GROWING GREEN

LESSON PACKET

Table of Contents

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LESSON ONE

1 | WHAT IS ENERGY?

2 HOUR

National Learning Standards:

ELEMENTARY SCHOOL

• NGSS-4-PS3-2 Energy: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

• Common Core Connection: CCSS.ELA-Literacy.W.5.7 - Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

MIDDLE SCHOOL

• NGSS-MS-PS3-5: Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

• Common Core Connection: CCSS.ELA-Literacy.RST.6-8.1 - Cite specific textual evidence to support analysis of science and technical texts.

HIGH SCHOOL

• NGSS-HS-PS3-2 Energy: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).

• Common Core Connection: CCSS.ELA.Literacy.SL.9-10.4 - Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

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:

• Energy: the ability to do work

• Potential energy: the energy stored by an object as a result of its position

• Kinetic energy: the energy of movement

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LESSON ONE

1 | WHAT IS ENERGY?

Background Information:

Energy takes many forms. It cannot be created or 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 here:

U.S. Energy Information Administration, “What is Energy?”

https://www.eia.gov/energyexplained/index.php?page=about_home

Materials:

- Coiling Snake Template
- Red construction paper (for snake tongue)
- String or thread (approx. 30 cm or 1 ft per group)
- Scissors
- Energy Detective Worksheet

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WHAT IS ENERGY?

1 INTRODUCTION (ANTICIPATORY SET):

(This introduction was adapted from the site Teach Engineering and can be found here.)

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 room? 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?
        i. The ability to do work or cause change
        ii. 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
        iii. To do work, energy is needed
    b. Where does energy come from?
        i. Natural energy sources: food, water, plants, trees, gravity, sun, fossil fuels, uranium, plutonium
        ii. 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.)
        i. Kinetic energy: electrical, light, thermal, solar, sound, wind, hydro
        ii. Potential energy: chemical, mechanical, nuclear, gravitational
    d. How do we use energy?
        i. To break down and digest food (in our bodies)
        ii. To heat houses and other buildings
        iii. To illuminate lights
        iv. To power televisions, radios, games, cars
        v. To run computers and appliances

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WHAT IS ENERGY?

1 | INPUT AND MODELING:

(This introduction was adapted from the site Teach Engineering and can be found here.)

1. Split the class into teams of two or three and distribute the "Coiling Snake Template" to each set.
2. Work with the students through the following steps:
    - Have students in each team cut their "Coiling Snake Templates," making sure to cut along all the lines.
    - Draw and cut a forked tongue from red construction paper.
    - Glue the tongue onto the snake.
    - Poke a hole in the snake's head or tail; using a hole punch works best.
    - Cut a piece of string (or thread) about 30 cm (1 foot) long.
    - Tie the string to the snake's head or tail, and knot it.
    - Hold the snake by the string over a candle or light bulb.
    - As the light bulb heats up, the snake should spin.

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.)"

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."

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WHAT IS ENERGY?

1 | INDEPENDENT PRACTICE:

PART A - FOR UPPER ELEMENTARY AND EARLY MIDDLE SCHOOL STUDENTS

1. Keep students in their groups of two or three.
2. Distribute the “Energy Detectives” worksheet.
3. Tell students that energy evaluations or energy audits are a common practice used to better understand how we are currently meeting our energy needs.
4. 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.

PART B - FOR MIDDLE SCHOOL AND EARLY HIGH SCHOOL STUDENTS

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

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1 | WRAP-UP (REVIEW, ASSESS, CHALLENGE):

