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WIND ENERGY LESSON PLANS

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Lesson Plan 1: The Wonderful Wind

In this lesson, students learn the distinction between nonrenewable and renewable sources of energy, recognizing that wind energy is one of the primary renewable sources used today. They also learn about the concept of resource scarcity as it pertains to energy and other natural resources. Students gain a conceptual understanding of how wind is converted into electricity and can therefore power homes, businesses, and schools in a community. In science, students investigate wind as an atmospheric phenomenon in the context of Earth's spheres. Students are introduced to the engineering design process (EDP) as a structure for group problem solving and are challenged to apply the EDP to a design problem.

ESSENTIAL QUESTIONS

- How can wind be used as a renewable source of energy for communities?
- How does resource scarcity affect populations worldwide?
- How do renewable energy sources address scarcity?

ESTABLISHED GOALS AND OBJECTIVES

At the conclusion of this lesson, students will be able to do the following:

- Identify renewable and nonrenewable resources and discuss how these are used in their daily lives
- Describe the power sources for their homes and schools
- Define and discuss the concept of resource scarcity
- Identify Earth's four spheres: atmosphere, biosphere, hydrosphere, and lithosphere
- Describe and illustrate interactions among Earth's spheres
- Discuss the role of Earth's spheres in the creation of wind
- Create a model that illustrates interactions among Earth's spheres

- Identify several limitations of models
- Identify the engineering design process (EDP) as a series of steps that engineers use to solve problems and create products
- Apply their understanding of wind energy and the EDP to create a solution to a design challenge

TIME REQUIRED

- 5 days (approximately 45 minutes each day; see Table 3.6, p. 42)

MATERIALS

Required Materials for Lesson 1

- STEM Research Notebooks (1 per student; see p. 26 for STEM Research Notebook student handout)
- Internet access for student research and viewing videos
- Handouts (attached at the end of this lesson)

Additional Materials for Enough for Everyone? (per group unless otherwise noted)

- 60 small pieces of candy in varied colors, such as M&Ms, Skittles, or jelly beans* (*Note:* If you wish to allow students to eat candy afterward, purchase extra, as students will handle the candy in groups during the activity. Remind students to not eat food used in the lab activity or in the lab.)
- Roll of paper towels (per class)
- 2 paper bags*
- Plastic resealable bag (quart size)
- 2 sets of 15 slips of paper, each set numbered 1 to 15
- Enough for Everyone? handout (1 per student; attached at the end of this lesson)

Additional Materials for Scarcity Scramble

- Envelopes (1 per group)*
- Slips of paper labeled with resource units*
- Scarcity Scramble handouts (1 set per student; attached at the end of this lesson)

*See Preparation for Lesson 1 on page 55 for more details.

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Additional Materials for Earth's Spheres

- Connect the Spheres handout (5 copies per student; attached at the end of this lesson)
- Earth's Spheres graphic organizer (1 per student; attached at the end of this lesson)
- Chart paper (1–2 sheets per group of 3–4 students)
- Markers

Additional Materials for Blown Away Design Challenge (per group unless otherwise noted)

- Small plastic or inflatable wading pool (1 per class)
- Water to fill pool a few inches deep
- 1 small plastic container (about 4 × 6 inches)
- Fan (1 per class)
- 5 small craft sticks
- 5 coffee stirrers
- 2 plastic drinking straws
- 3 index cards (3 × 5 inches)
- 1 piece of notebook or printer paper
- 1 piece of tissue paper
- 2 small paper cups (3 or 5 oz. size)
- 1 sheet of aluminum foil (about 12 × 6 inches)
- 1 sheet of waxed paper (about 12 × 6 inches)
- 1 plastic grocery bag
- 1 pair of scissors
- 1 roll of masking tape
- 8 large paper clips
- Blown Away Engineer It! handouts (1 set per student; attached at the end of this lesson)
- Safety glasses or goggles

Table 4.2. Key Vocabulary in Lesson 1

Key Vocabulary	Definition
atmosphere	the layer of gases surrounding Earth
biosphere	the outer parts of Earth that are occupied by living things; includes regions of the surface, atmosphere, and hydrosphere
collaboration	the act of working together in groups to achieve a goal or create something
electricity	a form of energy that is carried through wires and provides power to buildings, lights, machines, and other devices
entrepreneur	a person who starts and operates one or more businesses
hydrosphere	all the water on Earth's surface
lithosphere	Earth's solid outer surface, consisting of its crust and mantle
model	a simplified representation of a system or object that contains important features of the system or object
natural resources	substances that occur in nature and that may be used to make other products
nonrenewable energy sources	energy sources that cannot be replaced when used, such as fossil fuels
renewable energy sources	sources of energy that are naturally replenished when used, such as the Sun or wind
resources	a supply of materials that people or groups draw on to meet wants and needs
scarcity	the state of something being in short supply
scientific model	a representation to make a concept or object easier to understand; types of models include visual (such as a flowchart), physical (a globe), conceptual (weather forecasting), and mathematical models
system	a set of parts that interact with one another to create a complex whole
wind	moving air caused by the uneven heating of Earth's surface by the Sun
wind turbine	a tall tower with rotating blades attached at the top that uses wind to create electricity

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TEACHER BACKGROUND INFORMATION

This lesson introduces the module and the final challenge by connecting the concept of scarcity to energy sources and other resources we rely on daily. Wind energy is introduced as a viable option to nonrenewable energy sources as a way to address some of the scarcity issues surrounding fossil fuels. For students to more fully understand wind as a resource with variable availability, they investigate the origins of wind by considering the interaction of Earth's spheres. Students use both the EDP and the scientific method throughout the module, and the EDP is introduced in this lesson as a problem-solving process.

