“Solutions-Oriented Learning” Storyline

# 4-Renewable Energy: Solar

## Storyline introduction and overview:

Solar energy in the form of light is available to organisms on Earth in abundance. Natural systems and other organisms have structures that function in ways to manage the interaction with and use of this energy. In this storyline, students compare resources used for energy and their effect on the atmosphere. Students will explore how light energy interacts with materials and how light energy can be transformed into energy for heating and cooling.

**Renewable Energy: Solar NGSS Learning Progression:** The 4th grade storyline is part of a larger learning progression that includes students mastering standards pre-K to 12th grade. Look at how the 4th grade performance expectations fit in a continuum of learning for your students:

| **Placemaking:** | **Anchoring phenomena:** | **Drawdown:** |
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| Students learn how renewable energy sources are used in their region. | Images of cities before and after the 2020 Covid shutdown look different. How does the way we use our natural resources affect our environment? | Insulation<br>Solar Water |
| **Indigenous and other relevant cultural connections:**<br>Since time immemorial Indigenous peoples used the sun and materials in their environment to heat their homes, mark the passage of time and grow and harvest food. | **NGSS PEs (progress towards):**<br>4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment.<br><br>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. | |

## Estimated time required to implement this storyline: 3-4 weeks

## NGSS PEs:

**4-ESS3-1** Obtain and combine information to describe that energy and fuels are derived from natural resources and that 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.

| Science & Engineering Practice (SEP) | Disciplinary Core Idea (DCI) | Cross Cutting Concept (CCC) |
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| For 4-ESS3-1<br><br>**Obtaining, Evaluating, and Communicating Information**<br>Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods.<br>● Obtain and combine information from books and other reliable media to explain phenomena. | For 4-ESS3-1<br><br>**ESS3.A: Natural Resources**<br>Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. | For 4-ESS3-1<br><br>**Cause and Effect**<br>● Cause and effect relationships are routinely identified and used to explain change.<br>- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -<br>***Connections to Engineering, Technology, and Applications of Science***<br><br>**Interdependence of Science, Engineering, and Technology**<br>● Knowledge of relevant scientific concepts and research findings is important in engineering.<br>**Influence of Engineering, Technology, and Science on Society and the Natural World**<br>● Over time, people’s needs and wants change, as do their demands for new and improved technologies. |
| For 3-5-ETS1-2<br><br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.<br>● Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. | For 3-5-ETS1-2<br><br>**ETS1.B: Developing Possible Solutions**<br>● Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions.<br>● At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. | For 3-5-ETS1-2<br><br>**Influence of Science, Engineering, and Technology on Society and the Natural World**<br>● Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. |

## Materials:

| Learning Session | Materials |
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| Indigenous Northwest Stories of the Sun | How Raven stole the Sun book or<br>Solar Folklore stories of the Raven and the Sun |
| 7. Greenhouse Effect Demonstration | 2 clear 2-liter soda bottles (remove the label, bottle cap, and rinse it out) • Water• Duct tape (alternative: clay) • Scissors• 2 glass thermometers (alternative: digital thermometer probes) • 2-4 seltzer tablets• Tabletop lamp (at least 100W bulb) • Timer |
| 8. Passive Solar Design | Several plastic bottles filled with water<br>Framework or fish tank for the bottles<br>Thermometer |

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| 8. Insulation Investigation: Capturing the Sun’s Warmth | Each group needs:<br><br>● cardboard box (large enough to accommodate four cans with thermometers; ask students to bring from home)<br>● 4 small metal cans (all about the same size; ask students to bring from home)<br>● 4 non-mercury thermometers<br>● paintbrush<br>● 1 cup (~250 ml) sand<br>● 1 cup (~250 ml) salt<br>● 1 cup (~250 ml) water<br>● 1 cup (~250 ml) shredded newspaper<br>● Capturing the Sun's Warmth Worksheet, one per group<br><br>For the entire class to share:<br><br>● black paint<br>● newspaper (to put under the boxes while painting)<br>● masking tape<br>● marking pens<br>● measuring cups (or jars with 1 cup [~250 ml] level marked; ask students to bring jars from home)<br>● 1-2 extra non-mercury thermometers<br>● chopsticks or plastic utensils for stirring<br>● sunglasses and other appropriate sun protection<br>● several potholders or gloves<br><br>Reuse/recycling/disposal note: Recycle the cans and shredded paper. Collect and reuse the salt and sand. Throw away newspaper with paint on it.<br><br>Worksheets and Attachments<br>Capturing the Sun's Warmth Worksheet (pdf) |

