2013-2014

Secondary Energy Infobook Activities

A companion guide to the *Secondary Energy Infobook* that includes activities to reinforce general energy information, energy sources, electricity, and conservation.

Grade Level:

Secondary

Subject Areas:

Science

Social Studies

Language Arts

NEED
National Energy Education Development Project

Teacher Advisory Board

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.

Teacher Advisory Board Statement

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

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Energy Data Used in NEED Materials

NEED believes in providing the most recently reported energy data available to our teachers and students. Most statistics and data are derived from the U.S. Energy Information Administration's Annual Energy Review that is published yearly. Working in partnership with EIA, NEED includes easy to understand data in our curriculum materials. To do further research, visit the EIA web site at www.eia.gov. EIA's Energy Kids site has great lessons and activities for students at www.eia.gov/kids.

NEED
National Energy Education Development

1.800.875.5029
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NEED Curriculum Resources

For more in-depth information, inquiry investigations, and engaging activities, download these curriculum resources from www.NEED.org:

- *Secondary Science of Energy*
- *Secondary Energy Infobook*
- *Energy Flows*

Secondary Energy Infobook Activities

Table of Contents

Correlations to National Science Education Standards: Grades 9-12

This book has been correlated to National Science Education Content Standards.
For correlations to individual state standards, visit **www.NEED.org**.

Content Standard B | *PHYSICAL SCIENCE*

- **Motions and Forces**
  - The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel. The strength of the force is proportional to the charges, and, as with gravitation, inversely proportional to the square of the distance between them.
  - Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. These effects help students to understand electric motors and generators.
- **Conservation of Energy and the Increase in Disorder**
  - 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.
  - All energy can be considered to be either kinetic energy, which is the energy of motion; potential energy, which depends on relative position; or energy contained by a field, such as electromagnetic waves.
  - Heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion.

Content Standard D | *EARTH AND SPACE SCIENCE*

- **Energy in the Earth System**
  - 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.
  - The outward transfer of earth's internal heat drives convection circulation in the mantle that propels the plates comprising earth's surface across the face of the globe.
  - Heating of earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.
  - Global climate is determined by energy transfer from the sun at and near the earth's surface. The energy transfer is influenced by dynamic processes such as cloud cover and the earth's rotation, and static conditions such as the position of mountain ranges and oceans.

Content Standard F | *SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES*

- **Natural Resources**
  - Human populations use resources in the environment in order to maintain and improve their existence. Natural resources have been and will continue to be used to maintain human populations.
  - The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and it depletes those resources that cannot be renewed.

Teacher Guide

Background

Secondary Energy Infobook Activities is a series of student worksheets designed to reinforce the vocabulary and concepts in the *Secondary Energy Infobook*. You can download the *Secondary Energy Infobook* or specific energy fact sheets from www.NEED.org/Energy-Infobooks.

Skills

- Nonfiction Reading
- Critical Thinking
- Vocabulary
- Graphing

Preparation

- Decide which fact sheets and worksheets you will use with your class.
- Obtain a class set of *Secondary Energy Infobooks* or make copies of the fact sheets you plan to use.
- Make copies of the student worksheets you plan to use from this guide.
- Many other NEED activities also reinforce and synthesize the information in the infobooks, such as *Energy Jeopardy, Great Energy Debate, Mission Possible,* and *Energy Enigma*.

☑Procedure

1. Distribute one *Secondary Energy Infobook* or selected fact sheets and worksheets to each student.
2. Have the students read the selected fact sheets. Discuss the concepts and new vocabulary in the fact sheets.
3. Have the students complete the selected worksheets. These worksheets reinforce and synthesize the information in the *Secondary Energy Infobook*. Worksheets include:
    - *Forms of Energy*, page 8
    - Sources of energy worksheets, pages 9–16
    - Electricity worksheets, pages 17–22
    - Renewable Energy Bingo, page 23
4. Use the *Evaluation Form* on page 35 to evaluate the activities.

Time

Approximately 30 minutes per topic for the students to read the selected fact sheet and complete the associated worksheets.

Renewable Energy Bingo Instructions

***Energy Bingo* is a great icebreaker for a NEED workshop or conference. As a classroom activity, it also makes a great introduction to an energy unit.**

Preparation

- Low

Time

- 45 minutes

Get Ready

Duplicate as many *Renewable Energy Bingo* sheets (found on page 29) as needed for each person in your group. In addition, decide now if you want to give the winner of your game a prize and what the prize will be.

Additional *Energy Bingo* games focused on specific energy sources and topics can be found at www.NEED.org.

Get Set

Pass out one *Energy Bingo* sheet to each member of the group.

Go

PART ONE: FILLING IN THE BINGO SHEETS

Give the group the following instructions to play the game:

- *Energy Bingo* is very similar to regular bingo. However, there are a few things you'll need to know to play this game. First, please take a minute to look at your Energy Bingo sheet and read the 16 statements at the top of the page. Shortly, you'll be going around the room trying to find 16 people about whom the statements are true so you can write their names in one of the 16 boxes.
- When I give you the signal, you'll get up and ask a person if a statement at the top of your bingo sheet is true for them. If the person gives what you believe is a correct response, write the person's name in the corresponding box on the lower part of the page. For example, if you ask a person question "D" and he or she gives you what you think is a correct response, then go ahead and write the person's name in box D. A correct response is important because later on, if you get bingo, that person will be asked to answer the question correctly in front of the group. If he or she can't answer the question correctly, then you lose bingo. So, if someone gives you an incorrect answer, ask someone else! Don't use your name for one of the boxes or use the same person's name twice.
- Try to fill all 16 boxes in the next 20 minutes. This will increase your chances of winning. After the 20 minutes are up, please sit down and I will begin asking players to stand up and give their names. Are there any questions? You'll now have 20 minutes. Go!

PART TWO: PLAYING BINGO

During the next 20 minutes, move around the room to assist the players. Every five minutes or so tell the players how many minutes are remaining in the game. Give the players a warning when just a minute or two remains. When the 20 minutes are up, stop the players and ask them to be seated. Then give them the following instructions.

- When I point to you, please stand up and in a LOUD and CLEAR voice give us your name. Now, if anyone has the name of the person I call on, put a big "X" in the box with that person's name. When you get four names in a row—across, down, or diagonally—shout "Energy Bingo!" Then I'll ask you to come up front to verify your results.
- Let's start off with you (point to a player in the group). Please stand and give us your name. (Player gives name. Let's say the player's name was "Joe.") Okay, players, if any of you have Joe's name in one of your boxes, go ahead and put an "X" through that box.
- When the first player shouts "Energy Bingo," ask him (or her) to come to the front of the room. Ask him to give his name. Then ask him to tell the group how his bingo run was made, e.g., down from A to M, across from E to H, and so on.

- Now you need to verify the winner's results. Ask the bingo winner to call out the first person's name on his bingo run. That player then stands and the bingo winner asks him the question which he previously answered during the 20-minute session. For example, if the statement was "can name at least three renewable energy sources," the player must now name three sources. If he can answer the question correctly, the bingo winner calls out the next person's name on his bingo run. However, if he does not answer the question correctly, the bingo winner does not have bingo after all and must sit down with the rest of the players. You should continue to point to players until another person yells "Energy Bingo."