Wind and Wind Energy

Wind is caused by the unequal heating of Earth's surface due to Earth's rotation and different landforms, such as mountains. The Sun's heat is absorbed by Earth's surface and released back into the atmosphere. Because the surface of the land is uneven and the Sun shines on both land and water, different amounts of heat energy are released back into the air in different areas, causing temperature differentials. Different air temperatures are associated with different pressures. Cool air is denser than warm air, so cool air increases atmospheric pressure and sinks, while warm air reduces pressure and rises; when this air movement occurs, wind is created. Wind speed and direction are affected by atmospheric pressure, with wind blowing from areas of high pressure to low pressure. The National Energy Education Development (NEED) project provides educational resources on wind and wind energy that may be useful to you and your students. See "Wind Energy" at *www.need.org/files/curriculum/infobook/WindP.pdf*.

Wind is a renewable energy source (see definition in Table 4.2, p. 51). Although wind energy supplied only about 5% of the energy in the United States in 2016, according to the U.S. Energy Information Administration (EIA), it is the fastest-growing electricity source in the country. (For more information, see "Installed Wind Capacity" from the U.S. Department of Energy (DOE) at *https://apps2.eere.energy.gov/wind/windexchange/wind_installed_capacity.asp* and "Electricity Generation from Wind" from the U.S. Energy Information Administration (EIA) at *www.eia.gov/kids/energy.cfm?page=wind_home-basics#wind_electricity_generation-basics*).

There is evidence that wind energy has been used for thousands of years to propel boats, pump water, and grind grain. Wind energy was used to power windmills as early as 200 BC in China and the Middle East. The Dutch are known for their work in advancing and refining windmill technologies beginning around 1000 AD when wind power technologies spread to northern Europe. These technologies crossed the ocean with the settlement of the United States and were important in the country's westward expansion because windmills were commonly used to access water. Modern wind turbines use technology similar to that of historic windmills, with blades to capture the wind's kinetic

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energy. In modern turbines, however, the blades are connected to an electric generator that produces electricity for households and businesses.

Engineering

Students begin to gain an understanding of engineering and other professions related to resource use in this module. In particular, they should understand that engineers are people who design and build products in response to human needs. Engineers apply science and mathematics knowledge to create these designs and solutions. Students should also understand that there are many different types of engineers. For an overview of the various types of engineering professions, see the following websites:

- *www.engineeryourlife.org/?ID=6168*
- *www.nacme.org/types-of-engineering*
- *www.sciencekids.co.nz/sciencefacts/engineering/typesofengineeringjobs.html*

Career Connections

As career connections related to this lesson, you may wish to introduce the following:

- *Urban Planner:* Urban planners work to optimize the effectiveness of a community's land use by developing plans to create communities and plan for growth.
- *Geographer:* Geographers study the Earth's natural land formations and human society, with a focus on the relationship between these phenomena. In particular, they study the characteristics of various parts of the Earth, including physical characteristics and human culture. Many geographers work for the federal government. Teaching and field research are other areas in which geographers work. For more information, see *www.bls.gov/ooh/life-physical-and-social-science/geographers.htm.*
- *Mechanical Engineer:* Mechanical engineers design and build mechanical systems (such as motors) and tools.
- *Electrical Engineer:* Electrical engineers design electrical circuits and computer chips.
- *Civil Engineer:* Civil engineers design bridges, roads, and dams.
- *Computer Engineer:* Computer engineers do work that is similar to that of electrical engineers, but they specialize in computer technology. Much of their work with electrical circuits is on a very small scale, such as in microprocessors.

Engineering Design Process (EDP)

Students should understand that engineers need to work in groups to accomplish their work, and that collaboration is important for designing solutions to problems. In this module, students are challenged to work in teams to complete a variety of tasks and to act as design engineers. They will use the engineering design process (EDP), the same process that professional engineers use in their work. Your students may be familiar with the scientific method but may not have experience with the EDP. Students should understand that the processes are similar but are used in different situations. The scientific method is used to test predictions and explanations about the world. The EDP, on the other hand, is used to create a solution to a problem. In reality, engineers use both processes, and your students' experience will reflect this. A good summary of the similarities and differences between the processes is at *www.sciencebuddies.org/engineering-design-process/engineering-design-compare-scientific-method.shtml*. An additional resource about the EDP is the video "What Is the Engineering Design Process?" at *www.pbslearningmedia.org/resource/phy03.sci.engin.design.desprocess/what-is-the-design-process.*

A graphic representation of the EDP is provided at the end of this lesson. It may be useful to post this in your classroom. You may want to review each step of the EDP listed on the graphic with students.

COMMON MISCONCEPTIONS

Students will have various types of prior knowledge about the concepts introduced in this lesson. Table 4.3 outlines some common misconceptions students may have concerning these concepts. Because of the breadth of students' experiences, it is not possible to anticipate every misconception that students may bring as they approach this lesson. Incorrect or inaccurate prior understanding of concepts can influence student learning in the future, however, so it is important to be alert to misconceptions such as those presented in the table.

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