## Learning Sessions

**“Solutions-Oriented Learning” Storyline**

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| 1. | **Grounding Native Ways of Knowing:** | Estimated time: 50 minutes |
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| | 1. Students will learn from a story of the Tsimshian tribe of the Pacific Northwest, that the sun is a gift for all. Connect with members of your local tribes to find out if a storyteller or a willing member of the community can tell the story “Raven and the Sun” to students. This is one of the tribal stories about the Sun found in “Tales from Many Cultures”, Solar Folklore and Storytelling compiled by Deborah Scherrer.<br>2. After the reading or telling of the story, ask students what they learned. If students don’t mention that the sun should be for all and not only for the chief, guide the conversation with more specific questions afterwards:<br>a. Do you think the sun should be only for the chief?<br>b. Do you like that the sun is there every day for all animals, plants and humans?<br>c. What benefits does the sun bring to plants, animals and humans?<br>d. Can you think of ways in which the first peoples used the energy from the sun?<br>e. Do we still use the sun in the same way?<br><br>Consider exploring the following ideas in connection with your local tribal nation:<br><br>● Sun as part of life and for everyone.<br>● Sun in relation to dwelling design.<br>● Sun used to produce and preserve food.<br>● Sun as an indicator of time and seasons.<br>● What other natural sources of energy, such as hydro- power have changed the traditional ways of Indigenous people? There are two videos that explore the effect of the dams on the Celilo villagers along the Columbia River: Echo of Water Against Rocks and Seeing Through Water<br><br>In addition to stories of the past, research and connect with tribal nations close to your community. Explore their actions to mitigate and adapt to a changing climate. To access information on how to reach out and build relationships with local tribes, visit the OSPI Office of Native Education: Partnering with Tribes webpage. | |

| 2. | **Examine phenomena: Images of cities before and after the 2020 Covid shutdown look different.** | Estimated time: 50 minutes |
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| | 1. Students observe the difference in the before and after photos.<br>a. Global: Before-and-After Photos Show Dramatic Decline in Air Pollution Around the World During Coronavirus Lockdown<br>b. U.S: Traffic and Pollution Plummet as U.S. Cities Shut Down for Coronavirus<br>c. What do you notice? What do you wonder? Chart discussion and refer to it at the end of the storyline.<br>2. Show graph of pollution levels on pg. 6 of Covid-19 Air Quality Report (Teacher background knowledge; be familiar with pgs. 1-6) | |

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| | ○ This report compares measurements of the world's deadliest air pollutant, fine particulate matter (PM2.5), prior to and during the pandemic in 10 major global cities under lock-down.<br>○ Facilitate a discussion on how to read the graph.<br>○ Draw attention to U.S. cities (placemaking)<br>○ Students will discover: Findings reveal a drastic drop in PM2.5 pollution for most global locations under lockdown conditions<br>3. Show summary/graph on pg. 4. Ask students to make claims based on information in the graph.<br>4. While ground-level air pollution poses our greatest environmental health hazard today, many sources of PM2.5 pollution, such as fossil fuel combustion, also contribute to the change in climate. |

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| **3.** | **Pre Assessment:** | |
| | 4- Renewable Energy: Solar Pre-Assessment<br>4-Renewable Energy: Solar Rubric | |

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| **4.** | **Guiding question: What are renewable and nonrenewable energy resources?** | Estimated time:<br>Two 50-minute periods |
| | Students use Elementary-Energy Handbook (print pages)to learn about different energy resources (biomass, coal, geothermal, hydropower, natural gas, petroleum, propane, solar, uranium, wind)<br>● Each student will be given a 1-page resource to create an infographic (or other activity) that includes:<br>○ Characteristics<br>○ Renewable or nonrenewable<br>○ How it is used.<br>● Share with class orally or a gallery walk | |

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| **5.** | **Guiding question: Does CO2 emitted from fossil fuels cause an increase in global temperatures?** | Estimated time:<br>Two 50 minute periods |
| | 1. Discuss the interactive graphic Greenhouse Effect.. Have students show their understanding by drawing the components of the Greenhouse effect in their science journals and explain what fossil fuels are and how they affect the earth's temperature. | |

