Environmental Science Institute
UNIVERSITY OF TEXAS AT AUSTIN

LESSON PLAN – Measuring Solar Energy

Title of Lesson: Measuring Solar Energy
Description of class: 4th – 6th Grades
Length of Lesson: 90 minutes
Technology Lesson? *Yes (online references and voltmeter use)*
Purpose: In this lesson, students compare energy sources, discuss energy conservation techniques, and determine the best angle to hang a solar panel at their school.

Objectives: Students will be able to:
- **(a)** Use a voltmeter to measure energy produced by a solar panel
- **(b)** Interpret information from graph data,
- **(c)** Design a logical plan to manage solar energy resources at their school

TEKS addressed:
(4th & 5th Grades 1A) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations, following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to demonstrate safe practices and the use of safety equipment as described in the Texas Safety Standards during classroom and outdoor investigations.
(4th Grade 2B/ 5th Grade 2C) Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and outdoor investigations. The student is expected to collect information by detailed observations and accurate measuring;
(4th & 5th Grades 4A) Scientific investigation and reasoning. The student knows how to use a variety of tools, materials, equipment, and models to conduct science inquiry. The student is expected to collect, record, and analyze information using tools, including calculators, cameras, computers, metric rulers, compasses, notebooks, etc.

Equipment and Supplies: Resources, materials and supplies needed (for a class of 20 students)
Per group of 4 students: 1 voltmeter, [A mulitmeter, similar to the Extech MN36, which can be purchased for about $40], 1 portable solar panel/battery charging unit [a small solar panel (Wal-Mart carries camping solar panels in the range of $20 to $80 for a single panel)] Per student: Computer access (recommend printouts of webpage referenced in case of last-minute computer/technical difficulties). Students will be accessing information at www.infinitepower.soltrex.com **These are suggestions for activity supplies and do not serve as an endorsement of any particular brand by ESI, SECO, or UT Austin.

Overview: Solar energy is a renewable form of energy that is most commonly utilized by employing a solar panel array. Solar panel energy output is affected by weather, time of day and seasonal variations. The angle of the sun to the solar panel changes with the time of day and seasonal variations. This lesson introduces physics concepts for students, as well as lays down a foundation for seeing how students are a part of a global picture when it comes to our use of Earth's resources.

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Five-E Organization

Teacher Does	Probing Questions	Student Does
Engage: *Learning Experience(s)* Could have "Hear Comes the Sun" by the Beatles playing as students walk into the room. Have three calculators (or other object that the students can relate to) displayed at the front of the room: one that plugs into an outlet, one that runs on batteries, and one that is solar powered. **Approx. Time 5 mins**	What are these three objects? (hold up if not everyone can see) Who can tell me what is the same about these three calculators? What is different about these calculators? (pause for first answers) What makes these calculators work or run? Tell me about these different power sources. Where does electricity come from? Coal is something we call a fossil fuel. Tell me what you know about fossil fuels. Do you know another fossil fuel that we use for power/energy? (if they don't suggest it, ask: what about your car or school bus?) Do we have endless amounts of gasoline? *History: In 1973, an oil crisis (we were short on oil in America) encouraged scientists to work at finding other sources of power. Some had already been working with solar power over more than 150 years ago, but it was time to put solar power into action as a way to generate electricity.*	*Expected Student Responses/Misconceptions* [calculators] [they all do math/they all have buttons/etc.] [size, shape colors] [they run on different power sources – battery, electricity, solar power] [battery – they make things work, we replace them when they run out, we have to buy them] [solar – calculator won't work if it is dark] [electricity – runs through wires, we pay for it, turn off lights so we don't waste it… it comes from coal burning power plants] [they run out] [they come from really old dead plants and animals] [petroleum/gas] [yes- there is always more at the gas station if you pay for it] [no – we can run out of fossil fuels as said before about coal – there are limited amounts]

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Evaluation(Decision Point Assessment):	So what would be a good thing about using each of these calculators? What is a drawback to each of these calculators? Which one would you want to use?	[the battery one is good because you can just change the batteries when they run out, but you have to replace the batteries all the time] [the electric one works even in the dark, and you just plug it into the wall so you don't have to buy new batteries, but you have to be near an outlet, and it uses electricity that we have to pay for and comes from coal-burning power plants] [the solar one uses "free" and clean source of power, but won't work in the dark]