RENEWABLE ENERGY BINGO — ANSWERS

A. Has been to a renewable power plant
B. Knows which state has the most geothermal power plants
C. Can name at least three renewable energy sources
D. Knows the percentage of electricity produced by renewable sources in the U.S.
E. Can name two types of biomass
F. Knows the source of energy that drives the water cycle
G. Can name two factors to consider when siting a wind farm
H. Has used a solar clothes dryer
I. Has seen a modern wind turbine
J. Knows the renewable source that produces the most energy in the U.S.
K. Knows the renewable source that produces the most electricity in the U.S.
L. Knows the cost per kilowatt-hour of electricity for residential customers
M. Knows how radiant energy travels through space
N. Can name two kinds of hydropower
O. Has used wind energy for transportation
P. Can name the device in a hydropower plant that captures the energy of flowing water

A waste-to-energy, solar thermal, solar PV, hydropower plant	**B** California has 35	**C** solar hydropower wind geothermal biomass	**D** 13%
E wood, crops, manure, garbage, landfill gas, alcohol fuels, ethanol, and biodiesel	**F** Solar energy drives the water cycle	**G** Wind speed, environmental impact, ability to transport electricity to population centers, etc.	**H** Anyone who has hung clothes to dry outside
I ask for location/description	**J** biomass	**K** hydropower	**L** The national average is $0.12 per kWh for residential customers
M in electromagnetic waves (or transverse waves)	**N** pumped storage or run of river hydroelectric power plant, tidal power, wave power, ocean thermal energy conservation	**O** sailboat sailboard etc.	**P** A turbine captures the energy of flowing water.

Bingos are available on several different topics. Check out these resources for more bingo options!

- Energy Bingo— *Energy Games and Icebreakers*
- Science of Energy Bingo— *Science of Energy* guides
- Transportation Bingo — *Transportation Fuels Infobooks*
- Marine Renewable Energy Bingo —*Ocean Energy*
- Wind Energy Bingo—Wind guides
- Biomass Bingo— *Energy Stories and More*
- Hydrogen Bingo—*H2Educate*
- Solar Bingo—Solar guides
- Hydropower Bingo— Hydropower guides
- Change a Light Bingo—*Energy Conservation Contract*
- Energy Efficiency Bingo— *Monitoring and Mentoring* and *Learning and Conserving*
- Nuclear Energy Bingo— Nuclear guides
- Oil and Gas Bingo—Oil and Gas guides
- Offshore Oil and Gas Bingo — *Ocean Energy*

Forms of Energy

Fill in the blanks with the words at the bottom of the page. Some words may be used more than once.

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

Word Bank

- chemical
- Conservation of Energy
- electrical
- energy efficiency
- gravitational potential
- kinetic
- motion
- nuclear
- potential
- radiant
- sound
- stored mechanical
- thermal

Biomass

Description of biomass:

Renewable or nonrenewable:

Ways we turn biomass into energy we can use:

Description of photosynthesis:

Who uses biomass and for what purposes:

Effect of using biomass on the environment:

Important facts about biomass:

Coal

Description of coal:

Renewable or nonrenewable:

Where coal is located and how we recover it:

Ways we turn coal into energy we can use:

Who uses coal and for what purposes:

Effect of using coal on the environment:

Important facts about coal:

Geothermal

Description of geothermal energy:

Renewable or nonrenewable:

Where geothermal resources are located and how we recover them:

Ways we turn geothermal energy into energy we can use:

Who uses geothermal energy and for what purposes:

Effect of using geothermal energy on the environment:

Important facts about geothermal energy:

Hydropower

Description of hydropower:

Renewable or nonrenewable:

Description of the water cycle:

Ways we turn hydropower into energy we can use:

Who uses hydropower and for what purposes:

Effect of using hydropower on the environment:

Important facts about hydropower:

Natural Gas

Description of natural gas:

Renewable or nonrenewable:

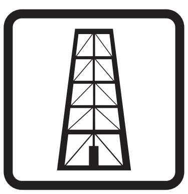
Where natural gas is located and how we recover it:

Ways we turn natural gas into energy we can use:

Who uses natural gas and for what purposes:

Effect of using natural gas on the environment:

Important facts about natural gas:



Petroleum

Description of petroleum:

Renewable or nonrenewable:

Where petroleum is located and how we recover it:

Ways we turn petroleum into energy we can use:

Who uses petroleum and for what purposes:

Effect of using petroleum on the environment:

Important facts about petroleum:

Propane

Description of propane:

Renewable or nonrenewable:

Where propane is located and how we recover it:

Ways we turn propane into energy we can use:

Who uses propane and for what purposes:

Effect of using propane on the environment:

Important facts about propane:

Solar

Description of solar energy:

Renewable or nonrenewable:

How solar energy is produced and how we recover it:

Ways we turn solar energy into energy we can use:

Who uses solar energy and for what purposes:

Effect of using solar energy on the environment:

Important facts about solar energy:

Uranium (Nuclear)

Description of uranium:

Renewable or nonrenewable:

Where uranium is located and how we recover it:

Ways we turn uranium into energy we can use:

Who uses uranium (nuclear energy) and for what purposes:

Effect of using uranium (nuclear energy) on the environment:

Important facts about uranium (nuclear energy):

Wind

Description of wind energy:

Renewable or nonrenewable:

Where wind energy is located and how we recover it:

Ways we turn wind into energy we can use:

Who uses wind and for what purposes:

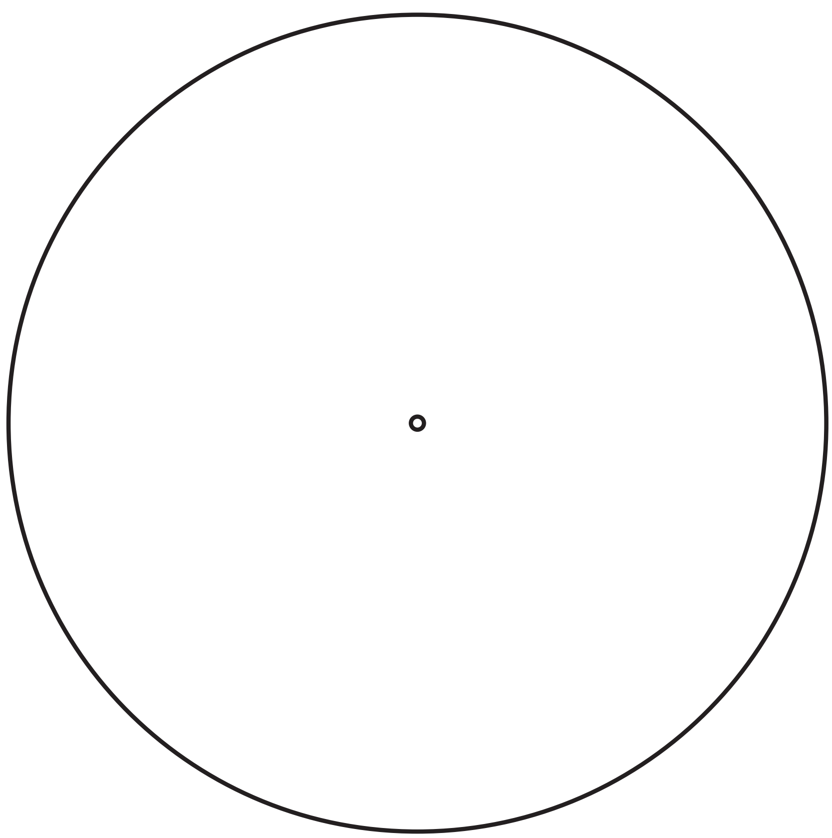
Effect of using wind on the environment:

Important facts about wind:

Renewables and Nonrenewables

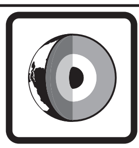
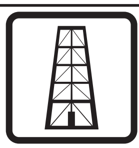
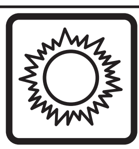
Convert the quads into percentages and make a pie chart showing how much U.S. energy in 2011 came from renewable sources and how much came from nonrenewable sources. Round to the nearest hundredth.
(Q = quad or quadrillion British thermal units)

Petroleum	**33.689 Q =**	______________ **%**
Natural Gas	**24.843 Q =**	______________ **%**
Coal	**19.643 Q =**	______________ **%**
Uranium	**8.259 Q =**	______________ **%**
Biomass	**4.411 Q =**	______________ **%**
Hydropower	**3.171 Q =**	______________ **%**
Propane	**1.594 Q =**	______________ **%**
Geothermal, Solar, and Wind	**1.552 Q =**	______________ **%**
Total Quad BTUs	________ **=**	______________ **%**



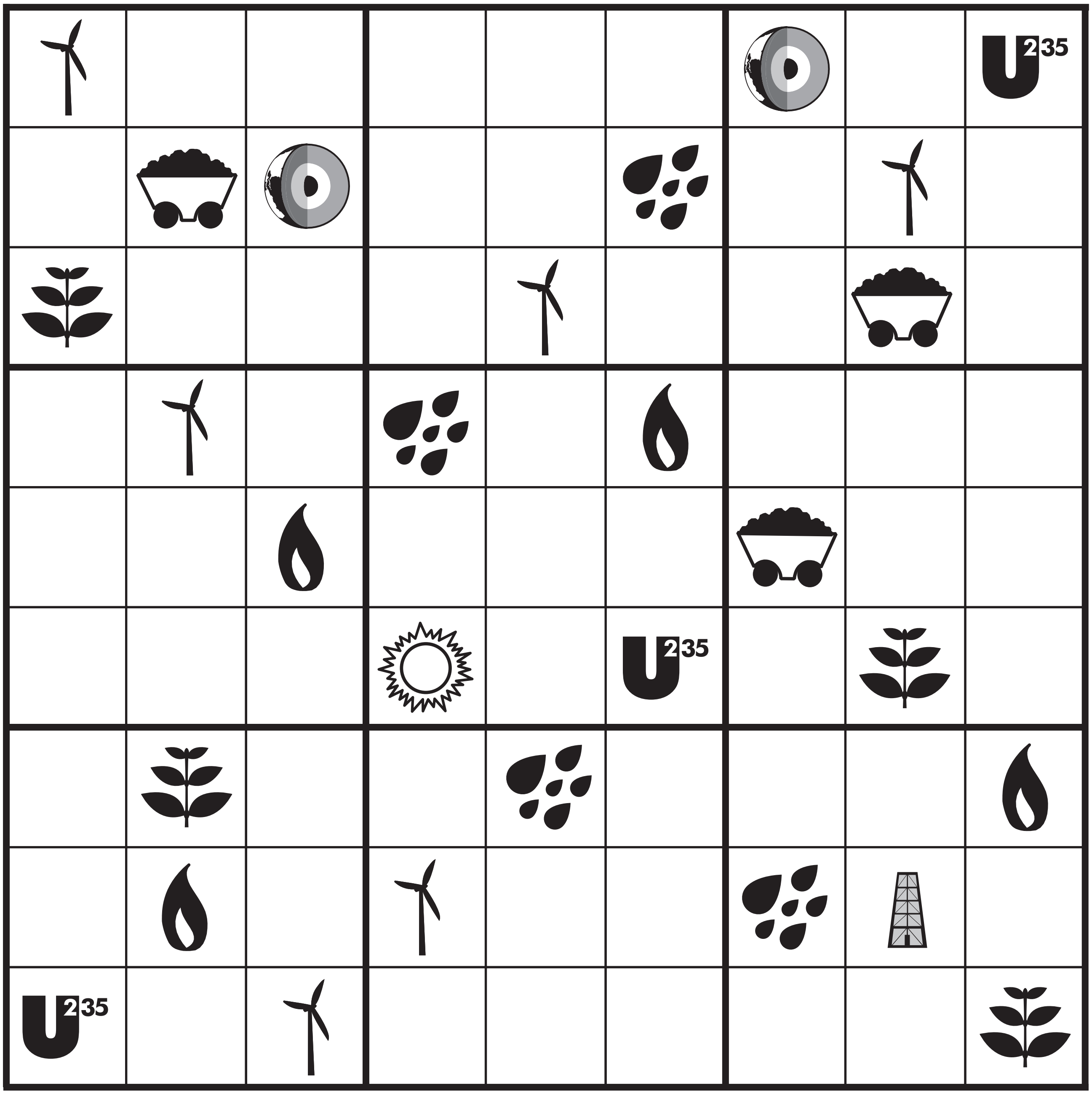
How We Use Our Energy Sources

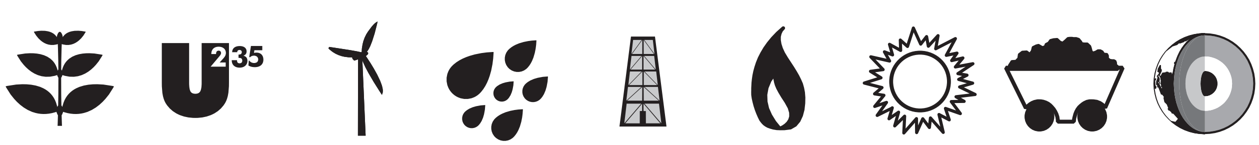
In the boxes, describe the main uses of each energy source. Put a * beside the most important use. Some sources may be used in only one or two ways.

	TRANSPORTATION	MAKE PRODUCTS	HEATING/COOLING	LIGHTING	MAKE ELECTRICITY
					
					
					
					
					
					
					
					
					
					

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. Use either the icons or 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.





