**Lesson 2: Watts Up with Electricity Prices?**

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This lesson explains the forms of energy used to make electricity and why that might cause the price, in kilowatt hours, of electricity to differ.

**Description of the lesson**

In this lesson, students delve into the world of electricity pricing through a relatable analogy with pizza-making. Students work collaboratively to create a pizza recipe, emphasizing the importance of ingredients and processes. This serves as a foundation for understanding the complexities of electricity generation. The lesson highlights the differentiation in electricity prices by exploring primary energy sources, their conversion to a secondary source (electricity), and the factors affecting these prices. Students then research the cost of electricity in various states, graphically represent their findings, and discuss the reasons behind the price variations. By the end of the lesson, students will gain a basic understanding of the key factors influencing electricity prices, including the types of fuel used, power plant costs, transportation networks, weather and climate, and governing rules and laws.

**Economic Concepts**

The lesson focuses on the economic concept of price and some of the factors that influence the price of goods and services. Knowledge of this is applied by comparing the pricing of a good (pizza) and a utility service (electricity), highlighting how prices can vary for essentially the same goods and services based on different factors.

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| --- | --- |
| **Objectives**:Students will be able to:* Research, chart, and compare the price of electricity across three different states.
* Identify the key factors that influence the price of electricity.
* Explain how knowledge of the key factors that influence the price of electricity can help us be informed decision makers.
* Identify the kilowatt-hour (kWh) as a unit of energy commonly used to measure electricity usage and price.
 | **Materials**:* Slides
* Computer(s) with Internet access for research
* Notebook/paper and pen/pencils for notes, one per student
* Post-it notes
* Activity 2.1: Chart, one copy per student
* Activity 2.2: Assessment, one copy per student
* Activity 2.2: Assessment, Answer Key, one copy for the teacher
* Visual 2.1: Natural Resources Used to Generate Electricity plus one copy per student.
* Visual 2.2: Chart Example
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| **Suggested Time Frame**: 90 minutes (can be broken into 2 – 45-minute sessions)**Concepts**: Price, Kilowatt Hour | **National Standards in Economics or Personal Finance**:Voluntary National Content Standards in Economics* Standard 7: Markets and Prices
	+ A market exists when buyers and sellers interact. This interaction determines market prices and thereby allocates scarce goods and services.
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|  **Preparation*** Make copies for each student of Visual 2.1 and Activities 2.1 and 2.2.
* Visual 2.2, one copy for the teacher
* Activity 2.2: Assessment, Answer Key, one copy for the teacher.
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|  **Lesson: Part One - Warm-up/Bellringer**1. Display Slide 2.2. Ask the students how many of them like pizza? Call on a few students to share their favorite kind of pizza.
2. Display Slide 2.3. Now tell the students that with their elbow buddy they are to try to develop a recipe for making pizza. Remind them that recipes include a list of ingredients and procedures, or steps, needed to make the food items. They should list the ingredients at the top and then write the steps. It is okay if they don’t know all the steps, just a basic outline will work. Give them five minutes to develop their recipes.
3. Display Slide 2.4. Now, ask the students to decide on a price for their pizza. Tell them that a **price** is what people pay when they buy a good or service, and what they receive when they sell a good or service. Ask them to consider the type of ingredients they used (e.g., did anyone use a “premium” topping or fancy cheese?) when they selected their price.
4. Call on a few pairs of students to come to the front of the class to share their recipes. It is helpful if you pick a few pairs that are different (e.g., a pair that used different toppings, another that made their dough from scratch v. premade dough). Ask them to share their ingredients, steps, and price. Write the names of the students and the prices on the board. You will come back to this in step #13.
5. Display Slide 2.5. Now tell the students, lucky for us, we don’t have to make pizza every time we want it. We can call and have it delivered. Ask them to name a few pizza delivery places. **(*Answers will vary but can include Papa Johns, Dominos, Little Caesars, and local restaurants*).**
6. Display Slide 2.6. Ask them if they think the price of pizza is the same from each of those delivery places? **(*Due to advertising, they will likely realize the prices are not the same. For example, Dominos advertises $5.99 medium pizzas, while Papa John’s is $9.99*).** Write down some places and prices that seem reasonable on the board. You will refer to this in step #13.
7. Now tell them they are going to learn about another concept and then they will see how pizza production relates to this concept.

