Outstanding home comfort through advanced technology

How would you like to have a heating and air conditioning system in your home that can:

- Save energy and slash electric bills,
- Cut greenhouse gas emissions,
- Rid your yard of unsightly outdoor equipment,
- Drastically reduce the cost of your hot water, and
- Reduce maintenance costs—

even as it improves the year-round comfort of your home?

Sound too good to be true?

In fact, such units, called geothermal systems, offer such a lengthy list of benefits that at first glance they do seem too good to be true.

Their benefits, though, flow directly from the clever application of sound technology—what you can think of as good science.

Once you understand how geothermal systems work, you'll understand how they can bring such an attractive list of benefits to your home.

What They Do

Geothermal systems provide heat in the winter and cooling in the summer, at efficiencies that are far better than those for most alternative systems.

Like conventional heat pumps, they are essentially air conditioners that can also run in reverse to provide heat in the winter. The primary difference is that they rely on the nearly constant temperature of the earth for heat transfer instead of the widely fluctuating temperatures of the outside air.

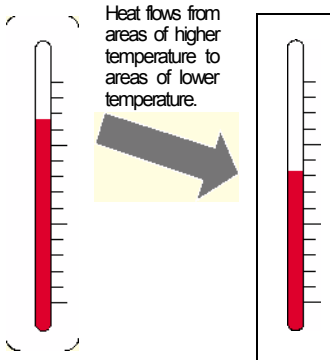
That is the key to the geothermal unit's surprising efficiency.

How They Work

Geothermal systems, like common heat pumps and air conditioners, make use of a refrigerant to help transfer (or pump) heat into and out of your home.

The refrigerant helps the geothermal system take advantage of two primary principles of heat transfer:

1. Heat energy always flows from areas of higher temperature to areas of lower temperature.



2. The greater the difference in temperature between two adjacent areas, the higher the rate of heat transfer between them.

Refrigerators, air conditioners, and heat pumps all operate by pumping refrigerant through a closed loop in a way that creates two distinct temperature zones—a cold zone and a hot zone.

The simplest example of such a system is the universally familiar home refrigerator. In a refrigerator, a fan blows the air inside the box over tubes containing refrigerant that is very cold (typically below 0°F). Heat flows from the interior air to the cooler refrigerant.

The refrigerant is then pumped to the high-temperature section, which is exposed to room air outside the refrigerator box. Because the refrigerant is hot in this zone, it gives up heat to the relatively cooler air in the room, before flowing back to the cold zone to begin the loop again.

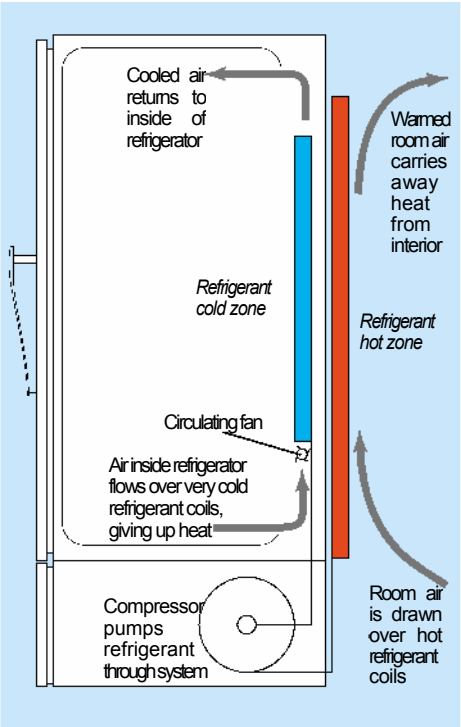
An air conditioner works in exactly the same way, except that it extracts heat from the air inside a room or building and transfers it to the air outside the building.

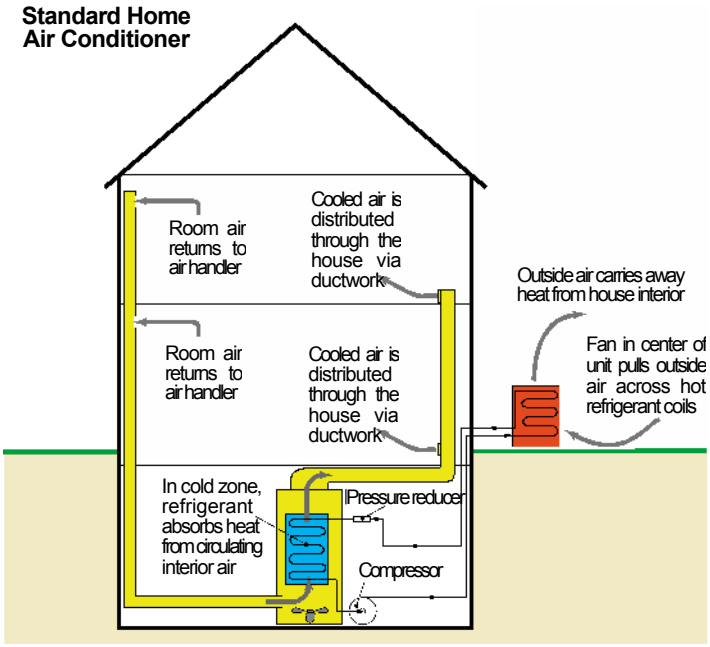
A conventional heat pump adds a reversing capability, so the hot zone and the cold zone can be switched. With the zones reversed, it can extract heat from the outside air in the winter and transfer it inside.