B U W H P N S C G

Electricity

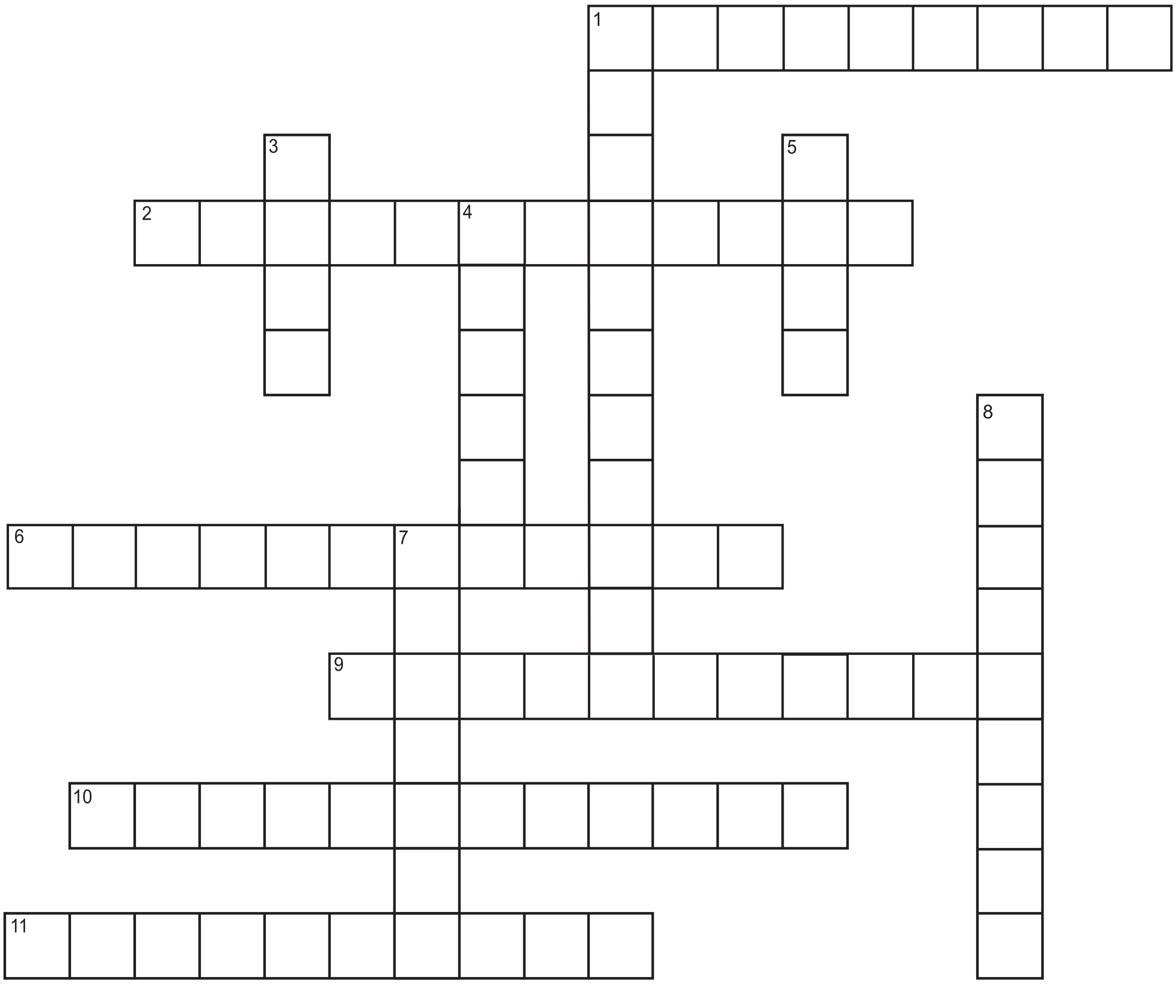
Write the correct word for each definition in the blank space. Use each word only once.

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. How well a utility delivers electricity at all times. ________________________
8. Electricity produced at all times to meet basic demand. ________________________
9. A merged network of electric utilities. ________________________
10. Reducing energy usage through behavioral changes. ________________________
11. A measurement of the amount of electricity used by consumers. ________________________
12. Power plants that burn fuel to produce electricity. ________________________
13. A material with little resistance to electric current. ________________________
14. A device measuring electricity consumption that allows for two-way wireless communication between the utility and consumer. ________________________
15. A source of energy that requires another source to produce it. ________________________
16. Manufacturing a product and producing electricity. ________________________
17. Reducing the amount of energy consumed by devices through advances in technology. ________________________

Word Bank

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

Electricity Crossword



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. In a coal-fired power plant, thirty-five percent of the fuel is converted into electricity. This is called the _____ of the power plant.

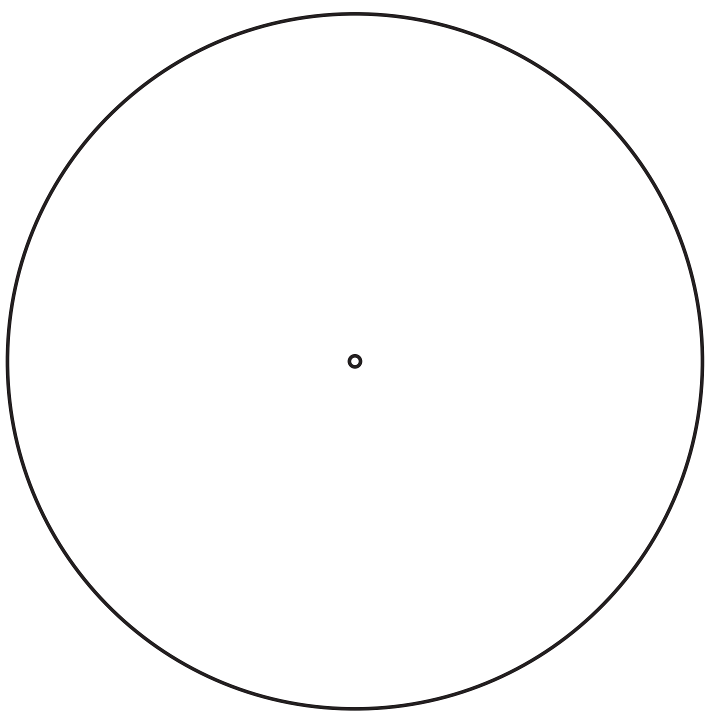
DOWN ▼

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 can be spun to create electricity.
5. _____ is the fossil fuel that makes the most electricity in the U.S.
7. High pressure steam turns the blades of a _____.
8. A _____ houses magnets and a spinning coil of copper wire.

Electric Power Generation

Convert the bkWh into percentages and make a pie chart showing how much of the electricity the U.S. consumed in 2011 came from each energy source. Round to the nearest tenth. (bkWh = billion kilowatt-hours)

Petroleum	**28.20 bkWh**	**= ____________ %**
Coal	**1734.30 bkWh**	**= ____________ %**
Natural Gas	**1016.60 bkWh**	**= ____________ %**
Uranium	**790.20 bkWh**	**= ____________ %**
Biomass	**56.70 bkWh**	**= ____________ %**
Hydropower	**319.20 bkWh**	**= ____________ %**
Geothermal	**16.70 bkWh**	**= ____________ %**
Wind	**119.70 bkWh**	**= ____________ %**
Other	**24.20 bkWh**	**= ____________ %**
Total bkWh	**__________**	**= ____________ %**



Famous Names in Electricity

The sentences below refer to famous scientists and inventors from the History of Electricity section of your electricity fact sheet. 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.

