



5-Day Introduction to Energy & Sustainability

Energy is the foundation of everything we do in the twenty-first-century world. It is an essential component in the provision of basic human needs, including food, water, shelter, transportation, healthcare, and education. Currently, we use more non-renewable energy sources than renewable energy. In the future, renewable energy sources will have to make up an increasing share of global energy sources if we are to continue to sustain our current standards. It positively affects the three domains of sustainability: social, economic, and environmental. To be sustainable, societies must have sustainable-energy systems.

This one-week lesson plan will give students a good understanding of energy and a basis for making informed future decisions on energy consumption. The plan will give the students a better understanding of energy basics, energy sources (both renewable and non-renewable), and energy portfolios. The focus is on energy used for heat, electricity, and fuel for cars. This lesson plan is split into five mini lessons with the end goal of student presentations on an energy portfolio they have created for Camp Colley:

- Day 1: The Basics - Introduce lesson and Camp Colley
- Day 2: Non-renewable Energy Sources - Where do fossil fuels come from?
- Day 3: Renewable Energy Sources - What are renewable energy sources?
- Day 4: Let's Work Together - Energy portfolio creation
- Day 5: Closing - Presentation of energy portfolios and a wrap-up of the week

So, what is Camp Colley?

The year is 2050 and the City of Phoenix is still running Camp Colley. Camp Colley is an outdoor adventure camp nestled in a pine forest on the Mogollon Rim about 50 miles north of Payson. At the camp, the Phoenix Parks and Recreation Department provides structured, supervised recreation opportunities in a unique forest setting. At an elevation of 6,700 feet, the camp provides a welcome summer escape from searing Valley temperatures. The city decided to have the camp go off-grid and the City Council is soliciting your students to design the camp's energy portfolio.

Before beginning, students should: have a basic understanding of the science behind energy. This lesson plan may be more appropriate for juniors and seniors. The week or day before this lesson, you may want to ask the kids to review the following website: www.eia.doe.gov/kids. This will get them to start thinking about energy, so they will be better prepared for the lesson. There are a number of games on the website, and you may want to ask them to complete a game or two as homework. Students should have some basic understanding of algebra and independent versus dependent variables.

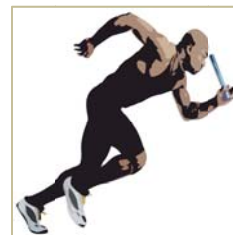
Sustainability Science for Sustainable Schools, a National Science Foundation funded program

Essential Question: What is energy?

The objective of this lesson is to introduce the general concept of energy

At the end of the lesson, students will be able to:

1. Define the terms “energy” and “energy portfolio”
2. Identify at least 3 different types of energy



Standards Addressed: Science Strand 1: Inquiry Process, C1:

Observations, Questions and Hypotheses; Science Strand 3: Science in Personal and Social Perspectives, C2: Science and Technology in Society

Themes: Systems thinking

Skills: Evidence based thinking

Key Vocabulary

Energy: The capacity of a physical system to perform work. Energy exists in several forms such as heat, kinetic or mechanical energy, light, potential energy, electrical, or other forms. Energy is also the resource for producing power.

Energy Portfolio: The diversity of energy resources being used by a particular place.

Non-renewable Energy: An energy resource that cannot be replaced once it is used or an energy resource that is not being replaced as fast as it is being used.

Renewable Energy: An energy resource that is replenished by natural processes on a sufficiently rapid time-scale so that humans can use it more or less indefinitely provided the quantity taken per unit of time is not too great.

