Cambridge Core Science Series: GeoBasics

ENERGY AND RESOURCES

Cambridge Educational

Teacher's Guide

Introduction

This Teacher's Guide provides information to help you get the most out of *Energy and Resources,* Part 7 of the *GeoBasics* series. The contents in this guide will allow you to prepare your students before they use the program, assist them as they navigate through the program, and present follow-up activities to reinforce the program's key learning points.

The *GeoBasics* series is intended to excite young people about science and teach them concepts that meet national educational standards for science literacy. Science, in its multiple disciplines, is inherently fascinating and helps explain the world around us. In addition to fulfilling our natural curiosity, studying science and learning critical thinking skills provides numerous practical benefits, including helping us make informed and reasoned decisions, solve problems, think creatively, and continue to learn.

This 20-minute video provides middle school and high school teenagers, grades 7 through 12, with an introduction to various types of energy sources available on the planet, but the program is not limited to use by this audience. Because science literacy is important for all people, the information presented in *Energy and Resources* could also be presented to vocational/technical schools or in adult education courses that focus on science and health.

Learning Objectives

After watching *Energy and Resources*, students will understand how to:

- Describe the various kinds of fossil fuels and how they were formed.
- Demonstrate an understanding of the current and future energy situation.
- Discuss what nuclear energy is, and what its advantages and disadvantages are over fossil fuels.
- List the various types of renewable energy and the differences between renewable energy and fossil fuels.
- Demonstrate an understanding of the human impact on farming, fishing, and forestry and how it affects the future viability of these resources.
- List various ways agencies, conservation groups, and scientists are trying to help combat the problems of dwindling energy resources.

Educational Standards

This program correlates with the following Standards: the National Standards of the National Academy of Sciences National Science Education, International Society for Technology in Education (ISTE), National Educational Technology Standards (NETS), and National Council of Teachers of English; and the State Standards of Florida, Ohio, and Texas for Earth and Space Sciences; Biology; Processes that Shape the Earth; How Living Things Interact with Their Environment; and Listening, Viewing, and Speaking.

- Develops an understanding of energy in the earth system, geochemical cycles, origin and evolution of the earth system, and origin and evolution of the universe. *(National Academy of Sciences National Science Education Standards, Earth and Space Science Standards: Grades 9-12)*

- Recognizes that processes in the lithosphere, atmosphere, hydrosphere, and biosphere interact to shape the Earth; understands the need for protection of the natural systems on Earth; understands the competitive, interdependent, cyclic nature of living things in the environment; and understands the consequences of using limited natural resources. *(Florida State Standards: Processes that Shape the Earth; How Living Things Interact with their Environment; Listening, Viewing, and Speaking)*

- Demonstrates an understanding about how earth systems and processes interact in the geosphere resulting in the habitability of Earth; and understands historical perspectives, scientific approaches, and emerging scientific issues associated with Earth and space sciences. *(Ohio State Earth and Space Science Standards)*

- Knows that interdependence and interactions occur within an ecosystem, and knows the significance of plants in the environment. *(Texas State Biology Standards)*

Program Overview

The *Cambridge Core Science* series is a 40-part series composed of subsets of programs addressing Life Science, Earth Science, Physical Science, Human Body Systems, and Space Science. The series is designed as a whole to give students a basic scientific understanding of themselves and the world around them.

The *GeoBasics* video program series consists of eight titles:

- Our Planet Earth
- Plate Tectonics
- Rocks and Minerals
- Oceans and Seas
- Geocycles
- Atmosphere, Climate, and Weather
- Energy and Resources
- Environmental Issues and Human Impact

The seventh title in the series, *Energy and Resources*, presents the various kinds of energy resources available today, including fossil fuels, nuclear energy, and renewable energy. It also explores how the various resources are in jeopardy because of our use and misuse of them over the centuries. It concludes with thought-provoking ways of combating the spiraling problems in today's times with potential solutions for the future.

Main Topics

Topic 1: Introduction
From the cars that we drive to the homes we live in, energy is a fundamental part of our universe and our daily lives. The introduction reminds students of how energy provides the necessary fuel for our demanding lifestyles.

Topic 2: Fossil Fuels
This topic covers in detail the fossil fuels of petroleum, natural gas, and coal, including how they develop and how they are refined into various end products.

Topic 3: Negative Impacts
The downsides of fossil fuels are discussed, from health and environmental effects, to their contribution to global warming, to the harsh reality of the resources' non-renewability.

