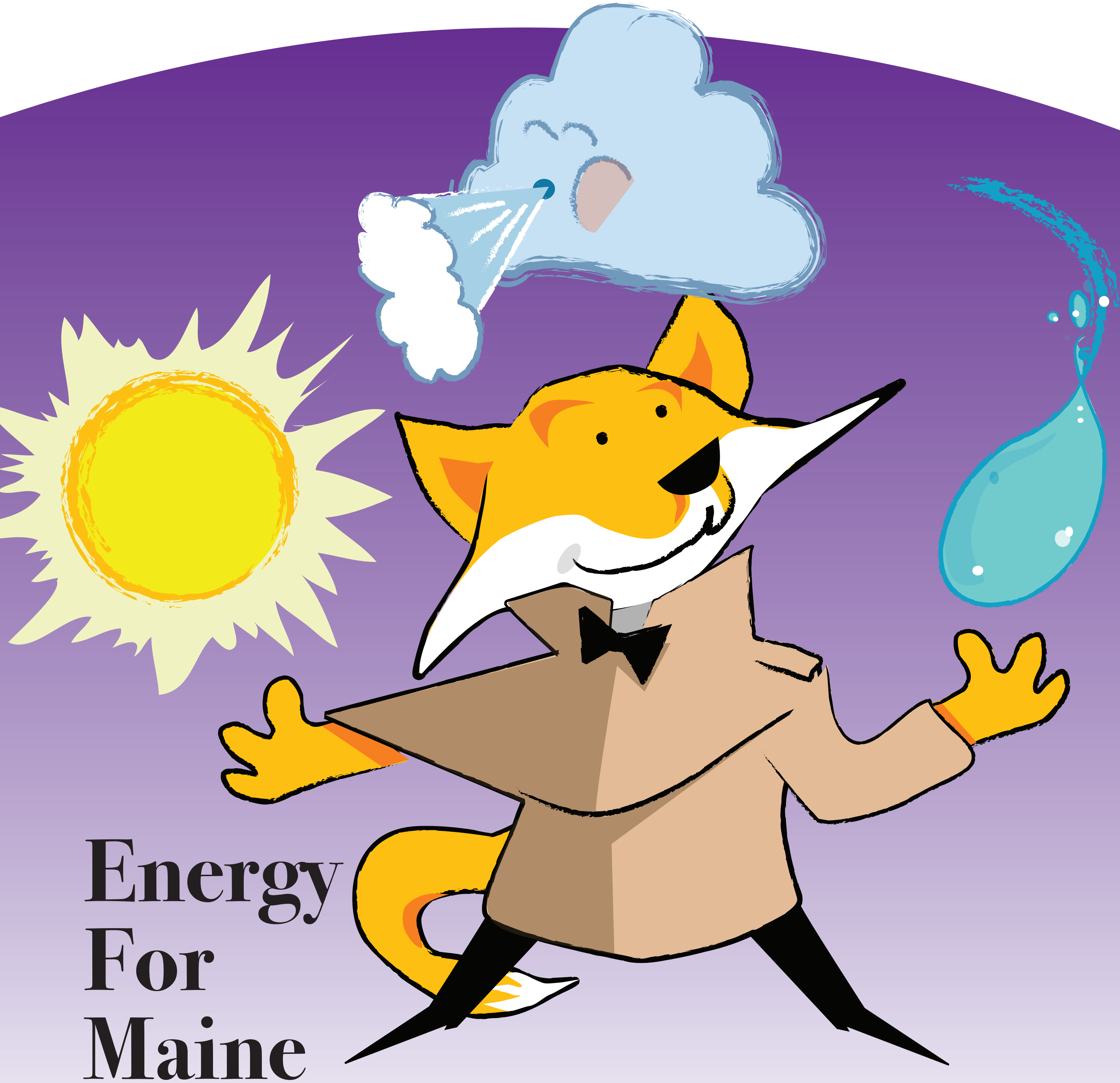
PowerSleuth



Energy For Maine

Curriculum Guide

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Energy For Maine is available for download at no cost at www.powersleuth.org

