SECONDARY INFOBOOK ACTIVITIES

A companion workbook to the Secondary Energy Infobooks: activities to reinforce general energy information and facts about the energy sources.

E
GENERAL ENERGY

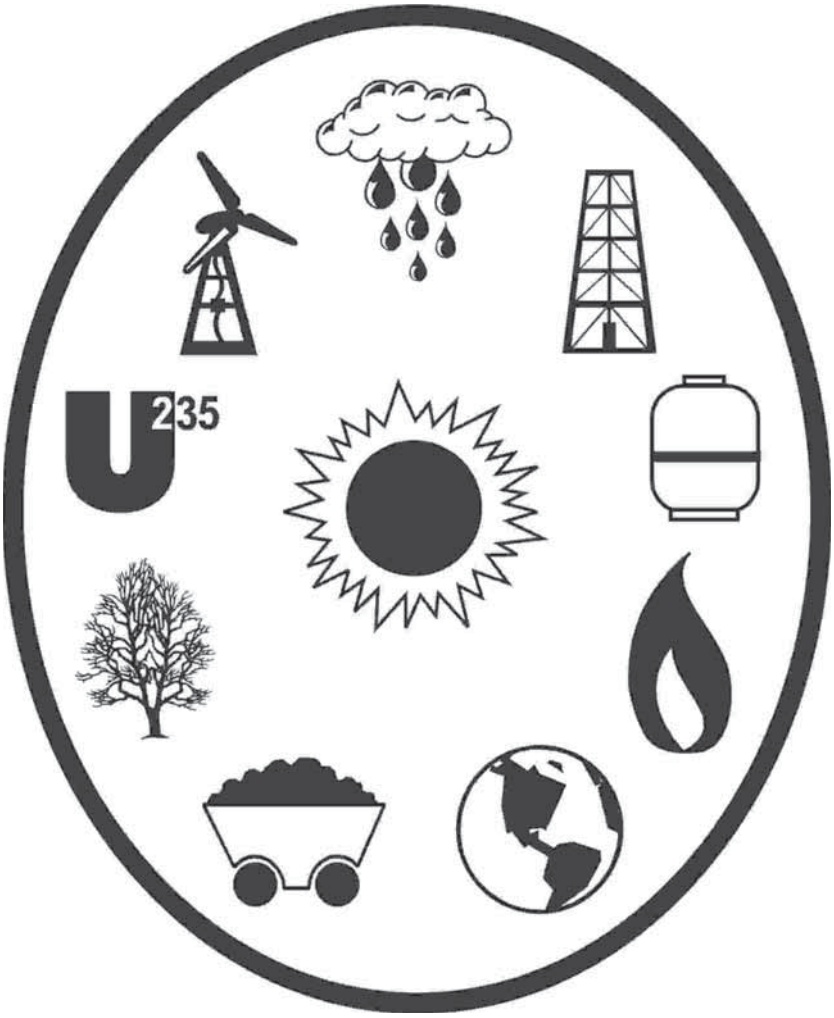
ENERGY SOURCES

GRADE LEVEL

Secondary

SUBJECT AREAS

Science
Social Studies
Math
Language Arts



NEED
2009-2010
Putting Energy into Education

NEED Project PO Box 10101 Manassas, VA 20108 1-800-875-5029 www.NEED.org

Teacher Advisory Board

Teacher Advisory Board Vision Statement
NEED Mission Statement

The mission of the NEED Project is to promote an energy conscious and educated society by creating effective networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs.

In support of NEED, the national Teacher Advisory Board (TAB) is dedicated to developing and promoting standards-based energy curriculum and training.

Permission to Reproduce

Printed on Recycled Paper with Soy-Based Ink

TABLE OF CONTENTS

NEED
Putting Energy into Education

Correlations to National Science Content Standards

(Bolded standards are emphasized in the unit.)

INT = Intermediate National Science Content Standards (Grades 5-8)

INT–B: 3.a	Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical.
INT–B: 3.b	**Energy is transferred in many ways.**
INT–B: 3.c	Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.
INT–B: 3.d	Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection).
INT–B: 3.e	**Electrical circuits provide a means of transferring electrical energy.**
INT–B: 3.f	**In most chemical and nuclear reactions, energy is transferred into or out of a system. Heat, light, mechanical motion, or electricity might all be involved in such transfers.**
INT–B: 3.g	**The sun is the major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths.**
INT–C: 4.a	For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. The energy then passes from organism to organism in food webs.
INT–D: 1.a	**The solid earth is layered with a lithosphere; hot, convecting mantle; and dense, metallic core.**
INT–D: 1.b	**Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the water cycle.**
INT–D: 2.a	Gravity governs the motion in the solar system. Gravity explains the phenomenon of the tides.
INT–D: 2.b	**The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle.**
INT–E: 2.c	Technological solutions are temporary and have side effects. Technologies cost, carry risks, and have benefits.
INT–E: 2.d	Many different people in different cultures have made and continue to make contributions to science and technology.
INT–E: 2.e	Science and technology are reciprocal. Science helps drive technology, as it asks questions that demand more sophisticated instruments and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to quantity, distance, location, size, and/or speed.
INT–E: 2.f	Perfectly designed solutions do not exist. All technological solutions have trade-offs, such as safety, cost, efficiency, and appearance. Risk is part of living in a highly technological world. Reducing risk often results in new technology.
INT–E: 2.g	Technological designs have constraints. Some constraints are unavoidable, such as properties of materials, or effects of weather and friction. Other constraints limit choices in design, such as environmental protection, human safety, and aesthetics.
INT–F: 1.a	Food provides energy and nutrients for growth and development.
INT–F: 1.b	Natural environments may contain substances that are harmful to human beings. Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air.
INT–F: 2.b	Causes of environmental degradation and resource depletion vary from region to region and from country to country.
INT–F: 3.a	Internal and external processes of the earth system cause natural hazards, events that change or destroy human and wildlife habitats, damage property, and harm or kill humans.
INT–F: 3.b	**Human activities can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal.**

INT–F: 3.c	Hazards can present personal and societal challenges because misidentifying the change or incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much cost for unneeded preventive measures.
INT–F: 4.b	Students should understand the risks associated with natural hazards, chemical hazards, biological hazards, social hazards, and personal hazards.
INT–F: 4.c	Students can use a systematic approach to thinking critically about risks and benefits.
INT–F: 4.d	Important personal and social decisions are made based on perceptions of benefits and risks.
INT–F: 5.a	Science influences society through its knowledge and world view. The effect of science on society is neither entirely beneficial nor entirely detrimental.
INT–F: 5.b	Societal challenges often inspire questions for scientific research, and societal priorities often influence research priorities.
INT–F: 5.c	Technology influences society through its products and processes. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. Social needs, attitudes, and values influence the direction of technological development.
INT–F: 5.d	Science and technology have contributed enormously to economic growth and productivity among societies and groups within societies.
INT–F: 5.e	Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Students should appreciate what science and technology can reasonably contribute to society and what they cannot do. For example, new technologies often will decrease some risks and increase others.
INT–G: 2.c	It is normal for scientists to differ with one another about the interpretation of new evidence. It is part of scientific inquiry to evaluate the results and explanations of other scientists. As scientific knowledge evolves, major disagreements are eventually resolved through such interactions between scientists.

SEC = Secondary National Science Content Standards (Grades 9-12)

SEC–B: 1.a Matter is made of minute particles called atoms, which are composed of even smaller components. These components have measurable properties, such as mass and electrical charge.

SEC–B: 1.b Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and electrons holds the atom together.

SEC–B: 1.c The atom's nucleus is composed of protons and neutrons, which are much more massive than electrons. When an element has atoms that differ in the number of neutrons, these atoms are called isotopes of the element.

SEC–B: 1.f Fission is the splitting of a large nucleus into smaller pieces.

SEC–B: 1.g Fusion is the joining of two nuclei at extremely high temperature and pressure and is the process responsible for the energy of the sun and other stars.

SEC–B: 1.h Radioactive isotopes are unstable and undergo spontaneous nuclear reactions, emitting particles and/or wavelike radiation.

SEC–B: 2.e Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.

SEC–B: 3.b Chemical reactions may release or consume energy. Some reactions, such as the burning of fossil fuels, release large amounts of energy by losing heat and by emitting light.

SEC–B: 3.c Light can initiate many chemical reactions such as photosynthesis and the evolution of urban smog.

SEC–B: 3.d A large number of important reactions involve the transfer of electrons or hydrogen ions. In other reactions, chemical bonds are broken by heat or light to form very reactive radicals with electrons ready to form new bonds. Radical reactions control many processes such as the presence of ozone and greenhouse gases in the atmosphere, burning and processing of fossil fuels, the formation of polymers, and explosions.

SEC–B: 4.c The electrical force is a universal force that exists between two charged objects.

SEC–B: 4.e Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces.

SEC–B: 5.a The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed. As these transfers occur, the matter involved becomes steadily less ordered.

