Lesson 8: Energy: We're All Connected – *Energy Knowledge into Action*

Overview

In this lesson, students examine the personal and collective, direct and indirect aspects of energy use and the implications of energy use in terms of sustainability and overall impact on our planet. They deepen their understanding of energy through the examination of renewable and nonrenewable energy sources. Finally, students put their energy knowledge into action through the development of a culminating display intended to makes others aware of the pervasive connections people have to energy and its use.

Teacher Background

Living within the Earth's limits and protecting the Earth for the future are key aspects of sustainability. Sustainability is a word that has different meanings to different people; people do not necessarily agree on its definition. However, the way people use energy is indisputably a major piece of sustainability. From an energy perspective, sustainability includes thinking about how best to ensure an adequate energy supply for everyone on the planet -now and in the future - while protecting the environment. Sustainability often refers to using the Earth's resources in such a way as to not deplete them or cause irreparable damage or pollute the Earth. At **www.sustainabletable.org** sustainability is described in this way: "*The ability to provide for the needs of the world's current population without damaging the ability of future generations to provide for themselves. When a process is sustainable, it can be carried out over and over without negative environmental effects or impossibly high costs to anyone involved.*"

While many people recognize a number of issues around energy use today, they may not regularly consider the cumulative effects of an individual's energy use, "hidden" or "indirect" energy use, or take into account the growing number of energy "users" – processes, products, and people that have dramatically increased the energy demands on the planet. Never before has there been a more important time to seriously examine our collective energy use, as the way we use energy is undeniably impacting the Earth and jeopardizing its sustainability. Our global dependence on fossil fuels presents an environmental problem. As fossil fuels are burned, carbon dioxide gas and particulate matter is released into the air. Carbon dioxide builds up in the atmosphere creating a blan-

ket that traps heat. Scientists believe that the excessive build up of "greenhouse" gases like carbon dioxide is the primary cause of global warming. Elevated amounts of particulate matter in the air contribute to health problems, such as asthma, and contribute to acid rain and global warming. Smog is the direct result of dust and smoke released into the air from burning fossil fuels.

Middle school students have undoubtedly heard terms such as sustainability, energy –efficiency, global warming, greenhouse gases, and climate change. Be advised that the topic of climate change and global warming is disturbing to many students. Consider the following recommendations outlined in the Edutopia article *"Truth and Consequences: Teaching Global Warming Doesn't Have to Spell 'Doom' "* as this subject matter is broached. The article suggests being selective and honest about what is shared. Focus conversations on positive things that are happening, and give students something tangible they can do to make a difference. This may reduce fears. (Visit http://**www.edutopia.org/global-warming-fear** to read the article in its entirety.)

This culminating lesson pulls together several concepts that have been developing throughout the *Energy for Maine* unit. A comparison of students' typical energy use to that of a person from a developing country links personal energy use to collective energy use on the planet. Demand for energy continues to increase as new ways of using energy emerge and as more of our world develops. A close examination of the "hidden" or "indirect" use of energy deepens students' recognition of energy connections and sets the stage for revisiting and expanding upon the connections between their Energy Discovery Box item and energy. An in-depth look at renewable and nonrenewable energy sources enables students to add another layer of understanding to energy consumption. Students create a product showcasing their knowledge of and aimed at teaching others about energy and its pervasive presence in everything we do.

There are a number of activities built into this lesson to provide a concrete way for engaging middle school students in a complex topic – the need to use energy responsibly. Depending on students' familiarity, proficiency, and interest, certain components of this culminating lesson can be abbreviated, omitted, and/or expanded. Students need to feel empowered and recognize that their actions to conserve and use energy efficiently do indeed make a difference to the overall health and sustainability of the planet. Using energy wisely is everyone's responsibility and something that all individuals, no matter what their age, can actively do by putting knowledge into action.

