# Solar-powered insects!

**Physical Science, Science and Technology**

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**Grade Level** 1 (K-2)

**Activity Dependency**

**Time Required** 150 minutes (5-30 minute class periods)

1. **Group Size** 3-4

**Expendable Cost per Group** US $12.95

**Summary**
Students will use the Engineering Design Process to create and improve an object powered by solar energy. First they will use prior knowledge to identify energy generated by objects in their morning routine. Then they will learn about different sources of energy that are used to generate electricity. Next they will differentiate between renewable and nonrenewable energy sources. Finally, they will use this knowledge and the Engineering Design Process to solve the problem of creating an object that moves without batteries or by being plugged in. As students work in groups, soft skills that are beneficial to scientists and engineers in their work such as collaboration, good communication, and problem solving, etc will be highlighted. At the end students will reflect on how they used the Engineering Design Process, how well they worked together in groups and how they grew as engineers.

**Engineering Connection**
We use energy every day to make our lives easier. We turn oil into gasoline to run our cars and use different sources of energy to generate electricity to power our air conditioners, refrigerators, and television . Electricity is not created but it is generated from sources of nonrenewable and renewable energy. Engineers are researching many different forms of renewable energy to generate electricity efficiently and meet the growing energy needs of our population. Solar panels have provided an opportunity to generate electricity in a way that is increasingly more cost effective and causes less harm to our environment than nonrenewable sources of energy.

**Engineering Category** =
Choose the category that best describes this activity's amount/depth of engineering content:
~~1. Relating science and/or math concept(s) to engineering~~
~~2. Engineering analysis or partial design~~
3. Engineering design process

**Keywords**
- energy
- light
- solar energy
- solar powered
- Sun

**Educational Standards** (List 2-4)
Source, year, standard number(s)/letter(s), grade band and text (its unique ID# is optional)
State STEM Standards (required)

- **TEKS 1.6A Forms of Energy -** Identify and discuss how forms of energy are important in everyday life such as light, thermal, and sound.

ITEEA Standards (required)

- Students will develop an understanding of engineering design.
  In order to comprehend engineering design, students should learn that:
  The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others (Grades K-2)

NGSS Standards (strongly recommended)

- **K-2-ETS1-1 Engineering Design -** Students who demonstrate understanding can: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
- **K-2-ETS1-2 Engineering Design** - Students who demonstrate understanding can:
  Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

CCSS Standards (strongly recommended)

**Prerequisite Knowledge**

Before this lesson, students should have a familiarity with light, sound, and heat energy and be able to identify different everyday objects that produce these types of energy. It would be beneficial for students to already be familiar with the Engineering Design Process.

**Learning Objectives**

After this activity, students should be able to:

- explain nonrenewable and renewable sources of energy.
- use the Engineering design process to create an object that solves the problem or reflect on why it didn't solve the problem

**Materials List**

**Each group needs:**

1. 1 Science Journal, per student (notebook or anything to write in) or 1 handout, per student
2. Frightened Grasshopper disassembled

**To share with the entire class:**

1. Engineering Design Process Anchor Chart (See Attached)
2. What Type of Engineer Are You Scale Chart (See Attached)
3. "Power Up! A Visual Exploration of Energy" by Shaker N. Paleja or a similar book about different sources of energy

**Introduction / Motivation**

**Day 1:**

1. Ask students, "How do you wake up in the morning and get ready to come to school?" Give students think time so they can imagine their routine. As a support, you may have students draw out in a comic strip the different steps of their routine. Then have students identify (and label) which part of their routine has objects that produce energy. [Examples include – alarm clock, cellphone, electric toothbrush, television, lights, refrigerator, stove, microwave, car, bus, etc.]
2. Then tell students to reimagine how their routines would be different without any energy. Have students Think-Pair-Share their responses. You may explain how in the past, people lived their lives without these machines so engineers and scientists have created inventions that use and produce energy in order to solve problems and make our lives easier. As an extension, you may also discuss that some communities currently do not use energy out of choice such as the Amish and/or due to lack of access.

3. Discuss with students how these machines use electricity to work. Energy is not created by scientists. It can neither be destroyed, just transferred from one form to another. The electricity that the objects use is generated from energy. Scientists have used different sources for energy to generate electricity.

