

Geothermal Energy



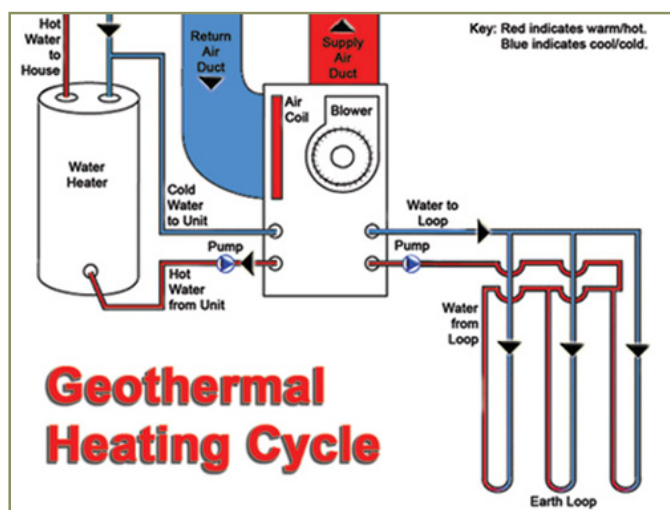
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Misconceptions about geothermal energy are driving a variety of myths about its practicality, reliability, benefits, and costs. The following compilation of information and facts about this generally untapped natural resource can aid potential future users and other interested parties in understanding current options for making geothermal energy a sustainable solution for many project needs.

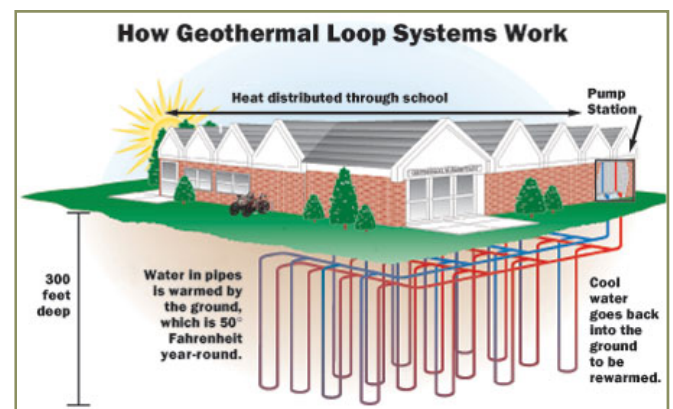
What is Geothermal Energy?

Geothermal energy is heat that is generated from within the Earth. Extreme temperatures are continuously being produced inside the Earth's core by the slow decay of radioactive isotopes. The molten iron core is a result of the formation of the planet and the intense gravitational pressure existing at the center of the earth. This heat then radiates outward toward the Earth's surface. Geothermal energy is not a new discovery; it has existed since Earth was created. The American Paleo-Indians were the first known humans to use geothermal energy more than 10,000 years ago. In 1922, the United States produced its first geothermal electricity plant which outputs 250 kilowatts to light streets and buildings in a city in Northern California.



What are Geothermal (or Ground Source) Heat Pump Systems?

A geothermal system consists of a network of pipes buried in the ground (filled with liquid), a heat exchanger, a heat pump, and ductwork in the building. Geothermal heat pump systems use the geothermal energy produced by the Earth to heat and cool buildings. While temperatures above ground can vary widely over the course of a day, the temperature 10 feet below the Earth's surface remains nearly constant between 50 to 60 degrees Fahrenheit. What this means for most areas is that soil temperatures are usually warmer than the air in the winter and cooler than the air in the summer. The Earth's heat is transferred through the buried pipes into the circulating liquid and then transferred back into the building through the heat exchanger and heat pump. During hot weather, the continually circulating fluid in the pipes removes heat from the building, helps to cool it and transfers it back into the earth. According to the U.S. Environmental Protection Agency (USEPA), geothermal heat pumps are the most energy efficient, environmentally clean, and cost-effective systems for temperature control. Although most homes still use traditional furnaces and air conditioners, geothermal heat pumps are rapidly becoming more popular. In recent years, the U.S. Department of Energy and the USEPA have partnered with industry leaders to promote the use of geothermal heat pumps in commercial and residential buildings.



