Growing Green

lesson packet

Purple Plow

Uncovering STEM Solutions

TABLE OF CONTENTS

What Is Energy?

Lesson Length: 1 hour

National Learning Standards: NGSS-4-PS3-2; CCSS.ELA-Literacy.W.5.7; NGSS-MS-PS3-5; CCSS.ELA-Literacy.RST.6-8.1; NGSS-HS-PS3-2; CCSS.ELA.Literacy.SL.9-10.4

Learning Objectives:

1. Students will be able to define energy.
2. Students will be able to define kinetic and potential energy.
3. Students will understand that energy can be transferred from one form to another to meet our needs.

Key Terms:

1. Energy: the ability to do work
2. Potential energy: the energy stored by an object as a result of its position
3. Kinetic energy: the energy of movement

Background Information:

Energy takes many forms. It cannot be created nor destroyed, but it can be converted into other forms. Energy is essentially the capacity to make something happen or to do "work." You can learn more energy basics by visiting: https://www.eia.gov/energyexplained/index.php?page=about_home

Materials:

1. Coiling Snake Template
2. Red construction paper (for snake tongue)
3. String (or thread) (~30 cm or 1 foot per group)
4. Scissors
5. Energy Detective work sheet

Introduction (Anticipatory Set)[i]: (10 minutes)

1. Introduce the concept of energy to the class and connect it to the current Purple Plow Challenge.
   a. Who remembers what our challenge question is? What do you know about energy?
   b. Today, we will explore basic terms and facts about energy.
2. Dive deeper into energy terms and concepts with a short explanation and discussion.
   a. "We classify energy in two ways. First is potential energy, which is the amount of energy something has stored inside it. Anything can have potential energy. A battery has potential energy stored by a difference in ionic concentration; even you have potential energy, as you sit in your chair. How much potential energy you have depends on a few things including how high up you are and how big you are." (From Teach Engineering's "What is Energy?")
   b. "Next is kinetic energy. Kinetic energy is the energy of an object in motion. Anything that is moving has kinetic energy. Mechanical objects, such as a clock or a person on a skateboard, have kinetic energy, but so do light, sound, wind and water. Can you see examples of energy around the classroom? Well, today we are going to find some of these examples and learn about how engineers work with different types of energy." (From Teach Engineering's "What is Energy?")
3. Write the following phrases on the board and discuss with the class.
   a. What is energy?
      - The ability to do work or cause change.
      - Work is the application of a force through a distance. (Ask students for examples, such as moving a box across the room, sweeping, etc.)
        - Force can put matter into motion or stop it if it is already moving.
        - Motion is a change in position of an object with time.
      - To do work, energy is needed.
   b. Where does energy come from?
      - Natural energy sources: food, water, plants, trees, gravity, sun, fossil fuels, uranium, plutonium
      - Ways that humans have harnessed or converted natural energy sources: hydroelectric dams, coal/oil power plants, nuclear power plants, wind turbines, solar panels, etc.
   c. What are different types of energy? (See the Vocabulary/Definitions section)
      - Kinetic energy: electrical, light, thermal, solar, sound, wind, hydro
      - Potential energy: chemical, mechanical, nuclear, gravitational

d. How do we use energy?
   - To break down and digest food (in our bodies)
   - To heat houses and other buildings
   - To illuminate lights
   - To power televisions, radios, games, cars
   - To run computers and appliances

Input and Modeling[ii]: (20 minutes)

