4 What Can You Learn?

d - Some energy sources are better for the environment than others

Purpose

To explore key concepts in greater depth and relate them to your school situation.

Key concepts

Some energy sources are better for the environment than others.

We use energy from many different sources and in many different forms. When we use energy, we often change it from one form to another, (e.g. electricity changes into light, fuel is transformed into movement in our cars and the energy in food becomes growth and movement when we eat it).

Different sources and forms of energy have different effects on the environment, so some are more environmentally friendly than others. Become more aware of what the impacts of energy use are.

Sources include sun, geothermal, wind, water, fuels.

Forms include electricity, heat, light, growth, movement, sound.

Consider

- Which sources of energy are renewable and which are non-renewable?
- How does our energy use affect the environment?

Evaluate / Reflect

- What are the problems with different sources of energy?
- How might this affect you in a school environment?
- How do you contribute to any problems?
- Which energy sources do you think are the best? Why?
- Which are the best sources of energy for making electricity?
- Where does most of our electricity come from?
- What forms of energy do we use for transport?
- What key insights can you add to your Pool of Knowledge that relate to energy use and its effects in your school environment?

Activities

Background text - Our atmosphere

4d.1 Energy options

4d.2 Impacts

4d.3 Energy and electricity: sources and uses

4d.4 Electricity Generation Sources

4d.5 Electricty Supply

Background text

Our Atmosphere Is Changing

Our energy use is part of the problem.

Around two thirds of the electricity generated in New Zealand comes from hydro-power, which is a clean, renewable energy source. The rest comes mainly from burning coal and gas. Since there are few opportunities to build more hydro-dams, any extra power used will come from burning more fossil fuels. Fossil fuels are also the principal source of energy for transportation, which is a major energy use in New Zealand.

Burning fossil fuels for energy releases gases like carbon dioxide and methane into the atmosphere. These gases are known as greenhouse gases. Having more of them is like having a thicker blanket over the Earth, or a more effective greenhouse, making the climate warmer overall. When the temperature rises, other things can change, like how much rain falls in different places, how much water is stored as ice in the polar regions and the level of the oceans. (Sea levels can rise both due to polar ice melt and due to expansion of the water itself as it gets warmer). These changes will also affect things like droughts and floods, which crops can be grown and which areas of land are flooded.

Methane is a gas produced by livestock, but carbon dioxide comes mainly from burning fuel. Carbon is stored by plants as they grow and is then contained in fossil fuels like coal and oil which are formed from plants. When wood, coal, petrol and gas are burned, carbon dioxide is released. This means that transportation and electricity use are important factors affecting our atmosphere. Using less carbon-based fuels, protecting our forests and planting more trees, are all beneficial in reducing carbon in our atmosphere and preventing global warming.

For more information and activities see
http://www.climatechange.govt.nz/reducing-our-emissions/schoolstuff/

Generating electricity can have other effects on the environment.

When hydro-dams are built, large areas of land go underwater and there may be ongoing risk of flooding, while changes in river flows downstream can affect river life. The dam itself can block eels and fish migrating between streams, rivers and the sea to complete their life cycle. Tapping into geothermal power can result in the loss of surface hot springs and geysers. Thermal power stations which burn coal or gas, such as Huntly, have to dispose of heated water through discharge into rivers. If not strictly controlled, this could make the river too hot for animals living there. Solar and wind farms are less polluting, though some people find wind farms unattractive in the landscape.

There is another form of generation, nuclear energy, which leaves behind dangerous radioactive waste, and can be very harmful to people and the environment if there are accidents at power plants. In New Zealand, we have powerful rivers and coal and gas deposits. This means we have not needed nuclear power generation to date. Although hydro-projects have had major environmental and societal impacts and caused great debate.

Non–renewable energy sources

Coal, oil and gas are formed from plants that existed a long time ago when dinosaurs were still around.

For this reason they are called 'fossil fuels' and there is only a limited amount of them to be found and used. Fossil fuels are a non-renewable source of energy, because once they are burned up, we cannot make more of them. Solar, wind and hydro-electric power are all renewable sources of energy. Currently, we use a lot of non-renewable fossil fuels, especially for transport.

