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# POWER UP

## *Post-Visit Activities*

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*Curriculum connections for Common Core, Next Generation Science Standards, and Maryland State Science Curriculum Frameworks follow each activity.*



# Power Path!

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How does electricity get to our homes? Where does it come from? This activity is a fun way for students to explore how power gets from the plant to the places we live.



## Objectives:

- Students will be able to identify that electricity is created at a power plant and reaches homes and businesses via a large system of wires and connections.



## Materials (for each group):

- Ball(s) of yarn or string
- Power Path cards

You may want to make extra copies of the transmission tower, transformer, and homes/buildings cards, so that each student can hold a card. Alternatively, students without cards could act out being transmission towers or wooden power poles.



## Procedure:

1. Pass out cards to students.
2. Give the ball of yarn to the student holding the power plant card.
3. Read the card aloud, then have the student keep hold of the end of the yarn and pass the ball on to the student holding the transmission substation card.
4. Continue adding on to the power path, while each student keeps holding on to the yarn until the power lines reach the student holding the home/building card.
5. The student with the distribution card could be a hub, holding and passing along several lines going out to transformers, wooden power poles and homes. This could also help illustrate the concept of distribution stations and the web of power lines.

Power path: power plant → transmission substation → transmission tower(s) → distribution substation → transformers (wooden power poles) → homes/buildings



## Expansion:

Have students drop connections to illustrate power outages. Discuss how broken connections along any part of the path mean that power cannot reach points beyond the break.



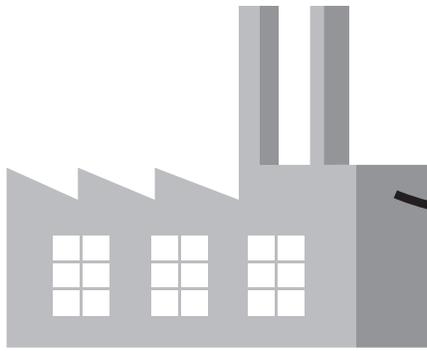
## Curriculum Connections:

Maryland State Science Curriculum Frameworks  
Electricity and Magnetism

- Grade 2: Indicator 1. Identify and describe the sources and uses of electricity in daily life.

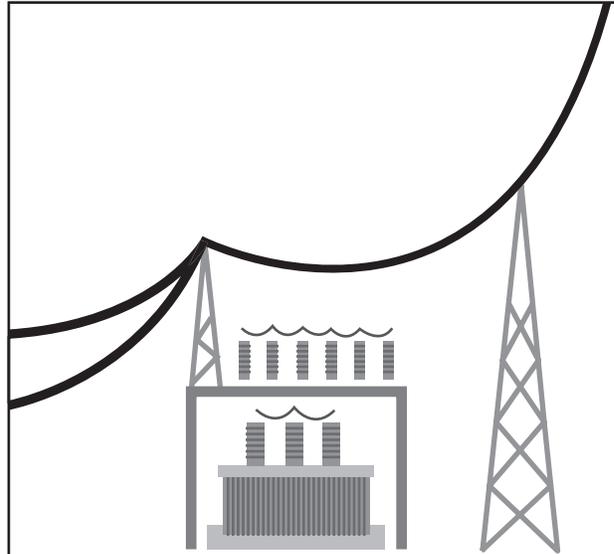
# Power Path!

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## Power Plant

At power plants, steam is used to make large machines called generators spin. The generators create electricity when they move.

