Frequently Asked Questions about Geothermal Energy

GEOTHERMAL ENERGY

What is geothermal energy?

Geothermal energy is heat (thermal) that comes from within the earth (geo). Water and steam warmed by the earth's heat are used to generate electricity, or can be used directly for heating. Even if water is not present, we can use the warm ground at depths of 4 to 300 feet for heating and cooling residential or commercial buildings.

How does geothermal heat get from the interior of the earth to the surface?

Heat is constantly generated within the earth's core and flows outward into cooler rocks, towards the earth's surface. This process is more efficient where magma (molten rock) reaches the earth's surface and volcanoes form. The hot rock heats groundwater that has accumulated from rain and snow melt that percolates into the ground. Sometimes this heated water re-emerges as hot springs.

Is geothermal energy a renewable resource?

Yes, the heat coming from the core of the earth cannot be depleted by human activities. When generating electricity from a geothermal reservoir it is common practice to inject the produced water back into the earth to be reheated and used again.

Where is geothermal energy found?

Rocks hot enough to be used to generate electricity are commonly found at tectonic plate boundaries where faults and volcanoes are common, like the "Ring of Fire" that borders the Pacific Ocean where oceanic crust of the Pacific plate collides with continental crust. Other areas where volcanoes are common are places where continental crust is being broken pulled apart like the African Rift Valley or the Basin and Range of the western US. Volcanoes also occur at "hot spots" in places like Yellowstone National Park and Hawaii. These big volcanoes occur despite the fact they are not associated with plate boundaries.

These hot geothermal reservoirs are found at depths of 1 to 2 miles below the surface. Lower temperature geothermally heated water can be used directly for heating buildings or spas or for aquaculture. This lower temperature water often occurs at shallower depths.

Geothermal heat pumps do not use hot water for heating and cooling. They use the earth as the heat source in the winter and as a heat sink in the summer. Ground source heat pumps exploit the lowest grade of geothermal energy. This is the fastest growing use of geothermal energy in the world.

Is there geothermal energy use in Utah?

Utah has many geothermal resources. Three power plants in central Utah produce a total of 73 megawatts, enough electricity to power 73,000 homes. In southern Utah, at Newcastle, Milgro grows flowers in 24 acres of geothermally heated greenhouses. At the Point of the Mountain, hot

water is used to heat 330,000 sq ft of the prison. Lower temperature waters are used for bathing at Crystal Hot Springs, The Homestead resort in Heber, and at Grantsville. Heat pumps are used for private residences, at Weber State University and Canyon View High School in Cedar City.

How is geothermal electricity produced?

There are three main types of geothermal power plants.

- **Dry steam plants** use steam from geothermal wells to directly spin a turbine which drives a generator that produces electricity. The Geysers in northern California, the world's largest single source of geothermal power, uses steam technology.
- **Flash plants** bring hot water to the surface where it boils to produce steam. The hot water (above about 440°F) "flashes" to steam when pressure is reduced in the surface facility. The steam is then sent directly to a turbine to drive the generator. The remaining liquid water is reinjected.
- **Binary cycle plants** use hot water to boil an organic fluid similar to the fluid used in air conditioners (a working fluid). The water is never directly in contact with the working fluid - heat is exchanged however. The expanding gas produced by boiling this working fluid is used to spin the turbine and drive the generator. All of the water used in the binary plant is injected into the subsurface where it is naturally reheated and eventually used again.

Do geothermal power plants produce emissions that lead to global warming?

Dry steam and flash power plants produce very small amounts of emissions, only about one-sixth of the carbon dioxide that a relatively clean natural-gas-fueled power plant produces. Binary plants release no emissions - they are closed loop systems. Almost all of the geothermal plants built in the last few years have been binary plants. You can read more about emissions in

www.nationalgeographic.com/environment/global-warming/geothermal-energy/

What are the advantages of geothermal energy?

Geothermal power has many advantages. For example:

1. It is a renewable resource with a very low environmental impact and small footprint.
2. The resource is immense, safe to use and clean. No fossil fuels are burned –binary power plants do not produce greenhouse gases.
3. Unlike solar and wind energy, geothermal energy is available 24 hours a day, 365 days a year.
4. Commercial and industrial direct heat or ground source (heat pump) users see large savings in cost and water use when compared to costs of conventional boilers. For example, the heat pump system being installed in the new Carolyn and Kem Gardner Building on the University of Utah campus will save about $62,000 a year compared to a traditional mechanical system. In addition, this system will save 1,440,000 gallons of water per year and eliminate more than 4 tons of CO_2 that would otherwise be released into the atmosphere. The heat pump system will incorporate 170 350-ft deep wells. Heat pump technologies allow geothermal energy to be used anywhere in the world.

What are the advantages of geothermal energy compared to other green energies?

Unlike solar and wind energy, geothermal energy can be generated constantly, not just when the sun is shining and the wind is blowing. The surface footprint of a geothermal power plant is very compact, generally less than 5 acres. Because the footprint is so small, geothermal plants have little impact on the local environment or wildlife.

What are the drawbacks of geothermal energy?

There are no drawbacks, only advantages to the use of geothermal energy for electricity production and direct use (heating, cooling). Currently, geothermal development for electricity generation occurs in areas where hot springs are found. In the future, new techniques (see EGS below) will allow geothermal development anywhere in the world.

How long do geothermal resources last?