**Vocabulary / Definitions**

| Word | Definition |
|---|---|
| Engineering Design Process | The engineering design process is a series of steps that guides engineering teams as we solve problems. |
| Engineer | The use of science and mathematics to solve problems to improve the world around us. |
| Energy | The capacity for doing work; raising weight, for example. |
| Photovoltaic | the conversion of light into electricity |
| Renewable Energy | energy that is made from sources that can be regenerated or reused is renewable |
| Solar Energy | Energy derived from sunlight. |
| Solar Cell | A photo-electric cell that converts sunlight directly into electrical energy and can be used as a power source. |

**Procedure**

**Background**

**What is energy?** Energy is the ability to do work. Energy is how things change and move. It's everywhere around us and takes all sorts of forms. It takes energy to cook food, to drive to school, and to jump in the air.

**Energy comes in different forms:**

- Heat (thermal)
- Light (radiant)
- Motion (kinetic)
- Electrical
- Chemical
- Nuclear energy
- Gravitational

**Conservation of energy:** To scientists, conservation of energy does not mean saving energy. Instead, the law of conservation of energy says that energy is neither created nor destroyed. When people use energy, it doesn't disappear. Energy changes from one form of energy into another form of energy.

A car engine burns gasoline, converting the chemical energy in gasoline into mechanical energy. Solar photovoltaic cells change radiant energy into electrical energy. Energy changes form, but the total amount of energy in the universe stays the same.

**Energy sources can be divided into two groups:**

- Renewable (an energy source that can be easily replenished)
- Nonrenewable (an energy source that cannot be easily replenished)

Renewable and nonrenewable energy sources can be used as primary energy sources to produce useful energy such as heat or used to produce secondary energy sources such as electricity.

When people use electricity in their homes, the electrical power was probably generated from burning coal or natural gas, a nuclear reaction, or a hydroelectric plant on a river, to name a few possible energy sources. The gasoline people use to fuel their cars is made from crude oil

(nonrenewable energy) and may contain a biofuel (renewable energy) like ethanol, which is made from processed corn.

Nonrenewable energy sources accounted for about 90% of all energy used. Biomass, which includes wood, biofuels, and biomass waste, is the largest renewable energy source, and it accounted for about half of all renewable energy and about 5% of total U.S. energy consumption.

**Renewable energy**
There are five main renewable energy sources:

- Solar energy from the sun
- Geothermal energy from heat inside the earth
- Wind energy
- Biomass from plants
- Hydropower from flowing water

**How do Solar Cells Work?** A solar cell is an electronic device that catches sunlight and turns it directly into electricity. It's about the size of an adult's palm, octagonal in shape, and colored bluish black. Solar cells are often bundled together to make larger units called solar modules, themselves coupled into even bigger units known as solar panels (the black- or blue-tinted slabs you see on people's homes—typically with several hundred individual solar cells per roof) or chopped into chips (to provide power for small gadgets like pocket calculators and digital watches).

Just like the cells in a battery, the cells in a solar panel are designed to generate electricity; but where a battery's cells make electricity from chemicals, a solar panel's cells generate power by capturing sunlight instead. They are sometimes called photovoltaic (PV) cells because they use sunlight ("photo" comes from the Greek word for light) to make electricity (the word "voltaic" is a reference to Italian electricity pioneer Alessandro Volta, 1745–1827).
We can think of light as being made of tiny particles called photons, so a beam of sunlight is like a bright yellow fire hose shooting trillions upon trillions of photons our way. Stick a solar cell in its path and it catches these energetic photons and converts them into a flow of electrons—an electric current. Each cell generates a few volts of electricity, so a solar panel's job is to combine the energy produced by many cells to make a useful amount of electric current and voltage. Virtually all of today's solar cells are made from slices of silicon (one of the most common chemical elements on Earth, found in sand), although as we'll see shortly, a variety of other materials can be used as well (or instead). When sunlight shines on a solar cell, the energy it carries blasts electrons out of the silicon. These can be forced to flow around an electric circuit and power anything that runs on electricity.

