Solar Powered Fan and Light Kit Activity Guide

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Contents

Solar Powered Fan & Light Kit – Overview

Introduction: The **Solar Powered Fan & Light Kit** provides extension activities to be used as a supplement to the 4th Grade **FOSS: Energy Unit.** Please be advised that it's important to teach the **Investigation 1: Energy and Circuits** lessons so that students have background knowledge on circuits. In order for this activity to be highly effective, it's suggested to use the **Solar Powered Fan & Light Kit** activity as outlined.
Note: 1) teachers need to find a suitable, sunny place outside for the activities; 2) the activities need to occur on sunny days because the lights won't turn on during a cloudy day.

Recommended plan for a 4 week unit (20 days):

1. Teach all of Investigation 1: Energy and Circuits (FOSS Teacher Guide pp. 91-170) Suggested Length of Time: 10 School Days in a 30-40 minute session;
2. Teach the Solar Powered Fan & Light Kit Lessons (Solar Powered Fan & Light Kit Activity Guide) Suggested Length of Time: 3 School Days in a 30-40 minute session;
3. Teach Investigation 5, Part 3: Engineering with Solar Cells Investigation (FOSS Teacher Guide: pp. 361-373) Suggested Length of Time: 3 School Days in a 30-40 minute session;
4. Suggestion is to go back to Investigation 2: The Force of Magnetism and schedule the remaining investigations to complete the **FOSS: Energy Unit.**

The Solar Powered Fan & Light Kit activity provides hands-on experiences for students to learn about solar energy and electricity. Students investigate conversion of energy forms, conservation of energy, and limits of solar energy. They explore energy transfer while observing a photovoltaic panel absorbing energy from the Sun and turning it into electricity. Students will need to understand that our energy source is the Sun. The Sun provides energy as light and heat. A photovoltaic panel takes the Sun's energy as light and changes it to electricity. We use electricity all the time. Electricity runs motors, makes objects spin, and turns on light bulbs. Energy is converted twice (first from sunlight to electricity and then from electricity to motion and light energy) in order for the fans and lightbulbs in this kit to work. You may choose to enrich your discussions by asking students questions about parallel circuits from FOSS Investigations 1: Energy and Circuits. By removing one light bulb, students can observe that a parallel circuit was built to run each fan and bulb set in the circuit. Also, you may choose to bring in Christmas lights to review series and parallel circuits.

Acknowledgments:
Lessons were created by Kim Adams, Sherry DiFiore, Casey Korder, and Casie Lewis, with support from Dr. Erica Marti and UNLV students Milady Ramirez, Francisco Chavarria, and Elizabeth Heider.

Standards

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-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

SEP-6. Constructing Explanations and Designing Solutions

SEP-8. Obtaining, Evaluating, and Communicating Information

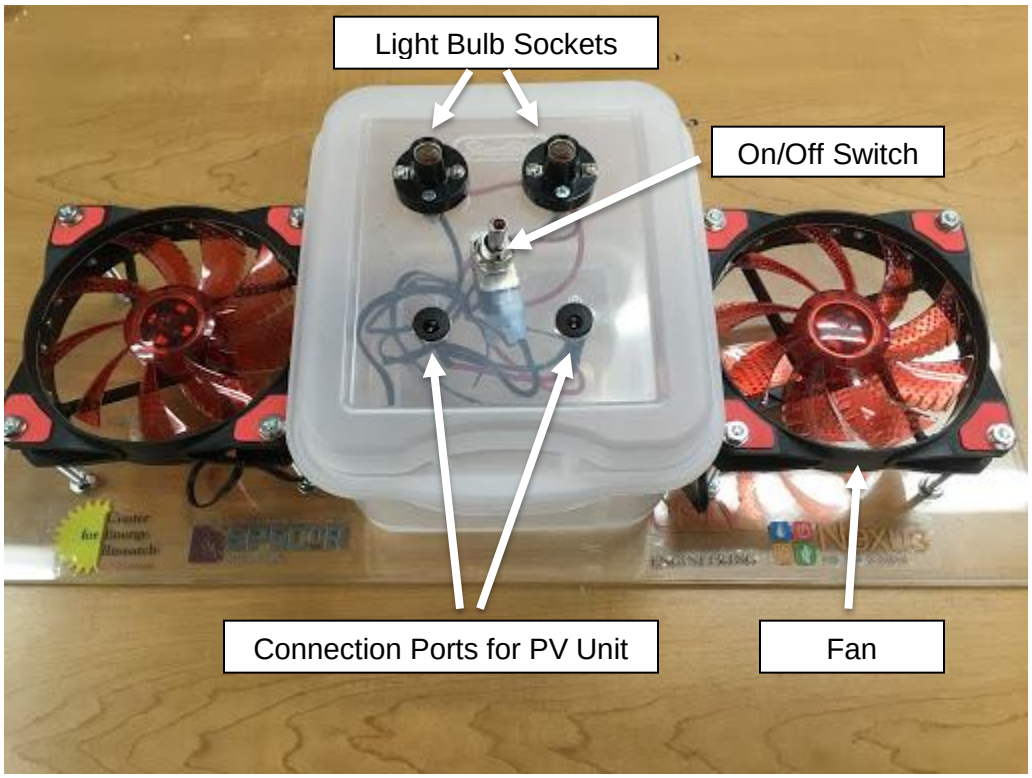
CCC-2. Cause and Effect: Mechanism and Explanation