Non-renewable energy sources come out of the ground as liquids, gases and solids. Petroleum (oil) is liquid. Natural gas and propane are gases, and coal is a solid. Coal, petroleum, natural gas, and propane are all considered fossil fuels because they formed from the buried remains of plants and animals that lived millions of years ago. Uranium ore used in nuclear energy is mined and converted to a fuel. Uranium is not a fossil fuel.

Most fossil fuels were formed many hundreds of millions of years ago during the geological time period called the Carboniferous Period. This geological time period started about 360 million years ago and ended about 286 million years ago. During this time the land was covered with swamps in which grew great trees, huge ferns and other plants. The plants got their energy from the sun's light through the process of photosynthesis. In the water there were millions upon millions of tiny plants called algae (you can see algae growing in stagnant ponds – it looks green and slimy).

Over time the trees died and fell into the swamps where they formed layers of peat. These layers of peat contain carbon which is the basic element in fossil fuels.

Gradually, as the land was worn away by the weather, the rivers carried the tiny particles of sand, clay and other minerals into the lakes and oceans. The tiny particles were deposited in layers on top of the peat. These layers of sand and clay formed sedimentary rocks. Gradually the weight and pressure of the overlying sedimentary rock caused the water in the peat to be squeezed out until it turned into coal. Coal is mined from underground coal seams or dug out of opencast mines on the surface. Coal fired power stations burn coal to heat water which makes steam. The steam drives the turbines to generate electricity.

Oil was also formed more than 300 million years ago from tiny sea creatures. Some scientists believe that oil comes from diatoms which are about the size of a pin head. Diatoms, like plants can convert sunlight directly into stored energy. When the diatoms died they sank to bottom and accumulated on the sea floor. Gradually they were buried under layers of sedimentary rocks. The weight of the overlying rocks squeezed the diatoms and the stored energy in their bodies couldn't escape. The carbon in their bodies eventually turned into oil under the great pressure and heat. This oil was trapped underground. Pressures and movements in the earth's crust folded the sedimentary rock layers. This folding and moving allowed the oil to collect in pockets. Oil and natural gas are found underground between folds of rock. Drills are sunk down into these pockets of oil and gas. The oil and gas is then pumped up to the surface.

The fossil fuels are our reserves of stored chemical energy. When we burn oil, coal or natural gas we release this stored energy and change it to heat energy, electrical energy and mechanical energy.

These fossil fuels have taken many millions of years to form. Once they are used up they are gone. We call fossil fuels, non-renewable energy sources.

Useful Websites

Non-renewable Energy Resources

- Energy Story
  www.energyquest.ca.govt/story/chapter17.html
- Coal and Mining in NZ
  www.teara.govt.nz (Browse using keywords: Energy – coal and coal mining)
- Oil and gas in NZ
  www.teara.govt.nz (keyword: Energy – Oil and gas)

Renewable Energy in New Zealand

- Solar
  www.schoolgen.co.nz
- Wind and Solar Power
  www.teara.govt.nz (keyword: Energy – wind and solar power)
- Hydro Electric
  www.teara.govt.nz (keyword: Energy – Hydroelectricity)
- Geothermal Energy
  www.teara.govt.nz (keyword: Energy – Geothermal)
- Sustainable Energy (Australian website)
  www.sustainableenergy.qld.edu.au

Electricity Generation

- Genesis Energy
  http://www.genesisenergy.co.nz
  - Schoolgen
  - Climate change
- TrustPower
  www.trustpower.co.nz
- Contact Energy
  www.contactenergy.co.nz
- Meridian Energy
  www.meridianenergy.co.nz
- Nova Energy
  www.novaenergy.co.nz
  - Eastern Bay of Plenty Generation

Useful Websites for Electricity and Electrical Safety

- Electric circuits and conductivity – quizzes and interactive activities
  - BBC Science Clips
    http://www.bbc.co.uk/schools/scienceclips/ages/6_7/electricity.shtml
- Information on electricity and interactive electrical safety activities
  - Unison Networks Ltd website
    http://www.unison.co.nz/unison_esw/html/kids5.html
  - E-ON UK Energy Company website
    https://eon-uk.com/EnergyExperience/102.htm

