Bay Area Scientists in Schools Presentation Plan

Lesson Name Renewable Energy & Climate Change
Presenter(s) Chemistry Grad Students
Grade Level 3rd

California Science Standards Connection(s)

Physical Science: Energy comes from the Sun to the Earth in the form of light. Energy can be stored in many forms.

Next Generation Science Standards:

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.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (**4-PS3-3**) Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (**4-PS3-2**)	PS3.B: Conservation of Energy and Energy Transfer • Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (**4-PS3-2**),(**4-PS3-3**) • Light also transfers energy from place to place. (4-PS3-2) • Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (**4-PS3-2**),(**4-PS3-4**) ESS3.A: Natural Resources • 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. (**4-ESS3-1**)	Cause and Effect • Cause and effect relationships are routinely identified and used to explain change. (**4-ESS3-1**) Energy and Matter • Energy can be transferred in various ways and between objects. (**4-PS3-1**), (**4-PS3-2**),(**4-PS3-3**),(**4-PS3-4**) Connections to Engineering, Technology, and Applications of Science Interdependence of Science, Engineering, and Technology • Knowledge of relevant scientific concepts and research findings is important in engineering. (**4-ESS3-1**)

Common Core Standards:

ELA/Literacy:

W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.

Mathematics:

MP.2 Reason abstractly and quantitatively.
MP.5 Use appropriate tools strategically.
MP.4 Model with mathematics.

FOSS Connections:

Grade 3 Module: Matter and Energy
Investigation 1: Energy

Abstract: Students will learn about the important concepts of renewable resources and solar energy through three fun activities! First, a mini-water mill to demonstrate how water can be reused. A solar-powered car shows students how light energy can be converted to chemical energy and electricity. Finally, students will experiment with the size of blades and orientation of the wind on a small wind turbine. We want to emphasize the benefits of energy from renewables versus energy from fossil fuels, and get students talking and thinking about energy in new ways.

Vocabulary/Definitions: 3 – 6 important (new) words

- Energy source
- Fossil fuels
- Climate change
- Renewable

Materials:

What will you bring with you?

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

What should students have ready (pencils, paper, scissors)?

None

Classroom Setup:

Need water from the faucet.
Students should be divided into 3 groups for activities.
Chalk/whiteboard for writing student responses.
Helpful: Students should be wearing nametags.

Classroom Visit

1. Personal Introduction _____3___ Minutes

Introduce volunteers by name. We are studying chemistry at UC Berkeley.
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.

2. Topic Introduction: _____20__ Minutes

A. Energy

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

B. Energy Sources

a. Fossil Fuels

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.
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.
- 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 the dinosaurs!

- 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.

b. Renewable

What can we use for our power besides fossil fuels? We need something that does not get used up. The word for this is **renewable**.

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 there any of the energy sources you mention earlier that are renewable?

Solar, wind, and water energy

3. Learning Experience(s): 25-30 Minutes

Divide students into 3 groups. They will rotate among the following hands-on stations.

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.
- 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.
- 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 a small wind turbine in front of an electric fan to try to turn on the LED light connected to the turbine.
- Questions: What effect does the fan speed setting have on the wind turbine? Wat 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?
- Students take turns testing the small wind turbine with the larger blades.

3. Wrap-up: Sharing Experiences **____5____ Minutes**

- What did we learn about? Write points on the board.
- What are the problems with fossil fuels? It takes too long for plants to be turned into fossil fuels. When you poured the water through the water mill, you collected the water back at the end, and you get to use it again. Do you get the gasoline back after your car uses it? Pollution from fossil fuels harms the environment and harms our health.
- What are the types of renewable energy we learned about and what are their advantages?

4. Connections & Close: **____2____ Minutes**

- Try to think about energy sources and uses throughout your day. Anytime you see something moving or producing heat and light, ask yourself where does it come from? How do we get the energy to cook our food? Or to turn on a flashlight? There are many sources of energy, and only some of them are renewable.
- Think about how important energy is to your life. Can you think of anything you do that doesn't require energy? What would your life be like if we didn't have any sources of energy?

Total: 50 – 60 Minutes

Differentiated Instruction:

English Learners: Repeat directions, if necessary, and physically model how to use the watermill and solar car. Write vocabulary, e.g. energy, fossil fuel, on the board and read words aloud. Vocabulary words can also be visually demonstrated using an illustration or action and redefined in very simplistic terms.

Advanced Learners: Have students think of other energy forms besides water and solar energy. Students can write down their ideas and discuss uses for these types of energy forms.

Super Advanced Learners: Discuss potential and kinetic energy, chemical energy.

Follow-up Possibilities

ELA Activity:
Students answer the following prompt:
"Write a letter to a friend explaining what you learned about renewable energy."