Key Ideas

- There are a growing number of energy "users" – processes, products, and people that have dramatically increased the energy demands put on the planet.
- Some energy sources are renewable and some energy sources are nonrenewable.
- It's everyone's responsibility to use energy efficiently or wisely. Conservation of energy is linked to our use of natural resources, which impacts our environment, economy, and national security.

Lesson Goals

Students will:

- see their individual roles in global energy use.
- recognize that energy use changes as countries become more industrialized.
- discover the interconnectedness of their energy demands on energy resources.
- identify and describe steps that can be taken to conserve energy and reasons for doing so.
- create a product that will make others aware of an individual's connections to energy and actions for conserving energy.

Vocabulary

conservation: reduction of wasteful or excessive use of energy resources.

energy efficiency: using less energy to perform the same function.

fossil fuel: a fuel such as coal, oil, or natural gas formed in the earth from plant or animal remains.

renewable resource: resources that replenish in a short period of time as part of natural cycles.

nonrenewable resource: resources that do not replenish as part of natural ecological cycles in a short period of time.

sustainability: using the Earth's resources in such a way as to not deplete them, cause irreparable damage, or pollute the Earth.

Preparation

1. Locate and review "A Day in the Life of Terese." http://www.geni.org/globalenergy/research/ruralelectrification/adayinthelife/index.shtml. Prepare to read the first few paragraphs of the article, stopping perhaps at "The Consequences" section. Also consider omitting the second sentence in boldface type: **"Terese's day is built around chores that become obsolete with electricity."** As the article is discussed, students will come to this conclusion.

2. Preview Energy Source online resources (see Step 4) and gather additional print and human resources, if applicable for students to use.

3. Gather students' annotated drawings of their Energy Discovery Box items.

4. Review the culminating student project description and criteria. Decide on the level of student choice in the final project. Modify Student Handout 8.3: The Energy Connection accordingly. Gather appropriate print, online, and human resources to support students.

5. Determine a format and audience for the public sharing of students' culminating project. Sharing can take a variety of forms, depending on time and space available. Students may present their final projects to one another, to another class, and/or to an outside audience (e.g. parent night, PTA, administrators, town officials, etc.).

Materials

Item	Quantity
Scientist's Notebook	1 per student
Computers with Internet access	1 per student or pair of students
Student Handout 8.1: A Washing Machine's Energy Pathway	1 per student
Student Handout 8.2: Evaluating Energy Sources	1 per student
Energy Discovery Box Items (from Lesson 1)	1
Students' Annotated Drawings of Discovery Box items (from Lesson 1)	1 for the class
Student Handout 8.3: The Energy Connection Project Guidelines and Sample Rubric	1 per student

Safety

No specific safety guidelines for this lesson.

Time Required: 4-6 sessions

Session 1: comparison of energy use, introduction to "hidden" or "indirect" energy use

Session 2: research, evaluation and discussion of energy sources

Session 3: brainstorm session about energy literacy, introduction of the energy connections culminating project

Sessions 4-6: work sessions for and presentation of culminating project

Connection to *Maine Learning Results (MLR), National Science Education Standards (NSES)* and *Benchmarks for Science Literacy (BSL)*:

- Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. NSES F (5-8)
- Industrialization brings an increased demand for and use of energy. Such usage contributes to having many more goods and services in the industrially developing nations but also leads to more rapid depletion of the earth's energy resources and to environmental risks associated with some energy resources. BSL 8C/H4* (9-12)
- Different ways of obtaining, transforming, and distributing energy have different environmental consequences. BSL 8C/M2 (6-8)
- Some resources are not renewable or renew very slowly. Fuels already accumulated in the earth, for instance, will become more difficult to obtain as the most readily available resources run out. How long the resources will last, however, is difficult to predict. The ultimate limit may be the prohibitive cost of obtaining them. BSL (SFAA) 8C/M10** (6-8)
- By burning fuels, people are releasing large amounts of carbon dioxide into the atmosphere and transforming chemical energy into thermal energy which spreads throughout the environment. BSL 8C/M11** (6-8)
- Sunlight is the ultimate source of most of the energy we use. The energy in fossil fuels such as oil and coal comes from energy that plants captured from the sun long ago. BSL 8C/H8** (9-12)

Teaching The Lesson

Engage

1 Compare and contrast energy use of Maine students to that of a person from a developing nation.

Explain to students that they will listen to a narrative "Energy Snapshot" from woman named Térese. Make note that students will learn more about Térese after they've listed to the narrative.