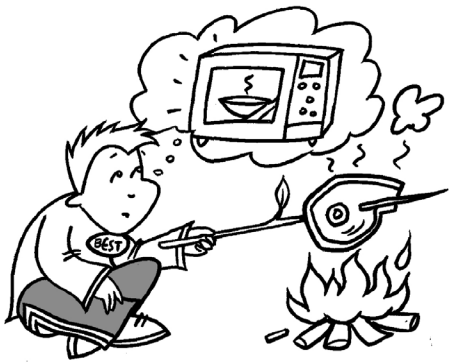
Community information on electrical safety

  - Horizon Energy
    http://www.horizonenergy.net.nz/support-safety-useful-information

4d.1 Energy Options

You will need

- A copy of the table



1 Think of three different ways you could do the following activities using different sources of energy

   a Melt a marshmallow

   b Make a light to see in the dark

   c Warm a litre of water

   d Get to school

2 In groups choose one of the activities and complete the table.

How could you do this activity?	What is your main source of energy?	Is it a renewable or sustainable source of energy?	Is this a good (efficient) way to do this activity?
1.			
2.			
3.			

4d.2 Impacts

This activity builds on 4c.5 Where Does It Come From? How Does It Change? which showed energy generation and transformation. This activity helps you to explore the impacts of different energy processes using cards which represent environmental impacts and costs of energy production, transport and use. Energy lost in transport includes both physical transport of fuels (tankers etc.) and electricity transmission (loss from the grid).

You will need

- A set of Good things/Bad things cards

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1 Take a "Good things/Bad things" Card. Look at the all the source-change product sequence jigsaws and work out where your card fits, then place it on the jigsaw.

2 If you have trouble finding a place for your card, the following impact scenarios will help. One person will need to read them clearly to others.

Impact card scenarios

An oil tanker grounds on rocks off the coast of New Zealand. Oil begins to spill into the ocean. It washes up on the shore and turns the beaches black. Seabirds' feathers turn black and greasy and they cannot fly anymore. Many drown and are washed ashore. Shellfish and seaweed suffocate and die.

Major oil reserves begin to run out. It gets harder and harder to find new ones and the oil is more and more expensive to extract.

Burning petrol releases carbon dioxide into the air. This builds up in the atmosphere above the Earth and acts like a blanket, or a greenhouse. The world gets warmer and in New Zealand, there are more storms and floods because of changing weather patterns.

A new dam is built across a wild river. Large areas upstream are flooded. Downstream, the river flow is lower and some plants and animals die. Young fish swimming up from the sea cannot get up to the places they like to live as adults, in cool bush streams.

Oil tankers bring oil from the other side of the world to Marsden Point to refine into petrol. Energy is burned by the oil tankers to travel all this distance.

Burning fires to heat homes produces air pollution. People in the city cough and wheeze.

Steam is drawn out of the ground to produce power. However the steam contains a lot of chemicals from deep in the ground. Once the steam has been used, it is put back into the river. The water becomes polluted.

Gas is burnt to produce electricity, which travels around through power lines.
A lot of the original energy in the gas is lost along the way before it gets to people's homes.

Burning gas to produce electricity creates a lot of hot water which goes back to the river. The fish find it too hot!

A calm, still day – no wind! No power either?

Wheat becomes flour becomes biscuits… Biscuits are wrapped in individual plastic bags, which take energy to produce.
The little bags are driven half way across New Zealand to a supermarket, driven home and appear in someone's lunchbox…
The plastic goes out in the rubbish bag and is driven over the hill to a landfill…
The energy used is much more than the energy in the biscuit!

Evaluate / Reflect

- What are some of the problems with energy production, transport and use?
- How do you and I contribute to these problems?
- Which sources do we have to keep paying for and which does nature give us for free?
- Which are the easiest to replace?
- Which do you think are the best energy sources? Why?
- Do you think there are ways we can use more of the best sources and less of the others?
- Which energy sources do you think we use the most for our electricity and transport?
- How does this affect your school?
- Can you identify any ways to resolve or reduce the environmental effects of energy use?

