



RENEWABLE VERSUS NON- RENEWABLE ENERGY SOURCES

PLANNING A SUSTAINABLE FUTURE FOR NEW ZEALAND

New Zealand has a government policy target of 90% renewable electricity generation by the year 2025, and also aims to reduce carbon emissions below 1990 levels by 2020. Currently NZ is well short of both targets.

These activities enable students to explore the difference between renewable and non-renewable energy sources used for the generation of electricity (and other forms of energy and/or production), identify impacts of their use, and relate this to New Zealand's nation-wide sustainability targets.

This learning resource explicitly or implicitly involves the following areas of the Level 4 and 5 Science curriculum and is typically suited to Year 9-11 students.

Teacher notes

Background

NZ has a government policy target of 90% renewable electricity generation by the year 2025 (currently this is around 75%), and also aims to reduce carbon emissions below 1990 levels by 2020 (in 2012 NZ was about 20% above 1990 levels).

Overview of Teaching Resource

These activities enable students to explore the difference between renewable and non-renewable energy sources used for the generation of electricity, and then to relate this to NZ's sustainability target for renewable electricity generation.

Activity 1 & 2: In Table 1 students identify a range of naturally occurring energy-rich resources, the type of energy they contain, and then link this to their use in **electricity generation** (as well as other uses such as heating). In Table 2 students decide whether these energy resources are classified as **renewable** or **non-renewable** and evaluate the by-products of their use. Students are also asked to consider how well the use of these resources contributes to a sustainable future: relative sustainability is evaluated qualitatively through ranking from **most sustainable** to **least sustainable**.

Activity 3 uses the 'Energy Cards' (sheet at end of student worksheet) – students sort and categorise energy sources and related ideas to reveal links and associations, with a goal of enabling further discussion and deeper understanding of the issues.

Activity 4 asks students to research and then present a plan for NZ to stay true to its word and meet the stated policies of the government to achieve 90% renewable electricity generation and contribute to a reduction of its carbon footprint. Students should consider that they may actually gain employment in fields which are working to achieve these major goals.

New Zealand Curriculum Links

L4-5 Science Strand	Focus
Nature of Science – Participating & Contributing	L4: Use their growing knowledge of science when considering issues of concern to them. Explore various aspects of an issue and make decisions about possible actions. L5: Develop an understanding of socio-scientific issues by gathering relevant scientific information in order to draw evidence-based conclusions and to take action where appropriate.
Nature of Science – Communicating in science	L4: Begin to use a range of science vocabulary, symbols and conventions. (L5: Use a wider range ...)
Planet Earth & Beyond – Earth Systems Interacting systems	L4: Develop an understanding that water, air, rocks and soil, and life forms make up our planet and recognise that these are also Earth's resources. L5: Investigate how heat (energy) from the sun, the earth and human activities is distributed around the Earth by the geosphere, hydrosphere, and atmosphere.
Physical World – Physical inquiry and physics concepts	L4: Explore examples of physical phenomena, such as movement, forces, electricity and magnetism, light, sound waves and heat. Identify and describe everyday examples of sources of energy, forms of energy, and energy transformations.

Values	Key Competencies	Principles
Innovation, inquiry, curiosity Ecological sustainability	Thinking Participating and contributing Learning to learn	Future Focus Coherence

Activity 1 & 2 outline

1. Identify Natural Energy Resources and their uses
2. Identify effects of using Natural Energy Sources on the environment

The aim of Activity 1 and 2 is to allow students to:

- identify the range of natural energy sources and the type of energy contained in them (Table 1)
- consider their current and historical uses (Table 1)
- to classify the use of these energy resources as renewable or non-renewable (Table 2)
- consider the downstream environmental impacts of their use (Table 2)
- qualitatively rank these resources as more/less sustainable (Table 2)

[See Student Activity]

In Table 1, students are prompted to list as many natural energy sources as they can think of, identify the main type of energy contained, along with their energy-related and other uses.

Discuss with students how the natural energy source (e.g. chemical potential energy in the case of coal, radiant energy in the case of solar etc.), can be transformed into electricity.

Interestingly electricity can be readily produced from all these energy sources – in nearly all cases a turbine is used to spin a generator (coils of wire moving within a magnetic field), with one important exception – photovoltaic panels contain no moving parts at all as they are based on electronic semiconductors.

Table 1: Identify Natural Energy Sources and their uses

Natural Energy Sources	Type of energy	Modern energy uses	Other uses
Coal	Chemical Potential Energy	Electricity (steam turbines), heating	Historical transport, cooking, steel making
Geothermal	etc.	Electricity (steam turbines), heating	Traditional cooking, bathing
Hydro (water pressure)		Electricity (hydro turbines)	Historical water mills (mechanical power)
Natural gas		Electricity (gas turbines), heating	Chemical production e.g. methanol.
Oil, diesel, petrol		Transport fuels, heating, electricity	Plastics, other chemical products
Solar		Electricity (photovoltaic panels), heating (hot water panels, passive heating of buildings)	Natural lighting, drying, solar cooking
Tidal		Electricity (hydro turbines)	Coastal activities, canal locks
Uranium (nuclear)		Electricity (steam turbines), heat	Nuclear powered ships & submarines, radiotherapy, nuclear weapons
Wind		Electricity (wind turbines)	Water pumps, clothes drying
Wave		Electricity (various turbine designs)	Surfing
Wood (and other biomass)		Electricity (steam turbines), heat	Building, textiles

Table 2 builds on the outline produced in Table 1, with the natural resources being simply classified into **renewable** or **non-renewable**, and the impact of each considered in terms of their global effects (if they increase carbon dioxide concentration in the atmosphere, or not), or in terms of more regional or local effects through the emission of other potentially harmful substances.

