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GEOTHERMAL

WHAT IS GEOTHERMAL ENERGY?

Geothermal energy is heat derived from within the sub-surface of the earth. Water and/or steam carry geothermal energy to the earth's surface. Depending on its characteristics, geothermal energy can be used for heating and cooling purposes or be harnessed to generate clean electricity. However, for electricity generation high or medium temperature reservoirs of heat are needed, which are usually located close to tectonically active regions.[1]

GEO FACT

The amount of heat within 10,000 metres of the earth's surface is estimated to contain 50,000 times more energy than all oil and gas resources worldwide.[2]

Geothermal energy was first used in Italy in 1904. Since then, it has been a consistent and evolving source of renewable energy. The International Renewable Energy Agency (IRENA) assessed that geothermal energy has grown steadily from around 10 GW worldwide in 2010 to 13.3 GW in 2018.[1]

Geothermal energy can be harnessed from solid rock as well as hot bodies of water, such as lakes, which are located at a minimum depth of 2 kilometres underneath the earth's surface with temperatures ranging from 70° C to 150° C. The energy can be used for heating and/or cooling purposes and to generate electricity.

Figure 1: Geothermal power plant (Source: WikiImages from Pixabay)

KEY FACTS

The prices for electricity production from geothermal technologies are becoming increasingly competitive, and they are anticipated to continue to fall through 2050.[2]

Advanced closed-loop geothermal power plants do not release greenhouse gases. **Life cycle emissions of GHG** (50 gCO_{2eq}/kWh) are **four times lower than solar PV** and **six to twenty times lower than natural gas.** Geothermal power plants use less water on average during their lifespan than most conventional power technologies.[7]

Geothermal heat pumps **can save consumers up to 70 percent on heating bills and 40 percent on cooling bills.**[8]

Generally, global total deployed geothermal power plant costs vary **from USD 1,870/kW to USD 5,050/kW.**[2]

TECHNOLOGIES TO HARNESS GEOTHERMAL ENERGY

A geothermal area's heat content will determine the best technology to be used for energy production. There are different geothermal technologies with distinct levels of maturity. Geothermal energy can be harnessed directly for the following purposes:

District heating

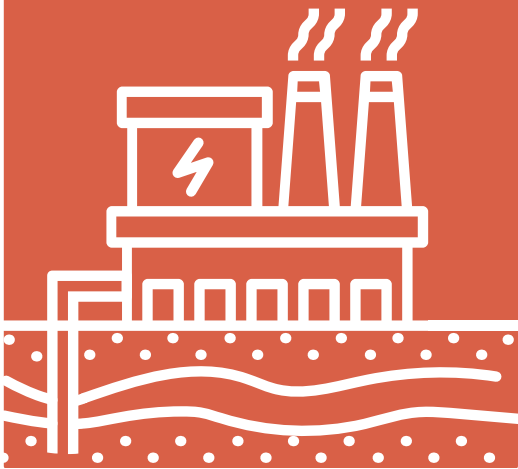
District heating is the use of one or more production areas as heat sources to provide a group of buildings and/or industries with thermal energy. Space heating, hot water supply, and space cooling are the key applications.[3]

Geothermal heat pumping

Geothermal heat pumping is a highly efficient renewable energy technology that extracts natural existing heat instead of generating heat by fossil fuel combustion.[4]

Geothermal greenhouse

Geothermal greenhouse technology uses low-grade soil heated air under the ground to grow perennials, herbs nursery stock and vegetables in a greenhouse.[5]



GEOTHERMAL PLANTS

Geothermal power generation requires high to medium heat content reserves. There are four types of technologies.

- **Dry steam plants** use steam directly from a geothermal reservoir to operate generator turbines.[6] This type of geothermal power plant requires 150° C or higher quality of steam. Usually the steam entering the turbine must be at least 99.9 percent dry. The capacity of direct dry steam plants range between 8 MW and 140 MW.[2]

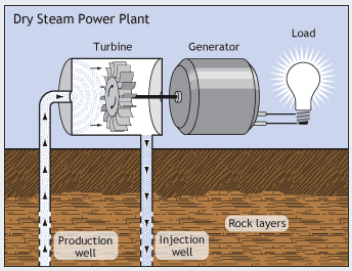


Figure 2: Direct dry steam plant (Source: U.S. Department of Energy, Energy Efficiency & Renewable Energy (public domain)

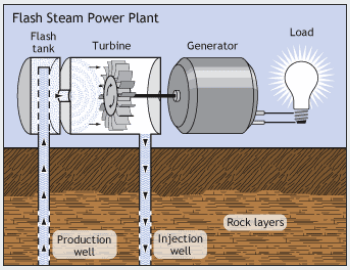


Figure 3: Flash steam plant (Source: same as above)

- **Flash steam plants** require heavy-pressure hot water from deep within the earth and convert it into steam to power turbine generators. Once the steam starts to cool, it condenses to water and is pumped back into the earth for reuse.[6]

  These are the most common type of geothermal power plants in operation today. The capacity of flash plants varies depending on whether they are single (0.2 - 80 MW), double (2 - 110 MW) or triple (60 - 150 MW) plants.[2]

- **Binary cycle power plants** transfer the geothermal hot water heat to another liquid. The heat causes the second liquid to transform into steam that can be used to power a turbine.[6] The size of binary plants is between 1 MW and 50 MW.[2]

- **Combined-cycle or hybrid plants** use a hybrid cycle that incorporates a typical rankine cycle to generate electricity from what would normally become waste heat from a binary cycle. The usual size of combined-cycle plants varies from several MW to 10 MW.[2]

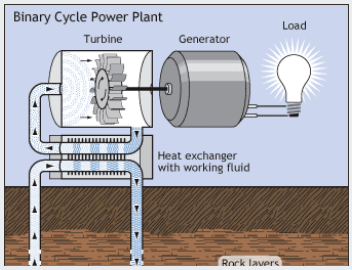


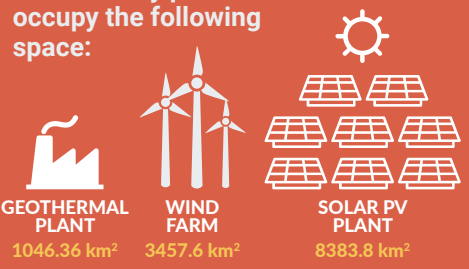
Figure 4: Binary cycle power plant (Source: same as above)

GEOTHERMAL AND SUSTAINABILITY

In 2018, more than 500 MW additional geothermal power generation capacity was installed globally. Geothermal can produce continuous energy for longer periods and can be a very economical source of energy where there are high temperature reservoirs available. The global weighted average cost of electricity of new geothermal installations commissioned in 2018 was USD 0.072/kWh, 1 percent lower than in 2017.[10] That makes geothermal energy a very competitive renewable energy source against other conventional energy sources.

KEY FACTS

A power plant capable of generating 1 GW (1,000 MW) of electricity per hour will occupy the following space:



Geothermal energy is a feasible and renewable source, which can be used to serve the base-load demand because it can generate electricity 24 hours a day, seven days a week.[9]

APPLICABILITY OF GEOTHERMAL PLANTS

Geothermal energy can be sourced from practically everywhere. However, the areas with high temperatures are more appropriate to harness this energy.[2]

For instance, areas located along plate boundaries (majority of the pacific ring-fire), mid-oceanic ridges (Iceland and the Azores) and last but not least, rift valleys (East African Rift) or hotspots (such as in Hawaii) are particularly promising locations for geothermal energy.[2]

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