

Lesson 4: Sources of Electricity

OBJECTIVE

Students will compare and contrast different climate zones in Texas and discuss the ways electricity is generated in Texas.

KEY CONCEPTS

- Climate
- Electricity Generation in Texas
- Limitations of Non-Renewable Resources
- Sources of Renewable Electricity
- Sources of Non-Renewable Electricity

LESSON RESOURCES

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LIMITED ENGLISH PROFICIENT, AT GRADE, AND ADVANCED

In this lesson, there are three versions provided for the Power Puzzle activity. Each version is designed for a particular ability level. The color-coded outlet in the upper right-hand corner indicates the ability level.



**LIMITED ENGLISH
PROFICIENT LEVEL**



AT GRADE LEVEL



**ADVANCED
GRADE LEVEL**



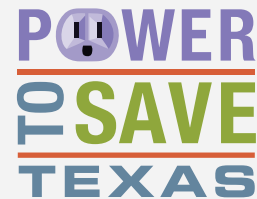
LESSON 4:

Sources of Electricity

Most days, Texas has more diverse weather than any other state in the United States. The variety of weather conditions found within the state of Texas is not only due to its size, but also to its unique position on the North American continent.

The climate in Texas is different from one area to the next. Part of the reason is because there is such a difference in the geography throughout the state. There are coastal regions, mountains, deserts, and wide open plains. Another reason the weather is so diverse from one region to another is that the state is located at a junction where several climate zones meet.

There are three main climate zones in Texas; the coastal region, which is humid and subtropical; the northern plains, where you will see the coldest and



LESSON 4 ENRICHMENT

Interactive Links

[Power to Choose](#)

This link is to an official and unbiased website of the Public Utility Commission of Texas. It shows various offers from electric providers so that customers can compare and choose a plan. This link is provided for awareness of available information only.

[University of Colorado](#)

This link “makes sparks fly” with John Travoltage. The main teaching topic is static electricity, but plenty of other resources can be found here.

[Kids & Energy](#)

This student-focused link offers brightly drawn images, which teach about the benefits of biomass energy. In addition, students can interact with information about energy basics as well as have fun and play games.



hottest temperatures in the state; and western Texas, which is mostly desert. In the center of Texas there are hills and its climate is similar to the Texas Panhandle, but not as extreme.

The warm air blowing from the warm waters of the Gulf of Mexico influences the Texas atmosphere. This moist air affects cities, like Houston, located in the flat plains along the coast. Houston is humid and, during the summer, morning humidity levels average over 90%. Houston is one of the most humid cities in the United States.²⁴

As a result of warm, moist Gulf air mixing with cool air from the Rocky Mountains and dry air from the desert, tornadoes are common in Texas. In fact, Dallas-Fort Worth lies at the lower end of “Tornado Alley.” The United States has more tornadoes than any other country in the world and, to some, Texas is known as the “Tornado Capital.”²⁵

With the variety of climates found in Texas, Texas has become rich in renewable and non-renewable energy resources. Here is a short list of interesting facts about the energy sources found in Texas:

- Texas is the leading producer of crude oil in the nation.
- More than one-quarter of all natural gas production occurs in Texas.
- Texas leads the U.S. in the ability to generate wind power.
- The world’s largest single wind power facility is in central Texas.
- Texas solar power potential is among the nation’s highest.
- Biomass energy resources are abundant in the state of Texas.
- The two nuclear power plants in Texas generate 7.9% of the state’s electricity.
- Texas produces and consumes more electricity than any other state.

In the list, the last line shows Texas as the leader in producing and consuming electricity.²⁶ In Lesson 3, you learned that industries consume about half of all of the energy used in Texas. With industries like cement production, petroleum refining, and aluminum and glass production, it is no wonder these are such major energy consumers.

