CONSERVATION STATION

WEEK OF RESOURCEFULNESS | CLASSROOM ACTIVITIES

## ENERY-WATER NEXUS STEM INVESTIGATIONS

# Solar Powered Homes

### KEY LEARNING OBJECTIVES

Students will be able to:

- **Evaluate** and **determine** which conditions provide solar panels the greatest amount of energy production.
- **Design** and **construct** a model of a home using solar panels.

## OVERVIEW

In this activity, students will study how solar electricity can be generated, stored, and utilized in homes. Students will be given a small solar panel to test and improve. Students will determine how much electricity is produced by the panel itself, and then how to improve how much electricity it produces by making modifications. Students will be given various materials to construct a house that has the highest output of electricity using the solar panel provided. The teacher will lead a class discussion on local legislature that provides incentives for the use of solar panels for apartments, multi-family dwelling or individual homes.

## CONNECTION TO THE ENERGY-WATER NEXUS

- Clean alternative energy sources can reduce reliance on energy sources that cause air and water pollution.
- Designing and constructing buildings with energy production in mind can increase the efficiency of power production from solar energy.

## NATIONAL STANDARDS

Next Generation Science Standards

- MS-PS4-2 Waves and their Applications in Technologies for Information Transfer
  Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
- MS-ETS1-3 Engineering Design
  Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4 Engineering Design
  Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.



Itron | Discovery EDUCATION

## BACKGROUND

The ultimate source of all energy on Earth is the sun. It provides the energy that flows through our food chains and has created the fuels that we use today. For thousands of years, people having been using the sun's radiation for warmth and for farming and agriculture. Over time, people developed technologies to collect solar radiation for heat and convert it into electricity. Solar photovoltaic (PV) devices, or solar cells, change sunlight directly into electricity. Many people use small PV cells in calculators, watches, and other small electronic devices. Electricity can be generated in a house if many solar cells are arranged in PV panels, which are arranged into multiple PV arrays. Some PV power plants have large arrays that cover many acres to produce electricity for thousands of homes!

## KEY VOCABULARY

- Solar energy
- Photovoltaic cell
- Volts
- Millivolts
- Energy efficiency
- Building codes

## MATERIALS

- Photovoltaic cells (one per group)
- Volt meters (one per group)
- AA battery
- Cardboard
- Construction paper (various colors)
- Aluminum foil
- Glue, tape, scissors, etc.
- *Solar Panel Test Data Sheet*

## TEACHER PREPARATION:

- *Copies of Solar Panel Test Data Sheet*

## PROCEDURE

1. Place students into small teams of 3 to 4 depending upon materials. Each group should have a PV cell, volt meter, cardboard, construction paper, aluminum foil, access to school supplies, and a copy of the *Solar Panel Test Data Sheet*.
2. Open the lesson by showing the students the PV cell and voltmeter. Do not provide any information or the names of the equipment. Ask students to write down 6–8 questions they have about the items you showed them. Once the students have finished, answer the questions they generated. Make sure that the students understand how PV cells work after the question and answer session. (When photons hit a solar cell, they knock electrons loose from their atoms. If conductors are attached to the positive and negative sides of a cell, it forms an electrical circuit. When electrons flow through such a circuit, they generate electricity. Multiple cells make up a solar panel, and multiple panels (modules) can be wired together to form a solar array. The more panels you can deploy, the more energy you can expect to generate. Solar panels are darker colors because they absorb the most heat energy.)
3. Demonstrate how a voltmeter can be used to determine the amount of electricity being generated by the PV cell. (Set the voltmeter to millivolts.) Then, hold up an AA battery and ask the students how much electricity the battery can produce. (1.5 volts, which is equal to 500 millivolts).
4. Provide the students some time to familiarize themselves with the voltmeter. They should investigate the difference in volts generated when the PV cell is in direct sunlight and when shaded by something such as cardboard.
5. The students will conduct a series of tests to determine how much electricity is generated when placing the PV cell under different conditions. Multiple measurements will be taken for each condition. Some conditions are provided for the students to investigate, but each group will also be responsible for developing 3 additional tests. Students will enter their data on the *Solar Panel Test Data Sheet.* (Some additional conditions could be using different color lights, facing the PV cells in different directions or alternate angles, using a magnifying glass, or surrounding the PV cell with different colored paper.
6. When all trials and tests are complete, the students should calculate the average millivolts (mV) for each condition. Students should then rank the conditions from 1–10 with 1 being the optimal condition and 10 being the least optimal condition.
7. The group's final challenge is to design a house/building using any of the materials they have been given to try and reach the highest electricity output possible. Before building, each student should create a sketch at the bottom of the *Solar Panel Test Data Sheet.* (Ideas might include a flat vs. pitched roof at a specific angle, color or material of roof, direction the roof is facing.) Each student in the group will share their sketch and provide reasoning for the design selected. Once every student has shared, the group will determine which design to use. It could be the design from one student in the group or a combination of designs.
8. Provide time for each group to construct their model. The time for this portion will vary depending on level of the group and the supplies provided.
9. When each group has completed their model and attached their PV cells, they should be placed in an area designated by the teacher. Each group should be allowed to place their models in any direction they prefer if they are not obstructing or moving other group's models.
10. The teacher will measure the millivolts for each group. The teacher may create an award for the group that created the optimal design to maximize solar power generation.
11. To close the activity, the teacher should lead a discussion with the students about what they learned about optimal solar panel conditions. How might local government use this information to make informed decisions about building codes for new buildings or retrofitting of existing buildings?

## EXTENSION

Not all schools, houses, libraries and supermarkets in every part of the world have electricity. Many countries have not enough or even no electricity available. We say these areas suffer from energy poverty. This happens because a country cannot afford or does not have enough resources to create the electricity it needs. These areas could benefit from using photovoltaic panels. Now that students understand how solar panels work, have the class work together to design a solar city.

| Solar Panel Test Data Sheet | | | | | | |
|---|---|---|---|---|---|---|
| | | Trial 1 (mV) | Trial 2 (mV) | Trial 3 (mV) | Average (mV) | Rank (1-highest) |
| 1 | Flat in Direct Sun | | | | | |
| 2 | Flat in Shade | | | | | |
| 3 | Angled _____° | | | | | |
| 4 | Angled _____° | | | | | |
| 5 | Indirect Sunlight | | | | | |
| 6 | Surrounded by Foil | | | | | |
| 7 | Placed on black paper | | | | | |
| 8 | | | | | | |
| 9 | | | | | | |
| 10 | | | | | | |

**All trials should be measured in millivolts (mV)*

**Design**

Use the space below to draw blueprints for a home designed to optimize solar power production. Use the information you gathered above to guide your design. Make sure to label your methods of optimizing power production.