Explore Renewables: Grades 6-8 Lesson Guide

Summary Page

Lesson Objectives: Students will be able to:

- Define renewable energy
- List at least three types of renewable resources
- Explain why renewable resources are important
- Identify the role of a turbine regarding renewable resources
- Explain the current and future renewable resources
- Identify the disadvantages of renewables and explain how to solve the problems
- Explain the advantages and disadvantages of large power plants
- Define distributed generation and identify its advantages
- Define a microgrid and Smart Grid
- Explain why it is important to use a combination of renewable resources
- Design and build a solar oven focusing on variables which improve its design
- Calculate and compare the pounds of coal or square footage of solar panels needed to produce enough electricity to power a school.
- Given financial and environmental restrictions, determine the ideal power mix (sources of electricity) for a hypothetical utility company.

Lesson Overview: In this overview lesson which introduces renewable energy, students will learn what it is, how it is made, and why it is important.

Activity 1: Electrico Power Mix Science, Math 1 hour

Students will weigh the financial and environmental costs of renewable and non-renewable energy sources as they are tasked with determining the power mix (sources of electricity) for a hypothetical utility company called Electrico. Students will be given a variety of renewable and non-renewables sources of energy too choose from, but must follow a budget both in dollars and carbon dioxide emissions.

Activity 1 Materials: Copies—1 per student or group—of the "Electrico Power Mix Worksheet" available in the "Related Resources" section of the 6th-8th grade *Explore Renewables* lesson on PowerSaveSchools.org/lesson-plans (password: efficientteacher). Coloring materials (7 colors of pens, pencils or markers).

Activity 2: Build a Solar Oven Science, Math 1.75 hours (1 hours for building ovens, 30 minutes for testing overs, and 15 minutes for discussion)

Students will analyze and experiment with the variables that create an effective solar oven.

Activity 2 Materials: Shoe boxes; different color construction paper (including black and white); cellophane wrap; tin foil; paper cups; thermometers.

Activity 3: Coal vs. Solar Science 20 minutes

This is an analytic activity to examine the amount of electricity used by your school, and then calculate the amount of coal and the square footage of solar panels that would be required to provide that electricity. Extensions are suggested to look at the relative carbon footprints and financial costs of solar vs. coal over 5, 10, and 20-year increments.

Activity 3 Materials: Calculators

Standards Correlations:

Next Generation Science Standards: Middle School

Physical Science: PS3-3
Earth and Human Activity: ESS3-1; ESS3-3; MS-ESS3-5
Engineering Design: ETS1-2, ETS1-3

Common Core Math Standards: Grades 6 - 8

6.P.3.C; 6.RP.3.D; 6.SP.1, 2, 3; 7.GA.1

Common Core English Language Arts Standards: 6 – 8

RST3, 7

**Note: many standards overlap between grade levels.*

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Flipped Lesson

Introduction: Introduce Renewable Energy to the class.

Conduct a brief discussion asking students some basic questions about renewable energy in order to determine their level of prior knowledge.

- What do you think of when you hear the word renewable energy?
- Do you know if you used any renewable energy today?
- What are some examples of renewable energy?
- Why is renewable energy important?

Content:

1. Explain that you want students to have a richer background in order to have a more in depth discussion in class AND to have time in class to do more activities after they learn the content.
2. Vocabulary: There is no prerequisite vocabulary needed before watching the video. Students may already be familiar with some of the vocabulary introduced in the video. Vocabulary that will be discussed in the video includes the following words: carbon dioxide (CO_2), climate change, renewable energy, geothermal, biomass, turbine, hydroelectric, tidal dams, transmission lines, solar thermal energy, photovoltaic cells, photons, biofuels, ethanol, distributed generation, electrical grid, smart grid
3. Introduce the video. Show students how to locate the video online at PowerSaveSchools.org/students (password: energy), under the 6^{th}-8^{th} grade *Explore Renewables* Lesson. Students will need to enter the password to view the video and quiz. Explain to students that they will be asked a few questions immediately after the video. The script for the video, quiz answers, and all other lesson plan resources for teachers can be found here: PowerSaveSchools.org/lesson-plans (password: efficientteacher), under the 6^{th}-8^{th} grade *Explore Renewables* Lesson. Please DO NOT give out this teacher information to students.
4. Remind students that this is like any other assigned homework, and not an optional assignment. They must watch the video outside of class in order to be able to participate fully in the fun activities that will follow in class.

