2017-2018

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:

Sec Secondary

Subject Areas:

Science

Social Studies

Language Arts

NEED

National Energy Education Development Project

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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.

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Teacher Advisory Board

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

Energy Data Used in NEED Materials

NEED believes in providing teachers and students with the most recently reported, available, and accurate energy data. Most statistics and data contained within this guide are derived from the U.S. Energy Information Administration. Data is compiled and updated annually where available. Where annual updates are not available, the most current, complete data year available at the time of updates is accessed and printed in NEED materials. To further research energy data, visit the EIA website at www.eia.gov.

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 shop.need.org:

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

Also, check out our digital and interactive infobook activities at www.NEED.org/energyinfobooks.

Secondary Energy Infobook Activities

Table of Contents

Standards Correlation Information

www.NEED.org/curriculumcorrelations

Next Generation Science Standards

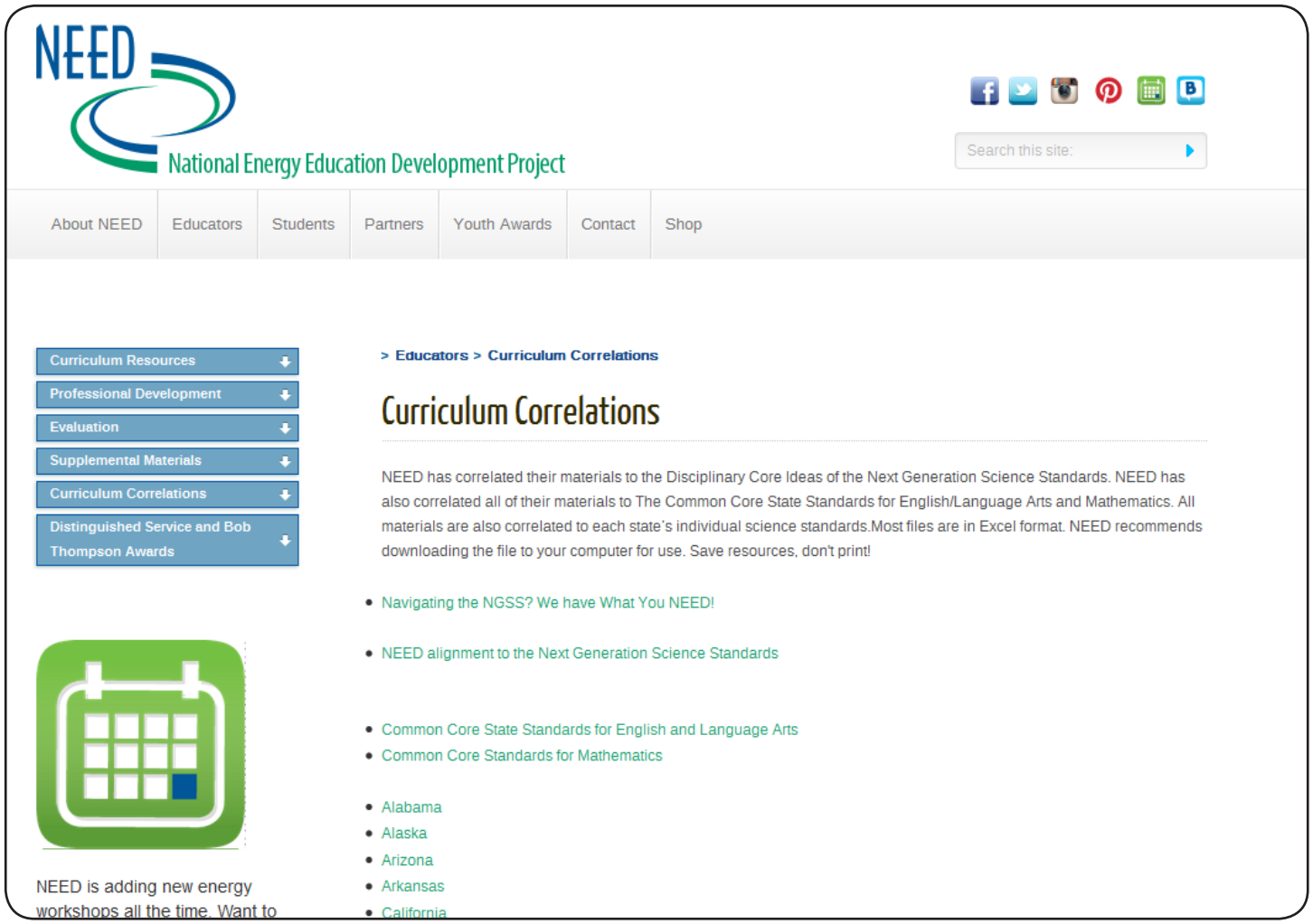
- This guide effectively supports many Next Generation Science Standards. This material can satisfy performance expectations, science and engineering practices, disciplinary core ideas, and cross cutting concepts within your required curriculum. For more details on these correlations, please visit NEED's curriculum correlations website.