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Explore: *Learning Experience(s)* *The mayor has challenged everyone in the city to use renewable resources to save money on energy. Every organization that _____ will receive a large amount of money. Our school wants to win the prize so we can build a new fancy playground!* **Approx. Time 30 mins**	*Critical questions that will allow you to decide whether students understand or are able to carry out the assigned task (formative)* What kinds of things could we do as a school to save energy? What idea might we get from the example of our calculators? How could we figure out if solar energy would be an option for our school? What do we need to know? How could we find out that information? We have some solar panels here that groups will use outside. This is a voltmeter and it will measure the electric current that tells us how much energy generated by the solar panel. Your group will take the solar panel outside and in the designated yard space, find the best place to put our potential solar panel. Each group needs to decide what you will test with the voltmeter and solar panel, and make a table to record your results. Think about what issues need to be address to make sure solar powered energy is right for our school, and where we would put the panel in our side yard for best results.	*Expected Student Responses/Misconceptions* [Recycle, plant trees, turn off water and lights when we're not using them] [Use solar energy to generate our electricity instead of using electricity from coal] [how much it costs to set up a solar panel, what supplies we would need, how much energy is actually generated during the day by a solar panel, how much energy we currently use, etc.] [We could look information up online, call someone who knows, ask another school that already uses solar power.]

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Watch to see what things the groups decide to observe and test. Ask questions if they seem stuck on what to test, which may happen if they are not used to thinking about solar energy. *Students go outside and take their voltmeter readings and record their measurements on their tables they designed. To encourage students to stay on task due to time constraints, have them assign roles to group members.*	How many voltmeter readings to you think you need to do to gather more accurate data? Be sure to list all repetitions on your chart/table for your group. Example issues to think about: What do you think will happen when if you put the solar panel under a tree? What will happen if a student stands over the solar panel and casts a shadow over it? Would the angle of the panel facing the sun make a difference? *Each group needs to designate a voltmeter handler, a solar panel handler, a data reader and a data recorder. The roles should be rotated so that each group member gets a chance at each role.*	[at least 3 at each location, for example, 3 in the sun at a 45-degree angle, 3 in the sun at a 90-degree angle, 3 in the shade at a 45-degree angle, and 3 in the shade at a 90-degree angle] [sample hypothesis: solar panel will not produce as much energy in the shade as in the sun, nor will it at a 45-degree angle versus a 90-degree angle]
Evaluation (Decision Point Assessment):	*The assessment you will use to determine what to do next.* When students have completed recording their measurements, everyone can go inside and move on to the next segment.	*What student outcome will indicate that you should move on to the explanation? What will you do if the outcome is something else?* Student data should be pretty consistent. If there seem to be too many outliers in a group, encourage another group to assist those that are struggling, or ask them to demonstrate what they have been doing for you so you can see where mistakes might be occurring.

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Explain: *Learning Experience(s)* *Go group by group and have the groups share their results with the class so that they can share their ideas and learn from what other groups have been processing.* **Approx. Time_10_mins**	*Critical questions that will allow you to help students clarify their understanding and introduce information related to concepts to be learned* Tell me about what your group discovered about energy output with your panel in the shade versus in the sun. Tell me about what your group discovered about the angle of tilt for the solar panel. Did the angle make a difference? Did anyone's group test any other variables with their panels? Tell us about what you found. Based on your experience, what time of day do you expect a solar panel to produce the most energy? Why? Is there a time of year that the solar panel would produce the most energy? Why do you think that?	*Expected Student Responses/Misconceptions*
Evaluation(Decision Point Assessment)	*The assessment you will use to determine what to do next.*	*What student outcome will indicate that you should move on to the extension? What will you do if the outcome is something else?*

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Extend / Elaborate: *Learning Experience(s)* Students will look at infinitepower.soltrex.com in order to observe current data from solar energy at schools, use findings to answer questions on a worksheet, and use this, combined with their exploration findings to formulate an idea about whether their school should use solar power for energy. **Approx. Time_30__mins**	*Critical questions that will allow you to decide whether students can extend conceptual connections in new situations*	*Expected Student Responses/Misconceptions*
Evaluation(Decision Point Assessment):	*The assessment you will use to determine what to do next.*	*What student outcome will indicate that you should move on to the final evaluation? What will you do if the outcome is something else?*

