How Solar Cells and Solar Panels Work
Student Activity Sheets

Engagement

1. Watch videos:

Solar Energy Basics - National Renewable Energy Laboratory
https://www.nrel.gov/research/re-solar.html

How do solar cells work?
https://www.youtube.com/watch?v=UJ8XW9AgUrw&ab_channel=SciToons

How do solar panels work? - Richard Komp
https://www.youtube.com/watch?v=xKxrkht7CpY

2. From EIA Energy Kids look at the diagram of the photovoltaic cell.
https://www.eia.gov/kids/energy-sources/solar/

Exploration

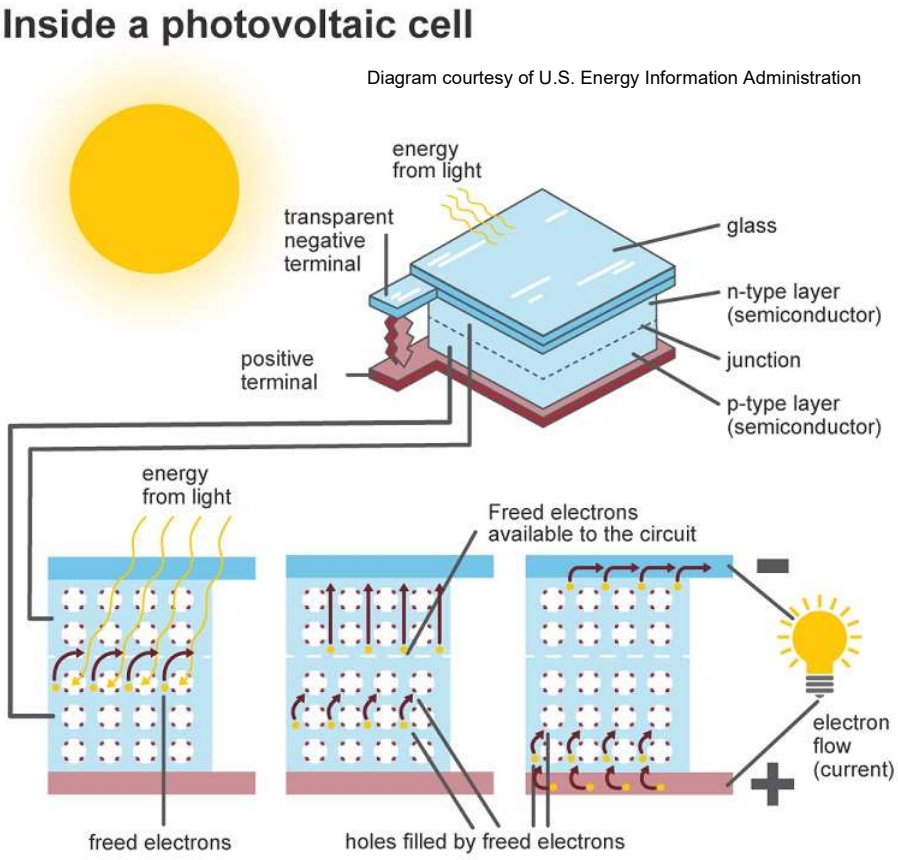
Part 1. Read the paragraphs below about how solar cells and solar panels are made and how they make electricity.

Most of the solar cells and solar panels currently being manufactured are composed primarily of the element silicon. Silicon is a plentiful natural resource that makes up more than one fourth of the earth's crust and is the main component of ordinary sand. The silicon used in the production of solar cells must be purified to a very high degree. Much of the cost of producing solar cells and solar panels results from the processes needed to remove unwanted impurities in order to produce the highest quality silicon.

Silicon solar cells and solar panels consist primarily of a slab or thin wafer of crystalline silicon. During manufacture, small amounts of different elements are introduced into the slab to cause the formation of two different layers of crystalline materials on opposite sides of the slab. The first type of crystalline material is created by adding a small amount of the element boron to one side of the crystalline silicon slab. Addition of the boron results in the presence of spaces or holes in the crystalline material which can accept additional electrons. This type of crystalline material is commonly referred to as "P-type" silicon material and it is used to form the bottom layer of a solar cell or solar panel.

The second type of crystalline material is created by adding a small amount of the element phosphorus to the other side of the crystalline silicon slab. Addition of phosphorus to the silicon results in the presence of free electrons in the crystalline material. This type of crystalline material is commonly referred to as “N-type" silicon and is used to form the top layer of a solar cell or solar panel. The P-type and N-type silicon crystalline materials in solar cells and solar panels are similar to the crystalline materials used to make computer chips, transistors and other electrical components.

After the two different types of crystalline materials are formed, some of the electrons in the N-type material move into the P-type material. Movement of the electrons creates an electric field in a region near the two different types of crystalline materials called the p-n junction.



When light penetrates into a solar cell or solar panel and reaches the area near the p-n junction it transfers energy to electrons in the crystalline materials. Electrons which have acquired energy from light move in the crystalline materials creating a flow of electrons. The flow of electrons is then collected by thin wires on the top of the solar cell or solar panel and can move through wires connected to the solar cell or solar panel.