Common Core State Standards

- This guide has been correlated to the Common Core State Standards in both language arts and mathematics. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED curriculum correlations website.

Individual State Science Standards

- This guide has been correlated to each state's individual science standards. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED website.



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/energyinfobooks. Digital and interactive versions of some of these activities can also be accessed at www.NEED.org/games.

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.

Procedure

1. Distribute one *Secondary Energy Infobook* or the selected fact sheets to each student. Also pass out the worksheets you want them to complete.
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
4. Answer keys for activities can be found on pages 24-33.
5. As an extension, play *Renewable Energy Bingo* as a class. Instructions can be found on pages 6-7 and the student worksheet can be found on page 23.
6. Use the *Evaluation Form* on page 34 to evaluate the activities.

Grade Level

- Secondary, grades 9-12

Time

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

Additional Resources

The *Secondary Energy Infobook* can be downloaded as an e-publication for easy use on tablets or interactive boards.

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*.

Renewable Energy BINGO Instructions

***Renewable 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

- 5 minutes

Time

- 45 minutes

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

- Biomass Bingo—*Energy Stories and More*
- Change a Light Bingo—*Energy Conservation Contract*
- Coal Bingo—Coal guides
- Energy Bingo—*Energy Games and Icebreakers*
- Energy Efficiency Bingo—*Monitoring and Mentoring* and *Learning and Conserving*
- Hydrogen Bingo—*H_2 Educate*
- Hydropower Bingo—Hydropower guides
- Nuclear Energy Bingo—Nuclear guides
- Oil and Natural Gas Bingo—Oil and Natural Gas guides
- Science of Energy Bingo—*Science of Energy* guides
- Solar Bingo—Solar guides
- Transportation Bingo—Transportation guides
- Wind Energy Bingo—Wind guides

Get Ready

Duplicate as many *Renewable Energy Bingo* sheets (found on page 23) 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.

Get Set

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

Go

PART ONE: FILLING IN THE BINGO SHEETS

Give the group the following instructions to create bingo cards:

- This bingo activity 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 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!
- 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.

PART TWO: PLAYING BINGO

Give the class the following instructions to play the game:

- 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 "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 "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 generates the most geothermal energy	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	**C** solar hydropower wind geothermal biomass	**D** 14% (13.58)
E wood, crops, manure, garbage, landfill gas, alcohol fuels, ethanol, and biodiesel	**F** Solar energy drives the water cycle	**G** Wind speed, wind blocks, 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 $0.127 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 conversion	**O** sailboat sailboard etc.	**P** A turbine captures the energy of flowing water.

Forms of Energy

Fill in the blanks with the words at the bottom of the page. Some words may be used more than once. Use the word that best completes the sentence.

1. Stored energy and the energy of position are _____ energy.

2. Compressed springs and stretched rubber bands are examples of _____ 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 _____ energy.

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
- elastic
- electrical
- energy efficiency
- gravitational potential
- kinetic
- motion
- nuclear
- potential
- radiant
- sound
- thermal

Biomass

Description of biomass:

Renewable or nonrenewable:

Description of photosynthesis:

Ways we turn biomass into energy we can use:

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:

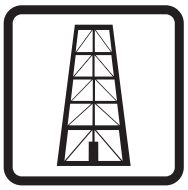
Where natural gas is located and how we recover it:

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:

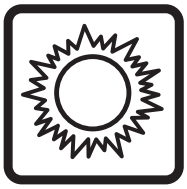
Where propane is located and how we recover it:

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:

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:

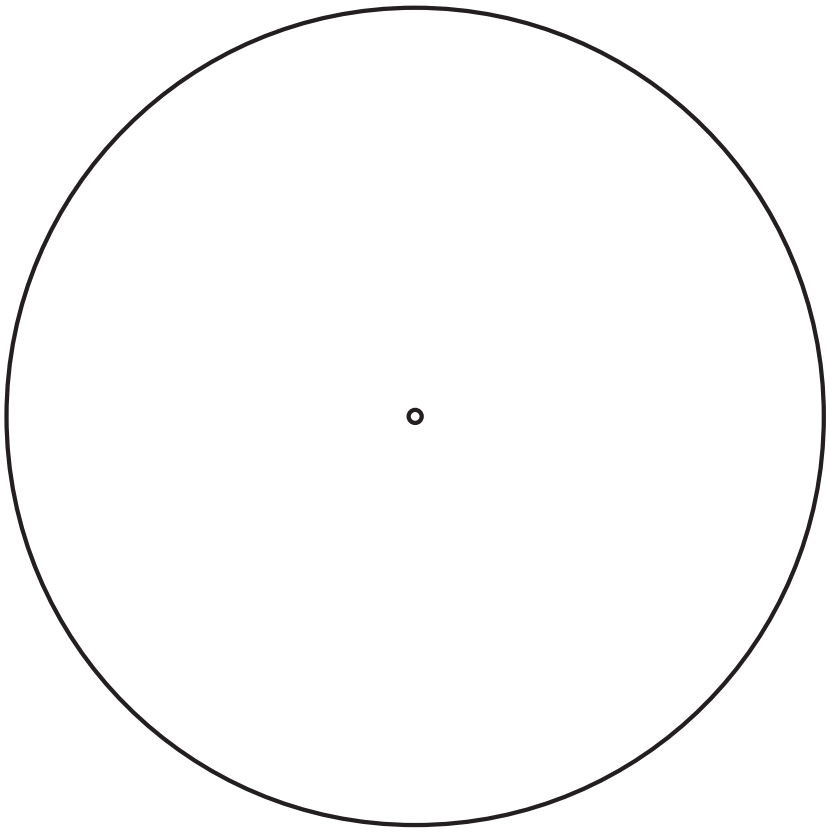
Effect of using wind on the environment:

Important facts about wind:

Renewables and Nonrenewables

Convert the quads into percentages and make a pie chart showing how much U.S. energy in 2015 came from renewable sources and how much came from nonrenewable sources. Round to the nearest hundredth.
(Q = quad or quadrillion British thermal units)

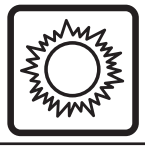
Petroleum*	**35.603 Q = _____ %**
Natural Gas*	**28.196 Q = _____ %**
Coal	**15.549 Q = _____ %**
Uranium	**8.337 Q = _____ %**
Biomass	**4.734 Q = _____ %**
Hydropower	**2.321 Q = _____ %**
Wind	**1.777 Q = _____ %**
Geothermal and Solar	**0.638 Q = _____ %**
Total Quad BTUs	**_____ = _____ %**