Energy For Maine

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PowerSleuth

Energy Education Curricula for Maine Students in Grades 4-8

Introduction

Developing an understanding of energy as a source of light, heat, and power is essential for making advancements in energy-related technology and for making responsible and informed decisions about its use. The Sun is the initial source of all light and heat energy on Earth. Harnessing that energy for power and using that power to satisfy the wants and needs of humans requires a conceptual understanding of energy. *Benchmarks for Science Literacy* states: "Energy is a mysterious concept, even though its forms can be precisely defined and measured....Although learning about energy does not make it less mysterious, it is worth trying to understand because a wide variety of scientific explanations are difficult to follow without some knowledge of the concept of energy."

PowerSleuth presents energy concepts that have been identified as essential knowledge in the state and national science standards for students in grades 4-8. *Maine Learning Results: Parameters for Essential Instruction* is the resource for the state standards, and *Benchmarks for Science Literacy* and the *National Science Education Standards* are the sources for the national standards. Through this curricula, students develop a conceptual understanding of energy while, simultaneously, becoming aware of the pervasive use of energy in their lives and strategies to use energy wisely and efficiently.

Background

The *PowerSleuth* curricula were developed as part of a three-year project, funded by Efficiency Maine, a program of Maine's Public Utilities Commission (PUC). The project's primary goal was to develop a coherent set of standards-based energy education curriculum materials and companion website (**www.powersleuth.org**) for Maine students in grades 4-8. Three units were developed: *Energy Lights Maine* for grades 4-5; *Energy Heats Maine* for grades 6-7; and *Energy for Maine* for grades 7- 8. Each curriculum unit consists of 9 lessons that follow a conceptual storyline mindful of Maine students and designed with consistent pedagogy. The lessons are research-informed and aligned with the 2007 *Maine Learning Results: Parameters for Essential Instruction*. Although the curriculum units were designed for specific grade spans, teachers can use them flexibly across the 4-8 grade levels. Several agencies across Maine served as content advisors to the Maine Mathematics

and Science Alliance in making connections to Maine's energy context including the Maine Public Utilities Commission, Maine Energy Education Program, Maine Public Service, Maine Department of Environmental Protection's Air Quality Division, and the Maine Lung Association. The *PowerSleuth* materials were reviewed and field tested by Maine educators. The development of a connected, coherent set of energy education curriculum materials designed with a conceptual flow establishes an important and necessary teaching resource for teachers in Maine and beyond.

Instructional Goals

Students will:

- understand essential energy-related concepts identified in state and national standards
- identify uses of energy in their Maine-based daily lives
- become aware of the efficient and responsible use of energy

Inquiry-Based Instructional Model

The lessons in these units are inquiry-based to help students construct an understanding of energy related concepts through direct experiences over time. The content of the lessons target essential knowledge about energy as identified in state and national standards. Through the experiences provided to the students, common misconceptions about energy related concepts are also addressed.

"Scientific inquiry refers to the activities of students in which they develop knowledge and understanding of scientific ideas as well as an understanding of how scientists study the natural world." (*National Science Education Standards*). The format of the *PowerSleuth* lessons supports an inquiry-based instructional model, and each lesson includes three phases. The first phase, Engage, sets the stage for learning by providing a common experience for all students, generating interest in the focus of the lesson, and eliciting prior knowledge. Providing a common experience for all students at the beginning of each lesson allows students from various backgrounds, interests, and expertise to make predictions, based on that experience, during the upcoming science investigations and offers all students an equal opportunity to learn. In addition, research on how students learn science shows that when students are expected to identify their current understanding of a concept, their awareness of how their own thinking changes over time is enhanced as they confront situations that challenge that current understanding. The second phase, Explore, is designed to provide students with direct, hand-on experiences that help build conceptual understanding of energy related concepts. During this stage, students carry out focused investigations that target the specific learning goal identified in each lesson, collecting, organizing, and analyzing data related to each investigation. The last stage, Reflect and Discuss, brings closure to each lesson as students reflect on the claims they generate, based on their data, and supported by the evidence they collected during their investigations. Students draw conclusions that reveal their conceptual development.