Debunking Geothermal Myths



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Myth #1: Geothermal energy is extremely expensive with a poor Return on Investment.

Fact: This may have been true years ago, but modern methods make geothermal systems one of the top energy performers today. Drilling is the most expensive portion of geothermal system installations; a properly designed system will minimize the drilling without impacting performance. Return on Investment is approximately three to five years; however, this can be as little as two years for a heating and cooling system. Typical savings range from 50 to 75 percent of a building's current energy bills.

Myth #2: Geothermal energy is only applicable in specific regions of the United States.

Fact: A geothermal system, either heating and cooling or power generation, can be constructed in any region of the United States. A properly engineered system can be constructed and controlled by the variations in ground temperature and soil/bedrock thermal characteristics for each individual site. Proximity to geysers and steam vents is not required!

Myth #3: Geothermal systems are a new and unproven technology.

Fact: Geothermal systems have been used and perfected for decades in Europe, but for various reasons, they have not caught on in the United States due in part to various misconceptions.

Myth #4: Geothermal energy is only applicable for new construction.

Fact: Geothermal is commonly implemented during new construction but is also commonly retrofitted to existing buildings. For older buildings with poor insulation and drafty windows, including those with historic value, geothermal systems can help provide heating and cooling for a much lower cost. The more energy a building uses, the more beneficial geothermal energy is.



Typical well being drilled behind a home

Myth #5: Geothermal systems are not user friendly and are prone to failure – only a rocket scientist can understand how they work!

Fact: A geothermal heating and cooling system generally requires less maintenance than an equivalent fossil fuel system. Additionally, heating and cooling is derived from the same equipment, in contrast to a conventional system which requires two units. The

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geothermal wells are virtually maintenance free; however, some wells are designed with pumps inside the well which will require minimal maintenance. Overall, maintenance costs are usually reduced and operation is similar to conventional systems.

Myth #6: Geothermal energy will produce electricity in my building.

Fact: Geothermal energy is the heat energy emanating from the core of the Earth and is a valuable renewable energy source that can be tapped on nearly every site. Ground source heat pumps tap into that energy using the Earth as a heat exchanger and provide heating and cooling to the building using equipment similar to conventional air conditioners. The ground source heat pumps typically operate within the top 1,500 feet of the Earth's crust. Geothermal power taps into the geothermal energy at depths of up to 10,000 feet of the Earth's crust (where it is much hotter) and produce steam which is used to drive turbines and generate electricity.

Did you know?

The United States Government is offering a 30 percent tax credit to Americans who install geothermal systems in their homes.

Myth #7: Geothermal energy requires large areas of land and causes disturbance to the immediate and surrounding ecosystems.

Fact: Geothermal energy is typically implemented through the drilling of wells, thus the actual land requirements are very small depending on the type of system. If a significant portion of land is available to develop a geothermal well field, a reduction in cost may

be realized with the drilling of several shallow wells versus a few deep wells. Geothermal wells create temperature fluctuations within an area local to the wells; they have no impacts on surrounding ecosystems. An additional benefit to using geothermal wells is that they do not emit pollutants and they can be tucked under parking lots and ball fields.

Myth #8: Energy demand (building load) software modeling predictions are always accurate.

Fact: Generally, software provided by equipment manufacturers overestimate (sometimes double) the equipment necessary to provide the climate control to a building. An independent engineering analysis will eliminate the over-accessorized HVAC system and save the client significant money.

Myth #9: Rules of thumb designs predict the best Geothermal System to be installed at your building.

Fact: Typical rules of thumb are good for a general approximation of what a project site may need for number and depth of geothermal wells. However, every site has varying soil, bedrock, and groundwater characteristics. Each building has specific spaces, the basis for HVAC design. A properly engineered geothermal system will be designed to provide a system which optimizes the site specific and building criteria. This site specific design process reduces the need for later unanticipated additional drilling.

We Can Help



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Bioengineering Group offers a skilled team of science, engineering, and construction management professionals who help clients make economical use of geothermal energy as an application of sustainability principles to site planning and development.