Teaching Instructions

1. Explain to students the breakdown for the week and the final product
2. Introduce students to Camp Colley. Ask if any students have ever been there. (See ppt.)
3. Begin by having a discussion about energy basics. What do kids think of when they hear the term “energy”? Record responses on white board. What do they have in common? Provide students with the definition of energy.
4. Ask the students how they think energy relates to food, water, and transportation. Create three columns (food, water, transportation) on the board and have the students explain how they relate. Ask the students:
 - a. What kind of energy is needed to make food? What kind of energy is created when we eat food? Where is food stored and does this require energy? How is food transported? How does water get to our homes? Where does our water originate from? Does our water come from rivers, aquifers, or somewhere else? What kind of energy does transportation require? How do we make our cars move? Where does gasoline come from?
 - b. Answers should include: Food - fuel for the tractors, electricity for the barns, fuel to transport the food in trucks/trains; You eat an apple and it becomes energy in the body and then your body radiates heat - this is known as caloric energy; Water - pumping the water out of the ground, transporting the water to towns, when you turn on the faucet in your house it requires energy; Transportation - energy to move the

Adapted by Auriane Koster from Clarkson University’s Office of Educational Partnerships

car forward, energy to extract and create gasoline.

5. Break students into groups of 3 students each. Ask the students to line up in sequence of their birthday month and date. Show the participants where the January birthdays should begin and let them go from there. Give the students 2 minutes to do so. Once they are lined up have them count off to seven (if you have 21 students, for example) and these are now their groups for the week.
6. Give students approximately 10 minutes to complete the Day 1 worksheet in their groups. Randomly select four groups, one at a time, to answer each of the four questions.
7. Provide students with the definition of non-renewable and renewable energy resources and ask them to label each of the types of energy in their chart as renewable or non-renewable.
8. Show student the electricity supply chain, and briefly explain it. (See ppt.)
9. Explain to students that a country uses a variety of energy sources and this is the country's energy portfolio. Provide definition. Show the students examples of energy portfolios. (See ppt.) Ask students what would be the dangers of relying on only one type of energy source. (i.e., Variety provides resiliency; What would be a consequence if the one resource ran out or we lost access to it?)

Homework: N/A

Additional Resources: www.eia.doe.gov/kids

Day One

Day Two

Day Three

Day Four

Day Five

Adapted by Auriane Koster from Clarkson University's Office of Educational Partnerships

Essential question: What are the pros and cons of using non-renewable energy? Where do our energy sources come from?

The objective of this lesson is to introduce various non-renewable energy sources.



At the end of the lesson, students will be able to:

3. Discuss different sources of non-renewable energy
4. Analyze trade-offs associated with non-renewable energy sources

Standards Addressed: Science Strand 1: Inquiry Process, Concept 1: Observations, Questions and Hypotheses; Science Strand 3: Science in Personal and Social Perspectives, Concept 2: Science and Technology in Society

Themes: Trade-offs

Skills: Problem solving

Key Vocabulary

Non-renewable Energy: An energy resource that cannot be replaced once it is used or an energy resource that is not being replaced as fast as it is being used.

Teaching Instructions

1. Start by having the students watch the fossil fuel creation video. (See ppt.) (www.planet-scicast.com/view_clip.cfm?cit_id=2869)
2. Remind students of the definition of non-renewable energy from first day.
3. Toil for Oil Activity
 - a. Start by telling the class that today they are going to “drill” for oil, a non-renewable resource, and they will model the extraction of oil reserves over 3 years.
 - b. Give each student 1 copy of the handout, Oil Extraction Data Sheet, and go over it with them. Show them the bowls, explaining that the red beans represent dirt and the black beans represent oil.
 - c. For a class of 25 or fewer, divide the class into 2 groups. For classes over 25, divide the class into 3 groups. Each group will represent an oil company.
 - d. Have each oil company choose a name.
 - e. Place the bowls with the beans in different areas of the room on top of the oil rig picture.
 - f. For each oil company, have 4 students representing the first year gather around the bowl filled with the mixed beans. The remaining students will wait while the Year 1 students extract the oil.
 - g. Give the four students 30 seconds to extract the oil by picking out the black beans from the bowl and leaving the red beans in the bowl. (They are competing for resources.)
 - h. At the end of the 30-second period, have the students stop extracting, count their barrels of oil, and record their oil extraction on their data sheets (each black bean is equal to 1

Adapted by Auriane Koster from *Facing the Future*

barrel of oil).