Topic 3: Alternative Resources
The program's geological experts present information on the benefits, costs, and environmental impact of various alternative resources, including nuclear power, solar power, tidal energy, biomass fuels, geothermal energy, hydroelectric power, and wind power.

Topic 4: Conclusion
The program concludes by touching on various ways that scientists strike a balance between innovating new alternative energy sources and ensuring the energy does not damage the planet. Scientists are hoping to devise sustainable energy sources for future generations.

Fast Facts

- There are three major forms of fossil fuels: coal, oil, and natural gas. All three were formed roughly three hundred million years ago during the Carboniferous Period—hence the name "fossil fuels." The Carboniferous Period gets its name from carbon, which is the basic element in fossil fuels.

- Crude oil is pumped out of the ground and heated, enabling its hydrocarbon molecules to be separated by size. At refineries, the smallest, lightest molecules rise to the top of the giant distillation towers, where they are drawn off as propane, butane, and other gases. Gasoline, aviation fuel, and other medium weight fractions condense near the middle of the tower, and the heavier petroleum products (diesel oil and home heating oil) condense near the bottom. Greases, waxes, and asphalt remain as residue.

- Most crude oil is used for energy products, and less than one-tenth goes into all the other uses of petrochemicals: plastics, fertilizers, pesticides, etc.

- The U.S. uses about 25% of the world's oil, or about 6 billion barrels per year. Most scientists agree that if we continue at our present rate of consumption, we will use up all of the world's petroleum resources by 2050, all of the natural gas resources within a few decades, and all of the coal resources by 2500.

- There is new and stronger evidence that most of the global warming over the last 50 years is attributable to human activities.

- According to the National Academy of Sciences, the Earth's surface temperature has risen by about 1 degree Fahrenheit in the past century, with accelerated warming during the past two decades. This may seem minor, but an EPA report (based on information from the Intergovernmental Panel on Climate) warns that in terms of global climate this could be very impactful. Temperatures during the last ice age were only 9°F lower than they are now—but that was cold enough to cover what is now New York City under three feet of ice.

- Fossil fuels burned to run vehicles, heat homes and businesses, and power factories are responsible for about 98% of U.S. carbon dioxide emissions, 24% of methane emissions, and 18% of nitrous oxide emissions. Increased agriculture, deforestation, landfills, industrial production, and mining also contribute a significant share of emissions.

- One ton of natural uranium can produce more than 40 million kilowatt-hours of electricity. This is equivalent to burning 16,000 tons of coal or 80,000 barrels of oil. Worldwide, there are about 442 nuclear power plants that supply about 23% of the world's electricity. Nuclear power plants accounted for 90% of the reduction in carbon emissions by the U.S. energy sector between 1981 and 1994.

- Geothermal heat warms more than 70% of the homes in Iceland, and the Geysers geothermal field in northern California produces enough electricity to meet the power demands of San Francisco. In addition to being an energy resource, some geothermal waters also contain sulfur, gold, silver, and mercury that can be recovered as byproducts of energy production.

- The first use of a large windmill to generate electricity was a system built in Ohio in 1888 by Charles F. Brush. The development of modern vertical-axis rotors was begun in France by G.J.M. Darrieus in the 1920s. U.S. efforts with the Darrieus concept at Sandia National Laboratories began after the 1973 oil embargo, with the entry of the U.S. Federal Wind Energy Program into the cycle of wind energy development.

- Geothermal energy is a proven resource for direct heat and power generation. In over 30 countries geothermal resources provide directly used heat capacity of 12,000 MW and electric power generation capacity of over 8,000 MW. It meets a significant portion of the electrical power demand in several developing countries. For example, in the Philippines geothermal energy provides 27% of that country's total electrical generation, from power plant complexes as large as 700 MW.

- Southern California has the world's largest solar power plant, located in the Mojave desert. Solel, an Israeli company, operates the plant, which consists of 1,000 acres of solar reflectors. This plant makes 90% of the world's commercially produced solar power.