SEC–B: 5.b All energy can be considered either kinetic energy—the energy of motion; potential energy—which depends on relative position; or energy contained by a field, such as electromagnetic waves.

SEC–B: 5.c Heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion.

SEC–B: 5.d Everything tends to become less organized and less orderly over time. Thus, in all energy transfers, the overall effect is that the energy is spread out uniformly. Examples are the transfer of energy from hotter to cooler objects by conduction, radiation, or convection and the warming of our surroundings when we burn fuels.

SEC–B: 6.a Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.

SEC–B: 6.d In some materials, such as metal, electrons flow easily, whereas in insulating materials such as glass, they can hardly flow at all.

SEC–C: 1.a Plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy rich organic compounds and release oxygen to the environment. This photosynthesis provides a vital connection between the sun and the energy needs of living systems.

SEC–C: 4.b Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores to decomposers.

SEC–C: 4.c Humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through harvesting, pollution, atmospheric changes, and other factors is threatening global stability, and if not addressed, ecosystems will be irreversibly affected.

SEC–C: 5.a All matter tends toward more disorganized states. Living systems require a continuous input of energy to maintain their chemical and physical organizations.

SEC–C: 5.b The energy for life primarily derives from the sun. Plants capture energy by absorbing light and using it to form strong chemical bonds. The energy stored in the bonds (chemical energy) can be used as sources of energy for life processes.

SEC–C: 5.c The chemical bonds of food molecules contain energy. Energy is released when the bonds are broken and new compounds with lower energy bonds are formed.

SEC–C: 5.e As matter and energy flows through different levels of organization of living systems—cells, organs, organisms, communities—and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.

SEC–D: 1.a Earth systems have internal and external sources of energy, both of which create heat. The sun is the major external source of energy. Two primary sources of internal energy are the decay of radioactive isotopes and the gravitational energy from the earth's original formation.

SEC–D: 1.b The outward transfer of earth's internal heat drives convection circulation in the mantle.

SEC–D: 1.c Heating of earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

SEC–D: 1.d Global climate is determined by energy transfer from the sun at and near the earth's surface.

SEC–D: 4.a Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium.

SEC–F: 3.a Human populations use resources in the environment to maintain and improve their existence.

SEC–F: 3.b The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and depletes those resources that cannot be renewed.

SEC–F: 3.c Humans use many natural systems as resources. Natural systems have the capacity to reuse waste but that capacity is limited. Natural systems can change to an extent that exceeds the limits of organisms to adapt naturally or humans to adapt technologically.

SEC–F: 4.a Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients. Humans are changing many of these basic processes, and the changes may be detrimental to humans.

SEC–F: 4.b Materials from human societies affect both physical and chemical cycles of the earth.

SEC–F: 4.c Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, overconsumption, the capacity of technology to solve problems, poverty, the role of economic, political, and religious views, and different ways humans view the earth.

SEC–F: 5.b Human activities can enhance potential for hazards. Acquisition of resources, urban growth, and waste disposal can accelerate rates of natural change.

SEC–F: 5.c Some hazards are rapid and spectacular, others are slow and progressive.

SEC–F: 5.d Natural and human-induced hazards present the need for humans to assess potential danger and risk. Many changes in the environment designed by humans bring benefits to society, as well as cause risks. Students should understand the costs and trade-offs of various hazards—ranging from those with minor risk to a few people to major catastrophes with major risk to many people.

SEC–F: 6.b Understanding basic concepts and principles of science and technology should precede active debate about the economics, policies, politics, and ethics of various science and technology related challenges. However, understanding science alone will not resolve local, national, and global challenges.

SEC–F: 6.c Individuals and society must decide on proposals involving new research and the introduction of new technologies into society.

SEC–F: 6.d Humans have a major effect on other species.

SEC–G: 1.a Individuals and teams contribute to the scientific enterprise.

Teacher Guide

BACKGROUND

Secondary Infobook Activities is a series of student worksheets designed to reinforce the vocabulary, concepts and information in the **Secondary Energy Infobook**.

TIME

Approximately 30 minutes per topic for the students to read the selected infosheet and complete the worksheets.

SKILLS

- Nonfiction Reading
- Critical Thinking
- Vocabulary
- Graphing

PROCEDURE

Step One—Preparation

- Decide which infosheets and worksheets you will use with your class.
- Obtain class sets of **Secondary Energy Infobooks,** make copies of the infosheets and accompanying worksheets, or download from ***www.need.org/guides.htm***.

  Many other NEED activities also reinforce and synthesize the information in the infobooks, such as ***Energy Jeopardy, Great Energy Debate Game, Transparent Energy, Mission Possible,*** *and* ***Energy Enigma.***

Step Two—Procedure

- Distribute one infosheet and worksheet to each student.
- Have the students read the selected infosheet. Discuss the concepts and new vocabulary in the infosheet.
- Have the students complete the selected worksheet.
- Once students have read all of the energy source infosheets and completed the worksheet for each source, have the students complete the worksheets on pages 15-17 of the workbook. These worksheets reinforce and synthesize the information in the source infosheets. Pages 18-23 are companion worksheets to the Electricity infosheet.
- Use the Evaluation Form on page 35 to evaluate the activities.

FORMS OF ENERGY

Fill in the blanks with the words at the bottom of the page. You can use words more than once.

1. Stored energy and the energy of position are _____ energy.
2. Compressed springs and stretched rubber bands are stored _____ energy.
3. The vibration and movement of the atoms and molecules within substances is called heat or _____ energy.
4. The energy stored in the center of atoms is called _____ energy.
5. The scientific rule that states that energy cannot be created or destroyed is called the Law of _____.
6. The movement of energy through substances in longitudinal waves is _____.
7. The energy of position, such as a rock on a hill, is _____ energy.
8. The movement of objects and substances from place to place is _____.
9. Electromagnetic energy traveling in transverse waves is _____ energy.
10. Energy stored in the bonds of atoms and molecules is _____ energy.
11. The movement of atoms, molecules, waves, and electrons is _____ energy.
12. The movement of electrons is _____ energy.
13. The amount of useful energy you get from a system is its _____.
14. The energy in petroleum and coal is stored as _____ energy.
15. X-rays are examples of _____ energy.
16. Fission and fusion are examples of _____ energy.
17. A hydropower reservoir is an example of _____ energy.
18. Wind is an example of the energy of _____.

radiant	gravitational	chemical	thermal	nuclear	electrical	mechanical
kinetic	potential	sound	motion	conservation of energy	energy efficiency	

BIOMASS

Description of biomass, where it is located and how it is recovered:

In what form the energy in biomass is stored and how it is converted into usable energy:

What/who uses biomass and for what purposes:

Advantages and disadvantages of using biomass:

COAL

Description of coal, where it is located and how it is recovered:

In what form the energy in coal is stored and how it is converted into usable energy:

What/who uses coal and for what purposes:

Advantages and disadvantages of using coal:

GEOTHERMAL

Description of geothermal energy, where it is located and how it is recovered:

In what form geothermal energy is stored and how it is converted into usable energy:

What/who uses geothermal energy and for what purposes:

Advantages and disadvantages of using geothermal energy:

HYDROPOWER

Description of hydropower, where it is located and how it is recovered:

In what form hydropower is stored and how it is converted into usable energy:

What/who uses hydropower and for what purposes:

Advantages and disadvantages of using hydropower:

NATURAL GAS

Description of natural gas, where it is located and how it is recovered:

In what form the energy in natural gas is stored and how it is converted into usable energy:

What/who uses natural gas and for what purposes:

Advantages and disadvantages of using natural gas:

PETROLEUM

Description of petroleum, where it is located and how it is recovered:

In what form the energy in petroleum is stored and how it is converted into usable energy:

What/who uses petroleum and for what purposes:

Advantages and disadvantages of using petroleum:

PROPANE

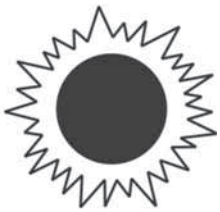
Description of propane, where it is located and how it is recovered:

In what form the energy in propane is stored and how it is converted into usable energy:

What/who uses propane and for what purposes:

Advantages and disadvantages of using propane:

SOLAR



Description of solar energy, where it is located and how it is recovered:

In what form the energy in solar energy is stored and how it is converted into usable energy:

What/who uses solar energy and for what purposes:

Advantages and disadvantages of using solar energy:

URANIUM

Description of uranium, where it is located and how it is recovered:

In what form the energy in uranium is stored and how it is converted into usable energy:

What/who uses uranium and for what purposes:

Advantages and disadvantages of using uranium:

WIND

Description of wind energy, where it is located and how it is recovered:

In what form the energy in wind is stored and how it is converted into usable energy:

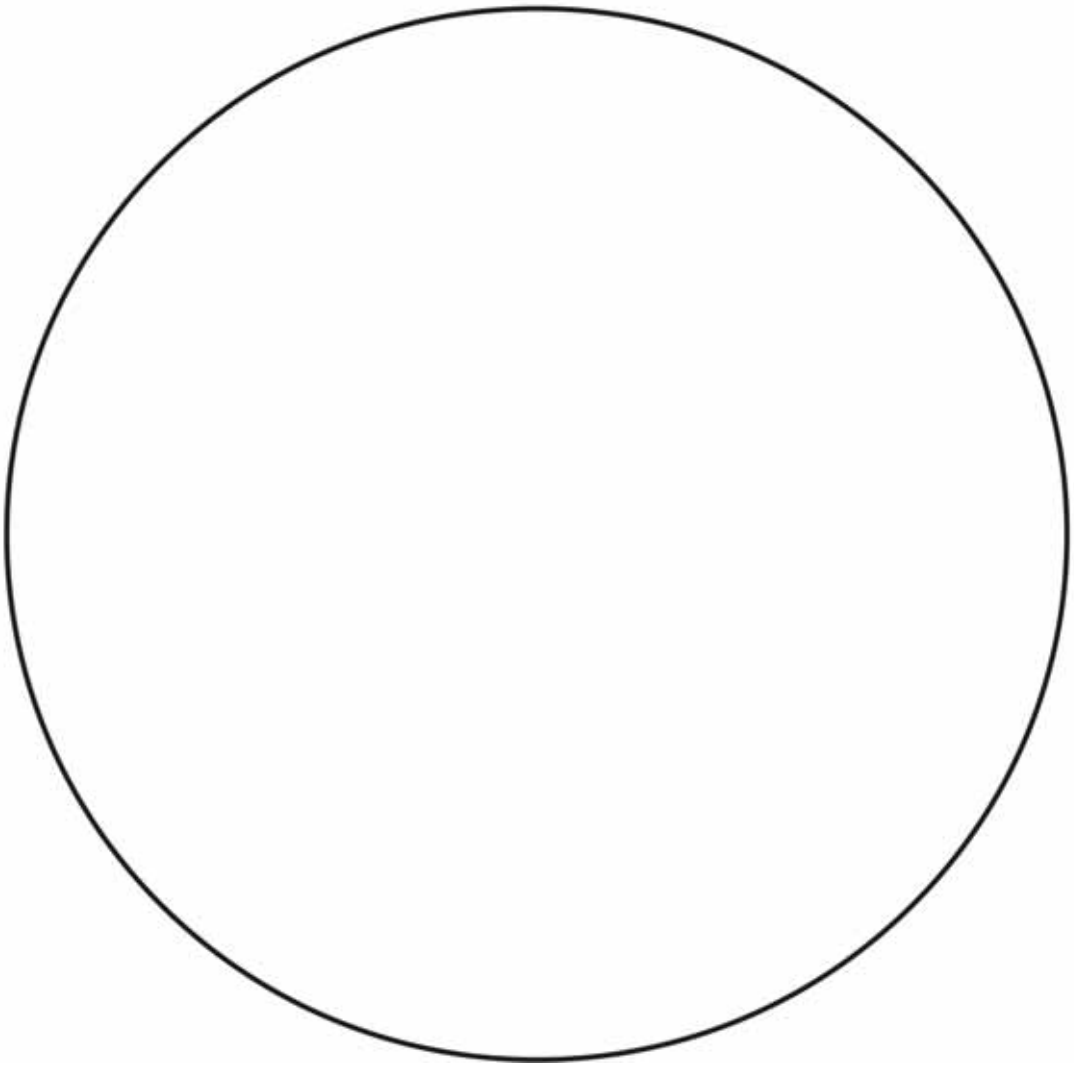
What/who uses wind energy and for what purposes:

Advantages and disadvantages of using wind energy:

RENEWABLES AND NONRENEWABLES

Convert the quads into percentages and make a pie chart showing how much U.S. energy in 2008 came from renewable sources and how much came from nonrenewable sources (Q = quad or quadrillion Btu). Round to the nearest tenth.

PETROLEUM	36.64 Q	=	_____ %
NATURAL GAS	23.34 Q	=	_____ %
COAL	22.42 Q	=	_____ %
URANIUM	8.46 Q	=	_____ %
BIOMASS	3.88 Q	=	_____ %
HYDROPOWER	2.45 Q	=	_____ %
PROPANE	1.0 Q	=	_____ %
GEOTHERMAL, SOLAR, WIND AND OTHER	0.96 Q	=	_____ %



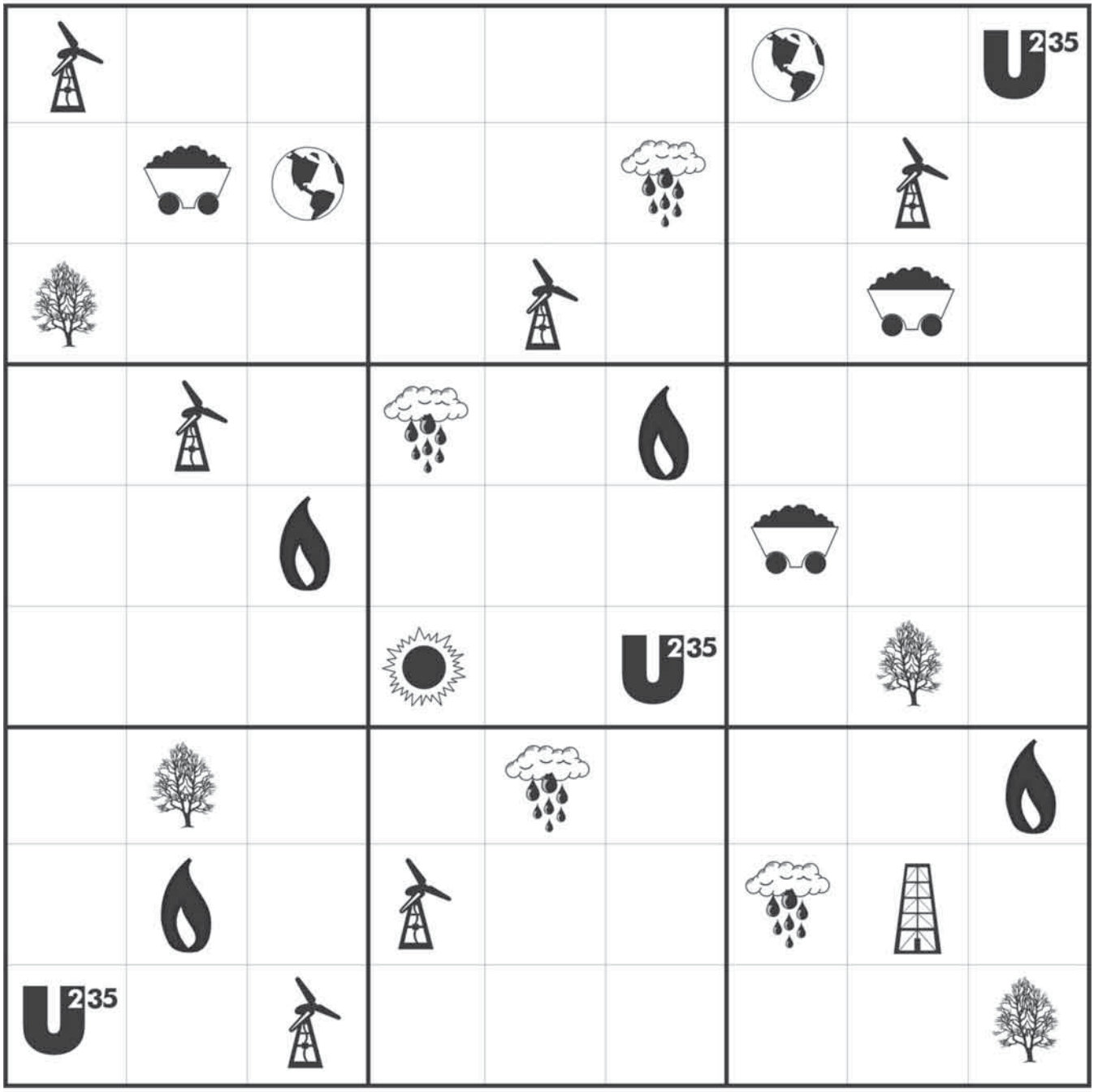
HOW WE USE OUR ENERGY SOURCES

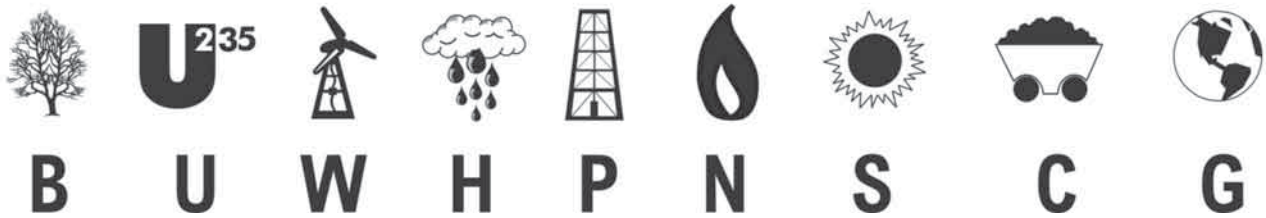
In the boxes, explain how each source is used for the tasks on the top. Star the main use of each source.

