Geothermal

Alternative Energy

DOSSIN

What is Geothermal Energy?

Geothermal energy comes from heat within the Earth. People around the world use geothermal energy to produce electricity, heat buildings and to provide hot water for a variety of uses.

The earths Crust, is not one continuous sheet of rock ,like an egg shell, but broken into pieces called plates.

What is Geothermal Energy?

These plates drift apart and push together in a process called plate tectonics. When this happens the crust becomes faulted (cracked) and through these crack plumes of magma from the earth's mantle rise up into the crust.

In areas where there is underground water, the magma can fill rock fractures and porous rocks. The water becomes heated and can circulate back to the surface to create hot springs or trapped underground forming deep geothermal reservoirs.

History and Uses of Geothermal Energy

Many ancient people, including the Romans, Chinese and Native American, used Geothermal Energy for a number of uses…

Bathing

Roman Bath

Cooking

"Hot pools in New Zealand have traditionally been used for cooking food, which was lowered into the water in flax bags. As the teapots indicate, the temperature was also hot enough to make tea."

Heating

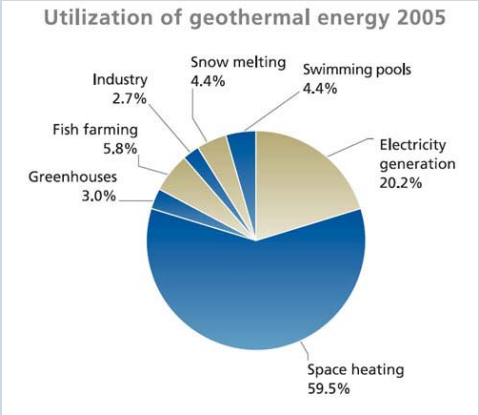
Romans heated floors in their building by geothermal

Healing Powers

Hot geothermal spring water was used for medicinal and healing purposes

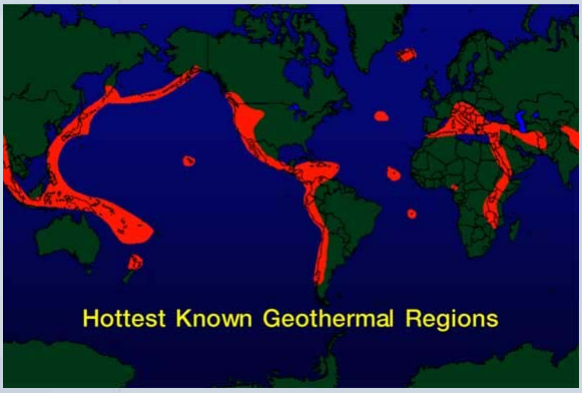
History and Uses of Geothermal Energy

Today we drill wells into geothermal reservoirs deep underground and use the steam and heat to drive turbines in power plants, heat buildings, increase growth rate of fish in hatcheries and crops in green houses, to pasteurize milk, dry foods and lumber, and for mineral baths.



Where is Geothermal Energy Found?

Geologists use many methods for finding geothermal reservoirs, from studying maps, analyzing chemistry of local soil and water, by measuring gravity and magnetic fields. But the only sure way is to drill an exploratory well.



The hottest geothermal regions are found where earthquakes and volcanoes are concentrated. The most concentrated area in known as the Ring of Fire.

High Temperature: Producing Electricity

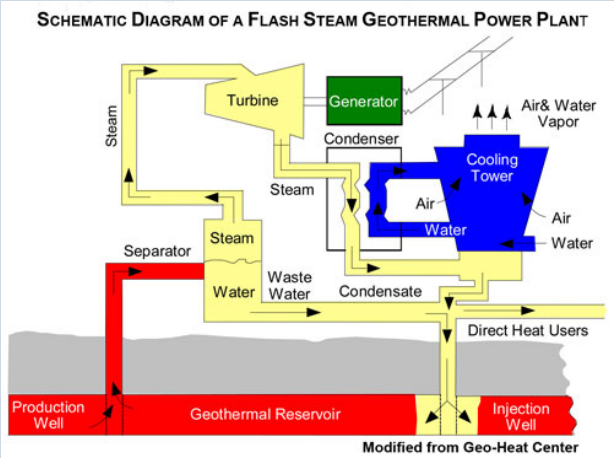
When wells are drilled, hot water and steam- at temperatures of 250-700 degrees F- are brought to the surface and used to generate electricity at power plants near the production wells. There are several different types of geothermal power plants.