Granted, being able to extract heat from frigid winter air seems like it shouldn't work. But it will if we can expose the cold air to refrigerant that's even colder than it is. And modern heat pumps can do that.

If the outside air gets extremely cold, though, a heat pump just can't make the temperature of the cold zone low enough. That's when supplemental electric heating elements kick in. Working much like a toaster, they supply warmth to the house, but at very high relative cost.

Typical home refrigerator





The Super Efficiency of Geothermal

Standard heat pumps, while relatively simple to operate, face one major challenge. Their operating efficiency is lowest when demand is highest; that is, heat pumps have to work hardest when we want the most from them.

As we've just seen, a regular heat pump extracts heat energy from outside air in winter, and rejects heat to outside air in summer. Unfortunately, the colder the outside air, the more difficult it is to extract heat from it, and the hotter the outside air, the harder it is to transfer heat to it.

The temperature difference between the air and the refrigerant is small in both cases, lowering heat transfer rates within the system.

Yet, the colder it gets outside, the higher the rate of heat loss through windows, around doors, and through walls and roofs, and the more heat we need to pump inside to keep indoor temperatures comfortable.

In summer, we face a similar dilemma. The hotter it gets outside, the higher the rate of heat infiltration into the house, and the more heat removal we need to maintain comfort.

A geothermal system eliminates this dilemma by using the relatively constant temperature of the earth as a heat source in winter and a heat sink in summer, instead of outside air.

Throughout most of the U.S., the temperature of the ground below the frost line (about 3 to 5 feet below the surface) remains at a nearly constant temperature, generally in the 45°–50°F range in northern latitudes, and in the 50°–70°F range in the south.

So, in the winter, a geothermal unit can extract heat from ground that's relatively warm compared to the cold outside air, and in the summer, it can discharge heat to ground that is relatively cool, compared to the hot outside air. Since the difference between the refrigerant temperature and the ground temperature remains relatively high in both seasons, so do heat transfer rates.

Consequently, the geothermal system operates at much higher year-round efficiencies than a standard heat pump.

The Cleanliness of Geothermal Systems

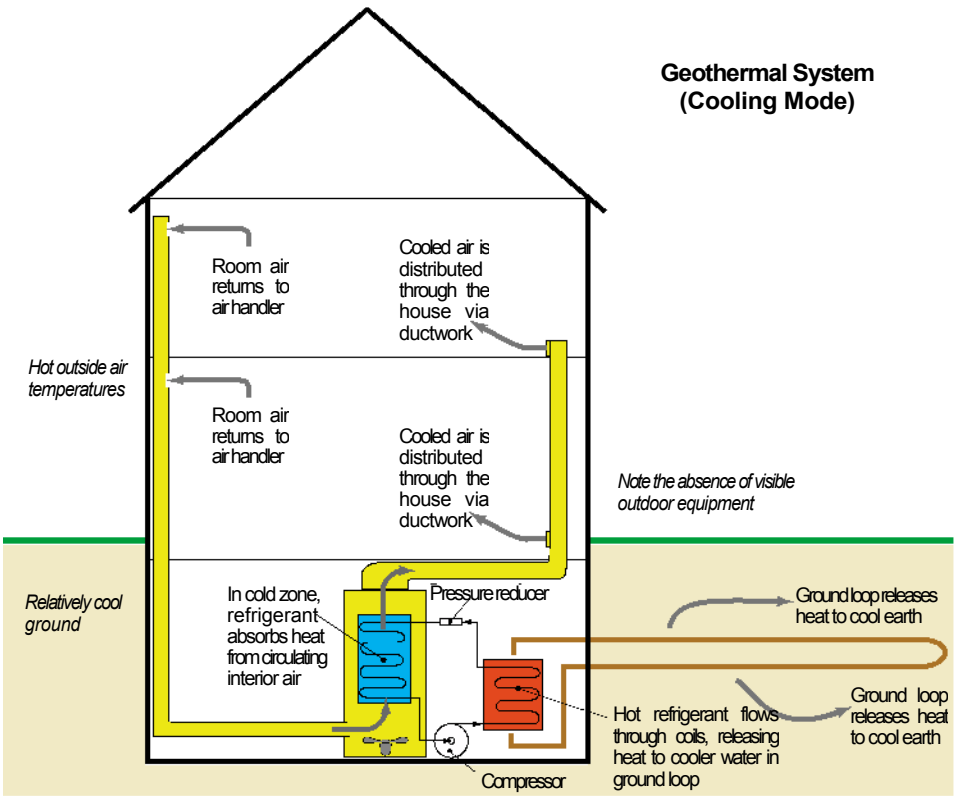
Installing a geothermal system is environmentally responsible. Since a geothermal system merely transfers heat from the ground into your home in winter, you don't need to burn any fossil fuels to create a warm interior environment.

