Energy Resource Demonstration Grades 9-12

Lesson developed by the Center for Climate Protection for use in the ECO2school Youth Leadership Program

Time: One class period 45-50 minutes

Summary:
Students will participate in simulations that demonstrate society's use of renewable and non- renewable energy resources to understand the factors that make a renewable energy resource sustainable. They will identify and define renewable and nonrenewable energy resources and explain the differences between them.

Next Generation Science Standards:
HS-ESSE-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratio.

Engaging in Argument from Evidence
Disciplinary Core Ideas
ESS3.A: Natural Resources,
STS1.B: Developing Possible Solutions
Crosscutting Concepts
Influence of Science, Engineering, and Technology on Society and the Natural World
Science Addresses Questions About the Natural and Material World

Preparation:

- Plan on arriving a half hour before your first presentation. Check in at the office and confirm school visitor procedures.
- Familiarize yourself with background knowledge and be prepared to ask and answer students questions to facilitate the understanding of key concepts.
- Use materials check list for each activity to prepare supplies
- Make a class set of the Making Connections hand out and the Vocabulary hand out

Background for Facilitator and Assumed Prior Student Knowledge:

Without a basic understanding of energy, energy sources, generation, use and conservation strategies, students cannot make informed decisions on topics ranging from smart energy use, consumer choices and local, national and international energy policy [(1)]. An energy

Facilitators note: Key vocabulary is bolded and defined on the Energy Literacy vocabulary worksheet.

literate student understands the impacts and consequences of energy use in current national and global issues related to fossil fuel supply and climate change.

Over time humans have developed an understanding of energy that has allowed us to use it beyond basic survival but to improve our standard of living. Access to energy resources is taking place a disparate rates in different countries across the world. Accessibility to energy has a major impact on our ability to thrive. It is deeply connected to industry, urban development, transportation and agriculture. In 2011 there were 1.3 billion people on earth without access to electricity.[(2)] Accessibility to energy resources and the production of energy have had and will continue to have impacts and consequences both good and bad. Awareness of what energy we use and how we use it is important if society is going to minimize waste and maximize efficiency. Society will continue to develop rules and regulations to minimize negative consequences. As new information technology become available energy policies are reevaluated.

We transfer and transform energy from the environment into forms we use for power. The availability of energy resources is constrained by the distribution, availability and affordability of natural resources. As well as technology, policy and socioeconomic status. **Natural resources** are the raw materials or fuel we use in our physical environment to meet our energy needs and wants. We can put them into two categories: nonrenewable and renewable. **Nonrenewable resources** are fuels that exist in finite or limited amounts. If we use all the available nonrenewables, no additional amounts of them will ever be available to us- at least not for millions of years. The only way we could get more of them is to mine them on other planets. **Fossil fuels** (coal, oil and natural gas) are examples of nonrenewable energy.

Renewable resources are fuels that can be replenished through natural and/or human processes. These resources are constantly or perpetually being restored through natural or human assisted processes. **Wind, solar** and **biomass** are all examples of renewable energy resources. Biomass is organic matter, like wood, used as a fuel, for the generation of electricity. Renewable resources need to be carefully managed. The maximum rate at which people can use a renewable resource without reducing the ability of the resource to renew itself is called **sustainable yield**. The sustainable yield of any resource varies from region to region, and it can be altered through various management practices.

Power generation is the process by which we transform natural resources into usable energy. **Electricity** is different from energy. Electricity is the dynamic release of energy stored in fuel to supply human needs. Electricity is not a primary source of energy but an energy carrier. **Transmission** refers to the movement of electrical energy from its generation source.

With the **industrial revolution** humans have increased the amount of energy we want and use. The combustion of fossil fuels and other natural resources have lead to a 30 percent increase in atmospheric concentrations of carbon dioxide, as well as rising methane and nitrous oxide. These greenhouse gases have enhanced the heat trapping capability of the earth's atmosphere. A process known as anthropomorphic **climate change** or global warming. **Clean energy** refers to resources that do not increase greenhouse gases or contribute to environmental destruction.

Decisions about what and how we use energy are influenced by economic, political, environmental and social factors. The amount of energy we use, conservation, behavior and design are effected by the society we live in. Our quality of life is affected by our energy choices. Economic and national security are negatively impacted by increased demand and limited energy supplies.

Introduction:
Energy is something we use every day. Energy provides the electricity we use it to power our homes, school, devices. We use it to get from one place to another. Most of the time we use energy without thinking about where it comes from or how it gets to our homes, school and devices. Today we are going to be looking at power generation. The choices we make about the quantity and quality of energy we use have a serious impact on climate change and the choices we make today will impact future generations. Today we are going to be playing a series of games that look at the benefits, challenges and cost of different power generation strategies. Energy can be broken down into two basic categories, renewable and non-renewable sources. Renewable energy sources are ones that we will regenerate over and over again. Non-renewables are energy sources that we have a finite quantity. Once they are dug up, removed and burned they are gone.