*** Includes Propane**

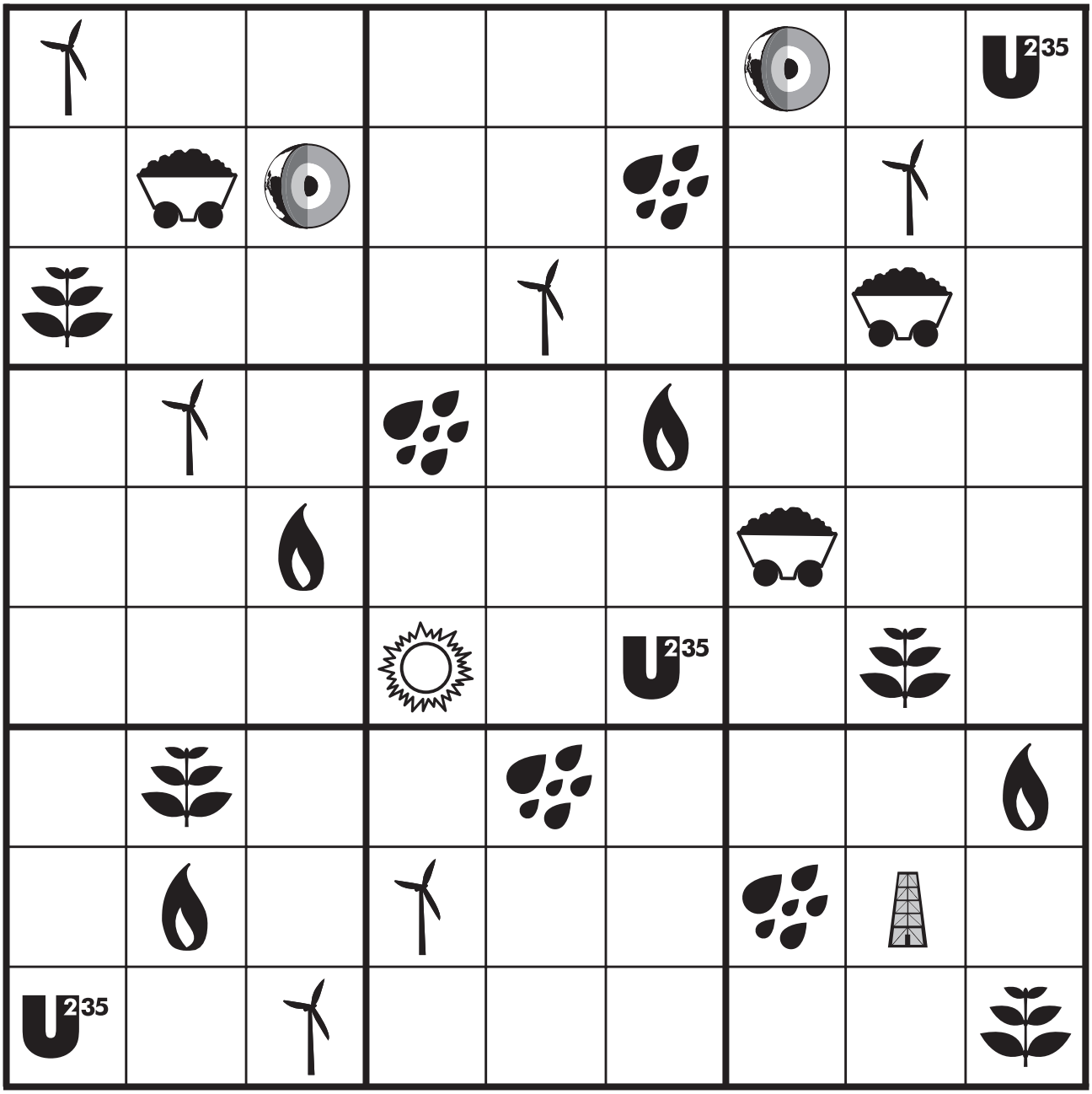
How We Use Our Energy Sources

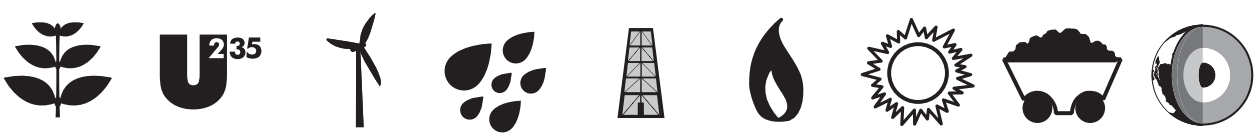
In the boxes, describe the main uses of each energy source. Put a * beside the most important use. Some sources may be used in only one or two ways.

	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.





Electricity

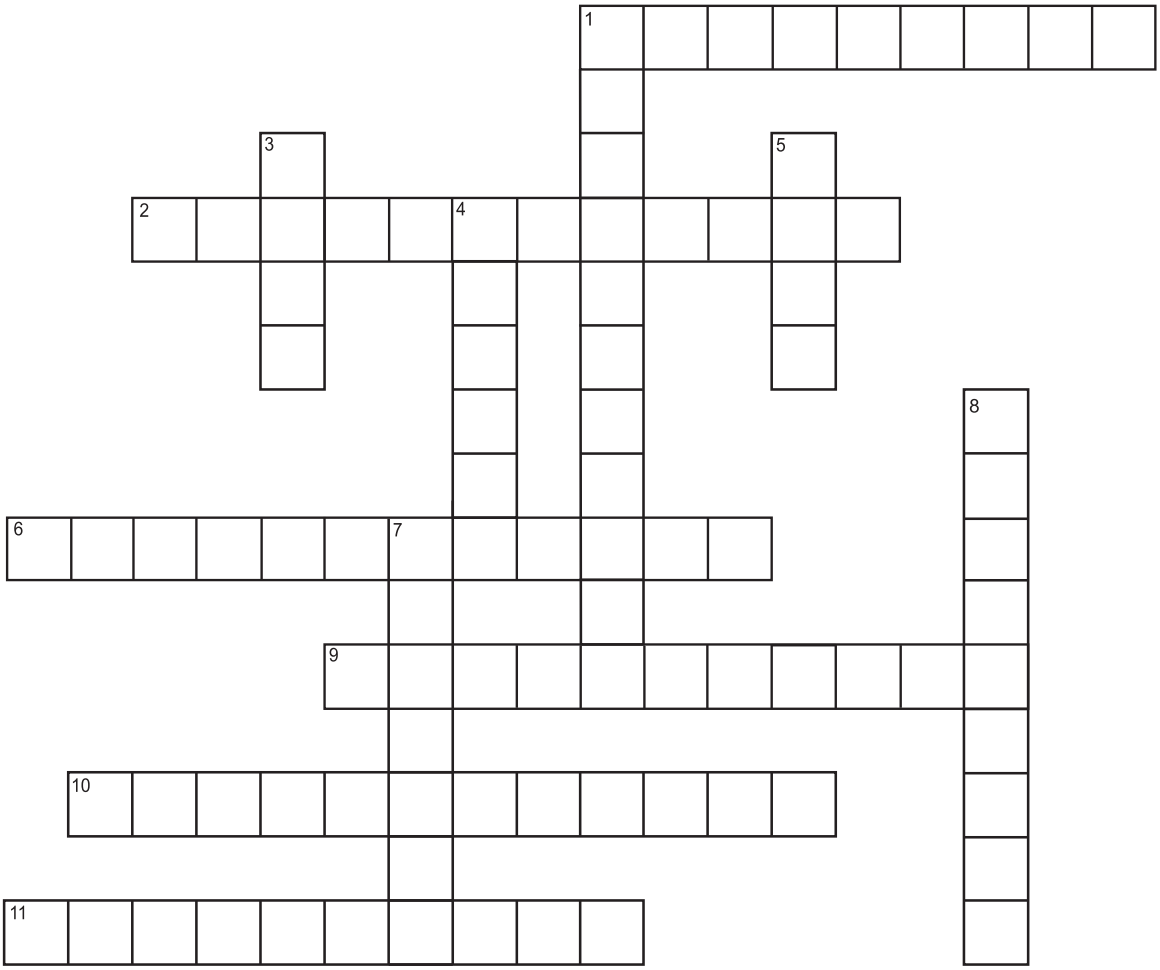
Write the word that best describes each definition in the blank space. Use each word only once.