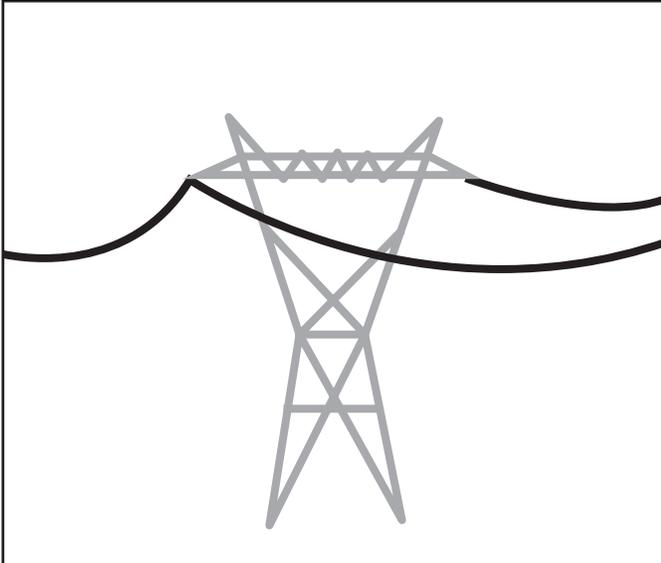


## Transmission Substation

Here the power of the electricity is increased so that it can move through hundreds of miles of power lines. This is called high voltage electricity.

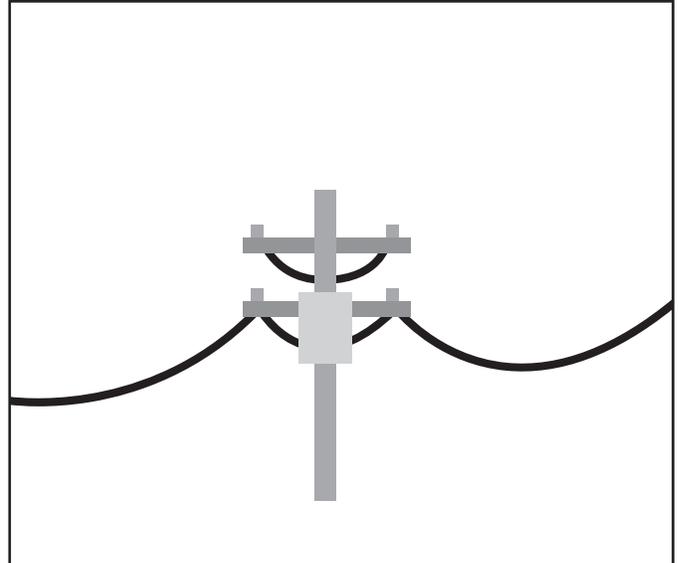
# Power Path!

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## Transmission Tower

High voltage electricity has so much power it needs to be raised up high away from the ground. These very tall towers move electricity out to the people who need it.

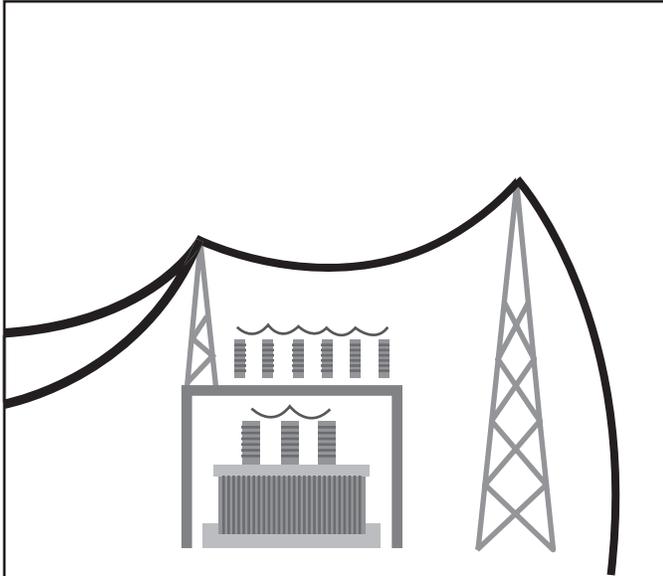


## Transformer

Transformers can be seen on some of the wood power poles around where we live. Here the power of the electricity gets turned down one more time to a level that devices in homes and other buildings can use.

# Power Path!

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## Distribution Substation

These are found close to cities and towns. High voltage electricity is turned down to lower voltage and sent off to different areas of the city or town.



## Homes/Buildings

The power is on!  
Many miles of power lines have connected our homes and buildings to the power plant where electricity was created.



# Cow Power

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## Curriculum Connections:

Common Core English Language Arts Standards

CCSS.ELA-Literacy.W.3-5.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

CCSS.ELA-Literacy.W.3-5.4 Produce writing in which the development and organization are appropriate to task and purpose.