- Flash Steam
- Dry Steam
- Binary Cycle Power Plants
- Hybrid Power Plants

High Temperature: Producing Electricity

Hot water from production wells flashes (explosively boils) into steam when it is released from the underground pressure of the reservoir. The force of the steam spins the turbine generator. To conserve water and maintain pressure in the reservoir, the steam is condensed into water and injected back into the reservoir to be reheated.

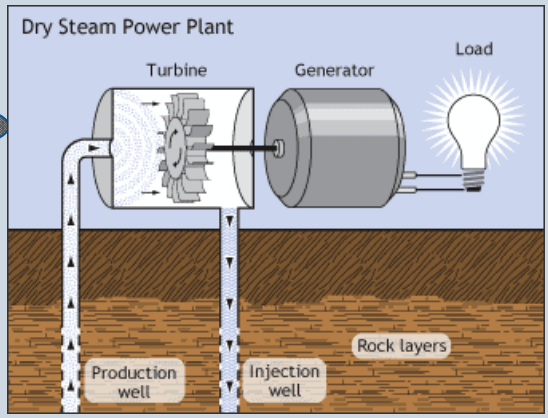
- Flash Steam



High Temperature: Producing Electricity

Steam from the reservoir shoots directly through a rock-catcher into the turbine generator.

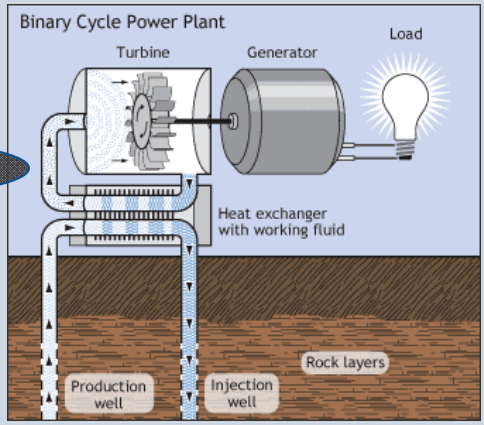
Dry Steam



High Temperature: Producing Electricity

Heat is transferred from the geothermal hot water to other liquids to produce electricity. The geothermal water is passed through a heat exchanger in a closed pipe system. The heat transfers to a fluid that boils at a lower temperature than water, and the vapor from this fluid turns the turbines. This system can produce electricity from reservoirs with lower temperatures, and since its closed system there is virtually no water loss.

Binary Cycle Power Plants



High Temperature: Producing Electricity

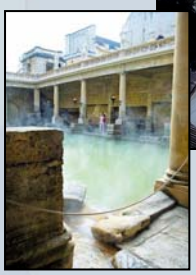
Some plants use flash and binary systems combined to make use of both the steam and hot water. (Puna Geothermal Venture Facility in Hawaii)

Hybrid Power Plants

Low Temperature: Direct Use or Heating

For centuries people have used hot springs for cooking & bathing. Early Romans used geothermal water to treat eye & skin diseases. Medieval wars were even fought over the lands for their hot springs. Today, millions of people around the world visit health spaces to soak in mineral-rich water.

Hot Spring Bathing & Spas



Low Temperature: Direct Use or Heating

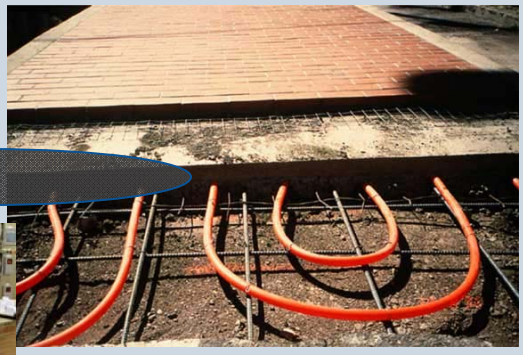
The warm water from geothermal reservoirs is used in many places to warm green houses that grow flowers, vegetables & other crops. This warm water also speeds the growth of fish, reptiles, shellfish and amphibians.

Agriculture & Aquaculture

Low Temperature: Direct Use or Heating

The heat from geothermal water is used worldwide for dying cloth, drying fruits and vegetables, washing wool, manufacturing paper, pasteurizing milk, and drying timber products. It is also used to help extract gold and silver from ore. In Klamath Falls, OR, hot water is piped under sidewalks and roads to keep them from freezing in winter.