 **Group Discussion – Introducing the Concept**1. Go to the light switch in the classroom and flip the light off. Then flip the light back on. Ask the students if you just made electricity? **(*No, you just told the lights, via the switch, to use the electricity. You did not make it.)***
2. Display Slide 2.7. Explain that there are several ways to create electricity, but most of them involve using a machine called a generator, which changes other primary forms of energy – or natural resources -- such as coal, natural gas, nuclear energy, solar energy, and wind energy into electricity. Because of this conversion process, electricity is known as asecondary energy source.
3. Display **Visual 2.1:** **Natural Resources Used to Generate Electricity.** The visual provides a brief definition of each resource and how it is used to make electricity. Distribute a copy of Visual 2.1 to each student as you go through Slides 2.8-2.12. Display Slides 2.8 - 2.12. Go over each primary source of energy briefly and how each is used to create electricity.
4. Explain different states might use different methods to create electricity, depending on what resources they have. For example, Kentucky is rich in coal deposits so they will be more likely to burn coal to generate electricity. However, remember, no matter how electricity is created, it's the same electricity that powers our lights, televisions, and video games.
5. Tell the students that they learned about making pizza first because, while the process of making electricity is more complicated, both processes involve taking different ingredients or elements and combining them to create something useful. Going over these will help students better understand the process of making electricity and why prices might be different. Explain how the process of making pizza and electricity is similar:

Display Slide 2.13: Both use ingredients* For pizza, we need ingredients like dough, sauce, cheese, and toppings.
* For electricity, we need things like wires, a source of power (e.g. battery or generator), and primary source of energy (e.g. coal, wind, or sunlight).

Display Slide 2.14: We mix and combine to create something new!* When we make pizza, we mix the dough, spread the sauce, add cheese and toppings, and bake it in the oven.
* When we make electricity, we use different methods to combine elements like coal, wind, or sunlight with wires and power source to create electrical energy.

Display Slide 2.15: A transformation happens!* In both cases, there is a transformation happening. In pizza-making, the ingredients transform into a delicious pizza when it is baked.
* In electricity-making, the different elements transform into electrical energy that can power our homes, lights, and devices.

Display Slide 2.16: Enjoying the result!* Finally, just like we enjoy eating our pizza, we can enjoy using the electricity to run our gadgets, light up our rooms, and more.
1. Display Slide 2.17. Now, refer to the prices you wrote on the board. Ask the

students if all pizza is basically the same – they have a crust, sauce, and toppings? **(*Yes*.)** Then ask if the pizzas are the same, do they all sell for the same price? **(*No*.)** Tell students this occurs when we make it at home or when we order out, so it seems to be true that pizza has different prices (it is!). 1. Ask students if they can think of reasons why this might be? Ask them to turn-and-talk with their elbow buddy to brainstorm reasons why the prices would be different. Give them a few minutes to talk and call on students to give their answers. **(*Answers will vary, but students might say the following: taste, quality, size, toppings, location, promotions/discounts, delivery, ingredients, etc.)***
2. Display Slide 2.18. Tell the students, just like pizza prices vary depending on a variety of factors, electricity prices do too. Explain that the price of electricity is expressed in **kilowatt hours**. The "kilowatt-hour" (kWh) is a unit of energy commonly used to measure electricity usage. It originated from the combination of two scientific units:
* Kilowatt (kW): This is a unit of power, named after James Watt, a Scottish engineer. It tells us how fast energy is used. One kilowatt equals 1,000 watts.
* Hour (h): a unit of time.
* When you multiply the power (kW) by the time (h), you get the kilowatt-hour (kWh) which refers to the energy – in the form of electricity – used over a span of an hour. This unit is widely used in electricity billing and measurement because it provides a convenient way to measure and understand energy usage over time.
1. Display Slide 2.19. Explain that the kWh is just the unit of measurement for the price of electricity. This is like our pizza example. When we say the price of pizza, it is either as a slice or whole pie. No one buys pizza by the inch or foot because that is not a unit of measurement for pizza. The kilowatt hour is the measurement of the amount of electricity used. The rate per kilowatt hour is what the electric company charges based on factors related to the costs of production of the electricity.