Classroom Follow-Up Activities:

There are several options for activities following the delivery of content. We suggest that the following activities be done in the sequence listed below, but teachers may choose the combination of activities which best fits their own teaching situation, together with the results of the on-line assessment and class time schedule.

1. **Brainstorm**: What is renewable energy and why is it important? Guided questions:

a. Ask students, what is renewable energy? What are some examples of sources of renewable energy?
b. In the U.S., does most of our energy come from fossil fuels or renewable energy? (*answer: fossil fuels)*
c. Why is it important that we produce electricity from renewable sources?

2. **Short Discussion / Transition**: Pair and Share
   a. In pairs: Tell a partner about any renewable energy power plants you've seen before, such as a solar array or wind farm.
   b. Pick 3 different sources of renewable energy and discuss at least 1 pro and 1 con of each source.
   c. Given what you know about renewable energy sources, choose 2 sources that you think would be the best sources for providing electricity for your town or city. [*If students live in a windy part of the country, wind power would be appropriate, hydropower would be appropriate if students live near a body of water, etc.*]

3. **Activity 1: Electrico Power Mix**
   a. Preparation:
      i. Print copies—1 per student or group—of the "Electrico Power Mix Worksheet" available in the "Related Resources" section of the 6th-8th grade *Explore Renewables* lesson on PowerSaveSchools.org/lesson-plans (password: efficientteacher).
      ii. Students will also need coloring materials (7 colors of pens, pencils or markers).
   b. The activity
      i. Tell students their assignment is to determine what sources of energy a hypothetical utility company called Electrico, will use to make their electricity. The options include renewable sources (solar thermal and photovoltaic, wind, hydroelectric, and geothermal) and non-renewable sources (coal and natural gas). The financial cost and pounds of carbon dioxide emitted per gigawatt-hour (GWh) of each source are as follows (Sources: http://www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf, http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html#footnotes). The number of sources is limited to allow students to complete the activity in a reasonable amount of time.

Source	Price per gigawatt-hour (1 gigawatt hour=1,000,000 watt hours) (Source: U.S. EIA)	Pounds of carbon dioxide emitted per gigawatt-hour (Source: EPA)
Solar Thermal	$261,500	Negligible because no fuels are combusted.
Solar Photovoltaic	$144,300	Negligible because no fuels are combusted.
Wind	$86,600	Negligible because no fuels are combusted.
Hydroelectric	$90,300	Negligible because no fuels are combusted.
Geothermal	$89,600	Negligible because no fuels are combusted.
Coal	$100,100	2,249,000
Natural Gas	$67,100	1,135,000

ii. Students will demonstrate their choices through the graph on the "Electrico Power Mix Worksheet." See the worksheet for further instructions.

iii. An answer key with justification is available in the "Electrico Power Mix Worksheet Answer Key" available in the "Related Resources" section of the 6th-8th grade *Explore Renewables* lesson on PowerSaveSchools.org/lesson-plans (password: efficientteacher).

c. Reflection:

i. After students are done with the worksheet, discuss the following questions as a class. *Potential answers are given in italics.*

1. Which source of electricity did you use the most of? Why?
    a. *Wind energy because it was the cheapest renewable source of energy and doesn't emit any significant carbon dioxide.*
2. Which source of electricity did you use the least?
    a. *Coal and Natural gas because they emit a lot of carbon dioxide and only 20,500,00 pounds of carbon dioxide were allowed*
3. Why couldn't Electrico use entirely renewable sources of electricity? What needs to happen to allow utility companies to use more renewable energy?
    a. Renewable energy is currently generally more expensive than fossil fuels. Of course, this does not take into account the costs of the environmental damage caused by fossil fuels. However, most utility companies are not responsible for paying for this environmental damage.

b. *Carbon taxes, which add a tax based on carbon emissions, would raise the price of fossil fuels and make renewables more competitive financially.*
c. *State and federal policies requiring a certain percentage of renewable energy in a power mix will raise the demand for renewable energy, which will lower prices over time.*

