the CEED

THE CENTER FOR ENERGY EFFICIENT DESIGN

Race Your Way to the Best Solar Panel Spot!

Grade Level	Third Grade	**Subject**	Science

Objectives:

Science

- The student will measure the distance a solar powered car travels.
- The student will measure the amount of time a solar car travels before stopping.
- The student will measure the air's temperature at time of the investigation.
- The student will make inferences about the best location for a solar panel.
- The student will explain advantages and disadvantages of using solar panels as a source of energy.
- The student will analyze graphs to determine advantages and disadvantages of placement spots for solar panels.

Math

- The student will measure to the nearest inch and/or centimeter.
- The student will measure the air temperature to the nearest degree Celsius and/or Fahrenheit.
- The student will create a visual display of data collected in the experiment.

SOLs Addressed:

Science

3.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which

a) observations are made and are repeated to ensure accuracy;
b) predictions are formulated using a variety of sources of information;
c) objects with similar characteristics or properties are classified into at least two sets and two subsets;
e) length and temperature are estimated and measured in metric and standard English units using proper tools and techniques;
f) time is measured to the nearest minute using proper tools and techniques;
g) questions are developed to formulate hypotheses;
h) data are gathered, charted, graphed, and analyzed;
i) unexpected or unusual quantitative data are recognized;
j) inferences are made and conclusions are drawn;
k) data are communicated;
l) models are designed and built

3.8 The student will investigate and understand basic patterns and cycles occurring in nature. Key concepts include

a) patterns of natural events such as day and night, seasonal changes, simple phases of the moon, and tides

3.11 The student will investigate and

	understand different sources of energy. Key concepts include a) energy from the sun; b) sources of renewable energy; and c) sources of nonrenewable energy. Math 3.9 The student will estimate and use U.S. Customary and metric units to measure a) length to the nearest ½ inch, inch, foot, yard, centimeter, and meter 3.13 The student will read temperature to the nearest degree from a Celsius thermometer and a Fahrenheit thermometer. 3.17 The student will a) collect and organize data, using observations, measurements, surveys, or experiments; b) construct a line plot, a picture graph, or a bar graph to represent the data; and c) read and interpret the data represented in line plots, bar graphs, and picture graphs and write a sentence analyzing the data.
	Next Generation Science Standards: **4-PS3-1.** Use evidence to construct an explanation relating the speed of an object to the energy of that object. **4-PS3-2.** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. **4-ESS3-1.** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

Materials Needed Per Class of 30 **and** **Prior Knowledge**	**Materials Needed:** • *SunnySide Up Classroom 10-pack* of solar powered cars from Sunwind Solar Industries, Inc. (http://sunwindsolar.com/sunny-side-up-classroom-10-pack/) **The cars will already be put together.* • *Set of 10 English/Metric Measuring Tapes* • *Dual Scale Student Thermometer – Set of 10* • *Access to http://dashboard.intellergy.us/ceed/index.php* • *Way to Record Data (e.g. paper)* • *Clock* • *Stopwatches (1 per group)* • *Chalk* • *Hula Hoops (2 per group)* • *Post-It Notes* • *Schoolhouse Rock video: "Energy Blues" from youtube.com* • *Science Notebook (composition book used throughout the school year)* **Prior Knowledge Needed:** • We have to use some source of energy to power electricity we use in our everyday life. • There are different sources of energy (renewable and nonrenewable). • Students need to have some background knowledge of nonrenewable sources of energy and how there is a concern for amount of usage vs. supply.
Ways to differentiate this lesson plan	• **EXTENSION** for Higher Level Learner - After measuring how far their car traveled in centimeters, students can measure how far their car traveled in inches. Students could observe the differences between using inches and centimeters. Students could also discuss which one they think it is easier to measure with and why. - After completing this activity, students could analyze their results and determine if there would be a better spot for a solar panel than the ones tested. (This would be done after groups have presented their spots and the CEED Dashboard has been discussed.) - After completing the initial test of where the better spot would be for a solar panel, have students research whether temperature seems to affect the amount of energy collected. They can use the CEED Dashboard, or they could complete this activity throughout the year during different seasons. - Have students discuss whether temperature affects the amount of energy collected or is it the tilt of the Earth during the seasons? Have them test a warmer winter day vs. a cooler winter day (or spring/fall day).

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Students can research how solar panels are usually positioned (which sides of building, where on the building) on the internet.
Students can create an advertisement to display in school to encourage others to research/invest in solar panels.
Students could research or invent how to create a sundial to tell time and actually create it. (This should be related to what they discovered about the sun's location throughout the day.)

