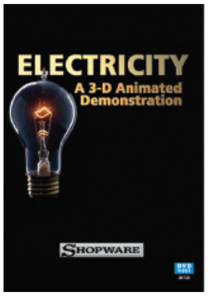


SHOPWARE

Instructor's Guide

Electricity: A 3-D Animated Demonstration

POWER AND EFFICIENCY

Introduction

This instructor's guide provides information to help you get the most out of *Power and Efficiency,* part of the eight-part series *Electricity: A 3-D Animated Demonstration.* The series makes the principles of electricity easier to understand and discuss. The series includes *Electrostatics; Electric Current; Ohm's Law; Circuits; Power and Efficiency; Electricity and Magnetism; Electric Motors;* and *Electric Generators*.

Power and Efficiency delves into the production, transmission, and consumption of electric power.

Learning Objectives

After watching the video program, students will be able to:

- Describe the efficiencies and inefficiencies of key electric power production devices
- Describe the efficiencies and inefficiencies of key electric power transport mechanisms
- Explain and diagram the components associated with the function of power transmission
- Compare and contrast incandescent and fluorescent bulbs
- Analyze and assess emerging forms of "efficient" energy for power production and energy conservation purposes
- Calculate electric power and consumption

Educational Standards

National Science Standards

This program correlates with the National Science Education Standards from the National Academies of Science, and Project 2061, from the American Association for the Advancement of Science.

Science as Inquiry
Content Standard A: As a result of activities in grades 9-12, all students should develop:
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science
Content Standard B: As a result of their activities in grades 9-12, all students should develop an understanding of:
- Structure of atoms
- Motions and forces
- Conservation of energy and increase in disorder
- Interactions of energy and matter

Science and Technology
Content Standard E: As a result of activities in grades 9-12, all students should develop understanding of:
- Abilities of technological design
- Understandings about science and technology

History and Nature of Science
Content Standard G: As a result of activities in grades 9-12, all students should develop understanding of
- Nature of scientific knowledge
- Historical perspectives

English Language Arts Standards

The activities in this instructor's guide were created in compliance with the following National Standards for the English Language Arts from the National Council of Teachers of English.

- Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

- Standard 8: Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Standards for the English Language Arts, by the International Reading Association and the National Council of Teachers of English. Copyright 1996 by the International Reading Association and the National Council of Teachers of English. Reprinted with permission.

Mathematics Standards

This program correlates with the Principles and Standards for School Mathematics by the National Council of Teachers of Mathematics.

Problem Solving

Instructional programs from pre-kindergarten through grade 12 should enable all students to:
- Build new mathematical knowledge through problem solving
- Solve problems that arise in mathematics and in other contexts
- Apply and adapt a variety of appropriate strategies to solve problems

Reasoning and Proof

Instructional programs from pre-kindergarten through grade 12 should enable all students to:
- Select and use various types of reasoning and methods of proof

Principles and Standards for School Mathematics by the National Council of Teachers of Mathematics. Published 4/12/2000. Reprinted with permission.

Technology Standards

The activities in this Teacher's Guide were created in compliance with the following National Education Technology Standards from the National Education Technology Standards Project.

Standard 2: Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.

Standard 3: Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information.

Standard 4: Critical Thinking, Problem-Solving & Decision-Making

Students use critical thinking skills to plan and conduct research, manage projects, solve problems and make informed decisions using appropriate digital tools and resources.

The National Education Technology Standards reprinted with permission from the International Society for Technology Education. Copyright 2007.

Program Summary

This program defines electric power and examines how it is produced, transmitted, and consumed. Efficiencies and inefficiencies relating to energy conservation are discussed in relation to power production, transmission, and consumption, with a particular focus on the efficiencies and inefficiencies associated with the conversion of electricity to light.

Main Topics

Topic 1: Efficiency I — Power Production
This introductory segment immerses students in the efficiencies and inefficiencies associated with electric power production. Students begin to question how to more efficiently extract electric energy from existing resources.

Topic 2: Power
In this section, students learn what electric power is and how it is calculated.

Topic 3: Efficiency II — Power Transport
Here, students examine and assess the efficiency of mechanisms — including alternating current and the electric lightbulb — that transport electric power.

Topic 4: Power Transmission
In this segment, students examine the operational structures of mechanisms that transmit power. They first revisit the physics principles of power (power is the product of current and voltage) to ground their understanding of the elements involved with power transmission.