Read the first few paragraphs of the article, omitting the second sentence in boldface type: *"Térese day is built around chores that become obsolete with electricity."* As the article is discussed, students will come to this conclusion. Stop reading the article just before the section *"The Consequences."*

After reading the article, ask students to share their reaction to Térese's story. Include the following in the discussion:

- *How does the energy used by Térese compare to the energy used by a Maine teenager or young American adult on a typical day?* Encourage students to think about the snapshots they created in earlier lessons as they discuss differences.
- *What do you think accounts for this difference?* Accept students' answers. Bring to the discussion the term "developing nations." Clarify what is meant by "developing nations" as students may not be familiar with this idea.
- *In what ways do you think a nation's energy use changes as it develops?* Discuss with students the idea that as countries like Térese's develop, their energy use changes and the demand for energy sources increases. It may be helpful to have students give specific examples of devices that may be introduced in developing countries and how their implementation and/or availability impacts energy use. For example, a grain-grinding machine was mentioned in Térese's story.

Make certain that students recognize that the way all people use energy is part of the global energy picture.

Note: *As the idea of developing nations is being discussed, make certain that students do not misinterpret "developed" or "industrialized" to mean "superior." Bring to students' attention that countries around the world have different lifestyles, ideas, and beliefs about*

what things enhance their quality of life. While progressing toward a more industrialized society may have benefits, there are also drawbacks that need careful consideration.

2 Connect efficiency data collected in Lesson 7 to personal energy use.

Have students consider the specific electrical energy measurements they made by investigating electrical nameplates and using the Kill A Watt meters. Discuss the following:

- *In what ways do you think we, as people living in a developed or industrialized country, use electricity or energy inefficiently or unnecessarily?* Accept students' answers but make certain that they back up what they say with evidence and/or reasoning. Encourage students to refer to their energy measurements and/or Energy Star label findings as evidence.
- *Are there tasks that you or your family do that could be accomplished by using energy differently or perhaps using a different form of energy?* The idea here is to get students to begin to consider some different ways tasks can be done using less energy or using energy that is not energy generated by a power plant. (ex: hanging clothes outside to dry rather than using an electric dryer, combining errands to conserve gasoline, taking a shorter shower to reduce energy needed to heat hot water, etc.) Ask students to work in small groups to brainstorm a list. Discuss students' ideas as a large group. Discuss the practicality, benefits of, and trade offs for various ideas.
- *Do you think industrialized nations' energy use will continue to climb?* Accept students' answers, again making certain they back up what they say with evidence and/or reasoning.

Consider sharing with students the statistic from the Teacher Background in Lesson 6: "The United States has 5% of the world's population yet accounts for 30% of the energy used worldwide" or this quote from Maurice Strong, Senior Advisor to the United Nations and World Bank: "A citizen of an advanced industrialized nation consumes in six months the energy that has to last the citizen of a developing country his entire life." Help students make the connection that if industrialized nations' energy use is projected to increase and developing countries' energy use increases, the global energy demand will only become greater - and that this is problematic.

Summarize this opening discussion by making sure students recognize that our need for and interactions with energy is something that connects all people, regardless of where they live and that because there are limited energy resources on Earth, it is everyone's job to use energy responsibly.