**Soft Skills you may highlight as you teach:**

- Communication skills
- Making decisions
- Self motivation
- Leadership skills
- Team working skills
- Creativity
- Problem-solving skills
- Time management

**Before the Activity**

1. Gather materials for each day of the lesson (anchor chart, books, videos, informational articles, etc.)
2. Post vocabulary

3. Make sure that the frightened grasshopper parts are disassembled.
4. Ensure students have their Science Journals available

**With the Students**

**Day 2:**

1. As a Pre Assessment, have students complete the Non Renewable vs. Energy Sort (See Attached). You may have students work independently and then Think-Pair-Share their predictions or you may have students work in pairs and then share out. If you have students work in pairs during the Pre-Assessment, remember to have the same students pair up for the Post-Assessment.
2. Read "Power Up! A Visual Exploration of Energy" by Shaker N. Paleja or a similar book about different sources of energy in order to help build students' background knowledge about different sources of energy. You may also show them several videos on energy sources as well such as the BrainPopJr. Video on Energy.
3. Now that students have some background information on sources of energy, as a whole group Pre Assessment, complete and Inquiry Chart (See Guidelines and Example attached). Keep the chart in an area that is easily viewed and accessible to students. Tell students that as they learn more, during the next couple of days of the activity that they can add answers to questions and new understandings.

**Day 3:**

1. Next, students will learn to distinguish between nonrenewable and renewable sources of energy. Have students identify sources of energy that they may have seen or heard (oil, coal, wind, solar, hydroelectric). As students list them, create a T-chart without a header in which you put renewable energy sources in one column and nonrenewable energy sources on the opposite column. Afterwards, in partners or groups have students analyze the list to see what each column has in common to determine appropriate titles for each. [Renewable vs. Nonrenweable]
2. Renewable vs. nonrenewable mini lesson – While referencing to your T-chart, tell students that traditionally, we have relied on nonrenewable energy sources such as oil to make gasoline for our cars and coal and natural gas to generate electricity for our homes. These sources of energy have been called nonrenewable because there is a limited amount of it on earth. They also have harmful effects on the environment. Renewable energy sources are unlimited and are less harmful to the environment. You may show different pictures of the sources of energy and their effects with a See-Think-Wonder Activity. Focus on solar energy for students' future reference.

**Day 4:**

1. Discuss with students their favorite toy; one that works or moves. Ask them what the toy does, how it works, etc. As an added support, you may have students draw and label the toy in their Science Journal. As a class, you may create a list and then identify how that toy uses energy. [Batteries, plugged in for electricity].
2. Introduce the Engineering Design Process. [Ask, Imagine, Plan, Create, Improve] by showing students your Anchor Chart. Explain to students that they will think like engineers in order to solve a problem just like engineers do each day. Engineers may not solve the problem on the first day, engineers rarely do, and sometimes they don't solve the problem at all but the Engineering Design Process helps them learn something new that will be useful when they solve a new problem. Reflecting as they work through the process helps them learn new things. Explain that engineers work in teams in order to solve problems. In order to work towards solving the problem, they need to work together. Emphasize a few (3-4) soft skills that you would like for your students to keep in mind as they work in groups. You can refer to the list in the background section for ideas. As they work throughout this activity, highlight examples of these skills as you see students using them in action. Once students begin to use the Engineering Design Process, they can track their progress by writing their names or a group name on a post-it note and moving it each time they move onto a new step.

3. Divide students into groups of 3 or 4. Ask them how a toy might work or move without batteries or being plugged in. Have students Think-Group-Share their ideas. You may ask groups probing questions such as “Have you seen any object work without batteries before?, Have you seen anything work without being plugged in?, What did it look like? How did it work?” As students work in groups, have the Teacher Rubric available so you are able to write down anecdotal data on each student.
4. Tell students that today they will learn the problem and be able to complete the Ask step of the Engineering Design Process. The problem is to use certain pieces to design and create a toy that does not use batteries to work. Invite students to ask you questions about the problem that may help them understand it better.