Topic 5: Power Consumption
Here, students begin to understand that all electricity sources produce electric power for consumption and how such consumption is measured.

Topic 6: Inefficiency I — The Lightbulb
This section delves into the physics properties that demonstrate the efficiencies and inefficiencies of electric energy conversion. The incandescent lightbulb is a featured example of inefficiency.

Topic 7: Efficiency III — The Fluorescent Bulb
This final segment addresses the need to find more efficient-energy devices. For example, replacing the inefficient incandescent lightbulb with the far more energy-efficient fluorescent bulb.

Fast Facts

- No energy transfer, or energy conversion, is completely efficient. When energy is converted, or transported, some of it turns into a form that is no longer useful — often, in the form of waste heat.
- Power is the energy transferred to do work in a period of time. Electric power is the product of current and voltage.
- Understanding the relationship between watts, amperes, and volts has a practical use in the home: it can help a homeowner avoid blowing fuses, for example.
- Niagara's successful AC power export to Buffalo set the stage for the modern world: alternating current is not totally efficient, but it is more efficient than DC for transporting high-voltage electricity over long distances.
- Thomas Edison's electric lightbulb is not an efficient lighting device, despite popular global usage.
- Power transmission over long distances is most efficient if the voltage is very high.
- Long distance electric transmission is generally a three-phase system.
- Electricity is produced for consumption, no matter the source.
- Energy conservation is very possible if there exist efficient ways to convert electric energy to do useful work.
- Nikola Tesla invented alternating current; Thomas Alva Edison invented the lightbulb.

Vocabulary Terms

AC voltage: This is the type of electricity that is typically found in a home. AC voltage in the home is commonly 110 volts for most ordinary consumer electronic items.

alternating current (AC): Alternating electrical current; AC is short for alternating current. The direction of the current flowing in a circuit is constantly being reversed back and forth.

ampere: The metric unit of current, one coulomb per second; also "amp."

cathode: The cathode of a device is the terminal where current flows out.

Celsius: Formerly known as Centigrade, a temperature scale based on the freezing (0 degrees) and boiling (100 degrees) points of water; abbreviated as "C."

circuit: A path between two or more points along which an electrical current can be carried.

circuit breaker: An automatic switch that stops the flow of electric current in a suddenly overloaded or otherwise abnormally stressed electrical system.

convection: Transferring heat by moving air, or transferring heat by means of upward motion of particles of liquid or gas heat from beneath.

convection current: A circulation pattern in which warmer material rises and colder material sinks.

current: The flow of electricity, commonly measured in amperes.

direct current (DC): Direct electrical current (continuous current).

efficiency (electrical): The efficiency of a device, component, or system in electronics and electrical engineering is defined as useful power output divided by the total electrical power consumed.

electric potential difference: Work that must be done against electrical forces to move a unit charge from one point to the other.

electric resistance: A material's opposition to the flow of electric current.

electromagnetic radiation: Radiation made up of oscillating electric and magnetic fields and propagated with the speed of light. Includes gamma radiation, X-rays, ultraviolet, visible, and infrared radiation, and radar and radio waves.

electromagnetic spectrum: The range of frequencies of electromagnetic radiation from zero to infinity.

entropy: Entropy is the quantitative measure of disorder in a system. The concept comes out of thermodynamics, which deals with the transfer of heat energy within a system.

fluorescent bulb: A lightbulb that emits light because the gas inside it glows when it is charged by electricity.

fossil fuel: Any naturally occurring organic fuel, such as petroleum, coal, and natural gas.

fuse: A safety device that protects electrical appliances by preventing too much electricity flowing into them.

gamma ray: Electromagnetic radiation emitted by radioactive decay and having energies in a range from ten thousand (104) to ten million (107) electron volts.

gravitational potential difference: The difference between two points on Earth is related to the energy that would be required to move a unit mass from one point to the other against the Earth's gravitational field.

greenhouse gas: Any gas that absorbs infrared radiation in the atmosphere.

ground circuit: A circuit can be completed between any level of voltage and the earth, or ground; ground is the reference point in an electrical circuit from which other voltages are measured.

hydroelectric: Electricity produced by turbines that are turned by water flow.

hydro power: Generating electricity by conversion of the energy of running water.

incandescent: Device (lamp/bulb) in which a filament is heated by an electric current until it emits visible light.