Scientists' Notebooks and Science Talk

Two specific features are incorporated into each lesson. The scientist's notebook is a place where students record all aspects of each investigation, including their evolving understanding of the targeted concept. Entries include predictions, focus questions, data, observations, drawing, claims, evidence, conclusions, and reflections. Several student recording sheets are included in these lessons. These can be inserted into students' notebooks without modifications, revised to make them more student-directed, or eliminated in favor of open-ended student entries into the notebooks. Several informative resources are available that provide background information on scientists' notebook as well as suggestions for implementing the notebook strategy in the classroom. Teachers are encouraged to refer to these resources:

Campbell, B., and Fulton, L. (2003). *Science notebooks: writing about inquiry.* Portsmouth, NH: Heinemann.

Fulwiler, B. (2007). *Writing in science*. Portsmouth, NH: Heinemann.

Klentschy, M. (2008). *Using science notebooks in the elementary classroom.* Arlington, VA: NSTA Press.

Worth, K., Winokur, J., Crissman, S., and Heller-Winokur, M. (2009). *Science and literacy – a natural fit: A guide for professional development leaders*. Portsmouth, NH: Heinemann.

Science talk through discussions is an essential component of the inquiry process. Besides being a rehearsal for writing, it provides a vehicle for students to develop academic vocabulary specific to the discipline of science. It also provides an opportunity for all students to enhance their verbal fluency and skill. This is particularly critical for students who are learning English as a second language, for students with special needs, and for those who need language enrichment opportunities. Demonstrations by students with concrete materials as they are explaining an idea to their classmates often enhances the clarity of the explanation, connects specific words to specific objects, and encourages students into using more precise vocabulary as they talk.

Lesson Planning and Pacing

For planning purposes, each lesson is divided into a certain number of sessions. Each session is designated as a 40-50 minute instructional period. Some lessons require one or more sessions to teach. Those that require more than one session often have suggestions as to how the lesson can be divided into multiple instructional periods. The actual number of sessions a lesson spans will depend on the prior experiences of students and the depth of instruction.

Formative Assessment

In an era of accountability, educators agree that assessment is an integral part of the educational experience for students. Formative assessment strategies help teachers become aware of students' current thinking about an idea or concept and guide instructional decisions. Seeing the connection between the variety of ideas that students often bring to a new learning experience and the targeted learning goal contributes to the design of effective learning experiences for all students. *PowerSleuth* incorporates several formative assessment strategies throughout the units. The source for several of these techniques is *Science Formative Assessment* (Keeley, P. 2008), a valuable resource for teachers with an interest in expanding their repertoire of formative assessment strategies. Another valuable reference is *Uncovering Student Ideas in Science* (Keeley, P.), a series of three books with formative assessment probes designed to elicit students' current thinking about a particular concept. Volumes 1-3 in this series offers probes in life, earth/space, as well as physical science.

Research on Student Learning

Students often come to classroom science with a wide range of preconceptions about everyday science phenomena. Being aware of common misconceptions provides a wealth of knowledge to teachers about their students and the design of learning experiences that will help students develop an understanding of essential science concepts. Research about how students learn science is available and that research base is incorporated in the *PowerSleuth* curricula. All lessons target energy concepts deemed as essential in the state and national standards and are designed to address common misconceptions identified in the research. A rich source of this research is *Making sense of secondary science* (Driver, R. 1994).

Home Involvement

Efforts are made throughout the units to include families in the learning process. However, accommodations in the form of school assistance are required for students whose families cannot, for whatever reason, collaborate in the learning process or establish a supportive learning environment at home. Sensitivity to this issue when assigning home projects is recommended.

Materials and Safety

Most of the materials that are used in the *PowerSleuth* lessons are relatively inexpensive and readily available. It may be necessary to obtain a few materials from a scientific supply company or a local high school science department. Consider using recycled materials and/or purchasing supplies locally when appropriate. Some advanced planning is necessary not only when it comes to gathering materials for lessons, but in thinking about how materials will be stored, distributed, and managed when working with students. Tips and suggestions for managing materials are offered throughout the lessons as a guide.

