

# GEOTHERMAL ENERGY GLOSSARY

## A

**acid rain:** common name for any precipitation (rain, snow, sleet, hail, fog) having a high amount of sulfuric acid and/or nitric acid or having a pH lower than 5.6. Normal rain has a pH of 5.6 - 5.7. Fossil fuel power plants are a major source of acid rain.

**agriculture:** the growing (farming) of plants, flowers, trees, grains, and other crops. Greenhouses can be heated with hot water from geothermal reservoirs. In some places pipes of hot water are buried under the soil. Geothermal heat is also used to dry crops.

**aquaculture:** the farming of fish and other water-dwelling organisms in freshwater or seawater. Geothermal water is used to help speed the growth of fish, prawns and alligators. China probably has more aquaculture operations than any other country.

**aquifer:** a large permeable body of underground rock capable of yielding quantities of water to springs or wells. Aquifers provide about 60% of American drinking water. Underground aquifers of hot water and steam are called geothermal reservoirs.

## B

**balneology:** using hot spring mineral water for therapy. This is perhaps the oldest use of natural geothermal waters.

**baseload power:** the amount of power needed to supply the minimum anticipated demand for electricity at any given time.

**binary power plant:** geothermal power plant that uses a heat exchanger to transfer heat to a second (binary means two) liquid that flashes to vapor and drives a turbine-generator.

**boiling point:** temperature at which a single substance, such as water, changes from a liquid to a gas (steam) under normal atmospheric pressure. The boiling point at which water transitions to steam is 212°F (100°C). Some liquids boil at a lower temperature than water — a principle utilized in binary power plants. Boiling point is also affected by pressure. The greater the pressure, the higher the boiling point. This principle is put to work in geothermal (flash) power plants when superheated (hotter than boiling) geothermal water is brought up wells. The hot water flashes to steam when the pressure is released as it reaches the surface. This phenomenon also occurs naturally, resulting in such features as geysers.

**brine:** a geothermal solution containing significant amounts of sodium chloride or other salts.

**BTU:** British thermal unit; the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at standard conditions (equal to 252 calories).

## C

**caldera:** a bowl-shaped landform, created either by a huge volcanic explosion (which destroys the top of a volcano) or by the collapse of a volcano's top.

**cap rocks:** rocks of low permeability that overlie a geothermal reservoir.

**carbon dioxide (CO<sub>2</sub>):** a gas produced by the combustion of fossil fuels and other substances. CO<sub>2</sub> also occurs naturally in large amounts in molten magma, which is involved in the explosive eruption of volcanoes. See *greenhouse effect*.

**chemical energy:** energy inherent in the chemical bonds which hold molecules together. Examples are coal and oil, which have energy potential that is released upon combustion.

**combustion:** the burning of gas, liquid, or solid, in which the fuel is oxidized, producing heat and often light.

**condense:** to change from a gas to drops of liquid. Water-cooled geothermal power plants use cooling towers to cool the used steam and condense it back to water for injection back to the edge of the reservoir. In binary power plants, an organic liquid is first vaporized (with heat from geothermal water) to drive a turbine, then cooled and condensed back to a liquid and recycled again and again in a closed loop.

**condenser:** equipment that condenses turbine exhaust steam into condensate.

**conduction:** the transfer of heat as a result of the direct contact of rapidly moving molecules through a medium, or from one medium to another, without movement of the media. The heat from geothermal water, for instance can be conducted through metal plates or pipes to heat other water for district heating systems or a second organic liquid for use in binary power plants.

**continental drift:** the theory that the continents have drifted apart when a supercontinent, Pangaea, broke apart. See *plate tectonics*.

**convection currents:** the currents caused by hot air or fluid rising and falling. Hot air or fluid expands and is therefore less dense than its cooler surroundings, thus it rises; as it cools it contracts, becomes more dense and sinks down creating something of a rolling motion. These motions are thought to be part of the dynamic geologic processes that drive the movement of crustal plates. See *plate tectonics*.

**cooling tower:** a structure in which heat is removed from hot condensate.

**core (outer and inner):** the extremely hot center of the earth. The outer core is probably molten rock and is located about 3,200 miles (5,100) kilometers down from the earth's surface; the inner core may be solid iron and is found at the very center of the earth — about 4,000 miles (6,400 kilometers) down.

**crust:** the solid outermost layer of the earth, mostly consisting of rock, and ranging from 3 - 35 miles (4.8 - 56 kilometers) thick, comprises the topmost portion of the lithosphere (see *lithospheric plates*). Earth's crust insulates us from the hot interior.