Industry

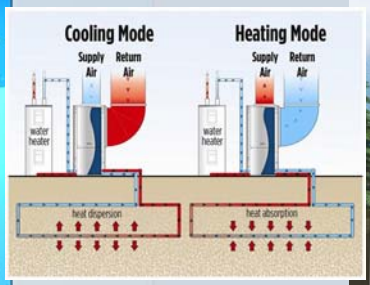


Low Temperature: Direct Use or Heating

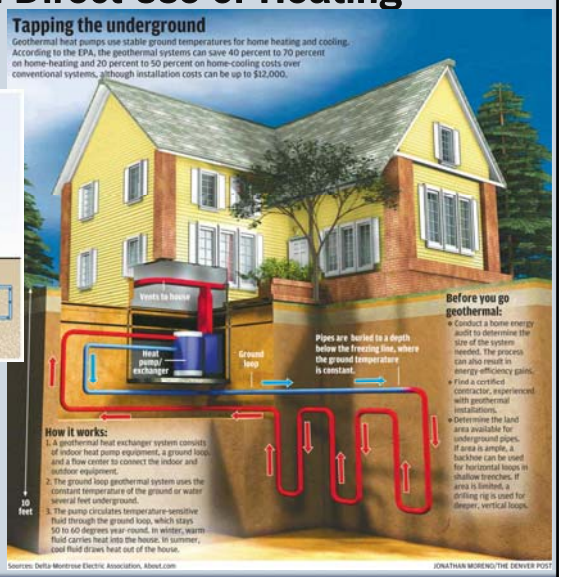
- The most widespread use of geothermal resources—after bathing—is to heat buildings. In the Paris basin in France, geothermal water from shallow wells was used to heat homes 600 years ago. More than 150,000 homes in France use geothermal heat today.
- Geothermal **district systems** pump hot water from a reservoir through a heat exchanger that transfers the heat to separate water pipes that go to many buildings. The geothermal water is then reinjected into the reservoir to be reheated.
- The first district heating system in the U.S. was built in 1893 in Boise, ID, where it is still in use. There are many other systems in use in the country today. Because it is clean and economical, district heating is becoming increasingly popular. In Iceland, almost 90 percent of residents use geothermal energy for heat and hot water. In Reykjavik, Iceland, a district heating system provides heat for 95 percent of the buildings.

Heating

Low Temperature: Direct Use or Heating

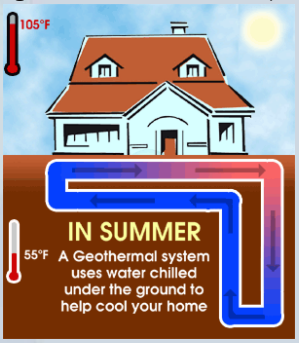


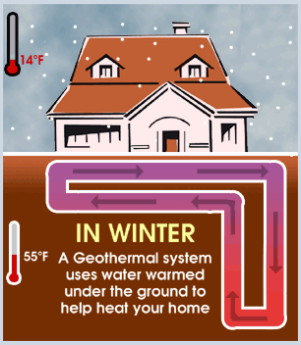
Heating



Geoexchange Systems: Heating and Cooling

- Once you go about 10-20 feet below the Earth's surface, the temperature is remarkably constant year round. In temperate regions, the temperature stays about 52 degrees Fahrenheit. In tropical regions, it can range as high as 65 to 70 degrees Fahrenheit, while certain arctic regions stay near freezing all year.
- For most areas, this means that soil temperatures are usually warmer than the air in winter and cooler than the air in summer. Geothermal exchange systems use the Earth's constant temperatures to heat and cool buildings. These heat pumps transfer heat from the ground into buildings in winter and reverse the process in the summer



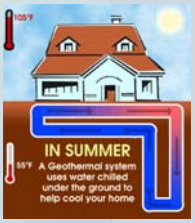


Geoexchange Systems: Heating and Cooling

- A geothermal exchange system doesn't look like a traditional furnace or air conditioner. For one thing, most of the equipment is underground. A liquid—usually a mixture of water and antifreeze—circulates through a long loop of plastic pipe buried in the ground. This liquid absorbs heat and carries it either into or out of the building.

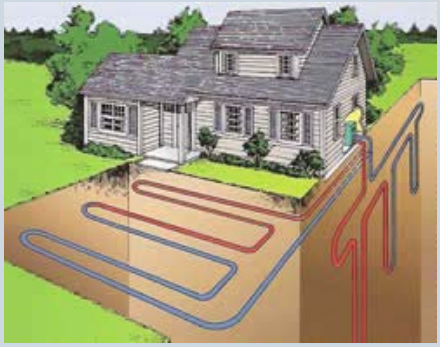
Geoexchange Systems: Heating and Cooling

- One advantage of a geothermal exchange system is that it doesn't have to manufacture heat. The heat is free, renewable, and readily available in the ground. The only energy this system needs is the electricity to pump the liquid through the pipes and deliver the conditioned air to the building. The pump itself is usually a small unit located inside the building.