4. Split the class into teams of two or three and distribute the "Coiling Snake Template" to each set.
5. Work with the students through the following steps:
   a. Have students in each team cut their Coiling Snake Templates making sure to cut along all the lines.
   b. Draw and cut a forked tongue from red construction paper.
   c. Glue the tongue onto the snake.
   d. Poke a hole in the snake's head or tail; using a hole punch works best.
   e. Cut a piece of string (or thread) about 30 cm (1 foot) long.
   f. Tie the string to the snake's head or tail, and knot it.
   g. Hold the snake by the string over a candle or light bulb.
   h. As the light bulb heats up, the snake should spin.
6. Explanation: "When the candle burns, two forms of energy are released, heat and light energy. The heat causes the air to rise up, which in turn makes the snake spin around. (The snake does not move up because the coiled shape of the snake allows the heat to rise through the middle and spin the snake.)"
7. Class discussion: "The energy we need comes from the food we eat. The energy required to turn the pedals of a bicycle comes from the person riding the bicycle. Cars and trucks get their energy from gasoline. Some homes are heated using oil or natural gas or firewood. When designing heating and cooling systems, engineers study thermal energy and how it creates air movement. They place heat vents and radiators low, near the floor, because they know that hot air rises. As hot air rises it mixes with the existing room air, preventing "cold" spots and making the space more comfortable. The same is true for cool air vents that are placed high, near the ceiling. The cool air sinks, evenly mixing with the existing room air."

Independent Practice: (20 minutes)

Option A — for upper elementary students and early middle school

8. Keep students in their groups of two or three
9. Distribute the "Energy Detectives" worksheet

10. Tell students that energy evaluations or energy audits are a common practice used to better understand how we are currently meeting our energy needs.
11. Explain that they are to explore the classroom and school setting to find where different sources of energy are being used and that they will report their findings at the end of class.

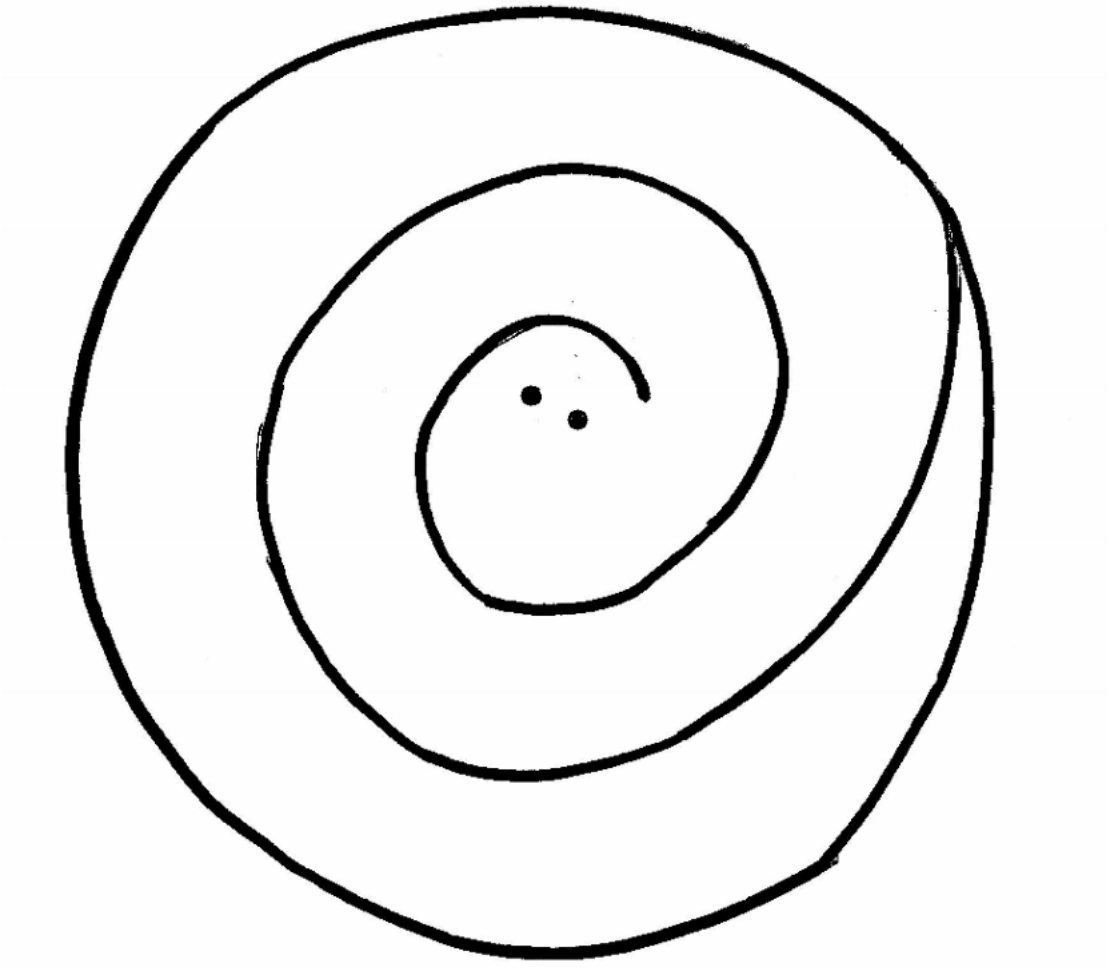
Option B — for middle school and early high school students