Evaluate: *Lesson Objective(s) Learned (WRAP –UP at end) -> Summarize* **Approx. Time_15_mins**	*Critical questions that will allow you to decide whether students understood main lesson objectives* Would purchasing a solar panel for our school be a wise investment? Would we save energy and get the prize money for a new playground? Explain why you think that.	*Expected Student Responses/Misconceptions*

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WORKSHEET – Measuring Solar Energy

Solar Panel Worksheet

Name:

<u>Use the graphs to answer the following questions</u>

1. **Label 'noon' and 'midnight' on the first graph's x-axis.**
2. **What is the power output at noon?**
3. **What is the power output at midnight?**
4. **Was your prediction from the previous worksheet correct?**
5. **Look at the second graph. Which month showed the lowest power output? The highest?**
6. **Is your prediction from the previous worksheet correct?**

1. **Is the power output the same in July 07 and July 08? Would you expect it to be? Why do you think it might be different?**
2. **What other data might we use to figure out why power output is different during different months?**

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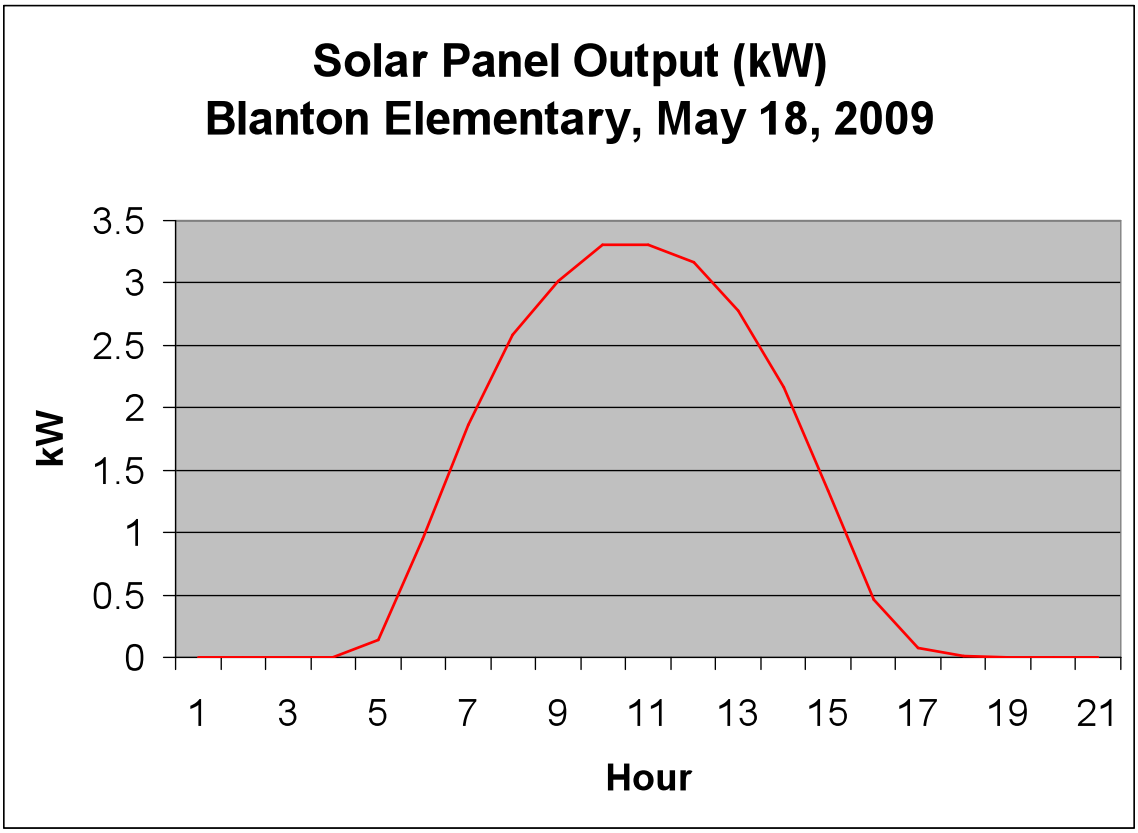

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