

Discovering Solar PV technology and its Uses

Science
Curriculum Levels 5-6

Activity Description

This inquiry learning resource guides students to investigate photovoltaic technology and its amazing applications and potential for the 21st Century and beyond. This resource addresses the ancient word origins of many scientific words, and then takes a closer look at the chemistry, physical properties and physics that are the basis of this technology.



Teaching Rationale

This resource allows students to conduct their own science-focused inquiry into a key technology for utilising the sun's energy to generate electricity.

Four mini-inquiries require the students to carry out some targeted background research around the general topic of photovoltaic technology. Each inquiry has 3 or 4 “supporting” questions to be considered before addressing the central question. This helps students break down a complex or multifaceted question into smaller more specific chunks.

Students carry out their own research about photovoltaic technology individually or in a small group. Students should be encouraged to explore around each question in the spirit of inquiry.

-  1. The first inquiry guides students to consider the origins of the word photovoltaic and could be seen within the Nature of Science strand of the New Zealand Curriculum, as it prompts the student to consider the usefulness of specific words with a precise meaning while appreciating the historical context.
-  2. The second inquiry guides students to recognise the extremely varied uses of electricity generated from sunlight—from a pocket calculator to the International Space Station. Students are also asked to consider beneficial ways in which they could apply/use solar generated electricity in their own lives.
-  3. The third inquiry topic guides students to consider how the properties of materials used in PV panels relates to chemical structure, and how this relates to how they can be used.
-  4. The final inquiry has students think about the physical aspects of generating their own electrical energy at home – how much solar radiation is received by their roof, how much north-facing area they might have, and how much electrical energy this could generate?

New Zealand Curriculum Links

Science	Achievement Objectives (Level 5-6)
Nature of Science	<p><i>Communicating in science -</i> Use a wider range of science vocabulary, symbols and conventions.</p> <p>Participating & Contributing – Develop and understanding of socio-scientific issues by gathering relevant scientific information to draw evidence based conclusions and to take action where appropriate</p>
Material World	<p><i>The structure of matter-</i> Describe the structure of the atoms of different elements.</p> <p><i>Chemistry & society-</i> Link the properties of different groups of substances to the way they are used in society or occur in nature</p>
Physical World	<p><i>Using physics-</i> Explore a technological application of physics.</p> <p><i>Physics concepts -</i> Identify and describe the patterns associated with physical phenomena found in simple everyday situations involving ... electricity and ... light.</p>

Values	Key Competencies	Principles
Innovation, inquiry and curiosity Community and participation Ecological sustainability	Thinking Managing self Relating to others Learning to learn	Future Focus Coherence

See below for Student Inquiry worksheets - Discovering Solar PV technology and its Uses

Discovering Solar PV technology and its Uses

Inquiry 1

Discuss the meaning and origin of the scientific word “photovoltaic”?

Before you try to answer Inquiry 1, have a go at answering supporting questions 1A, 1B and 1C below. The resources below may help you research information on these questions.

A large rectangular area defined by a dotted line, intended for students to write their answers to Inquiry 1.

Resources:

- Renewable Electricity from Solar Photovoltaic Cells - see factsheet below.
- Ancient Origins of Words- http://en.wikipedia.org/wiki/Greek_and_Latin_roots_in_English