12. Have students research the source of your local utility company's electricity. Is it coal, natural gas, hydro, nuclear, wind or some combination?
13. Students then draft a report explaining what they have found.

Wrap Up (Review, Assess, Challenge): (10 minutes)

14. Conclude the lesson with a discussion of the energy sources that were found and each team's definition of energy.

Coiling Snake Template



Source: Energy: Lesson 1, What Is Energy? Short Demos — Coiling Snake Template: https://www.teachengineering.org/content/cub_/activities/cub_energy2/cub_energy2_lesson01_activity1_template.pdf

Energy Detective Worksheet

What we know:

We know that energy can give off heat or light.

We know that energy causes movement.

We know _____

What we found:

Item that uses energy	We know it uses energy because…	Source of energy for this item

How many items that use energy did you find?

Below, write a definition for energy using what you learned.

Energy is…

Source: Energy: Lesson 1, What Is Energy? Short Demos — Energy Detective Worksheet: https://www.teachengineering.org/content/cub_/activities/cub_energy2/cub_energy2_lesson01_activity2_worksheet.pdf

Renewable and Nonrenewable Energy Sources

Lesson Length: 1 hour

National Learning Standards: NGSS.5-ESS3-1; CCSS.ELA-Literacy.W.5.9; NGSS.MS-ETS1-2; CCSS.ELA-Literacy.RST.6-8.7; NGSS.MS-ETS1-3; CCSS.ELA-Literacy.CCRA.R.8; NGSS.HS-LS2-7; CCSS.ELA-Literacy.WHST.9-10.7

Learning Objectives:

1. Students will be able to define renewable and nonrenewable energy sources.
2. Students will understand the benefits and disadvantages of using renewable and nonrenewable energy sources.

Key Terms:

1. Renewable energy
2. Nonrenewable energy
3. Fossil fuel

Background Information:

1. U.S. Energy and Information Administration's, "What is Renewable Energy?" https://www.eia.gov/energyexplained/?page=renewable_home
2. U.S. Energy and Information Administration's, "What is Nonrenewable Energy? https://www.eia.gov/energyexplained/index.php?page=nonrenewable_home

Materials:

1. Poster boards
2. Construction paper
3. Markers, colored pencils, crayons, etc.
4. Computer with internet access
5. National Geographic's "Renewable Energy" encyclopedic entry: https://www.nationalgeographic.org/encyclopedia/renewable-energy/
6. National Geographic's "Non-renewable Energy" encyclopedic entry: https://www.nationalgeographic.org/encyclopedia/non-renewable-energy/

Introduction (Anticipatory Set): (10 minutes)

1. Did you know that rotting bananas can power a town? Share the short BBC News article, "Bananas Could Power Aussie Homes": http://news.bbc.co.uk/2/hi/science/nature/3604666.stm
2. Ask students to describe what they have heard about renewable and nonrenewable energy and discuss as a class.
3. Introduce the concepts renewable energy and nonrenewable energy. Explain that each has advantages and disadvantages.
    a. Renewable energy sources are inexhaustible or replaceable. Sources such as solar, wind, hydro, etc. can be used to generate power. Renewables include solar, wind, hydropower, biomass, geothermal and even human power
    b. Nonrenewable energy sources are sources are considered nonrenewable if they cannot be replaced in a short period of time. Nonrenewable energy sources are comprised mostly of fossil fuels: coal, natural gas and crude oil. Uranium is also a nonrenewable energy source, but it is not considered a fossil fuel.

