



UNDERSTANDING GEOTHERMAL ENERGY



STUDENT FACT SHEET

IT COMES OUT OF THE GROUND

- The word geothermal means hot earth. Geo means earth and thermal means hot. Under the surface of the earth or what we call the earth's interior, it is very very hot – so hot in fact that 6450km deep, the temperatures can reach over 5000°C . These volcanic molten rocks are known as magma.
- Sometimes the magma can reach the surface of the earth where it comes out of volcanoes as lava but most of the magma stays below the crust of the heating rocks and rainwater that has seeped down into the earth. This hot water is known as geothermal water.
- In parts of New Zealand – mostly Taupo and Rotorua – some of this water travels to the surface through cracks in the ground and we know it as hot springs and geysers. Most of the water stays deep into the ground, trapped in cracks and rocks and we call this our geothermal reservoir. By drilling down into the earth we can use the heat or geothermal energy to make electricity without polluting the environment.



This Hot Pool Indicates Geothermal Activity

HOW IT MAKES ELECTRICITY

- To make electricity we use a special machine called a turbine which we make spin by using gas, water, or in this case the steam from the very hot water.
- The steam is forced through the blades of the turbine and makes it spin. When the turbine spins it makes the generator spin and the generator is the machine that makes the electricity. The generator spins at the same speed as the turbine – 3000 times every minute and at the new Mighty River Kawerau Power Station it produces 1100 volts and over 90 megawatts of power. This is enough power to provide electricity to 90,000 homes.

GETTING IT OUT OF THE GROUND

- To get the steam and water out of the earth, a hole is drilled using a drilling rig. We call this hole a well and it is about 27cm wide and can go down over 2.5km into the earth. It is very expensive to drill a well and it can cost up to \$8 million dollars.



The Turbine is Driven by Geothermal Steam

- When the well is being drilled, a special drilling mud is used to stop the well collapsing. A metal pipe is then put in to stop it collapsing when the well is in use. Inside this pipe is another pipe called the liner. The steam and water travel up this liner.
- At the top of this well is a master valve used to control the flow and then a pipeline carries the water and the steam to the power station.



Drilling a Geothermal Well

- At the Mighty River Kawerau Power Station there is about 8km of pipeline. The pipe has to be thick and welded together so it can stand the pressure from the hot steam and water. Bolted on to the pipelines are valves. These are like very big versions of taps we have at home. They are used to turn off the steam and water or to slow it down. The pipelines are also covered with insulation to stop the heat escaping and also to stop people from burning themselves. The pipes heat up to about 180°C.

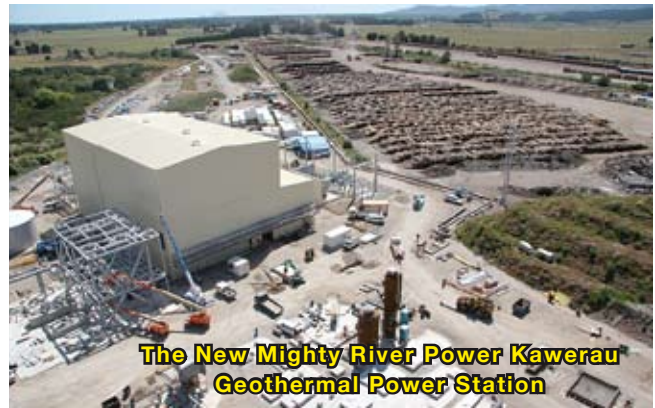
DETAILS OF HOW IT WORKS

- Use the diagram over the page to follow what happens from the time the steam and water come out of the well.
- Water is not used so it has to be separated from the steam. This is done by the separator which sends the water to a re-injection well that puts the water back deep into the ground.

ENERGY FROM INSIDE THE EARTH



Special Pipelines and Valves Deliver Energy



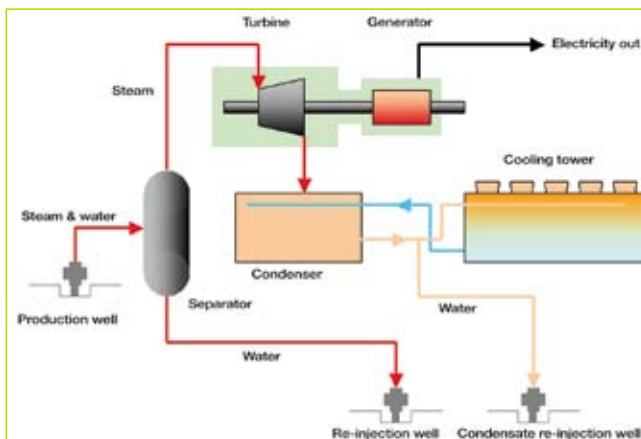
The New Mighty River Power Kawerau Geothermal Power Station

- This means the water can be reheated and used again.
- The steam is sent to the power station.
- The steam is sent to the turbine and as it passes through the turbine blades, it makes the turbine spin. The turbine causes the generator to spin and this is what produces the electricity.
- What happens to the steam? Once it comes out of the turbine, it goes to the condenser. The condenser's job is to turn the steam back into water so it can be re-injected back into the ground. Because the condenser needs to cool the steam to turn it back to water, water is used for cooling. The condensed water is then sent to the cooling tower to cool even more. The water needed for cooling is then used again - recycled - and the rest is put back into the ground.
- Once the electricity leaves the generator it is increased (stepped up) by a transformer from 11,000 volts to 110, 000 volts. This is so the electricity can travel long distances through the power lines (also called transmission lines).
- The electricity is sent down power lines to a sub-station and its job is to turn the electricity to the same electricity we use in our homes (stepped down to 230 volts).

GEOTHERMAL AND THE ENVIRONMENT

- When geothermal water and steam is removed from the earth, it can cause the ground to drop. This is because of a drop in pressure - a little like letting air out of a balloon. To stop this happening the water is re-injected back into the ground.
- This means that when the re-injected water is heated back up by the earth it can be used again.

How it all happens - Diagram



- In New Zealand we produce electricity from renewable and non-renewable resources. That is:

HYDRO = 55%
GEOTHERMAL = 8%
WIND = 2.5%

These are all renewable resources which have a smaller effect on the environment than gas, coal and oil (thermal generation).

GAS/COAL/OIL = 32%

- Geothermal power stations produce 30% less greenhouse gases than thermal power stations so are better for the environment.
- Compared to large oil, gas, and hydro power stations, geothermal power stations don't have a large effect (footprint) on the environment.

GEOTHERMAL BASELOAD GENERATION

- Baseload is the name we give to the smallest amount of electricity the country needs over a 24 hour period. Geothermal power stations provide some baseload power and these plants run at all times through the year except in the case of repairs or scheduled maintenance. Geothermal is the only baseload power that uses a renewable resource.
- When more power is needed we use other power stations and hydro is the first choice as it reaches full power in a few minutes. Oil and gas take about 30 minutes to produce full power but these are not renewable resources and release more greenhouse gases.
- Geothermal power is not affected by the weather such as lack of wind or rainfall. It is always able to be used.



Re-injecting Water Deep into the Earth