	TRANSPORTATION	MAKE PRODUCTS	HEATING/COOLING	LIGHTING	MAKE ELECTRICITY
U^{235}					

ENERGY SOURCE PUZZLE

By a process of elimination, fill in the blank squares so that each large square contains one of each energy source icon, using the letters that represent the icons as shown at the bottom of the puzzle. Each row and each column must also contain one of each icon. There is only one possible solution to the puzzle.





ELECTRICITY

Write the correct word for each definition in the blank space. Use each word only once.

1. A device that changes voltage. _____
2. A device that changes linear motion into circular motion. _____
3. Allowing competition in the power industry. _____
4. Managing how and when consumers use electricity. _____
5. The total amount of electricity a power plant can deliver. _____
6. Times when many customers need electricity. _____
7. A device that turns motion energy into electricity. _____
8. How well a utility delivers electricity at all times. _____
9. Electricity produced at all times to meet basic demand. _____
10. A merged network of electric utilities. _____
11. Reducing energy usage through behavioral changes. _____
12. A measurement of the amount of electricity used by consumers. _____
13. Power plants that burn fuel to produce electricity. _____
14. A material with little resistance to electric current. _____
15. Combining the nuclei of atoms to produce energy. _____
16. A source of energy that requires another source to produce it. _____
17. Manufacturing a product and producing electricity. _____
18. Reducing the amount of energy consumed by devices through advances in technology. _____

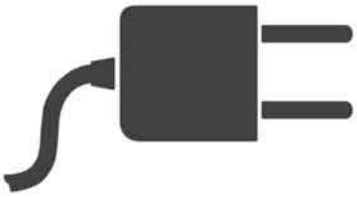
capacity reliability base-load peak demand secondary transformer fusion
turbine generator conservation efficiency demand-side management
kilowatt-hour deregulation cogeneration superconductor thermal power pool

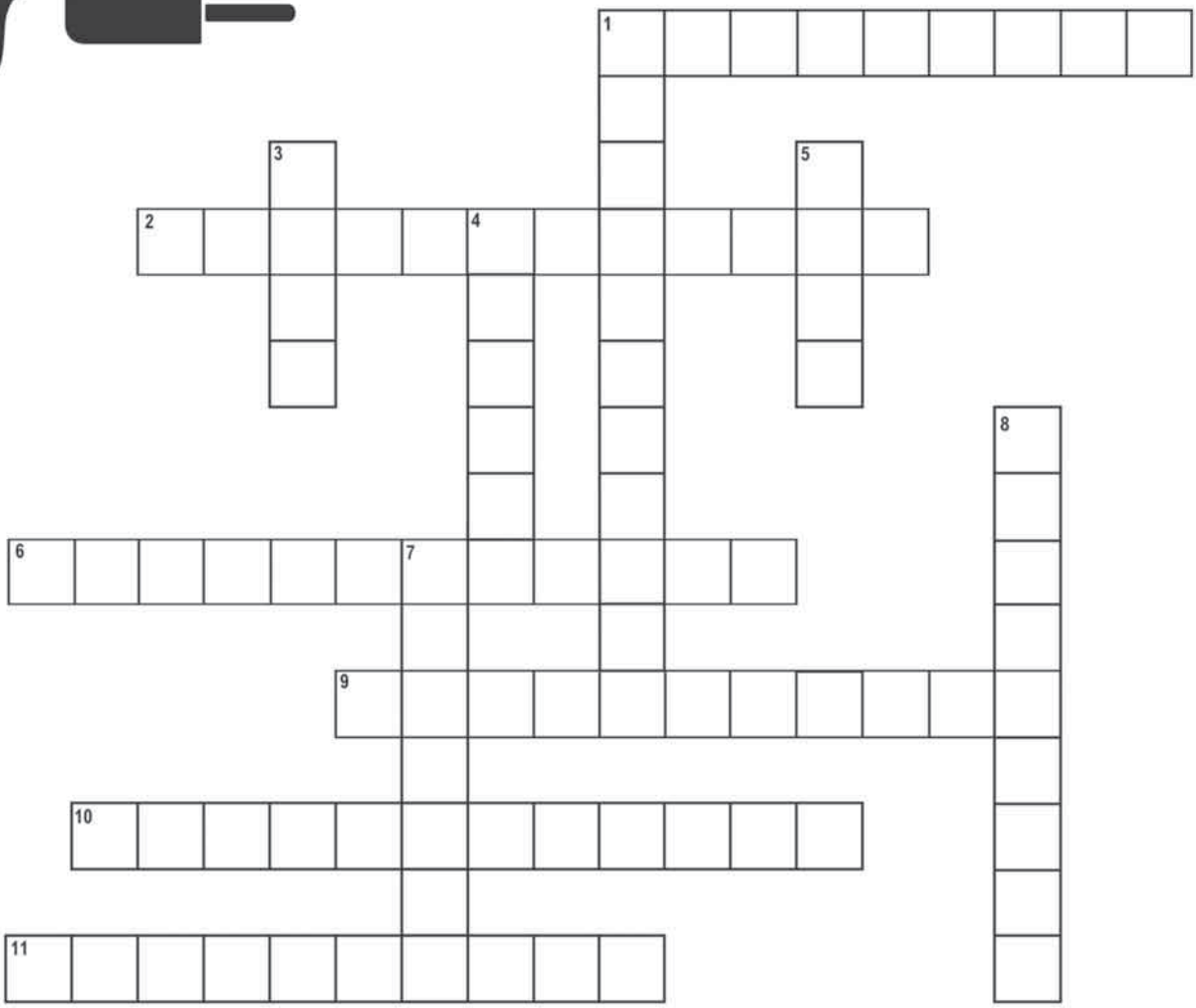
ELECTRIC POWER GENERATION

Convert the bkWh into percentages and make a pie chart showing how much of the electricity the U.S. consumed in 2008 came from each energy source (bkWh = billion kilowatt-hours). Round to the nearest tenth.

PETROLEUM	45 bkWh	=	_____ %
COAL	1,994 bkWh	=	_____ %
NATURAL GAS	877 bkWh	=	_____ %
URANIUM	806 bkWh	=	_____ %
BIOMASS	56 bkWh	=	_____ %
HYDROPOWER	242 bkWh	=	_____ %
GEOTHERMAL	15 bkWh	=	_____ %
WIND	52 bkWh	=	_____ %
OTHER	23 bkWh	=	_____ %

ELECTRICITY





ACROSS

1. Electricity is a ____ source of energy.
2. ____ lines send electricity over a nationwide network.
6. A ____ is the amount of energy used in one hour by ten 100 watt light bulbs.
9. Electricity is sent to a ____ that "steps up" the voltage.
10. ____ lines deliver electricity to your home.
11. Thirty-five percent of the fuel is converted into electricity. This is called the ____ of the power plant.

DOWN

1. ____ are small buildings containing transformers and electrical equipment.
3. A ____ is a measure of the electric power an appliance uses.
4. A ____ is found in a generator and motor.
5. ____ is the fossil fuel that makes the most electricity.
7. High pressure steam turns the blades of a ____.
8. A ____ houses magnets and a spinning coil of copper wire.

FAMOUS NAMES IN ELECTRICITY

The sentences below refer to famous scientists and inventors from *The History of Electricity* section of your infosheet. Read the sentence. Next, write the last name of the scientist or inventor in the squares and circles. Unscramble the letters in the circles to form the answer to the final statement.

1. First scientist to conduct an electric current by passing a magnet through copper wiring.

   □ □ ○ ○ □ ○ □

2. In 1895, he opened a power plant that used AC power.

   □ □ □ □ □ □ ○ □ □ □ ○ □

3. Many people believe he discovered electricity with his famous lightning experiment.

   ○ □ ○ □ □ ○ □ □

4. Using salt water, zinc, and copper, he created the first electric cell.

   □ □ ○ □ ○

5. He invented the light bulb and opened the first electric power plant.

   □ □ ○ □ □ ○

6. The first electric power plant able to transport electricity over 200 miles.

   □□□□□□□ □□□□□

ELECTRIC MATH

Match the following numbers with the statements below. You will use each number only once. Write the numbers on the lines to the left of the statements. Next, perform the mathematical operations indicated by each statement. Write your answers on the lines to the right of the statements.

11 120 1000 1882 1879 35

_____ 1. Start with the voltage used to operate most household appliances.

_____ 2. Divide this number by the cost, in cents, of a kilowatt-hour of electricity = _____
(Round number to nearest tenth.)