**cultivate:** to grow and tend (plants or crops), farm.

## D

**dehydrate:** to free from moisture in order to preserve; to dry fruits, vegetables or lumber, for instance. A factory in Nevada, for example, uses geothermal heat to dehydrate onions and garlic for restaurants.

**density:** the amount of mass in a given volume of something. Two objects can be the same size but have different densities because one of the objects has more mass “packed” into the same amount of space. Objects are smaller when they are cold, larger when hot.

**direct use:** use of geothermal water and its heat to grow fish, dry vegetable, fruit and wood products, heat greenhouses and city buildings, or provide hot water for spas.

**district heating system:** a heating system that provides heat to a large number of buildings all from a central facility. In geothermal district heating systems, one or more wells can serve entire districts.

**drilling:** boring into the earth to access geothermal resources, usually with oil and gas drilling equipment that has been modified to meet geothermal requirements.

**dry steam power plant:** geothermal power plant that uses steam directly from a steam-filled geothermal reservoir.

## E

**earthquake:** the vibration or movement of the ground caused by a sudden shift along faults (cracks) in the earth's crust; most earthquakes occur at the places where tectonic plate edges meet.

**efficiency:** the ratio of the useful energy output of a machine or other energy-converting plant to the energy input.

**electric current:** the continuous flow of electrons; often referred to as electricity.

**electrical energy:** energy of electric charges or electric currents.

**electron:** the smallest part of an atom (atoms are the tiny particles of which all substances are made). Electrons may be freed from atoms to produce an electric current.

**energy:** the ability to do work, such as making things move and heating them up. Energy can take many forms, including electrical, chemical, radiant, mechanical and heat.

**energy conversion:** the changing of energy from one form to another. One of the many examples are heat energy being converted into mechanical energy, and then mechanical energy into electrical energy, as is done in steam-driven electric power plants.

**energy efficiency:** the measure of the amount of energy which any technology can convert to useful work; technology with a higher energy efficiency will require less energy to do the same amount of work.

**energy resource:** a source of useable power which can be drawn on when needed. Energy resources are often classified as renewable or non-renewable.

**enhanced, or engineered, geothermal systems (EGS):** Rock fracturing, water injection, and water circulation technologies to sweep heat from the unproductive areas of existing geothermal fields or new fields lacking sufficient production capacity. Permeability can be created in hot rocks by hydraulic fracturing — injecting large volumes of water into a well at a pressure high enough to break the rocks. The artificial fracture system is mapped by seismic methods as it forms, and a second well is drilled to intersect the fracture system. Cold water can then be pumped down one well and hot water taken from the second well for use in a geothermal plant.

**Environmental Protection Agency (EPA):** Federal government agency that makes and enforces standards for pollution control; designed to protect the environment.

**eruption:** the explosive discharge of material such as molten rock and gases, or hot water (as from volcanoes or geysers).

## F

**fault:** a crack or break in the earth's crust along which movement has occurred, often resulting in earthquakes.

**fissure:** in geology, an extensive crack, break, or fracture in rock.

**flash power plant:** a geothermal power plant that uses a process in which geothermal water is converted to steam to drive a turbine.

**fracture:** a crack in the earth's crust along which no movement has occurred.

**fumarole:** a small hole or vent in the earth's surface, found near volcanic areas, from which steam or gases shoot out.

## G

**generator:** a machine that converts mechanical power into electricity by spinning copper wires (conductors) within a magnetic field.

**geology:** study of the planet Earth, its composition, structure, natural processes, and history.

**geothermal energy:** the earth's natural interior heat. The word geothermal comes from the Greek words geo(earth) and therme (heat), and means the heat of the earth. Earth's interior heat originated from its fiery consolidation from dust and gas over 4 billion years ago and is continually regenerated from the decay of radioactive elements that occur in all rocks.

**geothermal (ground source) heat pump:** a space heating/cooling system which moves heat from and to the earth, as opposed to making heat using a fuel source. Geothermal heat pumps take advantage of the almost constant temperature just a few feet underground — usually warmer than the air in winter and cooler than the air in summer.

**geothermal gradient:** the rate of temperature increase in the earth as a function of depth. Temperature increases an average of 1° Fahrenheit for every 75 feet in descent.

**geothermal phenomena:** an observable event at the surface, whose occurrence is the result of the earth's internal heat; includes volcanoes, geysers, hot springs, mud pots and fumaroles.

**geothermal power plant:** a facility which uses geothermal steam or heat to drive turbine-generators to produce electricity. Three different types make use of the various temperature ranges of geothermal resources: dry steam, flash and binary.

