

Solar charger kits are available for teacher check-out from the Jimmy Carter National Historic Site Education Program. Please contact Marle Usry : [marle\\_usry@partner.nps.gov](mailto:marle_usry@partner.nps.gov) for information.

### Solar Powered Plains: A Small Town with Big Sources of Energy

<b>Grade/ Grade Band:</b> HS Environmental Science, but can be used for 6 <sup>th</sup> , 7 <sup>th</sup> , or Biology	<b>Topic:</b> Solar Power, Sustainability, Renewable Energy	<b>Jimmy Carter National Historic Site Plains, GA</b>
<b>Brief Lesson Description:</b> Use solar panels as a model to understand how solar energy can be an alternative to fossil fuels.		
<b>Performance Expectation(s):</b> a. Analyze data on how solar panels turn the sun’s light into energy available for consumption. b. Differentiate between renewable and non-renewable energy sources. c. Design a model that uses the sun’s energy to power a smart phone and formulate conclusions about real life implications of the model. d. Construct an argument based on data about the risks and benefits of solar power, including environmental, social, and economic concerns.		
<b>Specific Learning Outcomes:</b> Design and build a solar-powered charging station and analyze the benefits and potential drawbacks of solar energy.		
<b>Narrative / Background Information:</b> The Jimmy Carter National Historic Site prides itself on commemorating the ideals of President Carter. One such ideal is alternative energy sources. In 2017, President Carter donated a portion of his family farmland to create a solar panel field. This land is a portion of the land that is run by the National Historic Site, so by creating curricula focused on solar energy, we are relating a component of the site and the values of President Carter to environmental issues.		
<b>Prior Student Knowledge:</b> The sun is the ultimate source of energy for all living things. Resources that are used up faster than they can be regenerated are called non-renewable resources. These are the main source of energy for the United States at this time. Fossil fuels, a non-renewable energy source, have negative effects on the environment and it is important to explore alternatives.		
<b>Science &amp; Engineering Practices:</b> Asking Questions and Defining Problems Developing and Using Models Analyzing and Interpreting Data Engaging in Argument from Evidence Obtaining, Evaluating, and Communicating Information Constructing Explanations and Defining Solutions	<b>Disciplinary Core Ideas*:</b> SEV3A: Analyze and interpret data to communicate information on the origin and consumption of renewable forms of energy (wind, solar, geothermal, biofuel, and tidal) and non-renewable energy sources (fossil fuels and nuclear energy). SEV3B: Construct an argument based on data about the risks and benefits of renewable and nonrenewable energy sources. (Clarification statement: This may include, but is not limited to, the environmental, social, and economic risks and benefits.)	<b>Crosscutting Concepts:</b> Cause and Effect Systems and System Models Energy and Matter Structure and Function Stability and Change
<b>Possible Preconceptions/Misconceptions:</b> There is no cost associated with solar energy because the sunlight is free. There are no negative effects of solar energy. All places get sunlight so all places can rely on solar energy. It isn’t possible for the country to run on renewable energy sources.		
<b>LESSON PLAN – 5-E Model</b>		
<b>ENGAGE:</b> <u>Opening Activity</u> – Access Prior Learning / Stimulate Interest / Generate Questions Show this photograph of solar panels being installed on the white house during Jimmy Carter’s presidency. <a href="https://ibb.co/MBX5nmL">https://ibb.co/MBX5nmL</a> (This is just an example, you can select any photo that you think is best.) Ask students to describe what they see and form a hypothesis about what is going on in the photo. You may need to tell them that this photo was taken on top of the White House during Jimmy Carter’s presidency.  <u>Lightbulb Model</u> Once the terms “solar panel” and “solar energy” come into the discussion, the teacher will show a model of a small photovoltaic cell (solar panel) illuminating a lightbulb. Students will be asked questions about what they are observing. Questions may include, but are not limited to: - What makes the lightbulb work?		

- What would cause the lightbulb to get brighter? Dimmer?
- What does this remind you of?
- Can you explain the transfer of energy?

**EXPLORE:**

Solar Cars

Give students each (if possible) a solar car and allow them to explore how it works. This will work best if students can go outside. Encourage students to explore different elements, such as shade, speed of the cars, and direct sunlight. While students are exploring, ask them prompting questions about what makes the cars work. The goal of this activity is for students to recognize that: (1) the amount of sunlight impacts the cars ability to move and (2) the small photovoltaic panel powers a motor on the underside of the car that spins the wheels.

**EXPLAIN:**

Give students a printed version of the “How a Solar Panel Works” PDF ([https://www.azscience.org/media/1551/how-a-solar-panel-works\\_infographic\\_revised-111715.pdf](https://www.azscience.org/media/1551/how-a-solar-panel-works_infographic_revised-111715.pdf)). Read through the document together. This vocabulary may be challenging for students, so it may be necessary to define some of the terms (listed below are some examples). These would be great words to display on a Word Wall.

As a group, discuss the difference between renewable and non-renewable energy sources. It is important for students to know that an energy source is renewable if it can be replenished naturally within a relatively short period of time. Examples include: hydropower, solar, wind, geothermal, and biofuels. Non-renewable resources are ones that are gone once they are used up or cannot be replenished as fast as they are used. Examples include: nuclear energy and fossil fuels such as coal, natural gas, and oil. Risks and benefits should be discussed.

The instructor should tie in President Carter’s focus on alternative energy, the creation of the department of energy, and the solar field at the Jimmy Carter National Historic Site. This could include a trip to the solar field to observe the panels.