_____ 3. Multiply this number by the average efficiency of a power plant = _____
(Round number to nearest tenth.)

_____ 4. Add to this number the year the light bulb was invented = _____
(Record this number to nearest tenth.)

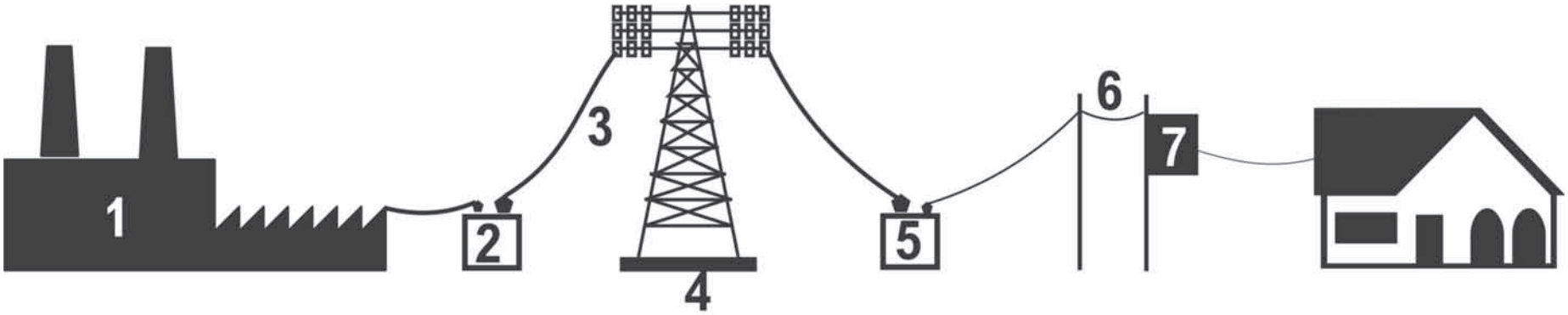
_____ 5. Divide this number by the number of watts in one kilowatt = _____
(Round number to nearest tenth.)

_____ 6. Multiply this number by the year Edison started his power plant = [ ]
(Record your answer to nearest tenth.)

ANSWER

TRANSPORTING ELECTRICITY

Explain what each of the components numbered below does to get electricity from the generator to the consumer.



1. Power plant -
2. Step-up transformer -
3. Transmission line -
4. Power tower -
5. Step-down transformer -
6. Distribution line -
7. Neighborhood transformer -

MEASURING ELECTRICITY

Directions: Fill in the blanks in the tables below.

Voltage	=	Current	x	Resistance
1.5 V	=	A	x	3 W
V	=	3 A	x	4 W
120 V	=	4 A	x	W
240 V	=	A	x	1 2 W

Power	=	Voltage	x	Current
27 W	=	9 V	x	A
W	=	120 V	x	1.5 A
45 W	=	V	x	3 A
W	=	120 V	x	2 A

Appliance	Power	=	Voltage	x	Current
TV	180 W	=	120 V	x	
Computer	40 W	=	120 V	x	
Printer	120 W	=	120 V	x	
Hair Dryer	1,000 W	=	120 V	x	

POWER	x	TIME	=	ELECTRICAL ENERGY	x	PRICE	=	COST
5 k W	x	100 h	=		x	$0.11	=	
1000 W	x	1 h	=		x	$0.11	=	
25 kW	x	4 h	=		x	$0.11	=	

BIOMASS ANSWER KEY

Description of biomass, where it is located and how it is recovered:

Biomass is any organic material that can be used as an energy source. It is located anywhere that can sustain plant growth or produces organic waste. It is collected from anywhere it is produced.

In what form the energy in biomass is stored and how it is converted into usable energy:

The energy in biomass is stored as chemical energy and can be burned, or converted to ethanol or methane.

What/who uses biomass and for what purposes:

Industry is the biggest user - burning wood to make products. It is burned in waste-to-energy plants to produce electricity. It is converted into ethanol for use as a vehicle fuel. Residences burn biomass for heat. In other countries it is turned into biogas for heat. Landfills capture methane produced by decaying garbage.

Advantages and disadvantages of using biomass:

Biomass is renewable and readily available. Using biomass does not increase the net amount of carbon dioxide in the atmosphere. Using biomass for energy reduces the amount sent to landfills and captures the stored energy. Land not needed for food production can be used to grow energy crops.

Burning biomass produces some pollutants and can produce foul odors. There is not as much energy per pound in biomass as in fossil fuels, so more must be burned.

COAL ANSWER KEY

Description of coal, where it is located and how it is recovered:

Coal is a solid fossil fuel formed by heat and pressure from the remains of ancient plants in swampy areas. Coal is buried underground in many areas of the country - especially the Appalachian Mountains, Wyoming, and Texas. Shallow coal is recovered with surface mines, deeper coal with underground mines.

In what form the energy in coal is stored and how it is converted into usable energy:

The energy in coal is stored as chemical energy and is released by burning or by conversion to methanol.

What/who uses coal and for what purposes:

Most coal is used by utilities to produce electricity. Industry burns coal to manufacture products. Some homes burn coal for heat. Coal can be converted into methanol and used as a vehicle fuel.

Advantages and disadvantages of using coal:

Coal is nonrenewable. It is the U.S.'s most abundant resource and produces nearly half of our electricity. Coal is an inexpensive and efficient fuel for producing electricity. It is also valuable to industry because it produces a very high heat.

Burning coal can produce air pollution and chemicals that cause acid rain. Mining coal can pollute water and damage the land.

GEOTHERMAL ANSWER KEY

Description of geothermal energy, where it is located and how it is recovered:

Geothermal energy is heat produced in the earth's core from the radioactive decay of natural elements. Low-temperature geothermal resources are almost everywhere. High-temperature resources are mostly along the Ring of Fire. It is recovered with wells or pipes placed under the ground.

In what form geothermal energy is stored and how it is converted into usable energy:

Geothermal energy is thermal energy. The heat can be used to heat buildings or to produce electricity.

What/who uses geothermal energy and for what purposes:

Power plants use high temperature steam to produce electricity. Buildings use geo exchange units to heat and cool interior spaces.

Advantages and disadvantages of using geothermal energy:

Geothermal energy is renewable; radioactive decay within the earth will continue for as long as the earth exists. It produces almost no air or water pollution. The water and steam that are extracted are reinjected into the ground.

High-temperature resources are not uniformly distributed. Geo exchange units are expensive to install but cheap to maintain and last a long time.

HYDROPOWER ANSWER KEY

Description of hydropower, where it is located and how it is recovered:

Hydropower is the energy in flowing water caused by the force of gravity. Hydro resources are everywhere there is precipitation and moving water. Usually dams are built across fast-moving rivers to harness the power of the water to turn turbines.

In what form hydropower is stored and how it is converted into usable energy:

Hydropower is stored mechanical energy. Dams control the flow of the water, converting the energy into electricity.

What/who uses hydropower and for what purposes:

Power plants build dams across rivers to harness the energy in moving water and convert it into electricity. The dams form a reservoir to hold the water. The dams have tubes called penstocks that direct the water through turbine generators to convert mechanical energy into electricity.

Advantages and disadvantages of using hydropower:

Hydropower is renewable; the water cycle will continue as long as the sun shines. Hydro dams produce no air pollution and are very cheap producers of electricity.

Large amounts of land are disturbed when dams are built. Wildlife habitats can be changed. Fish may have trouble getting to spawning grounds. Few places remain where dams can be built in the United States.

NATURAL GAS ANSWER KEY

Description of natural gas, where it is located and how it is recovered:

Natural gas is a fossil fuel - a colorless, odorless gas - formed from ancient sea plants and animals. It is located in sedimentary basins on and off shore and is recovered by drilling wells and piping the natural gas.

In what form the energy in natural gas is stored and how it is converted into usable energy:

The energy in natural gas is stored chemical energy. It is usually burned to produce heat.

What/who uses natural gas and for what purposes:

Industry is the largest user, burning natural gas to manufacture products. More than 60% of residences and commercial buildings use natural gas to heat indoor spaces and water. Natural gas can also be compressed and used as a transportation fuel or burned in power plants to produce electricity.

Advantages and disadvantages of using natural gas:

Natural gas is cleaner-burning than coal or petroleum. It is relatively inexpensive and the United States has adequate reserves for the next 25 - 50 years. It is a good fuel for peak demand power plants.

Natural gas is a nonrenewable fossil fuel. It can produce air pollution and carbon dioxide, a greenhouse gas, when burned.

PETROLEUM ANSWER KEY

Description of petroleum, where it is located and how it is recovered:

Petroleum is a liquid hydrocarbon fossil fuel formed from ancient sea plants and animals. It is located in sedimentary basins on and off shore. Wells are dug and the crude oil is pumped through pipelines.

In what form the energy in petroleum is stored and how it is converted into usable energy:

The energy in petroleum is stored as chemical energy. Petroleum is usually burned to produce heat.