Supporting Question 1A

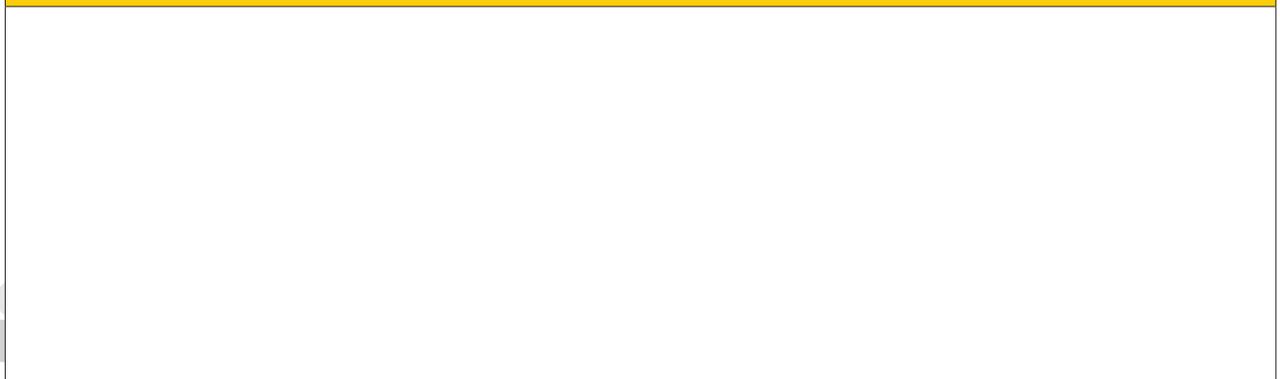
What are the 2 “mini” words in photovoltaic? What do they mean? What is their historical origin?

What are some other words that use the root: photo?



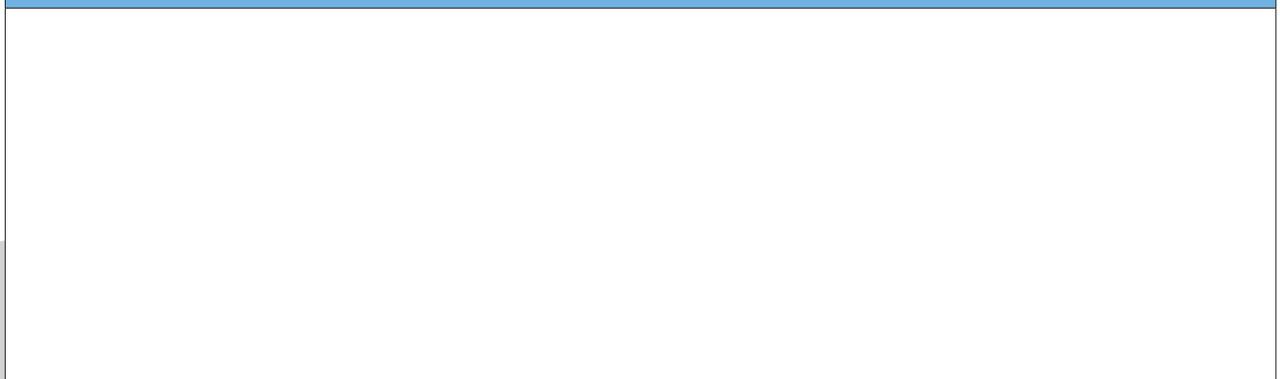
Supporting Question 1B

Explain the difference between a photovoltaic panel and the solar panel that heats water? (It might help to think about energy transformations)



