ENERGY USE AND DELIVERY – LESSON PLAN 3.4

Energy Delivery

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Describe how energy is delivered to homes.**
- **Describe how electricity is measured in homes (kWhs).**
- **Explain what will happen when there is a power outage.**
- **List the types of power outages.**

Public School System Teaching Standards Covered

Common Core Language Arts/Reading

- GA ELACC3RI: 1,2,3,6,7,8, and 10 3rd
- GA ELACC4RI: 1,3,5, and 10 4th
- GA ELACC5RI: 1,3,5,7,9, and 10 5th
- KY ELACC3RI: 1,3,8,and 10 3rd
- KY ELACC4RI: 1,3,5,6, and 10 4th
- KY ELACC5RI: 1,3,5, and 10 5th
- TNCCRA.R.1
- TN 3.RI: 2, 3, 6, and 8 3rd
- TN 4.RI: 1,2,3,6, and 10 4th
- TN 5.RI: 1,2,5,7,and 10 5th
- VA 3.6 b, d, k 3rd
- VA 3.7 a 3rd
- VA 4.6 a, g, i, j, k 4th
- VA 5.6 a, b, h, j, k 5th

Writing

- GA ELA CC3W: 2,4, and 7 3rd
- GA ELACC4W: 2,3,4, and 7 4th
- GA ELACC5W: 2,3,4 and 7 5th
- KY ELACC3W: 2,3,4, and 7 3rd
- KY ELACC4W: 2,3,4, and 7 4th
- KY ELACC5W: 2,3,4, and 7 5th
- TN CCRAW.7
- TN 3.W: 2,4, and 7 3rd
- TN 4.W: 2,3,4, and 7 4th
- TN 5.W: 2,3,4 and 7 5th
- VA 3.9 3rd
- VA 3.11 a, b, c 3rd
- VA 4.7 c, d, g 4th
- VA 5.7 b, c, e 5th

I. Anticipatory Set (Attention Grabber)

Essential Question

How does power get into your home?

II. Modeling (Concepts to Teach)

Once the electrical energy is generated using nuclear, wind, water, or coal energy sources, that energy then needs to be delivered to households. There are three steps involved in this process:

1. **Stepping up the voltage for transmission:** The electricity that is generated must be stepped up to a higher voltage using a **transformer**. Because electricity must travel long distances from where it is generated (produced) to where it is used (homes, schools, businesses, etc.), higher voltage electricity is able to travel over longer distances more efficiently (i.e. with less loss of energy). The high voltage lines carry electricity at voltages as high as 400,000 volts many hundreds of miles to substations.

   Transformers – A transformer is an electrical device that takes electricity of one voltage and changes it into another voltage.

2. **Stepping down the voltage at the substations:** At substations, high voltage electricity is stepped-down to a lower voltage and this electricity (in different power levels) is used to run factories, streetcars, mass transit, light street lamps and stop lights, and is sent to neighborhoods.

3. **Small transformers in neighborhoods reduce the voltage even further:** The voltage is reduced further before being safely delivered to homes and businesses. From transformers, electricity travels into buildings through wires called service drops. The service drops connect to a meter box, which measures the amount of electricity being used by that consumer or household. After being measured, the electricity goes through a circuit breaker box into homes. A circuit breaker box limits the amount of electrical current flowing through the wires. When a circuit breaker (or fuse) “trips”, something is wrong with an appliance or something was short-circuited.

The picture below is of a small neighborhood transformer that steps the voltage to its final 120/240 volts before going into a house or business.

How is electrical energy consumption measured?

The unit **kilowatt-hour** is used to measure electrical energy consumption.

When we talk about powering appliances in our home with electricity, we are not usually interested in how much energy an appliance uses, but rather the ***rate* of energy use**, or in other words, how much energy per *unit time* the appliance draws. This quantity is called the "power":

Power = Energy/Time

In particular, for electrical power we use the "watt" (named after the scientist James Watt):

1 Watt = 1 Joule/Second

It is important not to confuse power and energy, although they are closely related. Just remember that power is the ***rate*** at which energy is delivered, not an amount of energy itself. With simple algebra, turn the above formula for power around to solve for energy instead, and write:

Energy = Power x Time (Kilowatt x hour)

As mentioned above, the unit **kilowatt-hour** (kWh) is used to measure electrical energy consumption. One kilowatt-hour is defined as the energy consumed by power consumption of 1 kW during 1 hour:

1 kWh = 1 kW x 1 hour

What is the energy consumed when consuming 2 kW for 3 hours? Solution: 2 kW x 3 hours = 6 kWh.
In relation to watts, 1 kilowatt (kW) equals 1,000 watts and 1 kilowatt-hour equals using 1,000 watts for one hour. See lesson 3.2 for in-depth explanation and practice for kWh and kW.

Types of Power Outages

Power outages are categorized into three different phenomena, relating to the duration and effect of the outage: **http://en.wikipedia.org/wiki/Power_outage**

1. **A transient fault** is a momentary (a few seconds) power outage typically caused by a temporary fault on a power line. Power is automatically restored once the fault is cleared.
2. **A brownout** is a drop in voltage in an electrical power supply. The term brownout comes from the dimming experienced by lighting when the voltage sags. Brownouts can cause poor performance of equipment or even incorrect operation.
3. **A blackout** refers to a total power outage in an area and is the most severe form of power outage. Blackouts, which result from or result in power stations tripping, are particularly difficult to recover from in a quick fashion. Outages may last from a few minutes to a few weeks, depending on the nature of the blackout and the configuration of the electrical network.