What/who uses petroleum and for what purposes:

Petroleum is mainly a transportation fuel - it is refined into gasoline, jet fuel, diesel fuel, heating oil, and kerosene. Heating oil is burned to heat buildings and petroleum can be burned to produce electricity. Petroleum is also used to produce heat and as a feedstock to manufacture products.

Advantages and disadvantages of using petroleum:

Petroleum products fuel almost our entire transportation system and are essential to the manufacture of plastics and many other products.

Petroleum is a nonrenewable fossil fuel. It can pollute the air when burned and produces carbon dioxide, a greenhouse gas. It can also pollute land and water if it spills while being transported. The United States must import about two-thirds of the petroleum it uses. Much of the country's reserves are in sensitive environmental areas.

PROPANE ANSWER KEY

Description of propane, where it is located and how it is recovered:

Propane is a colorless, odorless, gaseous fossil fuel found in natural gas and petroleum deposits. It is recovered from petroleum refining and natural gas processing.

In what form the energy in propane is stored and how it is converted into usable energy:

The energy in propane is stored as chemical energy and burned to produce heat.

What/who uses propane and for what purposes:

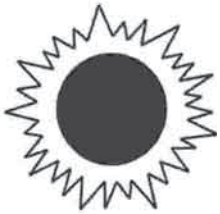
Industry is the largest user, burning propane to make products and fuel indoor vehicles. Farms and rural consumers use propane for heat. Backyard grills and recreational vehicles use propane as fuel. Some fleet vehicles use propane as a transportation fuel. Campers use propane for light, heat, and for cooking.

Advantages and disadvantages of using propane:

Propane is easily compressed into a liquid, in which state it can be easily transported. Propane is a good fuel for areas that do not have natural gas pipelines.

Propane is a clean-burning fossil fuel, but it can pollute the air and produces carbon dioxide, a greenhouse gas. Propane is nonrenewable.

SOLAR ANSWER KEY



Description of solar energy, where it is located and how it is recovered:

Solar energy is radiant energy produced by fusion in the sun's core. This energy radiates out from the sun in all directions. Some of it reaches the earth as radiant energy.

In what form the energy in solar energy is stored and how it is converted into usable energy:

Radiant energy can be converted into heat when it is absorbed by substances or converted directly into electricity by PV cells. Radiant energy as visible light is used for daylighting.

What/who uses solar energy and for what purposes:

Everyone uses daylighting to see, though we don't capture or harness it. Homes and buildings use solar collectors to heat interior spaces and water. Buildings and small appliances such as calculators and roadside telephones use PV cells to produce electricity. Remote areas use PV cells where there are no power lines.

Advantages and disadvantages of using solar energy:

Solar energy is renewable. It is also non-polluting and available to almost everyone.

Solar energy is difficult to harness because it is spread over a wide area and is not concentrated. PV technology is expensive at this time.

URANIUM ANSWER KEY

Description of uranium, where it is located and how it is recovered:

Uranium is a metallic ore that is abundant in the United States and around the world. Uranium ore is mined, milled, and enriched, before it can be used in power plants.

In what form the energy in uranium is stored and how it is converted into usable energy:

The energy in uranium is stored as nuclear energy. The energy is released through fission.

What/who uses uranium and for what purposes:

Nuclear power plants fission enriched uranium to produce heat to produce electricity.

Advantages and disadvantages of using uranium:

Nuclear power plants do not burn fuel, so there is little air or water pollution. Nuclear power is an efficient, cost-effective method of producing electricity.

Uranium is nonrenewable, though abundant. Nuclear power plants produce radioactive waste that can be very dangerous. Radioactive waste must be carefully stored for thousands of years. Right now, there is not a permanent repository in the United States.

WIND ANSWER KEY

Description of wind energy, where it is located and how it is recovered:

Wind is moving air caused by the uneven heating of the earth's surface by the sun. Many places have wind resources powerful and steady enough to harness. Wind machines can harness the energy in the wind.

In what form the energy in wind is stored and how it is converted into usable energy:

Wind energy is motion - kinetic energy. The blades of wind machines slow the speed of the wind and use the energy to produce electricity.

What/who uses wind energy and for what purposes:

Electric utilities and independent power producers use wind energy to produce electricity.

Advantages and disadvantages of using wind energy:

Wind energy is renewable. It is a non-polluting source of energy. It is an inexpensive way to produce electricity.

Wind machines cannot operate all the time - only when the wind is blowing at constant speeds of about 14 mph or higher. Wind farms take up a lot of land. Wind machines can be noisy.

FORMS OF ENERGY ANSWER KEY

Fill in the blanks with the words at the bottom of the page. You can use words more than once.

1. Stored energy and the energy of position are *potential* energy.
2. Compressed springs and stretched rubber bands are stored *mechanical* energy.
3. The vibration and movement of the atoms and molecules within substances is called heat or *thermal* energy.
4. The energy stored in the center of atoms is called *nuclear* energy.
5. The scientific rule that states that energy cannot be created or destroyed is called the Law of *Conservation of Energy*.
6. The movement of energy through substances in longitudinal waves is *sound*.
7. The energy of position, such as a rock on a hill, is *gravitational* energy.
8. The movement of objects and substances from place to place is *motion*.
9. Electromagnetic energy traveling in transverse waves is *radiant* energy.
10. Energy stored in the bonds of atoms and molecules is *chemical* energy.
11. The movement of atoms, molecules, waves, and electrons is *kinetic* energy.
12. The movement of electrons is *electrical* energy.
13. The amount of useful energy you get from a system is its *energy efficiency*.
14. The energy in petroleum and coal is stored as *chemical* energy.
15. X-rays are examples of *radiant* energy.
16. Fission and fusion are examples of *nuclear* energy.
17. A hydropower reservoir is an example of *gravitational* energy.
18. Wind is an example of the energy of *motion*.

radiant	gravitational	chemical	thermal	nuclear	electrical	mechanical
kinetic	potential	sound	motion	conservation of energy	energy efficiency	

RENEWABLES AND NONRENEWABLES ANSWER KEY

Convert the quads into percentages and make a pie chart showing how much of the energy the U.S. consumes comes from renewable sources and how much comes from nonrenewable sources (Q = quad or quadrillion Btu).

PETROLEUM	36.64 Q	=	37 %
NATURAL GAS	23.34 Q	=	23.5 %
COAL	22.42 Q	=	22.6%
URANIUM	8.46 Q	=	8.5 %
BIOMASS	3.88 Q	=	3.9 %
HYDROPOWER	2.45 Q	=	2.5 %
PROPANE	1.0 Q	=	1.0 %
GEOTHERMAL, SOLAR, WIND AND OTHER	0.96 Q	=	1.0 %

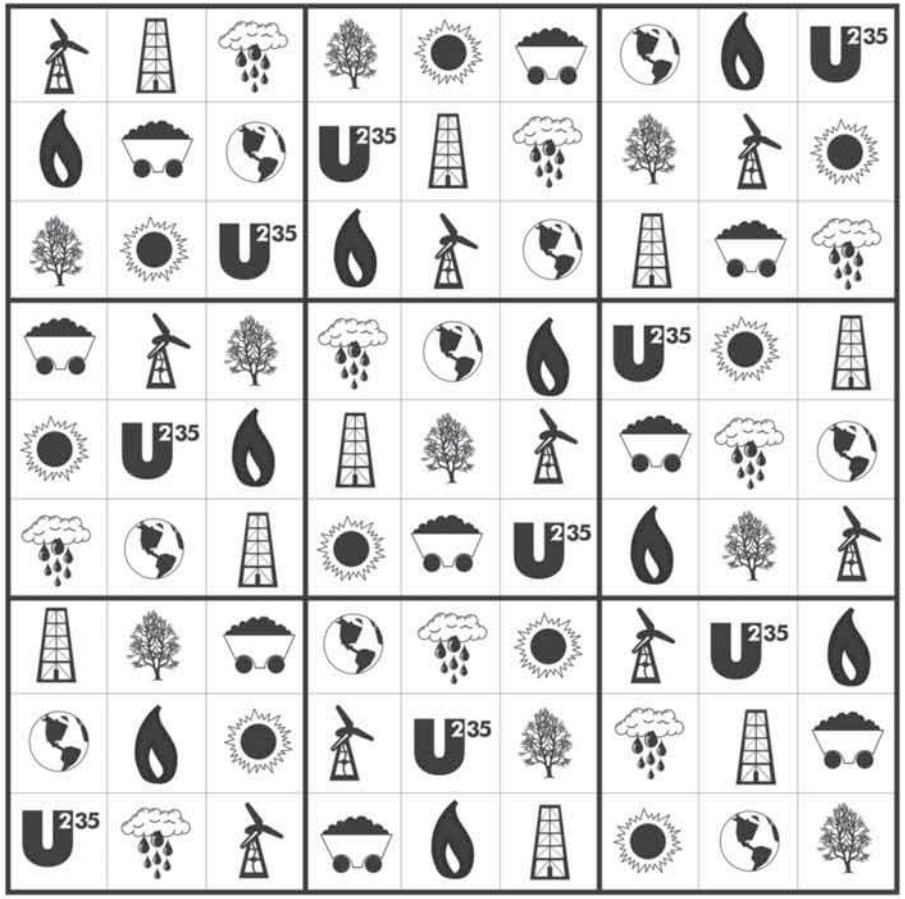
HOW WE USE OUR SOURCES ANSWER KEY

In the boxes, explain how each source is used for the tasks on the top. Star the main use of each source.