4. **Activity 2: Build a Solar Oven**
    a. Introductory discussion *(with potential answers in italics)*
        i. How does a solar oven work?
            1. *Solar ovens collect light energy from the sun, convert that energy into heat, and then use that to warm (or even cook) food.*
        ii. What factors affect the temperature in a solar oven? What materials make a good solar oven?
            1. *Reflection and Concentration of the sun's rays- directing the sun's rays as much as possible into the solar oven will increase the temperature. Aluminum foil reflectors can be used to direct the sun's rays into the box.*
            2. *Heat absorption- dark colors absorb heat better than light colors. Lining the bottom of a solar oven with black construction paper, for example, will raise the temperature.*
            3. *Heat retention- The more heat you can contain in the box, the hotter it will get. Using a transparent material like cellophane—that allows light in, but helps block heat loss—will increase the temperature.*
    b. The activity
        i. Ask students to design a solar oven either in class or as homework.
            1. Break students into teams of 2-3.
            2. Teams will compete to see whose oven can reach the highest temperature in 30 minutes.
            3. Teams can use the following suggested materials, and can experiment with their own designs.
                i. Materials: Shoe boxes; different color construction paper (including black and white); cellophane wrap; tin foil; paper cups; thermometers.
            4. Students can draw and describe the design of their solar oven using the "Solar Oven Worksheet" available in the "Related Resources" section of the High School *Explore Renewables* lesson on PowerSaveSchools.org/lesson-plans (password: efficientteacher).
            5. When they've completed their designs, the students will place the paper cup upside-down in the box, and place the thermometer on top of the cup (to measure the ambient temperature inside the box.)

ii. Have the students lay their boxes in the sun. After 30 minutes, take a temperature reading of each of the boxes. Whoever's is the highest, wins!

c. Reflection:
   i. Ask students:
      1. Which oven achieved the highest temperature? Why?

d. Extension:
   i. Those students who are inspired can create their own solar ovens at home, building on what they've learned, but using any materials they'd like (glass, plastic enclosures, mirrors, etc.) to see how hot they can get their ovens.
   ii. If students can get their ovens hot enough, consider cooking a treat for the class (i.e., s'mores.)

Closure and Next Steps:

1. Review
   a. Review the major concepts covered in the video or traditional lesson content.
      i. Review the definition of renewable energy.
      ii. Review the pros and cons of at least 3 sources of renewable energy.
      iii. Review why renewable resources are important
      iv. Review the definition of distributed generation and identify its advantages
      v. Review the definition of a smart grid and why we need a smarter electric grid
      vi. Review why it's important to use a combination of renewable energy sources in addition to practicing energy efficiency and demand response
   b. Briefly discuss and review the activities that students have completed.
2. Brainstorm
   a. What can students do to encourage your city, state, and/or the country to use more renewable sources for electricity generation? [*In the short term, students can join local campaigns to support renewable energy projects, research ways to bring on-site renewables such as solar thermal or PV to their school or homes, etc. In the longer terms, students can pursue green careers in the fields of renewable energy or policy.]*
3. Make a plan for next steps to be done.
   a. Which of the brainstorm ideas can you implement?

Assessment Opportunities:

Informal Assessment can occur throughout the lesson.

- Following the viewing of the video lesson, students' answers to the embedded follow-up questions will help teachers assess their understanding of the information presented in the video.

- Teacher observations of students' participation during the brainstorming session and discussion / transition discussion between the video viewing or lesson presentation and the activities will also help teachers assess their understanding of the information presented in the video.
- Teacher observations of formal discussion at the end of the "Electrico Power Mix" activity.
- Teacher observations of formal discussion during the "Coal vs. Solar" activity.
- Teacher observations of formal discussion during the "Build a Solar Oven" activity.

Graded Assessment opportunities

- Teachers can grade the "Electrico Power Mix" activity worksheet.
- Teachers can grade student's solar ovens made during the "Build a Solar Oven" activity. An example engineering and design rubric, such as the one found here: http://scholar.lib.vt.edu/ejournals/JITE/v44n1/asunda.html.