CCSS.ELA-Literacy.RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

# Future Fuels

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Read the following selection and complete the writing prompt below.

## Landfill Fuel

A lot of garbage gets buried in landfills, where it rots and produces smelly gasses like methane. By using a specially designed system to get buried trash to rot faster, large amounts of methane gas can be collected and used as fuel. Methane gas from rotting trash is collected and the gas is burned in a boiler to drive a steam-powered generator that creates electricity. By using landfill gas to generate electricity, we have a whole new way to recycle. With more and more companies using this technology, smelly open trash dumps where you can't capture methane will hopefully become a thing of the past

## Kite Power

Scientists in Europe are working on a way to harness high altitude winds using a computer-controlled kite. First, a base station launches a kite and guides it up high. As winds pull the kite, the station quickly unspools more line. Once the line runs out, the kite is slowly wound in a bit and let loose to fly again. The unwinding action of the kite line drives an electric generator that creates electricity. Nobody uses kite power yet, but experiments are happening all over the world. There are many designs, but the concept is the same—turn high altitude winds into electricity down here on Earth. Maybe one day you will see electricity-producing kites soaring high over Maryland.

## Solar Tower Power

In a solar tower station, a large area of earth is covered with a canopy, creating a kind of greenhouse. At its center is a large tower holding turbines and a generator. As the sun warms the air beneath the canopy, it moves upward because warm air rises. The rising air is channeled through the tower, creating an airflow that turns a turbine to drive a generator and create clean electricity. And there you have it—a new way to capture the power of the sun!

# Future Fuels

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## Algae Energy

Algae—the same green, slimy plant goop that grows in lakes, can be used to fuel vehicles and generate electricity. In an algae cultivation pond, huge amounts of algae are grown using energy from the sun in pools of wastewater, seawater or other drainage—water too dirty or gross to drink. Next, the algae is skimmed and squeezed to release oils that are held inside it, and the oils are concentrated to make green crude. The remaining goo can then be dried and used as animal feed. Finally, the green crude is processed at a refinery just like regular oil. What is the result? Refined algae fuel that can be used to create electricity. It can also be used to make gas for cars, diesel for trucks and jet fuel. The idea of turning algae into fuel may seem like a new one, but the earth has been doing it for millions of years. In fact, the crude oil that we use today came from organic matter that died millions of years ago.

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READ THIS PROMPT CAREFULLY BEFORE YOU BEGIN YOUR WRITING.

**If you were going to use one of these future fuels where you live, which would you choose and why?**

Write an essay for your teacher describing which fuel you would choose. Use details from the text to describe how the fuel is made and to support your reasons for selecting this fuel. Also, consider possible advantages and disadvantages of creating this future fuel and include these in your essay. Remember to use correct grammar, usage, capitalization, punctuation, and spelling when writing your essay.

# Future Fuels

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## Curriculum Connections:

Common Core English Language Arts Standards

CCSS.ELA-Literacy.W.3-5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

CCSS.ELA-Literacy.W.3-5.4 Produce writing in which the development and organization are appropriate to task and purpose.

CCSS.ELA-Literacy.W.3-5.4 With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose.

CCSS.ELA-Literacy.RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.



# Analyzing an Electric Bill

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This can be a great extension activity for many grade levels. You can take it as far as the math skills of your students will allow. You can use the sample bill provided or have students bring in a copy of their family's bill. A really nice example would be getting a copy of the schools electric bill for the students to analyze. They could suggest ways to conserve energy usage at school once they have had a chance to study the bill. Your principal would know who to contact for a copy of the bill. Below are suggested questions/problems that can be done by the students.

- Calculate the average monthly usage.
- In which month do you use the most/least energy? Can you guess why?
- What season do you use the most energy?
- Why does the bill show a greater use of electricity in July 2012 than in July 2013?
- What is the average daily usage between June 3 and July 5 (the current billing period)?
- What does this company charge for a kWh (kilowatt hour) of electricity?
- Could the bar graph of monthly usage be represented in another way?