- i. Have the same 4 students, plus 3 more students representing Year 2 oil drillers, gather around the same bowls and repeat the activity for 30 more seconds, extracting and recording. (More students are added because this represents an increasing population. There is still the same amount of oil available, but there are more people competing for the resource.)
- j. Have those same students, plus the remaining students in each oil company representing the 3rd year, gather around the same bowls and repeat the activity for 30 more seconds.
- k. Have each oil company report their total number of barrels.
- l. Have students complete the questions on the Oil Extraction Data Sheet, either individually or in their groups.
- m. Conclude with the reflection questions in the ppt and the answers to the worksheet. (Ask the students: What happened to the oil production as the number of oil drillers increased with each year? (It decreased) What might this simulate? (e.g., population increases, increased use per person); With each year, was it easier or harder to extract the oil? (Harder); What are some policies, laws, manufacturing practices, or other types of legislation that could be implemented to reduce dependency on non-renewable energy sources? (i.e., What are some changes that the government could force people to make?) (renewable energy, oil quotas, energy conservation, reduce dependency on plastic, biodiesel cars, more hybrid cars, electric cars where the electricity is made from renewable energy, ride bikes, etc.)

4. Remind students that non-renewable energy sources are coal, oil, and natural gas. End by explaining the pros and cons of non-renewable energy sources. (See ppt.)

Homework: N/A

Additional Resources: www.eia.doe.gov/kids

Day One

Day Two

Day Three

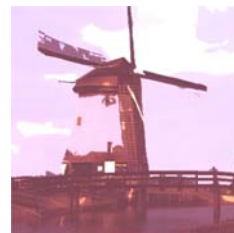
Day Four

Day Five

Adapted by Auriane Koster from Facing the Future

**Essential question: What are the pros and cons of using renewable energy?
Where do our energy sources come from?**

The objective of this lesson is to introduce various renewable energy sources.



At the end of the lesson, students will be able to:

1. Discuss different sources of renewable energy
2. Analyze trade-offs associated with using renewable energy sources
3. Apply math to real world problems

Standards Addressed: Science Strand 1: Inquiry Process, Concept 1: Observations, Questions and Hypotheses; Science Strand 3: Science in Personal and Social Perspectives, Concept 2: Science and Technology in Society; Math Strand 2: Data Analysis, probability, and Discrete Mathematics, Concept 1: Data Analysis (Statistics), PO 3

Themes: Trade-offs

Skills: Quantitative skills

Key Vocabulary

Independent variable: The variable whose value determines the value of other variables

Dependent variable: The variable that is being measured in an experiment

Renewable Energy: An energy resource that is replenished by natural processes on a sufficiently rapid time-scale so that it can be used by humans more or less indefinitely, provided the quantity taken per unit of time is not too great

Teaching Instructions

1. Show the students the renewable energy video. (See ppt.) (www.youtube.com/watch?v=Ts08M4bW0sQ&feature=related)
2. Remind students of definition of renewable energy from the first day.
3. Show the students the energy portfolio standards for US map. (See ppt.) Explain to them that these are individual states that have committed to using renewable energy. Some states have decided to use more renewable energy than others. This has to do with governments' decisions and the amount of renewable energy available in the state. (i.e., some states have more sun, wind, hydro power, etc., available than others.)
4. Show the students the different renewable energy potential maps. (See ppt.) Explain to students that this is where we can take advantage of the different renewable energy sources.
5. In AZ, we tend to focus on the potential of solar power. However, within the US wind power has a great deal of potential, especially off-shore, wind power.
6. Show the students the wind energy video. (www.thefutureschannel.com/dockets/science_technology/wind_farming/)

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5. Power Analysis Activity

- a. Split the students into pairs. Give each pair a worksheet and blank piece of paper.
- b. Ensure that students understand why the amount of power produced by a wind generator would increase as the wind speed increases.
- c. Discuss the fact that this is a functional relationship, and identify the independent variable(wind speed) and dependent variable (power). Then assign the task to the pairs.
- d. Students should determine values of k by plugging in the given values for wind speed and power. This will yield four slightly different values for each blade; it is up to the students to decide how to find one value of k that best represents the relationship, for each blade (i.e., calculate the average.) They would then use that value to find the power supplied at a wind speed of 25 mph. (See Day 3 worksheet and answer sheet.)