Supporting Question 1C

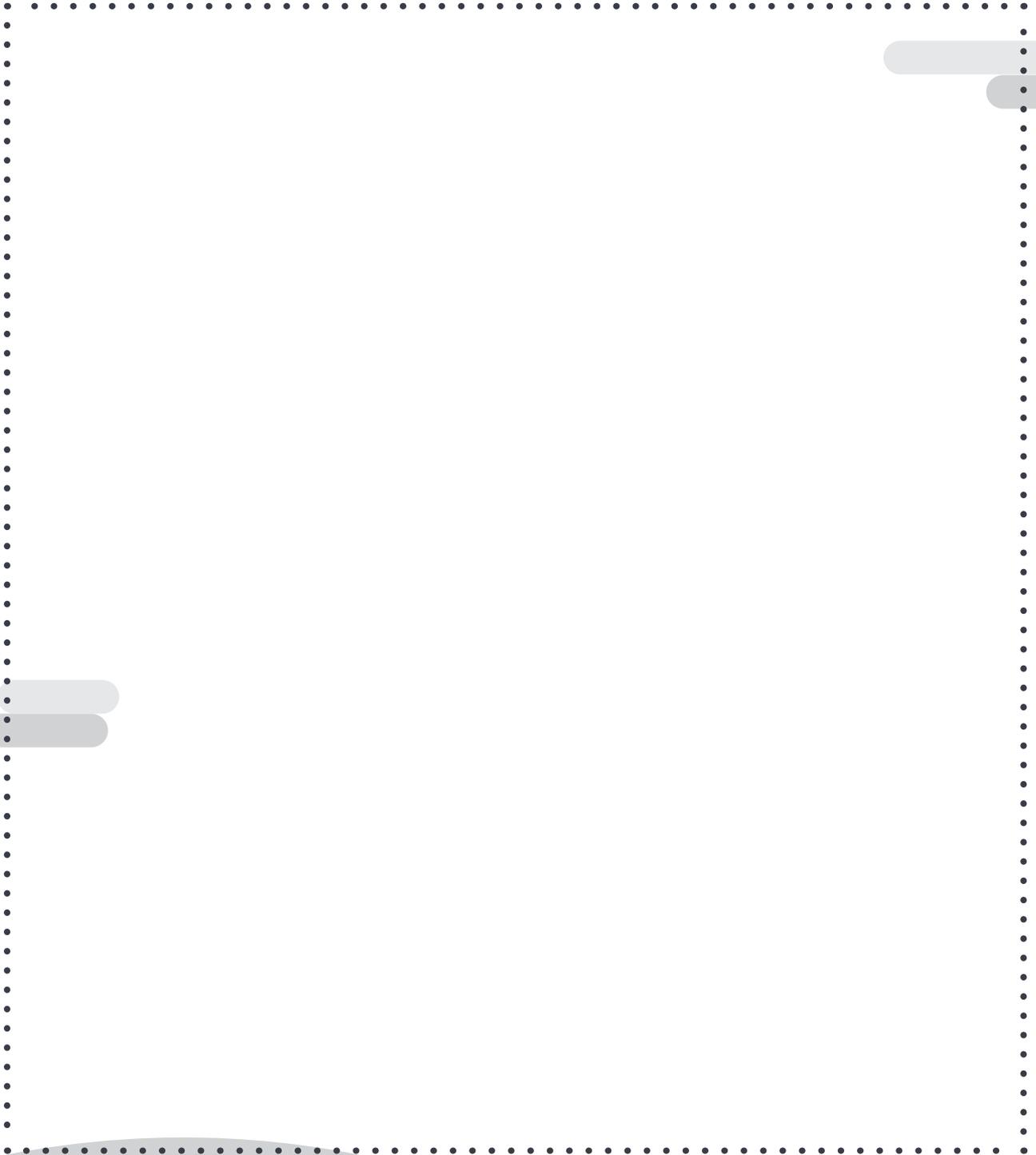
Why do you think scientists often use unfamiliar sounding words from Ancient Greece (about 500 BC) or other historical sources?



Inquiry 2

What are some beneficial or innovative uses for photovoltaic panels?

Before you try to answer Inquiry 2, have a go at answering supporting questions 2A, 2B, 2C and 2D below. The resources below may help you research information on these questions.



Resources:

- Renewable Electricity from Solar Photovoltaic Cells - see factsheet below.
- Solar Plane: <http://aroundtheworld.solarimpulse.com/>
- Solar Boat: <http://www.planetsolar.org/>
- Waka-waka Solar Light: <http://waka-waka.com/>

Supporting Question 2A

State at least 5 places you might find photovoltaic technology used:

Supporting Question 2B

In 2012 a boat circumnavigated the world using only solar energy. In 2016 a solar powered plane flew around the world. What are they trying to prove about photovoltaic technology? Briefly research these vehicles.