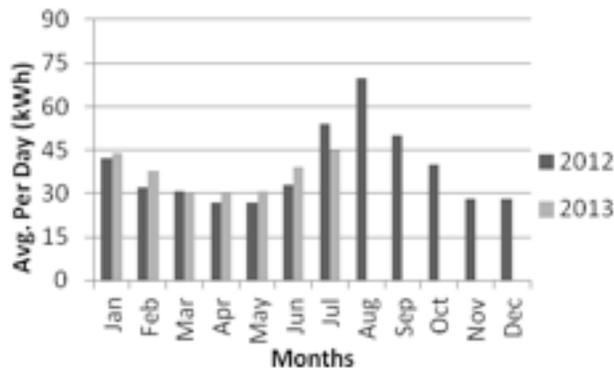
# Analyzing an Electric Bill

## Power Up Utilities

### Your Electric Usage Profile

Service to:  
ELECTRA WATT  
1 CURRENT ROAD  
SPARKS, MD 21152  
Meter: 0000000000

Your next reading is on or about Aug 3, 2013  
This section helps you understand your year-to-year electric use by month.



Monthly Comparison	Days Billed	kWh	Average kWh/Day	Average Temp
July 2013	32	1429	45	82
July 2012	32	1738	54	84

Billing Period	Type	Reading
Jul 5	Actual	44011
Jun 3	Actual	42582
32 Days	kWh Billed	1429

Yearly Comparison	Total Use	Avg. Monthly
Aug 2012 – Jul 2013	14116	1176
Aug 2011 – Jul 2012	14352	1196

### Billing Summary

Balance as of Jul 6, 2013 **\$0.00**

#### Charges:

Total Power Up Utilities Charges \$56.08  
Total Electric Supplier Charges \$135.61

Total Charges \$191.69  
Amount Due By Jul 27, 2013 \$191.69  
Account Balance \$191.69

PUU's price to compare for your rate is 8.774 cents per kWh effective 6/1/2013 to 8/31/2013.

### Billing Details

Previous Balance \$145.80  
Payment Received Jun 27, 2013 -\$145.80  
Balance as of Jul 6, 2013 \$0.00

#### Charges for – Electric Supplier

Electric Supplier Charges \$135.61

#### Charges for – Power Up Utilities

Distribution Charge:  
Customer Charge 8.75  
1,428 kWh at 3.32300000¢ per kWh 47.49  
MD Tax Adj Surcharge at -0.2760000% -0.16  
Total Power Up Utilities Charges \$56.08

**Amount Due By Jul 27, 2013 \$191.69**  
Account Balance \$191.69

# Graph Match

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## Objectives:

- To describe that demand for electricity varies with time of day and between building types.
- To identify that demand for electricity can be expressed as a load curve.



## Materials:

- A copy of the graph cards and building description cards for each student or group.



## Procedure:

Introduce the concept of a load curve by asking students to imagine a weekend day, and think about what times of day they use a lot of electricity, and what times of day they use very little. Work with the students to create a line graph on the board of a typical weekend day, with time on the x-axis and electrical demand on the y-axis, rising at times when they use more electrical devices and falling at times when they use fewer.

**Distribute the graph cards and building description cards. Invite students to read the cards and match each card to a load curve.**

**(Solution: A is the school; B is the house; C is the factory; D is the hospital)**

### Possible questions for discussion include:

- Which building uses the most electricity in a day? Why?
- Are there times of day when every building type is using a lot of electricity, or when every building type is using little electricity? What are possible reasons for these patterns?
- Why is each graph drawn with a different scale on the y-axis?
- Which of these building types would there be many of in a community, and which would there be fewer of?
- What would be some ways for each of these building types to reduce their energy use, and how would those actions change the load curves?

### Alternate Activities:

- Provide the four types of buildings ("House," "School," "Factory," and "Hospital") in place of the description cards, and allow students to match the building types to the graphs and come up with their own explanations of why electricity usage for each building type would match that graph.
- Provide only the graphs, and ask students to imagine buildings that would have that kind of load curve and write an explanation of how the buildings use electricity.

# Graph Match

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## Science Concepts:

**Demand** or **load** is the amount of energy needed by consumers in the grid. These graphs demonstrate that demand varies from one type of consumer to another and at different times of day. Other factors like seasons, days of the week, and holidays also influence demand.