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

- baseload
- 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.

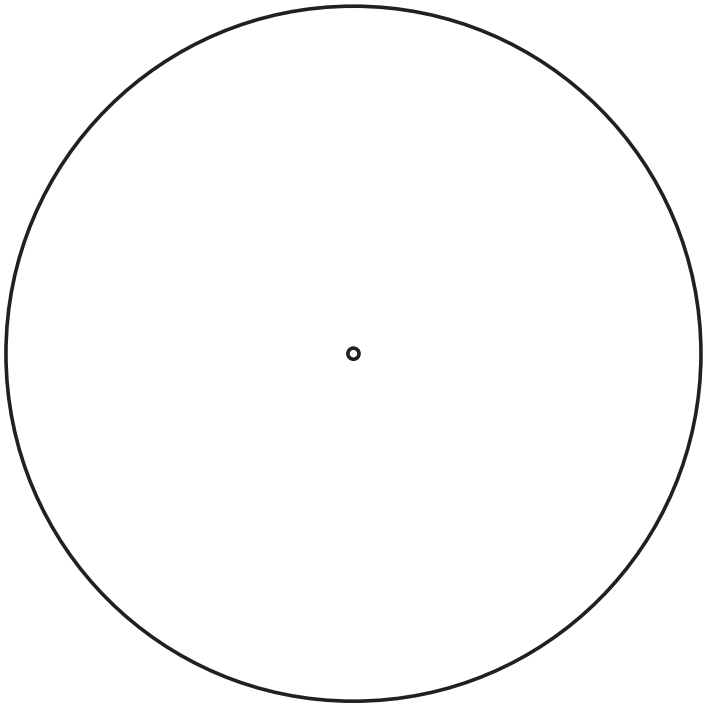
DOWN ▼

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 and 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. generated in 2015 came from each energy source. Round to the nearest hundredth. (bkWh = billion kilowatt-hours)

Petroleum	**28.443 bkWh**	**= _____ %**
Coal	**1356.057 bkWh**	**= _____ %**
Natural Gas	**1335.068 bkWh**	**= _____ %**
Uranium	**797.178 bkWh**	**= _____ %**
Biomass	**64.190 bkWh**	**= _____ %**
Hydropower	**246.074 bkWh**	**= _____ %**
Geothermal	**16.767 bkWh**	**= _____ %**
Wind	**190.927 bkWh**	**= _____ %**
Solar	**38.614 bkWh**	**= _____ %**
Other	**26.202 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.

12.7 120 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 = _____

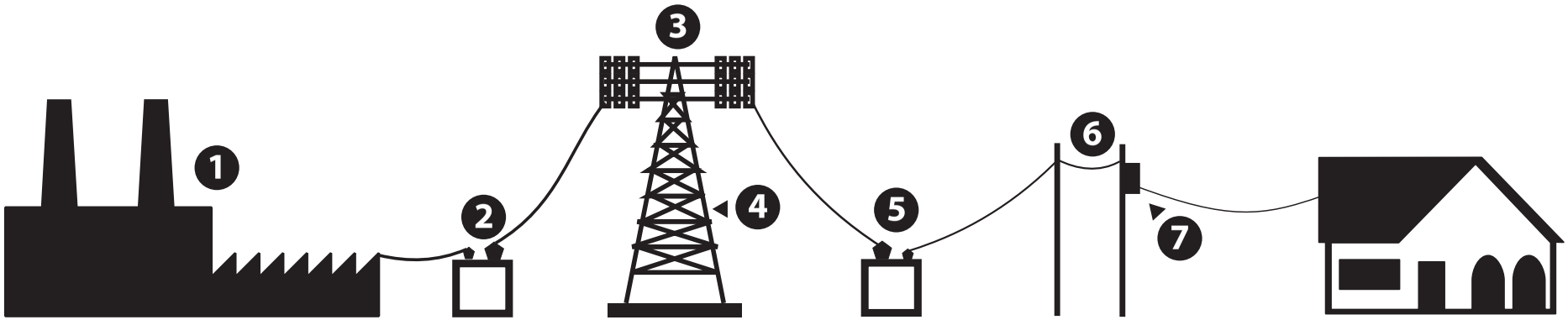
_____ 5. Divide this number by the number of watts in one kilowatt = _____