Explore

3 Introduce "hidden" or "indirect" energy use.

Ask students: *Do you think the energy measurements captured all of the energy associated or connected to a particular task? In other words, what "hidden" or "indirect" ways can you think of that energy has been used in association with a particular task?*

The idea here is to begin to get students thinking about an objects' energy pathway. Provide students with an example to get them started. Encourage students to add to the following example as they get the idea:

If a task involved using a washing machine to wash clothes, not only does the machine use electricity but energy is also used when the water pump in the basement starts up to work to fill the machine. If the clothes are being washed in warm or hot water, the water heater burns heating oil (a fossil fuel) in the furnace to heat up the water. The washing machine came from the appliance store in town and the store received the machine from a washing machine manufacturer. The washing machine was transported to the retail store and the person's home by a delivery truck that burned gasoline or diesel fuel (a fossil fuel).

How are washing machines made? Washing machines are made up of individual washing machine parts. Some of the parts are made of metal, some are made of plastic. Energy is used in the mining of the raw materials for the metal, in the transport of the raw materials to a steel plant, and in the transport of the sheet metal used for washing machine parts to the manufacturer. The plastic parts such as the control knobs, hoses, and sealants, are made from petroleum. Plastic parts are also made off site, packaged and shipped to the washing machine manufacturing facility. Energy is used to put all of the smaller parts together (sub-assembly) to the make bigger parts (assembly) of the washing machine. These activities take place in a washing machine manufacturing facility that requires electricity to light the building and operate the facility and fuel to heat and cool the facility. Workers drive to and from the washing machine facility. Washing clothes also involves using a detergent…. and so on.

Note: *Consider eliciting the help of student volunteers to take turns describing various aspects of the washing machine's energy pathway by reading the script found on Student Handout 8.1: A Washing Machine's Energy Pathway.*

4 Connect energy use with energy sources.

Say to students: *"You are becoming more and more aware of how everything we do and have is connected to energy. Energy is used in the production of materials, to fuel transportation, to warm our homes and businesses, and to power a myriad of electronic devices. At the beginning of this lesson, another aspect of energy use was introduced – the idea of increased demand for energy due to an increasing number of people using energy."*

Say to students: *In addition to looking at the way people use energy, it is important to consider the sources of energy.* Write the following focus questions on the board:

- *What sources fuel our energy use?*
- *What are the benefits and drawbacks of using these sources?*

Provide each student with a copy of Student Handout 8.2: Evaluating Energy Sources. Explain that students will work with a partner to complete the question set for one of the energy sources listed on the handout. Emphasize the importance of each pair working in a thorough way as others in the class ultimately depend on them for information about the particular energy source they researched. Each pair should use the questions on their handout to prepare for a 3 minute "briefing" about their energy source. Students may want to include in their briefing a picture representative of their energy source. As the energy sources are selected by or assigned to students, review what fossil fuels are and remind students that energy sources are categorized as renewable or nonrenewable.

Note: *Amend Student Handout 8.2 to reflect energy sources about which students can readily access information. If necessary, omit tidal and hydrogen depending on the availability of comprehensible resources. Consider supplementing with select print material.*

Direct students to the web resources below listed on the *PowerSleuth* website under *Energy for Maine*, Lesson 8.

Energy Sources
http://tonto.eia.doe.gov/kids/energy.cfm?page=2

Energy Info Zone
http://www.sciencemuseum.org.uk/on-line/energy/site/EIZinfogr.asp

Renewable Energy Resources
http://www.nrel.gov/learning/

Chewonki's Interactive Renewable Energy Poster
http://www.chewonki.org/pathways/interactive_poster/default.shtml

What You Need to Know About Energy from the National Academy
Select "Sources"
http://needtoknow.nas.edu/energy

US DOE: Renewable Energy
http://www.energysavers.gov/renewable_energy/

Connecticut Energy Education
http://www.ctenergyeducation.com/video_games.htm

Energy Resources
http://www.darvill.clara.net/altenerg/

Assist students as needed as they complete their research and plan for their 3 minute presentations.

