Te Ahi O Maui
GEOTHERMAL PROJECT

FACT SHEET 7

Geothermal Energy Generation

Geothermal energy is clean, green and fully renewable and the process of geothermal energy generation is fascinating. This fact sheet will tell you more about how energy will be generated at the Te Ahi o Maui geothermal project in Kawerau.

Extraction and reinjection

The use of geothermal energy typically starts with the extraction of fluid and steam from the geothermal reservoir (underground pool) and finishes with reinjection of that fluid back into the same geothermal reservoir. The hot water and steam mix, called the 'brine', is extracted from a geothermal reservoir at a depth approximately between 1200m and 3000m below the earth's surface.

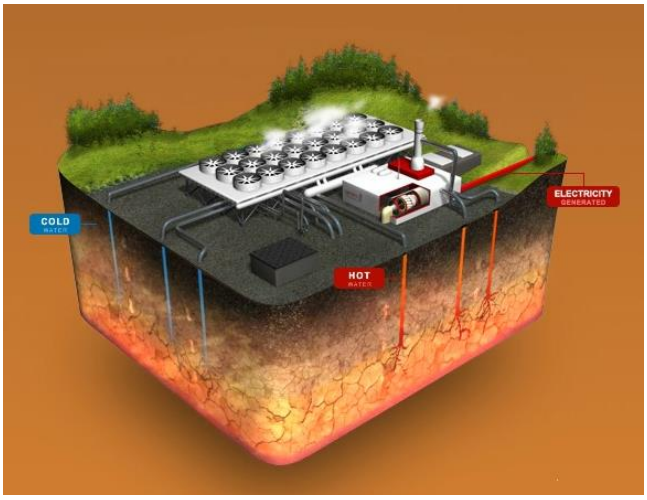

Fig 1 - Basic diagram of geothermal energy generation

The reinjection process is part of maintaining the long-term fluid volume and pressure in the geothermal reservoir. If we kept extracting fluid and steam without some level of reinjection, the total fluid volume and pressure in the reservoir may reduce and the reservoir could not continue to supply the volume of fluid and steam needed long-term by the power plant. Geothermal reservoirs do refill themselves naturally over time, but this rate may not keep up with extraction.

By the 1980s, geothermal surface features in Rotorua, like the world famous Pohutu Geyser, had gradually reduced in power. This was because the geothermal reservoir that fed the geyser also supplied geothermal heat and fluid to hotels, motels and homes in the area. The geothermal fluid was pumped into local drains and streams after use, instead of going back into the geothermal reservoir.

Nowadays, geothermal resource users have to reinject the used fluid back into the reservoir from which it was extracted. In Rotorua, this has led to the gradual recovery of the geothermal resource and the Pohutu Geyser has returned to its former glory (*Source:* Bay of Plenty Regional Council).

For the Te Ahi o Maui project, it is proposed that up to 15,000 tonnes of geothermal fluid will be extracted daily from the Kawerau geothermal reservoir. The exact reinjection rate will depend on the final design of the plant and Te Ahi o Maui is considering the following options:

- a conventional geothermal steam turbine system
- an organic Rankine cycle
- a combination of both.

Conventional geothermal steam turbine system

A turbine is a machine that uses energy to make it spin, and in this case, steam provides that energy. Here is the process in more detail, step-by-step:

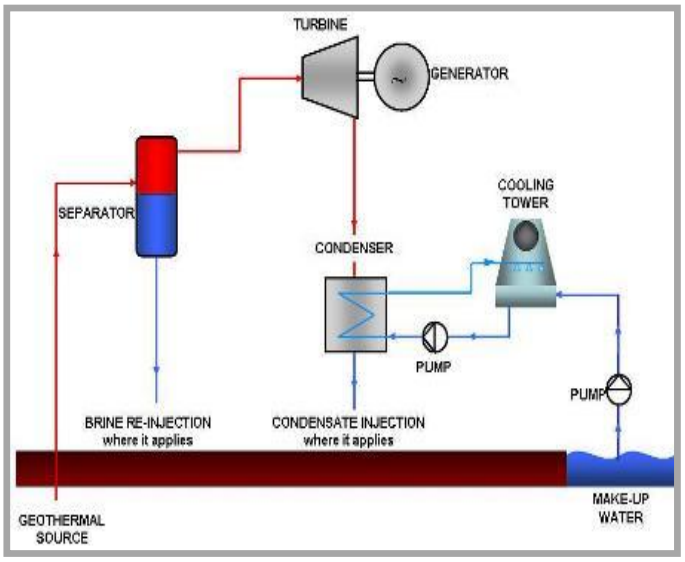

Fig 2 - Condensing steam turbine process

Step one: The hot water and steam come up from the geothermal reservoir through an extraction well to the earth's surface, where they enter the power plant's inlet pipe. The steam may be as hot as 270°C when it first exits the Kawerau geothermal reservoir. That's more than twice as hot as a boiling kettle, which is 100°C.

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Step two: The hot water and steam are physically separated from each other through a device that splits water droplets from steam.
Step three: The steam is passed through the turbine and expands, causing the turbine to spin. The steam turns to water in the condenser.

Step four: Water is cycled through the cooling tower and condenser and is returned to the reservoir via the reinjection well. The turbine can weigh as much as 50 tonnes (that's like 50 cars) and has blades shaped like an aeroplane wing that spin around 3000 times every minute.

Step five: As the turbine rotates, it turns a coil of wire suspended in a magnetic field. The change in the magnetic field through the coil creates a current and generates electricity.

Organic Rankine cycle

In the organic Rankine cycle, steps one and two are the same. At step three, the process changes and is described in more detail below.

Step three: The steam passes through two parallel heat exchangers. (A heat exchanger is a piece of equipment that is built for the efficient transfer of heat from one medium to another. We have heat exchangers in all sorts of everyday appliances such as fridges, air conditioners and space heaters). The heat exchangers transfer heat from the geothermal steam and fluid to pentane gas, which turns to pentane vapour. Pentane is a carbon-based organic compound that has a low boiling point and is a commonly used refrigerant (chemical used for cooling) in fridges and freezers.

Step four: The hot pentane vapour is passed through a turbine, causing the turbine blades to spin. The vapour from the turbine is condensed by cooling it with air blown over a series of finned tubes, similar to an automotive radiator. The cycle is completed when condensed pentane is pumped back to the vapouriser, where it is again boiled. Cooled geothermal fluids are then reinjected into the geothermal reservoir.

Cooling towers

Once through the heat exchanger or turbine, the steam exits the turbine and enters a cooling system where it is cooled to around 80-100^{o}C. At this cooler temperature, the steam is condensed back to water and is reinjected into the geothermal reservoir through another well that can be several kilometres from the extraction point. This distance ensures that the cooler fluid being reinjected into the geothermal reservoir does not cool the geothermal field at the extraction point.

Cooling systems vary and which one is used will depend on which generation system is chosen.

Air cooled condensers are used for organic Rankine cycle plants. Hot pentane vapour flows through finned tubes, much like the system in a car radiator. Air flow across the finned tubes cools the surface of the tubes, in turn cooling the pentane vapour and turning it back to fluid form.

Mechanical-draft wet-cooling towers are typically used for condensing steam turbines. Cooling steam and fluid (condensate) are sprayed over a large area of fill material and fans push air across the fill to assist with cooling. Some of the condensate evaporates, causing the remainder of the fluid to cool (due to the hidden heat of evaporation).

Te Ahi o Maui electricity

The electricity generated by the Te Ahi o Maui geothermal power plant will be available for use locally in Kawerau, or for supply into the National Grid. The power plant will generate approximately 15-20 MW (megawatts) of electricity.

A 9 megawatt power plant could generate enough power to supply 5000 homes at any one time. That's all of Kawerau's homes supplied, twice over! [Source: www.stats.govt.nz]

Questions? Please contact us

The Te Ahi o Maui Geothermal Project is a partnership between Eastland Group Limited and Kawerau A8D Ahu Whenua Trust.

For more information:
Visit www.taom.co.nz or call 07 308 2574