The change in demand over time can be expressed as a **load curve**. The load curves in this activity are for a time span of 24 hours. Some load curves show a much shorter time, while others show a year. Each of these curves is for a single consumer, but load curves can also include multiple consumers or the whole grid.

**Peak load** is the highest demand over a given time period. Peak load occurs at different times for different types of consumers. Over the whole grid, the peak load for a day usually occurs around 5:30 PM, when homes and workplaces are both using power.

**Capacity** is the maximum amount of energy that can be produced by power stations. If peak load exceeds capacity, there will be power outages.



## Curriculum Connections:

Maryland State Science Curriculum Frameworks

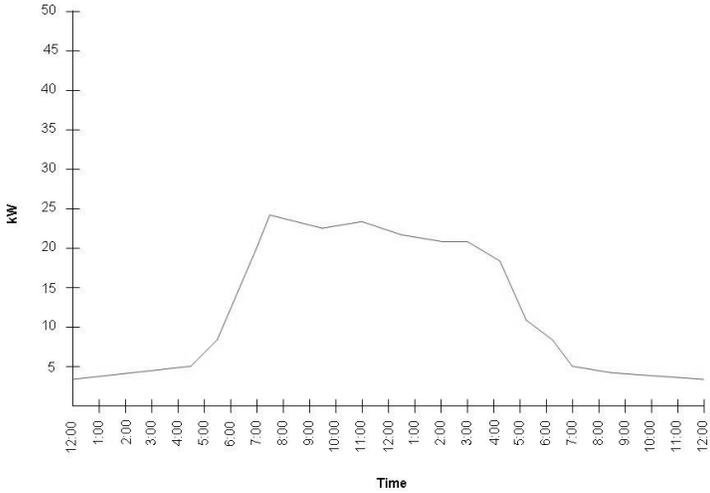
INDICATOR 1.5.1 The student will demonstrate the ability to summarize data (measurements/observations).

INDICATOR 1.5.4 The student will use tables, graphs, and displays to support arguments and claims in both written and oral communication.

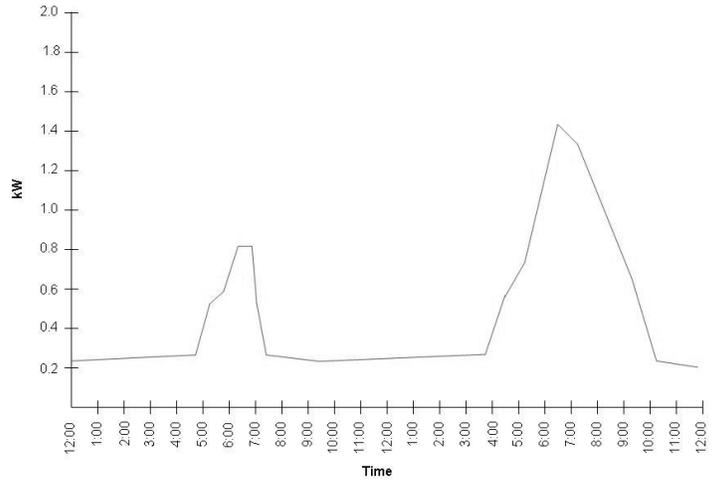
EXPECTATION 1.7 The student will show that connections exist both within the various fields of science and among science and other disciplines including mathematics, social studies, language arts, fine arts, and technology.