CCC-5. Energy and Matter: Flows, Cycles, and Conservation

Diagram and Set-Up

The kit is composed of a photovoltaic panel (PV unit), two computer fans, two light bulbs, and electrical connections housed in a clear plastic container. Except for the PV unit, all of the components are mounted on a clear Plexiglas base. These components should be not removed from the Plexiglas base at any time.

To begin, place the Plexiglas base on a flat surface and place the PV unit face-down next to the Plexiglas base. The PV unit should not be plugged into the connection port and the switch should be in the off (down) position. Check that the light bulbs are screwed in completely. Light bulbs are stored inside of the plastic container when the unit is not in use.



Safety in the Classroom

Adult supervision is necessary to prevent student injuries or damage to the kit. When the kit is in use, take the following precautions:

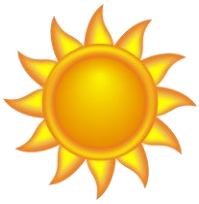
1. Use caution with the light bulbs because they can get very hot after being turned on for a while.
2. Do not stick fingers or other objects in the fans. Doing so could damage the fans.
3. Do not have students open the plastic container where the electronics are housed. Only view the items through the container.
4. Do not put any objects other than the plug from the PV unit into the connection port. Doing so could damage the connection port and cause the kit not to work.
5. Avoid touching the dark surface of the PV unit. The surface can become hot after being in the sun for a while.

Note: Take time before you start the activity to go over these safety measures and go over the diagram of the kit with the students.

Investigation Guide – Solar Powered Fan & Light Kit

	Time	Summary	Focus Question	Writing	Assessment
Activity 1: Energy Conversion	1 Session (30-40 minutes)	Students are introduced to the Sun as the source of energy for life on Earth. They will investigate how energy comes from the Sun and converted to different forms.	What is the main source of energy for all life on Earth?	Student observations, reflection questions, and completion of focus question.	Science Journal Entries * Focus Question Check *Student Observations
Activity 2: Conservation of Energy	1 Session (30-40 minutes)	Students investigate how the angle of the Sun relates to how much direct sunlight we receive, and, therefore, how much energy is received.	What happens to the fans and lights as you change the angle of the photovoltaic panel?	Student observations, reflection questions, and completion of focus question.	Science Journal Entries * Focus Question Check *Student Observations
Activity 3: Limits to Solar Energy	1 Session (30-40 minutes)	Students investigate how solar energy production is affected by a cloudy day as compared to a clear day.	Are there any limits to using solar power as an energy source?	Student observations, reflection questions, and completion of focus question.	Science Journal Entries * Focus Question Check *Student Observations