Specific safety concerns are noted at the beginning of each lesson however, students should be made aware of and follow safety rules according to school policy. The National Science Teachers' Association has several resources regarding elementary science safety. Visit them at www.nsta.org.

PowerSleuth Companion Website

The *PowerSleuth* website, wwwpowersleuth.org, is the online resource to supplement the *Energy Lights Maine*, *Energy Heats Maine*, and *Energy for Maine* modules. The companion website features activities, projects, video clips, links, the lesson plans, and other resources for each of the *PowerSleuth* modules. Teachers are encouraged to check the site frequently for updates and tips from other *PowerSleuth* teachers.

Energy For Maine

Overview

With so much attention devoted to energy topics and our day-to-day interactions with energy, it is tempting to assume that middle school students have a firm understanding of energy. However, helping students develop an understanding of energy is much less straightforward than it may seem for two key reasons:

(1) **Energy is an abstract concept.** The American Association for the Advancement of Science (AAAS)'s *Benchmarks for Science Literacy*, Chapter 4, Section E, notes that "energy is a major exception to the principle that students should understand ideas before being given labels for them. Children benefit from talking about energy before they are able to define it." It goes on to say: "…students should be introduced to energy primarily through energy transformations. Students should trace where energy comes from (and goes next) in examples that involve several different forms of energy along the way: heat, light, motion of objects, chemical, and elastically distorted materials. To change something's speed, to bend or stretch things, to heat or cool them, to push things together or tear them apart all require transfers (and some transformations) of energy" (American Association for the Advancement of Science 1993, p.81,84).

(2) The term **"energy" is used extensively in everyday contexts. Its meaning may seem "scientific,"** but frequently, it is used in a general sense and without precision as people write or speak about energy-related topics.

The *Energy for Maine* instructional unit aims to provide students with cohesive experiences that help them formulate scientifically accurate concepts of energy as they:

- discover the pervasive connections people have to energy and its use.
- consider and monitor their individual roles in energy use.
- attribute changes to an object or substance to energy.
- identify and describe different energy forms.
- differentiate between transfers and transformations and apply the understanding of energy to everyday contexts.
- examine the efficiency of energy transfers and transformations through observation, modeling, and use of tools.
- consider the benefits and drawbacks of various renewable and non-renewable energy sources.
- suggest strategies to use energy responsibly and make others aware of them.

Unlike traditional approaches to energy that focus on performing calculations, *Energy for Maine* employs qualitative observations and extensive mapping and modeling of energy transfers and transformations that occur in everyday situations. It is worth noting that "the ability to do work" is absent from *Energy for Maine's* definition but rather energy is described as "the ability to change an object or substance in some way." Lessons in *Energy for Maine* are designed to help students develop a conceptual understanding of energy using an "interactions" approach. This approach was developed through a National Science Foundation project called Constructing Ideas in Physical Science (CIPS) http://cipsproject.sdsu.edu/default.html. The approach uses "interactions" between objects as the focus for development of physical science concepts such as transfer of energy, energy conservation, properties, material interactions, forces, and so forth. This is a powerful approach; one that allows students to construct knowledge gradually and develop a much richer and more sophisticated understanding of complex ideas. The "interactions" approach allows for the layering of energy concepts using contexts familiar to middle school students.

Lesson 1

Prior to this introductory lesson, administer and review students' responses to the Pre Unit Assessment included in *Energy for Maine*. The Pre Unit Assessment and the activities in Lesson 1 are designed to help reveal students' current perception of targeted energy concepts. As already noted, teaching energy concepts presents many challenges. Research, as summarized in *Benchmarks for Science Literacy*, states: "students' meanings for 'energy' both before and after traditional instruction are considerably different from its scientific meaning (Solomon, 1983). In particular, students believe energy is associated only with humans or movement, is a fuel-like quantity which is used up, or is something that makes things happen and is expended in the process. Students rarely think energy is measurable and quantifiable (Solomon, 1985; Watts, 1983a). Although students typically hold these meanings for energy at all ages, upper elementary-school students tend to associate energy only with living things, in particular with growing, fitness, exercise, and food (Black & Solomon, 1983)." These trends in thinking will likely be initially observed in students' responses. Help students confront these ideas – not by telling them they are faulty – but by guiding students through experiences that allow them to discover more scientifically accepted ideas and develop deeper conceptual understandings.