Vocabulary Terms

algae: Any of various chiefly aquatic, eukaryotic, photosynthetic organisms, ranging in size from single-celled forms to the giant kelp. Algae were once considered to be plants but are now classified separately because they lack true roots, stems, leaves, and embryos.

anthracite: A dense, shiny coal that has a high carbon content and little volatile matter, and that burns with a clean flame. Also called "hard coal."

biomass fuel (biofuel): Any fuel that derives from recently living organisms or their metabolic byproducts, such as wood, crops, garbage, or manure from cows. Biofuels are renewable energy sources that are seen by many as a way to reduce the amount of carbon dioxide released into the atmosphere by using them to replace nonrenewable sources of energy.

crude oil: Unrefined petroleum consisting mainly of hydrocarbons.

energy: A source of usable heat or power, such as petroleum or coal.

environmental impact: Human environmental health impact, risk to ecological health, and changes to the ways in which nature benefits humans—sometmes referred to as "nature's services"—caused by an activity.

fold: A bend in a stratum of rock.

fossil fuel: Fuel consisting of the remains of organisms preserved in rocks in the earth's crust with high carbon and hydrogen content.

geothermal energy: A form of renewable energy produced by extracting and converting the earth's internal heat.

global warming: An increase in the average temperature of the earth's atmosphere, especially a sustained increase sufficient to cause climate change.

hydroelectric power: A form of energy generated by the conversion of free-falling water to electricity; the generation of electricity by using the motive power of water; also called *hydro-electricity.*

natural gas: A mixture of hydrocarbon gases that occurs with petroleum deposits, principally methane together with varying quantities of ethane, propane, butane, and other gases, and is used as a fuel and in the manufacture of organic compounds.

natural resource: A material source of wealth, such as timber, fresh water, oil, or a mineral deposit, that occurs in a natural state and has economic value.

nuclear power: Nuclear energy regarded as a source of electricity for the power grid (for civilian use). Also called *atomic power.*

petroleum: A thick, flammable, yellow-to-black mixture of gaseous, liquid, and solid hydrocarbons that occurs naturally beneath the earth's surface, can be separated into fractions including natural gas, gasoline, naphtha, kerosene, fuel and lubricating oils, paraffin wax, and asphalt, and is used as raw material for a wide variety of derivative products.

radioactivity: The radiation, including alpha particles, nucleons, electrons, and gamma rays, emitted by a radioactive substance.

refinery: An industrial plant for purifying a crude substance, such as petroleum.

Ring of Fire: An extensive zone of volcanic and seismic activity that coincides roughly with the borders of the Pacific Ocean.

solar power: Energy from the sun that is converted into thermal or electrical energy. Also called *solar energy.*

tidal power: A means of electricity-generation achieved by capturing kinetic energy of currents arising between ebbing and surging tides, and potential energy from the difference in height between high and low tides. Tidal power is a renewable energy source.

topography: Graphic representation of the surface features of a place or region on a map, indicating their relative positions and elevations.

wind power: Power derived from the wind (as by windmills).

Pre-Program Discussion Questions

1. Do you think we will have more energy resources in the future than we have today, or fewer? If more, what will be the most used alternative energy resource, and why?

2. Two hundred years from now, what do you think our energy needs will be, and will it be possible to meet those needs? What measures could be taken now to prevent an energy crisis of epic proportions in the future?

3. Is global warming the greatest environmental concern facing the world today? Why or why not? How can we reduce global warming now and in the future?

4. If an alternative energy resource such as wind or solar power were made available to your community, but at twice the cost of your current energy source, would you use it? If not, how much lower in price would it need to be to entice you to switch?

5. Would you consider purchasing a hybrid car? Why or why not? If not, what would need to happen to make you change your mind?

Post-Program Discussion Questions

1. Discuss where fossil fuels are located, how they are extracted, and how they get from the ground to people's homes and cars.

2. Name the various types of renewable energy and the differences between renewable energy and fossil fuels.

3. Think outside the box and brainstorm about alternative energy resources that have not yet been considered. How could your idea be realized?

4. Describe what you think the energy sources will be 5,000 years from now. What will future history books say about our current energy conservation measures?

5. Discuss what alternative energy resources you have seen personally in your community or your state. Are you aware of any initiatives by the local government or conservation groups to conserve energy? What are they?

Internet Activities

- List all of the various fossil fuels. Using the Internet as your research tool, collect the usage statistics for each fossil fuel type for the previous year in the United States. What accounted for the highest percentage of energy use? Create a pie chart and key to display your findings.

- Many of the Earth's natural energy resources are concentrated around plate boundaries. Write a 5-page paper on what these resources are, how they were utilized in the past and present, and how they could be used in the future.

Group Activities

Do you think nuclear energy is a safe and viable energy resource, or an unsafe and unwise solution? Divide the class into those who are for nuclear energy and those who are against it. After a suitable period to research supporting evidence, each group should present their views to the class in a debate format.