	TRANSPORTATION	MAKE PRODUCTS	HEATING/COOLING	LIGHTING	MAKE ELECTRICITY
	turned into ethanol and mixed with gasoline to make gasohol	***burned to make heat to manufacture products***	*burned to heat homes; converted to biogas to heat homes*	*burned to produce light (candles and (biogas)*	*burned in waste-to-energy plants to produce electricity*
	turned into methanol	*burned to make heat to manufacture products*	*burned to heat homes*		***burned to make heat to produce electricity***
			used in geothermal exchange systems to heat and cool homes		***heat used to produce electricity***
					mechanical energy used to produce electricity
	compressed to make CNG for fleet vehicles	***burned to make heat to manufacture products***	*burned to heat homes and commercial buildings*	*burned in some lanterns and street lights*	*burned to make heat to produce electricity*
	refined into gasoline, jet fuel, diesel fuel	*burned to make heat to manufacture products and as a feedstock*	*refined into heating oil and burned to heat homes*	*refined into kerosene and burned in lanterns*	*burned to make heat to produce electricity*
	pressurized for fleet and indoor vehicles	***burned to make heat to manufacture products***	*pressurized and burned to heat homes, barns, and buildings*	*pressurized and burned in lanterns*	
			used to heat homes and buildings	*provides daylighting*	***converted into electricity with PV cells***
U^{235}					***fissioned to make heat to produce electricity***
					mechanical energy turned into electricity

ENERGY SOURCE PUZZLE ANSWER KEY

By a process of elimination, fill in the blank squares so that each large square contains one of each energy source icon, using the letters that represent the icons as shown at the bottom of the puzzle. Each row and each column must also contain one of each icon. There is only one possible solution to the puzzle.



ELECTRICITY ANSWER KEY

Write the correct word for each definition in the blank space. Use each word only once.

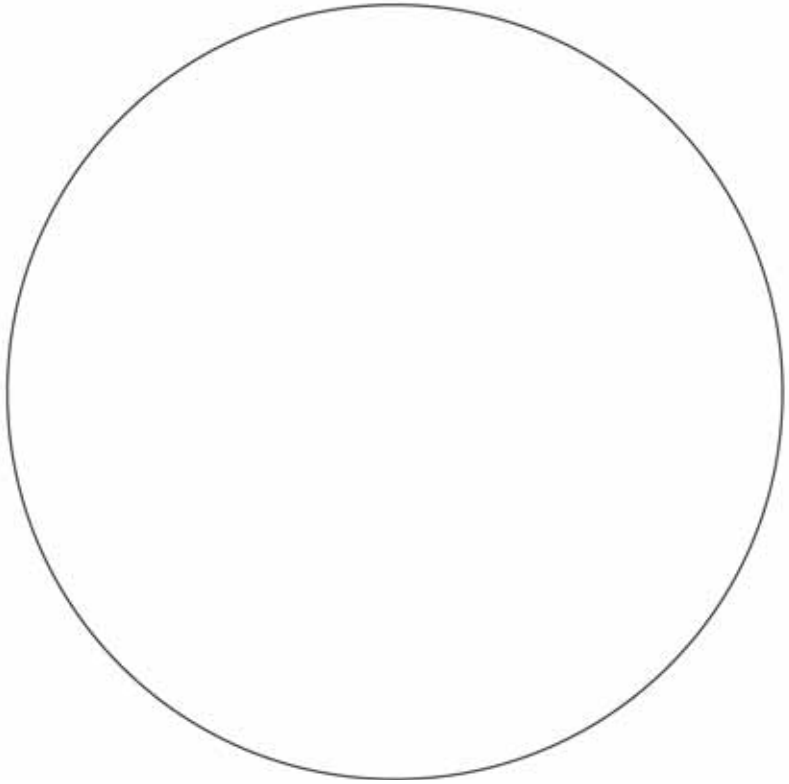
1. A device that changes voltage. *transformer*
2. A device that changes linear motion into circular motion. *turbine*
3. Allowing competition in the power industry. *deregulation*
4. Managing how and when consumers use electricity. *demand-side management*
5. The total amount of electricity a power plant can deliver. *capacity*
6. Times when many customers need electricity. *peak demand*
7. A device that turns motion energy into electricity. *generator*
8. How well a utility delivers electricity at all times. *reliability*
9. Electricity produced at all times to meet basic demand. *base-load*
10. A merged network of electric utilities. *power pool*
11. Reducing energy usage through behavioral changes. *conservation*
12. A measurement of the amount of electricity used by consumers. *kilowatt-hour*
13. Power plants that burn fuel to produce electricity. *thermal*
14. A material with little resistance to electric current. *superconductor*
15. Combining the nuclei of atoms to produce energy. *fusion*
16. A source of energy that requires another source to produce it. *secondary*
17. Manufacturing a product and producing electricity. *cogeneration*
18. Reducing the amount of energy consumed by devices through advances in technology. *efficiency*

capacity reliability base-load peak demand secondary transformer fusion
turbine generator conservation efficiency demand-side management
kilowatt-hour deregulation cogeneration superconductor thermal power pool

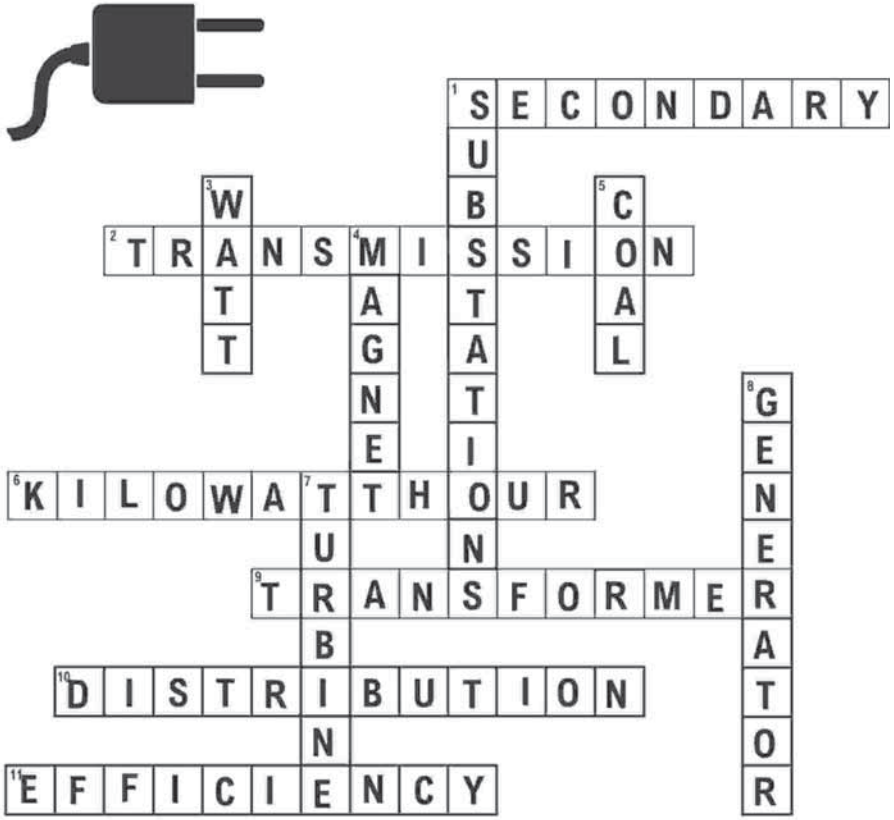
ELECTRIC POWER GENERATION

Convert the bkWh into percentages and make a pie chart showing how much of the electricity the U.S. consumed in 2008 came from each energy source (bkWh = billion kilowatt-hours). Round to the nearest tenth.

