

Renewable vs Non- renewable Energy Sources

Planning a Sustainable Future for New Zealand

Science, Social Science
Curriculum Levels 4-5

Activity Description

New Zealand has a government policy target to increase renewable energy generation, and also aims to reduce carbon emissions.

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.



Teaching rationale

Background

The NZ Government has a policy target of 100% renewable generation by 2035. Currently we have up to 85% renewable generation.

The Government is also aiming for NZ to have net-zero carbon emissions by 2050. In the nearer term, it has committed to reduce carbon emissions to 5% below 1990 levels by 2020.

Overview of the activities

These 4 linked 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.

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 100% renewable electricity generation and contribute to a reduction of its carbon footprint. Students should consider that fields of employment are increasingly opening up in these areas.

Curriculum Links

Science	Achievement Objectives
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.
Social Studies	Students will gain knowledge, skills and experience to ... Understand how peoples' management of resources impact on environmental and social sustainability.

Values	Key Competencies	Principles
Innovation, inquiry and curiosity. Ecological sustainability	Thinking Participating and contributing	Community engagement Future Focus Coherence

Running the Activities

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)

Table 1: Identify Natural Energy Sources and their uses

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 of 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.

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

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.

Resources used	Renewable	Non-renewable	Emits CO ₂ ?	Other pollutants emitted?
Coal	×	✓	✓ (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 (water pressure)			×	some CH ₄ (a powerful greenhouse gas)
Natural gas			✓ (a lot)	SO ₂ , NO _x , C soot, CO
Oil, diesel, petrol			✓ (a lot)	NO _x , C soot, CO
Solar			×	×
Tidal			×	×
Uranium (nuclear)			×	Radioactive waste
Wind			×	×
Wave			×	×
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

The School-gen student inquiry project- **What's My Carbon Footprint** is also a strongly related resource.

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 Worksheet.

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 3 activities in a real context. Students are tasked to create a scenario for New Zealand to meet its goal of generating 100% of its electricity from renewable sources by 2035 (as stated in current NZ policy).

TASK

1. Research how NZ currently generates its electricity (use Table 4).
2. Plan how we can generate 100% 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 2035 -

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 NZs 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 NZs 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. NZs 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 School-gen resources: **What's My Carbon Footprint**

Renewable vs Non-renewable Energy Sources

Planning a Sustainable Future for New Zealand

Activity 1

Identify Natural Energy Sources and their uses

Natural energy sources exist in the environment and can be transformed into more easily useable energy sources such as electricity and petrol, both of which are essential to our lives and modern society. Electricity can be generated from a wide range of natural (primary) energy sources, whereas petrol is separated and refined from crude oil.

In Table 1:

- a) i) **List** as many natural energy sources as you can e.g. *Coal*.
ii) **State** the main type of energy contained in it eg. *Chemical potential energy*.
- b) **State** what the major modern energy use, or uses, are for this natural energy source e.g. Coal is widely used in power stations to make electricity by first heating water into steam, the steam spins a turbine, which spins a generator to make electricity. The heat from burning coal is also used for heating buildings etc.
- c) **Identify** any other uses of this natural resource. Coal is also used in the process of making steel, and it also once was used in steam engines to power trains.

Activity 2

Identify effects of using Natural Energy Sources on the environment

Using available natural resources to generate electrical energy generally has a number of effects. Renewable resources are continually replenished so that they do not run out as humans use them. Non-renewable resources are finite, and will eventually run out sooner or later- they are either not renewed at all, or replenished very slowly. Many resources emit some kind of pollution that affects the environment.

In Table 2:

- a) i) After discussing your list of resources in Table 1 with others you, please add some other resources that you hadn't thought of.
- ii) Decide whether the energy resource you have identified is renewable or non-renewable.
- b) Does this resource emit much of the main global warming gas CO₂ (carbon dioxide- acts like a blanket in the atmosphere to trap the sun's heat)?
- c) What other pollutants does it emit that have a proven negative effect on the environment?

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

Resources used	Renewable	Non-renewable	Emits CO ₂ ?	Other pollutants emitted?
Coal	×	✓	✓ (a lot)	<i>soot, carbon monoxide, sulfur dioxide, nitrous oxides, mercury, ash</i>
Geothermal				
Hydro (water pressure)				
Natural gas				
Oil, diesel, petrol				
Solar				
Tidal				
Uranium (nuclear)				
Wind				
Wave				
Wood (and other biomass)				



Table 4: How NZ currently generates electricity

Energy Source for generating electricity	Current percentage	Positives	Negatives

Table 5: How NZ could generate electricity to meet targets in 2035

Future energy source	Suggested percentage	Positives	Negatives

Consider how this will affect NZs overall carbon footprint and whether it will help meet international commitments to controlling global warming/climate change?



Cards: Cut into individual cards for use in Activity 3.

Carbon dioxide (emits)	geothermal	Short term	solar
Carbon dioxide (absorbs)	global	non-renewable	sustainable
global warming	greenhouse gases	nuclear fission	tidal
coal	heat	oil, gas	long-term
climate change	hydro	photovoltaic	unsustainable
electricity	infinite/ unlimited	polluting	uranium
finite/ limited	biomass	renewable	wind
fossil fuels	New Zealand	replenished	Wood/biomass