Facilitators note: Ask the questions,

- *Who can give me an example of a renewable resource?*
- *Who can give me an example of a non-renewable resource?*

List student responses on the board.

*Renewable: **	*Non- renewable*
Solar	***Oil***
Wind	***Natural Gas***
Water	***Coal****
People Power	*Nuclear*

**Biomass- In 2011 Biomass accounted for 48% of US renewable energy generation. It is not included here because students are less familiar with the term.*

** Coal, Oil and Natural Gas are the three forms of fossil fuels, liquid, gas and solid.*

Activity 1:
Objective: Defining natural resources- 20 questions

Materials:

- Natural Resource Cards
- Tape
- Resource Definition Cards

Have each student receive a predetermined card with a nonrenewable or renewable resource on it. Do not let students look at their card. Tape card to their back so they cannot see their

word but it is displayed to the rest of the students.

Facilitators note:
Use information from the background section as needed to fill student knowledge gaps and insure that students are prepared to engage in the games successfully.

Students take turns asking each other "yes" or "no" questions to identify the resource posted on their back. Students can only ask each other one question before moving on to another person.

Demonstrate this for the students by having a helper tape a card to your back. Show the card to the students. Ask them yes or no questions until you figure out which card is on your back. After you identify the card remove it and tell students they are ready to play the game.

Example:
Natural Gas Card

- *Is is a renewable resource? No*
- *Is it a fossil fuel? Yes*
- *Is it a solid? No*
- *Is it a liquid? No*
- *Is it a gas? Yes*
- *Is it Natural Gas? Yes*

Make sure the students do not have any additional questions before starting.

As students guess their resource they should form a group with others who have like resources. Place the resource definition card for each energy source on a table so students know where to group.

Extension: If you have time have students work with their group to discuss their energy source and come up with a common definition. If you do this, do not use the definition cards. Use an extra resource card as a table marker. Go around the class and have one person from each team read their definition.

Example: Solar energy is a renewable energy obtained from the sun's radiation. It often refers to the process that uses solar radiation to generate heat or electricity for human use. It can also refer to passive energy which is sunlight that we use to heat a room through a window.

Activity 2, Popcorn Generation:
Objective: Understanding the finite quantity of non-renewable resources

Materials:

- 7-9oz of popped popcorn
- 4-8 small paper bags one-half full of popcorn
- 4 napkins (1 napkin per small group)
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Generations ago people energy resources like coal and oil were cheap and abundant. People did not think ahead to a time when that would not be the case. With each generation as the population grows and our resources become depleted we need to be more innovative and take larger risks to access the remaining resources like coal and oil.

Break the students into 4 students per group. Explain to the students that the popcorn represents the world's supply of non-renewable resources.

Invite the first generation volunteer to take as much popcorn as they want. Give them each a napkin. They can eat and fill their napkin but they cannot share with other students. Give them a finite amount of time, no more than one minute.

Repeat the activity with a second generation volunteer. The resources are not quite as abundant as they once were. It is harder to extract them from the bag. They also receive a napkin to help them stockpile their resources. Just like the first student, they eat all they want but they cannot share it with others.

Discuss with the students what is happening to the world's popcorn supply.

- As the population grows and the amount of non-renewable resources drops the completion for those resources becomes more fierce.
- What is happening to our total amount of non-renewable resources?
- Did any of the students who were part of the demonstration think about those who might be eating after them, or were they only trying to get as much popcorn as they could?
- What did the other students who were waiting for their turn think as they watched the first two generations?
- What parallels do the students see between the demonstration and what happens in the real world with fossil fuels?

Example:
The Canadian tar sands, coal mining mountain top removal and deep sea oil drilling are all examples of how industry has had to adapt to extract non renewables. Cost and risk increase supply diminishes and demand continues?

- What ideas do students have to address the challenge of supply and demand for energy?

Demonstration 2, Greed vs. Need:
Objective: Learning to manage renewable resources

Materials:
- One bag of resources per group with 12 fish crackers in each bag

Renewable resources also take time and management. How we generate, store, and use energy is important. If solar energy only works during the day how do we meet our energy needs at night? What happens if the wind is not blowing? Wood can be stored and transported easily but it renews itself slowly. Introduce the concept of sustainable yield.