In the list, the last line also states that Texas produces more electricity than any other state. As you may remember from Lesson 1, electricity can be produced

from renewable and non-renewable resources. Yet, how much is produced by each source in the state of Texas? Below, Table 1 and Table 2 answer this question.²⁷

TABLE 1

<i>Net Electricity Generation (share of total)</i>	<i>Texas</i>
Petroleum-Fired	-
Natural Gas-Fired	44.7%
Coal-Fired	36.5%
Nuclear	7.9%
Hydroelectric	0.2%
Other Renewables	10.0%

TABLE 2

<i>Generation (thousand megawatt hours)</i>	<i>Value (,000)</i>	<i>Percent of State Total</i>
Total Electricity Net Generation	411,695	100.0
Total Renewable Net Generation	28,967	7.0
Geothermal	-	-
Hydro Conventional	1,262	0.3
Solar	8	*
Wind	26,251	6.4
Wood/Wood Waste	900	0.2
MSW/Landfill Gas	449	0.1
Other Biomass	96	*

* = Absolute percentage less than 0.05.

- = Not data reported.



Green Link

Click on the green words “generate electricity” in the student lesson to watch a video showing how turbines work from the inside out. The screen displays alternative energy options and describes how generation works on its own. Upon completion of the video, click “continue” again to see “Select a Region” and choose a country of your choice. Follow the instructions on the screen. Energy icons will be engaged to power the region. Watch the meter on the lower right-hand corner to see how much power each icon generates.

As non-renewable resources will eventually run out, it is a good idea to take a second look at our list of renewable resources. As you studied the list and answered the questions, you may have wondered what exactly some of the resources were. The next few paragraphs will explain more about these types of energy.

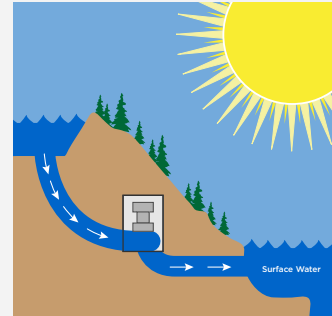
A source of energy is considered renewable when the source is easily replaced, and does not pollute the air, land, or water. About 20% of the electricity produced on the globe in 2009 came from renewable sources. Texans rely on four main sources for generating their electrical power:

1. Hydro Conventional
2. Solar
3. Wind
4. Wood/Wood Waste/
Landfill/Other Biomass

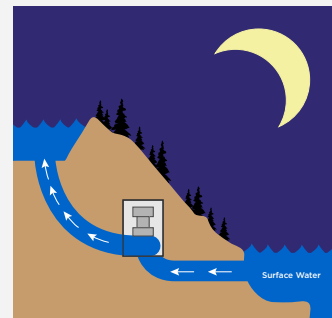
Many are familiar with hydroelectric power and may not even know it. Some believe this form of generating power must be one of the oldest methods because people have used moving water to help them in their work throughout history. A hydroelectric power plant uses a dam or reservoir to hold back water. The picture shows how dams work both day and night to generate electricity.²⁸

Solar power is another form of power that many people know about because the power comes from the sun. In fact, the word solar is from the Latin word

for sun (Sol). This form of energy is available most of the time, except at night or on cloudy days. When sunlight hits the earth, it arrives in the form of solar, or radiant, energy. Solar panels absorb radiant energy and convert it to electricity.



Water flows downhill through turbines, producing electricity.