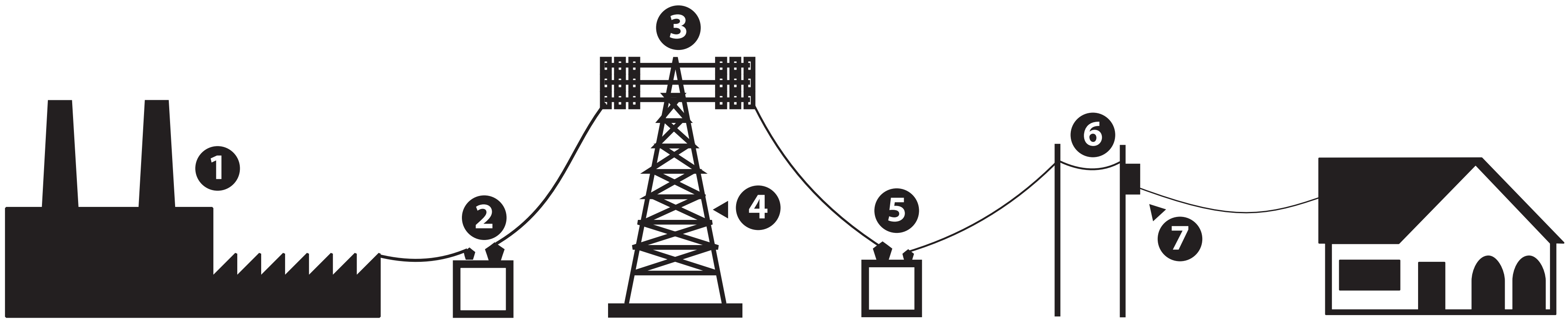
12   120   1000   1882   1879   35

______	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 =	______________
______	3. Multiply this number by the average efficiency of a thermal power plant =	______________
______	4. Add to this number the year the light bulb was invented =	______________
______	5. Divide this number by the number of watts in one kilowatt =	______________
______	6. Multiply this number by the year Edison started his power plant =	[ ]

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.

TABLE 1

VOLTAGE	=	CURRENT	X	RESISTANCE
1.5 V	=	_______ A	x	3 Ω
_______ V	=	3 A	x	4 Ω
120 V	=	4 A	x	_______ Ω
240 V	=	_______ A	x	12 Ω

TABLE 2

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

TABLE 3

APPLIANCE		POWER	=	VOLTAGE	X	CURRENT
TV		180 W	=	120 V	x	_______ A
COMPUTER		40 W	=	120 V	x	_______ A
PRINTER		120 W	=	120 V	x	_______ A
HAIR DRYER		1,000 W	=	120 V	x	_______ A

TABLE 4

POWER		TIME	=	ELECTRICAL ENERGY (kWh)	X	PRICE	=	COST
5 kW	x	100 h	=	______________	x	$ 0.12	=	$ _______
25 kW	x	4 h	=	______________	x	$ 0.12	=	$ _______
1,000 W	x	1 h	=	______________	x	$ 0.12	=	$ _______

RENEWABLE ENERGY BINGO

A. Has been to a renewable power plant

B. Knows which state has the most geothermal power plants

C. Can name at least three renewable energy sources

D. Knows the percentage of electricity produced by renewable sources in the U.S.

E. Can name two types of biomass

F. Knows the source of energy that drives the water cycle

G. Can name two factors to consider when siting a wind farm

H. Has used a solar clothes dryer

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M. Knows how radiant energy travels through space

N. Can name two kinds of hydropower

O. Has used wind energy for transportation

P. Can name the device in a hydropower plant that captures the energy of flowing water

A NAME	**B** NAME	**C** NAME	**D** NAME
E NAME	**F** NAME	**G** NAME	**H** NAME
I NAME	**J** NAME	**K** NAME	**L** NAME
M NAME	**N** NAME	**O** NAME	**P** NAME

Forms of Energy Answers

Fill in the blanks with the words at the bottom of the page. Some words may be used 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 **thermal** energy.
4. The scientific rule that states that energy cannot be created or destroyed is called the Law of **Conservation of Energy**.
5. The movement of energy through substances in longitudinal waves is **sound**.
6. The energy of position—such as a rock on a hill—is **gravitational** energy.
7. The movement of objects and substances from place to place is **motion** energy.
8. Electromagnetic energy traveling in transverse waves is **radiant** energy.
9. Energy stored in the bonds of atoms and molecules is **chemical** energy.
10. The movement of atoms, molecules, waves, and electrons is **kinetic** energy.
11. The movement of electrons is **electrical** energy.
12. The amount of useful energy you get from a system is its **energy efficiency**.
13. The energy in petroleum and coal is stored as **chemical** energy.
14. X-rays are an example of **radiant** energy.
15. Fission and fusion are examples of **nuclear** energy.
16. A hydropower reservoir is an example of **gravitational potential** energy.
17. Wind is an example of the energy of **motion**.

Word Bank

- chemical
- Conservation of Energy
- electrical
- energy efficiency
- gravitational potential
- kinetic
- motion
- nuclear
- potential
- radiant
- sound
- stored mechanical
- thermal

Biomass

Description of biomass:
Any organic material that can be used for its energy content—wood, garbage, yard waste, crop waste, animal waste, even human waste.

Renewable or nonrenewable:
Renewable

Description of photosynthesis:
The process by which radiant energy from the sun is converted to glucose, or sugar. This glucose stores chemical energy within the plant.

Ways we turn biomass into energy we can use:
Burning to produce heat, fermentation into alcohol fuel (ethanol), bacterial decay into methane, conversion to gas or liquid fuels by addition of heat or chemicals.

Who uses biomass and for what purposes:
Industry burns waste wood to make products, homes burn wood for heat, waste-to-energy plants burn organic waste products to produce electricity, and ethanol and biodiesel are used as a transportation fuels.

Effect of using biomass on the environment:
Burning biomass can produce air pollution and does produce carbon dioxide, a greenhouse gas. It can also produce odors. Burning biomass is cleaner than burning fossil fuels. Growing plants to use as biomass fuels removes carbon dioxide from atmosphere.

Important facts about biomass:
Biomass gets its energy from the sun through the process of photosynthesis.

Using biomass reduces the amount of organic material placed in landfills.

Fast-growing crops can be grown for their energy content.

Using biomass does not contribute as much to the greenhouse effect, since the amount of carbon dioxide produced by equipment is offset somewhat by the amount taken in during growth.

Coal

Description of coal:
Coal is a black, solid hydrocarbon (fossil fuel) formed from the remains of ancient plants in swamps hundreds of millions of years ago.

Renewable or nonrenewable:
Nonrenewable

Where coal is located and how we recover it:
Coal is located underground in many areas of the country. Shallow seams are surface mined. Coal buried deep is reached through underground mine shafts.

Ways we turn coal into energy we can use:
Most coal is burned to produce thermal energy.

Who uses coal and for what purposes:
Power plants burn most of the coal to produce electricity. Industries also burn coal to make products, especially steel and iron.

Effect of using coal on the environment:
Burning coal can pollute the air and cause acid rain. Burning coal also produces carbon dioxide, a greenhouse gas.

Important facts about coal:
Coal produces about 42 percent of the electricity in the U.S.

The U.S. has the largest reserves of coal in the world.

Coal is found in Appalachian states and some western states.

Wyoming, West Virginia, Kentucky, Pennsylvania, and Texas are the top coal producing states.

Coal is transported mainly by train and barge. Transporting coal is a huge expense.

Geothermal

Description of geothermal energy:
Geothermal energy is heat produced in the Earth's core by the slow decay of naturally-occurring radioactive particles.

Renewable or nonrenewable:
Renewable

Where geothermal resources are located and how we recover them:
Low temperature resources are almost everywhere a few feet underground. High temperature resources are found along major plate boundaries, especially around the Ring of Fire in the Pacific Ocean.

Ways we turn geothermal energy into energy we can use:
We can drill wells to reach high temperature resources, or lay pipes filled with fluid underground. Some geothermal resources come out of the ground naturally, and we can pipe it to where it's needed.

Who uses geothermal energy and for what purposes:
Power plants use geothermal steam to produce electricity. Homes and businesses use the hot water and steam for thermal energy.