What happens when there's a power outage?

The electrical grid is the connection of all of the power plants with each other. One grid can be as big as half of the United States! This is convenient if there is one power plant that has a failure because neighboring power plants can increase their output to make up for the difference. This can lead to mass power outages, however, because it sometimes leads to a great deal of strain on other power plants in the power grid. If the neighboring power plants are all near their maximum capacity, they cannot handle the extra load. To prevent themselves from overloading and failing, they will disconnect from the grid as well. That only makes the problem worse, and dozens of plants eventually disconnect. This can leave millions of people without power.

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	What are some causes of power outages? (Class discussion. Teacher can list reasons on the board).
UNDERSTAND	What are the effects of power outages? Together, brainstorm what happens when there is a power outage. What are some of the effects? What happens if you are cooking dinner? Doing homework? What if the whole city loses power? What would some of the effects be? For people at work? (Class discussion)
APPLY	Go to **http://childrensbooksheal.com/2012/01/06/blackout-by-john-rocco/** and watch the book trailer for the book, "Blackout" by John Rocco. Discuss these real peoples' experiences during a blackout in NYC. (Class discussion)
ANALYZE	Can we do anything to avoid a power outage, and what do we do if there is a power outage? Read: **http://scienceblogs.com/casaubonsbook/2009/12/08/when-the-power-goes-out/** for suggestions. (Class discussion)
EVALUATE	Evaluate the pros and cons of living with electrical power versus without. (Class discussion)

IV. Guided Practice Ideas

Recommended Items

How Power Plants Work Video; The Flow of Electricity – How Energy Gets to You (Interactive Diagram) (see below)

Videos

- How Power Plants Work Video: https://www.youtube.com/watch?v=GI7AhajfhWE
- Where Energy Comes From Video: **http://www.youtube.com/watch?v=__zB80SagIk**
- Natural Gas Power Plants Video: **http://www.youtube.com/watch?v=Em1crnEt45Q**
- Electricity Generation Video: **http://www.youtube.com/watch?v=20Vb6hlLQSg**

Field Trip

- Field Trip: If possible, teachers take students on a field trip to a local power plant.

Activities

- Interactive Diagram: The Flow of Electricity – How Energy Gets to You **http://www.fpl.com/storm/restoration_journey.shtml**
- Explanation of Electricity: **http://www.explainthatstuff.com/electricity.html**
- Voltage and Current: **http://www.fplsafetyworld.com/?ver=kkblue&utilid=fplforkids&id=16184**
- Measuring Heat Energy: **http://www.sciencebuddies.org/science-fair-projects/project_ideas/Chem_p092.shtml?from=Pinterest - procedure**
- Play charades: Teachers have students act out an “effect” of a power outage while other students guess which effect they are portraying (ex: car crashes because stoplights are out)

V. Independent Practice Ideas

Recommended Items

Parent or Guardian Interview (see below) Interview Guide provided

Other Resources

Personal Practice

- Sequence chart: Teachers ask students to write a sequence chart or draw a diagram explaining how power is transferred from the power plant to homes. Refer to The Flow of Electricity – How Energy Gets To You (Interactive Diagram): **http://www.fpl.com/storm/restoration_journey.shtml**

Practice That May Involve Parents or Guardians

- “How I Lived without Electricity” Interview and Write Up: Interview Guide provided.
  - Interview a grandparent or older person who has lived without electricity for a sizable portion of his/her life or someone who lived without electricity for some time because of the effects of a hurricane or other natural disaster.
  - Write a three paragraph paper based on interview answers about how that person lived without electricity.
- Parent or guardian interview: Interview Guide provided.
  - Students check their parents’ or guardians’ understanding of the things they learned in class. Refer to Section II. Modeling for detailed answers. Do they know how energy is delivered to your home? (Answer: Voltage is stepped up for transmission; Voltage is stepped down at the substations; Small transformers in neighborhoods reduce the voltage even further.) What do we typically do during a power outage?

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- "How I Lived without Electricity" Interview and Write Up (if completed as Independent Practice, as shown above)
- Parent or Guardian Interview (if completed as Independent Practice, as shown above)

VII. Materials Needed

- None

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How does power get into your home?

This page is intentionally blank.

INTERVIEW GUIDE FOR ENERGY DELIVERY LESSON 3.4

NAME: ____________________

How I Lived without Electricity

Instructions: Students interview a person who has lived without electricity for a period of time. This can be a grandparent or older person who has lived without electricity for a sizable portion of his/her life or someone who lived without electricity for some time because of the effects of a hurricane or other natural disaster.

Name of Interviewee: ______________________________

1. When did you live without electricity?

____

____

____

2. How did you go about daily life without electricity?

____

____

____

3. What do you think are the advantages of electricity?

____

____

____

4. What are the disadvantages of electricity?

____

____

____

INTERVIEW GUIDE FOR ENERGY DELIVERY LESSON 3.4 **NAME: ____________________**

Parent or Guardian Interview

Instructions: Students interview a parent or guardian.

Name of Interviewee: ______________________________

1. Who provides our power?

____

____

2. How is electricity delivered to our home?

____

____

____

3. What do we typically do during a power outage?

____

____

____

4. Have you ever experienced a blackout for an extended period of time?

____

____