Environmental Science Institute
UNIVERSITY OF TEXAS AT AUSTIN

LESSON PLAN – Harnessing the Sun's Energy

Title of Lesson: Harnessing the Sun's Energy
Description of class: 5th Grade Science
Length of Lesson: 90 minutes
Purpose: To illustrate the importance and usefulness of solar energy, to engage the students by showing them that how the Mars Rovers use solar energy is similar to how we use it, and to use technology to calculate energy.

Objectives: Students will be able to:
- **(a)** Access data online that calculate energy conversions
- **(b)** Compare solar energy to other sources of energy, such as mechanical, light, chemical, etc.
- **(c)** Discuss uses of solar energy near to home as well as in space

TEKS addressed (Note: Revised TEKS are referenced):
§112.16. Science, Grade 5, Beginning with School Year 2010-2011.
a. Introduction.
4) In Grade 5, investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(B) Within the natural environment, students learn how changes occur on Earth's surface and that predictable patterns occur in the sky. Students learn that the natural world consists of resources, including nonrenewable, renewable, and alternative energy sources.

b. Knowledge and Skills
(2) Scientific investigation and reasoning. The student uses scientific methods during laboratory and outdoor investigations. The student is expected to:

(D) analyze and interpret information to construct reasonable explanations from direct (observable) and indirect (inferred) evidence; and

(F) communicate valid conclusions in both written and verbal forms.

(3) Scientific investigation and reasoning. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:

(A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

(D) connect grade-level appropriate science concepts with the history of science, science careers, and contributions of scientists.

(8) Force, motion, and energy. The student knows that energy occurs in many forms and can be observed in cycles, patterns, and systems. The student is expected to:

(A) explore the uses of energy, including mechanical, light, thermal, electrical, and sound energy;

Equipment and Supplies: Solar Racers (brand: Solar Racers™ Sun Powered Micro Vehicles Outdoor Racing Set, price: $19.99 a pair), small solar panel (Wal-Mart carries camping solar panels in the range of $20 to $80 for a single panel). A mulitmeter, similar to the Extech MN36, which can be purchased for about $40. Gnomon (sun dial) can be easily constructed with a pencil stuck through a piece of paper into the ground or purchased for around $60 at a garden store (we recommend just building a simple one). **These are suggestions for activity supplies and do not serve as an endorsement of any particular brand by ESI, SECO, or UT Austin.

Websites to Access:
Energy Calculator: http://www.soltrex.com/learn/calculator.cfm and http://www.soltrex.com/systems.cfm?q=austin&state= (there are many intriguing uses for this website and teachers may choose to access other opportunities as well)
Rover Launch and Cruise, and Exploring the Martian Surface:
http://marsrover.nasa.gov/gallery/video/animation.html (choose small pieces to show of the videos that cover the questions needed to be asked, but showing the videos in their entirety would be too long for the classroom)

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Five-E Organization:

Teacher Does:	Probing Questions:	Student Does:
Engage: *Learning Experience(s)* To provide a focus for students' viewing of video, tell students that the video is an animation based on data collected from the actual Mars mission. Also, tell students that their task is to look for forms of energy as the video progresses. Show video where solar energy is used on a Mars mission, e.g. a web video showing the Mars Rovers (See Materials section above for web source). Before the video starts, instruct students to look for the different sources/forms of energy used beginning with the launching of the rocket from Earth containing the Mars Rover to its landing on Mar's surface. Historical note: Other missions used nuclear power and batteries. Today, with rare exception, nearly all space vehicles use solar panels and batteries (providing us with TV at home, internet, news, weather).	*Questions that will establish prior knowledge & create a need to know:* This would be a great place to ask the students what they expect in order to probe their prior knowledge about solar (light) energy. For example, you might ask them to list the kinds of energy that are present in the room and see what they say, recording the answers on the board and getting them to elaborate on what they mention. If energy is defined as the ability to cause changes in matter or to make things happen, what evidence do you have that the sun is a source of energy? What form of energy is being used to launch the rocket? When does the rocket begin to use a different form or source of energy? When is solar energy being used? Are there other ways to operate on Mars (historical note)? What are the challenges using solar energy on Mars? How are these challenges different from the Earth? Why are batteries necessary for a Mars Rover? How about on Earth?	*Expected Student Responses/Misconceptions* The students may not understand the concept of momentum exchange between the fast moving rocket exhaust and the vehicle, however, we can try to explain that it's not as simple as sitting on top of a bunch of explosions. Students will think the Mars video is "really cool!" There are no power plugs or gas stations on Mars. The Sun is accessible on Mars, too. You can bring energy with you, instead of using solar, but it runs out.
Explore: *Learning Experience(s)* Pass out the solar worksheet and inform them that they will now explore how we use solar energy on Earth in light of what they saw	*Critical Questions that will allow you to decide whether students understand or are able to carry out the assigned task (formative):* What is an example of a non-renewable or exhaustible energy source?	*Expected Student Responses/Misconceptions* "I don't understand why solar is useful for the rovers" (do you think it would be easier to carry a bunch of fuel with you to Mars?)