**Days 5-6:**

1. Show them the parts of the Frightened Grasshopper disassembled. Tell them today they will Imagine. As a check for understanding, ask students to first phrase the problem – they will use the pieces available to create a toy that works without batteries. You may have work together to write the problem in their Science Journals.
2. In groups, they will brainstorm ideas for how they might be able to create a toy out of these materials. Remind them to be respectful of each group member’s ideas and to use the predetermined soft skills to work effectively together. You may consider handing each student two chips or similar object that they place in the middle of the group while they share their idea hold each accountable for contributing. While students are sharing, you may circulate and ask group members to share with you what another partner shared to check for active listening.
3. Afterwards, tell students that now they will Plan. Do not yet give them access to the materials until they check in with you. They will use their ideas to plan their toy without batteries. As a group, they will write and/or draw and label their ideas in their Science Journals or in the optional Engineering Design Process : Plan Handout (See Attached). In groups, they can ask each other why and how their ideas might work.
4. When groups complete their plan, have them check in with you to explain and share their plan for their object. Ask them where are different places to test to see if it works. If they can explain their thinking, let the group move onto the Create phase. Provide them with a Create Handout (See Attached) the parts of the Frightened Grasshopper.
5. Groups in the Create phase, will work together to create their toy. As they put it together have each group member list the steps it takes to create their object so that someone else could also put it together the same way. As they put it together, ask them what are different places they can test their object to see if it works.
6. Once students finish putting their object together, have them test in the areas they had planned. After they test it, they can record their results on their handout.
7. When all the groups have completed their tests, bring the class together for a Think-Group-Share discussion to reflect on what worked well and what problems arose that they didn't expect. What would they improve on their object for next time? What steps of the Engineering Design Process did they use? You can also have the them discuss the soft skills that their group members exemplified with examples. Refer back to the Inquiry Chart and record any new understanding, new questions or corrected misconceptions.
8. If applicable, have the groups improve on their design and test their improved model using the Engineering Design Process: Improve handout (See Attached) to record changes, results and their reflections.

**Day 7:**

1. After all groups are done working through the Engineering Design Process, as a class again reflect on what they learned, how they worked together, what worked well and what problems were unexpected.
2. Ask students what type of energy their objects used and how did they find out? Ask them if solar energy is renewable or nonrenewable. They can access the Non-renewable vs. Renewable Energy

chart for support. Ask students: Why might it be beneficial to create more products that use solar energy? What are other sources of renewable energy that can be used to generate electricity?

3. As a Post Assessment. Refer back to the Inquiry Chart and invite students to share new understandings, corrected misconceptions and any outstanding questions. You can tie in how outstanding questions are a part of research and, like engineers and scientists, they still have the opportunity to research those answers.
4. As an individual or partner pair Post Assessment: Have students complete the Post Assessment Energy Sort so they can reflect on what they have learned about renewable and nonrenewable energy.

**Attachments**

- Engineering Design Process: Plan
- Engineering Design Process: Create
- Engineering Design Process: Improve
- What Type of Engineer Anchor Chart Example
- Post Assessment Teacher Rubric
- Engineering Design Process Anchor Chart Example
- Inquiry Chart Example
- Pre Assessment: Renewable vs. Nonrenewable Energy Sort
- Post Assessment: Renewable vs. Nonrenewable Energy Sort

**Troubleshooting Tips**

- Make sure that the wires are connected to the circuits on the solar panels so that they work properly.

**Investigating Questions**

- Why do you think your plan will work?
- Where are different places where you could test to see if your object works?
- What worked well about your design? What would you improve?
- What step of the Engineering Design Process are you in?
- What would you improve on your object? Why?
- How did you use the steps of the Engineering Design Process to solve the problem?
- Why do you think the Engineering Design Process is important for engineers?

**Assessment**

1. **Pre-Activity Assessment**
    - *Inquiry Chart:* **Pre Assessment**: As a whole class, ask students what they already know about energy and write all thoughts in same color. Even write down misconceptions, as students learn new information, it can be amended. In a second consistent color, write down questions about what students want to know about energy.
    - *Non Renewable vs. Non Renewable Energy Sort*: Have each student show you what you already know about nonrenewable vs. renewable energy. If they are not sure, have students give their most informed guess. After students are done, discuss why they decided to place the different sources of energy in that category.
2. **Activity Embedded Assessment**
    - *Inquiry Chart:* Throughout the activity, as students learn the answers to the questions or fix previous misconceptions, or gain new understandings in a third consistent color, write them down.
    - *Teacher Rubric:* Use one rubric per student. Throughout project write down anecdotal data about students working on through and reflecting on the Engineering Design Process, soft skills emphasized throughout the activity,

3. **Post-Activity Assessment**
    - *Inquiry Chart:* Post Assessment: As a class write down any remaining new understandings, corrected misconceptions, and remaining questions. .Then, as a whole group, analyze fixed misconceptions and new understandings or remaining questions. You can tie in how scientific research is iterative because new understandings lead to new questions which leads to more research.
    - *Teacher Rubric:* Use the rubric to rate each student on completion and reflection of the Engineering Design Process, exhibition of soft skills, content knowledge and usage of new vocabulary.
    - *Non Renewable vs. Nonrenewable Energy Sort*: Have each student show you what you learned about nonrenewable vs. renewable energy.

