Lesson 1 Modification: Electricity Discovery Box

Overview

This activity uses an Electricity Discovery Box to engage students and elicit their ideas about electricity. Students randomly select items from the box and discuss how they think each relates to electricity.

Teacher Background

The adaptations of Lesson 1 focus on the Energy Discovery Box portion of the lesson. The original lesson, available at: http://www.powersleuth.org/teacher/energy-powers/lesson1-overview has students considering how familiar items found in the box are connected to energy. The suggested modification is to change the theme of the discovery box to an Electricity Discovery Box and include items that will stimulate students' thinking about connections to electricity use, monitoring, and conservation. In selecting items for the Electricity Discovery Box, it is strongly recommended that teachers review the items and the descriptions of the energy connections outlined in Teacher Resource 1.1 of the original Energy for Maine lesson. As the teacher resource indicates, many of the same items can be used because they have a clear connection to electricity. A list of additional or substitute items for the Electricity Discovery Box can be found at the end of this document as well as information about the electricity connections that can be made for these items.

Use this activity prior to beginning the investigation as a way to stimulate interest and preassess students' ideas about electricity. Over the course of the investigation, students will expand their knowledge of electricity and its use and learn strategies for monitoring and conserving electricity. For this reason, use an explorative approach with this activity as opposed to expecting students to generate definitive and exhaustive answers.

Key Ideas

- Energy is in some way connected to all physical objects and processes in the universe.
- People use and depend on electricity in a variety of ways, many of which are not readily apparent.

Lesson Goals

Students will:

- explore their current ideas about electricity.
- examine people's first and second-hand interactions with electricity.

Teaching The Lesson

Follow Steps 1-5 of the lesson plan for *Energy for Maine,* Lesson 1 except shift the focus from energy to electricity. As students engage in their discussions about electricity, be certain to probe for students' ideas about the relationship between energy and electricity, making the distinction, when appropriate, that electricity is a secondary source of energy.

Alternatively, some teachers have modified the items in the discovery box, but kept the approach focused more broadly on energy in steps 1-4 as written in the original lesson, choosing instead to narrow the focus on the electricity connections. In this approach, students reexamine the annotated drawings and are asked *"What if I now asked you to note all of the connections these items had to electricity specifically – not energy in general? In what ways would your drawings change?"* Here the distinction between energy in general and electricity can be made.

> **Note:** *In Lesson 6 of Energy Lights Maine students investigate how electricity is generated on a large-scale basis and are introduced to the major components of electricity production using Power Puzzles. Energy sources used in electricity generation are included.*

Items in the Energy Discovery Box that can be used in the Electricity Discovery Box:

- coal
- subway ticket or map (select a system that runs on electricity – e.g. Boston, New York, San Francisco)
- battery (D-cell) and/or battery operated flashlight
- cell phone or other small appliance
- bottle of water
- pinwheel
- clothespin
- energy-efficient light bulb (CFL or LED)
- power strip

Additional items to add to the Electricity Discovery Box:

- **Sample electricity bill:** Sample electricity bills from three of Maine's utilities are included in these *Maine Saves Energy* materials. While students will likely readily identify connections to electricity, many students have probably never looked at an electric bill or given much thought to how people are charged for electricity use. It is important to note that examining sample electric bills is one of the first activities students will do as they begin their investigations, so give some thought to its inclusion here. See Steps 1 and 2 of the Investigation Guide for additional details and background information on electric bills.
- **Kill A Watt meter:** Kill A Watt meters are tools that measure the energy used by individual appliances. Appliances are plugged into the meter (which is plugged into a wall outlet or power strip) and most measure the Voltage (volts), Current (amperes), Power (Watts), and Kilowatt-hours (kWh). Some models are programmable and can calculate the electrical expenses incurred by a particular appliance by the day, week, month and year. Students will readily note that the meter has a plug and infer that in order to use the device it gets plugged into an electrical outlet. They may also have heard of the units written on the meter and also infer that the device measures these units somehow. Energy for Maine, Lesson 7 focuses on using these instruments to measure the amount of electricity various appliances use and contains additional background information on the units of electricity.
- **Energy Star Guide:** These bright yellow labels tell the consumer how much electricity an appliance uses and are helpful in comparing the energy use of different models as people shop for new appliances. In addition, appliances that meet the efficiency standards ratings set by the U.S. Environmental Protection Agency receive a blue Energy Star label. Energy Star guides have recently been redesigned making them easier for the consumer to read. Visit the Federal Trade Commission's website for more information on how to read an Energy Star Guide: http://www.ftc.gov/bcp/edu/pubs/consumer/homes/rea14.shtm. Energy Star Guides can often be downloaded from websites that sell appliances.
- **Electric Meter:** Most students will recognize an electric meter but may have limited understanding as to their role in electricity use and monitoring. Electric meters are owned by the utility company and measure the number of kilowatt hours of electricity a home, business, or school uses each month. Traditional meters are read by a utility official on a monthly basis and the number is listed on the customer's bill. Customers are charged for the

number of kilowatt hours per month they use. “Smart” meters will replace nearly all of the traditional dial meters across the state. Smart meters have digital displays, are wireless, and use a radio frequency band for two-way communication. They can be read remotely and are just one part of a system-wide upgrade of a more automated power grid system. Additional information about smart meters is found in the teacher background section of the Investigation Guide. Step 4 (optional) of the guide engages students in learning how to take readings from traditional dial meters.

- **Wires:** An item, such as a piece of wire, representative of the infrastructure required to deliver electricity to our homes can elicit student’s ideas about how electricity gets from its generation point to the home. Depending on students’ background experiences with circuits, they may also recognize that electricity requires a complete pathway or loop to travel.

Lesson 6 Modification: Maine's Energy Picture

Overview

Students analyze the way they personally use energy and investigate energy use on a much larger scale (in Maine and nationally) through examination of data. Students discuss and make predictions about the amount of energy used by each sector. They create a visual representation of their predictions which they then compare to the actual percentage of energy used by each sector. Students begin to discover how reliant all sectors (residential, commercial, industrial, transportation) are on electricity and fossil fuels as energy sources.

Teacher Background

This lesson is an adaptation of Energy for Maine, Lesson 6 and sets electricity use into the large context of energy use. Refer to the original version, available at: http://www.powersleuth.org/teacher/energy-powers/lesson6-overview for Teacher Background information relevant to the focus of this lesson. Teachers could further abbreviate this lesson by focusing only on select individual steps of this modified plan. Lesson 6 has information about advance lesson Preparation and Materials. State and national learning goals are identified in this guide's Investigation Guide and Supplementary Activity Matrix.

Key Ideas

- Data about energy use is divided into different categories known as sectors and include transportation, residential, industrial, and commercial.
- Different sectors use energy and electricity in different ways.
- The amount of energy people in the United States and in Maine use continues to increase.
- Data is collected to answer a question and can be used to make informed decisions.

Lesson Goals

Students will:

- become familiar with the various ways energy, including electricity, is used by different sectors.
- analyze and determine energy use trends for themselves, for Maine, and the nation.
- recognize that data is collected to answer a question.
- begin to consider the cumulative effects of the energy decisions they make daily.

Teaching The Lesson

Engage

1 Examination and discussion of students' energy snapshots. Working in small groups of 4, students share their snapshots. If students were given the option of documenting their energy use with digital photographs, show students a slideshow of the assembled images. Once snapshots have been shared, discuss the following:

- *What do our snapshots tell us about the way we use energy?* Students will likely notice that their day to day activities frequently involve electricity.
- *How do you think the way humans use energy has changed over time? For example, if this were 1950, what might be different about the energy snapshots? What do you think would be the same?* Students will likely recognize that energy use has increased, especially our dependence on electricity.
- *If this were 1900, what do you think our energy snapshots would include? If it were 2050? What do you think accounts for these differences?* Students should recognize that the way energy is used has changed and is due to a number of factors including increased population and increased sophistication in the types and availability of devices that have been engineered to utilize energy in many different ways.
- *What don't our snapshots tell us about our energy use that we might like to know?* Answers will vary but draw students' attention to what the snapshots can and can't tell us about in terms of their personal/specific instances and collective energy use. For example, snapshots tell us that we do use electricity but it doesn't tell us about the amount of electricity we use – the actual number of kilowatt hours. Samples represent a few examples of "typical" use but due to a relatively small sample size, we couldn't say we've used more, less, or about the same amount of energy as in the past. The snapshots don't help us identify the devices that use large amounts of electricity or those that use electricity for a long period of time.

- (Optional) *Would you consider these snapshots "data?"* Throughout the investigation, students examine, collect, and analyze different types of data. Consider using this opportunity to clarify what data is. The *Connected Math Project* developed by Michigan State University describes data in this way: Data is values such as counts, ratings, measurements, or opinions that are gathered to answer questions. Data can be categorical (data that are words or categories) or numerical (data that are numbers). Our snapshots would be an example of categorical data (show how electricity is being used). Our snapshot data was collected to answer a particular question; it answers how we (students) use energy.

Explain to students that in the next few lessons they will be collecting, and analyzing different types of data and one of the first key steps in working with data is to recognize its nature. Remind students that we'll regularly ask: *Why was the data collected? What question was the data trying to answer? How was the data collected, what can it tell us, and what are its limitations?*

Explore 

2 Consider changes in energy use over time. Have students view, either individually or as a class using an LCD projector, the Palmer Putnam podcast. The podcast can be accessed from the *PowerSleuth* website (www.powersleuth.org). Click on *Energy for Maine,* Teacher Zone, Lesson 6.

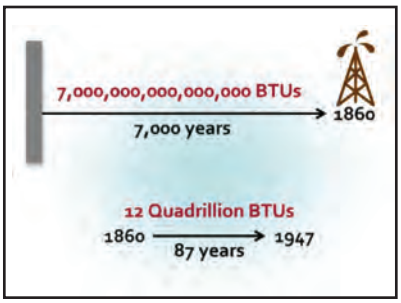
> **Note:** *Keep in mind the Palmer Putnam story and the examination energy use in different sectors addresses overall energy use– not just electrical. This broad view of energy consumption serves multiple purposes and examination of the "big picture" data allows students to 1) situate electricity use with the scope of overall energy use and 2) to begin students' involvement with looking at different types of data. In the Palmer Putnam slides, data is displayed using few details. However, trends in energy use are clearly shown including a notably dramatic spike increase of energy use after the discovery of petroleum. As students begin to examine energy use in different sectors (see Step 3), they first are asked to create a display showing their prediction of energy use by each sector and then examine a pie graph showing use for each of the different sectors for Maine.*

Set the context for viewing the podcast by asking students to focus on the following as they listen:

- *What question does Palmer's data answer?*

After students watch the podcast engage in a discussion of the following:

- *What question does Palmer's data answer?* Palmer's data answers the question of: "How much energy (in British thermal units) have humans used throughout history?"
- *How has the amount of energy people use changed throughout time? What accounts for these changes?* Students should recognize that energy use worldwide has dramatically changed with the discovery and use of petroleum in the 1860s.
- *What do you think the data will show about people's energy use in future years?*
- *How is our snapshot data related to Palmer's findings? Do you think your snapshots are representative of how people in Maine, across the United States and the world use energy? What are some other ways energy is used by people in our society?* The aim of this line of questioning is twofold; initially, to get students to recognize the dramatic and overwhelming increase in energy use in recent years and second, to help students recognize people's use of energy (in all sectors) is heavily reliant on petroleum and nonrenewable energy sources. Asking students about how their snapshot relates to Palmer's findings guides them to thinking about what role their own energy use plays in the larger energy-use picture. Students have most likely recognized people's reliance on electricity but probably have not considered the entire energy story – tracing electricity back to its source when they plug something in or flip a switch.