Individual Student Projects

- Interview two family members, friends, or neighbors, one of whom is between 40 and 50 years of age, and one of whom is over 70. Then, write a 5-page paper detailing their experiences with the following:
  - — the energy crisis of the 1970s
  - — the energy resources they used when they were children
  - — what energy resources are now used that were unimaginable in their day

- Consider the environmental issue of global warming in relation to its impact on farming, fishing, forestry, or humans. Write a paper comparing and contrasting the measures various groups in the U.S. are taking in response to global warming. Which approaches are working and which are not? Is the U.S. a forerunner in improving the situation or is it lagging behind the initiatives of other countries? What initiatives could the U.S. take that it is not currently taking?

Assessment Questions

Q1: What are the three main fossil fuels?
A: Petroleum, natural gas, and coal.

Q2: What fossil fuel is considered to be the most efficient?
A: Coal, made of 90% carbon, is a very efficient fossil fuel.

Q3: How does petroleum form?
A: Petroleum forms from algae, combined with just the right conditions of permeable rock covered by non-permeable rock with a fold present, and other complicated processes over the course of tens of millions of years.

Q4: Into what products can petroleum be refined?
A: Petroleum can be refined into crude oil, gasoline, jet fuel, kerosene, waxes, greases, and asphalt.

Q5: What are the problems caused by using fossil fuels?
A: Problems include the release of CO_2 into the atmosphere, health and environmental effects, and global warming; moreover, fossil fuels are non-renewable, meaning we run the risk of depleting these sources in the future.

Q6: How does nuclear power release energy?
A: Nuclear power is generated by nuclear fission, which converts heat to kinetic energy through a steam turbine and a generator.

Q7: Energy that harnesses the ocean current is what kind of alternative energy source?
A: Tidal energy.

Q8: What are biomass fuels?
A: Biomass fuels are alternative energy resources that burn wood, crops, manure, or garbage to provide heat or steam.

Q9: What alternative energy resources could be gleaned from the Ring of Fire?
A: Volcanic energy and geothermal energy could be possible alternative energy resources gleaned from the Ring of Fire.

Q10: What type of energy source provides a cheap form of power but can be harmful to fish?
A: Hydroelectric power is the cheapest form of power to run, but can be harmful to fish and interrupt the natural flow of wildlife, thus upsetting the ecosystem.

Additional Resources

USGS Education: Science for a Changing World
www.usgs.gov/education

Educypedia: The Educational Encyclopedia
http://users.pandora.be/educypedia/education/geology.htm

NASA's Science Mission Directorate Website
http://science.hq.nasa.gov

The Center for International Earth Science Information Network (CIESIN)
www.ciesin.org

The Earth Institute at Columbia University
www.earthinstitute.columbia.edu

The WWW Virtual Library: Earth Science
http://vlib.org/EarthScience

Earth Science Week
www.earthsciweek.org

National Earth Science Teachers Association
www.nestanet.org

Additional Resources at www.filmsmediagroup.com

Available from Films Media Group • www.filmsmediagroup.com • 1-800-257-5126

Earth Science I Video Library
- **VHS #30977**
- **VHS #30992—in Spanish**
- **DVD #30962**
- **Closed captioned**
- **Correlates to National Science Education Standards**
- **Includes a User's Guide**

Contains 18 video clips on the history of the Earth, fossils, paleontology, and mapping the Earth. Clips include *Introduction to Earth History, Thermal Features, Blue Hole, Extinction, Glaciers, Fossil Hunter, Fossil Voyage, Amber, Mammoth, Rhino Fossils, Fossil Tunnels, Early Maps, Remote Sensing, Global Positioning System, Mountains, Seafloor Maps, Measuring Latitude, Measuring Longitude*. A User's Guide is included, containing an overview; a numbered index of clips, with brief descriptions and lengths; time codes (VHS only); suggested instructional strategies; and a list of additional resources. A Discovery Channel/FFH&S Production. © 2003.

Earth Science II Video Library

- **VHS #30978**
- **VHS #30993—in Spanish**
- **DVD #30963**
- **Closed captioned**
- **Correlates to National Science Education Standards**
- **Includes a User's Guide**

The *Earth Science II Video Library* contains 24 video clips on volcanoes, earthquakes, oceans, seasons, weather, and climate. Clips include *Introduction to Volcanoes, Birth of a Volcano, Death and Destruction, Types of Volcanoes, Volcanology, Plate Tectonics, Earth in Motion, San Andreas Fault, Seismology, Earthquake-Proof, Earthquake Zone, Introduction to Oceans, Coral Reefs, Waves and Tides, Fish Harvesting, Currents, Introduction to Weather, Polar Weather, Man-Made Weather, Rain, Violent Weather, Heat and Weather, Weather Systems, Water Cycle*. A User's Guide is included, containing an overview; a numbered index of clips, with brief descriptions and lengths; time codes (VHS only); suggested instructional strategies; and a list of additional resources. A Discovery Channel/FFH&S Production. © 2003.