Geoexchange Systems: Heating and Cooling

- The geothermal exchange pipes can be buried in several ways. If space is limited, holes for the pipe can be dug straight into the ground as far down as 300 feet. In very rocky areas, this method might not be an option.
- If there is land available, the pipes can be buried horizontally in shallow trenches four to six feet underground, where the ground remains at approximately the same temperature all of the year. Once the pipes are in place, the surface can be used as a front lawn, football field, or parking lot. The pipes are durable and should last up to 50 years without maintenance.



Geoexchange Systems: Heating and Cooling

If a large lake or pond is nearby, the pipes can be buried in the water. The water must be at least six feet deep, though, or the temperature of the water will change too much. Deep, flowing water provides especially good heat exchange for a geothermal system.

Geoexchange Systems: Heating and Cooling

- Geothermal systems cost more to install than conventional heating and cooling systems. Over the life of the system, however, they can produce significant cost savings. They can reduce heating costs by 30–70 percent, and cooling costs by 20 to 50 percent. If the cost of the installation is spread out over several years, users see savings from the day they begin using the system. Over the life of the system, the average homeowner can anticipate saving about $20,000.
- In addition, geothermal systems are low maintenance and should last twice as long as conventional systems. The pumps should last 20 years, since they are located inside, away from the weather. And most of the energy they use is free. Electricity is used only to move the heat, not to produce it.

Cost / Benefits of Geo Thermal and Integrated Concrete Forms

Geo Thermal –

Geo Unit, two water heaters, 100% return on ducting	$ 28,000
Less cost of two high efficiency furnaces & A/C units (same size house)	-15,000
Extra cost	$13,000
Federal government rebate (2010)	- 8,400
Extra cost	4,600

Unit Payback Cost (est.)

Average cost per month (midwest town)

Typical cost to heat/cool same size house	$ 280/mo.
Cost for electrical Geo thermal pump, Compressor, fan	160/mo.
Month to Payoff	38 months (est. 3 years)

Integrated Concrete Forms (ICF)-

ICF units in full walkout basement (R22)	$15,600
Concrete walkout basement (R2)	8,000

Unit payback cost is more difficult to determine because it is integral with the GeoThermal. The walkout basement with ICFs maintains a temperature 68 F degrees all year round.

Geoexchange Systems: Heating and Cooling

Cost / Benefits of Geo Thermal and Integrated Concrete Forms

Geo Thermal –

Geo Unit, two water heaters, 100% return on ducting	$ 28,000
Less cost of two high efficiency furnaces & A/C units (same size house)	-15,000
Extra cost	$13,000
Federal government rebate (2010)	- 8,400
Extra cost	4,600

Unit Payback Cost (est.)

Average cost per month (midwest town)

Typical cost to heat/cool same size house	$ 280/mo.
Cost for electrical Geo thermal pump, Compressor, fan	160/mo.
Month to Payoff	38 months (est. 3 years)

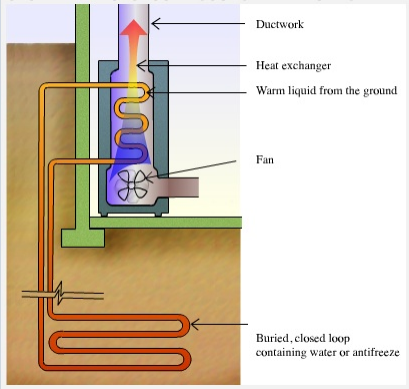
Integrated Concrete Forms (ICF)-

ICF units in full walkout basement (R22)	$15,600
Concrete walkout basement (R2)	8,000

Unit payback cost is more difficult to determine because it is integral with the GeoThermal. The walkout basement with ICFs maintains a temperature 68 F degrees all year round.

Geoexchange Systems: Heating and Cooling

- Today, more than a million homes and buildings in the United States use geothermal heat exchange systems. They are an efficient, economical alternative to conventional heating and cooling systems. The U.S. Environmental Protection Agency has rated geothermal heat pump systems among the most efficient heating and cooling technologies.