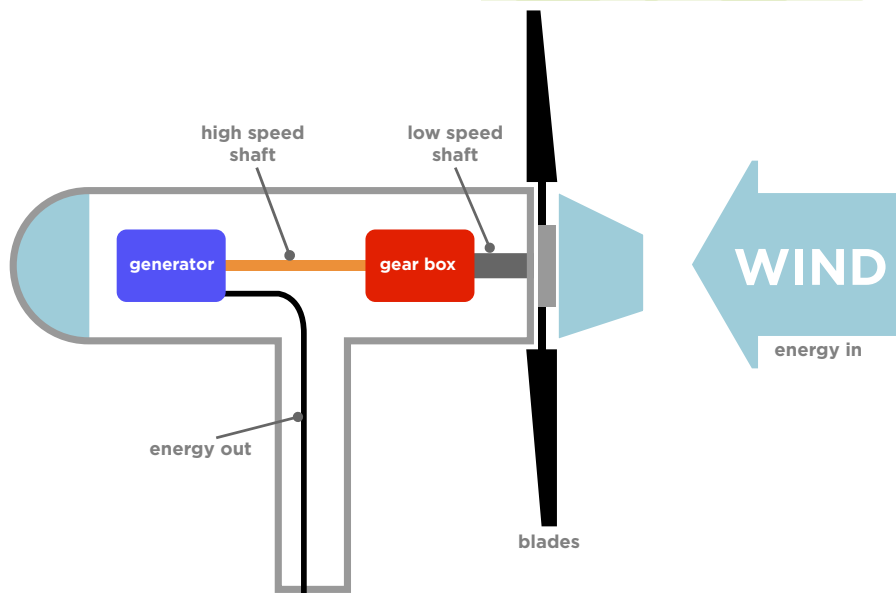
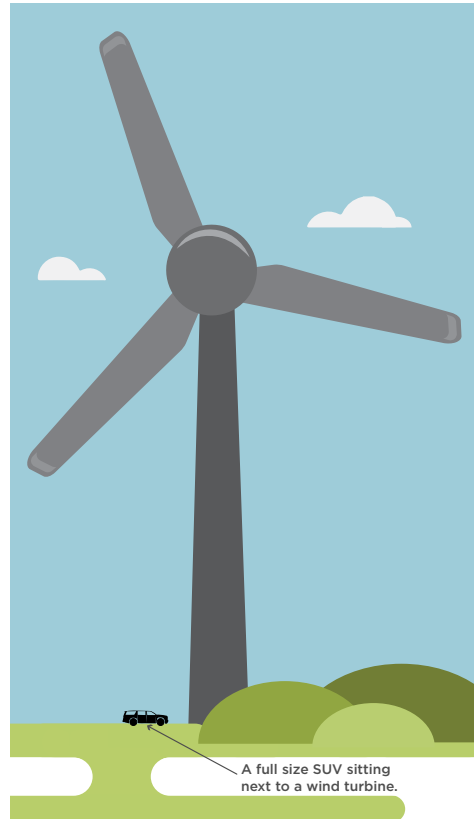
Water is pumped uphill to the reservoir for use the next day.

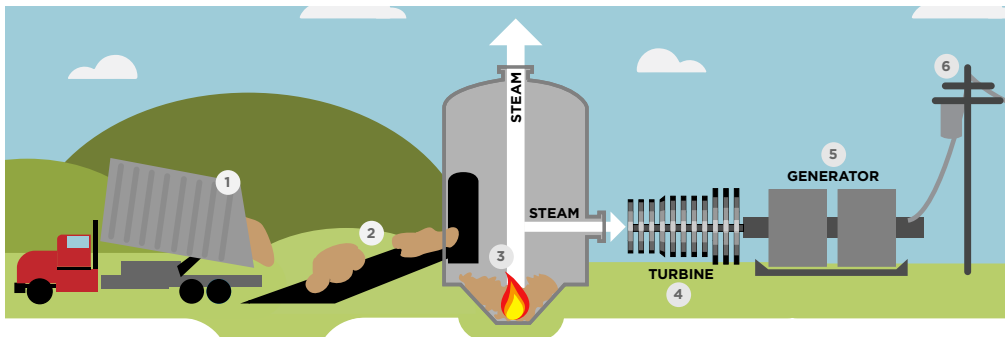
NOTES:

When thinking about renewable energy in the state of Texas, the most popular way to generate power is by taming the wind. Texas leads the nation in wind-powered generation, with seven of the 10 largest wind farms in the nation, including four of the top five.

Texas has more installed wind power capacity than all but five countries worldwide. Although wind power cannot completely replace other ways to generate electricity, it set a record in March of 2014 when it powered five million Texas homes. Almost one third of the power provided to Texans came from wind power!²⁹

So how do wind turbines work? Moving air (wind) has huge amounts of kinetic energy. All moving things have kinetic energy. The faster something moves, the more kinetic energy it has. Just like windmills, wind energy turbines have been around for over 1,000 years.³⁰





Biomass is burned to heat water, which makes steam to turn the turbines and generators to make electricity.

