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COMMUNITY RESOURCES FOR SCIENCE

BASIS Lesson Plan

Lesson Name: What is Renewable Energy?: Renewable Energy and Energy Transfer

Grade Level Connection(s)

NGSS Standards: Grade 4, Physical Science (4-PS3)
Grade 4, Earth Science (4-ESS3)
FOSS CA Edition: Grade 3, Physical Science (Matter and Energy)

**Note to teachers: Detailed standards connections can be found at the end of this lesson plan.*

Teaser/Overview

What are the different forms of energy? What is renewable energy and why is it important? Students will learn about renewable energy and solar energy through three fun activities! A mini-water mill demonstrates how water can be reused, a solar-powered car shows how light energy can be converted to chemical energy and electricity, and a small wind turbine demonstrates how the power of wind provides energy. We want to emphasize the benefits of energy from renewable sources versus energy from fossil fuels, and get students talking and thinking about energy in new ways!

Lesson Objectives

- Students will discover ways of transferring energy and how to maximize energy conversion.
- Students will learn about the importance of renewable energy and how renewable source contrast with fossil fuels.
- Using scientific models, students will test hypothesis and record their observations.

Vocabulary Words

- Energy source
- Renewable
- Fossil fuel
- Climate change
- Hypothesis

Materials

Scientist Volunteers will bring:

- 3 solar car kits
- 2 "sun" lamps
- 3 water mills
- 3 plastic cups
- 3 basins to catch water
- towels for cleanup
- 3 wind turbines
- 1 electric fan
- 2 handheld fans
- 25 in class worksheets for recording observations
- 25 worksheets for review

Materials teachers should provide:

- Pencils
- Something for students to write on (ie. a clipboard or a hardcover book)

Classroom Set-Up

Students will start the lesson sitting at their desks and should then be divided into 3 groups that will rotate through three stations. We need access to water from the faucet, two outlets, and chalk/whiteboard for writing student responses. If time allows, we will be lighting a very small, contained flame (candle) at the end of the lesson. It would be very helpful to have the students wear nametags during the lesson!

Classroom Visit

1. Introduction (18 minutes)

Role Model Introduction:

Introduce volunteers by name. We are studying chemistry at UC Berkeley. Brief, simple explanation of our research.
Tell students what "grade level" we are in. (e.g. 19th grade)
What is our path through school to get to that many grades?

Elementary school (5th grade), middle school (8th grade), high school (12th grade), college (16th grade), and then graduate school

What is graduate school?

We work in a lab to try to discover new things about chemistry that no one has ever known before.

Topic Introduction:

General phenomenon: Have all the students do 5 jumping jacks. Doing jumping jacks takes energy, where does your energy come from? Where do plants get their energy? What other energy sources are there?

Further questions: What is energy? What do you think about when you hear the word energy? Think about where you can get energy and what you can do with it.

[Small group discussion]

Sort ideas from discussion time into **energy sources**, storage, and uses:

Energy Sources	*Energy Storage*	*Energy Uses*
Fossil fuels	Batteries	Movement (e.g. running)
Sun	Water behind a dam	Electricity (e.g. lights)
Wind	Food	Transportation
Water	Biofuels	Temperature control

We can group the things you've mentioned into two (or three) categories. Energy can go from one form to another.

Some of the energy sources you mentioned (gasoline, coal, natural gas) have a special name, **fossil fuels**. Does anyone know where fossil fuels come from?

Fossil fuels are created when plants decompose and are buried under the surface of the earth.

How long do you think it takes for a plant to be converted into fossil fuels?

300 million years. That is older than the oldest grandma! The plants that made the fossil fuels that we are using now were alive before dinosaurs.

We need an energy source that is not used up like fossil fuels. We call these sources **renewable energy.**

Break down 'renewable' into its prefix, root, and suffix.

Can you think of examples of things that are renewable?

[Small group discussion]

Hair, fingernails, lizard tails, starfish arms, shark teeth, etc.

Are any of the energy sources you mentioned earlier renewable?

Solar, wind, and water energy

These energy sources do not get used up.

2. Learning Experience (25 minutes)

We have models of 3 different ways we can harness renewable energy. Explain each and why they are renewable (see below). We are going to thing about how these machines transfer renewable energy into forms we can use. We also want to figure out how to get the most energy out of each of our models.

Each student will get a worksheet to use like a lab notebook. At each station, you are going to make a hypothesis (an educated guess) about the best way to get the most energy out of the model system. On the worksheet they will describe how they tested the hypothesis (the experiment) and what the results were (observations).