 **Check for Understanding – Individual Activity**1. Display Slide 2.20. Distribute **Activity 2.1--Chart,** one copy per student. Tell students they are going to research the price of electricity in cents per kWh in their state and compare it with the price of electricity in two other states. Students will research the price of electricity for:
* Their state,
* A border state, and
* Another state of their choice, or one assigned by the teacher, but it should be far away from their home state.
1. Display Slide 2.21. Give them the following directions:

**Teacher note: The directions for the site might be different depending on the device students are using. Double check before you direct students.*** 1. Go to the website [www.eia.gov](http://www.eia.gov/)
	2. At the top of the page, there are three choices in the middle menu. Select “Geography” and then “US States”
	3. Choose the appropriate state, using the map or the list view.
	4. Under the state’s name, under “end-use consumption by source” click on the electricity icon.
	5. Find the “Average retail price by end-use sector” chart and find the line that says “(Name of state) all sectors” and record the number (cents per kilowatthour)
	6. Back on the state home page, record the electric power sector consumption by source.
	7. Repeat for each state, recording the values for the three assigned states on your chart.
	8. Record the year for the data.
1. Circulate around the classroom to check to make sure students are on the right track, finding the correct data, etc. Once all students have their three values, have them swap papers with another student to compare. They should have the same answers for their home state. Then, they will check each other’s work on the other two states (neighbor and far away).
2. Now that a classmate has verified their data, tell them they are going to create a bar chart to display their data. Display Slide 2.22. You may also walk around with a copy of **Visual 2.2 – Chart Example** if students would like a closer look. Point out the key parts of the chart that need to be filled in:
* The “date of data” in the title. This is the date of the data *not* today’s date. It is an important graphing skill to tell the reader *when* our data was collected.
* The name of their three states. In the example, the home state is DE, the neighboring state is NJ, and the far away state is WA.
* Then they will need to color in the chart to represent the amount. The vertical axis is in units of 5, so they will need to estimate if they do not have a whole number. Point out that DE is only a little above the “15” mark since the value is “15.27” while NJ is at a point higher above the “15” mark since its value is “17.64.”
* Tell them to add their data labels – this is the amount per kWh. Note, they do not need to add the cents sign “₵” because the unit is specified on the label of the vertical axis.
* The primary energy source. It is the first entry in the table on the website.

Finally, tell them you will collect their completed charts for a grade. You will be looking for accuracy of the data, clarity & neatness, and following directions.1. Circulate around the room to make sure students are on the right track.
2. Once the charts are complete, have them identify the highest and lowest priced among the three assigned states by writing “highest” and “lowest” under the applicable state name. Using Slide 2.20 again, point to the bottom where New Jersey is labeled highest and Washington is labeled the lowest.

If splitting into two – 45 minutes sessions, end here. Tell the students to put their charts away. Pick up with Step #23 on the second session. **Lesson: Part Two - Gallery Walk**1. Have the students leave their chart on the desk (or bring it back out on their desk if you split the lesson).
* Instruct the students that they will now participate in a gallery walk whereby students circulate around the classroom to look at the completed graphs of their classmates. As they do so, instruct them to check to make sure the highest and lowest states are accurately labeled. If they find an error, have them get a sticky note from you and place it on the desk where they found the error. The original student will be alerted by the sticky note to address it and other students will know the error has already been identified.
* Have them return to their seats when they have completed the gallery walk and tell any students that need to fix errors to do so.
* Tell students to make note of the highest and lowest prices as well as the primary source of energy for each state.
1. Debrief the gallery walk by asking the following:
	* What do you notice about the price of electricity? **(*It varied across states*.)**
	* Which state had the highest? The lowest? **(*Answers will vary depending on which states were used.*)**
	* What did you notice about the primary source of electricity for each state? Why do you think different states have different sources of energy? **(The geography and natural resources of each state will change the primary source of energy. For example, a state with mountains might have a lot of coal resources, while a state that is flat will use wind energy.)**
2. Collect their completed bar charts and grade them later to assess learning of objective #1. Grade them on the following components:

Accuracy of Data Representation:Did the student accurately collect and represent the electricity price data for the assigned states?Are the data values plotted correctly on the bar chart?Clarity and Organization:Is the date of the data correct?Are the three states (home state, neighboring state, far-away state) clearly identified on the chart?Are the prices for each state distinguishable and easy to read?Is the chart neatly presented and well-organized?Comparison:Does the student effectively compare the electricity prices by identifying the highest and lowest priced among the three assigned states?Each component can be assigned a point value or rating (e.g., Excellent, Good, Fair, Needs Improvement) to provide students with a clear assessment of their work. **Group Discussion – Electricity Prices**1. Display Slide 2.23. As a whole group, ask them if they can think of reasons why the price for electricity is different, even though it is the same product – electricity. Give them a few minutes to think of answers before you discuss. If they struggle, refer to your discussion about pizza and why prices might be different. You can further prompt them by going through Slides 2.24 to 2.29. For each slide ask: In which case will the price of electricity be higher?
	* Display Slide 2.24. In the Summer or Fall? **(*Summer. Prices are usually highest in the summer when lots of people want electricity to cool their homes, businesses, and schools or in the winter to heat their homes*.)**
	* Display Slide 2.25. Hot climates or moderate climates? **(*Hot climates. Just like the summer, in hot climates more people want electricity to cool their homes, businesses, and schools.*)**
	* Display Slide 2.26. States that have a lot of natural resources used to make electricity or states that have few natural resources? **(*A lot of natural resources.*)**
	* Display Slide 2.27. A state that burns coal or a state that uses hydro (water) to make electricity? **(*Fossil fuels, such as coal, cause the price of electricity to be higher because the price of the fuel is more. In fact, the prices by major source, which include the price of the fuel, plant operation & maintenance, in 2021 were as follows:***
		+ 1. ***Fossil Steam 35.66₵***
			2. ***Gas Turbine 30.18₵***
			3. ***Nuclear 22.74₵***
			4. ***Hydro-electric 12.30₵***

Source: <https://www.eia.gov/electricity/annual/html/epa_08_04.html> * Display Slide 2.28. For houses or factories? **(*Houses. In fact, in 2022, the price per kWh is 15.12₵ for households and 12.55₵ for commercial properties like factories. Businesses use more electricity, but because they are buying “in bulk” the price is cheaper.*)**

Source: <https://www.eia.gov/energyexplained/electricity/prices-and-factors-affecting-prices.php> * Display Slide 2.29. In Hawaii or Wyoming? (*Hawaii. Looking across all fifty states, in 2022, electricity was the most expensive in Hawaii [39.85₵ per kWh] and least expensive in Wyoming [8.24₵ per kWh]. In general, things tend to be more expensive on islands, like Hawaii, due to the transportation costs of getting things there.*)

Source: Table 5.6.B referenced above. **Note-Taking – Why Electricity Prices Differ**1. Display Slides 2.30 to 2.34. Tell students that there is a lot that goes into electricity pricing, but in general, there are the five key reasons prices differ according to the Energy Information Administration:
* Types of Fuel: Sometimes, the primary energy sources, or natural resources, we use to make electricity (e.g., natural gas or petroleum) can become more expensive. This can happen when lots of people need electricity, or if there are problems getting the fuel because of bad weather or accidents. When fuel costs more, making electricity becomes pricier too.
* Power Plant Costs: Every power plant where electricity is made has its own costs. It costs money to build, run, and take care of these power plants.
* Transportation Networks: There are big systems of wires and machines that carry electricity from power plants to our homes. It costs money to build, run, and fix these systems. Sometimes, bad weather or other issues can damage them, and that costs more money to fix.
* Weather & Climate: If it's very hot or very cold, we use more electricity to heat or cool our homes. This can make electricity more expensive. But when there's lots of rain or wind, making electricity can be cheaper because we use things like water and wind to help.
* Rules & Laws: Some places have strict rules about how much electricity can cost. In other places, it's more open, and companies that make electricity can set their prices. These rules can affect how much we pay for electricity.
1. Ask students why they should care about electricity prices. (*Answers will vary, but students might say the following: Knowing the factors that influence the price of electricity can help us be more informed consumers, using less electricity means paying a lower price for our electricity bill, using less of it in general (i.e. energy conservation), or advocating sources of electricity generation that are better for the environment.)*
2. Finally, Display Slide 2.35. Explain that while a few of the factors that affect the price of electricity are not in our control, some of them are.
* We might care about paying a lower price for electricity, using less of it in general, or advocating for electricity generation to use primary fuel sources that are better for the environment. Thus, it is important to know about the factors that influence price.
* As adults, you could also choose to live in areas where more renewable energy sources are used to make electricity. Right now, you can write to your government officials and ask them to explore different options for electricity generation.
* We can also do things like try to use less air conditioning (by turning the thermostat in our house up) during the months when we know the price for electricity will be higher. Thus, knowing the factors that influence the price of electricity can help us be more informed consumers – people who use electricity every day—of electricity.