_____ 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	$ 0.127	=	$ _____
25 kW	x	4 h	=	_____	x	$ 0.127	=	$ _____
1,000 W	x	1 h	=	_____	x	$ 0.127	=	$ _____

RENEWABLE ENERGY BINGO

A. Has been to a renewable power plant

B. Knows which state generates the most geothermal energy

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 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. Use the word that best completes the sentence

1. Stored energy and the energy of position are _____**potential**_____ energy.
2. Compressed springs and stretched rubber bands are examples of _____**elastic**_____ 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 potential**_____ 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
- elastic
- electrical
- energy efficiency
- gravitational potential
- kinetic
- motion
- nuclear
- potential
- radiant
- sound
- 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 the 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 as fossil fuels. The amount of carbon dioxide produced by equipment to process biofuels 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 millions to 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 contributes emissions of CO_2 and other pollution, and can cause acid rain. Burning coal also produces carbon dioxide, a greenhouse gas.

Important facts about coal:
Coal produces about 33.08 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, Illinois, and Pennsylvania 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 sea 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:
We burn natural gas to produce heat and generate electricity.

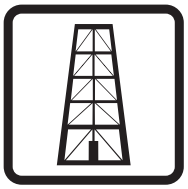
Who uses natural gas and for what purposes:
Power plants burn natural gas to produce electricity. Industry burns natural gas to manufacture products. Homes and businesses burn natural gas to heat buildings and water, and for cooking.

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 and above ground 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 causes air pollution and produces 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 48 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 sea plants and animals. It is produced from petroleum and natural gas.

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.

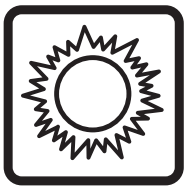
Effect of using propane on the environment:
Propane is a cleaner burning fossil fuel, but burning it does produce some air pollutants and carbon dioxide, a greenhouse gas.

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:
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. Solar power generation facilities use PV cells or mirrors to generate 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 energy:
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 on-site or in special repositories. There is no permanent repository in the United States at this time and most spent fuel 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. We can harness wind with sails, mills, turbines, and by living things.

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.

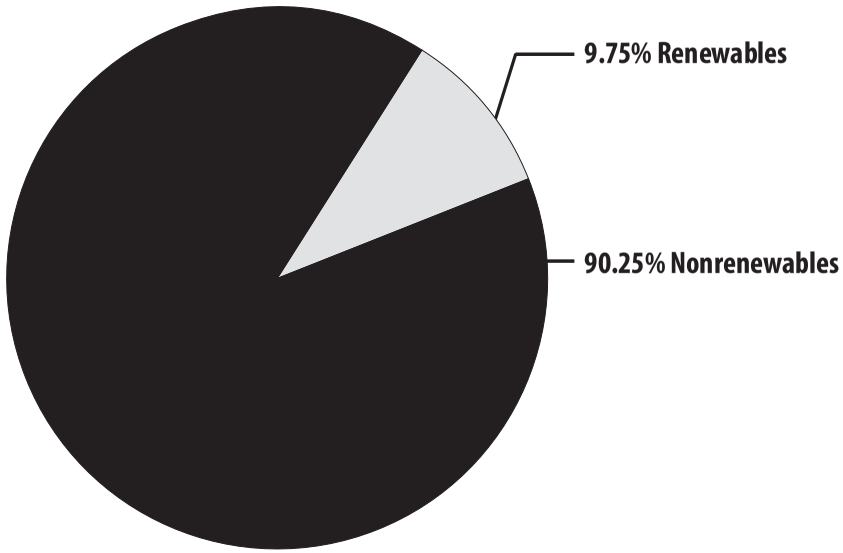
Wind turbines cannot be used in many areas. There must be stable, continuous wind resources.

There are large wind resources on the ocean. The first offshore wind farm in the United States came online in 2016 off the coast of Block Island, Rhode Island.

