Energy Explained: How Much Energy

LESSON OVERVIEW

In this lesson students explore how much energy they use. Students will begin by watching the three and a half minute Inside Energy video, *The State of Energy*, to introduce the idea that humans are using more energy than in the past. Students then explore their own energy usage by conducting an investigation to test the energy usage of several common household and classroom appliances and devices. Finally, students are challenged to extrapolate their investigation results by using energy use data and calculating how much coal, natural gas, and/or petroleum is used and how much carbon dioxide is emitted into the atmosphere due to the energy requirements of several tested items. This lesson follows the Inside Energy lesson, "Energy Explained: The Carbon Cycle," but can also stand alone. The lesson is organized using the 5E Instructional Model. While each section builds upon the previous, educators may find that they only need to use one or two sections to meet their teaching goals.

LEARNING OBJECTIVES

Students will:

- Use a power monitoring device to determine how much energy various appliances and devices use.
- Research the sources and percentages of energy in their community.
- Calculate the amount of fossil fuels required to power various devices and the amount of carbon dioxide produced.

GRADE LEVELS: 6-8

KEY VOCABULARY/CONCEPTS

- Fossil fuels
- Petroleum
- Natural Gas
- Coal
- Carbon cycle
- Atom
- Energy
- Watt (W)
- Kilowatt (kW)
- Kilowatt hour (kWh)

CREDITS: Lesson developed by Tiffany Kapler. Multimedia developed by Inside Energy.

MULTIMEDIA RESOURCES

Energy Explained: Where Does It Come From And How Much Do We Use? [Video]

SUGGESTED TIME: 2 days

- Day 1: Engagement, Exploration, and Explanation*
- Day 2: Elaboration

**Educator may choose to assign part of the Elaboration phase as homework.*

MATERIALS

- Power monitoring device(s)
- Lamp (or just the cord and lamp socket)
- 60 or 100 watt light bulb
- LED light bulb that fits lamp/socket
- Halogen light bulb that fits lamp/socket
- Other electrical appliances and/or their power cords (cell phone, laptop, desktop computer, coffee maker, alarm clock, outlet timers, other household/classroom items)
- Calculator(s)

LESSON PREP

Be sure to familiarize yourself with the power monitoring device prior to instruction.

THE LESSON

Engagement	View the Inside Energy video *Energy Explained* Discuss the following: • What are some reasons that we use – on average – three times more energy than our great-grandparents did 100 years ago? • Where do you think most of the energy for electricity in our community/city/state comes from? How do you know, or why do you think this? • Is our current energy usage sustainable? Will our current sources of energy be available in the future? • Why might it be important to understand that most of our energy – including electricity – comes from petroleum? • How much energy do YOU use? How much of it might come from petroleum, coal, or natural gas? **Evaluate** the discussion for current understanding as well as misconceptions. Use these points to focus and redirect during the Exploration and Explanation phases.
Exploration	Let's find out how much electricity we really use. 1. Introduce the power monitoring device and explain what it can measure. You may also need to introduce the terms ***watt***, ***kilowatt***, ***kilowatt-hour (kW-H)***, ***volt***, ***amps***. 2. Have students work as a group to test several lightbulbs and several appliances with the device. Results should be recording in their science journals or lab write-ups in kilowatts. Be sure to measure energy usage when the device is in several different settings (on, off, sleep, etc.) and even test chargers when the device is fully charged and/or when the device is not connected. 3. Based on measurements, have students determine how much energy (in kW) individual devices use in one hour, one day, one year.

	Teacher can use lab time to observe and converse with students to **evaluate** their understanding of their journeys as carbon atoms, as well as their understanding of their experiences.
Explanation	Conduct a class discussion and/or ask students to discuss their results in a lab write up. Guiding questions and discussion prompts might include: • Which appliances or electronics required the most energy? Which required the least? Did any of your results surprise you? • Did the items that claimed a certain wattage, actually measure the same wattage? Can you think of any reason for differences? • Did you find examples of energy waste? Where did you see unnecessary energy usage, or energy usage that you didn't expect? • Why might a lightbulb that uses less energy be as bright, or brighter than, a lightbulb that uses more energy? What happens to the energy? (*hint: did the person who was holding the higher wattage lightbulb notice anything as it was on?*) • The video stated that we use more energy today than 100 years ago. Based on your results, explain one or more reasons for the extra energy usage. • The video state that we use more energy today than 100 years ago. Are there any indications from your results that human energy usage could *decrease* in the future? Explain your answer. • If you have completed the Inside Energy lesson, "Lost in Transmission," how much energy would you estimate is lost before the electricity gets to the appliance? Explain your answer. • Consider where the majority of our energy comes from as described in the video, *The State of Energy*. Based on the graphic at 0:00:52 in the video, how much of the energy for a given appliance comes each of the different energy sources? • How could you use a power monitoring device in your own home? Teacher and students should **evaluate** student understanding of the concepts with a specific focus on the connection between the carbon cycle and human use of fossil fuels as resources.
Elaboration	Have student explore in greater detail their own energy use and energy sources: 1. Students should research where the energy in their community comes from to create a graphic similar to the video at 0:00:52. They may need to research online or call the utilities provider. If possible, also find out the amount of fuel required to generate 1 kWh of energy for the specific utilities provider. If the efficiency of the power plants are not available, students can use average efficiencies provided by the U.S. Energy Information Administration (see Teacher Resources) 2. Use the researched information to determine how much coal, natural gas, and/or petroleum is used to run two or more of the items tested during the Exploration phase for a year. If possible, compare two similar items, such as an incandescent lightbulb and a halogen or LED bulb of similar brightness. Students may find it helpful to arrange their data and calculations into a chart similar to the one below. Note that the sample chart assumes energy usage 24 hours/day, 7 days/week. Students may choose to adjust these assumptions.