Supporting Question 2C

What other electrical devices, apart from photovoltaic cells, are required to use the solar energy to achieve the bold aims of these adventures?

Supporting Question 2D

Apply solar energy in your own life: How could you personally benefit from photovoltaic technology? (Be practical and/or creative!)

Inquiry 3

Identify key materials used to create and protect photovoltaic cells?

Before you try to answer Inquiry 3, have a go at answering supporting questions 3A, 3B, 3C and 3D below. The resources below may help you research information on these questions.

Resources:

- Renewable Electricity from Solar Photovoltaic Cells - see factsheet below.
- Periodic Table of the Elements (interactive): <http://www.rsc.org/periodic-table>
- How photovoltaic cells form solar panels and solar arrays:
http://www.fsec.ucf.edu/en/consumer/solar_electricity/basics/cells_modules_arrays.htm
- Make your own solar PV panels <http://www.builditsolar.com/Projects/PV/pv.htm#MakePV>

Supporting Question 3A

Which common chemical element is used to make a typical photovoltaic cell? Write its chemical symbol, atomic number and mass number, and draw its atomic structure. How many electrons are in the valence (outer) shell? What kind of chemical bonds does it make with other atoms of the same kind?

Supporting Question 3B

What chemical reactions can be used to extract the desired element from the other atoms in sand?

Supporting Question 3C

What chemical element is typically used to conduct electricity from the top (front contact) of the photovoltaic cell to the circuit? Do the same as for 3A.