Activity 1: Energy Conversion

Activity 1: Energy Conversion 	**NGSS/NVACSS:** 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-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
Objectives	**Reasoning Targets** 1. Students understand that energy can be transferred in various ways between objects. 2. Students understand energy is present whenever there are moving objects, sound, light, or heat. **Performance Targets** 1. Students can make observations to produce data to explain that energy can be transferred from one place to another.
Vocabulary 	sun energy energy transfer fan photovoltaic panel solar energy source switch light bulbs
Materials	Solar Powered Fan & Light Kit Student Journals FOSS Video, Chapter 10: Transfer of Energy from the Sun (2:47) Extension Vocabulary Activity (provided if time allows)
Focus Question	What is the main source of energy for all life on Earth? Explain how this source is used to transfer energy based on your observations.
Procedures	1. During whole group discussion, the teacher will ask leading questions for students to communicate the answers provided. Teacher will ask: ***Where does energy come from?*** Students

will share their ideas. ***Answer:*** *Energy comes from the Sun. The Sun provides energy as light and heat.* ***Why do humans, plants, and animals need energy?*** Students will share their ideas. ***Answer:*** *Plants need light to grow and animals eat the plants as food, which gives the animals energy. Also, animals need heat to stay warm.* ***How is the Sun's energy stored?*** Students will share their ideas. ***Answer:*** *The Sun's energy gets stored in humans, plants, and animals. All of these energy forms are traced back to the Sun. Energy changes forms, like when plants convert light and carbon dioxide to sugar through photosynthesis. Or when you burn energy after you eat food.*

2. Students will set up journals as used in FOSS with the focus question on one page and observations/discussion notes on another page.

Focus Question: What is the main source of energy for all life on Earth? Explain how this source is used to transfer energy based on your observations.	**Notes/Observations**

3. Students will view the FOSS Energy module Chapter 10 video titled Transfer of Energy from the Sun (2:47).
4. Teacher will take the students outside and divide students into groups according to the number of kits to complete the investigation. Complete the following:
    a. Place the photovoltaic panel face down on the surface and connect the photovoltaic panel to the ports on plastic container that houses the electronics. Teacher will ask: ***What is a photovoltaic panel?*** ***Answer:*** *Photovoltaic energy is the conversion of sunlight into electricity through a photovoltaic (PVs) panel, commonly called a solar cell. A photovoltaic panel is a non-mechanical device usually made from silicon alloys… only the absorbed photons provide energy to generate electricity.* Turn on the switch. Teacher will ask: ***What are you observing?*** ***Answer:*** *The fan and light bulbs are not working.* ***What do we need to do to get the fans and lights to work?*** ***Answer:*** *Place the photovoltaic panel face up pointing to the Sun.*
    b. Teacher will face the photovoltaic panel face up on the surface and students will record their observations. [*Note: depending on the sunlight intensity, the teacher may need to help the fans to start spinning by blowing

	on them or giving the fan blades a quick spin.] c. Teacher will ask: ***What happened to the fans and lights when you turned over the photovoltaic panel?*** ***Answer:*** *The fans and lights turned on.* ***What happened to the sun's energy?*** ***Answer:*** *The Sun's energy was transferred into the photovoltaic panel.* ***How did the energy change forms?*** ***Answer:*** *The photovoltaic panel takes the Sun's energy and changes it to electricity. The electricity transferred through the circuit to turn on the fans and light bulbs. The Sun's energy is solar energy converted into electricity for the fans and light bulbs to work.* d. To further confirm that the PV panel is converting sunlight to electricity, students can cover up other parts of the Solar Powered Fan and Light Kit, such as the plastic container with the electronics, the fans, and the light bulbs. Students will see that covered those parts does not cause the fan and lights to stop. The teacher can turn the PV panel face down again, and students will observe that the fan and lights turn off.
Assessment 	Review the vocabulary and students will answer the focus question independently: ***What is the main source of energy for all life on Earth? Explain how this source is used to transfer energy based on your observations.*** Assess Progress: Check Focus Question **What to Look For** ● **The Sun is the main source of energy for all life on Earth.** ● **Electricity is converted by using a photovoltaic panel connected to a circuit for energy to transfer when the circuit switched is turned on.** ● **Solar energy is transferred to light and motion energy by being converted into electricity.** **Note: Students may use illustrations to explain their thinking along with a written explanation.** **Journal Entry Example:** **The main source of energy for all life on Earth is the Sun. In my observations, the Sun provides solar energy for the circuit to work. The photovoltaic panel converts the solar energy into electricity when the switch is on and the panel is facing the Sun. The electricity goes through the circuit to run the fans and light the bulbs. In conclusion, the Sun provides solar energy for the circuit to work.**