infrared wavelength: Of or relating to the range of invisible radiation wavelengths from about 750 nanometers, just longer than red in the visible spectrum, to 1 millimeter, on the border of the microwave region.

kilowatt: One thousand watts.

load: The amount of electric power delivered or required at any specific point or points on a system.

particulate pollution: Pollution made up of small liquid or solid particles suspended in the atmosphere or water supply.

phosphor: A substance that exhibits phosphorescence (that glows).

power: The rate at which energy is transferred. Electrical energy is usually measured in watts. Also used for a measurement of capacity.

power grid: A network of electric power lines and associated equipment used to transmit and distribute electricity over a geographic area.

radiant heat: Infrared radiation emitted from a source that is not heated sufficiently to give off visible radiation.

terminal: A conductor attached at the point where electricity enters or leaves a circuit, e.g. on a battery.

three-phase system: A common method of electric power transmission. It is a type of a system of various phases mainly used to power motors and many other devices. A three-phase system uses less conductor material to transmit electric power than equivalent single-phase, two-phase, or direct-current systems at the same voltage.

turbine: Device that converts the flow of a fluid (air, steam, water, or hot gases) into mechanical motion for generating electricity.

tungsten filament: Tungsten is a filament material; because of its strength, ductility, and workability, tungsten can readily be formed into the filament coils, used to enhance performance in modern incandescent bulbs (thus producing artificial light).

ultraviolet: Electromagnetic radiation at shorter wavelengths and higher energies than the violet part of visible light.

volt: A unit of electromotive force or potential difference.

voltage: A measure of the pressure under which electricity flows.

watt: The electrical unit of power.

Pre-Program Discussion Questions

1. What *does* produce electricity?

2. How do you think electric power is measured?

3. In what ways might electric power be inefficient?

4. What does energy conservation involve when it comes to electric power?

5. What are the benefits of lightbulbs? What might their deficits be?

Post-Program Discussion Questions

1. Describe electric power's key efficiencies and inefficiencies.

2. Why is a three-phase wiring system so valuable in electric power transmission?

3. What makes an incandescent lightbulb less energy-efficient than a fluorescent lightbulb?

4. Why is it useful to know how to measure electric power?

5. What will it take to make energy production, transmission, and consumption more efficient?

Individual Student Projects

Exploring Efficiency
Students can research and write a "white paper" on the efficiencies/inefficiencies associated with emerging power production methods, such as solar and wind power. Students assume roles of scientists who present their findings at an international energy forum.

Calculating Electric Power
Students use the electric power equation to calculate the electric power of electrical household devices.

Assessing Community Energy
Students explore the use of electric power in their community and determine its impact. For example, they may choose to focus on homeowners to query their use of electrical devices, determining their efficiency, and then make recommendations on how community members might be able to create more energy-efficient households. Or, students may focus on existing energy production concerns in their community and work with a local advocacy group to propel renewable-energy efforts.

Group Activities

Calculating Consumption
Students use electric power equations and energy costs to analyze the costs of meeting the electricity demands for an average household (perhaps their own). Students will then compare results.

Experimenting with Electric Power

Students can conduct one or more experiments that demonstrate physics properties/principles associated with electric power. Students explain and document their findings. Sample experiments include (be sure to modify for older students where appropriate):

- Compare light from incandescent lamps (32.5.12): www.uq.edu.au/_School_Science_Lessons/UNPh32.html#32.5.12
- Hydro-Power — The force of water!: www.energyquest.ca.gov/projects/hydro-power.html
- Model electric light bulb (4.65): www.uq.edu.au/_School_Science_Lessons/UNPhysics1.html#4.65

Diagramming Contrasts

Students assume the role of engineers charged with pitching an energy-conserving mechanism. As part of their pitch to a national association of electrical energy engineers, students present diagrams or a related visual (slide show, digital "gizmo," etc.) demonstrating how their proposed device would work, comparing it against an existing mechanism proven to be energy-inefficient (also diagrammed). The presentation builds on physics principles and properties associated with electric power production, transmission, and consumption.