Larderello, in Italy, was the first geothermal field in the world to be developed. It has been producing electricity commercially since 1913. Other geothermal fields in the United States, New Zealand, and Mexico have been producing electricity for more than 50 years. District heating in Boise, Idaho has operated since 1892 and in Iceland since the 1930. The heat is virtually inexhaustible.

GROUND SOURCE OR HEAT PUMP SYSTEMS

How does a geothermal heat pump work?

Animals burrow underground for warmth in the winter and to escape the heat in the summer. Do you have a basement in your house? Have you ever noticed how cool it is in the summer? Geothermal heat pumps take advantage of the constant moderate temperature near the earth's surface, in temperate climates like Utah it is usually between 50 and 55°F.

During the heating cycle, a geothermal heat pump uses water circulated through an underground loop to extract heat from the ground. The heat can be distributed through a house's duct system as warm air, or it can be used for a radiant floor system or domestic hot water heating. In the cooling mode, the heating process is reversed, instead of extracting heat from the ground, heat extracted from the air in your home can be put back into the ground. You can find more at *http://www.waterfurnace.com/how-it-works.aspx*

What are the requirements for a ground source heat pump loop?

For homes, shallow wells or trenches four to six feet deep and up to 400 feet long, are used for heating and cooling. Alternatively, one or more vertical wells can be drilled to provide surface area for heat exchange with the ground, and sometimes pond water is used instead of water circulated in wells. As a rule of thumb, 500-600 feet of pipe are required per ton of system capacity. Large buildings can require several hundred wells up to several hundred feet deep. Despite upfront installation costs for heat pump or ground loop systems, these units will pay for themselves after several years - beyond savings in water requirements and elimination of greenhouse gas emissions.

How long will it take to recoup costs after installing a ground source heat pump?

After the system's installation, you'll likely recoup your costs in the form of energy savings in **between 5 to 10 years**. You can read more on this at:

hartmannwelldrilling.blogspot.com/2012/05/how-long-can-geothermal-system-last.html

DIRECT USE

What is direct use geothermal energy?

There are many uses of geothermal energy besides electric generation. Warm geothermal waters can be used directly for heating spas and swimming pools, heating buildings and greenhouses, growing fish, vegetable drying, and melting snow. Direct use and heat pumps save 100 million barrels of oil per year and are used in 82 countries across the world.

ENHANCED GEOTHERMAL ELECTRIC GENERATION

What are Enhanced Geothermal Systems?

Most conventional geothermal power plants rely on hot rock, and a conductive channel in the crust (fracture or fault) that allows hot water to circulate through the rock. In conventional geothermal systems one or more wells are drilled to intersect these conductive channels and heated water/steam is brought to the surface to spin a turbine and generate electricity. This works effectively in parts of the country where temperature increases relatively rapidly with depth. Suppose that we can drill deeper to find hot rock but there are no conductive fractures/faults and no water can be produced? We can still create geothermal energy but we need to intervene by creating the fractures and providing an infrastructure to circulate water through this engineered reservoir. Cool water can be pumped underground down one well, where it is heated by the hot rock as it travels to the second well where it is pumped back up to the earth's surface to the power plant. We call this EGS (Enhanced or Engineered Geothermal Systems).

Will EGS development result in the earthquakes like those occurring in oil and gas operations?

It is important to understand the differences between EGS development and oil and gas operations. When oil and gas are produced, water naturally present in these reservoirs is co-produced with the hydrocarbons. In many places, the produced water is reinjected into deep dedicated disposal wells. If the disposal wells are not appropriately engineered, the large injected volumes can lead to earthquakes.

In EGS development, two or more wells are drilled into the same volume of rock and water circulated through the hot fractured rock heats up. The volume of water injected into an EGS reservoir is very similar to the volume produced. This is different from oil and gas development where the fluids are extracted from one area of the subsurface and injected into another. The balance of water put into, and removed from the ground in an EGS system minimizes the environmental impact and reduces the potential of large earthquakes resulting from human activities

Does geothermal energy development produce earthquakes?

All geothermal systems naturally experience some seismic activity, but it is generally too small to

be felt by humans. This natural seismic activity is the result of fractures being created in the rock, and this keeps the pathways open that allow water to circulate to depth, extract the heat and return to the surface to form hot springs. Small earthquakes also occur when cooled geothermal water is reinjected causing the hot rocks to contract and fracture.

GEOTHERMAL OPPORTUNITIES

How much geothermal energy is used in the US?

The available geothermal energy in the US is not being fully utilized. The existing power plants can produce 3550 megawatts of electricity, which can provide electricity for about 3.5 million homes. In Utah, geothermal power plants produce enough electricity for 72,000 homes, but the potential for producing more is much greater.

In the US heat pump systems have been installed in more than 50,000 homes and the number is growing quickly as more builders learn about heat pump installation. Worldwide, heat pump applications have been growing by 20% per year. Refer to:

http://geo-energy.org/currentUse.aspx#howmuch.

What is the potential of using geothermal resources in the US?

Geothermal energy is already used throughout the US and its applications are growing. Imagine providing the energy needed by Salt Lake City, San Francisco and New York from the earth's heat. The energy being used today is only a small fraction of the total recoverable heat that is available. If we could capture even 2% of the thermal energy at depths of ~2 to 6 miles, we could provide 2000 times the annual energy use in the United States. New technologies, including Enhanced Geothermal Systems are being developed to extract this heat. You can read more at:

http://geo-energy.org/currentUse.aspx#howmuch

https://energy.mit.edu/wp-content/uploads/2006/11/MITEI-The-Future-of-Geothermal-Energy.pdf