In this introductory lesson, students examine their current understanding of energy. What is energy, how do we use it, and what connections are there between energy and the items we interact with everyday? After selecting an item (a lump of coal, an energy bar, bottle of water, cell phone, a mitten, etc.) from an "Energy Discovery Box," students brainstorm its energy connections through drawing and discussion. These initial ideas are revisited and improved in Lesson 8. Students begin monitoring their personal connections to energy by keeping a record of the activities they do and thinking about how energy is involved. Students "Energy Snapshots" are analyzed in Lesson 6.

Lessons 2 and 3

Students begin their examination of events and phenomena with respect to energy in a discrete way starting with Lesson 2. Students are introduced to simple "interactions" and practice making claims that attribute an event to energy which they have come to recognize as the ability to change an object or substance in some way. Students support their claims by citing evidence. For example, how do we know that the person's hand interacted with book? The book's motion changed and there was a sound when the book fell. In the second part of Lesson 2, an energy lens is introduced; students practice writing claims and evidence and identifying the energy sources and receivers as they work through a series of "interaction stations" – simple tasks for students to do using familiar objects. The focus shifts to using maps to describe where energy comes from and where it goes. Students begin to recognize that energy receivers can become energy sources.

The concept of energy transfer is made explicit in Lesson 3. After becoming familiar with different forms of energy at the start of the lesson, students use this information to describe energy transfers from energy sources to energy receivers. They become aware that as energy is transferred, it can change form or in other words, it can be transformed. Students revisit the energy descriptions they made for the interaction stations in Lesson 2, adding the forms of energy involved.

Lessons 4 and 5

Students have had many experiences identifying energy sources and receivers and mapping energy transfers and transformations. Lesson 4 transitions students into thinking about engineered energy use and reveals how an understanding of the amount of energy available and how it changes as it is transferred from energy source to an intended energy receiver is beneficial. Students begin the lesson by constructing a rubber band powered spool racer.

They observe its energy interactions and map the energy sources, receivers, transfers, and transformations. They then consider how the amount of energy available at the beginning of the interaction compares to the amount of energy available at the end of the interaction. What happens to the energy? Where are the energy increases and energy decreases? Students begin to develop the idea that energy is not lost but rather is being transferred to "unintended" places or transformed to "unintended" forms; energy cannot be created or destroyed. Students begin to link "unintended" effects with efficient energy use as changes in available energy are discussed and modeled.

In Lesson 5, students try their hand at engineering energy transfers and transformations through the creation of an "efficient" water wheel. This lesson has two major goals: the first is to provide students with the opportunity to experience a technological design process as they observe, design, and build a working model water wheel. The second is to provide a context for students to compare, in a relatively simple way, the efficiency of their models in terms of energy. After being introduced to the criteria their water wheel must meet, students decide as a class how the "most efficient" water wheel will be determined.

Lessons 6 and 7

Lesson 6 opens with a look at the "Energy Snapshots" students have been developing. As students examine their snapshots, they recognize how reliant they are on energy, in particular electrical energy. Through discussion of a podcast, students reflect upon how energy use has changed throughout the last 200 years and predict what energy use trends can be anticipated in future years as they think about energy use on a much larger scale. After reviewing energy use data from Maine and the United States, students discover how reliant all sectors (residential, commercial, industrial, transportation) are on electricity and fossil fuels as energy sources.

In the second part of Lesson 6, students investigate the various methods of generating electricity and the efficiency of the energy transfers and transformations involved in the process. Through an exercise that models the efficiency of transfers and transformations for the various components of the electricity generating process, students become aware of the impact even small improvements in efficiency may have on meeting energy demands.

In Lesson 7 students determine how much electricity a particular device uses by reading electric nameplates and using Kill A Watt meters to monitor electrical energy consumption. (Kill A Watt meters have been provided to public and middle and high school libraries in Maine through Efficiency Maine.) Students also use the meters to determine if a device draws electricity even when switched "off." The effects of parasitic or phantom loads are cumulative, and students suggest strategies to minimize and/or eliminate them.