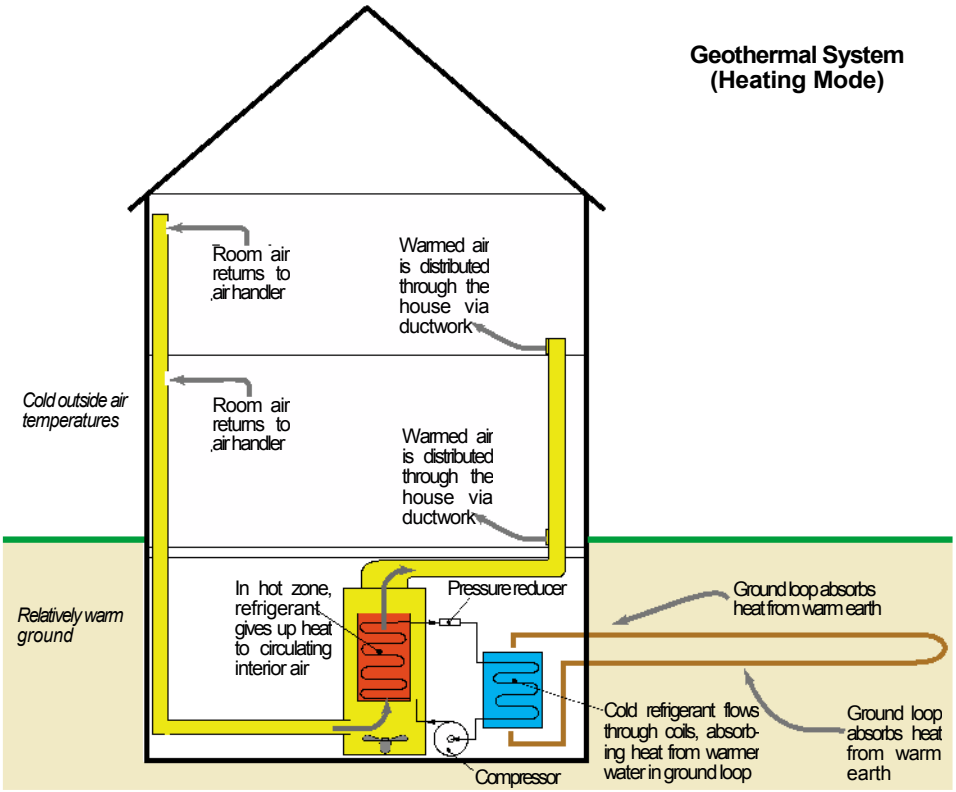
This approach drastically reduces carbon dioxide emissions (a greenhouse gas) compared with the operation of other heating systems, and completely eliminates the heating system as a potential source of carbon monoxide fumes within your home—making the geothermal system an environmentally friendly as well as safe and healthy alternative to traditional oil and gas furnaces.

Making The Ground Connection

The unique aspect of the geothermal system, and the key to its lengthy list of benefits, is the ground loop. The ground loop provides the means of transferring heat to the earth in summer, and extracting heat from the earth in winter.

Physically, the "ground loop" consists of several lengths of plastic pipe typically installed either in horizontal trenches or vertical holes that are sub-





sequently covered with earth and landscaping of your choice.

Water inside the ground loop piping is pumped through a heat exchanger in the geothermal unit. In the summer, it absorbs heat from the refrigerant hot zone and carries it to the ground through the ground loop piping. In winter, it absorbs heat from the earth through the ground loop, and then transfers that heat to the refrigerant cold zone.

The length of the ground loop will be determined by the heating and cooling loads, which are determined in turn by the size of your home, its design and construction, its orientation, and the climate where you live. Whether the ground loop is most efficiently installed in horizontal trenches or in vertical bore holes depends on the type of soil near the surface (rocky, sandy, clay-laden, etc.), the geology of the deeper terrain in your area, and the amount of land available.