Input and Modeling: (5 minutes)

4. Divide the students into groups of three or four.
5. Distribute materials to make a poster.
6. Assign each group a category — renewable or nonrenewable.
7. Challenge each team to make an informative poster that shares information about each category of energy including the trade-offs (advantages and disadvantages) of each source.

Independent Practice: (30 minutes)

8. Assign the internet article from National Geographic, "Renewable Energy." Allow students time to read the article. Then discuss the main ideas and focus on advantages and disadvantages of these power sources.
9. Assign the internet article from National Geographic, "Nonrenewable Energy." Allow students time to read the article. Then, discuss the main ideas and focus on advantages and disadvantages of these power sources.
10. Allow time for students to research, design and create their posters.

Wrap-Up (Review, Assess, Challenge): (15 minutes)

11. Allow students to share their posters and discuss renewable and nonrenewable energy sources.

Exploring Renewable Energy

Lesson Length: 1 hour

National Learning Standards: NGSS.5-ESS3-1; CCSS.ELA-Literacy.RI.5.9; NGSS.MS-ETS1-2; CCSS.ELA-Literacy.RST.6-8.9; NGSS.MS-ETS1-3; CCSS.ELA-Literacy.RST.6-8.9; CCSS.MATH.PRACTICE.MP2; CCSS.MATH.PRACTICE.MP3; CCSS.ELA-Literacy .CCRA.SL.2; CCSS.ELALiteracy.CCRA.SL.4; NGSS.HS-LS2-7; CCSS.ELA-Literacy.WHST.9-10.7

Learning Objectives:

1. Students will be able to understand and explain in general terms how solar, wind, hydro, biomass and geothermal power work.
2. Students will understand the benefits and disadvantages of using renewable and nonrenewable energy sources.
3. Students will demonstrate how engineers design more efficient ways to use generate energy.

Key Terms:

1. Biomass
2. Fossil fuel
3. Geothermal energy
4. Renewable energy
5. Wind turbine

Materials:

1. Renewable energy potential maps as found on the "Renewable Energy Living Lab" website (Printed, projected on screen, or give students access to computers): https://www.teachengineering.org/livinglabs/renewableenergy912
2. "Power Your School Worksheet," one per student (From the "Teach Engineering: Renewable Energy Living Lab: Power Your School" website, copy included)

Introduction (Anticipatory Set): (5 Minutes)

1. Where does renewable energy come from? Discuss this question with students and record their ideas on the board or piece of chart paper.
2. Discuss forms of renewable energy such as solar, wind, geothermal, hydro and biomass.
3. Explain that the students will be using an online tool to evaluate energy consumption of your school and make recommendations to increase renewable energy usage at the school.

Input and Modeling: (20 minutes)

4. Divide the group into groups of two or three.
5. Guide groups to the site: https://www.teachengineering.org/livinglabs/renewableenergy.
6. Explore the site together and discuss the data.
7. Complete the "Engage," "Explore," "Explain" and "Elaborate" sections including the calculations on the "Power Your School Work Sheet" together.

Independent Practice: (25 minutes)

8. Review the directions in the "Evaluate" section of the "Power Your School Work Sheet."
9. Allow students time to write their recommendations.

Wrap Up (Review, Assess, Challenge): (10 minutes)

10. Conclude the lesson by having students share their recommendations either in small group or as a whole class.

Power Your School Worksheet

LEARNING OBJECTIVES:
Students use energy data from the Renewable Energy Living Lab to calculate the potential energy for solar and wind energy at their school. They use this data to write a recommendation as to what type of energy generation the school should pursue.

ENGAGE:
Your school has received a grant from the Department of Energy to help offset power costs by funding the placement of either solar panels on your school roof or wind turbines on school grounds. Working as an engineer, your task is to analyze data about the potential amount of solar and wind energy available at your school location. Then, you will write a recommendation for which option (solar panels or wind turbines) your school should build, using your data analysis for support.