Internet Activities

Virtual Energy Quiz

Students can test their electric energy knowledge with an online quiz and then create a quiz (and if possible, give it a virtual presence). Find some quizzes at:

- Quiz-tree.com: Energy: www.quiz-tree.com/Energy_main.html
- Electricity Quiz: http://library.thinkquest.org/6064/quiz.html
- Squashed Frogs: Electricity Bills: www.squashedfrogs.co.uk/resources/2005/10/how_to_read_electricity_bills.doc

How They Work

Students log on to How Stuff Works http://www.howstuffworks.com to examine how the site explains the function of one or more of the devices discussed in the film, such as incandescent and fluorescent lightbulbs, transmission towers, power grids, etc. (Some of the film items may not be included on the site.) Using the articles as models, students write a similar online article to describe one of the devices the film discusses; they may focus on emerging energy-producing (and conserving) mechanisms such as solar and wind power. Students may pitch the article to the "How Stuff Works" editorial staff. Students may simply create a "how to" packet on electrical safety devices to distribute to the class, or, if they are able, create a how-to Web site or section on their school site that focuses on electric power.

Exploring Renewable Energy
Students can research the myriad organizations advocating for renewable and more efficient energy. Students may focus on one type of energy in which they are interested and compile data to create a fact sheet that represents key recommendations, data, projects, etc. associated with their selected topic. Find lists of organizations at the following sites:

- Environmental Science & Technology: Energy Links: http://pubs.acs.org/journals/esthag/links/energy.html
- Source Guides: Renewable Energy Government Organizations in the World: http://energy.sourceguides.com/businesses/byB/gov/gov.shtml
- World Environmental Organization: 100 Top Renewable Energy Sites: www.world.org/weo/energy

Assessment Questions

1: Electric power is the product of ______________________________.

2: What is the primary difference between alternating current and direct current in terms of power grids that transport electricity?

3: Which of the following uses less current and voltage to transmit electric power?
- a) single-phase system
- b) three-phase system
- c) two-phase system

4: A CD player draws 288 A of current with a 9 Volt battery. What is the CD's wattage (power)?

5: Incandescent lightbulb is to inefficiency as ____________ lightbulb is to efficiency.

6: Wasted energy is usually in the form of:
- a) light
- b) heat
- c) electricity

7: A filament lamp transforms electrical energy into _________________.
- a) heat
- b) gas and liquid
- c) heat and light

8: Calculate the energy consumption for the following: A 25-watt light bulb runs for 5 hours a day for 20 days. How much electrical energy is used in this time?

9: Infrared wavelengths are forms of _______________________.
- a) radiant heat
- b) electromagnetic radiation
- c) incandescence

10: What is a downside of nuclear power?
- a) greenhouse gas
- b) long-term storage of dangerous quantities of nuclear fuel
- c) particulate pollution

Assessment Questions Answer Key

1: Electric power is the product of ____________________________________.
A: current and voltage
Feedback: Electric power is defined as the work done in a period of time. Or, power is the energy transformed to do work in a period of time. Electric potential difference, measured in volts, is defined as electric energy transformed per unit of charge. Power, then, is energy transformed in a period of time, which can be expressed using voltage and charge.

2: What is the primary difference between alternating current and direct current in terms of power grids that transport electricity?
A: Direct current is inefficient.
Feedback: Compared to alternating current, direct current is not as efficient. High-voltage direct current wires lose more waste heat as they transfer electricity from power generating station to consumers, and back again.

3: Which of the following uses less current and voltage to transmit electric power?
- **a) single-phase system**
- **b) three-phase system**
- **c) two-phase system**

A: b
Feedback: In a three-phase system, at any moment in time and at any point in the transmission, when all three wires are connected together, the sum of the voltage is zero. In theory, a three-phase system needs no return because there is no current to return. Small fluctuations in voltage can produce small residual currents when three wires are connected. A single small return wire is all that's needed to complete the circuit back to the power plant.

4: A CD player draws 288 A of current with a 9 Volt battery. What is the CD's wattage (power)?
A: P = 2.59 kW
Feedback: Using the electric power equation: $P = IV$: $P = I \bullet V = (288\ A) \bullet (9\ V)$

5: Incandescent lightbulb is to inefficiency as ______________ lightbulb is to efficiency.
A: fluorescent
Feedback: The standard incandescent lightbulb, in the end, produces more heat when converted than light. Some 95% of this type of lightbulb's filament's radiation occurs in the invisible infrared region of the electromagnetic spectrum. Only 5% of the converted energy does the job of providing light. Fluorescent conversion of electricity to light can be several times as efficient as incandescence, largely because of the phosphors. When the phosphor electron loses energy and returns to a rest state, it will do so by emitting a photon in the visible range of electromagnetic radiation — in other words, light.