Activity 2: Conservation of Energy

Activity 2: Conservation of Energy 	**NGSS/NVACSS:** 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-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. 3-5-ETS1-3.Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
Objectives	**Reasoning Targets** 1. Students understand that energy can be transferred in various ways between objects. 2. Students understand energy is present whenever there are moving objects, sound, light, or heat. **Performance Targets** 1. Students can make observations to produce data to explain that energy can be transferred from one place to another.
Vocabulary 	sun energy energy transfer fan photovoltaic panel conservation solar energy source switch light bulbs angles absorb
Materials	Solar Powered Fan & Light Kit Student Journals How Stuff Works Video: https://youtu.be/av24fEMhDoU Smart Flower Video: https://www.youtube.com/watch?v=9wjGQW5f1ts Extension Vocabulary Activity (provided if time allows)
Focus Question	What happens to the fans and lights as you change the angle of the photovoltaic panel?

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<tr>
<td>Procedures</td>
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Reminder: The angles lesson will be determined based on the time of the day the lesson is conducted.

During whole group discussion, the teacher will ask leading questions for students to communicate the answers provided. Teacher will say: Light is energy. Light comes from systems that radiate light. Some light sources include lamps, lightning flashes, the Sun, and flames. Teacher will ask: How does light travel? Students will share their ideas. Answer: Light travels in straight lines called light waves. They never curve, but can bounce off surfaces and change direction. Bouncing off is called reflection. Teacher will ask: Can light be absorbed? Answer: Light can be absorbed. For example, when you wear a dark colored shirt the dark color absorbs the sun making you feel hotter. A white shirt is not going to make you feel as hot. The darker the shirt, the more energy it absorbs and so the hotter it becomes. Teacher will say: When sunlight hits a photovoltaic panel, it's either reflected, passes right through, or is absorbed. Only absorbed light provides energy that can be used for electricity.
Students will set up journals as used in FOSS with the focus question on one page and observations/discussion notes on another page.

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<tr><td>Focus Question: What happens to the fans and lights as you change the angle of the photovoltaic panel?</td><td>Notes/Observations</td></tr>
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<ol start="3">
View How Stuff Works Video: https://youtu.be/av24fEMhDoU
Teacher will take the students outside with their journals to complete the investigation. Complete the following:
<ol type="a">
Place the photovoltaic panel at an angle on the ground. Teacher will ask: How do the Sun and Earth move? How does the position of the Sun change throughout the day? Answer: Earth rotates on an axis. The rotation causes us to have day and night. It is daytime when your location on Earth is facing the Sun and it is night time when your location on Earth is facing away from the Sun. At midday, the Sun's light is direct and very strong. In the morning and at night, the Sun's light is indirect and not as strong. So we receive sunlight at

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	different angles and that affects how much energy we obtain from the sun. The angle of the sun relates to how much direct sunlight we receive and, therefore, how much energy we receive. b. Teacher will angle the panel in towards direct sunlight and ask: ***What happens when the photovoltaic panel is angled in direct sunlight?*** Students will observe and record observations. c. Teacher will change the angle to allow less sunlight to hit the photovoltaic panel. Teacher will ask: ***What happens when the photovoltaic panel is not in direct sunlight.*** Students will observe and record observations in their science journals. *5. Students will view short Smart Flower Video: https://www.youtube.com/watch?v=9wjGQW5f1ts and share observations back in the classroom. Teacher will lead a group discussion with the following questions:* ● *What happened to the fans and lights as you changed the angle of the photovoltaic panel? Possible answers: Based on the angle of the photovoltaic panel, the fans and light bulbs received more or less energy. The fans spun faster/slower and the light bulbs were brighter/dimmer.* ● *What do you think would happen to the fans and lights if you were closer to the sun and received more energy from the sun? Possible answers: The fans would spin faster and lights would be brighter. The Sun's angle influences the intensity of the light received by the Earth. The location of the Sun affects how much energy a solar panel generates.*
Assessment 	Review the vocabulary and students will answer the focus question independently: ***What happens to the fans and lights as you change the angle of the photovoltaic panel?*** Assess Progress: Check Focus Question **What to Look For** ● **The amount of sunlight determines how fast or slow the fans will move and how bright the light bulbs will be. The panel angled in direct sunlight causes the fan to spin faster and the bulbs to be brighter. The panel angled in less direct sunlight causes the fan to spin slower and the bulbs to be dimmer.** ● **Solar energy is transferred to light and motion energy by being converted into electricity depending on the angle of**

