

# Discovery Education STEM Camp – After School

## Module 3: How We Generate and Use Energy

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### Overview

In this Module, students will learn about the history of our use of energy. They will explore how we generate and use energy through the use of renewable and nonrenewable resources. They will learn about the pros and cons of using these resources. Students will learn about the energy sectors in our economy, including production and consumption. Students will employ many of the NGSS scientific and engineering practices and crosscutting concepts.

### Facilitator's Notes

#### Learning Objectives

After completing the activities in this module, students should be able to:

- Identify nonrenewable (fossil fuels and uranium) and renewable (biomass, water, geothermal, wind, solar) sources of energy.
- Construct a model of a device to capture useable energy from a renewable energy source.
- State the pros and cons of nonrenewable and renewable sources of energy.
- Identify the production and consumption makeup of the major energy sectors in our economy.
- Investigate the history of how humans have used different sources of energy over time.

#### Background

It is hard to imagine that many people did not have electricity in their homes less than 100 years ago. This is a concept that is especially hard for students to understand because they are surrounded by appliances, gadgets and electronics, all of which play an important role in their daily lives. While most of our electricity comes from the burning of coal, other fossil fuels, such as petroleum and natural gas, are used to help locate and extract many of the other natural resources we use, as well as to provide most of our transportation needs.

Energy we use comes from **renewable** and **nonrenewable** resources. The most common forms of renewable sources of energy include sunlight, wind, water and geothermal. These forms of energy can be replaced and used without worry of depletion. Because many of these sources of energy are dependent upon weather, their reliability can be reduced. At this time, nonrenewable sources of energy, such as fossil fuels like coal and petroleum are highly available but harmful to the environment. However, over time these sources, which are not regenerated, will no longer be available.

Energy use is divided among four major economic sectors including residential, commercial, transportation and industrial. In our daily lives we rely on energy in many ways. With our energy supply coming primarily from fossil fuels, the need to explore renewable resources becomes more and more important to ensure that affordable and clean energy will be readily available in the future.

#### Useful Web Resources

- [U.S. Energy Information Administration](#)
- U.S. Energy Information Administration [energy KIDS](#)

- [Union of Concerned Scientists Clean Energy](#)
- [Energy.Gov's Student Educational Resources - STEM](#)
- The Atlantic's special compilation of their articles on energy: [The Great Energy Shift](#)
- [NOAA Energy](#)
- [IEEE Spectrum: Energy](#)
- [Annenberg Learner's Science in focus: ENERGY](#)
- DOE's [Energy.gov](#)
- National Energy Education Development Project - [NEED](#)
- the National Academies [What You Need to Know About Energy](#)
- [Open EI \(Energy Information\)](#)
- [National Renewable Energy Laboratory](#)
- [History of use of energy](#)
- [History of electricity](#)
- [History of Energy](#)
- [Energy Consumption by source](#)
- [Energy Literacy \(DOE\)](#)
- [Energy 101 - YouTube Videos](#)

### **Key Vocabulary**

- Chemical Energy
- Consumer
- Electrical Engineer
- Electrical System
- Energy Sector
- Energy Transfer
- [Fossil Fuels](#)
- Geothermal Energy
- [Global Warming](#)
- [Hydroelectric Power](#)
- Kinetic Energy
- Light Energy
- Mechanical Energy
- [Natural Resource](#)
- [Nonrenewable Resource](#)
- Petroleum Engineer
- Potential Energy
- Producer
- [Renewable Resource](#)
- [Solar Energy](#)
- [Wind Energy](#)
- Wind Engineer

## Standards

### Next Generation Science Standards – Disciplinary Core Ideas

This module supports students understanding of the following Disciplinary Core Ideas:

#### ESS3.A: Natural Resources

- Humans depend on Earth’s land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1)

#### ESS3.C: Human Impacts On Earth Systems

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)

#### ESS3.C: Human Impacts On Earth Systems

- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MSESS3-3),(MS-ESS3-4)

#### ESS3.D: Global Climate Change

- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth’s mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

### Next Generation Science Standards – Practices of Science and Engineering

- Asking questions
- Defining problems
- Developing and Using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Constructing explanations
- Designing solutions
- Engaging in argument from evidence
- Using mathematical and computational thinking
- Obtaining, evaluating, and communicating information

### Next Generation Science Standards – Cross-Cutting Concepts

- Patterns
- Cause and Effect: Mechanism and Explanation

- Scale, Proportion, and Quantity
- Systems and System Models
- Energy and Matter: Flows, Cycles, and Conservation
- Structure and Function
- Stability and Change

## Setting the Stage

Turn the lights on and off. Play some music. Turn on a fan. Roll a marble down a ramp. Ask students to consider the benefits of energy in their daily lives.

Discuss with students about how they use energy in their daily lives (riding in a car or bus to school, watching television, staying cool inside on a hot summer day, etc.). Give students 3-5 minutes to make a list in their STEM notebooks of things they use energy for during their day. Share student responses, and ask students to consider how their day would be different without energy. Allow time for students to share.

Then, show students the video segment, [A Look at Energy \(1:11\)](#). Explain that we will be investigating how we generate and use energy and the different energy sources that we depend on.