**Activity Extensions**

- After students are done working with to see whether the Frightened Crickets work, you may have them investigate and test where they move more outside in direct sunlight, shade, through transparent or a shaded lens, sunlight through a window, using different lamps, flashlights.
- You may also have other solar powered objects already assembled for students to investigate and test as well. Afterwards, students can use backwards design to see how the products work.

**Activity Scaling**

- **For lower grades**, you may format the lesson as an investigation where students use an assembled Frightened Grasshopper, explore how it works and predict and test whether it will work with other sources of light.
- **For higher grades**, you may utilize a more complex solar powered object kit for the students such as the Solar Recycler available on amazon for $16.55, per group.

**Additional Multimedia Support**

- BrainPopJr What is Energy Video Link
- Energy Matters - SOLAR EDUCATION FOR KIDS AND TEENS Website
- NASA Video - Intro to Engineering

**References**


- "What Is Energy? - Energy Explained, Your Guide To Understanding Energy - Energy Information Administration." What Is Energy? Explained, U.S. Energy Information Administration, www.eia.gov/energyexplained/index.php?page=about_home.
- Energy Information Administration, Energy Kids Page, www.eia.gov/kids/
- https://www.ducksters.com/science/energy.php
- Self Grading Scale - http://www.morethanaworksheet.com/2015/07/23/how-to-grade-stem-projects/
- http://pz.harvard.edu/resources/see-think-wonder
- https://www.explainthatstuff.com/solarcells.html
- Engineering Design process **https://www.eie.org/sites/default/files/resource/file/edp_2015.pdf**
- Inquiry Chart Example **http://missnoonanthisisbliss.blogspot.com/2013/10/glad-guided-language-acquisition-design.html**
- Article on Social Skills - **http://www.cdl.org/articles/social-skills-and-school/**
- **List of Soft Skills - https://www.aeseducation.com/blog/2015/06/importance-of-soft-skills**


**Other**

- Information on See-Think-Wonder Process
- The Engineering Design Process in Action Overview and Video

**Redirect URL**

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**Classroom Testing Information (Anything that you changed, went well, didn't, how are you changing that to reflect that)**

**Suggestions from Kim:**

- Informal Pre and Post with energy anchor chart
- As they create their toy, have them write the instructions on how to recreate it
- Reflect on each part of the process that they happen to be in
- Soft skills in learning objective, tie in with standards, how do you assess soft skills (informal or reflective)
- Exciting

**Suggestions from Slideshow Presentation:**

- Tie in with math (conservation of energy, balancing equations)
- Rubric or sentence stems to answer questions at the end
- Having students learn about conservation of energy (what is energy?) It all comes in math
- Look at questions related to TEKS and have students answer related questions before and after the lesson
- Introduce vocabulary that may be too advanced for early exposure (photovoltaic)
- Have students test out the crickets in different settings
- Buy other solar powered objects and have students explore how they work in different settings
- Students will first be informally assessed in their knowledge about sources of energy in order to gage their learning at the end. (KWL, GLAD Strategies Chart)
- Then they will build background knowledge on sources of energy and the differences of between renewable and nonrenewable energy sources through Reading books, watching videos and possibly Reading informational articles. [Other possibilities include field trip to a solar farm, bringing in an expert]
- Then students will be reintroduced to the Engineering Design Process (I plan on doing several activities with them beforehand so that they are already familiar with it) and introduced to the problem – How can you create a toy that works/moves without batteries or being plugged in. They will be shown the parts for the Frightened Grasshopper and told to imagine how they may create a toy that works.
- In groups, they will be able to use the Engineering Design Process to plan their model by drawing, labeling and describing it, creating it, testing it and improving it. As they work, they will communicate and collaborate with their group members, record their plans, ideas and results in their Science Journal (any notebook students already use to write

down what they learn in Science).

- At the end, they will reflect on what/how they learned, whether they were successful in working coherently with a group and how they can apply what they've learned to other things.