a great deal of electricity. If the problem is the temperature gradient, is there something that we can do to change the gradient? Enter the ground-source heat pump!

A ground-source heat pump uses the earth as its heat source and heat sink. If you dig down about 6 to 10 feet, the temperature is not only moderate, but it is consistent all year long, 50˚F or so, depending on your area. If we take our example from the paragraph above, we now have 75˚F inside the home and 50˚F in the ground, that's a temperature gradient of only 25˚F. It's a lot easier to pull heat from 50˚F soil than it is to pull heat from 20˚F winter air. Now we have a system that is very efficient. What's more, for air conditioning, we are actually pumping ***with*** the temperature gradient, not against it!

How does it work? Instead of the typical condenser coil found outside a house with air conditioning or a traditional heat pump, geothermal systems include pipes that are buried in the ground or submerged in a well or a lake, either horizontally or vertically.

PAYBACK TIME

Why doesn't everybody have a ground-source heat pump? The cost to heat and cool the house is a fraction of the cost of air-to-air heat pumps and furnaces but every rose has its thorn. The thorn in this case is the upfront cost of installing the system.

Currently the payback time is in the order of 12 to 15 years. There are four factors that are changing this:

- The rising cost of energy will make these systems relatively more affordable.
- As more people demand these systems, more manufacturers and installers will get into the game and the cost will come down.
- Energy subsidies may tip the balance on payback time.
- People today have a desire to do something good for the environment even if the payback time is not favorable.

Even though geothermal systems have been around for a long time, the industry is still in its infancy. Expect to see more and more of these systems in the years to come.

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