The benefits of geothermal systems are numerous. Geothermal energy helps to reduce building heating and cooling costs; as a result, geothermal systems typically see a Return on Investment in three to five years. Geothermal systems are quiet and tap an infinitely renewable resource and eliminate the use of cooling towers and smoke stacks. Additionally, these systems are applicable to new construction, retrofits, residential, and commercial applications.

Bioengineering Group provides a full range of geothermal services including feasibility studies, building energy demand modeling, geothermal well field design, well construction oversight, construction documents, and problematic systems troubleshooting. We customize the design of geothermal systems for each individual project site based on site geology, available space, and a client's needs.

By assigning each project a team of experienced technical specialists that work together closely, we can achieve a client's objectives in the most economical and environmentally sustainable way. We pride ourselves on being able to develop creative solutions that provide geothermal methods and solutions for diverse applications.

Our expertise in geothermal systems allows us to offer the following services:

Geothermal well field layout including well locations, spacing, piping runs, electrical runs, valve vaults, well head vaults

Geothermal well design including vertical closed loop wells, horizontal loops, lake/pond/river loops, standing column wells

Heat pump design and suggested unit distribution, e.g. several small units are generally more efficient than one large unit

Building energy use analyses based on physical data and computer models

Primary Logic Computer (PLC)

programming to manage geothermal well functions, typically tied into a building's HVAC primary control system; programs manage well use based on planned cycling and real-time building peak loads

Geothermal well thermal load testing

to optimize well field design as every site has different soil and rock characteristics

Feasibility studies reviewing site specific

information to provide client geothermal well options as well as specific items that may reduce/increase costs based on well type selected

Troubleshooting and fixing existing troubled systems



Heat exchange and duct systems resemble conventional equipment

Residential Geothermal System

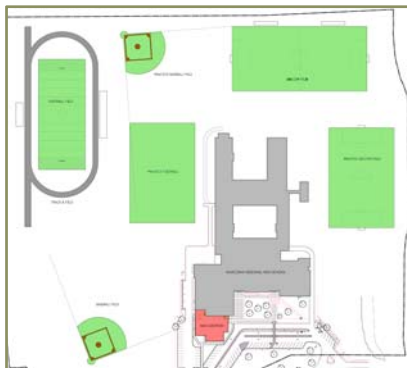
Southeastern Pennsylvania

Due to the rising cost of home heating oil prices, a homeowner in Southeastern Pennsylvania opted to investigate and install a residential geothermal/ground source heating and cooling system. Construction of a 3-ton closed-loop vertically drilled geothermal system required drilling three vertical wells, 275 feet of piping in each, and two heating/cooling units. The system is cost-effective, resulting in monthly savings of at least 50 percent for both heating and air conditioning.

Institutional Geothermal System

Wahconah Regional High School, Dalton, MA

As part of a site design for a new building addition at Wahconah Regional High School in Dalton, MA, Bioengineering Group evaluated three types of geothermal well systems to be used in conjunction with the ground source heat pump for the HVAC system: a vertical closed loop system, a shallow horizontal closed loop system, and a deep standing column well system. Based on available space, high water table, and cost of installation, we recommended the use of shallow horizontal closed loops with individual pumps. Our feasibility study proposed additional energy reduction methods including roof mounted solar hot water system and maintain heat temperatures in the building during the winter months.



Wells located beneath athletic fields

Commercial Geothermal System

River Wharf Realty Trust, Salem, MA

Bioengineering Group analyzed the property for the feasibility of geothermal heating and cooling to replace existing HVAC equipment. We conducted a blower door infiltration test to evaluate the building envelope and constructed an energy use model. Using the energy use and infiltration test, we calculated subsequent maximum loads based on average seasonal temperature fluctuations during the building's normal operating hours in the summer and winter months. The design consisted of three 400-foot closed loop geothermal wells based on thermal load test following the drilling of the first well to confirm the estimated design and optimize the well depth for overall efficiency.



Existing ducts, insulation, and light fixtures affect building energy demand