Good things/Bad things cards

Free Energy Source!	Free Energy Source!	Free Energy Source!
Will run out one day	Will run out one day	Can grow more
Can grow more	Flooding upstream	Oil spill
Fish can't swim past	River downstream dries up	Air pollution
Air pollution	Releases carbon dioxide - plant gets warmer	Lots of energy lost in transport
Lots of energy lost in transport	Lots of energy lost in transport	Lots of energy lost in transport
Energy depends on the weather	Energy depends on the weather	Energy used in processing and packaging
No burning = clean air, planet stays cool	No burning = clean air, planet stays cool	No burning = clean air, planet stays cool
Waste goes into the river	No burning = clean air, planet stays cool	Used up all the steam - geysers don't work
Absorbs carbon dioxide		

4d.3 Energy And Electricity In New Zealand

Sources and uses

These activities explore how we use energy from different sources for different uses. When we combine this information with what we know about impacts, we can begin to recognise changes that we can make.

You will need

- Copies of the pie graphs of primary energy sources in New Zealand and the electricity production

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1 Total energy use

How much of our energy do you think is produced from renewable sources? Look at the pie graph of energy sources. Colour in the graph giving renewable sources one colour (hydro, geothermal, other renewables) and non-renewable sources (coal, oil, gas) another colour. Cross-hatch with a pencil the sources from overseas (imported oil).

Evaluate / Reflect

- Which are the biggest pieces of pie?
- What do you think the oil is used for?
- What do you think the hydro and geothermal are used for?
- What about the gas?
- Which ones does nature give us for free?
- Which ones do you think come from overseas?
- Which ones do you think are burnt and release carbon dioxide?

2 Electricity sources

Look at the pie graph of where electricity comes from in New Zealand. Shade in the areas of electricity from renewable sources.

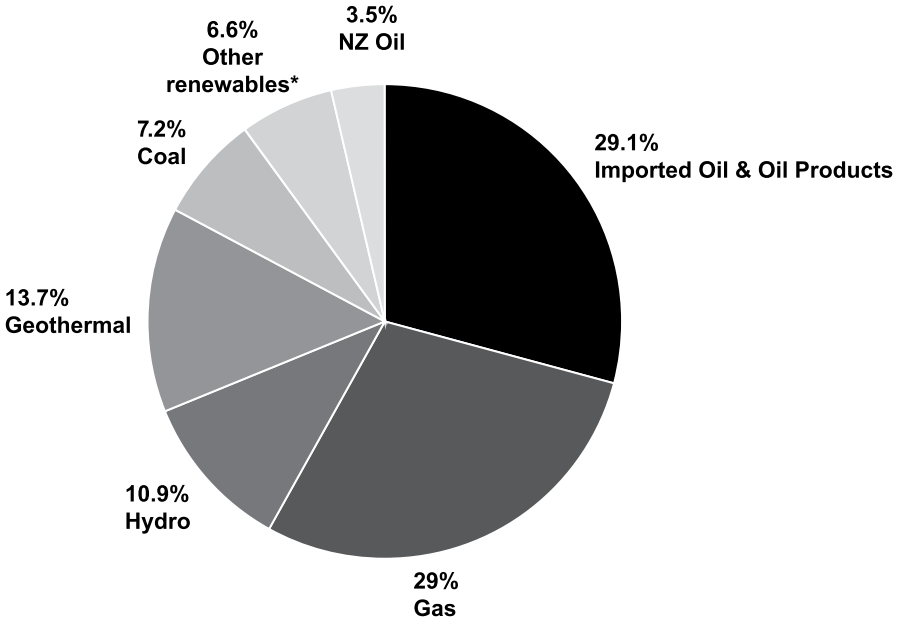
Evaluate / Reflect

- Where does most of our electricity come from?
- Can we get more from this source?
- What problems would there be?
- What other sources of electricity do we use as a top-up for our hydro?
- What are the problems with this source?