Remember: Some kids might need extra support during this activity. Additionally, be sure the students turn this in so that it can be graded and the correct answers provided.

6. End by explaining the pros and cons of renewable energy. (See ppt.)

Homework: N/A

Additional Resources: www.eere.energy.gov/basics, www.eia.doe.gov/kids

Day One

Day Two

Day Three

Day Four

Day Five

Adapted by Auriane Koster from The Future Channel

Essential question: How do you create a diverse energy portfolio that best serves society?

The objective of this lesson is to have the students create an energy portfolio based entirely on renewable sources



At the end of the lesson, students will be able to:

1. *Apply knowledge of renewable energy to solve a problem.*
2. *Calculate percentages of resource type in an energy portfolio.*
3. *Design an energy portfolio.*
4. *Create a short oral presentation of their energy portfolio.*

Standards Addressed: *Science Strand 1: Inquiry Process, Concept 1: Observations, Questions and Hypotheses; Science Strand 1: Inquiry Process, Concept 4: Communication; Science Strand 3: Science in Personal and Social Perspectives, Concept 2: Science and Technology in Society*

Themes: Systems thinking

Skills: Team skills

Key Vocabulary

Energy: *The capacity of a physical system to perform work. Energy exists in several forms such as heat, kinetic or mechanical energy, light, potential energy, electrical, or other forms. Energy is also the resource for producing power.*

Energy Portfolio: *The diversity of energy resources being used by a particular place.*

Renewable Energy: *An energy resource that is replenished by natural processes on a sufficiently rapid time-scale so that humans can use it more or less indefinitely provided the quantity taken per unit of time is not too great.*

Teaching Instructions

1. Explain to the class that they will be presenting their portfolios in front of the class the next day. They should decide today who they want to speak in front of the class, that way the student has the night to prepare if they choose.
2. Show the students examples of energy portfolios, as shown on day one. Provide them with Day 4 worksheet
3. Camp Colley Activity
 - a. Ask the students to get into their groups as determined on day one. Give each group a large piece of paper and 3-4 different colored markers.
 - b. Ask the students to create an energy portfolio for Camp Colley that does not include any non-renewable energy sources. Have them decide the percentages of the different energy sources and create a pie chart, like those shown.
 - c. On the same sheet of paper, perhaps to the side of the energy portfolio, ask the students to provide a short description of where this energy would come from. (i.e., If they say hydro power, they should explain that it would come from the flowing river.)

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- d. Have them recall the renewable energy sources maps that were shown the day before.
- e. Explain to them that they have an unlimited budget, but that diversity in sources is important as discussed on day 1.

Day One

Homework: N/A

Additional Resources: www.srpnet.com/environment/renewable.aspx

Day Two

Day Three

Day Four

Day Five

Essential question: What does a “good” energy portfolio look like?

The objective of this lesson is to have the students apply and synthesize what they’ve learned through the week. Each group will give a presentation of their plan followed with a class discussion.



At the end of the lesson, students will be able to:

- 1. Differentiate between renewable and non-renewable energy resources.*
- 2. Critique various energy sources for sustainability.*

Standards Addressed: *Science Strand 1: Inquiry Process, Concept 1: Observations, Questions and Hypotheses; Science Strand 1: Inquiry Process, Concept 4: Communication; Science Strand 3: Science in Personal and Social Perspectives, Concept 2: Science and Technology in Society*

Themes: Systems thinking, trade-offs

Skills: Oral communication

Key Vocabulary

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Teaching Instructions

1. Give each group 5-10 minutes to present their portfolio to the class.
2. Tape the different portfolios on the board, so that they are all next to each other.
3. Present to the class what Camp Colley actually does in order to stay off the grid. (See ppt.) Explain to the students that propane is not a sustainable source of energy. Is there a better way that the camp could cook food?

Homework: N/A

Additional Resources: www.eia.doe.gov/kids

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