 **Closure**1. Display Slide 2.35. Reinforce key concepts from the lesson by discussing the following:
	* How is the process of making pizza like the process of generating electricity? **(*Both processes involve taking different ingredients or elements and combining them to create something useful. They demonstrate how various components and steps can affect the final product or price.*)**
	* What is the name of the pricing unit of electricity? **(*Kilowatt-hour*)**
	* What is price? ***(Price is what people pay when they buy a good or service, and what they receive when they sell a good or service.)***
	* What are the five main reasons that the price of electricity differs? **(*Types of fuel used to make electricity, power plant operation and maintenance costs, transportation networks, weather & climate, and rules & laws*)**
	* Why do you think it is important for us to recognize the factors affecting electricity prices? **(*Recognizing these factors helps us make informed decisions about our energy consumption, use less energy, advocate for sustainable energy sources, and be aware how our choices – like cranking up the air conditioning during the summer – affect the cost of electricity.)***
	* Why do you think grownups always say, “turn off the lights when you leave the room!”? **(*Answers will vary but students should say things like to conserve electricity or if you use less electricity, you pay less for it.)***

 **Assessment**1. Distribute **Activity 2.2 – Assessment**, one copy for each student. Give them several minutes to complete and then review the answers using **Activity 2.2 – Assessment, Answer Key.**

 **Extension**Option 1. Electricity Bill Examination: Ask a few parents to send in a copy of their household's electricity bill (with sensitive information redacted). In small groups, students can analyze different sections of the bill, such as the total kilowatt-hours used, the rate per kilowatt-hour, and any additional charges or fees. They can compare bills to identify differences and discuss factors that might cause these variations. Examples could include household size (i.e. number of people living there), energy usage habits (i.e. keeping house cooler in the summer/warmer in winter, turning off lights/electronics when not in use), type of appliances (i.e. old v. new, Energy Star rated), and energy efficiency initiatives (e.g. LED lightbulbs, Energy Star appliances, programmable thermostat, insulated windows).Option 2. Further students understanding of energy production and consumption in the United States with this lesson from Esri GeoInquiries collection for Upper Elementary.<https://www.esri.com/content/dam/esrisites/en-us/media/pdf/geoinquiries/elementary/14-energy-elementary4-geoinquiry.pdf> Option 3. Pizza Price Comparison: Tell students: "In the lesson we just conjectured what the price of pizza delivery would be. Now let’s see how good of a job we did!" Divide the students into small groups and provide them with a list of different pizza places (e.g., Papa John's, Domino's, Little Caesars, a local pizzeria) along with their menu items and prices. Ask each group to compare the prices of a specific type of pizza (e.g., a large pepperoni pizza) across these pizza places.In their comparisons, students should consider factors such as the size of the pizza, the quality of ingredients, any promotions or discounts, and the location of the pizza place. They should discuss why the prices might vary among these options.Each group can then share their findings with the class, discussing the reasons behind the price differences, drawing parallels between this activity and the discussion on electricity prices in different states. This activity reinforces the concept of prices and helps students apply their understanding to a real-world scenario. |

**Comparison of Average Electricity Prices, \_\_\_\_\_\_\_\_**

Date of Data

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| --- | --- | --- | --- |
|  |  |  |  |
| 50 |  |  |  |
| 45 |  |  |  |
| 40 |  |  |  |
| 35 |  |  |  |
| 30 |  |  |  |
| 20 |  |  |  |
| 20 |  |  |  |
| 15 |  |  |  |
| 10 |  |  |  |
| 5 |  |  |  |
|  | My State: | Neighbor State: | Other State: |
| Highest? Lowest? |  |  |  |
| Primary source of electric power |  |  |  |

##

Source U.S. Energy Information Administration

Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Directions: Complete each part below.