3 **Introduce different sectors of energy use.** Provide each student with Maine's Energy Picture handout (optional). Introduce students to different categories, known as sectors, of energy use: transportation, residential, industrial, and commercial. List the different sectors on the board and briefly describe each category. Students may have limited knowledge of how energy is used by other sectors such as business, industry, and transportation. Differentiate between "commercial," (referring to businesses- those engaged in buying and selling goods and services), and "industrial," (referring to occupations that involve manufacture or production of a product). Provide local examples of commercial, industrial, and transportation to help students understand the dif-

ferences. Students may wonder how schools are categorized (commercial). Give students a few minutes first to brainstorm, with a partner, all the ways they think each sector uses energy and make a list in their scientists' notebooks.

After students have completed their lists, discuss some of the items they included. Give each pair 100 counters (pennies or beans), a piece of chart paper, and markers. Explain that they will be using their 100 counters to predict the percentage of energy they think each sector uses. Explain that each counter represents 1% of the total energy used by the different groups (sectors). Students should think about what percentage of total energy they think each sector uses and create a visual on chart paper showing the percentages for each sector in Maine. Students may create a pie chart, bar graph, or come up with some other way of representing their predictions. Alternatively students may make a representation without using counters.

Monitor students as they work. Talk with students about the reasons behind their predictions. Visit each pair and make note of the trends in students' displays. After a few minutes, call the class together to share the similarities and differences in the percentages displayed in their predictions.

4 Examine Maine energy consumption data. Distribute a copy of Maine Energy Consumption data (available in *Energy For Maine,* Lesson 6) to students and/or share the information by displaying an overhead or digital slide of this information. Discuss with students how the actual data compares with their predictions. Discuss with students what might account for (any) differences.

Revisit the types of questions posed to students as they examined their snapshots, but instead, ask about the data for Maine:

- *What does the Maine Energy Consumption data tell us about the way energy is used in our state?* Help students generate a list of statements that the data supports.
- *What doesn't the Maine Energy Consumption data tell us about the way energy is used in our state?* Help students generate a list of specific questions they have that this data doesn't answer. Save this list, as these could be questions for further study.
- *What additional questions do you have about Maine's energy use?* It may be necessary to provide students with an example question or two to get them started. For example: *How does Maine's energy use compare to other states? Do we use more or less energy than other states? How does Maine's energy use relate to Maine's electricity use?*

5 Read Energy Consumption article. Distribute a copy of "Energy Consumption" reading and from Energy for Maine, Student Handout 6.1: Advance Organizer for Energy Consumption Article to each student. Explain to students that this reading describes more specifically what each sector uses energy for and the energy sources most commonly used to fuel various tasks.

Encourage students to mark the article by underlining, circling, or highlighting parts of the article that pertain to the focus areas. Give students time to read the article silently or read the information together as a class.

Alternatively, use a jigsaw reading strategy with the article. Divide the class into "home groups" of three. One person in the trio reads the Residential and Commercial section (point out that these two categories are grouped together in the reading), another person in the home group reads the Industrial section, and the last person is assigned the Transportation section. All students in the class assigned to read the Residential and Commercial section (or Industrial, or Transportation respectively) gather to read and discuss their section in preparation for sharing their "expert" knowledge about their section with the home group. Experts return to their home group and take turns sharing a summary of their findings with the other members of their home group.

6 Summarize learnings and bring lesson to a close. Clarify any remaining questions students have about the Energy Consumption article. Explain that in upcoming lessons they will be using a variety of tools to investigate energy use, specifically electricity use in homes. Remind students of what their own Energy Snapshots showed: each of us interacts frequently with electricity, and therefore, we have a direct impact and influence on how electrical energy is used in our homes.

