The earth is a great reservoir of heat energy in the form of molten interior. Surface manifestation of this occurs in form of geysers and hot springs of water. Heat can be experienced with the increase in temperature of the earth's crust with the increase in depth. The geothermal heat is transferred to the underground reservoir of water which also circulates under the earth's crust.

The earth is composed of the :

- The crust: It's the topmost solid layer and extends for about 70-100km below the surface.
- The mantle: It a the second layer below the crust and is mainly composed of iron and magnesium. It extends for about 2900km below the surface
- The core: It is the inner most and central layer.It has a radius of 3500km and is made of molten rock.

Formation of geothermal wells

Geothermal resources are associated with plate tectonic activity, as it allows ground water to be heated by the subsurface heat source. Geothermal field require the combination of three geological phenomena- a natural underground source of water, an impermeable layer that traps water and allow formation of steam and a large mass of hot rock within the vicinity of the water system.

Geothermal well formation process

- Cool rainwater percolates underground from a large surface area and then circulates downwards.
- At depths of 2-6km the water is heated by conduction from the hot rocks
- Water expands on heating and flows buoyantly upwards in a restricted cross-sectional area.
- If the rocks have many interconnected fractures ,heated water rises quickly to the surface in form of hot springs
- However if the upward movement of the heated water is impeded by rock with few fractures, geothermal energy is stored in the reservoir rock below the impeding layer
- When such a site is drilled it becomes a sites for geothermal energy
- Geothermal gradient is the steady rise in temperature with increasing depth.

Types of geothermal resources

Hydrothermal resource

Are hot water reservoirs that can be tapped by drilling to deliver the heat to the surface for thermal use or generation of electricity. Such zones exist in areas of structural weakness. They are divided into:

- ***Hot water fields***
  At this locations, hot water below 100 degrees Celsius gushes out as hot springs. The geothermal aquifers covered by confining layers keep the hot spring under pressure. They are mainly used for baths.
- ***Wet steam fields***
  The pressurized water is more than 100 degrees Celsius and contains a small amount of steam and vapor in the geothermal reservoir. Steam occurs in bubbles surrounded by liquid water. Sites where steam escapes through the cracks are called fumaroles. The impermeable rocks prevents fluid from escaping to the surface and drilling is carried out to bring the fluid to the surface.

Vapor dominated resource

They produce dry saturated steam of pressure above the atmosphere and at high temperatures about 350 Degrees Celsius. Water and steam coexist but steam in dominant phase regulates the pressure in the reservoir. A hot dry rock comes under this category, this a geological formation with high temperature rocks at 650 degrees Celsius heated by conductive heat flow from magma. The rock is fractured and water injected to create an artificial reservoir

Geo-pressured resource

Contains moderate pressure brine containing dissolved methane. They are trapped under high pressure in a deep sedimentary formation sealed between impermeable layers of shale

Magma

Its molten rock at temperatures of between 700-1000 degrees Celsius.

Geothermal power generation

Electrical power from geothermal resources can be developed in the following manner:

Liquid dominated resource

Here the geothermal fluid is available from natural outflow or bored well. The drilling cost increases with depth and the technically viable depth is 10km.

They are of two major types:

- ***Flashed steam system***

  The choice of geothermal power plant is influenced by the brine characteristics and its temperature. Geothermal fluid is used for brine temperatures above 180 degrees Celsius. Geothermal fluid is a mixture of steam and brine ,it passes through a flash chamber where it a large part of the fluid is converted to steam. Dry saturated steam passes through the turbine coupled with the generator to produce electric power.

- ***Binary cycle system***

  Is used where the geothermal fluid is hot water with temperature less than 100degrees celcius.This plant operates with a low boiling point working fluid in a thermodynamic closed Rankine cycle. The working fluid is vaporized by the geothermal heat in a heat exchanger. The vapor is the passed through a turbine.

Vapor dominated geothermal electric power plant

Steam is extracted from geothermal wells passed through a separator to remove particulate contents and flows directly to a steam turbine. Steam operates a turbine which is coupled to a generator. Exhaust steam from the turbine passes through a condenser and the water so formed circulates through the cooling tower.

Geothermal –Preheat hybrid with conventional plant

Geothermal brine is used to preheat the feed water of conventional fossil fueled power plant.

Utilization of geothermal energy

- Power generation
- Space heating
- Greenhouse heating
- Extraction of borax and sulphur