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

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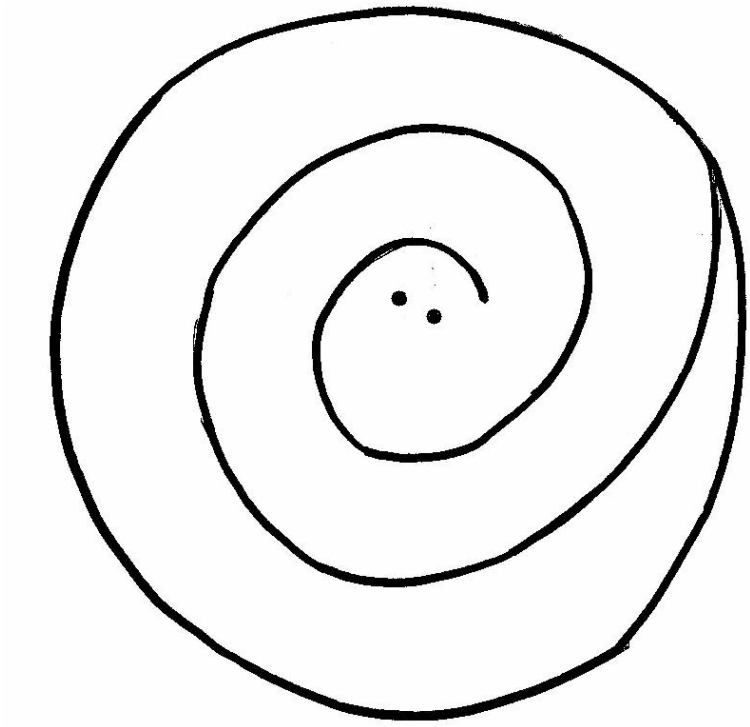
WHAT IS ENERGY?

1 | ACTIVITY SHEET 1



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WHAT IS ENERGY?

1 | ACTIVITY SHEET 2

Energy Detective Worksheet

WHAT WE KNOW:

Energy can give off heat or light.

We know that energy causes movement.

We know _____

WHAT WE FOUND:

1. Item that uses energy	2. We know it uses energy because...	3. Source of energy for this item

How many items did you find that use energy?

Below, write a definition for energy.

Source: www.teachengineering.org

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LESSON TWO

2 | RENEWABLE & NONRENEWABLE ENERGY SOURCES

National Learning Standards:

ELEMENTARY SCHOOL

• NGSS.5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

• Common Core Connection: CCSS.ELA-Literacy.W.5.9: Draw evidence from literary or informational texts to support analysis, reflection, and research.

MIDDLE SCHOOL

• NGSS.MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

• Common Core Connection: CCSS.ELA-Literacy.RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

• NGSS.MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

• Common Core Connection:CCSS.ELA-LITERACY.CCRA.R.8: Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

HIGH SCHOOL

• NGSS.HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

• Common Core Connection: CCSS.ELA-Literacy.WHST.9-10.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

LEARNING OBJECTIVES:

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

KEY TERMS:

Renewable energy Nonrenewable energy Fossil fuels

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LESSON TWO

2 | RENEWABLE & NONRENEWABLE ENERGY SOURCES

Background Information:

• U.S. Energy and Information Administration's, "What is Renewable Energy?"
https://www.eia.gov/energyexplained/?page=renewable_home

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

Materials:

• Poster boards

• Construction paper

• Markers, colored pencils, crayons, etc.

• Computer with Internet access

• National Geographic's "Renewable Resources"

• National Geographic's "Nonrenewable Resources"

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RENEWABLE & NONRENEWABLE ENERGY SOURCES

2 INTRODUCTION (ANTICIPATORY SET):

1. Did you know that rotting bananas can power a town? Share the short BBC News article, "Bananas Could Power Aussie Homes." Ask students to describe what they have heard about renewable and nonrenewable energy and discuss as a class.
2. 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 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.

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2 INPUT AND MODELING:

1. Divide the students into groups of three or four.
2. Distribute materials to make a poster.
3. Assign each group a category — renewable or nonrenewable.
4. 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.

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2 | INDEPENDENT PRACTICE

1. Assign the Internet article from National Geographic, "Renewable Resources." Allow students time to read the article. Then discuss the main ideas and focus on advantages and disadvantages of these power sources.
2. Assign the Internet article from National Geographic, "Nonrenewable Resources." Allow students time to read the article. Then, discuss the main ideas and focus on advantages and disadvantages of these power sources.
3. Allow time for students to research, design and create their posters.

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2 | WRAP-UP (REVIEW, ASSESS, CHALLENGE):

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

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LESSON THREE

3 | EXPLORING RENEWABLE ENERGY

National Learning Standards:

ELEMENTARY SCHOOL

• NGSS.5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

• CCSS.ELA-Literacy.RI.5.9: Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

MIDDLE SCHOOL

• NGSS. MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

• CCSS.ELA-Literacy.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

• NGSS.MS-ETS1-3 Analyze and interpret data to determine similarities and differences in findings among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

• CCSS.ELA-Literacy.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

• CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.

• CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others.

• CCSS.ELA-Literacy .CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

• CCSS.ELALiteracy.CCRA.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

HIGH SCHOOL

• NGSS.HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

• CCSS.ELA-Literacy.WHST.9-10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

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LESSON THREE

3 | EXPLORING RENEWABLE ENERGY

LEARNING OBJECTIVES:

1. Students will be able to understand and explain in general terms how solar, wind, hydro, biomass and geothermal 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:

Biomass Fossil Fuels Geothermal energy Renewable energy Wind turbine

Materials:

• Renewable energy potential maps as found on the "Renewable Energy Living Lab" website (Printed, projected on screen, or give students access to computers)

• "Power Your School Worksheet," one per student (From the "Teach Engineering: Renewable Energy Living Lab: Power Your School" website, copy included)

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EXPLORING RENEWABLE ENERGY

3 INTRODUCTION (ANTICIPATORY SET):

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.

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3 INPUT AND MODELING:

1. Divide the group into groups of two or three.
2. Guide groups to the Renewable Energy Living Lab website
3. Explore the site together and discuss the data.
4. Complete the “Engage,” “Explore,” “Explain” and “Elaborate” sections including the calculations on the “Power Your School Work Sheet” together.

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EXPLORING RENEWABLE ENERGY

3 INDEPENDENT PRACTICE:

1. Assign the Internet article from National Geographic, "Renewable Resources." Allow students time to read the article. Then discuss the main ideas and focus on advantages and disadvantages of these power sources.
2. Assign the Internet article from National Geographic, "Nonrenewable Resources." Allow students time to read the article. Then, discuss the main ideas and focus on advantages and disadvantages of these power sources.
3. Allow time for students to research, design and create their posters.

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3 WRAP-UP (REVIEW, ASSESS, CHALLENGE):

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

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EXPLORING RENEWABLE ENERGY

3 | ACTIVITY SHEET 1

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 www.teachengineering.org
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 read information 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]).

https://www.epa.gov/sites/production/files/2014-12/documents/recovering_value_from_waste.pdf

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EXPLORING RENEWABLE ENERGY

3 | ACTIVITY SHEET 1

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 m2.
   - 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: https://www.teachengineering.org/content/csm_/activities/csm_powerschool/csm_powerschool_activity1_worksheet_new2.pdf

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LESSON FOUR

4 | INDIRECT VS DIRECT ENERGY CONSUMPTION

National Learning Standards:

ELEMENTARY SCHOOL

• NGSS.4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

• Common Core Connection: CCSS.ELA-Literacy.W.4.9: Draw evidence from literary or informational texts to support analysis, reflection, and research.

MIDDLE SCHOOL

• NGSS.MS.ESS3-1: Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

• Common Core Connection:CCSS.ELA-Literacy.WHST.6-8.9: Draw evidence from informational texts to support analysis reflection, and research.

HIGH SCHOOL

• NGSS.HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

• Common Core Connection: CCSS.ELA-Literacy.WHST.9-10.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

• CCSS.ELA-Literacy.RH.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

LEARNING OBJECTIVES:

1. Students will examine how energy is consumed in agriculture.

2. Students will demonstrate that energy consumption is both direct and indirect.

KEY TERMS:

Direct Energy Consumption

Indirect Energy Consumption

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LESSON FOUR

4 | INDIRECT VS DIRECT ENERGY CONSUMPTION

1 HOUR

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:

- Construction paper
- Art supplies
- Scissors, glue
- Computers with Internet access
- Access to a printer

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INDIRECT VS DIRECT ENERGY CONSUMPTION

4 | INTRODUCTION (ANTICIPATORY SET):

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.

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INDIRECT VS DIRECT ENERGY CONSUMPTION

4 | INPUT & MODELING:

15 MIN

INSTRUCTIONS: OPTION A - FOR ELEMENTARY AND MIDDLE SCHOOL STUDENTS

- Share the following infographic and article with the whole group and read together.
- https://www.ers.usda.gov/amber-waves/2017/january-february/energy-consumption-and-production-in-agriculture
- Explain that they are going to explore direct and indirect energy consumption as it relates to farming and agriculture. Explain 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.
- Distribute “Activity Sheet 1” and “Activity Sheet 2” and review the directions.