	the panel in relation to the sun. ● **More electricity is converted by using a photovoltaic panel connected to a circuit for energy to transfer when the panel is angled in direct sunlight.** **Note: Students may use illustrations to explain their thinking along with a written explanation.** **Journal Entry Example:** **Changing the angles of the panel changes how the fans and lights work in the circuit. When the panel is in direct sunlight, the fans spin faster and the lights are brighter. When the panel is not in direct sunlight, the fans spin slower and the lights are dimmer. In conclusion, the position of the sun during the day and the angles of the panel determine how much energy is absorbed to be converted into electricity for the circuit to work.**

Activity 3: Limits to Solar Energy

Activity 3: Limits to Solar Energy 	**NGSS/NVACSS:** 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-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
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Vocabulary 	sun energy energy transfer fan photovoltaic panel conservation weather solar energy source switch light bulbs angles clouds rays
Material	Solar Powered Fan & Light Kit Student Journals Wax Paper Limits of Solar Energy Video: https://youtu.be/gW9wo66VRt4 Extension Vocabulary Activity (provided if time allows)
Focus Question	Are there any limits to using solar power as an energy source?
Procedures	1. Activate prior knowledge in a discussion based on previous lessons:

Ask the students to think about how a cloudy day would affect solar energy production. Teacher will ask: ***Does the PV panel generate the same amount of energy on a cloudy day as compared to a clear day? How can we find out using the Solar Powered Fan & Light Kit?*** Students will share their ideas.

Answer: *On a cloudy day the same amount of energy will not be generated by the PV panel as compared to a clear day. On a clear day, there is an abundance of sunshine. By shading the panel to simulate cloud coverage you can observe the amount of energy being produced in the circuit. Note: the sun produces the same amount of energy, but less energy reaches the PV panel due to the clouds.*

2. Students will set up journals as used in FOSS with focus question on one page and observations/discussion notes on another page.

Focus Question: Are there any limits to using solar power as an energy source?	**Notes/Observations**

3. Teacher will take the students outside to complete the investigation. Complete the following:
    a. Place the photovoltaic panel face up on a table or surface, pointing at the sun.
    b. Using a hand or another item (i.e. wax paper), cover up part of the photovoltaic panel. (Don't touch the panel because it gets very hot, just block the sun with your hand or other object.) *Note: You can also ask students to think about what would get the circuit to stop completely. Students will think of other objects that can cover the panel that will not allow light to fall on the panel.*
    c. Teacher will say: ***It is not just clouds that block solar panels. What other objects outside could block a solar panel?*** ***Answers:*** *Students may suggest trees, shrubs, buildings, walls, shadows, etc.* Teacher will encourage the students to move their kit to different areas in the schoolyard to test other objects blocking the Sun. Students will record their observations.
    d. Students will record observations and view Limits of Solar Energy video https://youtu.be/gW9wo66VRt4

Assessment 	Review the vocabulary and students will answer the focus question independently: ***Are there any limits to using solar power as an energy source?*** Assess Progress: Check Focus Question **What to Look For** ● **The panel facing direct sunlight causes the circuit to produce more energy causing the circuit to produce more electricity.** ● **The panel covered as if on a cloudy day causes less energy converted to electricity and less power for the fans and lights.** ● **The fans will run faster and the light bulbs will be brighter only when enough light falls on the photovoltaic panel.** ● **If you cover up part of the solar cell, the fan motors slow down and the light bulbs are dimmer. If you cover up the panel with an object that does not allow sunlight to fall on the panel, the circuit will stop.** ● **Different objects like trees, shrubs, and buildings can block the solar panel affecting the amount of energy absorbed by the panel.** **Note: Students may use illustrations to explain their thinking along with a written explanation.** **Journal Entry Example:** **There are limits to using solar power as an energy source. The limits include how photovoltaic panels are positioned as well as the weather. Photovoltaic panels positioned in direct sunlight without light being blocked increases the amount of energy being produced. On cloudy days, energy being produced decreases because the photovoltaic panel has less direct light. In conclusion, the amount of sunlight falling on a photovoltaic panel creates limits to using solar power.**