# Graph Match

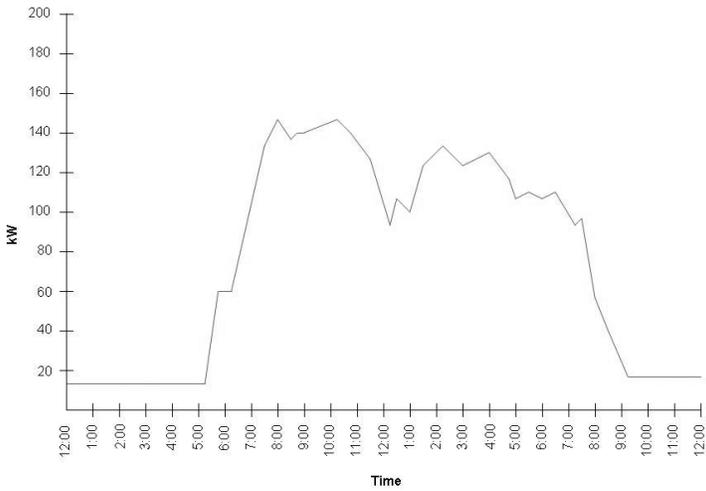
### Load Curve A



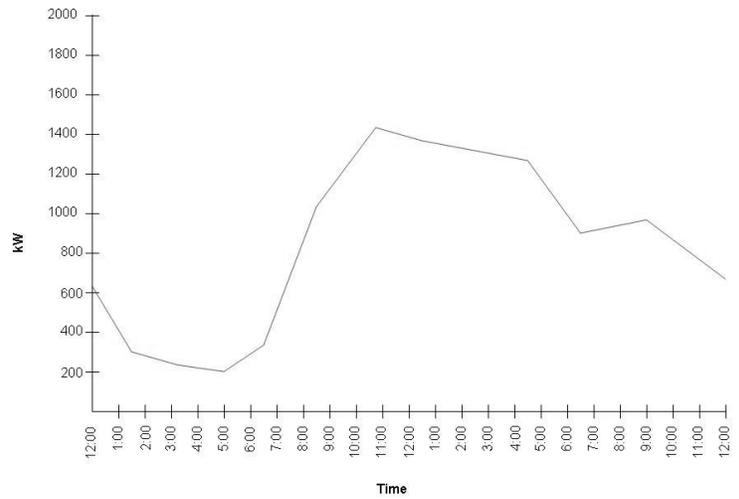
### Load Curve B



### Load Curve C



### Load Curve D



# Graph Match

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## **Nikola's House**

Nikola wakes up at 5:00 AM. He turns on the lights, cooks breakfast, and listens to the radio. He leaves for work at 7:15. When he gets home at 3:30 PM, he cooks dinner, watches TV, does laundry, and uses his computer. He goes to bed at 10:15 PM.

## **Edison Light Bulb Factory**

This small factory runs from 5:00 AM to 9:00 PM. Less equipment is running around noon, when the factory workers take breaks for lunch.

## **Westinghouse High School**

The staff arrives at 5:00 AM. Classes start at 7:00 AM. Classes end at 3:00 PM. After school activities continue until 5:00 PM. Teachers and staff leave by 7:00 PM.

## **Amperage City Hospital**

There are some patients and staff in the hospital all day, but most scheduled medical procedures and tests happen between 8:00 AM and 6:00 PM. Between 1:00 AM and 5:00 AM, some lights and machines are on but most people have gone home.

# Career Exploration Research Project

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The energy utility industry has a broad range of interesting and fulfilling employment opportunities located in virtually every city and neighborhood throughout our country. When most people consider jobs in the energy utility industry, they are likely to imagine electricians who hook up the wires in our houses, schools, and businesses to the nation's power grid, the power plant operators and factory workers who keep the power running at the flick of a switch, or the daring lineworkers who climb to dizzying heights to turn our power back on after a storm. However, the energy utility industry also provides a multitude of employment opportunities in a variety of traditional careers such as marketing, customer support, security, management, and accounting. In addition, there is always a need for individuals with specialized training such as environmental biologists, underwater welders, nuclear engineers, or political strategists. Safe and reliable energy is critical to keep our nation humming with vibrant and productive activity, and becomes even more important as we continue to develop new technologies and alternative power sources. A career in the energy utility industry may be the rewarding opportunity that you are looking for!

## Part One: Career Research and Summarization

Use the following links or other sources to research one of the many careers available in the energy utility industry:

- Exelon Corporation  
<http://careers.exeloncorp.com>  
(scroll to bottom of page for list of featured jobs by category or link for all jobs)
- Get Into Energy  
<http://www.getintoenergy.com>
- Center for Energy Workforce Development  
<http://www.cewd.org/roadmap/>
- Bureau of Labor Statistics Occupational Outlook Handbook  
<http://www.bls.gov/ooh/>

Next, write a summary description of your chosen career. Include the average salary, skills needed to perform the job as well as any educational and/or special training requirements. Also, describe the typical environment in which work is performed. Be sure to credit your sources.