Lesson 8

In this culminating lesson, students synthesize several aspects of energy use – personal, collective, direct and indirect and consider the implications of energy use on the planet. Do people around the world use energy in the same way? Do people "use" energy without realizing it? How much energy is associated with various products and services? What resources do we use for energy? What are the benefits and drawbacks of various energy sources? Will the future bring a greater demand for energy and if so, how will we meet this demand?

Several developing concepts converge in Lesson 8 to broaden students' view of energy and its use. Students examine a snapshot of energy use from a person in a developing country. This serves two purposes: 1) it reminds students that access to (electrical) energy varies across the world and 2) the demand for energy continues to increase as new ways to energy emerge. Investigation 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 put their energy knowledge into action by creating a product showcasing their knowledge of and aimed at teaching others about energy and its pervasive presence in everything we do.

America's dependence on foreign oil, development of alternative energy technologies, demand for sustainable energy choices, examination of climate change, awareness of ways to "go green", and efforts for reducing our carbon footprint, etc. are inextricably linked to energy. Certainly, these more abstract and complex connections surface in conversations about energy. While it is tempting when teaching about energy to delve into the complexities of these topics, keep in mind that even adults when pressed to explain such connections are unable to do so. The lessons in *Energy for Maine* are intended to develop foundational knowledge that students will draw upon in later grades to build a more sophisticated energy picture. Students' experiences with energy transfers and transformations will take them far in as they add to their energy understandings over time.

A quote from the National Resource Council's informational booklet *What You Need to Know about Energy* sums up the importance of having a well-developed understanding of and familiarity with energy: "American society, with a standard of living unprecedented in human history, can attribute a large measure of its success to increasingly sophisticated uses of energy. The strength of industry, the speed of transportation, the myriad of comforts and conveniences of home and workplace, and the security of the nation all derive from ever more ingenious provisions and application of various sources and forms of energy" (National Academy of Sciences 2008, p.2).

Lesson Matrix

Overview	Key Ideas	Lesson Goals Students will:	Connection to Learning Goals from • *Benchmarks for Science Literacy (BSL)*, • *National Science Education Standards (NSES)*, • *Maine Learning Results (MLR)*, • and *Science for All Americans (SFAA)*
Lesson 1: **The Energy Connection** *(1-2 sessions)* This introductory lesson uses an "Energy Discovery Box" to engage students and elicit their ideas about energy. Students randomly select items from the box and discuss how they think each relates to energy.	• Despite the fact that energy is something people are seemingly quite familiar with, developing an understanding of energy is challenging and occurs over time. • Energy is in some way connected to all physical objects and processes in the universe.	• explore their current ideas about energy. • begin to examine people's interactions with energy.	• Energy is required for technological processes such as taking apart, putting together, moving around, and communicating. BSL (SFAA) 8C/M7** (6-8) • Describe several different types of energy forms including heat energy, chemical energy, and mechanical energy. MLR D3(6-8) h
Lesson 2: Investigating Interactions Between Objects *(3 sessions)* Students examine "interactions" between objects and practice making claims with supporting evidence. In the second part of the lesson, students link interactions to energy as they practice identifying the energy sources and the energy receivers in different situations.	• Energy is the ability to change an object in some way. • When objects interact they act on or influence each other to cause an effect; a change. • Scientists describe interactions between objects by making claims supported by evidence. • Evidence that an interaction occurred usually includes one or more (observable) changes in one or both of the objects. Examples include changes in motion, sound, temperature, size, shape, illumination, and color or pattern. • In an interaction there is an energy source and an energy receiver.	• describe energy as the ability to change an object in some way. • recognize the influence (mutual or reciprocal action) that objects have upon one another as an "interaction." • practice making claims based on evidence. • describe interactions in terms of energy. For example, energy sources and energy receivers can be identified for various interactions. • recognize that objects can be both an energy receiver and an energy source.	• Present a brief scientific explanation orally or in writing that includes a claim and the evidence and reasoning that supports the claim. BSL 12D/M6** (6-8) • Notice and criticize the reasoning in arguments in which the claims are not consistent with the evidence given. BSL 12E/M5b* (6-8) • Energy is a property of many substances and is associated with heat, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways. NSES B (5-8) • Describe several different types of energy forms including heat energy, chemical energy, and mechanical energy. MRL D3 (6-8) h