Sample Chart:

Natural Gas Usage per Device						
	A	**B**	**C**	**D**	**E**	**F**
Device	**kW**	**Percentage of Energy from Natural Gas (expressed as a decimal)**	**kW from Natural Gas**	**Amount of Natural Gas Used in one hour (estimate 1000 cubic feet/kW-H from US Energy data)**	**Amount of Natural Gas used for one day of use. (cubic feet)**	**Amount of Natural Gas used for one year of use. (cubic feet)**
Calculations	*A*	*B*	*A x B*	*C x 1000*	*D x 24*	*E x 365*
60 Watt lightbulb	0.06	.38	0.0228	22.8	547.2	199,728
Cell phone charger w/o phone	0.002	.38	0.00076	0.76	18.24	6,493.44

3. Research an estimate for the amount of carbon put into the atmosphere per given quantity of natural gas, petroleum, and or coal combusted. Calculate how much carbon dioxide is put into the atmosphere to use various items for a year.

Discuss student results using the following discussion prompts:

- Do you see any practical options for reducing the amount of energy that you or your household use? Are the changes worth the effort? Why or why not?
- How does our behavior affect our energy usage? How do technology options affect our energy usage?
- Why is it important to consider how much natural gas, coal, or petroleum is used? Are these resources renewable?
- Why is it important to consider how much carbon dioxide is added to the atmosphere?
- What kind of effort would it take to eliminate the need for natural gas, coal, or petroleum in your community?
- What level of energy usage do you expect in the future? Explain your response.

Possible extensions:

1. Complete the Inside Energy lesson, "Energy Explained: The Carbon Cycle" prior to this lesson to help students make deeper connections to how increasing human energy consumption impacts the earth and its systems.
2. Complete the Inside Energy lesson, "Lost in Transmission" to explore the efficiency of

	our current energy grid and to understand how much energy is lost in relationship to how much we use. 3. Research the potential and actual effects of increasing carbon dioxide in the atmosphere. 4. Conduct an energy audit for the school or for have students conduct an audit for their own home to determine how much energy they use and where energy usage could be more efficient. **Evaluate** student understanding of concepts as they apply what they have learned and consider what they still do not know.
Evaluation	Teacher and students should evaluate student learning throughout the lesson.

TEACHER RESOURCES

BSCS 5E Instructional Model [1]
The BSCS 5E Instructional Model: Personal Reflections and Contemporary Implications[2]
U.S. Energy Information Administration FAQs[3]

STANDARDS ALIGNMENT

Colorado State Science Standards

SC09-GR.6-S.3-GLE.3 Earth's natural resources provide the foundation for human society's physical needs. Many natural resources are nonrenewable on human timescales, while others can be renewed or recycled

SC09-GR.8-S.1-GLE.2 There are different forms of energy, and those forms of energy can be changed from one form to another – but total energy is conserved.

Next Generation Science Standards

MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

National Standards – Benchmarks for Science Literacy

4C/M7 (Grades 6-8): Human activities, such as reducing the amount of forest cover, increasing the amount and variety of chemicals released into the atmosphere, and intensive farming, have changed the earth's land, oceans, and atmosphere. Some of these changes have decreased the capacity of the environment to support some life forms.

4E/M2 (Grades 6-8): Energy can be transferred from one system to another (or from a system to its environment) in different ways: 1) thermally, when a warmer object is in contact with a cooler one; 2) mechanically, when two objects push or pull on each other over a distance; 3) electrically, when an electrical source such as a battery or generator is connected in a complete circuit to an electrical device; or 4) by electromagnetic waves.

[1] https://bscs.org/bscs-5e-instructional-model
[2] http://static.nsta.org/files/sc1408_10.pdf
[3] https://www.eia.gov/tools/faqs/faq.cfm?id=667&t=6