MODIFICATIONS

If students are unable to test different locations around the school, have students test one spot at the school. Discuss the advantages or disadvantages of using this one spot.
If students need practice measuring length, time, or temperature before completing the investigation, have students practice by doing the following:

+ measuring the length of the solar powered car using the measuring tape
+ measuring the temperature of the room using the thermometer
+ measuring the time it takes someone to write their first and last name 20 times

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<tr><td>Introduction/ Anticipatory Set</td><td>Anticipatory Set:
Think-Pair-Share
"Take a minute to think of all the things you use during a day that are plugged into the wall." (If students need help, tell them to think of all the things they use that they cannot use when the power goes out.)

Questions to ask students:
What items do you use during a day that are plugged in to the wall?
Why are these items plugged in to the wall?
Why do we need these items in our daily lives? Do any of these items we listed have similarities? (The teacher will lead the students to think of what we use them for.)
How did ancient peoples get their needs met like the needs we just listed?</td><td>Introduction:
The students will create a list of things they use in their everyday life that are plugged in to get electricity. The teacher will record ideas from the students. After creating the list, the class will categorize the items by their use (e.g., to cook, to heat or cool, to entertain, etc.). The class will then discuss how the people that lived during ancient Egypt, Greece, Mali, China or even those that lived just hundreds of years ago without electricity. The teacher will make sure the idea of using the sun and wood for fire comes up.</td></tr>
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Guided Practice	The teacher will play the Schoolhouse Rock video: "Energy Blues" (available on youtube.com). After watching the video, the class will discuss: • How has our source of energy changed throughout time according to the video? • Why has it changed? • Why should we look into using renewable sources of energy instead of nonrenewable sources of energy? The teacher will tell students to get into groups of three (or already have the groups assigned). Within this group, students will use what information they saw in the video and what they already know about the sun to fill in a Venn diagram about advantages and disadvantages to using the sun as an energy source. The students will use the hula hoops and post-it notes to create this Venn diagram. (No teacher help here!)	
Independent Practice	The teacher will tell students that they need to prove the sun's energy can be used to power things. The teacher will explain that each group will receive a car that can be powered by the sun. The teacher will ask the students, "How can we tell the sun is giving the car energy?" The discussion should lead to the fact that the car will move if it has power. The teacher will let the students know that the class is going to compare how far their cars travel to determine where the best spot would be for a solar panel. Teams should discuss where around the school they think the car will get the most solar power. Each team will be able to test their spots (depending on teacher/adult availability). The class will discuss variables that could arise through the experiment. Through this discussion, the teacher will let students know they will complete the experiment at three different times of day: 9:00, 12:00, and 2:00. For each test, students should use the chalk to mark the starting spot and the finishing spot. The students should measure and record the distance between the chalk marks and the time it takes for the car to move in their science notebooks. Students should also record the air temperature at test times as well. The students can decide how to record this data and create a graph to show their data to the class. After completing the investigation, the teams will work together to analyze their results. They will ask themselves the following questions and answer in their science notebooks: - What was our most successful time of day? - Why might this have been the best time of day for our spot?	

	- Were there any drawbacks of our spot? - What observations did we make about the sun's location throughout the day? - Next time we complete this investigation, should we change anything? What would it be and why? After completing the 2:00 investigation, the class will use the CEED Dashboard (http://dashboard.intellergy.us/ceed/index.php) to look at actual solar panels in use and the power they produce throughout the same day. Once at this site, click on the Photovoltaic Array icon. The class will look at and discuss the data for the tracking PV, roof PV, and fixed PV set. The teams will compare the CEED data to their data. The teacher should make sure clouds and nighttime are discussed as factors in the data across days on the CEED Dashboard. Discuss the differences between the types of solar panels. The teacher should make sure the sun's location throughout the day is discussed and how this relates to the Earth's rotation. After looking at the CEED Dashboard as a group, have teams look at their Venn diagrams again. The students should see if there is anything else they would add. Discuss advantages and disadvantages together as a whole group.
Closure (Summary of Lesson)	The class will discuss advantages and disadvantages in their Venn diagrams. To end the lesson, students will have to answer a question on a post-it note as an "exit slip". The teacher should ask: "Why do you think solar panels are not used as the main power source for electricity? In your opinion, should they be used more?"
CEED Building Application/ Sensor Data	The class will look at the information on the CEED Dashboard to compare the data collected for the tracking PV, roof PV, and fixed PV set. The students will also be able to compare the data they collected throughout the day as well. This will help students see the advantages and disadvantages of solar power.
Assessment	- The teacher will use observations during group discussions as a form of assessment. - The Venn diagrams will serve as a form of assessment. - Each individual's answers to the questions after the investigation and the exit slips will be a form of assessment.