EXPLORE:
1. Go to the Renewable Energy Living Lab at http://www.teachengineering.org/livinglabs/index.php.
2. Enter the Renewable Energy Living Lab and choose age group K-12.
3. Zoom in on your state. Find your school!
4. Check the boxes under the Resources folder (located on the left under the Data Layers tab) to switch between the maps depicting the potential for the five different forms of renewable hydropower, biomass, geothermal, wind and solar. Use the icons in the lower left corner to readinformation about each form of energy.

EXPLAIN:
Part 1: Data Analysis
In order to make a decision, first analyze the potential for solar and wind energy at your school. Use the Renewable Energy Living Lab to figure out how much solar potential and wind potential exists at your school location. Follow the steps below to get started!
1. Describe the amount of solar energy that is received by your school. (Be detailed. Include the numerical data [that is, 5.0 kWh/m2
   /day]).

2. Describe the amount of wind energy received by your school. (Be detailed. Include both relative descriptions [that is, class type] and numerical data [that is, 5.0 m/s]).

Power Your School Worksheet

ELABORATE:

3. Using the numerical data from questions 1 and 2, calculate the amount of solar and wind energy the school could possibly generate in one year, based on the following conditions:
   - Your school roof has a surface area of approximately 4,300 square meters; 50% of that space is useable space.
   - Your school football field can hold approximately four wind turbines safely. Each wind turbine has an area of approximately 1,000 m^2
   - Your units should be in kilowatt hours/year. (Remember, 1000 W = 1 kW)

   Calculations:

My school would generate _____ kWH/year of solar energy.

My school would generate _____ kWH/year of wind energy.

EVALUATE:

Part 2: Writing a Recommendation

Now that you have analyzed the data, write your recommendation to explain whether your school should place solar panels on its roof or wind turbines on its grounds. Include the following in your recommendation:

1. Option selected (solar panels or wind turbines).
2. Explanation for your renewable energy source selection, based on data.
3. Recommendation for where the option should be located.

Source: Renewable Energy Living Lab: Power Your School activity — Worksheet 2: https://www.teachengineering.org/content/csm_/activities/csm_powerschool/csm_powerschool_activity1_worksheet_new2.pdf

Indirect versus Direct Energy Consumption

Lesson Length: 1 hour

National Learning Standards: NGSS.4-ESS3-1; CCSS.ELA-Literacy.W.4.9; NGSS.MS.ESS3-1; CCSS.ELA-Literacy.WHST.6-8.9; NGSS.HS-LS2-7; CCSS.ELA-Literacy.WHST.9-10.7; CCSS.ELA-Literacy.RH.11-12.7

Learning Objectives:

1. Students will examine how energy is consumed in agriculture.
2. Students will demonstrate an understanding that energy consumption is both direct and indirect.

Key Terms:

1. Direct energy consumption
2. Indirect energy consumption

Background Information:

Energy is consumed both directly and indirectly to produce our food. Some examples of direct energy consumption in agriculture include crop, livestock and poultry production as well as fuel consumption in areas of farm production such as operating machinery or drying grains. Indirect energy consumption consists of the energy used to manufacture, package or transport fertilizers, pesticides or farm machinery.

Materials:

1. Construction paper
2. Art supplies
3. Scissors
4. Glue
5. Computers with internet access
6. Access to a printer

Introduction (Anticipatory Set): (10 Minutes)

1. In what ways do farms use energy? What renewable sources are used in agriculture? What nonrenewable sources are used? List student responses on the board or on chart paper.
2. Explain to students that energy consumption can be either direct or indirect and review these terms and concepts.
   a. Direct energy consumption: energy consumed – either fossil fuels or renewables – used on location or directly to complete a task
   b. Indirect energy consumption: the energy required to produce something you use or purchase, for example, the energy required to produce the fertilizer a farmer applies to a crop.

Input and Modeling: (5-10 minutes)

Option A — For elementary and middle school students

3. Share the following infographic and article with the whole group and read together
   - https://www.eia.gov/todayinenergy/detail.php?id=18431#
   - https://www.ers.usda.gov/amber-waves/2017/januaryfebruary/energy-consumption-and-production-in-agriculture/
4. Explain that they are going to explore direct and indirect energy consumption as it relates to farming and agriculture. That they will review several images from agriculture and determine whether they best show an example of indirect or direct energy consumption. Understanding how energy is consumed to produce our food is a vital part of the Purple Plow Challenge.
5. Distribute "Activity Sheet 1" and "Activity Sheet 2" and review the directions.