**geothermal reservoir:** a large volume of underground hot water and steam in porous and fractured hot rock. The hot water in geothermal reservoirs occupies only 2 - 5% of the volume of rock, but if the reservoir is large enough and hot enough, it can be a powerful source of energy. Geothermal reservoirs are sometimes overlaid by a layer of impermeable rock. While geothermal reservoirs usually have surface manifestations such as hot springs or fumaroles, some do not.

**geothermal resource:** the natural heat, hot water, and steam within the earth.

**geothermal water (geothermal resources):** water heated by the natural heat inside the earth.

**geyser:** a natural hot spring that sends up a fountain of water and steam into the air; some geysers “spout” at regular intervals and some are unpredictable.

**Geysers, The:** a large geothermal steam field located north of San Francisco. The Geysers is home to 22 power plants.

**global warming/greenhouse effect:** the trapping of heat in the atmosphere. Incoming solar radiation goes through the atmosphere to the earth's surface, but outgoing radiation (heat) is absorbed by water vapor, carbon dioxide, and ozone in the atmosphere. At certain levels this is beneficial because it keeps the planet warm enough for life as we know it. However, an increase in the normal amount of carbon dioxide and other gases may contribute to a human-caused warming trend that could have serious effects on global climate, the global ecosystem, and food supplies.

**groundwater:** water that collects underground, mostly from surface water that has seeped down through cracks and pores in rock.

## H

**health spa:** an establishment (often commercial) which is visited by guests seeking therapy and relaxation; many center around hot mineral springs or use hot water from geothermal wells.

**heat exchanger:** a device in which heat is transferred by conduction through a metal barrier from a hotter liquid or gas, to warm a cooler liquid or gas on the other side of the metal barrier. Types of heat exchangers include “shell and tube,” and “plate.”

**heat flow:** movement of heat from within the earth to the surface, where it is dissipated by radiation into the atmosphere, surface water, and space.

**heat transfer:** the transmission of heat. There are three forms of heat transfer: “conduction,” “convection,” and “radiation.” See these terms.

**hot dry rock:** a potential source of accessible heat energy within the earth's crust; a geothermal resource created when hot but impermeable (does not allow water to pass through) underground rock structures are fractured to allow infiltration of water, thus creating an artificial geothermal reservoir. Geothermal engineers now use the term “enhanced, or engineered, geothermal systems” (EGS) to refer to systems using hot dry rock.

**hot spot:** areas of volcanic activity found in the middle of lithospheric plates, caused from an upwelling of concentrated heat in the mantle. Hot spots remain stationary while the plates move over them, often leaving a chain of extinct volcanoes as the plate moves away from the hot spot; examples include the Hawaiian Islands and Yellowstone National Park.

**hot springs:** a natural spring that puts out water warmer than body temperature and therefore feels hot; may collect in pools or flow into streams and lakes; a geothermal phenomenon.

**hydrogen sulfide:** a gas with a disagreeable odor, frequently dissolved in geothermal waters in small amounts; toxic at high concentrations.

**hydrothermal:** hydro means water and thermal means heat. Literally, hydrothermal means hot water. Steam and hot water reservoirs are hydrothermal reservoirs. Hot dry rock resources and magma resources are not considered to be hydrothermal resources.

**hydrothermal resource:** underground systems of hot water and/or steam.

## I

**impermeable:** does not allow liquids to pass through easily — certain rock types and clay soil are impermeable.

**injection well:** a well through which geothermal water is returned to an underground reservoir after use. Geothermal production and injection wells are constructed of pipes layered inside one another and cemented into the earth and to each other. This protects any shallow drinking water aquifers from mixing with deeper geothermal water.

## K

**KGRA:** known Geothermal Resource Area; region identified by the U.S. Geological Survey as containing geothermal resources.

**Kilowatt:** 1,000 watts—a unit of electric power; abbreviated kW. One kilowatt of electricity serves about 750 homes in the U.S.

**Kilowatt Hour:** the energy represented by 1 kilowatt of power consumed for a period of 1 hour — equal to 3,413 BTUs; abbreviated kWh.

## L

**lava:** molten magma that has reached the earth's surface.

## M

**magma:** hot, thick, molten (liquid) rock found beneath the earth's surface; formed mainly in the mantle.

**mantle:** the semi-molten interior of the earth that lies between the core and the crust making up nearly 80% of the earth's total volume; extends down to a depth of about 1800 miles (2,900 kilometers) from the surface.

**mechanical energy:** the energy an object has because of its motion or position and the forces acting on it.

**megawatt (MW):** a unit of power, equal to a thousand kilowatts (kW) or one million watts (W). The watt is a unit of power (energy/time), the rate energy is consumed or converted to electricity.

**mineralized:** containing minerals; for example, mineralized geothermal water contains dissolved minerals from inside the earth.