PETROLEUM	45 bkWh	= 1.1 %
COAL	1,994 bkWh	= 48.5 %
NATURAL GAS	877 bkWh	= 21.3 %
URANIUM	806 bkWh	= 19.6 %
BIOMASS	56 bkWh	= 1.4 %
HYDROPOWER	242 bkWh	= 5.9 %
GEOTHERMAL	15 bkWh	= 0.4 %
WIND	52 bkWh	= 1.3 %
OTHER	23 bkWh	= 0.6 %



ELECTRICITY ANSWER KEY



FAMOUS NAMES ANSWER KEY

1. FARADAY 2. WESTINGHOUSE 3. FRANKLIN 4. VOLTA 5. EDISON

6. NIAGARA FALLS

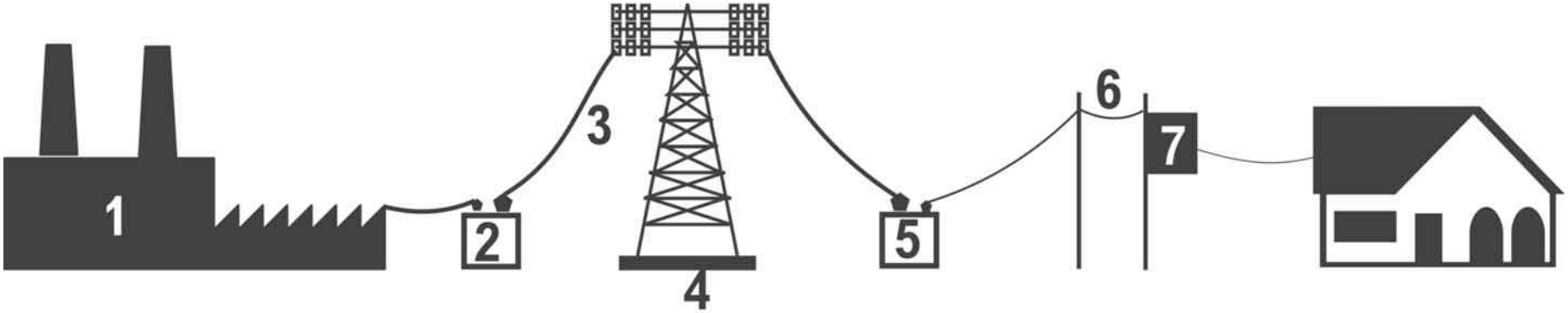
ELECTRIC MATH ANSWER KEY

LEFT COLUMN: 120, 9, 35, 1879, 1000, 1882

RIGHT COLUMN: 13.3, 465.5, 2344.5, 2.3, 4328.6

TRANSPORTING ELECTRICITY ANSWER KEY

Explain what each of the components numbered below does to get electricity from the generator to the consumer.



1. **Power plant -** generates electricity
2. **Step-up transformer -** increases voltage to reduce transmission loss
3. **Transmission line -** transports high-voltage electricity over long distances
4. **Power tower -** carries transmission lines
5. **Step-down transformer -** lowers voltage for smaller distribution lines
6. **Distribution line -** carries lower voltage electricity to homes and businesses
7. **Neighborhood transformer -** lowers voltage to the voltage used by appliances in homes and businesses (120 & 240 volts)

MEASURING ELECTRICITY

Directions: Fill in the blanks in the tables below.

Voltage	=	Current	x	Resistance
1.5 V	=	0.5 A	x	3 Ω
12 V	=	3 A	x	4 Ω
120 V	=	4 A	x	30 Ω
240 V	=	20 A	x	1 2 Ω

Power	=	Voltage	x	Current
27 W	=	9 V	x	3 A
180 W	=	120 V	x	1.5 A
45 W	=	15 V	x	3 A
240 W	=	120 V	x	2 A

Appliance	Power	=	Voltage	x	Current
TV	180 W	=	120 V	x	1.5 A
Computer	40 W	=	120 V	x	0.33 A
Printer	120 W	=	120 V	x	1 A
Hair Dryer	1,000 W	=	120 V	x	8.33 A

POWER	x	TIME	=	ELECTRICAL ENERGY	x	PRICE	=	COST
5 k W	x	100 h	=	500 kWh	x	$0.11	=	$55.00
1000 W	x	1 h	=	1000 Wh=1kWh	x	$0.11	=	$0.11
25 kW	x	4 h	=	100 kWh	x	$0.11	=	$11.00

SECONDARY ENERGY ACTIVITIES

Evaluation Form

State: _____ **Grade Level:** _____ **Number of Students:** _____

1. Did you conduct the entire activity?	Yes	No
2. Were the instructions clear and easy to follow?	Yes	No
3. Did the activity meet your academic objectives?	Yes	No
4. Was the activity age appropriate?	Yes	No
5. Were the allotted times sufficient to conduct the activity?	Yes	No
6. Was the activity easy to use?	Yes	No
7. Was the preparation required acceptable for the activity?	Yes	No
8. Were the students interested and motivated?	Yes	No
9. Was the energy knowledge content age appropriate?	Yes	No
10. Would you use the activity again?	Yes	No

How would you rate the activity overall (excellent, good, fair, poor)?

How would your students rate the activity overall (excellent, good, fair, poor)?

What would make the activity more useful to you?

Other Comments:

Please fax or mail to:
NEED Project
PO Box 10101
Manassas, VA 20108
FAX: 1-800-847-1820

NEED National Sponsors and Partners

American Association of Blacks in Energy
American Electric Power
American Electric Power Foundation
American Petroleum Institute
American Solar Energy Society
American Wind Energy Association
Aramco Services Company
Areva
Armstrong Energy Corporation
Association of Desk & Derrick Clubs
All Wild About Kentucky's Environment
Robert L. Bayless, Producer, LLC
BP Foundation
BP
BP Alaska
BP Solar
Bureau of Land Management – U.S. Department of the Interior
C&E Operators
Cape and Islands Self Reliance
Cape Cod Cooperative Extension
Cape Light Compact–Massachusetts
L.J. and Wilma Carr
Center for the Advancement of Process Technology–College of the Mainland–TX
Chesapeake Public Schools–VA
Chesterfield County Public Schools–VA
Chevron
Chevron Energy Solutions
ComEd
ConEd Solutions
ConocoPhillips
Council on Foreign Relations
CPS Energy
Cypress-Fairbanks Independent School District–TX
Dart Foundation
Desk and Derrick of Roswell, NM
Dominion
Dominion Foundation
Duke Energy
E.On
EDF
East Kentucky Power
El Paso Foundation
EnCana
Energy Information Administration – U.S. Department of Energy
Energy Training Solutions
Energy and Mineral Law Foundation
Energy Solutions Foundation
Equitable Resources
Escambia County School District–FL
FPL Energy Encounter–FL
First Roswell Company
Florida Department of Environmental Protection
Foundation for Environmental Education
Georgia Environmental Facilities Authority
Guam Energy Office
Gulf Power
Halliburton Foundation
Gerald Harrington, Geologist
Houston Museum of Natural Science
Hydro Foundation for Research and Education
Idaho Department of Education
Illinois Clean Energy Community Foundation
Independent Petroleum Association of America
Independent Petroleum Association of New Mexico
Indiana Office of Energy and Defense Development
Interstate Renewable Energy Council
Iowa Energy Center
Kentucky Clean Fuels Coalition
Kentucky Department of Energy Development and Independence
Kentucky Oil and Gas Association
Kentucky Propane Education and Research Council
Kentucky River Properties LLC
Keyspan
KidWind
Lenfest Foundation
Llano Land and Exploration
Long Island Power Authority–NY
Maine Energy Education Project
Maine Public Service Company
Marianas Islands Energy Office
Maryland Energy Administration
Massachusetts Division of Energy Resources
Michigan Energy Office
Michigan Oil and Gas Producers Education Foundation
Minerals Management Service – U.S. Department of the Interior
Mississippi Development Authority–Energy Division
Montana Energy Education Council
Narragansett Electric – A National Grid Company
NASA Educator Resource Center–WV
National Alternative Fuels Training Center–West Virginia University
National Association of State Energy Officials
National Association of State Universities and Land Grant Colleges
National Hydropower Association
National Ocean Industries Association
National Renewable Energy Laboratory
Nebraska Public Power District
New Jersey Department of Environmental Protection
New York Power Authority
New Mexico Oil Corporation
New Mexico Landman's Association
North Carolina Department of Administration–State Energy Office
Offshore Energy Center/Ocean Star/OEC Society
Offshore Technology Conference
Ohio Energy Project
Pacific Gas and Electric Company
PECO
Petroleum Equipment Suppliers Association
Poudre School District–CO
Puerto Rico Energy Affairs Administration
Puget Sound Energy
Roswell Climate Change Committee
Roswell Geological Society
Rhode Island State Energy Office
Sacramento Municipal Utility District
Saudi Aramco
Sentech, Inc.
Shell
Snohomish County Public Utility District–WA
Society of Petroleum Engineers
David Sorenson
Southern Company
Southern LNG
Southwest Gas
Spring Branch Independent School District–TX
Tennessee Department of Economic and Community Development–Energy Division
Toyota
TransOptions, Inc.
TXU Energy
United Technologies
University of Nevada–Las Vegas, NV
United Illuminating Company
U.S. Environmental Protection Agency
U.S. Department of Energy
U.S. Department of Energy–Hydrogen, Fuel Cells and Infrastructure Technologies
U.S. Department of Energy – Wind for Schools
Virgin Islands Energy Office
Virginia Department of Mines, Minerals and Energy
Virginia Department of Education
Virginia General Assembly
Wake County Public Schools–NC
Washington and Lee University
Western Kentucky Science Alliance
W. Plack Carr Company
Yates Petroleum