# Career Exploration Research Project

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## Part Two: Personal Response

After completing the research portion of this project, write an informative/explanatory essay for your teacher describing your chosen career. In addition to your description, include answers to the following questions:

- Why did you select this career to research?
- Were there skills or requirements for this career that surprised you?
- Are there skills required for this career that you think you'd be especially good at or that would be challenging for you?
- What would you consider to be advantages and disadvantages associated with this career?

Use details from your research summary to help you write your essay. Also, remember to use correct grammar, usage, capitalization, punctuation, and spelling when writing.

## Part Three: Bibliography

Attach a bibliography of websites and any other references used to complete your research.

# Career Exploration Research Project

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## Curriculum Connections:

Common Core English Language Arts Standards

CCSS.ELA-Literacy.W.5-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

CCSS.ELA-Literacy.W.5-8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-Literacy.W.5-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

CCSS.ELA-Literacy.W.5-8.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Maryland State Science Curriculum Frameworks

EXPECTATION 1.7 The student will show that connections exist both within the various fields of science and among science and other disciplines including mathematics, social studies, language arts, fine arts, and technology.

INDICATOR 1.7.6 The student will investigate career possibilities in the various areas of science.

# Resources for the Power Up Exhibit

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## Trade Books

### PreK-2

- Greene, J. and M. Gordon. 2005. *Why Should I Save Energy*. Barron's Educational Series Inc.  
Waring, G. 2011. *Oscar and the Bird: A Book about Electricity*. Candlewick.  
Stille, D. 2004. *Electricity: Bulbs Batteries and Sparks*. Picture Window Books.  
Brown, K.B. 2002. *Energy Makes Things Happen*. Harper Collins.  
Suen, A. 2007. *Wired*. Charlesbridge.  
Fix, A. 2007. *Energy*. Heinemann Library.  
Hewitt, S. 2008. *Amazing Electricity*. Crabtree.

### Grades 3-5

- Oxlade, C. 2012. *Making a Circuit*. Heinemann Library.  
Bailey, J. and M. Lilly. 2004. *Charged up: The Story of Electricity*. Picture Window Books.  
Kamkwamba, W. and B. Mealer. 2009. *The Boy Who Harnessed the Wind*. Harper Collins.  
Seuling, B. and N. Tobin. 2003. *Flick a Switch: How Electricity Gets to your Home*. Holiday House Inc.

## Teachers

- Gibilisco, S. 2005. *Electricity Demystified*. McGraw Hill.  
Parker, S. 2005. *Eyewitness Electricity*. D.K. Publishing.  
Royston, A. 2008. *Using Electricity*, Heinemann Library.

## NSTA Articles

- Watson, S. 2008. Discovery Bottles: A Unique, Inexpensive Science Tool for K-2 Science. *Science and Children* 45(9): 20-24.  
Sandifer, C. 2009. Shoebox Circuits. *Science and Children* 47(4): 20-23.  
Ashman, S. 2009. The Pennies-as-Electrons Analogy. *Science and Children* 47(4): 24-27.  
Morgan E. and K. Ansberry 2012. Energy Makes Things Happen. *Science and Children* 50(7): 24-29.

## Energy and Science Lesson Plans

[http://www.energyquest.ca.gov/teachers\\_resources/lesson\\_plans.html](http://www.energyquest.ca.gov/teachers_resources/lesson_plans.html)

## Virtual Labs

- Virtual lab circuit construction (available in many languages)  
<http://phet.colorado.edu/en/simulation/circuit-construction-kit-ac-virtual-lab>  
Virtual labs Electricity  
[http://www.wsd1.org/LTCActivities/46%20Freeware/virtual\\_labs\\_electricity.htm](http://www.wsd1.org/LTCActivities/46%20Freeware/virtual_labs_electricity.htm)  
How are voltage, current and resistance related?  
[http://www.glencoe.com/sites/common\\_assets/science/virtual\\_labs/E14/E14.html](http://www.glencoe.com/sites/common_assets/science/virtual_labs/E14/E14.html)  
Circuits (6-8)  
<http://www.mhhe.com/physsci/physical/giambattista/circuits/circuits.html>