Generally, horizontal loops are less expensive to install, but require more land area. Vertical holes require much less land area, but require the expense of drilling.

Another ground connection scheme—called an open loop system—involves using wells instead of closed loop piping. Where water is plentiful, it can be pumped out of a well, through the heat exchanger at the geothermal unit, and then pumped back into another well to return to the groundwater. Since the water merely absorbs or gives up heat, but is not altered in any other way, it leaves the geothermal unit as pure as it was when it entered it.

Any one of these installation schemes results in the same high efficiency, when properly sized.

Moreover, once the ground loop is installed, you can typically forget about it. The polyethylene piping (the same type used for cross-country natural gas lines) does not degrade, corrode, or break down in ground or water contact, so sound installations are expected to last 50 years or more.

Free Hot Water

As a side benefit, most geothermal systems can be designed to produce free hot water during the summer, by using waste heat extracted from the interior air during the air conditioning season.

Even in the winter, the geothermal unit can often help to reduce the use of electricity or gas by the hot water heater.

Premium Comfort Year Round

One of the complaints often heard from the owners of standard heat pumps is that the air coming from the vents in the winter is cool, creating a sense of draftiness.

While the air is actually warmer than room temperature by several degrees, it is much cooler than the average person's skin temperature. Heat transfer principle #1 says that heat will flow from our skin (an area of warmer temperature) to the air coming from the vents (an area of cooler temperature). And that makes the air feel cold and "drafty."

Geothermal systems don't have this problem. Because the ground temperature is much warmer than typical outside winter air temperatures, the geoexchange system can make the air much warmer than our skin—typically well over 100°F.

Since the air from the vents is at a higher temperature than our skin, heat flows from the air to our skin, making us feel warm and cozy.

Geothermal systems also provide superior year-round humidity control, and modular designs often make zoned heating and air conditioning practical—for even more comfort control through the entire house.

A message from John-David Thulin, Owner/Operator, Scandia Contractors:

Thanks for taking the time to read this article. Over the past 10 years, I've recommended this article to anyone interested in learning more about geothermal technology. In my opinion, this article gives a good fundamental understanding on how the technology works.

This article speaks of several types of ground heat exchangers or ground loops. Keep in mind that the choice of ground loop or ground heat exchanger is a function of where the installation takes place. The ground heat exchanger that works best in Kansas doesn't necessarily work on Long Island due to the thermal conductivity of the soil or how much heat our soil can give (heating mode) or absorb (cooling mode). For those of us here on Long Island, (see the paragraph above highlighted in red), our soil here is very sandy and is a poor conductor of energy. However, we do have an abundant supply of ground water which is easily to get to. In the event the ground water quality or quantity is not adequate for the geo equipment, we then consider the closed vertical loop method. I've consulted, designed and installed dozens of installations here on Long Island and I've recommended either open loop or closed vertical loop only.

For a 3000 sq.ft. home, the open loop cost is typically in the $8000 - $10,000 range, depending upon your depth to ground water. If your home has or requires a water well, the well can also be used for your geothermal system. Add the open loop recharge well (approx. $4000) and you are ready to go. Open loop cost is generally one third the cost of a closed vertical loop, therefore the open loop method is our first choice when evaluating a project.

We've been operating on an open loop system for 10 years in my own 3200 sqft home in Southampton. When we built our home, there is no municipal water supply available; therefore, we needed a water well. The water well provides our house with water, irrigation and meets our geothermal equipment needs. For us, the choice was simple - open loop. My heating and cooling bills for 2008-09 averaged $1924 ($160.33/month) and our geothermal system delivers better comfort than any other conventional heating and cooling system on the market today.

The initial cost for the equipment is comparable to conventional equipment. However, the geothermal system cost is generally higher than conventional systems. The additional cost is associated with the ground exchanger. With today's Federal Income Tax credit for geothermal systems (a tax credit of 30% of the complete installation including the ground loop) and LIPA's rebate ($1000/unit), the system cost is comparable to conventional heating and cooling systems. We've see the return on investment for open loops in less than 5 years and less than 10 years for closed loops. Financially, these systems are the best hedge against unpredictable energy costs.
The energy in the earth is an unlimited, non-capricious, tax free commodity you already own.

Let us show you how to lower your energy costs, experience a clean and renewable energy resource that improves your comfort, your property's aesthetics and increases the value of your home.

Whether you are building a new home or ready to upgrade your existing equipment, please call us at **631-259-3374** for a free consultation.

Best regards,

John Thulin
Scandia Contractors