A wind turbine works like a giant fan, but in reverse. Fans use electricity to make wind, but wind turbines use wind to make electricity. When wind passes over the blades, the turbine rotates, spinning a generator to produce electricity. When it comes to the size of wind turbines, bigger is better! The tallest wind turbines reach over 400 feet tall. This height is about the same as a 40-story building, or the Bryan Tower in downtown Dallas.

Wind turbines need winds of about 14 miles per hour (mph) to operate. A taller wind turbine is able to reach faster winds more easily. Most large turbines produce their maximum power at wind speeds around 33 mph. At 45 mph most large turbines shut down.³¹

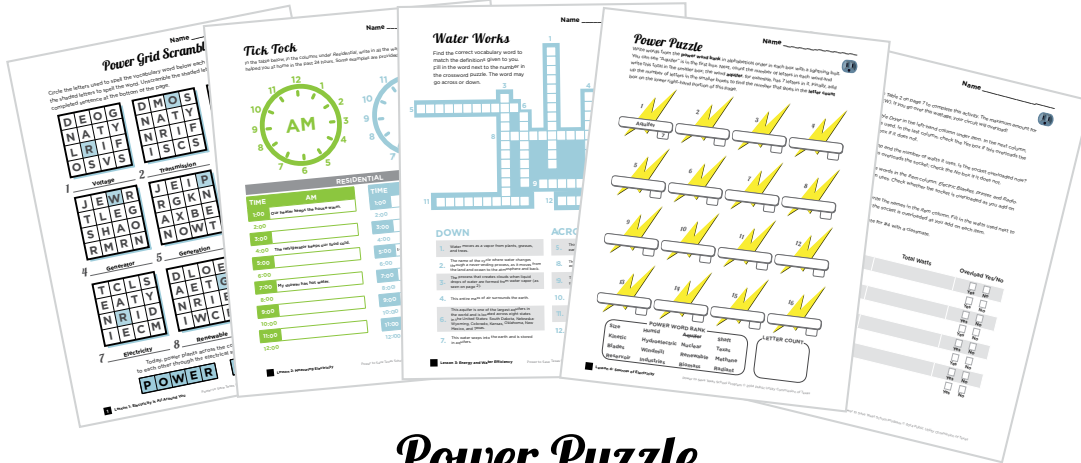
There are a number of safety systems that can turn off a wind turbine if the wind speed becomes too much and puts the structure in danger. Perhaps the most interesting system is the most simple. A metal ball is attached to a chain and sits on a tiny pedestal or pillar. If the turbine starts vibrating above a certain limit, the ball falls off the pedestal, pulls on the

chain, and begins putting on the brakes to stop the turbine blades from spinning.

The last source we will discuss for generating electrical power is biomass. You might have heard of this and thought, “How do we use trash to make electricity?” Biomass is organic material that comes from plants and animals. Some examples are wood, crops, animal manure, and human sewage.

Another form of energy from biomass is methane gas, which is produced as organic material decays. Methane captured from landfills or other organic material such as manure can be used to power a gas turbine and thus generate electricity. When methane gas is ignited, the energy (released in the form of natural gas) can be used to heat homes and buildings.

As the picture above shows, chemical energy in biomass is released as heat when it is burned. First, (1) the biomass is delivered to the plant; then, (2) it is carried to the boiler. Biomass is then (3) burned to heat water and make steam. Finally, (4) the steam turns turbines, which turn generators (5) to make electricity(6).³²





Power Puzzle

Ask your teacher for the Power Puzzle activity. You will receive one of three versions. The Power Puzzle uses vocabulary words from a word bank to identify words. Count the letters in each word and add them for a final letter count.