Option B — For high school students

6. Divide class into groups of two or three.
7. Explain that they are going to explore direct and indirect energy consumption as it relates to farming and agriculture. That they are to compile data of both direct and indirect energy consumption in farming. This list will serve as part of the research in completing the Purple Plow Challenge.
8. Direct students to the following sites:
   - https://www.eia.gov/todayinenergy/detail.php?id=18431#
   - https://www.ers.usda.gov/amber-waves/2017/januaryfebruary/energy-consumption-and-production-in-agriculture/
   - https://www.ers.usda.gov/publications/pub-details/?pubid=74661
   - https://ageconsearch.umn.edu/bitstream/21063/1/sp06mu02.pdf
   - http://www.usask.ca/agriculture/caedac/pubs/Food.PDF
   - https://www.eia.gov/todayinenergy/detail.php?id=18431

Independent Practice: (25-30 minutes)

Option A — For elementary and middle school students

9. Allow students time to complete the "Energy Sort" activity.
10. Pair students up as they finish so that they can discuss how they sorted their pictures. Encourage students to explain their choices.
    - Note to teacher/facilitator: There is no "correct" answer to how the students sort the images. The key in this activity is to promote discussion to deepen the students' understanding of energy consumption.

Option B —For high school students

Allow students to read the online articles and research further.

11. Challenge students to make an infographic with the data and information they have discovered.
12. They might make this using construction paper and printed materials, or they may choose to use technology. They might use any of the choices below or a tool of their choice.
    - Microsoft Publisher
    - Piktochart
    - Canva

Wrap-Up (Review, Assess, Challenge): (15 minutes)

Option A —For elementary and middle school students.

13. Students share their charts in small groups or with the entire class.

Option B —For high school students

14. Students share their infographics in small groups or with the entire class.
15. Students might also share their designs via social media or a class website.

Activity Sheet 1: Energy Examples

Directions: Cut out each thumbnail picture. Sort the pictures on the "Energy Sort"sheet into the two categories based on whether you feel it is an example of indirect energy consumption or direct energy consumption.

Activity Sheet 2: Energy Sort

Directions: Sort the pictures into the category you feel it best belongs. Be ready to discuss your energy sort and explain your choices.

Direct	Indirect

Uncertain

The United States Energy Portfolio

Lesson Length: 1 hour

National Learning Standards: NGSS.4-ESS3-1; CCSS.ELA-Literacy.W.4.9; CCSS.MATH.CONTENT.5.G.A.2; CCSS.MATH.CONTENT.5.MD.B.2; NGSS.MS-ESS3-3; CCSS.ELA-Literacy.WHST.6-8.9; CCSS.MATH.CONTENT.7.RPA.2; NGSS.MS.ESS3-; NGSS.HS-LS2-7; CCSS.ELA-Literacy.WHST.9-10.7

Learning Objectives:

1. Students will be able to describe the sources of energy most commonly used in the United States.
2. Students will be able to list several ways to conserve energy.

Key Terms:

1. Energy
2. Renewable energy
3. Nonrenewable energy
4. Fossil fuels
5. Solar energy
6. Consumption
7. Conservation

Background Information:

This lesson is adapted from the following Teach Engineering lessons "and activity:

- "Powering the U.S.": https://www.teachengineering.org/lessons/view/cub_earth_lesson08
- "Energy Conservation: Considering Sources, Cost, and Impact": https://www.teachengineering.org/lessons/view/cub_energy2_lesson02
- "Wasting Energy at Home": https://www.teachengineering.org/activities/view/cub_energy2_lesson02_activity1

Materials

1. "Residential Mix & Match Game" Sheet (From Teach Engineering, copy included)
2. "Agricultural Mix and Match Game" sheet
3. Paper bag

Introduction (Anticipatory Set): (15 minutes)

