Solar Energy for all of your Energy Needs

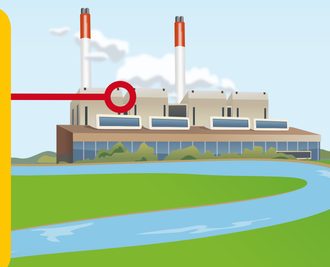
Sun Fact

Solar energy is created by nuclear reactions deep inside the sun's core. The energy from these reactions moves to the surface of the sun, where it is released as heat and light.

Where does our electricity come from?

Most of our electricity comes indirectly from solar energy.

Thermal power stations burn either **fossil fuels** (coal, oil or natural gas) or **biomass** (living or recently dead things, such as trees) to heat water to make steam. The steam turns **turbines** that generate electricity.



Hydro power stations use turbines and generators to harness energy from moving water.

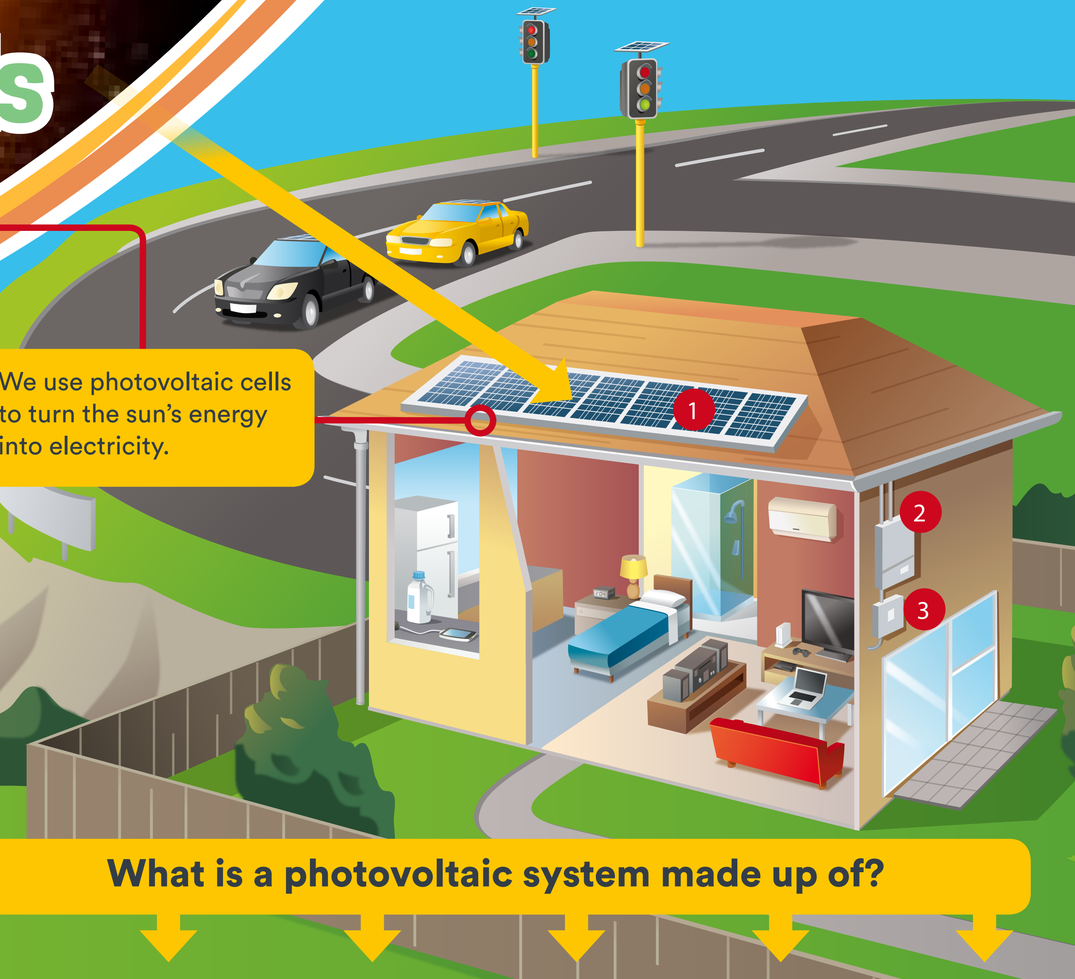
Wind power uses the force of moving air (wind) to turn the turbines.

Fossil fuels and **biomass** contain 'stored-up' chemical energy from plants and animals. This energy originally came from the sun and was converted into organic material by **photosythesis**.

The sun drives the **water cycle** by warming and evaporating the water in the oceans, lakes and rivers.

Wind is the result of the sun heating different parts of the earth's atmosphere at different rates.

We use photovoltaic cells to turn the sun's energy into electricity.



What is a photovoltaic system made up of?

A **photovoltaic system** is made up of:

1. the photovoltaic cells, grouped into solar panels
2. the **inverter**, which changes the **direct current (DC)** from the solar panels into **alternating current (AC)**
3. The **AC** feeds into the **distribution board** for use within the building.