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Overview	Key Ideas	Lesson Goals Students will:	Connection to Learning Goals from • *Benchmarks for Science Literacy (BSL)*, • *National Science Education Standards (NSES)*, • *Maine Learning Results (MLR)*, • and *Science for All Americans (SFAA)*
Lesson 3: Energy Takes Many Forms *(3 sessions)* Students revisit the energy descriptions and maps they made for the interaction stations in Lesson 2 and identify the forms of energy involved. Students begin to consider the energy transformations that take place as energy is transferred.	• Energy exists in many forms. • Energy can move from one place, object, or system to another. • Energy can change from one form to another.	• identify and describe different forms of energy including chemical, elastic, electrical, gravitational potential, heat, light, and motion. • recognize that energy moves from place to place and changes forms to make things happen.	• Energy appears in different forms and can be transformed within a system. Motion energy is associated with the speed of an object. Thermal energy is associated with the temperature of an object. Gravitational energy is associated with the height of an object above a reference point. Elastic energy is associated with the stretching or compressing of an elastic object. Chemical energy is associated with the composition of a substance. Electrical energy is associated with an electric current in a circuit. Light energy is associated with the frequency of electromagnetic waves. BSL 4E/M4 (6-8) • Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways. NSES B(5-8) 7 • Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced. NSES B(5-8) 10 • Describe several different types of energy forms including heat energy, chemical energy, and mechanical energy. MLR D3 (6-8) h
Lesson 4: Mapping Energy Increases and Decreases *(2-3 sessions)* In this lesson, students begin to consider the how the amount of energy available changes as it is transferred from an energy source to the intended energy receiver. Students discover that not all of the energy available from a source is transferred to the receiver in useful forms.	• When an interaction occurs, there is a decrease in some forms of energy in the source and an increase in some forms of energy in the receiver as energy is transferred from one object to another. • Not all the energy that goes into a device or process gets used in the way that people intend. As energy is transferred from one object to another, some transferred energy is likely to go into heat.	• identify the energy increases and energy decreases for an interaction in general terms. • describe "intended" energy transfers and transformation and "unintended" energy transfers and transformations.	• People have invented ingenious ways of deliberately bringing about energy transformations that are useful to them. BSL (SFAA) 8C/M8** (6-8) • Energy is required for technological processes such as taking apart, putting together, moving around, and communicating. BSL (SFAA) 8C/M7** (6-8) • Use examples of energy transformations from one form to another to explain that energy cannot be created or destroyed. MLR D3 (6-8) i

Lesson Matrix

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Lesson 5: Modeling Energy Efficiency *(4-5 sessions)* Students construct model water wheels using simple materials. Students test the water wheels comparing how efficiently each uses available energy.	• Water can be used as an energy source. Water's energy can make things happen. • Humans have purposefully used (engineered) energy transfers and transformations to accomplish tasks that improve the quality of life. • Technological design involves using scientific principles to solve problems. • Predicting, observing, designing, building, testing, analyzing, and retesting are all parts of technological design. • Things that are energy efficient use less energy to do the same task. Energy efficient devices minimize or redirect unintended energy transfers and/or transformations.	• describe how water can be used as an energy source. • describe examples of purposefully engineered energy transfers and transformations. • describe a "intended" energy transformation and an "unintended" energy transformation using the context of a water wheel. • recognize that energy efficient devices use less energy to do the same task.	• Whenever energy appears in one place, it must have disappeared from another. Whenever energy is lost from somewhere, it must have gone somewhere else. Sometimes when energy appears to be lost, it actually has been transferred to a system that is so large that the effect of the transferred energy is imperceptible. BSL4E/M1* (6-8) • Transformations and transfers of energy within a system usually result in some energy escaping into its surrounding environment. Some systems transfer less energy to their environment than others during these transformations and transfers. BSL 8C/M1* (6-6) • 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. BSL 4E/M2* (6-8) • People have invented ingenious ways of deliberately bringing about energy transformations that are useful to them. BSL (SFAA) 8C/M8** (6-8) • Use examples of energy transformations from one form to another to explain that energy cannot be created or destroyed. MLR D3 (6-8) i