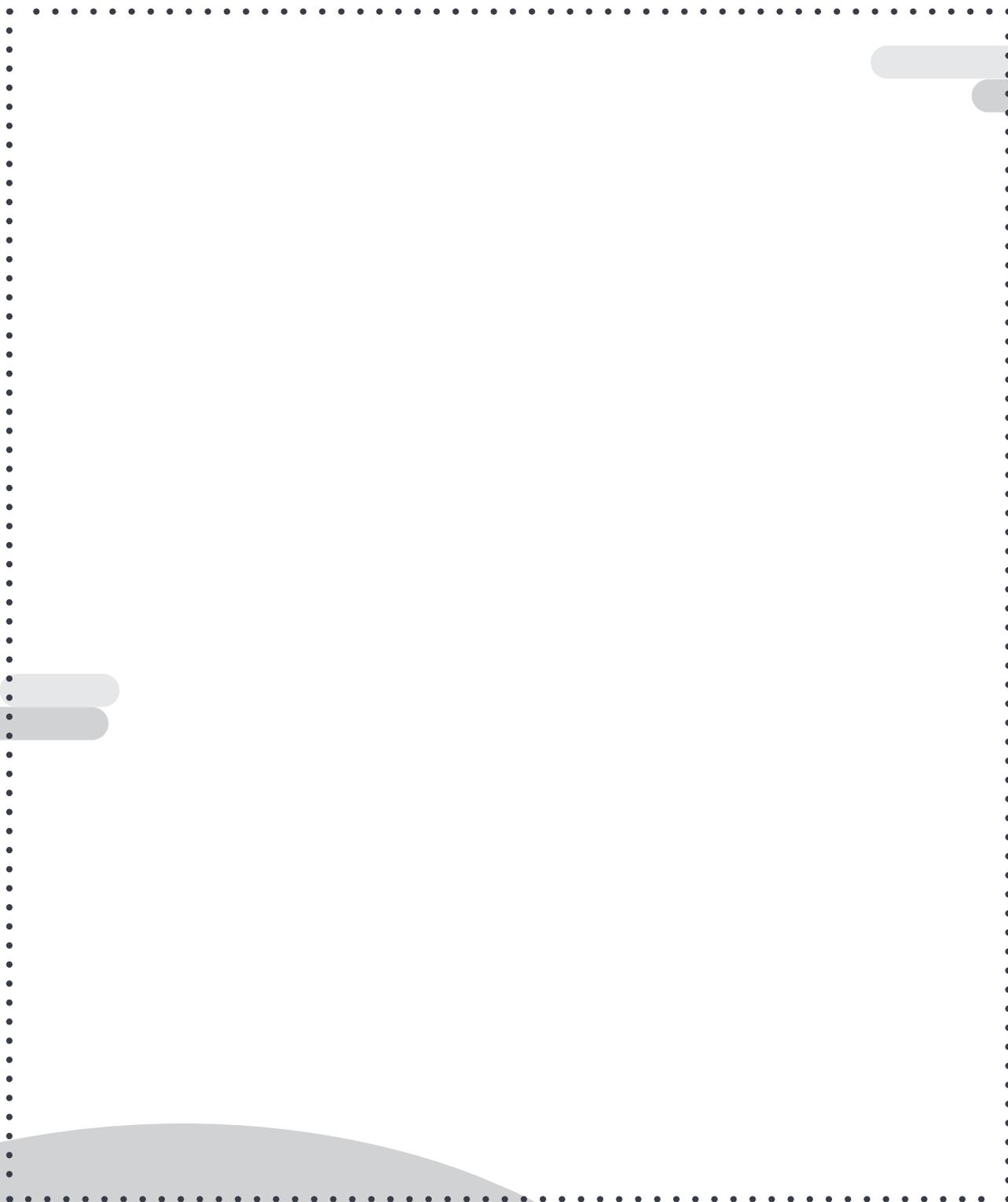
Supporting Question 3D

You can buy photovoltaic cells by themselves and make your own panels but you need to find a way to protect the very brittle photovoltaic cells. To be useful they must be protected by more durable materials. What do they need to be protected from? How long do they need to last for?

Inquiry 4

How much electricity can photovoltaic panels generate on my roof?

Before you attempt this inquiry, have a go at answering supporting questions 4A -E below. The resources below may help you research information on these questions.

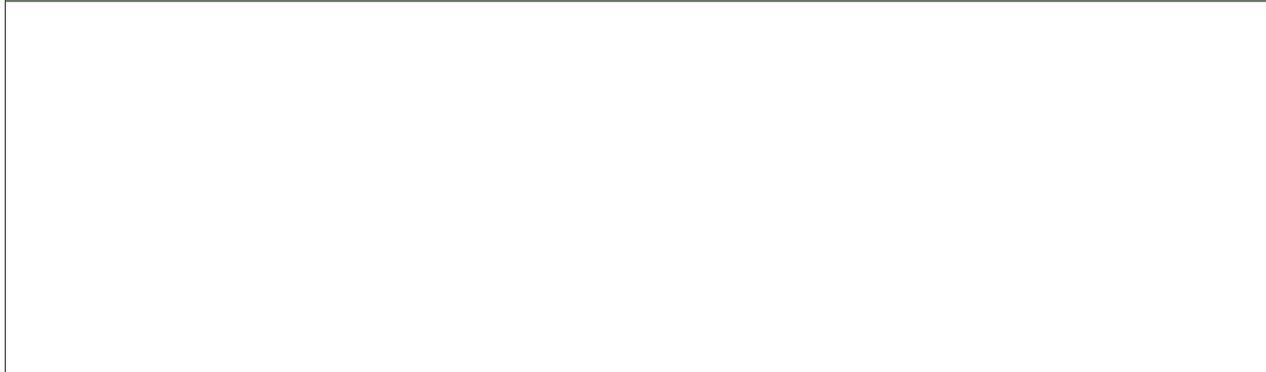


Resources:

- Renewable Electricity from Solar Photovoltaic Cells - see factsheet below.
- Find solar PV in a NZ school - <http://www.schoolgen.co.nz/solar-schools/>