“As good stewards of our land and the environment, we need to understand that clean energy generation is critical to meeting growing energy needs around the world while fighting the effects of climate change.” -President Carter, recording at the Plains Solar Field

**Vocabulary:**

photons, electrons, solar cell, circuit, current

**ELABORATE:**

Solar Chargers

Students will be given kits that contain the materials needed to create a USB charger that is powered by a small photovoltaic panel. This can be modified based on the level of the course and the students, ranging from giving them the materials and letting them create it through trial and error to giving them step-by-step instructions for the model. Teachers may want to have students design a model of their own on paper first and then discuss it prior to building. Once students create a successful model, the limitations of the model and real life applications should be discussed.

**EVALUATE:**

A final assessment on student learning will require them to use the knowledge they have acquired throughout the lesson to develop an argument based on data about the risks and benefits of solar power, including environmental, social, and economic concerns. This portion of the project may be best completed as a follow up activity to the JCNHS visit. Student arguments can be submitted in the form of a claim using the Claim-Evidence-Reasoning (CER) format, or could be modified to be a presentation or traditional essay response.

**\*Other standards that the lesson can be modified to address include:**

6<sup>th</sup> Grade-

S6E6A: Ask questions to determine the differences between renewable/sustainable energy resources (examples: hydro, solar, wind, geothermal, tidal, biomass) and nonrenewable energy resources (examples: nuclear: uranium, fossil fuels: oil, coal, and natural gas), and how they are used in our everyday lives.

7<sup>th</sup> Grade-

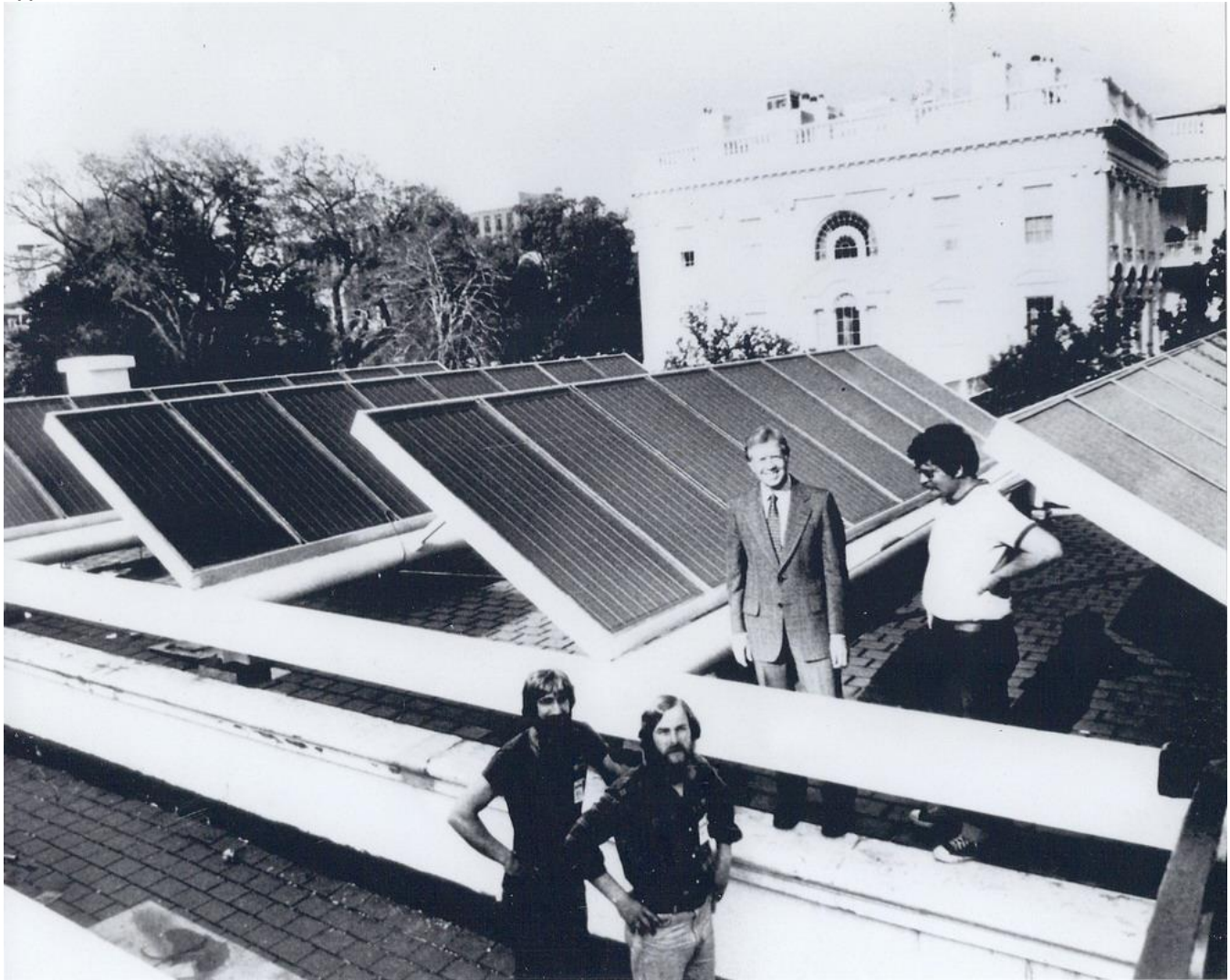
S7L4C: Analyze and interpret data to provide evidence for how resource availability, disease, climate, and human activity affect individual organisms, populations, communities, and ecosystems.

Biology-

SB5D: Design a solution to reduce the impact of a human activity on the environment. (Clarification statement: Human activities may include chemical use, natural resources consumption, introduction of non-native species, greenhouse gas production.)

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**Appendix A:** Photo of Solar Panels on the White House



**Appendix B:** Lightbulb Model setup

**Appendix C:** Solar Charger Model setup