Geothermal Energy -- Energy from the Earth's Core

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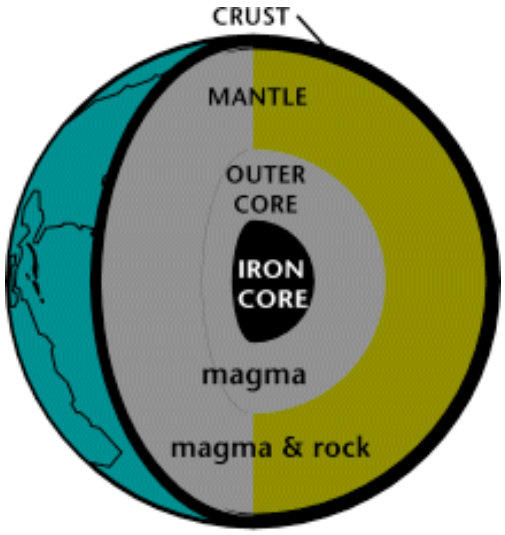
WHAT IS GEOTHERMAL ENERGY?

The word **geothermal** comes from the Greek words geo (earth) and therme (heat). So, geothermal energy is heat from within the earth. We can use the steam and hot water produced inside the earth to heat buildings or generate electricity. Geothermal energy is a **renewable** energy source because the water is replenished by rainfall and the heat is continuously produced inside the earth.

ENERGY INSIDE THE EARTH

Geothermal energy is generated in the earth's core, about 4,000 miles below the surface. Temperatures hotter than the sun's surface are continuously produced inside the earth by the slow decay of radioactive particles, a process that happens in all rocks. The earth has a number of different layers: The core itself has two layers: a **solid iron core** and an outer core made of very hot melted rock, called **magma**. The **mantle** which surrounds the core and is about 1,800 miles thick. It is made up of magma and rock.

The **crust** is the outermost layer of the earth, the land that forms the continents and ocean floors. It can be three to five miles thick under the oceans and 15 to 35 miles thick on the continents.



THE EARTH'S INTERIOR

The earth's crust is broken into pieces called **plates**. Magma comes close to the earth's surface near the edges of these plates. This is where volcanoes occur. The lava that erupts from volcanoes is partly magma. Deep underground, the rocks and water absorb the heat from this magma. The temperature of the rocks and water get hotter and hotter as you go deeper underground.

People around the world use geothermal energy to heat their homes and to produce Electricity by digging deep wells and pumping the heated underground water or steam to the surface. Or, we can make use of the stable temperatures near the surface of the earth to heat and cool buildings. (See Uses of Geothermal Energy below.)

WHERE IS GEOTHERMAL ENERGY FOUND ?

Most geothermal reservoirs are deep underground with no visible clues showing above ground. Geothermal energy can sometimes find its way to the surface in the form of: **volcanoes** and **fumaroles** (holes where volcanic gases are released) **hot springs** and **geysers**.

The most active geothermal resources are usually found along major plate boundaries where earthquakes and volcanoes are concentrated. Most of the geothermal activity in the world occurs in an area called the **Ring of Fire**. This area rims the Pacific Ocean.

When magma comes close to the surface it heats ground water found trapped in porous rock or water running along fractured rock surfaces and faults. Such **hydrothermal** resources have two common ingredients: water (hydro) and heat (thermal). Naturally occurring large areas of hydrothermal resources are called **geothermal reservoirs**.

Geologists use different methods to look for geothermal reservoirs. Drilling a well and testing the temperature deep underground is the only way to be sure a geothermal reservoir really exists. Most of the geothermal reservoirs in the United States are located in the western states, Alaska, and Hawaii. California is the state that generates the most electricity from geothermal energy. The Geysers dry steam reservoir in northern California is the largest known dry steam field in the world. The field has been producing electricity since 1960.