Effect of using geothermal energy on the environment:
There is very little environmental effect.

Important facts about geothermal energy:
Earth is made of layers—an inner core of iron, an outer core of magma (melted rock), a mantle of magma and rock, and a crust. The crust is not a solid piece, but giant plates of land that move. Along the edges of the plates, geothermal resources tend to come to the surface.

Hydropower

Description of hydropower:
Hydropower is the force of moving water caused by gravity.

Renewable or nonrenewable:
Renewable

Description of the water cycle:
The sun shines onto the Earth, evaporating the water in oceans, rivers, and lakes. The water vapor rises into the atmosphere and forms clouds. The water vapor condenses and falls to Earth as precipitation.

Ways we turn hydropower into energy we can use:
We can harness the energy in flowing water by damming rivers and using waterfalls.

Who uses hydropower and for what purposes:
Electric utilities use hydropower dams to turn the energy in flowing water into electricity.

Effect of using hydropower on the environment:
Dams can flood land and disrupt animal and fish habitats. Hydropower doesn't pollute the air, but it can churn up sediments in the water.

Important facts about hydropower:
Hydropower dams are the cheapest and cleanest way to produce electricity.

There are few places in the U.S. where new dams can be built.

Some existing dams could have turbines installed to produce electricity.

Natural Gas

Description of natural gas:
Natural gas is a colorless, odorless gas formed hundreds of millions of years ago from tiny plants and animals. It is a fossil fuel.

Renewable or nonrenewable:
Nonrenewable, although methane produced from landfill gas is classified as renewable.

Where natural gas is located and how we recover it:
Natural gas is located in underground rock formations in sedimentary basins. We drill wells to reach it and pipe it from the ground.

Ways we turn natural gas into energy we can use:
Usually we burn natural gas to produce heat.

Who uses natural gas and for what purposes:
Industry burns natural gas to manufacture products. Homes and businesses burn natural gas to heat buildings and water, and for cooking. Power plants burn natural gas to produce electricity.

Effect of using natural gas on the environment:
Natural gas is a cleaner burning fossil fuel, but it produces some air pollution and carbon dioxide, a greenhouse gas.

Important facts about natural gas:
Mercaptan, an odorant that smells like rotten eggs, is added to natural gas so leaks can be detected.

Natural gas is shipped hundreds of thousands of miles in underground pipelines.

Natural gas can be used as a transportation fuel if it is put under pressure and engines are modified.

Petroleum

Description of petroleum:
Petroleum is a liquid hydrocarbon, a fossil fuel formed hundreds of millions of years ago from the remains of tiny sea plants and animals. It can be thin and clear like water or thick and black like tar.

Renewable or nonrenewable:
Nonrenewable

Where petroleum is located and how we recover it:
Petroleum is located underground in rocks in sedimentary basins. Much is under water. We drill wells to find it, then must pump it from the ground.

Ways we turn petroleum into energy we can use:
Petroleum is refined into many different fuels that are burned to produce heat.

Who uses petroleum and for what purposes:

Most petroleum products are used by the transportation sector to move people and goods. Industry burns petroleum to manufacture products and also uses petroleum as a feedstock to produce many products.

Effect of using petroleum on the environment:
Burning petroleum can cause air pollution and produce carbon dioxide, a greenhouse gas. Drilling for and transporting petroleum can cause damage to the land and water if there are leaks or spills.

Important facts about petroleum:
We use more petroleum than any other energy source.

The U.S. does not produce enough petroleum to meet our needs.

We import about 45 percent of the petroleum we use from foreign countries.

The Middle East has huge reserves of petroleum.

Petroleum is moved over land mostly by pipeline, and over water by tanker.

Propane

Description of propane:
Propane is a colorless, odorless fossil fuel found with petroleum and natural gas. It was formed hundreds of millions of years ago from the remains of tiny plants and animals.

Renewable or nonrenewable:
Nonrenewable

Where propane is located and how we recover it:
Propane is found with petroleum and natural gas deposits and is separated from both fuels during refining and processing.

Ways we turn propane into energy we can use:
We put propane in tanks under pressure to turn it into a liquid so that it is more easily moved from place to place, then we burn it to produce thermal energy.

Who uses propane and for what purposes:
Industry uses propane to make products; farmers use propane for heat in rural areas; homes use propane for outdoor grills; businesses use propane to fuel indoor machinery and as a fleet fuel.

Effect of using propane on the environment:
Propane is a cleaner burning fossil fuel, but burning it does produce some air pollutants and carbon dioxide, a greenhouse gas.

Important facts about propane:
Propane is an LPG—liquefied petroleum gas.

Propane is easily turned into a liquid under pressure. It takes up 270 times less space as a liquid.

Propane is stored in underground caverns and moved by pipelines and trucks.

Propane is called a portable fuel because it is easily transported as a liquid.

Solar

Description of solar energy:
Solar energy is radiant energy from the sun that travels to Earth in electromagnetic waves or rays.

Renewable or nonrenewable:
Renewable

How solar energy is produced and how we recover it:
Solar energy is produced in the sun's core when atoms of hydrogen combine under pressure to produce helium, in a process called fusion. During fusion, radiant energy is emitted.

Ways we turn solar energy into energy we can use:
We can capture solar energy with solar collectors that turn the radiant energy into thermal energy, or with photovoltaic cells that turn radiant energy into electricity. We also use the visible light of solar energy to see.

Who uses solar energy and for what purposes:
We all use the visible light from the sun to see during the day. Many homes and buildings use solar collectors to heat interior spaces and water, and PV cells to produce electricity.

Effect of using solar energy on the environment:
Solar energy is very clean energy, producing no air or water pollution.

Important facts about solar:
Solar energy is not available all of the time and is spread out so that it is difficult to harness. Today, it is expensive to use solar energy to produce electricity, but new technologies will make solar energy a major energy source in the future.

Uranium (Nuclear)

Description of uranium:
Uranium is a common metallic element found in rocks all over the world.

Renewable or nonrenewable:
Nonrenewable

Where uranium is located and how we recover it:
Uranium is located underground in rock formations. Mines are dug to recover it.

Ways we turn uranium into energy we can use:
Uranium is processed and turned into uranium fuel pellets for nuclear power plants. Uranium atoms are split in the process of fission to produce thermal energy.

Who uses uranium (nuclear energy) and for what purposes:
Nuclear power plants use uranium to produce electricity.

Effect of using uranium (nuclear energy) on the environment:
Uranium fission produces radioactive waste that is dangerous for thousands of years and must be stored carefully. Leaks of radioactive materials pose a danger.

Important facts about uranium (nuclear energy):
Nuclear power plants produce little pollution except for radioactive waste, which must be stored in special repositories. There is no permanent repository in the United States at this time and most waste is stored on site at nuclear power plants. A permanent repository is mandated by Congress, but a final location has not been chosen.

Wind

Description of wind energy:
Wind is the circulation of air caused by the uneven heating of Earth's surface.

Renewable or nonrenewable:
Renewable

Where wind energy is located and how we recover it:
Wind is produced when the sun shines on the Earth, heating the land more quickly than the water. The warmer air over land rises and cooler air moves in to take its place, producing convection currents.

Ways we turn wind into energy we can use:
We use wind turbines that have blades which turn in the wind that turn a turbine to produce electricity.

Who uses wind and for what purposes:
Usually, independent power producers (not big utilities) build wind farms to produce electricity.