OPTION B - FOR HIGH SCHOOL STUDENTS

- Divide class into groups of two or three.
- Explain that they are going to explore direct and indirect energy consumption as it relates to farming and agriculture. Explain 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.
- Direct students to the following sites:
- https://www.ers.usda.gov/amber-waves/2017/january-february/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

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INDIRECT VS DIRECT ENERGY CONSUMPTION

4 | INDEPENDENT PRACTICE:

OPTION A - FOR ELEMENTARY AND MIDDLE SCHOOL STUDENTS

- Allow students time to complete the “Energy Sort” activity.
- 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.
- Challenge students to make an infographic with the data and information they have discovered. 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

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4 | WRAP-UP (REVIEW, ASSESS, CHALLENGE):

OPTION A - FOR ELEMENTARY AND MIDDLE SCHOOL STUDENTS

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

OPTION B - FOR HIGH SCHOOL STUDENTS

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

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INDIRECT VS DIRECT ENERGY CONSUMPTION

4 | ACTIVITY SHEET 1

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.

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INDIRECT VS DIRECT ENERGY CONSUMPTION

4 | ACTIVITY SHEET 2

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

1. Direct Energy	2. Indirect Energy

3. Uncertain

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LESSON FIVE

5 | THE UNITED STATES ENERGY PORTFOLIO

National Learning Standards:

ELEMENTARY SCHOOL

• NGSS.5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

• Common Core Connection: CCSS.ELA-Literacy.W.5.9: Draw evidence from literary or informational texts to support analysis, reflection, and research.

• CCSS.MATH.CONTENT.5.G.A.2: Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

• CCSS.MATH.CONTENT.5.MD.B.2: Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Use operations on fractions for

MIDDLE SCHOOL

• NGSS.MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

• Common Core Connection: CCSS.ELA-Literacy.WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research.

• CCSS.MATH.CONTENT.7.RPA.2: Recognize and represent proportional relationships between quantities.

• NGSS.MS.ESS3-1: Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

HIGH SCHOOL

• NGSS.HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

• Common Core Connection: CCSS.ELA-Literacy.WHST.9-10.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

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.

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LESSON FIVE

5 | THE UNITED STATES ENERGY PORTFOLIO

KEY TERMS:

Energy | Renewable energy | Nonrenewable energy | Fossil fuels
Solar energy | Consumption | Conservation

Background Information:

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

- Powering the U.S.
- Energy Conservation: Considering Sources, Cost, and Impact
- Wasting Energy at Home

Materials:

- "Mix & Match Game - Residential Examples"
- "Agricultural Mix and Match Examples" sheet
- Paper bag

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The United States Energy Portfolio

5 | Introduction (Anticipatory Set):

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

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5 | Input and Modeling:

1. The following comes from the lesson "Energy Conservation: Considering Sources, Cost, and Impact" found at Teach Engineering. Use this as a guide for discussing energy costs and impact.
    - Driving Example
    - Light Bulb Example
    - Home Heating Example

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THE UNITED STATES ENERGY PORTFOLIO

5 INDEPENDENT PRACTICE

- Prior to the activity, cut out the pieces to the “Mix & Match Game–Residential Examples” and place them in a paper bag from which students will draw one piece of paper.
- Each piece is either a conserving energy practice or an example of waste.
- 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.”
- Have each pair discuss how their activities conserve or waste energy.

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5 WRAP-UP (REVIEW, ASSESS, CHALLENGE):

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

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5 | Resources

https://www.nationalgeographic.com/environment/energy/reference/renewable-energy/

https://www.scienceforconservation.org/assets/downloads/TNC_ORB_Executive_Summary.pdf

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5 | ACTIVITY SHEET 1

Agricultural Mix and Match Game

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.
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.

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5 | Activity Sheet 1

Agricultural Mix and Match Game

CONSERVING ENERGY	WASTING ENERGY
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.
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.
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.
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.

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