**molecules:** extremely tiny particles of which all materials are made .

**mud pot (paint pot):** thermal surface feature which occurs where there is not enough water to support a geyser or hot spring even though there may be some hot water below. Steam and gas vapors bubble up through mud formed by the interaction of gases with rock.

## N

**natural gas:** a gas mixture (mostly methane) trapped underground in many places near the surface of the earth; a fossil fuel.

**nitrogen oxides (Nox):** formed in combustion; appear as yellowish-brown clouds; can irritate lungs, cause lung diseases, lead to formation of ozone (harmful in the lower atmosphere, but necessary as protection from UV rays in the upper atmosphere).

**nonrenewable resource:** resources not replaced or regenerated naturally within a period of time that is useful; includes fossil fuels, uranium and other minerals.

## P

**Pangaea:** the huge supercontinent which scientists think may have existed 250 million years ago. All of the continents may have at one time been joined together to make this huge land mass.

**particulates (particulate matter):** dust, soot, smoke and other suspended matter; can be respiratory irritants. Particulate matter smaller than 10 microns (pm10) has been found to be particularly harmful to health.

**pasteurize:** to use high temperatures to destroy disease-causing bacteria.

**permeable:** able to transmit water or other liquids; for example, rock with tiny passageways between holes, fractured rock, and gravel are permeable.

**plate tectonics:** the study of the movement of large crustal plates (lithospheric plates) of the earth's shell. The earth's shell is broken into several pieces (12 large ones and several smaller ones). These plates move toward and away from one another at about the rate our fingernails grow. The process that creates the dynamic movement of the plates includes the convection of magma in the mantle and lithosphere. Plate tectonics helps to explain continental drift, seafloor spreading, volcanic eruptions and other geothermal phenomena, earthquakes, mountain formation and the distribution of some plant and animal species.

**porous:** full of small holes (pores); able to be filled (permeated) by water, air, or other materials.

**power plant:** a central station where electricity is produced using turbines and generators.

**pressure:** the force exerted over a certain area. Our atmosphere exerts pressure on the surface of the earth, and layers of rock exert pressure on those below them.

## R

**radiant energy:** energy (heat) that is transferred by rays or waves, especially electromagnetic waves, through space or another medium. Radiation.

**renewable resource:** a resource that can be used continuously without being used up (because it regenerates itself within a useful amount of time). Examples include water (small hydro) and wind power, solar energy, and geothermal energy.

**reservoir:** see *geothermal reservoir*.

**rift zone:** long narrow fractures in the crust found along ocean floor or on land, from which lava flows out; often associated with spreading centers from which tectonic plates are diverging, such as the mid-Atlantic Ridge.

**Ring of Fire:** a belt of intense volcanic, geothermal and earthquake activity found all around the Pacific Rim caused by plate tectonic activity.

## S

**steam:** the vapor form of water that develops when water boils. Steam is made of very tiny heated water particles (molecules) which are bouncing around and bumping into each other at very high speeds. These heated water molecules are also spreading out and expanding in every direction they can. If we confine or trap water in a container, with a pipe as an opening, and heat the water to steam, it will create great pressure in the container and will rush out of the pipe with a great deal of force. This force (the "power" of steam) can be put to work turning a turbine connected to an electricity generator.

**subduction boundary:** one of two types of converging plate boundaries which occurs when one plate plunges under another overriding plate.

**sulfur oxides (S<sub>ox</sub>):** pungent, colorless gases (including sulfur dioxide (SO<sub>2</sub>)); formed primarily by the combustion of fossil fuels; may damage the respiratory tract, as well as plants and trees.

**sustainable:** material or energy sources which, if managed carefully, will provide the needs of a community or society indefinitely, without depriving future generations of their needs.

## T

**therapeutic:** the treatment of disease or other disorder; something that may benefit health. (Geothermal) hot springs are often thought of as therapeutic.

**transmission lines:** wires that transport electricity over long distances.

**turbine:** a machine with blades that are rotated by the forceful movement of liquid or gas, such as air, steam or water or a combination.

## V

**vaporize:** to change into the gas form anything which is normally a liquid or a solid; the term is most commonly used in reference to water (which vaporizes to steam).

**volcano:** an opening in the earth's crust from which lava, steam, and/or ashes erupt (or flow), either continuously or at intervals.

**voltage:** the measure of the amount of force that "pushes" an electric current.

## W

**water phases:** the change of water from one state to another. The change from ice to liquid is melting; the reverse process is freezing. The change from liquid to gas is evaporation and the product is water vapor; the change from water vapor to liquid is called condensation. Evaporation and condensation are both important functions in geothermal phenomena and in geothermal technology.

**Watt (W):** the measure of the amount of current flowing through a wire at a given time.