Effect of using wind on the environment:
Wind turbines are very clean, producing no air or water pollution. They take up a lot of land, but most of the land can be used for other things, such as farming and grazing cattle, at the same time.

Important facts about wind:
Wind turbines do not produce a lot of electricity, and do not produce it all of the time.

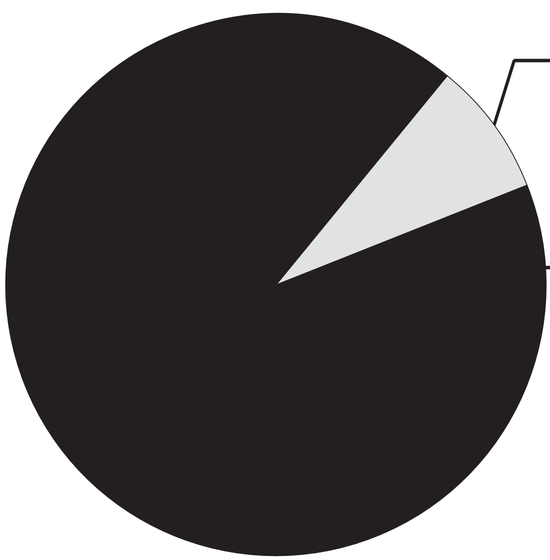
Wind turbines cannot be used in many areas. There must be stable, continuous wind resources.

There are large wind resources on the ocean. The first offshore wind farm in the United States was approved in 2011 and will be built off the coast of Cape Cod, Massachusetts.

Renewables and Nonrenewables

Convert the quads into percentages and make a pie chart showing how much U.S. energy in 2011 came from renewable sources and how much came from nonrenewable sources (Q = quad or quadrillion Btu). Round to the nearest hundredth.

Petroleum	**33.689 Q = 34.67 %**
Natural Gas	**24.843 Q = 25.57 %**
Coal	**19.643 Q = 20.22 %**
Uranium	**8.259 Q = 8.50 %**
Biomass	**4.411 Q = 4.54 %**
Hydropower	**3.171 Q = 3.26 %**
Propane	**1.594 Q = 1.64 %**
Geothermal, Solar, and Wind	**1.552 Q = 1.60 %**
Total Quads	**97.162 Q = 100%**



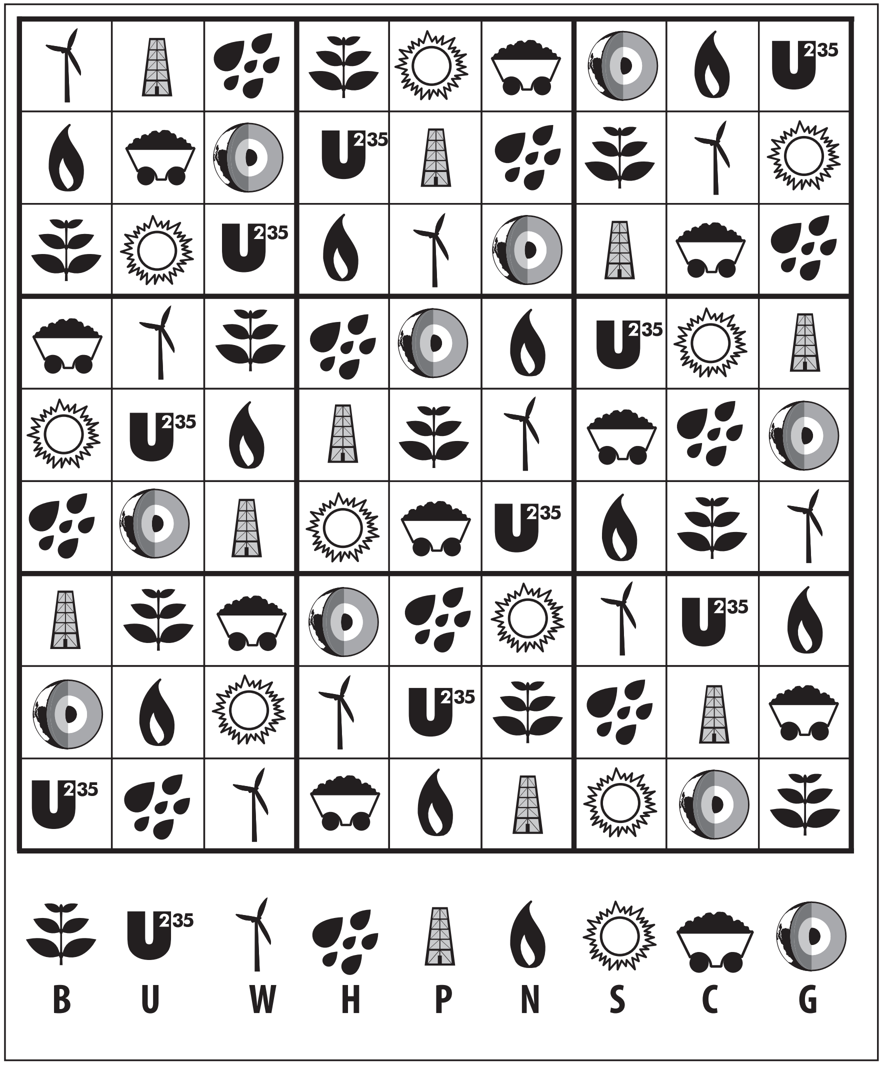
How We Use Our Energy Sources

In the boxes, describe the main uses of each energy source. Put a * beside the most important use. Some sources may be used in only one or two ways.

	TRANSPORTATION	MAKE PRODUCTS	HEATING/COOLING	LIGHTING	MAKE ELECTRICITY
	turned into ethanol and mixed with gasoline	***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*
		burned to make thermal energy to manufacture products	*burned to heat homes*		***burned to make thermal energy to produce electricity***
			used in geothermal exchange systems to heat and cool homes		***thermal energy used to produce electricity***
					mechanical energy used to produce electricity
	used in specially modified vehicles	*burned to make heat to manufacture products and as a feedstock*	***burned to heat homes and commercial buildings***	*burned in some lanterns and street lights*	*burned to make thermal energy to produce electricity*
	refined into gasoline, jet fuel, diesel fuel	*burned to make thermal energy to manufacture products*	*refined into heating oil and burned to heat homes*	*refined into kerosene and burned in lanterns*	*burned to make thermal energy to produce electricity*
	pressurized for fleet and indoor vehicles	***burned to make thermal energy 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 electricty with PV cells***
					fissioned to make thermal energy to produce electricity
					mechanical energy turned into electricty

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, use either the icons or 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

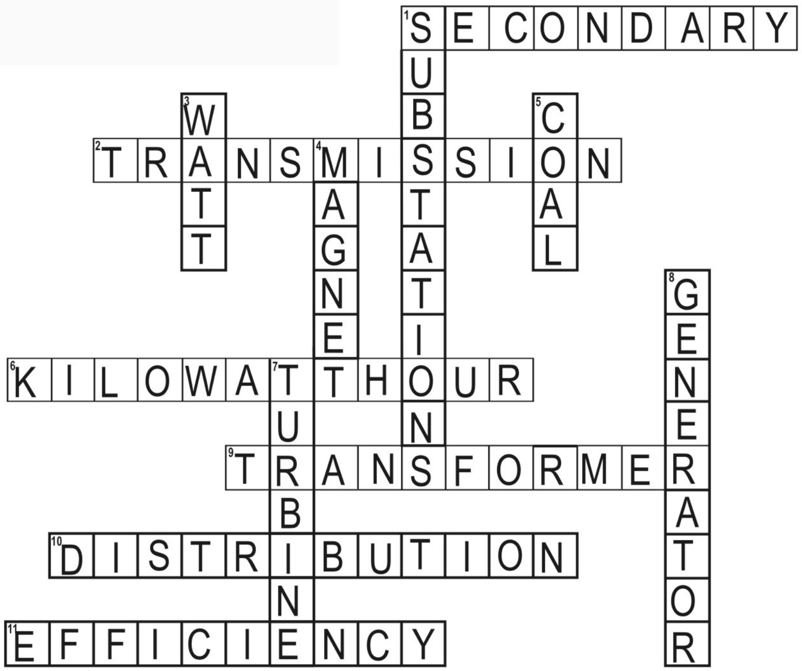
Write the correct word for each definition in the blank space. Use each word only once.