Long-Term Savings for Homes Tips

LIGHTING

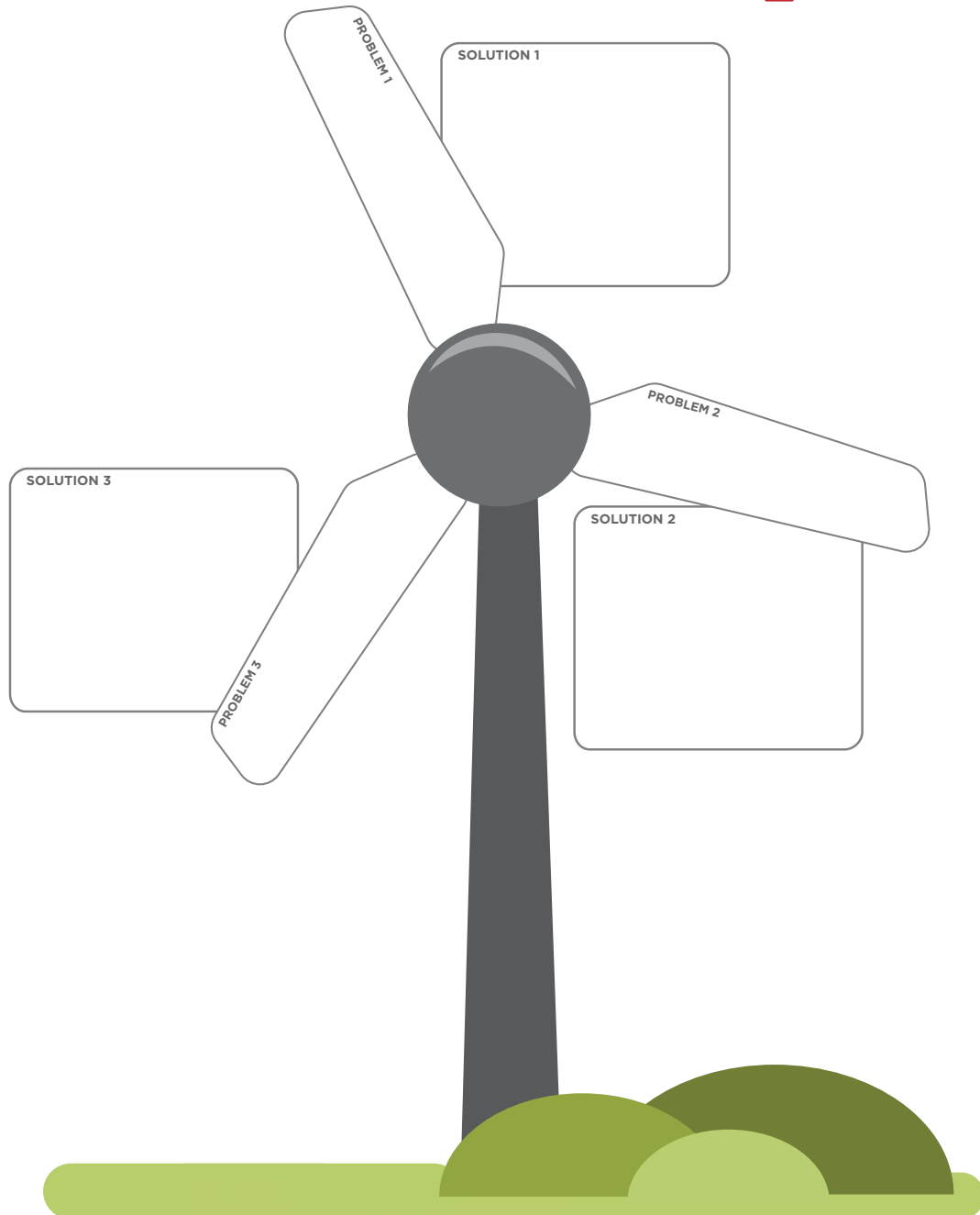
-  Check light sockets for the recommended bulb wattage for each lamp or light. Don't use a higher-wattage bulb; it wastes energy and can be a fire hazard. If you need more light, consider using a CFL bulb that produces more light with lower wattage.
-  When you can, use one higher-watt bulb instead of two lower-watt bulbs. A single higher-watt bulb is more efficient

See more at www.powertosavetexas.org.



Scan this QR Code with your smartphone to visit the program website.

Turn It for Texas



Focus on 5

Use these five questions for reflective journaling, short paragraph essays, or class discussion:

Reflective Journaling

1. List at least three positive attributes about this career that you found interesting or appealing.
2. List at least three negative attributes about this career that you thought did not apply or appeal to you.