USES OF GEOTHERMAL ENERGY

Some applications of geothermal energy use the earth's temperatures near the surface, while others require drilling miles into the earth. The three main uses of geothermal energy are:

1) Direct Use and District Heating Systems which use hot water from springs or reservoirs near the surface.

2) Electricity generation in a power plant requires water or steam at very high temperature (300 to 700 degrees Fahrenheit). Geothermal power plants are generally built where geothermal reservoirs are located within a mile or two of the surface.

3) Geothermal heat pumps use stable ground or water temperatures near the earth's surface to control building temperatures above ground.

DIRECT USE OF GEOTHERMAL ENERGY

The **direct use** of hot water as an energy source has been happening since ancient times. The Romans, Chinese, and Native Americans used hot mineral springs for bathing, cooking and heating. Today, many hot springs are still used for bathing, and many people believe the hot, mineral-rich waters have natural healing powers. After bathing, the most common direct use of geothermal energy is for heating buildings through **district heating systems**. Hot water near the earth's surface can be piped directly into buildings and industries for heat. A district heating system provides heat for 95 percent of the buildings in Reykjavik, Iceland. Examples of other direct uses include: growing crops, and drying lumber, fruits, and vegetables

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GEOTHERMAL POWER PLANTS

Geothermal power plants use **hydrothermal** resources which have two common ingredients: water (hydro) and heat (thermal). Geothermal plants require high temperature (300 to 700 degrees Fahrenheit) hydrothermal resources that may come from either dry steam wells or hot water wells. We can use these resources by drilling wells into the earth and piping the steam or hot water to the surface. Geothermal wells are one to two miles deep. The United States generates more geothermal electricity than any other country but the amount of electricity it produces is less than one-half of a percent of electricity produced in United States. Only four states have geothermal power plants: California - has 33 geothermal power plants that produce almost 90 percent of the nation's geothermal electricity. Nevada - has 14 geothermal power plants. Hawaii and Utah - each have one geothermal plant There are three basic types of geothermal power plants:

Dry steam plants - use steam piped directly from a geothermal reservoir to turn the generator turbines. The first geothermal power plant was built in 1904 in Tuscany, Italy at a place where natural steam was erupting from the earth.

Flash steam plants - take high-pressure hot water from deep inside the earth and convert it to steam to drive the generator turbines. When the steam cools, it condenses to water and is injected back into the ground to be used over and over again. Most geothermal power plants are flash plants.

Binary power plants - transfer the heat from geothermal hot water to another liquid. The heat causes the second liquid to turn to steam which is used to drive a generator turbine.

GEOTHERMAL HEAT PUMPS

While temperatures above ground change a lot from day to day and season to season, temperatures in the upper 10 feet of the Earth's surface hold nearly constant between 50 and 60 degrees Fahrenheit. For most areas, this means that soil temperatures are usually warmer than the air in winter and cooler than the air in summer. Geothermal heat pumps use the Earth's constant temperatures to heat and cool buildings. They transfer heat from the ground (or water) into buildings in winter and reverse the process in the summer. According to the U.S. Environmental Protection Agency (EPA), 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 becoming more popular. In recent years, the U.S. Department of Energy along with the EPA have partnered with industry to promote the use of geothermal heat pumps.

GEOTHERMAL ENERGY AND THE ENVIRONMENT

The environmental impact of geothermal energy depends on how it is being used. Direct use and heating applications have almost no negative impact on the environment. Geothermal power plants do not burn fuel to generate electricity, so their emission levels are very low. They release less than 1 percent of the carbon dioxide emissions of a fossil fuel plant. Geothermal plants use scrubber systems to clean the air of hydrogen sulfide that is naturally found in the steam and hot water. Geothermal plants emit 97 percent less acid rain - causing sulfur compounds than are emitted by fossil fuel plants. After the steam and water from a geothermal reservoir have been used, they are injected back into the earth. Geothermal features in national parks, such as geysers and fumaroles in Yellowstone National Park, are protected by law, to prevent the land from being disturbed