Notes

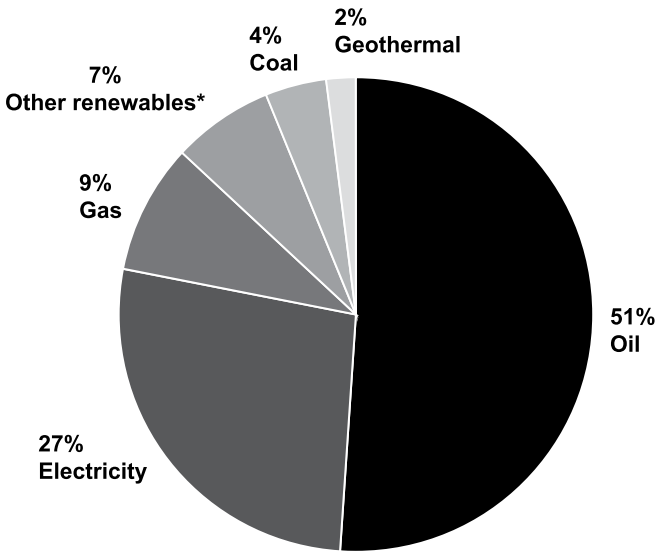
- This first pie graph shows TOTAL energy use, including transport; the second pie graph shows sources of electricity only
- Oil in the first graph is mainly used to make petrol for cars. It is non-renewable, polluting and releases carbon dioxide, causing climate change
- Hydro and geothermal sources are used for electricity and are renewable
- Gas is mainly burnt at Huntly, for electricity, though some goes to homes and cars. It is non-renewable
- Electricity is mainly generated from hydro (see second graph). Dams however, have major environmental impacts, so it is "unlikely" that we will build any more large dams. Currently, the extra electricity we use comes from non-renewable gas. If we use more electricity, this pie graph would probably show more use of non-renewable energy to produce electricity

Sources Of Energy Used In New Zealand 1999



NOTE: * "Other renewables" includes electricity generation from wind, biogas, industrial waste and wood

Fig 5.2 Consumer energy demand by fuel type, 2005



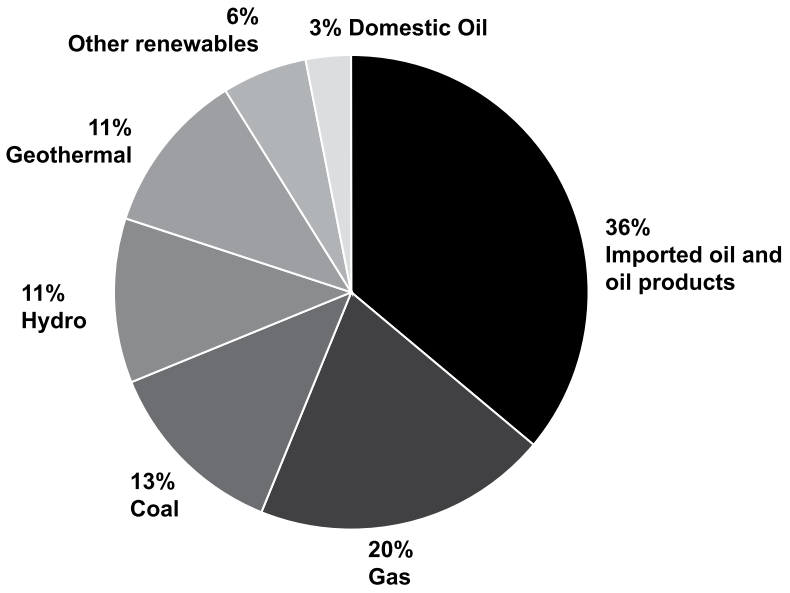
NOTE: * "Other renewables" includes solar water heating and electricity generation from wind, biogas and wood

Source: Ministry of Economic Development, 2006

Figure 5.2 shows consumer energy demand by fuel type for 2005.

Just over half of New Zealand's consumer energy demand was met by oil (51 per cent) and nearly a third (27 per cent) by electricity. The remaining demand was met by gas (9 per cent), other renewables (biogas, wind, wood, and solar) (7 per cent), coal (4 per cent), and geothermal (2 per cent).

Fig 5.6 Primary Energy Supply, 2005



NOTE: "Other renewables" includes solar water heating and electricity generation from wind, biogas and wood