Divide the class into teams of four. Each team represents a different country's population and energy needs. Give each team 12 crackers. Explain that students will play a game in which the cracker represents the team's supply of a renewable resource. It will be replenished after each round of play. Each student can take freely from the team supply but the goal is to sustain your community for generations. Each round is considered a new generation. Each team should keep in mind the following:

- For a country to sustain its energy needs the population needs to consume (or remove) one cracker per person each round.
- At the end of the game team member will get to eat all the crackers he or she has amassed

Round 1:
Add 12 fish crackers to their bag of remaining nonrenewable resources.

Round 2:
The cracker resource renews itself at the rate of ½ per generation. If each student does not or cannot take at least one cracker their country will not survive.

Round 3:
Renewable energy is a growth industry. Follow prompts on power point.

Discuss with the students what is happening with the world cracker supply:

- What were different teams management style? What worked?
- Did their consumption habits change when they understood the sustainability yield?
- What are the advantages and disadvantages of using a resource in a sustainable way?
- What advantages and disadvantages are there to using a resource in a non-sustainable

way?
- How would you apply the concept of sustainable yield to different types of renewable energy? Wind, solar, water?

Demonstration 3, Synthesis:
Objective: Strategizing to manage resources with increased variables.

Materials:
- Students will have remaining resources left in each bag
- 8-10 scenario cards

Summarize what has been covered in the previous three exercises and key points you have heard students make during the discussion sections. In the previous rounds students have had to identify different resources used to supply energy, deepen understanding of resource management and develop strategies to maintain their population. Students are now going to synthesize these concepts in this final exercise. By increasing the variables in energy distribution and supply students are challenged to think creatively about solutions.

Groups continue to represent their country from the previous round.

Students now have access to renewable (cracker) and nonrenewable (popcorn) resources. The facilitator distributes bags of resources to each group based.

Round 1: Students will play a game in which the snacks in front of them represent their team's available resources. Renewable resources will be replenished after each round of play. Use the same rate of renewal as the previous round.

Round 2: There are many variables that can potentially impact the quantity and quality of resources. Throw in a twist to the next round by giving each team a scenario card. Students must follow the directions written on their card. This is an opportunity for students to connect some of the social, political and environmental factors that impact energy consumption. Who are the people who are most likely to be impacted by the different scenarios?

Card scenarios are as follows:

- A hurricane has caused massive damage to infrastructure, cut your resources by 25%.
- Improved education leads to innovation, add 25% to renewable resources.
- Advanced technology systems increase productivity add 25% to renewable resources.
- There has been an oil spill off the coast. Lose 25% of your nonrenewable resources
- You have been fined for being an environmental polluter. Lose 25% of your non-renewable resource.
- California signs SB100 setting a goal of 60% renewables by 2030 and 100% carbon-free by 2045. Add 25% to renewable resources.

- Wind turbines are getting cheaper, bigger and more efficient each year. Add 25% to renewable resources.
- A BP drilling rig exploded in April 2010, killing 11 workers and spewing about 4 million barrels of oil into the Gulf. Lose 25% of your nonrenewable resources.
- Nearly two weeks after Hurricane Florence swamped the Carolinas, thousands of residents who get power from coal-fired utilities remain without electricity.
- Yet solar installations, which provide less than 5 percent of North Carolina's energy, were up and running the day after the storm. Add 25% to renewable resources.
- Global Bitcoin mining operations have been reported to consumer enough energy to power an entire country. Lose 25% of your nonrenewable resources.
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Round 3: Play another round. Did all the countries survive?

Now that different countries have had to manage different scenarios are there some countries that are more resource rich? What are some of the resource rich countries students can think of? Resource poor counties? Do resource rich countries have a responsibility to help struggling countries? Countries (teams) can decide how to divide resources before continuing.

Round 4: Final round with the division of resources. How did the choices about division of resources impact teams' survival? Do we still have enough given the rate of renewal?

Additional rounds: Think back to our warm-up exercise. What are some of the forms of energy (renewable vs. nonrenewable) countries use to address their energy needs? Countries can now pitch strategies for improving their energy portfolio to the facilitator (World Bank). Facilitator can decide on the resource value of these ideas.

Examples:

- *Team 1 wants to develop wind energy to increase their renewable energy portfolio, increase their renewable energy by 25%*
- *Team 2 is subsidizing roof top solar to increase their renewable energy portfolio, increase their renewable energy by 25%*

Discuss with the students what is happening with the world energy supply:

- How did you feel when you looked around the room and saw who had what?
- Did you think your team was symbolic of a particular country? What country? Why?
- What choices were available to teams that do not have enough resources to meet their energy needs?
- What were some scenarios that teams came up with to address their energy needs?

1. U.S. Department of Energy. *Energy Literacy: Essential Principles and Fundamental Concepts for Energy Education,* energy.gov/eere/energyliteracy
2. International Energy Agency. *World Energy Outlook,* 2011.http://www.iea.org/publications/freepublications/publication/weo2011_web.pdf