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happen on Mars. Have students answer these questions individually: "Why is solar energy useful for the Rovers?" "Why must the rovers use batteries?" "Why is solar energy considered inexhaustible?" and "How does inexhaustible energy benefit society as opposed to the Mars Rovers?" Have the students break into small groups (4 to 5 in each) and answer these questions: "List six devices that use solar energy" and "What are some challenges to using solar energy?"	What devices use those kinds of energy? Will we always be able to use that kind of energy? Walk around the room and ask them whether we use solar energy without using solar panels (big windows, sunroof, light tube, solar oven water heaters, ovens, satellites, etc.). Does solar energy work at night? When it's cloudy? Do the seasons of the year make a difference? Is protection of the equipment important? Recall the Mars Rover's challenge with night-time and dust covering the solar panels (dust devils tend to clean the panels once per year)?	Expect some confusion between renewable and inexhaustible resources. "We can't think of more than three devices"… (are you only considering solar panels? How else do we harness solar energy?). Technically, wind-mills require the sun to create the wind that turns them but we're looking for more direct applications. Students may struggle with the concept of a "challenge" to use solar. Questioning will help them realize that you need to protect panels with glass (i.e. for hail) or to make sure to have a battery for night-time.

Teacher Does:	**Probing Questions:**	**Student Does:**
Explain: *Hands-on Solar Devices* If possible, take the students outside (or set up one or two clamped, incandescent lamps in two areas of the room). Assign groups of four to five students and cycle the groups through the stations where they get to play with solar toys. For example, each station could have a solar racer toy and a solar panel plugged into a digital multi-meter to read the voltage on a solar panel. For example, they might be tasked with figuring out how to optimize the performance of each of the toys, or figure out which toy would work the best on Mars, or write an explanation for 3rd graders about how each toy works.	Walking between the groups, ask them to test whether the angle of incidence of the light from the bulb seems to make the racer's wheels turn faster or slower. When and why would the Sun have a similar effect on solar panels? If possible, have them cover the light bulb with a mesh material to decrease the incident light. Would clouds have a similar effect? Dust on Mars?	*Expected Student Responses/Misconceptions* Students will have a lot of fun with this but may be distracted. Active monitoring will help them run minor experiments to test the effects of angle of incidence and obstacles.
Using two globes (one for the Sun and one for the Earth), or with drawings on a chalkboard/white board, explain that the angle to the sun changes from season to season. Explain that, in Texas, the sun is never actually directly overhead. It spends most of its time in the Southern sky which is why solar panels are always mounted so they face south.	Many will be confused by this. Take them outside and use your sun dial to explain that a shadow represents the angle to the sun. In Texas, will there ever NOT be a shadow? Ask the students whether the shadow will be longer in the summer or in the winter? "How would the different seasons affect a solar energy collector? How could you account for that?	While they may guess the right answer, most students will be confused about why the sun is lower/higher in the sky during the winter/summer. It is worth revisiting different forms of solar energy collection because many students may get stuck on solar panels. All forms are affected by the changing

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	"Do you think the Mars Rovers were affected by the seasons? How might they adjust for the different seasons?"	seasons and weather!
Extend / Elaborate *Learning Experience(s)* Each student or pair of students needs to have access to a computer where they can access: www.soltrex.com/systems.cfm?q=austin&state= And www.soltrex.com/learn/calculator.cfm Pairs will work together to find the conversions of kilowatt-hours to other forms of energy in order to analyze the value of solar energy and share their observations and opinions based on those observations with the class. Teachers may choose to have every pair use the data from the same school, or introduce variables for comparisons: ~assign pairs different schools so that everyone is looking up different kilowatt data ~assign different data to look up at the same school, each group examines the usage for a different month of the year so that annual effects can be compared ~assign all pairs the same school data, but have each pair convert their data to a different type of energy to compare the efficiency of the energies	*Critical Questions that will allow you to help students clarify their understanding.*	*Expected Student Responses/Misconceptions*
Evaluate *Lesson Objective(s) Learned (WRAP-UP at end) -> Summarize* Collect and evaluate any worksheets with all discussion questions answered. Revisit concepts that seemed to confuse them.	*Critical questions that will allow you to decide whether students understood main lesson objectives.* In what forms do we find solar energy? Do the Mars Rovers face similar challenges to solar energy collectors on Earth? Why do we call solar energy an "inexhaustible" resources? Why would using it help society?	*Expected Student Responses/Misconceptions*

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Name_____ Date _____

WORKSHEET – Harnessing the Sun's Energy

Individual observations (record your thinking after viewing the video) **Solar Energy on Mars**

Why and how is solar energy useful when going to and working on Mars?

Why are batteries used with solar panels on the Mars Rover?

Individual observations (record your thinking after viewing the video) **Solar Energy on Earth**

Why is solar energy referred to as an "inexhaustible resource"?

Identify at least one other source of energy on earth that is classified as inexhaustible.

What are the benefits of using inexhaustible resources on Earth? Identify at least two.

Small group observations (discuss and share ideas in your group**)**

List at least six devices that use solar energy.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Identify at least 4 challenges associated with the use of solar energy.

1. _____
2. _____
3. _____
4. _____

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