Earth Story

- **8-part series**
- **VHS/DVD-R #8503**
- **"Extremely well done!" —*Booklist***

Beginning with the first land formations that emerged from a primordial ocean 4 billion years ago, this eight-part series explores how all geologic phenomena, from volcanoes to earthquakes, are intertwined. Journeying from the sea bottom to the highest peak in the Andes, the series presents the latest theories on plate tectonics, earthquakes, volcanoes, land formations, and continental drift. An indispensable resource for teaching earth science and geology. A BBC Production. (50 minutes each)

The series includes *Dating the Earth, Journey to the Ocean Floor, Continental Drift: Legacy of Fire, Death of the Dinosaurs, Winds of Change, Noah's Children, Oxygen: The Poison Gas, The Earth and the Moon.*

Landforms

- **CD-ROM #6978 (Windows only)**

What causes volcanoes and earthquakes? Why do tsunamis and floods occur? How do river beds and coastlines change? And what challenges do the forces that shape the Earth pose for people? Using this highly interactive CD-ROM, students can freely explore the Geodome, a virtual laboratory of geologic landforms. Learning stations provide targeted opportunities to manipulate 3-D topographical models, conduct simulations of natural disasters, examine hundreds of slides, and watch video clips. Plus, info/quiz features offer additional background and test comprehension. Headline-making catastrophes and issues of geologic concern drive home the present-day relevance of earth science, geology, and physical geography. Plate tectonics and seismology, eruptions and erosion, landslides and sedimentation—this disc has it all.

The Life and Times of El Niño

- **VHS/DVD-R #34956**
- **Closed captioned**

It has been linked to famines, epidemics, even the fall of empires. This program follows El Niño's deadly path through human history and the progress science has made in understanding the once-mysterious phenomenon. The effects of El Niño are presented in detail, including an 1878 outbreak of yellow fever in Tennessee, a concurrent drought that ravaged much of China, and more recent calamities that have brought the true nature of this climatic occurrence to light. Focusing on high-tech advances in meteorology, the video outlines El Niño's significance in the global warming debate and illustrates the use of computer models that can predict its next appearance. A BBCW Production. (50 minutes) © 2005.

Man and the Biosphere

- **12-part series**
- **VHS/DVD-R #2333**
- ***Recommended by Science Books & Films***

Using an integrated interdisciplinary approach combining the natural and the social sciences, these videos look at the relationships between living beings and their environments. The work of botanists, biologists, geologists, and demographers is used to examine the realities of ecological concerns in the framework of political realities. From the tops of the Himalayas to the bottom of the sea, from empty deserts to overcrowded cities, these videos show life where it thrives and where it has died out. Based on UNESCO's ground-breaking Man and the Biosphere Program, they illustrate the problems and concerns of preserving life, including human life, on Earth, and demonstrate numerous environmental projects that have successfully met the needs of both humankind and nature. (28 minutes each)

The series includes *Life in Arid and Semi-Arid Lands; The Desert as Laboratory; Life at the Top*; *Equilibrium in a Mountain Habitat; The Tropical Rain Forest; Preserving the Rain Forest; Coastlines; Ecology of the Coral Reef; Lagoons; Wetlands and Pinelands; Urban Ecology; Toward a Livable City*

BioBasics

- **8-part series**
- **VHS/DVD-R #33833**
- **Preview clip online at www.films.com (Search on 33833)**
- **Includes viewable/printable Teacher's Guide**
- **Correlates to National Academy of Sciences National Science Education Standards and the American Association for the Advancement of Science Benchmarks for Science Literacy**
- **"A welcome replacement for outdated life science programs."—*School Library Journal***

Use the comprehensive 8-part *BioBasics* series to excite your students about life science as you present the fundamental concepts they'll need for a firm foundation in biology. An engaging blend of computer graphics, interviews with scientists, and animations will hold their attention as they open their minds to a wide range of essential life science topics.

The series includes *Introduction to Life Science; Cells: The Building Blocks of Life;Genetics and Evolution; Organization and Diversity; Life Processes of Animals; Life Processes of Plants; Microorganisms; Interdependence of Life.* A Cambridge Educational Production. Viewable/printable teacher's guides are available at www.cambridgeeducational.com. (25 minutes each) © 2005.

For information on other programs

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www.cambridgeeducational.com

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