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Lesson 6: Energy Transfers and Efficiency in Large-Scale Energy Generation *(3-4 sessions)* Students analyze the way they personally use energy and begin to examine energy use on a much larger scale. Students discover how reliant all sectors (residential, commercial, industrial, transportation) are on electricity and fossil fuels as energy sources. As they investigate the energy transfers involved in the generation of electricity, students consider the efficiency of the transfers involved in the process.	• In order to meet increasing energy demands, people in Maine must utilize the potential energy in various sources in the most efficient ways they can. • Examining the efficiency of the transfers and transformations involved in electrical generation methods further supports the notion that the energy decisions people make have benefits and drawbacks.	• analyze and determine energy use trends for themselves, on Maine, and on the nation. • examine the efficiency of the energy transfers and transformations common to prominent electrical generation methods. • begin to consider the cumulative effects of the energy decisions people make daily.	• Transformations and transfers of energy within a system usually result in some energy escaping into its surrounding environment. Some systems transfer less energy to their environment than others during these transformations and transfers. BSL 8C/M1* (6-8) • Different ways of obtaining, transforming, and distributing energy have different environmental consequences. BSL 8C/M2 (6-8) • Electrical energy can be generated from a variety of energy resources and can be transformed into almost any other form of energy. Electric circuits are used to distribute energy quickly and conveniently to distant locations. BSL 8C/M4* (6-8) • Energy from the sun (and the wind and water energy derived from it) is available indefinitely. Because the transfer of energy from these resources is weak and variable, systems are needed to collect and concentrate the energy. BSL 8C/M5* (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)

Lesson Matrix

Overview	Key Ideas	Lesson Goals Students will:	Connection to Learning Goals from • ***Benchmarks for Science Literacy* (BSL)**, • ***National Science Education Standards* (NSES)**, • ***Maine Learning Results* (MLR)**, • **and *Science for All Americans* (SFAA)**
Lesson 7: Watt's in a Name(plate)? *(1-2 sessions)* In this lesson, students determine how much electricity a particular device uses by reading electric name plates and using Kill A Watt meters that monitor electrical consumption. They discuss the cumulative effects of parasitic or phantom loads and strategies to minimize and/or eliminate them.	• Many devices have parasitic or phantom loads even when switched "off." • Parasitic or phantom loads cumulatively have a significant impact on overall energy consumption. • Connecting devices that have parasitic/phantom loads to power strips and turning the strips completely off when a device is not in use and purchasing ENERGY STAR certified appliances are two strategies that can be used to reduce energy use.	• be able to determine the number of Watts an electrical device uses by reading the device's electric nameplate. • give an example of a parasitic or phantom load. • describe the cumulative effects of parasitic or phantom loads. • suggest strategies to eliminate or minimize parasitic or phantom loads.	• All technologies have effects other than those intended by the design, some of which may have been predictable and some not. BSL 3B/M2a (6-8) • Use statistics to summarize, describe, analyze, and interpret results. MLR B1(6-8) c • Use a variety of tools and technologies to improve investigations and communications. MLR B1 (6-8) e

Energy For Maine

Lesson Matrix

PowerSleuth
Maine Energy Education Curriculum

Overview	Key Ideas	Lesson Goals Students will:	Connection to Learning Goals from • ***Benchmarks for Science Literacy (BSL)***, • ***National Science Education Standards*** **(NSES)**, • ***Maine Learning Results (MLR)***, • **and** ***Science for All Americans (SFAA)***
Lesson 8: Energy: We're All Connected — Energy Knowledge into Action *(4-6 sessions)* 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 in action through the development of a culminating display intended to makes others aware of the pervasive connections people have to energy and its use.	• 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.	• 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 the reason for doing so. • create a product that will make others aware of an individual's connections to energy and actions for conserving energy.	• 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 (SFAA) 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 (SFAA) 8C/H8** (9-12)