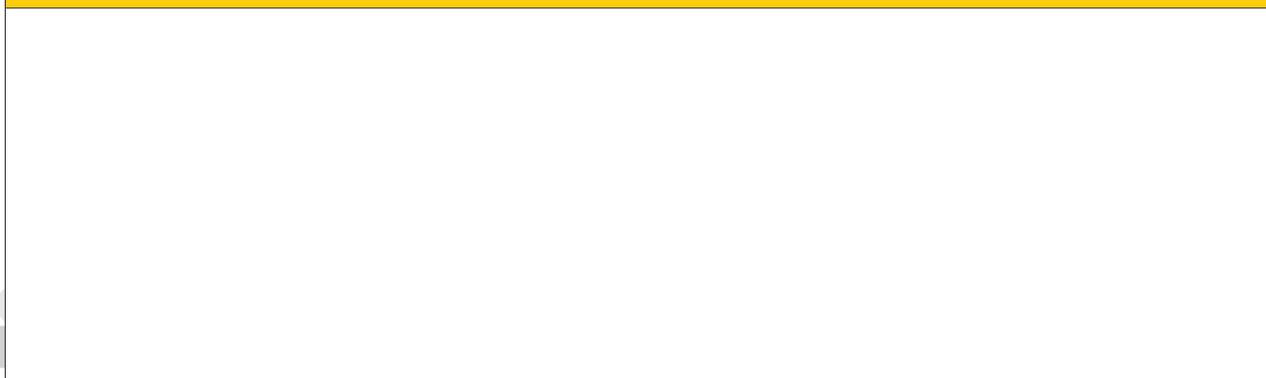
Supporting Question 4A

Outline the energy transformations involved in a photovoltaic cell generating electricity. Illustrate each step with a diagram or picture.



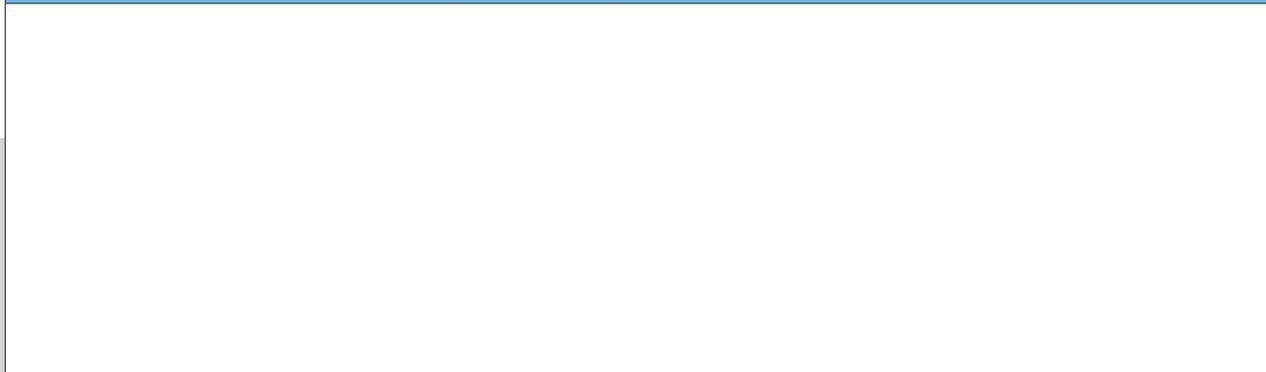
Supporting Question 4B

How much solar energy shines on the area where you live? How much does this vary between summer and winter? (You might like to show this with a graph).



Supporting Question 4C

A single photovoltaic panel, depending on brand/model, can generate a voltage of about 30 volts and a current of about 9 amperes in perfect sunny conditions. How much power is each panel generating? If there are 8 panels connected together (series), how much power is the whole system generating? Show your working and remember to state the unit of power.



Supporting Question 4D

If each PV panel is 1.6 m high by 1.0 m wide, and your roof is north-facing with dimensions of 7.5 m by 5 m, how many of these panels could you fit on the roof? (Sketch out the roof area first.)



Supporting Question 4E

What type of photovoltaic system would you select for your house if you had the option?