Short Essays

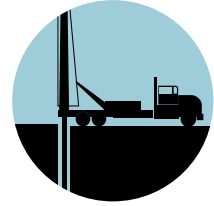
3. Why do you think the future of this job is predicted as it is shown?
4. In your city, who would be an employer you could contact to ask for more information about this career choice?

Class Discussion

5. Why do you think this job was featured as a part of this lesson?

Career Connection / Job Profile:

Are you interested in what is under the earth?
Are you good at figuring out how things work?
Do you like to do things in exactly the right order?



If you answered, "Yes," to these questions, you might like to be a construction and well driller. Construction and well drillers use heavy equipment to drill holes in the earth. They drill wells or get samples of rocks for clients.

As a construction and well driller, you would:

- Run drilling rigs to dig for water or bore holes in the earth.
- Study drilling sites and figure clients' costs.
- Design pumping systems for wells.
- Drive trucks or drilling rigs to work sites and put drills in position.
- Set up drills for the conditions at each site.
- Operate drills and change speed and pressure as needed.
- Pump water to clean holes drilled and to cool drill bits.
- Put well parts together, test them, and make sure water is clean.
- Keep machines in good working order and replace worn parts.
- Keep records of drilling progress and types of rocks found.

Will There Be Jobs in the Future?

In Texas, this occupation has high growth potential. Nationally, this occupation is growing at an average rate.

Education Required:

- To work as a construction and well driller, you typically need to:
- Have a high school diploma or GED; and
 - Have on-the-job training.

Provided courtesy of: www.onetonline.org

NOTES:

Focus on 5

Use these five questions for reflective journaling, short paragraph essays, or class discussion:

Reflective Journaling

1. List at least three positive attributes about this career that you found interesting or appealing.
2. List at least three negative attributes about this career that you thought did not apply or appeal to you.

Short Essays

3. Why do you think the future of this job is predicted as it is shown?
4. In your city, who would be an employer you could contact to ask for more information about this career choice?

Class Discussion

5. Why do you think this job was featured as a part of this lesson?

Career Connection / Job Profile:



Do you like working with other people?

Do you like to plan and organize activities?

Are you good at explaining ideas and giving directions?

If you answered, "Yes," to these questions, you might like to be a human resources manager. Human resources managers oversee how companies recruit, interview, and hire new employees. They also manage employee training, wages, and benefits and direct the human resources staff. Human resources managers often help top executives and employees work together to solve problems.

As a human resources manager, you would:

- Plan and manage how companies recruit, hire, train, and fire staff.
- Direct the work of the human resources or training staffs.
- Create budgets and be in charge of wages and benefits for staff.
- Work with managers on staff planning and help solve staff problems.
- Plan and direct staff training, create courses, and train teachers.
- Run classes for new staff and tell them about pay, benefits, and rules.
- Keep records, write reports, and talk to staff to find out why they quit.
- Study staff policies and find ways to make them better.
- Study laws and court rulings and work on contracts with unions.
- Get facts about accidents on the job and go to court if needed.

Will There Be Jobs in the Future?

In Texas and nationally, this occupation is growing at an average rate.

Education Required:

To work as a human resources manager, you typically need to:

- Have a high school diploma or GED;
- Have a bachelor's degree; and
- Have one to five years of work experience in human resources.

Provided courtesy of: www.onetonline.org

NOTES:

Stop Directions - Page 3

Objective:

Students will think critically about the information contained within Table A and Table B. This exercise may take place in the form of class discussion, journal entries, or a combination of both.

Instructions:

Ask students to read silently in order to familiarize themselves with the information contained in both Table A and Table B. Once students have completed this task, pose the following questions:

1. What is the difference between Table A and Table B?
2. Which part of Table A is explained in detail in Table B?
3. How is most of Texas's energy generated?
4. Of the renewable resources, which generates the most electricity?
5. Considering the first paragraphs you read in this lesson, why is the value for "Wind" in Table B so large?
6. What percent of the total does "Wind" make in Table B?
7. Texas has a unique, untapped geothermal resource: its large network of oil and gas wells. If geothermal energy is simply energy in the form of heat from Earth's core, why do you think this source has not been used to generate electricity in Texas?
8. In your opinion, would you classify nuclear energy as a renewable or non-renewable resource? Explain your answer.