> **Note:** *According to the Department of Energy, 21% of the energy people use in the U.S. is for the home; in Maine about ¼ of the energy used is residential (23%). While it is a bit tricky to pinpoint exactly how much of this home energy use is electrical, nationally 47% of home energy use is for heating the house, and another 17% of home energy use is for hot water for washing and bathing. Lighting, appliances, and refrigeration take 29% of home energy use, with the remaining 6% used for cooling the home.*

Consider closing the lesson by asking students to generate some preliminary questions about their home's electricity use, such as what (factors) they think affects how much electricity a particular home uses? Ask students to brainstorm all the electronic devices

they can think of that would impact use and other factors such as size of home, season (for lighting and heating), number of windows, age of home, etc.

References:

In addition to those resources listed in *Energy for Maine,* Lesson 6:

Michigan State University. (2009). *Connected Mathematics 2: Variables and Patterns.* New York, NY: Pearson Education.

Maine's Energy Picture: Predicting Energy Use by Sector

Directions: Energy data is divided into different categories known as sectors. Four categories are used: transportation, residential, industrial, and commercial. Commercial refers to businesses- those engaged in buying and selling goods and services, and industrial refers to occupations that involve manufacture or production of a product.

Part 1

With a partner, brainstorm all the ways you think each sector uses energy. Make a list for each sector.

Part 2

Using 100 counters (pennies or beans), a piece of chart paper, and markers, create a visual showing the percentage of use you predict for each sector in Maine. You may create a pie chart, bar graph, or come up with some other way of representing your prediction. You may make a representation without using counters.

Part 3

What similarities do you notice in the percentages of your classmates' predictions?

What differences do you notice?

Part 4

How does your prediction compare to the actual data?

What do you think may account for these differences?

Part 5

How do you think Maine's energy use relates to Maine's electricity use?

Next Month's Electricity Use

Directions: Elsa and Zack are arguing about how they might use the monthly kilowatt hour data they collected from the Fox family's electric bills to make a prediction about how many kilowatt hours (kWh) the family will use next month. Zack thinks they should use one of the measures of central tendency (mean, median, or mode). Elsa thinks they should make a graph of the data.

What would you do? Would you use Zack or Elsa's ideas or would you do something else? Explain how you would use the data to help the Fox family estimate how many kilowatt hours of electricity they will use in the upcoming month. Also, be able to explain why you think your approach would give the Fox family the most accurate estimate.

Monthly Electricity Use
Addison Fox

Month	2009 kWh	2010 kWh	2011 kWh
January	1078*	763*	577
February	531	789	552
March	560	658	481
April	751	751	610
May	639	587	
June	614	557	
July	718	594	
August	675	482	
September	624	561	
October	781	653	
November	697	702	
December	880	620	

* indicates estimate based on past usage

Appliance Card Sort Teacher Notes

A few notes about using the card set *This set of cards contains pictures of electrical appliances typically used in the home. Described below are activities that students can do using these cards. Examine the card set carefully. You may wish to add or delete appliances to the card set before distributing to students to adjust the level of complexity of a particular task. For instance, included in the set are both generic and specific names for certain appliances (e.g. TV). Leaving the TV's description ambiguous may invite a conversation about the efficiency of different technologies; including the specific TV types may prove confusing or frustrating, as there are many makes, models, and sizes that affect electricity use. Consider asking students to invite their parents or other community members to try the activities as well.*

Preassess students' knowledge about "energy hogs."

Have students, working in pairs, examine each of the appliances in the set, one at a time. Instruct students to discuss with their partner, in general terms, how much electricity they think each appliance uses and why. As students talk about each appliance, have them group the appliances according to which ones they think use a lot of electricity and which ones they think use smaller amounts of electricity. Students may sort appliances in a variety of ways; they may make distinct piles of big and small users, arrange the cards in some sort of continuum, or come up with some other configuration. It is not expected that students identify a particular range of watts or kilowatts a particular appliance draws, but rather that they can identify generally, which appliances use more electricity than others. Regardless of how students arrange the cards, the key to this exercise as a preassessment activity is to provide a catalyst for engaging students in thinking and talking about the electricity use of various household devices. Listen carefully to how students characterize each appliance and justify their choices. Students may raise questions about the appliances which indicates their knowledge about what devices are big energy users and which are not. For example, students may ask if the TV is a flat screen/LCD model or if the washing machine is using hot, warm, or cold water. Consider asking students to record the results of their card sort and their thinking about their choices/categories in their notebooks so that they may access and reflect on their thinking as the unit progresses.