5 Present and summarize energy sources findings.

Review the logistics of the energy source briefing presentations. Instruct students to jot down key notes in their scientists' notebooks about each energy source as each group is sharing information. Explain that at the conclusion of the briefings, students will be engaging in a discussion about future energy demands. Students will be expected to use their notes to support their thinking.

Once all student groups have shared their briefings, discuss the following with students:

- *Why do you think a variety of materials or substances are used as energy sources?* Accept students' answers and help students surface some of the benefits and drawbacks of various energy sources. Make certain that students recognize that there are no perfect solutions to meeting people's ongoing energy needs. As energy consumers we have some choice about the energy sources we use to meet our energy needs. When making these choices, there are several factors that need careful consideration.

Reflect and Discuss

6 Brainstorm why "energy literacy" is important.

Distribute one piece of chart paper and a marker to each group of 4. Direct each group to list reasons why they should be cognizant of their energy use. Ask *"Why," in terms of thinking about the way we as individuals, as Maine residents, and as people living on the Earth, should we think about the way we use energy. Why is it important that people understand energy and know about how it is used?*

Allow students 5 minutes to brainstorm a list. Post, review, and summarize students' lists. Leave these lists posted as they will serve as a reference to students' final project.

Consider revisiting Palmer Putnam podcast (www.powersleuth.org, *Energy for Maine,* Lesson 6.) Ask students to think about the narrator's comment "We (the world) use a lot of energy… but it is bad?")

7 (Optional) Connections to conservation and using energy efficiently.

Provide each student with a copy of Student Handout 8.1: A Washing Machine's Energy Pathway. Ask students to reexamine the description and to make suggestions as to how energy could be used more efficiently or conserved at various instances along the washing machine's energy pathway. Encourage students to identify opportunities for redirecting energy more efficiently by underlining passages from the script and writing in the right-hand margin a description of how energy could be used more effectively. Allow students a few minutes to complete this exercise and then discuss some of the students' suggestions.

8 Revisit energy connections of Discovery Box items.

Once again place the Energy Discovery Box in a place visible to all students. Place students initial annotated drawings of the different items next to the box. Say to students: *At the very beginning of the Energy for Maine unit, you were asked to make an annotated drawing showing the energy connections between the item you selected and energy.* Randomly select one of the items out of the box and hold it up. Display the corresponding annotated drawing and say: *Let's reflect for a moment on all that you've learned about energy in the last few weeks. What additional energy connections can you now make? What new questions do you have?* To get students started, review the connections described in the drawing. Ask students to describe the item's energy "trail" – connections to "hidden" and/or "indirect" uses of energy.

- *What energy forms are involved?*
- *What transfers and transformations are involved?*
- *What energy sources are involved?*
- *Are these renewable or nonrenewable resources?*
- *What role do fossil fuels play?*
- *What are the connections to energy efficiency or conservation to this item?*
- *What is the connection to the environment?*

Encourage students to brainstorm as many connections as they can. Ask probing questions to help students extend their thinking. If new questions about the item arises, ask students how they can find out. Suggest that students do additional research to clarify and/or to add to their existing knowledge.

Ask students: *Do you think people are aware of the energy connections of the items they use every day? How do you think people might use items differently if they recognized the energy connections of every day items?* Accept students' answers.

Ask: *What other items could be put in the Energy Discovery Box and why?* Students should clearly recognize that anything they put in the box has extensive energy connections.

9 Introduce culminating project.

Distribute a copy of Student Handout 8.3: The Energy Connection to each student. Explain that students are to create a product to "make public" the energy connections of a particular item. Students may use their Energy Discovery Box item or be allowed to select an item of choice (pending teacher approval). Point out that the Discover Box items were chosen because they have interesting and intriguing (often not obvious) energy connections. If students are allowed to select new items, encourage them to select items that perhaps have interesting or intriguing connections as well. If students are allowed to choose a new item, it may be helpful to brainstorm items with them. Remind students that they can add additional energy connections to the Discovery Box item they already chose.