Stop Directions - Page 7

Visit the [Teacher Portal](#) to access all three versions of the Power Puzzle and distribute to your students. Directions for this activity are listed below.

Objective:

Students will be better acquainted with the definitions of the new vocabulary words associated with electric generation in Texas. Student knowledge is enhanced by manipulating the vocabulary mathematically to correctly complete the Power Puzzle.

Instructions:

Provide students with one version of the Power Puzzle activity. Distribute the appropriate level(s) for your class.



Limited English Proficient

Write words from the “Power Word Bank” in alphabetical order in each box with a lightning bolt. You can see “Aquifer” is in the first box. Next, count the number of letters in each word and write this total in the smaller box; the word “Aquifer,” for example, has 7 letters in it. Finally, add up the number of letters in the smaller boxes to find the number that goes in the “Letter Count” box on the lower right-hand portion of this page.



At Grade Level

Your teacher will read definitions in number order for the vocabulary words you see in the “Power Word Bank” below. One word (Humid) has been provided for you. Place the appropriate word in a box in number order from 1 to 16. Next, count the number of letters in each word and write this total in the smaller box under your vocabulary word. Finally, add up all of the letter totals and fill in the “Letter Count” box on the lower right-hand portion of this page.



Advanced Grade Level

List as many vocabulary words that you have learned in Lesson 3 in the “Power Word Bank” below. Your teacher will read definitions in number order for some vocabulary words. Your Power Words may or may not be read. Place the appropriate word in a box in number order from 1 to 16. Next, count the number of letters in each word and write this total in the smaller box under your vocabulary word. Finally, add up all of the letter totals and fill in the “Letter Count” box on the lower right-hand portion of this page.

Answers

- | | | | |
|--------------|---------------|-------------|-------------------|
| 1. Reservoir | 2. Size | 3. Kinetic | 4. Texas |
| 5. Aquifer | 6. Industries | 7. Humid | 8. Nuclear |
| 9. Biomass | 10. Shaft | 11. Radiant | 12. Hydroelectric |
| 13. Blades | 14. Renewable | 15. Methane | 16. Windmill |

Stop Directions - Page 7 (continued)

At Grade and Advanced Grade Level Definitions:

1. This French word means artificial lake or pond and is usually created by a dam.
(Reservoir)
2. There are three main climate zones in Texas because of the state's unique position on the continent and its this. **(Size)**
3. Moving air has huge amounts of this kind of energy. The faster something moves, the more it has of this type of energy. **(Kinetic)**
4. This state leads the United States in the ability to generate wind power. **(Texas)**
5. In Latin, this means water-bearing formation, and it serves as a filter for water stored underground. **(Aquifer)**
6. These consume about half of all of the energy used in Texas. **(Industries)**
7. Houston has a relatively high level of water vapor in the atmosphere and is known to be this. **(Humid)**
8. Almost 8% of Texas's electricity is generated by this kind of power. **(Nuclear)**
9. This is organic material that comes from plants and animals. **(Biomass)**
10. This part of the turbine is located in the center; these may move at either a high or a low speed. **(Shaft)**
11. Solar panels absorb this kind of energy and convert it to electricity. **(Radiant)**
12. People have used moving water to help them in their work throughout history; therefore, this kind of power is believed (by some) to be the oldest. **(Hydroelectric)**
13. When these become unaligned with the wind, it puts the brakes on the turbine.
(Blades)
14. Biomass and wind are two examples of this type of resource. **(Renewable)**
15. This kind of gas is produced as organic material decays and can be used to power a turbine to generate electricity. **(Methane)**
16. Over 1,000 years ago, a wind turbine would have resembled one of these.
(Windmill)

Stop Directions - Page 8

Turn It for Texas

Objective:

Students will be prompted to think creatively about energy issues, which are critical to Texas.

Instructions:

Have students (individually or in small groups) think of three different problems associated with energy efficiency for Texans. Each problem should be written in the blades of the turbine in the Turn It for Texas activity on page 8. Students will then propose solutions for each of the three problems and write these in the “solution” boxes provided. Several turbine graphic organizers may be copied to create more scenarios.