1. A device that changes voltage. ***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. How well a utility delivers electricity at all times. ***reliability***
8. Electricity produced at all times to meet basic demand. ***base load***
9. A merged network of electric utilities. ***power pool***
10. Reducing energy usage through behavioral changes. ***conservation***
11. A measurement of the amount of electricity used by consumers. ***kilowatt-hour***
12. Power plants that burn fuel to produce electricity. ***thermal***
13. A material with little resistance to electric current. ***superconductor***
14. A device measuring electricity consumption that allows for two-way wireless communication between the utility and consumer. ***smart meter***
15. A source of energy that requires another source to produce it. ***secondary***
16. Manufacturing a product and producing electricity. ***cogeneration***
17. Reducing the amount of energy consumed by devices through advances in technology. ***efficiency***

Word Bank

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

Electricity Crossword



Famous Names in Electricity Answer Key

1. Faraday
2. Westinghouse
3. Franklin
4. Volta
5. Edison
6. Niagara Falls

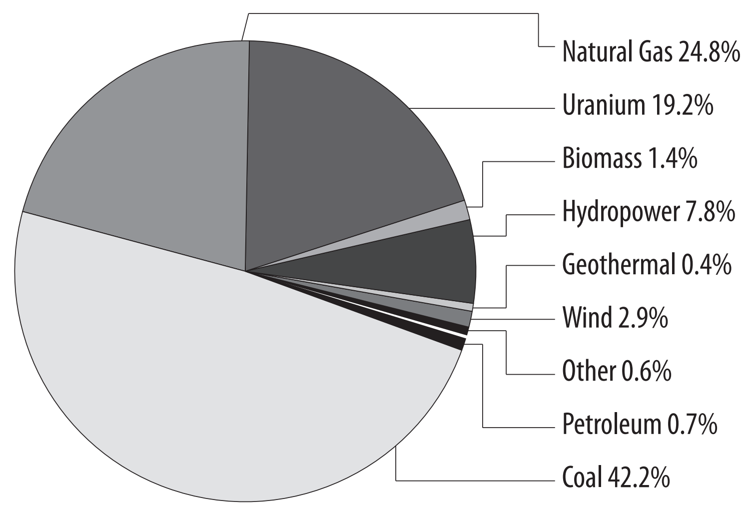
Electric Math Answer Key

Left Column:	120, 12, 35, 1879, 1000, 1882
Right Column:	10, 350, 2229, 2.229, 4194.978

Electric Power Generation

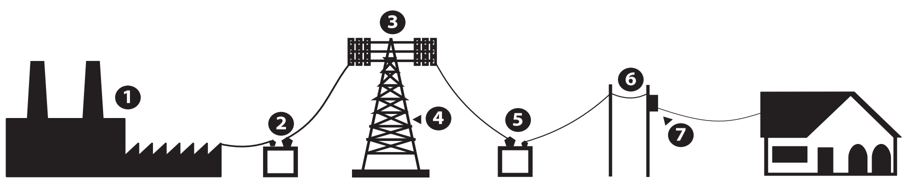
Convert the bkWh into percentages and make a pie chart showing how much of the electricity the U.S. consumed in 2011 came from each energy source (bkWh = billion kilowatt-hours). Round to the nearest tenth.

Petroleum	**28.20 bkWh**	**= 0.7 %**
Coal	**1,734.30 bkWh=**	**= 42.2%**
Natural Gas	**1,016.60 bkWh**	**= 24.8 %**
Uranium	**790.20 bkWh**	**= 19.2 %**
Biomass	**56.70 bkWh**	**= 1.4 %**
Hydropower	**319.20 bkWh**	**= 7.8%**
Geothermal	**16.70 bkWh**	**= 0.4 %**
Wind	**119.70 bkWh**	**= 2.9 %**
Other	**24.20 bkWh**	**= 0.6 %**
Total bkWh	**4,105.8 bkWh**	**= 100 %**



Transporting Electricity

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 electricty 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 electricty to homes and businesses*
7. **Neighborhood transformer:** *lowers voltage to an amount used by appliances in homes and businesses (120 & 240 volts)*

Measuring Electricity

Directions: Fill in the blanks in the tables below.

TABLE 1

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	12 Ω

TABLE 2

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

TABLE 3

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**

TABLE 4

POWER		TIME	=	ELECTRICAL ENERGY (kWh)	X	PRICE	=	COST
5 kW	x	100 h	=	**500 kWh**	x	$ 0.12	=	**$ 60.00**
25 kW	x	4 h	=	**100 kWh**	x	$ 0.12	=	**$ 12.00**
1,000 W	x	1 h	=	**1000 Wh = 1kWh**	x	$ 0.12	=	**$ 0.12**

2014 Youth Awards for Energy Achievement

All NEED schools have outstanding classroom-based programs in which students learn about energy. Does your school have student leaders who extend these activities into their communities? To recognize outstanding achievement and reward student leadership, The NEED Project conducts the National Youth Awards Program for Energy Achievement.

This program combines academic competition with recognition to acknowledge everyone involved in NEED during the year—and to recognize those who achieve excellence in energy education in their schools and communities.

What's involved?

Students and teachers set goals and objectives, and keep a record of their activities. In April, students combine their materials into scrapbooks and send them in and write summaries of their projects for inclusion in the Annual Report.

Want more info? Check out **www.NEED.org/Youth-Awards** for more application and program information, previous winners, and photos of past events.

Secondary Energy Infobook Activities Evaluation Form

State: ____________ Grade Level: ____________ Number of Students: ___________

1. Did you conduct all of the activities in the guide?	❑ Yes	❑ No
2. Were the instructions clear and easy to follow?	❑ Yes	❑ No
3. Did the activities meet your academic objectives?	❑ Yes	❑ No
4. Were the activities age appropriate?	❑ Yes	❑ No
5. Were the allotted times sufficient to conduct the activities?	❑ Yes	❑ No
6. Were the activities easy to use?	❑ Yes	❑ No
7. Was the preparation required acceptable for the activities?	❑ 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 this guide again?	❑ Yes	❑ No

Please explain any 'no' statement below.

How would you rate the guide overall?	❑ excellent	❑ good	❑ fair	❑ poor
How would your students rate the guide overall?	❑ excellent	❑ good	❑ fair	❑ poor

What would make the guide more useful to you?

Other Comments:

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

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