6: Wasted energy is usually in the form of:
- **a) light**
- **b) heat**
- **c) electricity**

A: b
Feedback: As energy is converted form one from to another, or transported from place to place, some of that energy is converted to a form that is no longer useful, often waste heat.

7: A filament lamp transforms electrical energy into ____________________.
- **a) heat**
- **b) gas and liquid**
- **c) heat and light**

A: c
Feedback: Inside a lightbulb, an inert gas helps protect a tungsten filament from a chemical change. As electric current flows heat in this filament, the vibrating molecules of tungsten radiate electromagnetic waves across a narrow band of the electromagnetic spectrum. As it is warming up, the lightbulb radiates only in the infrared heat range of the spectrum, but quickly the lightbulb becomes incandescent.

8: Calculate the energy consumption for the following: A 25-watt light bulb runs for 5 hours a day for 20 days. How much electrical energy is used in this time?
A: 2.5 kW
Feedback: Use the energy consumption formula: watt x hours x period of time = watt-hours.
Divide watt-hours by 1,000 watts/kilowatt to arrive at the total kilowatt usage during one month.
(25 watts) X (5 hours/day) X (20 days) = 2500 watt-hours; 2,500 watt-hours/(1,000 watts/kW) = 2.5 kW

9: Infrared wavelengths are forms of ____________________________.
- **a) radiant heat**
- **b) electromagnetic radiation**
- **c) incandescence**

A: b
Feedback: There is a broad spectrum of possible wavelengths of electromagnetic radiation, from radio waves to gamma rays. Infrared, or radiant heat, is one range of wavelengths.

10: What is a downside of nuclear power?
- **a) greenhouse gas**
- **b) long-term storage of dangerous quantities of nuclear fuel**
- **c) particulate pollution**

A: b
Feedback: The nuclear power industry offers virtually unlimited energy released by splitting atoms. But nuclear power plants take many years to construct and are expensive to do so. Safety and reliability are also a concern, because highly dangerous quantities of spent nuclear fuel must be safely stored for many thousands of years.

Additional Resources

BOOKS

Physics Experiments On File™. Facts on File, 2003. ISBN-10: 0816050430

Connecting The Dots To Future Electric Power, by Edward J. Bair. Author House, 2007. ISBN: 1425995861

Electric Power Generation, Transmission, and Distribution (Electric Power Engineering Handbook), by Leonard L. Grigsby. CRC; 2Rev Ed edition, 2007. ISBN: 0849392926

Electric Universe: The Shocking True Story of Electricity, by David Bodanis. Crown, 2005. ISBN: 1400045509

Energy Resources: Occurrence, Production, Conversion, Use, by Wendell H. Wiser. Springer; 1st edition, 1999. ISBN: 0387987444

Physics Demonstrations: A Sourcebook for Teachers of Physics, by Julien Clinton Sprott. University of Wisconsin Press; 1st edition, 2006. ISBN: 0299215806

Practical Photovoltaics: Electricity from Solar Cells, by Richard Komp. Aatec Publications, 2002. ISBN: 093794811X

Renewables Are Ready: People Creating Renewable Energy Solutions, by Nancy Cole and P.J. Skerrett. Chelsea Green Press, 1995. ISBN-10: 0930031733.

Schaum's Outline of Basic Mathematics for Electricity and Electronics, by Arthur Beiser. McGraw-Hill; 2nd edition, 1993. ISBN: 0070044392

Schaum's Outline of Basic Electricity, 2nd edition, by Milton Gussow. McGraw-Hill, 2006. ISBN: 0071474986

WEB SITES

BBC: Bitesize Revision — Efficiency
www.bbc.co.uk/schools/gcsebitesize/physics/energy/energy_transfer_and_efficiencyrev4.shtml

BBC: Bitesize Revision — Energy Resources and Energy Transfer
www.bbc.co.uk/schools/ks3bitesize/science/physics/energy_transfer_intro.shtml

comPADRE: Digital Resources for Physics and Astronomy Education
www.compadre.org

Energy Information Administration — Residential Electricity Prices: A Consumer's Guide
www.eia.doe.gov/bookshelf/brochures/rep

Energy Kids' Page — Electricity – A Secondary Energy Source
www.eia.doe.gov/kids/energyfacts/sources/electricity.html

Furry Elephant — Electrical Power
www.furryelephant.com/content/electricity/electrical-power