We use electricity every day of our lives, and the demand for electricity to power our everyday world is increasing.

Solar energy is free! It is also clean, renewable and sustainable.

Something to think about

Are photovoltaic panels the most effective way to generate electricity?

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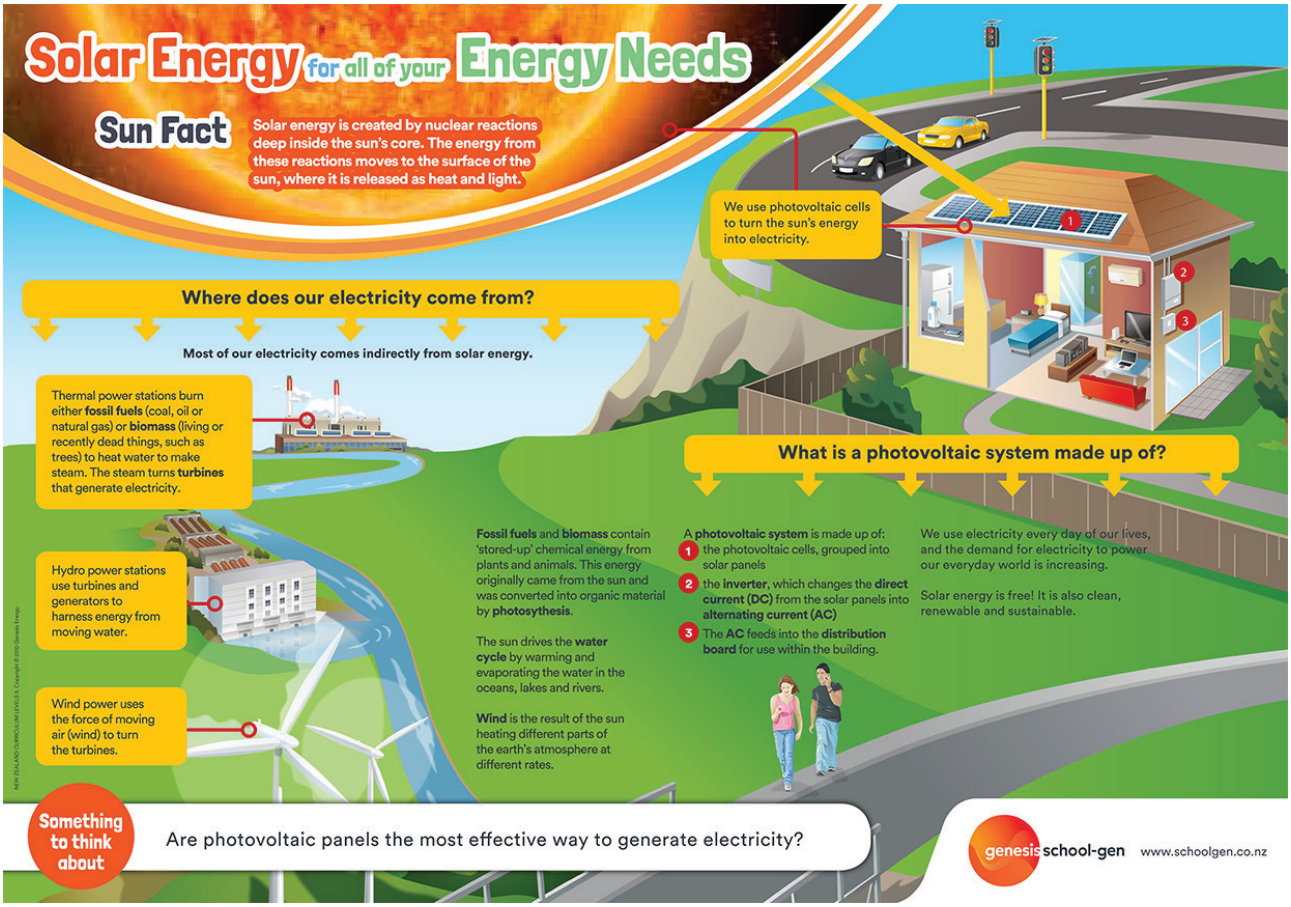
Solar Energy for all your Energy Needs: Levels 5



About this Poster

This poster briefly explains how much of New Zealand's electrical energy is currently generated (excluding geothermal) and introduces the rapidly growing technology of the photovoltaic cell and how this is integrated into a complete photovoltaic system.

Poster in detail

Energy transformations lie at the heart of this poster and start with the sun …
nuclear potential energy → radiant energy (visible/invisible light).

Then in different ways when received at the Earth's surface …

- The creation of biomass, and hence fossil fuels, through photosynthesis involves.
  radiant energy → chemical potential energy.
- Evaporation of water, and wind (motion of the atmosphere) is caused by radiant energy → heat energy (particle vibration).