Renewables and Nonrenewables

Convert the quads into percentages and make a pie chart showing how much U.S. energy in 2015 came from renewable sources and how much came from nonrenewable sources. Round to the nearest hundredth. (Q = quad or quadrillion Btu)

Petroleum*	**35.603 Q = 36.65 %**
Natural Gas*	**28.196 Q = 29.02 %**
Coal	**15.549 Q = 16.00 %**
Uranium	**8.337 Q = 8.58 %**
Biomass	**4.734 Q = 4.87 %**
Hydropower	**2.321 Q = 2.39 %**
Wind	**1.777 Q = 1.83 %**
Geothermal and Solar	**0.638 Q = 0.66 %**
Total Quad BTUs	**97.155 Q = 100.00%**



***Includes Propane**

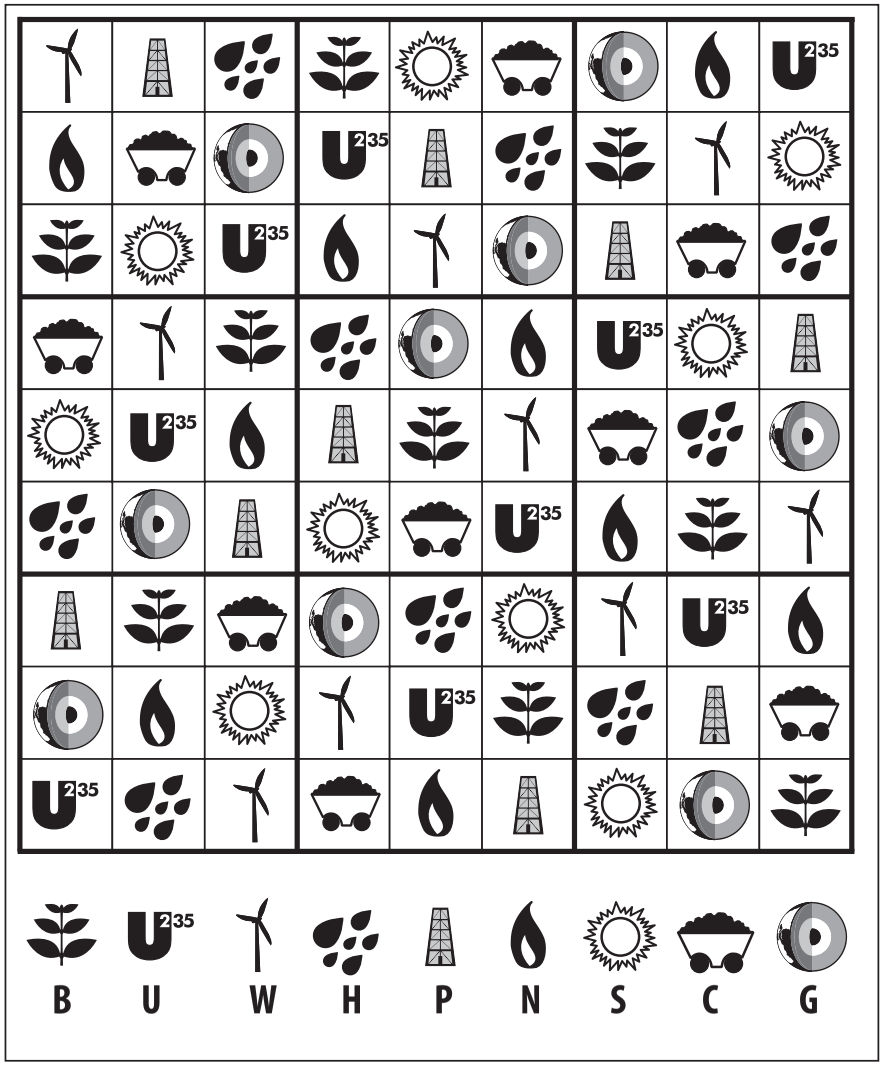
How We Use Our Energy Sources

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 thermal energy 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**
					***kinetic energy used to produce electricity**
	used in specially modified vehicles	***burned to make thermal energy 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**
					***kinetic 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