Source: Ministry of Economic Development, 2006

http://www.mfe.govt.nz/publications/ser/enz07-dec07/chapter-5.pdf

Sources Of Electricity Generation In New Zealand 1999

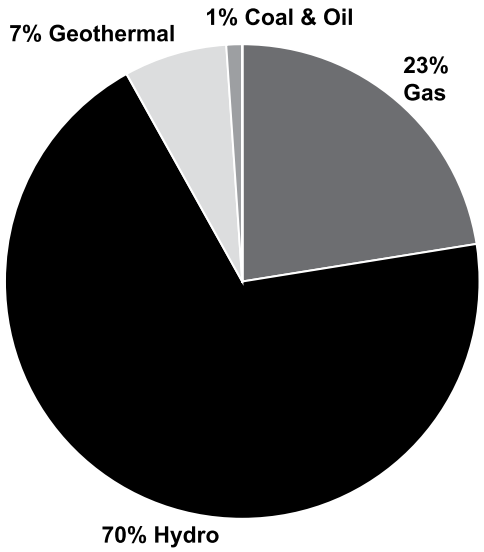
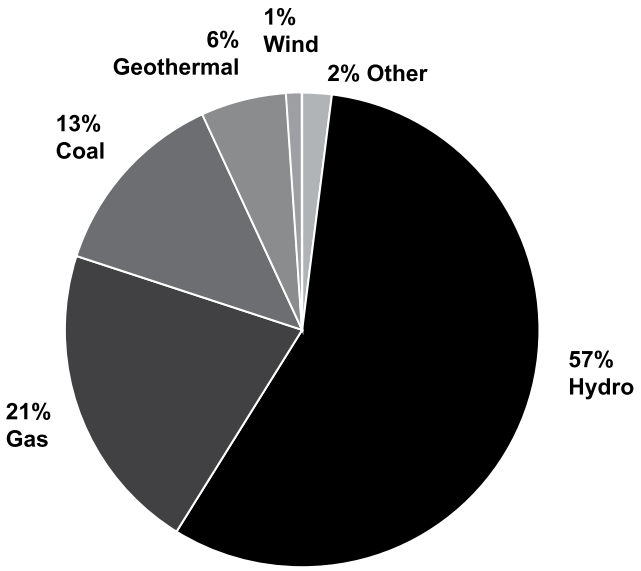


Fig 5.9 Electricity generation by fuel type, 2005



NOTE: "Others" includes energy generation from biogas, waste heat, and wood.

Data source: Adapted from Ministry of Economic Development, 2006

In comparison with many countries, New Zealand generates a high proportion of electricity from renewable sources. In 2005, renewable sources accounted for 66 per cent of New Zealand's electricity generation, with hydro-electricity providing 56 per cent of that amount. Geothermal (6 per cent), wind (1 per cent) and others (biogas, waste heat and wood) (2 per cent) are the other renewable sources contributing to New Zealand's annual electricity generation (these figures add up to 65 per cent due to rounding). See Figure 5.9.

http://www.mfe.govt.nz/publications/ser/enz07-dec07/chapter-5.pdf

4d.4 Electricity Generation Sources

You will need

- Copies of this sheet

New Zealand has a wide range of energy sources. Some of these sources are renewable and some are non-renewable.

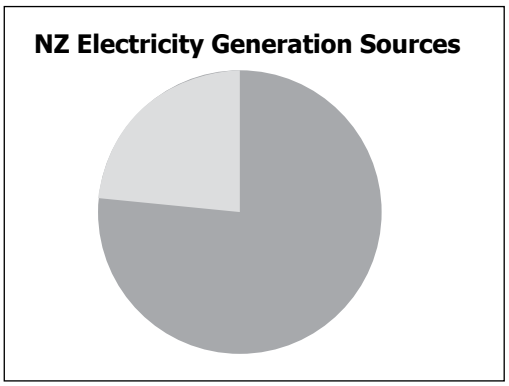
Fill in the missing letters

Renewable energy sources	H _ _ _ _ W _ _ _ B _ _ g _ _ _ G _ _ t _ _ _ _ _ _ W _ _ _ S _ _ _ _
Non-renewable energy sources	O _ _ G _ _ C _ _ _

Look at the figures in the table below.

Renewable energy sources	76%
Non-renewable energy sources	24%

Write "renewable" and "non-renewable" in the right segments of the pie chart.



Most electricity in New Zealand is generated in big hydroelectric power stations in the South Island and in the dams along the Waikato River. A lot of electricity is being generated by burning gas and coal at Huntly power station to create heat for the steam turbines.