1. Share the following website and discuss: https://www.eia.gov/energyexplained/?page=us_energy_home

Input and Modeling[iii]: (15 minutes)

2. Use the following as a guide for discussing energy costs and impact.
   a. Driving Example
      - How much does it cost to drive a car?
      - Does your family or someone you know drive a car to work? The average U.S. adult drives 15,000 miles (24,140 kilometers) per year and pays more than $2 per gallon of gas. Gas mileage is different for each type of car so how much you pay for fuel to drive your car may change a lot (see Table 1)! An example calculation for a sport utility vehicle (SUV): 19 mpg x $2 per gallon x 15,000 miles per year = $1,579 per year just to drive the car to work. Wow!

Activity: (15 minutes)

3. Prior to the activity, cut out the pieces to the "Residential Mix & Match Game"sheet and place them in a paper bag from which students will draw one piece of paper.
4. Each piece is either a conserving energy practice or an example of waste.
5. Have the students circulate the room searching for their matching part—for example, if you have the wasting energy slip stating, "Take a bath.", your partnering piece would be the strip that says,"Take a shower instead of a bath."
6. Have each pair discuss how their activities conserve or waste energy

Wrap-Up (Review, Assess, Challenge): (15 minutes)

7. Prior to the wrap-up, cut out the pieces on the "Agricultural Mix and Match Game" sheet and place in a paper bag from which students will draw one piece of paper.
8. Repeat the process in the prior activity using the new pieces.
9. Discuss as a class ways energy is conserved and wasted in farming.

Residential Mix and Match Game

Conserving Energy	Wasting Energy
Use a pan that matches the size of the stove burner	Use a small pan on a large burner
Cook many items in the oven at the same time	Cook one item in the oven at a time
Run the washing machine with a full load	Running the washing machine half full
Take a shower, instead of a bath	Take a bath
Close the curtains in the room that you are cooling	Leave the curtains open while trying to cool a room
Turn off the TV or radio when no one is watching or listening	Leave on the TV or radio when no one is watching or listening
Fix the leaking faucet	Let water drip from a leaking faucet
Open and close the refrigerator door quickly	Keep the refrigerator door open
Fill up your sink with water, then wash your dishes	Let the faucet run while you wash your dishes
Put on a jacket when it's cold in your house	Turn on the heater
Stuff rags, paper or rugs in the crack under an outside door	Have leaking doors or windows
Turn off the lights that you do not need	Leave lights on when you are not using them

Source: Energy: Lesson 2, Wasting Energy at Home Activity — Mix and Match Game: https://www.teachengineering.org/content/cub_/activities/cub_energy2/cub_energy2_lesson02_activity1_game.pdf

Agricultural Mix and Match Game[iv,v,vi,vii]

Conserving Energy	Wasting Energy
Keep light fixtures clean to maximize light levels and avoid using extra lighting.	Allow dust to accumulate on light fixtures.
Dim or turn off interior lights when daylight allows and illuminate only work areas (not the entire building).	Leave the lights on all day and forget to turn them off.
Seal windows and install weather stripping in closed buildings.	Leave windows open and unsealed.
Extend your barn's life with better ventilation, and when you upgrade fans, choose energy-efficient models.	Forget to upgrade fans in the barn.
On the dairy farm, save up to 50 percent on milk cooling costs by precooling milk with plate coolers (also called well water heat exchangers).	Transfer milk straight into the milk tank without cooling beforehand.
Maintain all equipment so that it burns less fuel and is safe for the environment (e.g., cleaning or replacing air filters regularly)!	Forget to maintain farm equipment and change air filters.
Insulate barns and buildings to ensure that heating and cooling is not wasted!	Run your air conditioner or heater more than required because your barn is not insulated properly.
Out with the old, in with the new! Stay up to date with technology by purchasing new, energy efficient models (i.e., Old irrigation pumps are often wasteful, yet newer models are efficient).	Keep operating with the same, old equipment that use higher amounts of fuel.
Maximize your resources and partner with other companies or government programs to work toward efficiency (i.e., The United States federal government facilitates REAP [Rural Energy for America Program], a program that aids in small farmers working towards improving energy efficiency).	Work by yourself and do your best to work toward energy efficiency avoiding government programs that help to work toward energy efficiency.