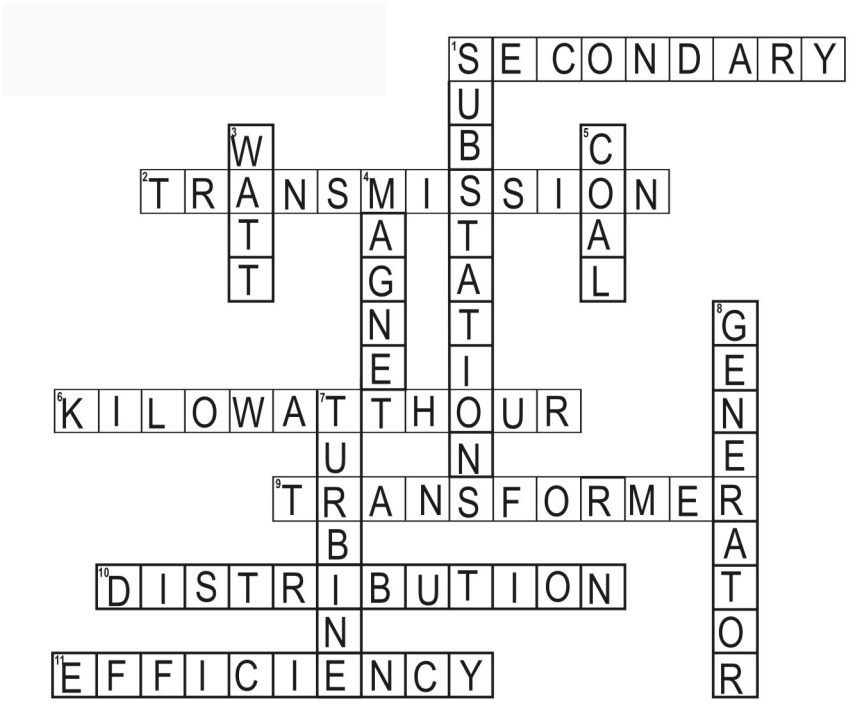
Write the word that best describes each definition in the blank space. Use each word only once.

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. **baseload**
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

- baseload
- 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, 12.7, 35, 1879, 1000, 1882

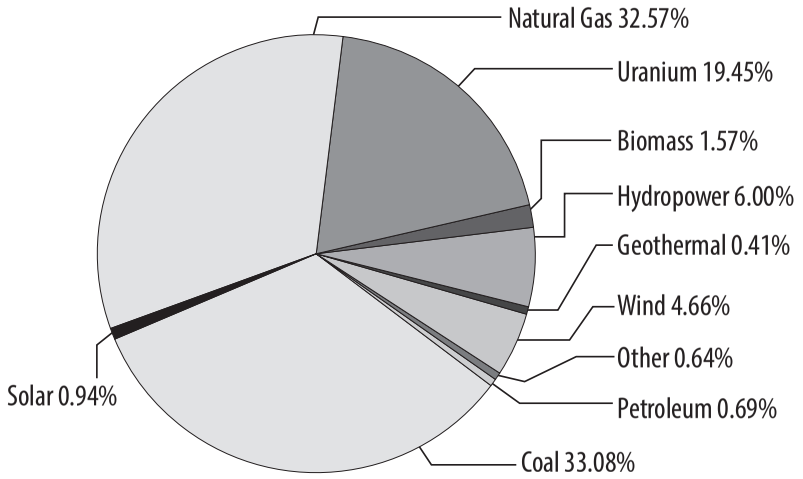
Right Column: 9.4, 329, 2218, 2.218, 4155.5

Electric Power Generation

Convert the bkWh into percentages and make a pie chart showing how much of the electricity the U.S. generated in 2015 came from each energy source. Round to the nearest hundredth. (bkWh = billion kilowatt-hours)

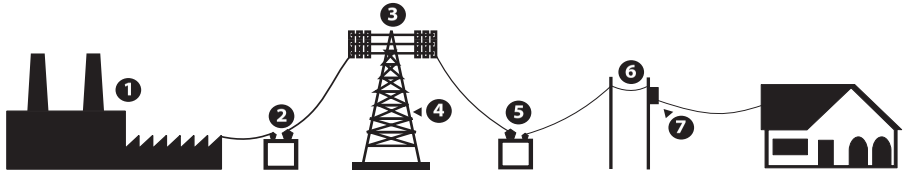
Petroleum	**28.443 bkWh**	**= 0.69%**
Coal	**1,356.057 bkWh**	**= 33.08 %**
Natural Gas	**1,335.068 bkWh**	**= 32.57 %**
Uranium	**797.178 bkWh**	**= 19.45 %**
Biomass	**64.190 bkWh**	**= 1.57%**
Hydropower	**246.074 bkWh**	**= 6.00%**
Geothermal	**16.767 bkWh**	**= 0.41 %**
Wind	**190.927 bkWh**	**= 4.66 %**
Solar	**38.614 bkWh**	**= 0.94 %**
Other	**26.202 bkWh**	**= 0.64 %**
Total bkWh	**4,099.520 bkWh**	**= 99.99* %**

***Total does not equal 100% due to rounding**



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 or holds 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	$ 0.127	=	**$ 63.50**
25 kW	x	4 h	=	**100 kWh**	x	$ 0.127	=	**$ 12.70**
1,000 W	x	1 h	=	**1,000 Wh = 1kWh**	x	$ 0.127	=	**$ 0.127**

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:

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U.S. Energy Information Administration
United States Virgin Islands Energy Office
Wayne County Sustainable Energy
Western Massachusetts Electric Company
Yates Petroleum Corporation