Students can write a letter to their parents or to the governor's office about why it's important to use renewable energy.

Reading Connections:
- Fossil Fuel Power by Josepha Sherman - Introduces the history, uses, production, advantages and disadvantages, and future of fossil fuel energy as a power resource. http://books.google.com/books/about/Fossil_Fuel_Power.html?id=IZH-qAlDtFAC

- Global Warming by Seymour Simon - In the brilliant Seymour Simon format, this book provides a photo essay examining global warming and the devastating facts regarding this enormous world issue. This NSTA/CBC Outstanding Science Trade Book for 2011 presents the facts in a clear text within the range of most readers from middle elementary to secondary level. http://www.nsta.org/recommends/ViewProduct.aspx?ProductID=20612

- How We Know What We Know about Our Changing Climate: Scientists and Kids Explore Global Warming by Lynne Cherry and Gary Braasch http://www.amazon.com/Know-What-About-Changing-Climate/dp/1584691034

- 365 Ways to Live Green for Kids: Saving the Environment at Home, School, or at Play – Every Day! By Sheri Amsel http://www.amazon.com/365-Ways-Live-Green-Kids/dp/1605506346

- The Everything Kids' Environment Book: Learn how you can help save the environment – by getting involved at school, at home, or at play by Sheri Amsel http://www.amazon.com/Everything-Kids-Environment-Book-environment/dp/159869670X/ref=pd_sim_b_2

- The New 50 Simple Things Kids Can Do to Save the Earth by Sophie Javna http://www.amazon.com/Simple-Things-Kids-Save-Earth/dp/B003F76HOS/ref=pd_bxgy_b_img_b

Mathematics Activity:
Have students calculate the average speed or distance traveled by the solar car.

Other:
Students can make a list of energy sources and their pros and cons.
This website has fun activities about energy efficiency and renewable energy sources: http://www.eere.energy.gov/kids/. They also have a list of energy related lesson plans for teachers.

Build a Reflective Solar Marshmallow Cooker - In this activity, learners use the Sun's energy to cook marshmallows. Learners construct the solar oven out of simple everyday materials. They experiment to see how the color of the marshmallow (vanilla or chocolate) and height of the straws affect cooking time. Use this activity to introduce learners to solar energy and reflection. Note: this activity requires adult supervision. http://stardate.org/teachers/activities/cooker

Activity Directions: http://stardate.org/sites/default/files/ReflectiveSolarCooker.pdf

This reflective solar cooker uses the Sun's energy to cook marshmallows. The target cooking area is the space where the light concentration is greatest. Never look directly at the Sun! It could damage your eyes. Don't allow the cooker to reflect sunlight into your eyes. This activity requires adult supervision.

Materials

- shoebox
- aluminum foil
- string
- tape
- straws
- manila folder
- marshmallows (white and chocolate, or other color)

Preparation

1. Cut slots of equal length down the short sides of the shoebox opposite each other. Draw a scale, beginning with zero at the top, along each slot. Then cut diagonal slits at the corners of the box for the string.

2. Cut a manila folder in half along the fold. Place one half inside the shoebox, so that the folder bows into a curved, half-pipe shape resting on the bottom of the box. Fasten with tape in this shape to the box.

3. Lay a sheet of aluminum foil, shiny-side up, along the curved folder. Tape it to the box, fitting it to the folder shape.

4. Cut two 20-inch lengths of string. Knot each at one end. Floss the knotted ends into slits A and B. Drape the string inside the box, and insert the other end into slits C and D.

Experiment

1. Place one white marshmallow onto a straw near the end, and a colored marshmallow (or more, if you have several colors) on a second straw.

2. Snip a slit at one end of the second straw and join the slit end to the other straw. Space the two marshmallows an inch or two apart from each other.

3. Lay the straw into the slot so that the marshmallows are near the center of the box. The straws should rest on the string at both ends.

4. Pull on both strings to bring the straw to the first level from the bottom.

5. Direct the box toward the Sun; prop it up. Allow the marshmallows to cook for a specified time.

6. Repeat with another set of marshmallows at a different height for the same length of time.

Analysis

1. Why is the shiny surface curved? Would this work if it were straight?

2. Did the color of the marshmallow make a difference? Why?

3. Did the height of the straws make a difference? Why?

Answers

1. It is curved to focus the sunlight. A straight surface will reflect but not focus light.

2. The darker marshmallows should cook faster, since white reflects rather than absorbs energy. (This is the reason you are cooler when you wear white clothes in the sunlight than when you wear dark colors.)

3. When the straws bring the marshmallows where the Sun's energy is most concentrated, the marshmallows will cook fastest. Imagine that the reflecting surface is part of a circular pipe (depending on the shape of your box, it may not be perfectly circular). The focus is one half of the radius of this pipe.