Agricultural Mix and Match Game[iv,v,vi,vii]

Conserving Energy	Wasting Energy
Operate tractors and machinery at optimal speed.	Drive your tractor too slow or fast rather than recommended optimal speed.
Use variety in your lighting features. Utilize efficient lighting fixtures and bulbs (i.e., replace incandescent light bulbs with efficient fluorescent lights).	Install the same lighting features throughout.
In greenhouses, be conscious of different crops and their specific needs for lighting and adjust accordingly.	Keep the same amount of light on each plant in your greenhouses regardless of crop variety.
Consider utilizing automatic temperature controls to heat and cool your building or barn.	Allow the temperature to fluctuate and maintain no system of temperature control.
Depending on the soil and other factors, farmers may be able to use conservation till practices. This is an energy efficient way to reduce consumption of fuel.	Till your fields without looking into alternative methods.
Utilize as much field drying for grain as possible. To remain energy efficient, run your grain drying system at maximum temperatures that will not damage the grain and avoid over drying.	Run the grain drying system at moderate temperatures and rely on your grain drying system to remove most of the moisture.
Install shades on farm buildings in order to keep heat outside of the facility during summer and inside the building in the winter.	Leave windows uncovered with no shades. Sunlight will come in through the windows and the temperature may rise in your building.
Use motion sensor lighting and set timers on additional light fixtures. Explore solar and other alternative lighting sources.	Install simple lighting. Don't install motion sensor lighting or utilize timers.
Drive to town when necessary and combine trips to purchase supplies, seed, chemical and equipment.	Use your truck excessively and make multiple trips into town each day for the supplies you need.
Check your tire pressure. According to a University of California Study, correctly inflated tire pressure required 20 percent less fuel than tires that were improperly inflated.	Over inflate or under inflate your tires.

Agricultural Mix and Match Game[iv,v,vi,vii]

Conserving Energy	Wasting Energy
Consider participating in an on-farm energy audit.	"Ignorance is bliss," or so they say. Stick to your practices and avoid participating in an energy audit.
Seek information on utilizing wind energy or other alternative forms of producing your own energy on the farm.	Avoid new technologies like wind energy.
Match field equipment and tractor implements to the appropriate tractor. This ensures maximum fuel efficiency.	Mix and match your equipment and tractors without proper thought.

References

[i] Regents of the University of Colorado. (2005). *Lesson: What is energy?* Retrieved from https://www.teachengineering.org/lessons/view/cub_energy2_lesson01

[ii] Regents of the University of Colorado. (2005). *Hands-on activity: What is energy? Short demos.* Retrieved from https://www.teachengineering.org/activities/view/cub_energy2_lesson01_activity1

[iii] Teach Engineering. (2018, March 14). *Lesson: Energy conservation: Considering sources, cost and impact.* Retrieved from https://www.teachengineering.org/lessons/view/cub_energy2_lesson02

[iv] Northeast Sustainable Agriculture Research and Education. (n.d.). *Farm energy IQ*. Retrieved from https://articles.extension.org/sites/default/files/Farm%20Energy%20Efficiency%20Principles%20-%20Fact%20Sheet.pdf

[v] The Institute for Energy and the Environment at Vermont Law School. (2007). *The farmer's handbook for energy self-reliance.* Retrieved from https://articles.extension.org/sites/default/files/Farmers%20Handbook%20-%20Vermont%20Law%20School.pdf

[vi] eXtenson Farm Energy. (2019, April 3). *Farm energy.* Retreived from https://articles.extension.org/pages/31542/grain-drying-energy-efficiency-checklist-and-tips

[vii] Shipley Energy. (n.d.). *Energy efficiency for agriculture.* Retrieved from https://www.shipleyenergy.com/energy-101-guides/guide/2018/09/19/energy-efficiency-for-agriculture

This resource is brought to you by

American Farm Bureau Foundation for Agriculture

Thanks to generous support from