2. Students can demonstrate the natural Greenhouse Effect through How-To Guide: Greenhouse Effect Demonstration
    - When completed ask, Which bottle is showing a higher temperature? Why?
    - How does carbon dioxide affect atmospheric temperature?
    - How does this activity demonstrate the greenhouse effect that naturally occurs in Earth's atmosphere?
3. Students will compare their energy profile to other regions by typing in their zip code in the Power Profile of Energy and the Environment. Students will generate the following information:
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    - Identify the %'s of different kinds of resources that are used in your area to generate electricity.
    - Determine whether the resources are renewable or nonrenewable.
    - Determine the emission rates of carbon dioxide and other greenhouse gases. (click on small boxes) of each resource.
    - Discover the kind of energy resource that is used most in your area to generate electricity.
    - Make connections between human activities of burning fossil fuels and the earth's atmosphere.

| 6. | **Guiding question: What are some of the criteria and constraints in using renewable energy sources?** | Estimated time: 50 minutes |
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Energy Island is a true story about a community that worked together to become independent of nonrenewable energy. Students watch the video Energy Island to identify/ write down the different kinds of energy and how each was used.

- What are some of the solutions proposed by the Sumso students?
- What are the criteria for choosing those solutions?
- What are some of the reasons that some of the Sumso residents did not want to change to renewable energy sources (constraints)?
- How did the community of Energy Island make such a big change from nonrenewable energy sources to renewable energy resources?
- Answer the question from the story: How can you make a difference on your island? (could make ELA connection)

| 7. | **Guiding question: How is solar energy used as a renewable energy resource?** | Estimated time: Two or three 50 minute periods depending on speaker |
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- Play the video What is Solar Energy?
  This video compares solar energy to other energy resources, ways to harness solar

energy, challenges of solar energy.
  - Before showing the video, state that the sun's rays are not heat; they need to hit matter for heat to occur.
  - Discuss guiding question

- Invite a community member who uses solar energy to talk to the students.
- Students are presented with the claim: "Using Solar energy as a resource rather than fossil fuels reduces carbon dioxide in the atmosphere." Students use evidence from the above activities to support this claim.

| 8. | **Guiding question: How is solar energy a better solution for heating than nonrenewable energy resources?** | Estimated time: Three 50-minute periods |
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1. How do animals manage solar energy in their environment? Examples: snakes, desert animals, polar bear. Students pick an animal and research how their choice uses the sun and prepare a short presentation for their peers.
2. How can we use energy from the sun's rays to heat our homes? Can we determine the effectiveness of different insulation materials?
   - Investigation: Capturing the Sun's Warmth. Students will investigate the thermal energy storage capacities of different test materials to determine which to use in passive solar building design.

3. How can we manage solar energy to keep a home cool? Students build a water wall (out of plastic bottles or use a fish tank filled with water). See Passive Solar Design: Water Wall Heat Sinks. Place a light source on one side of the "wall". Students take the temperature of one side of the "wall" and then the other side to compare.

4. Revisit wonder/notice chart from Phenomena (2.). Discuss old and new thinking.
5. Students are presented with the claim: "Using solar energy as a resource rather than fossil fuels reduces carbon dioxide emissions in the atmosphere."
   a. Students find 3 pieces of evidence from the above activities to support this claim.
   b. Students find a picture (photo) on the internet of a building that is using passive solar energy to use in c.
   c. Students design another infographic - this one specific to solar energy that displays the evidence from above

| 9. | **Post Assessment:** | |
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| | **4-Renewable Energy: Solar-Post Assessment**<br>**4-Renewable Energy: Solar Rubric** | |

# 4-Renewable Energy: Solar

| 10. | Possible next steps: Extension Activities | |
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| | 1. Exploring Solar Energy Student Guide (7 Activities)<br>2. Map a Career in Clean Energy<br>3. Use AirVisual to see air quality anywhere | |

## 4-Renewable Energy: Solar OER Tracker

Pacific Education Institute would like to acknowledge and thank the writing team for their work. The team included Kim VanEaton, Kristina Butler, Candy Kristovich, Lourdes Flores and Shelley Stromholt. In you have comments or questions please contact info@pacificeducationinstitute.org