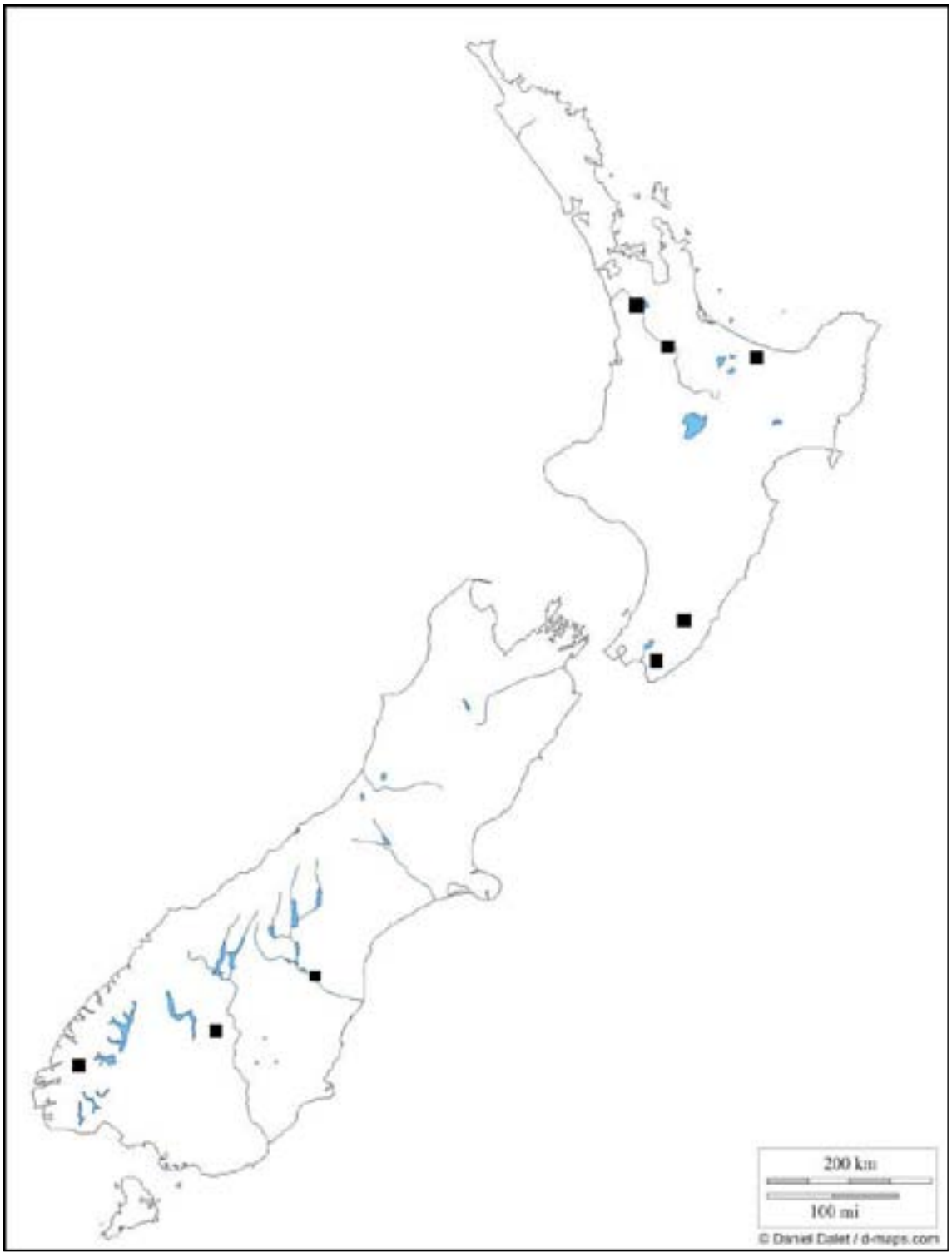
New Zealand has a lot of geothermal energy and more geothermal power stations are being built such as the one at Kawerau.