Table 2: Renewable or non-renewable? What other effects are there?

Resources used	Renewable	Non-renewable	Emits CO ₂ ?	Other pollutants emitted?
Coal	x	✓	✓ (a lot)	Soot (C), carbon monoxide (CO), sulfur dioxide (SO ₂), nitrous oxides (NO _x), mercury (Hg), ash
Geothermal			Small amounts	H ₂ S
Hydro			x	Some CH ₄ (a powerful greenhouse gas)
Oil, diesel, petrol (liquid fossil fuels)			✓ (a lot)	SO ₂ , NO _x , C soot, CO
Natural gas			✓ (a lot)	NO _x , C soot, CO
Solar			x	x
Tidal			x	x
Uranium			x	Radioactive waste
Wind			x	x
Wave			x	x
Wood (and other biomass)			(carbon neutral if regrown)	C soot, CO, NO _x , ash

You could have an interesting discussion following this on the extent of the impacts – are they global, regional or local?

Students are then asked to rank these resources from **most sustainable** to **least sustainable**. There is room for debate here!

Related Resources

A much more in-depth student investigation of carbon can be found in the Teacher Resource section on the Schoolgen website:

http://www.schoolgen.co.nz/pdf/EE_L5-6_FS_Carbon.What.is.it.pdf

The student inquiry project – **What's My Carbon Footprint?** is also a strongly related resource:

http://www.schoolgen.co.nz/pdf/EE_L5-6_FS_Carbon.footprint.pdf

Activity 3 outline: Energy Cards

How “sustainable” are the different types of energy resources?

The aim of this activity is to get students to become more familiar with scientific terms and to categorise terms and ideas to reveal links and associations and enable discussion (see Student Worksheets).

- Students are given a total of 36 cards with the 32 words written on each card as well as 4 customisable blank cards. Students can work in small groups (2-3 is ideal), or individually.
- Cards are printed at the end of the [Student Activity](#).

Students will categorise energy sources and their effects and characteristics in different ways. They should be prepared to justify their decisions as to why they placed cards in certain categories.

Task

1. Ask students to sort the cards into two contrasting basic categories such as renewable/ non-renewable, polluting/ non-polluting, greenhouse gas emitting/non-gas emitting, heat producing/non-heat producing, most sustainable and least sustainable.
2. Optional: Sort the cards into sub-categories of their own choosing. For example:

	Heat produced	No heat
Renewable	biomass, geothermal, solar	wind, hydro, tidal, wave
Non-Renewable	coal, oil, gas, nuclear	None (all non-renewable resources generate heat)

3. Students could possibly take a photo of each arrangement for an e-portfolio or else paste one of the arrangements onto paper once completed.

Activity 4 outline: Poster

How can NZ meet its renewable energy targets?

The aim of this activity is for students to **use** and **apply** the factual information they have gained from the first three activities in a **real context**. Students are tasked to create a scenario for New Zealand to meet its goal of generating 90% of its electricity from renewable sources by 2025 (as stated in current NZ policy).

Task

1. Research how NZ currently generates its electricity (use Table 4).
2. Plan how we can generate 90% of our electricity from renewable sources (use Table 5).
3. Create a poster that communicates this information in a visual way.
4. Optional: present their plan to the class using the poster as a communication tool.

Poster research

Tables 4 and 5 in the Student Activity Worksheets provide a framework for students to gather and organise information relating to this goal.

Table 4: How NZ currently generates electricity:

- What are the current ways of generating electricity in NZ and what are their relative percentages? List one positive and/or negative of each.

Table 5: How NZ could generate electricity to meet targets in 2025:

- What other options are available for generating electricity? What percentage should these be of the total? List one positive and/or negative of each.

Extension activity

Students could also consider how this will affect NZ's overall carbon footprint and how it will help meet international commitments to controlling global warming/climate change?

Notes on carbon and carbon emissions:

1. The majority of NZ's carbon emissions come from outside the sector of electricity generation (agriculture is the main sector responsible for nearly 50% of greenhouse gas emissions, mainly in the form of methane and nitrous oxide).
2. Road transport emissions increased very steadily from about 7.4 Million tonnes of CO₂ in 1990 to 12.6 Mt in 2011 (an increase of 70%).
3. Electricity sector emissions increased from about 3.5 Million tonnes of CO₂ in 1990, peaked at 9.0 Million tonnes of CO₂ in 2005, and have since rapidly decreased to 4.8 Mt in 2011.
4. NZ's largest electrical power generation site is Huntly Power Station and it is also, unlike the majority of power stations in this country, a fossil-fuel based generator (gas and coal). It has undergone, and is currently still undergoing a major shift from coal to gas fired power generation, and a shift from older less efficient **steam turbines**, to much more efficient **gas turbine** (which captures and reuses the waste heat in a steam turbine).
5. Related resources which go into a lot more detail on carbon and carbon footprint are found here:

http://www.schoolgen.co.nz/pdf/EE_L5-6_FS_Carbon.What.is.it.pdf

http://www.schoolgen.co.nz/pdf/EE_L5-6_FS_Carbon.footprint.pdf