Part A. Look at the list below.

If this is one of the key factors that influence the price of electricity place a “√” in the blank.

\_\_\_ Color of electrical wires \_\_\_ Type of fuel used \_\_\_ Weather and climate

\_\_\_ How old your home is \_\_\_ Noise level of power plants \_\_\_ Rules and laws

\_\_\_ Transportation networks \_\_\_ Type of pizza you like \_\_\_ Local wildlife

\_\_\_ Power plant operation and \_\_\_ Name of the power company \_\_\_ Amount of electricity used

 maintenance costs

Part B. Circle the unit of energy commonly used to measure electricity usage and price.

Volt Slice Mega Watt Watt Kilowatt Kilowatt-Hour

Part C. Your Aunt does not understand how knowing the key factors that influence the price of electricity can help us be informed decision makers. What would you say to her? Write your answer in the box below.

Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Directions: Complete each part below.

Part A. Look at the list below.

If this is one of the key factors that influence the price of electricity place a “√” in the blank.

\_\_\_ Color of electrical wires \_**√**\_ Type of fuel used \_**√**\_ Weather and climate

\_\_\_ How old your home is \_\_\_ Noise level of power plants \_**√**\_ Rules and laws

\_**√**\_ Transportation networks \_\_\_ Type of pizza you like \_\_\_ Local wildlife

\_**√**\_ Power plant operation and \_\_\_ Name of the power company \_**√**\_ Amount of electricity used

 maintenance costs

Part B. Circle the unit of energy commonly used to measure electricity usage and price.

Volt Slice Mega Watt Watt Kilowatt Kilowatt-Hour

Part C. Your Aunt does not understand how knowing the key factors that influence the price of electricity can help us be informed decision makers. What would you say to her? Write your answer in the box below.

Answers will vary but can include anything discussed in the lesson such as: recognizing these factors helps us make informed decisions about our energy consumption, advocate for sustainable energy sources, and be aware of the environmental and economic implications of our energy choices.

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**Petroleum** (Oil): a thick, black liquid found beneath the Earth's surface. It is a type of fossil fuel.

Use in Electricity Generation: Petroleum is burned to heat water, producing steam, which then drives turbines connected to generators.

**Natural Gas**: A flammable gas, mainly methane, found beneath the Earth's surface. It is a type of fossil fuel.

Use in Electricity Generation: Natural gas is burned in turbines to produce steam, which then drives generators to produce electricity.

**Renewable Energy**: Energy that comes from sources that can be naturally replenished, like the sun, wind, or water.

Use in Electricity Generation: There are various methods, such as using sunlight in solar panels or wind in wind turbines.

**Coal**: A black or brown rock, primarily composed of carbon, found beneath the Earth. It is a type of fossil fuel.

Use in Electricity Generation: Coal is burned to heat water, producing steam, which then drives turbines connected to generators.

**Nuclear Power**: Energy released from reactions in the nucleus of an atom, usually through the process of nuclear fission.

Use in Electricity Generation: In nuclear power plants, reactions heat water to produce steam, which then drives turbines.

**Comparison of Average Electricity Prices, \_\_\_\_\_\_\_\_**

July 2023

Date of Data

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| --- | --- | --- | --- |
|  |  |  |  |
| 50 |  |  |  |
| 45 |  |  |  |
| 40 |  |  |  |
| 35 |  |  |  |
| 30 |  |  |  |
| 20 |  | 17.46 |  |
| 20 | 15.27 |  |  |
| 15 |  |  | 10.87 |
| 10 |  |  |  |
| 5 |  |  |  |
|  | My State:Delaware | Neighbor State:New Jersey | Other State:Washington |
| Highest? Lowest? |  | Highest | Lowest |
| Primary source of electric power | Natural Gas | Nuclear Power | Renewable Energy |

Source U.S. Energy Information Administration