In the small groups talk about how the models compare to actual wind turbines, watermills, and solar panels.

<u>Hands on Stations: (students will rotate among the stations, spending 8 minutes at each station)</u>

A. "Using water as a Renewable Resource"

- Students will take turns pouring cups of water over the water mill, experimenting to determine the best place to pour the water (on the axle or off-center?).
- Students will make and test hypotheses about whether plastic spoons, plastic forks, or plastic knives would be more effective blades.
- Bonus: Students can experiment with varying the height of the cup above the water mill and see how that affects the speed.
- Why is it renewable? We can reuse the water in the bucket over and over again.
- The station volunteer will ask the students questions: Is there somewhere in the real world where water can turn the blades on its own? Why is it useful to spin a wheel with the flowing water? Can we convert the spinning kinetic energy into another type of energy?
- The volunteer will demonstrate a model water mill powering an LED light.

B. "Getting Energy from Sunlight"

- Solar car kits will be partially assembled. Students will predict where the light should shine in order to power the car. (solar cell)
- Students identify the parts of the car (body, wheels, motor, and solar cell) and try to figure out why the car does not move when the wires between the solar cell and the motor are disconnected.
- Each student will have the opportunity to "test drive" the solar cars by aiming the lamp at the solar cell.
- Why is it renewable? We can always get more energy from the sun.
- Questions: How does the light energy travel and how is it changed as it moves from the lamp to the wheels? What happens to the car if we switch the wire leads?

C. "Getting Energy from Wind"

- Students take turns holding small wind turbines in front of an electric fan to try to turn on the LED light connected to the turbine.

- Students will test three different blade sizes and make predictions on which will work the best. They can test which works the best at a fixed distance from the fan and which works at the greatest distance away from the fan.
- Why is it renewable? We just have to wait for more wind to get more energy.
- Questions: What effect does the fan speed setting have on the wind turbine? What effect does the distance from the fan have on the turbine? What happens if you turn the turbine sideways so that it is facing 90 degrees away from the direction of airflow? What happens if you turn the turbine around so that it is facing the opposite direction of airflow? Can you think of any modifications you could make to this wind turbine to improve its performance?

3. Wrap Up: Review and Discuss the Learning Experience (5 minutes)

- What did we learn about? Tell us one thing you learned from each station. Write points on the board.
- What are the types of renewable energy we learned about and what are their advantages?

4. Connections & Close (7 minutes)

Connections to the real world around students:
Does anyone know of a reason why we might not want to use fossil fuels?
[Small group discussion]

- Burning fossil fuels causes **climate change**. This means that temperatures change [Graphic of global temperature changes], ice caps melt, sea levels rise, and droughts and other extreme weather events occur more frequently. Farmers, people who live on the coast, and people in California are strongly affected by climate change.
- Burning fossil fuels also contributes to pollution. Asthma rates are on the rise. Maybe you have heard about the air pollution in China? Sometimes, fossil fuels can spill, making drinking water unsafe and killing the animals and plants that depend on the water.
- We will run out of fossil fuels around 2050. It will take 300 million years to make more. Can we safely use all the fossil fuels in the ground? No.

Fossil Fuel Demonstration (optional) - Light a small flame in a beaker and watch it burn up all the fuel. Where did the fuel go? What do we have to do if we want another fire?
Compare fossil fuels to renewable energy sources and reiterate why renewable sources are a better choice.

(As an informed citizen you have a civic duty to act based on these facts. What can you do?)

Close:

Opportunity for students to ask questions about the lesson, science, and being a scientist.

Follow Up: After the Presentation

Teachers who wish to extend the impact of this lesson may find the following CRS web pages useful:

- http://www.crscience.org/educators/helpfulreports
- http://www.crscience.org/educators/treasuretrove

Standards Connections

Next Generation Science Standards (NGSS):

- Connections by topic
  - Physical Science: 4. Energy
  - Earth Science: 4. Earth & Human Activity
- Connections by disciplinary core ideas
  - Physical Science: 4-PS3 Energy
  - Earth Science: 4-ESS3 Earth and Human Activity
- Connections by scientific & engineering practices
  - 1. Asking questions and defining problems
  - 3. Planning and carrying out investigations
  - 6. Constructing explanations & designing solutions
- Connections by crosscutting concepts
  - 2. Cause and effect: Mechanism and explanation
  - 5. Energy and matter: Flows, cycles, and conservation
- Connections by performance expectation
  - 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.

FOSS CA Edition:

Grade 3 Physical Science: Matter and Energy, Investigation 1 (Energy)