Research the number of watts each appliance uses.

As students learn more about electricity and begin investigations to find the actual number of Watts different appliances use (see Energy for Maine, Lesson 7 Watt's in a Nameplate?), have them add this information to the cards. They may also wish to add information that gives more detail about each appliance's electricity use. For example, students may wish to indicate that a refrigerator cycles on and off, which explains

why often a range of or average Wattage is given; an oven has different settings so the number of Watts it uses changes according to the setting selected. Students can also add an appliance of their choice to the set using one of the blank cards. As an extension, students can use the card set to learn how to convert the number of Watts each appliance uses to kilowatts. This is a particularly useful exercise to do before engaging students in the Kilowatt hour Scavenger Hunt.

Quick Reference Appliance Wattage Guide Teacher Reference

Note: *There are many ways to find out how many watts a particular appliance uses. While this number is listed on an appliance's nameplate or found in its users guide, values can be measured using Kill A Watt meters and/or often looked up online. (See Energy for Maine, Lesson 7, Student Handout 7.1: Kill A Watt Challenge for additional details.) The list below is to be used as a guide, as there is often great variability depending on make, model and year of the appliance and how it's used.*

Blender: 300 watts
Cable TV Box: 20 watts
Cathode ray tube TV: 90 watts
Ceiling fan: 60 watts
Central AC: 6000 watts
Clothes washer: 425 Watts
Coffee maker: 1200 watts
Compact florescent bulb: 25 watts
Computer:95 watts
Dishwasher: 200 watts
DVD player: 25 watts
Electric blanket: 250 watts
Electric clothes dryer: 4400 watts
Electric oven: 2000 watts
Freezer: 273 Watts
Hair dryer: 1800 watts
Humidifier: 90 watts
Incandescent light bulb: 60 watts
Iron: 1000 watts
Laptop: 50 watts
LCD TV: 110 watts
Light emitting diode (LED) bulb: 0.5 watts
Microwave oven: 1440 watts
Mixer: 200 watts
PC monitor: 150 watts
Plasma TV: 300 watts
Toaster: 1000 watts
Toaster oven: 1200 watts
Refrigerator: 188 watts
VCR: 11 Watts
Vacuum: 1100 watts
Water heater: 3800 Watts
Window AC: 1300 watts

A fun online reference for kids Energy Use Looker Upper: ***http://www.southerncompany.com/***

Resources:

http://www.brighthub.com/engineering/electrical/articles/79500.aspx
http://reviews.cnet.com/green-tech/tv-power-efficiency/
http://michaelbluejay.com/electricity/howmuch.html
learningpower/energyuse.aspx

Appliance Cards

Electric Oven 	**Laptop Computer** 	**Plasma (flat screen)TV** 
Microwave Oven 	**Desk Top Computer** 	**Cell Phone & Charger** 
Refrigerator 	**Gaming Station** 	**Radio** 
Coffee Maker 	**DVD Player** 	**Toaster Oven** 

Images from Microsoft Office Clip Art (2011).

Hair Dryer 	**Incandescent Light Bulb** 	**Compact Florescent Light Bulb (CFL)** 
Mixer 	**Electric Clothes Dryer** 	**Dishwasher** 
Washing Machine 	**Central Air Conditioning** 	**Window Air Conditioner** 
LCD TV 	**Vacuum** 	**Humidifier** 

Freezer 	**Water Heater** 	**Ceiling Fan** 
Blender 	**Cable TV Box** 	**Iron** 
Electric Blanket 	**Cathode Ray Tube TV** 	**TV**