Extension:

(a) You may choose to extend this last activity by asking students questions about parallel circuits from FOSS Investigations 1: Energy and Circuits. By removing one light bulb, students can observe that a parallel circuit was built to run each fan and bulb set in the circuit. Also, you may choose to bring in Christmas lights to review series and parallel circuits

(b) You may choose to swap the LED bulbs for incandescent bulbs with the same E10 base. The incandescent bulbs require more power than the LED bulb. Therefore, students may observe that the incandescent bulbs don't light up unless the sunlight intensity is very high on the PV panel. *Note: incandescent bulbs will get much hotter than LED bulbs.

Engineering Design Process Extension Activities

Extension Activity Explanation	Link
Engineering Design Process The engineering design process is a series of steps that guides engineering teams as we solve problems. The design process is iterative, meaning that we repeat the steps as many times as needed, making improvements along the way as we learn from failure and uncover new design possibilities to arrive at great solutions.	https://www.teachengineering.org/k12engineering/designprocess
Design a Solar City Students design and build a model city powered by the sun! They learn about the benefits of solar power, and how architectural and building engineers integrate photovoltaic panels into the design of buildings.	https://www.teachengineering.org/activities/view/cub_solarcity_activity1
Lights On Demo & Build! Intro to Simple Circuits Students are introduced to circuits through a teacher demonstration using a set of Christmas lights. Then student groups build simple circuits using batteries, wires and light bulbs. They examine how electricity is conducted through a light bulb using a battery as a power source. Students also observe the differences between series and parallel circuits by building each type.	https://www.teachengineering.org/activities/view/duk_eenergy_mem_act
Potato Power Students use potatoes to light an LED clock (or light bulb) as they learn how a battery works in a simple circuit and how chemical energy changes to electrical energy.	https://www.teachengineering.org/activities/view/cub_energy2_lesson04_activity2
Solar Power to the Rescue! Students learn how the innovative engineering of photovoltaics enables us to transform the sun's energy into usable power—electricity—through the use of photovoltaic cells.	https://www.teachengineering.org/lessons/view/unm-2006-photovoltaics-cells-solar-energy-panel-space
Solar Thermal Storage In this activity, students learn how engineers use solar energy to heat buildings by investigating the thermal storage properties of some common materials: sand, salt, water and shredded paper. Students then evaluate the usefulness of each material as a thermal storage material to be used as the thermal mass in a passive solar building.	https://www.teachengineering.org/activities/view/cub_environ_lesson09_activity1
Toilet Paper Flashlight Use a series circuit to make a flashlight.	https://youtu.be/FKfA3AHJ-Cc
Here Comes The Sun - Beatles	https://youtu.be/rh298ITCHm8

Vocabulary Extension

This is a list of possible vocabulary activities you could use with your students if time allows during each activity. Click on the links for directions and procedures for the vocabulary activities. Create a Headbandz type vocabulary game or word sort.

Vocabulary Ideas

Headbanz Game http://www.instructables.com/id/Homemade-Hedbanz-Game/

Vocabulary Games https://bit.ly/2MMfV2A

Sun
solar
energy
energy source
energy transfer
switch
fan
light bulbs
photovoltaic panel
angles
conservation
absorb

Sun	**Solar**	**Energy**	**Energy Source**	**Energy Transfer**	**Switch**
The star at the center of the solar system around which all of the solar system objects orbit.	Relating to or denoting energy derived from the Sun's rays.	The ability to do work.	A place where energy comes from, such as batteries, food, fuels, and the Sun.	The movement of energy from one place to another.	A device used to open and close circuits.
Fan	**Light Bulbs**	**Photovoltaic Panel**	**Angles**	**Conservation**	**Absorb**
An apparatus with rotating blades that creates a current of air for cooling or ventilation.	A filament held by two stiff wires and surrounded by a clear glass globe.	Photovoltaic panel is the conversion of sunlight into electricity through a photovoltaic (PV) panel, commonly called a solar cell.	The space (usually measured in degrees) between two intersecting lines or surfaces at or close to the point where they meet.	The act of conserving; prevention of injury, decay, waste, or loss; preservation.	Take in or soak up (energy, or a liquid or other substance) by chemical or physical action, typically gradually.