Geothermal Production

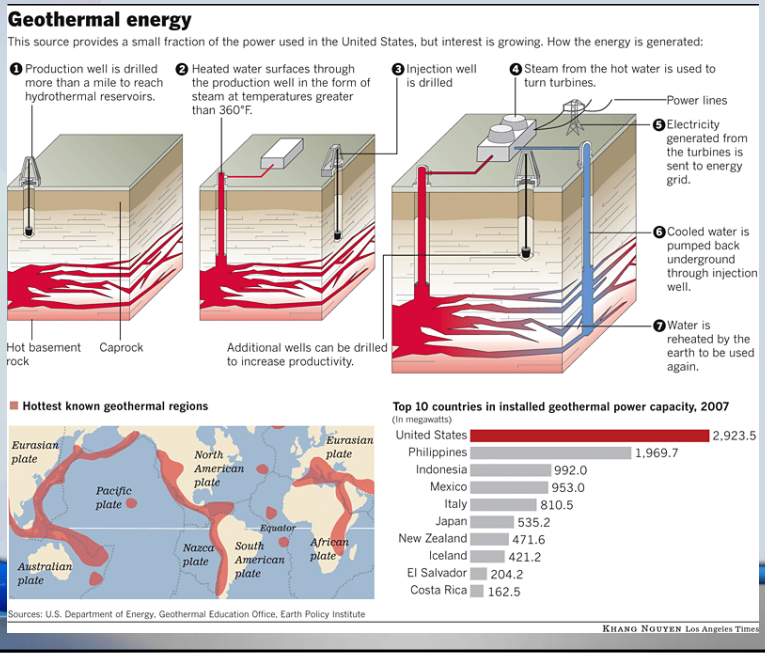
Geothermal energy is put to work in many places around the world. The best-known geothermal energy sources in the United States are located in western states and Hawaii

Geothermal power plants operate in California, Nevada, Utah, Hawaii, Idaho, Texas, and Montana.

In 2009, geothermal energy produced about 15.2 billion kilowatt hours (kWh) of electricity, or 0.38 percent of the electricity used in this country. This is enough to serve the electricity needs of over three million households. California gets more electricity from geothermal energy than any other state.

Geothermal Production

Geothermal Production



Geothermal Economics

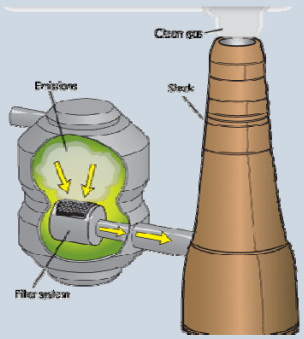
Geothermal power plants can produce electricity as cheaply as many conventional power plants. Operating and maintenance costs from one to three cents per kWh at a geothermal power plant, while the electric power generated sells for three to five cents per kWh. In comparison, new coal-fired and natural gas plants produce electricity at about four cents per kWh.

- Other Points
  - Initial Construction Costs are higher because geothermal wells and power plants must be constructed at the same time.
  - Over the lifetime, the cost is lower because price & availability of fuel is stable & predictable, & doesn't have to be imported or transported to the plant.
  - Geothermal power plants are excellent sources of **base load power**, because it can provide the same load any hour, day or night.

Geothermal Energy and the Environment

Geothermal energy is a renewable energy source that does little damage to the environment. Geothermal steam and hot water do contain naturally occurring traces of hydrogen sulfide (a gas that smells like rotten eggs) and other gases and chemicals that can be harmful in high concentrations.

Geothermal power plants use **scrubber systems** to clean the air of hydrogen sulfide and the other gases. Sometimes the gases are converted into marketable products, such as liquid fertilizer.



Geothermal power plants don't burn fuel to generate electricity, so their emission levels are very low. They release less than 1 percent of the carbon dioxide emitted by comparable fossil fuel plants.

Geothermal Energy and the Environment

Emissions of sulfur compounds from vehicles and fossil fuel plants also contribute to acid rain. Geothermal power plants, on the other hand, emit only one to three percent of the sulfur compounds that coal and oil-fired power plants do. Well-designed **binary cycle power plants** have no emissions at all.

Geothermal power plants are compatible with many environments. They have been built in deserts, in the middle of crops, and in mountain forests. Development is often allowed on federal lands because it does not significantly harm the environment. Geothermal features in national parks, such as geysers and fumaroles in Yellowstone and Lassen Volcanic National Parks, are protected by law, so geothermal reservoirs are not tapped in these areas.

•Geothermal Reserves

- 4%- Geothermal energy comprises 4% of the total U.S. domestic energy reserves

An energy source is considered an energy reserves only when it is economical to develop, the amount of geothermal reserves will increase as the price of other fuels increases. Improvements in technology will make it easier to capture geothermal resources. This will also bring costs down and increase geothermal reserves.

In 2008, there were geothermal power plants in 19 countries, generating 60,435 megawatts of electricity. Direct uses of geothermal reservoirs amount to over 10,000 megawatts of thermal energy in 24 countries. An additional 22 countries have new geothermal electricity projects in development.

And Yet Another Benefit of Geothermal… Monkeys Like It