SOLAR ROVER

A. OVERVIEW

Subject	Green Science
Age	6-10
Duration	60 minutes
Content	Electricity generation uses photovoltaic cells to convert solar energy to electrical energy.
Goals	Students will understand : 1. Solar energy provides a renewable, clean energy source. 2. Solar energy can be converted to electrical energy. 3. Photovoltaic cells are made of semiconductors such as impure silicon crystals. 4. The practicalities of large scale solar electricity generation.
Objectives	After completing this section, the students will understand the use of photovoltaic cells to harness solar energy.
Materials	Solar rover kit and instruction sheet Small cross-headed screwdriver Clean, empty soda can
Introduction	Reading material/Class discussion – Solar energy, photo-voltaic cells and electricity generation
Practical	Students will assemble the solar rover kits and demonstrate their use.
Extensions	Open ended discussion/investigation - energy conservation

B. BACKGROUND READING

Set the background reading as a homework assignment the day before the renewable energy lesson. The reading covers solar energy, photo-voltaic cells and electricity generation.

Review

Start the lesson by reviewing the reading.
Points to ensure are understood

- Solar energy can be converted to electricity
- Photovoltaic cells convert solar energy (photons) to electrical energy (moving electrons) due to the special properties of semi-conductors.

Reading material

Solar energy

On a clear day, the sun provides 1000 watts of energy to each square metre of the Earth's surface. If we could collect this energy we could supply all our power needs.

The sun's energy can be captured in many ways including electricity generation via photovoltaic solar cells, heat and cool air via solar chimneys, passive solar building design, heat water via solar-thermal panels and heat foodstuffs through solar ovens.

Silicon

Silicon atoms have the atomic number 14. This means they have 14 electrons and therefore according to the Bohr model have four electrons in their outer shell. In order to fill their outer shell they share electrons with neighbouring silicon atoms with covalent bonds in four directions. This ensures a very strong crystal structure. Pure silicon crystals are not good conductors as the electrons are not able to move freely.

Different impurities in the silicon crystals, phosphorous (N-type silicon) and boron (P-type silicon), ensure free movement of the electrons that would otherwise be held tight.

Photovoltaic cells

Photovoltaic cells are able to convert the sun's energy to electricity. They are made of special materials called semiconductors such as impure silicon crystals.

When light energy, as photons, hits a piece of silicon, one of three things can happen:
1. the photon can pass straight though the silicon
2. the photon reflects off the surface
3. the photon can be absorbed by the silicon.

The absorbed energy excites electrons in the silicon allowing it to break free from the crystal lattice.

Photovoltaic cells all have one or more electric fields that act to force electrons freed by light absorption to flow in a defined direction. This is why photovoltaic cells are sometimes referred to as diodes.

The moving electrons become the current. If metal contacts are placed at the top and bottom of the photovoltaic cell, the current can be drawn off to be used elsewhere. Thus solar energy is converted into electrical energy.

There are two other problems to counter – reflected light and exposure to the weather. Silicon is a very shiny material and therefore very reflective. An anti-reflective coating is applied to the top of the cell to reduce reflection losses. A glass cover plate is added to protect the cells from the elements.

Solar electricity generation
Photovoltaic modules are made by connecting several cells to achieve useful levels of voltage and current.

Photovoltaic cells are not highly efficient, converting only 12 to 15% of the sun's light into electricity. However, this is improving and prototypes are reaching 30 % efficiency. Until recently, it may well have cost more energy to make a cell than it could generate in a lifetime.

A large surface area is required to generate large amounts of power.
- if domestic solar panels produce 70 milliwatts per square inch
- with five hours of usable sunlight per day
- each square inch will generate 350 milliwatt-hours per day
- if the average house uses 600 watts per hour (14400 watt-hours/day)
- solar panel of 285 square feet (about 26 square meters) needed

A battery bank, inverter and attached equipment would also be needed to provide for the times when the sun isn't shining.

C. CLASS DISCUSSION

Why doesn't everyone use solar energy?
- Capital outlay in setting up expensive equipment
- Large surface area needed – aesthetically unattractive
- Need for storage batteries – further expense and space requirement
- 'Cheap' energy available in other forms due to burning of fossil fuels
- Need for coordinated research to increase efficiency and decrease costs

Where might solar energy be most useful?
- High sunshine hours
- Large empty spaces
- Isolated communities

To improve the practicality of solar power the size of solar panels needed must be reduced. One way to achieve this is to decrease the amount of power that needs to be generated.
What energy conservation can your class plan at home?
- HINT – think lighting – compact fluorescents
- Heating/cooling – insulation, thermostats, empty rooms
- Discuss 'stand-by' on appliances
- Discuss energy efficient appliances

What others can the class come up with??

D. PRACTICAL

Each group of students requires 1 kit and 1 instruction sheet. Select the relevant information from the instructions if necessary.
Go through the safety warnings advised in the instructions with the class before assembly.
Check each group's finished model and supervise the class' test runs.

E. EXTENSIONS

Plan to decrease your daily energy use
- What steps can you take every day to reduce your impact on the environment?
- Think globally, act locally
- HINT – everything can be made more efficient – transport, home heating/cooling, lighting, appliance use etc.

You might wish to involve your family and save energy and money!

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