## Activity Menu

Choose among the activities below

### Indoor Inquiry

- Let's Drill for Oil *Students will model how oil reservoirs are explored using clay of various colors and drinking straws. (hands-on activity, 60 minutes)*
- Waterwheel *Students will explore the concept of hydroelectric power by constructing a model waterwheel. (hands-on activity, 60 minutes)*
- Energy Trapped in The Earth *Students will explore the concept of geothermal energy by looking at how earth materials like rocks hold on to heat. (hands-on activity, 60 minutes)*
- A Short History of Energy *In this reading passage, students will learn about the history of our use of energy, including animal power, steam power, hydropower, petroleum, and nuclear energy.*

### Outdoor Inquiry

- Siemens Science Day: Blowin' In the Wind *Students will be challenged to create their own windmills and compare them to those made by their peers. (hands-on activity, 2 x 60 minutes)*
- Solar Distillation *In this activity students will construct and use a distiller to purify salty and muddy water using energy from the sun. (hands-on activity, 60 minutes)*

- Wind Around Your Home Students will make a simple device to measure wind strength at different sites around their house or apartment. (*hands-on activity, 60 minutes*)
- Force of Water Explorations In this activity, students will be able to identify variables that affect the force of flowing water at a dam. (hands-on, indoors or outdoors, 1 or 2 50 minute periods. Teacher guide on page 11, activity 7. Student worksheets available [here](#) on pages 47-51.)
- Wind Energy Students make a pinwheel to model a wind turbine. Much like engineers, they decide where and how their turbine works best by testing it at different areas of the playground. (hands-on activity, outdoors, 2 50-minute periods)

#### Technology Inquiry

- Cyber Investigation: Future Power In this Virtual Lab, students will explore the concept of using biomass as an alternative to fossil fuels as they make attempts to calculate the best combination of the two to create power. (30 minutes, Internet activity, [Teacher Guide](#))
- 3M Wind Energy Virtual Lab In a virtual environment, students will design, build, and test a wind turbine that will supply 400 homes with electricity for one year. (60 minutes, Internet activity; [Teacher Guide](#))
- Virtual Lab: How Big Is Your Footprint? Students will explore options for alternative energy. (45 minutes, Internet activity; [Teacher Guide](#); [Student Planning Sheet](#))
- Siemens We Can Change The World Challenge Students can take the environmental IQ quiz on the [middle school resources page](#).
- Energy Awareness Quiz Students can take a 10-question online quiz to check their understanding of important energy-related concepts. Detailed answers are provided.
- Water Power In this Exploration students investigate two factors (head height and volume of water) that affect the amount of electricity produced by a hydroelectric dam. (40 minutes; Internet activity; [Teacher Guide](#))
- Everyday Fossil Fuels In this Exploration students match synthetic products with fossil fuels to learn more about connections between everyday materials and fossil fuels. (40 minutes; Internet activity; [Teacher Guide](#))

#### Career/Community Connections

- Electrical Engineers Students will read the passage, Amri Hernandez-Pellerano: NASA Engineer. Then, students will watch the video segment [Electrical Engineer \(3:51\)](#), which is about careers in the electrical engineering industry.
  - What kind of education do you need to be an electrical engineer?
  - How do electrical engineers impact our daily lives?

- What skills does it take to be a good electrical engineer?
- Would you like to be an electrical engineer? Why/Why not?
  
- Petroleum Engineer Students will watch the video segment, Petroleum Engineer. Then they will visit the Navy in The Classroom website to explore a career as a Nuclear Engineer.
  - What kind of education do you need to be a petroleum engineer?
  - How do petroleum engineers impact our daily lives?
  - What skills does it take to be a good petroleum engineer?
  - Would you like to be a petroleum engineer? Why/Why not?
  
- Wind Engineer Students will explore the website, Science Buddies and read about wind energy engineers. Then they will view the video segment Cool Jobs in Science: Heather Dohan (1:05) from the 3M Science of Everyday Life: Cool Jobs in Science Page.
  - What kind of education do you need to be a wind engineer?
  - How do wind engineers impact our daily lives?
  - What skills does it take to be a good wind engineer?
  - Would you like to be a wind engineer? Why/Why not?

## Projects

Have students explore the topic of generating and using energy with one or more of the following projects:

- Create solar ovens using a pizza box, some foil and some dark paper. Encourage students to create their own investigations using the ovens.
- Write an editorial for the local newspaper explaining the need to explore and use renewable energy sources.
- Collect recent, but outdated, electricity bills from friends and neighbors. Study the electricity bills from those near you and calculate the average energy use. Research the average energy use across the United States and see how your neighborhood compares!
- Create a list of ways that people can help to ensure that our resources are available for future generations. Share the list with neighbors and friends.
- Research the Beaufort Scale. Keep a daily wind chart of spots near your home or school. Then, evaluate the chart to decide if your spot has good potential for generating electricity.
- Use some of the resources on the Department of Energy Web site, History of Energy, and the Energy Information Administration Web site, Today in Energy, to research the history of several different energy sources and present a summary to the class.
- Research energy production and consumption of different sectors of our economy with Web sites like this one from Wikipedia, the Energy Information Administration, and the EIA Energy Kids Energy Sources – Recent Statistics. Produce a summary to present to the class.

## Journal Reflections

Have students use their STEM journal and their experiences in this module to reflect on the following questions:

- *How could you decrease the amount of energy that you use every day?*

- *What are some ways that you can educate others about the need to use renewable resources?*
- *What goals do you have for future energy use?*
- *Which careers that you explored do you think will be around for future generations? Explain your thinking.*
- *How can you find out which sector of energy is the largest in your area? Research and find out if the residential, commercial, transportation or industrial sector is the largest? Which is the smallest?*
- *What questions do you still have about renewable and nonrenewable resources? How could you go about answering those questions?*