1. Have students draw their own diagrams that show how solar cells are constructed.

2. Have students use their diagrams to explain how solar cells and solar panels change energy in the form of light into electrical energy.

Part 2. Construct electrical circuits to demonstrate that a solar cell or solar panel can produce the electricity needed to make an LED light turn on and a circuit board operate.

a. Use the alligator clip to connect the positive (red) wire on the LED light to the positive (red) wire of a small solar panel. Make sure the alligator clip attaches to metal in the wire where the insulation has been removed.

b. Use the alligator clip to connect the negative (black) wire on the LED to the negative (black) wire of the small solar panel. Make sure the alligator clip attaches to metal in the wire where the insulation has been removed.

c. Illuminate the small solar panel by placing it under a bright electric lamp (75-100 watts or equivalent) or in a location where full sun light shines on the solar panel.

d. Did the LED light turn on? Yes / No

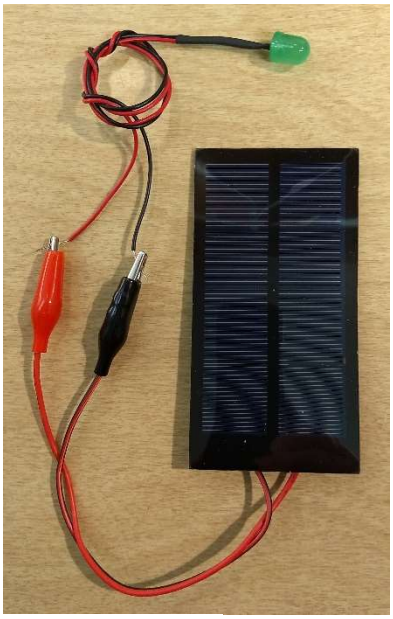


Photo by Doug Weirick

e. Try completely covering the small solar panel using your hands or a book so that it is fully shaded and no light shines on the solar panel. Is the LED light still on or did it turn off? On / Off

f. Start with the small solar panel completely covered and fully shaded from the electric lamp and sun. Make a prediction about what might happen to the LED light if the small solar panel was slowly uncovered so that increasing amounts of it (1/4, 1/2, 3/4) received light from the electric lamp or the sun until the whole solar panel was uncovered and receiving light.

g. Test your prediction by observing the LED light while slowly uncovering larger portions of the small solar panel a little more at a time until it is fully uncovered and not shaded. What happened when the solar panel was 1/4, 1/2, 3/4 and fully uncovered?

h. As the small solar panel was being slowly uncovered and larger portions received more light, what do you think was happening to the amount of electricity produced and that was available for the LED light?

i. Use the alligator clip to connect the positive (red) wire on the small solar panel to the positive (red) wire of the Sound and Light Board. Attach the clip to the metal in the wire where the insulation has been removed.

j. Use the alligator clip to connect the negative (black) wire on the small solar panel to the negative (black) wire of the Sound and Light Board. Attach the clip to the metal in the wire.

k. Illuminate the small solar panel by placing it under a bright electric lamp (75-100 watts or equivalent) or where full sun light shines on it.

Photo by Doug Weirick

l. Move the switch marked SW on the Sound and Light Board to the Torch setting. If the Torch LED does not light up, move the small solar panel closer to the electric lamp or in brighter sunlight. Did the Torch LED light up? Yes / No

m. Move the switch on the Sound and Light Board to the music setting. Do you hear any sound coming from the board? Yes / No

n. Start with the small solar panel completely covered and fully shaded from the electric lamp and sun. Make a prediction about what might happen to the sound if the small solar panel was slowly uncovered so that increasing amounts of it (1/4, 1/2, 3/4) received light from the electric lamp or the sun until the whole solar panel was uncovered and receiving light.

o. Test your prediction by listening to the sound while slowly uncovering larger portions of the small solar panel a little more at a time until it is fully uncovered and not shaded. What happened when the solar panel was 1/4, 1/2, 3/4 and fully uncovered?

p. As the small solar panel was being slowly uncovered and larger portions received more light, what do you think was happening to the amount of electricity produced and available for the Sound and Light Board

Explanation

1. Give a detailed explanation of what you observed which provides evidence that the small solar panel was making electricity.

2. Give a detailed explanation of what you observed which provides evidence that the amount of shading of the small solar panel affects the amount of electricity produced.

3. Draw a diagram of the sun, solar cell, and Sound and Light Board. Draw arrows to show the path that energy followed to make the Torch LED light up.

Extension

1. Give an example of a location that you think would be a good place to put solar panels.

2. Give an example of a location that you think would not be a good place to put solar panels.

3. Why did you choose the examples for a good and a bad location?

Evaluation

1. What happens when the energy from the sun hits a solar cell or solar panel?

2. Give at least two advantages of using solar energy to produce electricity instead of fossil fuels?