Review the project criteria and rubric outlined in Student Handout 8.3. Students will create a product clearly showing the energy connections for a selected item. Students may create a tri-fold table top display, PowerPoint or Keynote presentation, comic strip using Comic Life, an "infomercial" (short video clip), pamphlet, or other approved product. Students may use print and online resources or consult with local experts to research and fortify additional energy connections.

Answer students' questions and clarify criteria. Make certain that students recognize their product needs bring about an awareness of their item's energy connections and relate efficiency issues to their item.

10 Share projects.

Once students have completed their projects, have students share them. Consider involving students in making the decision about how their products will be shared. Ask students to reflect on their efforts and make suggestions as to how the products they created can be made public to a wider audience. Public sharing is a positive action that empowers students and can bring about energy-saving actions in the school and community.

Extension

Students may:

- identify "ordinary" items around the school and create engaging "posters" using Comic Life describing the energy connections to the ordinary item and energy. The poster would offer tips related to energy conservation and efficiency. For example, posters could be developed and placed near light switches, water fountains, recycling bins, doors or windows, computers, and in cafeterias to promote buying locally grown foods, etc.
- Take the "It's Up2me for kids" challenge. Students may learn how to initiate change in their school or community by taking one of several challenges outlined on the Up2me site. Learn how to reduce waste, energy use, car travel and water use. Generate ideas about how to grow food and take care of the biodiversity in the home and school environments. http://www.up2meforkids.com.au/
- learn simple measures they can take to conserve energy. http://www.powerscorecard.org/reduce_energy.cfm
- participate in NEED's Great Energy Debate. Students critique the advantages and disadvantages of the major energy sources in an innovative debate format. http://www.need.org/Guides-Grade.php.
- investigate the history of energy by visiting the Energy Information Administration's Energy for Kids Energy Timelines page: http://tonto.eia.doe.gov/kids/energy.cfm?page=timelines.
- plan for an Energy Fair. Determine a purpose for holding an Energy Fair. Who would be the audience? Where and when would it take place? What types of displays would be included? What community groups, individuals, and/or businesses can be elicited for help?
- compare the energy use in terms of kWh and oil of various household devices and receive tips on ways to optimize the way energy is used for these devices. This interactive tutorial accompanies PBS's Frontline episode "What's up with the Weather" and includes carbon dioxide emissions. http://www.pbs.org/wgbh/warming/carbon/playalready.html

Connection to Maine Agencies

MEEP (Maine Energy Education Program) has a Great Energy Debate Game (4th to 12th grade). What are the pros and cons of renewable versus nonrenewable resources? In this debate, students take on the real world challenge of convincing others that a particular energy source is the best choice for their situation. A MEEP representative will come to interested schools, free of charge, to guide this activity.

MEEP also has a Coal-Fired Power Plant Activity. Students learn how electricity is made in a power plant and discuss the pros and cons of using coal. Then they discover alternative ways to spin a turbine to run a generator. For more information contact MEEP at www.meepnews.org/classroomactivities

For schools in Aroostook County, a Maine Public Service (MPS) representative will come to interested schools, free of charge, to guide and support concepts developed in this lesson. A description of programs is available at www.mainepublicservice.com. Click on the education section of the site. To schedule a presentation contact Nancy Chandler at 207.760.2556 or nchandler@mainepublicservice.com.

Online resources and references

Portions of this lesson modeled after Climate Change North's "The Energy Trail" intermediate lesson plan. http://www.climatechangenorth.ca/section-LP/LP_11_HI_S_energy.html

The Sustainable Table
http://www.sustainabletable.org/home.php

eHow
http://www.ehow.com/how-does_5001829_how-washing-machines-made.html

Reference with clickable graph showing Global Energy Demands broken down in various views http://news.bbc.co.uk/2/hi/science/nature/3995135.stm