Research

Look at the map of New Zealand on the next page. Find out where these power stations are and write their name on the map. The power stations are shown on the map by a ■

Huntly (coal and gas)	Kawerau (geothermal)	Benmore (Hydro)	Clyde (Hydro)
Manapouri (Hydro)	Karapiro (Hydro)	Tararua (Wind)	Hau Nui (Wind)

Some Major Power Stations in New Zealand



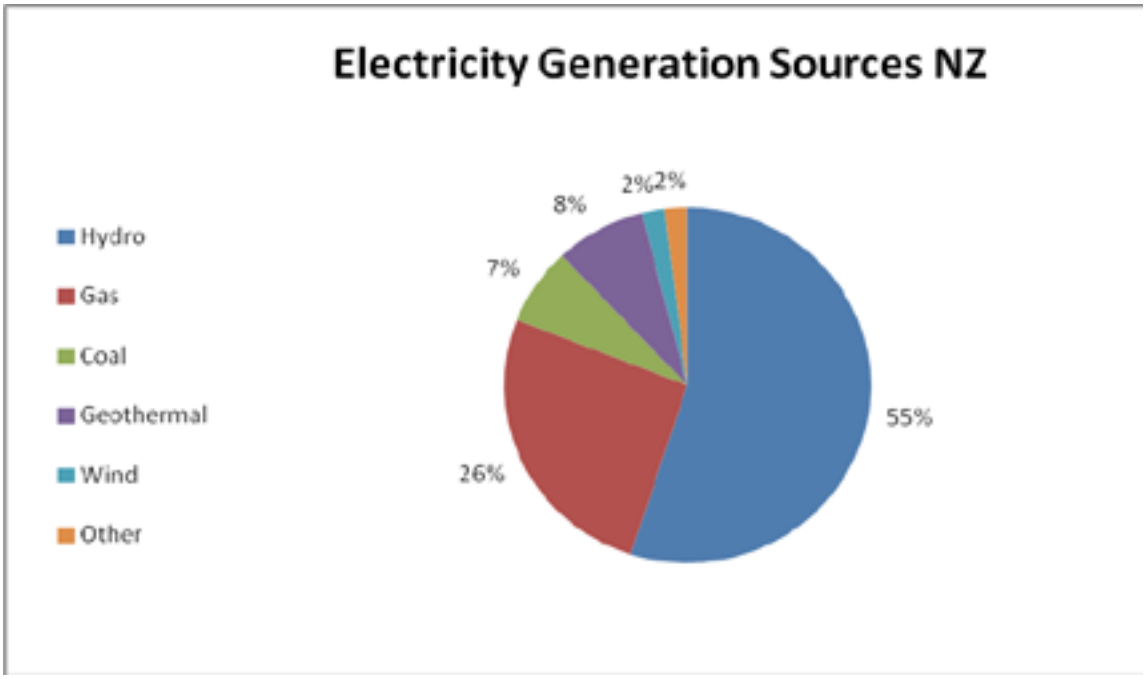
New Zealand is using more and more electricity. This means more and more electricity has to be generated. It may be necessary to build new power stations if we want to use more electricity in the future but it is not easy to decide which sort of power station to build.

All forms of electricity generation affect the environment so there are always lots of things to consider.

Our use of non-renewable fossil fuel energy adds to greenhouse gas and pollution which can harm the environment and affect human health.

On the other hand, the installation of wind farms changes the look of our landscape (or seascape) and taking geothermal heated water can have environmental impacts on local land and water.

Look at the pie chart and answer these questions:



Answer these questions:

1 Which source of energy is used more than any other to generate electricity in New Zealand?

_____

2 What percentage of electricity generation uses wind as a source? _____%

3 Which source provides just over a quarter of New Zealand's electricity? _____%

4 What is the total percentage of the non-renewable sources? _____%

5 Which section of the pie chart do you think would include the figures for solar electricity?

_____

4d.5 Electricity supply

Use each of the words in the box to fill in the spaces in the story below.

close	electricity	heat	longer	extra
photovoltaic	grid	power	used	

Most people get their electricity through _____ lines, which are connected to the national _____ . This grid carries electricity from large scale power stations that are often located a long way from where most of the electricity is_____.

As electricity travels along a power line some of it is lost as _____, and more needs to be generated to make up for this loss. The_____ the lines are, the larger the loss. About 15% of the _____ generated in New Zealand is 'lost' during these movements.

Electricity can also be generated _____ to where it is used. Some individuals and communities can generate electricity on site. If they are connected to local power lines they can sell any_____ electricity they generate. This is happening more and more in other countries like Australia, England and Germany, where people have solar _____ panels on their roofs to produce electricity for their home. Any surplus electricity is sold back to the grid for other people to use.