

THERMAL

What is thermal generation?

Thermal generation refers to the process of generating electricity from heat. There are four thermal energy fuels: coal, natural gas, wood waste and geo-thermal. Strictly speaking, nuclear power is also thermal energy fuel, but it is set aside in a class of its own because of its unique traits.

Fossil fuels, such as gas and coal, were created millions of years ago from layers of animal and plant matter.

When coal is burnt to produce heat, this heat can be used to create steam. The steam drives the steam turbine, which is connected to a generator. The energy produced by the generator is passed through a transformer into the National Grid transmission line which delivers electricity throughout New Zealand.

Natural gas can provide energy through the process of burning it for heating and cooking. It can also be used to fuel an electricity turbine.

Wood waste (bio-mass) comes from wood processing plants and other related industries. Often the wood waste is disposed of, but in some situations it can be burned in order to produce heat energy. Heat energy can make steam. Steam drives a steam turbine to generate power.

Three types of power plants are used to generate power from geo-thermal energy: dry steam, flash and binary. Dry steam plants take steam out of fractures in the

ground and use it to directly drive a turbine that spins a generator.



HUNTLY POWER STATION IN THE NORTH ISLAND SUPPLIES UP TO 20% OF NEW ZEALAND'S ELECTRICITY.
SOURCE: GENESIS ENERGY

How is electricity generated from thermal energy fuels?

In New Zealand, three types of turbines generate heat from natural gas:

Conventional Steam Turbine

Gas is burnt in a boiler to heat water into steam. A conventional steam turbine uses high pressure steam to turn a turbine. The turbine drives a generator which converts kinetic energy into electrical energy.

Open Cycle Gas Turbine

An open cycle gas turbine is very similar to a jet engine on an aircraft and is the most basic thermal energy turbine. Air is passed through a compressor and is then mixed



with fuel gas in a combustion chamber. It is then burnt and the hot gases create thrust that turns the gas turbine shaft. The gas turbine shaft is connected to a generator which generates electricity.

Combined Cycle Gas Turbine

Combined cycle gas turbines combust the gas and then pass the exhaust heat through a boiler to create steam. The steam turns a steam turbine, which generates power. Both the gas turbine and the steam turbine are connected to the generator.

What are the advantages of thermal energy?

The main benefit of thermal energy is that it can provide continuous, reliable energy that is not dependent on the weather.

Coal

Coal has been a useful fuel for generating electricity for many decades because it is relatively cheap and available. Coal is in plentiful supply worldwide which generally makes its price and availability reliable. New Zealand has abundant reserves of coal.

Natural Gas

Efficient combined cycle gas turbines produce a lot more electricity and burn cleaner than coal, meaning they emit much less carbon dioxide (CO₂) into the atmosphere.

Wood Waste

Wood waste is a renewable source of fuel. Wood waste is generally sourced from a pulp and paper mill which needs electricity and steam. Therefore the waste of the mill

can be used to provide steam and energy for itself. This reduces transportation cost. New Zealand has vast forests of exotic (non-native) trees. The processing of these trees into paper or milled timber, results in a large amount of bark and wood waste, which can be burnt in a boiler to create steam for manufacturing or electricity generation.

Geo-thermal

Geo-thermal energy is the only renewable thermal energy available in the world. Using geo-thermal energy is a cleaner, greener way to produce thermal energy, compared to fossil fuels, and is not dependent on the weather or mining.

What are the disadvantages of thermal energy?

Coal

Coal is a non-renewable resource and is only available in a few select areas of New Zealand. Burning coal creates carbon dioxide emissions which contribute to greenhouse gases.

Natural Gas

Natural Gas is a non-renewable resource and is only produced in the Taranaki region which limits the supply. Natural gas, once burned, also creates carbon dioxide emissions.

Wood Waste

A renewable resource, wood waste creates carbon dioxide emissions once burned although this is largely offset by growing new trees. Supply is limited and dependent on what's available.



Geo-thermal

Even though geo-thermal energy is renewable, its lifetime is limited, so we need to be careful with how we manage our geo-thermal resource. It's also expensive to build a geo-thermal plant and it doesn't generate a lot of energy compared to other sources.

How is thermal energy used in New Zealand?

Thermal energy plays a key role in supplying New Zealand's electricity. Huntly Power Station is the country's largest power station generating up to 20% of New Zealand's electricity requirements.

Huntly Power Station has five separate generating units (four turbines which each generate 250MW of power annually and one gas-fired turbine generating 48MW annually – a total of 1048MW annually). A new 385MW combined cycle gas turbine is nearing completion at Huntly. This new power station will reduce the amount of coal burnt at Huntly and will reduce carbon dioxide emissions as well.

ACTIVITIES

ACTIVITY ONE

Research project: What are carbon-dioxide emissions and why are they bad for the environment?

ACTIVITY TWO

Divide the class into seven groups. Assign each group one of the following energy sources:

- Co-generation
- Wind
- Hydro
- Thermal
- Nuclear
- Ocean
- Solar

Each group presents a case for why their energy source is the best to the class.

SUPPORTING RESOURCES

- New Zealand Geothermal Association: www.nzgeothermal.org.nz
- Energy Efficiency and Conservation Authority: www.eeca.govt.nz
- Ministry of Economic Development: www.med.govt.nz

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