How Stuff Works
www.howstuffworks.com

HyperPhysics — The Electromagnetic Spectrum
http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Institute of Physics: Teaching Resources — Episode 106: Electrical power
www.iop.org/activity/education/Teaching_Resources/Teaching%20Advanced%20Physics/Electricity/Electric%20Current/page_3170.html

MSN Encarta —Electric Power Systems
http://encarta.msn.com/encyclopedia_761566999/electric_power_systems.html

National Energy Education Development Project
www.need.org/EnergyInfobooks.php

National Energy Foundation
http://www.nef1.org

Physics.org
www.physics.org

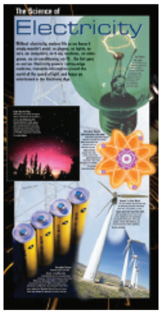
The Physics Classroom Tutorial — Power
www.glenbrook.k12.il.us

The Physics of Everyday Stuff — High-Voltage Transmission Lines
www.bsharp.org/physics/stuff/xmission.html

The Physics Factbook — Power Consumption of a Home
http://hypertextbook.com/facts/2003/BoiLu.shtml

Science Daily — Energy Technology
www.sciencedaily.com/articles/matter_energy/energy_technology

Additional Resources from www.films.com • 1-800-257-5126



The Science of Electricity Poster

- **17" x 32" Poster**
- **Correlates to National Science Education Standards**
- **Item # 36854**

Recommended for grades 7-12. © 2006

Investigations in Physics: Experiments and Observations

- **DVD/ VHS #6842**
- **Preview clip online**
- **Correlates to educational standards**
- **"Useful in secondary physics classes, especially where hands-on experimentation is limited."**

—*School Library Journal*

Designed for basic physics labs, this 9-part series offers an extensive collection of demonstrations and experiments essential to any core physics curriculum. Each program features three related lessons that are supported by tabletop close-ups, computer graphics and animation, re-creations of famous experiments using replicas of original equipment, and simple, concise narration. Some lessons incorporate sophisticated equipment not normally found in schools. Selected demonstrations take viewers to exotic sites to dramatically illustrate fundamental physics principles. The series includes *Equilibrium of Forces • Motion of Bodies and Mechanical Energy • Pressure • Heat • Waves and Sound • Optics • Magnetism and Static Electricity • Electrical Energy • Electric Current* (30 minutes each)

Electronics and Electrical Engineering, Volume 1

- **DVD/ VHS #36072**
- **Preview clip online**
- **Close captioned**
- **Correlates to educational standards**
- **Includes viewable/printable instructor's guides**

This 20-part series covers everything from basic electrical theory, to electronics troubleshooting, to residential electrical wiring. The series includes *• Electrical Principles • Electric Circuits: Ohm's Law • Electrical Components, Part I: Resistors, Batteries, and Switches • Electrical Components, Part II: Capacitors, Fuses, Flashers, and Coils • Electrical Components, Part III: Transformers, Relays, and Motors • Electronic Components, Part I: Semiconductors, Transistors, and Diodes • Electronic Components, Part II: Operation—Transistors and Diodes • Electronic Components, Part III: Thyristors, Piezo Crystals, Solar Cells, and Fiber Optics • Electrical Troubleshooting • Electronic Troubleshooting • The Service Entrance • Panelboards • Wiring Methods • Grounding • GFCIs and AFCIs • Receptacles and Switches • Wiring Light Fixtures • Wiring for Appliances • Math in Electrical Technology • Electrical Safety.* Recommended for high school, technical or vocational school, and training programs. (18-24 minutes each) © 2006

Energy I Video Library

- **DVD #30960**
- **Close captioned**
- **Correlates to educational standards**
- **Includes user guides**

Contains 22 video clips on forms of energy, nuclear energy, electricity, and magnetism:

- Fuel Cells
- Solar Energy
- Potential and Kinetic Energy
- Nuclear Energy Forms
- Nuclear Medicine
- Nuclear Submarines
- Electrical Energy
- The Body Electric
- Electricity Production
- Electromagnetism
- Lodestone
- Energy Production
- Chemical Energy
- Introduction to Nuclear Energy
- Natural Nuclear Reactions
- The Atomic Bomb
- Introduction to Electricity
- Harnessing Electricity
- High Wire Act
- Introduction to Magnetism
- Animal Navigation
- Earth as a Magnet

The Energy I Video Library is part of the complete Discovery Channel/Films for the Humanities & Sciences Science Video Library. © 2003