- Uneven heating of the earth's surface gives rise to areas of higher and lower air density/ pressure creating wind. The wind energy can then be harnessed to generate electricity.
  heat energy → kinetic energy (wind) → kinetic energy (turbines) → electrical energy.

- Electricity generation by hydroelectric turbines involves water evaporating, cooling and condensing high up in clouds and then precipitating back onto the land where some water is stored in elevated lakes and released to fall through turbines thus turning generators.
  heat energy → gravitational potential energy (of water) → kinetic energy (of water) → kinetic energy (of turbines) → electrical energy.

Poster Discussion Questions

- What are some of the advantages and disadvantages of photovoltaic systems?
- What is "the grid"? What is it like to be "off the grid"?
- How can electrical energy generated by PV systems be stored for later use, say at night, or if your house is off the grid?
- Think of ways that cars and motorbikes can also be powered by a building's photovoltaic system?
- What physical processes of the sun lead to the generation and radiation of solar energy?
- Create a flow chart showing the energy transformations for each of the ways of generating electricity.
- Design and build a model sustainable house which uses solar energy as effectively as possible.

Related Activity Links

- <Photovoltaic technology (factsheet)>
- <What's Cooking with Solar?>
- How to make a paper circuit
- How to make a sun inclinometer

Key Words

Fossil fuels, biomass, turbines, photosynthesis, carbon cycle, water cycle, photovoltaic cell, photovoltaic system, inverter, direct current (DC), alternating current (AC), distribution board, nuclear reactions.

[Put into Table (Column 1 key words, column 2 definitions)]

Alternating current (AC) –
Electricity that flows back and forth at a set frequency. AC is created by most power stations and transmitted through the electricity grid to power users.

Biomass-
Organic material formed by living or recently dead plants. Biomass such as wood is a source of chemical potential energy. The chemical potential energy is the result of photosynthesis transforming the sun's energy into a stored form. Biomass can be used as a fuel in power generation with less impact on global warming than burning fossil fuels.

Carbon cycle –
One of the Earth's most important cycles along with the water cycle. The carbon cycle exchanges and recycles carbon in its various forms (carbon dioxide, methane, biomass, coal, oil etc) between the reservoirs of oceans, atmosphere, land surface, earth's crust, plants and animals. By burning fossil fuels long stored underground we are upsetting the balance of carbon dioxide in the atmosphere leading to Global Warming.

Direct current (DC) –
Electricity that only flows in one direction around a circuit. DC is created by batteries and photovoltaic cells.

Distribution board –
The board which takes the incoming electrical power and distributes it to different circuits within the building such as lighting, hot water heating etc. Each circuit is protected by a fuse or circuit breaker.

Fossil fuels –
Fuels formed slowly over millions of years from buried and fossilised biomass (plants or animals). Most living things decompose when they die which releases carbon back into the atmosphere and to the carbon cycle. If the biomass is quickly buried without the chance to fully decompose the carbon can be stored geologically as coal, oil or natural gas and is removed from the active carbon cycle.

Inverter –
Electronic device that converts the DC electrical power from the photovoltaic modules to standard AC (230V at 50 Hz) used in the home by appliances.

Nuclear reactions –
Reactions that involve changes in the nucleus of an atom (distinct from chemical reactions). These reactions release large amounts of energy when some of the mass in the nucleus is transformed into energy according to Einstein's great equation E =mc2. Solar energy comes from nuclear fusion reactions in the sun's core where hydrogen nuclei are forced to combine under tremendous heat and pressure into helium.

Photosynthesis –
The process by which the energy from sunlight is used to chemically combine the raw materials of carbon dioxide gas and water into glucose sugar. This energy transformation, from active radiant energy (sunlight) to stored chemical potential energy (glucose) is carried out by tiny structures inside plant cells called chloroplasts. Chloroplasts contain the green molecule chlorophyll.

Photovoltaic cell –
An electronic device made of semiconductor materials that transforms the radiant energy of sunlight into electrical energy. The electricity generated by each cell is about 0.6 Volts (DC) so many are added in series to produce greater voltages.

Photovoltaic system –
A fully functioning renewable electricity generation system. It consists of one or more photovoltaic modules (panels with PV cells in series) connected to an inverter and then the distribution board.

Water cycle –
The cycle by which water is moved in its various forms (liquid, solid, gas/vapour) from one reservoir (oceans, atmosphere, land surface, earths crust, plants and animals) to another through the processes of evaporation, condensation, precipitation, runoff, freezing, melting etc. The water cycle is driven by the energy of sunlight.

New Zealand Curriculum Links

Level 5 Science (Physical World):	**Physical inquiry and physics concepts**	Identify and describe the patterns in physical phenomena found in simple everyday situations involving… electricity, light, waves and heat
	Using Physics:	Explore a technological … application of physics
Principles:	**Future Focus**	Exploring future focused issues such as sustainability
	Coherence	Makes links, provides for coherent transitions, opens up pathways to further learning